Working Paper Series
GRINCOH
Growth-Innovation-Competitiveness
Fostering Cohesion in Central and Eastern Europe

Serie 2
International economic relations
of the CEE countries

Paper No. 2.12

Regional growth dynamics in the new EU member states – The role of FDI and human capital

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2014

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This paper was funded under the FP7 project "Growth– Innovation – Competitiveness: Fostering Cohesion in Central and Eastern Europe (GRINCOH)" under the Programme SSH.2011.2.2-1: Addressing cohesion challenges in Central and Eastern Europe; Area 8.2.2 Regional, territorial and social cohesion. Project Nr. 290657

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Please cite as:
Völlmecke D., Marek P., Jindra B., (2014), 'Regional growth dynamics in the new EU member states – The role of FDI and human capital', GRINCOH Working Paper Series, Paper No. 2.12

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Abstract

This study examines regional GDP per capita income convergence for a sample of 269 EU-regions, and separately for a subsample of 59 CEEC regions between 2003 and 2010. By applying a Markov Chain approach to a new dataset that exploits micro-aggregated sub-national FDI statistics, the analysis provides insights into regional income growth dynamics. We use an endogenous broad capital model based on FDI agglomeration economies and human capital related technological accumulation. Our results indicate a weak process of overall income convergence among all EU regions. This does not apply to dynamics within the sub-sample of CEEC regions, where we find evidence of a "poverty trap" for CEEC regions in the lower end of the income distribution. In contrast to FDI, human capital on its own seems to be associated with higher income levels. Moreover, we find a positive interaction of FDI and human capital in their relation with income growth dynamics.

Content

1. Introduction

Regional disparities in per capita output and income have been a concern of the European Community (EC) since its inception. The objective of reducing income disparities across regions has been challenged by several waves of European integration as well as trade liberalization following the single market program. More recently, the Community has strengthened its aim of reducing regional income differences by implementing the European Union's (EU) Regional Policy in order to promote a higher degree of competitiveness and convergence in economic performance among regions.

A growing body of literature focuses on the EU's per capita income distribution at the sub-national level, regional convergence and the process of "catching-up" by less advanced regions. Some empirical studies suggest the existence of convergence in all European regions (Fingleton, 1997, 1999; Lopez-Bazo et al., 1999; Votteler, 2004), while others show evidence of regional GDP disparities and the formation of convergence clubs or multiple equilibriums within the income distribution (Lopez-Bazo et al., 1999; Ertur and Le Gallo, 2003; Canova, 2004; Le Gallo, 2004).

Given the existence of marked income disparities across European regions, governments, those of Central and East European transition countries in particular, have designed policies that use various incentives to attract foreign direct investment (FDI) to promote the catch-up in growth. Motivated by an endogenous growth framework (Romer, 1986; Lucas, 1988), the accumulation of FDI is regarded as an important growth driver that triggers technological processes, resulting in productivity spillovers. The positive impact of FDI on economic growth seems almost to have acquired the status of a stylized fact (Campos and Kinoshita, 2002), although the empirical evidence is ambiguous (Alfaro and Rodriguez-Clare, 2004; Görg and Strobl, 2001; Glass et al., 2001; UN/ECE, 2001; Lipsey and Sjöholm, 2005). There are concerns that positive knowledge spillover, predicted by an endogenous growth framework, does not occur in developing or transition countries. This could be linked to the negative effects of FDI, for example, through a "crowding out" of domestic investment (Agosin and Mayer, 2000). The impact of FDI seems to depend on a variety of economic and political conditions in the host country, such as the level of per capita income, the degree of openness in the economy and the human capital in science and technology (Herzer et al., 2006).

With regard to the latter, as early as 1969 Griliches (1969) emphasized the complementarity between human capital and private physical capital that affects productivity growth and economic performance. Arguably, human capital endowment favors the development and absorption of technology. It accelerates the rate of technological change through investments in education, workforce skills, scientific knowledge and social institutions (see Acemoglu, 1998, 2003; Benhabib and Spiegel, 1994, 2005; De la Fuente and Da Rocha, 1996; Nelson and Phelps, 1966). According to Klenow and Rodriguez-Clare (2005) and Mamuneas et al. (2006), the regional growth differentials are determined less by the pure endowment of human and physical capital as growth factors than by the relation between these productive factors and their externalities.

Against this backdrop, our paper contributes to the discussion on whether long-term per capita income growth paths are affected by the accumulation of FDI. In so doing, we assess the complementarity of FDI and human capital as determinants of income convergence dynamics. We investigate the association of both factors with regional per capita growth paths for 269 European regions (NUTS2) during 2003 and 2010. Although some studies in the research field of European regional convergence identify certain clubs of CEEC regions that tend to grow faster than Western

European regions, we design a second sub-sample of 56 CEEC regions for two reasons. Firstly, in order to analyze the catching-up process by CEEC regions compared to the whole EU sample over the period, and secondly, to gain additional insights into the extent of endogenous growth in newly integrated transition countries over time. We exploit a unique micro aggregated data set for EU NUTS2 regions that allows us to overcome the scarcity of regionally disaggregated data on FDI.

Research on regional convergence emphasizes the importance of capturing intra-distribution dynamics, since the relative position of regions can change over time. According to Quah (1997), more important than changes in the external shape are the movements within this particular distribution that explain intra-distributional dynamics and a catching-up process. We apply a Markov-chain approach to examine income distribution dynamics that rely upon the concept of computing transition matrices, which provide information about the stationary probabilities of transition from one income state to another. Following Quah (1996a, 1996b, 1996c, 1996d), the estimation of transition matrices provides information on the convergence behavior of an entire income distribution and offers detailed insights into the growth dynamics of income classes within the distribution.

We find a weak process of overall GDP per capita income convergence in all EU regions during the observation period. The findings for CEEC regions suggest a "poverty trap" for poor regions in lower income classes. Furthermore, our results indicate that higher FDI stocks as such are only weakly positively associated with higher long-term GDP per capita growth rates in both the EU and the CEECs regions. In contrast, we find higher long-term GDP per capita growth rates in regions with above average human capital endowment independent of their FDI stocks. However, we find support for strong complementarity between FDI and human capital. This indicates the existence of domestic as well as foreign-led regional growth patterns in the EU.

The structure of this study is organized as follows: section 2 reviews the economic theory of regional convergence in GDP per capita income, with an emphasis on the role of FDI and human capital. In addition, we provide an overview of the state-of-the-art in European convergence, including an outline of the role of FDI in regional economic performance as well as an introduction to the Markov chain approach. Section 3 introduces the dataset employed. Section 4 presents the results from the empirical investigations, which are discussed in more details in section 5. Section 6 provides conclusions.

2. Theory and literature review

2.1 Review of economic theory of endogenous growth patterns

The economic notion of catching-up, and the accompanying process of convergence, depends upon underlying theoretical assumptions. In standard neo-classical growth models with diminishing returns to capital (Solow-type), an exogenous increase of FDI extends the amount of capital and income per capita only temporarily, while diminishing returns have only short-term growth effects towards a steady state. The impact of FDI on long-term growth rates in this model is determined solely by the exogenous given frequency of technological processes in economic growth. The determinants of a FDI-led technological growth process are not specified.

Likewise, endogenous growth models have been motivated by this theoretical inability of neo-classical models to explain the dynamic growth impact of cross-country long-term growth. The seminal contributions by Romer (1986; 1994) and Lucas (1988) identify innovation, invention and creation as the main engines of growth. The growth dynamics of the endogenous models are generally characterized by the assumption of constant returns to the set of reproducible factors in the production function.

According to Martin and Sunley (1998), the theory of the endogenous broad capital model introduces two explanations for FDI promoted long-term growth by augmenting the existing stock of knowledge in the host economy. The first subset is based on the presence of external capital economies associated with FDI agglomeration economies (and local human capital). Economic geography has emphasized the importance of increasing returns to capital accumulation and raises the issue of the extent to which these returns are spatially localized. In the New Economic Geography (NEG) initiated by Krugman (1991) the importance of a number of endogenous factors that may attract foreign investors to a particular location has emerged – agglomeration economies, geographical proximity and the pooling of production factors. Krugman (1998) further suggests that internal economies of scale, combined with low transportation costs will lead to a geographical concentration of the same industrial activity.

With regard to an earlier stream of agglomeration economies, Marshall (1890), Arrow (1962) and Romer (1986) stress the importance of external economies of scale (MAR-Externalities). This approach assumes that firms in the same industry benefit from localized economies by requiring similar input factors, technology and types of workers. In contrast to the MAR externalities, Jacobs (1969) argues that firms could also benefit from externalities that arise from "urbanization economies", generated by the spatial concentration of firms supplying different goods and services (Jacob's externalities).

As far as agglomeration forces are concerned, some papers have considered dynamic externalities as a factor in explaining the growth of industries across cities. According to Glaeser et al. (1992), industry growth in cities can be enhanced through urbanization externalities as well as through knowledge spillovers that affect the overall level of economic growth occurring in a city. In this context, several studies find evidence for the causation of city size and localized economic activities.[1] Moreover, Behrens and Robert-Nicoud (2008) have found that income inequalities increase with the size of urban agglomeration economies. As a consequence of the self selection of productivity ("survival of the fittest") in cities, large urban areas are more productive and more polarized in specific sectors.

There have been numerous empirical investigations that stress the importance of agglomeration in local industrial structures in attracting foreign investors. Some contributions suggest that FDI tends to agglomerate even more than domestic investments (see Shatz and Venables, 2000). Furthermore, Head et al. (1999) and Procher (2011) observe that investors from the same home country choose to agglomerate more often than investors from different countries. With respect to the effects of agglomeration on FDI in European economies, the empirical literature reports homogenous results. For example, Wren and Jones (2011, for British regions) as well as Guimaraes and Figuseiredo (2000, for regions in Portugal) show the importance of agglomeration economies in the regional location

[1] On the relationship between city size (or population density) and productivity, see Sveikauskas (1975), Ciccone and Hall (1996), Syverson (2004) and for a survey, Rosenthal and Strange (2004). For empirical evidence of city size and worked hours that result from agglomeration see Rosenthal and Strange (2008). Verification of innovation and growth in cities is offered by Henderson et al. (1995) and Glaeser et al. (1992).

choice of FDI investors. The location of FDI across regions is significantly related to the classical location factors that affect a firm's revenue (per capita income, distance and knowledge), its costs (availability of skilled and unskilled labour) and its prospects (growth and risk factors). There seems thus to be evidence that specialization and sector density at the regional level attract further FDI investors. In the case of British regions, Wren and Jones (2011) argue that agglomerated manufacturing industries act as an important magnet for further FDIs in the same sector, although the power of agglomeration effects depends on specific industry traits.

The second subset of broad endogenous capital models is associated with the complementary relationship between various productive factors, in particular between human and physical capital. According to this second explanation, the works of Romer (1990) and Aghion and Howitt (1992) identify human capital as an endogenous driver of technological process. The endowment of human capital favors the absorption of technology and accelerates the rate of technological change in the host economy. If technological change is linked to intensive investment in (foreign) physical capital related to a qualified workforce, Romer (1990) speaks of a positive relationship between human and physical capital through "learning by doing" and "knowledge spillovers".

As a complement to this model, there has been a further consideration of endogenizing technical progress via the impact of human capital on knowledge creation (see e.g. Romer, 1990; Barro, 1991; Aghion and Howitt, 1992; Gemmell, 1996; Jones, 1996). A major contribution of these models is that knowledge is considered as a public good that can generate inter-temporal and -sectoral as well as international and interregional externalities.

Barro (1991) contends that a higher level of education increases the capacity to adopt foreign technologies and thus reduces the "knowledge gap" between technology "leading" countries or regions and those that are lagging behind. That is why technologically backward countries may be able to catch up if they have a larger stock of well educated workers (see e.g. Nelson and Phelps, 1966; Benhabib and Spiegel, 1994). This coincides with the model provided by Jones (1996), which incorporates human capital as an input in the creation of new ideas, or so called intermediate goods. Characterized by their non-rival character, intermediate goods can spill over to firms and regions, which have invested in the education of workers. Essentially, the level of education of workers (that is, human capital) can be determined as a further ingredient of knowledge creation, which is the basis for the advancement and diffusion of technology that will foster a catch-up process.

2.2 Existing insights into the EU and CEECs gained from empirical investigations

In following our first objective of examining the EU's regional income growth paths and the potential catching-up process in CEEC regions, we found that the empirical issue of European convergence has been widely investigated and that the findings have been manifold. The majority of these studies have found some evidence of convergence for all European regions, but a further "poverty trap" for CEEC regions that will remain poor over time (Le Gallo, 2004). Another stream of empirical work mentions the hypothesis of a "club convergence", where only a certain club of regions will converge at a similar steady state value (Quah, 1996d; Gorzelak and Jalowiecki, 2002). With respect to our estimation technique, the Markov chain method is a tool used commonly to examine the per capita income convergence process. Through the estimation of transition matrices, it can be hypothesized whether regions of a certain income class move along the income distribution or remain in their income stage. This sub-chapter focuses on empirical evidence obtained by this method to allow a better classification of our results.

Persistence in regional disparities and a possible poverty trap are an issue in the study by Neven (1995), who analyzes European convergence for 108 regions over the period 1980—1989, separating it into two sub-periods (1980–85 and 1985–1989). Neven finds only weak mobility for regions in changing their income classes by output per capita. Regarding the two designed sub-periods, Neven's work reveals that extreme classes in the distribution are reduced and that there is an increase in mobility between these classes. This is confirmed by the work of Carrington (2006), who also finds a fairly high persistence in income classes over the period 1984–1993, but observes an increase in the mobility pattern in low income classes for the 1980s. These results are similar to those in a study by Quah (1996b), who summarizes it thus: "regional income distribution is converging towards a tighter distribution"[2].

The notion of a poverty trap has also been investigated by Lòpez-Bazo et al. (1999), using similar data on GDP per capita for the same set of regions in the period 1980–1992. These authors argue that the dynamics of changing income classes are stronger in the upper tail of the distribution, while their estimations reveal only a "lack of convergence (…) from the group of the poorest regions"[3]. Moreover, they maintain their results by dividing the time period into two sub-periods (1980–1985 and 1985–1992) and find convergence solely for the upper income classes with an above-average GDP per capita in the early 1980s. In line with Neven (1995) and Lòpez-Bazo et al. (1999), Le Gallo (2004) also addresses a "limited poverty trap" for poor regions that are likely to remain poor in the future. LeGallo (2004) estimates Markov chains to examine convergence among 138 European regions. He points out that regional disparities in GDP per capita were persistent during the period from 1980 to 1995 and that the relative position of a region in the income distribution is strongly affected by the economic development of its neighboring regions. Moreover, LeGallo finds only weak transition mobility for poor regions in the GDP distribution and highlights a progressive bias towards a "poverty trap" for regions that lag behind.

In contrast to these findings, Castro (2003) provides evidence for a stronger convergence in European regions. He reports a high mobility between seven income classes for the period 1980–1996. Forty-one percent of the EU-12 regions have moved from one level to another over time and if they change, they will rise to the closest one. In this sense, Magrini's paper (1999) also supports empirical evidence of convergence as "the distribution has converged towards middle income classes"[4].

With regard to the findings discussed above, the results suggest that regional income inequalities have persisted over time and, more importantly for the focus of this study, the mobility of change between income classes exists only within certain sub-groups of regions. Quah (1996c) was the first to study the dynamics of (cross-regional) income distributions by emphasizing the features of persistence, immobility and polarization between the classes of per capita output, exemplified by the "convergence club" hypothesis.

From an endogenous growth perspective, convergence clubs are created by the different initial values of human capital and knowledge in production, leading to multiple state equilibriums (Galor, 1996). In this context, a number of studies of European regions have stressed this phenomenon and have found strong evidence for the existence of persistent economic disparities and the formation of

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[2] Quah, (1996b), p.955.

[3] Lòpez-Bazo et al. (1999), p.357.

[4] Magrini (1999), p.268.

convergence clubs (see e.g. Canova, 2004; Bartkowska and Riedl, 2012). Furthermore, Gorzelak and Jalowiecki (2002) document a distinct boundary for convergence clubs in Central Europe, separating Western European regions from Eastern Europe.

The club convergence hypothesis has been researched in a number of empirical studies. The literature takes convergence clubs into account when certain regions of the income distribution converge to a similar steady state value. Preliminary work in this area has been done by Quah (1996c, 1996d), who reveals, from a neoclassical point of view, that the dominant features of cross-country income dynamics are persistence, immobility and polarization.[5] According to these findings, convergence clubs appear at the high and low ends of income distribution, with a vanishing middle class. In several studies, Ben-David (1994, 1998) analyses the incidence of world income gaps between countries from a neoclassical perspective and also finds evidence for the existence of convergence clubs at the ends of the income spectrum.

With respect to the second objective of our study, that is to quantify the FDI-led growth determinants at a regional level, empirical evidence on EU regions' performance is, at least to our knowledge, quite scarce. While existing works generally concentrate on the regional location choices of FDI rather than on its effects on growth and productivity, our study aims to discover whether regional income performance is affected by higher initial FDI stocks and the human capital formation in science and technology.

Following the concept of Mankiw, Romer and Weil (1992), FDI is assumed to be more productive than domestic investments since FDI encourages economic growth by the incorporation of new technologies (i.e. R&D and human capital) in the production function of the host economy. According to this view, FDI-related technological spillover is able to trigger long-term growth in host economies. As Borensztein et al. (1998) argue, the intensity of spillovers varies across host economies and depends chiefly on the capacity of domestic firms to adopt superior technologies. Thus, through capital accumulation and knowledge spillover, FDI plays an important role in economic growth.

When the positive impact of the FDI-growth relationship is considered at a sub-national level, empirical evidence is ambiguous. While Mullen and Williams (2005) and Mayer-Foulkes and Nunnekamp (2009) argue that the effects of FDI on growth through productivity and knowledge spillovers are not affected by the geographical dimension of the economic unit being considered, Girma and Wakelin (2001) claim that FDI-related spillovers are assumed to be localized and to benefit primarily those regions that are able to absorb the knowledge spillover where FDI is located. If the host region does not possess the capacity to absorb the knowledge and the incorporated technology, FDI carries the risk of crowding out domestic investments and of harming regional economic performance.

Ali (2013) shows that in the catching-up process in Malaysian regions, the intensity of FDI inflow is positively and strongly related to GDP per capita income. By applying a regression model to 28 years of observation, he finds that regions with higher levels of FDI flow are also linked to higher income growth rates. Since a favorable foreign investment climate tends to be concentrated in developed

[5] Following Quah (1996d), the concept of convergence clubs is an alternative to β-convergence. Its basic premise is that countries with different long-term income levels segment into clubs which converge into their individual steady states. Since these convergence clubs describe a situation of imbalance in the income distribution, Quah describes this alternatively as a state with "twin peaks" of income distribution.

regions, the lower rates of FDI and GDP in backward regions have widened the regional disparities. Thus, the increase in FDI inflow reinforces the catching-up process in less developed regions towards a common steady state. Moreover, Bode and Nunnekamp (2010), in investigations in the US, have found that states with a high FDI density have a greater chance of being “rich” in the long term, while “poorer” states will remain so and will diverge from the national per capita income average.

Despite these potentially negative effects, the empirical evidence generally suggests that FDI has a positive impact on economic growth. In terms of post-transition countries, Nicolini and Resmini (2010) find evidence for positive spillover from FDI in Romania and, to a lesser extent, in Bulgaria from 1998–2003. Similarly, the surveys of Lim (2001) and Hansen and Rand (2006) also suggest that FDI has a positive effect on economic growth in developing countries, while the existence and degree of the impact depends on a variety of economical and political conditions in the host country, such as the level of per capita income, the degree of openness in the economy and the human capital in science and technology (Herzer et al., 2006).

Several studies have investigated the amount and significance of regional human capital in technical progress in terms of economic growth rates. With respect to the application of more advanced technologies, Nelson and Phelps (1966) show that the host economy requires the presence of an adequate level of human capital. The stock of human capital in the host country defines the absorptive capacity of a developing country. Benhabib and Spiegel (1994) indicate that human capital affects the growth of total factor productivity and they find positive evidence for the relation between human capital stock in levels and growth of per capita income. Correspondingly, Bassanini and Scarpetta (2001) report a positive and significant impact of human capital accumulation on output per capita in OECD countries. Their results support endogenous growth models, with constant returns to scale of broad human and physical capital.

2.3 Research Hypotheses

Drawing on the endogenous growth theory and previous findings, this study examines regional income convergence for the sample of all EU regions, and separately for the sub-sample of CEEC regions. In addition, the empirical analysis tests the impact of FDI agglomeration economies coupled with human capital-related technological accumulation on regional per capita income growth rates. FDI stocks are an important vehicle for the transfer of technology, but the higher productivity of foreign companies holds only when the host country has a minimum threshold stock of human capital. According to the endogenous broad capital model, higher densities of FDI and human capital stocks positively affect the long-term growth and output of regions that lag behind in catching up with richer regions in the income distribution.

The previous section illustrates the findings on regional income convergence for the EU since the 1980s. In general, the investigations report a slight move towards income convergence with only weak transition mobility for all EU regions within the income distribution (see e.g. Le Gallo, 2004). A large number of studies on European convergence also find evidence of a strong persistence among regions in lower income classes to remain poor over time (Neven, 1995; Gorzelak and Jalowiecki, 2002; Le Gallo, 2004). However, most of these studies analyze only Western EU regions while empirical evidence for CEEC regions is particularly scarce.

For this reason, our first hypothesis deals with the question of whether it is possible to detect a convergence process in GDP per capita growth rates for all European regions over the period from

2003 to 2010. By applying the Markov chain approach, we contribute to the investigation into how income distribution dynamics have changed explicitly over time, particularly if we pay special attention to the CEEC regions catching up with the EU-15 regions.

Since Krugman (1991) and Vernables (1996) emphasize the importance of agglomeration economies in regional development, the theory of new economic geography suggests that foreign owned firms will concentrate in those regions in close proximity to other foreign firms and economic activities closely related to their production. The positive benefits from FDI spillover will affect regional income growth in two ways: First, according to Hirschman (1958) and Markusen and Venables (1999), spillover to domestic firms are usually associated with closer client and supplier relationships (vertical spillover). Second, Mansfield and Romeo (1980) as well as Dunning (1993) observe that local competitors also profit from demonstration effects in production and the access to new technologies (horizontal spillover). In keeping with Findlay (1978) and his technology gap hypothesis, the potential growth effects of FDI are greater the bigger the difference in technological development. In the context of empirical evidence of the benefits from FDI-induced productivity spillovers, a number of surveys argue that the growth effects of foreign investments have been neutral or negative, especially in the case of transition countries (Gorg, 2001, 2006; Lipsey and Sjöholm, 2005). In contrast, Nicolini and Resmini (2010) find significant FDI-induced spillover in Romania and, to a lesser extent, in Bulgaria.

This leads to the second hypothesis, which deals with the effects of accumulated FDI on the whole economic growth performance of a region. The greater endowment of regions with high initial FDI stock is positively associated with the probability of accomplishing long-term growth within the income distribution.

The underlying rationale of hypothesis three is that growth and catching up are more likely to occur if foreign capital accumulation, in terms of foreign employees, is coupled with the accumulation of technology. Technological accumulation refers to the gradual building up of largely intangible assets that are reflected in the skills of the workforce and the design of capital equipment (Cantwell, 1989). In an endogenous growth framework, a higher level of human capital is expected to stimulate the economic performance of regions via increasing returns on physical capital. According to Nelson and Phelps (1966), Acemoglu (1998, 2003) and Glaeser and Resseger, 2010), greater human capital endowment favors the absorption of technology, making the rate of technological change faster if this change is related to intensive investments in new private physical capital.

This stream of literature formulates our third hypothesis, which deals with the complementary relationship between physical and human capital accumulation. More specifically, we test two hypotheses. Firstly, the potential of knowledge spillover, in terms of highly skilled human capital, to affect the FDI-led income growth of a region positively. Secondly, whether this underlying rationale is positively associated with a catching-up process in CEEC regions in post-transition economies.

3. Research method and data

3.1 The Markov chain approach

The traditional concept of income convergence originates from a neoclassical growth model and has been investigated by the use of two cross-section regression parameters: β- and σ-convergence (see e.g. Barro and Sala-i-Martin, 1991a; 1991b; 1995). While the estimation of these two regression coefficients can represent the average behavior of distribution dynamics, it does not offer any insights into the specific behavior of the entire distribution.The Markov chain approach introduced by Quah (1993a; 1993b) focuses on the investigation of the entire dynamic of the income distribution instead of the external shape or a single convergence parameter. The approach follows the basic idea of specifying a vector of state probabilities that represents the probability of moving up or down in the income hierarchy and being a member of a particular income class in a given year (Rey, 2001). The process of estimating transition probabilities is assumed to be memoryless and time invariant for every transition across economies. Quah (1996a) suggests in addition that the Markov chain method is a more flexible empirical strategy used to reveal information on how the entire distribution evolves over time. Fingleton (1997) also emphasizes the point that the Markov approach accounts for economic shocks and discontinuities, which are specific to the region of interest, and for regional dynamics rather than the smooth progression of a steady state implied by the neoclassical approach.

As far as previous results of convergence analysis by the Markov chain method are concerned, only a few researchers have addressed the issue of FDI as a component conditioning regional growth rates. Following the work of Bickenbach and Bode (2003) and Bode and Nunnenkamp (2010) using the Markov chain approach for growth effects of FDI on income rates for US regions, the empirical analysis in this study accounts for the effects of FDI and human capital on income between European regions. With regard to this functional form of FDI and income growth, the estimation of transition probabilities allows us to capture the dynamics within the income distribution and furthermore to draw several inferences from the interaction of FDI share in regions and economic convergence in GDP per capita.

The design of the estimated transition matrices can be constructed in several ways to model the regional relation between capital stocks and the evolution of GDP per capita income over time. The empirical analysis follows the idea of estimating separate Markov transition matrices for M sub-samples of $r \in R$ European regions with differing FDI stock levels. Furthermore, we will investigate the extent to which the relation between FDI stocks and income growth differs across the sub-samples.

In the following section, we provide a formal exposition of Markov chains, drawing from existing research (see e.g. Fingleton, 1997; Magrini, 1999; LeGallo, 2004; Bickenbach and Bode, 2001; and Bode and Nunnenkamp, 2010).

In the case of the distribution of per capita income across European regions, the empirical analysis will consider a finite first-order Markov chain with stationary transition probabilities. As illustration, the relative GDP per capita is denoted for regions *r* (= 1, 2,…, R) at each point in time *t* (= 0, 1, 2,…) and follows a state space of *N* ordered and non-overlapping income interval classes. Supposing an income condition by a region *r* at time *t*, $s_i(t)$ denotes the share of the R region in income class *i* (϶ *N*), where $s_i(t) \geq 0$ and $\sum_i s_i(t) = 1$. Then the Markov approach assumes that for a region in income class *i* at time *t* the transition probability $p_{ij}(t)$ of being a member of income class *j* at time *t*+1, with *j* ϵ *N*, $p_{ij}(t) \geq 0$ and $\sum_j p_{ij}(t) = 1$.

Following the *law of motion* used by Quah (1993b), it is typically assumed that the transition probabilities are time homogenous of order 1, such that $p_{ij}(t) = p_{ij}$ is considered for all *t*. By satisfying this relation for all classes, regions and points in time, the process can be called a discrete Markov chain and simply means that the probability of a region being in a certain income class *j* depends only on its present situation *i* (at time *t*). Correspondingly, the transition probability of a region is independent of the past history of the region, what is typically called the Markov property (Geppert and Stephan, 2008). However, the further derivation of time-homogeneity by the *law of motion* states that there is an *N x N* row standardized transition matrix Π_M, which reports the transition probability of elements p_{ij} in each cell, such that the regional income distribution at time *t* is given by the row vector $S(t) = (s_1(t), s_2(t), \dots, s_n(t))$. Under these conditions the process of transition between regional income classes $S(t+1)$ at time *t*+1 can be described as:

$$S(t+1) = S(t)\Pi_M = S(0){\Pi_M}^t.$$

Since the Markov chain process can be considered to be time-invariant, the (N x N) Markov transition matrix $\Pi_M$can, with regard to above conditions, be formally noted as:

$$\Pi_M = \begin{bmatrix} p_{11|M} & p_{12|M} & \cdots & p_{1N|M} \\ p_{21|M} & p_{22|M} & \cdots & p_{2N|M} \\ \vdots & \vdots & \ddots & \vdots \\ p_{N1|M} & p_{N2|M} & \cdots & p_{NN|M} \end{bmatrix}$$

summarizing all N^2 transition probabilities $p_{ij|M}(i, j = 1, \dots, N)$. Moreover, $p_{ij|M} \geq 0, \sum_{j=1}^{N} p_{ij|M} = 1$ describes the dynamics of the Markovian process over time by the initial distribution $s_M(0)$:

$$s_M(0) = (s_{1|M}(0), s_{2|M}(0), \dots, s_{N|M}(0)),$$

with $s_{i|M}(0) \geq 0, \sum_{i=1}^{N} s_{i|M}(0) = 1$. The probability elements $p_{ij|M}$ of the transition matrix Π_M represent the probability of a European region in sub-sample M either of remaining in the initial income class or moving up/down to income class j at any time t+1. In illustration, the second row of the transition matrix indicates the probability that a member of the second income class (i=2) will stay in the same class (p_{22}), descend into the lowest income class during one transition period (p_{21}), move up into the next income class (p_{23}) or possibly move two classes upward (p_{24}). If a region has once moved to another income class, it will behave according to the transition probability relevant to that class.

Providing the Markov transition matrix is regular, if all entries of the matrix Π_M are positive, the steady state equilibrium of regional incomes S^* can be derived if the distribution converges to a limiting (or "ergodic") distribution S_M^*. This limiting distribution can be reached after k transition periods and is independent of the initial distribution of regional incomes at time t=0:

$$s_M^* = \lim_{k\to\infty} s_M(0)\ \Pi^k = \lim_{k\to\infty} \Pi_M^k.$$

Consequently, the limiting distribution of shares in per capita income $S = (s_1, s_2, \dots, s_N)$ records the included information of the (N x N) transition matrix into a single (1 x N) row vector and identifies the steady state to which the distribution converges after a sufficient amount of k transition periods. By compromising the limiting distribution s_M^* with the initial distributions$s_M(0)$, it is possible to reveal whether a system of regions converges, diverges or possibly does neither. Hence, if $s_M^* > s_M(0)$ in the median class (es) but $s_M^* \leq s_M(0)$ in higher and lower income classes it suggests convergence; the contrary suggests divergence.

To sum up, the transition probability matrix provides a well suited non-parametric approach in providing a more detailed insight into the entire income distribution within a system of regions. In contrast to the neoclassical model and convergence regressions, the discrete approximation of crosssectional distributions determines N^2 transition probabilities, which form a matrix Π_M. This matrix exploits information on the regional dynamics of the income distribution of the sample in several ways: Firstly, the transition matrices offer a concrete probability of whether a region of a certain class will move to other income classes in the given time horizon. Secondly, by providing a regular transition matrix, the assignment of the limiting (ergodic) distribution can reveal whether a process of convergence or divergence exists across the economic system. Indeed, a number of authors (e.g. Fingleton, 1997; Magrini, 1999; Geppert and Stephan, 2008) note that the causal inferences drawing on the limiting distribution should be treated with some caution. In particular, the assumption of ever constant transition probabilities is not backed up by any empirical evidence. Instead of interpreting the limiting distribution as a definite forecast of long-term growth, it should be rendered rather as a hypothetical situation that will occur if the regional income patterns observed in the past persist. In this regard, the results obtained from the limiting distribution in the analysis will in the first place provide information on the 2003–2010 period and the near future, but not conclusively on long-term developments.[6]

Construction of the transition matrices

In order to identify a process of convergence or divergence in GDP per capita growth among European regions and separately for the CEEC regions, the dataset is further separated into the sub-samples m=1, 2. The first sub-sample investigates convergence among all European regions, while the second contains only CEEC member states in order to investigate the existence of the "club of convergence" phenomenon.

In creating these two sub-samples, the comparison of initial and limiting income distribution in each sub-sample can separately indicate whether evidence for the process of convergence exists. The inferences drawn from these estimations may be manifold. Firstly, the comparison of the limiting distributions across the *m* sub-samples might indicate whether the regions within an income group tend to be richer than others in the long term and face a higher probability of moving up into higher income classes. Secondly, the comparison of the initial and limiting distributions in the specific sub-sample may indicate whether the specific initial income gap of one sub-sample tends to increase or decrease more than the gap in the limiting distribution.

One of the major issues in estimating transition matrices relies on the concept of defining the per capita personal income classes (PCPI). This subject has been discussed in other studies (Geppert and Stephan, 2008; Eckey and Türck, 2006) and the empirical literature offers several approaches to the definition of cumulative and exclusive income stages. For the purpose of this study, the analysis will consider two systems of income class to confirm the dynamics of the estimated transition matrices: Firstly, the income classes are defined by the average growth rates of GDP per capita income in all regions of the sample. The observations for the initial and the final year of the transition are divided into the same number of classes. For the initial year 2003, the lower and upper bounds of the equally sized income classes are defined by the corresponding percentiles. Each sub-sample is divided into N = 5 income classes. In the complete EU sample, the first income class comprises the poorest regions with a PCPI of below 11150 € and the highest income class comprises those regions with an average PCPI of above 26750 €. The mean per capita income class falls into the third group, and ranges from

[6] Geppert and Stephan (2008), p.4.

18800 € to 21400 €.[7] The threshold levels for the period 2010 are defined by multiplying the initial threshold levels with the average growth rate of the regions in each (sub-) sample. In this concept, the move of a region to an upper/lower income class indicates that the region has experienced an income growth rate above/below average in comparison to the average regional growth rate.

3.2 Data

We employ information from 269 NUTS2 regions to analyze the effect of foreign physical capital accumulation and human capital accumulation on regional GDP per capita growth from 2003 to 2010.[8] The dataset is constructed by combining micro-aggregated regional FDI statistics from the AMADEUS database of the Bureau van Dijk with regional information on the GDP per capita growth rates and the current stock of human resources in science and technology occupations from Eurostat.

Micro-aggregated data

Balance of payment data on FDI is not available in a regionally disaggregated form. Thus, this study generates a unique micro-aggregated dataset based on information on the number, employment and turnover of firms with foreign ownership across NUTS2 regions in the EU27 between 2003 and 2010.

The study employs firm-level data drawn from Bureau van Dijk's AMADEUS Database. This database offers detailed information on the ownership structure of enterprises. This information allows the identification of assets that are owned by non-residents. A resident enterprise is considered to be foreign owned if a foreign shareholder holds at least 10% of the direct shares/voting rights or if the ultimate owner is foreign. In order to avoid the oversampling of firms from selected countries resulting from country specific differences in coverage, we include in the final sample only firms with at least 10 employees.

The original database consists of annual information about newly created and existing foreign firms covering the 2003–2010 period of the analysis. The period coincides with the two eastern enlargements of the EU and the due integration of 11 Central and Eastern European Countries (CEEC). The firm-level sample consists of 26 EU countries, including all 11 CEEC countries. The latter include Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia. The location of firms is disaggregated by the Nomenclature of the Territorial Units for Statistics of level two (NUTS2). The full sample includes 787,097 foreign firms located in 269 NUTS2 regions.[9]

Figure 1 indicates the relative growth rates of FDI stocks in terms of turnover generated by foreign firms during the observation period of 2003 to 2010. We find positive growth rates in foreign turnover in 185 regions, which generally confirms the results of the "International trade and FDI report" by EUROSTAT (2013). Whereas the growth in foreign turnover in Western Europe tends to be spread more evenly across all regions regardless of capital regions (excluding Spain and Portugal), the opposite seems to be true for CEECs. Growth in foreign turnover in the new EU member states seems

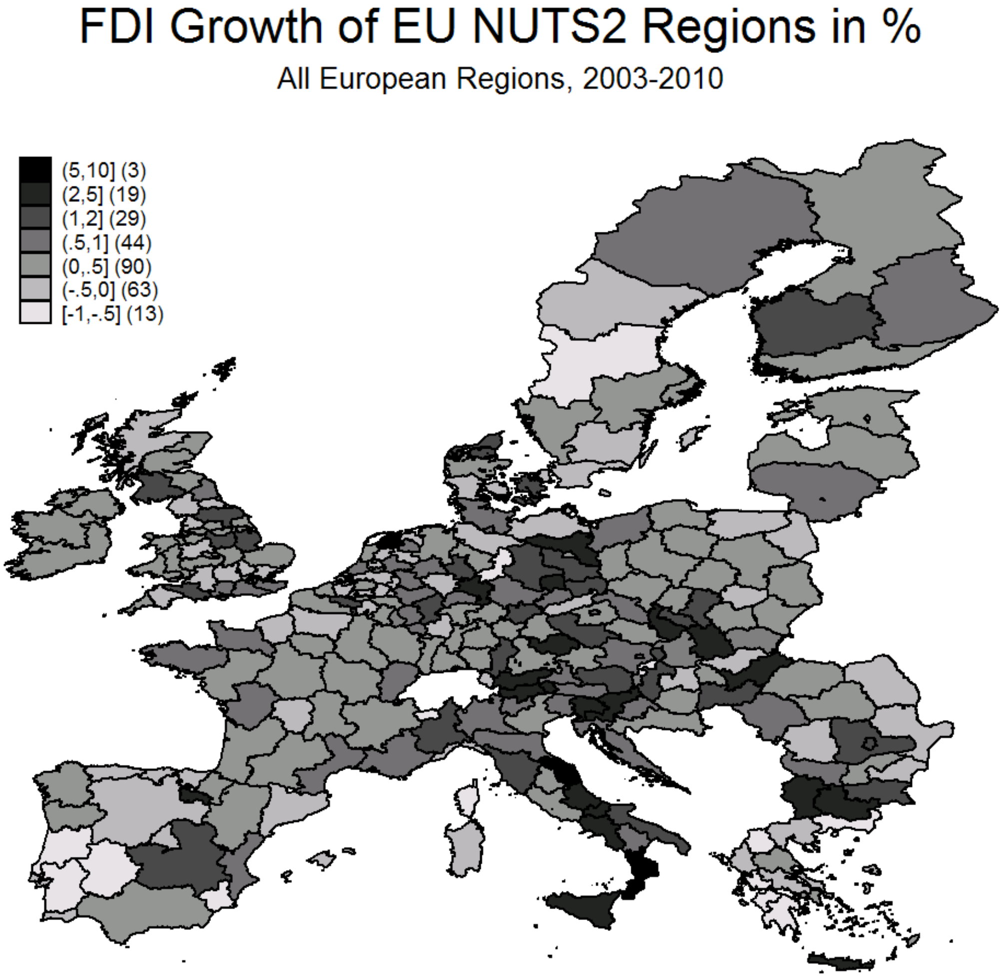
[7] Simultaneously, for the subsample of CEEC regions the first income class comprises the poorest regions with a below average PCPI of less than 2700 € and the highest income class regions with an average PCPI of above 12000 €. The mean per capita income class falls into the third class, which ranges from 4300 € to 7700 €.

[8] Malta and Cyprus are excluded because of their small sample size.

[9] For a detailed insight into the total amount of FDI companies located over the time period 2003-2010 in each country, as well as for the EU-15 and 11 CEEC regions see Table A3 in the Annex.

to be largely concentrated in Bulgaria, Hungary, Slovenia and Slovakia, and to a lesser extent in Poland and Romania. As with findings from other studies (Casi and Resmini, 2010, 2012), the capital and border regions of the CEEC states reflect a significantly more intensive growth than the rural regions.

Figure 1. FDI growth of all EU NUTS2 regions from the sample in %: 2003–2010



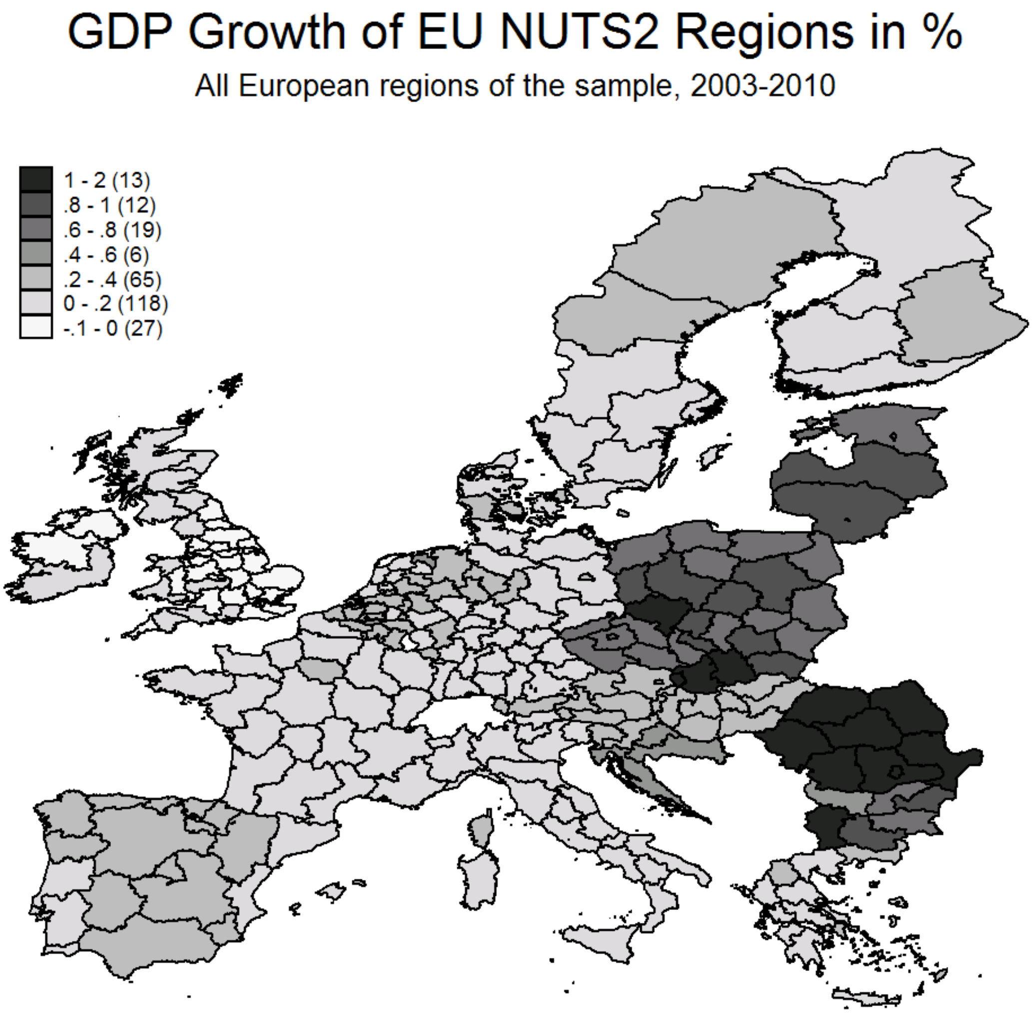
Source: Own estimations from the sample data, obtained from AMADEUS Database

Other regional data

The second dataset provides information on the regional income rates at NUTS2 level. The GDP per capita is calculated using population and income data collected by EUROSTAT and is expressed in Purchasing Power Standard (PPS) in order to take the differences in national price levels into account. Figure 2 summarizes the development of GDP per capita growth for all European regions over the time period 2003 to 2010.

This indicates that economic growth dynamics have been fairly positive for all Western European regions, which experienced a growth in income of up to 40% over the observation period. Exceptions are negative growth rates for the UK regions. Special attention can be turned to the regions in CEECs, which show an aggregate growth of more than 40%. A remarkably strong concentration of growth (between 100 and 200%) in per capita GDP can be identified in all regions of Slovakia and Romania and also, to some extent, in Croatia, the Czech Republic, Poland and the Baltic states.

Figure 2: GDP growth of all EU NUTS2 regions from the sample in %: 2003–2010



Source: Own estimations from the sample data, obtained from AMADEUS Database

Our analysis exploits an additional regional level dataset to capture the development of human capital across EU regions. In particular, we draw upon information about human resources in science and technology occupations (HRSTO) derived from the EU – Labor Force Survey (EU – LFS) and the Eurostat/Unesco/OECD data collection on education. In contrast to indications of human capital based on formal qualifications, the HRSTO indicator focuses on executed occupations. In addition, it captures the human capital related technological competency of the regional workforce. Thus, this indicator seems most appropriate in capturing the human capital-related aspect of technological accumulation in parallel to capital accumulation across regions.

4. Estimation results

4.1 Income convergence

First we examine the income convergence in the EU-27 and CEECs regions. Table 1a depicts the Markov transition matrix, Π_M in equation (2), for the entire sample of 269 EU regions in terms of their levels of GDP per capita growth. This table also indicates the initial distribution, s (t) in equation (3), in terms of absolute and relative frequencies (two columns labeled “initial distribution”), as well as the converging limiting distribution of the Markov chain (s* in equation (4.4), row labeled “limiting”).

Table 1: Evolution of income distribution across EU regions, 2003–2010

PCPI class	initial distribution N	%	final distribution 1	2	3	4	5
1	53	19,70	94,34	5,66	0,00	0,00	0,00
2	54	20,07	1,85	88,89	5,56	3,70	0,00
3	52	19,33	0,00	28,85	61,54	9,62	0,00
4	56	20,82	0,00	1,79	35,71	55,36	7,14
5	54	20,07	0,00	0,00	0,00	16,67	83,33
limiting	269	100	18,96	24,91	20,45	17,47	18,22

Source: Own estimations from the sample data

The initial distribution shows a fairly even distribution of observations across all five income classes, considering class 3 as the middle income class. The comparison of the initial and the limiting distribution indicates a rather weak tendency of income convergence across the whole sample of European regions between 2003 and 2010. The limiting distribution shows a slightly higher concentration in the middle income class, and lower concentrations in the extreme classes 1 and 5.

The comparison of the initial and the limiting distribution in the income classes shows only small differences of about five percent, indicating that the income distribution across all EU regions is already close to its steady state. However, the estimated transition matrix offers several detailed insights into the dynamics of this convergence process. Table 1a indicates that the below-average income classes (levels 1 and 2) face only small, but upward moving transition probabilities of about 5 to 10 percent of movement on the income ladder. In contrast, the higher income classes (levels 4 and 5) show a lesser degree of stationary probabilities and thus face higher transition probabilities of moving down than of moving up in the income distribution. The regions of income level 4 face a probability of 37,5 percent (35,71+1,79; second and third value of line 4) of relegation and a fairly low stationary probability of remaining in the level (55,36 percent).

These estimation results reveal a weak tendency of GDP per capita convergence across all European regions. The specific distribution dynamics show on average that below income classes were exposed to higher growth rates than higher income classes. To sum up, this could hint at an income convergence process across EU regions with limited catching-up by regions at the lower end of the European income distribution.

A closer look at the type of regions that reflected at least one level of growth shows that out of a total of 17 regions, nine can be identified as European capital cities (see Annex Table A6a). Even more remarkably, this includes the three capital regions of the Czech Republic, Romania and Slovakia.

Now we turn to the analysis of growth dynamics in the sub-sample of EU regions in the 10 CEECs during the observation period of 2003 to 2010. The initial distribution in Table 2 indicates – as in case of the EU26 – a fairly even distribution of regions across the five income classes. However, the limiting distribution differs significantly from the initial distribution, especially in PCPI classes 1 to 3. While the limiting distribution of income classes 2 and 4 increases around the middle income class 3, the lowest income class 1 and the middle income class 3 decrease considerably. This implies a concentration of CEECs regions at both extreme ends of the limiting income distribution and a decreasing middle income class.

Table 2: Evolution of income distribution across CEEC regions, 2003–2010

PCPI class	initial distribution N	%	final distribution 1	2	3	4	5
1	11	19,30	63,64	36,36	0,00	0,00	0,00
2	9	17,55	0,00	77,78	22,22	0,00	0,00
3	12	21,05	0,00	16,67	50,00	25,00	8,33
4	12	21,05	0,00	15,38	7,69	69,23	7,69
5	12	21.05	0,00	0,00	0,00	16,67	83,33
limiting	56	100	12,28	26,32	15,79	24,56	21,05

Source: Own estimations from the sample data

While the Markov approach identifies a process of convergence if $s_M^* > s_M(0)$ in the median class and $s_M^* \leq s_M(0)$ in the higher and lower income classes (suggesting the opposite development for divergence), the comparison of initial and limiting income distribution exhibits no evidence of convergence or divergence in the group of CEEC regions. The middle income class shrinks significantly, while its probabilities of moving up are higher than of moving down in the income distribution. Higher frequencies in the lowest and highest classes would indicate divergence, but the final distribution in the lowest income class decreases whereas the regions of the highest income class 5 remain with an unchanged probability. The concentration of regions in income classes 2, 4 and 5 suggests the existence of a club convergence or a poverty trap rather than a divergence.

When considering the explicit distribution dynamics of regions, the transition probabilities also indicate accumulation at both ends of the income distribution. While the PCPI classes 2, 4 and 5 show high stationary probabilities of remaining in the same class (up to 70 percent), regions in the middle income class 3 face a 50 per cent possibility to of remaining stable as well as a 17 per cent and 33 percent possibility of moving downwards – or upwards – respectively. The considerable decline of regions in the first and third PCPI class contributes to the notion of two peaks in the income distribution.

The most striking inference to be drawn from the estimated CEEC transition matrices is the high persistence of income classes at both ends of the income distribution. Even if the results from Figure 2 suggest that CEEC regions commonly enjoy higher GDP per capita growth rates than the EU-15 regions, the results on the evolution of the per capita income distribution do not offer much evidence for the existence of a "convergence club" in the CEEC as a whole. Since the middle income class vanishes and regions accumulate with a strong persistence at both ends of the income distribution, we can talk of a poverty trap for "poor" and lagging-behind CEEC regions.

If we now take a look at the type of regions with particular levels of growth over time (see Annex Table A6b), we can see that 21 CEEC regions have grown by one level of growth and seven by two levels. In contrast to the above findings for the EU sample, we find no capital cities, since capital regions in CEECs are already in the highest PCPI income class. These findings further strengthen the notion of poor regions that have in fact grown by one level, but still remain in the lower PCPI classes 1 to 3 and face only minor transition probabilities of catching up. Furthermore, we see that most of the regions in Poland and Romania have grown only within the PCPI income classes 1 to 3. More specifically, this is true for almost all Romanian regions (except capital city region RO32) and for all four Polish regions from region PL3. Surprisingly, almost all Bulgarian regions (except capital city region BG41) have remained in the lowest income class while almost all Hungarian regions (excepting capital city region HU10 and the western border region HU21) have fallen back by one level of growth to PCPI income classes 1 to 3.

4.2 FDI stocks and changes to the income distribution

This section investigates whether the density of FDI stocks increases the mobility of a region in the income distribution across EU regions between 2003 and 2010.

In order to identify the impact of FDI stocks on GDP income growth rates, the density of FDI stocks in a region will be measured by two indicators: a) the share of foreign generated turnover and b) the share of foreign employees per region. The latter measure takes account of the relative size of foreign owned firms in a region. This measure also eliminates potential bias resulting from the many small foreign owned firms in border regions between CEEC countries. For the extensive consideration of FDI stock densities by the share of foreign turnover and employees, the sample of each indicator will be further separated into EU and CEECs sub-samples. Following Bode and Nunnenkamp (2010), the differentiation of the samples is defined by the median FDI density of regions in the first year of the observation period (2003).[10] This distinction permits a direct comparison of the sub-samples in order to verify a positive association between FDI densities and income growth levels.

Estimation results for EU sample

First we analyze the relationship for the whole sample covering all EU regions by measuring the FDI stock density in terms of foreign generated turnover (see Annex Table A4a).

The initial distribution indicates that regions with an above average FDI density were already richer at the outset. The probability of starting from one of the two highest PCPI classes is about 44 percent for regions with a high density of foreign turnover and 38 percent for EU regions with a lower density.

The limiting distributions indicate that EU regions with an above average density of foreign turnover will tend, on average, to be richer in the long term than regions with a lower than average density of FDI stocks. The probability of ending up in one of the two highest income classes is about 40 percent for regions with a high density of foreign generated turnover, but only 33 percent for regions with a below average density of FDI stocks. However, the estimated transition probabilities of the limiting distribution reveal no evidence of a significant positive association of FDI stocks with long-term growth. While the sample of regions with an above average density of FDI stocks faces a higher probability of ending up in the two highest PCPI classes, these regions also face a similar probability of 40 percent of ending up in the lowest PCPI classes of the sub-sample with high FDI stocks. In contrast, the probability of regions in the below average FDI density sample ending up in PCPI classes 1 and 2 is higher (48 percent) than their ending up in classes 4 and 5 (33 percent). An additional comparison of the two samples of FDI stock densities in terms of generated turnover reveals that the PCPI classes in the below average FDI stock sample face much higher stationary probabilities of remaining in their income class than regions from the above average FDI stock sample, which show lower stationary probabilities by comparison but therefore higher distributional dynamics in the income distribution.

[10] The median of the sample in all European regions is19,95% in the case of foreign generated turnover and 13,94% in the case of foreign employees. Correspondingly, the median for the CEEC subsample is 22,41% in the case of foreign generated turnover and 14,29% in the case of foreign companies.

In the case of the sample of European regions measured in terms of FDI employment density (see Annex Table A5a), the findings corroborate the above estimations of FDI stocks in terms of foreign generated turnover. The results of the initial and limiting distributions of FDI employment draw a fairly similar picture of very limited positive effects on GDP per capita growth rates, while EU regions from the above average FDI density sample indicate a fairly equal probability of ending up in the two highest or in the lowest PCPI classes. Moreover, the estimated relationship between FDI employment and income dynamics is inverted if the FDI density is measured at the below median sample. The results of the limiting distribution indicate that the lowest income classes 1 and 2 now include about half the regions with a low density of FDI employment (48,82 percent). Furthermore, EU regions from these "lagging behind" income classes reflect high stationary probabilities (about 95 percent) and face lower transition probabilities (5,88 percent) of ascending into income classes 3 or 4.

Estimation results for sample of CEEC

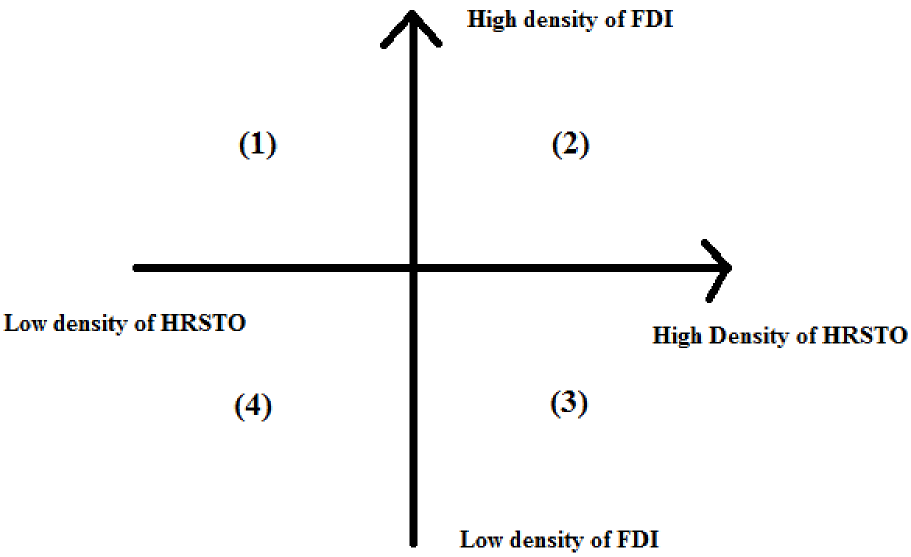
For the sub-sample of regions in CEECs (see Annex Table 4b), we find similar results by considering the FDI stock density in terms of foreign generated turnover, as mentioned for the EU26 sample. The initial and the limiting distributions also reveal that regions with above average FDI stocks are richer from the beginning of the observation period, and also tend to be richer in the long run than regions in the sub-sample with below average FDI stocks. In contrast to the findings for the EU26, CEEC regions with a higher FDI density face a higher probability of moving upwards into income classes 4 and 5 (46 percent) than of moving downwards into lower income classes 1 and 2 (38 percent). CEEC regions with a below median FDI density face an equal probability of moving upwards or downwards and also face higher stationary probabilities of remaining in their income class. Thus, the estimation results based on turnover as a measure of FDI stocks indicate a weak positive association between FDI density and growth rates for regions within CEECs.

By comparing these findings with the estimated distributions in the sub-sample of CEEC regions with a below median density of FDI employment (see Annex Table A5b), the results show a similar picture of "lagging behind" regions that face only low growth probabilities of entering the middle income class. Surprisingly, and in contrast to the findings for the EU26 sample, the sub-sample of CEEC regions with an above average density of FDI employment seems also to favor only certain regions in the income distribution. The limiting distribution shows that the middle income class 3 shrank (up to 10 percent), while the income classes 2 and 4 increased. Furthermore, neither of the PCPI classes 1 and 2 in this sub-sample face any growth prospects of ascending to higher PCPI classes.

4.3 Accounting for FDI stocks and human capital

In order to test the relationship between FDI stocks, human capital endowment and changes to the regional income distribution, we classify four groups of regions based on a taxonomy along two dimensions: FDI stocks (FDI) measured in terms of foreign employees, and human capital endowment measured in terms of human resources in science and technology occupations (HRSTO). The differentiation into above and below average groups is based on the median for each dimension at the start of our observation period (2003).

Figure 2. Stylized taxonomy groups by their density of FDI and HRSTO

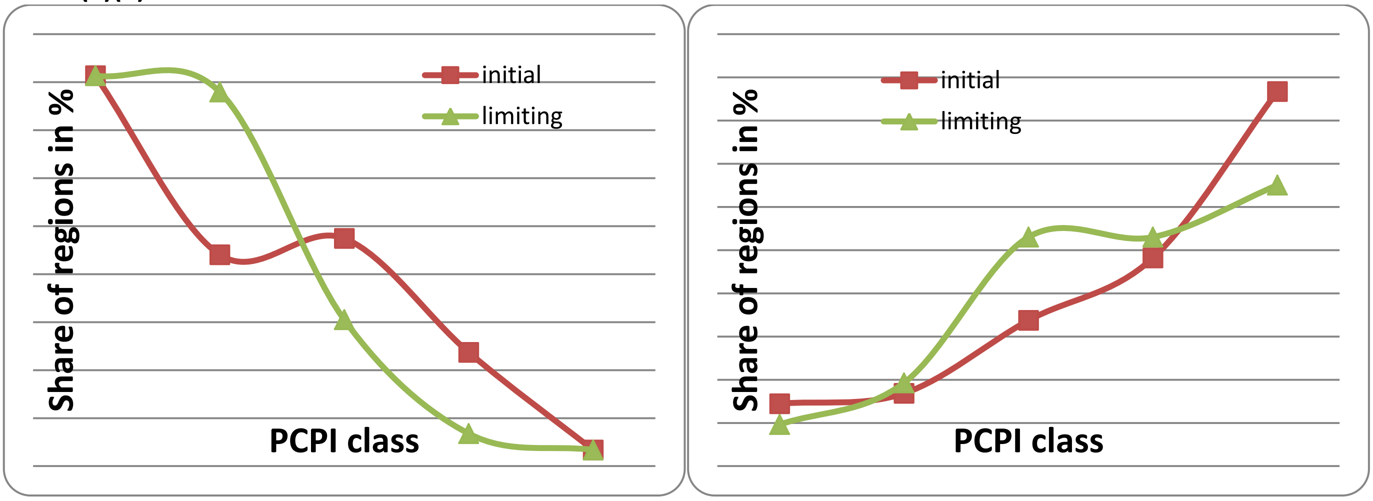


According to the above stylized taxonomy, group (1) is composed of regions that are characterized by high FDI stocks and low HRSTO endowment. In this group, development is potentially FDI-led, largely uncoupled from existing human capital endowment within these regions. Group (2) contains regions that show high endowment of FDI stocks as well as HRSTO. Group (3) covers regions that show high initial levels of HRSTO endowment with below average FDI stocks. This group could constitute the type of region that potentially follows a domestic-led development path, since the technology related human capital is relatively high and largely linked to domestic capital. Group (4) combines regions with relatively poor starting conditions, i.e. below average FDI stocks as well as below average HRSTO endowment.

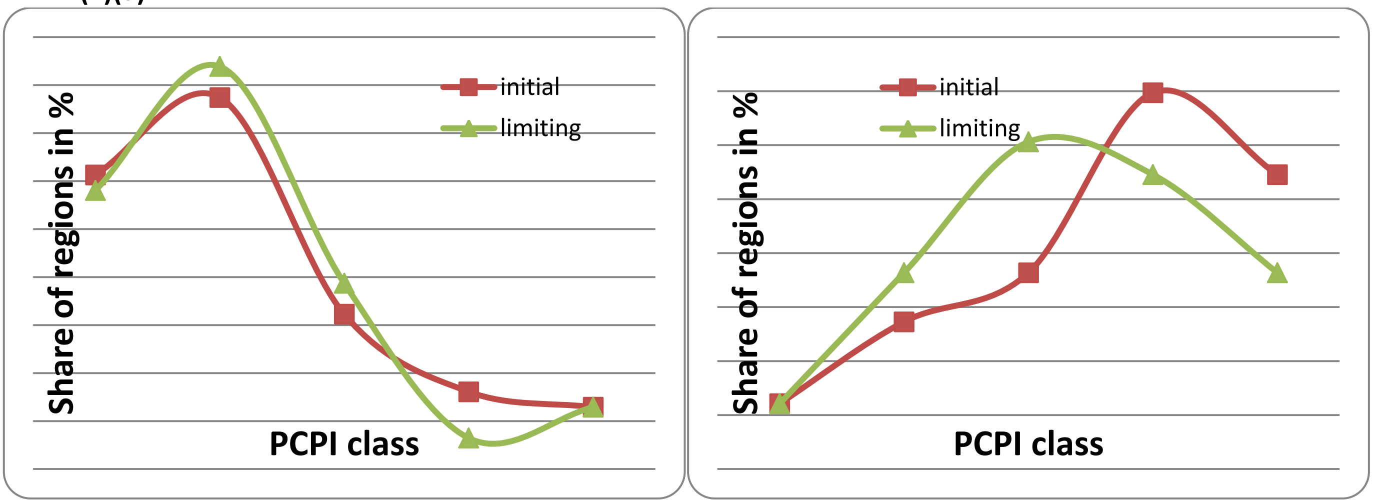
Figure 3a illustrates the initial and limiting distributions of the estimated Markov transition matrices for all European regions in the above described groups of regions and the corresponding income classes.

Figure 3a: Income distribution across EU regions, 2003–2010, by FDI and HRSTO densities – initial and limiting distributions

(1)(2)



(4)(3)



Source: Own estimations from the sample data

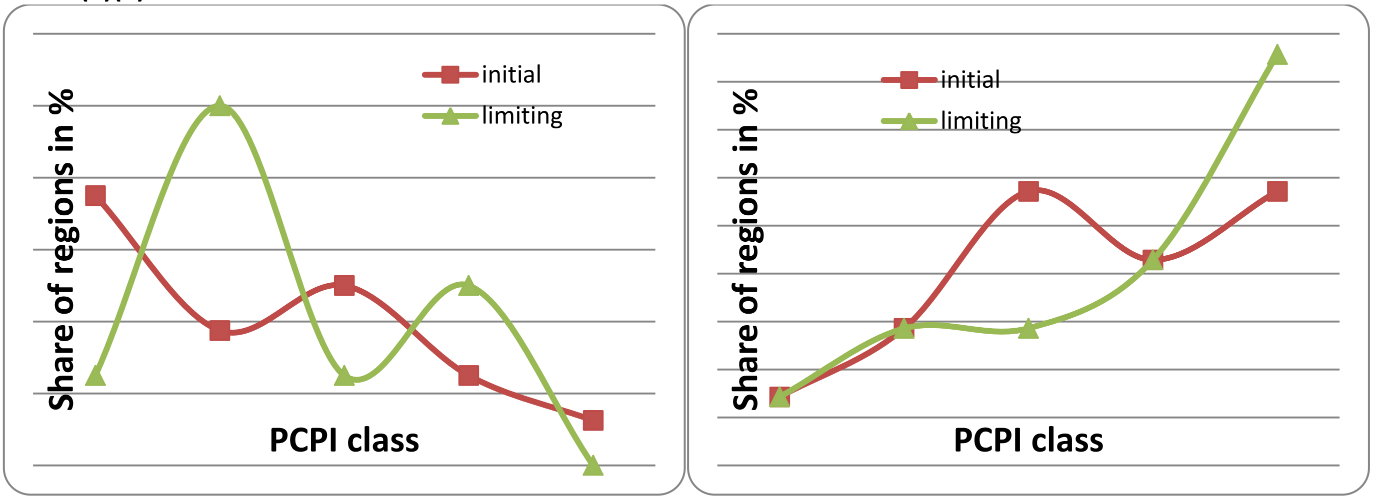
The limiting distributions for the four sub-samples in graphs (1) to (4) indicate that the FDI-led increases in long-term growth rates in European regions are conditional on a high accumulation of HRSTO. Graphs (2) and (3) show a positive association between income growth and higher human capital endowment. EU regions with a high share of HRSTO face particularly higher probabilities of being in one of the two above-median income classes than EU regions with a low density of HRSTO (graphs (1) and (4)). This implies that the domestic and FDI led regional growth path is driven mainly by human capital-related technological accumulation. In addition, the comparison of the limiting distributions in Figure 3a shows that regions with higher FDI stocks have only slightly higher probabilities of reaching higher income classes.

The comparison of initial and limiting distributions provides additional insights into the dynamics of the income distribution: Firstly, EU-regions with a high FDI stock coupled with a high density of HRSTO (graph (2)) have much higher long-term income growth rates (60 % for the PCPI classes 4 and 5) than all the other groups of regions. Secondly, while graphs (1) and (4) show no evidence of the process of convergence within their taxonomy groups, the distribution of regions from taxonomy groups (2) and (3) with a high HRSTO accumulation are homogenous with the income convergence detected above.

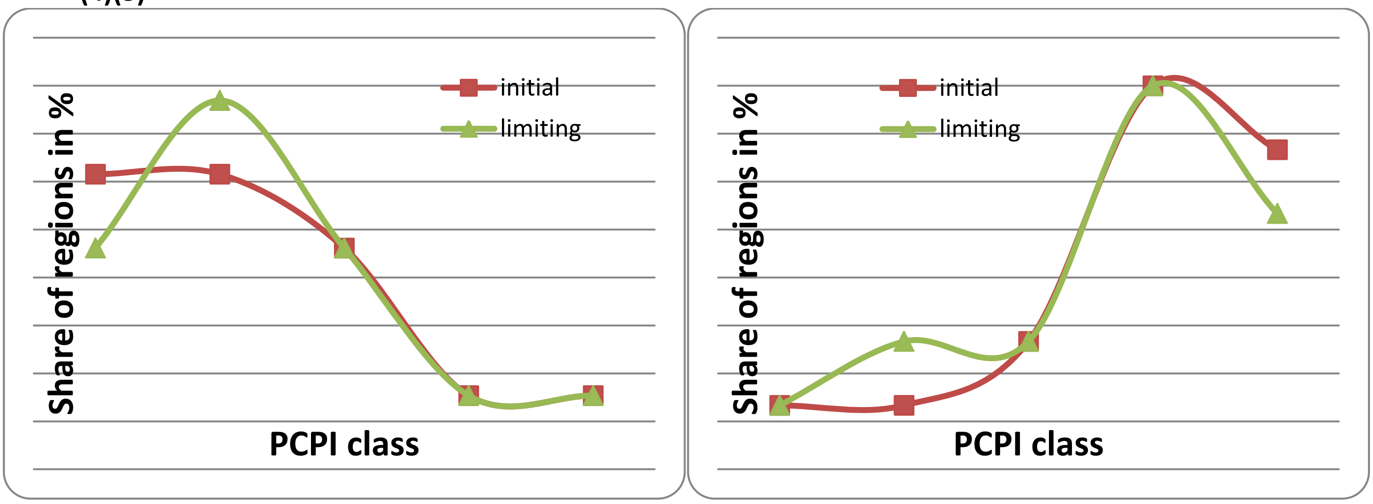
Now we turn to the integrated analysis of the relationship between FDI, human capital and growth dynamics for the sub-sample of CEEC regions in the EU. In order to do this we classify the sub-sample of CEEC regions into the four groups of regions based in their endowment with FDI and HRSTO at the start of our observation period (2003). The graphs (1) to (4) depict the initial and limiting distributions for the four corresponding groups of CEEC regions (see Figure 3b).

Figure 3b: Income distribution across CEEC regions, 2003–2010, by FDI and HRSTO densities – initial and limiting distributions

(1)(2)



(4)(3)



Source: Own estimations from the sample data

As in the results for all European regions, we find that regions in CEEC characterized by high FDI stocks as well as high HRSTO endowment are more likely to experience catch-up growth. The limiting distributions of graphs (2) and (3) indicate a positive relationship between long-term growth and higher stocks of HRSTO, regardless of the FDI density within the region. As a result, the group of regions where a high share of HRSTO is complemented by high initial FDI stocks shows considerably higher probabilities (about 65% in graphs (2) and (3)) of remaining in the high income classes.

In contrast to the above findings for all EU regions, the comparison of initial and limiting distributions shows that CEEC regions with a high degree of HRSTO endowment (graphs (2) and (3)) have strengthened their leading positions in income distribution instead of falling back. If we take a look at the types of CEEC regions that have considerably higher growth prospects initiated by higher HRSTO endowment, we find that all capital regions of CEECs are on this list (see Annex Table A7). Added to this, while the distribution of CEEC regions with high densities of human capital reflects much higher income growth prospects, the opposite distribution can be seen in graphs (1) and (4). These results confirm the overall process of divergence for all CEEC regions found in the income distribution, and validate the high persistence for both ends of the income distribution.

5. Discussion

This study analyses whether the long-term per capita income growth paths of European regions are affected by FDI accumulation. We assessed the complementary of FDI and human capital as determinants and income convergence dynamics. By applying a Markov chain approach to 269 EU regions over the 2003–2010 period, we estimated transition matrices to compare the catching-up process of the CEEC regions with western income levels.

The results of income convergence in the complete sample of EU regions indicate that regional disparities in per capita income between the EU24 regions decreased over the period 2003–2010. The low overall income convergence is specified by the considerable increase in the middle income class 3 in the limiting distribution, while the extreme income levels at both ends of the distribution fell during the observation period. Moreover, the above average and average PCPI income classes tend to lose their income advantage over the below average classes. This supports the findings of Cappelen et al. (2003), who also found a low income convergence rate for the EU12 between 1980 and 1999, as well as Geppert and Stephan (2005) who found an increase in the convergence process for the EU15 on a regional level in the period between 1980 and 1995. For the sample of CEEC regions, the results of the evolution of the income distribution reveal that regional disparities in GDP per capita income increased over the period from 2003 to 2010. The comparison of the initial and limiting income distribution shows no evidence for a process of convergence, nor of divergence. The middle income class 3 decreases considerably over time, while the lowest income classes face minor transition probabilities of catching up with the middle income class. We consider these results against the findings of Le Gallo (2004) for 138 European regions (EU-12), who finds that GDP disparities continue to persist during the period from 1980 to 1995, further highlighting a poverty trap between rich and poor regions, while poor regions face only a small probability of achieving the income levels of the richer regions. Furthermore, we find evidence for a concentration of certain regions in PCPI classes at both ends of the income distribution that confirms the hypothesized "poverty-trap" for lagging regions (Lopez-Bazo et al., 1999), but also indicates higher GDP per capita growth rates for the capital regions of CEECs. These findings of a rapid catching-up process by central European capitals in terms of GDP are confirmed by those of Darvas (2014), who found that EU membership boosted annual countrywide GDP growth about half a percent on average in the 10 new CEEC members. Moreover, he emphasizes that in post-transition economies the rapid rise of CEEC capitals and a few other regions is characterized by an efficient concentration of economic activities that widen the regional income differences within these countries.

By considering the FDI accumulation as a determinant of income convergence dynamics, our analysis finds that European regions with a high FDI stock show only slight evidence for greater chances of being rich in the long term. Furthermore, the limiting distributions of FDI stocks, in terms of foreign generated turnover, show that the sub-samples with high FDI densities are in line with the weak overall income convergence among the GDP per capita growth rates. Even though EU regions with a high density of FDI are still estimated to have more favorable income and growth prospects than EU regions with a below average density of FDI, the results show that regions with high FDI stock have been falling back in the income distribution over time and instead have converged slowly with the middle income class. This evidence seems to be contrary to most existing studies at the country level of analysis, which show a positive relation between FDI accumulation and economic growth (see e.g. Carkovich and Levine, 2002; Ozturk and Kalyoncu, 2007; Mallick and Moore, 2008). The further investigation of the role of FDI in the growth process of CEEC regions shows that high densities of FDI stocks have only a minor association with long-term income rates. In contrast to most existing studies on a positive FDI growth relationship in developing (see e.g. Mallick and Moore, 2008) or Eastern Europe countries (see e.g. Weber, 2011) – but in line with Nistor (2012) – the findings for CEEC regions with above and below median FDI densities indicate neither robust evidence of greater chances to become rich in the long term nor of catching up. In particular, for CEEC regions with a below average density of FDI stocks, foreign capital accumulation plays a minor role in generating growth-enhancing economies of agglomeration. Whereas evidence exists for positive direct and indirect effects of foreign presence on productivity growth of CEEC firms (see for an overview Hanousek et al., 2011) our results show that a positive relationship between FDI and growth performance does not apply unconditionally to CEEC regions during the observation period. This might provide a possible explanation of the results from recent investigations that could not find a positive relationship between FDI and growth or per capita incomes for developing and emerging economies at the aggregate (national) level of analysis (Herzer et al., 2008; Yalta, 2013).Our study provides new empirical evidence for the key role of human capital in the growth process in European regions by integrating growth factors related to foreign capital and human capital accumulation. The results for all EU regions show a predominantly positive effect on long-term growth prospects when foreign physical capital is coupled with a threshold level of human resources in science and technology. This supports the theoretical assumptions of an endogenous broad capital model that emphasizes the complementary relationship between FDI accumulation coupled with higher human capital, in terms of technological and knowledge absorption, and the wider distribution of regional income in Europe. These results are in line with those of Mulas-Granados and Sanz (2008) who find in a regional sample of 177 EU regions from 1990 to 2002 that changes in the dispersion of technology are among the most important drivers in explaining changes in the distribution of regional per capita income over time. Furthermore, the results of Pablo-Romero and Gomez-Calero (2013) confirm the strong relationship between human and physical capital in the economic growth of Spanish provinces from 1985 to 2006, while they emphasize that the effect of human capital on economic growth depends significantly on the increments in private physical capital. This underlines the importance of human capital, in terms of technological and knowledge absorption, for domestic as well as foreign-led regional growth patterns in a European regional context.

In keeping with the prior findings for the whole EU sample, we can show that FDI-led income growth materializes for CEEC regions in the long run if it is accompanied by the accumulation of human capital stocks within regions. Again, these findings are in line with prior empirical evidence at the aggregate (national) level (Borensztein and Lee, 1998; Hansen and Rand, 2006), which also highlights the complementary between FDI and the knowledge absorption capacity in developing countries to facilitate a positive effect upon income growth. In principal, the evidence for the CEECs shows the existence of two types of regional growth patterns: one is FDI-led in combination with a high level of human capital endowment in regions. However, the second regional growth path is domestic-led and driven by human capital-related accumulation within the CEEC regions.

In emphasizing these important results for the CEEC regions, Table A7 considers the explicit list of regions in the taxonomy groups in graphs (2) and (3) from Figure 3b. While the upper part of Table 5 registers CEEC regions from the sub-sample in graph (2), the lower part indicates CEEC regions from graph (3). By considering all listed regions as those which accumulate at the higher end of the income distribution, it is clear that all ten capital cities of the CEECs have more favorable growth prospects than the rest of their inner regions. These findings moreover underline the growth prospects of domestic and FDI-led income growth paths in CEEC capital cities that profit primarily through their threshold level of HRSTO.

6. Conclusion

This paper has investigated the evolution of GDP per capita income disparities in the European regions, and separately for the CEEC regions, over the period from 2003 to 2010. The study applied an infinite first-order Markov chain approach to a sample of 269 European regions. The evidence from this study indicates a weak process of overall income convergence among all EU regions during the observation period. For the sub-sample of CEEC regions, the analysis finds no evidence of convergence, or of any divergence in per capita growth rates. Instead, the results support a “poverty trap” for poor regions in lower income classes, which face a higher probability of remaining in their income position than of catching up with wealthier regions.

This paper has emphasized that regional growth and catching-up are more likely if foreign capital accumulation is coupled with a minimum threshold level of human capital-related technological accumulation. While existing evidence highlights a positive link between FDI inflows and economic growth for CEECs on the aggregate level of analysis (see for example EBRD, 2009), the evidence for a regional level clearly indicates that FDI-led growth only materializes under the condition of human capital related technological accumulation within CEEC regions. Furthermore, there is evidence of a domestic led regional growth path driven by human capital-related technological accumulation rather than foreign capital accumulation in CEEC regions.

In the context of an EU regional policy, the abovementioned findings of FDI-led growth imply some important policy messages. We find that the EU cohesion policy, creating more favorable conditions for investments in peripheral regions through the funding of training, infrastructure and R&D developments (EC, 2007) have succeeded in attracting foreign investments and counteracting agglomeration forces that lead to a concentration of economic growth in CEEC regions, particularly in their capital cities. In particular, our findings suggest that the development in human capital formation, in terms of knowledge absorption and diffusion, and technological accumulation promotes stronger long-term growth paths and reduces regional per capita income disparities with western income levels. On the other hand, policy makers should also seize the opportunities of a domestic led regional growth path to catch up, particularly within CEECs, since the reliance upon FDI in regions that are poor in terms of human capital does not translate into long-term growth.

Acknowledgements

The authors gratefully acknowledge Professor Bruno Merlevede, who gave much valuable advice in the early stages of this work.

Annex

Table A3: No. of FDI companies

Country Code	No. of FDI (Total amount in 2003-2010)
EU-15	
Austria	17.862
Belgium	11.948
Denmark	18.966
Finland	4.604
France	63.932
Germany	24.329
Greece	34.183
Ireland	94.241
Italy	44.368
Luxembourg	6.146
Netherlands	27.028
Portugal	7.026
Spain	41.120
Sweden	10.830
United Kingdom	40.376
EU-15 total	446.959
CEEC	
Bulgaria	51.391
Croatia	12.075
Czech Republic	106.979
Estonia	71.554
Hungary	6.475
Latvia	2.384
Lithuania	9.384
Poland	19.614
Romania	48.034
Slovakia	10.608
Slovenia	1.640
CEEC total	340.138

Table A4a: Income distribution across EU regions (levels of growth), 2003–2010, by the density of foreign turnover

Share of foreign turnover > median of foreign turnover							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	29	20,57	93,10	6,90	0,00	0,00	0,00
2	22	14,89	4,76	80,95	9,52	4,76	0,00
3	29	20,57	0,00	37,93	51,72	10,34	0,00
4	28	19,86	0,00	3,57	39,29	42,86	14,29
5	34	24,11	0,00	0,00	0,00	20,59	79,41
limiting	142	100	19,86	21,99	19,86	16,31	21,99
Share of foreign turnover < median of foreign turnover							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	24	18,90	95,83	4,17	0,00	0,00	0,00
2	33	25,98	0,00	93,94	3,03	3,03	0,00
3	22	17,32	0,00	18,18	72,73	9,09	0,00
4	28	22,05	0,00	0,00	32,14	67,86	0,00
5	20	15,75	0,00	0,00	0,00	10,00	90,00
limiting	127	100	18,11	28,35	20,47	18,90	12,50

Source: Own estimations from the sample data

Table A4b: Income distribution across CEEC regions (levels of growth), 2003–2010, by the density of foreign turnover

Share of foreign turnover > median of foreign turnover							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	6	21,43	50,00	50,00	0,00	0,00	0,00
2	4	14,29	0,00	100	0,00	0,00	0,00
3	5	17,86	0,00	20,00	60,00	0,00	20,00
4	5	17,86	0,00	0,00	20,00	60,00	20,00
5	8	28,57	0,00	0,00	0,00	37,50	62,50
limiting	28	100	10,71	28,57	14,29	21,43	25,00
Share of foreign turnover < median of foreign turnover							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	5	17,86	80,00	20,00	0,00	0,00	0,00
2	5	17,86	0,00	60,00	40,00	0,00	0,00
3	7	25,00	0,00	14,29	57,14	28,57	0,00
4	6	21,43	0,00	33,33	0,00	66,67	0,00
5	5	17,86	0,00	0,00	0,00	20,00	80,00
limiting	28	100	14,29	25,00	21,43	25,00	14,29

Source: Own estimations from the sample data

Table A5a: Income distribution across EU regions (levels of growth), 2003–2010, by the density of foreign employees

Share of foreign employees > median of foreign employees							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	29	20,57	93,10	6,90	0,00	0,00	0,00
2	20	14,18	5,00	80,00	10,00	5,00	0,00
3	26	18,44	0,00	34,62	57,69	7,69	0,00
4	29	20,57	0,00	3,45	37,93	44,83	13,79
5	37	26,24	0,00	0,00	0,00	18,92	81,08
limiting	142	100	19,86	19,86	19,86	16,31	24,11
Share of foreign employees < median of foreign employees							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	24	18,90	95,38	4,17	0,00	0,00	0,00
2	34	26,77	0,00	94,12	2,94	2,94	0,00
3	25	19,69	0,00	24,00	64,00	12,00	0,00
4	27	21,26	0,00	0,00	33,33	66,67	0,00
5	17	13,39	0,00	0,00	0,00	11,76	88,24
limiting	127	100	18,11	30,71	20,47	18,90	11,81

Source: Own estimations from the sample data

Table A5b: Income distribution across CEEC regions (levels of growth), 2003–2010, by the density of foreign employees

Share of foreign employees > median of foreign employees							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	6	21,43	33,33	66,67	0,00	0,00	0,00
2	4	14,29	0,00	100	0,00	0,00	0,00
3	8	28,57	0,00	12,50	62,50	12,50	12,50
4	4	14,29	0,00	0,00	0,00	75,00	25,00
5	6	21,43	0,00	0,00	0,00	33,33	66,67
limiting	28	100	7,14	32,14	17,86	21,43	21,43
Share of foreign employees < median of foreign employees							
PCPI class	initial distribution		final distribution				
	N	%	1	2	3	4	5
1	5	17,86	100	0,00	0,00	0,00	0,00
2	5	17,86	0,00	60,00	40,00	0,00	0,00
3	4	14,29	0,00	25,00	50,00	25,00	0,00
4	7	25,00	0,00	28,57	14,29	57,14	0,00
5	7	25,00	0,00	0,00	0,00	28,57	71,43
limiting	28	100	17,86	21,43	17,86	25,00	17,86

Source: Own estimations from the sample data

Table A6a: List of EU regions by the difference in growth levels

NUTS2 Code	Name of region	Level of growth +1	+2
AT-13*	Wien	1	0
BE-31	Wallonisch-Brabant	1	0
BE-35	Provinz Namur	1	0
CZ-01*	Praha	0	1
DE-30*	Berlin	1	0
DE-94	Weser-Ems	1	0
DE-A3	Münster	1	0
ES-21	País Vasco	1	0
GR-30*	Athens	1	0
GR-42	Südliche Ägäis	1	0
NL-32*	Noord-Holland	1	0
NL-42	Limburg	1	0
PL-12*	Mazowieckie	1	0
RO-32*	București-Ilfov	0	1
SE-12	Östra Mellansverige	1	0
SI-02*	Zahodna Slovenija	1	0
SK-01*	Bratislavský kraj	0	1

*Note: *Capital regions*

Table A6b: List of CEEC regions by the difference in growth levels

NUTS2 Code	Name of region	Level of growth +1	+2
BG-41	Yugozapaden	0	1
CZ-04	Severozápad	1	0
CZ-05	Severovýchod	1	0
CZ-06	Jihovýchod	1	0
CZ-07	Střední Morava	1	0
CZ-08	Moravskoslezsko	1	0
LT-00	Lithuania	1	0
LV-00	Latvia	0	1
PL-11	Łódzkie	1	0
PL-21	Małopolskie	1	0
PL-33	Świętokrzyskie	1	0
PL-34	Podlaskie	1	0
PL-42	Zachodniopomorskie	1	0
PL-43	Lubuskie	0	1
PL-51	Dolnośląskie	1	0
PL-52	Opolskie	1	0
PL-62	Warmińsko-Mazurskie	1	0
PL-63	Pomorskie	1	0
RO-11	Nord-Vest	1	0
RO-12	Centru	1	0
RO-22	Sud-Est	1	0
RO-31	Sud-Muntenia	1	0
RO-32	București-Ilfov	0	1
RO-41	Sud-Vest Oltenia	1	0
RO-42	Vest	1	0
SK-02	Western Slovakia	0	1
SK-03	Central Slovakia	1	0
SK-04	Eastern Slovakia	0	1

Table A7: List of CEEC regions – Integrated Analysis

High density of FDI & high share of HRSTO	
NUTS2 Code	Name of region
CZ-01*	Praha
CZ-02	Střední Čechy
CZ-06	Jihovýchod
CZ-08	Moravskoslezsko
EE-00*	Estonia
HR-04*	Continental Croatia
LT-00*	Lithuania
LV-00*	Latvia
PL-12*	Mazowieckie
PL-42	Zachodniopomorskie
PL-62	Warmińsko-Mazurskie
RO-32*	București-Ilfov
Low density of FDI & high share of HRSTO	
BG-31	Severozapaden
BG-41	Yugozapaden
CZ-03	Southwest
CZ-04	Northwest
CZ-05	Northeast
CZ-07	Central Moravia
HR-03	Adriatic Croatia
HU-10*	Central Hungary
HU-21	Central Transdanubia
HU-23	Southern Transdanubia

HU-32	Northern Great Plain
PL-22	Śląskie
SI-01	Eastern Slovenia
SI-02*	Western Slovenia
SK-01*	Bratislava Region
SK-02	Western Slovakia
SK-03	Central Slovakia

*Note: *Capital regions*

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