

Regional Dimensions of Human Capital and Economic Growth: A Review of Empirical Research

Štefan Rehák 

University of Economics in Bratislava, Faculty of National Economy, Department of Public Administration and Regional Development, Slovakia

Abstract

Intuition thus tells us that the relationship between human capital and economic growth at the regional level is more complex compared to the national level. The aim of this article is to survey the theoretical and empirical approaches of the relationship between human capital and economic growth at the regional level. We selected all articles in top scientific journals whose authors used the term *human capital* in their keywords. The total sample consists of 21 articles from the Journal of Economic Geography, 46 articles in Regional Studies, 35 articles in Papers in Regional Science and 4 articles in Economic Geography. The theoretical and empirical research at the regional level highlights the role of interregional migration, and the role of human capital in externalities in dense urban agglomerations. The greater complexity of the economic processes associated with the accumulation of human capital in the regions requires policies tailored to the needs of the regions.

Keywords

Human Capital, Regional Economic Growth, Externalities, Migration, Regional Policy

JEL Classification

J24, R23, R11

Introduction

Declining returns on capital are offset by the impact of the emergence of new technologies and growth of education. Such statements form the basis of several concepts of so-called new growth theories. This includes in particular the ground-breaking works of Becker (1964), Lucas (1988) and Romer (1986). In this paper, we focus on the mechanisms by which human capital shape the economic growth at the regional level. Examples of the importance of human capital for economic growth, income or employment can be found when comparing the level of economic development and education of developing and developed countries, analysing income inequalities of workers with different education or comparing productivity of firms with different levels of human capital.

What are the specific features of the human capital theory when applied to regions? The aggregate level of education of developed economies is similar, as they have similar education systems. However, within developed countries, there are relatively large differences especially when comparing urbanized and rural regions (Berry, Glaeser 2005). Data in the EU28 from 2017 show that the relationship between the educational level and the level of economic development is very similar when comparing countries (Fig. 1a), NUTS 2 regions (Fig. 1b) or regions at NUTS 3 level (Fig. 1c).

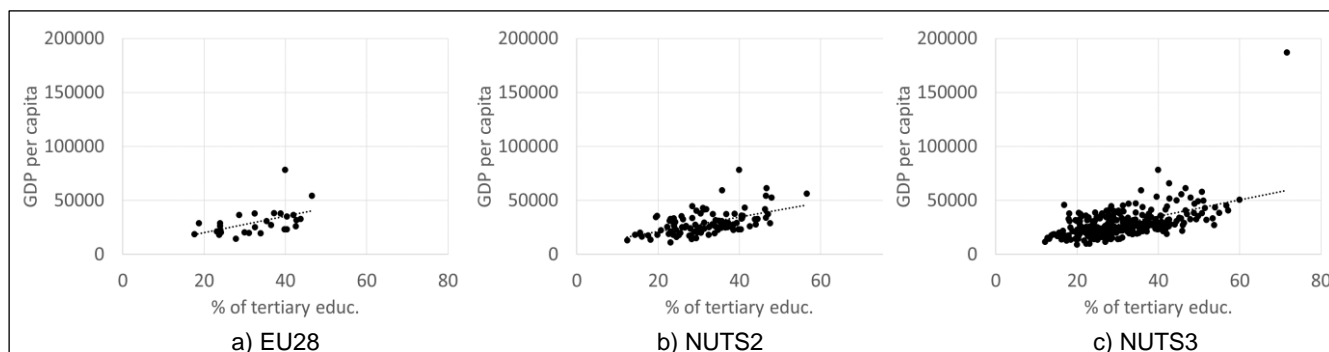


Fig. 1. The relation between education and economic development (2017).

Source: own elaboration based on the Eurostat database (2017)

Corresponding author:

Štefan Rehák, University of Economics, Dolnozemska cesta 1, 852 19 Bratislava
Email: stefan.rehak@euba.sk

The share of the population aged 25-64 with a university degree in the 10 most economically developed NUTS3 regions in the EU 28 (2017) was 56.4%. At the same time for the 10 least economically developed regions, this share was 14.2%. The more detailed classification of a spatial unit we use, the greater are the differences in the human capital. Differences at the level of EU countries are in the range of 17.6 - 46.5% (coefficient of variation 0.25), at the level of NUTS2 it ranges from 12.4 to 56.5% (coefficient of variation 0.27) and at NUTS3 level it is in the interval 12.1 - 71.6% (coefficient of variation 0.32). Particularly noteworthy is the increase in the maximum value, which increases from 45.5% to 71.6%, i.e. by almost 26 percentage points (Fig. 2).

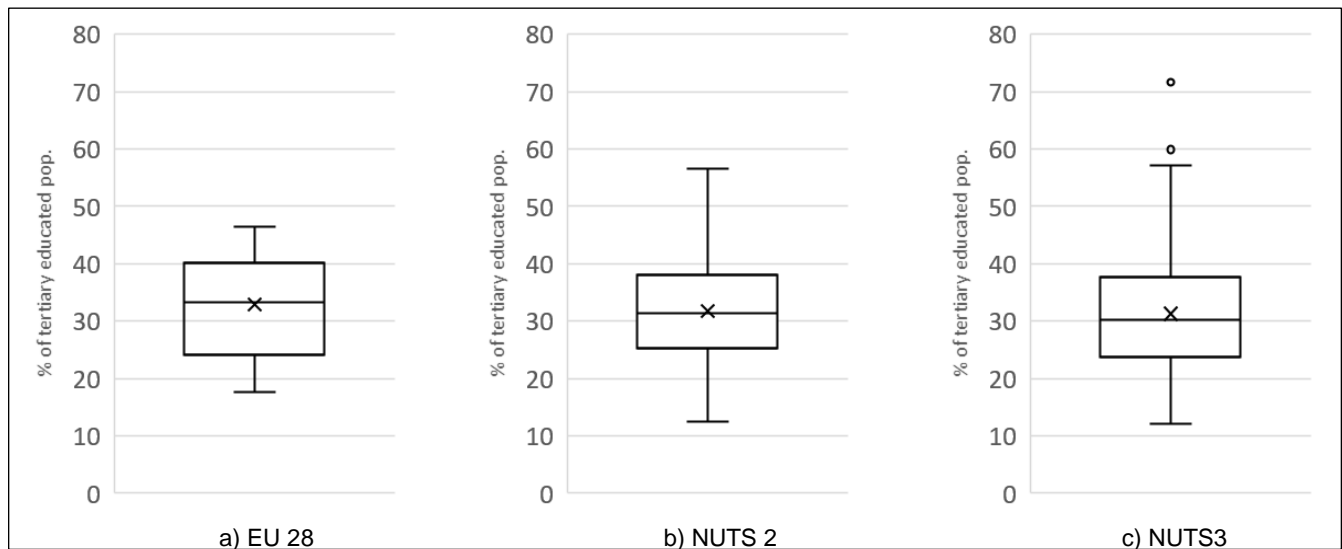


Fig. 2. Distribution of the tertiary educated population in the EU.

Source: own elaboration based on the Eurostat database (2017)

These simple analyses suggest that individuals with higher education are much more selective at regional level than at country level. A typical picture is that educated people are concentrated mainly in highly urbanized regions (Fig. 3a). These regions are also among the most developed in the EU (Fig. 3b).

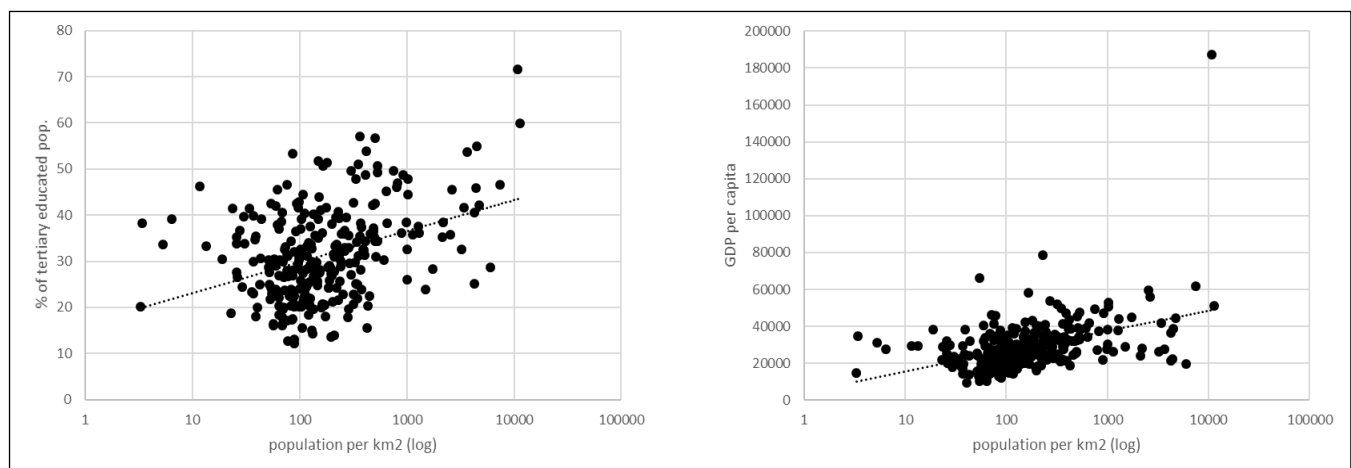


Fig. 3. The relation between urbanization, human capital and economic development.

Source: own elaboration based on the Eurostat database (2017)

Economic intuition tells us that the relationship between human capital and economic growth at the regional level is more complex. The aim of this article is to survey the theoretical and empirical approaches of the relationship between human capital and economic growth at the regional level. We focus on spatial processes that underlie the relationship between human capital and economic growth. We put attention on the data and measurements problems and we also introduce the most frequent methods used in empirical research. At the end of the article, we also discuss the possibilities of public policy to intervene in the regional human capital accumulation.

Human capital concept – a brief description

The literature on human capital is relatively rich, and since the second half of the 20th century, several authors have pointed out the importance of human capital in modern economies. Among others, Mincer's (1958) analysis of the relationship between education and wages provided a good framework for empirical research. Becker's book *Human Capital* (1964) created a comprehensive framework for analysing the relation between human capital and

economic development. According to Becker, human capital includes knowledge, skills, health and values. Unlike classical capital, human capital is inseparable from its bearer. The vast majority of authors who carry out empirical research identify human capital with education. In international comparisons, the number of years in education is used as the primary indicator. The differences between countries are very large, mainly due to the large share of the population without education in developing countries. On the other hand, when comparing developed countries, the biggest differences are in the share of people with a university degree.

Traditional neoclassical models of economic growth of the Solow-Swan type explained growth on the basis of the interaction of labour, capital and exogenously defined total factor productivity. The problem with these models was that the model did not explain the most important growth factor. It was not until Romer (1986) but especially Lucas (1988) who pointed out that role of human capital for economic growth. Lucas's formal model has the following notation:

$$Y = AK^{\beta}(uhL)^{1-\beta}h_a^{\gamma} \quad (1)$$

where

Y – aggregate product,

A – proportionality factor (constant in time),

K – capital,

L – number of workers,

h – human capital.

Human capital is a function of the time the worker spends in education. However, human capital is found twice in the model. At first, it has an impact on worker's productivity and secondly human capital is an externality that affects the whole economy. If the coefficient γ is significant and positive, then due to externalities, the social benefits of education are higher than private, which gives an argument for public support for education.

Methodology

The next part of the article is based on a review of theoretical and empirical literature in four most prestigious journals in the field of regional science, regional studies and economic geography. We selected all articles whose authors used the term human capital in their keywords. The total sample consists of 21 articles from the Journal of Economic Geography, 46 articles in Regional Studies, 35 articles in Papers in Regional Science and 4 articles in Economic Geography. Subsequently, we analysed the articles according to the focus of empirical research in the article or conceptual approach used in the article. The analysis showed that the articles address four main areas, namely economic growth, migration, externalities of human capital and policy related issues.

Human capital and growth in regional research

In empirical research, human capital is typically defined by the educational level of the population (or workers). Even though majority of authors agree that human capital is more than just a formal education, most empirical studies measure human capital using formal education level.

However, there are also other approaches. Florida (Florida et al. 2008; Florida et al. 2012) with his concept of creative class has challenged the traditional view by emphasising that what people do is more important than what they have studied. Creative class are people in professions that require a higher degree of creativity. However, the concept of the creative class has been subject to very intense criticism. This was mainly due to the fact that the creative professions largely overlap with the professions that require a university degree. Marrocu and Paci (2012) therefore separated these two groups into highly educated graduates working in creative professions, highly educated graduates working in non-creative professions and bohemians.

Other authors go step further and propose even finer classification. For example, Scott (2010) classify occupations by set of skills they require to analytical, social and manual skills. Abel and Gabe (2011) calculated an alternative the so-called knowledge index that is based on information about the importance of knowledge in different occupations.

Table 1. Different definitions of human capital in the empirical research.

Authors	Definition of human capital
Posé, Bufí, (2005)	The share of respondents with a secondary or tertiary education or the share of workers in high skilled occupations (stock). Proportion of respondents in formal education (State) and proportion of respondents with vocational training (Match)
Florida, Mellander, Stolarick (2008)	Creative class Super creative core
Ramos et al. (2010)	Number of years in primary, secondary and tertiary education
Abel, Gabe (2011)	Proportion of the working age population

	Knowledge index
Marrocu, Paci (2012)	Highly educated graduates working in creative professions, highly educated graduates not working in creative professions and bohemians
Vogel (2013)	Proportion of population with higher education
Qian (2017)	11 types of skill and a composite index
Männasoo, Hein, Ruubel (2018)	Proportion of population aged 25–64 with tertiary education
	Proportion of the population 25-64 in lifelong learning or training

Source: own elaboration based on the literature listed in the table.

Human capital and regional economic growth

Regions are spatial units defined at a level lower than national, i.e. subnational regions. The Tab. 2 provides an overview of studies which analysed the impact of human capital on regional growth. In the case of Europe, the regional unit are typically defined either as NUTS 2 or NUTS 3 regions. In case of the USA, these spatial units represent individual states or metropolitan areas (Tab. 2).

The fundamental difference between studying the relationship between human capital and economic growth at national and regional level is that regions far more open economies and interactions between regions are more frequent than interactions between countries. The smaller the unit we examine, the more pronounced are flows of goods, labour, capital, but also human capital and information. It is precisely these interactions that should be incorporated into general models of economic growth.

Given that people migrate between regions and learn from people in other regions, it is appropriate to use spatial econometric models (e.g. Ramos et al. 2010; Marrocu Paci 2012; Detorri et al. 2012; Felsenstein, 2015; Ciccarelli, Fachin 2017). This group of models analyses the impact of neighbouring regions on economic growth in the examined region. The authors usually use spatially lagged variables, such as average level of human capital in neighbouring regions. Ramos et al. (2010) analysed the spatial effects of human capital in Spanish regions in the years 1980 - 2007. He confirmed the impact of education on growth, however they also found that the level of human capital in neighbouring regions has negative impact on the economic growth of the studied region. The exact mechanism of this phenomenon is not obvious, but the authors suggest that this could results from migration of educated workers and competition for jobs with higher added value. Felsenstein (2015) also confirmed the impact of human capital on wage levels in 6 regions in Israel. He also examined the role of foreign migrants with high human capital in the growth of average wages in region. What he found is that this factor was not significant or in some specification even negative.

Some authors argue that investing in education might lead to the problem with overeducation. The study by Ramos et al. (2012), however, suggest that the problem of over-education does not lead to a decline in regional economic performance but, on the contrary, to higher growth. He explains this by the existence of externalities of human capital, which we discuss later in this article.

Human capital increases total factor productivity (Vogel 2013, Marrocu, Paci 2012; Detorri et al. 2012. Vogel (2013) in a study of 159 EU-15 regions in 1992-2005 confirmed the impact of human capital on overall factor productivity in the manufacturing sector. Detorri et al (2012) found that the overall productivity of production factors in the neighbouring regions has significantly and positive impact on growth. According to Männasoo, Hein, Ruubel (2018) the impact of human capital on growth is higher in less developed regions of Western Europe compared to Eastern Europe. This finding is explained by differences in the quality of institutions.

Table 2. Human capital and regional economic growth.

Authors	Main finding	Spatial unit
Bhatta, Lobo (2000)	In the case of the 17 least developed countries, human capital explains on average 49 percent of the difference in gross government product per capita	States of the USA
Ramos et al. (2010)	Higher education in neighbouring regions has a negative impact on the economic growth of the region	NUTS 3 regions in Spain
Abel, Gabe (2011)	An increase in the educational level by 1 percent leads to an increase in GDP per capita by 2 percent	290 metropolitan regions in the USA
Ramos et al. (2012)	Over-education does not lead to a decline in regional economic performance but, on the contrary, to higher growth	NUTS1 to NUTS3 regions in 7 EU countries
Marrocu, Paci (2012)	Highly educated graduates working in creative professions have the highest influence on the overall productivity of factors, highly educated graduates working in creative professions have a lower influence and bohemians have no influence	257 NUTS 3 regions in EU27

Dettori et al. (2012)	A substantial part of the total factor productivity is influenced by intangible factors, including human capital, and also found the spatial effects of the TFP of the surrounding regions, especially at a distance of up to 300 km	199 EU regions (NUTS 1 and 2)
Vogel (2013)	Positive impact of human capital on the growth of total factor productivity	159 NUTS2 regions
Felsenstein (2015)	Confirmed the impact of human capital on wages, the inflow of educated foreign migrants does not increase the average wage	6 regions in Israel
Ciccarelli, Fachin (2017)	Regions with higher human capital recorded higher growth in industrial production in the period 1871–1911	69 NUTS3 regions in Italy
Männasoo, Hein, Ruubel (2018)	The impact of human capital on total factor productivity is most significant in regions farther from the production frontier, the impact of human capital is less significant in Eastern Europe	99 NUTS1 EU regions

Source: own elaboration based on the literature listed in the table

Regional migration and human capital externalities

The literature review revealed that there are two specific topics in the discussion at the regional level. The first factor is the mobility of human capital. If education is a key mechanism for human capital formation, then migration is the main mechanism by which human capital is redistributed in space. The lower is the spatial level the weaker is the relation between investment in a regional education system and aggregate human capital in the region, as some school leavers will migrate to other regions after graduation.

As we showed earlier, people with higher education are concentrated in most urbanized regions. The spatial proximity of individuals with higher education allows more frequent interactions and mutual learning. The second specific topic in regional research are the externalities of human capital. Externalities increase productivity of companies and raise wages of workers in regions with a high supply of human capital. In the following part, we will therefore focus on the description of the main theoretical mechanisms as well as the results of empirical research in this area.

Human capital theory of migration

The theoretical concept that describes migration from the perspective of human capital follows the ideas of Harris and Todaro (1970) and Sjaastad (1962). In this view, education is considered to be an investment decision. Consequently, individuals decide to migrate from the home region if the net present value of their education investments is higher in other region. In other words, an individual compares the expected utility in different regions, and if the expected net increase in utility is positive, it moves. The decision on migration between regions j and k is formally a comparison of the expected utility, which is derived from the net present value of future revenues at time (0) after deducting the costs related to migration. We can write this decision as follows:

$$NPV_i = E\{U[R_j(0)]\} < E\{U[R_k(0)]\} - E[C_{jk}(0)] \quad (2)$$

where

NPV – net present value

$E\{U[R_j(0)]\}$ – expected utility from revenues in region j ,

$E\{U[R_k(0)]\}$ – expected utility from revenues in region k ,

$E[C_{jk}(0)]$ – expected costs of migration from j to k .

The individual chooses the region with highest expected utility. Empirically, the validity of this theory is most often examined using probabilistic discrete choice models of an individual from the region o , who is deciding to move:

$$P_{ioj} = P[V_{ioj} + \varepsilon_{ioj} > V_{iok} + \varepsilon_{iok}] \forall j \neq k \quad (3)$$

where

P_{ioj} – probability of migration from region o to region j ,

V_{ioj} – vector of observed components of utility of individual i in region j ,

V_{iok} – vector of observed components of utility of individual i in region k ,

$\varepsilon_{ioj}, \varepsilon_{iok}$ – unknown random components.

Other line of research argue that non-monetary factors, such as e.g. architecture, climate, natural environment, sports and culture are also crucial factors of migration decisions. Both concepts human capital theory of migration and amenity migration show that higher educated individuals migrate more frequently as jobs and urban amenities are concentrated in space. In addition, educated individuals have also better ability to search for and analyse various options and are more adaptable to changes related to migration. As a result, individuals with high human capital migrate more frequently compared to individuals with lower education.

As documented by Winters (2018), due to migration, there is no direct relationship between the share of the

university population and the further accumulation of human capital in the region. Empirical research in the field of migration can be divided into three main topics. The first tests the hypothesis that individuals with higher human capital migrate more often. In this case, the conclusions are relatively clear. Higher education is associated with more frequent migration both for university studies (Tosi et al., 2019) and for post-school work (Faggian et al. 2013; Berck et al., 2016). The migration of individuals with higher human capital usually leads to a smaller number of economically more developed regions. Individuals do not migrate in isolation, but an important part of migration is in couples. Simon (2019) found that couples in which both partners have a university degree migrate more often to large cities than couples where only a man has such an education. It is the result of better career opportunities, especially for women (Simon 2019). Other authors have tried to use alternative definitions of human capital. Hansen and Niedomysl (2009) compared migration of the creative class with the migration of non-creative individuals and did not find any significant difference. Marinelli (2013), Berck et al. (2016) and Tosi et al. (2019) used marks from schools as an indicator of human capital, and Gordon (2015) again examined ambitions as a form of dynamic human capital. They all concluded that these characteristics have an impact on higher probability of migration and the economic benefits from it.

The second research topic is the role of wages in migration vis-a-vis the role of amenities. Empirical research agrees that migration is mainly associated with higher wages (Abreu, Faggian, McCann, 2015; Arntz 2010) that migrants earn by migrating to the most urbanized regions (Korpi, Clark 2019; Gordon 2015). In addition to higher wages, individuals in these regions also receive other labour market benefits, such as opportunities for jobs changes (Korpi, Clark 2019) and the carrier satisfaction is higher in developed urban regions (Abreu, Faggian, McCann 2015). The importance of factors related to climate, social structure and population density has not been confirmed, resp. their impact is significantly lower compared to labour market factors (Scott 2010).

Table 3. Human capital and migration.

Authors	Main result	Spatial unit
Hansen, Niedomysl (2009)	The migration of the creative class is only slightly higher than the migration of non-creative individuals	70 local labour markets in Sweden
Scott (2010)	The main migration factor are job opportunities. The importance of factors related to climate, social structure and population density has not been confirmed.	Metropolitan regions in the USA
Arntz (2010)	Interregional migration of higher educated workers is mainly the result of wage differences while migration of less educated workers is the result of differences in employment opportunities	27 aggregated planning regions (aggregation from 97 regions)
Faggian et al. (2013)	Individuals with higher education migrate more often and to a smaller number of destinations.	Artificial spatial units (circle with a diameter of 15 km)
Marinelli (2013)	University graduates who returned to their home region had worse academic results than those who migrated to work in other regions	20 NUTS2 regions in Italy
Berck et al. (2014)	Individuals with better grades from primary school migrate more often to developed regions after university graduation	17 commuting regions in Sweden
Gordon (2015)	More ambitious individuals (<i>dynamic human capital</i>) benefit more from migration to London	Dummy variables for London and its districts
Simon (2017)	Couples in which both partners have a university degree migrate more often to large cities than couples where only a man has such an education. Larger cities with a high share of human capital have better career opportunities for couples, especially women.	Metropolitan regions in the USA
Winters (2018)	An increase in the share of people with a university degree in the state (by place of birth) by 1% results in 0.52% increase the share of people with a university degree by place of residence	50 states of the USA
Tosi et al. (2019)	Individuals with better grades from secondary school migrate more often to other regions to study at university	20 NUTS2 regions in Italy
Korpi, Clark (2019)	Metropolitan regions have the highest wage premium for all migrants. University-educated individuals have higher wage growth in these regions due to better opportunities to change jobs.	3 types of regions – metropolitan, urban regions, rural regions

Source: own elaboration based on the literature listed in the table

Human capital externalities

As we mentioned earlier, the concept of human capital suggests that the increase in human capital in the economy will result in an increase in aggregate productivity. Higher productivity is associated with higher incomes. The wages in large densely populated urban regions are usually significantly higher than wages in less urbanized regions and in rural regions. Combes et al. (2008) found that the average wage in Paris is 15 percent higher compared to other large cities in France, 35 percent higher than medium-sized cities, and 60 percent higher than in rural areas. This is usually referred to the so-called urban wage premium. Higher wages in urbanized regions are associated with a higher share of higher educated workers working in knowledge-intensive sectors. From this point of view, the main source of the city wage premium is the process of spatial sorting, in which workers with higher human capital migrate to large cities. Eliasson et al. (2020) studied spatial sorting in Finland and Sweden over 3 decades and found that individuals with higher education migrate significantly more often to large cities. In addition, they found that the level of education alone is not a sufficient indicator of human capital. Individuals who had better grades in secondary school and have parents with higher education also tend to migrate to large cities (Eliasson et al. 2020).

Empirical research has also shown that an increase in aggregate productivity (at the city level) is usually higher than the effect productivity growth at the individual level. This is usually explained as the effect of human capital externalities (Moretti, 2004). The main mechanisms are as follows. Higher concentration of human capital causes faster accumulation of human capital due to easier learning from other individuals in the city. A higher concentration of educated people in agglomerations allows for easier social interactions with individuals working in the same industries. This results in localisation economies, which increase productivity of firms in the same industry (Marshall 1890). In large diversified cities, there is also greater interaction and learning from people across sectors, and this effect is known as urbanisation economies leading to higher rate of innovation (Jacobs 1969).

Empirical research in human capital externalities can be divided into two research strategies. First approach is based on comparing wages across regions with different levels of aggregate human capital. Typically, authors estimate the human capital effect using following econometric specification (based on Moretti, 2004):

$$\log(w_{ijt}) = \alpha X_{it} + \beta H_{jt} + \gamma Z_{jt} + d_j + d_t + u_{ijt} \quad (4)$$

where

w_{ijt} – wage of worker i living in region j in period t ,

X_{it} – vector of individual characteristics,

H_{jt} – aggregate human capital in region j ,

Z_{jt} – vector of regional characteristics in period,

d_j – regional fixed effects,

d_t – time fixed effects.

The coefficient of interest is β , which represents the effect of the aggregate human capital on individual wages. Second approach is based on comparison of productivity of firms located in different regions. Empirical research follows Cobb-Douglas production function (based on Moretti, 2004):

$$y_{fjmt} = A_{fjmt} L1_{fjmt}^{\alpha_{1j}} L2_{fjmt}^{\alpha_{0j}} K_{fjmt}^{\beta_j} \quad (5)$$

where

y_{fjmt} – output of the firm f from industry m located in region j in period t ,

A – total factor productivity,

$L1$ – number of hours worked by skilled workers,

$L2$ – number of hours worked by unskilled workers,

K – capital

Estimating A using following equation we can measure the effect of aggregate human capital:

$$\ln A_{fjmt} = \gamma \bar{H}_{jt} + \varepsilon_{fjmt} \quad (6)$$

where

\bar{H}_{jt} – aggregate human capital in region j in period t ,

ε_{fjmt} – unobserved factors.

The positive and significant parameter γ suggests the existence of human capital externalities. Empirical findings are presented in Tab. 4. Using firm level data Czaller (2017) found that an increase in average education in the region by one year is associated with a 3% increase in regional wages. Similarly, Liu (2014) found that an increase in the average length of education in the city by one year increases the company's productivity by 14%. Samromá and Ramos (2007) also confirmed that a one-year increase in the level of education in the region increases average wages in the region by about 6%, but this effect is not significant when using instrumental variables. According to them, this means that wage differences are not caused by externalities of human capital but rather by demand

factors. Rarely, the authors also test externalities between regions. Ramos et al. (2010) examined the existence of human capital externalities among regions in Spain but did not prove their existence.

Table 4. Human capital externalities

Authors	Output indicator	Definition of aggregate human capital	Main finding
Sanromá, Ramos (2007)	Wages	Average length of education in the city (in years)	An increase in the level of education in the region by one year increases the average wages in the region by 6 percent, but this effect is not significant in the case of regression with instrumental variables
Liu (2014)	Firm productivity	Average length of education in the city (in years)	An increase in the average length of education by 1 year increases productivity by 14%
Czaller (2017)	Wages	Average length of education in the city (in years)	An increase in the average length of education by 1 year increases wages by 3%
Melo (2017)	Wages	Proportion of the working age population with qualifications (NVQ) level 4 and above	An increase in the share of the population with higher education by 10% increases the individual wage by 0.6% - 0.9%

Source: own elaboration based on the literature listed in the table

The extent to which differences in productivity and wages are the result of the sorting of human capital or the human capital externalities is not entirely clear. Andersson et al. (2014) found that agglomeration externalities are not very high in general, but are higher in sectors where non-routine jobs predominate. In sectors where routine tasks are important, agglomeration externalities are negligible (Andersson et al., 2014). Similarly, Liu (2014) confirmed that externalities are higher in sectors with a higher share of human capital.

Policy related issues

What are the implications of these processes for regions and what recommendations for public policy can we identify? In a review article Faggian et al. (2017) discuss the positive and negative consequences of the migration of skilled people to the destination regions and origins. The accumulation of human capital in the target regions has positive effects due to increased productivity, the emergence and adoption of innovations and technologies (Faggian, McCann 2009). In addition, the inflow of migrants results in the development of local amenities and ethnic and cultural diversity (Florida et al. 2008). On the other hand, the growth in the number of educated people in region increases the prices of local goods, especially real estate prices (Moretti, 2004). Diversity growth can also pose a problem of cultural conflicts among native population and immigrants (Florida et al. 2012). The outflow of human capital from home regions is also known as the brain drain. The negative consequence of the brain drain is lower economic growth and decline of employment rate. On the other hand, the positive consequences may include the influx of remittances, the return of educated people as well as the emergence of networks that increase trade, capital transfer and knowledge flows from other regions (Faggian et al., 2017). As the concept of human capital externalities emphasizes, the concentration of human capital increases the productivity of companies and the wages of workers. The growth of human capital is also associated with social externalities, such as reduction of crime, and growth in the quality of institutions and better policy decisions (Moretti, 2004).

Regional growth is closely associated with the accumulation of human capital, which leads us to the notion that education is one of the main areas for development policies. As the social benefits of education are greater than private (due to externalities), public support has a clear justification. Moretti (2004) further discusses the problem which level of public administration is best suitable for public policy in education. If most human capital externalities take place at the local level, then education should also be organized at the local level. However, if externalities have a wider spatial scope, education should be the responsibility of regional or national authorities. Empirical research does not yield convincing results in terms of the size of human capital externalities (Moretti, 2004). It is therefore not possible to estimate what the amount of public support should be dedicated to education.

There is no simple relationship between education and the accumulation of human capital in the region. If the regional labour market is not attractive enough in terms of wages and career opportunities, graduates will migrate to other regions. Therefore, policy should also target on the migration flows of educated people (Reiner, 2010). Attraction and retention of university graduates is important especially for lagging regions. Examples of policy instruments in this area are labour market related measures focused on attraction of graduates by e.g. green card

system or information systems that identify shortcomings at the regional labour market. Measures in the field of higher education may also be important. These measures focus on participation in higher education with aim to attract students from other regions or attract graduates who have studied outside the region (Leguizamón, Hammond, 2015). Finally, large part of measures focus on the access to housing and investment in the quality of regional amenities (Mathur, Stein, 2005; Coniglio, Prota, 2007).

Conclusions

The aim of this article was to identify main theoretical and empirical approaches to the regional dimension of the human capital theory. In this paper, we analysed articles published in the four most prestigious journals in the field of regional science, regional studies and economic geography. The concept of human capital has received a significant attention from authors who explore economic processes at the regional level. A review of the articles showed that the relation between human capital and regional development has several specific features. These results from the key characteristics of regional economies, which are their openness, mutual interdependence and existence of agglomeration economies. Hence, theoretical and empirical research at the regional level highlights the role of interregional migration, and the role of human capital in externalities in dense urban agglomerations.

In addition to an overview of the results of empirical research, an important part of this article is a discussion of policy options to influence the accumulation of human capital in the regions. The greater complexity of the processes associated with the accumulation of human capital in the regions requires policies tailored to the needs of the regions.

There are several areas of research, which are getting relatively less attention. For example, the sectoral dimension of human capital is a relatively little explored area. Here we can include e.g. issues of coherence between the structure of education and the necessary qualifications in the region. The education job matching is an important policy issue, as it affects both decision-making on the structure of education and on labour market policies. Another topic that needs to be addressed in the future is the issue of the quality of education. There are significant differences in the quality of schools, so we can expect that the quality of education will affect the economic processes in the regions.

Acknowledgement

The paper was supported by the project VEGA 1/0774/19 Accumulation of human capital in the regions - economic and social consequences.

References

- Abel, J. R., & Gabe, T. M. (2011). Human capital and economic activity in urban America. *Regional Studies*, 45(8), 1079-1090.
- Abreu, M., Faggian, A., & McCann, P. (2015). Migration and inter-industry mobility of UK graduates. *Journal of Economic Geography*, 15(2), 353-385.
- Andersson, M., Klaesson, J., & Larsson, J. P. (2014). The sources of the urban wage premium by worker skills: Spatial sorting or agglomeration economies? *Papers in Regional Science*, 93(4), 727-747.
- Arntz, M. (2010). What attracts human capital? Understanding the skill composition of interregional job matches in Germany. *Regional Studies*, 44(4), 423-441.
- Becker, G. (1964). Human Capital. New York: NBER Columbia University Press.
- Berck, P., Tano, S., & Westerlund, O. (2016). Regional sorting of human capital: the choice of location among young adults in Sweden. *Regional Studies*, 50(5), 757-770.
- Berry, C. R., & Glaeser, E. L. (2005). The divergence of human capital levels across cities. *Papers in regional science*, 84(3), 407-444.
- Bhatta, S. D., & Lobo, J. (2000). Human capital and per capita product: A comparison of US states. *Papers in Regional Science*, 79(4), 393-411.
- Ciccarelli, C., & Fachin, S. (2017). Regional growth with spatial dependence: A case study on early Italian industrialization. *Papers in Regional Science*, 96(4), 675-695.
- Combes et al. (2008). Spatial wage disparities: Sorting matters! *Journal of Urban Economics* 63(2), 723-742.
- Coniglio, N. D., & Prota, F. (2008). Human capital accumulation and migration in a peripheral EU region: the case of Basilicata. *Papers in Regional Science*, 87(1), 77-95.
- Czaller, L. (2017). Increasing social returns to human capital: evidence from Hungarian regions. *Regional Studies*, 51(3), 467-477.
- Dettori, B., Marrocu, E., & Paci, R. (2012). Total factor productivity, intangible assets and spatial dependence in the European regions. *Regional studies*, 46(10), 1401-1416.
- Eliasson, K., Haapanen, M., & Westerlund, O. (2020). Regional concentration of university graduates: The role of high school grades and parental background. *European Urban and Regional Studies* (in press).
- Faggian, A., & McCann, P. (2009). Human capital, graduate migration and innovation in British regions. *Cambridge Journal of Economics*, 33(2), 317-333.
- Faggian, A., Corcoran, J., & McCann, P. (2013). Modelling geographical graduate job search using circular statistics. *Papers in Regional Science*, 92(2), 329-343.
- Faggian, A., Rajbhandari, I., & Dotzel, K. R. (2017). The interregional migration of human capital and its regional consequences: a review. *Regional Studies*, 51(1), 128-143.

- Felsenstein, D. (2015). Factors affecting regional productivity and innovation in Israel: Some empirical evidence. *Regional Studies*, 49(9), 1457-1468.
- Florida, R., Mellander, C., & Stolarick, K. (2008). Inside the black box of regional development—human capital, the creative class and tolerance. *Journal of economic geography*, 8(5), 615-649.
- Florida, R., Mellander, C., Stolarick, K., & Ross, A. (2012). Cities, skills and wages. *Journal of Economic Geography*, 12(2), 355-377.
- Gordon, I. R. (2015). Ambition, human capital acquisition and the metropolitan escalator. *Regional Studies*, 49(6), 1042-1055.
- Hansen, H. K., & Niedomysl, T. (2009). Migration of the creative class: evidence from Sweden. *Journal of economic geography*, 9(2), 191-206.
- Harris, J. R., & Todaro, M. P. (1970). Migration, unemployment and development: a two-sector analysis. *The American economic review*, 60(1), 126-142.
- Jacobs, J. (1969). *The Economy of Cities*. New York: Random House.
- Korpi, M., & Clark, W. A. (2019). Migration and occupational careers: The static and dynamic urban wage premium by education and city size. *Papers in Regional Science*, 98(1), 555-574.
- Leguizamón, J. S., & Hammond, G. W. (2015). Merit-based college tuition assistance and the conditional probability of in-state work. *Papers in Regional Science*, 94(1), 197-218.
- Liu, Z. (2014). Human capital externalities in cities: evidence from Chinese manufacturing firms. *Journal of economic geography*, 14(3), 621-649.
- Lucas R. (1988). On the Mechanism of Economic Development, *Journal of Monetary Economics*, 22, 3-42.
- Männasoo, K., Hein, H., & Ruubel, R. (2018). The contributions of human capital, R&D spending and convergence to total factor productivity growth. *Regional Studies*, 52(12), 1598-1611.
- Marinelli, E. (2013). Sub-national graduate mobility and knowledge flows: An exploratory analysis of onward-and return-migrants in Italy. *Regional Studies*, 47(10), 1618-1633.
- Marrocu, E., & Paci, R. (2012). Education or creativity: What matters most for economic performance? *Economic geography*, 88(4), 369-401.
- Marshall, A. (1890). *Principles of Economics*. New York: MacMillan.
- Mathur, V. K., & Stein, S. H. (2005). Do amenities matter in attracting knowledge workers for regional economic development?. *Papers in Regional Science*, 84(2), 251-269.
- Melo, P. C. (2017). People, places and earnings differentials in Scotland. *Regional Studies*, 51(3), 389-403.
- Mincer, J. (1958). Investment in human capital and personal income distribution. *Journal of political economy*, 66(4), 281-302.
- Moretti, E. (2004). Human capital externalities in cities. In Henderson, V. & Thisse, J. F. (2004). *Handbook of regional and urban economics*, 4, North Holland: Elsevier.
- Qian, H. (2017). Skills and knowledge-based entrepreneurship: evidence from US cities. *Regional Studies*, 51(10), 1469-1482.
- Ramos, R., Suriñach, J., & Artís, M. (2010). Human capital spillovers, productivity and regional convergence in Spain. *Papers in Regional Science*, 89(2), 435-447.
- Ramos, R., Surinach, J., & Artís, M. (2012). Regional economic growth and human capital: the role of over-education. *Regional Studies*, 46(10), 1389-1400.
- Reiner, C. (2010). Brain competition policy as a new paradigm of regional policy: A European perspective. *Papers in Regional Science*, 89(2), 449-461.
- Rodríguez-Pose, A., & Vilalta-Buffi, M. (2005). Education, migration, and job satisfaction: the regional returns of human capital in the EU. *Journal of Economic Geography*, 5(5), 545-566.
- Romer, P. M. (1986). Increasing returns and long-run growth. *Journal of political economy*, 94(5), 1002-1037.
- Sanromá, E., & Ramos, R. (2007). Local human capital and productivity: an analysis for the Spanish regions. *Regional Studies*, 41(3), 349-359.
- Scott, A. J. (2010). Jobs or amenities? Destination choices of migrant engineers in the USA. *Papers in Regional Science*, 89(1), 43-63.
- Simon, C. J. (2019). Migration and career attainment of power couples: the roles of city size and human capital composition. *Journal of Economic Geography*, 19(2), 505-534.
- Sjaastad, L. (1962). The costs and returns of human migration. *Journal of Political Economy*, 70(5), 80-93.
- Tosi, F., Impicciatore, R., & Rettaroli, R. (2019). Individual skills and student mobility in Italy: a regional perspective. *Regional Studies*, 53(8), 1099-1111.
- Vogel, J. (2015). The two faces of R & D and human capital: Evidence from Western European regions. *Papers in Regional Science*, 94(3), 525-551.
- Winters, J. V. (2018). Do higher college graduation rates increase local education levels?. *Papers in Regional Science*, 97(3), 617-638.