Creativity, Education or What? On the Measurement of Regional Human Capital

Eckhardt Bode,
Lucia Perez Villar

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Abstract:
This paper substantiates the debate following Richard Florida's suggestion to measure regional human capital by creative occupations rather than education. Consistent with Florida's notion of creativity, it suggests a microfoundation that relates creativity to workers' cognitive and noncognitive skills. It shows that this microfoundation is similar to that of human capital in recent labor economics, which has facilitated important new insights. It also shows that Florida's measure is too crude to make a difference. Nonetheless, it is time to rethink regional human capital. Occupations may help project workers' cognitive and noncognitive skills from the micro to the regional level.

Keywords: Human Capital, Education, Creativity, Cognitive Skills, Noncognitive Skills, Occupation, Regional Wages, Regional Growth.

JEL classification: I21, I25, J24, R12, R23

Echkhardt Bode (corresponding author)
Kiel Institute for the World Economy

D-24105 Kiel, Germany
Phone +49 431 8814462
Email: eckhardt.bode@ifw-kiel.de

Lucia Perez Villar
Kiel Institute for the World Economy,
and University of Kiel
D-24105 Kiel, Germany

Email: l.perez-villar@economics.uni-kiel.de

1. Introduction

There is frequently quite some mismatch between what we intend to measure and what we actually do measure in empirical economics and other disciplines of social science. Human capital offers an example of this mismatch.[1] While most economists agree that human capital is more than just formal education, they also agree that the population or employment share with a bachelor degree or higher measures human capital sufficiently well at the aggregate, regional or national level. Enrico Moretti, for example, introduces his 2004 review article on human capital externalities by saying (Moretti 2004: 2245):

> "After 40 years of research on the relationship between education and earnings, economists have a good idea of the private benefits of human capital. We know that individuals with more education earn more, and most empirical work suggests that this difference in earnings is in fact a reflection of education per se and not a result of differences in unmeasured worker characteristics."

More recent studies like Gennaioli et al. (2013) corroborate this view. Measuring aggregate human capital in terms of formal education is convenient not only because data on educational attainment is readily available for almost all countries and regions over a long period of time. It is also convenient because education-based measures are reasonably well-founded in microeconomic theory. Human capital investment theory (Mincer 1958, Becker 1964) establishes a systematic positive relationship between a worker's earnings and her educational attainment and work experience (Card 1999). This relationship can, with only a few, moderately restrictive assumptions, be aggregated across workers to establish a systematic positive relationship between average regional (national) wages and average education and age of the regional (national) workforce or population.

Richard Florida (2002) has challenged the widespread agreement among economists about measurement of regional human capital.[2] Emphasizing that it is "more important to measure what people do rather than what they study" (Mellander and Florida 2011: 639) he suggests a broader measure of human capital that reflects not only potential talent or skill but also takes into account how this talent or skill is actually utilized in the economy (Florida et al. 2008: 618). He claims to measure "creativity" in his 2002 book but later agrees with Glaeser (2005) in that the terms creativity and human capital are synonyms (Florida 2004: 3). He clarifies, though, that creativity, alias human capital, is shaped not only by intelligence, schooling or

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[1] Welfare is another prominent example (e.g., Stiglitz et al. 2009). While economists have known perfectly well that households' well-being is shaped by a variety of economic, environmental and psychological factors, most of them have agreed in that it is measured sufficiently well by just monetary income.

[2] Measurement issues are not the primary focus of his bestselling book titled "The Rise of the Creative Class", though. The book focuses on the arguably crucial role of "creative" workers for contemporary and future development of firms and cities in highly developed countries and on those local cultural amenities that are arguably valued particularly highly by these workers: mind-openness, tolerance and diversity.

work experience but also by a variety of personal characteristics, including self-assurance, motivation, the ability to synthesize and to take risks (Florida 2002: 31).

Florida actually measures the regional stock of human capital by the share of workers in specific knowledge-intensive occupations, his so-called "creative class" (Florida 2002, Appendix 1).[3] While he describes the characteristics of creative workers fairly accurately in theory (see Section 3 below), he does nonetheless not succeed in mapping these characteristics into similarly accurate criteria for defining his actual measure. In addition to its conceptual deficiencies, the measure comes with a rather diffuse "creative capital theory of city growth" (Glaeser 2005: 594), which policy makers may love but most economists and quite a few economic geographers and urban planners find hard to swallow (see Glaeser 2005, Markusen 2006, Scott 2006, among many others). Both factors, the lack of rigor in the delineation of creative occupations and the more general reservations against Florida's "theory", may have led many scholars to reject even Florida's call for better measurement of human capital.

On this backdrop, the present paper takes stock of the recent discussion on the measurement of human capital in regional economics and substantiates this discussion. The paper takes stock by reviewing the empirical literature in regional economics that aims at testing Florida's creativity measure of human capital against the traditional education-based measure. It argues that this literature is not too insightful because it tests inferior measures of human capital against each other and suffers from a several methodological shortcomings. The paper substantiates the discussion by suggesting an economic microfoundation of Florida's notion of creativity that turns out to be very similar to the microfoundation of human capital in modern labor economics, and showing that this new microfoundation of human capital in labor economics has facilitated empirical insights that go far beyond the insights facilitated by the traditional human capital investment theory.

To obtain the microfoundation of creativity, the paper traces Florida's notion of creativity back to its roots in psychology and interprets it in terms of a "creativity production function" that relates a worker's creativity to those skills and external factors that, according to psychological studies, shape a worker's creativity. The skills include both cognitive (intelligence) and noncognitive skills (personality). It is precisely these cognitive and noncognitive skills that are considered the main determinants of human capital in modern labor and education economics. Scholars like James Heckman (e.g., Heckman and Rubinstein 2001) have successfully adopted insights from psychology to model an individual's human capital as a function

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[3] Florida subdivides these "creative class" occupations into two groups by means of 1-digit items of the Standard Occupation Classification: the "super-creative core" (computer and math occupations, architecture and engineering, life, physical, and social science, education, training, and library positions, arts and design work, and entertainment, sports, and media occupations) and "creative professionals" (management occupations, business and financial operations, legal positions, healthcare practitioners, technical occupations, and high-end sales and sales management). In addition to this creative class, Florida defines two more mutually exclusive classes, the "working class", which comprises occupations that perform physical work, and the "service class", which comprises occupations that perform routine services.

of her endowments with cognitive and noncognitive skills. They show empirically that personality matters for a variety of educational and labor market outcomes (Almlund et al. 2011). It affects outcomes like labor market participation, occupational choice, productivity and wages not only through educational attainment but also directly. It thus helps explain why workers with similar education levels choose different occupations and earn different wages. The striking similarity between Heckman and Florida in modeling human capital, resp. creativity, is complemented by their similar motives for rethinking human capital. Both of them start from the critique of the traditional Becker-Mincer approach in their respective fields. Both are particularly dissatisfied with the neglect of personality in the traditional models and measures of human capital. These similarities corroborate, on the one hand, Glaeser's view: What Florida labels creativity is actually human capital (Glaeser 2005: 594). On the other hand, these similarities substantiate Florida's call for more informative measures of human capital in regional economics. Like in labor economics, these measures may facilitate new insights into the causes of regional differences in wages, innovativeness and growth as well as into the factors driving spatial sorting of workers and industries. Rather than discarding Florida's call right away, regional economists should acknowledge the recent advances in labor economics and think about how to benefit from these advances. A good deal of creativity is still warranted to develop measures of regional human capital that account for both cognitive and noncognitive skills, though.

The next section traces Florida's notion of creativity back to its psychological roots at the level of individuals and shows that its determinants, as discussed in psychology, are essentially the same as the microeconomic determinants of human capital advocated in recent labor and education economics. Section 3 reviews the empirical literature that aims at testing the two measures of human capital, formal education and creativity, against each other with respect to their effects on regional outcomes. Section 4, finally, concludes the paper by discussing options to develop a more comprehensive measure of regional human capital.

2. Creativity and human capital: Microeconomic foundation

While Florida does not define creativity explicitly in his 2002 book or his subsequent articles, definitions of creativity are available from psychologists as well as from economists.[4] Psychologists have been investigating creativity extensively since the middle of the last century at least (Funke 2009). This section starts by defining creativity, focusing on two definitions, one by Teresa Amabile, a management psychologist, and one by Åke Andersson, an economist. It then interprets theses definitions in terms of a microeconomic production function, and finally

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[4] Florida's discussion of his notion of creativity (Florida 2002: 30–35) and his characterizations of creative people (see Section 3; Florida 2002: 69) suggest that he borrows heavily from standard psychological notions of creativity, though.

shows that the psychological determinants of creativity are essentially what labor economists have labeled cognitive and noncognitive skills.

Amabile (2012, p. 1) defines creativity as "the production of a novel and appropriate response, product, or solution to an open-ended task". Andersson (2011) defines it as "a process that gives rise to a flow of ideas from an individual or a group of individuals. For the process to be regarded as creative, relevant experts will – sooner or later – have to judge the flow of ideas as new and at least potentially useful for consumers, producers or other creators" Andersson (2011: 14). Three elements of these definitions are particularly useful for economic interpretations of creativity. First, they request relevant outcomes of creativity to be new. This element links creativity to invention. Second, they focus on appropriate, i.e., economically valuable and feasible, outcomes. This element links creativity to innovation, i.e., economically valuable invention, while excluding economically valueless inventions.[5] And third, they characterize creativity as a production process. This element links creativity to microeconomic production theory.

Conceptually similar to knowledge or innovation production functions (Griliches 1979, Romer 1990) we may thus postulate a general microeconomic creativity production function of the form

(1) $\Gamma_i = f_{1\Gamma}(\mathbf{X}_i)$

that describes how a worker i maps specific inputs, the vector $\mathbf{X}_i$, and some production technology, $f_{1\Gamma}(\cdot)$, into valuable creative output, Γ_i. While neither the inputs nor the technology are specified explicitly in Amabile's or Andersson's definitions, they are discussed extensively in the psychological literature under varying labels. Amabile (2012), for example, labels them 'components' in her 'Componential Theory of Creativity' while Sternberg (2006) labels them 'resources' in his 'Investment Theory of Creativity'.[6] Sternberg categorizes them by six groups: Intellectual skills, knowledge, thinking style, personality, motivation, and environment.[7]

(1) The *intellectual skills* relevant for creativity are synthetic skills that help approach problems from new, unconventional perspectives, analytic skills that help separate promising

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[5] From a psychologist's perspective, Runco and Jaeger (2012) consider these two elements the crucial requirements of the "standard" definition of creativity.

[6] Even some features of the production technology are discussed under the label "confluence" in Sternberg (2006, p.90). We will not focus too much on the technology in this paper, though. It may be rather complex because some of the inputs (listed below) tend to complement each other while others tend to substitute for each other, according to Sternberg (2006, p. 89). For example, intrinsic motivation will not work without sufficient intellectual skills and knowledge but may help overcome a conservative environment. In addition to this, thresholds and non-linearities may be an issue. While too little knowledge will be an obstacle to creativity and a medium amount of knowledge will complement an innovative thinking style, too much specialized knowledge may create kind of lock-in effects by inducing people to think more adaptively rather than innovatively. Economists do, however, have a long tradition of approximating complex production processes by rather simple and stylized yet insightful production functions.

[7] Amabile groups essentially the same factors into four groups of components: domain-relevant skills, creativity-relevant skills, task motivation and environment.

from less promising ideas, and contextual skills that help convince others of the value of an idea.

(2) *Knowledge* is needed to understand problems technically and explore the domains of their possible solutions.

(3) *Thinking style* (or *cognitive style*) is the way skills are deployed. The adaption-innovation model, for example, locates individual's styles of problem solving on a continuum between adaption and innovation (Kirton 1976). Adaptive thinkers stay within a familiar paradigm and try doing things better while innovative thinkers go beyond existing paradigms and try doing things differently. From this perspective, innovative thinking may be considered as being more conducive to creativity than adaptive thinking.

(4) The *personality* traits considered particularly relevant for creativity are independence and self-efficacy, determination, self-discipline, tolerance for ambiguity and tolerance for risks.

(5) *Motivation* is essentially intrinsic motivation, i.e., doing things out of passion and curiosity rather than out of monetary incentives.

(6) The *environment*, finally, represents the factors outside the individual that may encourage or discourage individual creativity. It includes the cultural, social, regional and business environment. For example, management practices that are open to suggestions and criticism and that support individual responsibility and collaboration in diversely skilled teams will encourage creativity. Likewise, social or cultural norms or habits that raise neighbors' and friends' curiosity rather than skepticism about unconventional, innovative ways of thinking and behavior will encourage creativity.[8]

Denoting the five groups of personal resources just introduced by the vectors $\mathbf{X}_{1i} - \mathbf{X}_{5i}$ and the group of environmental factors by the $\mathbf{E}_i$, we rewrite the creativity production function (1) as

(2) $\qquad \Gamma_i = f_{2\Gamma}(\mathbf{X}_{1i}, \dots, \mathbf{X}_{5i}, \mathbf{E}_i),$

where the vector $\mathbf{X}_{1i}$, for example, collects all the facets of the intellectual skills that shape creativity.

The production function in (2) rests on a broader notion of human capital (alias creativity) than the traditional human capital investment theory. Rather than just formal schooling and experience, it covers a whole battery of personal resources that may account better for the multifaceted nature of human capital. It does, however, not facilitate aggregation of human capital across workers to the regional level as easily as the traditional theory because data on personal resources are available only from surveys that cover only small fractions of the population of workers and are usually not representative at the regional level. As we will argue in

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[8] Florida strongly emphasizes the interdependence between environment and creativity in his 2002 book, arguing that an open-minded, tolerant and diverse local environment is, on the one hand, fostering individuals' creativity and, on the other hand, attracting creative people.

the concluding section, exploring alternative ways to do this aggregation may nonetheless be a fruitful task for future research.

Interestingly, the microeconomic approach to modelling creativity just sketched is very similar to the approach to modelling human capital in recent labor and education economics. Scholars like James Heckman also attribute an individual's human capital to a battery of personal characteristics, summarized in two groups, cognitive skills (intelligence) and noncognitive skills (personality).[9] Similar to Florida, labor and education economists exploit insights from psychological research extensively to explain economic phenomena but go one step ahead by formulating rigorous economic or econometric models to more carefully investigate the causal links and interdependencies between personal characteristics and labor market outcomes or educational achievements. To clarify the similarity of this approach to the creativity production function in (2), we interpret it in terms of a "human capital production function", which, in its simplest form, may read

$$(3) \qquad H_i = h(\mathbf{C}_i, \mathbf{N}_i, \mathbf{E}_i, \mathbf{Z}_i).$$

$\mathbf{C}_i$ is a vector of worker i's cognitive skills, which include the first three inputs to creativity listed above: intellectual skills, knowledge and thinking style, i.e. $\mathbf{C}_i = \{\mathbf{X}_{1i}, \mathbf{X}_{1i}, \mathbf{X}_{3i}, ...\}$. $\mathbf{N}_i$ is a vector of her noncognitive skills, which include the fourth and fifth inputs to creativity: personality traits and motivation,[10] i.e., $\mathbf{N}_i = \{\mathbf{X}_{4i}, \mathbf{X}_{5i}, ...\}$. In addition to these skills, the vectors $\mathbf{E}_i$ **and** $\mathbf{Z}_i$ control for, respectively, environmental factors, the sixth input to creativity, and physical individual characteristics such as age, sex, physical strength or beauty. Almlund et al. (2011) interpret the various cognitive and noncognitive skills as personal endowments that give rise to comparative advantages. Knowing about their own endowments, workers can be expected to exploit their comparative advantages by deliberately choosing their schooling, occupations and professional careers so as to maximize their utility.

From the empirical perspective, models like (2) or (3) are generally estimable parametrically or non-parametrically for a sample of workers even though the outcomes, Γ_i or H_i, are unobservable, if they are complemented by a model that relates creativity or human capital to some observable outcome such as earnings, innovativeness or occupational choice. Cognitive skills are typically measured by IQ scores or test scores of standardized assessments of mathematics, reading and science achievements like OECD's PISA tests (Hanushek and Woessmann 2008, Brunello and Schlotter 2011). Since the scores for the different facets of cognitive skills assessed by such tests are highly correlated with each other, they are frequently summarized by a single common factor, the so-called general intelligence factor "g". Measures of noncognitive skills are typically derived from test scores for the so-called "Big Five" (Goldberg 1990), a broadly accepted taxonomy that groups various facets of noncognitive skills

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[9]   See Bowles et al. (2001), Hanushek and Woessmann (2008), Borghans et al. (2008), Almlund et al. (2011) and Brunello and Schlotter (2011) for surveys of this literature.

[10] Borghans et al. (2008) assume motivation to be an argument of the individuals utility function, though.

into five categories: openness to experience, conscientiousness, extroversion, agreeableness and neuroticism. Table 1 gives a more detailed list of traits in these categories.[11] Unlike the cognitive skills, the various noncognitive skills covered by the Big Five are only weakly correlated with each other across individuals (Deke and Haimson 2006).[12] This suggests that the noncognitive skills may better be measured by a vector of individual test scores or a sufficient number of common factors derived from these scores rather than by a single composite indicator.

While empirical research on the effects of cognitive and noncognitive skills on labor market outcomes is still pretty much in its infancy, and while some empirical findings should be considered preliminary, this research has generated a variety of relevant and interesting insights in labor economics. Heckman and Rubinstein (2001) find, for example, that noncognitive skills are in fact priced in the labor market. Comparing two groups of US workers to each other who arguably share the same level of formal education, namely high-school graduates and General Educational Development (GED) recipients,[13] they show that the latter earn lower wages not because they are less intelligent but because they lack specific noncognitive skills, as evidenced by their more extensive criminal activity in the past. Cawley et al. (2001) and Heckman et al. (2006) find that cognitive and noncognitive skills explain wages not only indirectly through educational attainment. These skills additionally affect wages directly. While the magnitude of the direct effects is still subject to debate,[14] this finding is an important motivation for the present paper and should alert regional economists. It does, in fact, suggest that formal education measures regional human capital only imperfectly.

Cognitive and noncognitive skills have also been found to affect occupational choices. Microeconometric studies such as those reviewed in Almlund et al. (2011: 110—111) as well as John and Thomsen (2014) suggest that workers do in fact tend to self-select into occupations whose skill requirements match their own endowments of cognitive and noncognitive skills. They also suggest that markets value, in terms of wages, noncognitive skills differently in different occupations. This is especially true for skills related to conscientiousness, agreeableness, self-esteem and locus of control. This microeconometric evidence tends to corroborate

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[11] Other, narrower measures of noncognitive skills used in labor or education economics are the Rotter measure of internal locus of control (own ability to influence outcomes) or measures of self-esteem. Noncognitive skills are typically measured less precisely than cognitive skills because they are frequently based on self-assessments, which are subject to significant measurement errors (Hanushek and Woessmann 2008). Heckman et al. (2006) account for these measurement errors by assuming that these observed scores depend on unobserved skills.

[12] The noncognitive skills are also only weakly correlated with the cognitive skills across individuals (Deke and Haimson 2006).

[13] The GED program is a second-chance program for high-school dropouts to earn a degree (GED certificate) that is equivalent to a high-school diploma. The control group is US high-school graduates who did not go on to college. See Heckman et al. (2011b) for a review of the extensive research on the GED program.

[14] Recent results by Heckman et al. (2011a, 2014) indicate that earlier studies may have overstated the direct effects of noncognitive skills on wages.

Table 1. Big Five Personality Traits

Dimension → Short description	Facet (correlated trait adjective)
Openness (vs. Closedness) to Experience → Tendency to be open to new aesthetic, cultural or intellectual experience	Ideas (curious) Fantasy (imaginative) Aesthetics (artistic) Actions (wide interest) Feelings (excitable) Values (unconventional)
Conscientiousness (vs. Lack of Direction) → Tendency to be organized, responsible and hardworking	Competence (efficient) Order (organized) Dutifulness (not careless) Achievement striving (thorough, ambitious) Self-discipline (not lazy) Deliberation (not impulsive)
Extroversion (vs. Introversion) → Orientation of one's interests and energies toward the outer world of people and things rather than the inner world of subjective experience; characterized by positive affect and sociability	Gregariousness (sociable) Assertiveness (forceful) Activity (energetic) Excitement-seeking (adventurous) Positive emotions (enthusiastic) Warmth (outgoing)
Agreeableness (vs. Antagonism) → Tendency to act in a cooperative, unselfish manner	Trust (forgiving) Straightforwardness (not demanding) Altruism (warm) Compliance (not stubborn) Modesty (not showing off) Tender-mindedness (sympathetic)
Neuroticism (vs. Emotional Stability) → Neuroticism: Chronical level of emotional instability and proneness to psychological distress → Emotional Stability: Predictability and consistency in emotional reactions, with absence of rapid mood changes	Anxiety (tense) Angry hostility (irritable) Depression (not contented) Self-consciousness (shy) Impulsiveness (moody) Vulnerability (not self-confident)

Sources: Mueller and Plug (2006: 5), Almlund et al. (2011: 44–45).

Florida's idea to measure regional creativity, alias human capital, through occupations. If workers do indeed select into occupations whose skill requirements match their own endowments as closely as possible, the occupational composition of a region's workforce may actually carry valuable information about its endowments with cognitive and noncognitive skills.

To sum up, the microeconometric evidence in labor economics suggests that a region's endowment with cognitive and noncognitive skills, embodied in its workforce, may be able to explain regional outcomes such as the average wage rate, average productivity, innovative-

ness, income growth or ability to cope with adverse shocks better than the than its endowment with university graduates. It also suggests that a region's occupational composition may be informative about its endowment with cognitive and noncognitive skills. This generally corroborates Florida's suggestion to better measure a region's human capital stock by means of occupations rather than by means of formal education. The next section will explore to what extent the actual occupation-based measure Florida suggests, the "creative class", is superior to the traditional education-based measure of human capital in explaining regional outcomes.

3. Educational attainment versus creativity: Discriminatory evidence

Several empirical studies aim at testing whether or not Florida's measure of the "Creative Class" explains aggregate outcomes better than the traditional measure of human capital, formal schooling. Most of these studies use regions, cities or metropolitan areas as their units of analysis and seek to assess the effects of creativity and educational attainment on regional outcomes from a static (levels) or a dynamic perspective (growth rates). A few studies use firm-level data to assess the effects of creativity on firms' innovativeness (Antonietti 2013). We are not aware of a single study using individual-level data.

Most studies test creativity against educational attainment by regressing some outcome variable, Y_{rt}, on creativity, Γ_{rt}, educational attainment, S_{rt}, and a set of control variables, $\mathbf{Z}_{rt}$ for a cross section or panel of regions:

$$(4) \qquad Y_{\mathrm{rt}} = \gamma\Gamma_{\mathrm{rt}} + \alpha S_{rt} + Z_{\mathrm{rt}}\boldsymbol{\beta} + \varepsilon_{\mathrm{rt}}.$$

r indexes regions, t time, and $\varepsilon_{\mathrm{rt}}$ is the error term. S_{rt} is usually measured by the population or employment share of persons with completed tertiary education. Γ_{rt} is measured by the employment share of occupations (or industries) considered creative by the respective authors. γ and α are the parameters of main interest that are supposed to measure the marginal effects of, respectively, creativity and educational attainment on the outcome. Some studies test creativity against educational attainment by estimating more complex systems of interrelated equations, using a "structural equation modeling" (SEM) approach. This approach will be reviewed in more detail at the end of this section.

The studies that estimate a model like (4) differ widely with respect to the outcome variable of interest, Y_{rt}, which implies that they focus on different economic mechanisms. The majority of studies focus on dynamic (growth) effects of human capital by choosing as their dependent variable the growth rate of regional population or employment,[15] or the growth rate of income, GDP per capita, wages or productivity.[16] Regressing population or employment

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[15] See Andersen et al. (2010), Boschma and Fritsch (2009), Donegan et al. (2008), Glaeser (2005), Marlet and van Woerkens (2007), McGranahan and Wojan (2007), Möller and Tubadji (2009) and Wedemeier (2012).

[16] See Donegan et al. (2008), Rausch and Negrey (2006), Möller and Tubadji (2009), Lobo et al. (2012) and Wedemeier (2012).

growth on the two indicators of human capital implies, from a growth-theoretic perspective, testing if more creative or more skilled cities generate greater production- or consumption-related dynamic externalities (of urbanization or localization) that give rise to more new jobs or attract more additional people of all kinds (creative or noncreative, skilled or unskilled). Likewise, choosing income, GDP per capita, wages or productivity growth as the outcome typically implies testing if production-related externalities monetize in faster growth of productivity or wages (for all kinds of workers).

Other studies focus on static effects of human capital by choosing as outcomes the levels of regional employment, wages, labor productivity or total factor productivity (TFP),[17] or some indicator of entrepreneurship like the number of business startups, of self-employed or of small- and medium-size firms (Boschma and Fritsch 2009, Audretsch and Belitski 2013). Regressions of wages or productivity on human capital intensities typically seek to identify the magnitudes of static skill (or profit) premia, which may result from higher individual productivity or from higher human capital externalities (e.g., Ciccone and Peri 2006), while regressions of entrepreneurship indicators on human capital intensities focus on the innovativeness of creative or skilled cities.

Studies also differ widely in their conclusions. Some studies, including Marlet and van Woerkens (2007), McGranahan and Wojan (2007), Boschma and Fritsch (2009), Möller and Tubadji (2009), Marrocu and Paci (2012, 2013) and the studies by Florida and his co-authors (Florida et al. 2008, Mellander and Florida 2011, Lobo et al. 2012) conclude that the creative class measure outperforms the educational attainment measure. Other studies, including Glaeser (2005) and Donegan et al. (2008), find the opposite result.

Several issues arise with the specification and the estimation of models like (4). We focus on three of them, measurement of creativity, multicollinearity and endogeneity.

As to the measurement of creativity,[18] virtually all studies refer to Florida's notion of the creative class. Florida actually describes the characteristic features of creative workers fairly accurately in theory. He characterizes the "Super-Creative Core", the most creative subset of his creative class, as comprising people "producing new forms or designs that are readily transferable and widely useful … People at the core of the creative class engage in this kind of work regularly; it's what they are paid for" (Florida 2002: 69). And he characterizes the "creative professionals", the less creative subset, as people who "engage in creative problem solving, drawing on complex bodies of knowledge to solve specific problems. … People who do this kind of work may sometimes come up with methods or products that turn out to be widely useful, but it's not part of the basic job description" (Florida 2002: 69). Nonetheless,

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[17] See Florida et al. (2008), Mellander and Florida (2011), Lobo et al. (2012) and Marrocu and Paci (2012, 2013).

[18] Markusen et al. (2008) and Santos Cruz and Teixeira (2012) review the various delineations of creative employment.

these features are notoriously difficult to translate into workable criteria that may guide the delineation of creative occupations from statistical classification systems for occupations.[19] Various authors and institutions have attempted to refine and substantiate Florida's delineation of the creative class (see Markusen et al. 2008, Santos Cruz and Teixeira 2012). None of them has, however, succeeded in solving the basic problem, the lack of accurate, workable criteria for empirically delineating creativity. Like educational attainment, the occupations-based creative class indicator may therefore understate the role of noncognitive skills and of creative workers without a university degree. From this perspective, the studies reviewed here actually aim at discriminating between two conceptually inferior measures of human capital.

The second issue is multicollinearity. The lack of accurate, workable criteria for empirically delineating creativity may be among the reasons why delineations of creativity tend to be biased toward occupations with high average levels of education (Markusen 2006: 1922–1923). Measuring more or less the same thing, the two indicators of human capital intensity, Γ_{rt} and S_{rt}, are highly correlated with each other in many studies.[20] The standard deviations of their parameters may consequently be inflated, and one or even both parameters may look like lacking statistical significance. Moreover, the multicollinearity will reduce the power of discriminatory formal statistical tests. In addition to this, the parameters estimates may be rather sensitive to outliers (e.g., Rausch and Negrey 2006) or misspecification of the functional form. With high multicollinearity, a slight nonlinearity in the relationship between human capital and the outcome may notably affect the point estimates of γ or α.

Some studies try escaping multicollinearity traps by comparing the regression results of two restricted versions of (4) to each other, one where Γ_{rt} is omitted and the other where S_{rt} is omitted (e.g., Donegan et al. 2008, Boschma and Fritsch 2009, or Wedemeier 2012). None of these studies formally tests these two restricted versions against each other by, for example, a J test. Other studies find only one of the two parameters in (4), γ or α, to be significant while the other is smaller and insignificant. For example, Glaeser (2005) finds educational attainment to outperform creativity in explaining employment growth in US metropolitan areas, using Florida's data on the creative class. Marlet and van Woerkens (2007) find the opposite for the 50 largest Dutch cities, by contrast. Again other studies (Marrocu and Paci 2012, 2013) reduce multicollinearity by dividing the population of high-skilled workers into "creative graduates" and "non-creative graduates". Using a more disaggregated classification of

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[19] For example, the 2010 Standard Occupational Classification characterize "Administrative Law Judges, Adjudicators, and Hearing Officers" (SOC 23-1021) as workers who "Conduct hearings to recommend or make decisions on claims concerning government programs or other government-related matters. Determine liability, sanctions, or penalties, or recommend the acceptance or rejection of claims or settlements" (http://www.bls.gov/soc/2010/soc231021.htm). Florida classifies these workers as creative professionals, similar to all workers in "Legal Occupations" (SOC 23). But how creative are they actually? Or why exactly should they be considered creative?

[20] This correlation differs across studies, though. While Glaeser (2005), Florida et al. (2008) and Möller and Tubadji (2009) report fairly high correlations (r > 0.7) between the shares of creative and highly educated workers, Lobo et al. (2012) report a more moderate correlation (r = 0.484).

occupations than Florida, Marrocu and Paci define creative graduates from the European Labor Force Survey by means of those occupations from Florida's super-creative core whose labels suggest that a university degree is mandatory. Non-creative graduates are all the other university graduates. They find that that both creative and non-creative graduates contribute significantly to explaining TFP in 2007 (Marrocu and Paci 2012) as well as labor productivity and TFP growth 2002–2007 (Marrocu and Paci 2013). They estimate somewhat higher elasticities for creative than for non-creative graduates, though. While Marrocu and Paci control for the effects of Bohemians, which they find to be insignificant, they do not account for possible effects of creative nongraduates, i.e., workers who dispose of noncognitive skills conducive to creativity (resp. innovation) but just lack a university degree. This may bias their estimated parameter of creative graduates upward.

The third issue is endogeneity of the measures of human capital. The estimated parameters of human capital may be biased by (i) common temporary shocks that affect both human capital and the outcome alike, (ii) omitted structural variables that are correlated with both human capital and the outcome, and (iii) reverse causality that makes the parameters of interest pick up general equilibrium feedbacks. Reverse causality includes simultaneity, the fact that human capital and the outcome are determined simultaneously in the long-run equilibrium. Studies vary considerably in their efforts to account for potential endogeneity biases.

Biases from common temporary shocks may generally be accounted for by lagging the human-capital variables for a sufficiently long period of time. Most of the studies do in fact lag the human-capital variables by at least one year. One-year lags may not be long enough, though. Marrocu and Paci (2012) show that it takes up to five years for shocks to TFP to peter out in some European regions.

Accounting effectively for omitted variables requires controlling extensively for covariates that are correlated with both regional human capital and the outcome but are not (causally) affected by human capital. While the set of these covariates evidently depends on the specific outcome under study, it will frequently include those time-varying and time-invariant factors that affect workers' location decisions directly or indirectly. Examples of such factors include a region's size and economic density, its natural, climatic and cultural amenities, its political and regulatory system, or its industrial specialization patterns (or comparative advantages). For example, regressions of regional wages on human capital intensities may over- or understate the true skill premia of creativity or higher formal education. The true skill premia may be overstated, if average wages are higher in creative or educated cities just to compensate households for higher costs of tougher environmental or land use regulations enforced by the creative or educated people (e.g., Glaeser et al. 2014). They may also be overstated, if (average) regional wages grow faster just because less productive workers who cannot afford the costs of additional environmental or land use regulations enforced by the creative or educated move away. Or the true skill premia may be understated, if creative or educated people accept

lower wages in those cities that offer them higher amenities. Since some omitted variables are difficult—or even impossible—to measure, the set of observed control variables should be complemented by some sort of a "catch all the rest" variable. One such variable is the serial lag of the outcome, $Y_{rt-i}, i \geq 1$; another, the spatial lag of the outcome (average of neighbors' outcomes), and still another, region fixed effects. The serially lagged outcome, which is a feasible control in both cross-section and panel data models, helps eliminating history in the sense that it accounts for time-varying and time-invariant effects that affected the outcome in the past up to time $t - i$. This includes spatial sorting of human capital in past—but not contemporary spatial sorting. The spatially lagged outcome, which is also a feasible control in cross-section or panel data models, helps eliminating time-varying and time-invariant regional specificities that change only smoothly across space.[21] Finally, region fixed effects, which are feasible controls only in panel data models, account for time-invariant unobserved effects.

Some studies put considerable effort in accounting for omitted variables. Audretsch and Belitski (2013) use a large variety of observed controls in their cross-section model, and Marlet and van Woerkens (2007) use the spatial lag of the outcome variable. Möller and Tubadji (2009) adopt a dynamic panel data approach with region fixed effects to explain regional employment growth in West Germany 1975–2004, estimating the parameters by GMM (Arellano-Bond). Since each period covers five years in Möller and Tubadji's panel dataset, their serially lagged dependent variable possibly controls rather successfully for omitted variables without being subject to common temporary shocks.[22] Wedemeier (2012) adopts a less conventional panel data approach to explain employment growth in German regions. Like Möller and Tubadji, he pools across several five years' periods. These periods are non-consecutive, though (1980-1986, 1989-1995, 1998-2004). And rather than from the initial year, he takes the serial lag of employment from three years before this initial year, i.e., from 1977, 1986 and 1995, respectively, arguably to mitigate possible endogeneity biases even without instrumentation. However, Wedemeier reintroduces endogeneity problems by using a fixed effects panel data estimator that estimates the parameters from the demeaned regression model. Since the control variable overlaps in time with the dependent variable for the years 1986 and 1995, the demeaned control variable may be correlated with the mean of the dependent variable, and thus with the demeaned error term.

Reverse causality resp. simultaneity biases are particularly difficult to come by (e.g., Moretti 2004). If Florida (2002) is right, for example, regions will not only be larger, richer or faster

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[21] Adding a spatial lag requires, on the one hand, specifying ex ante the spatial pattern of these effects, which is generally unknown. Monte Carlo studies indicate that the unweighted average of the outcomes in the directly neighboring regions (binary first-order contiguity, row-standardized) will do a reasonable job in many cases, though (Stakhovych and Bijmolt 2008). On the other hand, it is inherent endogenous because contemporary outcomes in the neighboring regions are determined simultaneously with the outcome in the region in question in spatial equilibrium. This endogeneity may bias not only the parameter of the spatial lag but also the parameters of the human capital indicators. It warrants instrumentation.

[22] As a control variable, this serial lag should not be considered part of the structural model, however. The long-term effects Möller and Tubadji calculate from the (short-term) parameter estimates may be misleading.

growing because they are creative. They will also be more creative because they are larger, richer or faster growing.[23] To identify the parameters γ and α in an instrumental variables approach, some exogenous sources of variations of the regions' creativity and formal education are needed that are unrelated to the outcome.

Only few studies address this endogeneity bias thoroughly. Interestingly, all of these studies find that the creative class indicator of human capital outperforms the traditional education-based indicator slightly. Möller and Tubadji (2009) instrument the human capital variables by their respective (five years') time lags. These instruments will be rather weak if the system of regions under study is characterized by a high degree of persistence, i.e., if the regional economies evolved along their stable long-run growth paths. However, Möller and Tubadji additionally control for initial employment by the serial lag of the dependent variable, which should account reasonably well for this persistence. In a similar fashion, though for a cross section rather than a panel dataset, Marrocu and Paci (2013) regress labor productivity growth 2002–2007 in European regions on initial-year (2002) human capital and labor productivity. They argue that, on the one hand, labor productivity growth 2002–2007 is unlikely to affect human capital in 2002 directly (no reverse causality). On the other hand, initial labor productivity in 2002 will control for simultaneity by eliminating possible effects of spatial sorting of skilled or creative workers into rich regions in 2002 or earlier. Marlet and van Woerkens (2007) instrument human capital by a variety of regional indicators in their cross-section regressions of employment growth in Dutch cities on either creativity or educational attainment.[24] Unfortunately, they do not instrument human capital in those regressions that test the effects of both measures of human capital directly against each other. While the quality of their instruments is debatable, their results suggest that endogeneity tends to bias the OLS parameter of creativity downward and that of educational attainment upward. It does not reverse the signs of the parameters or their statistical significance, though.

The studies that test creativity against educational attainment by estimating systems of equations by SEM include Florida et al (2008), Mellander and Florida (2011) and Lobo et al (2012).[25] Florida et al. (2008), for example, estimate a system of three equations simultane-

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[23] Empirical evidence does, in fact, suggest that reverse causality should be taken serious in the empirical studies reviewed here. Boschma and Fritsch (2009), for example, report a strong positive effect of regional employment growth on the employment share of creative workers. Möller and Tubadji (2009) also report evidence suggesting that creative workers tend to prefer more prosperous regions in Germany. Haisch and Klöpper (2013) report similar results for richer regions in Switzerland.

[24] Their instruments set includes "proximity to nature", number of students, share of privately owned houses, number of museums, quality of secondary schools, share of historical buildings, and ethnic diversity.

[25] In a nutshell, structural equation modeling is a family of statistical procedures used frequently in social sciences or psychology to estimate systems of interdependent equations simultaneously by minimizing $\mathbf{S}-\mathbf{\Sigma}(\mathbf{\theta})$, the difference between the variance-covariance matrices of the observed ($\mathbf{S}$) and the fitted ($\mathbf{\Sigma}(\mathbf{\theta})$) variables in the model, by means of least squares or maximum likelihood estimators (e.g., Kline 2005). The parameter vector to be estimated, $\mathbf{\theta}$, comprises one parameter for each arrow in the path model (see Figure 1) and one error variance for each observed variable in the model (rectangles in Figure 1). In contrast to standard regression methods, SEM allows each observed variable, endogenous or exogenous, to be measured with errors. It also facilitates dealing with endogenous latent (unobserved) variables in the model (e.g., Van Oort et al.

ously for different combinations of indicators using data for US metropolitan areas in 2000.[26] They specify a model where the outcome, either regional income or regional wages, depends on three factors (Figure 1): technology (a "Tech Pole" Index), talent (either employment share of the creative class or population share of graduates), and tolerance (combined Gay and Bohemian index[27]). Technology and talent, in turn, are treated as endogenous variables in the sense that they are assumed to depend on other variables of the model, which is akin to instrumentation. Technology is assumed to depend on tolerance, talent and consumer services (number of local service industries considered attractive to consumers). Talent is assumed to depend on tolerance, university (faculty per capita) and consumer services.

Florida et al.'s main result is that formal education and creativity play complementary roles in regional development: "education operates through the channel of income, raising overall regional wealth. The creative class acts through wages and is much more closely associated with regional labor productivity" (Florida et al. (2008: 633). This result may, however, be spurious for two reasons at least. First, the creative class measure and wages are observed at the workplace while the education measure and income are observed at the place of residence. The weaker correlation of education with wages (than with income) may thus be a statistical artefact because wages are from a different population. And second, possible endogeneity of talent (creativity or education) is not accounted for effectively. This is not only because the model is rather sparse, leaving ample room for omitted variable biases. In fact, the authors spend surprisingly little effort on explaining why this setup is preferable over alternative set-ups. It is also because reverse causality is not accounted for effectively. While the equation

Figure 1: Path model estimated by Florida et al. (2008)
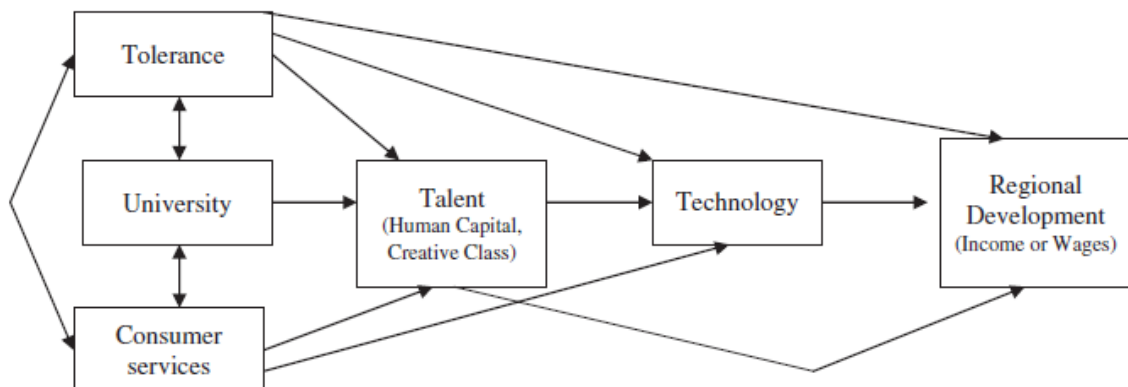
Source: Florida et al. (2008: 622).

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for talent serves a similar purpose as the first stage regression in an instrumental variable approach, the instruments of talent (tolerance, university and consumer services) can hardly be considered exogenous. For example, regions with higher income or wages may well attract a greater variety of consumer services.

4. Conclusions

There are reasons to rethink the measurement of regional human capital. Based on the Becker-Mincer human capital investment theory, human capital has for decades been measured by the population or employment share of the highly educated. Recent microeconometric evidence from labor and education economics suggests, however, that the education-based measures capture human capital only imperfectly. Building on insights from psychological research, this evidence indicates that, over and above education, cognitive and noncognitive skills (intelligence and personality, resp.) shape a person's human capital significantly and are independently valued by the market in terms of higher wages.

Motivated by related insights, Richard Florida voices a similar—though theoretically and empirically less well-founded—critique of the traditional education-based measures in his bestselling 2002 book on "The Rise of the Creative Class". The alternative measure he proposes, the regional employment share of creative, resp. knowledge-intensive, occupations, has a couple of conceptual shortcomings, however, and does, as this paper shows, not make a big difference in terms of its explanatory power for regional wages or growth, compared to the traditional education-based measure.

So how else may a measure of regional human capital be constructed that captures both the cognitive and the noncognitive skills of the workforce? While developing such a measure is clearly beyond the scope of the present paper, a few ideas come into mind.

Generally speaking, a region's aggregate skill composition should be some sort of an average of the skill compositions of its workers. Unlike formal education, the various facets of cognitive and noncognitive skills cannot just be averaged across all workers, however. Data on workers' cognitive and noncognitive skills is available only from surveys among individual workers that cover small fractions of the whole populations and are usually not representative for single regions. An indicator variable is needed that is observable at both the individual and the regional level on the one hand, and facilitates categorization of workers into a limited number of groups with characteristic skill compositions on the other. The skill compositions should differ across groups but be as homogeneous as possible within the groups. Florida's idea of exploiting the occupational composition of the regional workforce may actually be helpful in this context. Occupations are observed for both individuals and regions, and the microeconometric evidence reviewed in section 2 suggests that workers do purposefully self-select into those occupations whose skill requirements closely match their personal endow-

ments of cognitive and the noncognitive skills. A simple measure of a region's human capital, that comprises one indicators for each facet of cognitive and the noncognitive skills in the micro data, may thus be constructed by first determining the "typical" skill composition for each occupation from the micro data—e.g., by averaging the scores for each facet of cognitive and the noncognitive skills across all surveyed workers in that occupation—and then calculating the regional skill endowment separately for each facet as the average of the "typical" test scores across occupations, weighted by the occupation-specific employment shares in the region.

This simple measure will reflect *hypothetical* human capital because it ignores whether or not the individual facets of cognitive and noncognitive skills are actually relevant for the occupations. This relevance differs considerable. John and Thomsen (2014) find, for example, that openness to new experience is rather important for professionals while it matters little for technicians or service workers. The human-capital indicator of *actual* (or *active*) regional openness should therefore reflect the degree of openness of the professionals (and all other occupations where openness matters) but not that of technicians or service workers. Accounting for these differences complicates the construction of a regional human capital measure considerably. Rather than just calculating sample averages for each occupation and facet from the survey data, it requires estimating an occupational choice model that identifies the relative importance of the various facets for individual occupations. And this occupational choice model will then have to be inverted to infer a region's skill composition (or its most likely skill composition) from its observed occupational composition for given parameters of the occupational choice model. Working out the methodological details of this procedure may be rather cumbersome. It should be worth a try, though.

References

Almlund, M., A.L. Duckworth, J.J. Heckman, and T.D. Kautz, (2011). Personality Psychology and Economics. In E.A. Hanushek, S. Machin and L. Woessmann (eds.), *Handbook of the Economics of Education*, Volume 4. Elsevier, Amsterdam, pp. 1–181.

Amabile, T. (2012), Componential Theory of Creativity. Working Paper 12-096. Harvard Business School, Cambridge.

Andersen, K.V., H.K Hansen, A. Isaksen and M. Raunio (2010), Nordic City Regions in the Creative Class Debate: Putting the Creative Class Thesis to a Test. *Industry and Innovation* 17 (2): 215–240.

Andersson, Å.E. (2011), Creative People Need Creative Cities. In D.E. Andersson, Å.E. Andersson and C. Mellander, *Handbook of Creative Cities*. Edward Elgar, Cheltenham, pp. 14–55.

Antonietti, R. (2013), From Creativeness to Innovativeness: A Firm-level Investigation. "Marco Fanno" Working Paper 159, Dipartimento di Scienze Economiche ed Aziendali "Marco Fanno", Universita degli Studi di Padova.

Audretsch, D.B., and M. Belitski (2013), The Missing Pillar: The Creativity Theory of Knowledge Spillover Entrepreneurship. *Small Business Economics* 41 (4):819–836.

Becker, G. (1964), *Human Capital*. Columbia University Press, New York.

Borghans, L., A.L. Duckworth, J.J. Heckman and B. ter Weel (2008), The Economics and Psychology of Personality Traits. *Journal of Human Resources* 43 (4): 972–1059.

Boschma, R.A., and M. Fritsch (2009), Creative Class and Regional Growth – Empirical Evidence from Seven European Countries. *Economic Geography* 85(4): 391–423.

Bowles, S., H. Gintis and M. Osborne (2001), The Determinants of Earnings: A Behavioral Approach. *Journal of Economic Literature* 39 (4): 1137–1176.

Brunello, G., and M. Schlotter (2011), Non Cognitive Skills and Personality Traits: Labour Market Relevance and their Development in Education & Training Systems. IZA Discussion Paper 5743. Bonn.

Card, D. (1999), The Causal Effect of Education on Earnings. In: Ashenfelter, O., and Card, D. (eds.), *Handbook of Labor Economics*, Volume 3a, Elsevier. Amsterdam, pp. 1801–1863.

Cawley, J., J.J. Heckman and E. Vytlacil (2001), Three Observations on Wages and Measured Cognitive Ability. *Labour Economics* 8 (4): 419–442.

Ciccone and Peri (2006), Identifying Human-Capital Externalities: Theory with Applications. *Review of Economic Studies* 73 (2): 381–412.

Deke, J. and J. Haimson (2006). Valuing Student Competencies: Which Ones Predict Postsecondary Educational Attainment and Earnings, and for Whom? Mathematica Policy Research Inc. http://mathematica-mpr.com/publications/pdfs/valuestudent.pdf.

Donegan, M., J. Drucker, H. Goldstein, N. Lowe and E. Malizia (2008), Which Indicators Explain Metropolitan Economic Performance Best? Traditional or Creative Class. *Journal of the American Planning Association* 74 (2): 180–195.

Florida, R. (2002), *The Rise of the Creative Class*. Basic Books, New York (paperback edition).

Florida, R. (2004), Response to Edward Glaeser's review of The Rise of the Creative Class. Mimeo. (http://creativeclass.com/rfcgdb/articles/ResponsetoGlaeser.pdf).

Florida, R., C. Mellander and K. Stolarick (2008), Inside the Black Box of Regional Development—Human Capital, the Creative Class and Tolerance. *Journal of Economic Geography* 8 (5): 615–649.

Funke, J. (2009), On the psychology of Creativity. In P. Meusburger, J. Funke and E. Wunder (eds.), *Milieus of Creativity*. Springer, Heidelberg, pp. 11–23.

Gennaioli, N., R. La Porta, F. Lopez-de-Silanes and A. Shleifer (2013), Human Capital and Regional Development. *Quarterly Journal of Economics* 128 (1): 105–164.

Glaeser, E.L. (2005), Review of Richard Florida's The Rise of the Creative Class. *Regional Science and Urban Economics* 35 (5): 593–596.

Glaeser, E.L., G.A.M. Ponzetto and K. Tobio (2014), Cities, Skills and Regional Change. *Regional Studies* 48 (1): 7–43.

Griliches, Z. (1979), Issues in Assessing the Contribution of R&D to Productivity Growth. *Bell Journal of Economics* 10 (1): 92–116.

Goldberg, L.R. (1990). An Alternative Description of Personality: The Big Five Factor Structure. *Journal of Personality and Social Psychology* 59 (6): 1216-29.

Hanushek, E.A., and L. Woessmann (2008), The Role of Cognitive Skills in Economic Development. *Journal of Economic Literature* 46 (3): 607–668.

Haisch, T., and C. Klöpper (2013), Location Choice of the Creative Class: Does Tolerance Make a Difference? Mimeo, University of Bern.

Heckman, J.J., J.E. Humphries and N.S. Mader (2011b), The GED. In E.A. Hanushek, S. Machin and L. Woessmann (eds.), *Handbook of the Economics of Education*, Volume 3. Elsevier, Amsterdam, pp. 423–483.

Heckman, J.J., J.E. Humphries, S. Urzua and G. Veramendi (2011a), The Effects of Educational Choices on Labor Market, Health, and Social Outcomes. Working Paper 2011-002. Human Capital and Economic Opportunity Working Group, Chicago (http://humcap.uchicago.edu/RePEc/hka/wpaper/HHUV_2010_effect-edu-choice.pdf).

Heckman, J.J., J.E. Humphries, S. Urzua and G. Veramendi (2014), Education, Health and Wages. NBER Working Paper 19971. National Bureau of Economic Research, Cambridge.

Heckman, J.J., and Y. Rubinstein (2001), The Importance of Noncognitive Skills: Lessons from the GED Testing Program. *American Economic Review* 91 (2): 145–149.

Heckman, J.J., Stixrud, J., and Urzua, S. (2006). The Effects of Cognitive and Noncognitive Abilities on Labor Market Outcomes and Social Behavior. *Journal of Labor Economics* 24 (3): 411–482.

John, K., and Thomsen, S.L. (2014), Heterogeneous Returns to Personality: The Role of Occupational Choice. *Empirical Economics* 47 (2): 553–592.

Kirton, M. (1976), Adaptors and Innovators: A Description and Measure. *Journal of Applied Psychology* 61 (5): 622–629.

Kline, R.B. (2005), *Principles and Practice of Structural Equation Modeling*. 2nd ed. Guilford Press, New York.

Lobo, J., C. Mellander, K. Stolarick and D. Strumsky (2012), The Inventive, the Educated, and the Creative: How Do They Affect Metropolitan Productivity? CESIS Electronic Working Paper 263. Centre of Excellence for Science and Innovation Studies (CESIS), Royal Institute of Technology, Stockholm.

Markusen, A. (2006), Urban Development and the Politics of a Creative Class: Evidence from a Study of Artists. *Environment and Planning A* 38 (10): 1921–1940.

Markusen, A., G.H. Wassall, D. DeNatale and R. Cohen (2008), Defining the Creative Economy: Industry and Occupational Approaches. *Economic Development Quarterly* 22 (1): 24–45.

Marlet, G., and C. van Woerkens (2007), 'The Dutch Creative Class and How It Fosters Urban Employment Growth. *Urban Studies* 44 (13):2605–2626.

Marrocu, E., and R. Paci (2012), Education or Creativity: What Matters Most for Economic Performance? *Economic Geography* 88 (4):369–401.

Marrocu, E., and R. Paci (2013), Regional Development and Creativity. *International Regional Science Review* 36 (3): 354–391.

McGranahan, D., and T. Wojan (2007), Recasting the Creative Class to Examine Growth: Processes in Rural and Urban Counties. *Regional Studies* 41 (2):197–216.

Mellander, C., and R. Florida (2011), Creativity, Talent, and Regional Wages in Sweden. *Annals of Regional Science* 46 (3): 637–660.

Mincer, J. (1958), Investment in Human Capital and Personal Income Distribution. *Journal of Political Economy* 66 (4): 281–302.

Möller, J., and A. Tubadji (2009), The Creative Class, Bohemians and Local Labor Market Performance: A Micro-data Panel Study for Germany 1975–2004. *Jahrbücher für Nationalökonomie u. Statistik* 229 (2+3): 270–291.

Moretti (2004), Human-capital Externalities in Cities. In J.V. Henderson and J.-F. Thisse (eds.), *Handbook of Urban and Regional Economics*, Volume 4. Amsterdam: Elsevier, pp. 2243–2291.

Mueller, G., and E. Plug (2006), Estimating the Effect of Personality on Male and Female Earnings. *Industrial and Labor Relations Review* 60 (1): 3–22.

Rausch, S., and C. Negrey (2006), Does the Creative Engine Run? A Consideration of the Effect of Creative Class on Economic Strength and Growth. *Journal of Urban Affairs* 28 (5): 473–489.

Romer, P.M., (1990), Endogenous Technical Change. *Journal of Political Economy* 98 (5): S71–S102.

Runco, M.A., and G.J. Jaeger (2012), The Standard Definition of Creativity. *Creativity Research Journal* 24 (1): 92–96.

Santos Cruz, S.S., and A.A.C. Teixeira (2012), Methodological Approaches for Measuring the Creative Employment: A Critical Appraisal With an Application to Portugal. FEP Working Paper 455. University of Porto.

Scott, A.J. (2006), Creative Cities: Conceptual Issues and Policy Questions. *Journal of Urban Affairs* 28 (1): 1–17.

Stakhovych, S., and T.H.A. Bijmolt (2008), Specification of Spatial Models: A Simulation Study on Weights Matrices. *Papers in Regional Science* 88 (2): 389–408.

Sternberg, R.J. (2006), The Nature of Creativity. *Creativity Research Journal* 18 (1): 87–98.

Stiglitz, J.E., A. Sen and J.-P. Fitoussi (2009), Report by the Commission on the Measurement of Economic Performance and Social Progress. Paris (http://www.stiglitz-sen-fitoussi.fr/documents/rapport_anglais.pdf).

Van Oort, F.G., J.H.L. Oud and O. Raspe (2009), The Urban Knowledge Economy and Employment Growth: A Spatial Structural Equation Modeling Approach. *Annals of Regional Science* 43 (4): 859–877.

Wedemeier, J., (2012), Creative Professionals and High-skilled Agents: Polarization of Employment Growth? HWWI research paper 119. Hamburg Institute of International Economics.