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Creativity, education or what? On the measurement of regional human capital*

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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 non-cognitive skills. It shows that this microfoundation is similar to that of human capital in recent labour economics, which has facilitated important new insights. While the regional measures of creative occupations developed by Florida or others are too crude to make a difference, occupations may help project workers' cognitive and non-cognitive skills from the micro to the regional level.

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

Key words: Human capital, education, creativity, cognitive skills, non-cognitive skills

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, p. 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.

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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.

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.

In his bestselling book, *The rise of the creative class*, Richard Florida (2002) has challenged the widespread agreement among economists about measurement of regional human capital.[2] He emphasizes that it is 'more important to measure what people do rather than what they study' (Mellander and Florida 2011, p. 639). He suggests a broader concept of human capital that reflects not only workers' potential talents or skills but also takes into account how the regional economy utilizes these talents or skills (Florida et al. 2008), namely, elements of the demand for human capital. He also links his concept to psychological insights by emphasizing that it is shaped not only by intelligence, schooling or work experience but also by a variety of personal characteristics, including self-assurance, motivation, or the ability to synthesize and to take risks (Florida 2002, p. 31). While he prefers the notion of 'creativity' for this concept in his 2002 book to distinguish it from the education-based concept of human capital, he agrees with Glaeser (2005) in that the notion of creativity is synonymous to that of human capital (Florida 2004). This synonymy is a logical consequence of his belief that creativity is the key factor of production in modern economies (Florida 2002, p. 44).[3]

Even though Florida provides a fairly accurate theoretical description of the characteristics of creative workers, neither he nor the subsequent empirical literature has succeeded so far in mapping these characteristics into similarly accurate criteria for measuring creativity. In his book, Florida suggests measuring creativity by the share of workers in specific knowledge-intensive occupations, his so-called 'creative class' (Florida 2002, Appendix 1).[4] A variety of subsequent studies, reviewed in Markusen et al. (2008), Comunian et al. (2010) and Santos Cruz and Teixeira (2012), aim at refining Florida's measure by using finer occupations, or industry or task characteristics. They make little progress in developing objective criteria for distinguishing 'creative' from 'non-creative' activities, however. In addition to its conceptual deficiencies, Florida's concept of creativity comes with a rather diffuse 'creative capital theory of city growth' (Glaeser 2005, p. 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 aspects, the lack of rigour in the delineation of creative

[2] Measurement issues are not the primary focus of this book, though. Inspired by traditional Marxism, which he combines with Joseph Schumpeter's perspective on innovation and Jane Jacobs' perspective on cities, Florida brings together insights from various disciplines, including economics, economic geography, psychology, sociology, human resource sciences, marketing and cultural sciences, to emphasize the crucial role of creativity 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. We are grateful to an anonymous referee who drew our attention to the intellectual background of Florida's notion of creativity.

[3] Somewhat less ambitiously, Rubenson and Runco (1992) treat creativity as one element (or component) of human capital. They use the human capital investment theory explicitly as a blueprint for their so-called 'creativity potential investment theory'.

[4] 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.

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 creativity measures of human capital against the traditional education-based measure. This review concludes that the creativity measures available so far make little difference. It also shows that the reviewed 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 sketching an economic microfoundation of creativity that exploits insights from the psychological literature on creativity to trace a worker's endowment with 'creative capital' back to her endowments with cognitive skills (intelligence) and non-cognitive skills (personality) as well as to her environment (social, workplace). It also shows that this microfoundation of creativity is very similar to the microfoundation of human capital in modern labour economics. In labour economics, this new microfoundation of human capital has facilitated promising empirical insights that go far beyond the insights facilitated by the traditional human capital investment theory. Modelling an individual's human capital as a function of her endowments with cognitive and non-cognitive skills, labour economics like James Heckman show empirically that personality matters for a variety of educational and labour market outcomes (Borghans et al. 2008; Almlund et al. 2011; Dohmen 2014). It affects outcomes like labour market participation, occupational choice, productivity and wages not only through educational attainment but also directly. It thus helps explain, for example, why workers with similar education levels choose different occupations and earn different wages.

The striking similarity between Heckman and Florida in modelling 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 Glaeser's (2005) view: what Florida labels creativity is actually human capital, or at least an important element of human capital. In addition to this, they corroborate Florida's call for more informative measures of human capital in regional economics. Like in labour 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. The fact that the creative-class measures Florida and others have developed so far have not been too successful in this respect is not a sufficient reason for discarding Florida's call altogether. Regional economists should rather acknowledge the recent advances in labour economics and think about how to benefit from these advances. A good deal of creativity is still warranted, though, to develop microeconomically better founded measures of regional human capital that account for both cognitive and non-cognitive skills.

The next section traces Florida's notion of creativity back to its psychological roots at the level of individuals and discusses its relationship to human capital. 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, microfounded measure of regional human capital.

2 Creativity and human capital: Microeconomic foundation

This section goes back to the microeconomic level in order to define an individual's creativity as an element of human capital and relate it formally to its determinants identified by psychologists.

The section also shows that labour and education economists have used a similar relationship between human capital at large and its psychological determinants to successfully explain a variety of labour market, educational and social outcomes.

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.[5] Psychologists have been investigating creativity extensively since the middle of the last century at least (Funke 2009). Inspired by this research, Andersson has been emphasizing the economic relevance of creativity since the mid-1980s in the economics domain (Andersson and Mellander 2011). Creativity has been defined as a process by most psychologists. Teresa Amabile (2012, p. 1), for example, a management psychologist, defines it as 'the production of a novel and appropriate response, product, or solution to an open-ended task'. Andersson follows these psychologists by defining 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, p. 14). From this perspective, creativity, namely, the process of developing creative ideas, is the first step of knowledge or innovation production, as formalized in economics by Griliches (1979) or Romer (1990). To relate creativity to human capital, we follow Karlsson (2011), however, in defining creativity as an intangible human resource. Karlsson adopts a definition by Margaret Boden (2004, p. 1), a social psychologist and information scientist, who defines creativity as 'the ability to come up with ideas that are new, surprising, and valuable'. This ability is essentially what Glaeser (2005) labels 'creative capital' or Rubenson and Runco (1992), 'creative potential'. Like the process-related definitions of creativity, this ability-related definition restricts creative ideas to those that are both 'new' and 'valuable' (see Simonton 2011; Runco and Jaeger 2012). While there has been a vivid discussion on what precisely 'new' and 'valuable' mean, neither reinvention of the wheel nor socially valueless inventions are considered relevant outcomes of creativity by most authors.

Psychological studies show that a person's creative capital is shaped by a variety of factors. Sternberg (2006) categorizes these factors into six groups: intellectual skills, knowledge, thinking style, personality, motivation, and environment.[6]

1. The *intellectual skills* relevant for creativity are synthetic skills that help approach problems from new, unconventional perspectives, analytic skills that help separate promising 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, openness to new experience, tolerance for ambiguity and tolerance for risks.
5. *Motivation* is essentially intrinsic motivation, that is, doing things out of passion and curiosity rather than out of monetary incentives.

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

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

6. The *environment*, finally, represents the factors outside the individual that may encourage or discourage her from fully exploiting her creative capital. 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 neighbours' and friends' curiosity rather than scepticism about unconventional, innovative ways of thinking and behavior will encourage creativity.[7]

Given these factors, we may formally express the creative capital of a representative individual i, Γ_i, as:

$$\Gamma_i = f_\Gamma(\mathbf{X}_{1i}, \ldots \mathbf{X}_{5i}, \mathbf{E}_i), \tag{1}$$

where the vectors $\mathbf{X}_{1i}$–$\mathbf{X}_{5i}$ denote the first five of the above groups of personal resources and $\mathbf{E}_i$ the group of environmental factors. $f_\Gamma(\cdot)$ is some function that describes the potential contributions of the individual resources to creative capital. We assume that this function is the same across all individuals. This function, the details of which are not known well, may be rather complex. Psychometric studies suggest that some of the resources tend to complement each other while others tend to substitute for each other (Sternberg 2006; Dohmen 2014). They suggest, for example, that intrinsic motivation will not work without sufficient intellectual skills and knowledge but may help overcome a conservative environment. Studies also suggest that thresholds and non-linearities may be an issue. For example, 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. Whether or not the environment, $\mathbf{E}_i$, should be an argument to the function $f_\Gamma(\cdot)$ is debatable. On the one hand, it is largely outside the sphere of influence of the individual and may, as such, not affect the individual's potential ability to come up with new and valuable ideas. On the other hand, however, it may interact differently with the individual resources $\mathbf{X}_{1i}$–$\mathbf{X}_{5i}$, as the above-mentioned example of intrinsic motivation indicates. We therefore keep the environment as sort of a set of productivity parameters that rescale the potential contributions of the individual resources to creative capital.

While the formal model of creative capital in (1) covers a variety of personal resources, it reflects human capital only incompletely. It does not, for example, capture motor or social skills. A craftsman may have high motor skills that enable him to repair machines efficiently but may still not be creative enough to develop new machines. Likewise, a manager may have high social skills that enable him to motivate his workers to be creative but may not be creative at all himself. The sets of personal resources that determine such other elements of human capital may partly overlap with those relevant for creative capital. But the respective functional forms will most likely differ from $f_\Gamma(\cdot)$. Creative capital should therefore not be taken as a synonym for human capital at large, even though Florida hypothesizes that is crucial for regional prosperity.

For practical reasons, it may nonetheless be useful to construct a model like (1) for human capital at large by simply extending the right-hand side to cover all kinds of personal characteristics and letting the data decide on the relative importance of these characteristics and the form of the function $f(\cdot)$. Interestingly, this is essentially how human capital is modelled in recent labour and education economics. Scholars like James Heckman attribute an individual's human capital to a battery of personal characteristics, summarized in two broad groups, cognitive skills

[7] 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.

(intelligence) and non-cognitive skills (personality).[8] Similar to Florida, labour and education economists exploit insights from psychological research extensively to explain economic phenomena. They actually go one step further by formulating rigorous economic or econometric models to more carefully investigate the causal links and interdependencies between personal characteristics and labour market outcomes or educational achievements. To clarify the similarity of our creative capital approach in (1) with this approach, we reformulate (1) in terms of a model for human capital at large, such that:

$$H_i = h(\mathbf{C}_i, \mathbf{N}_i, \mathbf{E}_i, \mathbf{Z}_i). \tag{2}$$

H_i denotes worker i's (unobserved) stock of human capital, C_i is a vector of her cognitive skills, which include the first three inputs to creativity listed above: intellectual skills, knowledge and thinking style, i.e. $\mathbf{C}_i = \{\mathbf{X}_{1i}, \mathbf{X}_{1i}, \mathbf{X}_{3i}, \ldots\}$. $\mathbf{N}_i$ is a vector of her non-cognitive skills, which include the fourth and fifth inputs to creativity: personality traits and motivation,[9] namely, $\mathbf{N}_i = \{\mathbf{X}_{4i}, \mathbf{X}_{5i}, \ldots\}$. In addition to these skills, the vectors $\boldsymbol{E}_i$ and $\boldsymbol{Z}_i$ 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 non-cognitive 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 (1) or (2) are, in principle, estimable parametrically or non-parametrically for a sample of workers even though the outcomes, Γ_i or H_i , are unobservable, if they are substituted into 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 non-cognitive skills are typically derived from test scores for the so-called 'Big Five' (Goldberg 1990), a broadly accepted taxonomy that groups various facets of non-cognitive skills into five categories: openness to experience, conscientiousness, extraversion, agreeableness and neuroticism. Table 1 gives a more detailed list of traits in these categories.[10] Additional measures of non-cognitive skills used in labour or education economics are the Rotter measure of internal locus of control (own ability to influence outcomes) or measures of self-esteem. Unlike the cognitive skills, the various non-cognitive skills are only weakly correlated with each other across individuals (Deke and Haimson 2006).[11] This suggests that the non-cognitive 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.

[8] 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.

[9] Borghans et al. (2008) assume motivation to be an argument of the individual's utility function, though.

[10] For a recent assessment of the measurement of creativity in psychology, see Villalba (2012) and the related articles in the special issue of the 2012 volume of the *Creativity Research* Journal (issue 1). Non-cognitive 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.

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

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)
Extraversion (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 co-operative, 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) and Almlund et al. (2011).

While the microeconometric research on the effects of cognitive and non-cognitive skills on labour 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 labour economics. Heckman and Rubinstein (2001) find, for example, that non-cognitive skills are in fact priced in the labour market independently of education. 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,[12] they show that the latter earn lower wages not because they are less intelligent but because they lack specific non-cognitive 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 non-cognitive skills explain wages not only indirectly through educational attainment. These skills additionally affect wages directly. While the magnitude of the direct effects is still

[12] The GED programme is a second-chance programme 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. (2011a) for a review of the extensive research on the GED programme.

subject to debate,[13] 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 non-cognitive skills have also been found to affect occupational choices. Microeconometric studies such as those reviewed in Almlund et al. (2011, pp. 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 non-cognitive skills. They also suggest that, in terms of wages, markets value non-cognitive skills differently in different occupations. This is especially true for skills related to conscientiousness, agreeableness, self-esteem and locus of control. Sorgner (2015) complements this skill-occupation nexus by employment status, showing that there is a more complex interdependency between personality, occupational choice and entrepreneurial attitudes.

This microeconometric evidence generally corroborates Florida's idea to measure regional creativity, or, for that matter, human capital at large, 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 should carry valuable information about its endowments with cognitive and non-cognitive skills. The next section will explore to what extent the specific occupation-based measures of creative, resp. human, capital developed by Florida and his followers do in fact explain regional outcomes better than the traditional education-based measure of human capital.

3 Educational attainment versus creativity: Discriminatory evidence

Several empirical studies aim at testing whether or not Florida's occupation-based measure of the 'creative class' or related measures developed since the early 2000s explain aggregate outcomes better than the traditional measure of human capital and 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).[14]

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:

$$Y_{rt} = \gamma \Gamma_{rt} + \alpha S_{rt} + \mathbf{Z}_{rt}\boldsymbol{\beta} + \varepsilon_{rt}. \tag{3}$$

r indexes regions, t time, and ε_{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 modelling (SEM) approach. This approach will be reviewed in more detail at the end of this section.

The studies that estimate a model like (3) differ widely with respect to the outcome variable of interest, Y_{rt}, which implies that they focus on different economic mechanisms. The majority

[13] Recent results by Heckman et al. (2011b, 2014) indicate that earlier studies may have overstated the direct effects of non-cognitive skills on wages.

[14] Only very few studies use firm-level data to assess the effects of creativity on firms' innovativeness (Antonietti 2013) or individual-level data to assess the effects of creativity on entrepreneurship (Fritsch and Sorgner 2013).

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 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 non-creative, 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, labour productivity or total factor productivity (TFP) (See Florida et al. 2008; Mellander and Florida 2011; Lobo et al. 2014; Marrocu and Paci 2012, 2013), or some indicator of entrepreneurship like the number of business startups, of self-employed or of small- and medium-sized 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. 2014) conclude that the creative class measure outperforms the educational attainment measure. Other studies, including Glaeser (2005), Donegan et al. (2008) and Faggian et al. (2011), find the opposite result.

Several issues arise with the specification and the estimation of models like (3). We focus on three of them, measurement of creativity, multicollinearity and endogeneity. As to the measurement of creativity,[17] 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, p. 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, p. 69). Nonetheless, these features are notoriously difficult to translate into workable criteria that may guide the delineation of creative occupations from statistical classification systems for

[15] See Glaeser (2005), Marlet and van Woerkens (2007), McGranahan and Wojan (2007), Donegan et al. (2008), Boschma and Fritsch (2009), Möller and Tubadji (2009), Andersen et al. (2010), Faggian et al. (2011), Wedemeier (2012) and Alehegn et al. (2013).

[16] See Rausch and Negrey (2006), Donegan et al. (2008), Möller and Tubadji (2009), Lobo et al. (2014), Wedemeier (2012) and Alehegn et al. (2013).

[17] Markusen et al. (2008), Comunian et al. (2010), Santos Cruz and Teixeira (2012) and Correia and da Silva (2014) review the various delineations of creative employment. Comunian et al. (2010) suggest that the occupation-based delineations of creativity preferred by most of the studies reviewed here are related to labour supply while industry-based delineations are related to labour demand. This distinction between supply and demand is somewhat artificial, however, because both occupation and industry statistics report actual employment, that is, realized matches for supply and demand.

occupations.[18] Various authors and institutions have attempted to refine and substantiate Florida's delineation of the creative class. None of them has, however, succeeded in solving the basic problem, the lack of accurate, workable criteria for empirically delineating creativity.[19] Like educational attainment, the occupation-based creative class indicator may therefore understate the role of non-cognitive skills and of creative workers without a university degree. The findings by Fritsch and Sorgner (2013) corroborate this conclusion. They show for a sample of German workers that the probability of being self-employed is positively and significantly associated not only with formal education and creative occupation but on top of this also with some of the arguably most relevant personality traits, namely openness to experience, extraversion and willingness to take risks. Educational attainment and creativity obviously do not sufficiently capture those personality traits that are associated with entrepreneurship, neither individually nor jointly. From this perspective, the region-level studies reviewed here actually aim at discriminating between two conceptually inferior measures of human capital.

Creativity measures have also been criticized for being too heterogeneous (Markusen 2006). Covering a broad array of occupations as diverse as Bohemians, lawyers and engineers, these measures may be poor indicators in estimations of the contribution of creativity to regional outcomes. Comunian et al. (2010) and Faggian et al. (2013) show, for example, that Bohemian graduates on average earn significantly less than non-Bohemian graduates in the UK, at least in earlier stages of their careers. Unless these Bohemians and other low-paid creative activities generate positive externalities that monetize in aggregate regional outcomes, the heterogeneity of the creativity measures will cause an understatement of the effects of creativity on regional outcomes in models like (3). A similar argument could be made for education-based measures as well, however. Rewards to university degrees likely differ across disciplines at least as much as across creative occupations.

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, Comunian et al. 2010). 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 test statistics. In addition to this, the parameter estimates may be rather sensitive to outliers (e.g., Rausch and Negrey 2006) or misspecification of the functional form. With high multicollinearity, a slight non-linearity in the relationship between human capital and the outcome may affect the point estimates of γ or α notably.

Some studies try escaping multicollinearity traps by comparing the regression results of two restricted versions of (3) 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, Wedemeier 2012, Alehegn et al. 2013). None of these studies formally test these two restricted versions against each other by, for example, a J test. Other studies find only one of the two parameters in (3), γ or α, to be

[18] For example, the 2010 Standard Occupational Classification characterizes 'Administrative Law Judges, Adjudicators, and Hearing Officers' (SOC 23–1021) as workers who 'Conduct hearings to recommend or make decisions on claims concerning government programmes 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?

[19] See Faggian et al. (2011) for a critical discussion of measurement issues for different facets of human capital, including creativity, entrepreneurship and education.

[20] This correlation differs across studies, though. While Glaeser (2005), Florida et al. (2008), Möller and Tubadji (2009) and Alehegn et al. (2013) report fairly high correlations ($r > 0.7$) between the shares of creative and highly educated workers, Lobo et al. (2014) report a more moderate correlation ($r = 0.48$).

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 occupations than Florida, Marrocu and Paci define creative graduates from the European Labour 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 both creative and non-creative graduates contribute significantly to explaining TFP in 2007 (Marrocu and Paci 2012) as well as labour 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 non-graduates, namely, workers who dispose of non-cognitive 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 neighbours' 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 eliminate 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 eliminate 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 generalized method of moments (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 year 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, that is, 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 growing because they are creative. They will also be more creative because they are larger, richer or faster growing. 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 (2015) report similar results for richer regions in Switzerland. 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 explicitly. Interestingly, all of these studies find that the creative class indicator of human capital slightly outperforms the traditional education-based indicator. 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, that is, if the regional economies evolved along their stable long-run growth paths. Möller and Tubadji additionally control for initial employment by the serial lag of the dependent variable to account for this

[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 neighbouring regions (binary first-order contiguity, row-standardized) will do a reasonable job in many cases, though (Stakhovych and Bijmolt 2008). On the other hand, the spatial lag is inherent endogenous because contemporary outcomes in the neighbouring 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.

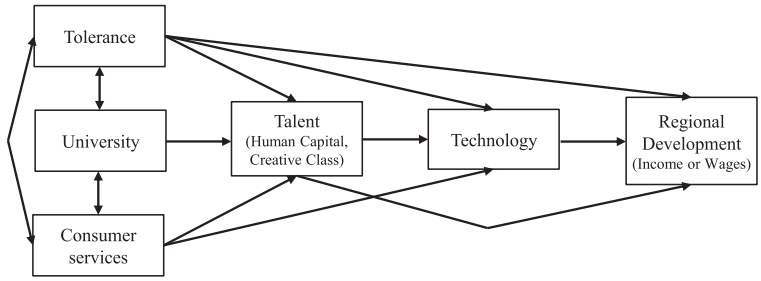

Fig. 1. Path model estimated by Florida et al. (2008)

persistence. 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.[23] 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. Rather than pursuing an instrumentation strategy, Marrocu and Paci (2013) regress labour productivity growth 2002–2007 in European regions on initial-year (2002) human capital and labour productivity. They prefer lags of their key explanatory variables to escape reverse causality between the contemporary levels of productivity and human capital. However, Reed (2015) shows that this estimation strategy will not remove the endogeneity bias, if the level of human capital does affect the productivity level contemporaneously (in period t). The OLS parameters of (lagged) human capital will be biased upward by the effect of productivity on human capital in this case.

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. (2014).[24] Florida et al. (2008), for example, estimate a system of three equations simultaneously for different combinations of indicators using data for US metropolitan areas in 2000.[25] 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[26]). 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

[23] 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.

[24] In a nutshell, structural equation modelling is a family of statistical procedures used frequently in social sciences or psychology to estimate systems of interdependent equations simultaneously by minimizing $\mathbf{S} - \boldsymbol{\Sigma}(\boldsymbol{\theta})$, the difference between the variance-covariance matrices of the observed ($\mathbf{S}$) and the fitted ($\boldsymbol{\Sigma}(\boldsymbol{\theta})$) variables in the model, by means of least squares or maximum likelihood estimators (e.g., Kline 2005). The parameter vector to be estimated, $\boldsymbol{\theta}$, 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. 2009). The three studies reviewed here do not include latent variables, though. Heckman et al. (2006) extend this approach to identify the causal effects of unobserved cognitive and non-cognitive skills on wages, occupational choice and a variety of other human-capital related outcomes.

[25] Mellander and Florida (2011) estimate a similar model for Swedish labour market areas in 2003.

[26] See Florida et al. (2008) for the definitions of these measures of tolerance.

service industries considered attractive to consumers). Talent is assumed to depend on tolerance, university (faculty *per capita*) and consumer services.

Florida et al.'s (2008, p. 633) 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'. This result should be taken with some care, however, 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. In a cross-section of metropolitan areas, the weaker correlation of education with wages (than with income) may partly be due to cities like those in Florida where high-skilled retirees live out of non-wage income in the first place. And second, possible endogeneity of talent (creativity or education) is not accounted for effectively, which the authors acknowledge explicitly (Florida et al. 2008, p. 627). While the equation 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) may still be endogenous. For example, regions with higher income or wages may attract a greater variety of consumer services.

4 Conclusions

The concept for measuring human capital in terms of educational attainment and work experience, which is rooted in the Becker-Mincer human capital investment theory and has dominated economic research for decades, has recently been challenged in several subdisciplines of economics, most notably labour and regional economics. Labour economists like James Heckman present compelling microeconometric evidence suggesting that the education-based measures capture human capital only imperfectly. Exploiting insights from psychological research, they suggest measuring human capital instead by cognitive and non-cognitive skills (intelligence and personality). In regional economics, Richard Florida has triggered a vivid discussion on the measurement of human capital as well. Emphasizing that it is 'more important to measure what people do rather than what they study' (Mellander and Florida 2011, p. 639), he suggests measuring human capital by the employment share of creative occupations rather than that of university graduates. In motivating the role of creativity, he also refers extensively to insights from psychology.

While microeconometric research in labour economics has presented compelling evidence on the superiority of cognitive and non-cognitive skills over traditional education-based measures in explaining a variety of individual outcomes, similarly compelling evidence on the superiority of creativity-based measures is still lacking in regional economics. The present paper shows that this is not only due to methodological shortcomings of the empirical literature that has been looking for this evidence. It is also due to serious conceptual shortcomings of the measure itself.

The paper argues that Florida is nonetheless on the right track. Reinterpreting his concept of creativity on the backdrop of the insights from psychology he refers to, it shows that the microfoundation of creativity is actually very similar to the microfoundation of human capital in labour economics. This offers the opportunity to develop a measure of regional human capital that is both microfounded and related to creativity.

Generally speaking, a region's aggregate skill composition should be some sort of an average of the skill compositions of its workforce. Unlike formal education, the various facets of cognitive and non-cognitive skills cannot just be averaged across all workers, however. Data on workers' cognitive and non-cognitive 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 microeconometric evidence suggests that workers do self-select purposefully into those occupations whose skill requirements closely match their personal endowments of cognitive and non-cognitive skills.

A simple measure of a region's human capital, that comprises one indicator for each facet of cognitive and non-cognitive skills in the micro data, may thus be constructed by first determining the characteristic skill composition for each occupation from the micro data, for example, by averaging the scores for each facet of cognitive and the non-cognitive skills across all surveyed workers in that occupation, and then calculating the regional skill endowment separately for each facet as the average of the characteristic skill patterns across occupations, weighted by the occupation-specific employment shares in the region.

This simple measure will just reflect hypothetical human capital because it ignores whether or not the individual facets of cognitive and non-cognitive 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 estimated occupational choice model. The methodological details of this procedure may be rather cumbersome. Working them out should be worth a try, though.

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Resumen. Este artículo corrobora el debate iniciado a partir de la sugerencia de Richard Florida de medir el capital humano regional por medio de las ocupaciones creativas, en lugar de empleando la educación. En apoyo de la noción de creatividad de Florida, el artículo sugiere una microfundamentación que relaciona la creatividad de los trabajadores con sus habilidades cognitivas y no cognitivas. Se demuestra que esta microfundamentación es similar a la del capital humano en la reciente economía laboral, que ha facilitado nuevas e importantes ideas. Si bien las medidas regionales de las ocupaciones creativas desarrolladas por Florida u otros son demasiado toscas como para lograr una diferencia, las ocupaciones pueden ayudar a proyectar las habilidades cognitivas y no cognitivas de los trabajadores desde el nivel micro al nivel regional.

要約: 本稿では、地域の人的資本を学歴ではなく創造的職業で測定するというRichard Floridの提案に続く議論を具体的に示す。Floridの概念における創造性と同じく、この議論は創造性と労働者の認知的/非認知的スキルを関連させるミクロ的基礎を提示する。この議論は、前述のミクロ的基礎が最近の労働経済学における人的資本のミクロ的基礎に類似していることを示しているが、これは新しい重要な理解を促進している。Floridaや他の研究者が開発した創造的職業による地域の測定方法は、確立されたものではないため大きな影響力は無いが、職業がミクロレベルから地域レベルでの労働者の認知的/非認知的スキルを反映する可能性がある。