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Creative and science oriented employees and firm-level innovation

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ABSTRACT

This paper examines the link between innovation and the endowments of creative and science oriented STEM – Science, Technology, Engineering and Mathematics – workers at the level of the firm and at the city-/regional-level in Germany. It also looks into whether the presence of these two groups of workers has greater benefits for larger cities than smaller locations, thus justifying policies to attract these workers in order to make German cities 'smarter'. The empirical analysis is based on a probit estimation, covering 115,000 firm-level observations between 1998 and 2015. The results highlight that firms that employ creative and STEM workers are more innovative than those that do not. However, the positive connection of creative workers to innovation is limited to the boundaries of the firm, whereas that of STEM workers is as associated to the generation of considerable innovation spillovers. Hence, attracting STEM workers is more likely to end up making German cities smarter than focusing exclusively on creative workers.

1. Introduction

"Creative, innovative and open-minded… Discover the city of opportunities". Under this slogan, Berlin launched its branding campaign in 2008. The aim of the campaign was to burnish Germany's capital image as a colourful, diverse, and tolerant metropolis, capable of attracting both tourists and, more importantly, entrepreneurs. Creativity and innovativeness were, in this way, put right at the top of Berlin's economic agenda. But Berlin is far from an exception among cities trying to build their economic reputation on creativity: throughout the USA, various "cool city" initiatives have been implemented and the Scottish city Dundee has brandished itself in the same way by setting up a "Cultural Quarter" (Nathan, 2007). Every aspiring *Smart City* seeks to lure a creative class – often by means of improving local amenities and living conditions (Florida, 2004; Partridge, 2010) – in order to become more dynamic, productive, efficient, more competitive, and *smarter*. More creative cities are deemed livelier and hubs of socioeconomic wellbeing and growth. Therefore, creative cities become Smart Cities that offer the best conditions for innovation and economic growth. Hence, creativity, technology and innovation are at the heart of most smart city and urban development strategies (Florida, 2014; Lee & Rodríguez-Pose, 2016).

The link between an open and creative environment, on the one hand, and innovation and economic growth, on the other, is not new and can be traced at least to the work of Jacobs (1969). Creative workers are considered to use knowledge and information – the instruments of creativity – to produce innovation, making innovation the product of creativity and an essential factor of economic growth (Florida, 2004). This is something that has been embraced by decision-makers the world over, who have oftentimes enthusiastically supported the idea that vying for creative workers puts their city on track to become a smart city. Hence, from this perspective, Berlin is following the right steps.

Whereas the idea that creativity and the presence of a creative class lead to innovation and smart cities has been welcomed by politicians, the opinions by researchers are more mixed. Some argue that the creative class just comprises individuals with high skills, whose contribution to the economy was already well-measured by human capital indicators. From this perspective, dynamic local economies are more related to attracting skilled – and not specifically creative and/or bohemian – people (Glaeser, 2005; Markusen, 2006; Marrocu & Paci, 2012; Nathan, 2007). Moreover, it is often difficult to disentangle skill-related from creative effects: the definition of creative occupations tends often to be subjective and includes, in addition to creative people – such as bohemians, artists, and designers, among others – a large number of workers conducting creative activities in science-related jobs, i.e. STEM occupations (Science, Technology, Engineering and Mathematics) which, in general, also hold a high level of skills (Hyde, Lindberg, Linn, Ellis, & Williams, 2008). Hence, a question that has lingered in the literature relates to whether innovation is indeed driven

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by creative individuals – what Marrocu and Paci (2012) call bohemians – or by highly skilled professionals conducting creative activities in STEM sectors. This is the question that drives this paper: to what extent does the presence of creative workers drive innovation in firms and, consequently, in cities in Germany.

In order to address this question we consider, first, the association between creative and STEM employees and firm-level innovation incentives. This is a relatively new area of research comprising a small number of contributions (e.g. Peri, Shih, & Sparber, 2015; Siepel, Camerani, Pellegrino, & Masucci, 2016). We extend this approach and, second, focus on potential spillover effects of both groups emerging at the level of industry and region. Third, we contemplate size effects and whether firms become more innovative when they are located in an area with strong positive externalities or a "buzz region". For this purpose we make use of comprehensive data at the local level in Germany and estimate the probability of German firms increasing different types of innovation outcomes – adaptation, introduction and improvement of new products and services, but also process innovation – depending on the characteristics of their workforce and that of the places where they are located.

The study is structured as follows. Section 2 presents the theory as well as the related literature on creativity and innovation. Section 3 introduces the definition of creative and STEM occupations and gives information about the data and variables. A descriptive overview of creative and STEM employment in relation to innovation is provided in Section 4. Section 5 discusses the results of the probit regression estimations, while Section 6 presents the main conclusions and policy implications.

2. To what extent do creative workers spur innovation?

According to Griliches (1979), innovative processes require innovation-related inputs such as R&D capital and human capital. These innovation-related inputs are more likely to take place in urban environments and, thus, in Smart Cities for three reasons. First, cities have a higher knowledge intensity in innovation, leading to potentially reduced innovation costs. Second, knowledge has the properties of a public good, meaning that at least part of the research costs are covered by others as long as the "outside" knowledge can be absorbed by the innovator (Cohen & Levinthal, 1990). If such knowledge is limited to urban areas, only local innovators would gain from it. Lastly, meetings and face-to-face contacts make knowledge exchange of vertically-linked firms easier and more frequent (Gertler, 2003; Storper & Venables, 2004). All these reasons generate an urban 'buzz' and localized positive knowledge spillover effects and therefore urban centres offer potentially better conditions to perform all types of innovation.

Innovative processes, moreover, require human capital and creativity. Florida (2004), following Jacobs (1969), puts the emphasis on the presence of a so-called creative class as the main motor of urban innovation. Different types of creative workers influence the innovative capacity of an economy in a number of ways. The *creative core* (e.g. architects, designers, writers, artists) produce new forms or designs in all aspects of life and work. They provide a cultural environment by means of art galleries, operas, theatres, improving the cultural environment and local living conditions. They may also be directly involved in other innovative processes. Creative professionals engage in a creative, problem-solving process which is at the root of firm-level innovation. Empirical evidence highlights that the concentration of this type of creative people in urban areas creates the right environment for innovation (Boschma & Fritsch, 2009; Clifton, 2014; Fritsch & Stuetzer, 2014; Gottschalk & Hamm, 2011).

There is, however, considerable controversy about the definition of a creative worker. According to Glaeser (2005), creatives can be equated to highly skilled individuals. He argues that the creative class theory can be embedded in the human capital theory of economic growth. However, it has become increasingly common to distinguish between creativity as an output in the labour market, and thus related to specific occupations and human skills as an input, purely connected to the levels of educational attainment of the individual (Cunningham & Higgs, 2009; Marrocu & Paci, 2012; Mellander & Florida, 2014).

Taking this division into account, researchers have tried to analyse the economic impact of the presence of a creative class and creative industries. The majority of the analyses have provided a positive link between both phenomena. It has been found that cities with a greater share of creative industries and creative workers generate more innovation (Bakhshi & McVittie, 2009; Bakhshi, McVittie, & Simmie, 2008; Knudsen, Florida, Gates, & Stolarick, 2007; Lee & Drever, 2013; Lee, Florida, & Gates, 2010; Lee & Rodríguez-Pose, 2014a, 2014b); that creativity is associated with higher wages and GDP (Gabe, Colby, & Bell, 2007; Mellander & Florida, 2011; Moeller & Tubadji, 2009; Wedemeier, 2010) and with employment growth (Boschma & Fritsch, 2009; Marlet & van Woerkens, 2007; McGranahan & Wojan, 2007; Moeller & Tubadji, 2009; Wedemeier, 2010). Moreover, the presence of a creative class is regarded to lead to greater economic competitiveness and productivity (Huggins & Clifton, 2011; Marrocu & Paci, 2012) and to higher levels of entrepreneurship and new firm formation (Boschma & Fritsch, 2009; Clifton, 2014; Lee, Florida, & Acs, 2004; Rodríguez-Pose & Hardy, 2015). However, some studies are less optimistic and question the relationship between creativity and better economic outcomes (e.g. Fritsch & Stuetzer, 2014; Gottschalk & Hamm, 2011).

The analysis of the impact of a different type of highly-skilled and creative individuals – the so-called STEM-trained (Science, Technology, Engineering, and Mathematics) workers – on innovation has attracted somewhat less attention than that of the creative class. There is nevertheless an increasing consensus around the idea that the presence of STEM workers in the firm facilitates complex problem-solving (Hyde et al., 2008; Rothwell, 2013). "STEM workers are uniquely capable of generating ideas, innovation, and externalities that benefit productivity" (Peri et al., 2015: 249) and said increases in individual-level productivity are derived from a greater capacity to produce new innovations associated with the hiring and/or presence of STEM graduates and workers (Moretti, 2012; Wright, Ellis, & Townley, 2017). Greater STEM capacities at the level of the firm drive science- and skill-based innovation (Peri et al., 2015: 248), boosting, in turn, job growth, wage rates, and competitiveness in international markets. STEM workers also play a key role in improving living conditions in terms of health, education, and environmental issues (Atkinson & Mayo, 2010). Conversely, a lack of supply of STEM trained individuals is very often considered an important constraint for firms to innovate (Wright et al., 2017: 190).

The empirical verification of the link between the presence of STEM workers and innovation is, however, still relatively limited. Most of this research, however, highlights a positive link between the presence of STEM workers and firm-level innovation. Recent empirical studies making use of US data have been at the forefront of proving this relationship. Winters (2014a), for example, detects that STEM graduates, native and foreign born, significantly increase both innovation – measured by the metropolitan area patent intensity – and wages, even for not-STEM graduates (Winters, 2014b). Policies aiming to attract STEM graduates can have high social benefits. Peri, Shih, and Sparber (2014) and Peri et al. (2015) investigate the effects of an inflow of foreign STEM workers and show a significant wage increase of college educated natives and, to a smaller but still significant extent, of non-college educated workers. Moreover, it is stressed that the returns of STEM activities are greater in cities, as living in in denser STEM areas increases the probabilities of matching STEM degree holders with STEM occupations (Wright et al., 2017).

Finally, the combination of creative and STEM activities at the level of the firm may be self-reinforcing for innovation, as indicated by Siepel et al. (2016). These authors examine the joint effect of creative and STEM employees by focusing on the revenue and innovation behaviour of UK firms. They provide evidence that mixing creative and STEM