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Is Happiness Conducive to Entrepreneurship? Exploring Subjective Well-Being – Entrepreneurship Relationship across Major European Cities

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Abstract
Using perception of quality of life survey by Eurostat we construct the City Ecosystem Index (CEI) – a systemic indicator that measures subjective well-being in European cities. The purpose of the index is to inform public, policy-makers and entrepreneurs by providing a holistic view on subjective well-being across European cities. Once contrasted with the Global and Regional Systems of Entrepreneurship indices, which illustrate entrepreneurship environment in regions, we demonstrate that happiness of cities is associated with a higher entrepreneurial activity. CEI may be used as a control variable when predicting the level of entrepreneurship and entrepreneurial aspirations in cities.

Keywords
happiness, well-being, entrepreneurship, ecosystem, cities, Europe

JEL Classifications
C43, I31, L26, R20

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1 Introduction

Positive moods and feelings as well as life satisfaction have been found to generate many beneficial effects- such as enhanced task performance and productivity, increased career and personal success, higher risk taking behaviour. These benefits appear to extend to entrepreneurs (Baron, 2015). Much of the debate on this topic has been over importance of life satisfaction or subjective well-being – defined as people's subjective cognitive and affective evaluations of their quality of life (Florida et al., 2013). Life satisfaction may facilitate innovation and entrepreneurial spirit in places, attracting more high-quality labour force (Glaeser et al., 2001, 2011). Quantity and quality of human, social, built and natural capital were found as important predictors of residents' subjective well-being (Vemuri and Costanza, 2006; Smith et al., 2013).

The choice of a place to live and work is driven by variables related to "quality of life" (Glaeser, 2011). Understanding "quality of life" in cities has become a priority for scholars and regional policy makers who aim to understand the drivers of entrepreneurship and innovation. Florida et al. (2013) and Smith et al. (2013) illustrate a number of single indices of subjective-well being developed for the US, Canada, Australia, New Zealand and other OECD countries. Numerous attempts have been made to develop comprehensive well-being indicators to analyse the socioeconomic development of society over time. From both a theoretical and methodological perspective researchers, such as Botterman et al. (2012) questioned whether subjective well-being can be presented as a unidimensional construct with the answer on "impossible to construct one single indicator for social cohesion when taking the multidimensionality of the concept into account" (Botterman et al., 2012, p. 185).

Our study seeks to bridge this gap for European cities, debate the validity of a holistic approach to study well-being we well as design the first systemic indicator that measures subjective well-being in major European cities. We posit a question: Is happiness of cities conducive to entrepreneurial activity and entrepreneurial aspirations delivered by the regional systems of entrepreneurship (Szerb et al., 2013; Qian et al., 2013; Acs et al., 2014)?

Considering subjective well-being at the city level is important to answer this question as individuals select their residence location in relation to the job opportunities, housing prices, environmental conditions, quality of public goods and administrative services, satisfaction with healthcare and safety, social cohesion, trust and culture (Sjaastad, 1962; Florida & Mellander, 2010). As a start, we aim to create an indicator and use a comprehensive method to shed a light on the following: What is the well-being in European cities? How does it vary across cities? How efficient are regional entrepreneurial ecosystems at each conditional level of subjective well-

being? This study contributes to an ongoing debate over happiness, well-being and entrepreneurship in cities (Florida et al., 2013) and employs newly available data from a European perception quality of life survey (Eurostat, 2014).

While national-level studies have stressed the connection between well-being and the level of entrepreneurial activity, drawing from studies of city economic performance (Audretsch et al., 2006, 2015a; Glaeser et al., 2010; Florida & Mellander, 2010) it is argued that entrepreneurship ecosystem creates conditions in which the region's entrepreneurial dynamic operates efficiently (Szerb et al., 2013; Acs et al., 2014) is likely to play a considerable role in city happiness. We measure "happiness" as "are you satisfied with?" in terms of survey answer. A growing literature both in economics and in psychology uses it with the patterns in the answers is reasonable across European regions (Cummins, 2003; Eurostat, 2013).

This is the first study in regional entrepreneurship and well-being literature that tracks the relationship between a quality of entrepreneurship ecosystem measured by Regional Entrepreneurship Ecosystem Index (REDI) and happiness measured by the CEI in European cities. Using correlation and index method analysis, this study finds that cities with the highest quality of entrepreneurship ecosystems have the highest life satisfaction.

This work contributes to regional economics and entrepreneurship literature by bringing together Regional System of Entrepreneurship (Szerb et al., 2013; Acs et al., 2014), Regional Systems of Innovation theory (Nambisan & Baron, 2013) and a homeostatic theory of well-being (Cummins, 2003; Smith et al., 2013) to develop the CEI and test the CEI-REDI link.

First, we construct the CEI index that measures happiness or subjective wellbeing in European cities utilizing perception of quality of life surveys in 2004, 2006 and 2009 (Eurostat, 2014).

The CEI is structured around six important themes: physical infrastructure (including environment, roads and amenities), culture and norms within the neighbourhood (including taking care of neighbourhood and local trust); demand (job market opportunities and demand for housing); institutional framework (administrative efficiently and responsibly in resource distribution), health and safety conditions; access to information and technology (Malecki, 2011; Acs et al., 2014; Mason & Brown, 2014; Feld, 2012). The CEI first for the well-being indices introduces information technology and Internet access as an important domain of subjective well-being (Lead, 2014; Belitski and Desai, 2015).

Second, we map the CEI against the REDI. Our finding illustrates diminishing marginal returns of the relationship. Although the CEI-REDI relationship is positive, while REDI reaching 60 points

and more, the CEI indicator plateaus. This association demonstrates that the relationship between the quality of entrepreneurship ecosystem and the level of happiness in a city is not linear although positive and statistically significant.

Third, an effort to create new measure of subjective well-being is made to facilitate regional well-being and entrepreneurial policy decisions and has both theoretical and empirical importance.

The structure of this work is as follows. In the next section we discuss the level of analysis and existing measurements of well-being as well as introduce regional systems of entrepreneurship. Section three debates the development of the CEI. Section four constructs CEI, including the new weighting method of the Penalty For Bottlenecks (Acs et al., 20111; Szerb et al., 2013). Section five reports the developments and calculation of the bottlenecks as well as provides rankings of cities by the CEI and CEI PFB adjusted. This is followed by the comparison between CEI (CEI adjusted) and the REDI / GEDI indices, using correlation and mapping method. Section 6 provides illustrates the inpportance of the CEI for entrepreneurial activity delivered by the REDI. Section seven discusses the main finding and contributions . Finally, section eight concludes with limitations and highlights future research and policy implications.

2 Theoretical and methodological aspects of well-being

2.1 Well-being measurement: systemic approach

Well-being has fallen into two main definitions: the traditional measures (e.g. GDP, gross value added, productivity, income, and poverty level) and subjective measures that attempt to measure how people perceive their quality of life and how much they are satisfied with their lives, which may considerably differ from the available macro-economic indicators of life quality.

Although one of the most popular indicators to measure the well-being is the Gallup-Healthways index and the Gallup's World Poll (Deaton, 2008), there is no agreed definition of a well-being as well as the methodology to calculate it. Although the effectiveness and the implications of alternative measures is debatable (Smith et al., 2013), scholars agree on a more comprehensive indicator is necessary to measure the influence of local context on well-being, relative to economic, social, political and institutional factors (Deaton, 2008; Smith et al., 2013). Policy makers at various geographical levels would like to know how their decisions impact lives and subjective well-being in cities (e.g. health and safety, infrastructure, jobs, facilities, technology, culture). Viewed through a lens of sustainability theory, these domains of the city

ecosystem constitutes to environmental, economic and societal well-being (OECD, 2011a; Summers et al., 2012). A composite index for metropolitan ecosystem need to reach beyond income, unemployment, jobs and value added (Summers et al., 2012). Saying this, applying a robust method of well-being measurement systemically is a key to analysing created value by public policy and city ecosystem.

A holistic indicator will extends beyond the level of GDP per capita, as a correlation between happiness and GDP in cities may mean correlation, but not causality (Florida et al., 2013). Cities in Europe have more advanced healthcare systems, education and welfare than countries in the other world regions, however in the case of a relative homogeneity between the units of analysis (e.g. cities in Western and Central Europe all of which have a converging standard of living and income per capita), quantitative measures of socio-economic development such as GDP fails to draw distinctions in a well-being between cities (Eckersley, 2000). Cummins et al. (2003, p. 160) debates "The GDP was never intended as a measure of population wellbeing. It is merely the tally of products and services bought and sold". GDP assumes that every transaction adds to wellbeing which is not the case in societies with a high level of inequality (e.g. cities in Central and Eastern Europe, Mediterranean region). Cummins et al. (2003, p. 160) further posits "the GDP disregards technology distribution. It also disregards important aspects of living such as social cohesion and trust, administrative efficiency and social support of reforms, and GDP does not change with changes in culture".

Wellbeing measures were thoroughly synthesised in the study of Smith et al. (2013) and selected within the themes as various combinations of subjective well-being. Many of the measures revised by Smith et. al. (2013) include other indices of economic, societal, institutional progress, security, housing, unemployment (Miringoff & Miringoff, 1999), human and social capital (Rentfrow et al. 2009; Lawless & Lucas, 2010), social capital, cohesion and trust (Botterman et al., 2012); community life, political freedom and support to government (EIU, 2005), ecology, education, community, civic participation measures (Smith et al., 2013); build environemnt and infrastructure (Woolley, 2014), health and economic development (Jamieson, 2007), domesticated diversity, culture, freedom and governance, knowledge (Deiner et al., 2003; Prescott-Allen, 2001). Most of these indicators are at a country level, rather than regional or county levels (Watts, 1984; Smith et al., 2013).

Although a number of subjective well-being indicators has been developed (Graham, 2009) and the results are encouraging, the interdisciplinary research on individual perception of well-being continues, with Wikiprogress became an information platform aiming to develop and validate

new measures of well-being based on economic, social and environmental factors (OECD, 2011b).

2.2 Well-being measurement: the theory of subjective wellbeing homeostasis approach

The homeostatic theory is one of the well-known interdisciplinary approaches to explain a subjective wellbeing of an individual or community (Cummins & Nistico, 2002). Similar to the homeostatic maintenance of blood pressure, subjective well-being is controlled and supported through a number of psychological mechanisms controlled by a person. Homeostasis theory operates at non-specific level and can be expressed as the general question "Overall, how satisfied are you with your life in a place?" This is exactly a question employed by Eurostat (2014) when designing and implementing the quality of life perception surveys. Given the explicit generalization of this question, the response that respondents give illustrates a feeling of happiness and their subjective wellbeing at a time. This is precisely the level at which the homeostatic system operates (Cummins et al., 2003). First, one of the main advantages of *homeostasis approach* to measurement a well-being is it is significantly stable. With time the "psychological mechanisms" reverse any shocks or events that happened with the person back to its general satisfaction with life and its previous level (Suh & Diener, 1996). Second, the "set-point" where a person's subjective wellbeing is clustered, lies within the "satisfied" sector of the non-satisfying spectrum. That is, a scale of zero is usually applied to study the subjective well-being, starting from zero of absolute dissatisfaction with a specific domain of the quality of life or the quality of life overall; and 100 represents absolute satisfaction. Interestingly, respondents' set-point is known to lies within the positive scale range of 50–100 (Cummins et al., 2003). Former also found that in the West Europe has the average of 75 points on a 100 scale. The theory of homeostasis is often used in practical psychology to measure the perception of life satisfaction of the individuals and was used as a tool to measure the distinctive themes across socio-economic, political, cultural and technology aspects of modern life in cities.

Although income was found to have a major impact on life satisfaction (Florida et al., 2013), Graham (2009) shows the relationship between the two is relative. Graham (2009) work highlights that although people can be happy at lower levels of income, like peasants, they are far less happy when there is greater uncertainty over their future wealth, like millionnaires. This extends the homeostasis theory of individual perceptions, emphasising income–happiness relationship is not only perceptions-based, but also highly embedded in local context where

people live and work as well as take their decisions. This argument was used in systemic approach to analyse individual decision-making process (Feld, 2012).

2.3 Systemic approach to measuring entrepreneurship

Unlike measurement of subjective well-being indices across countries (Smith et al., 2013; EIU, 2005 and other), accessing entrepreneurial aspirations embedded within innovation and entrepreneurship ecosystems globally and regionally has been given less attention (Acs and Szerb, 2010; Acs et al., 2013). The recent trend in the entrepreneurship policy of 2010s – an increasing emphasis on taking a more multi-functional and multi-disciplinary approach, including both national, regional, local and individual prospective to study entrepreneurship (WEF, 2013; Mason & Brown, 2014). We also know that the phenomenon of entrepreneurship has been studied extensively at both the individual and contextual levels (Acs et al., 2014) and the complex two-way relationships between the individual and national (regional) level has been addressed by researching entrepreneurship in a systemic way. A System of Entrepreneurship is defined as "dynamic, institutionally embedded interaction between entrepreneurial attitudes, ability, and aspirations, by individuals, which drives the allocation of resources through the creation and operation of new ventures" (Acs et al., 2014). Entrepreneurship is acknowledged as a decision-making process embedded in a complex local and national environments and a wider socioeconomic and institutional context (WEF, 2013).

Developed recently *Global Entrepreneurship and Development Index (GEDI)* (Acs et al., 2013) and REDI index (Szerb et al., 2013) allow capturing the interaction between individuals and their contexts at national and regional levels. REDI and GEDI enable to measure the magnitude of entrepreneurial activity within a region (nation), an important gap still remains the systemic approach to analysis of individuals and their local contexts (Qian et al., 2013).

We utilise the REDI and the GEDI indices to better explore regional systems of entrepreneurship (Acs et al., 2014) as well as the evidence from the Regional Entrepreneurship Accelerator Programme (Mason & Brown, 2014) to offer a local-context prospective on entrepreneurship using the REDI measure of entrepreneurship ecosystem.

To measure the quality of entrepreneurship ecosystem in regions, the REDI consists of three sub-indices, 14 pillars, and 28 variables (Szerb et al., 2013, p. 6). Altogether the REDI utilises 40 institutional indicators merged in three sub-indices of attitudes, abilities, and aspiration constitute the entrepreneurship super-index, which we call REDI. All three sub-indices contain four or five pillars measuring innovation, technology, socioeconomic conditions, regulation,

infrastructure, culture, networks, high growth and other. These features set the REDI index apart from simple summative indices that assume full substitutability between entrepreneurship system components, making it uniquely suited to profiling Regional Systems of Entrepreneurship in EU regions (Szerb et al., 2013, p. 6). The results of the REDI analysis at the NUTS II level in EU countries.[1]

In brief, the REDI illustrates how individual actions drive the entrepreneurial process within a wider local context and how this context regulates the quality and quantity of entrepreneurship in cities (Levie & Autio, 2008, 2011; Qian et al., 2013).

This index will be used in our study to relate the development of the regional systems of entrepreneurship to subjective well-being or happiness in the largest metropolitan areas in Europe (Malecki, 2011; Feld, 2012; Acs et al., 2013, 2014). It will shed light on a question: Are happy cities entrepreneurial?

3 Debating and theoretical development of the City Ecosystem Index

We pick city-level context for four main reasons highlighted in a leading literature on regions and entrepreneurship (Audrestch & Lehmann, 2005; Audretsch et al., 2006; Fritsch & Storey, 2014; Stam, 2014) to name a few. Firstly, most entrepreneurial action takes place locally and in cities (Glaeser et al., 2010; Audrestch & Belitski, 2013; Bosma & Sternberg, 2014). Therefore entrepreneurs are subjected to local norms and culture, local resources and regulation, attitudes, available physical infrastructure, information and communication technologies (ICT), local demand for jobs and other contextual factors (Saxenian, 1994; Audretsch et al., 2006). Secondly, in Europe there exist significant differences in sectoral structure and socioeconomic development between clusters of cities, emphasizing the importance of regional and more specific city focus (Fritsch & Storey, 2014). Thirdly, entrepreneurship ecosystems are seen as a localized 'container', enabling local interactions (Stam, 2014), Fourthly, as a practical issue, the Eurostat collects harmonized and synchronized data across EU regional and urban economies, e.g. UK Urban audit project, perception of quality of life surveys (Eurostat, 2014).

[1] The Nomenclature of Territorial Units for Statistics (NUTS) was developed at the beginning of the 1970s by the Statistical Office of the European Communities (Eurostat) in close collaboration with the national statistical institutes of the EU Member States. The NUTS ensures uniform statistical classification of the territorial units of the EU Member States to support comparable, harmonized regional statistics for socio-economic analyses.

Finally, data coming from individuals within the city dimension enables us to measure variations in the extent to which city residents are happy with transport connectivity, agglomeration economies, quality of governance, social capital, safety and security, technology and other local context.

3.1 CEI construction: theoretical framework

While constructing the City Ecosystem Index we build on the previous research in regional economics, phycology, sustainability and well-being to consider a number of factors that the literature identifies as influencing happiness at the individual and/or state levels (Florida et al., 2013). This section describes six important domains known which contribute to the CEI development.

First, we draw our attention on satisfaction with infrastructure represented by city amenities and facilities. This domain has been extensively studied in regional economics and entrepreneurship literatures (Albouy, 2008; Florida & Mellander, 2010; Woolley, 2014). Florida and Mellander (2010) found that cost of renting and buying a property in a city is used as a proxy for higher levels of amenities and better infrastructure with generally higher quality of life areas. Thus, housing costs although being a burden for tenants, may illustrate other city amenities and be positively associated with happiness. Glaeser et al. (2001) highlighted the role of amenities and infrastructure in creating condusive environmnt for innovation, well-being and life satisfaction. Developed infrastructure, museums, green areas, cinemas, coffee shops, pubs and restaurants all contribute and attract high-skilled labour forming a creative class (Florida 2002). People are ready to move to cities with abundant amenities, often trading off house prices and real wages against amenities and facilities. Glaeser (2001, p. 131) argues that New York – a “fun” place – is now growing rapidly, after a period of stagnation allegedly due to crime and violence. The author posits that “in the year 2000, people were willing to accept lower real wages to live in New York” due amenities.

Woolley (2014) demonstrated how the elements of infrastructure emerge and configure through systemic coevolution and addressed the importance of infrsatructure for new emerging industries, e.g. nantechnology. It is debated that changes in entrepreneurial ecosystem create and augment the resources and structures that new firms need to survive. Creating well-functioning contextual infrastructure necessary for nascent entrepreneurship policy makes it easier for business and labour resourses to connect increasing residents’ satisfaction with physical infrastructure.

Transport infrastructure adds to amenities and with high-speed connectivity to be important to commuter. Time to commute is negatively associated with happiness and life satisfaction (Krueger et al., 2008). Long commute to work and spending most of working time in transport is the most unpleasant activity of the day, hence affecting the level of satisfaction with transport (Stutzar & Frey, 2008). We therefore assume better transport links, developed infrastructure and facilities, including types of infrastructure supporting connectivity and communication (Audretsch et al., 2015b) will increase subjective well-being and happiness of city residents.

Our second domain is represented by demand factors such as market agglomeration, demand for housing and labour. All were found important for life satisfaction (Eurostat, 2013; Delgado et al., 2010). A number of works in regional economics studied the relationship between employment and happiness as well as comparison of income and life satisfaction (Clark & Oswald, 1996; Winkelmann & Winkelmann, 1998). Job offerings and lifestyle are one of the leading factors why people move to leading cities. Smith et al. (2013) posit that job offering alone with financial security are important factors of life satisfaction. Former factors contribute to the Canadian Index of Well-being, Nova Scotia GPI and the OECD Better Life Initiative Indices (Osberg & Sharpe, 2009). Economic security and marlket size that offers jobs (Glaeser, 2011) drives both high and low-qualified labour in large cities. Financial security and availability of public goods (Glaeser et al., 2004), diverse social and economic services for employment are associated with higher subjective wellbeing and secure lifestyle.

While moving in large cities, housing prices become a main caveat for residents. It is intuitively expected that people will be happier in cities where housing is more affordable and available. This is not always the case. Although people are happy with a low housing prices, those reflect quality of life and the desire of people to live in a city. Rentfrow et al. (2009) found that higher housing values are associated with higher subjective well-being at the country level. While Lawless & Lucas (2010) found mixed results, they confirmed that higher challenges of finding a house to be associated with higher happiness, however the association between higher human capital or income and happiness was stronger. As Glaeser in his book Triumph of the City (Glaeser, 2011, p. 130) posits “When a city has really high housing prices relative to incomes you can bet that there is something nice about that place”. We therefore expect higher challenges to find an affordable housing as well as availability of jobs are associated with a higher subjective well-being.

Third domain of factors illustrates culture and norms that make people align and trust each other as an important determinant of subjective well-being. Personal characteristics and culture play an important role in subjective well-being (Diener et al., 2003). Putnam (2000)

demonstrated, that higher levels of happiness associated with a higher levels of social capital and trust were in areas with relatively low population density. A good example is Davis and Fine-davis (1991) study on Irish country-side communities who found that people in smaller communities trusted each other more than residents in a larger cities due more opportunites for socialisation. Trust fosters building a close relationship and develops nessessary level of social cohesion which makes people feel happier. Behaviors associated with trust and reciprocity were often used as a proxy for community cohesion and contributed to indicators such as The Canadian Index of Well-being, Gross National Happiness index, The State of the Commonwealth Index (Watts, 2004). To follow, cognitive factors such as trust can influence life satisfaction and happiness directly and indirectly through culture and norms which changes the feeling of a place, community association, social involvement and trust (Deiner et al., 2003). We expect higher social cohesion and trust be associated with stronger individual well-bing and happiness (Higginbotham et al., 2007).

Our forth domain highlights the importance of efficient administration framework and regulation, that represent formal institutions (Estrin et al., 2013). Efficient regulation plays major role in helping individuals to live, work and start their business. The size of a local administration shapes and distributes organizational and entrepreneurial resources (Bruton et al., 2010) facilitating or impeding entrepreneurs in their access to finance (Korosteleva & Mickiewicz, 2011). Provisioning efficient regulation in resource distribution as well as balancing four types of capital – human, built, social and natural (Vemuri & Costanza, 2006) increases the likelihood of achieving higher individual and public well-being. Efficient regulation and administration improve the living standards, while efficient accumulation and distribution of socioeconomic services allow achieving higher life satisfaction. Recent research suggests that efficient resource management is highly appreciated by community (Estrin et al., 2013). Interestingly, enhancement of living standards by formal institutions and creating an efficient distribution of resources may take place without significant change in the household income (Folbre, 2009). Efficiency in administrative services enables an increase in life satisfaction mainly by increasing social cohesion and trust, uplifted attitudes to government (Estrin et al., 2013). Thus, we expect a positive relationship between the efficiency in resource distribution and subjective well-being.

Our fifth domain of index construction follows Maslow's hierarchy, that underlines food security, helthcare conditions and safety to be the basic human needs having a direct impact on overall life satisfaction. Phycology literature highlights that satisfaction with the healthcare services is driven by higher life expectancy and lower mortality rates significantly improves the overall life

satisfaction. Healthcare provision also includes healthy lifestyle and ease of healthcare access as well as food quality (Smith et al., 2013).

Personal satisfaction with the level of security is often related to employment status, education, trust, but most often with a rate of crime, number of accidents in the area, and perceived neighbourhood security. The perception of safety can be altered to account for possible natural and technological disasters as a result of economic activity and environemental pressure. Personal safety and security were found to impede new business start-ups and prevent people from moving into a city (Glaeser et al., 2010). In reference to safety and security higher violant and property crime rates in the area, traffic accidents, disasters are associated with poor life satisfaction and hapiness.

Finally, our sixth domain brings ufront the role that IT infrastructure, information technology and access to information play in subjective well-being. The shift from a 'managed' economy to an 'entrepreneurial' and now "digital" economy is among the most significant changes over the last decade. These factors have been largely ignored (Smith et al., 2013). Facilitating IT infrastructure and Internet access to global information systems is crucial while moving from managed to a digital economy (LEAD, 2014). This is coupled with an increasing role of industries rich in knowledge and creativity in producing new ideas and entreprneurs (Audretsch & Belitski, 2013, 2014). The most obvious signs of digital economy shift are: knowledge is increasingly replacing physical capital and labour; individuals rather than multinationals are the leading force of creativity and new knowledge creation; SMEs enabled by technologies play a dominant role in recognising and pushing newly created knowledge into market; alignment of business and IT in cities producing ICT clusters (LEAD, 2014; Belitski and Desai, 2015).

Information technology and internet is an important tool in retaining and developing customers. For residents it is saving time tool, linking them to friends and helping at work. Although the embeddidness of Internet into individuals' lives has been acknowledged, information technologies and accessibility of Internet services are bearly cited among the well-being indices reviewed (Osberg & Sharpe, 2009; Graham, 2009; EIU, 2005; Smith et al., 2013). The only excemption is the EDFx Index which is under development by NESTA within the Startup Europe Partnership (SEP, 2015) which offers an integrated pan-European platform to help the best startups emerge from local ecosystems and grow. The EDFx index will contain composite indicators describing how well different European cities support digital entrepreneurship and will include, in addition to conventional key factors, such domains as the skillset of the workforce in the area and the quality of the supporting infrastructure and networks, employes Internet

access related indicators – Internet speed, coverage of broadband, Penetration of 4G, Average speed of mobile phone connection, free public wifi and availability of fibre.

We suggest higher Internet coverage and penetration at work and at home is positively associated with subjective well-being. It may be used as one of the measures of ICT development in cities, information update, higher computer literacy and technology-enabled education, quality of information transfer and exchange (Belitski and Desai, 2015).

Table 1 below describes the structure of the CEI. The index consists of five steps index-building: (1) indicators (2) variables, (3) pillars, (4) sub-indexes and (5) the index itself. The six sub-indexes of infrastructure, demand, culture, government and institutions, health and safety and, finally, access to Internet technology constitute the CEI (column 1, Table 1). Pillars are the most important layers in the index structure (column 2, Table 1) because they provide the basis for indicators and variables to build on. The sub-indexes and pillars altogether comprise the indicators of the Penalty for Bottleneck (PFB) analysis drawing on the REDI index construction approach (Szerb et. al,. 2013; Acs et. al. 2014). PFB correction methodology hs proved to be useful when understanding the drawbacks and develop urban entrepreneurship policy (column 5, Table 1) to leverage the existing bottlenecks in cities (Acs et al., 2011). Each of the twelve pillars consists of an institutional (column 3, Table 1) and an individual variable (column 4, Table 1) which are build within the individual's perception indicators. The eight indicators are the building blocks of the bottlenecks designed using the perception survey which also shape the pillars and weight the final index taking into account existing constraints that weaken urban entrepreneurship. Some institutional indicators taken from the perception survey are complex and designed by Eurostat (Eurostat, 2014). No PFB is applied to Internet connectivity domain given no data major discussion on Internet accessibility has been taken place within Eurostat (2014) surveys.

Table 1. The structure of the City Ecosystem Index (6 Themes and 12 pillars)

Structure of the CEFCE	Pillars	Institutional variable	Individual variable (0-100 scale)	Individual Indicators PFB weighting
(1)	(2)	(3)	(4)	(5)
Infrastructure sub-index	Transport	Accessibility	Satisfied with transport (0-100)	Most important is public transport (0-100)
	Facilities	Amenities	Satisfied with city and cultural facilities (0-100)	Most important is road infrastructure (0-100)[2]
Demand sub-index	Demand for labour	Market agglomeration	It is easy to find a good job (0-100)	Most important is jobs creation (0-100)
	Demand for housing		Challenge to find a housing at reasonable price (0-100)[3]	Most important is housing conditions (0-100)
Institutional framework sub-index	Administer framework	Quality of local governance	Administrative services help efficiently (0-100)	Most important is social services (0-100)
	Resource management		Resources spent responsibly (0-100)	
Culture and norms sub-index	Trust	Social capital	Most people can be trusted (0-100)	Most important is education (0-100)
Health and safety sub-index	Healthcare level	Quality of healthcare	Satisfied with health care (0-100)	Most important is health services (0-100)
	Local security	Safety and security	Feel safe in this neighbourhood (0-100)	Most important in city Urban safety (0-100)
	Urban Security		Feel safe in this city (0-100)	
Access to technology sub-index[4]	Internet connectivity private	Information transfer	Satisfied with internet at home (0-100)	
	Internet connectivity public		Satisfied with public internet (0-100)	

Source: Authors editing.

[2] Road infrastructure although weakly operationalises cultural facilities is considered to be the most important amenity in a city that creates connectivity and spillovers other city facilities and infrastructure (Acs and Armington, 2004; Glaeser et. al., 2010)

[3] The variable was calculated as 100 minus 'Easy to find housing at reasonable price' indicator on (0-100) scale developed by Eurostat. Challenge to find housing at reasonable price scaled from 0 to 100 indicates high demand for housing in a city which is opposite to housing available at a reasonable price. Demand drives house prices and lowers their availability (Florida et al. 2013).

[4] No indicator that could be used to leverage the bottlenecks in a city is available for internet connectivity and information transfer. Therefore it was not possible to penalise for a bottleneck in a city in regard to availability or public and private internet connection. At the same time, Access to technology sub-index[4] is highly correlated with housing facilities satrisfaction and availability of cultural facilities. For example the pairwise correlation coefficient between housing conditions importance and internet connectivity public is 0.23 and internet connectivity at home respectively 0.17. The correlation between availability of cultural facilities and internet at home is 0.52 and in public places 0.56 accordingly. We assume when designing policies targeting bottlenecks in cultural amenities and quality of houseing could be an important policy in improving the internet connectivity both at home and in public areas.

The six sub-indices (column 1, Table 1) constitute the CEI index. Each of our 12 pillars is associated with an institutional and individual variable (perception score). In this case, institutional variables can be viewed as particular (city-level) contextual factors of the individual variables taken from the Eurostat perception surveys (Eurostat, 2011). More details to follow.

3.2 CEI variables description

Our CEI index incorporates individual and institutional variables from the Eurostat perception surveys 2004, 2006, 2009 (Eurostat, 2014). The survey includes many of the standard demographics in 75 major European cities in the EU-27 and 5 cities in Turkey and Croatia. In random telephone interviews, 500 citizens in each city were asked about: their perception of various aspects of the quality of life in "their" city. These perception surveys allow for comparisons between perception and "real" data from various statistical sources on issues such as urban security, entrepreneurship, labour market, technology, infrastructure, unemployment and other. All three waves of surveys and all 75 cities available[5] were included in the CEI construction and weighting for bottlenecks.[6] Unlike the REDI index, the CEI was constructed using twelve out of twelve individual indicators used directly as variables.

Our main concern for the individual variables used is the representative power of sample size as for each of cities as the first perception survey was made in January 2004 in 31 cities in the EU-15, only (see Eurostat, 2014) with more cities added in 2006 and 2009. The specific linear dependences between the individual variables that constitute the pillars of the CEI are illustrated in Table 2.

[5] For more details on cities included in the study see:
http://ec.europa.eu/public_opinion/flash/fl_156_en.pdf (Flash EB 196) and
http://ec.europa.eu/regional_policy/themes/urban/audit/index_en.htm (also in French and German)
(October 22, 2014)

[6] See the detailed description of individual variables in the Table 1 column 4 More information please refer to the Quality of life in cities report (Eurostat, 2013)

Table 2. Correlation table of individual variable in CEI from Table 1

Variables	1	2	3	4	5	6	7	8	9	10	11
1. Satisfied with transport	1										
2. Satisfied with cultural facilities	0.46*	1									
3. Challenge to find a housing	–0.12	0.06	1								
4. Easy to find a good job	0.23*	0.37*	0.38*	1							
5. Administrative services efficient	0.45*	0.38*	–0.18*	0.35*	1						
6. Resources spent responsibly	0.48*	0.14	–0.04	0.30*	0.71*	1					
7. Most people can be trusted	0.40*	0.40*	–0.26*	0.18*	0.42*	0.37*	1				
8. Satisfied with health care	0.46*	0.55*	–0.08	0.29*	0.53*	0.39*	0.63*	1			
9. Safety in neighbourhood	0.41*	0.43*	–0.11	0.25*	0.41*	0.43*	0.73*	0.59*	1		
10. Safety in this city	0.42*	0.40*	–0.12	0.30*	0.46*	0.51*	0.80*	0.48*	0.87*	1	
11. Satisfied with public internet	0.39*	0.52*	–0.10	0.42*	0.41*	0.17*	0.26*	0.23*	0.30*	0.36*	1
12. Satisfied with internet at home	0.21*	0.56*	–0.05	0.33*	0.21*	–0.01	0.31*	0.17*	0.16*	0.26*	0.57*

Source: Eurostat (2014) Perception survey on 74 cities in 2004, 2006 and 2009

While applying the individual variable to proxy the institutional indices for city analyses we avoided possible complications in multiplication of numerous variables and building more complex constructs where the variables could be potentially interdependent, running into endogeneity problem. Self-reporting problem and section bias within the city is avoided as at least 500 random telephone interviews took place in each city using random sampling methodology thoroughly described by Eurostat (2014). All individual and institutional indices in this study are at the city level.

Categorization of indicators from existing satisfaction indices into a core set of well-being domains is challenging. We operationalized Cummins et al., (2003), Osberg & Sharpe (2009), Florida et al. (2013), Smith et al. (2013) and the REDI (Szerb et. al. 2013) methodology of development of the existing indeces of well-being for the U.S, Australia, New Zealand, Canada

other countries, including Europe such as healthcare, social cohesion and trust, culture, security, human capital, life satisfaction and happiness, administrative services and other. Subjective social indicators are known to have a credibility to form indices and their joint use has been acknowledged by policy makers and authorities (Diener, 2000). The following principles were respected:

1) The potential to link each sub-index logically to a subjective well-being.

2) Explanatory power of the selected variable. Interpretation issues arise from understanding statistical significance of a relationship with a number of climate change, environmental, creativity, green areas, healthcare variables. We did not include those in the CEI construction.

3) Avoiding the appearance of the same factor more than once in the different institutional indices (Szerb et al., 2013).

4) The methodology identifies the pillar created with the particular variable should positively correlate to the final CEI. The variables of life satisfaction should be positively associated with each other.

An increase in the CEI illustrates positive changes in the quality of societal, economic, institutional and technology factors in city which is expected to be positively associated with productive and opportunity-driven entrepreneurship (Reynolds, 2005; Stam & Nooteboom, 2011).

A potential limitation of the CEI method is an arbitrary selection of individual and institutional variables as well as omitted variable bias, illustrating potentially important local contexts that were not included in the index. We aimed to collect and test alternative combinations of individual perceptional variables and apply various weighting for PFB function, but the results were not statistically significant when applying t-test.

4 The CEI: methodology

In this study both the CEI and the CEI weighted for PFB were constructed. While constructing the CEI PFB, we operationalized the weighting methodology in REDI, which includes the PFB correction (Acs et al., 2011, 2014).

The CEI index was calculated by averaging the normalized values of the six sub-indices within the 12 layers of the CEI pillars. More specifically, we averaged the individual perception on the scale

from 0 to 100 by each city over three time periods (2004, 2006, 2009) depending on data availability. If the data was available for 3 periods, then three period averaging was applied. Data for all 75 cities was available in 2009. The Individual perceptions are averaged within all 12 pillars. We do not have a robust reason to differentiate between the pillars (Szerb et al., 2013) to answer why does any specific pillar need to have differentiated weighting scheme (e.g. institutions should be weighted higher, for instance, than the technological or infrastructure pillars). So improving by 1 unit of any institutional condition in cities should require the same additional resource as compared to all the other 11 pillars, on the average. As a consequence, we need a transformation to equate the average values of the 12 pillars within one index. No weighting was applied when calculating the original CEI index, so we assigned the arithmetically same weight for each of 12 pillars:

$$\mathrm{CEI}_{i,t,x} = \frac{\sum_{i=1}^{n} x_{i,t}}{n} \qquad for\ all\ j, \mathrm{t, i} > 0 \tag{1}$$

for all t = 1, 2, 3 is the number of time periods; for all I = 1,…,74 stands for being city-specific for all x = 1,…,12 is the original value for a pillar normalized between 0-100 (see column 4, Table 1), where $CEI_{i,t,x}$ is the CEI index for city i and time t given the averaged values of x pillar.

In addition we design and calculate the CEI adjusted for PFB (CEI PFB). The PFB adjusted CEI is $\mathrm{CEI}_{i,t,x}$, where each pillar is weighted by the bottleneck index $PFB_{i,t,j}$ associated with each pillar in the CEI.

As the value of the CEI suggests the overall satisfaction with the city ecosystem as perceived by residents, the CEI PFB demonstrates how these perceptions about city ecosystem could be improved: either by improvement the layers of the pillars themselves which represent individuals' perception in regard to satisfaction with the city ecosystem or by improvement the bottleneck individual perception of the ecosystem.

Policy-makers aiming to make a city more livable would focus on improvement the weakest link in the city ecosystem first, rather than making an ambitious target of improving them all or equalize them. Therefore, the CEI PFB may be more useful for decision making (Acs et al., 2011). The developed PFB methodology (Szerb et. al., 2013) in the REDI index has a strong policy application and it is used to weight the originally created the CEI index. One of the drawbacks of the CEI is it penalizes large agglomeration economies in Western Europe due relatively weaker socioeconomic context and institutions than in smaller areas (Putnam, 2000), while they economies remain crucial for an innovation and entrepreneurship (Audretsch et al., 2015a). This is because Western cities, and in particular capitals may be under ranked. For example, public

transport and roads may be perceived by the residents as a bottleneck due traffic jams and high congestion in London and Paris; trust could be ranked lower in agglomerations due to diluted sense of a community in a large urban area (Putnam, 2000). In addition, feeling safe in the neighbourhood within large agglomeration is less likely due higher crime rates (Saxenian, 1994; Glaeser et al., 2001; 2010). Citizens also pay higher prices to rent properties in larger cities which may increase dissatisfaction with the neighborhood (Lawless & Lucas, 2010).

The most important message for economic development and well-being policy is that improvement of the CEI can be achieved by targeting the weakest links of the ecosystem known as a bottleneck.

A bottleneck is defined as the worst performing and weakest link, or binding condition that is hard to overcome and that needs external correction (Acs et al., 2011). With respect to the CEI, a bottleneck identifies a priority area where the resources are expected to be directed as residents signal the problem of satisfaction with the development in this area. The bottleneck is a hypothetical situation that could further worsen the life satisfaction within a certain area (political, institutional, informational, societal) should the action not been taken and the inefficiencies within the local context continue to exist. The bottleneck may cause lower level of satisfaction with the pillar and a failure of a pillar to accumulate resources and deliver the issue effectively so residents feel satisfied. It is seen as the most important issue to address by policy makers to improve subjective well-being.

The bottleneck index is built on the same principle as the CEI pillar ranked between 0 and one, unlike the benchmarking principle used in the REDI (Szerb et al., 2013). The selection of the benchmarking criteria influences the individual indices points within the PFB. Before normalizing and calculating the CEI PFB, we controlled for the outliers which could lead to skewed results. One outlier was found only leaving us with 74 out of 75 cities. All sub-indices included in the CEI are composed of twelve pillars that define indicators with the scores of all the indicators already normalized from 0 to 100 by Eurostat (2014) having the same magnitudes.

Applied to the bottlenecks we consider the answer "Most important for your city" question from the perception survey (Eurostat, 2014) when zero reflects the bottleneck while, a hundred reflects the issue is addressed properly. The first step was to calculate the dispersion of index by city from zero to one for each period that explains the differences in the variable between the maximum value and the minimum value in a city i at time t. The minimum illustrates a city where the potential bottleneck caused by inefficiencies in a pillar is of concern. Cities that reported low

values illustrate a pillar to be a major issue to draw attention in a city (a bottleneck) (e.g. roads, social services, health services, safety).

Starting from now the PFB weighting is applied for the CEI index aims to change the nominal value of the original CEI penalizing each pillar within the CEI with the PFB weight, assigned according to perception surveys responses (Eurostat, 2014). Applying the REDI method the $s_{i,t,j}$ values of the PFB eight indicators are all in the range [0, 1], however in Eurostat data the lowest value is not necessary equal to 0 while the highest value is never one. In this case all city' ecosystem efforts are evaluated in relation to the benchmarking city criteria, but the worst performing city is not set to zero per se unless it scored zero (no cities was observed scoring zero at any of the eight indicators) following Szerb et al. (2013) methodology. As mentioned earlier technology-based pillar could not be weighted due to absence of variables and indicators which would allow identifying a bottleneck within the perception survey. The eight bottleneck individual indicators of the normalized values imply that reaching the same performance for all eight indicators is almost impossible and will require an accumulation of effort and resources.

We assume that simple averaging here is an approximation of the bottlenecks and the weighting could be biased. We use all eight coefficients separately matching the relevant weight to each pillar within the nominal CEI index theme. To be more informative, we need to imply a unique weight for the CEI pillar for each city. To further average the impact of each of twelve variables (see formula 2) we make the following adjustment: let $s_{i,j,t}$ be the score for city i for a particular individual variable j of the PFB at time t (column 5 table 1), let $x_{i,t}$ be the original value for the CEI pillar normalized between 0 and 100 (see column 2, Table 1). The weighting is done by matching each PFB variable from column 5 to each pillar (x) in column 2 (Table 1). The weight of 1 is applied for the Internet access pillars (sub-index).

The PFB weighted average of individual variable j corrected for each theme within pillar using formula (2) for each city i over the three time waves is calculate as:

$$\mathrm{CEI}_{i,t,x} = \frac{\sum_{i=1}^{n} s_{i,j,t}(x_{i,t})}{n} \qquad for\ all\ j, \mathrm{t, i} > 0 \qquad (2)$$

for all i = 1,…,74 stands for being city-specific.

Policy makes would like to maximize $\mathrm{CEI}_{i,t,x}$ composed by x pillars at time t in a city i.

We normalized the $PFB_{i,t,j}$ weights across all cities at each time t between zero and one and the values for some cities (countries) are illustrated in Table 3 in the next section.

Calculation of the CEI PFB reflects to the magnitude of the penalty between the original CEI and the new one which applies PFB adjustment. Our PFB weights averaged across all eight indicators for each of 74 cities and ranges from 0.19 in Ostrava, Czech Republic which implies the highest average value of a bottleneck to 0.35 in Oulu and Helsinki in Finland and Dublin (Ireland) which implies the lowest value of a bottleneck.

Both CEI indices are important as they include indicators which relate to various political, economic, social/cultural, and technological factors to public and policy. Both are informative and demonstrate to policymakers where the intervention may be needed.

5 Results

5.1 The examination of the bottlenecks

Table 3 illustrates the short version of the PFB index for 16 out of 25 available European countries (subsample). The analysis on the 8 indicators of the PFB provides a more detailed picture about the nature of bottlenecks from the 74 cities. We suppress some countries leaving a combination of Western and Eastern European economies as well as cities not covered by the REDI index (Szerb et al., 2013).

Table 3: The structure of the variables used in the PFB calculation

City	Transport	Roads	Job creation reverse	Housing	Social services	Education	healthcare	Safety	Country
Graz	0.28	0.2	0.59	0.13	0.24	0.41	0.33	0.36	Austria
Wien	0.22	0.13	0.54	0.19	0.19	0.48	0.44	0.44	Austria
Antwerp	0.28	0.3	0.76	0.19	0.23	0.25	0.23	0.47	Belgium
Liege	0.19	0.16	0.57	0.21	0.18	0.3	0.27	0.5	Belgium
Brussels	0.28	0.12	0.63	0.25	0.18	0.35	0.28	0.45	Belgium
Burgas	0.09	0.34	0.61	0.04	0.12	0.16	0.51	0.2	Bulgaria
Sofia	0.25	0.51	0.82	0.05	0.14	0.23	0.38	0.24	Bulgaria
Copenhagen	0.3	0.16	0.67	0.28	0.24	0.38	0.39	0.28	Denmark
Aalborg	0.2	0.23	0.6	0.2	0.24	0.47	0.49	0.27	Denmark
Tallinn	0.18	0.33	0.45	0.12	0.34	0.21	0.44	0.31	Estonia
Munich	0.25	0.15	0.57	0.32	0.22	0.5	0.26	0.34	Germany
Hamburg	0.14	0.18	0.48	0.25	0.26	0.59	0.28	0.34	Germany
Dortmund	0.13	0.31	0.34	0.11	0.26	0.51	0.28	0.3	Germany
Essen	0.2	0.28	0.4	0.13	0.28	0.51	0.29	0.27	Germany
Leipzig	0.13	0.31	0.31	0.1	0.28	0.5	0.28	0.27	Germany
Berlin	0.19	0.18	0.32	0.1	0.27	0.59	0.27	0.34	Germany
Budapest	0.27	0.26	0.5	0.09	0.19	0.17	0.46	0.39	Hungary
Miskolc	0.19	0.25	0.22	0.11	0.2	0.13	0.4	0.49	Hungary
Dublin	0.31	0.17	0.37	0.17	0.21	0.48	0.63	0.18	Ireland
Riga	0.1	0.17	0.31	0.13	0.38	0.36	0.59	0.31	Latvia
Vilnius	0.14	0.22	0.47	0.14	0.26	0.18	0.46	0.31	Lithuania
Luxembourg	0.27	0.18	0.56	0.39	0.2	0.47	0.37	0.28	Luxembourg
Valletta	0.19	0.31	0.81	0.08	0.15	0.23	0.37	0.16	Malta
Rotterdam	0.23	0.16	0.68	0.2	0.2	0.41	0.38	0.52	Netherlands
Amsterdam	0.22	0.19	0.69	0.35	0.25	0.46	0.38	0.39	Netherlands
Groningen	0.23	0.24	0.59	0.23	0.26	0.44	0.4	0.38	Netherlands
Malmo	0.19	0.11	0.46	0.34	0.15	0.23	0.46	0.38	Sweden
Stockholm	0.37	0.25	0.6	0.41	0.16	0.22	0.4	0.21	Sweden
London	0.37	0.13	0.59	0.3	0.19	0.44	0.49	0.29	UK
Manchester	0.35	0.18	0.56	0.29	0.18	0.47	0.46	0.3	UK
Glasgow	0.27	0.16	0.53	0.34	0.22	0.51	0.53	0.2	UK
Belfast	0.28	0.16	0.48	0.27	0.19	0.57	0.57	0.16	UK
Cardiff	0.34	0.21	0.54	0.22	0.21	0.49	0.55	0.24	UK
Newcastle	0.31	0.19	0.48	0.26	0.21	0.5	0.53	0.23	UK

Note: Calculation for all 74 cities is available from authors on request. Job creation is calculated in reverse as 1-original index. As the question states the most important issue is targeting unemployment and job creation – the higher values indicate the problem of unemployment in cities while the lower values indicates job creation issues has been addressed. Reverse weights will be applied for this question only in formula 2 with higher reverse values illustrating addressing the issue competently, and lowest value – where residents identified a bottleneck as a need for job creation and reduction in unemployment.

Source: Authors calculations based on Eurostat (2014) perception surveys 2004, 2006, 2009.

To estimate the price for a bottleneck in a perception survey the residents were asked to identify three most important issues for the city from the list of ten, including roads, transport, health and government social services, job creation and fight unemployment, housing, education, safety, noise and air pollution. Within the scale of a hundred raising major issues for cities, higher values were associated with the higher satisfaction with the issue indicating city's strength in this factor. The only exception is job creation and unemployment where higher scores reflected the issue of unemployment to be a problem. All answers in regard to application of the PFB methodology, we checked with statistical data on cities (Eurostat, 2014) and the first part of the perception survey on satisfaction. We were able to identify cities reporting higher values of bottlenecks were likely to perform better than those cities reporting lower values. The threshold above 0.5 PFB defines residents' positive perception of an issue. The threshold below 0.26 implies a problem for cities. The range between 0.26 and 0.50 is a medium range where the bottleneck is not severe, but may need policy intervention in the future. For example, Irish capital Dublin has a maximum value in healthcare services (0.63) it demonstrates satisfaction with the health services, but road infrastructure (0.17) and safety (0.18) does not enter in the residents' major issues for cities. Dublin has also average in job creation (0.37), while Miskolc (Hungary), Berlin and Leipzig (Germany), Riga (Latvia) score lower and have potential bottlenecks for the job creation (<0.31).

Although the PFB does not directly prove the existence of a bottleneck, it nevertheless could be useful in identifying potential areas of most important issues in cities as compared to the relatively least important issues to be consideed in policy.

5.2 The CEI scores and rankings

Two CEI indices were calculated: the CEI original index and the CEI PFB. We also compared the CEI scores with the existing REDI and GEDI scores (limited to city availability in REDI) in a correlation matrix to understand the degree of interdependence between the CEI and REDI in a region where this city is located and the GEDI index of a country where the city is located (Acs et al., 2014; Qian et al., 2013). For large cities above 500 thousand residents the geographical borders of the City Ecosystem Index and the REDI overlap. The CEI is available for 74 cities in 25 European countries. According to descriptive statistics and correlation table, there is a high degree of dependence between the CEI, the CEI adjusted for PFB, the REDI and the GEDI indices. Interestingly, the PFB adjustment of the City Ecosystem Index increases the correlation with the REDI from 0.61 to 0.69 and with the GEDI from 0.68 to 0.74 accordingly (see Table 4).

Table 4. Summary statistics and correlation table of the REDI, GEDI and CEI

Index	Obs.	Mean	St. dev.	Min	Max	CEI	CEI PFB adjusted	REDI
CEI	179	70.82	8.37	48.63	86.93	1.00		
CEI PFB adjusted	179	30.37	4.33	19.65	39.62	0.91*	1.00	
REDI	162	49.07	15.99	18.40	82.20	0.61*	0.69*	1.00
GEDI	174	57.50	11.36	40.60	72.70	0.68*	0.74*	0.84*

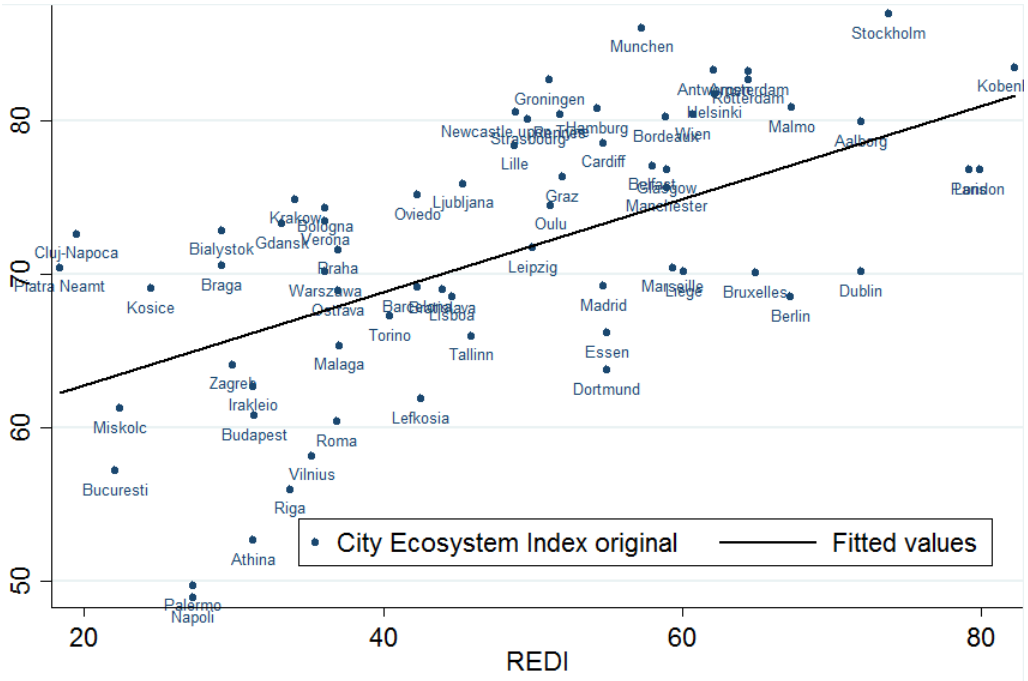
Note: the number of observations between the indices is different, because some regions are not included in the REDI, but is available for the City Ecosystem Index (cities in Turkey, Luxembourg, Malta, Cyprus). The correlation coefficients are calculated on 162 obs. Available for the REDI, the GEDI and the CEI.

Source: Authors calculations based on Eurostat (2014); Acs and Szerb (2010); Szerb et. al. (2013)

The CEI original varies between 48.6 and 86.9 to the hypothetically maximum of 100 showing that even the best European cities is almost 13 points away from the potential level. The CEI adjusted for PFB varies from 19.65 to 39.62 maximum due to penalty adjustment coefficient (see Table 3) and formula (2).

Figure 1 and 2 illustrate the association between the REDI and the City Ecosystem index (both original and adjusted PFB). The CEI is calculated using the average on three periods from 2002-2009 with all cities being available in the Eurostat perception survey 2009 (Eurostat, 2014). The REDI is taken from the REDI report (Szerb et al., 2013; Acs et al., 2014) using 2013 year data. Hence, there is a four years gap between the residents' perception on quality of life in a city in 2009 and the entrepreneurship ecosystem characteristics in a year 2013. This time gap enables us to hypothesize the relationship coming from a subjective well-being of a city to quality of entrepreneurship ecosystem in a region (REDI).

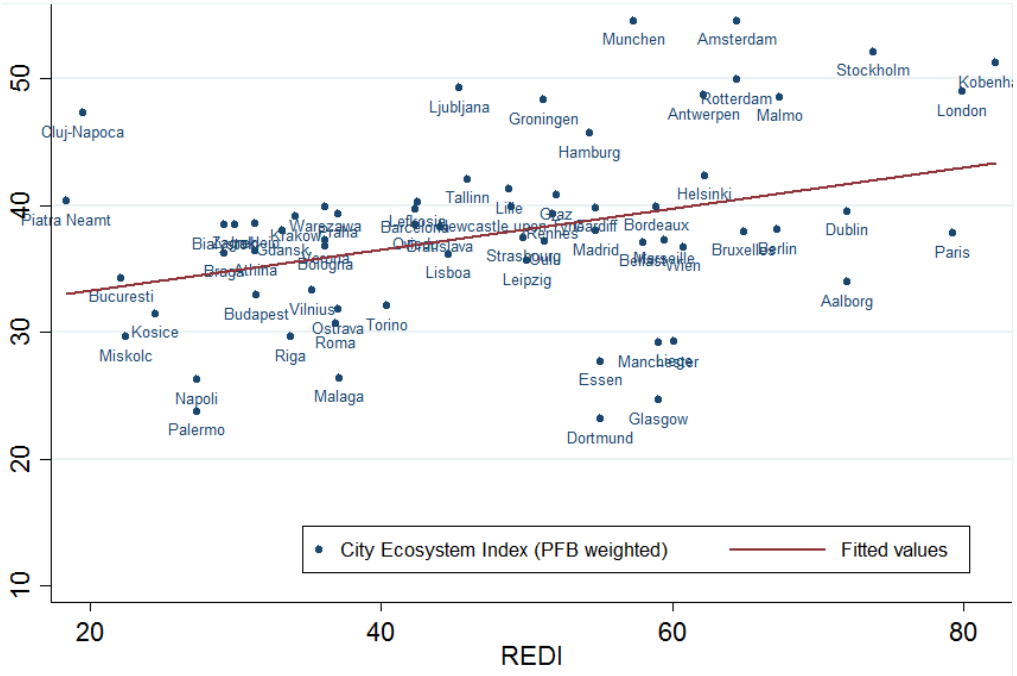
Figure 1. Plotting REDI scores in 2013 against City Ecosystem Index in 2009



Notes: Number of observations = 74

Source: own calculation.

Figure 2. Plotting REDI scores in 2013 against City Ecosystem Index (PFB weighted) in 2009



Notes: Number of observations = 74

Source: own calculation.

The regression line on Figure 1 between the REDI and the City Ecosystem Index explains 38 percent of the variations of the variation in REDI the where CEI refers to city happiness. The regression line in Figure 2 between the REDI and the City Ecosystem Index (PFB weighted) explains 48.5 percent of the variation in REDI. We observe the weighting for the PFB considerably improved the association between the REDI and the City Ecosystem Index. The associated Pearson's correlation coefficient between the REDI and the CEI (PFB weighted) is 0.69, showing strong connection between two.

5.3 Empirical illustration: the CEFCE and the GEDI index rankings

We rank 74 cities as per their CEI score and compare with the REDI ranking on 66 cities (Table 5). The maximum index value both in CEI and in CEI PFB is 100 and a minimum is zero. A maximum value is possible should all sub-indices be equal to 100 and there is no penalty for the bottlenecks applied to it. The higher the rank of a city in the CEI the higher is the subjective well-being. The REDI ranking by city illustrates a business environment conducive to for entrepreneurial activity calculated using the GEM data (Acs et al., 2014). The main difference between the REDI and the City Ecosystem Index is that the REDI measures regional context for entrepreneurship in major European regions, while the CEI measures the perception of the local context by people who work and live in a city. For each city we indicated both the rank and the value of the indices. Innovation-driven Western European countries are in the top of the City Ecosystem Index both original and PFB adjusted which is not surprising. Oviedo city (Spain) and Prague (Czech Republic) take the top ranking amongst the Mediterranean and Eastern Europe 26th and 28th position accordingly. The variations in the CEI over the 74 cities are substantial. Not accounting for the bottlenecks of the local context, the city of Munich scoring first (81.9) and Copenhagen scoring second (81.8) with the 74th city is Italian Palermo scoring 51.3. This follows the REDI findings (Szerb et. al., 2013) who found the top entrepreneurial city to be Copenhagen region and last ten cities are cities from Bulgaria cities in the European Union.

Although CEI is highly correlated with its derivative CEI PFB, the former changes ranking position, placing Amsterdam (38.6) and Rotterdam (38.0) in Netherlands in the top of city ecosystem. Napoli (20.6) and Palermo (20.0) in Italy remains in the bottom. According to our CEI adjustment for bottlenecks calculation, the Dutch Amsterdam, Rotterdam and Groningen as well as Finish Helsinki and Belgium Antwerp have the most conducive societal, economic, institutional and ICT conditions valued by their residents, which we found all to be important to promote entrepreneurship in a city (Szerb et. al., 2013; SEP, 2015). These cities are followed by

Aalborg, Copenhagen, Vienna, Munich and Cardiff in the Top 10. The division in the quality of the local context between Eastern and Western European cities is not new (Acs et. al., 2014).

The CEI development makes two important contributions: first, it enables comparison between subjective well-being and entrepreneurship ecosystem conditions in cities using REDI. Second, it maps European cities within the two main dimensions: happiness and well-being perception (CEI) and entrepreneurial aspirations and attitudes in regions (REDI). Although regions around London, Paris, Dublin, Stockholm and Berlin are conducive to entrepreneurship, the local context and subjective well-being need further improvement to support regional entrepreneurship ecosystems. Severe bottlenecks pulled two largest agglomerations in Europe - London and Paris down to 16th and 25th place respectively unlike 2nd and 3rd in the REDI (Szerb et. al., 2013). High agglomeration economies given their market size, infrastructure facilities, agglomeration and economies of scale attract entrepreneurs (Delgado et al., 2010; Glaeser, 2011), while falling short on subjective well-being and quality of life. This ranking illustrates that there may be a growing gap between what policy-makers and business aim to deliver and what is appreciated by voters and residents.

The reasons for agglomeration economies scoring lower in the CEI is because large cities have higher population density, cultural clash and foreigners integration issues, transportation and infrastructure collapses and most importantly safety and security issues (Glaeser et al., 2010). While capitals have on average higher entrepreneurial activity, the local context factors may negatively affect business growth in the future. More on city types mapped within the REDI and the CEI PFB in the next section.

Table 5. The City Ecosystem Index (CEI), adjusted for PFB (CEI PFB) and the REDI ranking for 74 cities

City	CEI	CEI PFB	REDI	Country	Rank CEI	Rank CEI PFB	Rank REDI	City	CEI	CEI PFB	REDI	Country	Rank CEI	Rank CEI PFB	Rank REDI
Amsterdam	81.3	38.6	64.4	Netherlands	6	1	10	Ljubljana	73.4	30.3	45.3	Slovenia	30	38	36
Rotterdam	80.5	38.0	64.4	Netherlands	9	2	11	Bologna	74.7	30.2	36.1	Italy	27	39	48
Helsinki	81.4	37.9	62.2	Finland	4	3	12	Gdansk	71.6	30.1	33.2	Poland	35	40	53
Groningen	81.7	37.4	51.1	Netherlands	3	4	30	Braga	69.5	30.1	29.2	Portugal	42	41	58
Antwerp	80.5	36.8	62.1	Belgium	8	5	13	Berlin	66.8	30.1	67.2	Germany	53	42	8
Aalborg	80.1	36.4	72.0	Denmark	11	6	5	Dublin	71.7	30.1	72.0	Ireland	34	43	6
Copenhagen	81.9	36.0	82.2	Denmark	2	7	1	Marseille	68.8	29.5	59.4	France	44	44	16
Vienna	79.7	35.6	60.7	Austria	13	8	14	Madrid	67.8	29.4	54.7	Spain	47	45	25
Munich	81.9	35.3	57.3	Germany	1	9	21	Bratislava	67.0	29.1	44.0	Slovakia	52	46	38
Cardiff	79.4	35.3	54.7	UK	15	10	24	Miskolc	64.9	28.8	22.4	Hungary	58	47	63
Newcastle	80.1	34.8	48.9	UK	10	11	33	Budapest	62.5	28.5	31.4	Hungary	63	48	54
Hamburg	79.2	34.7	54.3	Germany	17	12	26	Bialystok	68.3	28.4	29.2	Poland	46	49	59
Oulu	76.6	34.5	51.2	Finland	22	13	29	Cluj-Napoca	73.6	28.1	19.5	Romania	29	50	65
Manchester	75.6	34.2	59.0	UK	24	14	17	Malaga	65.2	28.0	37.1	Spain	55	51	43
Luxembourg	81.4	34.1		Luxembg.	5	15		Lisboan	63.8	27.8	44.6	Portugal	60	52	37
London	74.3	34.1	79.9	UK	28	16	2	Lefkosia	63.1	27.7	42.5	Cyprus	61	53	39
Glasgow	77.1	33.8	59.0	UK	20	17	18	Valletta	69.6	27.4		Malta	41	54	
Stockholm	80.0	33.3	73.8	Sweden	12	18	4	Zagreb	65.0	27.3	29.9	Croatia	57	55	57
Rennes	81.2	33.2	51.8	France	7	19	28	Riga	60.3	27.0	33.8	Latvia	66	56	52
Belfast	77.1	33.0	58.0	UK	21	20	20	Verona	72.9	27.0	36.1	Italy	32	57	49
Lille	77.7	32.9	48.8	France	18	21	34	Sofia	54.2	26.9		Bulgaria	72	58	
Bordeaux	79.4	32.9	58.9	France	16	22	19	Antalya	64.5	26.8		Turkey	59	59	
Graz	75.3	32.9	52.0	Austria	26	23	27	Vilnius	61.7	26.8	35.2	Lithuania	64	60	50
Malmo	77.2	32.5	67.3	Sweden	19	24	7	Iraklion	65.0	26.3	31.3	Greece	56	61	55
Paris	76.2	31.9	79.2	France	23	25	3	Kosice	67.7	26.3	24.5	Slovakia	49	62	62
Oviedo	75.4	31.9	42.3	Spain	25	26	40	Bucharest	57.1	26.0	22.1	Romania	68	63	64
Strasbourg	79.5	31.8	49.7	France	14	27	32	PiatraNeamt	70.1	25.7	18.4	Romania	39	64	66
Praha	71.9	31.3	37.0	Czech R	33	28	44	Torino	66.5	25.5	40.4	Italy	54	65	42
Brussels	71.5	31.2	64.9	Belgium	36	29	9	Roma	62.7	25.4	36.9	Italy	62	66	46
Warszawa	67.8	31.0	36.1	Poland	48	30	47	Ostrava	67.6	24.8	37.0	Czech	50	67	45
Tallinn	67.6	30.7	45.9	Estonia	51	31	35	Ankara	60.1	23.9		Turkey	67	68	
Krakow	73.1	30.7	34.1	Poland	31	32	51	Burgas	60.7	23.7		Bulgaria	65	69	
Leipzig	70.7	30.6	50.0	Germany	37	33	31	Athens	55.5	23.3	31.3	Greece	70	70	56
Essen	68.7	30.5	55.0	Germany	45	34	22	Istanbul	54.6	22.4		Turkey	71	71	
Liege	69.8	30.5	60.1	Belgium	40	35	15	Diyarbakir	57.1	22.3		Turkey	69	72	
Dortmund	68.9	30.5	55.0	Germany	43	36	23	Napoli	51.3	20.6	27.3	Italy	73	73	60
Barcelona	70.4	30.4	42.3	Spain	38	37	41	Palermo	51.0	20.0	27.3	Italy	74	74	61

Source: Authors calculation.

6 Linking the CEI and the REDI

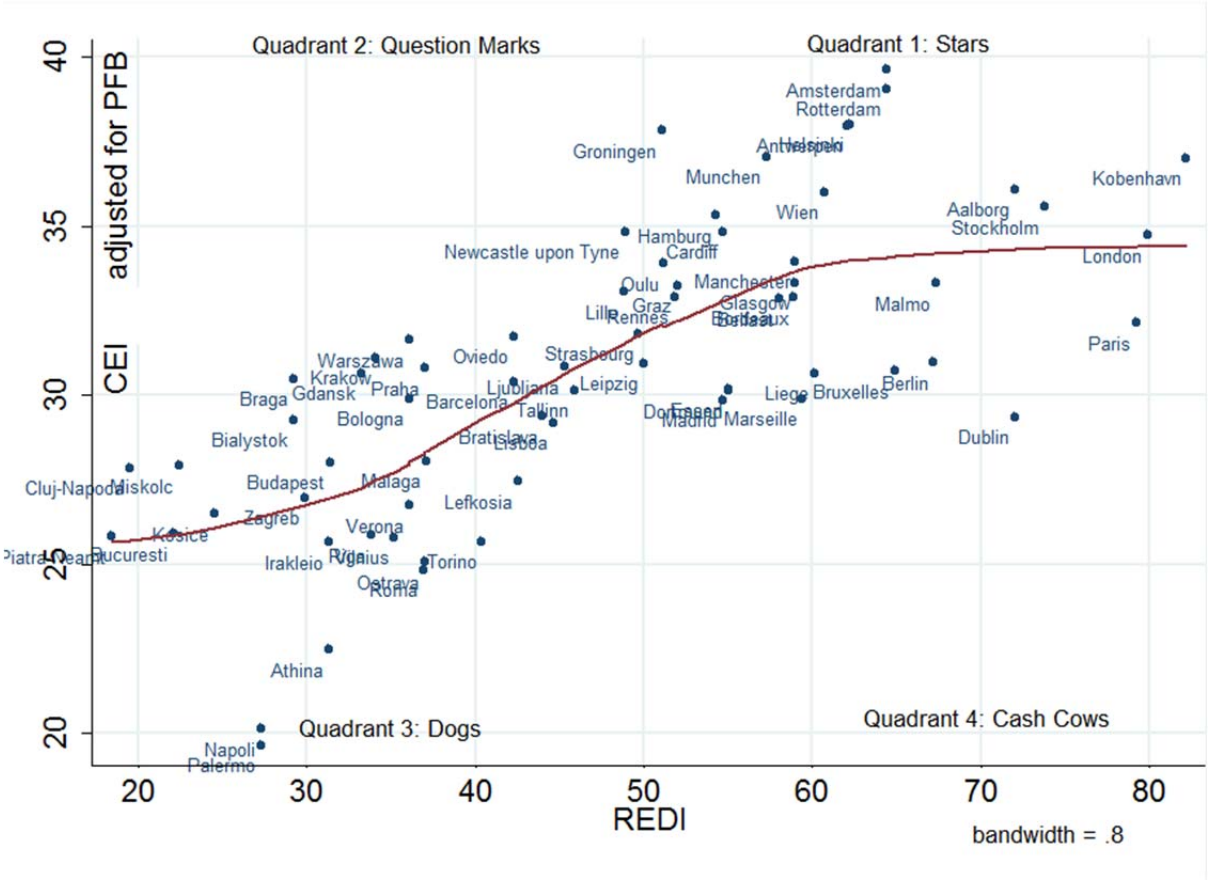
In this section describe the mapping of the CEI and CEI PFB against the REDI index using a lowess smoothing technique. Figure 3 demonstrates the lowess smoothing and carries out a locally weighted regression of the CEI PFB-adjusted and the REDI with the final graph displaying the smoothed variables. Unlike the scatterplots or correlations lowess enables us to identify a functional form of association between the CEI and the REDI. Figure 3 clearly illustrates a non-linear s-shape relationship between these two indices. It allows to draw a subjective well-being - entrepreneurship ecosystem matrix similar to the growth-share matrix (Boston Matrix) developed by Bruce D. Henderson for the Boston Consultancy Group to help corporations to analyse their business units, that is their product lines (Henderson, 1984). In this section we apply the Boston matrix terminology to cities and divide them into four types-quadrants. The border line that distinguishes the quadrants lies along the lowess smoother line, so the shape of the quadrants in fact is not quadratic, but bounded within the lowess smoother regression. The first quadrant reflects happy cities with a high quality of entrepreneurship ecosystem. We name these cities “stars” or “leaders” (e.g. London, Antwerp, Amsterdam, Copenhagen, Aalborg, Vienna). The policy intervention here is unlikely unless the government would like to improve the quality of live in large agglomerations. The fourth quadrant reflects cities with a high level of entrepreneurial aspirations and conducive business environment conducive to business paired with relatively lower quality of city ecosystem (e.g. Dublin, Malmo, Paris, Brussels). This position is not sustainable in a long run, because entrepreneurial aspirations will change due to negative perception of residents on their life quality. Market size may shrink due to residents moving out in search of better amenities, should the local bottlenecks remain still. This will constrain entrepreneurial activity. We call these cities “cash cows” that produce entrepreneurs but may require immediate intervention to improve their residents’ perception of well-being. The second quadrant is “question marks” –cities with relatively high performing poorly in entrepreneurship with an ecosystem of entrepreneurship being not conducive to grow businesses (Brage, Bologna, Prague, Budapest and even Newcastle, although marginally). These cities having a lot of pride and glorious history may get into a “glory trap” while it is clearly important improving business conditions as well as stimulating entrepreneurial attitudes and aspirations. While the socioeconomic, information and institutional contexts are promising, the objective factors may in fact impede entrepreneurial activity and economic development (Audretsch et al., 2015). Policy intervention on promoting entrepreneurship through public-private partnership, public engagement and promoting entrepreneurial culture and the culture of innovation is needed there. “Question marks” cities may become future leaders in their entrepreneurship ecosystems,

should consider this position be a signal to policy. In particular these border cities like Newcastle, Strasburg, Lille, Leipzig, have all potential to succeed and become stars should entrepreneurial aspirations and business culture grow in these cities. Finally, the third quadrant is “outsiders” or “dogs” (Henderson, 1984) – cities with a low quality of city ecosystem and unfavorable regional ecosystem of entrepreneurship conditions. This quadrant on its bottom edge includes Palermo and Napoli in Italy and Athens in Greece, but also Vilnius, Verona, Lefkosia, Torino, Irakleon, Riga, and even Lisbon and Tallinn on a high edge. Baltic capitals, unlike Mediterranean cities have already realized the importance of improving indicators in particular related to various political, social and cultural factors. Although excellent business conditions have been eveloped in Tallinn, Riga and Vilinius, inter-cultural tensions, political and cultural insolvency as well as othr local contexct factors potentially impede subjective well-being of an average resident. Cities in this quadrant should realise that growth of entrepreneurial aspirations and business culture is closely related to people feeling comfortable in a city, including providing equal access to housing and job market for all residents. Should these factors be further unedrestimated, cities in this quadrant are at risk of slowing down their entrepreneurship ecosystem development. The policy for Palermo, Napoli and Athens should be completely different and target poverty reduction as well as better management of perceived bottlenecks (see Table 3).

We found that the average value of 34 of the CEI PFB is a sufficient condition to generate the highest quality of entrepreneurship ecosystem. Figure 3 also illustrates diminishing marginal returns of the City Ecosystem Index in respect to the REDI. It is clear that entrepreneurial aspiration cannot grow linearly and the REDI index plateaus at about 60, while the CEI PFBB continues to grow from 34 and above. The number 34 (CEI) indicates an important threshold for entrepreneurship and well-being policies: once the city achieves 34 on the subjective well-being the conditions are sufficient enough to create an excellent regional system of entrepreneurship (Eckersley, 2000).

We also realize that the position of cities on the Figure 3 changes overtime and additional evidence is needed to justify policy intervention. This is limited by availability of cross-sectional data on the REDI. So far, this is the recent evidence on the positive association between the level of happiness in cities and the quality of regional systems of entrepreneurship. In other words happiness is a conducive environment for entrepreneurial activity.

Figure 3: Lowess smoothing with Boston matrix quadrants built using the CEI (PFB adjusted) and the REDI index during 2009-2013.



Notes: Number of observations = 74

Source: own calculation based on Eurostat (2014) and Szerb et. al. (2013).

7 Discussion

First and most important, the City Ecosystem Index is a first systemic indicator measuring a subjective well-being in European cities, utilizing perception of quality of life (Eurostat, 2014). Second, this is the first indicator to demonstrate a strong statistical relationship between happiness in European cities and regional systems of entrepreneurship quality. Third, information technology and Internet access was explicitly included in the CEI as a pillar, embedding access to new technologies into residents' subjective well-being.

The main focus of this study was on creating and testing a reliable measure of the City Ecosystem Index drawing on sustainability well-being, regional economics and the homeostatic theory literatures. Both are reputable in measurement of country and regional well-being in different world regions and inter-disciplinary (Cummins, 2003). The CEI aim is to ultimately inform public,

policy-makers and entrepreneurs by providing a holistic view on subjective well-being across major European cities.

This study compared and confronted the CEI index calculated during 2004-2009 period with the recently developed REDI (Szerb et al., 2014; Acs et al., 2014) for 2013. The CEI demonstrated a strong association with the REDI and the direction of impact. We answered yes to our main question: Is happiness conducive to entrepreneurship?

This study has contributed to a discussion in regional entrepreneurship, well-being and psychology literature on the importance of systemic holistic approach to better understand the embeddedness of individuals in a local context when decision-making (Zacharakis et al., 2003; Isenberg, 2010; Feld, 2012) and individual's perception of well-being (Deaton, 2008; Smith et. al., 2013).

Given a number of existing measures of well-being are one-dimensional (e.g. value added, GDP per capita, income) its analysis and legacy is limited (Cummins, 2003), while systemic multi-dimensional measures are proved to be more robust across disciplines (Diener, 2000; Diener et al., 2003; EIU, 2005; WEF, 2013). The CEI index was presented in both original and weighted for the Penalty of the Bottleneck versions. Although highly correlated with the REDI and the GEDI indices (0.69) and (0.74), the CEI should not be seen as a substitute or compliment of the regional systems of entrepreneurship. It is a combination of factors perceived as contributing to happiness of cities which creates a desirable ecosystem for entrepreneurial aspirations and intensions to grow (Glaeser, 2001, 2011; Acs et al., 2013).

Following Cummins et al., (2003), Osberg & Sharpe, 2009; Smith et al. (2013) and the REDI methodological approaches to well-being index development, the CEI unveils interactions between individual perception of local context, providing a contextual grounding for individual's decision making.

This study makes the following sound contributions to regional entrepreneurship and well-being literature: (1) constructs the CEI index that measures happiness in 75 European cities incorporating various socioeconomic, institutional and technology domains of the city ecosystem; (2) identifies bottleneck factors that hold back subjective well-being in cities and debates the actions of systemic support needed to address those bottlenecks; (3) maps the CEI against the REDI and defines the relationship between the quality of entrepreneurship ecosystem and the level of happiness in a city to be non-linear although positive and statistically significant; (4) reflects the various aspects of the local contexts for entrepreneurship linked to subjective well-being in cities, thereby making it a useful guidance for policy makes on

addressing both issues; (5) attracts policy makers attention to the relevance of analysing the regional and local contexts as a system – the CEI adjusted predicts 49 percent of the variation in the REDI; (6) offers the CEI and CEI adjusted as a powerful control variable when predicting the level of entrepreneurial activity and aspirations in cities. As many of existing indices the CEI has its limitations, including high interdependences and endogeneity within the index.

8 POCITY implications for future research

In addition to policy design, the CEI systemic approach offers an important platform for future research in urban entrepreneurship and well-being both from the individual prospective (attitudes, intentions, aspirations), local context prospective (institutional, technological, economic, social) and government policy prospective (Florida et al., 2013). The CEI is useful in understanding preconditions for economic growth and start-ups rates with a little evidence existing up to date on the city ecosystems conditions that drive innovation, entrepreneurship and economic growth (Audretsch et al., 2015a).

The most important limitations of the CEI to be further addressed are: (1) we have been constrained by perception survey with the data mostly available between 2004 and 2009; and the REDI data available on regions and for one year only. The CEI extends the study to city-regions not included in the REDI due missing data (Szerb et al., 2013; Qian et al., 2013); (2) while more data and research is available on regional and national-level well-being, little theory exists that connect various factors that influence subjective well-being to the regional entrepreneurship ecosystems. We therefore suggest that the list of six sub-indices and twelve pillars used to create the CEI may be expended. More work is needed on experimenting with various proxies referring to local contexts and in particular identifying the bottlenecks for technology and information diffusion and accessibility in cities which has not been addressed in this study; (3) the reduction of the twelve pillar values into a single CEI index and the application of eight PFB to twelve pillars is simplification. It is possible that different combinations of weights may be needed, applying them both from the perception survey but also experimenting with qualitative methods of information collection to implement the PFB adjustment; (4) institutional factors are likely to be more important and have higher marginal impact on subjective well-being in the Eastern and Central Europe and need to be given higher weight than in the institutional context in Western economies.

We expect the CEI index may become a template for future well-being and regional entrepreneurship scholars to be updated once more reliable longitudinal data on

entrepreneurship ecosystem conditions will become available (Acs et al., 2014). Comparing the correlations between the two CEI and the REDI their values inform us on importance of considering the bottlenecks (CEI adjusted for PFB) to better predict change in entrepreneurship conditions. We suggest to policy-makers and scholars to use both CEI indices in their research to complement each other in understanding the link between entrepreneurship and happiness in cities.

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