Small Bus Econ (2014) 42:77–98
DOI 10.1007/s11187-012-9462-8

Analyzing the determinants of entrepreneurship in European cities

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Accepted: 10 November 2012 / Published online: 7 February 2013

Abstract This study investigated the determinants of business creation as a measure of entrepreneurship in European cities. It examined supply- and demand-side elements, actual and equilibrium rates of entrepreneurship, institutions and culture. These components were characterized using a dataset consisting of 21 indicators drawn from 184 cities in 20 European countries during the years 1999–2010. The study found that city size, self-employment, and tertiary education have a significant and positive impact on the number of new businesses registered. The implications of these findings are discussed in view of the European Commission's Small Business Act, which provides guidelines for the conception and implementation of entrepreneurship policies in the European Union. This paper's main contribution lies in the differentiation of factors that are context-specific (e.g., city-size) and others that can be influenced by policy (e.g., tertiary education).

Keywords Entrepreneurship · Business creation · Self-employment · Europe · Cities · Agglomeration · Policy

JEL Classifications C21 · C38 · L26 · L50 · M13 · O52 · R10

1 Introduction: the European agenda and a focus on cities

At the turn of the 21st century, the European Commission drafted the Lisbon Agenda and, in this act, established guidelines intended to make Europe "the most competitive and dynamic knowledge-based economy in the world, capable of sustainable economic growth with more and better jobs and greater social cohesion" (Lisbon Council 2000). The Lisbon Agenda (European Commission 2003) highlighted the crucial role played by entrepreneurship in the region's capacity to adapt to economic changes and hence improve competitiveness. It emphasized the necessity to create a favorable environment for creating and developing small and medium enterprises (SMEs). This development reflected growing evidence in support of the benefits of entrepreneurship for employment, economic growth, and innovation—core themes of the Lisbon Agenda. At the start of the next decade the Agenda was succeeded by the Europe 2020 Strategy. This new strategy focused on "smart, sustainable and inclusive growth" and included a

Electronic supplementary material The online version of this article (doi:10.1007/s11187-012-9462-8) contains supplementary material, which is available to authorized users.

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specific section on entrepreneurship policy (European Commission 2010).

In parallel with these policy commitments towards entrepreneurship, recent research has advanced our understanding of the factors that stimulate entrepreneurial activity. Academics have made particular progress through an exploration of the geographical dimension, and advances in data collection have made it possible to narrow the geographical unit of analysis—from countries to regions and cities. This closer focus has enabled researchers to gain a better understanding of the role of socio-economic determinants in entrepreneurial dynamism. This paper seeks to contribute to these efforts; it aims to advance the academic discussion and enrich the vision of European practitioners in the areas of both business and economic development.

This study investigates the determinants thought to influence the rate of business creation. According to Audretsch et al. (2002) these can be classified as supply- and demand-side elements, actual and equilibrium rates of entrepreneurship, institutions and culture. These elements are characterized using a dataset consisting of 21 indicators drawn from 184 cities in 20 European countries in three time periods: 1999–2002, 2003–2006 and 2007–2010. The data structure is analyzed using a principal component analysis (PCA) in order to construct representative indices (six in this case). These indices are used in a cross-sectional analysis to model entrepreneurship in cities under a dynamic perspective using the rate of business creation. It finds that city size, self-employment, and tertiary education have a significant and positive impact on the number of new business registrations. Furthermore, it finds that capital cities have an advantage over other cities, independently of size. Aside these empirical findings, this paper contributes to the literature in several ways. First, it explores the relationship between self-employment and business creation as proxies for entrepreneurship. It discusses and models to what extent individuals in "own-account" work can be viewed as an input for the creation of new companies. Second, it proposes a ranking of cities for benchmarking purposes in terms of entrepreneurial dynamism and six dimensions of determinants. Third, this paper enables policy-makers—interested in promoting entrepreneurship at the city-level—to distinguish between context-specific factors (e.g., city size) and those which may be influenced by policy (e.g., tertiary education).

This paper is organized as follows: Sect. 2 presents a concise review of previous work and discusses ways of understanding the determinants of entrepreneurship to propose the hypotheses. Section 3 describes the dataset used in the analysis and describe how its underlying structure was analyzed in order to identify six general dimensions (factors) and build representative indices. Section 4 presents the econometric models and analysis, outlines the evidence and presents relevant robustness checks. Section 5 discusses the contribution of these results to policy-making. Finally, Sect. 6 contains concluding remarks including the limitations of this study and opportunities for future research.

2 Background: entrepreneurship economics

The European Commission's approach to entrepreneurship policy-making is manifested in the Small Business Act drafted in 2008. The Act consists of ten principles guiding the conception and implementation of policies at the European and national level. Its goal is to "improve the overall policy approach to entrepreneurship and to promote small and medium enterprise (SME) growth" (European Commission 2008). The aim was to harmonize the administrative and legal environment for SMEs across Europe, facilitating conditions for creating and running them. Although all European Union Member States have acknowledged the importance of implementing the guidelines, approaches and results vary widely from nation to nation (European Commission 2010). Should it be needed, political motivation for encouraging entrepreneurship can be found in an extensive body of literature which suggests that it brings several benefits for economic development.

The general consensus among economists is that technological change and innovation are the principal drivers of economic growth (Aghion and Durlauf 2006; Barro and Sala-i-Martin 2003). Entrepreneurship has been identified as a key (albeit not exhaustive) source of innovation (Acs and Audretsch 2005) and, in some instances, a significant source of knowledge spillover and economic growth (Audretsch 2004; Sternberg and Wennekers 2005). van Praag and Versloot (2007) reviewed 87 articles published in high-impact journals on the economic value of entrepreneurship. These quantitative studies attempted to discern the economic contribution of entrepreneurship. Most of the studies showed that new businesses grew faster than their more

established counterparts and that entrepreneurship favored job creation, although jobs were of lower quality (in terms of, e.g., pay and benefits) than new positions offered by well-established firms. Moreover, the jobs that were created were found to be less secure, due to higher volatility and the potential business failure. Remarkably, employees in entrepreneurial companies reported higher job satisfaction. In terms of innovation, the evidence showed that entrepreneurs invested relatively as much as well-established firms, but generated fewer innovations. However, new businesses excelled both in patent production *per employee* and in patent citations. When it came to the adoption of innovations, new businesses preferred low-cost solutions, while well-established firms tended to opt for more expensive innovations. van Praag and Versloot (2007) particularly highlighted empirical, country-level studies that showed the positive contribution of entrepreneurial activity and the capacity to innovate (Sternberg and Wennekers 2005) and technological change in the European Union (Acs and Varga 2005).

Although the majority of the evidence supports the idea of the economic benefits of entrepreneurship, we should also note the distinction between productive and unproductive entrepreneurship first introduced by Baumol (1990). The author distinguished between different types of entrepreneurship and their associated contribution to society, that is, activities that create wealth (e.g., product innovation) and those which destroy it (e.g., lobbying and lawsuits). Furthermore, the author suggested that institutions are crucial for productive entrepreneurship. Sobel (2008) tested and confirmed these hypotheses in the United States. This study found that high quality administrative and legal institutions were associated with higher rates of new business. Conversely, it also reported a prevalence of lobbying and lawsuit activities in those states with the least effective institutions.

2.1 Selecting a proxy for entrepreneurship

According to Freytag and Thurik (2006), there are two suggested approaches for measuring entrepreneurship by using either stock or flow indicators. Respectively, studies may have static or dynamic perspectives (Wennekers 1997). Examples of stock indicators are business ownership and self-employment, while firm births and start-up activity are possible flow variables (Grilo and Irigoyen 2006).

Self-employment is understood as the generation of income by an individual's own business or professional activity (Grilo and Thurik 2008). Several empirical studies take self-employment as a proxy measure of entrepreneurship (van Praag and Versloot 2007). This is because many self-employed individuals go on to establish new businesses and grow, generating employment. However, the extent to which self-employment captures rates of entrepreneurship has been shown to be limited as not all self-employed are entrepreneurs (Parker 2004). This indicator includes not only the individuals which run their own companies but also independent contractors (e.g., manual workers) and freelancers (e.g., journalists and artists).

According to Singh (1996), the level of unemployment is the main demand-side determinant for the self-employment rate. Furthermore, "own-account" work is more common in construction and commercial (trade, restaurants and hotels) business sectors, which are more important in southern European cities (see Sect. 3.1). "Some own-account workers might prefer to be employees, but are somehow constrained (for instance, because of a non-clearing market for employees) and thus are involuntarily self-employed" (Earle and Sakova 2000). Moreover, this type of employment is generally not preferred by the educated youth, despite the fact that some may become successful entrepreneurs (Singh 1996). Finally, the fact that self-employment does not distinguish between ownership of small and large firms favors the use of more dynamic measures (Glaeser 2007).

This study opted for business creation as a dynamic measure of entrepreneurship. More specifically, it used the number of new business registrations as proxy.[1] It is noteworthy that founders of new firms are by definition self-employed.[2] However, the extent to which self-employment results in business creation is not clear. This paper seeks to advance our understanding of what socio-economic factors determine the creation of new companies, including self-employment as a demographic resource. The empirical

[1] Dynamic measures have their own drawbacks. For instance, the business creation rate does not consider whether these companies survive. However, the aim of this paper is to model entrepreneurial dynamism; whether new businesses are successful, being a subject worth analyzing, falls out of its scope.

[2] See Sect. 3 for the working definitions of self-employment and new business registration.

estimation (Sect. 4.1) discusses how the relationship between self-employment and business creation may cause a significant divergence in the identification of entrepreneurship determinants.

2.2 The determinants of entrepreneurship: considerations from the literature

Having considered the economic benefits of entrepreneurship, we now focus on the factors that affect business creation, in particular at the level of the city. Regarding empirical works, there have traditionally been two main strands in entrepreneurial research that can be distinguished by the preferred unit of analysis (Storey 1991). The first approach has focused on comparisons at the *industrial* level and has investigated the role of sectoral characteristics. The second strand has focused on businesses and aims to understand the influence of the macro-economic environment on the rate of new business creation.

Recently, however, the spatial dimension of entrepreneurial research has become more fine-grained. While previously limited to inter-country variations, newly available data has enabled research into the differences at regional (Reynolds et al. 1995; Audretsch and Fritsch 2002) and city level (Rosenthal and Ross 2010; Doms et al. 2010; Belitski and Korosteleva 2010). These studies have emphasized that entrepreneurs do not work in social, cultural or economic isolation. They are either encouraged or hindered depending on the local societal and organizational infrastructure. Entrepreneurship occurs in a specific environment in which the entrepreneur finds collaborators (business partners) and an audience (customers). These spatial characteristics make it more fruitful to seek to understand the determinants of entrepreneurship at the level of the city or the region rather than nations. The geographic approach has, in turn, brought together both industry and business-based approaches.

Audretsch et al. (2002) proposed an *eclectic framework* to classify entrepreneurship determinants, encompassing theory and empirical findings from "various disciplines and several levels of analysis (micro, meso and macro)" (Freytag and Thurik 2006). The Framework consists of six basic elements:

- *Demand side*, which creates opportunities for new businesses through consumers' needs for goods and services;
- *Supply side*, which provides the potential for entrepreneurs to act upon these opportunities;
- *Individual decision making*, which includes *personal* attributes which influence the individual tendency to engage in entrepreneurship;
- *Actual and equilibrium rates*, which relate to natural (optimal) and new business dynamism in the given context;
- *Institutions*, which relates to policies that influence entrepreneurial activity; and
- *Culture*, which includes the *societal* attributes that affect the individual tendency to engage in entrepreneurship.

The following sub-sections include the theoretical considerations and empirical findings. Hypotheses are derived for the relationship between business creation and tertiary education, self-employment and factors of agglomeration. Thereupon, the section concludes with other factors emphasized by the literature.

2.2.1 The role of tertiary education

Education is an important supply-side factor, as it encourages the development of entrepreneurial skills and attitudes (Reynolds et al. 1999; Gavron et al. 1998). It promotes the awareness of commercial opportunities and entrepreneurship as a career choice. Furthermore, education (particularly at the tertiary level) provides individuals with knowledge that can be embodied in new products or services.

Several studies have investigated the role of education in the rate of entrepreneurship in United States urban zones, e.g., Doms et al. (2010) and Glaeser (2007): self-employment in cities; Reynolds et al. (1995): business creation in labor-market areas.[3] These studies reported higher entrepreneurial rates in areas with a more highly educated population. In particular, the Doms et al. study indicated a preference for entrepreneurs to establish themselves in areas with a highly educated workforce; the reported contribution of education was found to be stronger as the *level* of education rose. Similarly, Reynolds et al. (1995) found the presence of educated, mid-career adults to be a significant precursor to firm births.

Belitski and Korosteleva (2010), however, found that only lower levels of education significantly

[3] Aggregations of U.S. counties based on commuting patterns.

contributed to the entrepreneurship rate in European cities. As in Doms et al. (2010) and Glaeser (2007), the authors used self-employment as a proxy measure of entrepreneurship. Following the argument in Singh (1996), they infer that highly educated individuals prefer paid employment to self-employment, particularly in countries with lower GDP per capita. Despite this finding, most literature points toward a positive effect. The first hypothesis thus postulates as follows.

Hypothesis 1 Cities with higher levels of tertiary education will have greater rates of business creation.

2.2.2 *From self-employment to business creation*

The self-employment rate is a static proxy for the current stock (or actual rate) of entrepreneurship. Actual rates of entrepreneurship may not be optimal when demand-side opportunities are under or overestimated, leading to faster or slower rates of business entry, respectively (Carree et al. 2002). Considering the discussion in Sect. 2.1, self-employment can be viewed as a resource for business creation. By definition self-employed individuals represent the *potential* creators of companies. On one hand, "own-account" workers may not be business owners but rather be engaged in freelance or precarious jobs in commercial or construction activities. On the other hand, a new company can be created by either a new or previously self-employed individual. Furthermore, "own-account" workers can be sole or joint owners of more than one company. With these considerations we can expect a positive relationship between self-employment and business creation.

Hypothesis 2 Cities with higher rates of self-employment will have higher rates of business creation.

2.2.3 *Factors of agglomeration*

According to Chinitz (1961), entrepreneurship growth is a result of agglomeration effects. Some cities may be favored by the agglomeration of certain demand and supply-side factors which may enhance the potential access to knowledge and new ideas, factors of production, and clients or costumers (Reynolds et al. 1995). Entrepreneurs can leverage these economies of scale in densely populated cities. For instance, technology agglomeration facilitates knowledge spillovers in a given area (Acs and Varga 2005). Furthermore, market proximity and business infrastructure have shown to positively affect entrepreneurship (Brüderl and Preisendörfer 1998). Positive relationships have been reported in the United States (Reynolds et al. 1995) and European cities (Belitski and Korosteleva 2010). This literature suggests that city size has an *accelerating* impact upon the business creation rate. Hence, the following third hypothesis is proposed.

Hypothesis 3 Larger cities will have higher rates of business creation, with increasing returns to scale.

2.2.4 *Other determinants to be considered*

Alongside these three expected relationships, other factors from previous literature should be considered to effectively model entrepreneurship. Audretsch et al. (2002) highlighted other equilibrium, supply and demand-side relationships. As supply-side factors we have the unemployment and the age structure. A low level of unemployment can be regarded as an indicator of a growing economy with ample entrepreneurship opportunities (Reynolds et al. 1995). Studies have found that individuals between 20–40 years of age or older are more likely to start a business. With respect to the demand side, sectoral characteristics are noteworthy, e.g., the service sector of an economy is characterized by low initial capital requirements which provides opportunities for new business creation. For example, Audretsch (1999) found the effect of taxation rates in Germany's regional start-up rates to vary depending on the industry. Lastly, concerning actual and equilibrium rates, a large number of companies in a given market might be associated with diminishing profitability (higher competition) and thus lower entrepreneurial entry.

Several works have considered the role of culture and institutions. Using an income-choice model Grilo and Thurik (2008) explain entrepreneurial engagement levels in Europe and the United States. They designed a qualitative measure of individual inclination towards entrepreneurship and introduced a multinomial logit model to explain these preferences in terms of demographic indicators, measures of perceptions regarding administrative complexities, availability of financial support, and risk tolerance. They found that European countries display lower levels of

engagement than the United States; administrative complexity has a negative effect upon engagement levels; and, remarkably, a perception of lack of financial support did not have any significant effect.

Freytag and Thurik (2006) studied an inter-country setting (Europe and the United States) to investigate the influence of culture on both preferences for entrepreneurship and actual levels. In contrast to Grilo and Thurik (2008), they studied entrepreneurship from a country-aggregate perspective rather than at an individual level. They reported that cultural factors provided a better explanation of preferences than actual rates of entrepreneurship. In particular, they found that regulations which constrained economic freedom, a communist heritage, higher levels of life expectancy, and social spending were deterrents to entrepreneurship.

More specifically to institutions, the protection of property rights was found to be conducive to entrepreneurial activity (Aidis et al. 2009; Belitski and Korosteleva 2010), while the size of the state sector has been shown to have a negative effect (Aidis et al. 2009). In addition, Estrin and Mickiewicz (2010) demonstrated that in European countries, the existence of institutions inherited from the Soviet Union decreased the rate of entrepreneurship. This obstacle remained despite formal institutions making significant progress in supporting market activities; this suggests that informal institutions lag behind in matters such as attitudes, individual disposition towards entrepreneurship, and social norms.

Rosenthal and Ross (2010) looked at the relationship between crime and entrepreneurship in the retail, wholesale, and restaurant sectors in five cities in the United States. Remarkably, they found a higher rate of new business start-up in areas of high criminality, although retailers were more likely to establish themselves in safer locations than wholesalers. A similar distinction was found between low and high-end restaurants, the latter preferring areas with lower criminality. These findings suggested that entrepreneurs' location preferences were sensitive to crime rates. Belitski and Korosteleva (2010), on the other hand, found that the criminality rate had an overall negative effect in entrepreneurship.

Lastly, according to Lever (1993) capital cities have higher rates of economic growth than non-capitals. An economic advantage may be explained by the governmental institutions and headquarters of major corporations, which brings additional human capital and, in turn, higher productivity to capital cities (Crouch and Galès 2012). This suggests that the capital status is associated with additional economic activity in cities, which may also be reflected in higher rates of entrepreneurship.

3 Dataset: the Eurostat Urban Audit

The *Eurostat Urban Audit* dataset provides information and standardized metrics related to various aspects of the quality of life in European cities (Eurostat 2012). It provides a comprehensive set of indicators which help to describe the socio-economic environment for entrepreneurship.[4] In order to understand the determinants of entrepreneurship in European cities *New business registered* was selected as the performance variable, which offers a dynamic approach to entrepreneurship. The dataset included 184 cities in 20 European countries in the years 1999–2010. The source data is divided into three quadrennial periods: 1999–2002, 2003–2006 and 2007–2010. A total of 246 observations were obtained. The extraction process yielded a total of 21 indicators, which described the various aspects of entrepreneurship covered in the previous section. Table 1 displays the selected indicators, their classification according to the framework proposed by Audretsch et al. (2002) and their corresponding summary statistics.

Before analyzing how these local indicators may explain entrepreneurship, careful attention should be given to the delimitation of spatial units. This study follows the Eurostat concept of Local Administrative Unit (LAU) level 2 (former NUTS 5 regions), corresponding to the administrative boundaries of the city (Eurostat 2004). It is important to note that economic activity often overpasses these political boundaries. The 'total population' indicator provides the amount of people living *within* the city, but does not include surrounding communities outside of the city limits.[5] It would be possible for the surrounding

[4] Further details of Eurostat's Urban Audit data collection can be found in Eurostat (2004).

[5] However, paid employment indicators consider the jobs offered inside city limits, including employees who commute. For 'total employment/population in working age,' some observations exceed 100 %.

Table 1 Summary statistics—extracted Eurostat data

Statistic	Obs	Mean	Std. dev.	Min	Max
Demand side					
Employment in mining, manufacturing and energy, % of total	246	22.26	8.19	6.9	44.1
Employment in construction, % of total	246	6.12	2.78	2	17.8
Employment in trade, hotels and restaurants, % of total	246	18.54	3.24	8.7	32.6
Employment in transport and communication, % of total	246	6.97	2.32	2.4	14.7
Employment in secondary sector industries, % of total	246	16.15	7.17	3.7	35.8
Employment in tertiary sector industries, % of total	246	76.70	8.65	50.5	92.5
Supply side					
Total land area (km^2), in log	246	5.25	0.83	2.53	7.86
Total population, in log	246	12.58	0.85	10.95	15.79
Demographic young-age dependence, in %	246	34.47	7.38	23.20	71.10
Demographic old-age dependence, in %	246	24.13	4.77	8.90	38.20
Average employment per company, in log	246	2.55	0.80	0.64	4.88
Full/part-time employment, in %	246	8.58	12.78	1.51	89.11
Total employment/population in working age, in %	246	77.67	20.65	34.12	168.55
Students in upper and further education per 1,000 inh, in log	246	4.08	0.53	2.10	5.46
Students in tertiary education per 1,000 inh, in log	246	4.45	0.66	1.90	5.95
Actual and equilibrium rates					
Pre-existing companies per 1000 inh, in log	246	3.49	0.80	0.71	5.23
Self-employment rate, in %	246	10.30	3.19	3	23
Institutions and culture					
Employment public admin., health and education, % of total	246	33.81	6.65	20.2	52.1
Prop. of male elected city representatives, in %	246	68.62	10.69	47	100
Car thefts per 1,000 inh	246	3.85	3.55	0	19.8
Number of domestic burglary per 1,000 inh	246	3.82	3.33	0	23

Source Author's calculations based on Eurostat (2012)

agglomeration economies to influence business creation within the city.[6] In Sect. 4.2, a robustness test considers this possibility by leveraging on the concept of market potential introduced by Harris (1954).

An advantage of using administrative boundaries is an emphasis on political responsibility. This sampling criteria means that every city indicator is under the jurisdiction of local authorities. Larger regional indicators aggregate additional populations and areas, skewing the values in an unknown direction. This may make it difficult to derive policy implications from evidence. For instance assuming (for the sake of argument) that under a regional perspective high crime rates are found detrimental to entrepreneurship at a regional level. It would be unclear whether a high incidence of criminality in the suburbs affects the creation of businesses at the city's core. Administrative boundaries thus provide a more fine-grained level of analysis compared to regions.

Most of the gathered indicators are straightforward. The two supply side indicators, *demographic young-age dependence* (YD) and *demographic old-age dependence* (OD) capture the age distribution of the population in a given city. YD measures the proportion of the population aged under 20 as a ratio of the population aged 20–65. Similarly, OD calculates the proportion of the population aged over 65 as a ratio of the population aged 20–65.

[6] Eurostat (2004) acknowledged comparability limitations of LAU administrative boundaries. As a solution, Eurostat also aggregates data into Larger Urban Zone (LUZ) spatial units. In general, this unit is approximated using NUTS level 3 data, which corresponds to the administrative region surrounding the given city. During this paper's writing, several of the included variables were not available in LUZ spatial units.

$$YD = \frac{POP_{x<20years}}{POP_{20years \geq x \geq 65years}},$$

$$OD = \frac{POP_{x>65years}}{POP_{20years \geq x \geq 65years}}$$

It is worth looking into the definition of *New business registered* as it is the selected proxy for business creation and, moreover, to address its relationship to self-employment. As stated in Eurostat (2004), business registration in a given city refers to the birth of enterprises in a given city[7] and, in addition, the act of moving into that city.[8] This latter element of the definition moves away from the measurement of business creation: the re-establishment of a large company into another location should not be regarded as the creation of a new company. However, in practice, the indicator has only centered in firm births since it has business registers as statistical base Eurostat (2007).[9]

Eurostat considers individuals to be self-employed if they derive income from their own account and if they do not have a remunerated job as a main activity (Eurostat 1996). This includes not only managers of companies but also farmers, foresters, fishermen; shop-owners, craftsmen; and professionals (e.g., lawyers, medical practitioners, and accountants) (Eurostat 2004). The definition reflects the discussion in Sect. 2.1: while new companies are founded by self-employed individuals, self-employment in itself does not necessarily imply business ownership.

Three points should be noted regarding the eclectic framework. First, as this study takes a dynamic approach at an aggregate city level, *Individual decision making* variables are excluded, as these are more relevant to income-choice models (Freytag and Thurik 2006; Grilo and Thurik 2008).[10] Secondly, the available institutional quality indicators deal mostly with informal elements, which are commonly seen as cultural[11] (North 1990). In view of this constraint, the *Institutions* and *Culture* categories are merged. The limitation in this dimensions needs to be acknowledged, as ideally the detailed, specific characteristics of the historical, temporal, institutional, spatial and social context would be taken into account as they provide opportunities and limitations for entrepreneurship (Welter 2011). Following the approach taken by earlier studies (e.g., Freytag and Thurik 2006) we assume cultural and institutional elements (e.g., the national taxation regime) are captured in cross-regional and, with more precision, in cross-country effects. Finally, although most cities appear in only one of the three time periods, several cities appear in more than one. In the Urban Audit, the data availability for each country for a given year is roughly homogeneous, e.g., all French city data corresponds to the 1999–2002 period.[12] In the econometric analysis presented in Sect. 4, time heterogeneity is taken into account.

The composition of the dataset is shown in Fig. 1, which indicates the number of city observations per country. The figure shows that the dataset is heterogeneous. Germany has the most city observations—double the number in France, which takes second place. Using the United Nations geographical classification of countries (United Nations 2012), the structure of the dataset can be characterized as: 43 % western Europe, 26 % northern Europe, 20 % eastern Europe, and the remaining 11 % southern Europe. The full list of cities surveyed can be found in Appendix 1. Another factor that should be taken into account is the distribution of time periods: 122 (49 %) of the city observations are from 1999–2002, 112 (45 %) from 2003–2006 and the remaining 14 (6 %) from 2007–2010.

3.1 Structure the data via PCA

Although there is a substantial body of data to test the hypotheses stated in Sect. 2.2, it cannot be used for linear regression modeling in its raw state. Many of the variables are strongly correlated with each other, which violates the assumption of linear independence between the explanatory variables. To solve this problem, a PCA is used to identify common variance

[7] Excluding mergers, break-ups, split-offs, restructuring of enterprises, changes of activity or in the name of the company.

[8] Eurostat (2007) argued it should be considered as a new company in the city.

[9] According to Eurostat (2010), changing location is not a sufficient reason to delete an existing company record in the previous location and create one in the new city.

[10] Regarding the access to formal finance, for example, Belitski and Korosteleva (2010) reported an overall insignificant effect.

[11] Audretsch et al. (2002) argues for the separation of institutions (formal) and culture (informal).

[12] However, in the absence of data for the period 1999–2002 on 'domestic burglary' and 'male elected city representatives' indicators, 2003–2006 values were used.

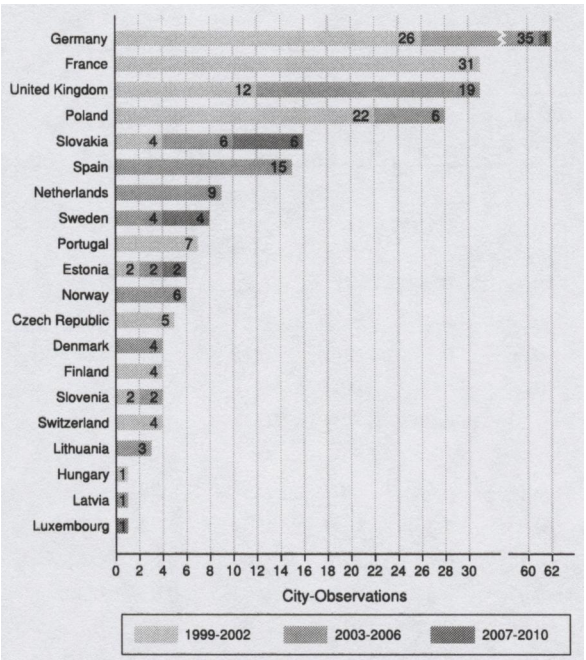

Fig. 1 Countries and associated number of city observations. *Source* Author's calculations based on Eurostat (2012)

in the data and build a set of uncorrelated indices. For example, the variables *proportion of employment in secondary sector industries* and *proportion of employment in mining, manufacturing and energy* are highly correlated and should therefore form a common dimension.[13] In this way, PCA distinguishes the unique variance between the indicators under consideration. It is then possible to examine the effect of individual factors and avoid potential feedback between indicators. However, in turn, this approach has the disadvantage that indicators contained within factors cannot be decoupled. To alleviate this problem the grouping of indicators must be carefully analyzed.

The resulting structure from PCA can be compared to that of the framework proposed by Audretsch et al. (2002); does the data structure (variance) follow that of their classification? Should 'Demand side' variables be assessed independently of 'Supply side' variables, and so on? As PCA aims to extract the greatest amount of information from the data, it maximizes the overall variance captured by each index. It is important to note that the resulting index is not homogeneously correlated by its main variables and that variables with lower loadings, while they play a less important role in the factor, should not be disregarded.[14] From the PCA, indices can be constructed that represent the common variance in the 21 dataset indicators and each of the identified factors.

Table 2 shows the results of the PCA in the period 1999–2010. The middle columns show the factor loadings, i.e., the correlations between each identified factor (group of common variance) and each variable. Loadings also indicate the weight of each indicator in the factor. The last column shows the amount of variance that is unique to the variable and not included in the identified factors. The analysis successfully detected an underlying structure in the variables. The figures in bold show the most significant values from the correlation matrix; these factors are interpreted below.

For the interpretation of factors, we note the highest correlation value for each indicator (row) to see which factor is influenced the most. We then look at each factor (column) to identify which variables have the strongest presence. Factor 1 shows a highlighted, positive correlation for the proportion of employment in the mining, manufacturing and energy sector and secondary sector industries, and a negative correlation with tertiary sector industries. This group of variables describes an economy which is oriented towards manufacturing rather than services. Furthermore, this type of economy has a small proportion of employees in public administration, health and education (i.e., the service sector). Factor 1 can therefore be labeled as a *Secondary-sector oriented economy*. This factor makes it possible to distinguish whether the economy of a city is oriented towards manufacturing or services and to investigate how differences between business sectors affect the business creation rate, although not in the same level of detail as Audretsch (1999). In its last row, Table 2 shows a negative correlation between this factor and the number of new businesses registered.

Continuing to the next column, we note that the second factor is proportional to the number of pre-existing companies and inversely proportional to the

[13] Note that this example deals with positive correlations, although strong negative correlations would also violate the assumption of linear independence.

[14] Note, for example, the correlation of −0.5147 between young-age dependence and Factor 6 'tertiary education and high employment' in Table 2.

Table 2 PCA of selected Eurostat variables (1999–2010)

Variables	Correlations						Uniqueness
	Factor 1	Factor 2	Factor 3	Factor 4	Factor 5	Factor 6	
Demand side							
Employment in mining, manufacturing and energy, % of total	**0.97**	0.12	−0.10	−0.07	0.03	−0.05	0.02
Employment in construction, % of total	0.43	0.21	−0.06	−0.11	**0.57**	−0.25	0.37
Employment in trade, hotels and restaurants, % of total	0.03	−0.34	0.05	0.26	**0.67**	0.07	0.36
Employment in transport and communication, % of total	−0.027	**0.56**	0.16	0.13	−0.15	0.41	0.45
Employment in secondary sector industries, % of total	**0.95**	0.06	−0.09	−0.04	−0.18	0.04	0.05
Employment in tertiary sector industries, % of total	**−0.95**	−0.11	0.09	0.09	−0.11	0.11	0.04
Supply side							
Total land area (km^2), in log	−0.20	0.18	**0.68**	−0.03	0.04	−0.28	0.39
Total population, in log	−0.14	−0.05	**0.83**	0.09	0.04	0.22	0.23
Demographic young-age dependence, in %	0.01	0.15	−0.09	**0.70**	−0.06	−0.51	0.21
Demographic old-age dependence, in %	−0.08	**−0.51**	0.36	−0.44	−0.04	0.03	0.40
Average employment per company, in log	−0.28	**−0.86**	−0.01	0.06	0.05	0.19	0.14
Full/part-time employment, in %	0.35	0.31	**−0.39**	0.08	0.34	0.27	0.43
Total employment/population in working age (ratio)	−0.39	−0.32	−0.03	−0.15	0.11	**0.63**	0.31
Students in upper and further education per 1,000 inh, in log	0.09	**0.49**	−0.41	−0.14	−0.41	0.20	0.36
Students in tertiary education per 1,000 inh, in log	0.08	0.27	−0.28	0.00	−0.13	**0.40**	0.67
Actual and equilibrium rates							
Pre-existing companies per 1,000 inh, in log	0.18	**0.86**	0.01	−0.03	0.02	−0.01	0.23
Self-employment rate, in %	0.03	−0.05	0.00	−0.20	**0.73**	0.17	0.39
Institutions and culture							
Employment in public admin., health and education, % of total	**−0.67**	0.02	−0.33	0.00	−0.31	−0.49	0.11
Prop. of male elected city representatives, in %	0.33	0.20	**−0.50**	0.20	0.29	−0.01	0.48
Car thefts per 1,000 inh	−0.21	0.04	0.37	**0.67**	−0.07	−0.07	0.36
Number of domestic burglary per 1,000 inh	−0.33	−0.24	−0.02	**0.77**	0.06	0.20	0.20
Correlation with new business registered, in log	−0.12	0.16	0.66	−0.21	−0.01	0.28	

Cumulative explained variance: 70.46 %. Rotation: oblimin

Source Author's calculations based on Eurostat (2012)

Values in bold show the most significant values from the correlation matrix

average employment per company. The first characteristic of this dimension therefore indicates companies with a small number of employees (SMEs). Accordingly, this factor can be labeled as *SME prevalence*. This dimension is also negatively related to the demographic old-age dependence and only has a slight correlation with young-age dependence. This suggests that SMEs are prevalent in European cities where a larger proportion of the population is of working age (20–65 years). This dimension also indicates SMEs are more plentiful in the transport and communication sector and in cities with higher ratios of students in upper and further non-tertiary education (ISCED levels 3–4). As in Belitski and Korosteleva (2010), lower levels of education (ISCED 1–2) tend to be associated with higher business ownership rather than higher education (ISCED 5–6). Table 2 indicates this factor is positively correlated with the rate of business registrations.

Factor 3 shows positive statistical relationships between land area and the number of inhabitants, and a negative correlation with the proportion of the population in full-time employment and the number of male elected city representatives. This dimension is summarized with the label *large city* as it describes large and populated areas. It should be noted that larger cities tend to provide less stable employment and have a greater number of elected female representatives. In Table 2 this dimension has the highest positive correlation with the number of new business registrations.

The fourth column links per capita car thefts and domestic burglary with the demographic young-age dependence. This suggests that European cities with fewer inhabitants aged under 20 suffer less from these types of criminal activity. Cities with a greater proportion of younger inhabitants, on the other hand, experience higher levels of crime. We label this dimension *crime and young-age population*. Table 2 shows a negative correlation with the indicator for business creation.

The fifth factor shows that European cities with high levels of self-employment also have a significant proportion of the workforce employed in construction and commerce (trade, hotels and restaurants). This dimension, labeled *self-employment*, supports the relationship mentioned in Sect. 2.1. Table 3 provides a geographical overview of the average values for cities for the variables related to this factor. Consistent with Singh (1996), there is a greater tendency in southern Europe towards self-employment, coupled with higher proportions of employment in commercial and construction business sectors. We note a correlation close to zero between this factor and new business registered in Table 2.

Finally, the sixth factor indicates that higher levels of tertiary education (ISCED levels 5–6) attendance are coupled with high levels of employment. This statistical relationship suggests areas with high levels of human capital that are associated with above-average employment rates. We therefore label this last factor *tertiary education and high employment*. It is worth noting the negative correlation (−0.49) with the proportion of employment provided by the public administration, health and education sector. The first factor removed this indicator's variance in relation to tertiary-sector activities. The variance captured by this dimension is therefore directly related to employment and tertiary education variables. This suggests that cities with higher levels of employment and educational attainment are less dependent on public sector jobs. Table 2 displays a positive correlation with the entrepreneurial rate.

This factor structure can be regarded as stable, particularly given that the observations-to-variables proportion of 246:21 (11.71:1) is above the accepted 10:1 recommendation for PCA (Costello and Osborne 2005). The presence of deviations from the factors given in the eclectic framework is noteworthy. Factor 1 is mainly composed of 'demand side' variables and includes a variable from 'institutions and culture'; *large city* includes three 'supply side' and one 'institutions and culture' variable, and so on. However, the elements from the eclectic framework are coherent according to the PCA. Factors 1 and 5 can be regarded as 'demand side'; Factors 2 and 3 are mainly related to 'supply side' indicators with a mixture of 'actual and equilibrium rates' and 'institutions and culture', respectively; Factor 4 is a partial form of 'institutions and culture'; and Factor 6 is 'supply side', distinguished by the fact that it specifically addresses human capital. Having established a set of dimensions, we now turn to the econometric analysis that will test their relationship to entrepreneurship.

4 Modeling entrepreneurship

To analyze the determinants of entrepreneurial dynamism, business creation is modeled as a function of the

Table 3 Regional averages for the main variables of Factor 5, in %

Proportions of employment	Southern Europe	Western Europe	Eastern Europe	Northern Europe
Self-employment	14.23	10.67	10.46	7.94
Trade, hotels and restaurants	21.62	17.59	17.13	20.00
Construction	10.97	4.83	7.15	5.48

Source Author's calculations based on Eurostat (2012)

Table 4 Summary statistics for the regression variables

Statistic	Obs	Mean	Std. dev.	Min	Max
Explained variable					
New business registered, in log	246	7.45	1.05	5.08	10.64
Identified factor indices					
Secondary-sector oriented economy	246	0	1	−1.99	2.67
SME prevalence	246	0	1	−2.51	2.24
Large city	246	0	1	−2.68	2.82
Crime and young-age pop.	246	0	1	−1.82	3.60
Self-employment	246	0	1	−1.93	3.84
Tertiary education and high employment	246	0	1	−3.65	3.42
Dummy variables					
1999–2002 observation	246	0.49	0.50	0	1
Capital city	246	0.11	0.31	0	1
Western Europe city	246	0.43	0.50	0	1
Northern Europe city	246	0.26	0.44	0	1
Eastern Europe city	246	0.20	0.40	0	1

Source Author's calculations based on Eurostat (2012)

six factors that emerged from the Eurostat dataset. Five models were used in a cross-sectional analysis. They are described in a set of equations below. The summary statistics for the variables to be included in these models are shown in Table 4.

$$n_i = \sum_{k=1}^{6} \beta_k I_{ki} + c + \epsilon \qquad \text{(Model1)}$$

$$n_i = \sum_{k=1}^{6} \beta_k I_{ki} + \beta_7 T_i + c + \epsilon \qquad \text{(Model2)}$$

$$n_i = \sum_{k=1}^{6} \beta_k I_{ki} + \beta_7 T_i + \beta_8 C_i + c + \epsilon \qquad \text{(Model3)}$$

$$n_i = \sum_{k=1}^{6} \beta_k I_{ki} + \beta_7 T_i + \beta_8 C_i + \sum_{l=1}^{3} \beta_{(l+8)} R_{li} + c + \epsilon \qquad \text{(Model4)}$$

$$n_i = \sum_{k=1}^{6} \beta_k I_{ki} + \beta_7 T_i + \beta_8 C_i + \sum_{l=1}^{16} \beta_{(l+8)} N_{li} + c + \epsilon \qquad \text{(Model5)}$$

The variable explained is the *log* of *New business registered* (n) for i cities. The basic model (Model 1) only includes the six indices (I_k) as explanatory variables, a constant (c) and an error term (ϵ). Model 2 adds a time period dummy variable (T) which takes the value *true* for observations from the period 1999–2002,[15] and thus takes into account time effects between this period and more recent observations.

Model 3 includes a binary variable to distinguish between capital and non-capital cities (C). The fourth model takes into account regional differences in culture and other forms of institutions (e.g., policies) by including three dummy variables (R_l) which represent the United Nations' geographical classification of countries outlined in Sect. 3 (with southern Europe as the null case). Since it cannot be assumed that institutions and culture are homogeneous within regions, a fifth model implements country dummies (N_l) with France as the null case.[16]

4.1 Empirical results

Table 5 contains the results of the regressions of the models described above. This table displays the estimated coefficients for each model. The last column (Model 5a) takes into account nonlinear effects, by including a quadratic term (see Sect. 4.2). As evidence of heteroskedasticity was found in every specification,

[15] We do not use dummies for the periods 2003–2006 nor 2007–2010 as the lower proportion of observations yielded estimates that suffered from high variance inflation factors, which indicated high multicollinearity.

[16] This last model excludes Hungary, Latvia and Luxembourg as data was only available for one city in these countries.

Table 5 Regressions for *new business registered*

Variables	Coefficients					
	Model 1	Model 2	Model 3	Model 4	Model 5	Model 5a
Secondary-sector oriented economy	−0.121**	−0.116**	−0.104**	−0.157***	−0.137*	−0.128*
	(0.0481)	(0.0485)	(0.0479)	(0.0521)	(0.0740)	(0.0751)
SME prevalence	0.172***	0.201***	0.176***	−0.0274	0.0720	0.0625
	(0.0399)	(0.0396)	(0.0424)	(0.0605)	(0.0974)	(0.0936)
Large city	0.693***	0.697***	0.672***	0.755***	0.644***	0.635***
	(0.0460)	(0.0464)	(0.0510)	(0.0495)	(0.0460)	(0.0498)
Crime and young-age pop.	−0.225***	−0.214***	−0.214***	−0.207***	0.1000	0.0919
	(0.0391)	(0.0387)	(0.0387)	(0.0456)	(0.0651)	(0.0780)
Self-employment	−0.00806	−0.0221	−0.0329	0.122**	0.200***	0.302***
	(0.0453)	(0.0461)	(0.0465)	(0.0531)	(0.0629)	(0.0723)
Tertiary education and high employment	0.291***	0.288***	0.266***	0.146**	0.249***	0.258***
	(0.0662)	(0.0658)	(0.0652)	(0.0642)	(0.0543)	(0.0506)
1999–2002 observation		−0.171*	−0.151	−0.170*	−0.130	−0.160*
		(0.0904)	(0.0925)	(0.0883)	(0.0820)	(0.0840)
Capital city			0.262	0.427**	0.653***	0.650***
			(0.198)	(0.195)	(0.163)	(0.150)
Western Europe city				0.983***		
				(0.191)		
Northern Europe city				0.651***		
				(0.197)		
Eastern Europe city				1.568***		
				(0.238)		
Country dummies					✔	✔
Quadratic effects						✔
Constant	7.452***	7.536***	7.498***	6.577***	7.294***	7.455***
	(0.0429)	(0.0542)	(0.0610)	(0.167)	(0.159)	(0.186)
Observations	246	246	246	246	243	243
R^2	0.599	0.604	0.608	0.704	0.825	0.848

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Source Author's calculations based on Eurostat (2012)

the Huber–White Sandwich estimator was used to calculate robust standard errors.

The first hypothesis, stating that higher participation in tertiary education is positively related to business creation, is supported. The 'tertiary education and high employment' index yielded positive coefficients with p values less than 1 % in all regressions. This suggests there is more new business creation in cities with higher numbers of university students (rather than lower ISCED levels), differing from the results reported by Belitski and Korosteleva (2010) for European cities and concurring with other studies in United States urban zones (Reynolds et al. 1995; Glaeser 2007; Doms et al. 2010). This index also indicates a positive effect from higher levels of employment, as reported by Reynolds et al. (1995). Looking at the size of the public sector (the proportion of the workforce employed in public administration, health and education), Sect. 3.1 demonstrated that this variable has a negative impact on this index. This relationship can be applied here to infer that cities that do not rely on the public sector for employment may be more entrepreneurial.

Models 1–3 do not provide support for the second hypothesis regarding an effect from self-employment upon business creation. However, the corresponding index becomes statistically significant when taking into account regional effects (Model 4) and, with lower p values, when country-specific effects are included (Model 5). This suggests the presence of correlations between self-employment and the added dummies.[17] In other words, while self-employment does not appear to explain differences in new business formation at the European level, evidence indicates it becomes relevant to understand variations within a given country.

We find support for the third hypothesis regarding a positive contribution from city size upon business creation. The 'large city' index reveals consistently positive, highly significant coefficients in all regressions. This is consistent with the result reported by Reynolds et al. (1999) relative to labor market areas in the United States, and by Belitski and Korosteleva (2010) for European cities—factors of agglomeration are conducive to high levels of entrepreneurial dynamism. In other words, the data shows that small European cities are at a disadvantage when it comes to entrepreneurial dynamism. Overall, the 'large city' coefficients were relatively higher than those of other significant indices. This indicates that the business creation rate is more sensitive to agglomeration factors compared to, for example, differences in self-employment levels. Results from Model 5a, which considers quadratic effects, suggest that the effect of city size has increasing returns to scale.[18]

We now cover the controls added to the model. The 'secondary-sector oriented economy' index shows results with varying levels of significance, i.e., p values of lower than 5 % for the first three models, less than 1 % for the fourth model, and less than 10 % for the fifth model. It suggests, albeit with low robustness, that the structure of the economy does have an influence on the business creation rate. Cities with service-oriented economies may see more start-ups than those that are oriented towards manufacturing, as suggested in Audretsch et al. (2002).

Contrary to the 'self-employment' index, 'SME prevalence' and 'crime and young-age population' *lost* their explanatory power when considering regional or country effects. The loss in significance indicates that city-level amounts of SMEs, criminality rates and the age structures are better explained by country-wide factors (i.e., culture and institutions). In other words, there is no evidence of explanatory power for these two factors regarding business creation *within* countries.

The regressions also suggest that years after 2002 were more favorable for business creation, albeit not robustly. More conclusively, results indicate that more businesses are registered in capital cities than in non-capital cities. This is consistent with the notion stated by Crouch and Galès (2012) such that the capital status provides an advantage to business creation (as economic activity), which goes beyond factors of agglomeration.

With respect to the regional classification, eastern European cities had the highest rates, followed by western and then northern European cities; southern Europe (the null case in the regional classification dummies) demonstrated the lowest rate. Model 5 breaks down the regional classification to country level (these results are reported in detail in Table 9 of Appendix 2). Compared to France, Poland and Germany have a higher rate of entrepreneurship with similar coefficient values. Lower and significant levels of entrepreneurship were seen in the following countries (in descending order): the Netherlands, Portugal, Lithuania, the United Kingdom, Spain, Slovenia, and Switzerland. The origin of these deviations, which are unaccounted by the indices, may be explained by institutional and cultural differences (e.g., property rights law and enforcement and the national taxation regime) for which little data was available.

The importance of the territorial classifications is also demonstrated by the R^2 metrics which increase from 0.608 (Model 3) to 0.704 when including regional effects (Model 4). This suggests that cultural and institutional factors offer considerable explanatory power. The R^2 value increased further to 0.825 with the introduction of country effects, suggesting that these factors are not homogeneous within regions. Therefore an econometric analysis that takes a more fine-grained approach and looks at the data at the level of individual countries is recommended. More detailed data collection and further research is needed

[17] The coefficient for *self-employment* increased in value, suggesting that estimates were negatively biased in the first three models.

[18] Refer to the following section for more details.

in order to clarify the cultural and institutional factors which provoke these effects.

These results suggest that city rankings can be seen as a benchmarking tool through the use of derived indices that have a statistically significant influence on entrepreneurial activity. Appendix 1 illustrates the idea; it ranks cities according to *new business registered* and includes each of the constructed indices. The significance of the country dummy variables and the high R^2 benchmark suggest that it is more accurate to compare cities within countries rather than at a continental or even regional level. Appendix 1 only shows rankings for countries with more than ten city observations as the inclusion of countries with fewer city observations may be misleading. When looking at the rankings in Appendix 1, it is important to take into account the time period of the city in question, as different cities in the same country may refer to different periods (e.g., Germany). Moreover, for each country, cities may appear more than once depending on the time period (e.g., Slovakia).

Additional specifications take the *self-employment rate* as the explained variable in Model 5 and include *new business registered* as an explanatory variable, to further explore the relation between these two proxies of entrepreneurship. The results are included in Table 6. Column 1 includes the basic swap of variables. With the purpose of identifying differences between the indicators, we consider the share of ICT companies[19] to the analysis as a possible source of entrepreneurship in column 2. Columns 3 and 4 restrict this analysis to western European cities.

As expected from the results in Table 5, *new business registered* provides positive and significant coefficients. SME prevalence shows a positive effect with a p value lower than 5 %. This suggests that self-employment rates are high in cities which have more SMEs than large companies, which is understandable considering that, by definition, SMEs are run by self-employed individuals. Contrary to business creation, city size indicates a negative effect (10 % significance). This result suggests that smaller cities have higher self-employment rates. In other words, factors of agglomeration may favor higher proportions of *paid* employment. Also in contrast with Table 5 results, coefficients for the 'capital city' dummy did not yield significant estimations; contrary to business registration, there is no evidence to suggest that the capital status provides a favorable environment for entrepreneurship in terms of "own-account" work. The share of ICT companies did not yield additional predictive power for self-employment. When the sample is restricted to western cities, SME prevalence and city size have no statistical significance. For this region the rate of self-employment was only associated with business registrations.

Column 5 adds the share of ICT companies to Model 5, while column 6 additionally restricts the sample to western European cities. Only column 6 revealed a significant effect from ICT companies, suggesting that only in this region do higher shares of this type of companies helps to spark additional businesses. Unlike the estimations for self-employment, reducing the sample to this region did not yield lower explanatory power in the factor indices, nor reduced R^2 values.

4.2 Robustness checks

In Sect. 3, we considered the spatial unit's boundary definition and the possible repercussions in the analysis. The economic areas which (to different extents) surpass administrative boundaries, may impact business creation within the city's core. Exogenous effects could bias the estimations presented above. To check for this possibility, a control was designed to compare two agglomeration economies, i.e., within and outside the city. It is based on the "market potential" function introduced by Harris (1954): $P = \sum(M/d)$.The market potential P equals the sum of accessible market sizes (M) divided by the geographic distances to those markets (d). Regions could be seen as agglomeration of markets upon a given area. Likewise (albeit at a different scale) cities agglomerate districts upon certain distances. Following Head and Mayer (2000), the sum of distances may be approximated as an area (A).[20] Accordingly, the market size can be regarded as the gross domestic product (GDP) of the corresponding area. We refer to this proxy for market potential as economic density: $D = (\mathrm{GDP}/A)$.

[19] Logarithmic transformation. Summary statistics: obs = 264, mean = 3.82, std. dev. = 0.93, min = −0.51 and max = 6.50. *Source* Eurostat (2012).

[20] This approximation assumes that producers and consumers are evenly distributed within the area (A). However, the goal here is to capture the differences in magnitude of agglomeration economies across two different areas, i.e., within and outside city boundaries.

Table 6 Estimations for self-employment based on Model 5

Dependent variable	Self-employment rate				New business registered	
Included cities	All		Western Europe		All	Western Europe
Variable	(1)	(2)	(3)	(4)	(5)	(6)
New business registered	1.065***	1.033***	1.505***	1.452***		
	(0.263)	(0.265)	(0.391)	(0.400)		
Secondary-sector oriented economy	0.184	0.254	0.0258	0.0512	−0.12	−0.342***
	(0.335)	(0.327)	(0.679)	(0.692)	(0.0737)	(0.124)
SME prevalence	1.005**	1.133**	0.842	0.913	0.103	−0.0968
	(0.495)	(0.485)	(0.856)	(0.860)	(0.0986)	(0.174)
Large city	−0.628*	−0.632*	−0.803	−0.799	0.638***	0.694***
	(0.329)	(0.327)	(0.519)	(0.525)	(0.0458)	(0.0583)
Crime and young-age pop.	−0.47	−0.468	0.383	0.419	0.1	0.142
	(0.322)	(0.321)	(0.514)	(0.524)	(0.0646)	(0.121)
Self-employment					0.195***	0.287**
					(0.0638)	(0.118)
Tertiary education and high employment	0.0887	0.0544	0.0512	0.00754	0.238***	0.168**
	(0.215)	(0.215)	(0.266)	(0.281)	(0.0562)	(0.0701)
1999–2002 observation	0.0796	−0.00336	−0.726	−0.841	−0.149*	−0.356***
	(0.390)	(0.395)	(0.540)	(0.590)	(0.0813)	(0.113)
Capital city	−0.378	−0.317	1.013	1.112	0.663***	0.768*
	(0.664)	(0.678)	(1.017)	(1.028)	(0.163)	(0.406)
Share of ICT companies, log		0.234		0.322	0.0567	0.257**
		(0.184)		(0.570)	(0.0478)	(0.124)
Country dummies	✔	✔	✔	✔	✔	✔
Constant	1.87	1.259	−0.908	−1.687	7.084***	6.477***
	(1.901)	(1.923)	(2.740)	(3.018)	(0.251)	(0.547)
Observations	243	243	106	106	243	106
R^2	0.677	0.679	0.433	0.435	0.826	0.859

Robust standard errors in parentheses

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Source Author's calculations based on Eurostat (2012)

In order to check whether the spatial unit introduces a bias in the econometric setup, we compare two different densities, i.e., the core-city (LAU level 2) and the outer region (NUTS level 3, minus LAU level 2) with the ratio $D_{\text{external}}/D_{\text{internal}}$. This control was added to Model 5; results are included in Table 10 of Appendix 3.[21] Estimations for the control's coefficient were not statistically significant. Moreover, the coefficients for the rest of the variables do not seem to vary after including the control. Wald tests did not yield evidence to reject the null hypothesis of equality of coefficients across Model 5 and the expanded model. In other words, this control does not indicate an effect from regional externalities upon business creation in cities, nor a distortion in the previously estimated effects. The procedure provides no evidence to suggest that a greater economic density of the region, with respect to its enclosed city, results in more businesses being registered within that city.

[21] For some cities, NUTS level 3 is roughly the same as LAU level two. Observations with city-land areas equivalent to 95 % or more of its region were excluded. Data extracted from the Eurostat Urban Audit (Eurostat 2012).

The augmented component-plus-residual plots shown in Fig. 2 were used to detect potential non-linearities (Mallows 1986). These plots depict the relationship between each of the indices and *new business registered* and illustrate the marginal effects captured by the cross-sectional regression of Model 5. The gray line shows the linear prediction of the effect of a particular index on business creation, assuming the other variables in the model remain constant, while the black line indicates a smooth estimation. A model specification test confirmed the presence of non-linear relationships as observed in the graphs.[22] We then consider a variation of Model 5 including quadratic effects for the explanatory variables (Model 5a in Table 5), adding the following term to the specification:

$$\sum_{m=1}^{6} \beta_{(m+24)} I_{mi}^2$$

This term adds the squared values of each factor index (I_m) to the regression. Table 9 of Appendix 2 shows some significant quadratic effects. 'Large city' (1 % level) indicates increasing returns from economies of scale. This means that not only do larger cities have higher rates of new business creation, but also at an accelerating rate. Levels of self-employment (5 % level) demonstrated, on the other hand, decreasing marginal returns. In other words, as the rate of self-employment in cities increased, the positive effect on entrepreneurship decreased. Extreme values of self-employment may be deviating from optimal levels of entrepreneurship as noted by Carree et al. (2002) and Audretsch et al. (2002). Furthermore, high values may indicate lack of work opportunities rather than business ownership (Earle and Sakova 2000). A similar phenomenon is shown by the 'tertiary education and high employment' index (5 % level). The positive contribution of this index increases before reaching the average score, thereupon decreasing. This may represent certain dynamics in the *exclusivity* of knowledge, e.g., at lower levels of attainment in cities there may be more opportunities for highly-educated individuals to find knowledge applications.

The Durbin–Wu–Hausman test was used to consider the possibility of endogeneity in the models; the test was carried out in two steps. First, each potentially endogenous variable was regressed with respect to all the indicators used in the construction of the indices. In a second step the resulting residuals were added to the regressions from the original models (1–5). If a residual were to yield a significant estimation, then the corresponding index must be accepted as endogenous (Wooldridge 2002). However, the test did not detect any evidence of an endogeneity bias.

A variety of diagnostics were implemented in order to validate the estimations presented above. An inter-quartile analysis verifies the normality of the predicted errors, in order to check the accuracy of the p values; no extreme outliers were found, which suggests that residuals were close to a normal distribution. The potential for multicollinearity is verified by calculating the variance inflation factors in each of the models;[23] none of the results provided cause for concern. Appendix 3 replicates the cross-sectional analysis with averaged observations for cities which appeared more than once. In Appendix 3, Fig. 4 shows the number of unique cities per country while Table 11 displays the results from this modified sample.[24] In relation to Table 5, coefficients conserve equal signs and their values remain mostly stable. It is however worth noting that the 10 % level significance is lost in Model 5 for the index 'secondary-sector oriented economy', while the 'SME prevalence' index gained explanatory power (10 % level).

Finally, Fig. 3 compares the performance of the cross-sectional estimates of Models 1 and 5a. These two graphs plot the actual values of *new business registered* versus those predicted by the respective models.

5 Policy implications

These results suggest three policy approaches to the promotion of entrepreneurship in cities: encouraging

[22] The squares of the estimated values for *new business registered* ($\hat{n}_i^2$) were found to have a significant explanatory power for the observed values (n_i). This suggests the presence of non-linear effects in the specification (Model 5).

[23] $vif(\hat{B}_i) = 1/(1 - R_i^2)$, where R_i^2 corresponds to the R^2 of the regression in which the explanatory variable associated with $\hat{B}_i$ becomes the explained variable, as a function of all the other explanatory variables of the original model. A large R^2 suggests a high goodness of fit and so, in this case, multicollinearity in the original model.

[24] Since only one observation is included per city, time effects are not included in these regressions.

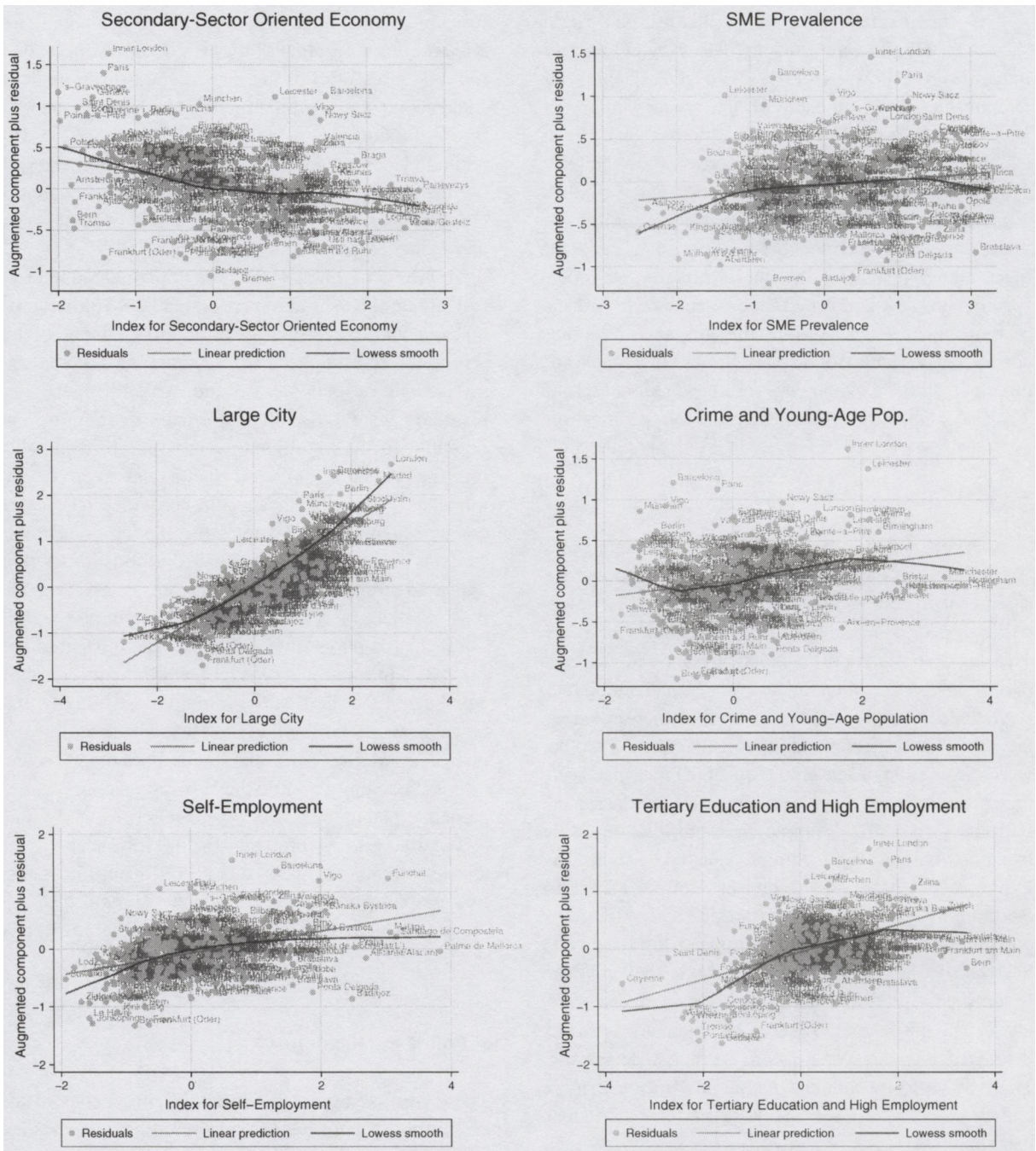

Fig. 2 Augmented component-plus-residual plots, Model 5. *Source* author's calculations based on Eurostat (2012)

tertiary education, supporting self-employment, and levering economies of scale. In general terms, the development of homogeneous policies and their implementation throughout the European Union is important in order to take advantage of the opportunities offered by the Single Market (European Commission 2008, 2010). As follows, this section discusses these approaches in the context of political initiatives

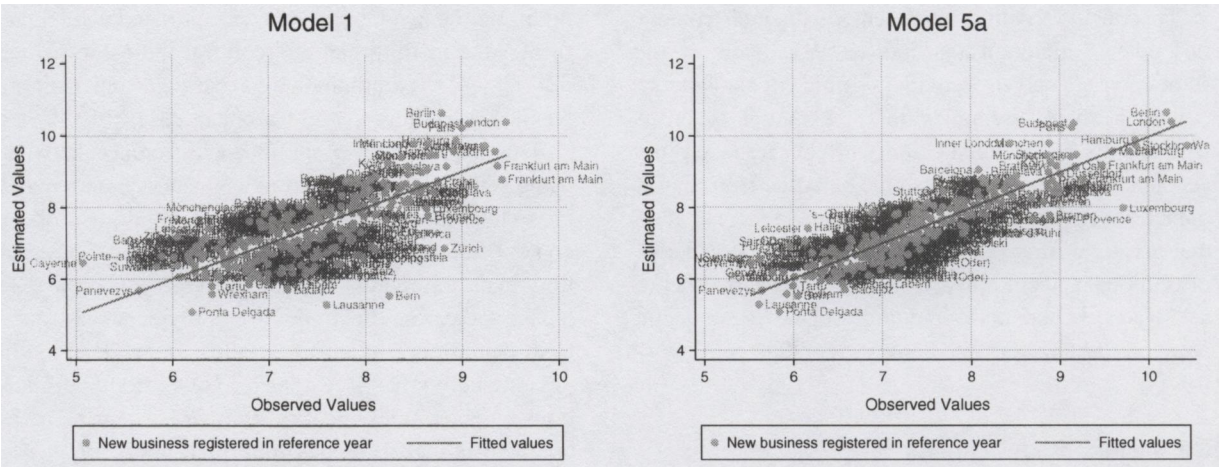

Fig. 3 Actual versus estimated values. *Source* author's calculations based on Eurostat (2012)

taken by the European Commission. Particular attention is paid to the best practice principles for policy implementation included in the Small Business Act (SBA), which was drafted as a result of the Lisbon Agenda and was emphasized in the Europe 2020 Strategy. Throughout these policy documents, the European Commission regards entrepreneurship as the creation and growth of SMEs.[25] It is important to note that the evidence collected in this paper is specific to business creation.

Results show that policies which foster self-employment will result in higher new business creation. However, the contribution is lower in cities with higher levels of "own-account" workers. This may reflect larger proportions of activities which are not related to business ownership. The first principle found in the SBA highlights the necessity to create an entrepreneurial mindset. Public organizations should not only encourage self-employment, but also aid in the transition from precarious "own-account" jobs (in commercial or construction activities) to business creation. To achieve this, policy solutions could explore ways to alleviate market frictions, as stated in the SBA's seventh principle, which centers around helping entrepreneurs to benefit more from opportunities offered by the Single Market.

There is evidence of a positive link between entrepreneurial dynamism and a higher proportion of participation in tertiary education. This supports the Act's eight principle which emphasizes the promotion of skills in entrepreneurs. A high level of education provides individuals with the necessary tools and knowledge to form a new business and helps them to identify market opportunities. In this respect, governments should take note that cities with lower levels of educational attainment are associated with higher unemployment, higher proportions of public sector jobs, and tend to demonstrate lower rates of enterprise creation. Finally, the evidenced quadratic effect in this factor suggests that efforts for promoting higher education are more fruitful when attainment levels are low.

There is evidence to support that agglomeration favors business creation with increasing marginal returns. In other words, the size of a city is proportional to the number of businesses created and, more remarkably, the effect increases as a function of scale. This means that the policies of European governments should yield better results in an urban context, a factor which the SBA does not take into account. An urban bias is, however, not without drawbacks; governments should also evaluate the potential impact on rural entrepreneurship rates.

[25] The SBA itself centers around policies that favor an "SME-friendly environment" (European Commission 2008). Support to business creation is included implicitly, as seen in some recommended practices (e.g., strengthening nascent entrepreneurship in educational programs and reducing administrative burdens for registering businesses) and more directly in the second policy principle which is about promoting recovery from bankruptcy.

To conclude with a final remark on inter-country differences, although the indices developed in the econometric analysis provide significant explanatory power, it should be noted that the model performs significantly better when country effects are taken into account. This highlights, first, the heterogeneous entrepreneurial environment in Europe. Second, it suggests that greater effort should be devoted to the capture of institutional and cultural data at the city level in order to achieve a better understanding of the relationship between these factors and entrepreneurship.

6 Conclusions and outlook

This paper examined the various factors theorized to influence entrepreneurship in European cities, using the Eurostat Urban Audit dataset. Data extraction yielded 21 variables taken from data on 184 cities in 20 European countries between 1999–2010. PCA was used to analyze the data structure; this identified a set of common dimensions and made it possible to construct representative indices.

The PCA enabled relations in the Eurostat indicators to be identified based on common variance, together with the structuring of the dataset into six main factors. This data summary process is appropriate to model business creation assuming the independence between the identified factors. Furthermore, it allows cities to be benchmarked in these dimensions. Nevertheless, further work should identify instrumental variables to further clarify the role of correlated and grouped indicators.

Among all the factors examined, this study found that the number of new business registrations was positively linked with city size, self-employment, and tertiary education rates. Increasing returns of scale were detected for the size of cities (factors of agglomeration), while educational attainment levels and the amount of "own-account" workers reported decreasing returns to scale. These findings are robust to the definition of a city's boundaries. Alongside these effects, evidence indicated that eastern European cities had the highest rates of entrepreneurship, followed by western and northern Europe. Southern European was the most stagnant region in terms of new business registration. The results suggested capital cities have an advantage over other cities, independent of city size. These localized differences highlight the need to account, compile and investigate further the institutional and cultural indicators which may play a complementary roles in determining business creation rates in European cities.

This study noted a significant difference between using self-employment and new business creation as a proxy measure of entrepreneurship; in the European context self-employment is closely related to construction and commercial sector activities. Contrary to business creation, this type of employment was found to be more prevalent in smaller cities. Factors of agglomeration therefore appear to favor higher proportions of paid employment over "own-account" jobs.

The findings provide important implications for policy-making at the European level, in the context of the Lisbon Agenda and the Europe 2020 Strategy. Results support the implementation of several of the principles described by European Commission's Small Business Act, regarding the promotion of a favorable environment for business creation. The existence of regional and country differences emphasize the diversity of European countries. Given the spatial dimension of the findings and the economies of scales this study highlights, discussion should focus on the suitability of an urban framework for localized policies which aim to stimulate city economic development via entrepreneurship.

Acknowledgments The author is grateful to three anonymous referees for their valuable comments. Special thanks to Ahmed Bounfour and Alejandro Hoyos for their useful suggestions and support. The usual disclaimer applies.

Appendices

Please refer to the electronic supplementary material found in the online version of this article (doi: 10.1007/s11187-012-9462-8).

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