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New ranking of European cultural and creative cities: a super-efficiency and productivity approach

Nueva clasificación de las ciudades culturales y creativas europeas: un enfoque de supereficiencia y productividad

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Abstract

The objective of this paper is to conduct a new benchmark analysis of European cities based of a composite index of efficiency from the dimensions of the Cultural and Creative Cities Monitor 2019 (CCCM). We use two new methodological proposals in this field. In a first phase, the analysis of super-efficiency of the CCCM cities and their convergence process is addressed. As mentioned by Pavkovic' *et al*. (2021) the report CCCM is produced by the Joint Research Center, the European Commission's in-house research center according to the statistical recommendations of (Nardo *et al*., 2008). The C3 index, based on 29 variables, as mentioned by De Jorge-Moreno and De Jorge-Huertas (2020), evaluates three dimensions: Cultural Vibrancy (CV), Creative Economy (CE) and Enable Environment (EE). These dimensions have been obtained through qualitative and quantitative variables. In this paper we will use the BCC-DEA (Banker *et al*., 1984 and Data Envelopment Analysis) extension proposed by Andersen and Petersen (1993) to classify the efficient units (super-efficiency model, hereafter). As mentioned by Santin (2014) the super-efficiency reasoning consists of comparing the evaluated unit with a linear combination of all other units in the sample except itself. The evaluated city or DMU (Decision Making Unit) is removed from the inputs and outputs constraints and omitted from the benchmark units. In a second phase, the Hicks-Moortensen indexes are used to estimate the creative productivity of the cities in the existing years. Authors such as O'Donnell (2008, 2011) mention issues such as the fact that Malmquist indices are not fully multiplicative, in addition to not satisfying the transitivity conditions.

In relation to productivity performance, there is an increase of 2.02% in average terms across the 190 cities between 2017 and 2019. These productivity gains are a consequence of both technological progress and efficiency with values of 0.02% and 5.39% respectively. Cluster analyses allow us to segment the sample of cities into three groups, which could be considered low, medium and high performers based on their average productivity levels, whose values are -2.79%; 0.9% and 13.41% respectively.

It is evident that within the objective of this work in the establishment of a hierarchical classification of cities, according to their efficient management of resources, that allow to establish references for the rest, other questions arise. Such as the fact that it is possible to observe in parallel a certain inequality within European cities with different creative competitive patterns and spatial disparity. However, both the aforementioned convergence analysis and the possibility of establishing good management practices through the best references found, provide a dose of optimism for the future.

The methodologies used in this work could be considered useful tools for decision making aimed at finding points of improvement in the management practices of cities. Among the limitations of this work are the short time period analysed, which, although it is the only one available at the moment, also represents a novelty in this field of analysis, given that, in general, cross-sectional data have been used up to now. Possible extensions of this work could be aimed at the consideration of a second stage or exogenous variables that could influence the levels of efficiency or productivity of the cities.

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Keywords: Super-efficiency, productivity, Hicks-Moortensen index, cultural creative cities monitor, convergence process, benchmark analysis.

JEL codes: M21, Z31.

Resumen

El objetivo de este trabajo es realizar un nuevo análisis comparativo de las ciudades europeas basado en un índice compuesto de eficiencia a partir de las dimensiones del Monitor de Ciudades Culturales y Creativas 2019 (CCCM). El análisis se basa en técnicas más robustas que las utilizadas anteriormente en este campo. En concreto, se estudiarán los índices de supereficiencia y de productividad total de los factores (PTF) de Hicks-Moortensen de las 190 ciudades en los años 2017 y 2019. Los principales resultados revelan que tres ciudades (París, Londres y Florencia) pueden considerarse supereficientes en los años analizados, incorporándose posteriormente Dublín. El análisis de convergencia corrobora la mejora de las ciudades que parten inicialmente de niveles más bajos de eficiencia en la gestión de los recursos. Los resultados de productividad reportan un aumento del 2,02% en términos medios en el conjunto de las 190 ciudades entre 2017 y 2019. Estas ganancias de productividad son consecuencia tanto del progreso tecnológico como de la eficiencia con valores del 0,02% y 5,39% respectivamente. El análisis de conglomerados nos permite segmentar la muestra de ciudades en tres grupos (de bajo, medio y alto rendimiento).

Palabras clave: Supereficiencia, productividad, índice de Hicks-Moortensen, monitor de ciudades creativas culturales, proceso de convergencia, análisis comparativo.

Códigos JEL: M21, Z31.

1. Introduction

The first quarter of the 21st century has challenged the world with momentous changes, as mentioned Loots *et al.* (2022). The influence of these changes is reflected in communities and cities, with the Cultural and Creative Industries (CCI) being particularly affected. One of the priority objectives in the management of cities, which are immersed in the continuous technological advances and digitalization processes, is related to the generation of institutional and cooperation structures for their economic and social development, considering the quality of life of their citizens. In this sense, greater job opportunities, education, and health, are part of the factors to be considered. The attraction of professionals in different fields, related to the CCI, students and tourists, is configured as a priority objective. There is no doubt about the relationship between companies and their environment and therefore it seems reasonable to consider that a better understanding of the local and regional context in which the creation of companies takes place is fundamental, not only to promote a solid business fabric, but also to be able to understand the differences in growth between regions or cities.

Authors such as Betzler and Leuschen (2021), among others, point out the importance of creative cities (Cultural Creative Cities, hereinafter CCC) as sources of job creation and economic development. In this sense, the attenuation tendencies of governmental institutions towards CCC aid and support for creativity and business innovation are a consequence of the growth prospects of this sector.

For their part Li *et al.* (2022) point out the relevant contribution of the CCIs in the national economy in particular and global development in general. From the academic point of view, as these authors point out, there is an important increase in literature investigating different countries, regions, and cities. In this sense, Cerisola and Panzera (2021) show how the cultural and creative characteristics of the CCI have strong indirect effects that benefit the regions in which they are located. Yan and Liu (2023) derive cultural impact indicators to assess the sustainable cultural development of CCCs. Other authors Pavkovic' *et al.* 2021) study the relationship between the cultural strength of cities and reputation. Other works focus their attention on the analysis of efficiency by means of composite indicators, such as De Jorge-Moreno and De Jorge-Huertas (2020) or Van Puyenbroeck *et al.* (2021) among others. In this sense, the aim of this work is the analysis of CCCs, establishing a new ranking of best practices of the 190 cities considered in the Cultural Creative Cities Monitor 2019. Specifically, the super-efficiency and total factor productivity (TFP) of the cities in the years 2017 and 2019 will be studied. With this objective, it is intended to fill an existing gap, in both methodological and temporal terms by addressing the two existing years of information. This objective could be relevant, by contributing to the decision making of the different agents in the planning and improvement of the cities.

This paper is organized as follows. The second section presents the data and methodology used. The third section shows the results achieved. First, the results related to the analysis of super-efficiency and the convergence process of the cities. Secondly and thirdly, attention is paid to the analysis of productivity and the segmentation of the sample of cities, respectively. Finally, the fourth section presents the main conclusions of the paper.

2. Data and Methodology

The data used in this paper comes from information contained in the Cultural and Creative Cities Monitor 2019 C3 Index (https://composite-indicators.jrc.ec.europa.eu/cultural-creative-cities-monitor/docs-and-data). The C3 is a composite indicator that measures the cultural and creative performance of 190 cities in 30 European countries (the EU plus the UK, Norway, and Switzerland). As mentioned by Pavkovic' *et al.* (2021) the report is produced by the Joint Research Center, the European Commission's in-house research center according to the statistical recommendations of (Nardo *et al*., 2008)

The C3 index, based on 29 variables, as mentioned by De Jorge-Moreno and De Jorge-Huertas (2020), evaluates three dimensions: Cultural Vibrancy (CV), Creative Economy (CE) and Enable Environment (EE). These dimensions have been obtained through qualitative and quantitative variables. As mentioned, Pavkovic' *et al.* (2021) the C3 is a useful tool for policy makers in planning effective strategies. Some examples in this direction would be cities such as Bologna, Edinburgh, Geneva, or Madrid among others (Montalvo *et al*., 2019).

Specifically, Pavkovic' *et al.* (2021) analyse by means of regressions and correlations the relationship between the cultural strength of cities and reputation in twenty European cities. Their results indicate that cultural spaces and facilities are not related to the reputation of cities, while the correlation between cultural participation and attractiveness is. For their part (Mareque *et al.,* 2021) using the composite indicator C3 and by means of bootstrap techniques and the generation of confidence intervals find that smaller cities present positive characteristics to foster creative tourism (i.e., they have cultural infrastructure and participation at least as good as larger cities).

However, in other aspects, small cities still have room for improvement, such as local and international connections or future developments for the creative industry. (Boal-San Miguel and Herrero-Prieto 2021) develop the construction of a synthetic indicator of creativity with regional disaggregation and different forms of aggregation. Their results show inequality in the regional distribution of creativity in Europe. According to the authors, the formation of clusters implies creative gap model that in turn trigger greater spatial disparities in creativity.

Research using C3 associated with efficiency as in this work is still scarce for the moment, among them are De Jorge-Moreno and De Jorge-Huertas (2020) who perform a comparative analysis of European cities based on the estimation of a composite efficiency index, with DEA methodology. Likewise (Van Puyenbroeck *et al.* 2021) perform a similar analysis to identify the specific strengths of each city. This work uses the same proposal of the C3 index used by De Jorge-Moreno and De Jorge-Huertas (2020) who rely on the proposal of Lovell and Pastor (1999) and (Cherchye *et al.*, 2007). As mentioned by these authors, the main difference with respect to a traditional DEA model is that C3 does not consider the resources used. The main idea is to obtain an indicator that merges with the rest of the cities and thus obtain a single measure of performance thanks to comparative analysis.

In this paper we will use the BCC-DEA (Banker *et al*., 1984 and Data Envelopment Analysis) extension proposed by Andersen and Petersen (1993) to classify the efficient units (super-efficiency model, hereafter). As mentioned by Santin (2014) the super-efficiency reasoning consists of comparing the evaluated unit with a linear combination of all other units in the sample except itself. The evaluated city or DMU (Decision Making Unit) is removed from the inputs and outputs constraints and omitted from the benchmark units according to:

$$\max \varnothing_o + \varepsilon\left(\sum_{i=1}^{m} S_i^- + \sum_{r=1}^{s} S_r^+\right)$$

$$\text{s.a} \quad \sum_{\substack{j=1\\ j\neq 0}}^{N} \lambda_j x_{ij} + S_i^- = x_{i0} \quad i = 1,2,\ldots m$$

$$\sum_{\substack{j=1\\ j\neq 0}}^{N} \lambda_j y_{rj} - S_r^+ = \Theta_0 y_{r0} \quad r = 1,2,\ldots s \qquad [1]$$

$$\sum_{\substack{j=1\\ j\neq 0}}^{N} \lambda_j \leq 1$$

$$\lambda_j \geq 0;\ \lambda_0 = 0$$

$$S_i^- \geq 0;\ S_r^+ \geq 0;\ j = 1,2,\ldots,N;\ j \neq 0$$

Where x_{ij} denotes the *ith* input (in this case a single input equal to unity) and y_{ij} *r*th output (out of a total s output, in this case the factor CV, CE, EE) for the DMU j; θ_0 is the efficiency index of the DMUo under evaluation where DMUo = DMU_k for some k ϵ {1,…,N}. λ_j are the weights, ε is a non-archimedean infinitesimal constant less than any positive real number, and S_i^- y S_r^+ are the *ith* input and la *rth* output respectively. A DMU is relatively efficient only if its efficiency index (radial component) is equal to unity and its calculated slack (non-radial component) is equal to zero. In this case, only radial measurements will be paid attention to. Unlike traditional DEA models, the evaluated city could have an efficiency index value greater than unity. The score or index reflects the equiproportional expansion from the evaluated DMU to the estimated production frontier.

In relation to the measurement of productivity, the Hicks-Moortensen indexes will be used, given their greater robustness, for example in comparison with the Malmquist indexes. Authors such as O'Donnell (2008, 2011) mention issues such as the fact that Malmquist indices are not fully multiplicative, in addition to not satisfying the transitivity conditions. In this work according to O'Donnell (2011) and under constant yields, the mathematical approach would be as follows:

Equations 2 and 3 show the output and input vectors respectively.

$$Y(y_{it})= D_0^T (x_o, y_{it}) \quad [2]$$

$$X(x_{it})= D_0^T (x_{it}, y_o) \quad [3]$$

Where $x= (x_1,.....x_k)' \in R^k_+ + y\ q= (q_1,.....q_j)' \in R^j_+$ denote the input and output vectors respectively. It is assumed that for each period t there are h observations with different inputs and outputs, denoted as (y_j^t, x_k^t) whose technological reference would be $D^t(y_j^t, x_k^t) \in R^k_+ x\ R^j_+$: where x_k^t *produce* y_j^t.

The Hicks Moortensen (HM) obtainment would be defined by Equation 4

$$HM_I^{t,t+1}\left(x^t, y^t, x^{t+1}, y^{t+1}\right) = \frac{QI^{t,t+1}(x^t, y^t, x^{t+1}, y^{t+1}}{XI^{t,t+1}(x^t, y^t, x^{t+1}, y^{t+1}} = \frac{\left[\frac{D_o^t(x^t, y^{t+1})}{D_o^t(x^t, y^t)} \cdot \frac{D_o^{t+1}(x^{t+1}, y^{t+1})}{D_o^{t+1}(x^{t+1}, y^t)}\right]^{1/2}}{\left[\frac{D_I^t(x^{t+1}, y^t)}{D_I^t(x^t, y^t)} \cdot \frac{D_I^{t+1}(x^{t+1}, y^{t+1})}{D_I^{t+1}(x^t, y^{t+1})}\right]^{1/2}} \quad [4]$$

The numerator and denominator of equation 4 are related to the aggregate indexes of outputs and inputs, respectively. Higher/lower values obtained for each index imply increases/decreases of those (for more details see O'Donnell 2011; 2012).

In order to analyze the efficiency convergence process, linear quartile regressions (50, 70, 90) and nonparametric Nadaraya-Watson regressions will be used. The models will be the following.

$$Super\text{-}efficiency_m = \alpha + \beta_1\ Super\text{-}efficiency_{2017} + \varepsilon \quad [5]$$

$$Super\text{-}efficiency_m = \alpha + f(Super\text{-}efficiency_{2019}) + \varepsilon \quad [6]$$

where super-efficiency$_{ym}$ represents the growth rate of the period analysed, super-efficiency2017 is the super-efficiency of the initial year. In the results section, the processes carried out for the analysis will be discussed in detail.

The software used to carry out the methodological proposals described above was R and its RStudio interface with the Benchmarking and Productivity packages, to estimate super-efficiency and productivity with the Hicks-Moortensen indexes, respectively. With the Gretl software, quartile and non-parametric regression estimations were carried out with Nadaraya Watson and finally Statgraphics for cluster, discriminant, and violin graph analysis.

3. Results

Table 1 shows the results of the super-efficiency analysis of the top 15 countries (results for all 190 countries can be found in the appendix) with the highest super-efficiency levels estimated from equation 1. Super-efficiency levels with values greater than 1 refer to Paris, London, and Florence, with super-efficiency levels of 1.415; 1.101; 1.058 in 2017 and these same countries including Dublin;1.473;1.067:1.040;1.009 respectively in 2019. The estimation of the BCC-VRS model which is not shown to save space report that these same cities mentioned are on the border with values equal to unity. In this sense, with this methodology it is not possible to achieve the tiebreaker in the ranking.

Cities with inefficiency values obtain levels below 1 and are between the 4th or 5th to 15th positions depending on the

Table 1. Ranking of the 15 cities by level of super-efficiency and benchmarks.

		Super-efficiency		Nº. of times reference	
id	Country	2017	2019	2017	2019
1	Paris	1.415	1.473	185	161
2	London	1.101	1.067	131	92
3	Florence	1.058	1.040	47	53
4	Dublin	0.914	1.009	-	116
5	Weimar	0.959	0.973		
6	Venice	0.949	0.968		
7	Copenhagen	0.995	0.964		
8	Bern	0.984	0.946		
9	Edinburgh	0.936	0.929		
10	Glasgow	0.956	0.919		
11	Geneva	0.913	0.889		
12	Basel	0.889	0.873		
13	Cork	0.854	0.861		
14	Galway	0.957	0.861		
15	Nottingham	0.885	0.856		

Source: Own elaboration.

year. Efficiency values range from 0.914 for Dublin included in that position by the change experienced 2019 to 0.885 and 0.856 for 2017 and 2019 respectively. On the right side of Table 1, the times that cities with super-efficiency levels have been benchmarked against the rest are shown. In 2017 and 2019, Paris has been, in 185 and 161 times respectively followed by London and Florence, with 131 and 92 for the former and 47 and 53 for the latter depending on the year. Finally, Dublin is super-efficient in 2019 being a reference 116 times.

The results of the quartile regression shown in Table 2 confirm a convergence process between the Super efficiency rate and the initial Super efficiency in 2017. As can be seen the parameter β of the variable Superefficiency2017 is negative and statistically significant at 99%. This implies that cities with lower levels of initial super-efficiency, obtain higher levels of super-efficiency for the period analysed. In other words, their management of CCCs improves. Note that the values of the parameter β of the variable Superefficiency2017 are decreasing as the quartile increases from -0.064 in quartile 50 to -0.223 in quartile 90.

For a better observation of the quartile regression, Figure 1 shows the non-parametric regression (Nadaraya-Watson) where the convergence of the initial super-efficiency versus the growth rate is observed, corroborating the results obtained with the linear models.

Table 3 shows the TFP values according to HM, as well as that of its components Technical Change (TC) or technological progress and Technical Efficiency Changes (TEC) or catching-up effect (approaching the frontier).

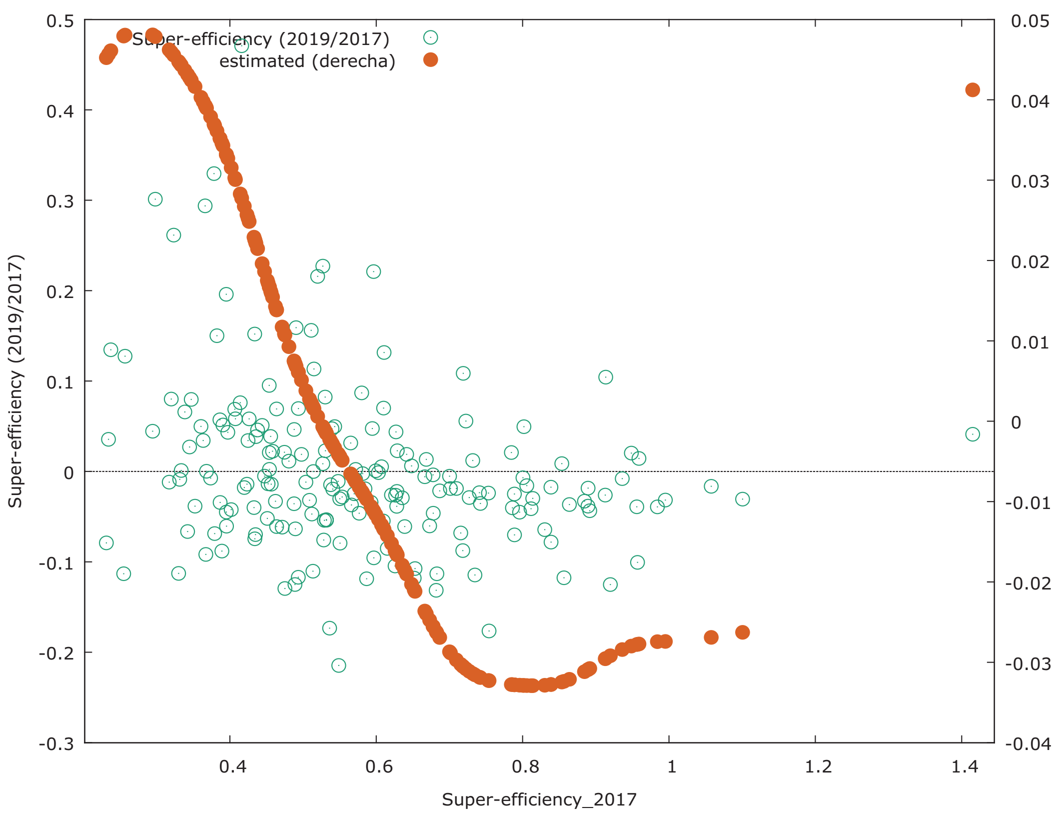
As can be seen, European cities increase their TFP by 2.02% ((1.0202-1)*100) in average terms. Increases are also observed in the median and third quartile with values of 0.02% and 5.39%. The maximum value is 34.32%. Productivity decreases are observed only in the first quartile with -2.51%, the minimum being -16.82%. TFP gains are a consequence of both TC and TEC, in the case of the mean, third quartile and maximum value. For example, in

Table 2. Quartile Regression Results.

Quartile	50	70	90
const	0.024**	0.098**	0.227***
	-0.011	0.019	-0.019
Super-efficiency$_{2017}$	-0.064***	-0.130***	-0.222***
	-0.019	-0.032	-0.016
Nº of observations	190	190	190
lnL	212.6	187.9	106.1

Source: Own elaboration.

Figure 1. Non-parametric regression (Nadaraya-Watson).



Source: Own elaboration.

Table 3. Productivity results according to Hicks-Moortensen.

	PTF_HM	TC	TEC
Mean	1.0202	1.0176	1.0028
Median	1.0002	1.0204	0.9882
Max.	1.3423	1.0356	1.3194
Third quartile	1.0539	1.0209	1.0439
Primer quartile	0.9749	1.0017	0.9537
Min.	0.8318	0.9939	0.8041

Source: Own elaboration.

Table 4. Characteristics of the Clusters.

Clusters	Nº of Cities	%	PTF_ HM	TC	TEC
1	102	53.68	0.9721	1.0234	0.9498
2	41	21.58	1.0091	1.0013	1.0077
3	47	24.74	1.1341	1.0187	1.1133

Source: Own elaboration.

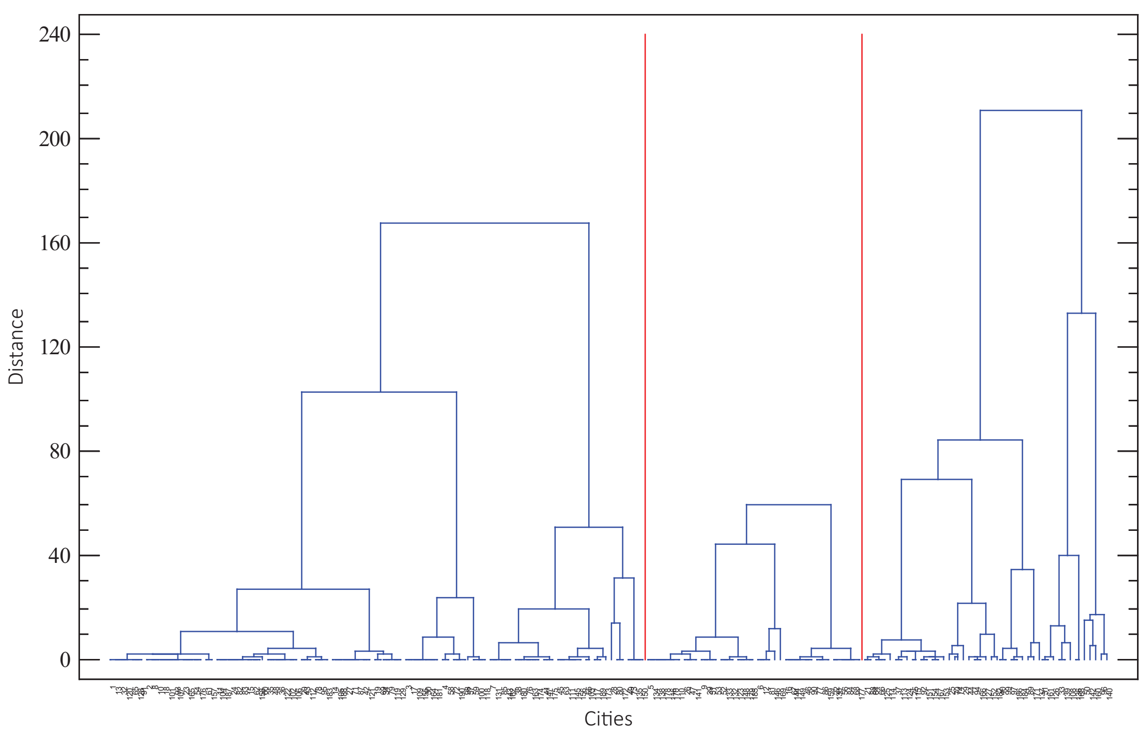
the case of the median, the 2.02% increase in TFP is associated with 1.76% and 0.028% increases in TC and TEC, respectively. In the case of the median, the TFP increases mentioned are the result of two forces of antagonistic behaviour, increases in TC by 2.04% and decreases in TEC or distance from the frontier of -1.18%. In this case half of the cities cannot keep pace with the leaders that manage resources more efficiently.

In order to determine the existence of different TFP behaviours in the sample of cities, a cluster analysis was carried out using Ward's method and Euclidean distance squared, one of the most widely used nesting procedures. The final segmentation of the cities is structured in three clusters, according to the discriminant analysis with a classification of 97.3% of successful cases whose discriminant functions are corroborated by Wilks' lambda statistics 0.1138 (chi2 404.14, Pvalue 0.000) and 0.4050 (chi2 168.1, Pvalue 0.000). The cluster structure is shown in the dendrogram in Figure 2 and Table 4.

As can be seen, cluster_1 which accounts for 53.64% of the cities who's average TFP value is -2.79%, followed by the clusters with TFP gains of 0.9% and 13.41%, cluster_2 and cluster_3 respectively. The TC values report technological progress in all clusters. Finally, only cluster_1 shows efficiency decreases of -5.02%.

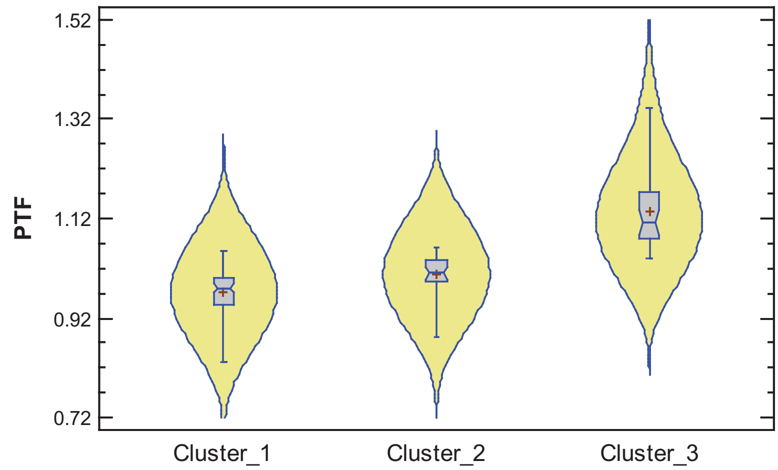
In order to go deeper into TFP, Figure 3 shows violin plots, where the dispersion of the distributions and their TFP levels can be appreciated. Both the median values, represented by the notch of the internal box and whiskers

Figure 2. Dendogram of the productivity clusters.



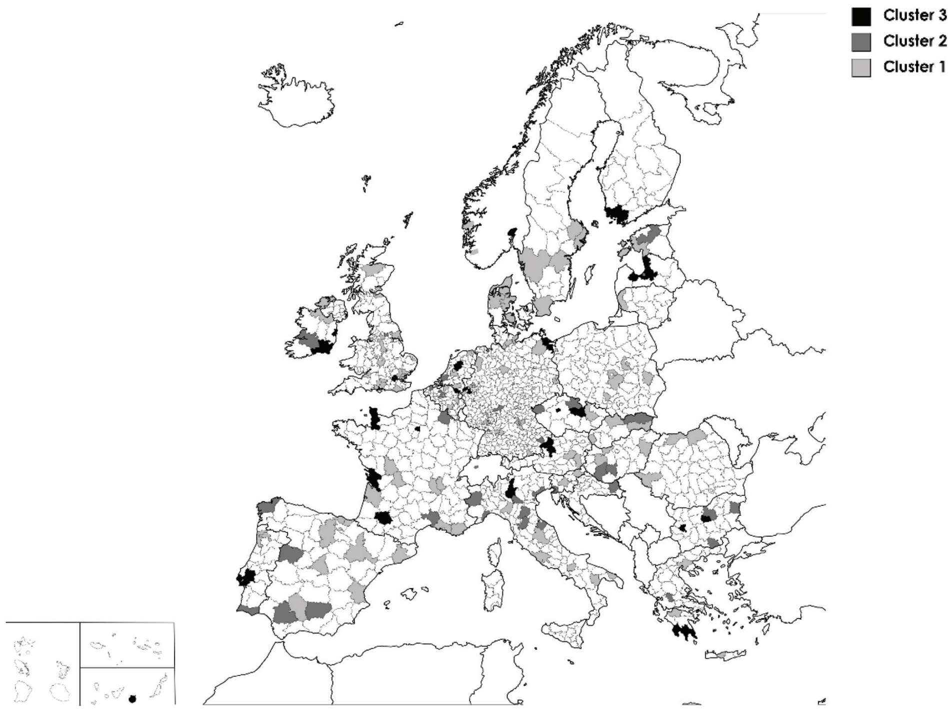
Source: Own elaboration.

Figure 3. Violin graphs on productivity.



Source: Own elaboration.

Figure 4. Map of clusters according to cities.



Source: Own elaboration.

diagram, and the mean, represented by a cross, increase as one moves from cluster_1 at the origin to cluster_3.

Cluster_3, clearly shows a greater dispersion, associated with high TFP values. This group includes cities such as Paris, London, Cork, Luxembourg, among others. The map (Nuts3) in Figure 4 shows the representation of the clusters according to the cities to which they belong. As can be seen, there is a wide dispersion in the location of the cities according to the clusters.

4. Conclusions

In this work, an output-oriented super-efficiency model has been proposed to establish a ranking of the best practices of the 190 cities considered in the Monitor in the years 2017 and 2019. A convergence analysis of the analysed cities has also been carried out. The main results reveal that the cities of Paris, London and Florence are clearly the benchmark for the rest of the two years, with the city of Dublin joining in

2019. The convergence analysis corroborates the improvement of cities starting initially with lower levels of resource management efficiency.

In relation to productivity performance, there is an increase of 2.02% in average terms across the 190 cities between 2017 and 2019. These productivity gains are a consequence of both technological progress and efficiency with values of 0.02% and 5.39% respectively. Cluster analyses allow us to segment the sample of cities into three groups, which could be considered low, medium and high performers based on their average productivity levels, whose values are -2.79%; 0.9% and 13.41% respectively.

It is evident that within the objective of this work in the establishment of a hierarchical classification of cities, according to their efficient management of resources, that allow to establish references for the rest, other questions arise. Such as the fact that it is possible to observe in parallel a certain inequality within European cities with different creative competitive patterns and spatial disparity. However, both the aforementioned convergence analysis and the possibility of establishing good management practices through the best references found, provide a dose of optimism for the future.

The methodologies used in this work could be considered useful tools for decision making aimed at finding points of improvement in the management practices of cities. Among the limitations of this work are the short time period analysed, which, although it is the only one available at the moment, also represents a novelty in this field of analysis, given that, in general, cross-sectional data have been used up to now. Possible extensions of this work could be aimed at the consideration of second stage or exogenous variables that could influence the levels of efficiency or productivity of the cities.

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ANNEX I

Ranking of European cities by efficiency level

id	Country	2017	2019	id	Country	2017	2019
1	Paris	1.415	1.473	96	Hannover	0.566	0.545
2	London	1.101	1.067	97	Kraków	0.531	0.543
3	Florence	1.058	1.040	98	Nantes	0.548	0.542
4	Dublin	0.914	1.009	99	Valencia	0.597	0.540
5	Weimar	0.959	0.973	100	Lleida	0.553	0.538
6	Venice	0.949	0.968	101	Bratislava	0.550	0.534
7	Copenhagen	0.995	0.964	102	Vilnius	0.527	0.532
8	Bern	0.984	0.946	103	Maribor	0.541	0.530
9	Edinburgh	0.936	0.929	104	Bochum	0.538	0.530
10	Glasgow	0.956	0.919	105	Kortrijk	0.494	0.528
11	Geneva	0.913	0.889	106	Malmö	0.587	0.517
12	Basel	0.889	0.873	107	Zagreb	0.514	0.514
13	Cork	0.854	0.861	108	Rome	0.488	0.511
14	Galway	0.957	0.861	109	Limoges	0.498	0.507
15	Nottingham	0.885	0.856	110	Saint-Etienne	0.551	0.507
16	Brighton and Hove	0.889	0.855	111	Rijeka	0.532	0.503
17	Zurich	0.892	0.853	112	Valletta	0.532	0.503
18	Lisbon	0.802	0.842	113	Brno	0.378	0.503
19	Avignon	0.864	0.832	114	Bergen	0.529	0.501
20	Manchester	0.839	0.824	115	Coimbra	0.434	0.500
21	Heidelberg	0.920	0.805	116	Nicosia	0.504	0.498
22	Karlsruhe	0.785	0.801	117	Cagliari	0.454	0.497
23	Tartu	0.719	0.797	118	Osijek	0.464	0.496
24	Norwich	0.800	0.795	119	Timişoara	0.509	0.493
25	Limerick	0.806	0.793	120	Leipzig	0.528	0.488
26	Munich	0.814	0.790	121	Cluj-Napoca	0.512	0.488
27	York	0.811	0.778	122	Norrköping	0.481	0.486
28	Amsterdam	0.830	0.777	123	Pesaro	0.475	0.485
29	Utrecht	0.839	0.773	124	Gdańsk	0.366	0.474
30	Bristol	0.789	0.769	125	Sibiu	0.456	0.473
31	Lund	0.722	0.763	126	Poznań	0.395	0.473
32	Luxembourg	0.796	0.760	127	Liège	0.488	0.470
33	Stockholm	0.857	0.756	128	Genoa	0.458	0.469
34	Barcelona	0.786	0.755	129	Faro	0.444	0.467
35	Birmingham	0.732	0.741	130	Perugia	0.454	0.463
36	Leuven	0.753	0.735	131	Bordeaux	0.489	0.458
37	Vienna	0.789	0.734	132	Split	0.438	0.458
38	Trento	0.596	0.728	133	Essen	0.513	0.457
39	Madrid	0.741	0.724	134	San Sebastián-Donostia	0.454	0.455
40	Liverpool	0.742	0.716	135	Karlovy Vary	0.436	0.452
41	Eindhoven	0.727	0.706	136	Lecce	0.426	0.451

(Continued)

Ranking of European cities by efficiency level ***(Continued)***

id	Country	2017	2019	id	Country	2017	2019
42	Prague	0.700	0.697	137	Warsaw	0.456	0.450
43	Mainz	0.709	0.696	138	Szeged	0.462	0.447
44	Turku	0.611	0.691	139	Ravenna	0.452	0.446
45	Odense	0.701	0.688	140	Ostend	0.414	0.446
46	Graz	0.668	0.677	141	Mons	0.447	0.445
47	Leeds	0.678	0.675	142	Umeå	0.536	0.443
48	Frankfurt	0.687	0.672	143	Stavanger	0.471	0.442
49	Stuttgart	0.715	0.667	144	Katowice	0.382	0.440
50	Athens	0.666	0.663	145	Parma	0.425	0.439
51	Dundee	0.718	0.655	146	Seville	0.493	0.436
52	Toulouse	0.627	0.654	147	Bilbao	0.464	0.436
53	Helsinki	0.642	0.654	148	Namur	0.407	0.435
54	Waterford	0.610	0.653	149	Sofia	0.408	0.431
55	Granada	0.648	0.652	150	Bucharest	0.549	0.431
56	Trieste	0.735	0.651	151	Zaragoza	0.489	0.428
57	Porto	0.527	0.647	152	Terrassa	0.451	0.428
58	Berlin	0.678	0.647	153	Turin	0.423	0.417
59	Oslo	0.629	0.643	154	Marseille	0.433	0.416
60	Aarhus	0.673	0.632	155	Iaşi	0.397	0.414
61	Tampere	0.520	0.632	156	Nitra	0.475	0.414
62	Espoo	0.580	0.631	157	Kaunas	0.420	0.412
63	Bologna	0.595	0.623	158	Wrocław	0.390	0.411
64	Leiden	0.754	0.621	159	Limassol	0.386	0.409
65	Ghent	0.636	0.617	160	Riga	0.323	0.408
66	Nuremberg	0.628	0.614	161	Baia Mare	0.435	0.405
67	Pula	0.416	0.612	162	Lille	0.434	0.402
68	Maastricht	0.607	0.610	163	Lublin	0.298	0.388
69	Dresden	0.626	0.610	164	Klaipeda	0.402	0.385
70	Montpellier	0.683	0.606	165	Naples	0.360	0.378
71	Groningen	0.621	0.605	166	Thessaloniki	0.395	0.377
72	Amersfoort	0.628	0.604	167	Brescia	0.364	0.376
73	Brussels	0.603	0.602	168	Łódź	0.347	0.375
74	Milan	0.639	0.600	169	Cordova	0.387	0.373
75	Bruges	0.599	0.600	170	Debrecen	0.395	0.371
76	Uppsala	0.682	0.592	171	Veliko Tarnovo	0.374	0.371
77	Linz	0.511	0.591	172	Olomouc	0.368	0.368
78	Ljubljana	0.565	0.583	173	Sintra	0.338	0.361
79	Rotterdam	0.653	0.583	174	Veszprém	0.389	0.355
80	Leeuwarden	0.581	0.580	175	Liepāja	0.345	0.354
81	‘s-Hertogenbosch	0.610	0.576	176	Burgos	0.379	0.353
82	Gothenburg	0.652	0.575	177	Toruń	0.320	0.346
83	Lyon	0.530	0.574	178	Győr	0.352	0.339
84	Mannheim	0.585	0.573	179	Braga	0.334	0.334

id	Country	2017	2019	id	Country	2017	2019
85	Matera	0.515	0.573	180	Las Palmas	0.367	0.333
86	Cologne	0.572	0.573	181	Pilsen	0.331	0.329
87	Bradford	0.593	0.573	182	Pécs	0.342	0.319
88	Tallinn	0.543	0.570	183	Guimarães	0.317	0.313
89	Budapest	0.490	0.569	184	Kalamata	0.294	0.308
90	Bremen	0.572	0.567	185	Košice	0.330	0.293
91	Santiago	0.539	0.565	186	Ostrava	0.257	0.289
92	The Hague	0.615	0.563	187	Prešov	0.237	0.269
93	Salamanca	0.626	0.560	188	Varna	0.234	0.242
94	Antwerp	0.570	0.556	189	Plovdiv	0.255	0.226