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## CHANGES IN THE COMMAND AND CONTROL POTENTIAL OF EUROPEAN CITIES IN 2006-2016

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### Abstract

The aim of the study was to analyze changes in the command and control functions of cities in 2006 and 2016 based on the method of gravity centers. The analysis was performed both for individual sectors of the economy as well as for the European economy as a whole. The shift in the center of gravity of the studied command and control functions of cities in the direction of Central Eastern Europe is examined in the paper. The fairly recent development of CEE and European integration increasing to the east and south has triggered the relocation of many companies from west to east and has also increased the importance of local companies. It may therefore be argued that the importance of the command and control functions of cities in developing countries has also increased (Poland, Russia). There is also a related decline in the importance of the so-called blue banana region and cities in Great Britain and Germany. This is especially visible in terms of the number of corporate headquarters in the western part of the continent. However, the shift in capital is not that clear – and both German and British corporations still remain the leaders in Europe.

### Key words

command and control function • transnational corporation • gravity • corporate headquarters • cities  
• Europe

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### Introduction

The strength of a city on the international stage may be measured in a number of ways. Investment inflow and outflow is one way to measure the international standing of a city. Other ways include the number of employees working for international companies and the capital of these companies.

It is also believed that inequalities in the flow of international capital say more about the position of a city in the global system than the rank of specific companies dependent on a small number of partner companies. One of the seven notions of the world city argues that the global command and control functions of international corporations are directly related to the activity of the

production sector (Friedmann 1986). However, newer approaches to the world city concept show that service companies are better able to show the international linkages of cities than can manufacturing companies (Beaverstock et al. 1999). In the modern globalized world, the significance of physical distance is decreasing in terms of the movement of the labor force and movement of capital. This then leads to the emergence of an international economic system, with increasing linkages between corporations and between cities (Sassen 2000). It may be argued that the command and control function of cities (C&C) is a most basic element that is needed in order to understand them in the era of globalization (Ni et al. 2011). According to G. Csomós (2013), the companies that perform the command and control function of cities are the 2,000 companies found on the Forbes Global 2000 list ([www.forbes.com](http://www.forbes.com)).

Cities aim to improve their level of competitiveness in the contemporary world economy (Begg 1999). The acceleration of European unification is also resulting in declining differences in the level of economic development between EU member states. This shift is triggering a transition from competition between countries to competition between regions and even cities (Storper 1995). The so-called EU cohesion policy has helped facilitate a substantial decline in differences between more affluent and less affluent EU states. Nevertheless, new EU member states face increasing differences in development between major cities and smaller cities and rural areas (Kramar 2006). This process appears to have been reversed in recent years in CEE countries, and differences in the level of development between capital cities and smaller cities have begun to decline (Śmętkowski 2015). This new trend is increasing the significance of key local determinants that may either attract or repel international capital, major corporations, key investors, and tourists (Parkinson et al. 2004). One main element of this process is expansion via acquisition of other companies or moving parts of a business to countries with lower costs of labor (Ziolo

2006; Kilar 2015). The establishment of local branches of international firms has allowed many Central and Eastern European cities to join the international economic system (Domański 2004; Raźniak & Winiarczyk-Raźniak 2015; Raźniak et al. 2018).

The research literature provides many different examples of spatial differences in social and economic development in Europe. One such example is the “European backbone” (Brunet 1989), later called the “blue banana” or the central area of Western Europe. Despite the passing of two decades, its shape has not changed and this region continues to economically dominate Europe (Kincses et al. 2013). Another pattern known as the “Central European boomerang” is said to be the most economically developed region of Central and Eastern Europe (Gorzalak 1996). This area is strongly dominated by both Warsaw and Prague (Raźniak et al. 2017). Yet another view has been put forth by M. Wegener and K.R. Kunzmann (1996) who do not agree with the notion that the “blue banana” is the dominant economic region in Europe. They argue that the continent’s economic structure is polycentric and based on strong metropolitan areas that are roughly evenly distributed across the continent.

The research literature provides examples of studies that use centroids to illustrate the modern world and each given continent via the GDP of countries and cities (Tóth & Nagy 2017). Other studies employ the concept of the command and control function (Tóth & Csomós 2016). However, there do not exist any studies that would focus on the movement of centroids based on the financial results of companies on the European scale, and especially the command and control function by economic sector. Hence, the purpose of the paper is to identify centers of gravity for the command and control function for cities in the years 2006 and 2016, both for specific sectors of the economy and for the European comprehensive potential index. A proper determination of the shift in the financial potential of companies in each given economic sector may illustrate the economic

strength of specific regions across the world and the change in their significance in the global economy.

## Methods

The study period consists of 2006 and 2016, with the former being the last year before the global financial crisis of 2008, which actually began in the United States in 2007. Hence, the paper illustrates the strength of the command and control function of cities before and after the financial crisis of 2008.

A sector-based international potential index (sIPI) [1] was created in order to determine the economic value of the command and control function for cities. The index is based on the following standardized values: revenue, profit, assets, market value of key economic sectors considering the number of corporate headquarters (HQs) obtained from a list of 2,000 major companies listed by Forbes Global. The study assumes that 4 HQs is the boundary value, as is noted in the research literature (Csomós 2017; Dorocki et al. 2018; 2019). In order to eliminate negative values, all calculated index values are supplemented with the minimum value for the given sector, which leads to the minimum value also being zero.

$$sIPI = \left( \frac{\sum_{i=1}^N \frac{x_i - \bar{x}}{SD_x}}{N} \cdot \frac{HQ_s}{4} \right) + \left| \left( \frac{\sum_{i=1}^N \frac{x_i - \bar{x}}{SD_x}}{N} \cdot \frac{HQ_s}{4} \right)_{\min} \right| \quad [1]$$

where

- $x$  – revenue, profit, assets, and market value of economic sectors
- $\bar{x}$  – mean revenue, profit, assets, and market value of economic sectors
- $s$  – sector of the economy
- $SD_x$  – standard deviation of revenue, profit, assets, and market value of economic sectors
- $N$  – number of variables  $x$
- $HQ$  – number of headquarters of international corporations in a given city
- $(\dots)_{\min}$  – minimum value for a given sector

The total potential of each city is summarized by the summation of the potential values for each given sector (sIPI) resulting in a potential command and control value for each given city via the International Potential Index (IPI) [2].

$$IPI = \sum_{i=1}^N sIPI_i \quad [2]$$

The potential index for the command and control function of cities constitutes not only the summation of revenue, profit, assets, and the market value of each given company with its headquarters in a given city, but also a relative total of the potential related to the potential value for specific economic sectors in European cities. The significance of a given city is largely dependent on its potential relative to a given sector – even a sector with a lower value of financial indicators versus all analyzed sectors – rather than the cumulative financial value of all sectors in a given city (Raźniak et al. 2016).

Other indicators of economic potential are available in the research literature. Examples include the Globalization and World Cities (GaWC) index and the “location quotient” index (Śleszyński 2007). The index used in the present study has been adapted to utilize any available comparative data, and is based on simple statistical methods that may be readily used in future research on the economic potential of cities.

The concept of the center of gravity or centroid (Morrill & Symons 1977) is also used in further analysis in order to examine any spatial changes in IPI values (Kudłacz 1981; Jażdżewska 2006; Śleszyński 2008; Weidmann et al. 2010; Dorocki & Struś 2017).

The coordinates of the center of gravity were calculated based on the number of sHQs, total number of HQs, sIPI values, and IPI values using the following formula:

$$\begin{aligned}
 x &= \frac{\sum_{i=1}^N (sHQ_i \vee HQ_i \vee sIPI_i \vee IPI_i) x_i}{\sum_{i=1}^N (sHQ_i \vee HQ_i \vee sIPI_i \vee IPI_i)} \\
 y &= \frac{\sum_{i=1}^N (sHQ_i \vee HQ_i \vee sIPI_i \vee IPI_i) y_i}{\sum_{i=1}^N (sHQ_i \vee HQ_i \vee sIPI_i \vee IPI_i)} \quad [3]
 \end{aligned}$$

where

$x$  – latitude

$y$  – longitude

### European cities and their command and control functions

Three key regions were identified based on a spatial analysis of the location of corporate headquarters: Western Europe, Eastern United States, and East Asia (Raźniak et al. 2015, 2017). However, the economic potential of cities has varied widely across history. The economic center of gravity kept moving from the Middle East in the northeastern direction up to the middle of the 20th century. Its direction then changed towards the east (Dobbs et al. 2012). Since the beginning of the 21st century, the economic

center of gravity of cities has been migrating towards the southeast; this may be due to rapid urbanization in developing countries, especially in China. Acceleration of economic growth triggers greater urbanization leading to further stimulation of the economy. However, the fastest growth does not occur in the largest cities such as Bombay or Shanghai, but in midsize cities. One example is Foshan in China. Another example is Surat in India. The abovementioned trend is confirmed by existing studies on the command and control potential of cities conducted by a variety of researchers and an analysis of HQ location data (Raźniak et al. 2018).

The largest increases in the number of HQs and the value of the international potential index in the period 2006-2016 occurred in Asia, in the Middle East, and in Africa. This growth occurred at the expense of the potential of cities in Europe and North America – especially the United States, where the decline in the number of HQs and IPI potential equaled about 5% (Tab. 1). Hence, it appears reasonable to pursue work on determining whether a similar shift to the east can be observed in Europe for IPI potential given the increase in the economic significance of CEE countries.

The distribution of corporate headquarters in Europe in the studied period assumes the shape of the so-called blue banana noted

**Table 1.** Percentage of HQs and IPI potential by region of the world in the years 2006-2016

Regions	HQ [%]			IPI [%]		
	2006	2016	Δ	2006	2016	Δ
Asia (without Middle East)	29.20	35.78	6.58	25.80	36.45	10.65
Middle East	0.75	3.15	2.40	0.88	2.71	1.83
North America (without U.S.)	4.15	3.70	-0.45	3.50	3.33	-0.17
U.S.	34.75	29.44	-5.31	35.49	30.33	-5.16
Europe	25.95	23.04	-2.91	30.59	23.58	-7.01
South America	2.25	2.00	-0.25	1.37	1.57	0.20
Australia	1.85	1.75	-0.10	1.83	1.34	-0.49
Africa	1.10	1.15	0.05	0.55	0.69	0.14

Source: based on data from Forbes Global 2000.

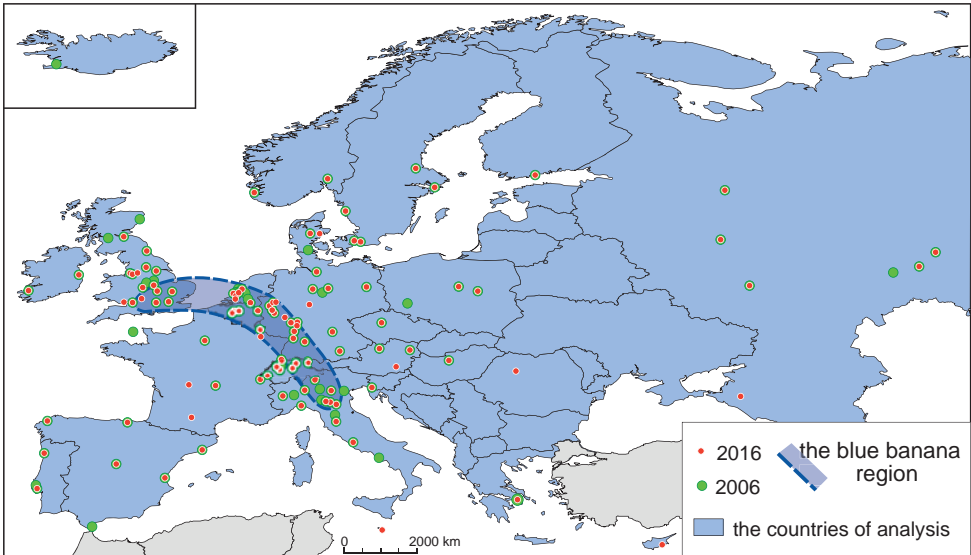
in the research literature. This is the most developed part of the continent, as measured in terms of pure economics and technology (Metaxas & Tsavdaridou 2013). The HQ distribution pattern is rather inert in the studied period, with most HQs being located in the largest cities in Europe. The number of new headquarters increases east of the blue banana over the studied period of time (Fig. 1). It is important to note the asymmetry of the current division of HQs between east and west on the European continent. Peripheral areas of Europe are now becoming more relevant in terms of the number of HQs. A small increase in the concentration of HQs relative to geographic longitude (about 20.49% for IPI and about 5.37% for the number of HQs, where 2006 = 100%, as well as an increase in the deconcentration of HQs relative to geographic latitude were observed for the period 2006-2016 based on the coefficient of variation (Tab. 2).

It is noteworthy that the increase in HQ concentration in the core European region was strongly stunted during the economic crisis of 2008 (Dorocki et al. 2018). The

so-called blue banana region of Europe featured 57 cities in 2006 and only 49 cities in 2016 with Forbes 2000 corporations. In the same period of time, peripheral areas of Europe had an increase in the number of Forbes-ranked corporate HQs from 59 to 62. The blue banana's share of all corporate HQs on the Forbes 2000 list also decreased from 49.24% to 45.77%.

Despite the decline in the share of HQs relative to peripheral areas, the mean value of the IPI potential for the blue banana area increased from 2.38 to 2.42 in the studied period, with an increase of the mean for peripheral areas from 2.13 to 2.14. A large change in the IPI pattern was noted for the two studied years for cities located in peripheral areas, with nearly unchanged values for the blue banana region of Europe (Fig. 2A).

When mean values were tested for similarity for 2006 and 2016, no basis was noted for either year for the rejection of the hypothesis of the lack of significant difference between the mean value of the IPI potential for cities located in the blue banana area and peripheral areas at the  $p = 0.05$  significance level.



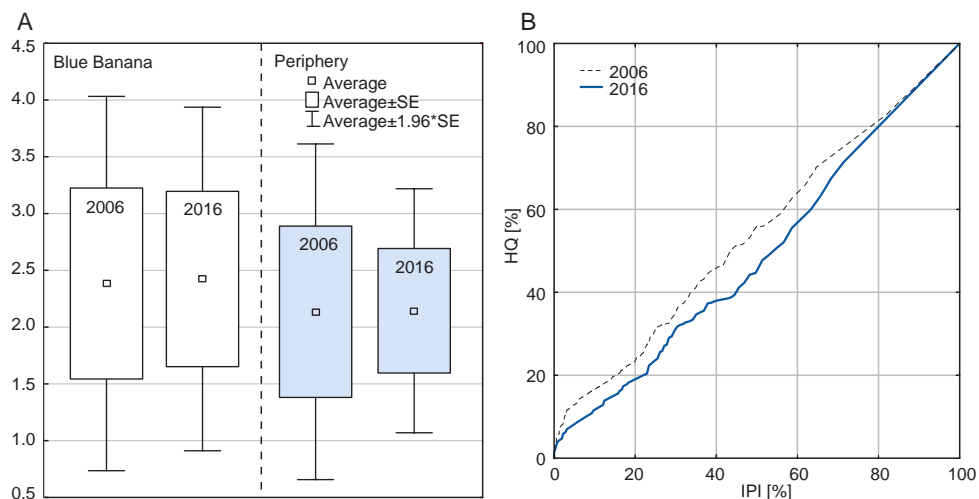
**Figure 1.** Cities with corporate headquarters in the years 2006 and 2016

Source: based on data from Forbes Global 2000.

**Table 2.** Coefficient of variation based on the number of corporate headquarters (HQ) and the International Potential Index (IPI) in the period 2006-2016

	Center of gravity						Coefficient of variation					
	geographic longitude			geographic latitude			geographic longitude			geographic latitude		
	2006	2016	difference	2006	2016	difference	2006	2016	difference [%]	2006	2016	difference [%]
IPI	50.24	50.03	-0.21	6.06	7.80	1.74	2.64	2.10	-20.49	1.72	1.75	1.55
HQ	50.12	50.20	0.08	6.71	7.65	0.93	2.40	2.27	-5.34	2.28	2.33	2.54

Source: based on data from Forbes Global 2000.



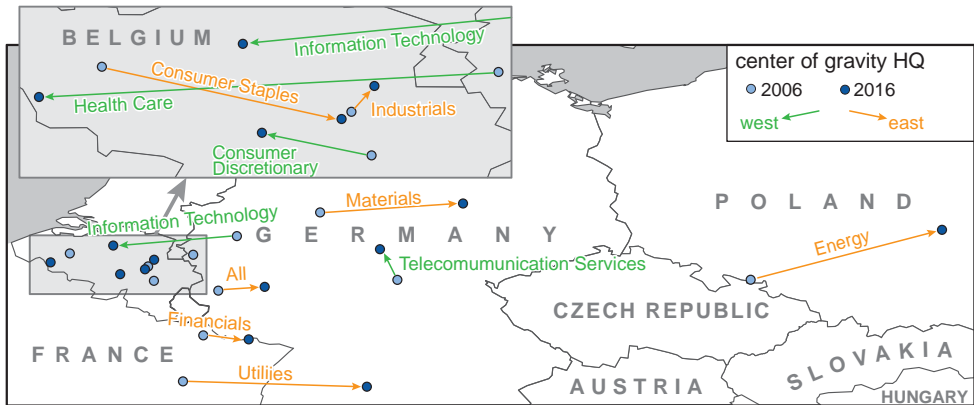
**Figure 2.** Mean values versus IPI values for cities located in the blue banana region and peripheral areas (A) and concentration of IPI values versus the number of HQs (B) in the years 2006 and 2016

Source: Author’s own work based on data from Forbes Global 2000.

Only a small shift can be observed in the IPI potential concentration versus the number of HQs for cities with midsize and very small potential (Fig. 2B). An increase in IPI occurred between 2006 and 2016 in relation to the share of HQs. This may indicate an equalization of the command and control potential of European cities.

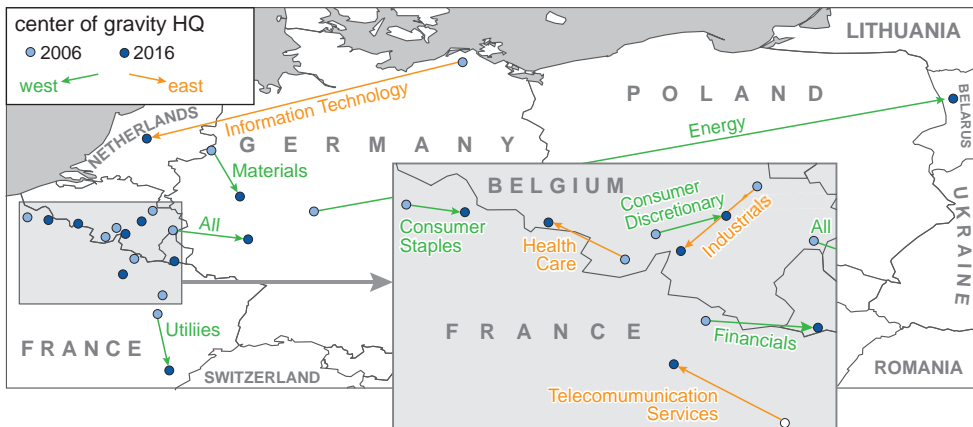
Despite the process of C&C potential decentralization, the centers of gravity of both HQs and IPI values remained in the blue banana region of Europe in the studied years (Figs. 3, 4).

Corporate headquarters were distributed more unevenly than IPI values during the study period (Tab. 2). However, larger differences were noted for geographic longitude than latitude. Yet it was IPI values relative to geographic longitude that exhibited a greater decrease in their differences than was the case for HQs. This illustrates the concentration of the command and control potential of cities along the east-west axis. These changes may be related to the theory of the yellow banana, which states that social and economic development in Europe will



**Figure 3.** Location of the centers of gravity of the number of headquarters in 2006 and 2016

Source: based on data from Forbes Global 2000.



**Figure 4.** Location of centers of gravity based on IPI potential in 2006 and 2016

Source: based on data from Forbes Global 2000.

assume the direction Paris-Warsaw and will reach further east (Hospers 2003).

A closer look at the location of centroids for 2006 and 2016 shows that both points had moved in the eastern direction. The shift was about 0.9 degrees for HQs and about 1.7 degrees for IPI values (geographic longitude). This difference shows that despite a small change in the location of corporate HQs, a significant change in the command and control potential of cities had occurred. Finally, changes in the geographic latitude of the centroids were very small.

For sector centroids, the largest shifts east were noted for energy companies due to the increase in the significance of companies headquartered in Russia. This sector was located in both years in the east of Europe. Despite a decline in the number of HQs, the region experienced the establishment of strong international companies such as PKN Orlen and OMV Petrom (Tab. 3). The HQ-based centroids of sectors such as energy and utilities and materials also shifted east in the studied period. The shifting of these sectors was associated with economic development

**Table 3.** Number of HQs and IPI values for 2006 and 2016 (50 max)

lp	City	Country	HQ		IPI		Change 2006-2016	
			2006	2016	2006	2016	HQ	IPI
1	London	United Kingdom	91	75	48.92	40.25	-16.00	-8.67
2	Paris	France	66	57	46.72	36.64	-9.00	-10.08
3	Dublin	Ireland	8	18	2.00	8.72	10.00	6.72
4	Stockholm	Sweden	23	19	9.34	8.15	-4.00	-1.19
5	Moscow	Russia	8	16	3.56	7.62	8.00	4.06
6	Munich	Germany	9	10	5.99	7.00	1.00	1.00
7	Madrid	Spain	19	16	8.65	6.89	-3.00	-1.76
8	Zurich	Switzerland	4	14	0.96	5.57	10.00	4.61
9	Lausanne	Switzerland	9	10	5.26	5.09	1.00	-0.17
10	Basel	Switzerland	8	7	4.28	4.50	-1.00	0.22
11	Frankfurt am Main	Germany	8	6	3.50	4.29	-2.00	0.79
12	Rome	Italy	8	7	4.86	3.96	-1.00	-0.90
13	Amsterdam	Netherlands	14	9	7.37	3.66	-5.00	-3.71
14	Bonn	Germany	2	2	4.26	3.48	0.00	-0.78
15	The Hague	Netherlands	3	5	3.60	3.12	2.00	-0.49
16	Copenhagen	Denmark	9	9	3.20	3.11	0.00	-0.09
17	Helsinki	Finland	15	8	6.81	2.65	-7.00	-4.16
18	Milan	Italy	15	8	4.38	2.39	-7.00	-1.99
19	Stuttgart	Germany	4	3	2.98	2.35	-1.00	-0.63
20	Geneva	Switzerland	8	5	2.42	2.33	-3.00	-0.08
21	Rotterdam	Netherlands	2	2	1.80	2.24	0.00	0.44
22	Wolfsburg	Germany	1	1	1.22	2.11	0.00	0.89
23	Brussels	Belgium	10	9	2.44	2.08	-1.00	-0.36
24	Cologne	Germany	2	1	1.22	1.99	-1.00	0.77
25	Oslo	Norway	8	7	2.55	1.96	-1.00	-0.59
26	Ludwigshafen	Germany	1	1	1.09	1.92	0.00	0.83
27	Eindhoven	Netherlands	1	2	0.11	1.91	1.00	1.80
28	Bilbao	Spain	3	2	0.90	1.70	-1.00	0.80
29	Leuven	Belgium	1	1	0.30	1.52	0.00	1.22
30	Turin	Italy	6	2	1.38	1.27	-4.00	-0.11
31	Barcelona	Spain	4	6	3.02	1.23	2.00	-1.79
32	Toulouse	France	0	1	0.00	1.23	1.00	1.23
33	Athens	Greece	12	6	2.06	1.21	-6.00	-0.85
34	Düsseldorf	Germany	5	5	2.79	1.12	0.00	-1.67
35	Vienna	Austria	7	6	1.56	1.07	-1.00	-0.49



Ip	City	Country	HQ		IPI		Change 2006-2016	
			2006	2016	2006	2016	HQ	IPI
36	Gothenburg	Sweden	2	2	1.07	0.97	0.00	-0.10
37	Surgut	Russia	1	1	0.28	0.93	0.00	0.66
38	Edinburgh	United Kingdom	3	2	2.18	0.81	-1.00	-1.38
39	Hannover	Germany	3	3	0.59	0.76	0.00	0.17
40	Essen	Germany	5	3	2.40	0.67	-2.00	-1.73
41	A Coruña	Spain	2	1	0.24	0.65	-1.00	0.41
42	Nuremberg	Germany	3	3	0.45	0.56	0.00	0.11
43	Trieste	Italy	1	1	0.54	0.52	0.00	-0.02
44	Bern	Switzerland	4	3	0.48	0.51	-1.00	0.03
45	Bristol	United Kingdom	1	1	0.17	0.50	0.00	0.33
46	Lisbon	Portugal	3	3	0.28	0.44	0.00	0.16
47	Cologne	Germany	1	1	0.31	0.42	0.00	0.11
48	Warsaw	Poland	1	4	0.06	0.41	3.00	0.35
49	Mannheim	Germany	4	1	0.40	0.36	-3.00	-0.04
50	Darmstadt	Germany	1	1	0.19	0.32	0.00	0.14

Source: based on data from Forbes Global 2000.

in the countries of Eastern Europe and Southern Europe. Centers of gravity shifted westward for such sectors as information technology, healthcare, industrials, and telecommunication services. A modern industrial sector demands technologically advanced infrastructure and a scientific base. The availability of investment capital is also important, as new solutions are burdened with a high degree of risk. This explains why new clusters of advanced technologies (Dorocki et al. 2017) form in the most affluent and best developed cities in Western Europe. On the other hand, Central and Eastern Europe is dominated by companies with headquarters in Western Europe (Zdanowska 2017).

Healthcare was the sector whose center of gravity based on the number of HQs moved farthest west. Both healthcare and IT are currently the most innovative sectors of the economy. Both scientific progress and demographic processes such as population aging are driving the rapid development of the IT sector (Dorocki 2014). The location of IT decision centers is also largely driven

by the level of sophistication of a region in science and research (Dorocki & Boguś 2014). This is why companies in the life sciences sector are concentrating in regions with large potential in human resources in science and technology (HRST) and close proximity to R&D centers and a large capital base. This leads to the emergence of biotechnology clusters, the largest of which occupies most of Western Europe (Site Selection for Life... 2016; Boguś & Dorocki 2018).

A closer look at the command and control potential of cities in Europe shows that certain changes have occurred in this respect during the study period. The largest change in the number of HQs and IPI values in the study period occurred for Dublin, Zurich, and Moscow (Fig. 5). Cities such as Eindhoven (Philips, DAF Trucks, Brabantia), Toulouse, and Leuven (Anheuser-Busch InBev SA/NV) have noted large increases (1% or more). These cities had only had one or two corporate headquarters before. The main driver of growth for these cities was the local corporation or corporations. However, in addition

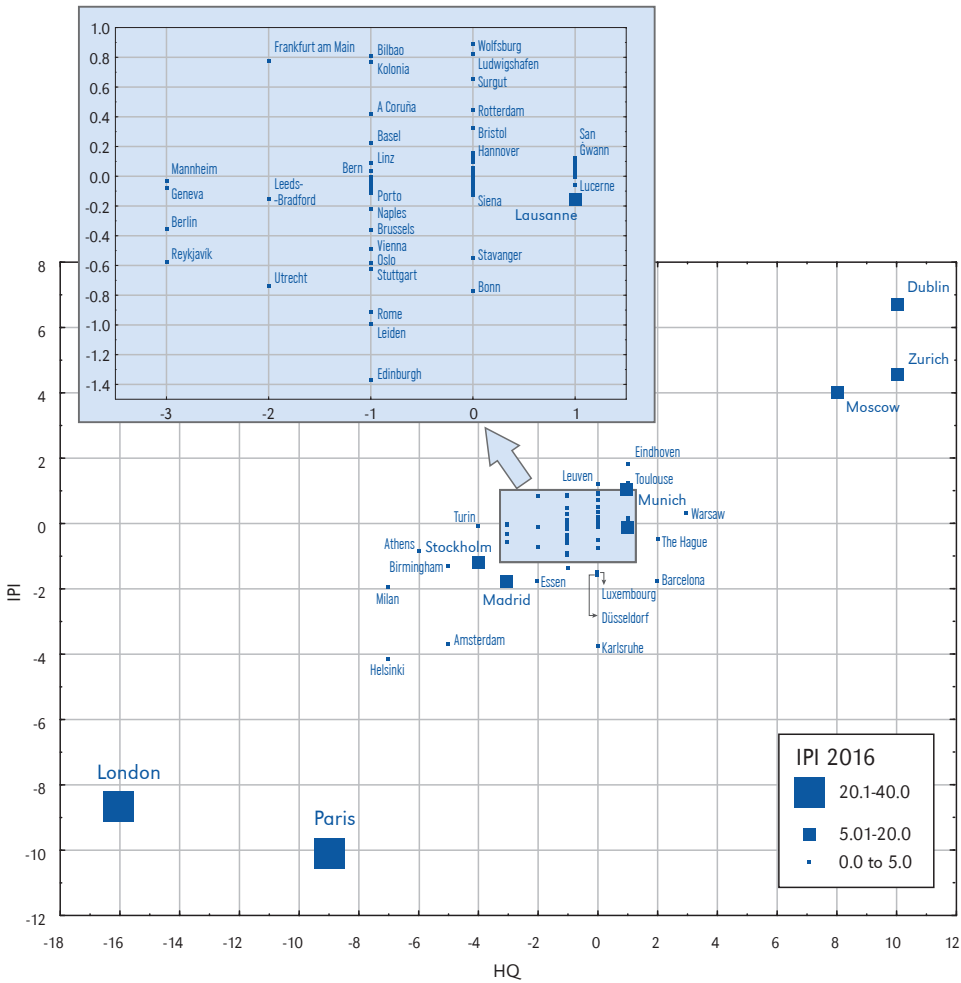


Figure 5. Changes in HQs and IPI values for European cities in 2006 and 2016.

Source: based on data from Forbes Global 2000.

to production activity, these cities also were able to develop clusters associated with their dominant industries. For example, Leuven already had a food processing industry and was able to create spin-offs in the biotechnology sector. In Eindhoven, the Philips corporation was able to attract other high-tech companies and initiate a host of new business enterprises thanks to its investment in R&D (one-third of national R&D budget). Start-up companies are created in this environment at the High Tech Campus Eindhoven.

In addition to the cities already discussed, several other cities were also noted for IPI value increases: Munich, Basel, Frankfurt am Main, Rotterdam, Wolfsburg.

On the other hand, the largest declines occurred for key cities such as Paris and London, although both cities remain in a leadership position in Europe. At the same time, cities in the periphery of Europe are making gains: Warsaw, Tarko-Sale, Krasnodar. These increases mostly concern the potential of cities, while the sector structure of business

enterprises exhibits strong inertia and a concentration of high technology sectors in traditional high technology areas in Western Europe.

## **Conclusion**

The significance of the command and control function is noticeably increasing in urban economies and in the international standing of selected countries. Despite globalization and the delocalization of production facilities, both management and strategic entities such as research centers exhibit a strong spatial inertia. Hence, changes in the location of international company headquarters are one of symptoms of contemporary economic processes. International company structures are responding to current social and economic changes and then adapting to emerging conditions on the world scene. One example of this is the weakening of the historically relevant blue banana geographic pattern modeled after the old trading routes of the Middle Ages. Shifts in the location of company headquarters from west to east and the increasing significance of local firms in developing countries are occurring mainly due to economic development in the east of Europe and overall integration of the European continent – increasing in the eastern and southern directions. Changes in the command and control potential of cities and the number of corporate headquarters vary substantially and depend on economic sector. The largest changes in location during the study period were noted for the energy sector and high-tech sectors.

It appears that the change in these sectors was triggered by location factors in the context of regional economic specialization in Europe. One example of headquarters change relative to the raw material supply base is that of the energy sector whose centroid has moved east mostly due to the entrance into the market of companies from Russia and Ukraine. The 2006-2016 shift of corporate headquarters and the command and control function of high-tech

sectors west resulted from strong relationships between these sectors and the R&D community as well as its link to the availability of investment capital. Production clusters have emerged in cities with a number of large corporations that attract other companies and create new business entities. The important driver of development in these sectors is the R&D community, which is why firms in high-tech sectors are not moving their headquarters away in the direction of peripheral cities experiencing accelerated growth in recent years. A simulated shift of corporate headquarters is possible in cases where a corporation takes over a local company in order to dominate a market.

The processes described above have affected the command and control position of both cities and countries in Europe. One general pattern is that of the increasing significance of cities located in developing countries such as Poland and Russia. This pattern is particularly visible in terms of the number of corporate headquarters. However, the movement of capital in Europe has not been as straightforward, and countries such as Germany and Great Britain remain the leaders of the European economy. This disproportion is particularly visible in the case of Paris and London. London experienced the financial crisis of 2008 the most of any city in Europe in terms of the command and control function. It appears that current political decisions may affect the future position of Great Britain relative to countries on the European continent.

The paper does not focus on political issues or the financial crisis of 2008 and its effects on changes in corporate headquarters' locations. These issues require a separate analysis.

Editors' note:

Unless otherwise stated, the sources of tables and figures are the authors', on the basis of their own research.

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