Mapping the position of cities in corporate research and development through a gravity model-based bidimensional regression analysis

Tóth, Géza and Csomós, György

Hungarian Central Statistical Office, Department of Civil Engineering University of Debrecen

October 2016

VISUALIZATIONS

Mapping the position of cities in corporate research and development through a gravity model-based bidimensional regression analysis

Géza Tóth
Hungarian Central Statistical Office, Budapest, Hungary
E-mail: geza.toth@ksh.hu

György Csomós
Department of Civil Engineering University of Debrecen, Hungary
E-mail: csomos@eng.unideb.hu

In her seminal work entitled 'The Global City', Saskia Sassen (1991) specified New York, London, Tokyo, Frankfurt and Paris as leading examples of global cities. Furthermore, she defined the most important characteristics of global cities (Sassen 2001: 4), one of which is that global cities are major sites of production of innovation. Since Sassen's global city notion was first introduced, significant changes have occurred in the world economy, which can be characterised by, for example, the massive economic growth of developing countries, especially that of China, and rapid technological changes due to fast-growing industries such as nanotechnology, biotechnology and information technology (Nicolini and Nozza 2008; Dernis et al. 2015; Csomós and Tóth 2016a). As a result of these developments, global cities have been continuously losing their privileged position as major sites of production of innovation, and new competitors have emerged in developing countries, even in the home countries of the global cities.

In this analysis, we illustrate the position of 475 cities as centres of corporate research and development (R&D)[1] in 2014. The volume of R&D in a given city is calculated based on the combined R&D investments of leading R&D investor

[1] Our analysis is based upon the hypothesis that the 'production of innovation' requires conducting advanced R&D activities. Therefore, there is a close connection between R&D activities conducted by companies and the innovation produced by them.

Regional Statistics, Vol 6, No 1. 2016: 217–220; DOI: 10.15196/RS06111

companies headquartered in it. The world's leading R&D investors are annually listed by 'The 2015 EU Industrial R&D Investment Scoreboard' (Hernández et al. 2015). We use a bidimensional regression analysis based on a gravity model to describe the spatial structure of global corporate R&D (for more information on the model, see Dusek, 2012, Tóth et al. 2014, Csomós and Tóth 2016b). The grid is fitted to the coordinate system of the dependent form, and its interpolated modified position makes it possible to further generalise the information about the points of the regression. The white arrows show the direction of movement and the grid shading refers to the nature of the distortion. Areas indicated with green refer to concentration and movements in the same directions (convergence), which can be considered as the most important gravitational centres.

We find four significant regions where corporate R&D is highly concentrated: the West Coast and the East Coast of Northern America, Western Europe and East Asia.

The West Coast of Northern America: The focal point of this region is the San Francisco Bay Area (including San Jose and the cities of the Silicon Valley), the largest corporate R&D centre in the world in terms of annual corporate R&D investments. In 2014, leading companies headquartered in the San Francisco Bay Area invested $81 billion in R&D activities, which corresponded to almost 11 per cent of the total expenditure on R&D by businesses worldwide. Most companies in this region operate in information technology, one of today's fastest-growing industries. Seattle, Los Angeles and San Diego are also significant nodes in corporate R&D.

The East Coast of Northern America: The centre of this region is still New York, investing more than $43 billion in corporate R&D; however, thanks to the rapid growth of the biotechnology (and information technology) industry, Boston seems to be the most dynamically growing gravitational zone in the region. Major cities such as Washington and Philadelphia and some second-tier cities (for example, Bridgeport and Hartford) have a partial, but not negligible, role in corporate R&D.

Western Europe: Although Paris and London are definitely the major single corporate R&D centres in Europe, the most important gravitational zone can be detected around the combined areas of Switzerland and Southern Germany, with the leading roles played by Basel and Zurich in Switzerland and Stuttgart, Munich, Mainz, Mannheim and Frankfurt am Main in Germany. Both Paris and London have a complex structure in corporate R&D, having no extremely dominant industry, whereas the Swiss and German cities generally have a leading industry; for example, Basel's most dominant industry is pharmaceuticals in terms of the total expenditure on R&D by headquartered companies. Outside this zone, there are some middle-sized isolated R&D centres, such as Helsinki (Finland), Toulouse (France), Madrid (Spain), Amsterdam (Netherland) and Rome (Italy).

East Asia: Five out of the 10 largest R&D centres in the world, in terms of combined R&D expenditure by headquartered companies, are located in East Asia. Tokyo, as the world's second-largest single corporate R&D centre, surpasses in the

region. Seoul comes second in East Asia, thanks to its globally significant electronics industry. The South Korean capital is followed by two Japanese conurbations, Osaka and Nagoya. These cities are different in that Osaka has a complex corporate R&D structure, while Nagoya's corporate R&D is largely determined by the automotive industry. Furthermore, it seems that a new gravitational zone is emerging in East Asia with the leading role of Beijing.

It is predicted that the Chinese capital will soon became one of the world's most important corporate R&D centres, because the total expenditure on R&D by Beijing-based companies has recently been growing very fast.

South American, South African, Indian and Australian cities have a minor role as corporate R&D centres.

Acknowledgement

This paper is supported by the **János Bolyai Research Scholarship** of the Hungarian Academy of Sciences.

REFERENCES

CSOMÓS, G.–TÓTH, G. (2016a): Exploring the position of cities in global corporate research and development: A bibliometric analysis by two different geographical approaches *Journal of Informetrics* 10 (2): 516–532.

CSOMÓS, G.–TÓTH, G. (2016b). Modelling the shifting command and control function of cities through a gravity model based bidimensional regression analysis *Environment and Planning A* 48 (4): 613–615.

DERNIS, H.–DOSSO, M.–HERVÁS, F.–MILLOT, V.–SQUICCIARINI, M.–VEZZANI A. (2015): *World Corporate Top R&D Investors: Innovation and IP bundles* A JRC and OECD common report. Publications Office of the European Union, Luxembourg.

DUSEK, T. (2012): Bidimensional Regression in Spatial Analysis *Regional Statistics* 2 (1): 61–73.

HERNÁNDEZ, H.–HERVÁS, F.–TÜBKE, A.–VEZZANI, A.–DOSSO, M.–AMOROSO, S.–GRASSANO, N.–COAD, A.–GKOTSIS, P. (2015): *The 2015 EU Industrial R&D Investment Scoreboard* Office for Official Publications of the European Communities, Luxembourg.

NICOLINI, C.–NOZZA, F. (2008): Objective assessment of scientific performances world-wide *Scientometrics* 76 (3): 527–541.

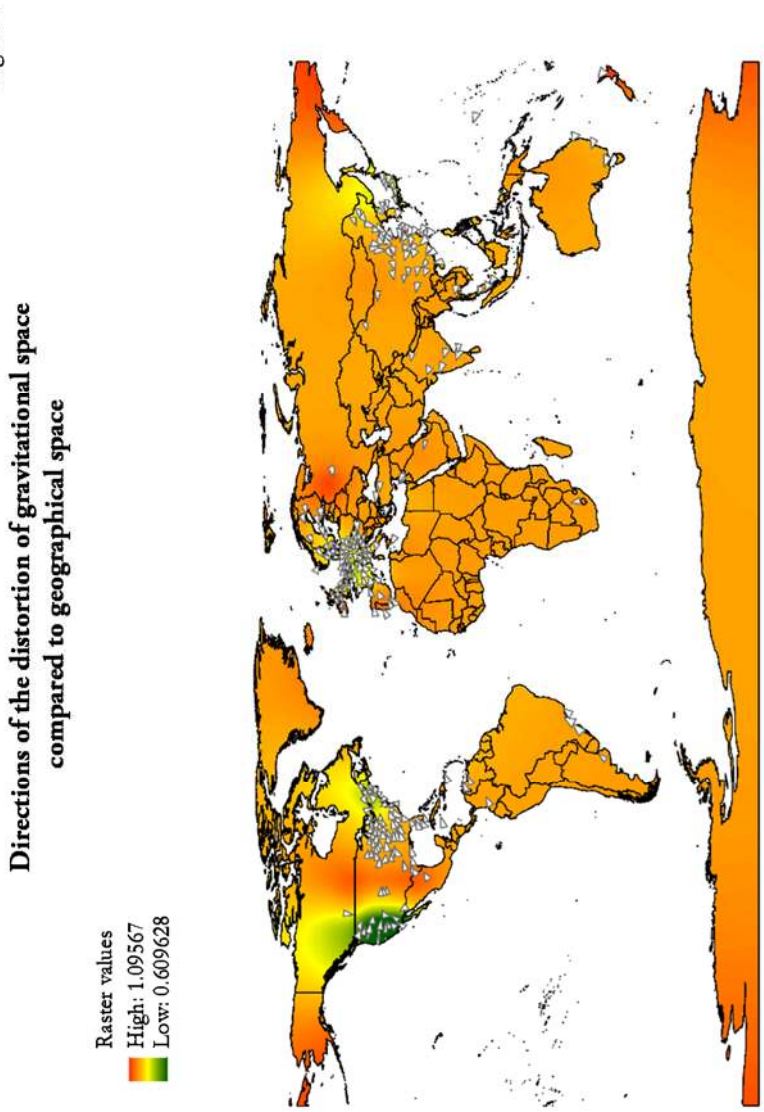
SASSEN, S. (1991): *The Global City* Princeton University Press, Princeton.

SASSEN, S. (2001): *The Global City: New York, London, Tokyo* Second Edition.Princeton University Press, Princeton.

TÓTH, G.–KINCSES, Á,–NAGY, Z. (2014): The changing economic spatial structure of Europe *Norsk Geografisk Tidsskrift* 68 (5): 301–309.

Software: ArcGIS, Darcy 2.0 (http://thema.univ-fcomte.fr/production/logiciels/16-categories-en-francais/cat-productions-fr/cat-logiciels-fr/294-art-darcy).

Figure 1


Directions of the distortion of gravitational space
compared to geographical space
Raster values
High: 1.09567
Low: 0.609628