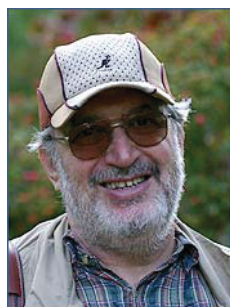


TERNARY PLOTS OF SCIENCE IN A TRIPOLAR WORLD



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The concept of the *Triad* (EU-USA-Japan) conceived by Kenichi Ohmae [1] in the eighties, became widely used in international analyses either in economics [2] or in S&T [3], and became a cliché by the turn of the millennium. Attempts were even made to extend the concept to a *Tetrad* including also China [4]. Nevertheless, at the beginning of the 2000's – particularly in the world of S&T – the Triad served for the rest of the world as main orientation poles.

In the present work the position of the "rest-of-the-world" countries relative to the Triad is studied as co-authoring partners and as source of citations. This position can be impressively presented in ternary plots. Such diagrams were originally developed for visualizing the composition of ternary systems (in physical chemistry and geology, among others; see Wikipedia insert). Several commercial and non-commercial softwares aid the construction of such "triplots"; for our purposes the freeware "Triplot 4.0.2" by Todd Thompson Software (<http://php.indiana.edu/~tthomps/programs/html/tnttriplot.htm>) was found to be a perfectly satisfactory tool.

The data used in our analysis were retrieved from the Web of Science database (presently owned by Thomson-Reuters); source data for the years 1992, 2000 and 2002 were considered, citations to the publications of the year 2000 were retrieved in the period 2000-2002. Both cited and citing papers were assigned to countries on the basis of the

institutional affiliation of their authors. In case of international co-operation, on the cited side, each contributing country was credited by a full count; on the citing side, counts were fractionated equally among the contributing countries. This way, citation counts can easily be partitioned into regional components by direct summation. To ensure comparisons in time, EU15 (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden, UK) was regarded as "EU" independently of the actual situation in the given year.

Wikipedia: Ternary plot

A ternary plot, ternary graph, triangle plot, simplex plot, or de Finetti diagram is a barycentric plot on three variables which sum to a constant. It graphically depicts the ratios of the three variables as positions in an equilateral triangle. It is used in petrology, mineralogy, metallurgy, and other physical sciences to show the compositions of systems composed of three species. In population genetics, it is often called a de Finetti diagram. In game theory, it is often called a simplex plot.

In a ternary plot, the proportions of the three variables a , b , and c must sum to some constant, K . Usually, this constant is represented as 1.0 or 100%. Because $a + b + c = K$ for all substances being graphed, any one variable is not independent of the others, so only two variables must be known to find a sample's point on the graph: for instance, c must be equal to $K - a - b$. Because the three proportions cannot vary independently, it is possible to graph the intersection of all three variables in only two dimensions.

A ternary plot is drawn as triangle. Each base, or side, of the triangle represents a proportion of 0%, with the point of the triangle opposite that base representing a proportion of 100%. As a proportions increases in any one sample, the point representing that sample moves from the base to the opposite point of the triangle.

(Source: http://en.wikipedia.org/wiki/Ternary_plot)

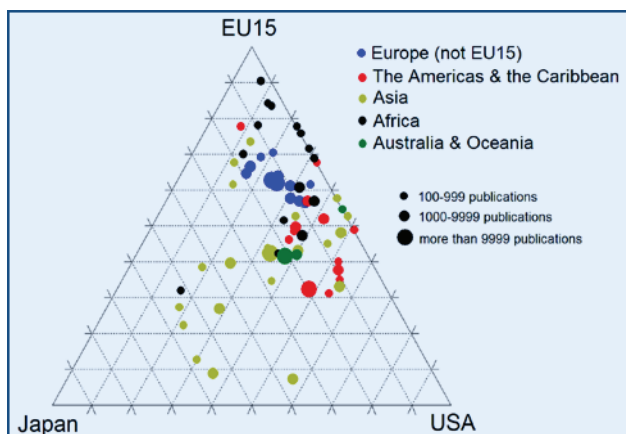


Figure 1a Co-authorship triplot, 1992

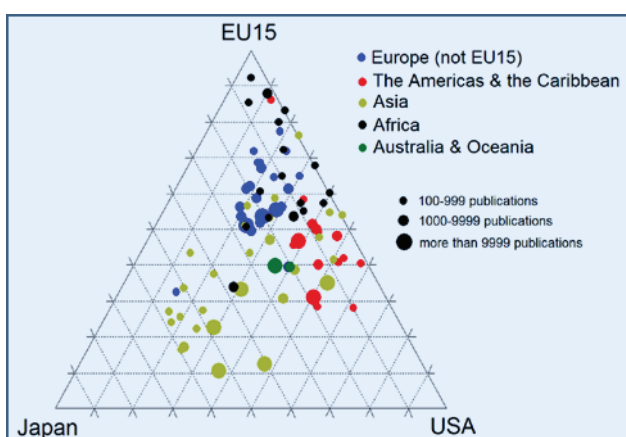


Figure 1b Co-authorship triplot, 2002

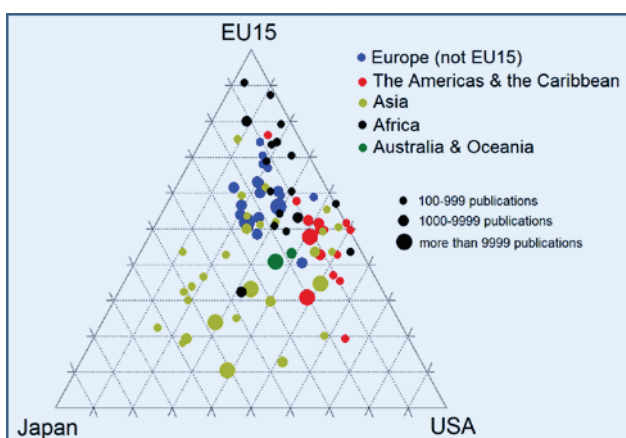


Figure 2a Co-authorship triplot, 2000

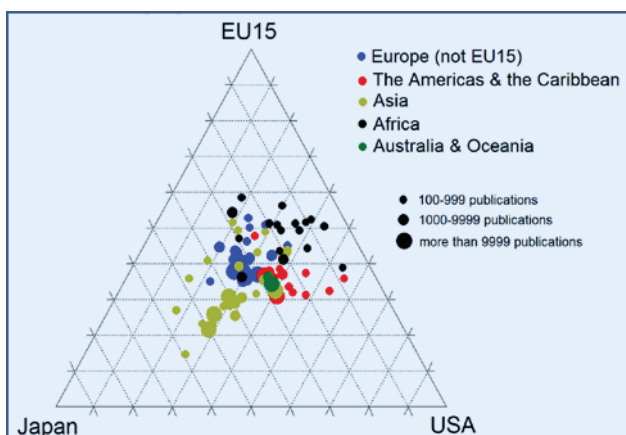


Figure 2b Cross-citation, 2000

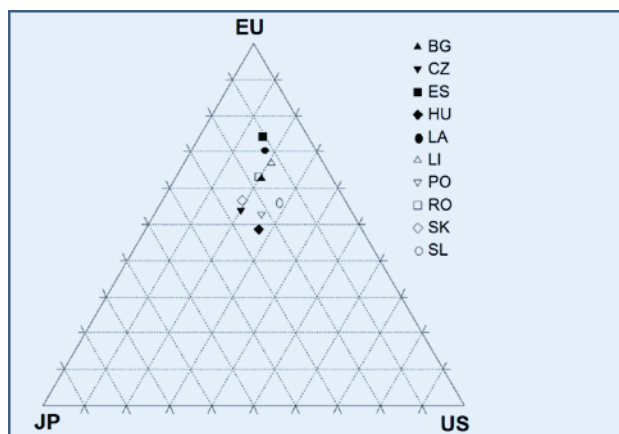


Figure 3 Co-authorship triplot of the ten new member states of the EU, 2000

Figures 1a,b present the co-authorship triplots for the years 1992, and 2002, respectively. Although the general picture shows a remarkable stability, there is a definite drift of several European countries towards Japan.

Figures 2a,b show the co-authorship and cross-citation plots for the year 2000. Although the relative position of the countries of the five regions is fairly similar in both diagrams, the entire cross-citation plot is contracted towards the centre. This means that while the citation preferences parallel the co-authorship preferences, the latter are much tighter bounds - obviously because of the greater significance of geographical distance.

Figure 3 focuses on the ten new member states of the EU (BG: Bulgaria, CZ: Czech Republic, ES: Estonia, HU: Hungary, LA: Latvia, LI: Lithuania, PO: Poland, RO: Romania, SK: Slovakia, SL: Slovenia). In 2000 (then, as candidate states), the Baltic countries showed the tightest co-authorship attachment to the EU15, whereas the Czech Republic, Poland and, most particularly, Hungary had positions closest to the Japan-USA axis.

In summary, the ternary plot seems to be a useful supplementary tool in the presentation of scientometric indicators. It may reveal relations and changes that otherwise might remain hidden. Its 'Triad'-related application proved to be particularly impressive and instructive.

References

- [1] K. Ohmae: Triad Power: The Coming Shape of Global Competition. Free Press, New York, 1985
- [2] C. Freeman, L. Soete: The Economics of Industrial Innovation, MIT Press, 1997
- [3] Second European Report on Science & Technology Indicators (REIST-2), European Commission, 1997
- [4] W. Glänzel, K. Debackere, M. Meyer: 'Triad' or 'Tetrad'? On global changes in a dynamic world, *Scientometrics*, 74(1) (2008) 71-88.