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Luciano Pietronero studied physics in Rome and was a research scientist at Xerox Research in Webster (1974) and Brown Boveri Research Center (CH) 1975-1983. He then moved to Univ. of Groningen (NL), where he was professor of Condensed Matter Theory (1983-87). Since 1987 he is professor of Physics at the University of Rome "Sapienza". Founder and director of the Institute for Complex Systems of CNR (2004-2014). Broad international experience in academic and industrial environments. The scientific activity is of

both fundamental and applied nature, with a problem oriented interdisciplinary perspective. Development of novel and original views in all the areas of activity. Leader of a generation of young scientists who are protagonists of the complexity scene internationally.

In 2008 he received the Fermi Prize (highest award of the Italian Physical Society).

Research interests: Condensed Matter Theory; High-temperature superconductivity; Statistical Physics; Fractal Growth; Self-Organized-Criticality; Complex Systems and its interdisciplinary applications. Recent activity in Economic Complexity:

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### **New Metrics for Economic Complexity: Measuring the Intangible Growth Potential of Countries**

Economic Complexity refers to a new line of research which portrays economic growth as a process of evolution of ecosystems of technologies and industrial capabilities. Complex systems analysis, simulation, systems science methods, and big data capabilities offer new opportunities to empirically map technology and capability ecosystems of countries and industrial sectors, analyse their structure, understand their dynamics and measure economic complexity. This approach provides a new vision of a data driven fundamental economics in a strongly connected, globalised world.

In particular here we discuss the COMTRADE dataset which provides the matrix of countries and their exported products. According to the standard economic theory the specialization of countries towards certain specific products should be optimal. The observed data show that this is not the case and that diversification is actually more important. Specialization may be the leading effect in a static situation but the strongly dynamical globalized world market

suggests instead that flexibility and adaptability are essential elements of competitiveness as in bio-systems. The situation is different for individual companies or sectors which seem instead to specialize only on few products.

The crucial challenge is then how to turn these qualitative observations into quantitative variables. We have introduced a new metrics for the Fitness of countries and the Complexity of products which corresponds to the fixed point of the iteration of two nonlinear coupled equations and is a sort of economic version of the Google Page rank approach. However, in this case, the nonlinearity is crucial because it represents the fact that the upper bound on the Complexity of a product is given by the less developed country that can produce it. The information provided by the new metrics can be used in various ways. The direct comparison of the Fitness with the country GDP gives an assessment of the non-expressed potential of the country. This can be used as a predictor of GDP evolution or stock index and sectors performances. These results are also useful for risk analysis, planning of industrial development and strategies to exit from the “poverty trap”.

The global economic dynamics shows a large degree of *heterogeneity* which implies that countries which are in a certain zone of the parameter space evolve in a predictable way while others show a chaotic behaviour. This heterogeneous dynamics is also outside the usual economic concepts. When dealing with heterogeneous systems, in fact, the usual tools of linear regressions become of inappropriate. Recently we have developed a specific strategy to control and forecast the evolution of the entire Product Space Network. This allows us to perform a more detailed analysis of the evolution focused on the individual industrial sectors.

### References

- [1] A. Tacchella, M. Cristelli, G. Caldarelli, A. Gabrielli and L. Pietronero: *A New Metrics for Countries' Fitness and Products' Complexity*, Nature: Scientific Reports, 2-723 (2012)
- [2] M. Cristelli, A. Gabrielli, A. Tacchella, G. Caldarelli and L. Pietronero: *Measuring the Intangibles: A Metrics for the Economic Complexity of Countries and Products*, PLOS One Vol. 8, e70726 (2013)