# **Economic Fitness: Concepts, Methods and Applications**

(L. Pietronero, Fermi Center, Rome; June 2022)

# What is Economic Fitness and Complexity (EFC)?

**Economic Fitness and Complexity** is the recent economic discipline and methodology developed in Rome by the group of LP (first at Sapienza University and ISC-CNR and now at the Fermi Center: [www.cref.it](http://www.cref.it)) together with several international collaborators. EFC makes use and develops the modern techniques of data analysis to build economic models based on a scientific methodology inspired by the science of Complex Systems with special attention to quantitative tests to provide a sound scientific framework. It consists of a ***data based* and *bottom up*** approach that considers specific and concrete problems without economic ideologies and it acquires information from the previous growth data of all countries with methods of **Complex Networks, Algorithms and Machine Learning**. Its main characteristics are the scientific rigor, the precision in the analysis and in the forecasting, transparency and adaptability. The new Fitness algorithm overcomes the conceptual and practical problems of the early attempts in this field and sets the basis for a testable and successful implementation of the field of Economic Complexity. The ideological debate about which is the ideal economic theory for economic development is replaced by a **new paradigm**. There is no such a thing as the ideal theory valid for all situations. As in medicine one has first to carefully identify the pathology and then implement the appropriate therapy, there is no universal medicine valid for all problems. Similarly for the economic development of a country one has to analyze its level of competitiveness and identify the possible realistic lines of development. These concepts remind the New Structural Development of Justin Lin developed at the University of Peking for which EFC provides now also a scientific quantitative analysis that complements these general economic ideas. In this way it is possible to develop a **scientifically grounded aware information** as a basis for the decisions of governmental policy makers but also for the business and the market. This leads to a novel perspective, modern and objective, for the traditional dilemma between **state and market**, often characterized by obsolete and ideological positions. The scientific power of the method has been tested in detail with respect the forecasting of the growth of many countries with a back test totally out of the box and far superior to the usual regressions. The results have been compared in detail with the standard IMF forecasting and they are substantially more accurate.

According to **Bloomberg Views**: **“***New research has demonstrated that the "fitness" technique systematically outperforms standard methods, despite requiring much less data*”

In addition EFC has provided a detailed understanding and forecasting of the fantastic growth of China in the past thirty years which has been a major mystery for most of the standard economic analysts.

# Concrete and Specific Results

The Economic Fitness represents a synthetic measure of the **degree of competitivity** in terms of the capabilities to produce products and services. Mathematically the Fitness corresponds to the **diversification weighted by the complexity of the products**. The diversification provides stability and resilience while the complexity of the products represents the exclusivity and the relative wealth. From the financial point of view this approach is also ethical because it suggests investments based on the development of capabilities rather than on pure speculation. One can then define the Fitness specific to each productive sector and evaluate its possible evolution with methods of **Machine Learning**. Considering the range and completeness of the dataset analyzed in a scientific and systematic way one can then reach a level of **granularity** which is far superior than the usual methods and perform an analysis of competitiveness and possibility of development for each of the **5200 products** considered. The same can be done for the development of **technologies**, using the information provided by the patents and also for the **scientific activity** through the publications. This leads to **three platforms**, the first based on the products leads to the **Economic Fitness**, the second to the **Technological Fitness** and the third to the **Scientific Fitness**. From the connections between these three platforms one can then understand the relations between science, technology and products and address in a systematic way problems like **innovation and the technology transfer**.

# Who uses EFC?

* **The European Commission (Joint Research Center)** has recently adopted these methods for

the study of the 27 EU countries. It will be used to evaluate the best planning and the impact of the recovery fund projects (PNRR) to stimulate the economy of EU in the era post COVID-19

In the Website: <https://publications.jrc.ec.europa.eu/repository/handle/JRC124939>

one can find a general methodological document together with the analysis of each of the 27 countries performed with EFC methods that identify the present situation together with the possible paths of evolution in relation to the PNRR projects. With these methods it is also possible to extend these analysis in various directions and optimize the projects accordingly.

* Since a few years it has been used by **IFC-World Bank Group** to define specific economic

actions tuned for specific countries, in particular for developing ones. One of the main targets is to identify the products or technologies which will **enable to open new markets**, considering the specific situation of each country. The IFC-WB has also supported the development of these methodology which is now officially adopted for the planning of its interventions. An example for African countries can be found here: <https://www.ifc.org/wps/wcm/connect/fb4761f5-809b-4685-8fd7-24bd23bad6d3/EMCompass-Note-88-West-African-Industrial-Development.pdf?MOD=AJPERES&CVID=ngxrg.e>

In the Fermi Center we are establishing a joint research group with IFC-WB for the study and forecasting of the international market. A similar collaboration has already started with Sony CRS for the study of the UN Sustainable Development Goals.

* In a recent collaboration with **CNEL and ISTAT** we have made a specific analysis for Italy and

its regions to define the present level of competitivity and identify the possible lines of development.

# What can EFC do in practice?

* **Plan the industrial development on medium long range.** It is possible to identify the specific opportunities for industrial development at a national and regional level, enhancing the technological capabilities already present to increase the international competitiveness. Also for the cities these methods permit a detailed analysis in view of the development of **Smart Cities** within a modern and sustainable development.
* **Economic Growth and Resilience.** These two factors are core elements of the EFC methodology. From the analysis of the various industrial sectors it is possible to make accurate predictions of the impact that new products or technologies may have for the economic stability and competitivity of the country. From these analysis it is also possible to estimate the growth of the **standard GDP** but also the **innovation and creativity**.
* **Research and Technology Transfer.** By considering the presentsituation of the research it is possible to identify which technological areas have the largest potential to impact on the industrial system in the medium term. It is then possible to identify the **specific opportunities** for a given country to enter **new sectors** in which there is a good perspective to become an important player in the market.
* **Green economy and Sustainability.** The EFC methodology permits a coherent long term planning for the evolution towards a **stable ecological transition**. This implies developing green products and technologies which are necessary for an economy which is at the same time **competitive but also green and sustainable**. Considering the complexity and interconnected nature of these elements a scientific approach based on complexity science is absolutely necessary. The risk is that even the best intentions, without a scientific control, may lead to disappointing results.
* **Job Market and Education.** Considering the predictions for the development and growth in various sectors and in different regions, it is possible to predict which professional figures and related competencies will be necessary in the near future. Anticipating the needs of the job market is extremely important to orient the education system of the future generations.
* **EFC for Companies.** Also for companies the EFC analysis leads to a variety of original results. Companies show a **block-nested** pattern with respect to the matrix of the products which requires a different analysis with respect to the country matrix which is fully nested. The Fitness algorithm can be applied within each block to define the **Company Fitness**. Then from the patents one can obtain the technological network and introduce the concept of **coherency** for a groups of technologies related to a specific product. The Product Progression identifies the next product or technology that a company may be able to produce and its competitiveness in the various markets. Along these lines one can derive a number of results related to the opportunities to enter a certain market or to develop a new product. Also the analysis and optimization of the Merging and Acquisition process can be done with these methods.