# GROWTHCOM

## Growth and innovation policy-modeling: applying next generation tools, data, and economic complexity ideas.

### http://www.growthcom.eu

Seventh Framework Programme (FP7)

Funding Scheme: Collaborative Project

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# D5.1:  PROJECT PERIODIC REPORT

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## 3.1    Publishable summary

In the wake of the financial crisis one of the major challenges faced by policymakers in Europe and around the world is re-kindling economic growth and innovation. Recent research portrays economic growth as a process of evolution of ecosystems of technologies and industrial capabilities. This research has also shown a strong relationship between the development of the complexity of economies in a globalized market and overall output growth. ICT based tools, in particular complex systems analysis, simulation, systems science methods, and big data capabilities offer policymakers new opportunities to empirically map technology and capability ecosystems of countries and industrial sectors, analyze their structure, understand their dynamics, measure economic complexity, and design policy interventions more likely to have positive impacts on growth over time.

This project proposes to apply ICT tools in this way to yield insights on the industrial competitiveness and fragility of countries, the evolution of technologies and capabilities, the network of products, the adaptability of companies, and the ecology of E-commerce. In particular, E-commerce provides an important example of the active involvement of citizen in terms of their feedbacks on products and companies. The project will be a European and global collaboration amongst a network of researchers highly experienced in these topics. The teams involved represent an interdisciplinary consortium in which various research lines will be integrated in a network of collaborative effort to address challenging problems for a new vision of a data driven fundamental economics in a strongly connected, globalized world. The results of the project will provide a novel basis for economic forecasting and risk analysis for countries, companies and technological sectors, and they will also provide a new perspective for growth and innovation policymaking.

We propose a novel approach to understanding economic development and technology innovation that is empirically grounded by Big Data analysis. We intend to study the evolution of the ecosystem of the complex space of products, industries and technologies. The datasets that we will use include a comprehensive record of patents, detailed data on production and exports and e-commerce feedback databases, that will allow to understand how also the matching of offer and demand triggers the evolution of production baskets. A common element in these data sets is that the key information is provided in terms of multi-partite networks. In the spirit of the Google Page rank approach we will define new algorithms and metrics that will help us make sense of these data, and that will guide us in the development of a new theoretical framework enabling a deeper understanding of economic growth. An interesting outcome of this approach is that there cannot be just a single algorithm (i.e. Google) but each area of the Big Data galaxy requires the development of new algorithms suited to the specific problem considered. For example for Economic Complexity it is necessary to resort to a non linear algorithm to represent the realistic properties of the bipartite economic network of Countries and Products. Our theoretical view is that to understand growth it is necessary to focus on the complex structure of the economy starting from the micro level of technologies, products, capabilities and transactions.

This is in contrast to traditional economics, which has historically used highly aggregated data and a simplified description of the micro-structure. Our approach begins by developing product, industry, technology and country spaces as uni-partite projections of the multi-partite networks we derive them from. In this process, we will generate algorithmic metrics that characterize the complexity and network properties of the various elements of the system. It also allows us to generate new taxonomies and to study their evolution. We will use advanced data visualization techniques to communicate our results. The availability of micro level data, Big Data techniques, algorithmic methods, and network analysis makes this bottom-up picture of economic growth only very recently possible. For the first time we can have an empirically derived, granular, dynamic picture of how national and global economies evolve and grow.

At the end of the first year of work the GROWTHCOM consortium has reached all the milestones of the project. The three internal meetings boosted the cooperation between the teams and helped set the stage for the next objectives as well as inspiring new ideas and possible cross-team applications.

The heterogeneous dynamics of Economic Complexity has been deeply analyzed and understood. With the application of statistical tools derived from the field of dynamical systems we developed an innovative framework to deal with macroeconomic forecasting, the so-called *Selective Predictability Scheme*. In this framework we are able to distinguish countries whose economic fate is predictable, being driven by their economic and industrial complexity, and those that are dominated by other less predictable factors. The space where the productive structures of countries move has also been object of study. We have observed that products live in a hierarchical technological space, which is the topology that countries face when developing. In the next years we plan to study in detail the dynamics of countries in this topology and to integrate the Selective Predictability Scheme with the information given by the topology of the product's network and the expected dynamics of countries over it. This will allow us to determine which industrial sectors are more likely to develop, country-by-country, given their present occupation of the product's space and their position in the heterogeneous fitness-income vector field. In parallel we explored the potential of applying non-linear metrics to different kinds of bipartite networks, and as a first attempt we gathered data on international research activity, with encouraging results.

On a more microscopic level we are studying how technologies are linked among themselves and how these are expected to evolve and trigger innovation. We worked on a quantitative method for distributional forecasts based on historical records of a technology's costs. We have extended this method to include historical production data as well.

Given a distributional forecast for the future cost of a technology, we have developed methods of computing optimal portfolio weights for investment in that technology. We have studied this in idealized settings and shown that the weights are highly sensitive to the details of the forecasts.

Using an extensive dataset on patents' applications we have been studying the properties of the co-occurrence network, which is based on the co-appearance of technology codes in patents. We are currently using this to characterize technological eras.

Data collection is a fundamental part of the activities of GROTHCOM project. In order to better collaborate within the GROWTHCOM team members, the HU (Hang Zhou) team has organized two meetings Hang Zhou, China (May and October 2014, respectively). In particular, for both meetings, the location was inside Alibaba.com, and more than 600 Alibaba employers have participate. This provided a unique opportunity for both promoting the impact of GROWTHCOM in the world largest e-commerce company, and benefited data collection for research purpose for this project.

During the first year we aggregated e-commerce dataset and made them available to the consortium via a dedicated data-platform. We have collected five representative datasets from Alibaba, including customer-product, user-item-interaction, shop-keyword_timestamp, shop-keyword-time, and shop-category. The data-platform allows the possibility for the member of the consortium to download such data and upload and share the datasets coming from the activities in the various work packages.

In relation to E-commerce data we concentrated our work on the determination of the effect of information filtering tools on markets' ecologies and the development of an algorithm to measure traders' reputation and products' quality in e-markets. Our research progress is in two directions in particular: (1) The long-term effect of recommendation on information systems and (2) The temporal leadership of users in online systems. In order to disseminate appropriately and in real time the evolution of the project, of the Consortium and the result of the scientific activity a website www.growthcom.eu has been designed, realized and implemented (see WP6 description) in a user friendly way. This is the main tool to diffuse in the scientific community, policy makers and in general interested people all the main information about the composition of the Consortium, the scientific mission and guidelines of the project, the publications of the results of scientific investigations and collaborations and more in general news useful for dissemination. This tool is strengthened by the realization of a Facebook page and a Twitter account of the project GROWTHCOM where news on the project are disseminated in real time so that to receive an immediate feedback by follower users of the two platforms. Here a simple screenshot of the home webpage of the Growthcom website is given. It shows the simple and user-friendly architecture to render the navigation of the site very.
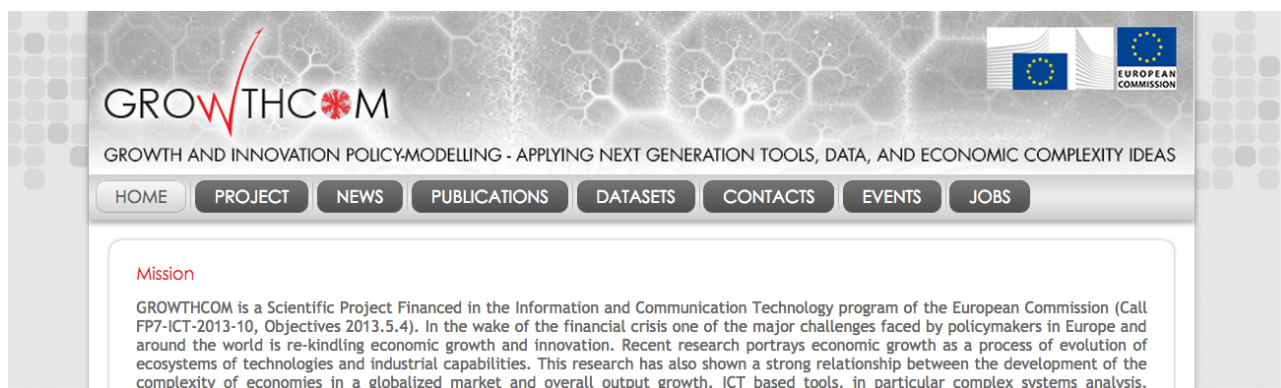
## Consortium partners and contact persons

**CNR team (Research National Council, Rome, Italy): Coordinator.** The Italian CNR supports interdisciplinary research in the most advanced scientific fields. In particular it supports advanced research activities in modern physics and science of complex systems to which it have devoted a big Institute: the Institute of Complex Systems (ISC). The institution will be involved in the project both in R&D activities and in the management of the project, through a multidisciplinary team.
**Contact person:** Prof. Luciano Pietronero (Project Coordinator, email luciano.pietronero@roma1.infn.it).

**London Center for Mathematical Sciences LBG (LIMS, London, UK):** The London Institute for Mathematical Sciences (LIMS) is Britain's first private institute for theoretical scientific research. It gives scientists the support and freedom to do what they do best: make fundamental discoveries. LIMS does research in all branches of the mathematical sciences, including finance and economics. In this project LIMS is associated with INET (Institute for New Economic Thinking) of Oxford University (PI Prof. Doyne Farmer).
**Contact person:** Dr. Thomas Fink (Team leader, email tmafink@gmail.com).

**Université de Fribourg (UF, Switzerland).** University of Fribourg is institution unique in the sense that it is bilingual (German and French) and its Master and PhD programs are in English. It has since long emphasized to aim at excellence at complexity sciences by encouraging cross-disciplinary research. The group at the University of Fribourg applies methods and tools of theoretical physics (statistical mechanics, probability theory, etc.) to economics, game theory, network theory, and information filtering.
**Contact person:** Prof. Yi-Cheng Zhang (Team leader, email yi-cheng.zhang@unifr.ch).

**Hangzhou Normal University (HU, China).** One of the participant to our Consortium comes from China: Hangzhou Normal University. It will be composed of personnel coming from the Alibaba Business School and from the Institute of Information Economy. The Alibaba Business School, co-established and co-invested by Hangzhou Normal University (HU) and Alibaba (China) Co.Ltd through establishing a long-term collaboration relationship since 2008, is an international business school with the advanced concept, unique institution combining education and businesses. The Institute of Information Economy is the research arm of the Alibaba Business School. It focuses on the research projects both related to internet economy and academic research.
**Contact person:** Prof. Zi-Ke Zhang (Team leader, email zhangzike@gmail.com).

## Cooperation with other projects/programmes

During this first period a cooperation activity with other international and national research project has been started in the context of our research activity. The project involved in this collaborations are:

• CRISIS (LIMS/Oxford team) is a project sponsored by FET under FP7 with the goal of making a

comprehensive agent-based model of the economy. A key element lacking in economic theory is a method of modeling long-term growth based on realistic agent-based dynamics. There are potential interactions with GROWTHCOM in the future, as it might help provide the basis for such a model, which CRISIS might render in agent-based form.

• NESS (Fribourg team) is a coordination action funded by FP7 with the goal to bring together leading researchers within Non-Equilibrium Social Science (NESS) to build a community, address current pressing issues and engage with policy makers, business and other stakeholders. It aims to help create a new ICT and NESS-aware paradigm for economics. GROWTHCOM is being publicized by NESS in its final months of activity (NESS ends on 31/12/2014).

• CRISIS-LAB (CNR Rome team) is a Special Project of Italian Research Ministry (2013-2015). L. Pietronero is the general coordinator of this large project based mainly on ISC-CNR Roma and IMT Lucca. The objective of the project is to establish a new foundation to the economic and financial sciences and it is especially focused on the risk problem.

• EveryAware (Sapienza Univ. of Rome team), EU STReP project, dedicated to the analysis of awareness and trust in socio-economic areas with suitably designed controlled experiments


Moreover contacts with policy maker organization have been built in this first period in order to cooperate on specific points of the scientific effort of the Consortium and optimize some lines of research for public utility (see WP6).

**List of policy maker organization with which we have developed important contacts and collaborations**

• Institute of Public Policy Research (UK)
• Boston Consulting Group (USA)
• Alibaba Research Center for Complexity Sciences (China)
• Royal Dutch Shell Strategic Institute (NL)
• Stiglitz's Task Force on Industrialization