Knowledge, connectivity and creativity: shaping the future.

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Abstract:

Our socio-economic system, which involves an interplay between policy makers, the private sector, the research community and civil society, is complex, difficult to describe, and is continuously adapting to new opportunities and challenges. For example, while research and innovation are currently being looked to as a way to revamp growth and jobs, big data and the access to information will definitely affect our lives in the near future. Exactly how these two areas will impact society, however, is not clear.

Here I propose a formula that identifies the main factors that would influence the evolution of the socio-economic system. The formula, even if not rigorous, can be memorized as the famous Einstein's $E=mc^2$.

RESEARCH & INNOVATION, BIG DATA and GROWTH

The world is facing grand societal and economic challenges. Research and innovation are now widely considered as sources of a renewed growth¹, and there is a broadly shared perception that higher rates and levels of growth are positively correlated to the investments in research and exploitation of technologies. In the countries that demonstrate this correlation, it can be attributed to the presence of policy programs supporting exploratory/commercially oriented research and human resources training, and industrial investments in technologies².

Big data, and their access, are expected to boost the economy³ and will be one of the hot global topics in the near future for the dynamics of growth, jobs and legislation. The revolution associated to the data-collection and consumer-profiling of information has indeed become a social issue⁴. We are not only dealing with the challenge of storing and handling vast data streams but, primarily, to optimize the interpretation and impact of information⁵. The accuracy of the information, the analysis of the data and their interpretation, are also a matter of discussion and concern: especially when dealing with the impact of knowledge circulation in the popular consciousness⁶.

Research, industry, policy and civil society are being asked to be jointly involved towards a sustainable socio-economic system, where a shared value has to be adopted as a responsible cost/benefit approach in an interconnected and complex system⁷. The awareness of the interconnections between technological advances and socio-economic institutions have encouraged the conceptualization of "science, technology, innovation and growth systems (STIG)" as appropriate subjects for support to policy decisions and policy-oriented research⁸.

Unfortunately, the complexity of the system in terms of sectors, disciplines, stakeholders and legislation, makes it challenging to provide an accurate prediction of the future and to support policy decisions. We mainly deal with a chaotic system, which does not mean that there is not a cause-effect relation between the actors but that we are not capable to anticipate the state well in advance. Information can be difficult to describe, represent, manage and use: distilling meaning from big data may be adventurous and the failure to understand these complexities could lead to misguided policies^{9,10}.

As a matter of fact, the challenge of big data is rarely jointly addressed by the different of communities, responsibilities and interests of the many involved aspects and stakeholders (telecommunication, ethics, research, internal market, employment etc.), mainly adding uncertainty for the dynamics of the roles and

connections between public authorities, private sector, research community and civil society. In this context, any evolution of the global system can be linearized, and consequently adequately predicted, only on a short time-scale or small spatial-scales, and past experiences will be marginally helpful¹¹. For this reason, a sort of simplification is needed to focus on the main priorities to be to be communicated, especially to politicians and civil society.

"VALUE" IN THE UPCOMING SOCIO-ECONOMIC SYSTEM

Here I propose a new paradigm for describing, and memorizing, "value" in the incoming socio-economic system, and which can be a sort of qualitative indicator to guide policy programs.

The important components that contribute to "value" are resources, knowledge and creativity. These components are usually addressed in isolation: however, none of them alone can guarantee prosperity. Indeed, each of these aspects has to be accessible: raw materials/energy have to be transported/distributed, knowledge has to be circulated, and creativity has to be introduced in a global market that tends to homogenize any diversity. This means that resources, knowledge, creativity are strongly linked to the connectivity between the stakeholders that are producing or using them. So, the interconnectivity between resources, knowledge and creativity will be at the core of our next socio-economic system.

When connectivity is efficient and effective, the impact is large. However, there is no standard and quantitative indicator for measuring the connectivity in terms of its impact. In a world where information and materials can be distributed quickly and everywhere, a qualitative measure of the impact can be associated with the ratio between the time taken for the distribution of information/materials and the time taken for the system to evolve, which in turn depends on the rate at which they are accepted. In principle, if the information can instantaneously connect and shape the system, the system itself will behave as a cyborg, where human brains and technologies are strongly connected, becoming a single organism. In this case the value will rocket to infinity. This factor, which aims at taking into account the impact of information, products and services on the global system, can be shaped mathematically in different ways. Here I propose a simple metric to assess value that combines the factors described above and which has a

form similar to the famous Einstein's $E = m\gamma c^2$, where $\gamma = 1/\sqrt{1 - \frac{v^2}{c^2}}$, thus making it easy to remember:

Value = resources*knowledge*creativity/
$$1 - \frac{(t)}{2}$$

$$\frac{(\text{timescale of acceptance of infomation or materials})^2}{(\text{timescale of feedback from the global system})^2}$$

For the analogy, resources (materials and energy) can be memorized as the "mass", and knowledge multiplied by creativity to the (velocity of light)². This formula does not claim to be quantitative and dimensional. Its intent is to give the "flavor" of the main factors and links that are shaping the socio-economic system.

THE GLOBAL KNOWLEDGE SOCIETY

The importance of creating a global knowledge society has been claimed as crucial in its role of tackling societal challenges, crafting international relations (the so called science diplomacy), and shifting the role of science from gaining military advances to bringing peace¹². Knowledge and creativity will in fact increase democracy (each human has a brain!), while community cleverness is urgently required to address the societal challenges and build a sustainable future^{13,14}. Policy, in such a socio-economic system, will indeed take the crucial role to guarantee the access and neutrality of Internet, privacy, market competition, progress on well being of citizens¹⁵.

China has experienced unprecedented investment in skills and science, which has resulted in rapid growth in innovative outputs. The challenges for US and EU governments will not relate to protecting themselves or deterring investment in China or other emerging economies, but to 1) ensuring investment in their own economies such that they take the leadership in innovation and 2) promoting neutrality of, and openness to, information.

Since knowledge will be transferred quickly and easily, achieving the best capability will therefore require establishing a collaborative advantage between the production and the exploitation of knowledge. This means that users and producers of ideas, services and goods have to become closer and faster in their interconnections.

At the moment, where knowledge transfer is not efficient at global level, the mismatch between production and exploitation of innovation can result in a widening of the gaps between the territories in terms of jobs and growth¹⁶.

The decoupling between jobs and productivity, already experienced from 2000¹⁷, has been addressed mainly to digitalization and robots, even if there is no economic law that says digital progress and information technology will benefit everyone evenly. This trend for decoupling should to be monitored and investigated in the near future, where knowledge and creativity can definitely generate income, if adequately supported, and invert the trend.

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