

## **Panel Discussion**

### **Sustainable systems of innovation: How level is the playing field for developed and developing economies?**

*Carlos Montalvo<sup>1</sup>*

#### **Issues for the debate**

Developed and developing economies are facing new challenges to design policies that help sustain and increase economic growth, competitiveness and quality of life in the long term. In this regard it is recognized that new challenges like outsourcing and off-shoring of industrial activities and R&D; the rise of low cost hubs not only for production but also for R&D; and changes in the nature of the innovation process itself towards openness and integration as organizing factors affect developed and developed economies in different ways. In addition, socio-economic factors such as the aging of population, race to the bottom in labour costs, environment degradation, urban population concentration, high prices of energy and raw materials now are common to all economies. In advanced economies innovation is seen as the most likely saviour and enabler of solutions to these challenges while spurring new economic multipliers via the creation of new markets and further economic growth. Thus, there is the belief amongst policy and academic circles that those governments which best promote, manage and diffuse innovations will be best positioned to renew competitive features of their countries in the long term.

This belief amongst academics and policymaking circles arises partially from the impact experienced from implemented policies focused on the promotion of economic development over the last five decades – in government and corporate spheres. Here the exploitation of innumerable innovations across the global economy has increased productivity of firms and increased consumption and welfare at an unprecedented scale. With respect to this level of consumption, however, it has been acknowledged that it is not possible to continue producing and consuming in the same fashion and at the same rate in the long term. Science and technology are expected to play a major role in the search for solutions.<sup>2</sup>

What has not been accepted in policymaking circles is that our current technological stock has a major entropic anomaly, including the way we currently conduct technological innovation. It represents a massive environmental failure of current technological paradigms. This failure consists of the following: The generation of residuals (pollutants or other) is a problem common to all industries, especially advanced technology industries, such as microelectronics, micro-systems, and nano-technologies. The reason is that these advanced technologies require large amounts of pure materials, and large production and supporting systems per produced and used unit. To a large extent, this is also applicable to the new wave

---

<sup>1</sup> TNO – The Netherlands Organisation for Applied Scientific research, [Carlos.Montalvo@tno.nl](mailto:Carlos.Montalvo@tno.nl)

<sup>2</sup> Here it is worth noticing that the academic and policy circles mentioned belong to different epistemic communities and centres of power and frequently hold conflicting positions.

of renewable and energy efficiency technologies (e.g., LED lighting , windmills, bio-fuels, photo-cells, fuel-cells, etc.)<sup>3</sup> as they also present pollution problems in their production and decommissioning stages.

The common thread connecting all industrial and services activities is the neglect of the first and second law of thermodynamics in stages of design, development, manufacture, commercialisation, usage and decommissioning.<sup>4</sup> For more than 150 years of industrialization economic activities underpinned by our current technological stock have been and are producing pollution and causing environmental degradation (both localized and global depending on the scale and scope of industrial operations and consumptions patterns). *The challenge lies in replacing a large proportion of our current technological stock with new technologies underpinned by new science and applied knowledge that do not violate but accommodate the first and second laws of thermodynamics.*

It is surprising that the implications of these laws have been largely neglected in engineering practice for so long and are still not readily accepted in the technology and industry policy arenas. The implications are huge but the problem is becoming greater over time as global economic growth increases with the growing demand for more production of goods and provision of services as emergent economies enter in full swing to the mass consumption mode of development characterised by rapid obsolescence of products. The problem is so extensive because, in practice, it has been largely negated in all instances of human organisation. Science, technology and innovation have brought many benefits to human kind but it must be accepted that the Schumpeterian notion of *creative destruction* as a general economic multiplier<sup>5</sup> could, if not re-oriented, well come to be understood literally what it means in environmental terms, i.e. the degradation of our natural environment that supports life. That is, a focus on innovation for the sake of economic growth alone is not sufficient anymore.

Given the highly complex problem that environmental sustainability represents the emergence of a sustainable system of innovation seems highly desirable. Sustainable innovation is an idea that arises from the need to maintain the natural environment that supports our production and consumption as much as possible in the long term. It is only recently that sustainable innovation is seen also as a potential source to sharpen the competitive edge of firms. Improvement of economic efficiency

Thus, sustainable systems of innovation can be conceptualised as serving two intertwined aims: fostering international competitiveness and/or enabling the creation of sustainable innovations (that is, innovations focused on environmental sustainability).

The notion of *sustainable systems of innovation* comes to merge two distinct schools of thought. In a stylised manner it can be said that “sustainable systems of innovation” as a concept arises from two epistemic communities that have largely dedicated to analyse disparate subjects. The *sustainability* discourse has been primarily occupied with describing and analysing the problem of progressive environmental degradation and the likely collapse of the natural systems that support human life if the current production and consumption style and trends continue. In the literature of sustainable development, there is agreement that for a

---

<sup>3</sup> These technologies are being developed and diffused in the face of climate change and high energy prices.

<sup>4</sup> According to the first law, matter can neither be created nor destroyed, but only transformed. The second law refers to the fact that every anthropogenic work produces a degradation of energy and matter. These laws have many implications for product and process development in particular and for whole economic system in general. For a discussion see Georgescu-Roegen (1971).

<sup>5</sup> This notion was conceptualized before Schumpeter by Mikhail Bakunin, Friedrich Nietzsche and Werner Sombart.

society to be sustainable it must be sustainable in economic, societal and environmental terms.

In contrast, the epistemic community studying “*systems of innovation*” has been primarily concerned with the analysis of economic growth and international competitiveness and the role that science, technology and innovation play in the economic process. Systems of innovation research and policy have been primarily occupied with the promotion of an engine of innovation towards the leverage of countries’ competitiveness. Here networks of scientific and technical institutions, infrastructures and the social environment contribute to making the creation of innovation and its exploitation a reality. The more efficient the working of the system of innovation, the better the economic performance of firms and sectors and hence a contribution to the economic growth of an economy.

*Sustainable innovation as a new economic multiplier.* From classical economics we know that the income generation process in an economy is a concurrent phenomena where ideas, needs, supply and demand converge to create organised work in order to fulfil human needs. This means that an *economic multiplier* can arise from any of these mentioned sources.

In this regard, sustainable innovation, as mentioned above, is an idea that arises from the need to maintain as much as possible the natural environment that supports our production and consumption. If we are due to replace a great deal of our current technological stock here there is an important role for science, technology and innovation to bring about massive structural change across the global economy. If this challenge is taken seriously – as it should, given the severe anomaly of our current technological stock – there is the possibility of rolling out one of the biggest economic multipliers of modern times. Sustainable innovation requires industrial and innovation policy throughout the innovation cycle, from basic research to diffusion and global exploitation of eco-innovations. We are currently witnessing the first symptoms of a new wave of innovations (sustainable innovation) reflected already at the stock market during the last two years: The fastest growing holdings of venture capital in the stock market are those companies conducting research, producing and aiming to commercialise cleaner technologies.

*The role of government and systems of innovation.* Similarly, from the last three decades of industrial organisation research, we know that the competitiveness of firms can be maintained, improved or lost over time. Thus, national performance is dependent on the ability of governments to design and implement appropriate policies and framework conditions for businesses to thrive (e.g., the existence of a national system of innovation, benevolent tax regime and regulation, protection of IPRs, strong knowledge infrastructures, etc.). Here the role of government is to implement the necessary and sufficient conditions for firms to compete internationally. If we are to replace a large part of our technological stock based on new scientific principles, the concept of sustainable systems of innovation offers an unprecedented opportunity to restructure international markets in the medium-long term where developing economies might, de facto, have a head start. The main components of this argument are outlined below to open a discussion about the contours of future lead markets related to sustainability and the role of systems of innovation.

- We know that a system of innovation is composed of diverse actors, rules, and institutions whereby several actors and institutions converge interests for a specific technology to forge its exploitation. Thus, current dominant firms are likely to focus their primary efforts on maintaining their core technologies in the market neglecting or not being able to renew their knowledge stock as they can be expected struggle to

maintain their current position. Their core competences are to become their core rigidities in the face of sustainable innovation.

- We also know from diffusion research that one of the prime barriers to diffusion of new technologies is the dominance of current technologies (know-how, standards and regulations) and its associated infrastructures and centres of economic and political power.
- We know from experience the capacity of some firms (or countries) to leap-frog in scientific and technological capacity that some countries have demonstrated in the past decade. Developing economies have less baggage to carry in terms of non-sustainable production and consumption infrastructures.
- To a large extent, developed economies have quasi-saturated markets. Conversely, developing economies are characterised by underdeveloped markets. This opens the way for the creation of new lead markets in developing economies.
- The average consumer in developed economies is so accustomed to mass consumption and fast obsolescence of products and services they enjoy that he/she would find it hard to renounce to his/her current life style.
- The knowledge required for sustainable innovation is not necessarily associated with the development of high tech. Rather, with the reconceptualisation of the services provided by current technologies.

Given the above, it is likely that current systems of innovations in developed economies face more rigid structures than those in developing economies, effectively giving a head start to developing economies. In order to evaluate the relative differences, we need to look at the consumption and production sides as well as the related institutions and existent infrastructure. Some of the categories that should be compared are summarised in the table below.

	<b>Developed economies</b>	<b>Developing economies</b>
<b>Markets</b>	Saturated	Underdeveloped
<b>Consumer characteristics</b>	Large proportion have access to mass consumption	Small proportion have access to mass consumption
<b>Venture capital</b>	Easy access	Micro credits
<b>Infrastructure</b>	Widespread, mature to old	Limited scope, underdeveloped or old
<b>IPR</b>	Mature	Limited, often non-existent
<b>Patents</b>	Large numbers	Extremely limited
<b>Population</b>	Aging fast	Aging at a lower pace (many young)
<b>Regulatory institutions</b>	Strong - inflexible	Lax - Flexible
<b>Industrial park</b>		
<b>Tax regimes</b>	Strong	Lax
<b>Number of Engineers</b>	High	Low
<b>Number of Scientists</b>	High	Low
<b>Mindset of engineers and Scientist in terms of technological paradigm</b>		

**Relevant questions here are:**

- How level is the playing field for advanced and developing economies to forge ahead sustainable innovation?
- What are the relevant categories that enable sound comparison of competitive advantages?
- Is sustainable innovation by definition in conflict with international competitiveness and global trade?
- What type of knowledge new capabilities are required?

**Author's short biography**

Dr Montalvo works at TNO as senior adviser and strategist with TNO-KvL Innovation Policy and TNO-Bouw Environment and Innovation. He joined TNO as senior staff member on Technology and Innovation Policy in 2002. He holds a BSc. in Electro-mechanical Engineering and MSc. in Industrial Economics. He completed a DPhil in Science and Technology Policy Studies at SPRU, University of Sussex (UK). Dr Montalvo has 20 years of professional experience, with extensive practice as an engineer and in project and R&D management. His is an authority on technology innovation and management with wide experience in multidisciplinary and international research. Previous to joining TNO, Dr Montalvo held a number of engineering and management positions in industry and on international organisations. Currently acts as Subject editor for the Journal of Cleaner Production and member of several Board of Experts giving support to key European actions on R&D, Innovation and Competitiveness as well as serving as evaluator in the European Framework Program and the UK's ESRC. Dr. Montalvo current activities and research interest focus on: competitiveness, R&D and innovation; evaluation of RTD programs; innovation policy monitoring and impact; innovation and environment; technology adoption and diffusion analyses, and in the application of behavioural and non-linear models to explore the interaction between innovation and regulation.