THE NEW TECHNOLOGICAL PARADIGM AND THE LONG CYCLE IN THE CONTEXT OF SUSTAINABLE DEVELOPMENT

Cristina TĂNĂSESCU
"Lucian Blaga" University, Sibiu, Romania, e-mail cristina.tanasescu@ulbsibiu.ro

ABSTRACT: The now prevailing industrial technological mode of production, its last stage – fifth technological wave has mainly exhausted its potential, is in the state of a deep crisis. In the tradition of technological innovation waves (modelled following Kondratieff's long waves hypothesis), the paper explores the emergence of the 6th technological wave associated with the development of new technological classes. The changes have the potential to influence the cyclic effects in economic development and cause a paradigm shift, a change in the technological regime. The new paradigm needs a new organizing principle, new policy framework and new "theory of moral sentiments". At the heart of the debate over the potential effectiveness of sustainable development is the question of whether technological change, even if it can be achieved, can reduce the impact of economic development sufficiently to ensure other types of change will not be necessary.

KEY WORDS: long cycle, sustainable development, technological paradigm

1. GLOBAL SOCIO-ECONOMIC REALM AND KONDRATIEFF CYCLE

In a large rolling over the way in economic development, when all the foundations of economic life - present and past - are put back into question, and all the lessons of history do not help those who have learned them, the precise understanding of long cycles, which seem to obey certain laws or tendentious rules, is an opportunity for learning about the direction in which the contemporary world economy is moving. General development of the economy (based on data relating to advanced countries) shows that the country's productive forces takes place in the form of "waves" (cycles) long by 40-60 years. This period is dominated by a technical way of production of certain technology. Some experts identify the big "waves" with the history time of the outbreak, maturation and exhaustion values of an industrial revolution.

In the development of each economy - and this especially in light cycles – two main phases are distinguished: an ascending phase and a descending phase, each with a duration of 20-30 years.

In the ascending phase the implementation and technical operation of the new way of production occurs, business activities - based on new technologies - take place at this stage, with increased efficiency. Within the period of 20-30 years there are being observed: the dominance of years of prosperity, relatively high rates of economic growth, rising living standards, high employment level, etc. The period of transition from the old way to the new production techniques is marked by a structural crisis, a period which is extended during downward phase. In this phase of long economic cycles, initially, some showing signs of exhaustion values of favourable growth factors occur. There is a tendency of decreased efficiency and rate of profit. It is the sustained period of scientific research to find solutions to streamline the production process. It also marks a transition to new production techniques.

If we look at the parallel fluctuations of investment and scientific research over the two stages of the long cycle, we will note the following:

• The ascending phase entails a sustained and effective investment process based on previous scientific discoveries (in the downward phase). In this phase of the research recorded a rebound (in intensity) and a high efficiency of investments made on the basis of previous findings.

• The downward phase, produces instead a relative decline in investment efficiency (of production) and an increase in the scientific and technological research. Now the structural crisis manifests (technology, industry, etc.), crisis which is specific for transition from one technology to another, from one stage of technical progress and scientific and technical office to another. Available statistics seem to show that the peaks of scientific discoveries and technological innovations have placed in downward phases of long cycles.

Innovation is the exogenous factor of production "that makes economic life to be cyclical in nature". Innovation should not be confused with invention. The invention of a new manufacturing process becomes innovation as long as it is not brought into production. Innovation is a process of industrial transformation that continuously revolutionizes the economic structure from inside, destroying continuous its old items and creating new items continuously.

A short term decline may be experienced during a long-term expansion, as may be a small increase within long-term contracts. These large oscillations are due to the specific dynamics of various components of social and economic system (population, employment, fixed assets, raw materials and energy resources, economic mechanism), the interaction between them, the contradictions that have appeared in economic and social development, the delayed reaction of economic agents in different modification, the inertia that is shown by some components.

The invention of a new product or process occurs within what could be called the techno-scientific sphere and it can remain there forever. By contrast, an innovation is an economic fact. The first commercial introduction of an innovation transfers it into the techno – economic sphere as an isolated event, the future of which will be decided in the market. In case of failure, it can disappear for a long time or forever. In case of success it can either still remain an isolated fact or become economically significant, depending upon the degree of appropriability, its impact on competitors or on others area of economic activity. Yet, the fact with the most far-reaching social consequences is the process of massive adoption. Vast diffusion is what really transforms what was once an invention into a socio-economic phenomenon.

So, inventions can occur at any time, with different importance and at varying rhythms. Not all of them become innovations and not all innovations diffuse widely.

The cluster of innovations at the start of each wave is associated with a shift towards a new technological transformation, with a combination of new technologies, the development of new industrial activities and a deep transformation of human behaviour (Devezas, 1999). Each new technology system grows logistically until it reaches market saturation and then declines and begins to be replaced by a newer technology system – there is a successive alternation of growth and decadence with duration of 50-60 years (Devezas, 1997).

The present period is defined as one of transition between two distinct technological styles – or techno-economic paradigms – and at the same time as the period of construction of a new mode of growth. Such construction would imply a process of deep, though gradual, change in ideas, behaviours, organizations and institutions, strongly related to the nature of the wave of technical change involved. (Carlota Perez, 2004, pp. 217)

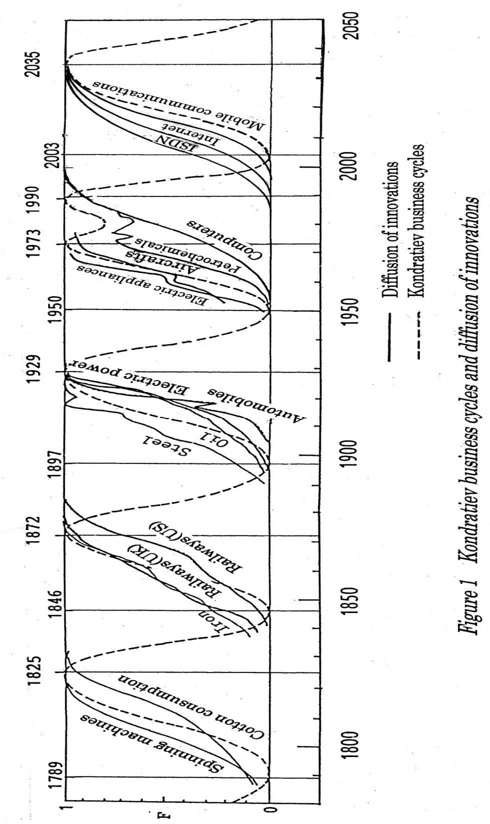

Figure 1. Kondratiev business cycles and diffusion of innovations

2. THE INNOVATION PARADIGM

The diffusion of innovation can be described by a logistic equation as shown by Grilliches (1957). An innovation paradigm consists of three trajectories: technology, development and diffusion in this order (Hirooka, 1998). The technology trajectory appears first. The technologies developed formulate a technology trajectory and the matured technologies begin to produce new products which formulate a development trajectory. The market of new products develops a diffusion trajectory. Thus, an innovation paradigm can be described by a series of three trajectories as shown in Figure 2.

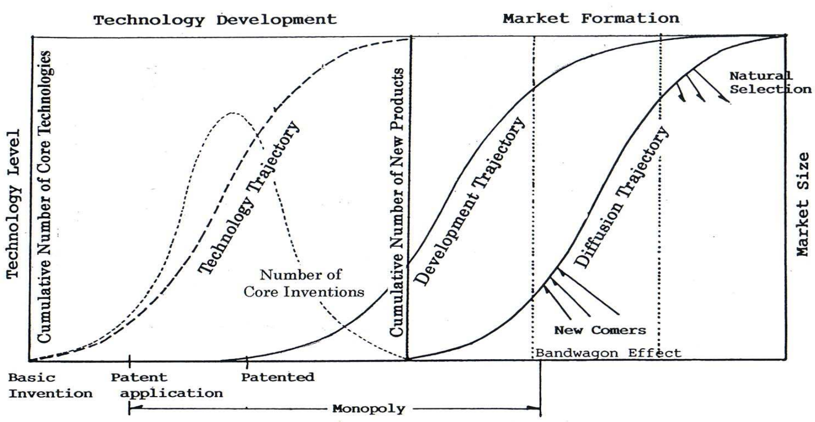

Figure 2. The description of an Innovation Paradigm

An example of innovation paradigm is exhibited in the case of electronics paradigm. The technology trajectory started from the radical invention of transistor by Shockley et al. and integrated circuits pushed up the development. Through the inventions of MOS IC and submicron lithography technology, the technology trajectory was completed with about 25 years time span. The development of integrated circuits with ca. four years steps in each degree of integration formulated the development trajectory. The diffusion trajectory can be described by chasing the market development of the ICs. These trajectories are shown in Figure 3 (after Masaaki Hirooka in The Future of Civilizations and Strategy of Civilizational Partnership, 2009).

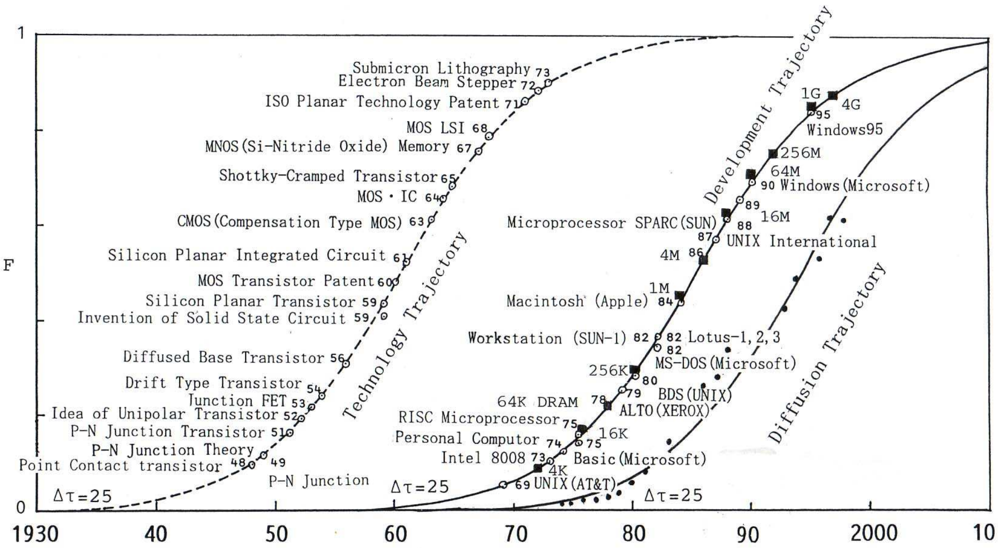

Figure 3. An example of innovation paradigm - electronics

Information technology (IT) and the Internet are major drivers of research, innovation, growth and social change. The OECD Information Technology Outlook 2010 analyses the economic crisis and recovery, and suggests that the outlook for IT goods and services industries is good after weathering a turbulent economic period better than during the crisis at the beginning of the 2000s. The industry continues to restructure, with non-OECD economies, particularly China and India, major suppliers of information and communications technology-related goods and services.

The role of information and communications technologies (ICTs) in tackling environmental problems and climate change is analysed extensively, with emphasis on the role of ICTs in enabling more widespread improvements in environmental performance across the economy and in underpinning systemic changes in behaviour.

Recent trends in OECD ICT policies are analysed to see if they are rising to new challenges in the recovery. Priorities are now on getting the economy moving, focusing on ICT skills and employment, broadband diffusion, ICT R&D and venture finance, and a major new emphasis on using ICTs to tackle environmental problems and climate change.

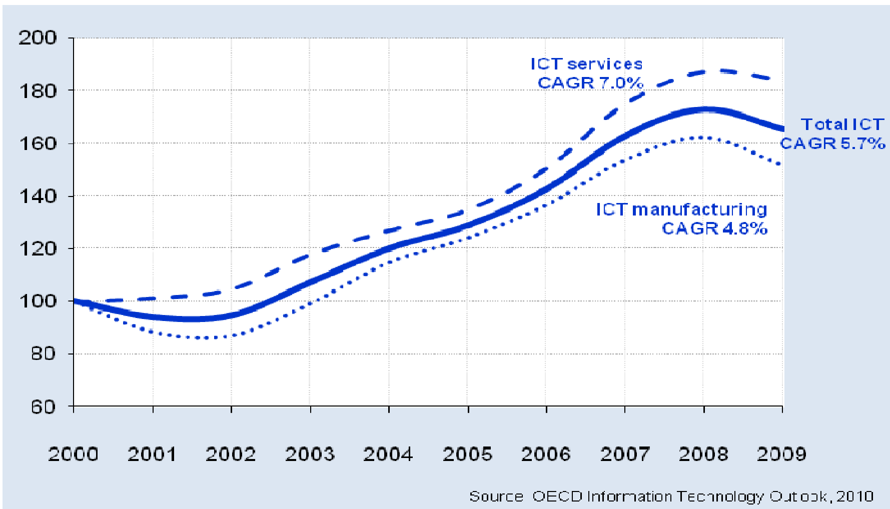

Figure 4. Trends in Top 10 ICT firms' revenues globally, 2000-2008

Global ICT industry shows 3-4% growth in 2010 and the outlook is for continued growth in 2011. IT services firms are weathering the crisis much better than manufacturing firms. This benefits firms like IBM and Fujitsu that were hardware producers a decade ago, but have today become largely services businesses. The world’s ten biggest Internet firms' revenues increased by 10% during the crisis year 2009.

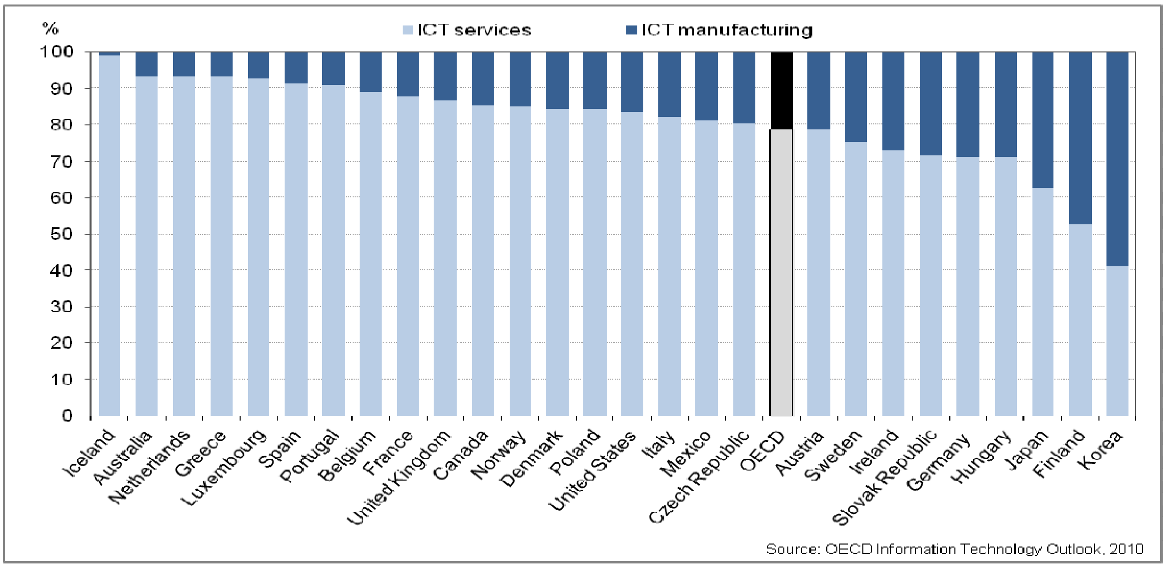

Figure 5. ICT sector value added in OECD countries

OECD countries have been increasingly specializing in the provision of ICT services. Around 80% of ICT sector value-added in the OECD is generated by ICT services. This mirrors the shift of ICT manufacturing to Asian economies over the past decade.

50% of global trade in manufactured ICT products takes place outside the OECD countries. Chinese companies such as Huawei and ZTE are growing ever more competitive and innovative in emerging markets.

ICT firms outside the OECD are becoming major international investors. In 2009, one-quarter (24%) of international M&A deals in the ICT sector were initiated by firms outside the OECD, e.g. China, India, Russia, Arab countries.

ICTs and the environment

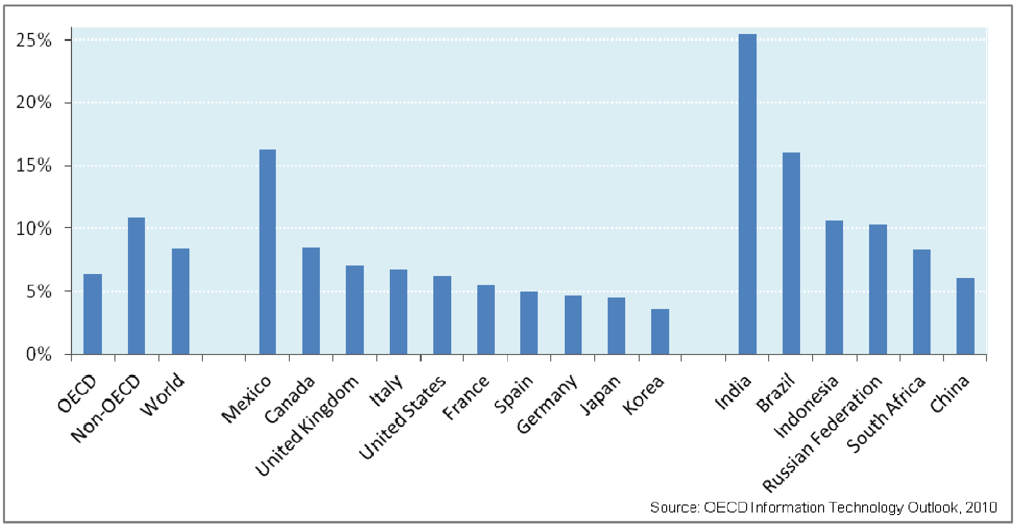

Figure 6. Electricity lost during transmission and distribution globally

Industry and governments are looking in more detail at “net” environmental impacts of using ICTs. The smart grid is an area that can make electricity production, consumption and management more sustainable. For example, it can mitigate the amount of electricity worldwide that is lost – around 8% of the total.

At the same time the sector needs to address related life-cycle issues, e.g. energy use, electronic waste. Smart electricity meters allow better energy conservation by final customers, but also increase the need for servers, data centres and networks, begging the question of “how green is the Internet?”. Internet use and consumption of “digital content” also contribute to environmental efficiencies. As one quarter of music consumption today is in a digital form, physical carriers become increasingly obsolete – no need to produce them, ship and drive them around, dump or recycle them.

3. SOME CHALLENGES OF TOMORROW’S WORLD

The industrial economic system oriented at the system of market-capitalist relations, every possible exploitation of labor and natural resources and militarization for the sake of deriving maximum profits prevailed in the vanguard civilizations and world economy during two centuries has mainly exhausted its growth potential. Plus, a neo-liberal model of spontaneous market self-regulation of economy and globalization prevailed in the last quarter of the century has shown its inadequacy. It is necessary to shift to the model of a harmonious combination of market enterprise and self-regulation with governmental and inter-governmental regulation of functioning and development of economy in the context of interests of the present, past and future generations.

The global system is aimed at maintaining its homeostasis or keeping humankind safe. Sustainable development of humankind lies in maintaining the global system integral for a long period of time. The necessary condition for this sustainable development is institutions which provide compromise base for interaction between nations and it's group consolidation - local civilizations within the global system.

It appears necessary in this regard:

• optimization of the level of consumption of energy, forest, land, water and other natural resources, surmounting a wasteful industrial mode of production and consumption. In this context, it is important to estimate the level of consumption established of energy and other natural resources and elaboration of consumption standards optimal and distributed in time and space for separate resources on a global scale and by countries in the context of their natural-climate, technological, socio-economic and civilizational distinctive features and energy-ecological needs, food patterns and standards of life of population.

• strategy of saving of energy and other natural resources in the context of interests of future generations, replacement of non-renewable natural resources with alternative energy sources and materials that will allow extending the exploitation and satisfaction of needs in such resources for a super long prospect.

• alternative sources of energy and materials. The key direction in saving of fossil fuel and resources is their large-scale replacement with alternative sources – hydrogen energy and fuel cells, biofuel of the second generation, renewable sources of energy, composites, and nanomaterials.

4. ACKNOWLEDGEMENTS

The present paper has been co-funded by the European Social Fund - Sectorial Operational Programme for Human Resource Development 2007-2013, under the project no. POSDRU/89/1.5/S/63258 entitled “Postdoctoral School for Zootechnical Biodiversity and Food Biotechnology based on the Eco-Economy and Bio-Economy required by Eco-Sanogenesis”.

REFERENCES

1. Hirooka, M., “Innovation Dynamism and Technological Opportunities for Venture Businesses”, Journal of Ryutsu Kagaku University – Information , Economics and Management Science, 6 (2), pp.55-67 (1998)
2. Hirooka, M., “Innovation Dynamism and Economic Growth – A Nonlinear Perspective”, Edward Elgar, Cheltenham, UK (2006)
3. Carlota Perez, ”Technological Revolutions, paradigm shifts and Socio-Institutional Change”, published in: Reinert, Erik (ed.), ”Globalization, Economic Development and Inequality: an alternative perspective”, Edward Elgar, Cheltenham, UK, Northampton, MA, USA, 2004, pp. 217-242
4. Yu.V. Yakovets, B.N. Kuzyk, N.S. Bekturganov (coord.) The Future of Civilizations and Strategy of Civilizational Partnership. Part 9 of the Global Forecast “Future of Civilizations” for 2050, Moscow: SKII, 2009, 600 p.
5. http://www.oecd.org/sti/ito