Chapter 1

Technological Reconstruction of the Global Economy

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Additional information is available at the end of the chapter

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Abstract

The chapter addresses the technological evolution of global economy since the yearly post war years until the beginning of world crisis in 2008. The author explains spectacular growth, demonstrated in the world economy, by implication of technologies, invented during "the golden age of technologies", the dual-use peculiarity for the majority of them and their subsequent transfer from the leading countries to the less developed, enforced the extension in scale of production and markets. It should be recognized that the technological system, launched after the World War II represents the backbone of the contemporary global economy, despite the different role of its main drivers: manufacturing production, trade in goods and services or foreign direct investments. The theoretical model of the steady-state growth most appropriately describes how the increments in capital and investments enforce the economic growth, no matter of where there are originating from. The 2008 global crisis reveals the exhaustion of the "technological source" for continuing growth of the world economy, reflecting in many ways the emerging discrepancy between technological development and economic growth: deindustrialization of the leading economies, "bubble effect", eroding the foundation for economic sustainability, "Dutch disease" for the oil-dependent countries, the bias toward the energy resources in the world trade in general and, of course, worldwide growing militarization. The chapter highlights the necessity for the revision of that states of affairs in the world economy and proposes in where to start creating the new global technological system as the new backbone for restarting the economic growth and international civil cooperation.

Keywords: technological change, epochal innovations, steady-state growth model, economy of scale, economy of scope, dual-use technologies, regional comparative advantage, creative destruction, localization of technological change

1. Preface

Globalization means that world has been functioning as a single system, where any country-specific fluctuations spread over the other countries and being substantial in scope and scale urge them to adjust, even through revision of the domestic policy. The increasing circulation of resources – labor, financial and physical among regions, countries and continents makes the "resource scarcity" senseless, thus impeding the overall technological development and on that way – the global economic growth. In terms of technological and local diversities, the world became more standardized and less unique, which, in turn, engenders its fragility. Undoubtedly, diversity makes the world stronger and, on the contrary, squeezing diversity makes the world weaker!

Scientists, monitoring the economic development, could be, probably, divided on those, who are formally or informally followers of the "steady-state growth" theory and denies the most evidently approaching destruction of the existing global economic system, and those, who recognizes the realities of the Schumpeterian "creative destruction" epoch, similar or even more profound that of the Great Depression in 1930. The different standpoints are reflected in the different insights into economic development and its prospects: "followers" preserve the existing order of things (through reallocation of financial and labor resources, application of the austerity measures, confronting the national identification processes) and "Schumpeterians", who recognize the cyclical mode of economic development, with its essential downturn stage and depression (leading further to the new highs in growth and prosperity, enforced by the application of technological innovations); the emergence of new innovative companies, replacing the "old champions"; and the new individuals-innovators coming to the scene and taking a lead over societies with their exceptional ability of taking a risk of novelty rather than exploiting the way things go on.

Among the multifaceted contradictions of our epoch, the profound transformation of global economic and technological system spurs any other political, ecological, social challenges confronting the global society. Probably the new and more sustainable global politico-economic system will originate from the technologically transformed local societies intersected in between and on that way establishing a new model of interregional and subsequently international division of labor as the core of the renovated market economy[1]. This is our main standpoint underpinning our further insights into globalization.

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[1]The market economy foundation is explicitly explained by A. Smith in his famous investigation "An Inquiry into the Nature and Causes of the Wealth of Nations". He starts his insights into the market economy with the analyses of the division of labor, which enforces gradual technological improvements, leading to the labor productivity growth and hereupon increasing the volume of tradable goods as contribution into the wealth of nations. In his first chapter, entitled "Of the Division of Labor" he writes: "This great increase of the quantity of work, which, in consequence of the division of labour, the same number of people are capable of performing, is owing to three different circumstances;
- first, to the increase of dexterity in every particular workman;
- secondly, to the saving of the time which is commonly lost in passing from one species of work to another;
- and lastly, to the invention of a great number of machines which facilitate and abridge labour, and enable one man to do work of many". (A. [19]). Actually, A.Smith treats the division of labour and technological change as the market foundation in controversy with the "laissez faire, laissez passer" principle, which is usually refers to his name.

2. Creating the global economy after the World War II

The twentieth century historically is unprecedented in terms of economic growth, elevated by the growth in production output, trade, emergence of new business in services, tourism and information, spreading over the countries, involving their population into economic activities, therefore increasing personal incomes and consuming capabilities almost in all over the world.

Peaking point in the global economic development after the World War II was reached in 2008, before the first sign of the incoming economic downturn has appeared. During the period 1950–2007 the Gross World Product has increased from $5.3 trillion to $65.6 trillion. – more than 12 times. During the same period the World export has increased from $295 billion. to $12 trillion. – more than 40 times. About the growing welfare has been witnessing the following fact: in 2007, at the eve of the world economic crisis the world car sales have reached its highest level of $1183 billion (or 8.7% of the whole world export) or over 2 times higher than the trade in textile and clothes. The other spectacular fact – the pace of growth of the average income in China, one of the poorest countries in the twentieth century: in 1952 with only 445 CNY per year while in 2016 it amounted 67,569 CNY per year, increasing almost in 152 times!

The explanation of that fabulous global economic growth would be inappropriate without mentioning the critically low level from which it originates. After the World War II, the manufacturing capacities, transportation systems, houses in many countries in Europe and Asia were almost totally destroyed. Margaret MacMillan writes: "In Germany, it has been estimated, 70% of housing had gone and, in the Soviet Union, 1700 towns and 70,000 villages. Factories and workshops were in ruins, fields, forests and vineyards ripped to pieces. Millions of acres in north China were flooded after the Japanese destroyed the dykes. Many Europeans were surviving on less than 1000 calories per day; in the Netherlands they were eating tulip bulbs. Apart from the United States and allies such as Canada and Australia, who were largely unscathed by the war's destruction, the European powers such as Britain and France had precious little to spare. Britain had largely bankrupted itself fighting the war and France had been stripped bare by the Germans" [1]. The twentieth century economic story is, the most probably, about the post war recovery, steady growth in production output, successive extension of trade and markets, appearance of new profitable business in services with the involvement of new countries and companies into the global trade.

Figure 1 shows the linkage between the World GDP and growth in manufacturing output, revealing the key role of industrial production in driving the economic growth, creation of new jobs and extension of markets, supplying producers with raw resources and materials and providing sales of final and semi-final goods. **Figure 2** displays the increasing role of trade in the development of global economy beginning from 1990. Elimination of trade barriers, pursued by the World Trade Organization (successor of the General Agreement on Tariffs and Trade, established in 1947 with the inclusion of 164 member states up to 2017 among 196 total number of states in the world[2]), has played significant role in developing the world trade and global economy in general.

[2]Some controversy might happen here. The United Nations, for example, recognizes more than 240 countries and territories. The United States, however, officially recognizes fewer than 200 nations. Ultimately, the best answer is that there are 196 countries in the world. The number of the countries in the world. https://www.thoughtco.com/number-of-countries-in-the-world-1433445

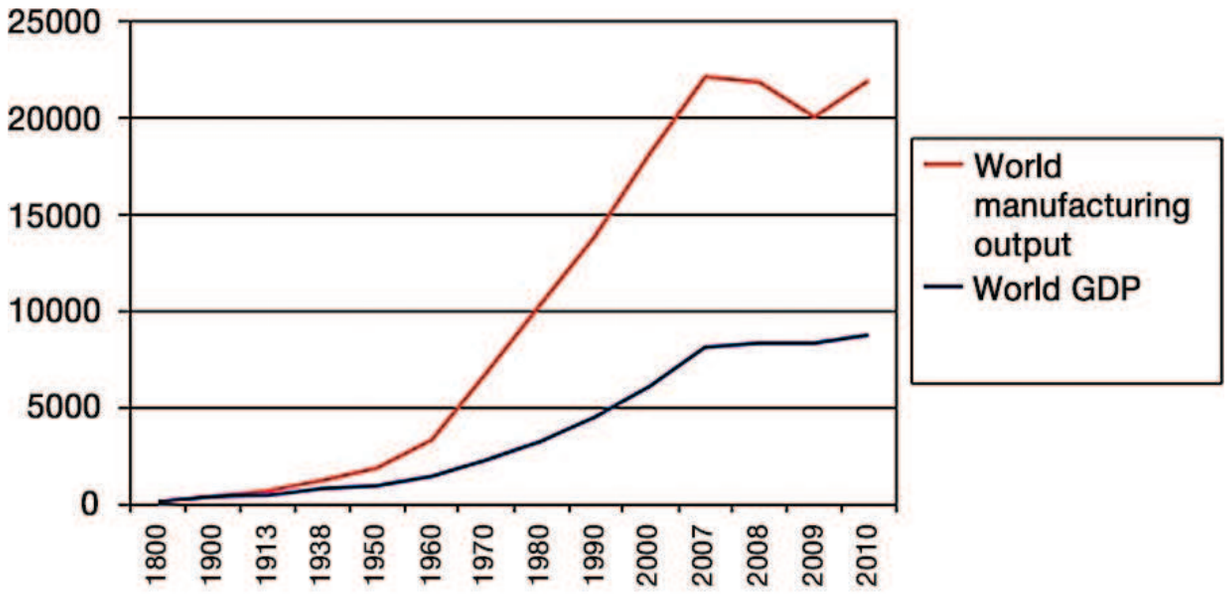

Figure 1. World manufacturing output and GDP (rebased, 1800 = 100). Source: HIS global insight, Paul Bairoch, World Trade Organization. https://pt.slideshare.net/geoffriley/tutor2u-global-economy-peter-marsh-on-a-new-industrial-revolution?ref=&smtNoRedir=1.

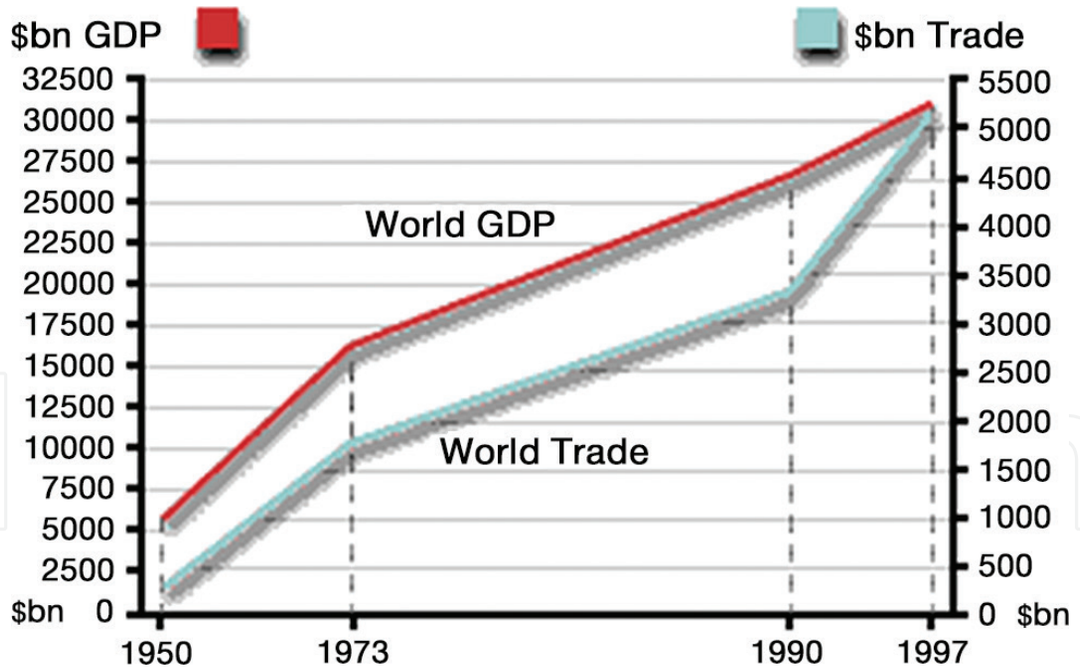

Figure 2. The development of world trade. Source: WTO.

At the same time the circulation of the production factors – capital and labor – among the countries has intensified substantially. Gross cross-border capital flows rose from about 5% of world GDP in the mid-1990s to about 20% in 2007, or about three times faster than

world trade flows[3]. According to the International Labour Organization, in 2015 the migrant workers accounted for 150.3 million of the world's approximately 232 million international migrants. The vast majority of migrant workers are in the services sectors, with 106.8 million workers accounting for 71.1% of the total, followed by industry, including manufacturing and construction, with 26.7 million (17.8%) and agriculture with 16.7 million (11.1%)[4].

The interdependence among the countries became critical. The United States, for instance, being the dominated country for the rest of the world, depends substantially on the inflows of foreign capital. According to Kames K. Jackson, the US direct investment at the current cost in 2015, included into the "net international investment position of the United States" amounted $7280.6 billion.[5] The other case of the increasing dependence of national state from its international disposition demonstrates Russia with its crucial dependence on trade in oil and gas. And almost every country in the world has been falling under the Chinese economic dependence in terms of trade, investment and world economic growth in general. The fragility of the global economy became so high that a minor fluctuation somewhere in the world might be a trigger for dismantling the whole post war economic architecture.

3. Technological system: the backbone of the post war economy

Economists often treat the monetary policy, embracing manipulation of interest rates, exchange rates, taxes as the main regulation intervention of state to the market economy and the means for spurring the economic growth. Charles I. Jones writes on that matter: "…it is helpful to think of the economist as a laboratory scientist. The economist sets up a model and has a control over the parameters and exogenous variables. The 'experiments' is the model itself. Once the model is setup, the economist starts the experiment and watches to see how the endogenous variables evolve over time" ([2]).

On the contrary, our perception about economic growth is based on the assumption that it is driven by the technological nucleus, endogenously created within the economic system. Technological systems overlapping with economic systems could either facilitate the economic growth or impede it. After the World War II and until 2008, the technological input into economic development has produced an output – explosive economic growth, gradually spreading over the increasing number of countries.

The technologies, invented during the so-called "golden age of technologies" (the period embracing the second half of the nineteenth century and the first decades of twentieth century), have composed the technological backbone for the post war recovery and forthcoming economic growth. In his book, entitled "Creating the Twentieth Century" Vaclav Smil

[3]International capital flows: Structural reforms and experience with the OECD Code of Liberalization of Capital Movements Report from the OECD to the G20 Sub-Group on Capital Flow Management June 2011 https://www.oecd.org/economy/48972216.pdf

[4]http://www.vitainternational.media/en/article/2015/12/17/150-million-migrants-in-the-global-workforce/139/

[5]"T James, K. Jackson. The United States as a Net Debtor Nation: Overview of the International Investment Position" October 7, 2016. https://fas.org/sgp/crs/misc/RL32964.pdf

states that: "The greatest technical discontinuity in history took place between 1867 and 1914. This era was distinguished by the most extraordinary concatenation of a large number of scientific and technical advances the synergy of which produced bold and imaginative innovations as well as ingenious improvements of older ideas, by the rapidity with which these innovations were improved after their introduction, by their prompt commercial adoption and widespread diffusion, and by the extent of the resulting socio-economic impacts. Even the most rudimentary list of these epoch-defining innovations must include telephones, sound recordings, light bulbs, practical typewriters, chemical pulp, and reinforced concrete for the pre-1880 years. The astonishing 1880s, the most inventive decade in history, brought reliable electric lights, electricity-generated plants, electric motors and trains, transformers, steam turbines, gramophone, popular photography, practical gasoline-fueled internal combustion engines, motorcycles, cars, aluminum production, crude oil tankers, air-filled rubber tires, steel-skeleton skyscrapers and pre-stressed concrete. The 1980s saw Diesel engines, x-rays, movies, liquefaction of air, and the first wireless signals. And the period between 1900 and 1914 witnessed mass-produced cars, the first airplanes, tractors, radio broadcasts, vacuum diodes and triodes, tungsten light bulbs, neon lights, common use of halftones in printing, stainless steel, air conditioning, and the Haber-Bosch synthesis of ammonia (without which at least 40% of humanity would not be alive)" (Vaclav [3]). The mismatch between these technologies, requiring the long-term investments into capital-intensive production and the gradual extension of sales, on the one side and the "market shortemism" on the other side was overcome by the state intervention. During the War economies of twentieth century the leading countries: the United States, the USSR, Germany, the United Kingdom, Japan and many others pursued the state intervention policy, replacing the market in terms of provision the long-term financial resources, state military procurement, R&D facilitation and protection of national companies from the international competition. Margaret McMillan writes: "Under the stimulus of war, governments poured resources into developing new medicines and technologies. Without the war, it would have taken us much longer, if ever, to enjoy the benefits of penicillin, microwaves, computers – the list goes on. In many countries, social change also speeded up" (Margaret [1]).

After the World War II, the enormous intellectual capital and R&D capabilities, accumulated during the war in order to facilitate the production of armaments, were shifted to the non-military production, especially in the countries, in which the military spending were prohibited (Japan, Germany and alike). In coincidence, the world was divided on the fast growing countries, competing on the market of non-military production (the most spectacular was the rise of the so-called "catching up countries" of the East Asia), and the countries, producing innovations regardless their predominantly military application, the United States and the USSR to mention here.

That was the time of permanently cumulating welfare around the globe: the scale and diversity of production output in the leading countries was growing steadily, the international trade, propelled by the gradual elimination of the trade barriers expanded quite rapidly. The emergence of the new comer countries, "producing the same at less cost", filled out the fast

growing market of consumer goods, first emerged in the leading countries and then – in the rest of the world. Besides, the new economic activities, such as tourism, logistics and transportation, appear. The technological backbone, created at the beginning of twentieth century, gave a birth for the enormous varieties of economic activities, embracing countries, companies and ordinary people.

4. Endogenous insight into the technological input into production output

There are two different theoretical insights into the role of technologies in economic development: one considers technologies as the exogenous input into production output and economic growth, the other considers technologies as the endogenous input into production output and economic growth. The critics of the "exogenous theory" writes: "Growth has occurred not by producing more of the same, using static techniques, but by creating new products, new processes, and new forms of organization" [4].

The general principles of the endogenous theory are reflected in the "steady-state growth model". Smriti Chand explains the essence of that model in the following way: "The concept of steady-state growth is the counterpart of long-run equilibrium in static theory. It is consistent with the concept of equilibrium growth. In steady-state growth all variables, such as output, population, capital stock, saving, investment, and technical progress, either grow at constant exponential rate, or are constant [5].

To some extent the Cobb–Douglas production function, based on the assumption that output increases by the labor and capital increments would be referred as the endogenous theory of economic growth, based on the steady-state principles. Peter Howitt writes: "The first version of endogenous growth theory was AK theory, which did not make an explicit distinction between capital accumulation and technological progress" ([6]). Charles I. Jones explains that theoretical model in the following way: The production function describes how input such as bulldozers, semiconductors, engineers, and steel-workers combine to produce output. To simplify the model, we group these inputs into two categories, capital, K, and labor, L, and denote output as Y. The production function is assumed to have the Cobb–Douglas form and is given by

$$Y = F(K, L) = K^{\alpha}L^{1-\alpha}$$

where α is some number between 0 and 1. Notice that this production function exhibits constant returns to scale: if all of the inputs are doubled, output will exactly double [2].

In other words, to produce more output the additional input of labor and capital is required – this is the core of the "steady-state" visioning of economic growth. Is there any other theoretical justification for the large corporations exploiting more and more resources all over the world, absorbing more and more people, ignoring their national identities and personal dignity?

The Cobb-Douglas model was further developed by the Nobel laureate in economics Robert Solow, by adding a technology variable, A, to the production function:

$$Y = F(K, AL) = K^{\alpha}(AL)^{1-\alpha}$$

where A represents the technology variable.

Charles I. Jones writes: "An important assumption of the Solow model is that technological progress is exogenous: in common phrase, technology is like 'manna from heaven', in that it descends upon the economy automatically and regardless of whatever else is going on in the economy" [2]. Evidently, the "steady-state growth model", based on the exogenous insight into the role of technology in the production function and in economic growth in general, is not coinciding with the "new reality" of increasing economic flexibility.

Exogenous insource of technological changes in economies was further criticized by the followers of the endogenous economic growth theory. Paul Romer, Kenith J. Arrow, Lucas and others proposed their quite different insight into the role of technologies in economic growth. As Peter Howitt underlines: "The neoclassical growth theory of Solow (1956) and Swan (1956) assumes the rate of technological progress to be determined by a scientific process that is separate from, and independent of, economic forces. Neoclassical theory thus implies that economists can take the long-run growth rate as given exogenously from outside the economic system. Endogenous growth theory challenges this neoclassical view by proposing channels through which the rate of technological progress, and hence the long-run rate of economic growth, can be influenced by economic factors. It starts from the observation that technological progress takes place through innovations, in the form of new products, processes and markets, many of which are the result of economic activities". ([6]). However, the both theories consider labor and capital as the dominant factors for economic growth even when explaining the role of the "technological input" into the production output to quote here James Morley who writes for the World Economic Forum: "Economist Paul Romer has developed a theory of economic growth with 'endogenous' technological change — that is, it can depend on population growth and capital accumulation" ([7]).

Assumedly, the notion "endogenous" for explaining the modern economic development based on technological innovations precisely is what the new economic mainstream should have as its core. However, the theories, shortly described above, have a critical shortage – they are academic. Robert L. Heilbroner describes this shortcoming as the economic irrelevance: "As a rule, the aspect of economics that upsets those who begin to study it is its abstractness, its seeming removal from life, but any instructor worth his salt can reassure his students that this abstract quality is a strength and not a weakness if we are to study large-scale questions, and that the "unreality" of many economic conceptions conceals a sharp cutting edge" [8].

Perhaps there are at least two main aspects of the "endogeneity" of the modern technology-driven economic development stemming from the real life and practice:

- technological innovations represent the main tool, invented by the human being, for overcoming various obstacles, restricting economic development or even worse – threatening

the humans existence. Probably, the J. Watt steam engine was never invented unless the deforestation, encountering by England in seventeenth and eighteenth centuries. In this sense, the successful technologies starts not when they are supported by the government but when they are focused on overcoming the very precisely identified economic necessities;

- emergence of the technological innovations per se results from a very complicated economic configuration. This is not an easy deal to produce fabulous tune on that piano! Only a few remarks on that matter: the technological innovations (from its start in basic research as a part of the overall R&D) are very unattractive for the private investments (they require substantial long-term investments with low portion of commercially successful outcomes with high "spillover" and immense number of "imitators" "waiting at the door"). Moreover, successful technologies embraces not only the stage of their creation in the R&D laboratories, but their selection by the private companies, their adoption in the production processes, their commercialization on the market, their diffusion among as much as many national companies (for cumulating the national economic growth in general), their technological feedbacking from the markets. That is why it is a substantial simplification to consider technological development within a narrow framework of the government financial support for R&D and education.

In fact, the intersection between technologies and economy represents one of the most significant theoretical and practical shortages. In this exploration we would like to explain only two among many others distinctive features of the core twentieth century technologies: their dual-use capabilities and the large-scale character.

The majority of the key technologies in twentieth century initially was applied in the production of armaments and then were diffused into the non-military production. VernonW. Ruttan in his book "Is War Necessary for Economic Growth? Military Procurement and Technology Development" writes about the dual-use properties of the military technologies: "It is difficult to overemphasize the importance of the historical role that military procurement has played in the process of technology development. Knowledge acquired in making weapons was an important source of the industrial revolution" [9]. The Scandinavian scientist T. Cronberg underlines the role of state in the R&D development in the United States: "State expenditure on research and development for the military has been the way the US government created a national technology base. In contrary where industrial policy and state intervention in the affairs of commercial companies are not accepted, military technology has been a way to go around this sensitive theme. Military research and development has constituted the industrial policy of the US, the very nature of the spin-off paradigm bears witness to this. The dual-use handshake is simply a new way of defending industrial policy" [10].

The military procurements from the United States Department of Defense gave rise the basic industries, such as triangle - Aerospace, Communications and Electronic industries (ACE), incubating large American companies Rockwell, Lockheed, McDonnel-Douglas, General Dynamics, Huges, Northrop and others. The number of the new industries emerged in consequence of the advance in the military technologies and their spin off to the civil production: computers, jet aircraft, nuclear power and space communication.

From the graph, depicted on **Figure 3** [11] the changing role of military and civil aircraft manufacturing during the wars and in between is seen. However, there would be no doubt that the military aircraft production fertilizes civil aircraft manufacturing in terms of technologies, R&D capabilities, graduation of personnel, provision of equipments and in terms of the other common production characteristics.

Similar to aircraft manufacturing the other industries in the United States acquired advantage from the dual-use capabilities of key technologies. To mention electronic industry, about which T. Cronberg writes, "Early military and space programs helped the US electronic industry to achieve research and production superiority over its competitors through the early 1970s. The military requirement-for example, for miniaturization and lower power consumption- coincided almost exactly with the likely needs of commercial uses in the computer industry" [10].

Undoubtedly, the war economy had been dominating through the entire twentieth century and it cross fertilized the other industries and countries through the process of technology spin off. However, the impact of the military technology on the civil production has changed since then. Ann Markuzen and Joel Yudken underline: "The military requirement no longer coincides with the likely needs of commercial users. This is due to the more complex nature of the military technology, its special product development environment and the general dynamics of the military-industrial complex itself. Innovation in the military becomes scrutinized and leads only to incremental improvements…. Submarines become faster and faster, quieter, bigger and with longer ranged instead of becoming simpler and more efficient. At the

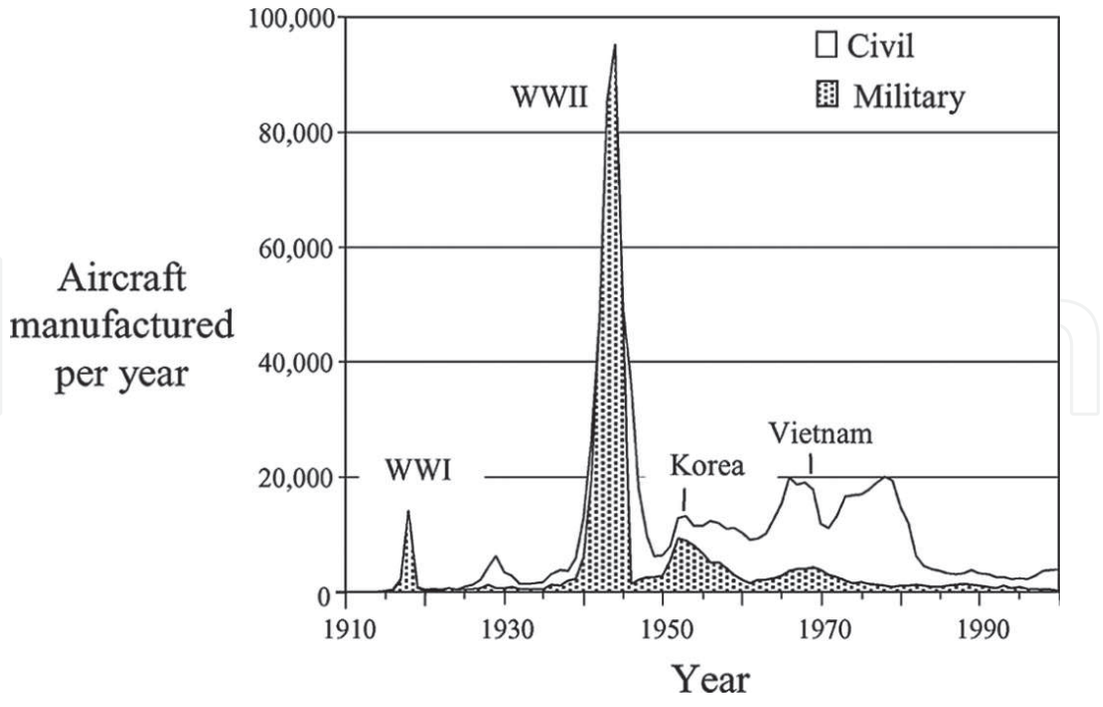

Figure 3. U.S. aircraft production in the twentieth century. Source: Paul D.Collopy. Military technology pull and the structure of the commercial aircraft industry. 2004 https://www.researchgate.net/figure/U-S-aircraft-production-in-the-20th-century-9-10_245430534.

same time the military industry becomes more dependent on commercial technology, such as computers" [12]. Therefore, the military technologies could not play a role of the technological drivers for the national and global economic growth any more.

The other economic peculiarity of the core technologies in twentieth century, which we would like to mention in our investigation, is their consistency with the "economy of scale". In other words, in terms of capital turnover, profitability and cost competitiveness, their implication in industry requires gradual extension in production scale and subsequently in market sales scale. In case of issuing only a few copies, as it has happened with the aircraft manufacturing in Russia at the beginning of 1990, the industry could not exist.

The extension of production scale makes the cost of unit less, requiring expansions of the products sales on the international markets, conquering competitors and advocating the free trade regime. Ultimately, large corporations take the lead on the markets, swallowing up the competitors through mergers and acquisitions, launching the "entry barriers", establishing the multinational network in production and sale. The offshore production launched in the countries with cheap labor, tax holidays and devaluated currency, enables the large corporations to reduce costs of production through the exploitation of "geographic advantage" rather than application of process technologies. Logistically, the offshore production finds its sales in the United States, Europe and the other countries with high average income, large number of consumers and in the countries, where the domestic production was replaced by import (to mention here Russia and the other ex-USSR countries). The advantage of "large" became more lucrative and less risky than testing something new. The technological drive is not what the large corporations would like to accept. Needless to say, that that path of economic development became resource consuming, ecologically unfriendly and leads to suppression of the own national business in as much number of countries as never before. The most probably "national identity" agenda, which has been accepting today in many countries and usually referred by political establishment as "populism of political opposition" has its fundamental nucleus – the exhausted capacities of "large", whether they are corporations or any other actors, in their mission to lead the global world. The global world needs to reconstruct the whole economic architecture, reconsidering the role of large and small as its important chains.

5. Changing role of technological system: from driving to impeding the global economic growth

The global crisis has interrupted the spectacular economic growth in 2008. As many experts agreed, the main causes of the beginning economic downfall were emerged in the financial sector. That is why the economic crisis was denoted as the global financial crisis. We have quite different standpoint on the nature of the global economic crisis, explaining it by the technological reasons. Generally speaking, large companies as the main actors in the global economy are not technological drivers any more, as we noted it before. The theoretical conceptualization of that fact is yet insufficient, that is why we are quoting the participants of the Davos forum 2017, who had expressed a strong concern about the emerging "shortemism"

in the global economic affairs, which is essentially inconsistent with the long-term nature of the technology-driven development. We would like to quote the British businessman Martin Stuart Sorrell, who has evaluated the technologies, applied by the global companies as: "big companies made incremental, but not fundamental innovations". Sharing that vision on large business the Ivorian businessman TidjaneThiam says: "Once you became big your natural impose is to be incrementalist and conservative and protect your position"[6]. Therefore, the most probably the large multinational companies has been acting today as the opposition rather than supporters to technological change of society.

Among the other reasons, restricting the further technological development and therefore negatively effecting the growth of global economy are the following:

1. The deindustrialization of the leading economies, which is denoted in the increasing share of services in the GDP and employment. For example, when the global economic crisis starts in 2008 the share of services in the GDP composed: over 80% in the United States, about 69% in Germany, 77.4% in France and 72.3% in Japan. It means that manufacturing production, whether it is knowledge-intensive or not, has been losing its common ground. Among many circumstances are increasing cost of labor, favoring consumption rather than production, stringent ecological requirements elaborated for the manufacturing production, import-favorable exchange rate of the national currencies in many leading countries.
2. The "Dutch disease phenomenon", affected Russia, Saudi Arabia, Venezuela and the other oil-dependent countries. The Russian economic drama emerged since the early 1990th, when the market-driven insight on the way the country should follow, has ignored a substantial pool of R&D capabilities, accumulated during the Soviet times. As a result today the Russian dependence on oil and natural gas is enormous: 33% of total export, refined oil and gas products estimated as 24% of total export and natural gas estimated as 14% of total export (three articles in sum composes 71% of the total export), which is depicted in **Figure 4**. It is worth remembering that the second half of the twentieth century was marked by a strong technological confrontation between the United States and the USSR, enforcing the worldwide move forward in science, technologies and education. When Russia, as the main USSR successor and one of the leading global technology race participant, has left its disposition it negatively affected the other countries.
3. The general global economic biases toward increasing role of raw, specifically energy, resources in trade, which is depicted on **Figure 5**.

In 2015 the crude oil sales overflow any other trading items, reaching $786.3 billion., the third position in the global trade was occupied by the processed petroleum oil, estimated as much as $605.9 billion. The car sales, estimated as $672.9 were on the second position[7].

[6]Davos 2017 - Size Matters: The Future of Big Business https://www.youtube.com/watch?v=0dT3D3Ip7xo&t=370s
[7]List of countries by export. https://en.wikipedia.org/wiki/List_of_countries_by_exports

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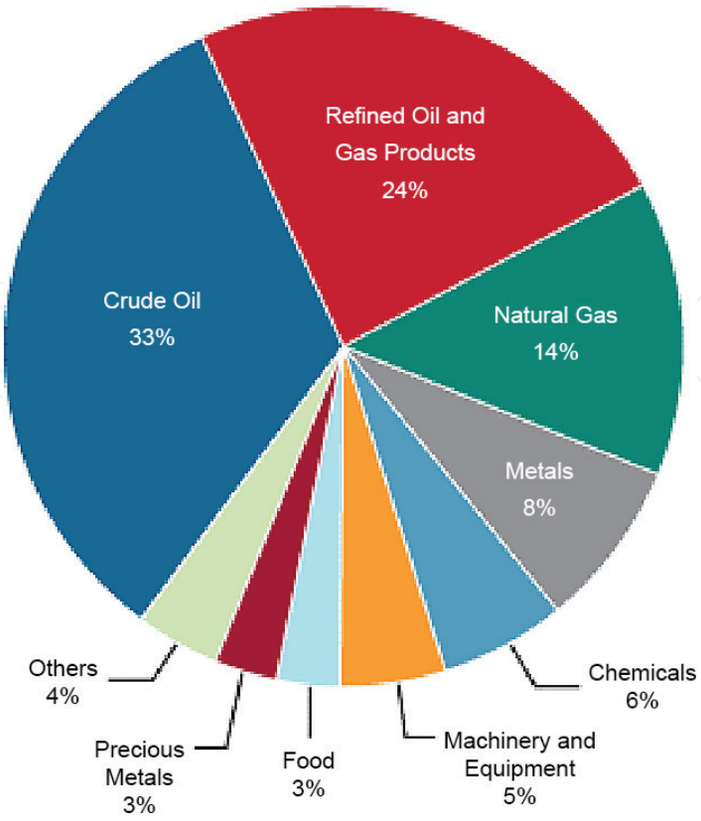

Figure 4. Russian export breakdown (as of 2013). Source: Federal Customs Service. Renaissance capital. US global Investors. http://www.valuewalk.com/2016/06/brexit-sanctions-russia/.

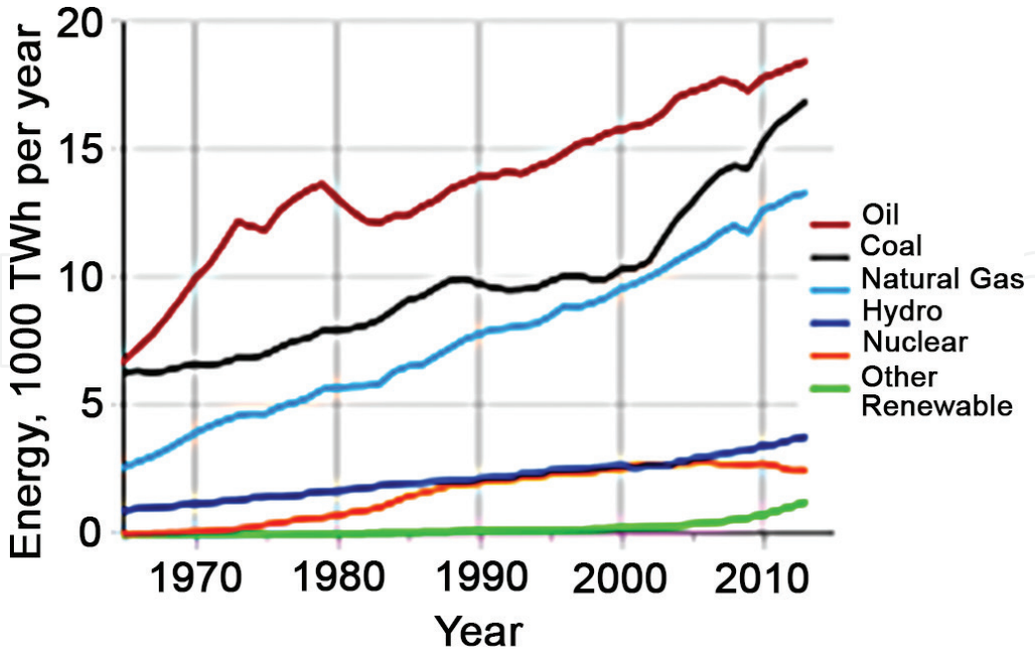

Figure 5. World consumption of primary energy by energy type. Source: Peak oil. http://en.wikipedia.org/wiki/Peak_oil.

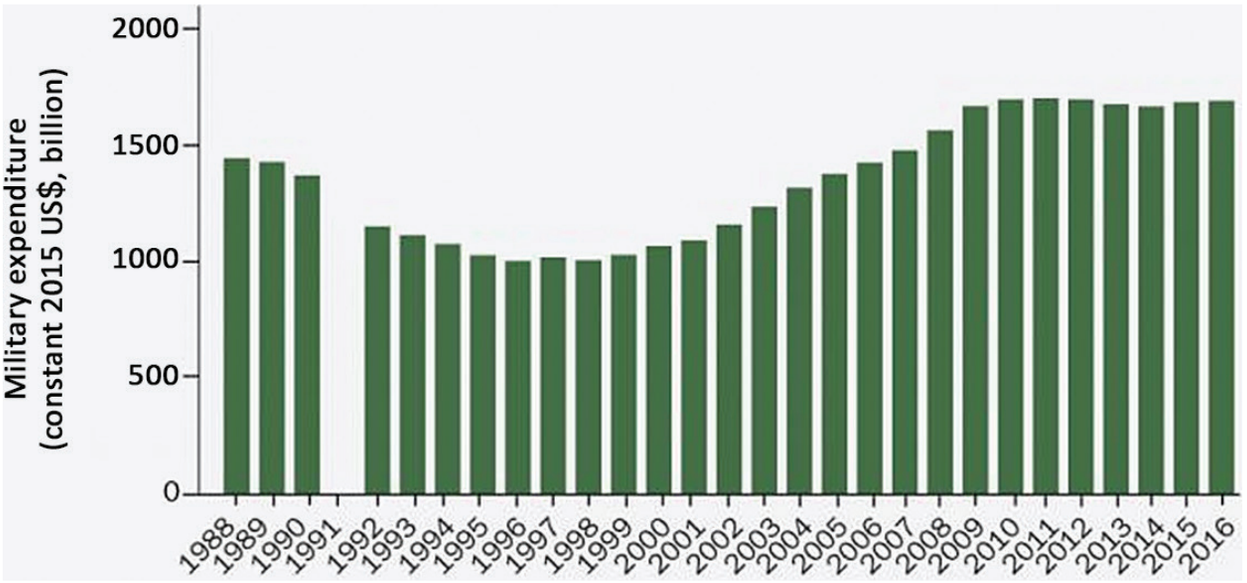

Figure 6. World military expenditure, 1988–2016. Source: World military spending: Increases in the USA and Europe, decreases in oil-exporting countries. https://www.sipri.org/media/press-release/2017/world-military-spending-increases-usa-and-europe.

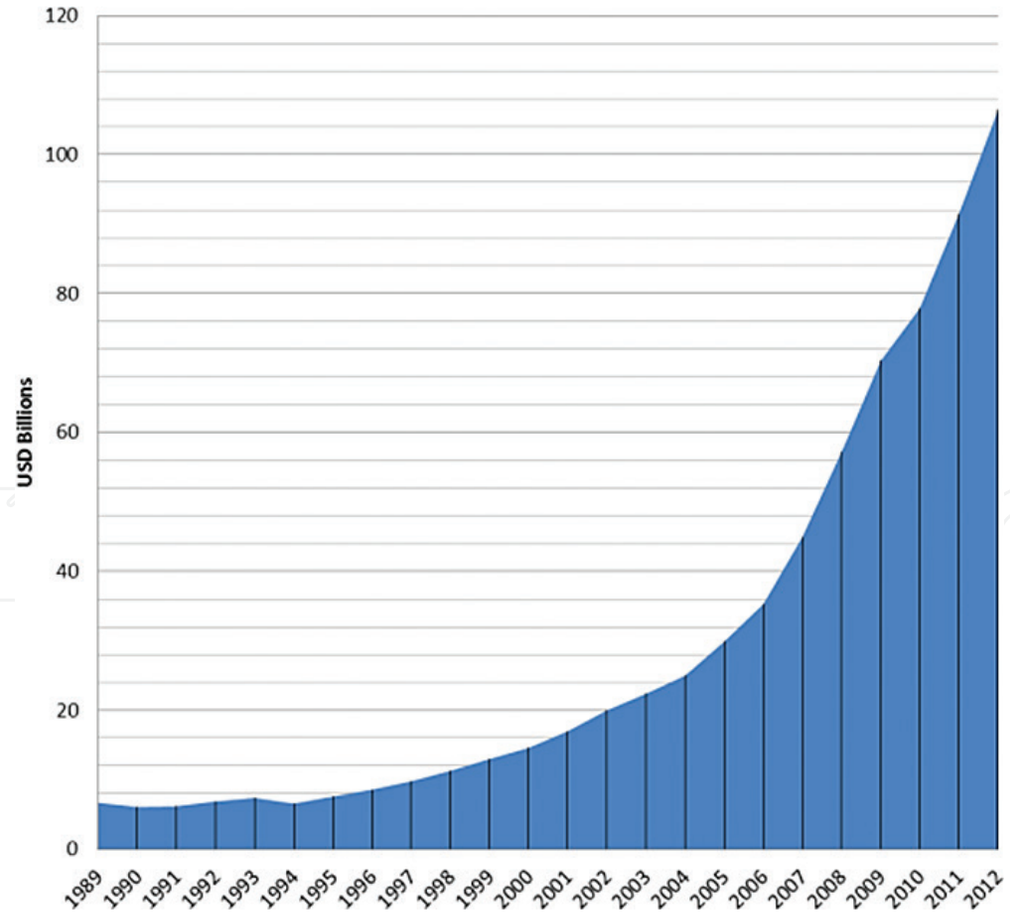

Figure 7. China published military budget. Source: Military budget of China https://en.wikipedia.org/wiki/Military_budget_of_China.

4. The escalation of military spending and defense procurements represents not the last factor, undermining the further technological development and growth in global economy. **Figures 6** and **7** depict the military spending in the world, specifically fast growing in China.

The growing militarization of the economies means that commercial technologies are gradually replaced by the military, the state has been replacing the market in the processes of creation and application of new technologies and the companies are forced to compete for the state military contracts rather than market share and cost reduction. Besides, the cost of the new type of armaments is growing rapidly, negatively affecting the state budgets, which has been undermining the financial stability in the military dependent countries. In his article "The Jet That Ate the Pentagon: The F-35 Is A Boondoggle. It's Time to Throw It In the Trash Bin (excerpt)" Winslow Wheeler writes: "The F-35 will actually cost multiples of the $395.7 billion cited above. That is the current estimate only to acquire it, not the full life-cycle cost to operate it. The current appraisal for operations and support is $1.1 trillion - making for a grand total of $1.5 trillion, or more than the annual GDP of Spain" [13].

Therefore, the modern economy, flourished on a substantial technological base, became unfriendly for the further technological development.

6. Creating new technological system in twenty-first century

The challenges, encountering the global society, have been steadily multiplying in scale and variety: escalation of trade wars, financial flexibility, disintegration processes in Europe, migration crisis, militarization of economies, global warming – these and many other problems have been undermining sustainable life of human beings. To cope that challenges the governments, pursuing the monetary paradigm in regulation, are spending more from their budget (at least mentioning 50 billion pounds, which the UK will pay for their leave the EU), rather aggravating than improving the state of affairs. The entire global system has been badly working provoking manifold disruptions as it is listed above. What would be more useless than the efforts focused on improvement the obsolete, ill working politico-economic system? Let us recall here the Simon Kuznets statement, which he made in his Nobel lecture in 1971: "… the changing course of economic history can perhaps be subdivided into economic epoch, each identified by the **epochal innovation** with the distinctive characteristics of growth that it generates" ([14])[8].

Epochal innovations and epochal transformation of the global economy requires new knowledge, new mindsets and new individuals, pursuing the novelty in theory and practical decision makings. When Charles Jones explains economist "as a laboratory scientist, setting up a model…" [2] we could not agree. Economics in accordance with our perception is a kind of

[8]S. Kuznetc explains the epochal innovations as the following: "The major breakthroughs in the advance of human knowledge, those that constituted dominant sources of sustained growth over long periods and spread to a substantial part of the world, may be termed epochal innovations". From: Simon Kuznets. Modern Economic Growth: Findings and Reflections. http://www.nobelprize.org/nobel_prizes/economics/laureates/1971/kuznets-lecture.html

social engineering science [15], and economists are social engineers, occupied in creation a building of new economy, rather than manipulating data, drafting economic scenarios or just only criticizing governments.

What should we know about technological adjustment to the ongoing processes of global disruption? Let us make some preliminary insights, which, probably will be reflected in the further investigations.

First, the general evolution leads to a gradual replacement of labor-intensive and capital-intensive by respectively labor-saving and capital saving mode of production. In this regards, any labor-intensive or investment-intensive decisions in economy should be treated as inconsistent to the general trend and prospective. Once when we have made our investigation for the prospects of economic development of the Russian Far East, we were brought to the conclusion that for that specific region, peculiar in terms of shortage in population, substantial dependence on external energy resources and scarcity of capital resources, the labor-intensive and capital-intensive (energy intensive as well) model of economic development is inapplicable. It led us searching the new technologies, substituting the scarce regional resources and they were found. Only one case among many others: three scientists and five engineers had started to produce extracts from Holothuroidea, which brought them substantial benefit and contributed into improvement of the regional economic performance in general. Production of that kind brings substantial export revenues, accumulate financial resources to pay salaries, taxes and making further own investments into extension of production facilities. Besides, it is energy, capital and labor saving technologies and what is also very important – environmentally friendly [16]. This important finding encouraged us to learn the technology-intensive capabilities, existing in some other Russian regions. In fact, the reserves for technology-driven economic growth even in the lagged behind regions are enormous. Who knows, probably, the other countries also endowed with that kind of "hidden" localized capabilities.

Second, the other decisive characteristic of the prospective key technologies for restarting the economic growth stems from the technology life-cycle shortening. It increases the rapidity with which the new technologies has been replacing the already applied, requiring the close cooperation (face-to-face interaction) between scientists from various fields of knowledge (cross-discipline interaction), small and medium innovation companies, local administration, financial institutions, universities and the other "innovation stakeholders". The higher flexibility of small and medium companies appropriate to the increasing rapidity of technological change makes that companies a new technological drivers, replacing the large companies in that mission. The "economy of scope" when production of technologically unique products dominates over the exploitation of the given technologies within the "economy of scale" paradigm, signifies about the appearance of the new stage in technological development.

Third, there are no justifications anymore for the development of military technologies neither in terms of their spin-off effect on the civil production and employment nor R&D advancement and multiplication of investments. Militarization represents a resource consuming process, harmful for the environment and risky for the financial stability of the national states. Explaining the necessity of elevation the armaments production, accompanied by anticipating

job creation, R&D facilitation and investment growth, the politicians should be clear enough about its long-term destructive consequences.

Fourth, we would like to emphasize specifically the process of "technological localization", which is not common, but would enable understanding the new role of regions in the global reconstruction. Perhaps, regions would be a new nutshell for incubating not only specific technologies and technological innovations, but new technological systems, embracing S&M innovative companies; universities, providing the R&D and education capabilities; and local administrations. Simon Kuznets denotes a special technological advantage of small nations in the following statements: "Obviously, community of feeling, a sense of common destiny, and subordination of individual or group interest to that of the whole, are far easier to attain in small and homogenous nations than in large nations with their regional, racial and other diversities"…. "Another possible advantage of small units is the rapidity with which they can adjust to changing situations. In a sense this rapidity is related to the greater possible ease of reaching secular decisions. And since economic growth is a process of continuous adjustment to a changing technological potential and a changing constellation of national structures, the speed with which small nations may be able to make such an adjustment is a great advantage" [17].

Obviously, regions are endowed with specific resources, making them different from each other. Usually that regional specification is indicated as "regional comparative advantage". Technologies represent a means with which regions overcome their specific "comparative disadvantage" and resource scarcity, develop their specific "comparative advantage" and within their specific niche accumulates R&D capabilities to produce technologically complicated products for increasing value-added production, spurring the economic growth, making the local society more sustainable, wealthy and adjustable to the exogenous turmoil.

Localities or regions would be a space, where technologies are strongly related with the real economic needs, which is quite different from the vision of technologies as some know-how, produced in R&D laboratories and transferred into innovation companies with the assistance of venture capital. Our perception of the technology-oriented networking local communities, clusters considers them as a new "drivers" for technological change and global economic growth, replacing large companies – "old champions" in that mission. From that standpoint the phenomenon of "Brexit" or "Katalonia's challenge" could be explained as the first signs of the forthcoming technological transformation of the national and local societies, based on their specific "national (regional) comparative advantage" or "national (regional) economic identity". These processes need to be carefully governed in a proper economic, rather than political, manner. No doubt technologically advanced local societies, pursuing technology-based economic growth, will make the global community more interactive, sustainable and civilized.

7. Instead of conclusion

The growing contradictions in international and economic relations between countries lead to the destruction of the established world order, which can produce a negative impact on

humanitarian stability in the world. Overcoming of the world's major problems should be sought not in the military sphere, or even in the political dialog, but in the economy, in its transformation to a new stage in development. Today, as never before, intellectuals from various countries of the world should gather together for proposing a new agenda for the global development based on new fundamental principles [18].

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