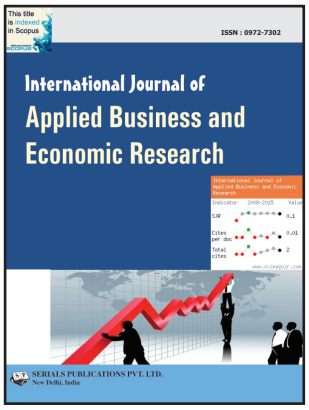

International Journal of Applied Business and Economic Research

ISSN: 0972-7302

available at http: www.serialsjournal.com

Volume 15 • Number 13 • 2017

Unintended Consequences of Innovation Activity, Revisited

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ABSTRACT

This paper continues the previous research of innovative activity impact on the growing inequality in income distribution between the countries and within social groups within countries. In our view, the consequence of this inequality is that the income of the well-off section of the society (especially upper high class) are growing faster than the other layers of society, while the share of the middle class, on the contrary, decreases. Statistics shows that in the United States the proportion of households belonging to the middle class has significantly reduced; they have moved to the better-off groups. The next technological revolution leads to further reduction of manual unskilled labor while demand for occupations requiring high qualifications is growing. This trend results in "labor polarization", leading to polarization of income and reducing the share of the middle class in the structure of society. This paper pays considerable attention to the impact of global climate change on economic activity. Despite the passage of the part of the advanced countries to the innovative development strategies, the negative human impact on the environment remains unchanged. At the same time less developed countries of Asia and Africa, which cause significantly less damage to nature, suffer more. Climate changes, such as global warming, reduce productivity in hotter and, at the same time, poorer countries. This will only exacerbate existing inequalities in the income. The largest air pollution is observed in the cities, which have become the main engines of economic growth. And the majority of households belonging to the middle class are concentrated in cities. We believe that the negative impact of climate change, which enhances the property and otherwise division of society, will also reduce the share of the middle class in the structure of society.

JEL Classification: O10, O49, O53, O30.

Keywords: Innovation, economic growth, middle class, climate change, social structure, Asia, Africa.

1. INTRODUCTION

In our previous articles (Dmitriev et. al., 2016; Dmitriev et. al., 2016), we have already touched upon the issue of the negative impact of the innovative activity on the social structure as a whole as a factor of reduction of the number of middle class in particular.

Summing up the preliminary results of this study, it seems necessary to focus on the fact that usually escapes the attention of most of the authors relating to similar issues - namely, on the impact of the obvious climatic changes resulting from socio-economic activities of mankind (reinforced by the transition to the innovative way of development) on reducing middle class.

2. LITERATURE REVIEW

The literature on global warming is so vast that may well compete with the many varieties of string theory, which numbers (according to physicists' spiteful remarks) are larger than those of atoms in the universe.

As far back as in 1979 J. Charney reported to the National Academy of Sciences (USA) that a global warming of 3 Kelvin (with a possible error of ±1,5 Kelvin) was most likely because of the doubling of the amount of CO_2 emissions (Charney, 1979). Since then, the number of articles and monographs about global warming and climate change has grown exponentially.

As G. Heal and J. Park rightly noted, temperature effects on human economic activity has long been a subject of scientific interest (Heal & Park, 2015). Dell, Jones and Olken trace this interest from Ancient Greece through the medieval Arabic literature before the European Enlightenment (Dell, Jones & Olken, 2009; Dell, Jones & Olken, 2012; Dell, Jones & Olken, 2014).

Most researchers studying economic consequences of climate change focus their attention on the indirect effects, such as the impact of heat on crops or sea-level rise on the infrastructure, but in recent years a significant number of studies focused on the direct effects: for example, the effects of extreme temperature on human physiology and psychology. (It is fair to note that the effects of climate change on human morphology and, more broadly, the impact of the physical conditions on the genesis of various kinds, have been the subject of scientific publications since at least 1877) (Arndt & Arent, 2016). Such an influence may take the form of damage to health (increased morbidity and mortality), reducing labor productivity, as well as a possible reduction in the accumulation of human capital and, ultimately, a decrease of the GDP. Among these works, we would mention Heal & Park (Heal & Park, 2015), Burke, Hsiang & Miguel, (Burke, Hsiang, & Miguel, 2015) Deschenes & Greenstone (Deschênes & Greenstone, 2011). For example, Deschenes and Greenstone have found that in addition to the number of ordinary days with average daily temperature above 90oF in the US leads to an increase of the annual death rate by 0.11%. Similarly, Cauchon and others note the negative impact of the extremely high temperatures in the automotive production in the US, if the average of daily temperature is above 90oF for six days or more, the weekly output is reduced by an average of 8%.

3. HUMAN IMPACT ON THE ENVIRONMENT AND CLIMATE CHANGE

Among the factors most frequently mentioned as the cause of global warming, the researchers emphasize an increase in the amount of carbon dioxide in the atmosphere:

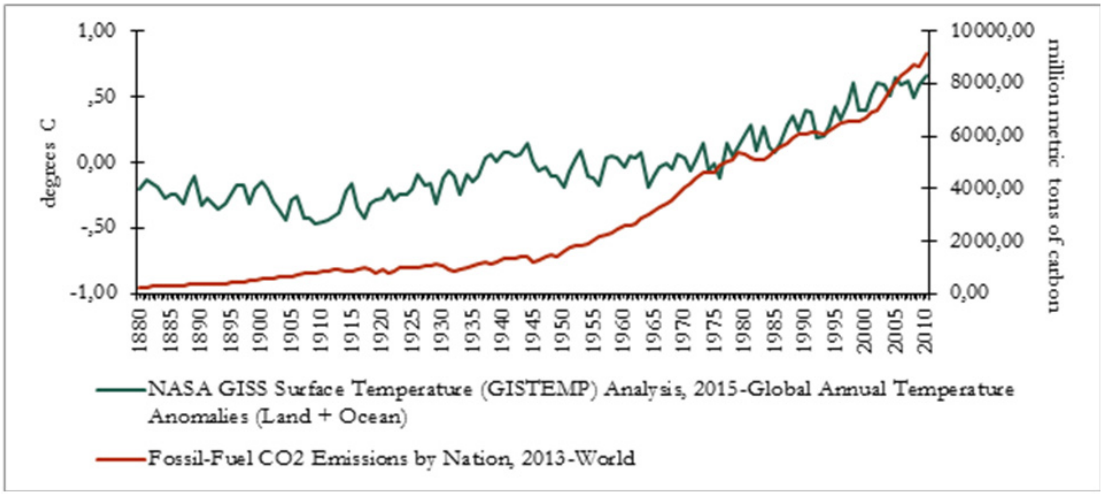

Figure 1: Global CO_2 emissions and climate change ("*Climate Change*", 2017; ("*Climate Change and Greenhouse Gas Emissions*", 2017) Source: Carbon Dioxide Information Analysis Center

The dynamics of carbon dioxide emissions in the context of the country is given in Table 1.

Table 1
CO_2 Emissions, million metric tons of carbon (Dmitriev et. al., 2016)

	1753	*1800*	*1900*	*1950*	*1992*	*2000*	*2008*
The whole world	3.0	8.0	534.0	1630.0	6110.0	6727.0	8738.0
China				21.5	735.2	928.6	1956.8
The United States of America		0.1	180.9	692.1	1339.3	1554.9	1533.3
Russian Federation					566.9	424.8	467.7
India			3.6	18.2	190.6	281.4	427.7
Japan				28.0	306.5	332.8	330.0
Germany		0.2	89.2		243.2	226.3	212.9
Iran				-1.5	62.4	101.6	158.7
Kanada		0.0	5.6	42.1	120.3	145.,8	147.0
Great Britain	2.6	7.3	114.6	136.6	151.7	147.7	141.8
South Korea				0.6	77.5	122.1	138.4
South Africa			0.6	16.7	83.9	103.3	135.7
Mexico			0.3	8.3	89.6	104.3	129.4
Italy (including San Marino)			3.8	11.3	114.7	122.9	121.9
Saudi Arabia				1.4	77.9	81.0	117.3
Indonesia			0.3	2.7	55.2	71.8	113.6
Brazil				5.4	60.2	89.4	105.7
Australia			2.8	14.9	73.1	89.8	105.2
France (including Monaco)			35.3	55.2	99.,8	98.7	99.8
Spain			3.1	9.0	63.8	80.3	89.8

From the standpoint of the world regions the overall emissions of carbon dioxide are the following:

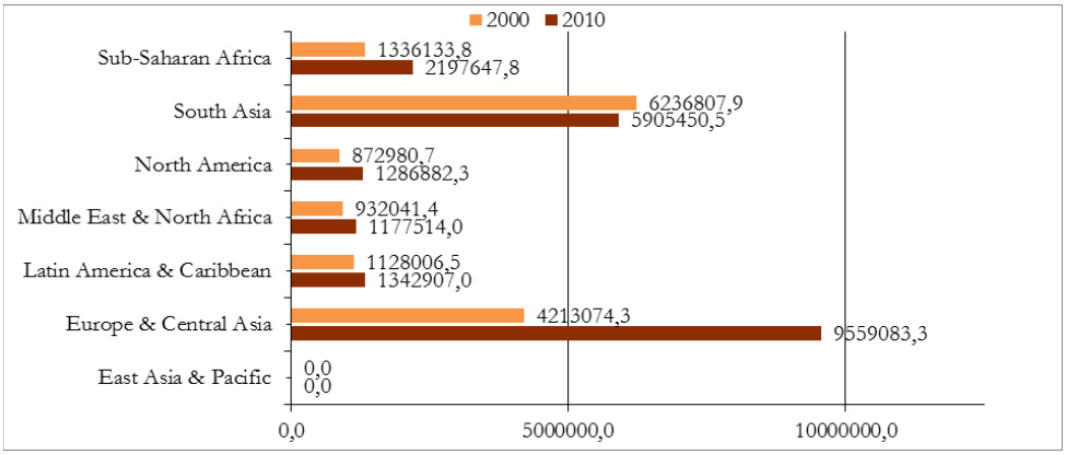

Figure 2: Total CO_2 emissions in the context of the world regions, 1,000 metric tons ("*Climate Change and Greenhouse Gas Emissions*", 2017). Source: World Bank Climate Change, December 2015

According to the data of the Figure 2, sub-Saharan Africa is not among the region's most polluting the earth's atmosphere. At the same time, we know that the African continent is one of those regions most affected by climate changes (Field et. al. 2014). On the other hand, Africa has a significant potential in the use of renewable energy sources; thus it is possible to assume that over the coming decades African countries will invest billions of dollars in facilities (Ash & Fetter, 2004) associated with the use of biofuels, solar and wind energy (Fant, Schlosser & Strzepek, 2016). Currently these sources (traditionally associated with low levels of greenhouse gases emissions into the atmosphere) are not used *("African Development Bank"*, 2012.), and South Africa's energy needs are satisfied by the coal industry, but the needs of the region's energy sources are getting bigger: according to the experience of the last few years, they have increased by 12% in Mozambique and by 10% in Zimbabwe.

If the growing energy demand is not satisfied, it will lead to a drop in the living standards in African countries (which are already low), and an economic growth observed over the past two decades in this region will stop. In addition, it is necessary to understand that maintaining the rate of economic growth of African countries, provided, as we noted above, by the use of fossil fuels (coal), will lead to an increase in CO2 emissions, which have already increased over the past two decades *("Southern Africa Power Pool. Annual Report",* 2012*)*:

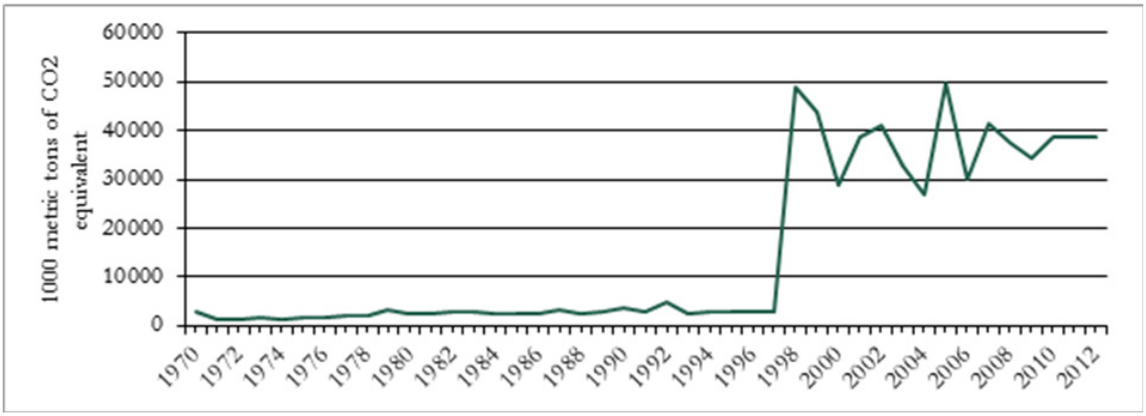

Figure 3: Dynamics of various greenhouse gasses emission (HFC, PFC, SF6) in South Africa ("*Climate Change and Greenhouse Gas Emissions*", 2017)

This scenario is not acceptable for the region where, according to the forecast, in 2050 about 25% of the world population will live (80% of them will live in sub-Saharan Africa) (Ash & Fetter, 2004).

On the contrary, the introduction of a special tax on carbon emissions and the use of hydroelectric power plants on the Congo River, as it is suggested by Gebretsadik, Schlosser, and Strzepek (Gebretsadik, Schlosser & Strzepek, 2014), will not have a negative impact on economic growth, however, it will reduce employment by 1%.

The following shows the dynamics of carbon dioxide emission depending on their source:

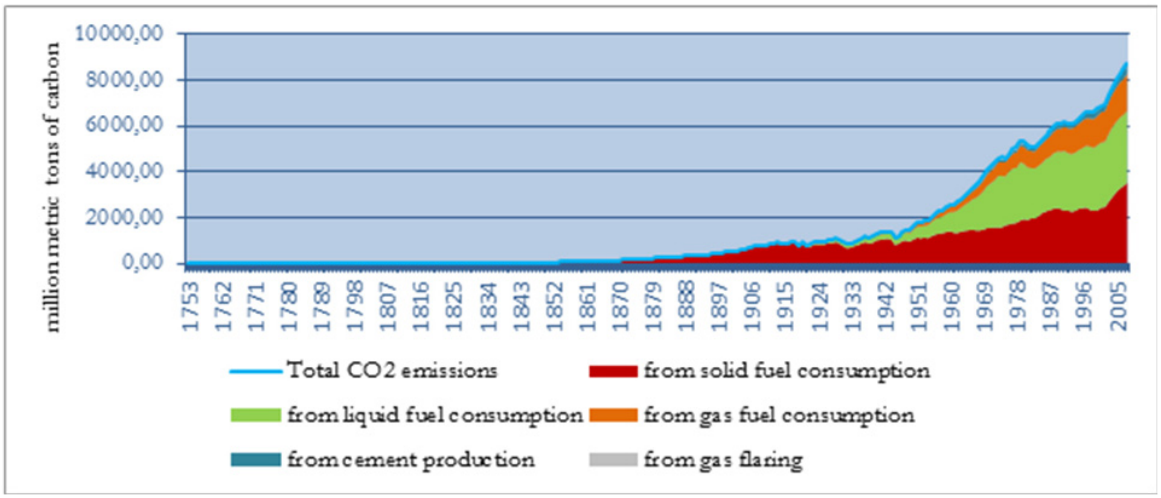

Figure 4: Sources of the CO_2 emissions to the atmosphere ("*Climate Change and Greenhouse Gas Emissions*", 2017)

As you can see, despite the innovations in the field of "green economy", the majority of emissions are due to the use of mineral resources, i.e. a technology that cannot be called modern.

Summarizing the data presented above it can be concluded that the anthropogenic factor began to exert a decisive influence on the global climate changes:

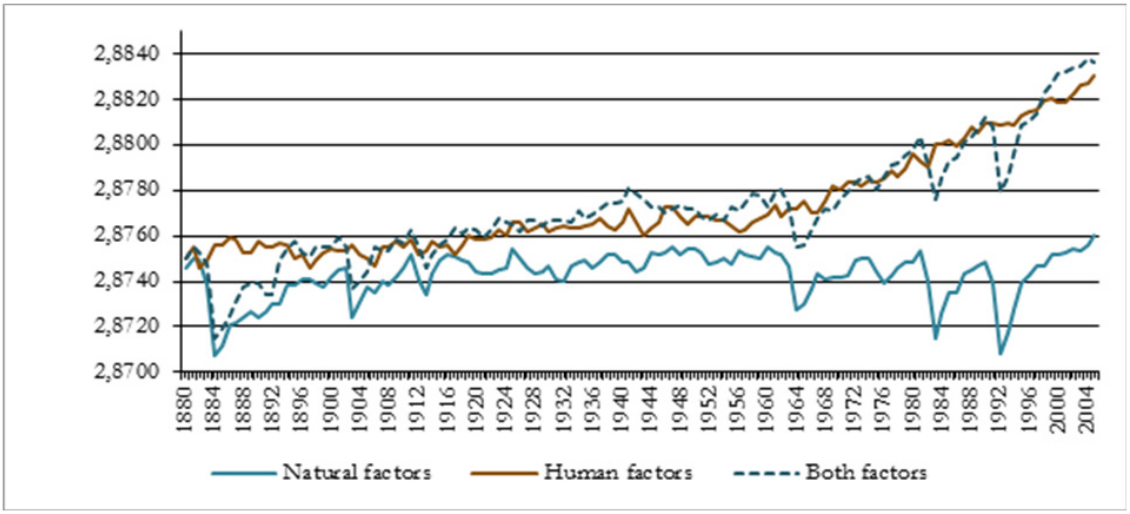

Figure 5: Strengthening the radiation at the tropopause: the effects of natural and human factors (W/m_2) ("*What's really warming the Earth?*", 2017). Data source: NASA's Goddard Institute for Space Studies

This graph clearly shows that since the mid-60-s of the 20th century (i.e. since the acceleration of innovative development) anthropogenic factors are far ahead of natural on the degree of its impact on climate change in general, and on increase in average annual temperature in particular. 2015 year was the hottest on record:

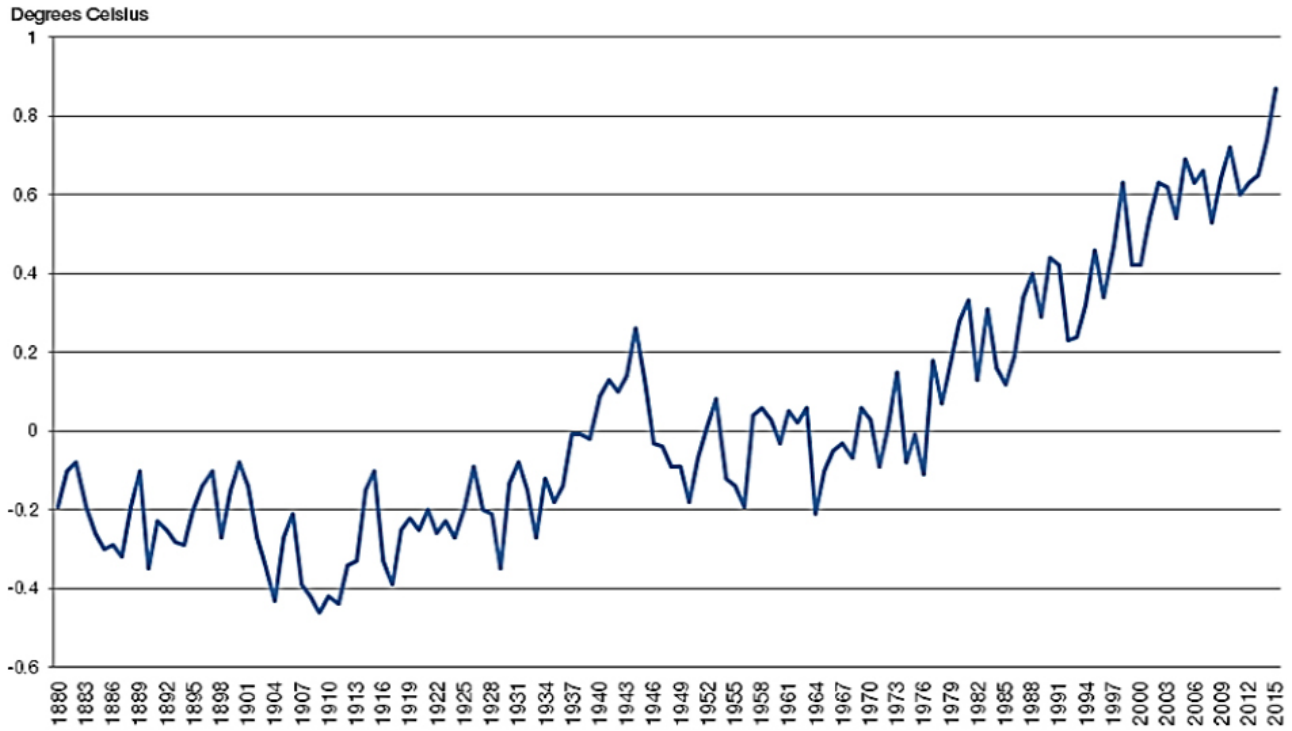

Figure 6: Changes in global temperatures compared to the average temperature in the period 1950 - 1980 (Rockström, 2016). *Source:* NASA/GISS

It is necessary to note that the warming and the rise of sea level are not the only consequences of human impact on the environment. Plastic is one of the ever-growing pollutants of both land and oceans. It has become one of the key geological indicators of a new geological epoch. (Zalasiewicz et. al., 2016) In 1997, the scientists collected about 334.271 pieces of plastic on every square kilometer area of the ocean between Hawaii and Long Beach, California; plankton was found six times less often (Zalasiewicz & Williams, 2014). In one year factories of the world produce about 280 mln. tons of plastic and only half of this amount is disposed of in the landfills. Much of the second half falls in the oceans. At current growth rates in the production of plastic products, by the middle of the 21-st century plastic production will reach 33 billion. *t.*

Global climate change caused by human factors have led a number of scientists (Steffen, Crutzen & McNeil, 2007; Waters et. al., 2016) to the idea that we are observing a new geological epoch called "Anthropocene" (the term was proposed in the 1980s by an American biologist Eugene F. Stoermer, supported in 2000 by Paul Jozef Crutzen, the then winner of the Nobel Prize in Chemistry (the Netherlands)). It is believed that this new era should include the period of time when mankind began to have a strong impact on the environment. The so-called "Anthropocene Working Group" bringing together researchers of this phenomenon over the last seven years, consider the beginning of this geological era to be the end of 1940 - the beginning of the 1950s, although there is no consensus on this issue among scientists: some

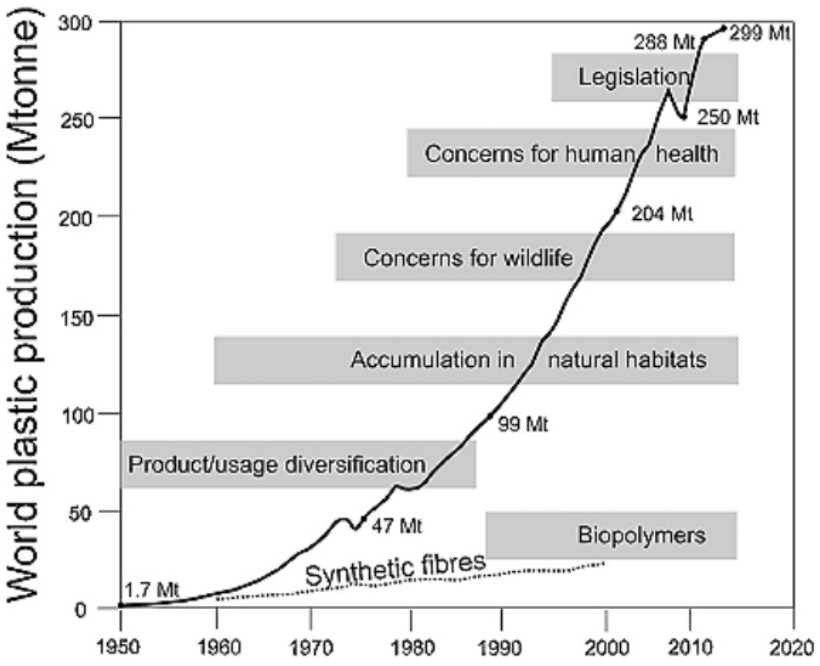

Figure 7: The increase in production of plastic products, million tons/year (80)

researchers, for example, archaeologists, refer the Anthropocene era to 7000 years ago, when mankind began to cut down the forest to make an arable land, thereby increasing the CO2 emissions into the atmosphere (Voosen, 2016). Others refer the start of Anthropocene to the beginning of the industrial revolution (Abramet al., 2016).

This uncertainty gives the opponents of the theory of Antropocene reason to argue that the term refers more to the pop culture than to an exact science, because, from the geological point of view, the borders of a new era (similar to those shared by Pleistocene and Holocene) are not observed.

It seems reasonable to affirm that the beginning of the Anthropocene can be referred to 1950s because after the first nuclear weapons tests, radioactive elements spread across the globe and it will be possible to track them over the next 100,000 years. We have already mentioned another convenient marker – plastic, which is easy to follow up in ocean sediments.

At the same time, humanity is the species that can not only have a negative impact on the environment but also minimize this impact. It is too early for optimism, but in 2015 (for the first time in forty years' history of observation!) the global economy grew, and CO2 emissions to the atmosphere remained at the 2014 level:

The same pauses were noted before, but they were associated with economic downturns (the collapse of the Soviet Union, the global economic crisis of 2008-2009, etc...), But in 2014 the world economy increased by an average of 3.4%, and in 2015 - by 3.1% ("*Decoupling of global emissions and economic growth confirmed*", 2017).

Just as the Holocene formed today's outlines of seas, oceans, and land, developed the known animal and plant species, Anthropocene creates a new humanity; collective actions of this humanity have begun to prevail over natural planetary mechanisms. The famous scientist-astronomer and ormer president of the Royal Society Martin Rees suggest that Anthropocene gives people unprecedented opportunities for

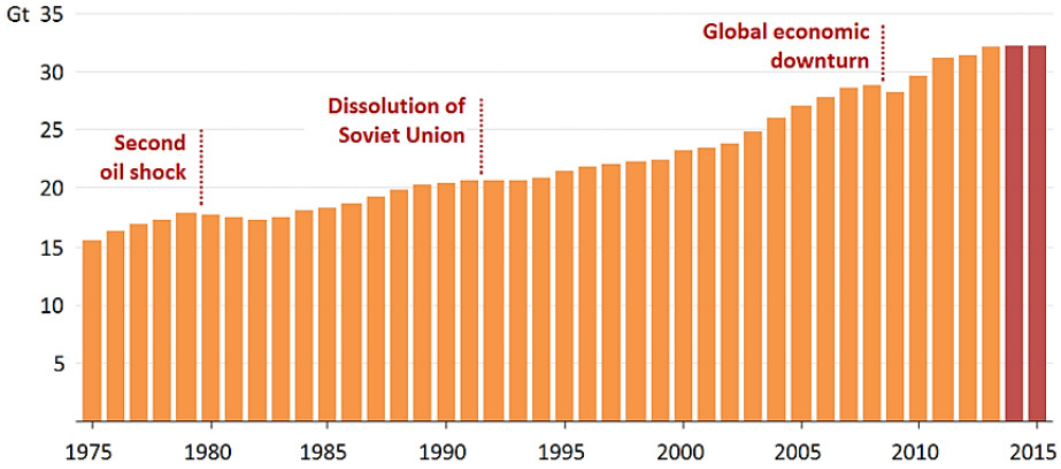

Figure 8: Global CO_2 emissions related to energy, million tons ("*Decoupling of global emissions and economic growth confirmed*", 2017).

development. According to Reeves, people can achieve the post-biological stage of evolution, when the representatives of the organic nature will turn to electronic (and potentially immortal) creatures when people surpass existing limits in front of them and spread its influence far beyond the Earth. Unlike previous geological epoch, the Anthropocene duration depends on humanity itself (Rees, 2016).

The explosive development of digital technology has allowed scientists to draw a parallel between the current situation and the so-called "Cambrian explosion": approx. 540 million years ago, a simple ecosystem was gone, replaced by a new, more complex ecosystem. Living organisms acquired exoskeletons; there appeared predators and prey, biodiversity suddenly increased. Scientists see one possible cause of this phenomenon in the increase of oxygen in the sea water resulting in an increase of its transparency. Modern social networks and the Internet in general also increase the level of transparency of the activities of economic agents and governments (Dennett & Roy, 2015). Corporations can no longer spend months on the development of its PR-strategy: information is spread over several days, if not hours, and can be a decisive factor for the multiplication of wealth and for bankruptcy. One of the basic tenets of the theory of games is that agents must keep their secrets so as not to become an object of manipulation. In the modern world, it is becoming increasingly difficult, which will also affect the strategies of market participants.

If the hardware and software are a kind of exocortex (some draw analogies between the bits of information in digital storage and synapses of the human brain - and this comparison is not in favor of the humans (Pratt, 2015)), the exponential growth in the use of robots can be considered as the formation of human exoskeletons - like those that appeared in organisms during the Cambrian explosion. In this connection, there are a lot of questions, but the scope of the article, as usual, are too narrow for their detailed consideration. As economists, we are primarily interested in the threat to the labor market, as well as in the fact that robots will certainly create wealth, but the distribution of this growing wealth among market participants can become very problematic.

4. DISCUSSION OF THE RESEARCH OUTCOMES

According to Schumpeter thought, the sense of innovation is to obtain monopoly rents - at least as long as the innovation will not be repeated or copied by competitors. Getting these rents, on the one hand,

it increases the richness of its recipients, on the other - increases the competition. Based on innovation, technological revolutions of 20-21 centuries contributed to global economic growth, but in different countries and regions of the world, it occurred at different rates. The global growth helped reduce poverty, but the differentiation in relation to revenues has increased.

In addition, economic growth was accompanied by increasing human influence on the environment, and this effect was not beneficial for the latter. Various countries of the region and the worlds were differentiated: industrial growth and a steady increase in a macroeconomic performance characterized by the developed countries, more than any other atmospheric pollutants, and the negative effects of climate change as a result of this contamination have got a share of poor countries, especially in Asia and Africa.

It should be noted that different levels of prosperity and technological development create a completely unequal starting conditions for the nations of the world. We believe that the difference between the countries in their ability to adapt to global climate change, caused by different levels of technological development and different levels of well-being of the world, will lead to a further redistribution of wealth from the poor, the more prone to climatic anomalies of countries in favor of the rich and developed. In this sense, we can speak of new "climate" colonialism, and, therefore, the intensification of conflicts in various regions of the world.

Finally, global climate change will accelerate the income inequality even in prosperous countries and within these segments of the population. This will result in further reduction of the middle class in the structure of society.

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