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PROBLEMS OF SOCIO-ECONOMIC INEQUALITY UNDER THE INNOVATION-BASED ECONOMY

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ПРОБЛЕМИ СОЦІАЛЬНО-ЕКОНОМІЧНОЇ НЕРІВНОСТІ В УМОВАХ ІННОВАЦІЙНОЇ ЕКОНОМІКИ

The article spotlights the mutual link between the socio-economic inequality and innovation-driven economic growth. The evidence shows that the economic prosperity of leading countries is based generally not on the inequivalent transfrontier exchange but on the technological and institutional transformations of the national economy, which, however, did not lead immediately to the increase of real wages and living standards of broad social strata. The reverse of these trends in the first half of 20th century stipulated the hypothesis about the self-induced tendency of income inequality to reduce, foremost due to the technological advance as an economic growth factor together with the rise of labour force's qualification level. In the meantime, the majority of studies show the negative effect of deepening inequality on the economic growth. The analysis of key innovation and general macroeconomic indicators of the OECD economies in 1990-2015 has shown the intensification of innovation development as well as the rise in income inequality accompanied by the economic slowdown. The objective reason for the combination of these trends is the effect of fundamental economic laws and objective tendencies (diminishing factor returns, the tendency of the capital-labour ratio to rise) while the subjective ones are the following: price discrimination of inventors and innovative entrepreneurs by the oligopsonists (corporations and venture capitalists), lobbying for overprotection of intellectual and industrial property rights which hinders the innovation diffusion. Hence, besides the measures of social policy, some rate of technological and innovation externalities should be maintained, as well as government risk-taking and direct investment into the early-stage innovation projects.

Стаття присвячена дослідженню каузальних взаємозв'язків між соціально-економічною нерівністю та економічним зростанням, заснованим на інноваційній моделі. Розглянуто наукові підходи до дослідження соціально-економічної нерівності, історичні тенденції її зміни в умовах довгострокового економічного зростання та оцінки впливу цього чинника на макроекономічну динаміку. Проаналізовано об'єктивні (викликані іманентними капіталістичній економіці законами та тенденціями) та суб'єктивні (пов'язані з лобізмом і дискримінаційною поведінкою) причини розширення соціально-економічної нерівності в умовах інноваційної економіки. На прикладі країн ОЕСР доведено, що в сучасній інноваційній економіці підвищення наукоємності ВВП при уповільненні темпів його зростання супроводжується ще більш повільним збільшенням реальної заробітної плати. Охарактеризовано загальні напрями інноваційної та соціальної політики, що можуть пом'якшити існуючі дисбаланси.

Keywords: *socio-economic inequality, scientific and technological advance, innovation-based economy, GDP, real wages, R&D (research and development) expenditure, innovation externalities.*

Ключові слова: *соціально-економічна нерівність, науково-технічний прогрес, інноваційна економіка, ВВП, реальна заробітна плата, витрати на науково-дослідницькі та дослідно-конструкторські роботи (НДДКР), інноваційні екстерналії.*

Introduction. The innovation-driven economic growth, the first steps to which the Western countries had already made during the Industrial Revolution of the first half of the 19th century, began to take its modern shapes after the World War II. At the current stage, this growth model is based on a regular, systematic and institutionally shaped interaction between industry, small and medium-sized businesses, financial capital, universities, research institutions and government with the aim of developing, assimilating, commercializing innovations; and at the macro level it provides for the periodic formation of a new technological base for the next wave of long-run economic growth.

As any social and economic mode, the innovation-based development of the market economy is not free of some failures, which include, among other things, the continuous "grinding" of resources involved in the economic growth, huge economic waste at certain stages of the marketing cycle, ignoring environmental issues. One of the most serious problems, however, is the fact that the impressive fruits of the economic advance are distributed in an utterly uneven way, both within national economies and worldwide.

The review of latest research and publications. Nobel Memorial Prize laureate in Economic Sciences S. Kuznets was one of the pioneers in the long-run empirical analysis of economic growth and its factors, among which he emphasized "the role of science in the search for useful knowledge and the new knowledge of the technological innovations in modern economic growth over the last two centuries" [12, p. 26]. Further researches in this area were carried out by his disciples, among them can be mentioned A. Maddison [16]. The Kuznets model of economic growth is supplemented by the "Kuznets curve", based on the hypothesis that during its early stages, the dynamic economic growth is accompanied by increased income inequality, which, however, after the "turning point" of the U-shaped curve is changed to a trend towards the more even income distribution. This, according to Kuznets, is primarily due to the gradual movement of employees from the agrarian to the fastest growing industrial sector which was more productive [13]. Further verification of the "Kuznets curve" gave conflicting results: for example, 682 observations in 108 countries in 90% of cases did not identify the decrease in the income quintiles and Ginny coefficients along with economic growth [9].

Among econometricians, there is a certain consensus about the negative effects of increasing income inequality on the pace and quality of economic growth. Thus, there is a significant negative impact of distributional inequality on the economic growth [20], often through the rise of Ginny coefficient [7], in particular, because inequality leads to macroeconomic instability [4]; in light of this the positive impact of redistribution policy on economic growth was identified [19]. However, only few researchers find the inverse correlation between inequality and economic growth statistically insignificant [8].

Another important task for S. Kuznets's followers was to substantiate the positive effect of R&D expenditure on macroeconomic indicators. Further development of economic growth models is aimed at finding its internal drivers, which are determined and follow from the endogenous variables of the model. Among the endogenous models of economic growth, a group of the Neo-Schumpeterian models (P. Romer (1990) [22], Ph. Aghion and P. Howitt (the first version – 1992) [1], G. Grossman and E. Helpman (1990) [11], etc.) should be specially noted. These authors have focused on the explanation and quantification of the mechanisms and constant reproducibility of technological advance and innovations, the specifics of patents' pricing and economic returns in the research sector.

Identifying the simultaneous intercorrelation and interdependence between three variables: scientific and technological advance, socio-economic inequality and economic growth, remains a complex and insufficiently researched issue. Some studies point out the uneven distribution of benefits reaped from scientific advance as a factor in the expansion of income inequality [14], as well as a strong positive relationship between innovation indicators and inequality [2]. However, regarding such a fundamental problem, the identification of functional dependencies should be supplemented by studying causal connection, which is not sufficiently highlighted in the latest research.

The **purpose** of this article is to substantiate the causal dependencies between the increase in socio-economic inequality and the high rates of innovative development (evidence from the OECD countries), investigate their objective and subjective dimensions, together with the study of the scope of economic and innovation policies that can alleviate the negative socio-economic effects of these trends.

The results of research. Application of the economic growth models to the long-run historical and economic processes in developed countries has shown that the economic leadership of the Western world was achieved not due to the inequivalent exchange with periphery or colonial expansion, but first and foremost due to the development of the technological base of social production, sustained by the effective socio-cultural and socio-political institutions (though which of these factors proved to be determining, as well as the significance of each factor for different countries, remains the subject of discussion and research). The initial stage of the transition of Western Europe from the "Malthusian" system to the "self-sustaining" development was the second half of the 18th century. Table 1 shows that all along the existence of European civilization, according to the expert estimations, the average growth rates were barely positive, and only after 1820 they have sharply accelerated. A cyclical crisis of 1825, which was the first one in the history of capitalism in Britain, was characterized by the exhaustion of the first technological mode of production and the transition to a new one, based on the further mechanization and use of new energy sources. Thus, with the completion of the Industrial Revolution, the capitalist economy is beginning to self-reproduce and renovate its material and technological basis, what J. Schumpeter has called "the creative destruction" (although S. Kuznets and A. Maddison dispute the existence of long-wave economic cycles, induced by the technological shifts).

Table 1.

Average growth rates of real GDP per capita, %

Region/ period	1–1000	1000–1500	1500–1820	1820–1870	1870–1913	1913–1950	1950–1973	1973–2003	2004-2015*
Western Europe	−0.03	0.12	0.14	0.98	1.33	0.76	4.05	1.87	**0.91/ 0.63****
Great Britain	0.00	0.12	0.27	1.26	1.01	0.93	2.42	1.93	0.70
USA	0.00	0.00	0.36	1.34	1.82	1.61	2.45	1.86	0.91
Japan	0.01	0.03	0.09	0.19	1.48	0.88	8.06	2.08	0.82
China	0.00	0.06	0.00	−0.25	0.10	−0.56	2.76	5.99	9.20
Former USSR	0.00	0.04	0.10	0.63	1.06	1.76	3.35	−0.38	..
World	**0.00**	**0.05**	**0.05**	**0.54**	**1.31**	**0.88**	**2.91**	**1.56**	**1.65**

Source: A. Maddison, [16, p. 383].

* Author's own calculations on the basis of World Bank data [10].

** The 2004-2015 indicators calculated for European Union / Euro area

The condition for long-run sustainable growth of developed capitalist countries was the ongoing rise of the factor productivity which had been increasing even during the 1922-1938 period. These trends had intensified within the postwar recovery, however, after a series of crises of the 1970s, they slowed down significantly. According to Table 1, the countries of Western Europe and the United States have been maintaining a positive average economic growth rate for a long historical period, but in 2004-2015 these indicators have reached the lowest rates since the beginning of the Industrial Revolution at the turn of the 18th and 19th centuries.

As it has been noted, with the transition to the sustainable economic growth, according to S. Kuznets, there was a gradual moderation of income inequality. It was explained by the fact that higher productivity of factors in the expanding industrial sector provides higher real wages for workers moving there. Thus, deepening inequality at the height of the Industrial Revolution in the period 1780-1850 in England and 1840-1890 in Germany and the USA [13, p. 19], was only a temporary phenomenon, which marked a painful transition from the traditional agrarian economy. The trends noted by S. Kuznets did take place until the mid-1970s, but at that period they were largely supported by the active redistribution policies and financial regulation in economically developed countries. After a series of crises and the transition of leading states to the principles of neoliberal policies (lowering tax rates, massive deregulation of the financial sector), the inequality in income and wealth within these countries began to increase again. For example, the share of the top decile in the US national income on the eve of the 2008 crisis reached a century maximum (50%), surpassing a similar indicator before the Great Depression of 1929 [21, p.24].

According to T. Piketty, the comeback of the trend towards the increase in the capital/income ratio with a relatively stable rate of return on capital (4-5%), exceeding the average annual economic growth rate, would increase the share of capital in the national income, contributing to even more intensive accumulation of wealth, aggravation of income and property inequality [21, pp. 571-573]. The author believes that the “forces of divergence” can be partially counterbalanced by “forces of convergence”, “associated in particular with the diffusion of knowledge and skills” [21, p. 572]. One should apparently understand by them the positive impact of scientific and technological advance, which, however, is not enough to achieve economic growth rates comparable to the average rate of return on capital.

According to Table 2, in the economically developed countries, and especially in the Euro Area, the pre-crisis rates of the economic growth have not recovered as yet. So, after the recession of 2008-2009 the EU countries have never managed to achieve the 2007 growth rate of real GDP, and the OECD countries as a whole achieved this only once – in 2010.

Table 2.

Annual growth rates of real GDP, PPP, %

Countries	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
EU-28	3,05	0,42	-4,37	2,15	1,66	-0,47	0,25	1,63	2,24	1,87
EU-19	3,01	0,42	-4,52	2,09	1,55	-0,91	-0,26	1,17	2,05	1,73
OECD	2,69	0,25	-3,46	3,04	2,01	1,34	1,43	2,01	2,34	..

Source: author’s own calculations on the basis of OECD [18]

Average annual growth rate of GDP at the period 2007-2015 amounted: in OECD countries – 1.28%, in 19 countries of European Union (EU) – 0.49%, in the EU as a whole – 0.71%. These rates are much lower than the average rates of growth of gross domestic R&D expenditure (Table 3).

Table 3.

Annual growth rates of gross domestic expenditure on R&D, constant 2015 prices, PPP, %

Countries	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**Average annual**

EU-28	3,81	4,89	-0,07	2,08	3,92	1,78	0,63	2,87	2,07	2,25
EU-15	3,58	4,75	-0,09	1,74	3,40	1,13	0,53	2,57	1,46	1,95
OECD	4,91	3,96	-1,26	1,46	3,67	1,46	2,68	3,15	2,34	**2,47**

Source: author's own calculations on the basis of OECD [18].

So the growth rates of gross domestic expenditure on R&D in the countries under review tend to increase faster than GDP, and in the crisis years they declined much less than GDP (Table 3). The second fact, among other things, is due to the government's active intervention: in 2009, in OECD countries an increase by 4.6% in government R&D spending, largely neutralized the drop in innovative business investment by 4.2% [17, p. 27].

Thus, the R&D intensity of GDP (gross domestic expenditure on R&D as a percentage of GDP) in economically developed countries has increased (Table 4), and the macroeconomic returns on R&D, respectively, have decreased. The growth of R&D intensity of GDP in itself is a desirable and strategically important macroeconomic indicator, but the problem lies in a significant slowdown in the rate of economic growth that has exacerbated after 2008-2009.

Table 4.

R&D intensity of GDP in different countries, %

Country		**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**
OECD		**2,22**	**2,29**	**2,34**	**2,30**	**2,33**	**2,34**	**2,37**	**2,39**	**2,40**
EU (28)		**1,69**	**1,76**	**1,84**	**1,84**	**1,88**	**1,92**	**1,93**	**1,95**	**1,95**
EU (15)		**1,82**	**1,91**	**1,99**	**1,99**	**2,03**	**2,06**	**2,07**	**2,10**	**2,08**
OECD	USA	2,63	2,77	2,82	2,74	2,77	2,71	2,74	2,76	2,79
	Japan	3,46	3,47	3,36	3,25	3,38	3,34	3,48	3,59	3,49
	Korea	3,00	3,12	3,29	3,47	3,74	4,03	4,15	4,29	4,23
	Germany	2,45	2,60	2,73	2,71	2,80	2,87	2,82	2,89	2,87
	France	2,02	2,06	2,21	2,18	2,19	2,23	2,24	2,24	2,23
	UK	1,63	1,64	1,70	1,68	1,68	1,61	1,66	1,68	1,70
	Poland	0,56	0,60	0,66	0,72	0,75	0,88	0,87	0,94	1,00
China		1,37	1,44	1,66	1,71	1,78	1,91	1,99	2,02	2,07
Ukraine		0,93	0,90	0,95	0,90	0,79	0,80	0,80	0,69	0,64

Source: compiled by the author on the basis of OECD [18].

At the same time there is an increase in income inequality in these countries. The rates of Ginny coefficient, which takes into account the inequality in disposable income, are presented in statistics quite fragmentarily. However, the available data are sufficient to identify the rise in income inequality over the past decades. Thus, in the USA, the Ginny coefficient for the period 1971-2012 increased from 0.316 to 0.389, and in 2013 and 2014 it was 0.396 and 0.394, respectively, according to the new methodology of calculation. In Japan, for the period 1984-2013, the Ginny coefficient increased from 0.304 in 1985 to 0.33 in 2012, in the united Germany for the period 1992-2011 it rose from 0.256 to 0.293 [18]. Indirect, however, very important information on the increase in inequality, can be received from the average annual growth rate of real wages of hired workers, which for the period 2007-2015 in the OECD countries grew by 0.4% annually (Table 5) compared to an average annual GDP growth of 1.28%. This indicates a decrease in

the share of labour in the gross domestic product, which undoubtedly affects the increase in inequality indicators. At the same time, the growth rates of R&D expenditures, as it have been noted, show a faster dynamics, averaging 2.47% annually. Fig. 1 indicates, that at the early 1990-s the situation was completely different: OECD countries experienced the decrease of R&D expenditure under the positive economic growth rates.

Table 5.

Annual growth rates of real wages in OECD countries, PPP, %

Country	2007	2008	2009	2010	2011	2012	2013	2014	2015	Average annual
OECD	1,16	-0,34	0,53	-0,21	0,29	0,13	0,07	0,63	1,35	0,40
USA	1,99	-0,39	0,87	0,64	0,25	0,80	-0,52	1,57	1,94	0,79
Japan	-0,92	0,30	-1,43	1,88	2,49	-1,15	0,45	-1,41	0,45	0,06
Germany	-0,17	0,63	0,40	0,40	1,75	1,08	1,01	1,44	2,24	0,97

Source: author's calculations on the basis of OECD [18]

The most comprehensive reason for decline of real wages is the decrease in marginal productivity of labour. So, in the pre-crisis period of 2001-2007, all OECD countries showed an increase in labour productivity, averaging 2.49% per year. In the post-crisis period 2008-2013 almost all OECD countries experienced a slowdown in labor productivity growth, and some (for example, the southern European states) suffered from its sharp decline. The average annual growth rate of labour productivity in this period in OECD countries was only 0.64% [17, p.150].

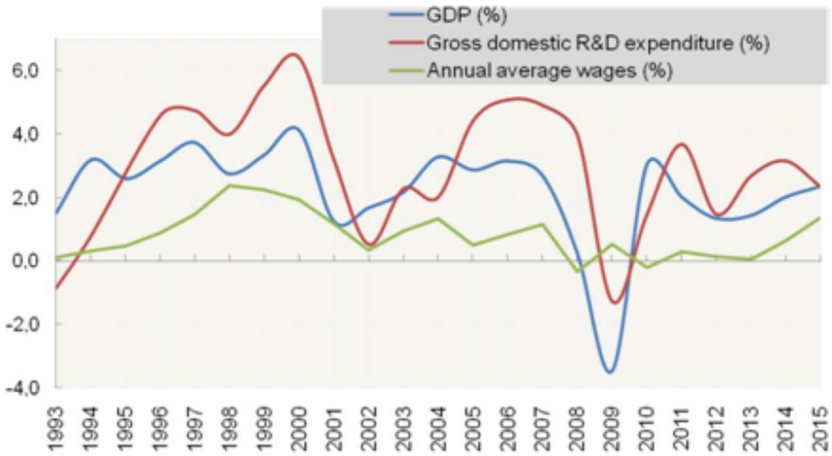

Fig. 1. Annual growth rate of GDP, gross domestic R&D expenditure and average real wages in the OECD countries, %

Source: calculated and compiled by the author on the base of OECD [18]

Another important effect of scientific and technological advance on the increasing income inequality is wage differentiation. Even during the pre-crisis period in the USA there was a significant decline in the demand for low-skill and middle-skill labour force due to innovatization of economy and development of international outsourcing [5, p. 193]. The further growth of unemployment brought to poverty a significant number of such workers.

In recent years these trends have become the subject of study by the leading economists. A research conducted in 2011 in the USA identified the unequal distribution of benefits from scientific progress as a factor in the expansion of income inequality: "capital owners largely benefited from the technological change. Their consumption boosted as a result of increase in income from labor and capital; … workers gained from technological change as well, although their gains were lower than the ones of entrepreneurs" [14, p. 33]. Under the guidance of Ph. Aghion, there was conducted the modeling of the relationship between innovation dynamics (foremost

the share and the quality of high-tech patents) and economic inequality indicators (the share of top 1 % income, Ginny coefficients). For the period of 2006-2010 in the USA there was found a strong positive correlation between innovation indicators and inequality [2, p. 40-41]. However, the authors of model focused on small innovative businesses, especially considering the direct inventors as patent holders and thus not paying much attention to the fact that the owners of the most strategically important patents with high commercialization potential are usually the largest multinational corporations. Together with the Nobel Memorial Prize laureate in Economic Sciences A. Deaton, Ph. Aghion also researched the relationship between the "creative destruction" and subjective well-being. The results showed a positive correlation between social welfare and active control for unemployment, the creation of new jobs and unemployment insurance policy, neutralizing the negative social effects of the "creative destruction" [3, pp. 3894-3895].

Through the example of the Dot-com bubble of 1997-2011 W. Lazonick and M. Mazzucato show the collision of innovators' and capitalists' interests as a factor of increasing inequality. The prosperity period of this bubble was the reason for lobbying the corporate tax cuts, while its crash brought out the movement of workplaces to Asia, leaving domestic researchers and inventors jobless [15, pp. 1097-1101]. In this view, corporations, personified by their top executives along with major venture capitalists, banks, hedge funds, playing the key role in funding of innovation activities, at the same time reap the major benefits from them, reducing the reward of direct innovators (scientists, inventors, engineers, venture businessmen). The price of their products (inventions, patent licenses, know-how, innovative startups) is being formed under the imperfect competition and determined generally by the discounted value of potential benefits from the productive use of these innovations. The most potentially innovative inventions are often the most risky as well, and that fact contributes to their market undervaluation.

Moreover, the overprotection of intellectual and industrial property rights (the time of which typically exceeds the time required to cover the costs and to earn the average and economic profit) hinders the innovation diffusion. Such inefficient legal institutions minimize the level of externalities generated by the R&D activities. But according to W. Baumol, the society needs to maintain a certain rate of innovation externalities for the sustainable economic growth and increase of social welfare [6].

Some researchers recognize the existence of innovation externalities not only within the borders of states, but also at the global level. This means that when choosing fiscal measures to enhance innovations, government should take into account not only the ratio between the private benefits of the innovator and the effect for social welfare, but also their impact on other countries. It cannot be ruled out that excessive R&D subsidies would directly contribute the increase of other countries' national income [23, p. 143]. Since the harmonization of fiscal policy, especially between economically developed countries and, for example, the fast-growing economies of Asia, is a very difficult issue, that fact may induce technological donor countries to strengthen the protectionist barriers. Such unfavorable scenario might also contribute to global economic inequality.

Conclusion. The Western countries, and later some other states, have been consistently realizing the model of innovation-based economy, the foundations of which were laid 200 years ago in the course of the Industrial Revolution. Industrialization and the significant increase in the factors' productivity made it possible to use the fruits of growth for broad social strata. Active redistribution and macro-financial policies from the mid-1930s to the mid-1970s still greater reduced the extent of socio-economic inequality. The further crisis of this model led to a significant shift in macroeconomic policy of the developed countries and reversed the noted trends in distribution. The income and wealth inequality, the harmful effect of which on the economic development is proved by multiply researches, has reached the highest level in modern history. The previous growth rates of the economy were not restored, but there was a significant increase in the innovation component of economic development. All these imbalances and contradictions were aggravated by the global crisis of 2008, which may indicate, among other things, the exhaustion of the previous techno-economic paradigm.

In the OECD countries in the period 2007-2015, the average annual growth rate of real GDP had been 1.28%, the average annual growth rate of real wages had been 0.4%, and the average annual growth rate of R&D expenditure had been 2.47%. Together with increasing Ginny coefficients (measuring the inequality in disposable income) in the majority of OECD countries, these data may indicate, firstly, a relative slowdown in economic growth rates, secondly, an increase in distribution inequality, and thirdly, the further increase of GDP science intensity and the development of innovation-based economy.

The decline in labor productivity in OECD countries results in a very low rates of real wage growth, falling much short of the economic growth rates. This, however, can not provide the desired growth in the rate of profit; and the high level of capital monopolization creates serious barriers to its mobility under the "creative destruction". A significant part of jobs, including highly skilled, are being transferred abroad, and the structure of employment under the innovation-based economy is changing quite rapidly.

Increasing investments in R&D are made by private capital mostly in the late stages of the innovation cycle, when the expected rate of return is no longer discounted by high risks. At the same time, authors of promising high-tech projects often have problems with access to capital and, accordingly, the implementation of their research advances. Thus, government needs to take a share of risks, subsidizing R&D, contributing to the creation of positive innovation externalities and reducing barriers to the diffusion of technologies while maintaining the incentives for innovation activities of economic agents. The ongoing structural shifts in economy induced by the scientific and technological advance require the active employment and social policies, which might prevent the growth of socio-economic inequality under the innovation-based economy.

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