

The Limits of the Modern Economic System

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Introduction

Economic development and its principles and objective laws are one of the most pressing, politically charged and controversial issues of modern science and journalism. In part, this is due to the present state of the global economic system itself: the economy and the laws and principles that govern it are something that is often ignored when things go well, but that immediately gets into the center of public attention when significant problems arise. A veritable trove of articles is published by authors of various schools of thought and points of view, but most are usually either too detached from reality and focused on mathematical models, cover only local problems or particular aspects of the economy, or are too distorted by political bias. Few researchers attempt to piece together a more or less complete picture out of separate theoretical works and empirical data, despite the fact that this line of work is just as important. This paper is a result of such an attempt to give a systematic review of the laws and consistent patterns that influence the way modern economy functions and, specifically, of the natural limits to its growth and development: do such limits exist, what are they based on, and how close is modern society to overshooting them?

The metaphor about being able to see further by standing on the shoulders of giants became popular after it was used by Sir Isaac Newton, but sources indicate that it existed in literature at the very least since the XII century. It describes this particular paper really well: it contains very little original statistical material, concepts or discoveries, but simply puts several already existing theories together into something that is greater than just the sum of its parts. It wouldn't have been possible without centuries of careful work by economists such as Adam Smith, David Ricardo, Karl Marx, Thomas Piketty and others, not to mention sociologists, ecologists and scientists from several other areas of expertise, who contributed to the modern understanding of the laws of development of economy and modes of production.

The idea that the modern economic system based on accumulation and multiplication of capital may have some natural limits, after surpassing which it stops developing and starts degrading, was first proposed by David Ricardo, who was the first to notice the tendency of the rate of profit to fall. Similar ideas concerning food production were developed by Thomas Malthus, although he completely failed to take social and technological progress into account. In the XIX century, Ricardo's ideas were developed by Marx, but by the middle of the XX century criticism and research of capitalism had somewhat stagnated. Many researchers preferred to see what they wanted to see: that

the system had changed in some fundamental manner, and old laws and tendencies did not apply to it anymore. Keynesian economic policy became a panacea of sorts, allowing governments to preserve all the benefits of the capitalist mode of production while reducing all its flaws. In the developed nations of the West this opinion was also supported by political agenda during the Cold War.

Ironically, the first indications that reality might differ from the optimistic picture of limitless growth and prosperity drawn by American economists, such as S. Kuznets, appeared in the 80s, when the free market economy prepared to celebrate its triumph over the only existing alternative – the socialist bloc – and public opinion was convinced, more than ever, that there was no realistic alternative to capitalism, and more so, that no alternative was, is, or will ever be needed. Nowadays, when the systemic character of the crisis that has engulfed the global economy becomes more and more obvious to a larger circle of experts and public figures, old questions arise again: what is happening? Why is it happening? And, more importantly, how to bring back the era of relatively stable prosperity and carefree consumption growth? Despite that, present problems are often dismissed as temporary difficulties, after dealing with which the economy will continue to develop the same way as before. This paper is supposed to cast some doubt on that, but also to help understand the limits of the modern economic system and possible consequences of surpassing said limits.

Historical retrospective and statistical data show, that it is the period of limitless economic growth and prosperity, which people became so accustomed to in more than 50 years since World War II, that is the temporary coincidence, and not the new stage of development for the whole system, as some people want to think. The middle of the XX century saw the peak of unprecedented rates of population and productivity growth, the reasons for which go back to the Industrial Revolution. This growth actually allowed the global economy to expand and provide a whole new level in living standards for billions. Nevertheless, the demographic transition that has already ended in developed countries is approaching its finish even in the poorest of developing nations, and the technological progress rates are getting slower (as comprehensively shown, for example, in T. Cowen's book "The Great Stagnation") and are unable to fill the niche left by the demographic component of economic growth. Moreover, since at least the 70s there have been alarming indications that the destruction of the biosphere and exhaustion of natural resources that occurred as a side effect of this turbulent growth may lead to significant increase in production expenses in the future, in which case a large portion of the economic effect created by technological progress will have to be spent to simply maintain global production on its pre-crisis level.

In these conditions old tendencies and contradictions, previously thought dead and buried by the triumphant free market, arise again, stronger than ever. The tendency of the rate of profit to fall, discovered by Ricardo and Marx, has for a long time been considered by economists to be an unfulfilled prophesy, a myth of the XIX century, disproven by the rapid march of progress. But what will happen with the rate of profit if economic growth decreases from the high rates than modern society is familiar with to 1 or 2 percent a year, a figure quite normal for the XIX century that seems utterly miserly nowadays? What will happen if, due to some ecological or resource-driven crisis, growth stops at all or becomes negative, turning into a stable decrease?

Modern studies, for example those conducted by a French economist Thomas Piketty, show that even a stable, but low, growth rate of 1-2% exposes old problems first pointed out by Marx. These issues may take different forms now than they did more than a hundred years ago, but their core, defined by the inner workings of a free market economy, remains the same. The tendency of income to concentrate in the hands of capital owners, discovered by Piketty, is the other side of the tendency of the rate of profit to fall: when the growth rate of the economy decreases below a certain point, which is the rate of profit that capital owners are accustomed to, they compensate for it by increasing the share of the surplus value in the product, therefore decreasing the share that goes to the employees for their labor. Without this mechanism the rate of profit would fall to the actual value of economic growth, thus fulfilling, with a long delay, the prognostications of Marx and Ricardo. Should the rate of profit remain the same, Marx's prediction of absolute impoverishment (that is, the decrease in income and quality of life) of employees will come to life, possibly for the first time in modern history.

The only scenario that defeats both these tendencies is the scenario of continuous high economic growth that was observed during the whole of the XX century, but there is a nigh-insurmountable obstacle in its path: the natural limits to growth, defined by the amount of resources available on our planet and the capacity of the environment to process pollution. All three of these tendencies are connected: to exist in the modern system, capital has to provide a certain rate of profitability, to ensure the profitability of capital, the system has to either maintain constant economic growth that leads to surpassing the natural limits of pollution and resources, or to decrease the share of income that goes to hired labor, which leads to complications of a socio-political character, seeing how high quality of life is a prerequisite for modern liberal democracy, at least in developed countries.

This paper takes a look at all three of these tendencies and examines their interaction with one another, as well as possible ways to overcome the present situation. The first chapter is devoted to the tendency of the rate of profit to fall and Marx's theory of surplus value and their relationship with the tendency of capital's share of income to increase, that was discovered by Piketty. The second chapter examines the model of limits to economic growth, first proposed in 1972 by Donella and Dennis Meadows and Jorgen Randers, and updated several times since then. The third chapter reviews the interactions of these tendencies and their penchant for supporting and emphasizing each other. Finally, the fourth chapter contains some considerations on how to overcome the limits outlined in previous chapters without the destruction or significant degradation of modern technological civilization.

Chapter 1

The rate of profit and the share of capital in gross world product

Two sides of the same coin

1. Rate of profit, GWP and surplus value

The Gross World Product of 2013 was estimated at approximately 75.59 trillion US dollars¹. Theoretically, this number expresses the mean market value of all goods and services produced on planet Earth during 2013, but in fact it is merely a sum of all GNP (Gross National Product) values for all the nations in the world. Such an estimate cannot be in any way precise since the relative value of the same goods and services may vary from country to country depending on the value of the national currency, and many economists consider the Purchasing Power Parity (PPP) version of GWP, which in 2013 was 87.25 trillion US dollars, to be a more accurate estimate². Even this version is not very precise due to the difficulties in gathering global statistical information and providing a mean market value for goods and services, but it gives a certain understanding about the size of the gross product of the whole global economy.

Classical economics defines the three factors of production as land, labor and capital. The modern economy is pretty far removed from the original agrarian-industrial society of the XVIII century, when this definition was first coined, and some modern economists, such as Thomas Piketty, propose that land in its traditional form (a plot of land used for agriculture or construction) should be merged with capital³. This point of view is based on the fact that modern land plots and their properties have so much added value and human labor invested in them over the centuries, that they may no longer be considered a mere element of the environment, but are just another element of the means of production instead, an item of capital. Considering the mostly anthropogenic landscape of modern developed countries, one finds it difficult to completely disagree with this idea. Nevertheless, such a merger does not shorten the list of the factors of production

¹ Gross Domestic Product 2013. The World Bank DataBank. 2014.

<http://databank.worldbank.org/data/download/GDP.pdf>

² The World Factbook”, Central Intelligence Agency, 2015

<https://www.cia.gov/library/publications/the-world-factbook/geos/xx.html>

³ Piketty T. translated by A. Goldhammer, Capital in the XXI century, Part 1: Income and Capital, Chapter 1, Income and Output, What Is Capital?

to just two – labor and capital – since some sort of modifier representing the qualities of the environment, the sum of its resources and its capacity to process pollution has to be included as one of them. The “land” inherited from feudalism as agricultural or development plots became a part of capital, but the Earth as the sum of environmental factors remains. This particular factor is examined in-depth in the second chapter of this paper.

Since GWP is basically extracted from the environment by labor with the help of capital, it can be divided in two parts: the part that goes to pay for labor directly or indirectly, that Marx called variable capital or wage capital, and the part that goes to the owner of said capital to cover its depreciation during the process of production, and to be consumed and re-invested by the owner. These elements may be generalized as the wage and the surplus value of the global capitalist system. It cannot be, and is not, completely equal to the whole amount of wages and capital income in the world, because capital income is taxed and is partially transferred to the employees as state-provided social benefits, and wages are received as salaries by those capital owners who occupy management positions in their own (or someone else’s) companies. But, as a generalization, the GWP may be expressed as

$$P = m + v$$

Where P is the GWP, m is the surplus value, meaning the part of the product that actually goes to the owners of the capital, and v is wages, meaning the part of the product that goes to the employees one way or the other. Since any expenses on amortization or raw materials in a global economy become someone else’s wages and surplus value, they are not present in this formula.

Global wealth, meaning the accumulated capital expressed via its monetary value, was around 241 trillion US dollars in 2013, out of which only 152 trillion was private capital by January 2014⁴. Since the main principle of the capitalist economy is the tendency of capital to multiply itself by accumulation and reinvestment, the other important factors of this system are the rate of profit and the profitability of capital, that express the amount of money or other assets as a percentage of the initial investment that the owner expects to receive as payment for the use of his or her own capital in the process of production. The rate of profit was postulated by Marx to be

$$p = \frac{m}{C + v}$$

Where p is the rate of profit and C is the permanent capital utilized in production⁵.

In his work “Capital in the XXI Century”, Thomas Piketty attempted to approach this issue from a different direction and empirically calculate the share of capital in the total product from the average return on capital (about 5% on average throughout the whole history of capitalism, from 5.1% in the beginning of the XX century to 4.3% now) and a proportion between the accumulated private capital and the product itself⁶. For developed countries this proportion, that can also be expressed as $\frac{C}{P}$, turned out to be about 5 to 6, if only private capital, that demands profitability, is taken into account,

⁴ Boston Consulting Group, Global Wealth 2014

https://www.bcgperspectives.com/content/articles/financial_institutions_business_unit_strategy_global_wealth_2014_riding_wave_growth/

⁵ K. Marx, Capital, Volume 3

⁶ Piketty T. translated by A. Goldhammer, “Capital in the XXI century”, Part 1: Income and Capital, The Capital-Income Ratio

and for the whole world this proportion would be about 2. This ratio can be considered a measure of “how intensely capitalistic a society is”, quoting Piketty, that is how developed are capitalist relations in a given country or the global economy in general. It also gives an idea about how much of the capital-derived profits is consumed and how much is reinvested. Therefore, if the average return on capital is 5% and the ratio of capital to product in an economy is 6, the share of capital in the annual product should be about 30%. This tendency, which Piketty named “The First Fundamental Law of Capitalism”, can be expressed as

$$\alpha = r \cdot \frac{C}{P}$$

Where r is the average return on capital, C is the approximate sum of all private capital, and P is the annual product.

But what is this share of capital in the product, if not the approximate expression of the surplus value, extracted by the owners of capital? Disregarding taxes and other means of redistributing the product from capital to labor and back, that should cancel each other on a global scale due to the system being enclosed, we get

$$m = r \cdot \frac{C}{P}$$

By taking available empirical figures of gross world product, return on capital and accumulated private wealth it is possible to approximate the amount of surplus value in the global economy. If the global private capital is approximately twice the size of gross world product, and the return on capital is around 5%, then the capital owners are due somewhere around 10% of the gross world product, which translates into 7,5 to 8,7 trillion USD annually. It is much easier to find data on separate countries, than it is on the world at large, so at the moment it is hard to test this proportion in practice, but as Piketty’s work shows, it holds in case of developed capitalist countries.

If this profit from capital is reinvested, thus turning into capital itself, capital grows. If capital grows, and the amount of labor being invested in the economy by the population stays the same, or grows significantly slower than needed, then according to Marx’s formula the organic composition of capital changes and the rate of profit must fall, if only the surplus value does not increase in proportion to variable capital – that is, wages. Since the rate of profit is

$$p = \frac{m}{C + v}$$

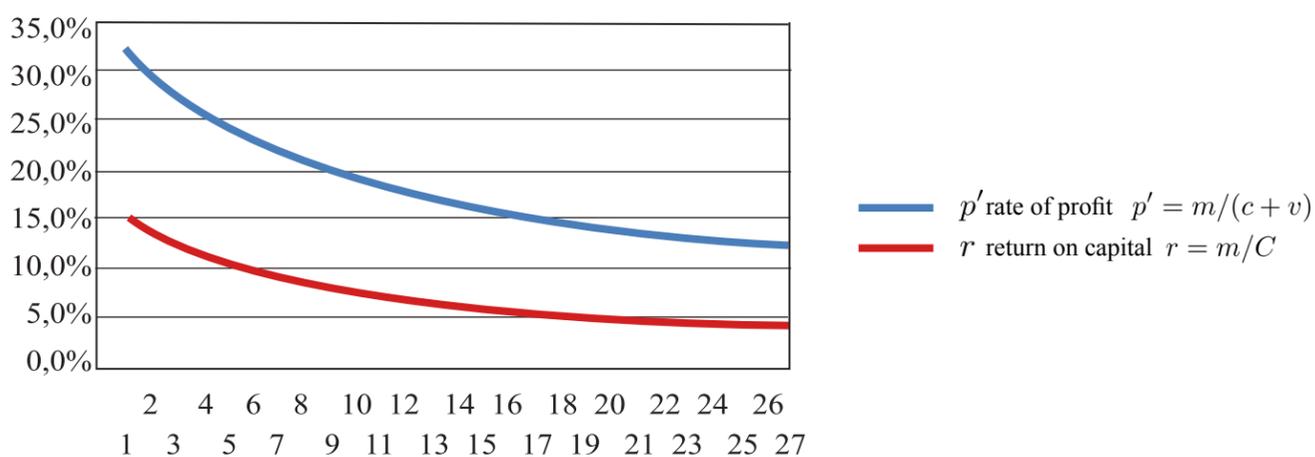
the increase of total capital used in production (C) will accordingly increase the expenses on maintenance and raw materials (c) which in Marx’s writings are called fixed capital, that are translated into the cost of the product. Therefore the more developed a capitalist economy is, the more important is the role of fixed capital in forming the value of goods and services, and the fewer are the opportunities for the average capital owner to obtain profit.

Marx considered this trend to be one of the main features of the whole capitalist system, and the fact that it hadn’t materialized during the 20th century is routinely used

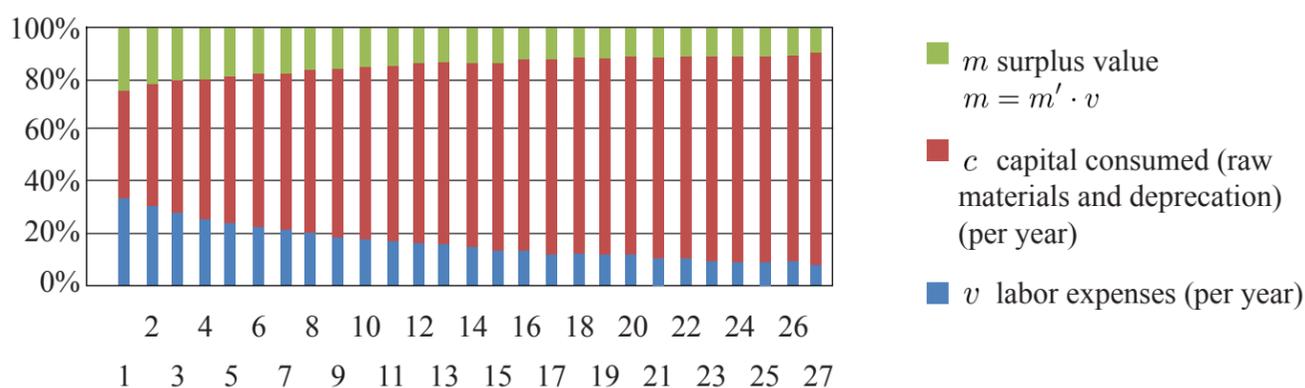
as an argument against his whole contribution to economic theory. But there exists a condition under which the rate of profit would not fall and the wages would not shrink: economic growth, when the sum of $m + v$ itself, which is the gross product, increases. In separate sectors of the economy and in several documented cases the rate of profit does indeed have a tendency to fall⁷.

The connection between the rate of profit and the return on capital is a separate issue, that deserves a more detailed examination. They are by no means the same, but taken in the context of the whole system they possess a similar dynamic. Let's say that C is the total sum of capital invested, c is the capital consumed during the process of production (raw materials and maintenance) in a year, v is the variable capital (wages), m' is the rate of surplus value (in percent), m is surplus value itself, P is the end value of the product, p' is the rate of profit (in percent) and r is the rate of return on capital (also in percent). The surplus value will thus be defined by the formula $m = m' \cdot v$, the total value $- P = c + m + v$, and the rate of profit $- p' = m / (c + v)$. The pure rate of return on capital in this case will be defined through the percentage of capital returned to the owner via the surplus value: $r = m / C$.

This is how it will look like with some hypothetical test data inserted into the equations and a rate of surplus value of 75% in a new sector of the economy that is yet to be saturated with capital and where the rate of return on capital reaches 15%:



Further we can see how both the surplus value and the expenses on wages drop as the organic composition of capital changes.



⁷ Basu, Deepankar, Manolakos, Panayotis T. "Is there a tendency for the rate of profit to fall? Econometric evidence for the U.S. economy, 1948-2007", 2010

http://scholarworks.umass.edu/cgi/viewcontent.cgi?article=1098&context=econ_workingpaper

Therefore the rate of profit and the rate of return on capital show the same dynamic which is the tendency of both to fall when a sector or the economy in general is saturated with capital.

2. Economic growth as a stabilizing factor of the system

The only way this system can preserve the rate of return on capital on its usual level without lowering the absolute value of the share of product that goes to labor, is the way of constant economic growth. Economic growth is the difference between the products of the present year and the previous year expressed as a percentage of the previous year's product, and looks like

$$g = \frac{P' - P}{P}$$

Since the product is a complex derivative from capital and labor modified by environmental conditions, the amount of capital invested in production does not influence the size of the product in a linear way, owing to the law of diminishing returns. Economic growth can therefore be divided into two components: a demographical one, produced by the population growth and therefore by the growth of the amount of labor invested into the economy, and a technological one, produced by increasing the productivity of labor. In 2013 global population growth was estimated at 1.096%⁸. So we can assume that the productivity of labor increased about 2%.

Growth can be defined more easily as $g = \Delta P$. Meanwhile, from the distributive point of view, it can also be defined as $\Delta m + \Delta v$, with both parameters being able to go into negative values when the changes in their proportion towards one another are more than the economic growth itself, when the $\frac{m}{v}$ proportion changes or when there is an economic decline instead of growth. In 2013, economic growth estimated by the IMF was 3,3%⁹. Global private capital in 2013 grew 14,6%. The Boston Consulting Group report that this value was taken from shows two sources of capital growth: reinvestment (creation of new assets) and the increase in the value of existing assets, with the latter being prevalent. Since the share of capital in the product directly depends on the proportion between product and capital, and therefore on the growth rates of both, it is possible to say that

$$\Delta m = \frac{\Delta C}{\Delta P}$$

and if all profit from capital is being reinvested, then $\Delta C = r$, and since $\Delta P = g$ it turns out that

$$\Delta m = \frac{r}{g}$$

⁸ CIA World Factbook, although UN data shows a figure closer to 1,2%
<http://www.un.org/en/development/desa/population/publications/pdf/trends/Concise%20Report%20on%20the%20World%20Population%20Situation%202014/en.pdf>

⁹ IMF World Economic Outlook,
<http://www.imf.org/external/pubs/ft/weo/2014/02/index.htm>

which can assume positive or negative values depending on whether economic growth is larger than the return on capital. It has to be noted that this proportion only works in relative terms, since in absolute terms if r and g are roughly the same, m may increase simultaneously and equally with v , just as when there is economic decline instead of growth m may stay the same in absolute terms but increase relatively to v .

From the empirical data we can see that new capital, made out of reinvested profits from capital, was only 4% in 2013, with the other 10% caused by an increase in the value of existing assets¹⁰. This forces us to take the ability of capital to increase or decrease in value according to global conditions into account in our calculations. This can be called demand on capital, which in short-term perspective is dictated by political processes in the world and other perturbations, and in the long-term perspective – by the degradation of the environment, that increases demand on capital to produce the same amount of product as before in worsening conditions, which will be covered in more detail in chapter 3 of this paper. This factor, the variation in value of capital and its total amount, can be designated e and expressed via a percentage of the initial value of capital, with the formula becoming $\Delta C = r + e$. During turbulent times when political instability leads to the destruction of large amounts of capital (whether physically or financially) this parameter may have a negative value, for example, during the World Wars of the 20th century. Therefore the part of ΔC that isn't connected to the investment process is designated e .

If we assume that the modern economic system requires a more or less constant rate of return on capital r to make capitalism viable and a more or less constant proportion $\frac{m}{v}$ to preserve the quality of life on the same level, it makes economic growth g the only factor that ensures the stability of the system. The periodic destruction and devaluation of capital during those periods when e has a negative value cannot be considered a constant or desirable factor, since historically it was only achieved through massive loss of life and wealth. In case economic growth slows down and becomes smaller than the comfortable rate of return on capital the system loses balance and the share of the annual product that goes to capital starts increasing.

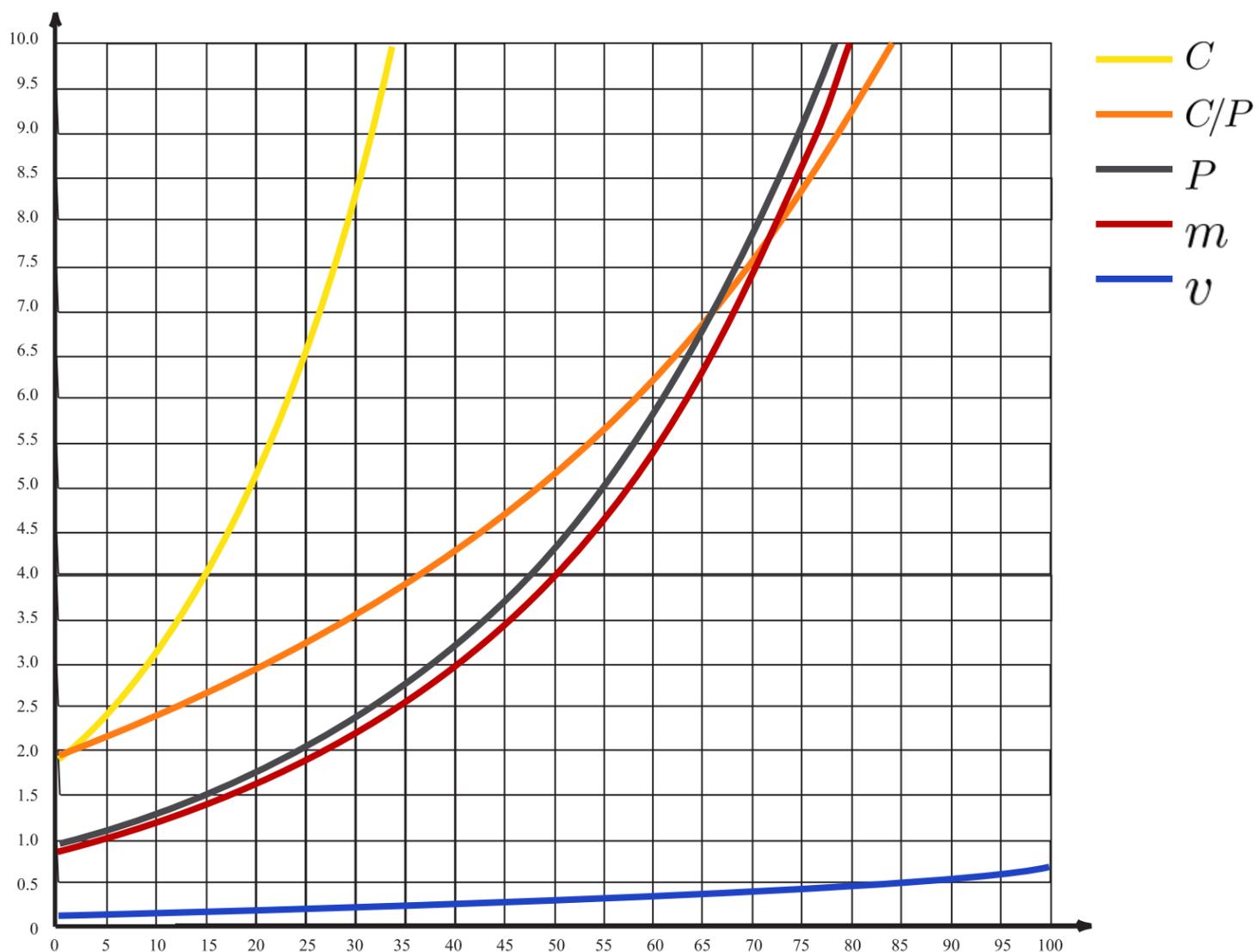
3. “Absolute impoverishment” as a formula: $r > g$

“Absolute impoverishment of the proletariat”, as first introduced by Marx, is a concept that describes the way employees’ income and quality of life decline over time in absolute terms, and is one of the most controversial concepts of Marx’s works on economics. Many 20th-century economists, noting the constant growth of income and improvement of the quality of life for most of the population, stated that absolute impoverishment – unlike relative impoverishment – is as much of a myth as the tendency of the rate of profit to fall. In reality, the fact that a long-term decrease in real income of workers and employees in general did not occur (as opposed to short-term decreases during cyclical economic crises) can be explained by the very same constant exponential economic growth that prevented the rate of profit from falling. In the model discussed earlier, “absolute impoverishment”, the decline in real income from labor, happens only when the growth of the capital’s share of annual product is more than the growth of said product, which causes the share of labor in absolute terms to decrease. It can be described as $\Delta m > \Delta P$. This very formula, if we assume that $\Delta m = r$ and

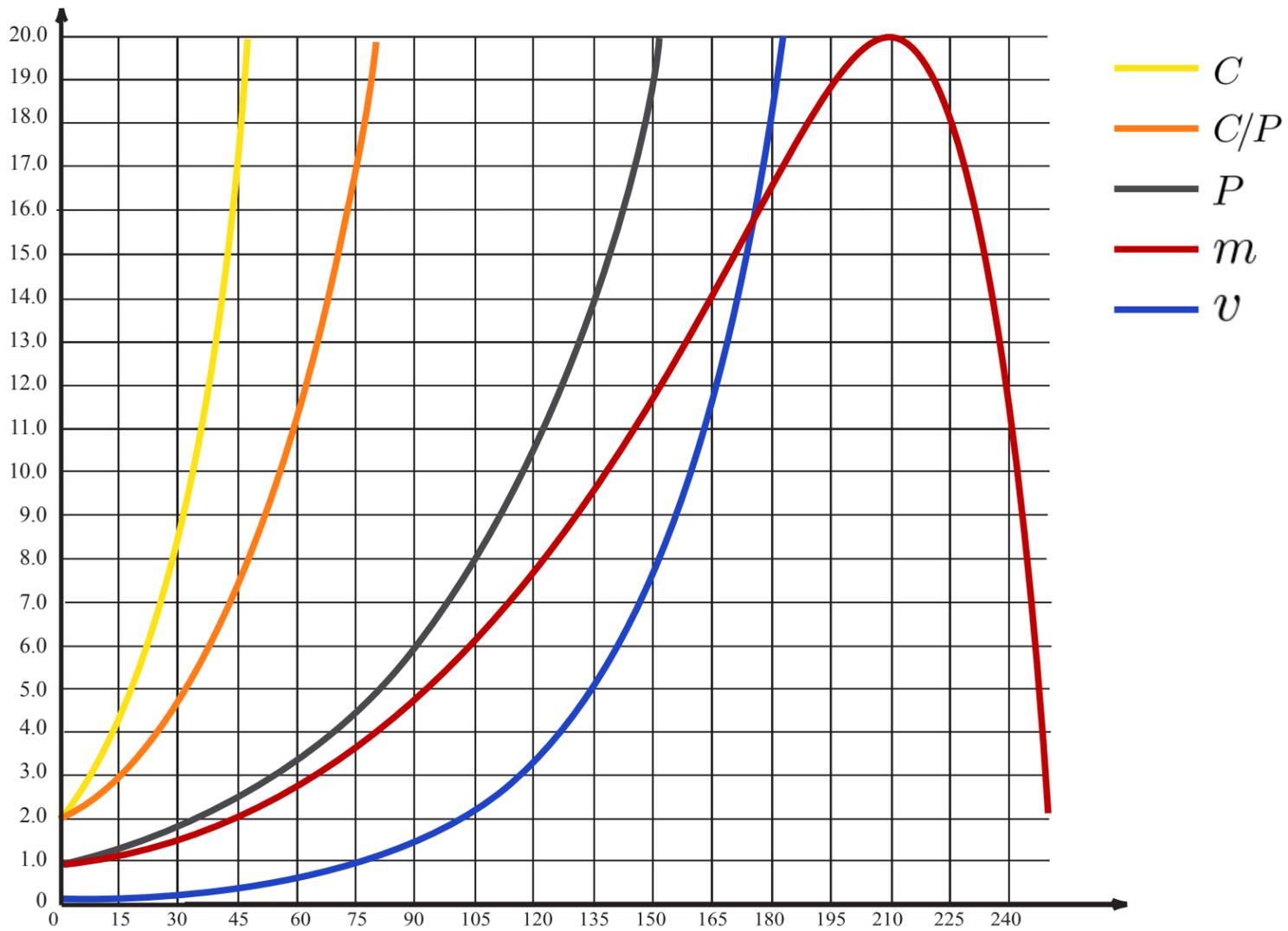
¹⁰ Boston Consulting Group, Global Wealth 2014

$\Delta P = g$ was created by T. Piketty as the Second Fundamental Law of Capitalism, the one stating that if return on capital (which is concurrent with the rate of profit) is higher than economic growth the capital's share of the product must increase and labor's share must fall. Relative impoverishment, that is, the fact that the income and quality of life of the capital owners, especially high net-worth ones, always grow faster than those of the people they employ, is almost undeniable nowadays. This brings us to a conclusion, that the process of absolute impoverishment only starts when the growth of the global economy slows down and falls below the average rate of return on capital.

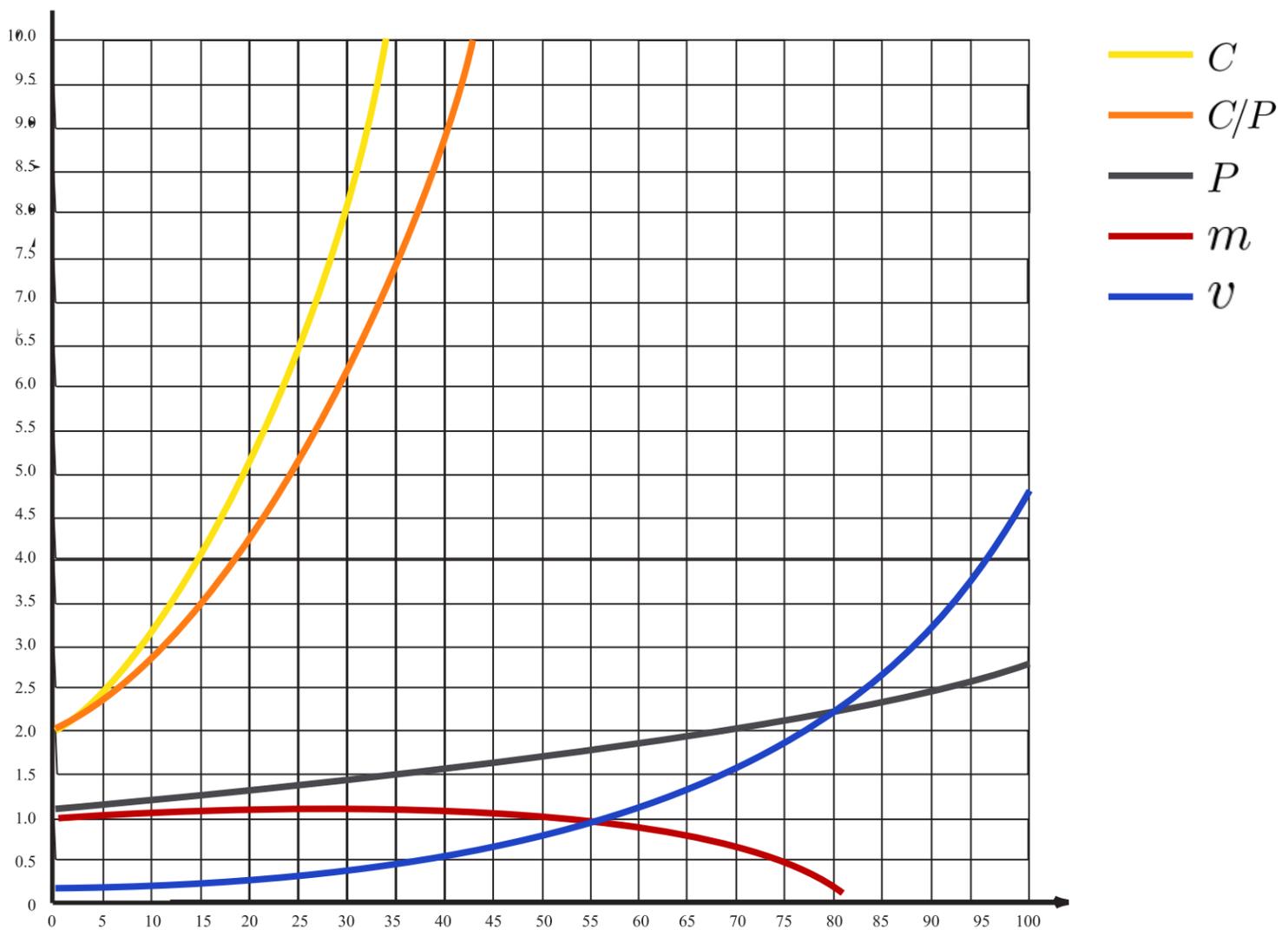
To illustrate this tendency, let's take the empirical data on the global economy in 2013-2014 that were discussed earlier. If the GWP equals about 75,59 trillion USD, and the global private wealth is double this sum, then with the return on capital being its usual 5% the capital owners are due 10% of the product – 7,559 trillion USD. If we temporarily ignore the variations in value of existing capital assets, that rapidly increase or decrease its amount in the short term, then we can see that in 2013 capital grew about 4,3% due to reinvestment, and the global economy grew only 2,9%. This means that next year capital owners will appropriate 10,3% of the gross world product, which means that the relative share of capital in the product increases, and the labor's share decreases. For the labor's share in the product to decrease in comparison with previous years in absolute terms, however, which would mark the beginning of the absolute impoverishment process, it would take much more time. The mathematical model described in Appendix 1 of this paper used with empirical data for 2013-2014 shows that if return on capital and growth rates persist on present levels and there is no increase in the value of capital due to degradation of the environment or other factors, on a global scale absolute impoverishment of the proletariat can only become real in a very distant future, or not at all, since any forecast on such a timescale (more than 1000 years) is essentially meaningless.



But if growth rates fall from the present 3% to just 2% with the same rate of return on capital, this horizon rapidly shrinks to a more acceptable mark of about 200 years:



While a scenario in which global economic growth shrinks to 1% makes this possible in the coming 50 years.



This leads us to a conclusion that the collapse caused by tendencies discovered by T. Piketty, while inevitable in any scenario where growth rates are lower than the return on capital, approaches much more rapidly as the growth rates decrease. In a system with zero economic growth, absolute impoverishment starts immediately and the time of total collapse depends only on the initial proportion between product and capital. This dilemma perfectly explains why Marx thought absolute impoverishment to be inevitable, and why his forecast never came to be in the 20th century: he was observing a system in which economic growth was always lower than the traditional figure of return on capital. This is definitely a forgivable mistake, since before the 20th century, and even more so before the Industrial Revolution global growth rates had never been this high. But this period of unprecedented growth has ended, and as growth shrinks to lower and lower figures absolute impoverishment of the population seems inevitable in case the present economic system is preserved. This is even without taking into account the environmental factors, which are going to be discussed in chapter 2.

Liberal democracy as a product of $g > r$ and its end

The quality of life as an abstract expression of all material goods and human development opportunities open to the average inhabitant of a given country is, without doubt, one of the main markers by which a society can be evaluated, but it is very hard to measure objectively and more or less precisely. This paper uses the Human Development Index (HDI, formerly known as the Human Potential Development Index) published by the UNDP, as one of the more realistic of all the existing indexes.

Out of all the parameters this index measures it is clear that the HDI by itself can only serve as a general estimate of the state of economic development in a given country, like GDP or average income do, and not as the measure of the quality of life for the average person it is supposed to be. Fortunately, the relatively recent addition of the Inequality-adjusted HDI serves this purpose much better. The methodology of measurement for both indexes can be found on the UNDP website. As a brief summary, the inequality coefficient is measured by inequality in three major areas: income, education and life expectancy. This index is closer to the real state of affairs since it reflects not only the level of economic development in a country, but also how accessible are its fruits to the average citizen of said country. It can be said that IHDI gives an impression on how hard the exploitation coefficient is on the population at large.

It is easy to see that the first positions in any list of countries sorted by IHDI are occupied not by the largest of the world's economies, but the countries with the highest level of both economic and social development, which are usually capitalist countries with developed social democracy, most of which are located in Western Europe, especially Scandinavia. USA, for example, has one of the highest HDI in the world, yet in these lists the US always fall to the level of Poland and Hungary due to extremely high inequality. The same can be said about Japan, Russia and South Korea.

Western sociologists state a plethora of different factors as the basis for stable liberal democracy in their countries, including the ratio of the so-called “middle class” amongst the whole population. In terms of this paper it can be expressed as follows: the maintenance of a stable liberal democratic political system is only possible when v (per capita, obviously) is equal to or higher than a certain level, roughly equivalent to that of developed countries. The extent of social support provided by a given country’s government and its relative “leniency” towards its citizens depends on the ratio of how intense exploitation in this country is: it is no accident that countries defined by the UNDP as having higher inequality have a harsher political regime in comparison to the reference standard of Western Europe. This can be seen even in the rather biased Democracy Index published by the Economist group. The same gradient, but in time instead of space, can be observed during the whole of the 20th century, when high economic growth and constant improvement of the quality of life led to continuous softening of western governments and the rise of the welfare state.

As for the so-called “middle class”, most Western sociologists note the trend that they perceive as a threat to Western democracy: the fact that during the last 25 years it experiences systematic stratification and as a result grows smaller. This effect probably has something to do with the fact that income from labor in largest Western economies stagnates around the level of the 1980-s, whether as the cost of maintaining the middle-class lifestyle constantly rises. This seems to be a natural process, seeing how, according to T. Piketty, the “middle class” is also a product of constant high economic growth of the 20th century. With this period over, the processes that supported the existence of the middle class as a large social stratum have ceased as well.

Chapter 2: Resource depletion, pollution overflow and capital depreciation Running in place

Land as a factor of production

Out of the three factors of production, land has always been the least defined. In classical economic theory and Marx’s “Capital”, land is defined in a rather narrow fashion, as a literal plot of land, a piece of territory used for agriculture or industrial production. The only reason it is even present as a factor is because if one wants to use it, one has to pay rent to its owner. Thomas Piketty in “Capital in the XXI century” notes that, since land improvement and cultivation requires no less effort than any other capital, land itself is basically a form of capital.

According to the aforementioned definition it is indeed so, land has long since become just another capital asset on the financial market. However, this doesn’t mean that capital and labor exist in a vacuum and the process of production is completely independent from the environment. There exists a factor that defines how easy it is to procure various kinds of resources, to maintain production and to sustain life. The XIX century economists paid little attention to it because in their time the environment seemed to them an endless or nigh-inexhaustible repository of resources, and the only

problem they had to deal with was the deficit of land as simple territory for production in capitalist countries.

The recognition of ecological problems was a long and arduous process in the XX century, but in its second half humanity finally understood, that our planet in no way resembles an inexhaustible “black box”. Its resources are finite, and their natural replenishment systems break down, pollution sinks overflow, and this whole process is inseparable from human economic development. From the economic point of view this process can be divided into two factors: the first is the increase of the cost of resources as they are depleted, and the second is increase in the depreciation of capital as our environment degrades.

The first process is caused by the fact that capitalist industries, which tend to maximize profit and minimize expenses, always starts extraction of any valuable resource from the most easily accessible and plentiful deposits, and switch to smaller, less accessible ones only when these major deposits have been depleted. This causes the cost of resources to start increasing way before there is any threat of depleting all known reserves, as extraction has to switch to less and less suitable deposits. Therefore, a system that depends on these resources will face a crisis far in advance of any sort of total depletion, or maybe even peak production.

The second process is much more straightforward: the overflow of pollution sinks means that the economy produces more pollution in a unit of time than the environment is capable of neutralizing in the same amount of time. This undermines the ability of the environment to sustain human life and forces the economy to suffer significant expenses on purification, recycling and reclamation only to maintain prosperity and production on the same level as before, and these ecological amortization expenses tend to increase over time if the flow of pollution is not reduced.

If we return to the issue of land as a factor of production, we can see that the environment (which should be the modern definition of “land”, or rather, the Earth) is not so much a direct factor of the production process, like capital and labor, as it is a modifier, and their relationship should look somewhat like this:

where L is labor, and E is the environmental factor, which is “land”. The higher this factor is, the more capital and labor is needed to produce the same amount of product. If L is assumed to be a constant, or to change exclusively due to demographic growth, it turns out that an increase in the environmental factor can be mitigated only by increase in the value of capital, which is what happens in practice. The easiest example is the increase in capital of resource extraction companies. As resources are depleted, their producing cost increases, along with their market value, and with them – the stock of the companies on the financial market, which means that their capital grows. This inflation of capital by means of increased value of existing assets was discussed in paragraph 2 of chapter 1 of this paper as e , where e is exactly the value added to capital to compen-

sate for the growth of E – in the long term, of course, since in the short term this value is defined by various forces, most of them political.

Therefore, the growth of the environmental factor is another destabilizing element on the system, one that is capable of amplifying disruptive tendencies, outlined by Marx and Piketty, since the increase in value of capital leans to increase of the share of capital in the product and, in turn, of the absolute rate of capital growth, which forms a positive feedback loop. This mechanism will be investigated further in the following paragraphs.

Resource depletion and pollution sink overflow as consequences of unchecked growth

As was previously shown in chapter 1 of this paper, the modern economic system requires constant exponential growth to remain in a state of equilibrium, and the smaller the growth, the closer its possible collapse gets. If growth falls lower than a certain threshold or stops altogether, it will cause either the fall of returns on capital, which will make the whole capitalist system unprofitable, or the absolute impoverishment of the population, which will lead to rapid increase in social tensions. In both of these scenarios the modern system as we know it will come to an end, since capitalism is impossible without acceptable return on capital, and modern democracy is impossible for an impoverished population. But the exponential growth needed to prolong the existence of the system itself causes a series of problems, most of which were described in the famous work “Limits to growth” by Dennis and Donella Meadows and Jorgen Randers.

This group of researchers has formulated a concept of limits to growth, a certain level of resource consumption and pollution sink fill-up, which causes the system to stop being self-sustaining and move towards collapse after surpassing it. The main problem of exponential growth as a developmental principle is that it embodies the transition of quantity into quality and in time assumes an explosive pattern, and an exponentially growing variable reaches certain limits often completely unexpectedly for an outside observer. At some point in time exponential growth amasses such strength, that reaction time shortens to a minimum and controlling it or dealing with it becomes impossible. As a rule of thumb, the doubling time of an exponentially growing variable equals roughly 72 divided by the percentage of growth. This means that, assuming modern rates of

growth persist, the GWP will double in about 24 years, while capital will double in 14 years.

According to Meadows's definition, exponential growth can take place when something reproduces itself, or when something depends on something else that reproduces. Therefore, exponential economic growth is necessary for capitalism, since the production of capital by capital is the main principle of capitalist economy. Capital will grow anyway, so for its share in product not to increase ad infinitum, the product itself has to grow.

The system thus seems to have three limits: the limit of profitability, the limit of quality of life and the limit of growth, and the logic of its development and existence is such that it cannot avoid surpassing at least one of them. To remain capitalist, it has to turn a profit, to remain democratic, it has to maintain the quality of life, and to provide for both of these parameters it has to grow exponentially.

Meadows and his colleagues used the World3 system-dynamics model, which they themselves constantly improved upon. The viability of this model, which includes a broad variety of factors, is reinforced by the fact that conclusions made on its basis correlate with the factual data and tendencies observed throughout its whole lifespan since 1972. These conclusions may be summed in the following four statements:

The human economy is now using many critical resources and producing wastes at rates that are not sustainable. Sources are being depleted. Sinks are filling and, in some cases, overflowing. Most throughput streams cannot be maintained over the long term even at their current flow rates, much less increased. We expect many of them will reach their peaks and then decline in this century.

These high rates of throughput are not necessary. Technical, distributional, and institutional changes could reduce them greatly while sustaining and even improving the average quality of life of the world's people.

The human burden on the natural environment is already above sustainable levels, and it cannot be maintained for more than a generation or two. As a consequence, there are already apparent many negative impacts on human health and the economy.

The true costs of materials are increasing.

The influence of the aforementioned factors on capital and its reproduction on a global scale, however, may be felt long before their effects on the quality of life and the health of the population become visible.

The overflow of pollution sinks has similar consequences for the economy to those of resource depletion, but in a less obvious manner. Apart from damaging the health of the population and lowering life expectancy, all of which also have an economic impact, it directly causes an increase in amortization expenses towards maintaining industrial and other material capital in working order, and also shorten its working life. Just like the true cost of materials constantly rises as resources are depleted, inflating the value of

existing capital assets, as the environment is polluted and degrades, expenses towards capital maintenance also increase, inflating its value further.

The environmental and resource crises and the collapse of the system

Out of all the scenarios processed through the World3 model, two are the most probable: one linked to a natural resource depletion crisis, and the other to an environmental pollution crisis. Both scenarios assume that the global economy continues business as usual until it is too late, which is still the case as of now, supported by empirical data. The only actual difference between these scenarios depends on whether modern estimates of existing natural resources reserves are correct: if so, then the present growth rates lead to the first scenario, and if reserves are underestimated (which is entirely possible) – then they lead to the second. The issue is in which crisis strikes first, and not in whether there's going to be a crisis at all. In a world with finite resources and pollution sinks an exponentially growing capitalist economy will inevitably end in disaster, and the initial parameters of the system may only influence the actual shape of this catastrophe.

When the economy overshoots the limits of its growth, it starts several mechanisms which D. Meadows called “erosion loops”, three of which present the most interest to us. They are erosion loops in agriculture, industry and services, the three fundamental sectors of the economy. Exponentially growing agriculture, for instance, causes soil exhaustion and a following food production crisis, which puts society in danger of famine.

This crisis, in turn, requires more investment in agriculture to maintain the production of food on the same level as before. The larger the loss of arable land, the more intense the use of remaining land gets, and the faster it degrades, which means that either food production has to decrease, or more and more capital has to be invested in agriculture, with food prices rising in both cases. Such diversion of capital from the industrial sector into agriculture undermines the reproduction of material industrial capital, since less funds are left to compensate for wear and tear. This in turn leads to a decrease in industrial production, and the shrinkage of the industrial basis that could support intensive agriculture on a constantly rising level. A multi-tiered positive feedback loop is created, one that in long-term perspective leads to decline in both agriculture and industry.

Such decline of the economy drastically shortens the amount of services per person. Since there is an observable correlation between reproduction rates and the amount of services available per person (negative before demographic transition, and positive after, which means that a large amount of services per person helps control population growth in developing countries and stimulate it in developed ones), this reduction means that population growth will either speed up, putting more strain on the economy or slow down, decreasing the available labor pool and causing a further economic decline due to labor shortages. Therefore this particular crisis is dangerous for developed countries and emerging economies both, but in different ways.

In the first scenario of the World3 model resource depletion requires more and more financial investments to maintain the flow of resources on the same level, and the lack of funds in industrial manufacturing and services leads first to a decline in these sectors, and then to a decline in agriculture and resource extraction industry due to manufacturing not being able to cope with their increasing demands. Food production and healthcare degrade as a result, which rapidly lowers life expectancy of the population and its number. This decline is unavoidable, since the economy cannot stop investing into resource extraction industries it depends on, and even if it could, it would quickly provoke a shortage of fuel and raw materials, which would collapse industrial manufacturing even faster.

All these factors lead to a decrease in population and average life expectancy, which damages the economy even further due to a shortage in both qualified labor and effective demand. The situation starts resembling an overproduction crisis in reverse: instead of the abundance of goods and services, which outstrips demand, bankrupting enterprises and lowering demand even more, this crisis increases the prices on essential goods and services, which leads to a decline in population, a shrinking workforce and as a result – the prices grow more and more.

One of the less obvious features of this crisis which nevertheless has serious repercussions for the future is that it is possibly irreversible: economic decline lowers scientific and industrial potential which will be impossible to rebuild in a world without cheap resources. Technological progress can possibly countermand this issue by discovering new untapped resources, but the shrunken scientific potential of the post-crisis society means that the chances of such a discovery being made on an observable timescale are lower than they are now.

The second scenario is based on environmental pollution, which influences the productivity of arable land and undermines agriculture. The falling productivity of agriculture causes famine, lowering population numbers and life expectancy, which are already suffering from pollution themselves, and launching an erosion loop described in the previous case. This scenario is much more catastrophic, since the full effect of the crisis will be felt much faster and over a shorter period of time, but it is possibly less irreversible. Theoretically, once the anthropogenic pressure on the environment drops, the environment – unlike finite natural resources – will sooner or later recover, but this point of view is debatable. It is also theoretically possible for the environment to degrade to such a point where it would be incapable to recover or exist at all without human assistance, meaning extra expenses on part of the struggling economy which would be unable to cover them.

The other less obvious, but no less important features of this crisis is its ability to emphasize and hasten processes described in chapter 1 of this paper, since the political, social and economic effects caused by an increase in value of existing capital assets will, most likely, be felt long before any collapse predicted by Meadows's model.

Chapter 3. The positive feedback loop How these two problems aggravate each other

The falling rate of profit requires economic growth

In a world of limited resources and natural limits to growth, the capitalist economy becomes a vicious circle of destructive tendencies. Its fundamental principles require constant exponential growth, which causes the economy to overshoot its limitations, which in turn increases demand for capital, and therefore growth, even more. The global economy is in a very unstable state of dynamic equilibrium between the tendency of the rate of profit to fall, the tendency for the capital's share of the product to increase, the rising value of existing assets and the necessity to maintain the same quality of life – at least, in the developed countries – to avoid social collapse. The starting point of this issue, however, is not the resource limitations and not even the level of consumer pressure that residents of developed countries put on the environment, but the main principles of capitalism, which dictate that capital produces capital, and the main stimulus for economic activity is the acquisition of profit to increase capital.

Most concepts of reforms, including the state regulation measures proposed by Thomas Piketty in Part Four of “Capital in the XXI Century”, and the free-market self-regulatory measures outlined by D. Meadows in the “Limits to growth”, are directed at redistribution and limitation of profits from capital, to control its constant growth and the processes that stem from it. But, just as the problems described by Marx and Piketty are two sides of the same coin, the mutually exclusive conditions of the same crisis (either the rate of profit falls, or the labor's share in product does), the decisions provided by Piketty and Meadows can only help us choose one of the two pathways to collapse. If the rate of return on capital is limited by way of fiscal state measures to a value lower than economic growth, as Piketty proposes, the threat of social collapse caused by the uncontrollable increase of the share of capital in the product will be neutralized to an extent. But, as Meadows's model shows well enough, even small exponential growth is still exponential growth, which can still lead to a catastrophe, just at a slightly later date. Since the exponential growth of the economy itself remains, the crisis caused by overshooting the limits will still be as much of a threat, or even more so. If free-market self-control measures proposed by Meadows are put into effect to attain what Meadows called “sustainable development” or “zero-growth scenario”, the capital's share of the product will start increasing rapidly, as Piketty has shown, since with zero economic growth there will be decidedly nothing to compensate for it.

This issue could be addressed if all profits from capital were to be directed into amortization expenses for existing assets and the rest was consumed by the capital owners themselves, instead of being reinvested, i.e. creating new assets. The capital owners would thus turn into the ultimate rentier, whose livelihood would be completely secure and guaranteed. Unfortunately for the reformers, the harsh reality of the market economy makes such a scenario unfeasible. The main incentive for capital owners to increase their capital is not an irrational drive to amass riches, or a rational desire to increase their standard of living. No, in a free market economy the value of individual assets,

and, as a result, the profits received by their owners, is not guaranteed by anything and is as susceptible to the vagaries of the market, as the cost of labor or an employee's salary might be. The owner has to constantly reinvest a part of his income if he wishes to ensure, more or less, a similarly steady income in the future. It is no accident that those heirs to large fortunes, who choose to mindlessly spend their inheritance instead of managing it properly, usually end up destitute.

This mechanism, along with the competition between capital owners, inherent in the free market model, means that, to maintain competitiveness and a certain guaranteed level of personal consumption, one has to constantly strive to increase one's capital by reinvesting at least a part of income from it - the bigger, the better. As a consequence, it is impossible to excise or suppress the impetus to increase capital from the system without excising or suppressing market economy itself, which would no longer be considered a mere reform, since such a step would require a fundamental transformation of all the principles on which both modern economy and modern society stand. The system needs exponential growth to avoid social or economic collapse, but this exponential growth leads it into an ecological collapse anyway.

Economic growth pushes the economy beyond the limits

Economic growth, which will inevitably cause a corresponding increase in real production and consumption, cannot last indefinitely. Sooner or later it will overshoot the limits inherent in the system, which in case of the global economy take shape of exhaustible resources and accumulating pollutants. For this exponential growth to continue without repercussions, the economy has to constantly discover new resources to exploit and new ways to deal with pollution, and the costs of these discoveries have to decrease with time, and not increase as it usually happens in technological progress.

The introduction of resource-saving and ecologically safe technologies in a market economy does not prevent it from surpassing the limits, since it's only possible in cases where such technologies provide a competitive advantage, which means earning more profit by selling more goods. The total ecological damage from an increase in production and consumption in such cases massively outweighs any resource preservation and pollution reduction at the level of a single item.

In a capitalist economy, technological progress works towards increasing overall consumption at every step, which means more manufacturing capabilities to support it, instead of developing industries that would "preserve the biosphere". Moreover, capitalism turns technological breakthroughs in metal, fuel or energy savings, pollution reduction, etc, by turning them into their opposites: this is the well-known Jevons paradox, which states that any increase in effectiveness of use for any resource resulting from technological progress leads to an increase in demand for this resource and a corresponding increase in overall consumption, since "resource conserving" industries attract more investments and significantly increase their output in comparison with their traditional competitors.

The fact that modern economy has already overshoot the limits, outlined for it by existing resource reserves and pollution sinks, can be convincingly proven by Meadows's data and the research of other environmental scientists:

1) The reduction of area of major biomes and the extinction of species tends to accelerate in general, despite individual successes. In 2002, during a conference on sustainable development in Johannesburg, world leaders signed the Biodiversity convention, which was supposed to reduce the risk of species extinction and major biome degradation by 2010. To evaluate the rate of completion for this goal, ecologists have developed 31 measures, indicating the vital capacity of species and their population dynamics.

Despite that, the article on the results, published in "Science" in 2010 paints a bleak picture: all the measures indicate shrinking areas of wild nature and degradation of biodiversity.

2) All biological resources that are exploited at the moment are rapidly being depleted, especially fish, game and timber, despite developed fields of science making it possible to predict stocks and reserves and, calculate the maximum acceptable extraction rates. Many international treaties and conventions on protection of these resources and prevention of overexploitation and poaching have been signed, but to no avail. The global fishing industry, for example, has reached its peak in 1980-1990s (and its continuation at the same pace would cause a collapse in populations of commercially important species) and has been declining since.

3) The total area of degraded, barren or polluted land requiring reclamation is constantly increasing.

4) Ecosystems are being intensively "intermixed" due to human activity.

5) During the last 30 years observations have found signs that natural ecosystems are not capable of conditioning our common environment – purify polluted water, air and soil, consume excessive carbon dioxide produced by industry, transport, biomass burning, rotting agricultural remains and the like – anymore. For instance, the buffering systems of the world's oceans are already failing to prevent an increase in the acidity of water due to excess carbon dioxide being dissolved in it. The acidity levels are rising, bringing a host of negative consequences for the environment, which may be comparable to the mass extinction during the Permian-Triassic transition, one of the causes of which is thought to be a similar acidification of water.

The formation of a positive feedback loop and the difficulty of escaping it

The approaching environmental crisis itself greatly accelerates the socioeconomic processes caused by the fundamental properties of the capitalist economy. Capital depreciation costs increase, but private wealth grows, without corresponding growth on part of the product, due to the rising value of existing assets. The demand on capital from the main sectors of the economy: agriculture and resource extraction industries – rapidly increases, and the rate of profit, on the other hand, falls constantly, because getting the same result requires more and more investment with each iteration.

This increase in the value of capital will inevitably push the system out of its present state of dynamic equilibrium, if economic growth does not increase proportionately, which is very unlikely, given the hard times the economy will have to face by then. Technological progress might soften this crisis a little, especially in the beginning, but the sheer number of factors destabilizing the economy and society as well, and the erosion loops that will have formed already, make this hope a very faint one. These factors and loops can be described as follows:

The decrease in food production leads to a rise in price of foodstuffs and lowers the quality of life and life expectancy worldwide, especially in developing countries. Malnutrition also negatively affects the health of the population.

Accumulated pollution also undermines the health of the population, increasing the workload of healthcare systems and expenses directed at reclamation and protection from pollutants.

All the above diminishes the available workforce by a decrease in the population itself, by making remaining laborers unfit to work and prolonging sick leaves.

Population decline and a decrease in quality of life reduce effective demand for non-essential goods and services, launching an overproduction crisis in these industries.

Decreasing income of the population expands the volume of toxic debts, starting a financial crisis.

Thus the environmental crisis starts several erosion loops at the same time, loops that the system will be unable to overcome by itself due to its own structural features, since there will be no opportunities for extensive expansion or intensive development, which used to stabilize it in the past. Therefore the issue passes from the realm of socioeconomics into the realm of politics, where any attempts to address it will face a contradiction that is also inherent in the fundamental principles of the economic model, which the present political system is based on.

One of the fundamental principles of the market economy, as well as of liberal democracy, which is based on it, is the principle of competition. In the context of the aforementioned limits to growth issue, this principle is disadvantageous because of an almost overwhelming priority of short-term profits over long-term gains inherent in it. Both companies competing with each other on the market, and the candidates competing with each other during a run-up to an election, almost always choose short-term profit to gain an edge over their opponents, because, in a competitive environment, this is the choice that tends to win. In the economic sphere this phenomenon obstructs decisions directed at a long-term perspective. In politics it leads to the government, which is supposed to defend the interests of the ruling class, to protect its short-term interests

more than long-term ones, and the more democratic a given state is, that is, the less it's detached from its society, the stronger this tendency gets.

Preventing the collapse of the system is obviously one of the long-term interests of capital owners – their main long-term goal, to be exact – but the sum total of their short-term interests, which are to minimize any limitations to their business activities on part of the state, always prevails. Besides, those capital owners that neglect the long-term interests of the system in favor of their own short-term profits tend to be more successful when competing with others, which means this behavior pattern becomes entrenched and widespread, and will overpower any drive for self-limitation caused by a desire to preserve the system for the future. Theoretically, a strong authoritarian state might limit short-term interests of individual capital owners to ensure their long-term survival as a class, but such a transition would have to happen in all developed countries at once, or the country that goes through it first would be, on one hand, politically isolated and ostracized, and on the other hand – would lose competition in attracting and retaining capital.

The transformation of the capitalist system in the middle of the XX century, that led to the emergence of the welfare state, is indeed an example of such self-limitation, but it was caused by a combination of factors which is unlikely to repeat in the near future: rapid population and productivity growth, the destruction of large amounts of capital in two World Wars and a series of crises, and competition with an alternative economic system which motivated and unified capitalist governments and societies, etcetera. In modern times, defined as they are by shrinking economic growth and surpassed environmental limits, the system as a whole and its elements will probably drift in the opposite direction: the lack of extra growth and resources which could be directed at increasing the quality of life without endangering the profits of the capital owners, and the absence of political will born out of an absence of competition with another system. Even the destruction of large amounts of capital, inevitable during collapse of the system, will be, firstly, rapidly compensated for by increasing value of surviving assets, and secondly, without high growth rates endemic for the post-war period of the XX century, it will only aggravate the matter. Such a crisis will destroy – along with an enormous amount of financial capital in form of accumulated debts – a large amount of real resources and means of production, with no extra growth to restore them.

Chapter 4. Overcoming the limits

Sustainable development instead of exponential growth

According to Meadows's model, the solution to the problem of limits is sustainable development, meaning a way of economic and societal development that prioritizes stability and environmental protection. A sustainable society "is one that meets the needs of the present without compromising the ability of future generations to meet their own needs". A better fitting term would be the German variant "nachhaltige Entwicklung", meaning "continuing development", one that may last long into the future, potentially forever. This means a clear requirement to provide future generations with resource reserves no smaller than the ones that we use ourselves (including biodiversity and natu-

ral ecosystem “services”), and a clear prohibition on transferring environmental risks created by industry and lifestyle onto future generations.

The logic of capitalism forces industries to exploit the most easily accessible resource deposits first, switching to smaller and less convenient ones only after these are exhausted. The logic of sustainable development prescribes the opposite: a constant search and exploitation of smaller and more difficult deposits, while leaving the large and conveniently located ones as a reserve to guarantee future development. Such a practice increases the cost of raw materials in the short term, but ensures that in the future, as the economy develops, the true cost of raw materials is not going to rise, but will remain on the same level or even decrease.

Herman Daily once outlined the three conditions necessary for sustainable development:

- 1) Its rates of use of renewable resources do not exceed their rates of regeneration.
- 2) Its rates of use of nonrenewable resources do not exceed the rate at which sustainable renewable substitutes are developed.
- 3) Its rates of pollution emission do not exceed the assimilative capacity of the environment.

Such a choice in favor of long-term perspective is the main principle of sustainable development, which is incompatible with the fundamental features of a free market economy, as will be shown further in the text. Apart from a more rational and economical way of resource usage and introduction of environmentally-friendly technologies, a sustainable society would also have to limit its consumption, since these measures by themselves do not remove the problem and merely alleviate its consequences. The World3 model shows that a global transition to a sustainable society is theoretically possible without significantly lowering population numbers or living standards. On the contrary, averaged-out or up-scaled living standards are a prerequisite for sustainable development. To stop constant exponential population growth in developing countries their population has to be provided with necessary resources and services to break out of the “poverty begets poverty” feedback loop. The residents of developed countries, on their part, will have to limit their consumption of goods and services, choosing quality over quantity.

«A sustainable society would not paralyze into permanence the current inequitable patterns of distribution. It would certainly not lock the poor permanently in their poverty. To do so would not be sustainable for two reasons. First, the poor would not and should not stand for it. Second, keeping any part of the population in poverty would not, except under dire coercive measures or rising death rates, stabilize the population. For both practical and moral reasons, any sustainable society must provide sufficiency and security for all. To get to sustainability from here, the remaining growth possible—whatever space there is for more resource use and pollution emissions, plus whatever space is freed up by higher efficiencies and lifestyle moderations on the part of the rich—would logically and, one would hope, joyfully be allocated to those who need it most.» - says “Limits to Growth” in a chapter devoted to the outline of a sustainable society. Unfortunately, Meadows and his colleagues did not pay enough attention to the laws and fundamental principles of the capitalist economic system, which makes such a model of development almost entirely unfeasible within its borders. What follows is a

list of decisions proposed by Meadows and his colleagues, along with a description of how exactly does the free market economy make each of them impossible to achieve.

Extend the planning horizon. As was already stated in the previous chapters, the main principles of capitalist economy and competitive free market lead to a priority of short-term profits over long-term ones, especially when said profits are private, and the interests are communal. The same can be said about modern-day politics.

Improve the signals. Since the prosperity and competitive ability of economic actors and governments that are influenced by them directly rely on the continuation of exponential growth, their motivation in creating an objective picture of the state of the environment, as well as society, is rather low. The opposition towards any environmental initiatives from major capital owners and their political figures in the USA, which goes as far as to deny scientific facts recognized by the international community, is the best proof of that.

Speed up response times. The monitoring of signals indicating tension that the environment or society experience excess pressure is confounded by the grant system that dominates science in developed countries. This system puts scientists that are supposed to monitor such signals in a position of financial dependence from business interests.

Minimize the use of nonrenewable resources. It is highly improbable due to the same reasons as in No.1: in a free market companies that use nonrenewable resources for all that they're worth will gain a competitive advantage over those that don't, and government regulation will only lead to an outflow of capital into those countries that do not have such restrictions.

Prevent the erosion of renewable resources. Also rather improbable, since market logic in a situation where a resource faces exhaustion encourages economic actors to exhaust it to the maximum and then transfer capital into another industry.

Use all resources with maximum efficiency. Is impossible as a rule, since market economy requires significant marketing expenses that result in giant amounts of single-use packaging, advertising materials and other items, constant encouragement of the population towards greater consumption, and planned obsolescence of technological goods.

Slow and eventually stop exponential growth of population and physical capital. The fact that capitalism depends on exponential economic growth was shown in the previous chapters, and if said growth happens purely on part of virtual financial capital, the economy will face a crisis of debt overproduction.

The objectivity and realism of the aforementioned critical notes to Meadows's measures is proven the best by the fact that since the first "Limits to Growth" has been published in 1972, developed countries have yet to implement the overwhelming majority of the measures proposed by Meadows and colleagues, as well as those offered by the global environmental science community. Meadows writes, that "to restore hope and to solve very real problems, these are three areas where completely new thinking is needed: poverty, unemployment and unmet nonmaterial needs". At least two of these areas – unemployment and unmet needs – are structural features of modern capitalism. Without unemployment there can be no cheap labor, which allows industries to produce cheap goods while making profits for the capital owners. The higher living standards and employment levels in a country are, the less competitive it becomes on the global

capital market, and the lower the rate of profit is. Without unmet nonmaterial and material needs, and constant creation of new industries and therefore new markets, modern economy would cease to function, since a falling rate of profit constantly pushes it to encourage consumption.

The state of the modern global economy, which depends on cheap labor of people living in developing countries on one hand, and constantly rising consumption of people living in developed countries on the other, is no accident born out of history or geography. Such an imbalance is inevitable in an economy based on free market and private property, no matter what explanation is traditionally provided for it: accumulated wealth of previous generations, the absence or existence of so-called “entrepreneurial talent”, or simple coincidence. Feedback loops formed by fundamental principles of the system create concentrations of capital, consumption and high quality of life in some places, and areas of degrading poverty in others. Therefore, we have to conclude that the modern economic system is incapable of providing conditions for sustainable development, and to avoid catastrophe it has to be transformed in its entirety.

2. Socialization of capital as a condition for sustainable development

A list of measures necessary to form a sustainable economy and society was provided in the previous paragraph:

Extend the planning horizon.

Improve the signals.

Speed up response times.

Minimize the use of nonrenewable resources.

Prevent the erosion of renewable resources.

Use all resources with maximum efficiency.

Slow and eventually stop exponential growth of population and physical capital.

If we take these measures as obligatory conditions for building a sustainable society, we can try and extrapolate the mechanisms and features of an economic model that would satisfy them.

Modern technologies in the field of gathering, accumulating and processing data allow economic planning with acceptable accuracy on a scale of years if not decades. The popular opinion that strategic planning in economics is bound to fail can be overridden by simple practical examples. For instance, the largest transnational corporations, that incorporate multiple enterprises from various areas, tend to use long-term strategic planning with no intervention on part of the state (towards their own ends and profits, obviously). This mechanism became possible as a result of market competition, and the very fact that such corporations exist is proof enough that economic planning is feasible. Another successful example is Roosevelt’s “New Deal” policy that effectively dragged the US out of the Great Depression in the 1930s.

It has to be noted, that the more industries and whole sectors of the economy are incorporated into this planning system, the more factors it is possible to monitor, there-

fore the more effective this planning will become and the further its horizons will be. But this approach has its problems: the more factors you have to monitor, the more data you have to process. This is why mere decades ago it was entirely plausible to state that large-scale economic planning with acceptable accuracy is impossible due to technological limitations.

Fortunately, nowadays the situation has changed dramatically, not only in the field of computation and data processing, but also in the field of information gathering. Now it is possible to gather and process data almost in real time and from a variety of sources: ecosystem monitoring, meteorological satellites, geological exploration satellites, factories, infrastructure – from pipelines and railways to the smallest transportation vehicles, agricultural complexes, social infrastructure facilities (hospitals, schools, recreation zones and the rest), various warehouses and shops. It is hard to imagine a case when data from an economically significant facility would be impossible to rapidly gather and process.

All of the above provides a necessary technological foundation for an economic system that would be able to gather information – signals – from its own actors, and from those parts of the environment that are not a direct object of economic activities. The potential horizons for planning in such a system can be stretched for at least several decades ahead. Moreover, it will have an important feature, inaccessible in the past: flexibility, which is the capacity to alter plans quickly and at a relatively small expense in case of unforeseen events and conditions: natural and man-made disasters, unaccounted for social factors etc.

Despite all that, the main obstacle standing in the way of global economic planning today is the conflict between private interests of competing economic entities, whether they are corporations, or governments. Socialization of those means of production that belong to them, to achieve global economic planning that would be the most effective and beneficial for everyone, directly contradicts these interests. Overcoming this obstacle is no small task, and at first it may seem insurmountable.

The introduction of global economic planning automatically solves one of the structural and unavoidable problems of the modern economic system: the so-called production of risks. It includes environmental risks produced by cutting costs on purity and urgency in processing waste that resulted from manufacture and use of goods. It also includes social ills like poverty, unemployment and crime, inseparable from the capitalist mode of production, and the risks suffered by ordinary citizens – that they will fall

prey to one of these categories if they are not competitive and successful enough on the ruthless job market.

This situation is a result of a strategy common to any business venture: always privatize the profits and socialize the risks. It has to be noted that in most cases the resulting risks are located in the nearest future, within a few decades or even years. If such a strategy is used in global planning, these risks will fall within the boundaries of planning, available to the system, which makes the planning dilemma unsolvable. In this case the only possible solution to this problem is to calculate the risks of production as precisely as possible at the planning stage, and allocate part of the product in advance towards neutralization of produced risks.

This condition in turn requires the sustainable society to abandon the usual strategy of private enterprise, which includes the manufacture of risks as a necessity of survival. This condition is completely incompatible with free market economy, where each economic actor has to minimize its expenses at any cost due to competition, which is the main source of risk production. It is because of this that market mechanisms in the management of the global economy have to be abandoned. The free market cannot be prevented from producing risks and, as a rule, is inimical towards the environment.

Thus the necessity of economic planning on a global scale and abandonment of market principles in management inevitably lead to the institute of private property on the means of production being replaced with communal property, managed by a unified planning institution, which acts on behalf of the whole society. The main principles of this mechanism are worthy of separate research and discussion.

The replacement of private property with a communal planning institution also means a fundamental change in priorities of development of productive forces and in principles of distribution of surplus value, since when a multitude of competing private interests is replaced by a collective management, which acts in the interests of the whole society, there is no reason for competition.

In turn, the disappearance of competition means that priorities in economic activity shift from maximal profit towards preserving and developing productive forces. Given the limited resources that our planet possesses, the preservation of productive forces is an obligatory condition for global planning. Without multiple competing proprietors, long-term goals will no longer be overshadowed by short-term private gains which ignore the interests of society.

To achieve stability, the resulting system will have to create maximally effective mechanisms of “feedback” from the planet’s ecosystems. The activities of scientists and various experts towards researching and protecting the environment will no longer contradict those interests of business and governments that prevail today. At the same time, the wasteful and profligate expenditure of valuable resources in today’s developed countries, that is required to support economic growth, will come to an end. Without being sustained by aggressive marketing stimulating overconsumption, a typical example of which is the annual renewal of status items, whether it’s cars, gadgets or mobile phones, part of these expenses will disappear on their own. These resources will be directed towards pulling developing countries out of their vicious circle of poverty that causes constant population growth:

In poor countries, by contrast, capital growth has a hard time keeping up with population growth. Output that might be reinvested is more likely to be required to provide schools and hospitals and to fulfill subsistence consumption needs. Because immediate requirements leave little output for industrial investment, the economy grows only slowly. The demographic transition stays stuck in the middle phase, with a large gap between birth and death rates. When women see no attractive educational or economic alternatives to childbearing, children are one of the few forms of investment available; thus the population grows bigger without growing richer.

As the saying goes, “The rich get richer and the poor get children.”

The population of these countries has to be provided with modern and effective jobs, access to education, medicine and other basic social services and goods.

Even now we can outline a series of goals, methods of reaching which are yet to be found: how to transform economic management from multiple proprietors to a global planning institution, how to abandon free market principles, how will the unified planning institution actually work and what shape it should take, and how to replace competition with other incentives towards development.

The means and methods of these transformational measures, and the structure and form of political institutions that will undertake them, are outside the boundaries of this paper.

Conclusion

The global economy and development of humanity as a whole are approaching a period, when recognition and adherence to long-term interests stop being a desirable, but elusive goal, and become a condition vital to survival. The modern economic system, like capitalism in general, are incapable of recognizing and following these interests due to their fundamental features, which are a priority of short-term profit over long-term interests of economic entities, whether they are capital owners or their employees. As was shown in this paper, the upcoming turbulence in the global economy are no random or temporary matter, but a complex and systemic crisis caused by the fundamental principles of its structure and development.

This paper, as was stated in the introduction, does not contain almost anything completely new, but serves an important purpose of binding theories, discoveries and models from different areas of expertise to create a comprehensive scientific picture.

The necessity of a fundamental transformation of the global economic system stems not out of political ideals or wishful humanism, but out of a completely practical goal of prolonging its development and avoiding a collapse that would considerably lower living standards and any opportunities for further development. It is obvious that such a goal cannot be achieved by partial measures of separate governments, or a partial reform of the existing economic and political systems. The whole world – from developed countries to developing ones - has to be radically transformed, and there is not much time left to start this process. It is not possible to make an accurate prediction at

this time, but considering all that was shown by Meadows and other researchers, it can be said that by the second half of the XXI century the chance will already be wasted.

Приложение 1

Математическая модель

Для роста продукта, равного 3% в год при капитале равном 2 годовым продуктам и норме прибыли в 5%:

$$p = 1,03^{x-1}$$

$$c = 2 \cdot 1,05^{x-1}$$

$$\frac{c}{p} = \frac{2 \cdot 1,05^{x-1}}{1,03^{x-1}}$$

$$m = \frac{2 \cdot 1,05^{x-1}}{1,03^{x-1} \cdot 0,05}$$

За единицу принимается значение валового продукта в исходный год.

Некоторые эмпирические данные

В данной таблице собраны данные по росту Валового мирового продукта (по данным CIA World Factbook) и мирового частного капитала (по данным ежегодных докладов Boston Consulting Group) в процентах.

Год	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
Рост ВМП	3	4,8	2,7	3	3,8	4,9	4,7	5,3	5,2	3,1	-0,7	4,9	3,7	3,4	3,4	3,4
Рост частного капитала	18	6	-4,4			6,2	8	7,5	-10	12	8	3,6	7,8	8,7	14,6	