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## The problem of energy efficiency, known as the Jevons paradox

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### ABSTRACT

Jevons paradox described the phenomenon in 1865. By the English economist William Jevons Staneleya in the book *The Coal Question* (The issue of carbon), which foresaw the gradual depletion of the British coal deposits. In general, this paradox states that the more efficiently we use a given raw material, the more its consumption increases. In the case of coal, the more effective use of energy contained in it with the use of steam engines resulted in an increase in demand for this raw material. The aim of the article is to analyze the occurrence of Jevons' paradox in economics and ecology based on the analysis of foreign literature. The article also points to the relations that exist between ecology and economics, on the example of coal mining in North America.

**Keywords:** paradox, Jevons paradox, productivity, ecology, economy

### 1. INTRODUCTION

Jevons' paradox analyzes are usually quite general. The authors focus in them on individual technological effects, not taking into account the historical context. Just like Jevons, they ignore the nature of industrialization. They also lack a realistic view of capitalist development, driven by accumulation. An economic system geared towards profit, accumulation and expansion will endlessly use every performance increase and any cost reduction to increase the scale of production. Technological innovation is subordinated to the

same expansive goals. Everyone from flagship inventions of the eighteenth and nineteenth centuries XX (i.e. steam engine, railway, car) was therefore a breakthrough that stimulated the accumulation of capital and he led to growth of the entire economy.

Scale effects resulting from their development, from necessity outstripped the increase in technological efficiency. The preservation of resources in capitalism is impossible, the ratio of output / entry can, however, in the production process of a given good should be increased. This is because all savings are a stimulus for further investment, of course if there are markets available. This regularity applies especially to the resources of essential to industry - "basic products", as Jevons wrote. The aim of the article is to analyze the occurrence of Jevons' paradox in economics and ecology based on the analysis of foreign literature. The article also points to the relations that exist between ecology and economics, on the example of coal mining in North America.

## **2. NEO CLASH SCHOOL AS A PRIMARY NURT**

The neoclassical school is an economic school that continued the main idea of the classical school in the free market trend. The creators of this theory believed that there is a close interdependence between the individual factors of production, because their volumes harmonize harmoniously in the economic process (Khazzoom, 1980). This adjustment ensures balance while fully utilizing the production potential. All claims about social phenomena should be reduced to claims about the behavior of individuals. This research approach is otherwise called methodological individualism. The most important economists associated with the neoclassical school were William Stanley Jevons and Alfred Marshall (Alcott, 2005). Neoclassical studies used the partial equilibrium method. The vast majority of models assumed excellent competition.

The neoclassical school, also known as the Orthodox school, is one of the schools in the history of economic thought, whose origins date back to the 1870s, and its concepts are developed to the present. This trend is otherwise called marginalism and has become the dominant trend in the field of microeconomics. The most important representatives of the neoclassical school include such people as Carl Menger (1840-1921), Leon Walras (1834-1910), and William Stanley Jevons (1835-1882). Between 1871 and 1874, they published three books that had an impact on the development of orthodox economics. "Theory of Political Economy" (Clark, Foster, 2001), "Grundsätze der Volkswirtschaftslehre" (C. Menger), "Elements de l'economie pure" (L. Walras). However, Alfred Marshall (1842-1924), professor at the University of Cambridge, is considered to be the father of modern orthodox microeconomics. In his work titled Economics, he attempted to reconstruct the views of the classics of economic sciences.

Marshall assumed that economics should focus on analyzing social and economic communities by looking at them in terms of the behavior of individuals in these communities. He also noted that individuals make decisions on the market taking into account all possible benefits and costs resulting from specific activities. However, in contrast to the classics of economic thought, he assumed that individuals in the economy primarily seek to maximize usability rather than wealth (Freire-González, Puig-Ventosa, 2014).

Neoclassical economics, referring to the classic achievements of classical economics, argues that there is a close interdependence between the individual factors of economic activity.

In addition, in the economic process, the individual volumes are harmoniously adjusted, which leads to a balance with the assumption of full use of production factors. Thus, the price on the market is the size determined by demand and supply. In the nineties neoclassicals, with the participation of marginal analysis, developed the concept of extreme productivity of production factors. The new analysis mainly focused on how to share rare resources between alternative market applications. Other key concepts of that period include: decreasing marginal utility, maximizing usability, and interpersonal comparison of usability. Assuming the desire to maximize profit / usability, theoretical models were developed for households and enterprises, as highly abstract at that time. While the emerging models mainly concerned the demand side of households and enterprises, the supply did not find much interest in theoretical constructions. Neoclassical economics is also a trend in economics, also called subjective-marginalistic, dominating from the 70s of the 19th century to the 30th century XX (Madlener, Alcott, 2009).

Achievements of this direction are min; development of the theory of demand, supply and consumer, creation of the theory of market equilibrium and the balance between global demand and global supply; introduction of differential calculus allowing for the study of dependencies between economic phenomena through the so-called limit values. The output of this trend arose simultaneously in three economic schools: the Anglo-American School represented by William Stanley Jevons, John Bates Clark and later by Alfred Marshall; School of Lausanne - Matematyczna, whose creator was Leon Marie Walras, and the representative was Vilfredo Pareto and the Austrian Psychological School, whose creator Carl Menger. The book by Carl Menger Principles of Economics published in 1871 revived the scholastic approach to economics. It was also a pillar of the so-called "marginalist revolution" in the history of economic sciences. Menger included three main theses in his publication (Polimeni, Polimeni, 2006):

- The theory of needs - Human are characterized by the fact that they still need something. All theoretical and economic searches start with the realization of this fact. Satisfying these needs is the ultimate goal of the human economy. Individual needs are generally transformed into general social needs.
- The theory of economic goods - It concerns the relation of man-thing. The thing is good if it has the capacity to meet the needs of the individual and is available. Goods are divided into those to which access is unlimited, and for economic goods that are rare and are in a certain amount.
- Economic theory of social institutions - this is an innovative theory describing social institutions. Hayek later developed this thought. Menger noted that social institutions arise as a result of human action and interaction, as a result of a social process consisting of various human behaviors.

This direction has focused its research on what has been omitted by the classical economy, which focused on the supply, namely how the utility or consumer preferences can be translated into the demand for goods. The extreme usability theory complemented the theory of the market mechanism. In neoclassical economics, for the first time mathematics and econometrics have been applied, allowing for measuring, for example, such quantities as total domestic production and total income. An important achievement of this direction was the creation of the so-called Optimum Pareto, or the condition of optimal allocation of resources, which states that a situation in which no member of the community can improve his situation without simultaneously deteriorating the situation of at least one other member of the community.

This model, also called standard, explains the behavior of entities in economies. Assumptions contained therein determine (Khazzoom, 1980): rationality of units, actions based on accurate and complete information and unlimited possibility of its processing, the goal of maximizing profits in companies and maximizing the expected utility for consumers, activities that are included in a narrow sense - without taking into account the usability of the environment, making decisions, which is based on Bayesowski's inference rule, consistent preferences (eg temporary), according to the exponentially discounted usability model, treatment of income and variable resources as unspecified for their purpose or origin. In neoclassical economics, the concept of a model economy governed by perfect competition developed. This model is an appropriate way to assess the effectiveness of competition in the real world. According to the neoclassicals, actual competition in the range it differs from the model is undesirable and even harmful. The perfect competition is based on four main assumptions made by Frank Knight (Sorrell, 2009):

- There are infinitely many entrepreneurs in the economy, but each of them has a small share in the production of the entire branch,
- The product should be homogeneous,
- Information about a given product between buyers must be perfect,
- There are no entry and exit barriers on the market.

The market is perfectly competitive if it meets all of these assumptions. If at least one of these conditions is not met, then we deal with monopolistic competition or oligopoly. According to the first assumption, individual activities of the entrepreneur in the change of the supply volume will not affect the price of the given good. Therefore, the demand curve for such an enterprise is a horizontal straight line. If the company raised the price of this good, consumers would start to buy products from the competition. After lowering the price, compared to the established market price, the entrepreneur would have achieved a lower profit, because after just the market price, you can sell an infinite number of products. The second assumption tells us that the features of goods produced on the market should be the same. In this situation, consumers do not look at who they buy the good from. Thanks to the third assumption, the consumer knows that products from different sources are really the same (Khazzoom, 1980).

Lack of barriers to entry and exit means that if entrepreneurs limited the total supply of a specific product, increasing its price, it would be a stimulus for others to enter the market and through competitive activity set prices so that they would equal the previous level. Another significant achievement of the neoclassical economics was the development by LM Walras of a mathematical model expressing the state of general equilibrium. This model assumes the functioning of an economy consisting of two sectors, ie enterprises and households, not taking into account the role of the state or foreign trade, with unchanged production technique and full employment. Enterprises operate in conditions of perfect competition, while households, with constant incomes and unchanged preferences, report demand for consumer goods in sizes determined by the sum of incomes earned from their production factors. This mechanism assumes that changing one of the factors causes changes of others. A change in the price of one of the products will change the production structure, and this will entail a change in the demand for inputs, which will result in a change in the distribution of income.

The greatest merit of Walras was to show in this model the mutual dependence of all prices and all quantities of resources. Another point of the neoclassical economics is the development by JB Clark of the theory of the marginal productivity of production factors, which

has become the tool of many modern models of effective allocation of resources (Sovacool, et al, 2015).

### **3. WILLIAM STANLEY JEVONS**

William Stanley Jevons (born September 1) 1835 in Liverpool, d. August 13 1882 in Bexhill-on-Sea near Hastings) - an English logician and economist. The creator of the neoclassical school in economics. He also dealt with the methodology of science. He lectured at the universities of Manchester and London. He was also a popularizer of science (York, 2006).

Jevons was born as the ninth child in a very wealthy industrialist family. As a member of the non-conformist Unitarian church, he was in those years a closed road to universities such as the University of Oxford and the University of Cambridge. He took his initial studies at home, then graduated from the Liverpool Mechanics Institute, and in 1852 he joined University College London (UCL), where he studied chemistry, mathematics and logic (Braess, 2005). However, the financial crisis of the family forced him to stop his studies and go to Australia to work. He made contacts with the local scientific community here; he conducted research on climate, geography, geology and flora of Australia. Local discussions on the conditions of railway construction encouraged him to study economics, which he approached with a view to using mathematical methods in it. He returned to London in 1859 and here a year later he obtained a baccalaureate at UCL. He received his Master's degree (from logic, philosophy and political economy) in 1862. In the same year, he published two important works: the necessity of using mathematics scientific apparatus in the economy and seasonal price fluctuations ((York, 2010). In 1863, he wrote *Pure Logic*, in which he creatively developed the ideas of George Boole. In 1866-1875 he lectured (first without a formal job, from 1866 as a professor) logic, moral philosophy and economics at Owens College in Manchester, in 1875-1880 he was a professor of economics at University College London . Didactic work tormented Jevons and did not give him satisfaction. From 1872, he was a member of the Royal Society. Jevons drowned while swimming in the sea. He was 47 years old (Alcott, 2005).

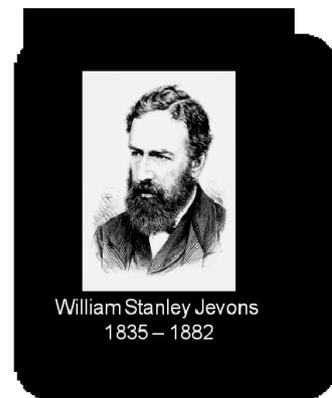
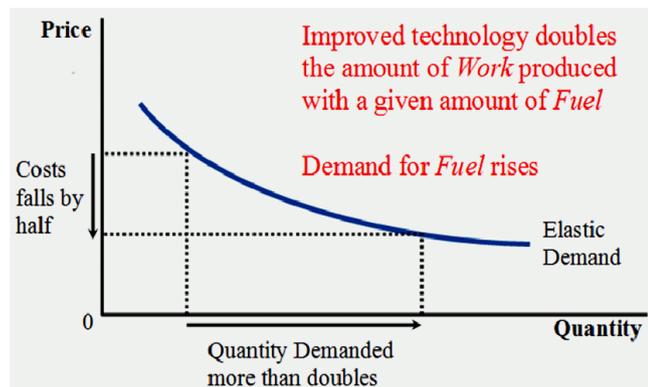
He is considered one of the founders of the subjectivist course in economics, namely the neoclassical school; he believed that the economy should study the quantitative side of economic phenomena; he proposed the concept that the wave of economic life is related to sunspots. He was the author of excellent logic textbooks. His *Logic* (1870) was published in Polish in 1921 (Marchetti, 1994). He was also the constructor of the first logical machine, mechanizing deductive reasoning. Jevons' work the problem of coal is the initiation of reflection on the problem of the dependence of the economic system on an exhausting resource. He pointed to the potential threat posed by the dependence of the British economy on hard coal . Reflections in this field developed only in the twentieth century (nearly 100 years after the death of Jevons) along with the activities of the Roman Club (Clark, Foster, 2001).

### **4. JEVONS PARADOX AND EXAMPLE OF OCCURRENCE**

Jevons' paradox is a phenomenon described in 1865 by the English economist William Staneley Jevons in his book *The Coal Question* (The issue of carbon), which foresaw the

gradual depletion of the British coal deposits. In general, this paradox states that the more efficiently we use a given raw material, the more its consumption increases. In the case of coal, the more efficient use of energy contained in it with the use of steam engines caused an increase in demand for this raw material (Peltzman, 1975). An example of the occurrence of the Jevons paradox is shown in Fig. 1.

### Jevons Paradox will apply to 'Cloud Computing': Consumption of the processing power will increase (rather than decrease)



*Technological progress that increases the efficiency with which a resource is used tends to increase (rather than decrease) the rate of consumption of that resource*

**Figure 1.** A curve depicting Jevons' Paradox.

The improved technology doubles the amount of labor produced at a given amount of fuel. The demand for fuel increases. Costs are halved. Technological progress, which increases the efficiency with which the resource is used, usually increases (rather than decreases) the rate of consumption of this resource (Potts, Harwood, Richard, 2007).

WS Jevons, analyzing the use of hard coal. He wrote: no one can assume that coal in this saved way will be saved - it is only saved for use in one case in for its use in other cases, the benefits will soon lead to wider application in many other ways. Individual industries are strongly interdependent and progress in under one of they lead to the progress of almost all others (Schwartz, 2015). The paradox, which Jevons pointed out, has received numerous confirmations on economic grounds, including in the form of Sayer's law, which says that supply creates its own demand. That's why despite the growing energy efficiency and with an increased share of renewable energy, the countries of the old European Union consume much more energy than eg new members, an energy consumption in from 1991-2008 in most of these countries grew (Freire-González, Puig-Ventosa, 2014).

Armstrong's answer was given by William Stanley Jevons, one of the creators of the neoclassical school of economics, in the book "The problem of coal. National development a probable depletion of resources in our mines. ("The Coal Question: Inquiry Concerning the Progress of the Nation, and the Probable Exhaustion of Our Coal Mines", 1865). Jevons claimed that The development of British industry is dependent on cheap coal (Schipper, Grubb, 2000). Increase in raw material prices - caused by the need to reach for deeper and deeper it will probably lead "within one generation" to loss of "commercial domination and production", a "Over the centuries" to "Stillness" in economy. In his opinion, neither technological progress nor replacement of coal with another energy source will change it (Khazzoom, 1980).

Jevons' book gained wide publicity. John Herschel, an important figure in British science, agreed with Jevons, writing: W we are squandering our resources and constantly growing rate we increase the standard of living - sooner or later a terrible day of payment must come. IN April 1866 John Stuart Mill praised the "Coal Problem" in House of Commons, at the same time inclining towards the idea of Jevons in answers for shrinking deposits of this important raw material reduce public debt. The matter was also taken up by the then Minister of Treasury, William Gladstone, who called on the parliament to activities on to reduce debt, justifying it fear of the shortage of coal resources. No wonder then Jevons' book quickly became a bestseller (Madlener, Alcott, 2009).

In However, the author has made a mistake. Coal production in Great Britain has increased in within 30 years of book publication - along with increase in demand - more than double. In same time in The United States has increased tenfold while remaining on lower than in Great Britain (Polimeni, Polimeni, 2006). Still, on At the turn of the centuries no panic broke out background of fears against depletion of available raw material resources. The main mistake of Jevons - w which he was not alone in the prominent figures of his time - there was the inability to predict such alternative energy sources for the industry as oil and hydropower. In 1936 seventy years after the sensation that w Parliament raised the book of Jevons, John Maynard Keynes referred to the author's vision, judging that forecasts for the topic of declining carbon availability has been strained and exaggerated . Could add that Jevons' perspective was quite narrow (Braess, 2005).

## **5. JEVON'S PARADOX IN ECOLOGICAL VIEW**

The Jevons paradox, however, is in ecological economics still considered to be crucial. In Chapter Seven of the "Coal Problem", entitled "On fuel economy," Jevons referred to popular view that new, more effective and economical ways of using coal will solve the problem of decreasing availability of this raw material, and that it benefits from carbon can be multiplied, keeping its consumption on the same level or even reducing it (Madlener, Alcott, 2009). Jevons definitely rejected this one view, stating that more efficient use of coal leads - contrary to what you could to expect - only to increased demand for this raw material (Dumbaugh, Li, 2010).

Along with The increase of efficiency is followed by further economic expansion. This a great misunderstanding to suppose that economical use of fuel equals its reduced consumption. It's just the opposite. New, more economical ways of farming lead to increased consumption of a given resource. They show it experience with many similar cases. [...] The more so it applies such a widely used raw material as coal. This more efficient coal management leads to its increased consumption - he wrote (Madlener, Alcott, 2009).

Describing in detail the development of steam engines, the author of "The Problem of Coal" pointed out that every improvement in their production made it they were more efficient under in terms of thermodynamics. Together with however, the consumption of coal has improved. Savery's engine, one of the the first steam engines, had such low efficiency that - as Jevons said - it did not pay to use it; its burning rate was so high that he did not consume coal at all (Marchetti, 1994) . Other models, such as the famous Watta steam engine, were more efficient, which meant that demand for the coal grew. Behind every time an improved engine is introduced for use, the consumption of carbon increases. It is in fact, a stimulus for every branch of industry - the work of workers is replaced by the work of machines, a large enterprises that were previously unprofitable from due to high cost of steam power can be realized (Freire-González, Puig-Ventosa, 2014).

Although Jevons believed that this paradox applies not only to coal, in his book focused on the raw material that he saw as the main factor of industrialization and stimulus for investment goods industries. Coal was not just a fuel for modern steam engines. In in the mid-19th century it was also the main raw material used in large iron smelting furnaces - the most important product of industry and the foundation of economic dominance. With reasons for the huge development of this industry, in 1870 yr. (Peltzman, 1975). Great Britain, called the "workshop of the world", was responsible for production of roughly half of the iron on ground. Performance increase in using coal has made that it was possible to produce more iron. This It led to development of the entire industry, a so to increase in demand for carbon (Potts, Harwood, Richard, 2007).

Jevons took it in the following method: If the amount of coal consumed in the blast furnace will decrease in relation to the quantity of the finished product, the sector's profit will increase, it will attract it new capital, the price of pig iron will drop, but demand for it will increase. Along with an increase in the number of furnaces - despite the higher efficiency of each them - coal consumption will increase. Even if it does not always happen that way In the case of a single industry, it should be remembered that the development of any branch is a stimulus for new activity in most of the others. This leads indirectly, if not directly, to increased extraction of our coal (Potts, Harwood, Richard, 2007).

Such an observation was then extremely important. They were aware that industrial development is dependent on the possibility of cheap iron production. Less coal needed in furnaces meant industrial expansion, increased production capacity, conquest of new markets, and also - in effect - increase in demand for black gold. In 1869 coal consumption by the British iron industry and steel was 32 million tons and exceeded the level of its total consumption in production (28 million tonnes) and for the needs of rail (2 million tons) (Schwartz, 2015).

It was the era of capital and industry. About the power of the economy was then determined by the amount of coal produced and pig iron. Coal production and iron grew in this time in Great Britain in same speed - between 1830 and 1860 she tripled. As Jevons said: Immediately after charcoal [...] the foundation of our power is iron. This the backbone of our manufacturing system (Clark, Foster, 2001). Political writers rightly recognized the invention of a blast furnace coal in the most important source of our wealth [...] Production of iron, raw material, z which our machines are built is the best measure of our wealth and power (Schipper, Grubb, 2000).

Reading the book of Jevons, you can not fail to notice the influence it has on the industry would have a more efficient use of coal and its increased mining, to which would in the result came. Economics - Jevons wrote - multiplies the value and efficiency of our most important

raw material; infinitely increases our wealth and the amount of funds needed to live, leads to population growth, development of our manufactories and trade - this everything gives us in this moment of contentment, but it will not last forever (Khazzoom, 1980).

Jevons did not care about ecology. Instead, he was worried about the prospect of Britain losing a dominant position world. Although he devoted a lot of attention to the problem of shrinking resources, he did not think about it the consequences that the depletion of energy resources will have on the environment. He ignored air, soil and pollution caused by coal production water. He was silent as well the issue of occupational diseases and dangers lurking for mine workers and factories, in which it is burned (Alcott, 2005).

Jevons assumed after just that mass degradation of the earth's surface is something natural. Although the prospect of coal depletion provoked the question about the ability to stop economic growth, the author has never taken up the issue of sustainable development. Renewable energy sources, like water and wind, they were in Jevons' opinions uncertain, limited to specific time and space (Alcott, 2005). The economy, in his opinion, must remain in constant motion. On the other hand, coal provided the capital with a universal source of energy supplying production and not disturbing the current business model.

The author of "Coal Problem" did not know the answer to the paradox he described. Great Britain could act with your cheap energy source two ways: use coal quickly or slower. Jevons was in favor the first solution: If we are to multiply our wealth, both material and above intellectual, it is hard to underestimate the beneficial influence we can currently exert [on the rest of the world]. However, maintaining such a position is physically impossible (Braess, 2005). We must make a historical choice between short-term, but real power, and long-term mediocrity.

If a matter is put in such a way, you know what to choose: the path of praise today and drastic reduction in living standards tomorrow. Jevons did not know how to remedy the inevitable and fast - as he himself claimed - the exhaustion of domestic coal deposits. British capital and the government did not see an alternative to business as usual. Ultimately, interestingly, Jevons' book served as an argument on to limit state debt. In the face of the expected slowdown in economic growth had it be a preventive measure. As Keynes wrote: Thesis that we are squandering our natural capital, provoking an irrational reaction that we need to quickly lower the public debt dead (York, 2010).

The entire attention of the world of politics has been focused on how irony, on the penultimate chapter of Jevons' book, titled "Taxes and national debt ". Jevons and other people who share his view, like Mill or Gladstone, never favored preservation of coal deposits (Dumbaugh, Li, 2010). Engels wrote in one of letters to Marx, that industrial capitalism squanders solar energy with past, as evidenced by that it wastes our energy reserves, our coal, ores, forests, etc.

W Jevons's analysis is vain to look for similar theses. He was unfamiliar with the idea that social relations of production should be shaped not by chasing profit, but by human needs and social and ecological balance. The use of fossil fuels other than coal (like oil and natural gas) and hydroelectric power stations, an also the use of the entire planet's resources, has made it the problems that Jevons predicted were moved in time (York, 2010). Today, when we stand before global ecological problem, Jevons' paradox returns.

## **6. NATURAL LAW**

Describing coal as the "most important raw material" for the British industry, Jevons pointed out replacing one "basic product for industry" by another. A great dispute over grain laws showed (he turned on this attention is already father of Jevons, Thomas) that lower price of the basic product drives the demand and eventually leads to shortages, what in the case of grain meant the necessity of its import. Under late nineteenth century of deficiency in the Malthusian sense was spoken, however, not in the context of grain, but coal (Marchetti, 1994).

Jevons put in his book thesis, Keynes pointed out, that condition for maintaining prosperity and economic leadership by the United Kingdom is the constant development of heavy industry, which will translate into geometric increase in demand for carbon (York, 2006). Jevons proposed this principle as a complement to the static theory of Malthus and Malthus resources he called it the natural law of social development [...] Hence, only a step to replace in Malthus theory of grain with coal.

Jevons emphasized that about how much the population has grown since at the beginning of the 19th century, four times coal consumption increased sixteen times. The growth of coal production was in his opinion indispensable for the rapid industrial development, which sooner or later it must end. The author of "Coal Problem" did not devote attention to the fundamental contradiction that it is the essence of the paradox he describes - the dynamics of accumulation or extended reproduction, characteristic of capitalism. As one of first neoclassical economists, Jevons w different from classical economists did not focus on classes and accumulation. His economic analysis took the form of a static equilibrium theory (Peltzman, 1975). Jevons was therefore lacking the appropriate conceptual apparatus deal with problems of accumulation and economic growth.

Population growth, industry development, and also an increase in demand for coal (as the main raw material in industry) was, according to Jevons, who based on Malthus's theory, after the result of the abstract "natural law of social development". Author of the "Coal Problem" he perceived capitalism not as a certain social creation but in in terms of something natural. No wonder then to explain the ever-growing demand he was looking for in individual behavior, Malthusian demography and price mechanism. Instead of focusing on recital profit, he appealed to the abstract law of force, formulated by Justus von Liebig: Civilization, says Baron Liebig, it economy of power, an Our strength is coal (Potts, Harwood, Richard, 2007). Jevons also lacked a realistic view of economics and capitalist society. He testifies about the fact that forces stimulating economic expansion and industrialization - a so leading to increase in demand for coal - he presented, an Amazingly, as weak and undeveloped.

## **7. THE RETURN EFFECT OF JEVONSA PARADOX**

Jevons' paradox was forgotten for three-fourths of the 20th century - in the oil age. He returned in 70s along with growing anxiety caused by the prospect of resource depletion. These fears have taken on strength during the oil crisis of 1973-74. Together with introduction of energy efficiency measurements, economists began to think about their effectiveness. This made that on at the turn of the 1970s and 80. attention was again paid to essential in Jevons paradox, the issue which was called the turning effect (Sovacool, et al, 2015). It is the view that along with by increasing production efficiency, the effective price of a given commodity

decreases, which leads to increased demand for this product. In this is how to benefit from productivity growth does not translate into reducing the consumption of goods. Jevons' paradox was often called the extreme form of the feedback effect, where along with "Savings in production "is not a decrease, but an increase in the consumption of a given resource. Optimists argued that the return effect is small, which means that ecological problems can be solved in largely due to technical innovations (Sovacool, et al, 2015). They will lead to more efficient energy consumption and raw materials (dematerialisation). However, there is strong evidence for is that the feedback effect is significant.

On technical example of improvement in motor vehicles led after 1980 in USA to 30 percent increase in the average number of miles driven one gallon of fuel. However, the total energy consumption of these vehicles has not decreased. About how much fuel consumption per vehicle remains on the same level, so much productivity increase has not only caused that the number of cars and trucks on roads (and miles traveled), but also their size and performance (acceleration, speed, etc.) (Sorrell, 2009). On highways in The USA is now dominated by sports utility vehicles (SUVs) and minivans.

In macro scale Jevons paradox reveals itself in that although energy efficiency (saving power consumption by devices) in United States after 1975 doubled, energy consumption drastically increased. Juliet Schor notes that for the last 35 years: energy consumption on The GDP dollar has fallen by half. Need for instead of falling, the energy increased by 40%. It's worth mentioning that demand increases fastest in these sectors, in the largest increase in productivity was recorded - in transport and households. The capacity of refrigerators increased by 10%, but the number of these devices increased by 20%. In aviation fuel consumption a mile fell by over 40%, but in relationship with the increase in the number of people, total fuel consumption has increased by 150%. The situation in car case. The increase in demand was accompanied by the increase in carbon dioxide emissions - in these two sectors was 40% (Schipper, Grubb, 2000).

Economists and environmentalists who try to assess the direct impact of performance on lowering prices and the occurrence of a return effect, they usually think that this effect is relatively small. In their opinion, it is 10-30% in industries, in which consume a lot of energy, such as refrigeration and heating or motorization. If however, he will take it under indirect effects on macro level, Jevons' paradox proves to be very important. This just on the macro level gives up signs of scale effects - increasing energy efficiency can reduce the effective cost of different products, driving the entire economy and increasing total energy consumption. Mario Giampietro and Kozo Mayumi, economists dealing with ecology, say that Jevons' paradox can only be understood through a macro-evolutionary model, where better performance leads to changes in flow tables, which ultimately leads to increase in scale and the pace of the system as a whole (Dumbaugh, Li, 2010).

## **8. CONCLUSIONS**

Jevons' paradox is the production of the capitalist system which in the macro scale is unable to conservation of natural resources. This system still strives for maximizing energy flow and material - from sources to drain. Energy saved in capitalism, is used for its further development. As he put it Alfred Lotka, instead of the minimum energy production, this system causes its "maximum circulation". Absolute energy saving (v different from relative) does not

lie in the nature of capitalism. This system has been sold to the gods of production and profit. As Marx mocked: Accumulate, accumulate! That's what Moses and I say prophets!

If we look at Jevons' paradox in the context of capitalist society, we will see that it exposes the contemporary myth that ecological problems affecting humanity can be solved only thanks to technology. The environmental mainstream economists often refer to the phenomenon of "dematerialisation" or "decoupling" of economic growth from energy consumption and resources. The increase in energy efficiency is often regarded as iron evidence for is that environmental problems go to past. Material savings and energy in context of a given production process are not, as we saw it the above examples, something new; they are entered in the development of capitalism. Every new steam engine, Jevons emphasized, was more efficient than previous. As noted by the sociologist of environmental protection, Stephen Bunker, Activities aimed at the purpose of saving raw materials are older than the industrial revolution and evolved into the history of capitalism.

Any view that higher energy efficiency usually leads to energy saving, does not take under attention to the fact who was paying attention to Jevons. What is saved is for further investments and multiplying goods, what with turn leads to increased demand for resources. The fact that increased productivity results in increased energy consumption and raw materials, it is not in The "system of capital authority" is something extraordinary. As the authors of "The Weight of Nations" (2000), an important work presenting research on subject of material flows in last decades in five industrial countries (Austria, Germany, the Netherlands, USA and Japan), Performance gains, resulting from the development of technology and new ways of managing were balanced by the scale of economic growth.

In the effect we have to deal with still growing mountains of commodities, decreasing unit costs and an even greater waste of resources. In monopoly capitalism, goods are given an artificial value - a substitute for authentic human needs. Is responsible for is a powerful marketing machine, and the goal is to increase demand for these goods and increase in the value of their exchangeable values for consumers. The production of unnecessary goods serves only to achieve better economic results and it takes place at the expense of the natural environment. In the current system, any attempt to stop the process of environmental degradation, however, means an economic catastrophe.

According to Jevons, the "historic choice" in terms of business as usual is simple: either "short-lived but true power" or "long-term mediocrity". Jevons advocated the first option - maximum energy circulation. A century and a half later, in our much larger, more global economy, the stake in the game is not just national supremacy, but the fate of the entire planet. Of course, there are those who maintain that we should "live on a high rate and let future generations take care of themselves". However, such a path leads to a global catastrophe. The only effective solution for humanity (including future generations) and the entire planet is changing social production relations and creating a system where performance is no longer a curse - a better system in which equality, social development, community and sustainable development are the highest goals.

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