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The Paradox of Value and Economic Bubbles: New Insights for Sustainable Economic Development

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Abstract: The article presents a new approach to the solution to the paradox of value based on the theory of marginal utility of the Austrian School of Economics. The new approach is based on the theory of compound interests and economic bubbles. The study presents valuable theoretical insight towards sustainable economic development. The paper provides a brief formulation of the theory of compound interests, introduces the structure of compound interests model, and shows the relations between simple and compound interests as well as dimensionless interests. It reveals the saturation phenomena, and emphasizes its impact on economic and financial bubbles. The relation between the value of paradox and the price bubbles is presented. The article also explains the possibilities of the phenomenology of growth in formulating the paradox of saturation and studying the paradox of value. The phenomenological method allows to relate prices and financial and economic bubbles into a general entirety. Therefore, this paper deals with very important sustainable development issues as it discusses the market saturation phenomena, economic bubbles, and emotional consumer behavior. The limitations of behavioral theories are pointed out and their misunderstandings of information cascades are emphasized. The article provides the explanation of the nature of economic bubbles by employing the theory of compound interests.

Keywords: sustainable economic development; economic bubbles; market saturation phenomena; paradox of value

1. Introduction

Sustainable economic development is major concern of scholars, however, important economic paradoxes and puzzles exist, which needs closer attention. Economic bubbles are one of the major issues and challenge of sustainable economic development, and this problem is also linked with paradox value. Though there are still many debates among economists regarding economic paradoxes, puzzles, and controversies [1–6], some very old economic paradoxes like paradox of value are not yet solved and still attract the attention of the scientists [7–9]. The paradox of value, discovered more than 200 year ago, raises the question: Why is vital water so cheap, meanwhile not so practically useful diamonds are so expensive? This question is often called the water–diamond paradox. Economists and philosophers, however, formulated this question in a broader sense: Why are certain essential goods cheap, meanwhile exceptional luxury goods are very expensive.

It was long thought that this classical paradox was finally solved by applying the law of diminishing marginal utility [10]. However, it became clear that the law was not universal, and not always applicable

when solving the paradox of value. It cannot be applied to unique and indivisible objects; however, these objects were the first to give rise to this paradox. As it was later found out, the paradox of value cannot be solved within the framework of classical economic theory because the benefit of goods and their purchase price are influenced by emotional buyer (consumer) behavior rather than objective factors.

The main contribution of this paper is the development of the new approach to the solution to the paradox of value based on the theory of compound interests and its main insights for analysis of economic bubbles phenomena.

The aim of the article is to present a new solution to the paradox of value based on specific properties of compound interests and the resulting saturation phenomena, and to show how the paradox of value relates to the price bubble problem.

In order to achieve this aim, the following objectives have been set:

1. To study the question of paradoxicality of value in relation to the case of the water–diamond paradox.
2. To review the historical solution to the paradox of value in economic theories.
3. To provide exceptional insights on this matter by pioneer of the Austrian School of Economics—C. Menger.
4. To discuss the gaps of the conception of marginal utility and possibilities to overcome them.
5. To show the suitability of compound interests and the saturation phenomena in solving the problem of the paradox of value.
6. To reveal the possibilities of the phenomenology of growth in studying the paradox of value.
7. To discuss the relations between price bubbles and emotional consumer behavior: To provide a case analysis of collecting magic, investment, and gambling passion.

Research methods: Systematic and comparative analysis of scientific sources, mathematical modelling, graphical data presentation, phenomenological method, economic analysis and synthesis, comparison, evaluation, and generalization of theoretical and empirical study results.

The structure of the paper is presented below: In Section 2, literature review is provided to address the paradox of value and the gaps and main insights of theories dealing with paradox of value; in Section 3, the compound interests approach and saturation phenomena are introduced; and in Section 4, the phenomena of economic bubbles is discussed by linking economic bubbles with paradox of value insights; in Section 5, conclusions are given.

2. Literature Review

2.1. Recent Studies

Most studies dealing with economic bubbles and financial crisis stress the concept of green and sustainable finance, which is closely linked to corporate social responsibility [11–18]. The green and sustainable finance, corporate social responsibility, and intellectual and human capital have become very important for competitive advantages of companies. The results of studies indicated that there is a relationship between corporate social responsibility, intellectual capital, and firms' financial performance [11–13]. Therefore, socially responsible firms follow green or sustainable finance principles and also invest accordingly [14–16]. The concept of sustainable finances allows them to achieve sustainable development and mitigate possible negative impact of economic bubbles [16,17].

Other studies stressed that intellectual capital and innovativeness of the firms are the main drivers of corporate social responsibility initiatives and sustainable finances [19–21].

The consequences of financial shocks were analyzed [22] by revealing the asymmetric effects on the international transmission of US financial stress. The current high level of internalization of world financial systems creates potential risks of irresponsible financial policies on sustainability of global finances.

Logistic growth theory [23] provided analysis of logistical capital growth function based on the on limited (logistic) growth model of Verhülst, which was applied for biological populations.

The other studies paid more attention to the effect of consumer behavior or financial behavior in formation of economic bubbles [24–29]. Akerlof and Shiller [24] in their study stressed manipulation and deception as the main reason for economic recession. Gerding [25] emphasized the impact of weak laws and financial regulations having impact on sustainability of financial systems. Kindleberger [26] analyzed the long history of financial crises and highlighted manias, panics, and other herd behavior impact on financial crisis. R. Shiller [27] analyzed irrational behavior on financial markets and it's negative consequences. Sornette [28] provided analysis of critical events in financial systems causing the crashes of these systems. Schumpeter [29] critically assessed business cycles as inevitable processes of capitalistic systems.

The current study tries to develop and test new theoretical hypotheses by linking the economic and bubbles with market saturation concept and compound interest theory, showing that infinitive growth is not possible in limited systems as economy, including financial and other markets, can be treated as systems having limitations for growth. The paradox of value can also be analyzed as economic bubble by applying the saturation and compound interests approach, therefore the paradox of value and gaps of scientific literature in solving this paradox are addressed in the following sub-sections of literature review. The insights of behavioral economics are also dealt with in the literature review in order to get a complete picture of literature addressing paradox of value.

2.2. Economic Paradoxes and Paradox of Value

The term paradox originated from Ancient Greek philosophy and was used to denote a new, unusual, original opinion. This is a multidimensional term used in various scientific areas. Paradox has the following three main meanings:

○ Opinion, reasoning, or conclusion that apparently does not match the globally accepted opinion and objects "reason" (often at first sight only);
○ unexpected phenomenon or event that does not meet the usual idea;
○ in set theory and logic, it is a contradiction arising from any digression from the truth.

Revealing contradictions of paradoxes is related to significant discoveries in various fields of science. The existence of the unexpected factor in a paradox is usually related to insufficient knowledge of a respective area. A branch of science that has many unresolved paradoxes requires a more detailed and profound knowledge of it [1,2].

The water–diamond paradox used to be treated as philosophical, whereas now it is an economic paradox.

The solution to the value paradox has impact on the development of the economic theory, which influences the development of economy and formation of crises. Despite this, there are many people who have doubts in the relevance of paradoxes, especially the water–diamond issue. Some specialists see many high prices as paradoxical. Others, on the other hand, think that prices can be high naturally, especially if a good is rare, and they do not see a paradox here. It is clear, however, that prices of rare and marketable goods are always high, whereas prices of mass goods are high sometimes. This position is based on the labor theory of value, sometimes—on the consumer or exchange theory of value, factors or cost of production, and other theories.

Though the price formation and reasons of economic bubbles were widely investigated [23–29] the paradox of value was not linked with price bubble before. It was clear to researchers of the paradox of value that rare goods could be expensive, but why were they sometimes inadequately expensive? The rare but especially high price raised questions. This is called a paradox. Researchers were also concerned by the fact that rare and expensive goods sometimes became worthless or even ended up in dumps, especially during political or economic crises.

Historically speaking, the question of the paradox of value was limited by rare and marketable goods leaving popular mass goods behind. However, it is necessary to point out that these two groups of goods were not strictly separated. Of course, rare yet unsaleable goods do not match the conditions of the definition of paradox, thus were not taken into account. It became clear that it was insufficient to ground price level on the rarity of goods. Paradox then was explained in terms of the theory of diminishing marginal utility. However, the application of this theory here also has its problems because it suits divisible batch goods, but not rare (unique) goods.

Here, a recently formulated theory of compound interests and the resulting phenomena of saturation are helpful [30]. It shows that high prices relate to not only the rarity of those goods, but also a specific emotional consumer behavior.

Despite recent insights, many modern economists still follow the theory of marginal utility when solving the paradox of value and reject other theories. From the economic thought perspective, it can be noticed that the solution to the paradox of value was quite complex: Supporters of the theory of objective value thought that value was determined by the physical benefit of an object or labor necessary to produce an object. Later on, an opinion that the price of a good was determined by its marginal utility rather than its general utility became prevalent. Supporters of this opinion followed the theory of marginal utility according to which marginal utility of a plentiful good was low; therefore, the price was determined by the benefit of a marginal unit. It became clear, however, that this theory was not without its limitations [10].

2.3. The Gaps of the Conception of Marginal Utility in Solving Value Paradox

It can seem that the paradox of value is an insignificant problem; however, such doubts can be easily cleared by reviewing the historical path of the solution to this problem. Famously, since the 13th century, there were discussions among theorists and philosophers regarding the water–diamonds value paradox. Even the famous Scottish professor, one of the creators of the classical economic theory, Smith, A. (1723–1790), could not solve this paradox, as he thought in terms of general utility.

Until now, it was generally thought that the value of rare goods could be assessed based on the theory of marginal utility that quickly became the main theory of value in economics [10]. The pioneer of the Austrian School of Economics, C. Menger (1840–1921), solved this classical paradox of value in his work *Basics of Learning about National Economy* by showing that value is the approach of individuals towards individual units and is determined subjectively by evaluating in relation with the law of diminishing marginal utility. The less the individual has of the good, the more benefit every additional unit of the good provides him. C. Menger showed that this paradox was only assumed: It disappears as soon as we stop questioning value of the classes of goods as an entirety that is economically independent when people make decisions. If we instead ask about the laws that control the evolution of individual units of goods, the answer becomes clear. There is so much water that it not only serves to satisfy the most important, thus highest standing need of a human being for water, but also less important needs such as decorative fountains; thus, the value of the least important yet satisfied need determines the economic value of each unit of water that dictates low market price. Conversely, diamonds are so rare that their existing supply can satisfy only the most important need for them; therefore, they are very expensive. C. Menger claims: Under conventional circumstances, no need will remain unsatisfied if the person cannot get a certain amount of drinking water. In the case of diamonds, on the other hand, even though the least significant needs are satisfied by their general amount, they still have a relatively high importance for a saving (economy generating) person. Thus, specific amounts of drinking water usually do not have value for a saving person, whereas specific amounts of diamonds have high value. In order to confirm such insights, C. Menger provides an example of an oasis where water from a well that satisfies every human need for water does not have value (is worthless) and, on the contrary, water in an oasis gains value when the water flow from the well decreases to the point that having a certain amount of water becomes an essential condition to satisfy a person's specific need.

It is important to note that the paradox of value was known for Ancient Greek thinkers, especially the pioneer of objective idealism, Plato (427–347 BC). Being unable to solve the water–diamond paradox, classical economists were forced to distinguish value into two categories, i.e., consumerist value (it showed the significance of a good in satisfying human needs) and exchange value (it showed the market price of a good), claiming that consumerist value is a given and unexplained assumption of the exchange value, and focusing their analysis exceptionally on the exchange value, which prevented them from creating a complete (closed) human action theory that would integrate consumer choices with businessmen's calculations and choices.

Even though creators of the theory of marginal utility thought that they have solved the old water–diamond paradox, it later became clear that the problem still remained [30].

The theory of marginal utility is suitable in the presence of a sufficient amount of divisible goods. However, it is not valid in terms of small portions of indivisible goods and apparent need for them in the beginning of their consumption process. The theory was suitable for indivisible goods on the condition that the amount of the goods was high. According to the creators of the theory, low price of water stands for its marginal utility for the last unit bought by consumers. Meanwhile, the buying price of diamonds is high because they are rare and their production is expensive. Diamonds are bought by those who desire them and for whom marginal utility of diamonds is high, which determines their high price. However, for the theory to be applied to diamonds, their quantity has to be relatively high. As we have seen, the essence of the paradox consists of unique and expensive diamonds rather than expensive mass diamonds. Previous theories of value were suitable to evaluate mass diamonds, and there is no need to apply the theory of marginal utility for them.

Generally speaking, diamonds are diverse. Million carats of diamonds are dug up each year worldwide. Tons of jewelry is made from them. Thus, diamonds can be treated as a popular mass good. Especially when smart businessmen managed to convince the society that an engagement ring must have a diamond worth at least two months' pay (this was carried out by the company De Beers in 1930). Therefore, there is no doubt that evaluating the price of diamonds can include the application of the law of marginal utility. However, an engagement ring is beyond the scope of the definition of the diamond–water paradox.

Also, more and more doubts were raised by decreasing application of the theory of marginal utility for small amounts of indivisible goods—it is impossible to apply the mathematical limit theory that divides the quantities of goods to diminishing sizes for them. It is not difficult to do this with water. The theory can be applied to diamonds of mass production with certain reservations. What can we do with a rare and exceptional diamond? How should we assess the price of such diamonds? [31–33].

For instance, can we apply the theory of diminishing marginal utility for the Great Star of Africa diamond that is the only one in the world and there is no other like it? There have been insights that it would be exceptionally expensive, i.e., over 400 million dollars. What principles is such a paradoxical sum based on? It is evident that the theory of diminishing marginal utility cannot be applied here because the diamond is indivisible and does not have any mathematical (segmentation) limit (physical segmentation of a diamond greatly diminishes its sum value). A similar situation can be observed with another record diamond—Pink Star, etc.

On the other hand, the paradox of value encompasses not only water and diamonds, but all rare and marketable goods. A life-size modern bronze sculpture *L'Homme Qui Marche I* by one of the best known sculptors of the 20th century, Alberto Giacometti (1901–1966), was sold in London in eight minutes for a record 103.7 million dollars on 3 February 2010. In 2015, another bronze sculpture, *Homme Signalent* by *Giacometti*, reached the new record of the most expensive sculpture sold in an auction, i.e., it was sold for 141.285 million dollars. Naturally, the question is: How is the value of unique collectable objects or other rare goods calculated? The labor theory of value does not have an answer to this question because such goods are not the pure result of labor similarly to archaeological discoveries, rare works of art, or collectables [31].

However, the prices of such goods that are in demand, especially collectables, cannot be explained not only in terms of labor costs, but also marginal utility. A possible (perhaps, a frequent) case is that each new collectable is more valuable because it increases the value of the entire collection.

It is evident that the pricing of such unique goods is impacted by consumer behavior (collecting passion). A part of rare goods would not have any value if there was no certain collecting culture. For instance, postage stamps (especially used ones) do not essentially have any material value. They cannot be directly used to pay for parcels. They are not works of art, special china, antique pieces, or jewels. However, the price of some units is especially high. Physically, they are insignificant. This can be only be explained based on collecting passion. It strengthens the demand for certain objects. In 2014 in New York, a 19th century purple-red postage stamp from former British Guiana worth 1 cent was sold for 9.5 million USD. Before that, the title of the most expensive postage stamp had belonged to a Swedish postage stamp printed with a mistake called *Treskilling* that one international corporation bought for 2.3 million USD in 2010.

The aforementioned objects are not the most expensive rare goods. It is important that each good is unique and has a sufficient number of buyers. For specific goods there is a closed (deficit) market that includes at least a minimal number of active buyers. Auctions and "utility" of a specific good help to achieve the highest price possible at that moment.

Summing up, it can be said that marginal utility laws cannot be applied to unique goods because they do not meet the essential requirements of mathematical limit theory. Moreover, the same problem exists elsewhere.

2.4. Integration of Emotional Consumer Behavior for Dealing with Paradox of Value

According to R. J. Shiller, the economy is controlled by emotions. Euphoric people can simultaneously invest in the same markets and create bubbles. When these bubbles deflate, economy cannot recover for a long time because people are disappointed and spend money more carefully [27].

Consumer (buyer) behavior is an area of marketing that aims at understanding and anticipating consumer behavior (actions), finding out reasons and consequences, relations that control the consumer through his/her experience, habits, beliefs, information, learning. [23,27,32–34].

In this case, we are interested in a specific case—the phenomenon of collecting and behavior of investors into collections. Analyzing the paradox of value calls for looking at rare goods and the phenomenon of collecting in general. The phenomenon of collecting is seen from different perspectives, i.e., some treat collecting as a secretive activity of people, whereas others attribute this practice to psychological anomalies. Interest in collections, pleasure in art itself appears, and a close connection with one's collection is formed. This connection becomes a certain ritual. Of course, the objects of collecting already have a special status that other objects do not have. Exceptional behavior of a collector (consumer) transforms a simple object by creating a different method of its evaluation. It is not important what is collected, i.e., whether it is artwork, autographs of athletes, buttons from military uniforms or cans of drinks. It is important to correctly carry out the complex ritual of demarketing, complete demodification, and isolation of a work or object. Demodification in this case stands for detachment of a collection object from its naturally formed environment (free market) and placing it in a sphere of deficit. It is possible when a collector's enthusiasm and purposeful activities infect the general audience with the spirit of evaluating and knowing that artwork or another object. Unsystematized objects often end their days in dumps, whereas typologized trivial objects acquire new meanings full of insights of a collector and continue to live in museums. Resourceful grouping according to certain criteria gives collections a certain appeal that a certain part of the society is infected with. Strange collections appear, i.e., from statuettes of devils to scents, toilet covers, or belly button lint.

Meanwhile, museums can acknowledge or reject the importance of collections saved by collectors. Museums give collections, especially collections of art, a long-term vitality and status of high value. A collection can gain a trustworthy value in a museum. Collections of trustworthy value make fans admire them, thus stimulating the demand of these (especially art) collections. Because of this, new

private museums have been established recently. Around 700 such new art institutions are established every year globally. In over a decade, the number of new museums has been higher than in the last 200 years.

Not only investment into collections is different in its specificity and magic. Gambling passion should also be attributed to specific consumer behavior. Investment into collections, promotions, or other financial assets usually has features of gambling. All of this relates to risk and potential winning. Investment into hidden or even open financial pyramids can be indicated as marginal investment. High tempting winning often suppresses the fear of even higher risk. The boundaries of reason are sometimes crossed here. This is why there are so many investors into cryptocurrency markets. Gamblers are tempted by the secrecy of the smart financial pyramid and the possibility to win when the price bubble inflates.

Therefore, the investment into securities or collections (rare goods) is often like a gambling game. It has similarities and differences. In both cases, it is important to maximize profit with minimal risk. Auction trade is not an exception. However, certain investors, like many gamblers, are controlled by ardor, and gambling can become an addiction. Gambling addiction can be seen as a hidden problem because there are no evident physical symptoms. Aim for profit can be compared to the gambling passion. Gambling passion can essentially change consumer (buyer of rare goods—collector) behavior.

How do we explain the paradox of value? In order to understand it, we need to look back at the theory of interests.

3. Methods

3.1. The Saturation Phenomena and Compound Interests

The family of compound interests is different from simple interests as they have a capital growth limit parameter. This means that these interests encompass and evaluate the phenomenon of saturation [29,35].

The theory of compound interests, which is based on market saturation, is also a basis for bubble formation. Simple interests are used until now in dealing with infinite growth. Actually, infinite growth does not exist at all. Practice shows that every growth ends sooner or later. According to experience and the phenomenological method, we can claim that the rule of infinite growth compound interest must be replaced by the limited growth logistic function.

Limited growth modelling was attributed Gompertz and Verhülst models in the beginning of the 19th century [36]. They used the growth limit parameter—a possible highest value of increased product. We shall call this value a potential capital (potential product or potential population). Despite the fact that limited growth (logistic) models have not yet won against compound and straight interest.

Analyzing the growth of various populations, the application of logistic models is becoming more and more attractive. Different models are often applied when modelling growth in different fields of activity. In biology, the Verhülst model has been used for a long time; in social sciences—the Bass or Gompertz growth functions. However, the possibilities of classical logistic models are not yet sufficiently exploited, and they have not been used to calculate percentages. This is because the variables of these models are not expressed through parameters of interest.

Let us discuss the limited (logistic) growth. Let us take the Verhülst model [36]:

$$K(t) = \frac{K}{1 + \left(K_p/K_0 - 1\right) \cdot \exp(-m \cdot t)} \tag{1}$$

where $K(t)$—value of product (capital) accumulated in period t (sometimes we shall use K instead of $K(t)$), K_0—initial value of a product, K_p—potential (marginal, maximum) value of a product (capital), t—duration (number of periods), m—coefficient that has impact on the growth rate.

The main step towards calculating interest rate was made when, according to formula (1), simple interests [19] were comprised that had the following form:

$$K(t) = \frac{K_p \cdot K_0 \cdot (1+i)^t}{\left(K_p - K_0\right) + K_0 \cdot (1+i)^t} \tag{2}$$

where $i = \exp(m) - 1$ there is growth (interest rate) norm expressed in percentages for one time t unit.

The trajectory of interest rate growth is a logistic curve that has the form of extended letter S. The most important is the fact that as the growth limit is indefinitely increasing ($K_p \to \infty$), formula (2) becomes a formula for compound interest, i.e.,

$$\lim_{K_p \to \infty} K(t) = \lim_{K_p \to \infty} \frac{K_p \cdot K_0 \cdot (1+i)^t}{\left(K_p - K_0\right) + K_0 \cdot (1+i)^t} = K_0(1+i)^t \tag{3}$$

Therefore, from logistic percentages (2) we get a well-known expression of compound interest

$$K(t)\big|_{Kp \to \infty} = K_0(1+i)^t \tag{4}$$

This transformation allows joining all percentage models into one general structure because not only simple interests are transformed into compound, but compound interest is easily transformed into dimensionless percentages.

This article provides only the transformation of simple interests into compound interests and, finally, dimensionless interests. Figure 1 introduces the aforementioned structure of interest rates models. It shows how one type of interest is turned into another type of interest by consistently changing parameters.
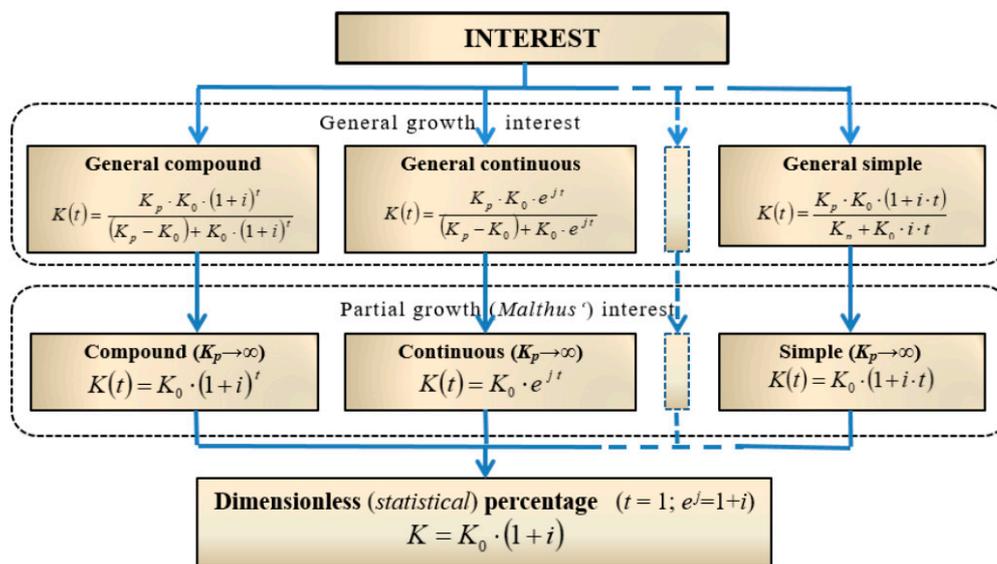

Figure 1. Structure of interest rates models. Source: Created by the authors.

Let us go back to formula (2). Here, K_p records the growth limit; however, ratio K/K_p ($K < K_p$; $K \to K_p$) is more important. This ratio shows the level of saturation of the growth space. Saturation is very important in biology, chemistry, physics, and other areas. Studies have shown that this fact is important and even essential in economics as well. In economics, it mostly manifests as market saturation. Market saturation is partial or complete fill of closed or partially closed market with, first of all, investment capital, and later with products. Finally, saturation manifests through excess (reproduction) of respective market products.

Market saturation is one of the most complex factors that have a high degree of impact on various market development processes. It begins when market capacity turns from infinite into measurable [35], or, as we will see later, when demand exceeds supply. This happens when investments are more rapid than expansion of the market, i.e., when demand grows faster than supply.

When modelling growth with the help of general (logistic) interest (2), it was seen that with increasing saturation (closer to growth saturation point, i.e., when $K/K_p \rightarrow 1$) the internal turnover (profitability) increases. This is an especially important fact when speaking of consumption expectations, ability of markets of the changing environment (supply and demand changes), etc.

The Equation (2) relates the following five variables by means of functional dependency: $K(t)$, K_0, K_p, t, and i. In different expressions of the interest rate function, these values can be different in their quantitative expression. Under conditions of a specific problem, part of variables such as the value of the initial product K_0, potential product value K_p, and growth norm i can be treated as parameters. The accumulated product value $K(t)$ is a temporal function, and the trajectory is very close to the compound interest trajectory. Later, these trajectories separate and essentially go further away one from the other.

Tsoliaris [37] analyzed logistic growth models in detail. He pointed out that they had a common (generalized) growth model form. Other logistic growth models are separate cases of the general model only. However, many aforementioned models are not suitable for the analysis of economic phenomena. Modifying equation (1), the growth rate parameter m had to be transformed. Therefore, seeing variable $m = \ln(1 + i)$ as the growth rate parameter in those models, we can turn to the expression of the percentage formula.

This transformation of the models allowed applying general logistic models to the analysis of economic phenomena. This step enabled the analysis of the impact of market saturation in logistic models on profitability, which in its turn ensured a qualitative leap on the economic theory, i.e., to discover new economic phenomena. Expressing the growth parameter through percentages and applying discounting, new economic phenomena (paradoxes) were discovered. This is the paradox of increasing utility (saturation) (that manifests through market heat and economic bubbles), the paradox of debt (that manifests as a suddenly increasing load of debt), etc. All this was achieved by using discounting when calculating current value of investment and its internal profitability. It is difficult to do these using standard logistic functions because they usually do not have an initial expression of population, which is why they are so difficult to apply for discounting and evaluation of saturation.

Alongside the aforementioned general percentage (2) expression, there is another very important expression of compound interests, i.e., dependency of norm i on saturation. From general percentage Equation (2) we find the dependency of growth norm i on the level of saturation K/K_p, $(K_0 < K < K_p)$:

$$i = \sqrt[n]{\frac{K}{K_0} \cdot \frac{1 - K_0/K_p}{1 - K/K_p}} - 1 \tag{5}$$

According to formula (5), let us draw the dependency of simple interest rate growth based on the level of saturation K/K_p. When $K = 0$, then $K/K_p = 0$, and when $K = K_p$, then $K/K_p = 1$. Thus, in calculations we treat that K/K_p changes in interval $(0; 1)$. Let us take the following growth parameters: $K_0 = 0.75$, $K = 1$, $n = 2$, $i_0 = 15.5\%$, when $K_0 < K < K_p$ (Figure 2).

The dependency (5) shows that with increasing saturation, the productivity is also continuously increasing. Moreover, as saturation gets closer to one, this increase is becoming especially intensive (hyperbole). It can be seen that such productivity change is not random. Even though we do not analyze other general interest rates models in this article, we show their diagrams along compound ones.

It is important to note that such curves as in Figure 2 can be obtained by discounting monetary flows and setting the dependency on internal investment profit rate on the degree of market saturation. Dependency (5) is called the phenomena or paradox of saturation. The economic meaning of the

paradox of saturation is as follows: If capital is invested in a closed (deficit) market, then investment profitability growth with increasing saturation of the market with capital.
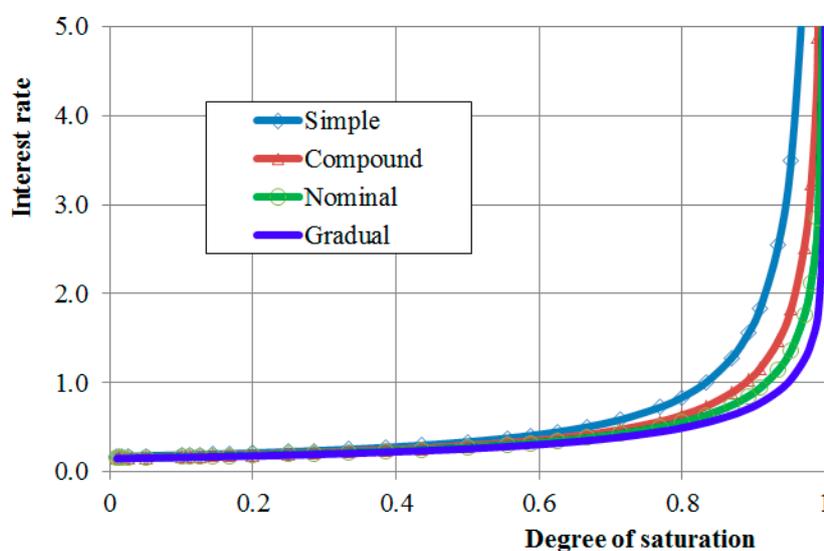
Figure 2. Paradox of saturation: Dependency of interests rates on the degree of saturation with various types of compound interests (with increasing saturation, the profitability rate is increasing). Source: Created by the authors.

Thus, if capital is invested in a closed market, investment profitability is growing with increasing saturation of the market. We know that when supply increases, profitability decreases in the conventional market. For instance, if there is a good harvest of wheat one year, it can be understood that their price in the regional market will drop due to increasing supply (with stable demand) and vice versa—if the harvest is bad, the price of wheat will increase. Meanwhile, here it is on the contrary—as the supply increases, the profitability increases as well. Thus, we see the phenomenon of increasing productivity (phenomena or paradox of saturation). The market saturation (phenomenon of increasing efficiency) enables theoretical explanation of the price bubble formation mechanism. It is interesting to note that theoretical explanation of the price bubble formation mechanism allows easily grounding it empirically as well. In other words, we have a case when theory does not only operate directly, but also makes empirical grounding easier.

Recently, the term "phenomenology" is used in the scientific context to describe the entirety of knowledge obtained by means of empirical observation and comparison of the results. The phenomenological method takes up an intermediate approach between theory and experiment. The phenomenological method in the theory of compound interests also has its place, i.e., it helps to determine generalized models and ground the appearance of paradoxical economic phenomena.

We used the method of phenomenology mostly in those cases where there was a need to show (emphasis) the operation of a phenomenon in its most general form (macro level). Such is the growth phenomenon defined by the formula of compound interests. The growth of each population is defined on the micro level by its own specific indexes. On the micro level, the growth rate of various populations is determined according to the principles particular to every population. Meanwhile, all these populations together retain the phenomenological principle so that their growth speed is proportionate to their size, and grow in the presence of a certain growth limit. This generality shows that the same populations are probably characteristic of other population growth principles as well. Here we are mostly interested in the dependency of productivity (growth norm) on saturation. This is important because such productivity growth may evoke the change of population, formation of a bubble and, finally, burst of the system. This has impact on the development sustainability of any

system. The phenomenological approach allows relating price and financial and economic bubbles into a general entirety.

It is important to note that in nature, certain biological populations experience saturation and explosive growth. In other words, the phenomenological method allows observing growth processes from a different point of view and explain economic overheat, formation of bubbles, and appearance of crises. Summing up, compound interests and the resulting increased productivity (saturation) effect is a phenomenological growth law.

It is important to show, how does the paradox of saturation manifest in rare goods during auction trade? Let us discuss a situation when there is one good and more than one potential buyer. Moreover, all buyers want to buy this good and are in the mood to compete for it.

If there were one buyer, s/he would purchase the good for price K_0. Let us keep in mind that if the price were too high, there would be no buyers at all, and the auction would be deemed failed. However, if there is one good and more buyers, they compete by raising price K. Thus, we have a deficit market. If buyers' motivation and financial capacity are similar and clearly expressed, competition can take time, and the price can increase significantly. As price K increases, saturation increases as well along with profitability of the good. Saturation $K/K_p = 1$ is achieved when $\rightarrow K_p$, i.e., when offered price K approaches potential price K_p. The question is: What is potential price K_p? It is the highest price that participants in the auction are ready to offer for the good. Different participants are likely to offer different potential prices K_p. Since a competition occurs during trading, this is determined by K_p offered by the strongest participant of the auction. The potential price can be a changing sum related to the emotions of the participant. If the same or similar potential price K_p is offered by several buyers, the competition continues, and a higher degree of saturation is achieved. If competitors are weak, saturation is weak, and the winner buys a cheap good.

This is the formation mechanism of the paradox of price of rare goods that results from the theory of compound interests (formula (5)). It is important to emphasize that the market here is deficit. If the market is not deficit, there is no saturation, and the price is determined by the interaction of supply–demand.

Taking into account the aforementioned statements, the paradox of saturation (the phenomenon of increasing productivity) can be defined as follows: Development of population (capital growth) in a saturated environment is always more rapid than in an unsaturated environment, and the growth rate depends on the degree of saturation; moreover, as the degree of saturation approaches one, the growth rate increases infinitely.

3.2. Closed and Open Markets and Saturation Phenomena

In this section we will discuss the concept of market capacity. Marketing science [38] (in the case of perfect competition and with regard to saturation, i.e., the relation of supply (S) and demand (D)) presents the following markets:

- Balancing market when demand (*D*) and supply (*S*) are more or less the same ($S \approx D$);
- deficit market when demand exceeds supply ($D > S$);
- surplus (proficient) market when supply exceeds demand ($S > D$).

We know that in deficit market demand (*D*) is higher than supply (*S*). Then, the ratio is $D/S > 1$, and in surplus (proficient) market supply is higher than demand, so the ratio is $D/S < 1$. In markets, this ratio is not stable; it can be higher or lower than one depending on this stability, and the type of the market can change. When ratio D/S is evidently (for a long time, stable) higher than one ($D/S >> 1$), market transformation occurs.

It is important to mention the concept of market as well. Normally, it is treated that the free market is a market where prices are determined only in the presence of the demand–supply mechanism. The approach of the theory of general principles is slightly different [31]. The free market is a market where supply is steadily higher or equal to demand. This market is adapting (self-regulating). In the

opposite case, the market is deficit because the demand is always higher than supply. We cannot strictly attribute deficit market to free markets because they do not include the mechanism of self-regulation.

What type of market is open or of infinite capacity? Theoretically, it is a market into which an unlimited (infinite) sum of capital can be invested, i.e., a market where it is possible to create unlimited (infinite) supply (S). In our study, it is sufficient for this supply to be higher than demand (D) without creating reproduction ($S > D$).

In a finite capacity market (closed market), investment is limited. That is, it can create only limited supply. This means that there is supply that can be higher than demand ($D > S$, or $D/S > 1$). Thus, deficit forms in a closed market (a deficit market forms). On the other hand, why is a deficit market "closed"? It is because when supply exceeds demand, the resources of goods diminish—as if transactions occur in a closed space. A closed market is a homonym of another economic term that stands for physical closure. Meanwhile, in an open system, supply constantly renews (replenishes), and deficit does not form [38].

As the context shows, only closed markets can be saturates, whereas open markets are impossible to saturate. What mechanism does this saturation have? When investing, monetary funds primarily go to the security (capital) market and then move to production (goods market). Production preparation and production of a product (or service provision) needs a certain amount of time. Due to the specificity of the technological cycle (innovation, complexity, long duration, high price, etc.), production ends up with the consumer with a certain delay. This often happens in the real estate market.

Therefore, there is a situation in the goods market when the deficit of goods forms: Demand exists (investment has been carried out) but the product is still absent. Expectation is an important factor here. In cases when expectations are strongly expressed, demand can exceed supply, which means that a deficit of products may occur. With this situation, speculative demand can occur. It strengthens deficit. Appearance of the features of a deficit market creates premises for the formation of a closed market. In other words, gradual market saturation begins when there is deficit present in the market, i.e., when the market "closes". When a market "closes", there is a possibility to gradually saturate the market, which means that there is the paradox of saturation (phenomenon of increasing profitability) in operation that increases the profitability of the production and puts the cyclic growth in motion [31,32].

This is how a financial bubble forms. We can see that the financial bubble formation mechanism is slightly different than that of a price bubble. Moreover, there is no place for information cascades mentioned in behavioral finances, even though cyclic price growth occurs. It is impacted by the paradox of saturation.

The analysis of saturation shows that the market itself can be both saturated and not saturated with changing conditions [29]. In other words, the same market can be both self-regulating and not self-regulating. The question is: When does a market transform from infinite capacity market into infinite capacity market? According to the phenomenological method, it can be said that as long as demand is more or less equal to supply, the market is not saturable (infinite). When demand remains higher than supply for a longer time, market capacity becomes limited and it becomes saturable. The profitability of a saturated market is always higher than that of an unsaturated market. On the other hand, when saturation increases, profitability also increases and grows increasingly. This market feature attracts investors thus increasing investments into both the production sector (supply) and consumption (supply). Thus, cyclic price growth is created. Such market loses its property of self-regulation. Market transition from supply market towards demand market makes the market operate based on other, i.e., saturable market, laws. This new approach to market transformation can be modelled using a simplified scheme (Figure 3).
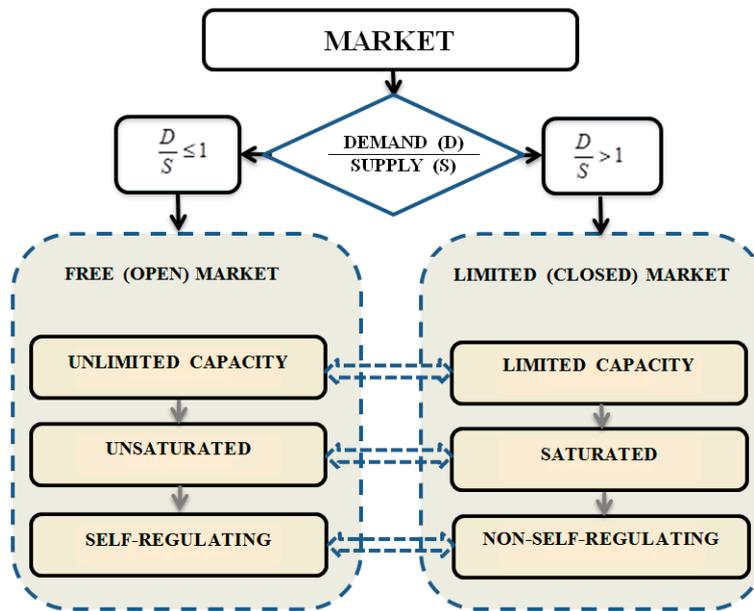
Figure 3. Market duality. Source: Created by the authors.

4. Economic Bubbles and Market Saturation Phenomena

Having analyzed compound interests, the paradox of saturation, price, and financial bubbles, we can move on to the analysis of economic resonance. According to the model provided (Figure 4), cyclic scheme of bubble inflation (financial resonance) operates in the following way: When demand exceeds supply (this usually happens when advertised long-term technological projects are realized), a deficit market forms. This market becomes saturable (closed). Investing into a saturable market triggers the phenomenon of increasing profitability *SOTIS*—the price increase impulse reaches the market. This affects optimistic expectations of investors, which in its turn increases demand. The cycle closes. The process becomes more active when speculators join, i.e., they significantly increase demand, saturation, profitability, etc. The market becomes heated. If demand and saturation increase suddenly and significantly, economic resonance occurs. It is important to note that without the SOTIS phenomenon information cascades emphasized by some authors [33,34] can never generate resonance.
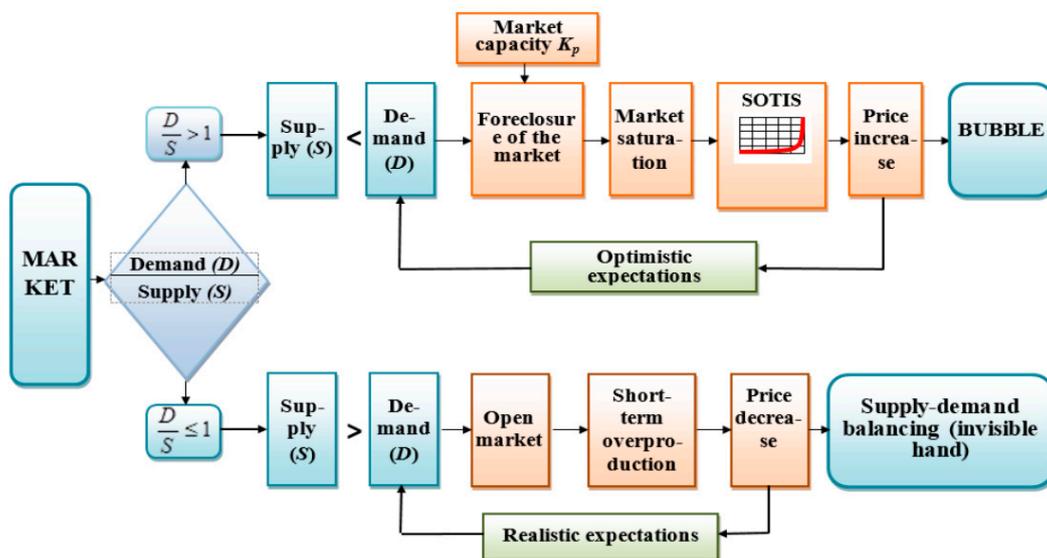

Figure 4. Model of cyclic operation dual market (SOTIS—manifestation of the market saturation phenomenon). Source: Created by the authors.

This is a simplified scheme. Parallel inflation processes (with a certain delay) occur in security and goods markets. Cyclically reoccurring investment process is activated by optimistic expectations of price increase, and when there is sufficient regularity of investments, the effect of resonance and inflation of a bubble are triggered. If demand does not exceed supply, higher demand creates short-term reproduction and decreased prices increase demand, thus balancing the market. Such process occurs in a classical free market. As we can see, consumer and investor behavior are very important in the case of economic resonance. It is quite rational here if we do not suppose that profitable investment is also a certain form of gambling, with all the resulting consequences. Inability to stop investment in time bursts financial (speculation) bubbles. The process is similar to gambling in a casino, yet the extent is different and the consequences are more serious here. It is also important to emphasize that the definition of a financial bubble proposed by Kindleberger is incorrect, because it does not include the elements that are necessary to ensure the inflation process (Kindleberger, 2005 [26]). According to Kindleberger [26], a bubble is a high increase of assets or asset set during a continuous process when the initial price increase created expectations for further growth and attracts new buyers—mostly speculators who are concerned with profit from sales of assets rather than the ability of assets to generate income.

Kindleberger's definition of the financial bubble is reminiscent of perpetual motion, when a mechanism turns itself. It is evident that a financial bubble is not some mystical object, but rather a specific phenomenon formed by actual environmental factors. Bubble formation must be based on a specific principle of operation. The phenomenological method shows that a bubble can form only when the cyclic development process occurs and there is additional stimulation (activation). This additional stimulant is the phenomenon of increasing profitability SOTIS.

Modern definitions of price bubble can be proposed [39,40]. An economic bubble usually occurs in the markets of long-term technological cycles when demand (D) incidentally exceeds supply (S) and a deficit, saturable market is created. Then, the phenomenon of increasing profitability manifests and insignificantly increases market product prices. Increased prices have impact on consumer expectations that increase product demand even more. The cycle reoccurs, attracting the attention of short-term investors (speculators), thus increasing market saturation, activating the impact of the phenomenon of increasing profitability and creating expectations for further stable increase of income. Increasing growth of profitability and cyclic (reoccurring) impact of expectations on demand ensure inflation of the price bubble. If the cycles reoccur regularly, economic resonance is achieved. Therefore, economic bubbles are formed by saturation of economy with capital and relatively rational price increase expectations that trigger economic resonance. In this case, consumer behavior plays a critical role. It is, however, more rational than it has been thought.

5. Generalization and Conclusions

The insights representatives of the Austrian School of Economics were not able to solve the paradox of value based on the law of diminishing marginal utility. For the paradox of value, the duality is characteristic: When the paradox of prices encompasses mass goods, the law of diminishing marginal utility can be applied, and when it encompasses indivisible or unique goods, the theory of the price bubbles should be applied.

It is important to emphasize that naturally the markets of water and diamonds (rare diamonds) are of different types: The former is open and cannot be saturated, whereas the latter one is a closed and saturable market. The free market can also transform into a closed market under certain conditions that operates in a different manner than free markets, and in which demand must exceed supply for a relatively long period of time. Evidently, a reverse transformation is also possible, i.e., a closed or deficit market may transform into an open or free market if the demand-supply ratio changes.

Therefore, the economic theories of the Austrian School of Economics can be fully applied to the free market only. When a free market transforms into deficit market, the Austrian economic theories can be applied in a limited way. The nature of prices of goods, especially rare ones, in deficit markets

can be figured out only by using the theory of compound interests and economic bubbles whose application motivates further interest in the free market or its fundamental property of self-regulation. An especially promising novelty is potential capital which stands for market capacity. This allows viewing markets from a completely different perspective knowing the closure peculiarity of such markets. The compound interests theory suggests a different conception of the free market definition.

It is important to stress that under usual conditions, deficit market manifests the phenomenon of increasing profitability—the market is approached by the price increase impulse. The increasing profitability phenomenon that manifests through the fact that when market saturation increases, the profitability rather decreases. This also determines a strong deficit due to low supply.

Summing up, we can conclude that the paradox of value is characteristic of duality: When there is a large number of expensive goods, whether they are indivisible (houses, cars, televisions, diamonds, etc.) or divisible (champagne, gold, etc.), the paradox can be explained based on the law of diminishing marginal utility that manifests in free markets. However, when goods are rare (unique), the law of diminishing marginal profitability does not suit them. Then, their prices can be explained based on the operation of the phenomenon of saturation that manifests in deficit (closed) markets.

We often relate high prices to price bubbles. However, price bubbles manifest in not only rare goods, but also all goods that have a deficit market. It is also important to note that price bubbles of rare goods are more stable than conventional price bubbles. This is because reproduction is hardly possible because there are no such other copies (especially those that would have an exceptional story). Furthermore, demand is formed by the representatives of a stable financial area, whereas experienced auctions take up sales. This is why investment into rare goods is usually more reliable than into other assets (for instance, real estate).

The phenomenological method allows understanding and analyzing the mechanism of market transformation based on the new concept of the free market that states that supply in the market cannot be lower than demand. Thus, only self-regulating markets are attributed to free markets.

The theory of compound interests confirms the statement that the law of diminishing marginal utility cannot be applied to rare and unique goods. The theory of compound interests reveals why the paradox of saturation exists. The mechanism of the price bubble formation is explained both theoretically and empirically. It has been revealed that the paradox of value is also influenced by emotional consumer behavior. Passion for collecting and gambling mania as well as their impact on exceptionally strong saturation has been emphasized.

Practical implications of this study are linked to policy implications for dealing with financial bubbles. Financial sustainability can be achieved by regulatory measures targeting the management of market saturation processes, as well as better regulations imposed on financial institutions, however, voluntary measures driving sustainable corporate finance development can play a major role, as governmental interventions into markets and strict regulations to overcome market failures in the end can provide for governmental failures having even worse consequences for sustainable economic development of the world.

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