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Yazar/Author

Hasan ALPAGO*

Makale Adı/Article Name

Altın Oran Teorisinin Ekonomik Teoriler Açısından Analizi

Analysis of the Golden Ratio Theory in Terms of Economic Theories

ÖZ

Ekonomik kaynaklar ile doğal denge arasında doğrudan bir ilişki söz konusudur. Nitekim doğa yasaları, doğadaki canlı ve cansız varlıkların davranış ve hareketlerine yön veren bir süreç olarak temel belirleyici bir rol oynamaktadır. Adam Smith'e göre ekonominin işleyişi ve genel denge durumunun oluşması tamamen "görünmez el" olarak adlandırılan rasyonel insan davranışı sayesinde gerçekleşir. Demek ki doğa insanları kendi çıkarlarını gözeterek toplumsal çıkarlara hizmet etmeye yönlendiren bir içgüdüyle donatmıştır. Smith'in bu yaklaşımı Keynes tarafından da kabul edilmektedir. Keynes'e göre bireyler tüketim ve diğer ekonomik kararları "spiritus animalis" yaklaşımı çerçevesinde tıpkı göçmen kuşlar gibi içgüdülerine göre hareket ederek en doğru kararı vermeye çalışırlar. Smith ve Keynes'in bu yaklaşımları, matematikte altın oran ve buna dayalı Fibonacci yaklaşımlarının ekonomik göstergeler arasındaki ilişkiler açısından da değerlendirilebileceğini göstermektedir. Bu çalışmada altın oranı ile makroekonomik göstergeler arasında karşılıklı ve uyumlu bir ilişki olduğu tezi çerçevesinde bir analiz yapılmaya çalışılmıştır. Bu çerçevede altın oran teorisi ve Fibonacci sayıları makroekonomik dengelerin varlığı ve sağlanması açısından karşılaştırmalı bir analizle örneklerle analiz edilmeye çalışılmıştır.

Anahtar Kelimeler: Fibonacci, Finansal Analiz, Altın Oran, Makroekonomik Göstergeler

ABSTRACT

There is a direct relationship between the economic resources and the natural balance. Indeed, the laws of nature play a fundamental determining role as a process that directs the behavior and movements of living and non-living beings in nature. According to Adam Smith, the functioning of the economy and the formation of the general state of equilibrium occur entirely thanks to the rational human behavior called the "invisible hand". It means nature has equipped people with an instinct that directs them to serve the social interest while considering their own concerns. This approach of Smith is also accepted by Keynes. According to Keynes, while individuals make consumption and other economic decisions with the "spiritus animalis", they try to make the best decision by acting according to their instincts, just like migratory birds. These approaches of Smith and Keynes show that the golden ratio in mathematics and the Fibonacci approaches based on it can also be evaluated in terms of the relations between economic indicators. In this study, an analysis has been tried to be made within the framework of the thesis that there is a mutual and harmonious relationship between macroeconomic indicators and the golden ratio of a country. Moreover, the golden ratio theory and Fibonacci numbers have been tried to be analyzed with examples in terms of the existence and provision of macroeconomic balances with a comparative analysis.

Keywords:Fibonacci, Financial Analysis, Golden Ratio, Macroeconomic Indicators

* Dr. Öğr. Üyesi, İstanbul Nişantaşı Üniversitesi, İİSBF, hasan.alpago@nisantasi.edu.tr ORCID: 0000-0001-7695-2794

Prologue

Scientific studies can basically make progress by imitating nature. Nature, on the other hand, consists of a mechanism that operates within a certain order and logic. This mechanism is designed in accordance with the laws of mathematics, physics and chemistry. While science defines it as a spontaneous formation mechanism spread over time, philosophy of faith considers it as a manifestation of divine power. The common point of both approaches is that this process produces healthy and useful results as a result of a logical and perfect mechanism. Any formation that violates these natural laws leads to chaos or cannot survive. For this reason, there is a process of change and transformation in nature based on a constant effort to adapt to conditions.

The golden ratio theory has been consciously handled in different dimensions on the basis of ensuring proportional balance in all activities of people. However, the conceptual expression of this was only expressed by Euiclid in the Ancient Greek civilization. Indeed, it is possible to observe the proportional data expressed by the golden ratio theory in cave paintings, structures and sculptures that have survived to the present day.

Although it is named after Leonardo Fibonacci, who described it in 1227, the rule of proportional variation in Fibonacci numbers was known before Christ. Since then, it has occupied mathematicians and non-mathematicians alike with its numerous interesting properties and fields of application. It is now known as a common fact that the Fibonacci sequence is used in daily life, especially in nature, to draw conclusions from the Fibonacci sequence in fields such as genetics, botany and stock analysis, and to predict the course of the market in macroeconomic analysis (Seckın and Bulbul, 2020).

From this point of view, it is seen that some common values and approaches in all branches of science play a fundamental role in the development of theories. Indeed, the majority economists, including Smith, Say, Malthus, and Keynes, base their theories on a foundation based on the logic of the golden ratio theory. For example, Malthus stated that the population growth rate increased geometrically, and the food rate increased arithmetically, and based the logic of the ratios between macro parameters on a certain logical ratio, just like the Fibonacci numbers.

From a macroeconomic point of view, it is seen that this natural process reveals the consumption and production behaviors of individuals and society within the framework of a certain logic and rules. It is possible to see this in the golden ratio and especially in the Fibonacci numbers. In this study, the natural link between macroeconomic policies and the golden ratio theory has been examined with a comparative analysis within the framework of the approaches of various theorists.

1. Theoretical and Conceptual Framework

The golden ratio, which takes its source from nature and the universe and has become one of the basic elements of aesthetics in architecture and art as well as in macroeconomic data. It shows itself particularly in many architectural masterpieces from past to present as well. The golden ratio was first used in the 3rd century BC to refer to the term "extraordinary and average ratio" in Euclid's book Stoicheia. It is claimed that this date goes back to the 3rd millennium BC. The golden ratio, which is the equivalent of the number 1.618 obtained with the Fibonacci number sequence, has been the subject of many scientific and artistic studies from the past to the present (Runion, 1990).

These numbers were first included in the famous rabbit problem in the second edition of Fibonacci's book "Liber Abaci" (Book of Abacus) written in 1202, in 1228. Basically, this is the problem: “Starting with a pair of rabbits, a new pair of rabbits are born every month, the newborn couple becomes adult in a month and gives birth to a new pair of rabbits in the second month, this cycle continues for 1 year, and in this process, no rabbits are born. How many pairs of rabbits will you have at the end of the year if the rabbit does not die?” form a problem. The golden ratio is seen as a mathematical element of aesthetics in the field of architecture and becomes the "aesthetic" counterpart of rational designs (Huntley, 1970).

At the beginning of the 19th century, the Golden Ratio was used again in studies in the field of mathematics with the examination of irrational numbers in the field of arithmetic. The reason why the Golden Ratio has created so much controversy is that its source is also found in nature. In nature, it appears as a ratio in the leaf arrangement of many plants, in their development, in the anatomical structure of animals and in human anatomy. The use of the Golden Ratio in works of art is as old as Egyptian art. It was used in the Pyramids, one of the seven wonders of the world, and in Egyptian architecture. In Greek Art, the Golden Ratio appears in many works of art.

Moreover, the Golden Ratio observed in Greek sculptures, vases, and architecture. The fact that the Greek sculptor Phidias was a complete practitioner of the Golden Ratio and included this ratio system in all his works, caused the name of the number 1.618 to be mentioned with the letter Phi (Fi) in the Greek alphabet, which is its first two letters. In the Renaissance, artists almost competed to use this ratio system in their works. The Golden Ratio had its most magnificent period in the Renaissance, with Luca Pacioli's description of the Golden Ratio in his work "De Divine Proportion" and Leonardo Da Vinci's drawings of the book. The Golden Ratio has also been used in the historical process from the Renaissance to the Modern period. During the Roman period it is seen in the façade layout of Gothic Cathedrals. In the modern period, Le Courbusier adapted the Golden Ratio to Modular, the ratio system he had created, according to the developing modern system and industrialization. The Golden Ratio or other ratio systems are used in today's industrial design (Ghyka, 1970).

As we mentioned above, the golden ratio is denoted by the Greek letter Phi (Φ). It is represented by the irrational number approximately 1.6180339887. Renaissance architects, artists and designers also worked on this fascinating subject, as the golden ratio was found unique and mysterious by many researchers and mathematicians. The golden ratio has been documented by many artists using it in their outstanding works, paintings and architectural structures. Regardless of the length of the line segment, the ratio is 1.618 when this operation is performed. Euclid named this ratio 'extreme and mean ratio' (Livio, 2002).

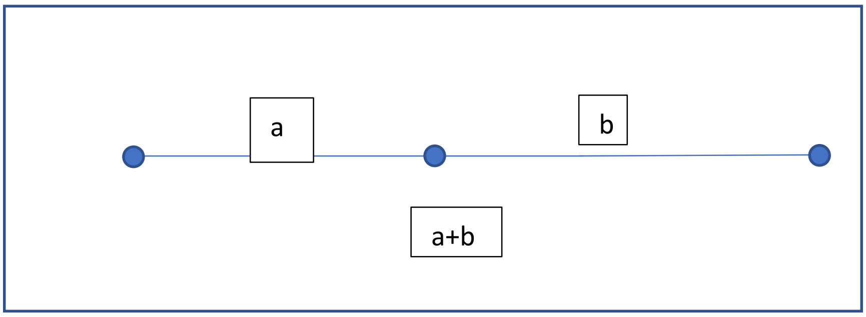

Figure 1. Mathematical Ratio of Fibonacci numbers **Source**: (Elam, 2001).

As seen in the Figure 1, $\frac{a}{b}$ ratio and $\frac{a+b}{a}$ ratio is equal and its value is 1.618. When the mathematical connection is created, the following formula emerges (Elam, 2001).

If $\frac{a}{b} = \frac{a+b}{a}$ then $a^2 = a.b + b^2$. It means $a^2 - a.b - b^2 = 0$.

The positive root of the equation gives the golden ratio value.

$$\varphi = \frac{1+\sqrt{5}}{2} = 1{,}618033 \ldots$$

from its long side to its short side. The Golden Rectangle is a rectangle made up of two consecutive numbers from the Fibonacci sequence. Of all the geometric forms of the Golden Rectangle, it is known to be one of the most visually pleasing. A golden rectangle is a rectangle with one side proportional to “1” and the other side proportional to “1.618”. When squares are subtracted into the golden rectangle so that each time the short side length forms one side of the square, each remaining rectangle appears as a golden rectangle. This situation repeats itself forever. The spiral passing through the diagonals of the resulting square will give a snail spiral; This shape appears naturally in many places in nature. The existence of another number or ratio that satisfies all these mathematical rules is not yet known in mathematics. For this reason, the golden ratio has a great importance in all fields of science as well as in mathematics. The first book written on the golden ratio is Divine Proportion by Luca Palcioli (1445-1519). The book illustrated by Leonardo da Vinci was published in 1509 (Ferdinand, 1999).

This ratio, which was known as the holy ratio until the 1830s, started to be called the golden ratio when the German mathematician Georg Simon Ohm named it "Golden ratio" in a book and its popularity increased. It was believed that the golden ratio system was perfect, just as the gold mine was the most perfect and incorruptible among all mines. For this reason, this proportion system is called the "Golden Section", that is, the "Golden ratio". The golden ratio is a special ratio that is known to exist among all living and non-living beings in nature and in their relations with each other. The idea of proportion has led artists and thinkers to a quest. This search led the Italian mathematician Fibonacci, who lived between 1170-1250, to find the Fibonacci numbers 1,1,2,3,5,8,13,21, 34,… The ratio of two consecutive numbers in the Fibonacci sequence of numbers gives approximately φ=1.61804. This value is called the "Golden Ratio". The golden ratio is a mathematical concept as it seems. But it is a classification of art and aesthetics as a criterion of harmony and beauty (Aslaner and Bakan, 2020).

2. History of the Golden Ratio

Euclid (365 BC – 300 BC) talked about dividing a line by 1.6180339… in his work “Elements” and called this as dividing a line in an extreme and significant way. The Egyptians used both Π and Φ ratios in the design of the Cheops Pyramid. The Greeks based the entire design of the Parthenon on the Golden Ratio. This ratio was also used by the famous Greek sculptor Phidias. An Italian mathematician named Leonardo Fibonacci discovered the extraordinary properties of the numerical series named after him, but it is unknown whether he grasped its relation to the Golden Ratio. Leonardo da Vinci gave illustrations to a work called Divine Proportion, published by Luca Pacioli in 1509 (Dunlap, 1997).

In this book, there are pictures called Five Platonic Solids made by Leonardo da Vinci. These are illustrations of a cube, a Tetrahedron, a Dodecahedron, an Octahedron, and an Icosahedron. Leonardo da Vinci was probably the first to use the Latin equivalent of the Golden Ratio. Renaissance artists often used the Golden Ratio in their paintings and sculptures to achieve balance and beauty. For example, Leonardo da Vinci applied the Golden Ratio in his painting called The Last Supper, from the dimensions of the table where Jesus and the apostles sat to the walls and windows in the back. Johannes Kepler (1571-1630), who discovered the elliptical structure of the orbits of the planets around the Sun, stated the Golden Ratio as follows: “Geometry has two great treasures; one is Pythagoras' theorem, the other is the division of a line according to the Golden Ratio." To illustrate this ratio, American mathematician Mark Barr used the Greek letter Φ in the 1900s, in honor of Phidias, the architect of the Parthenon and the first person known to have officially used this ratio (Iversen, 1955).

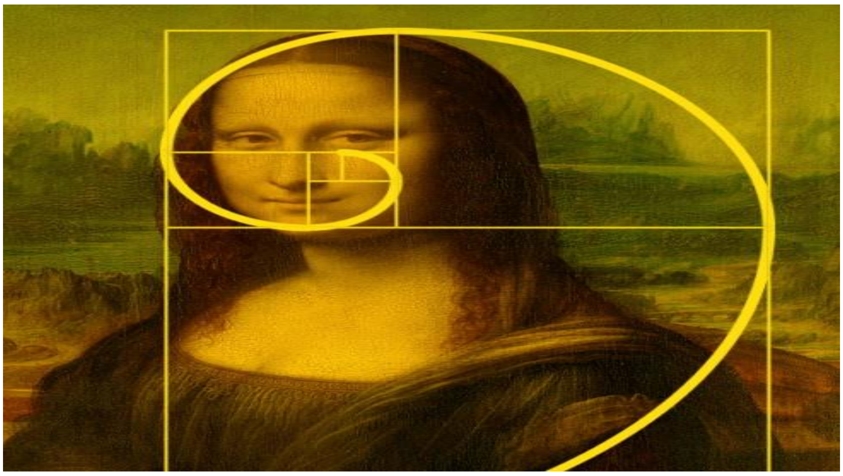

Figure 1. Leonardo da Vinci’s Mona Lisa and Golden Ratio **Source:** Huntley, E.H, (1970)

The Golden Ratio has played an incredible role as a number in the history of humanity, science and art. Phi continues to open new doors for us to understand the universe and life. In the 1970s, Roger Penrose discovered the "folding of surfaces with penta symmetry", which was thought to be impossible until then, thanks to the Golden Ratio.

In the modern era, the Golden Ratio has turned into prefabrication and modularity from a single source with the steps taken towards industrialization. Iron gauge chain, fastening cutting, stone binding were also used as clamps. (Clement. 2005). Abraham Derby de Coalbrookdale, who managed to use coke instead of the stored charcoal, which was found in the second half of the century, succeeded in melting the steel and obtained a better material than the materials known until that day. The increasing demand for weapons during the wars led to the emergence of many organizations, especially John Wilkinson. The technical applications of iron became a historical figure in this period (Markowsky, 1992).

All innovations in the field of engineering at the beginning of the 19th century began to be presented in world exhibitions established starting from 1851. During the first half of the 19th century, exhibitions were limited nationally. The reason for this was that other developing countries, except England, had imposed heavy restrictions on foreign trade in order to protect their local industries. After 1850, almost every country, especially France, abolished customs, however, it was possible to compare products from all over the world. The first world exhibition was held in Hyde Park, London in 1851. As a result of the competition, a project consisting of glass and iron was chosen for the construction of the exhibition. However, all projects, including the first project, consisted of large items that could not be used after the exhibition ended. The exhibition committee then decided to make a project of its own and invited other entrepreneurs for possible suggestions. Meanwhile, Joseph Paxton prepared a project and presented it with two contractors who joined the committee (Karaçay, 2008).

The project was built as the most economical project. With the experience gained by Paxton, whose main profession was to manufacture conservatories, he produced iron glass frames in certain proportions in a way that can be used later. Thus, Paxton made modular production before Le Corbusier came to the modern era. Le Corbusier, one of the pioneers of 20th century modern architecture, was closely interested in the Golden Ratio. Le Corbusier, who applied the proportional arrangements he produced from approximately Golden Rectangles on the plans and facades of his buildings, using his creativity, developed an original measurement-proportion system, Modulor, by utilizing the Golden Ratio and the Fibonacci sequence (Knott, 2020).

Le Courbusier, who previously accepted the human height as 175 cm, divided this human figure according to the rules of the Golden Ratio and obtained 108 cm. Like Leonardo da Vinci, Le Courbusier understood that this length was actually special. This length was equal to the height of the human belly button from the ground, and since it is a special ratio, there is a special meaning behind it being marked with a small hole (Rasmussen, 1994). Over the years, it has found its place in different fields such as industrial design, architecture, plastic reconstructive surgery as well as art. Our age is the age of technology, and the meaning of the word "Design" is much deeper today, in order to be one step ahead in industrial designs in today's technology, competing companies in product design; They try to present human usability, functionality and beauty together.

When we examine the design of the iPod, which offers a state-of-the-art technology, one of the indispensables of today's youth, and ergonomics, usability and beauty, we encounter the Golden Ratio. When we compare the size of a iPhone as A, the screen part as B, and the control part as C, we get the ratio A/C=C/B=1.618 (Baykut and Kıvanç, 2004).

3. Characteristics and Construction of ϕ Number

Different techniques are applied in finding and displaying the number ϕ. Consider the line segment given in Figure 1. The $\frac{a}{b}$ ratio and $\frac{a+b}{a}$ are equal and its value is 1.618. When the mathematical connection is created, the following formula emerges (Boles & Newman, 1993).

$$\frac{a}{b} = \frac{a + b}{a}$$

If we rearrange the above equation, we get $\frac{a}{b} = 1 + \frac{b}{a}$. If we substitute ϕ for . $\frac{a}{b}$, we get $= 1 + \frac{1}{\phi}$.

From here,

ϕ^2=ϕ+1 (1)

Equality is achieved. If we rearrange the equation,

ϕ^2-ϕ-1=0

For solutions of this quadratic equation, we use the following equation.

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

The coefficients of the quadratic equation are a=1, b=-1, c=-1. If we substitute the coefficients in the above equation, the roots of the quadratic equation

$$\boldsymbol{\phi} = \frac{1 \pm \sqrt{5}}{2} = 1{,}61803$$

The value found is the golden ratio.

There is also another way to get the value of the golden ratio.

If we take the square root of both sides of the equation in equation numbered,

$\sqrt{\phi^2} = \sqrt{\phi + 1}$We get it. If we edit the expression, we get $\phi = \sqrt{\phi + 1}$If we write $\phi = \sqrt{\phi + 1}$ in this equation, we get $\phi = \sqrt{\sqrt{\phi + 1} + 1}$. If we continue this process

$$\phi = \sqrt{\sqrt{\sqrt{\sqrt{\phi + 1} + 1} + 1} + 1}$$

A different representation of the golden ratio is obtained.

$$\varphi = \frac{1 + \sqrt{5}}{2} = 1{,}618033 \ldots$$

A different representation of the golden ratio is made using Fibonacci numbers. The general rule for a Fibonacci sequence is the sum of the two numbers preceding each term. The first two terms of this sequence are 1. The terms of the index are shown in the figure below.

1,1,2,3,5,8,13,21,34,55,89,144,233

The general term of the sequence is $F_{(n+2)} = F_{(n+1)} + F_n$ with n>3 and $F_1=F_2=1$. The limit of two consecutive terms of the Fibonacci sequence gives the golden ratio (Danikas, & Panagopoulos, 2004).

$$\lim_{n\to\infty} \frac{F_{n+1}}{F_n} = \varphi$$

4. Golden Raito and Economic Theories

The golden ratio rule is a rule that can be determined not only in concrete objects but also in abstract events. For example, some macro-economic and social relations emerge proportionally as the result of a certain harmony and series of rules, as in the golden ratio theory. In macroeconomic and social events, this situation is defined as integration. Unless there is a proportional integration in a system, that system is defined as freak or unworkable. Thus, a certain harmony based on integration of all effort in macro-economic and social systems is sought and targeted. The only difference here is that while the golden ratio in nature is formed as a result of evolution over time, such harmony is tried to be realized in abstract systems with laws, rules and similar compulsions. If such a system is not established, the process of disintegration and conflict begins (Basak, 2022).

The golden ratio theory can be regarded as a kind of existence rule. In other words, according to this theory, the proportional connection of the elements that make up the bodies and systems, based on the harmony with each other, are the natural rules that must be in order for them to continue their existence. For example, the anatomical structure of a human consists of various organs and limbs that complement each other in certain proportions and that have a certain harmony and task distribution among themselves. Any condition other than this fit is defined as a sick, deficient, or crippled condition. This fact applies to abstract systems. Macroeconomic imbalances are seen as elements that disrupt harmony in an economic system, and economic crises occur after the deterioration of this harmony (Thapa and Thapa, 2018).

In international trade and cooperation, harmonization policies based on the golden ratio theory are followed. In other words, the harmony and balance between the parts of the bodies is a method followed in abstract systems as well. In fact, the common feature of all abstract and concrete systems is based on the principle of integration and proportional balance between them (Sandalcılar, 2012).

The golden ratio theory approach can be observed with Fibonacci numbers by Leonardo Fibonacci, Invisible hand theory by Smith and Say's law by Jean Baptiste Say, Cobweb theory by Kaldor and Spiritus animales theory by Keynes. The balance in nature aspect of golden theory approach can be observed in economic issues as well. In fact, the proportional connection expressed by the golden ratio theory was handled directly or indirectly by thinkers such as Euclid (300 BC), Fibonacci (1170), Smith (1723), Say (1803), Kaldor (1934), Keynes (1936). This ratio also stands out as a guiding theory in the explanation of economic relations and activities (Keynes, 1936).

The golden ratio theory can actually be defined as a discovery rather than an invention. It is possible to see the traces of this in Mesopotamian and Egyptian civilizations in the structures and works of art that have survived to the present day. However, according to the available sources, the golden ratio theory was first mentioned by Euclid of Alexandria in 300 BC and its place in life was emphasized. Euclid especially stated that human, animal and plant structures came into being as a mathematically perfect symmetrical structure. Eucklid stated that this natural formula is also reflected in the structures built by humans (Kaygin, Balçin, Yildiz, ve Arslan, 2011).

Indeed, it is seen that a proportional balance is constantly taken into account in the Egyptian pyramids and ancient Greek amphitheater, sculpture and other works of ancient Mesopotamian civilizations. The golden ratio has also been observed in the works of Renaissance artists such as Leonardo Da Vinci, Michelangelo Buonarroti, Raffaello Sanzio, William Shakespeare and Michel de Montaigne. Indeed, the proportional balance in Da Vinci's Mona Lisa has given this painting an immortality. At the same time, a poetic balance can be observed in Shakespeare's sonatas.

The invisible hand of the market is a metaphor from Adam Smith's The Wealth of Nations. According to Smith, the founder of classical economics, the selfish actions of individuals automatically improve the common good in society. These include, for example, product innovations, low prices, the highest quality or optimal product quantities. Let's say you want to earn a better income and you decide to open a bakery. Not only will you benefit from this decision, but also your customers who have a wide range of breads (Smith, 1789).

Thus, the market, that is, supply and demand, is completely self-regulated by an invisible hand. From this point of view, it can be said that human behavior has a symmetrical character just like the golden ratio theory. After all, every behavior is based on the principle of cause and action or effect and reaction. The approach expressed in the golden ratio theory points to this. For example, if each part of the body were not in a certain order and proportion, it would look like a monstrous creature and the body would not be able to fully perform its functions. In this respect, logically, human behavior can be better analyzed within the framework of a mathematical logic. This is why mathematics and statistics are increasingly found in economics.

The invisible hand constitutes the basic idea of a free market economy where economic subjects are given as much freedom as possible to increase the welfare of the economy according to Adam Smith's principle. In his model, if the state were to interfere with the self-regulation of the market through economic policy measures and laws, individuals would no longer be able to act in a way that maximizes utility or profit, and the invisible hand would have no or only limited influence. From the point of view of the golden ratio theory, it can be concluded that nature has designed people's anatomical structures as well as designed their behaviors rationally and to protect their interests.

As a matter of fact, Say, who supports Smith's theory of the invisible hand and classical economic theories that human behaviors are proportional and calculable, expresses the same opinion. According to the economist Jean Baptiste Say (1767), the economic theorem in which it is assumed that each economic supply creates its own demand, as the production of goods simultaneously increasing of the purchasing power to buy these goods. Aggregate supply and demand then tend to a state of equilibrium where there is full employment.

Say, like Smith, states that the natural balance will be established by itself. According to Say's law, supply creates its own demand. More precisely, the increased planned supply of goods therefore automatically creates a correspondingly higher planned demand. Therefore, an insufficient level of demand cannot exist in any way from a macroeconomic point of view, except for short-term fluctuations. As can be seen, Say, just like Smith, talks about a natural balance mechanism like an invisible hand. This mechanism fully coincides with the golden ratio rule in nature. It means still the golden ratio is observable in nature asl well.

Moreover, Thomas Malthus based his theory of population on a certain mathematical logic in 1789. According to the basic approach of this idea, if there are no limiting factors such as pandemic under suitable conditions, the population increases in the form of a geometric sequence, that is, in the form of 2, 4, 8, 16, 32, 64, ... On the other hand, nutrients increase in the form of an arithmetic sequence, that is, in the form of 1, 2, 3, 4, 5, 6, …. According to Malthus, this is why this difference in nature causes the death of some individuals in the population and a balance is achieved. From this point of view, it somewhat overlaps with the supply and demand equilibrium approach of Smith and Say (Ferdinand, 1999).

Kaldor expresses a similar approach to Smith and Say's approaches that can be based on the golden ratio theory. Kaldor supports the idea that how the market comes to equilibrium with Cobweb theory and that people who act rationally act with the same instincts by basing this on people's instincts. In this view, it can be said that it has a character that coincides with the golden ratio theory. The spider web theorem stands out as an approach to explain oscillating price and quantity movements based on delayed supply adjustments. The model is based on the premise that the entrepreneurs' offer is based on the prices of the previous period. Accordingly, the supply of a good, especially the production process in the agricultural sector, is not a random process. On the contrary, it consists of a symmetrical behavioral model that is shaped according to action, reaction and acquired experience and expectation.

Finally, Keynes (1936), crowning the approaches of thinkers such as Euiclid, Fibonacci, Smith, Say and Kaldor, states that human behaviors that guide economic activities within the framework of the concept of spiritus animales are not random, but depend on a natural and instinctive behavior mechanism (Darwin, 1859). Accordingly, the economy may not move along the lines predicted by classical economists or monetary theory. He argues that human behavior is not rational but occurs due to fluctuations of irrational optimism or pessimism, and it is necessary to evaluate this as a result of the resulting behavior (Alpago, 2016).

5. **Fibonacci Number**

The use of the golden ratio theory and the Fibonacci ratio in macroeconomic equations and forecasts is a proof of the importance of this ratio in abstract systems. As a matter of fact, especially in the stock market and other speculative economic movements, decision makers mostly use the Fibonacci rule to make their investment decisions more accurate in the face of uncertainty (Hacıbebekoğlu, 2018).

Within the framework of the golden ratio theory, Fibonacci numbers have a very important place in the evaluation of macroeconomic data and market analysis today. In this respect, the role and importance of Fibonacci numbers are discussed in more detail here. Fibonacci is an Italian mathematician who came up with Fibonacci numbers. It is extremely popular among financial market traders in technical analysis, as it can be applied to all timeframes.

The most common Fibonacci levels are extension and correction levels. Fibonacci retracement levels indicate the correction levels before prices continue the trend. It is the simple division of the vertical distances between the selected lower and selected upper (or vice versa) levels into zones at 23.6%, 38.2%, 50% and 61.8%. Prices tend to come back to these levels before continuing in the dominant trend. Fibonacci extension levels indicate levels that prices can reach after initial volatility and corrections (Prokopakis, Picavet and Hellings, 2013).

Fibonacci numbers have been the focus of attention of mankind and especially scientists for centuries for three different reasons. The first is that several of the initial terms of the sequence can appear repeatedly in unexpected places in nature. The second reason is that 1.618033988749895…, the limit value of the odds, is a very important and well-known number. Third, these numbers themselves have interesting uses in number theory. Considering how Fibonacci numbers are encountered in nature, some plants and tree species should be examined. If one of the leaves of the tree is the starting point and starting from there, exactly below the starting point or if leaves are counted until one leaf is found above the stem (more than one the number of leaves found is different for different plants and trees, but it is always a Fibonacci number (Benevolo, 1981).

Together, a tufted willow tree needs thirteen leaves for five cycles. In general, botanical science is like a botanical goldmine for Fibonacci numbers. Daisies normally have as many petals as one Fibonacci number. One of the most famous examples of Fibonacci numbers in nature is the case of sunflowers. In the flower part of the sunflower, there are seeds in small lozenges. The borders of these parts are in the form of spiral curves starting from the center and going to the outer edge of the flower. If clockwise and non-clockwise spirals are counted in such a pattern, successive numbers in the Fibonacci sequence are encountered. Many vegetative shapes contain Fibonacci helices, such as the seed heads of many flowers, the leaves of a curl, the layers of an onion, the layered skins of pineapples and cones. (Orhani, 2022) Fibonacci Numbers are an analysis method that is frequently used especially in financial market analysis. This shows that the golden ratio theory can be considered as a tool used to explain economic developments.

In fact, the Fibonacci Sequence is used in the finance industry to predict the receivables of financial assets. It is the golden ratio that we can reach with the Fibonacci Sequence used in technical analysis applications. Generally used ratios are 1.618 and 1.232. Let's take a parity that has seen the lowest price of 1.0520 and the highest price of 1.1376 in the timeframe we took as a basis. Subtracting the high price from the low price, we get 1.1376 – 1.0520 = 0.0856. Multiplying this value by 1.272 above will get 0.0856 * 0.232 = 0.0198. When we add this value to the high price of 1.1376, it will be 1.1578. This resulting value reveals the trend we expect the pair to rise. As can be understood from this example, it is not possible to expect a parity's movement in the financial sector to occur uninterruptedly. The Fibonacci Sequence provides analysis that can help us identify this trend (Tekkanat, 2006).

Another use of the Fibonacci Sequence in the finance industry is the Fibonacci Time Ranges. Price is not the only variable in the analysis methods we mentioned above. The time variable should also be examined comprehensively. In this context, Fibonacci Sequences can be used in time intervals as well as in price changes. While determining the time intervals, the numbers in the Fibonacci Sequence are taken as days, that is, they are divided into trend day intervals as 1-1-2-3-5-8-13-21-34.

This analysis is used to determine the duration of the fluctuations. As we mentioned in other Fibonacci Analysis, a guideline is drawn at the floor and ceiling points in Fibonacci Fans. This guiding line should be drawn at the ceiling point of the intermediate trend, not the main trend. Fibonacci Fan Analysis is not a definitive analysis method. This is because the margin of error increases in volatile markets or periods. For this reason, it is recommended to be applied in more stable markets (Thapa and Thapa, 2018).

Conclusion

It can be said that all branches of science as a whole act according to some common ground in every field and scientific theories basically provide progress. In addition, science develops by taking the laws of nature as an example as a basic guide. In addition, methods based on logic, mathematics and a systematic theory are followed in all branches of science.

This reality applies to economics as well. From this perspective, all theorists from Smith to today's economists try to predict the direction and future state of economic developments, especially based on statistics, mathematics and logic. That's why it is important to evaluate the Fibonacci numbers and the golden ratio theory in terms of economics. In this respect, this article aims to contribute to this field in terms of both ideas and theoretical analysis with a holistic approach.

Finally, as in every field, in order to analyze the economic life that takes place within the framework of the rules and guidelines existing in nature, it tries to make evaluations and predictions by developing theories and methods according to the rules existing in nature. In order for these evaluations to be accurate and scientific, they benefit greatly from the laws of mathematics and statistics, especially the golden ratio.

The golden ratio theory and Fibonacci numbers, which state that the assets in nature are shaped according to a certain mathematical harmony and ratio and are based on a system based on this, are increasingly being used in the evaluation of macroeconomic data. In this respect, since this approach is increasingly used in macroeconomic evaluations, scientific studies in this field should be emphasized.

The observance of certain rules and regulations both in nature and in the economic and social systems that form the cornerstone of societies are facts that have continued from the past to the present. As the history of humanity progresses, on the one hand, the limits of freedom expand, on the other hand, the importance given to harmony and integration increases. Indeed, for macroeconomic success, the principle of coherent and accurate estimation, classification, and evaluation of data in a more realistic way becomes important. In this respect, economic integration is increasing on a global basis. Like the European Union, regional unions are also shaped according to this rule. At the same time, multinational companies act in accordance with the principles of harmony and general acceptance on a global basis in product development and becoming a global power. This is also seen in the reshaping of health and social values. People are increasing their efforts to reach more and more aesthetic and harmonious bodies and systems.

This fact is based on completing the harmony and balance that cannot be fully provided by nature or missing artificial methods. In addition, with globalization, harmony and general balance are becoming increasingly important, from the shaping of the physical appearance of the products to the relations. Technological advances and scientific studies accelerate people's adaptation and perfectionist approaches by providing opportunities. As a result, the golden ratio and Fibonacci approaches are now accepted.

People follow policies to implement the proportional harmony required by these theories in all areas, including economics. In this respect, scientific studies based on the golden ratio and Fibonacci approaches are gaining importance in every field, from the evaluation of macroeconomic data to future predictions.

Golden ratio theory and Fibonnaci numbers are approaches that confirm each other. The proportional harmony predicted by these approaches has been proven in nature and has an important place in the evaluation of socioeconomic data. Finally, the golden ratio balance, which is also defined as the divine balance, can be defined as a proportional harmony process that must be followed in order for nature to continue its activities completely or with less error. In this respect, we can state that these scarce resources can be managed in a more harmonious way within the framework of the rules stipulated by the golden ratio and Fibonacci numbers, based on Adam Smith's principle that resources are scarce and needs are endless.

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Makalenin yazarı, bu çalışma ile ilgili taraf olabilecek herhangi bir kişi ya da finansal ilişkisi bulunmadığını dolayısıyla herhangi bir çıkar çatışmasının olmadığını beyan eder.

Destek ve Teşekkür

Çalışmada herhangi bir kurum ya da kuruluştan destek alınmamıştır.