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Separate the Tithe: Economic Issues in the Holy Scriptures

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Abstract

The paper starts with the hypothesis that Adam, having been commanded to eat in the sweat of his brow, had no leisure time in the modern sense, and his leisure was limited by the sleeping time. The verification of this hypothesis needs both statistical and analytical data. Field studies of sleeping habits in hunting-and-gathering tribes from Africa and Southern America revealed statistically reliable data of 5.7–7.1 hours of sleeping time, a duration near the low end of those industrial societies. This result supports the historical analysis of sleeping habits in the preindustrial Europe. The model of economic equilibrium in a hunting-and-gathering society uncovers the perfect allocation of time produced by the golden ratio, also known as the divine proportion. The mathematics of economic equilibrium results in 6.63 hours of sleep. Applying this result to the tangibles-intangibles trade-off in the preindustrial Hebrew economy reveals the perfect share of giving to the church and the needy. It is equal to two tithes commanded to Hebrews by the Old Testament.

Keywords: golden ratio, giving, tithe, Old Testament

1. Introduction

The Holy Scriptures have been the object of study for theologians and historians. However, a new academic discipline, economic theology, has recently emerged. *The Routledge Handbook of Economic Theology*, published in 2020, powerfully summarized this new vision of religious texts. But its use of economic theory, however, remains insufficient. Even the linguistic analysis can generate many fruitful ideas that correspond to the modern economic theory. First of all, economic theology misses the opportunities of the economic approach itself, which can efficiently explain the properties of the nonmarket preindustrial economy:

> "The economic approach is clearly not restricted to material goods and wants, nor even to market sector. Prices, be they the money prices of the market sector or the shadow "imputed" prices of the nonmarket sector, measure the opportunity cost of using scare resources, and the economic approach predicts the same kind of response to shadow prices as to market prices. Consider, for example, a person whose only scares resource is his limited amount of time. This time is used to produce various commodities that enter his preference function, the aim being to maximize utility. Even without a market sector, either directly or indirectly, each commodity has a relevant marginal "shadow" price, namely, the time required to produce the unit change in this commodity; in equilibrium, the ratio of these process must equal the ratio of the marginal utilities." (Becker, 1987, p. 6).

Following those considerations, the paper analyzes the limited amount of time measured by opportunity costs and imputed prices that implicitly accompanied the preindustrial economic activities of hunting, gathering, and farming that dominated in the times of the Old Testament. Even the literal and metaphorical language of the Holy Scriptures contains enough economic information to be reproduced by mathematics of the utility theory.

The paper is organized as follows. It starts with the analysis of the behest to eat "in the sweat of the brow" (Genesis, 3:19), which pays attention to the sleeping time as the residual of labor. Then the analysis turns to historical and statistical data on sleeping habits in preindustrial societies to get some target value to be used in economic modeling. Next, the paper addresses the literary daily schedule of a world-famous "preindustrial laborer." The allocation of Robinson Crusoe's time between his "employments" and healthy sleep discovers its perfect proportions, previously found in workings of invisible hand on commodity and in marriage markets (Malakhov, 2022a, b). These proportions hold for both consumption-leisure and tangibles-intangibles utility functions, resulting in the perfect share of giving from agricultural income.

2. Method

The analysis of economic issues in the Holy Scriptures needs a specific synthesis of economic theory, statistics, mathematics, and linguistics. The study of the literary heritage of the Old Testament should consider Bibles Versions and the Masoretic Text itself. Economics offers the theory of consumption-leisure choice and the concept of opportunity cost. Statistics simply verifies assumptions provided by mathematics. Finally, this synthesis is cemented by

concepts of product lifecycle and project management.

2.1 By Sweat of His Brow

The economic analysis starts from the very beginning of the Holy Scriptures. After being banished from the Garden of Eden, Adam should get his food in labor:

> "By the sweat of your face you shall eat bread until you return to the ground, for out of it you were taken; you are dust, and to dust you shall return." (Genesis 3:19; NRSV).

From here, we can assume that he had no leisure in the modern sense. His leisure time was limited to sleeping to replenish his forces; the rest of the time he had to work.

Readers can accept the idea that Adam had no time for entertainments. but they also can ask the reasonable question about eating. Here, we can address Calvin and his commentary on the Bible:

> "**In the sweat of thy face**. Some indeed, translate it 'labor;' the translation, however, is forced. But by "sweat" is understood hard labor and full of fatigue and weariness, which, by its difficulty produces sweat. It is a repetition of the former sentence, where it was said, 'Thou shalt eat it in labor.'" (https://www.studylight.org/commentary/genesis/3-19).

Calvin's commentary gives the idea that Adam also had no eating time like we do and got his food during gathering and cropping. As a result, that time wasn't part of leisure but part of labor.

We cannot prove the hypothesis that Adam's leisure was limited by sleep, but we can make it more reliable. For that, we need some analytical measurement of the sleeping time of preindustrial laborers: hunters, gatherers, and farmers. Here, we can address the practice of Sleep Research Societies. They analyze historical and statistical data on the duration of sleeping time. Modern trends in the allocation of time don't correspond to preindustrial habits in societies that didn't know artificial lighting. Then researchers address historical data: charts of guilds and monasteries, legal documents, literature, and even folklore. The last one was illustratively presented by R. Ekirch: "A seventeenth-century proverb instructed, "To sup at six and go to bed at ten, will make a man live ten times ten." Vincent Stuckey Lean, Lean's Collectanea, 4 vols. (Bristol, 1902–04), 1: 503. A French variation, common in the sixteenth century, counseled: "To rise at five, to dine at nine, To sup at five, to sleep at nine, Lengthens life to ninety-nine." Lloyd's Evening Post (London), February 19, 1768." (Ekirch, 2001, p. 351).

These proverbs give us eight hours of preindustrial sleep. But Ekirch also discovered the phenomenon of broken sleep. He wrote his work on preindustrial slumber in the British Isles but started it with a description of sleeping habits in continental France. Ekirch drew it from Robert Louis Stevenson's journal when the author of **Treasure Island** made a voyage across the Cevennes: "But rather than resting until dawn, Stevenson awoke shortly past midnight. Only after lazily smoking a cigarette and enjoying an hour's contemplation did he fall back to sleep. "There is one stirring hour," he later recorded in his journal, "unknown to those who dweil in houses, when a wakeful infiluence goes abroad over the sleeping hemisphere, and all

the outdoor world are on their feet, men and beasts alike." Ekirch wrote that in midnight "families rose from their beds to urinate, smoke tobacco, and even visit close neighbors. Remaining abed, many persons also made love, prayed, and, most important, reflected on the dreams that typically preceded waking from their "first sleep"" (Ekirch, 2001, pp. 343–344).

That 'stirring hour' reduced the sleeping time. The same habit was discovered by G.Garnier in his analysis of sleeping habits in France during 1700–1850. Garnier also analyzed the archives of Poitiers, where he found that summer sleeping time had started at 22 or 23 o'clock and finished at 5 or 6 o'clock (Garnier, 2013).

However, the research activity went beyond the historical data. A few years ago, the international team analyzed the sleeping habits of preindustrial hunting-and-gathering tribes in Bolivia, Tanzania, and Namibia. There, the samples were equipped with Actiwatch devices worn for 6–28 days. The results were amazing. While those tribes were separated by the Atlantic Ocean, they had identical sleeping habits. Yetish et al. discovered that hunters and gatherers slept on average about 5.7-7.1=6.4 hours per day, one hour more in the winter than in the summer (Yetish et al., 2015). These results look even more amazing, if we compare them with the historical analysis of preindustrial Europe. Sleeping habits stayed identical not only across oceans but also over time.

For today, science cannot explain this statistical and historical correlation. But these studies give an idea of where to find an example of a hunter's allocation of time in literature. And we can get it. That was Robinson Crusoe.

2.2 Robinson Crusoe's Consumption-Leisure Choice

This choice is not an occasional one. Economic analysis of labor-leisure choice typically addresses the so-called "Robinson Crusoe's economy," in which Daniel Defo's actor played both roles, that of "producer" and "consumer".

The following example brings life to this academic model. Robinson had really spent all his active time on hunting and gathering before he miraculously found English barley.

Let's reduce Crusoe's output, berries, grapes, and quarry, to the 'grouse' and analyze the allocation of his time before he started farming. His time was allocated between the 'forest' T_f on hunting, the 'house' T_d on cooking (plucking, salting, grilling), and leisure H that he spent either in the forest or at home. So, the imputed price P of a cooked grouse was as follows:

$$P_{producer} = MC_f + MC_d = P_{consumer} = \frac{wT_f}{Q} + \frac{wT_d}{Q} \quad (1)$$

where MC_f – marginal costs of hunting; MC_d – marginal costs of cooking; w – imputed wage rate; Q – quarry, i.e., quantity of 'grouse'.

However, Crusoe's lifestyle had some attributes that are important for our analysis. He had money that he had found on the wrecked ship, but he didn't use it: "I smiled to myself at the sight of this money: "O drug!" said I, aloud, "what art thou good for? Thou art not worth to me…"

And he had no watches. Of course, he could follow the sun, but how did he measure his efforts in a dense forest or in a cloudy day? Without watches and money, the measure was the unit of quarry, one 'grouse'. Indeed, even today, farmers in outback country measure time during plowing by natural values like the number of plowed rows until lunch. This preindustrial habit appears today in the cost accounting of output rates and daily production quotas. However, this consideration gives us the following equation:

$$T_f = Q \tag{2}$$

Crusoe's hunting time was equal to the number of grouse he brought home. This equation, on the other hand, gives us the imputed values of both the marginal costs of hunting and Crusoe's wage rate:

$$MC_f = \frac{wT_f}{Q} = w = 1 \tag{3}$$

We can say that, without watches, Robinson recalculated his time work into piece work.

As a result, we get the imputed equilibrium price of one cooked grouse:

$$P_e = P_{producer} = P_{consumer} = MC_f\left(1 + \frac{MC_d}{MC_f}\right) = 1 + MC_d \tag{4}$$

Now we can start to optimize Crusoe's allocation of time. From here, we should understand that all the time at home was also measured by opportunity costs in 'grouse'. If he napped after lunch, he could say that he missed one or two grouse while hunting.

Let's compare the allocation of Crusoe's total production costs $TC(T_f;T_d)$ costs between hunting and cooking and the marginal rate of substitution of leisure for consumption *MRS (H for Q)* under the following budget constraint:

$$w(T_f + T_d) = QP_e \tag{5}$$

The allocation of production costs can be reduced to the values of time under *AC=MC* assumption:

$$\frac{TC_d}{TC_f} = \frac{wT_d}{wT_f} = \frac{wT_d/Q}{wT_f/Q} = \frac{MC_d}{MC_f} = \frac{T_d}{T_f} \tag{6}$$

The *MRS (H for Q)* gets its traditional form, but the daily output rate also reduces it to the values of time:

$$\frac{w}{P_e} = \frac{Q}{T_f + T_d} = \frac{T_f}{T_f + T_d} \tag{7}$$

If we equalize the allocation of working time with the marginal rate of substitution, we get the equation well known to all mathematicians:

$$\frac{T_d}{T_f} = \frac{T_f}{T_f + T_d} \tag{8}$$

$$\frac{T_d}{T_f} = \Phi = 0.618034\ldots = \frac{1}{\varphi} = \frac{1}{1.618034\ldots} \tag{9}$$

or the allocation if time between hunting and cooking is equal to the golden ratio conjugate $\Phi = 1/\varphi$.

From here we get the following imputed values:

$$\frac{T_d}{T_f} = \frac{MC_d}{MC_f} = \frac{MC_d}{1} = MC_d = \Phi \tag{10}$$

$$P_e = MC_f + MC_d = 1 + \Phi = 1 + \frac{1}{\varphi} = \varphi \tag{11}$$

These imputed values provide a 'one-line proof of the golden ratio':

$$\frac{MC_d}{MC_f} = MC_d = \frac{w}{P} = \frac{1}{MC_f + MC_d} = \frac{1}{1 + MC_d} \approx 0{,}618034\ldots = \Phi = \frac{1}{\varphi} \tag{12}$$

The golden ratio changes the exposition of the total differential of the consumption-leisure utility function $U(Q;H)$:

$$dQMU_Q + dHMU_H = 0 \tag{13.1}$$

$$-\frac{dQ}{dH} = \frac{MU_H}{MU_Q} \tag{13.2}$$

$$-\frac{dQ}{dH} = \frac{w}{P} = \frac{1}{P} = \Phi \tag{13.3}$$

$$dQP + dH = 0 = dQ + \frac{dH}{P} = dQ + \Phi dH \tag{13.4}$$

But the optimal cost allocation between hunting and cooking produces the same result:

$$\frac{MC_d}{MC_f} = \frac{MC_d}{1} = MC_d = \Phi = -\frac{dQ}{dH} \tag{14.1}$$

$$PdQ + wdH = 0 = dQ + \Phi dH = MC_f dQ + MC_d dH \tag{14.2}$$

This means that the golden ratio makes tangent both the utility curve and the total costs' curve. This is the equilibrium of Robinson Crusoe's economy (Figure 1):

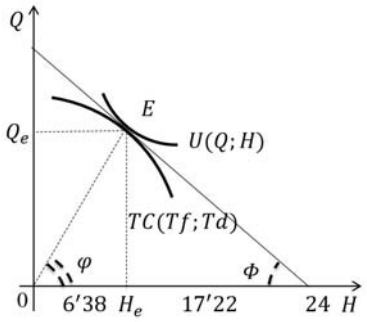

Figure 1. Crusoe's optimal consumption-leisure choice

We see that the equilibrium solution has another optimal property. At equilibrium, the normal $[0;E]$ produces the following ratio:

$$\frac{Q_e}{H_e} = \varphi \tag{15}$$

But from here we get very important result:

$$\frac{Q_e}{H_e} = \varphi \rightarrow \frac{H_e}{Q_e} = \Phi = \frac{H_e}{T_f} = \frac{T_d}{T_f} \rightarrow H_e = T_d \tag{16}$$

We can apply this result to the allocation of the total time horizon T_{total}:

$$T_{total} = T_f + T_d + H_e = (\varphi + 1)T_d + H_e = \varphi^2 T_d + H_e \tag{17.1}$$

$$T_{total} = (1 + \varphi^2)H_e = 3.618034\ldots H_e \tag{17.2}$$

This proportion is relevant for any time horizon, either measured in 'grouse' or in hours. And we can check it for 24 hours' time horizon:

$$H_e \approx 0.2763932\ldots T_{total} \approx 6.633437\ldots hr \tag{18.1}$$

$$T_d = H_e \approx 6.633437\ldots hr \tag{18.2}$$

$$T_f = \varphi T_d \approx 10.733126\ldots hr \tag{18.3}$$

$$T_{total} = 6.633437\ldots + 6.633437\ldots + 10.733126\ldots = 24\ hr \tag{18.4}$$

Here, readers have to get used to infinite numbers. All variables of the model are irrational as derivatives of the golden ratio irrational value and expressed by infinite numbers.

These results can also be confirmed through the analysis of cooking. This is what the economics of time allocation refers to as "dual activity" (Aguiar & Hurst, 2007). Cooking represents both work and leisure at the same time. But we can separate the utility at home from the utility of hunting. Coming back home with an optimal quantity of grouse Q_e, Robinson allocated his time between cooking T_d and sleeping H. At equilibrium, Robinson should get the same utility from cooking as from sleeping because both pursue the same need—to regain forces for hunting. Crusoe didn't calculate utility. For him, it was enough to understand that both cooking and sleeping have the same opportunity costs of missed 'grouse'. It means that cooking and sleeping had the same imputed prices. As a result, the transformation rate of cooking for sleeping was equal to one that made them equal either in 'grouse' or in hours. The $T_d=H$ equation provides the unique equilibrium solution because it fails for other $(Q;H)$ values of the budget constraint with the Φ-slope.

However, Crusoe solved neither the utility maximization problem nor the cost minimization one. He simply applied the rule of thumb and equally allocated his time at home between cooking and sleeping. Indeed, making a delicious meal over basic needs implied forgoing basic needs' sleep.

And approximative 6'38 hours of sleep represent basic needs. We see that the Crusoe's leisure time corresponds to the sleeping time of preindustrial societies. If we suppose that Crusoe's leisure was limited by his sleeping time, we get the rational reason for the statistical correlation of both literature and field studies of slumber. And it also makes the initial hypothesis that Adam's leisure was also limited by sleep reliable.

There is another, now theological, consideration that reinforces this hypothesis. The golden ratio that derives the optimal allocation of time has another, more literary name. Luca Pacioli, father-founder of the modern accounting, called it as the divine proportion. He chose the same title for his book, *Divina Proportione*, and Leonardo da Vinci, his friend, added to it an illustration, his world-famous *Vitruvian man.* In this picture, the human body is placed in a circle. If the distance from the bellybutton to the crown is taken as a unit, then the distance from the bellybutton to the foot is equal to 1.618034. And the full height of the "Vitruvian man" is equal to 2.618034 = $\varphi^2 = \varphi + 1$

2.3 Robinson Crusoe's Tangibles-Intangibles Trade-off

There is the important difference Crusoe's lifestyle and the behest to eat in labor. Robinson organized his dinner like a ceremony:

> "Then, to see how like a king I dined, too, all alone, attended by my servants! Poll, as if he had been my favourite, was the only person permitted to talk to me. My dog, who was now grown old and crazy, and had found no species to multiply his kind upon, sat always at my right hand; and two cats, one on one side of the table and one on the other, expecting now and then a bit from my hand, as a mark of especial favour."

It looks like Crusoe's dinner really was a part of his leisure. Indeed, Robinson's dinner looked

like the ceremony. But through the production lifecycle's optics his dinner was the ceremonial end of getting tangibles, like Harvest festivals in England and Fêtes de la moisson in France. It means that dinner time didn't represent his leisure, which was limited by healthy sleep. Even his conversations with Poll, the parrot, weren't leisure. That was again the "dual activity", the home production like pets' care in economics of the allocation of time (Aguiar & Hurst, 2007). Really, that was Poll who awakened Crusoe crying "Poor Robinson!" when he was ill.

There is another, now methodological, reason to exclude Crusoe's dinner time from leisure. Let's look at his daily schedule through the optics of the tangibles-intangibles trade-off. There, we can find only one activity ***net of tangibles***. That was his healthy sleep, which, according to our calculations, took 0.2763932…≈27.64% of 24 hours.

From the beginning, Robison hadn't other intangibles. But once the miracle happened:

> "It was a little before the great rains just now mentioned that I threw this stuff away, taking no notice, and not so much as remembering that I had thrown anything there, when, about a month after, or thereabouts, I saw some few stalks of something green shooting out of the ground, which I fancied might be some plant I had not seen; but I was surprised, and perfectly astonished, when, after a little longer time, I saw about ten or twelve ears come out, which were perfect green barley, of the same kind as our European - nay, as our English barley.
>
> It is impossible to express the astonishment and confusion of my thoughts on this occasion. I had hitherto acted upon no religious foundation at all; indeed, I had very few notions of religion in my head, nor had entertained any sense of anything that had befallen me otherwise than as chance, or, as we lightly say, what pleases God, without so much as inquiring into the end of Providence in these things, or His order in governing events for the world. But after I saw barley grow there, in a climate which I knew was not proper for corn, and especially that I knew not how it came there, it startled me strangely, and I began to suggest that God had miraculously caused His grain to grow without any help of seed sown, and that it was so directed purely for my sustenance on that wild, miserable place."

That discovery completely changed his life. He started farming. But what was more important was that he began reading the Bible.

Reading the Bible wasn't Crusoe's leisure but one of his 'employments':

> "I was very seldom idle, but having regularly divided my time according to the several daily employments that were before me, such as: first, my duty to God, and the reading the Scriptures, which I constantly set apart some time for thrice every day."

It means that the standard labor-leisure trade-off that economics uses in describing 'Robinson Crusoe economy' doesn't work here. There is another perspective. After he found barley, he started to produce and consume not only tangibles, like food and shelter, but also intangibles, like reading the Bible and praying:

> "JULY 4. – In the morning I took the Bible; and beginning at the New Testament, I began seriously to read it, and imposed upon myself to read a while every morning and every night; not tying myself to the number of chapters, but long as my thoughts should engage me. It was not long after I set seriously to this work till I found my heart more deeply and sincerely affected with the wickedness of my past life…My thoughts being directed, by a constant reading the Scripture and praying to God, to things of a higher nature, I had a great deal of comfort within, which till now I knew nothing of."

Robinson started to produce and to consume intangibles. But how we can measure them? Here we can again address Becker:

> "The definition of economics in terms of material goods is the narrowest and the least satisfactory. It does not describe adequately either the market sector or what economics "do"" (Becker 1987, p. 4).

We can measure intangibles by their opportunity costs, in Crusoe's case, by the quarry lost reading the Bible. However, the basic needs' approach holds. Robinson substituted some quarry in his basic needs' bundle for spiritual nourishment. Indeed, soul food also strengthened his forces.

It means that we must deduct the constant value of 6'38 hours' sleep from the 24 hours' time horizon and analyze the tangibles-intangibles trade-off for the 17'22 hours' time horizon.

However, reading the Bible and sleeping have one important common attribute. Both represent the time ***net of tangibles***, sleeping for the 24 hours' time horizon and reading for 17'22 hours' time horizon. It means that the optimal tangibles-intangibles trade-off keeps the same proportions for the 17'22 hours' time horizon as the consumption-leisure choice for the 24 hours' time horizon. If leisure takes 27.64% of 24 hours, reading the Bible and praying also take 27.64%, now of 17'22 hours.

The time spent on tangibles is equal to 12.566563…≈12'34 hours. We get the irrational number with infinite decimals once more. However, the time has come for intangibles to break free from the vicious circle of irrational numbers. Approximative 0.2763932…≈27.64 percent of 17.366563…≈17'22 hours' time horizon is exactly equal to 4.8 hours = 4'48 hours on intangibles. Robinson spent 4'48 hours a day on reading Bible and praying.

This result looks like a mathematical paradox. The product of two irrational numbers, derived from the divine proportion, is the rational one:

$$17'22 \approx 17.366563\ldots hr \times 0.2763932\ldots = 4{,}8\ hr = 4'48 \qquad (19)$$

Crusoe started to maximize another utility function, that of tangibles-intangibles trade-off $U(Tn;In)_{17'22}$ (Figure 2):

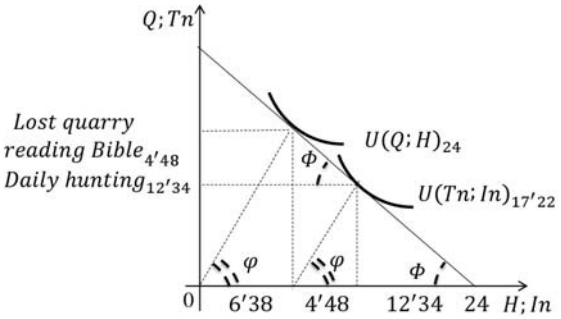

Figure 2. Robinson's optimal tangibles-intangibles trade-off

3. Results

The analysis of Robinson Crusoe's economy has made us ready to examine the Hebrew economy in the times of the Old Testament. It general, it was the agricultural economy, and we can proceed to the analysis of the farmer's model of behavior.

3.1 Separate the Tithe

We start with the assumption that the farmer didn't read the Torah, but he got intangibles in the other way. He made giving to the church, widows, and fatherless. It means that he slept the same 6'38 hours and worked all other 17'22 hours, which were separated between working for personal consumption and giving.

Here again we don't know the value of intangibles *In*, but we can evaluate it by their opportunity costs, i.e., tangibles *Tn*, produced for charity and donations during the same time that Crusoe spent reading the Bible.

We assume that 17'22 hours' working time is the equilibrium labor supply L_e that produces by cropping and cooking both tangibles for personal consumption and tangibles for charity and donations, which represent opportunity costs of intangibles. The total of tangibles produced gives us the equilibrium quantity of tangibles, $Q_e=Tn_{17'22}$.

Then we assume that giving doesn't change the farmer's diligence, and he works for charity, i.e., for widows and the fatherless, as hard as he works for his personal consumption, i.e., for himself. Our assumption is that the farmer's diligence Q_e/L_e stays constant during all 17'22 hours:

$$\Phi = \frac{Q_e}{L_e} = \frac{Tn_{17'22}}{17'22} \tag{20}$$

Constant diligence during 17'22 hours of working matters both for 12'34 hours' working time spent on personal consumption and 4'48 hours' working time spent on giving:

$$\Phi = \frac{Tn_{17'22}}{17'22} = \frac{Tn_{12'34}}{12'34} = \frac{Tn_{4'48}}{4'48} \tag{21}$$

We can rearrange this equation to get the share of charity and donation in the total harvest produced during 17'22 hours' time horizon:

$$\frac{Tn_{4'48}}{Tn_{17'22}} = \frac{4'48}{17'22} \approx 0.276393\ldots \approx 27.64\% \tag{22}$$

Indeed, we get again the same approximative value of 27.64%. It means that the share of the harvest to be given is equal to 0.276393… of the equilibrium output. As a result, the allocation of tangibles between consumption and charity again corresponds to derivatives of the golden ratio:

$$\frac{4'48}{12'34} = \frac{Tn_{4'48}}{Tn_{12'34}} \approx 0.381966\ldots = \Phi^2 = 1/\varphi^2 \tag{23}$$

Now let's take the simple example of daily diligence. We suppose that in subtropical area, the farmer irrigates the field all the working day. He sleeps at night, but the harvest continues to grow. In the night, nature takes care of it and irrigates the field with the dew. So, when the farmer harvests, he gets both the results of his work and those of nature.

If the farmer irrigates as thoroughly as nature does, then both night tangibles $Tn_{6'38}$ from 6'38 hours and total tangibles Tn_{24} from 24 hours will get the same rate of diligence:

$$\Phi = \frac{Tn_{6'38}}{6'38} = \frac{Tn_{24}}{24} \tag{24}$$

This conclusion can be illustrated in the following way, where Tn_{24} = *Total harvest*$_{24}$; $Tn_{6'38}$ = *Night harvest*$_{6'38}$; $Tn_{17'22}$ = *Daily harvest*$_{17'22}$; $Tn_{4'48}$ = *Giving*$_{4'48}$; $Tn_{12'34}$ = *Consumption*$_{12'34}$ (Figure 3):

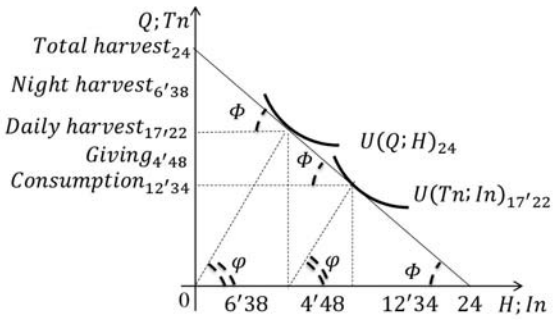

Figure 3. The distribution of harvest in Hebrew economy

We see that the farmer maximizes his tangibles-intangibles' utility $U(Tn;In)_{17'22}$ from *Daily harvest*$_{17'22}$ when he gives up 27.64 per cent for *Giving*$_{4'48}$.

He does, however, get an extra *Night harvest*$_{6'38}$. The absolute value of *Giving*$_{4'48}$ remains the same, but its share is decreasing, if we consider not only *Daily harvest* but also the *Night harvest*. When we calculate the share of *Giving*$_{4'48}$ in the *Total harvest*$_{24}$ using all previous equations, we leave out the irrational infinite share of 0.276393… Here, this irrational value takes the rational form:

$$\frac{Tn_{4'48}}{Tn_{24}} = \frac{4'48}{24} = 0.200000\ldots = 20\% \qquad (25)$$

or the share of tangibles for charity and donations is exactly equal to 20% of the total harvest.

We see that the irrational number of the divine proportion produces the rational conclusion:

When a farmer's diligence is equal to the golden ratio conjugate, the optimal giving is equal to twenty percent of the harvest.

But this rationality isn't a methodological puzzle. The rational number has a rational explanation.

The commandments, transferred to Hebrews by Moses, prescribed ***donations of two tithes from the total harvest*** to be spent on religious holidays and allocated among Levites, aliens, widows, and fatherless (Numbers 18:21–26; Deuteronomy 12:17–19; 14:22–29).

Flavius Josephus summarized the tithing instructions in his *Antiquities of Jews* as follows:

> "Besides those two tithes, which I have already said you are to pay every year, the one for the Levites, the other for the festivals, you are to bring every third year a third tithe to be distributed to those that want; to women also that are widows, and to children that are orphans." (Flavius Josephus. Ant 4.8.22)

However, the Commandments made a very important precision based on the harvest lifecycle approach, which required a rest for the land:

> « Six years you shall sow your field, and six years you shall prune your vineyard, and gather in their yield; but in the seventh year there shall be a sabbath of **complete rest for the land**, a sabbath for the Lord: you shall not sow your field or prune your vineyard. » (Leviticus 25:3-4)

This precision means that Moses received the commandment to pay exactly two tithes during all 7-years sabbatical period. There, the Hebrews paid 6 tithes for the Levites, 6 tithes for the festivals, and 2 tithes for the poor. The total resulted in 14 payments for 7 years or two tithes' annuity.

Later, the Torah presented those commandments in the following way: "Torah states [Deuteronomy 18:4]: "The first of your grain, your wine, and your oil." Afterwards, he separates one tenth from the remainder. This is called the first tithe and must be given to the Levite…" (Mishneh Torah, 6:2).

In fact, one tenth from the reminder means 19 per cents of giving in total. The first tithe was given to Levites, and the second tithe from the reminder was used for religious holidays, which was substituted every third year by the tithe for strangers, widows, and fatherless.

However, the Masoretic text says nothing about the reminder. The verse discussed is presented in the King James Version as follows:

> "At the end of three years thou shalt bring forth **all the tithe of thine increase** the same year…" (Deuteronomy 14:28).

The New Revised Standard Version gives the following translation: "*Every third year you shall bring out **the full tithe of your produce** for that year*", where the bold font represents the translation from the Masoretic תְּבוּאָתְךָ֖ מַעְשַׂ֣ר כָּל־ .

According to The Brown-Driver-Briggs Hebrew and English Lexicon the word כּוֹל is the "*noun masculine the whole; with following genitive (as usually) the whole of, to be rendered, however, often in our idiom, to avoid stiffness, all or every.*" (https://bible-teka.com/strong-hebrew/3606/).

The genitive case is a noun case which is used mainly to show possession. It means that the Masoretic text talks about ***the whole tithe of the total output*** but not of the reminder.

We can also find this understanding in one of the earliest Bible versions:

> "The third year thou shalt separate **another tithe of all things** that grow to thee at that time, and shalt lay it up within thy gates" (Douay-Reims Bible, Note 1).

In fact, two tithes or one fifth on charity stayed in the Talmud as a breakeven point: "Apropos the ordinances instituted by the Sages in Usha, the Gemara cites another one. Rabbi Ile'a said: In Usha the Sages instituted that one who dispenses his money to charity should not dispense more than one-fifth. That opinion is also taught in a baraita: One who scatters should not scatter more than one-fifth, lest he render himself destitute and need the help of other people …" (Ketubot 50a:2–3)

Sages in Usha, the ancient city in western Galilee, were undoubtedly sages. Their 'not dispense more than one-fifth' has a very important meaning in our model. It means that giving could be less than two tithes. When does it happen? The value of *Night harvest* is based on the strong assumption that the farmer irrigates as thoroughly as nature does. It means that a farmer's diligence is equal to that of nature. If nature is more 'diligent' than the farmer, the *Night harvest* will be greater. But it means that 27.64 percent of *Daily harvest* will be less than 20 percent of the *Total harvest*. Two tithes correspond to the 'diligence' of nature. In fact, the sages in Usha said, that a man could not be more diligent than nature. So, he could not give more than one-fifth.

One can say that the equality of twenty percent of giving, derived from the divine proportion, represents the random occurrence. But it is not so. A random occurrence may appear once, but not twice. The Old Testament speaks about the other enigmatic value, which is little understood for theologians even today.

3.2 Pay Five Oxen for an Ox

This is the case of paybacks for the theft. The double payback looks the most reasonable, and it was prescribed in the Old Testament (Exodus 22:4; 22:7).

But there the Commandments start with the little-understood five-times payback:

> "When someone steals an ox or a sheep, and slaughters it or sells it, the thief shall pay five oxen for an ox, and four sheep for a sheep" (Exodus 22:1).

Theologians, historians, and economists unanimously agree that four-sheep payback with respect to five-oxen payback is explained by the different importance of sheep and oxen in the household, but in the same unanimous manner, scientists cannot explain five-times payback. It looks like a historical paradox, but the most consistent explanation was given by Philo of Alexandria two thousand years ago. He wrote:

> "For he commands that the thief shall restore four sheep and five oxen in the place of the one which he has stolen; since a sheep gives four kinds of tribute, milk and cheese, and its fleece, and a lamb, every year: but an ox furnishes five; three of which are the same as those of the sheep – the milk, the cheese, and the offspring; but two are peculiar to itself, the ploughing on the earth, and the threshing of the corn; the first of which actions is the first step toward the sowing of the crops, and the other is the end, being for the purification of the crop after it is gathered in, in order to the more easy use of it for food." (III [11] About the theft of a sheep or an ox. Philo, 2017).

This explanation looks superficial and raises doubts among theologians. Really, the cheese represents the product of milk. Furthermore, functions such as ploughing and threshing are difficult to summarize with milk and cheese. However, the intuitive use by Philo the idea of product lifecycle looks reasonable. If we reinforce it by the opportunity costs' approach, we get the rational explanation of the five-times payback.

The Hebrews made giving to get intangibles, the divine mercy. At equilibrium, the opportunity costs of intangibles are equal to 4'48 hours of righteous labor. Theft means unrighteous labor. And thief's leisure can hardly be righteous. So, to get the divine mercy, the thief should recover from the total unrighteousness of both labor and leisure. For him, the opportunity costs of intangibles are equal to 24 hours.

The ox provided the opportunity for the righteous laborer not only to produce the harvest but also to give two tithes. Without an ox, the farmer couldn't do it. If he wanted to give two tithes, he should buy an ox, to produce the harvest and separate one fifth for giving.

Any action pursuing either tangible or intangible benefits can be seen as a project, which needs both working capital and investment. The pleasure of cycling needs our physical efforts and the bicycle itself. Producing intangibles by harvesting also is the project, which needs both working capital and investment. Here, the working capital is equal to daily work during 17'22 hours, while an ox represents an investment. Intangibles are produced by 4'48 hours work for giving. So, the 4'48/17'22 ratio represents the intangible return on tangible working capital. However, project management also considers the return on investment. Here,

the intangible return on tangible investment is equal to 4’48/P_{ox} ratio, where P_{ox} represents the purchase price of an ox.

The thief should get intangibles for 24 hours. To do this, he should make an investment $P_{payback}$ with the same rate of return like the farmer did it. And we get the following equation:

$$\frac{4'48}{P_{ox}} = \frac{24}{P_{payback}} \tag{26}$$

From here we get the value of payback with respect to the purchase price of an ox:

$$\frac{P_{payback}}{P_{ox}} = \frac{24}{4'48} = 5 \tag{27}$$

Here we get the inverse ratio of two tithes. Again, it returns the rational number. The payback for the stolen ox is equal to its five purchase prices.

4. Discussion

Economics agrees that equilibrium has some particular attributes of optimality. This idea ascends to Adam Smith’s best guess of the invisible hand (Arrow, 1985). However, the analysis of Smith’s hypothesis revealed its deeper roots. We can find attributes of optimality through the historical study of preindustrial economies. This paper exhibits three important findings: The sleeping time in hunting-and-gathering societies corresponds to the analytical derivation of the golden ratio; the tithing and paybacks’ instructions in the Old Testament are also equal to the derivatives of the divine proportion. These three findings call into question the assumption of random occurrence and bring social and natural sciences closer together in a Newtonian style (Newton 2021). His observations of physical units resulted in mathematical models that explained the behavior of those units, from apples to planets. We can apply the same approach to ancient economic models of behavior, described in religious texts.

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Notes

Note 1. The DR Version was published much earlier than the King James Version. The New Testament was published in Reims, in 1582, and the Old Testament in 1609-1610 by the University of Douai.