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Separate the tithe: cliometrics of giving in ancient Hebrew society.

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cliometrics of giving in ancient Hebrew society.

Abstract

Both historical and statistical analyses of sleeping habits in preindustrial societies show that summer sleeping time is approximately equal to six and a half hours. The application of these results to Daniel Defoe's description of Robinson Crusoe's lifestyle results in the optimal consumption-leisure choice, where the allocation of Crusoe's time between hunting, farming, cooking, and healthy slumber uncovers proportions, set by the golden ratio, also known as the divine proportion. The golden ratio confirms historical and statistical analysis, leaving Robinson 6'38 hours for sleep. The introduction of his other employment, reading the Bible, transforms the consumption-leisure choice into the tangibles-intangibles trade-off, where the optimal time for reading equals 4'38 hours. The application of the tangible-intangible utility function to the allocation of the harvest between personal consumption and giving, which farmers faced in the time of the Old Testament, reveals yet another property of divine proportion. It results in twenty percent of the total harvest being given up for the needy, which is equal to two tithes, as prescribed to Hebrews by the Old Testament.

JEL Codes: J22, N85, Z12.

Key words: cliometrics, giving, tithe, Old Testament, golden ratio.

Introduction

The study of ancient Hebrew society inevitably addresses the Holy Scriptures. Religious texts describe the history, habits, and social norms of people who lived two thousand years ago. Their lifestyle has usually been a matter of theology. However, once economics also became interested in the *modus vivendi* of ancient Hebrew society. That trend created the academic synthesis, which joined the efforts of both theologians and economists and got the name "economic theology."

Economic theology progressively expanded its interest beyond Judaism and Christianity and resulted in comprehensive studies of the economic *modus operandi* of all world religions. *The Routledge Handbook of Economic Theology*, published in 2020, summarized those efforts in a very efficient way.

However, the economic theology doesn't use the potential of modern economic theory. Its considerations are very deep, but by taking a verbal form, they miss chances to reinforce their conclusions. In this sense, cliometrics seems to be a more efficient tool for analyzing the literary heritage of the world religions.

Cliometrics is the "application of economic theory and statistical analysis to the study of history" (Britannica www/britannica.com/topic/cliometrics). Between economic methods, cliometrics widely uses the concept of opportunity costs. As appeared in Fogel's landmark railroad study, opportunity costs became an efficient tool for other fields, like fertility, where cliometrics examines the costs of women's time, education, and child-rearing (Diebolt et al. 2019). There, cliometrics addresses Gary Becker's analysis of fertility and his theory of allocation of time (Becker 1960,1965). For Becker, those works served as the basis for his famous *Treatise on the Family* and *Economic Analysis and Human Behavior*, where he used to all its strength the concept of "shadow prices" of human attractiveness and presented his understanding of an economic approach:

"*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).

It means that opportunity costs can be measured either by market or by "shadow" price. Econometrics can evaluate child-rearing either by the loss in wages or by time lost for keeping feminine attractiveness, making-up, jogging, educating, etc.

The use of opportunity costs and "shadow" prices give the great advantage to cliometrics over economic theology. However, the methodology itself is not the case. Cliometrics is less emotional. For economic theology, like for theology in general, it is very difficult to stay dispassionate. Cliometrics can do it. Economic approach is not afraid to be accused of blasphemy and unemotionally states the rigorous facts of everyday religious practice in the past.

Just this consideration has organized the paper as follows: First, it briefly presents the methodology. Then, the paper introduces its applications, addressing not only the Holy Scriptures but also the literature of the 19th century and modern statistical studies. Really, the analysis of giving should be well prepared. And the paper accomplishes this by presenting the findings of a statistical analysis of sleeping time in preindustrial societies as well as 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 2022 a.b). These proportions hold for both consumption-leisure and tangibles-intangibles utility functions, resulting in the perfect share of giving from agricultural income.

1.Methodology

The analysis of giving in ancient Hebrew society needs a specific synthesis of economic theory, statistics, mathematics, and linguistics. The study of the literary heritage of the Holy Scriptures should consider their first editions, like the Masoretic Text and the Septuagint. Economics offers the theory of consumption-leisure choice and the concepts of decreasing marginal utility and opportunity cost. Statistics simply verifies assumptions provided by mathematics. Finally, this synthesis is cemented by concepts of product lifecycle and project management.

2.Applications

2.1. By sweat of his brow: what does it mean?

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 by the "sweat of his brow" (Genesis 3:19). 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.

Of course, we cannot prove this hypothesis, 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, p351).

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 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.

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" or "seller" and "buyer."

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 analyze Crusoe's allocation of time before he started farming. His time was allocated between the 'forest' T_f on hunting, the 'house' T_d on salting and cooking, 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:

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

where MC_f – marginal costs of hunting; MC_d – marginal costs of cooking; w – 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 followed the sun, but that wasn't the measure of his efforts. Without money, the measure was the unit of quarry, 'one grouse'. If he napped after lunch, he could say, that he missed one or two grouse while hunting. Indeed, even today, farmers in outback country measure time during plowing by natural values like the number of plowed rows until lunch. However, this consideration gives us the following equation:

(2) $T_f = Q$

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:

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

Without watches, Robinson, in fact, recalculated his time work into the piece work. But there is nothing unusual. On a free labor market, the equilibrium wage rate should be equal to the equilibrium marginal costs of production, or $w_e = MC_{pe}$. In other words, at equilibrium the costs of piece work MC_{pe} are equal to the costs of the time work w_e. And modern labor markets try to follow this equilibrium rule. Today in the UK, piece workers must be paid at least the minimum wage rate for every hour worked.

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

(4) $P_e = P_{seller} = P_{buyer} = MC_f(1 + \frac{MC_d}{MC_f}) = 1 + MC_d$

Now we can start to optimize Crusoe's allocation of time. It will be easy task if we know the marginal cost of "producing" leisure. But we don't know it. So, we should divide the solution in few steps. First, we must demonstrate the tangency of his total costs $TC(TC_f; TC_d)$ curve to the budget constraint, which looks like this:

(5) $w(T_f + T_d) = QP_e$

So, we escape from unequal physical units in the marginal costs-marginal rate of substitution equation and get the tangency required:

(6) $$\frac{TC_d}{TC_f} = \frac{wT_d}{wT_f} = \frac{MC_d}{MC_f} = \frac{T_d}{T_f} = \frac{w}{P_e} = \frac{Q}{T_f + T_d} = \frac{T_f}{T_f + T_d}$$

As a result, we come to the equation, well known to all mathematicians:

(7) $$\frac{T_d}{T_f} = \frac{T_f}{T_f + T_d}$$

(8) $$\frac{T_d}{T_f} = \Phi = 0.618034 \ldots = \frac{1}{\varphi} = \frac{1}{1.618034 \ldots}$$

or the allocation if time between hunting and cooking is determined by the golden ratio.

When the imputed marginal costs on hunting are equal to one, the imputed marginal costs of cooking are equal to the golden ratio conjugate Φ:

(9) $$\frac{MC_d}{MC_f} = \frac{MC_d}{1} = MC_d = \Phi$$

And the imputed equilibrium price of a cooked grouse becomes equal to the golden ratio itself and illustrates its unique property:

(10) $$P_e = MC_f + MC_d = 1 + \Phi = 1 + \frac{1}{\varphi} = \varphi$$

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

(11) $$\frac{MC_d}{MC_f} = MC_d = \frac{w}{P} = \frac{1}{MC_f + MC_d} = \frac{1}{1 + MC_d} \approx 0{,}618034 \ldots = \Phi = \frac{1}{\varphi}$$

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

(12.1) $$dQMU_Q + dHMU_H = 0$$

(12.2) $$-\frac{dQ}{dH} = \frac{MU_H}{MU_Q}$$

(12.3) $$-\frac{dQ}{dH} = \frac{w}{P} = \frac{1}{P} = \Phi$$

(12.4) $$dQP + dH = 0 = dQ + \frac{dH}{P} = dQ + \Phi dH$$

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

(13.1) $$\frac{MC_d}{MC_f} = \frac{MC_d}{1} = MC_d = -\frac{dQ}{dH} = \Phi$$

(13.2) $$dQ + MC_d dH = 0 = dQ + \Phi dH$$

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 (Fig.1):

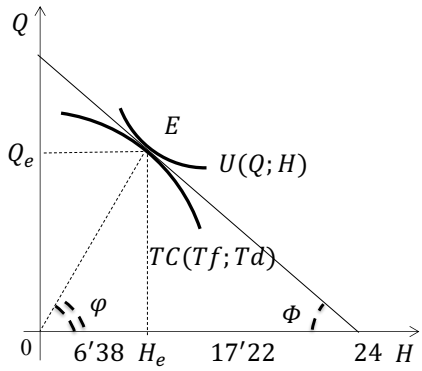


Fig.1.

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

(14) $$\frac{Q_e}{H_e} = \varphi$$

But from here we get very important result:

(15) $$\frac{Q_e}{H_e} = \varphi \rightarrow \frac{H_e}{Q_e} = \Phi = \frac{H_e}{T_f} = \frac{T_d}{T_f} \rightarrow H_e = T_d$$

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

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

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

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:

(17.1) $$H_e \approx 0.2763932 \ldots T_{total} \approx 6.633437 \ldots hr$$

(17.2) $T_d = H_e \approx 6.633437 \ldots hr$

(17.3) $T_f = \varphi T_d \approx 10.733126 \ldots hr$

(17.4) $T_{total} = 6.633437 \ldots + 6.633437 \ldots + 10.733126 \ldots = 24\ hr$

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 and 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 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.*[1]

This is just the case because Defoe's admirers can say that Robinson spent much time reading the Bible. That was true. However, reading the Bible wasn't leisure for Crusoe, 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*."

Defoe's admirers can give another reason. Crusoe organized his dinner like 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. But it was not so. Here we come to another utility function, that of the tangibles-intangibles trade-off.

2.2.Tangibles-Intangibles trade-off.

[1] 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 growth of the "Vitruvian man" will be equal to 2.618034, the number, which expresses another unique property of the golden ratio:

$$\varphi^2 = \varphi + 1 = 2.618034 \ldots$$

Consumption-leisure utility function represents the standard economic decision for the labor-leisure trade-off. But it is not enough to understand human behavior. Becker wrote: "*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)

Becker talked about education as the alternative use of time. Reading the Bible also was to Crusoe an intangible alternative to tangible hunting. Here we should not forget that Robinson plays two parts, that of producer and of consumer. But it means that under tangibles-intangibles trade-off, Crusoe's time for intangibles consisted of both their "production" and "consumption". Reading the Bible was nothing more than self-education, "production" of intangibles. In exchange, what did Robinson consume? He answered this question in his journal: "*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.*"

In fact, Crusoe's time spent on intangibles represented their production lifecycle, which starts with planning and ends with consumption. That was the same for tangibles. It started with the planning either of farming or hunting and ended with the consumption. 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 talks with the parrot and healthy sleep.

At the beginning of his hunting lifestyle, Crusoe had no tangibles at all. They appeared when he found barley: "*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."

Starting farming, Crusoe also began to read Bible, to produce and to consume intangibles. So, he started to maximize another utility function, that of both tangibles and intangibles. Intangibles didn't change his sleeping habits, and he got the same 6'38 hours of leisure time. It means that he maximized the tangible-intangibles utility function *U(Tn:In)* for the 17.366563…≈17'22 hours' time horizon.

But the optimal allocation of 17'22 hours have the same proportions as 24 hours. It means that Crusoe spent approximative 72.36% from 17'22 hours on tangibles and 27.64% on intangibles.[2]

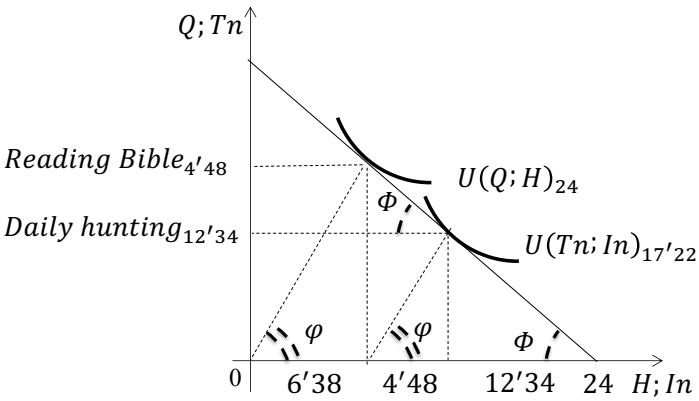
These proportions hold if Robinson read the Bible with the same diligence as for hunting. Once he confirmed that diligence in his journal:

"*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*

[2] Both slumber and intangibles have the same economic sense. This is the time net of tangibles, the first in 24 hours' time horizon and the second in 17'22 hours' time horizon. So, their parts should be equal.

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."

These proportions result in 12.566563…≈12'34 hours on tangibles. 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 (Fig.2):



Fid.2. Robinson's optimal allocation of time

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

(18) $17'22 \approx 17.366563 \ldots hr \times 0.2763932 \ldots = 4{,}8\ hr = 4'48$

From here, the feeling appears that intangibles represent an enigmatic value. The following analysis strengthens this feeling.

2.3. Separate the tithes.

Now we're ready to proceed to the subject of the paper: the giving in Hebrew economy.

It general, it was the agricultural economy. We can apply Robinson Crusoe's model to it and to analyze the farmer's model of behavior.

We simplify it by 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.

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 for tangibles, i.e., personal consumption, and intangibles, i.e., tangibles for charity and donations. 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:

$$(19) \quad \Phi = \frac{Q_e}{L_e} = \frac{Tn_{17'22}}{17'22}$$

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:

$$(20) \quad \Phi = \frac{Tn_{17'22}}{17'22} = \frac{Tn_{12'34}}{12'34} = \frac{Tn_{4'48}}{4'48}$$

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

$$(21) \quad \frac{Tn_{4'48}}{Tn_{17'22}} = \frac{4'48}{17'22} \approx 0.276393 \ldots \approx 27.64\%$$

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:

$$(22) \quad \frac{4'48}{12'34} = \frac{Tn_{4'48}}{Tn_{12'34}} \approx 0.381966 \ldots = \Phi^2 = 1/\varphi^2$$

Now let's take the simple example of daily diligence. We suppose that in subtropical areas, the farmer irrigates the field all 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:

$$(23) \quad \Phi = \frac{Tn_{6'38}}{6'38} = \frac{Tn_{24}}{24}$$

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*$_{12'34}$ (Fig 3):[3]

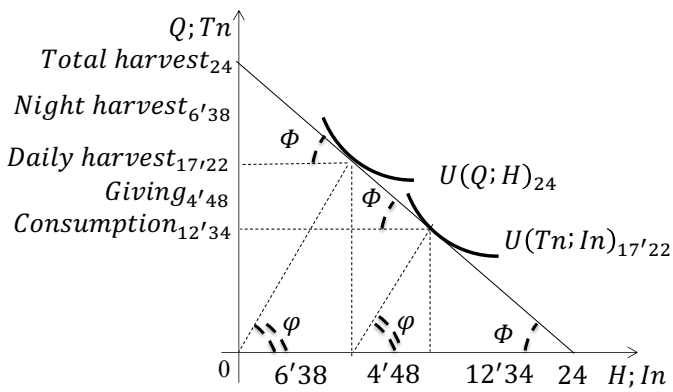


Fig.3.The distribution of harvest in Hebrew economy

[3] Here the origin of $U(Tn;In)_{17'22}$ function is shifted to the east for illustrative purposes. But in fact the origin has coordinates (6'38;Night harvest$_{6'38}$) and shifts to the north-east that matches both utility functions at equilibrium.

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:

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

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 enigma loses its mysterious character and gets 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).

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 means19 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), where the bold font represents the translation from the Masoretic כָּל־ מַעְשַׂר תְּבוּאָתְךָ .

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."

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." (*Deuteronomy 14:28 Douay–Rheims Bible).[4]

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*

[4] 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.

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 cannot be more diligent than nature. So, he cannot 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.

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 laborer 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 laborer did it. And we get the following equation:

$$(25) \quad \frac{4'48}{P_{ox}} = \frac{24}{P_{payback}}$$

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

$$(26) \quad \frac{P_{payback}}{P_{ox}} = \frac{24}{4'48} = 5$$

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.

Both two tithes and five-times payback represent the derivatives of golden ratio and can hardly be considered random occurrences.

2.4. The differential of intangibles.

The Commandments and considerations of Sages from Usha give an idea that the Hebrews knew the artwork of *prescience* in the literal sense of the word. They intuitively used scientific concepts, developed by humanity much later. The analysis of the New Testament proves this assumption.

There is another enigmatic value, which hasn’t gotten an explanation until nowadays. This is a logically contradictory comparison of one repentant sinner with ninety-nine righteous, given by the parable of the lost sheep:

"*Which one of you, having a hundred sheep and losing one of them, does not leave the ninety-nine in the wilderness and go after the one that is lost until he finds it? When he has found it, he lays it on his shoulders and rejoices. And when he comes home, he calls together his friends and neighbors, saying to them, "Rejoice with me, for I have found my sheep that was lost.' Just so, I tell you, there will be more joy in heaven over one sinner who repents than over ninety-nine righteous persons who need no repentance."* (Luke 15:4-7).

Theology has traditionally and unanimously emphasized Almighty's care for a repentant sinner, but it has also historically been confused in his comparison with the ninety-nine righteous. Some theologians think that the ninety-nine righteous are angels that the Almighty should not take care of, while others, on the contrary, think that in the Scriptures it was told about the Pharisees, since that parable was expressed during the discussion with them.

Cliometrics can give its understanding of this logically contradictory comparison of one repentant sinner with the ninety-nine righteous.

The solution needs three steps. First, we apply to the parable concepts of decreasing marginal utility and opportunity costs.

When the farmer collects oranges, the decreasing marginal utility works. The hundredth orange produces less utility than the other ninety-nine. However, if the farmer decides to make fresh juice, the opportunity cost of oranges starts to work. For the first glass of juice, he chooses 'inferior' oranges, which are already mushy and can rot the next day. The first glass gives him great pleasure. Then the farmer makes the second glass, now from firm 'normal' oranges. And the second glass gives him less pleasure. It means that in their alternative use 'inferior' items really can produce greater utility than the 'normal' ones. "*Indeed, some are last who will be first, and some are first who will be last.*" (Luke 13:30).

Then we again need some linguistic analysis. In the New Testament text, the Greek word χαρά means "joy," "delight," that is, a fleeting joy. This assumption appears plausible because the narrator uses the imperative mood in

the parable: "*Rejoice with me*." This consideration leads to the conclusion that "joy" does not equal the total intangibles *In* but rather represents their marginal increase, or the differential *dIn*. When the sinner starts to repent, the differential of that initial repentance, like the pleasure from the first glass of juice from mushy oranges, is great, or at least positive, $dIn_{repentant\ sinner} > 0$.

Here we can apply the mathematics of infinitesimals. The parable states that ninety-nine righteous men need no repentance. It means that the differentials of their individual intangibles tend to zero $dIn_{righteous} \to 0$. But, according to the mathematics of infinitesimals the differential of all ninety-nine righteous men $99dIn_{righteous}$ also tends to zero. And we get the correct mathematical result:

(27) $dIn_{repentant\ sinner} > 99dIn_{righteous}$

We see how cliometrics can efficiently join forces of economics, linguistics, and mathematics. The Hebrews really were armed by the *prescience* of both the mathematics of infinitesimals and the economics of opportunity costs, developed only in the 17th – 19th centuries.

Conclusion

The efficient application of cliometrics to the Holy Scriptures doesn't mean that it challenges economic theology. Both academic disciplines can work together on literary heritage of world religions. There is a brilliant peacemaker between them. Isaak Newton wrote that "*God created everything by number, weight, and measure*. " It is very difficult to tell more for promoting joint efforts.

Both disciplines have the natural field for the cooperation: the comparative study of economic growth in Northern and the Southern Europe with regard their religious virtues. There, the subject of tithes remains very important as an indicator of agricultural growth; this is the approach already used by the French Association of Economic Historians (AFHE 1972).

There is another interesting field for the cooperation between cliometrics and economic theology. This is the problem of tax evasion. Both decent and indecent taxpayers face the opportunity costs of tax evasion. It means that paying taxes may be a case of demonstrative decency, like the Pharisees demonstrated their righteousness by also paying the tithes.

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