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HERODOTUS'S STATISTICS: QUANTITATIVE COMMENTARY

BY
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I. INTRODUCTION

The ancient Greeks were admired for many things, but particularly for their lack of the corrosive, self-centered complex that leads many authors today to believe that everything started with, and everything originated in, Greece. The ancient Greeks were self-confident enough to accept that they had been influenced by and had absorbed many foreign elements, which their talent then transformed into a new expression of civilization. At a somewhat less mundane level, many ideas that have shaped our thoughts and continue to influence our thinking today, across the world, originated in the past. They were also debated from different points of view in Athens and in other areas in Greece.

An amazing source of the ancient world is preserved in the *Histories* of Herodotus (484–425 B.C.). According to Cicero, Herodotus is the father of History (Cicero, *De Legibus* I, 5). His objectivity seems to spring from an inner sense of duty to describe situations and report events accurately. For a modern scholar in statistics, Herodotus's work is particularly interesting since he introduces to historical research for the first time mathematical concepts, such as measurements of length, width, and weight where Babylonian arithmetic is thoroughly elaborated. This was available to the Greeks who ranged into Chaldean circles (O. Neugebaur 1969). He also introduces many other demographic data such as capacity, sophisticated strategies, tests of hypotheses, assessments, as well as facts on climatic research and seasonal effects.

Herodotus, with his abundance of references to customs and morals of various countries, with the rich material he describes about the society and economy of the areas, attracted the interest of the economists and the historians of economics, such as the founder of the German Historical School W. Roscher (1866), the Greek economics historian A. M. Andreades (1926), the historian of economic thought J. J. Spengler (1955), the historian A. Momigliano (1958), and the statistician Ernest Rubin (1968). The illustrations of the quantitative character of the ancient world that Rubin (1968) has selected from Herodotus's *Histories* constitute a very

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small sample of the material he provides.[1] Furthermore, others, such as M. G. Kendall (1956), P. C. Mahalanobis (1957), S. Sambursky (1956), and F. N. David (1962) wonder why there is a total absence of any mention of the contribution of ancient Greek thought to the study of Probability and Statistics. One explanation is that the ancient Greeks, despite their otherwise amazing performance in all other sciences, failed to concern themselves with the theory of probability; that is, they did not develop the idea of chance. Kendall (1960) seems to believe that the idea of randomness did not develop adequately in the ancient world because of the existence of religious teaching and strong moral restrictions. His belief, however, does not seem to be supported by enough evidence.

Moses I. Finley's paper presented at the Second International Conference of Economic History, and his later publications, amount to an extended warning of the gulf that separates "oikonomia" from modern economics.[2] The ancient preoccupation with status makes modern economic analogies useless. Antiquity did not know policies based on the pursuit of market activities, and the states took no account of the balance of payments. Finley (1973, p. 34) says: "I reject the conception and the approaches." In his article "Aristotle and Economic Analysis" (1970) and in the second edition of his "The Ancient Economy" (1985), he also makes the point that the Greeks lacked a concern for quantification, but focused on quality. He was influenced by J. A. Schumpeter (1954, pp. 54–55), who underlined only the element of quality. Finley (1951, pp. 252–53) emphasized both in his review of Chantraine's book on Xenophon and in his 1970 article (p. 11; see also Finley 1973) that Xenophon was only aware of "quality" in his famous discussion of the division of labor in the *Cyropaedia* (VIII, II, 8), even though Xenophon included a discussion of an assembly line system of shoe production. However, even Karl Marx (1867, Vol. I), in his *Kapital*, quotes Xenophon's discussion of the division of labor and concludes that it only emphasizes quality, and not quantity, although he accepts the discussion as the origin of the "extent of the market" thesis attributed to Adam Smith. Schumpeter (1954, p. 54, fn. 1) also states that the Greek historians, especially Thucydides and Polybius, are of absorbing interest to any student of economy and society.

A mention of Finley's insistence on a qualitative orientation in antiquity in the introduction gives a reference point for the importance of the data featuring Herodotus's quantification. It is hard to explain the obsession with quality in Finley's work, particularly when the "hedonic calculus" is so extensively presented in Plato's dialogue, *Protagoras.*

The present paper has two purposes: First, an attempt has been made to carry Rubin's idea further, and pay homage to his memory, by providing useful examples and illustrations of various statistical procedures and concepts that originated several thousand years ago. Secondly, I would like this work to contribute to the debate suggesting that, despite the objections of eminent scientists, it is possible to argue, on the basis of what Herodotus has written, that there exists a Greek theoretical approach to probability.

[1]Rubin was an editor of the *Journal of the American Statistical Association* from 1969 to 1971 and edited the Questions and Answers Section of the *American Statistician* from 1954 to 1973. He died on November 12, 1978, after having lived with cancer for six years.

[2]See Finley (1965, pp. 3–25), reprinted in Finley (1974, ch. 2), and Finley (1973).

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II. DATA COMMENTARY

In Herodotus we can see the development of the idea of the random event and the origin of games of chance. It is possible, but not altogether likely, that the games originated in Egypt. From David (1962, p. 4) we learn that on the whole, like the concept of number, the balance of probabilities would appear to be in favor of their having a still-older origin and to have spread westward from Arabia or India or even farther east. It is most unlikely that the origin was Greek, although Herodotus is willing to credit his fellow countrymen or allied peoples with inventing much. According to Homer, when Patroclus was a little boy he became so angry with his opponent when playing a game of knucklebones that he fought with and nearly killed him. Concerning the famine in Lydia (circa 1500 BC), Herodotus (I, 94) remarks:

> The Lydians have very nearly the same customs as the Greeks. They claim also the invention of all games which they have in common with the Greeks. These they declare they invented about the time of the following account. In the days of Atys, the son of Manes, there was great scarcity through the whole land of Lydia. For some time the Lydians bore the affliction patiently, but finding that it did not pass away, they set to work to devise remedies for the evil. Various expedients were discovered by various persons; dice and knucklebones and ball and all such games were invented, except tables (i.e., backgammon), the invention of which they do not claim as theirs. The plan adopted against famine was to engage in games on one day so entirely as not to feel any craving for food, and the next day to eat and abstain from games. In this way they spent eighteen years.

There are many statistical methods useful for analyzing survival time data. A pioneer precursor method of survival analysis, which is not certainly of survival analysis in the modern sense, is that which Herodotus (I, 94) describes: During an eighteen-year famine which plagued the country of Lydia, the king conceived of a plan for survival which implemented a statistical approach. This plan involved separating the population into two groups. The separation was established by the drawing of lots, whereby one group would emigrate and the other group would stay behind to help its country subsist in any way it could. He notes:

> So the king determined to divide the nation in half, and to make the two portions draw *lots*, the one to stay, the other to leave the land. He would continue to reign over those whose lot it should be to remain behind; the emigrants should have his son Tyrrhenus for their leader. *The lot was cast*, and they who had to emigrate went down to Smyrna, and built themselves ships, in which, after they had put on board all needful stores, they sailed away in search of new homes and better sustenance.

Whether the drawing of lots was considered by the Lydians as an expression of "divine will" is not clarified by Herodotus. For the Greeks, however, the possibility of a randomly defined event was certainly accepted as real. J. B. Bury (1909) argues that the conception of randomization seems to be evident even in Homer, where lots are drawn on several occasions. P. Decharme (1929, pp. 210–36) argued that for the Greeks future events were not predetermined and men as well as Gods acted

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freely upon the world. Both human as well as divine actions were only limited by "destiny or fate"—*moira*—the share of happiness or unhappiness of each man, which is not a divinity, but can best be described as the sum of natural laws which determine the context in which human action may take place.

Of course it can still be argued that the drawing of lots can be interpreted as an expression of "divine will," as much as randomization in the sense it is used here. In my view it is a matter of interpretation; however, it must be stressed that Herodotus also refers in his stories to the "blind Goddess Tyche (Chance)," i.e., to chance emanating from the Goddess, which is expressed through the process of drawing lots: the actual word used, "cleros" (lot), meaning twig, refers to the twigs that were used in the drawing of lots. The process of drawing lots, as I mentioned earlier, was known since Homeric times, when lots were drawn from helmets on a variety of occasions, such as when Aias drew the lot to face Hector (Homer *Iliad*, pp. 175–80). Likewise the famous Exhikia's amphora pictures Achilles and Aias playing dice during a break of Troy's battle (see Vatican's museum), and Saoul commanded the Philistines to cast lots between himself and his son Jonathan (*Kings*, I XIV p. 42).[3]

In yet another commentary we are told that Palamedes invented games of chance during the Trojan Wars. During the ten year siege of the city of Troy various games were invented to bolster up the soldiers' morale, since they suffered from boredom. The die, which the Greeks called "tessera," a word coming from the Greek term for "four," had undoubtedly evolved by this time, but in classical times the principal randomizing agent would seem to have been the astragalus or talus (the heel bone). We shall never know the genius who first introduced the random element in this way. That gaming was developed from game-playing is, however, at least a possibility. David (1962, p. 7) wrote that although game-playing was developed in Egypt (Ca. 3500 BC), gaming is said to have been introduced by Ptolemy of Greece at around 300 years earlier. Moreover Mahabharata tells us that with adulterated dice Yundistira (India kingdom's king) loses his reign, his brothers, himself, and finally their common wife Draupandi in a single tossing. I think that every invention has its bad part and its good part proportionally; it depends on how man uses it. It is well known that the modern term mathematical "expectation" or "expected value" has its origin in games of chance. R. V. Hogg and A. T. Craig (1978, p. 42) give a very nice example of what expected value means in that context. Such an interpretation of expectation (as the total player's claim) is what stands out in my mind as one that helps the students and motivates the term. Moreover Palamedes' games of chance consist the precursors of Mathematical games (see for example V. C. Hombas (1997) and its relevant references).

Progress in science is often attributed to experimentation. The research worker performs an experiment and obtains some data. On the basis of the data, certain conclusions are drawn. In other words, the scientist may generalize from a particular experiment to the class of all similar experiments. Inductive inference is one way in which new knowledge is acquired and it is well known to be a hazardous process. One simply cannot make absolutely certain generalizations. An example of inductive

[3]The Hebrews also used lots, and reported censuses. See, for example, the Bible where Matthias was one of the apostles chosen by lot to replace Judas Iscariot (*Acts of the Apostles* I′, 23-26).

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inference by sampling can be seen in Herodotus's *Histories* (II, 2.2–4): In attempting to determine the origins of the human race, Egyptian King Psammetichus (663–609 B.C.) thought that his were the oldest among the peoples of the world. For this reason he decided to examine whether Egyptians or Phrygians were the oldest, and he devised the following experiment:

> He took two children of the common sort, and gave them over to a herdsman to bring up at his folds, strictly charging him to let no one utter a word in their presence... and in all other respects look after them. His object herein was to know, after the indistinct babblings of infancy were over, what word they would first articulate. The herdsman obeyed his orders for two years, and at the end of that time, on his one day opening the door of their room and going in, the children... distinctly said Becos... Psammetichus then himself heard them say the word... he learned that 'becos' (βεκός) was the Phrygian word for bread. In consideration of this circumstance the Egyptians yielded their claims, and admitted the greater antiquity of the Phrygians.

In his discussion regarding laws (customs), Herodotus (III, 38) called attention to some very basic data considerations. Following is an example of estimation and bias. He says:

> For if one were to offer men to choose out of all the best laws (customs) in the world, they would examine the whole number, and end by preferring their own; so convinced are they that their own usages far surpass those of all others ... There are many instances that people have this feeling about their own laws ... Dareius, after becoming king, called into his presence certain Greeks who were at hand and asked what he should pay them to eat the bodies of their fathers when they died. To which they, answered that there was no sum that would tempt them to do such a thing. He then sent for certain Indians, of the race called Gallatians, men who eat their fathers, and asked them, while the Greeks [...] knew by the help of an interpreter all that was said, what he should give them to burn the bodies of their fathers upon their death. The Indians exclaimed aloud, bade him forbear from such language. Such is men's custom; and Pindar was right, in my opinion, when he said "Law is king over all."

III. QUANTITATIVE METHODOLOGY

In the work of Herodotus one is impressed by the systems of units measuring distances, areas, capacity, etc. Also of considerable interest is his conjecture concerning the physio-economic base of geometry in Egypt as provided in the following account, which is an indication that land was a contributing factor to income taxation. Herodotus (II, 109) says:

> Sesotris ... made a division of the soil of Egypt among the inhabitants, assigning equally square plots to all obtaining his chief yearly revenue. If the river carried away any portion of a man's lot, he appeared before the king, and he said what had happened: upon which the king sent estimators... and thenceforth only such a rent was demanded of him as was proportionate to the reduced size of the plot.

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An idea of the length of the coastline of Egypt can also be obtained from the writings of Herodotus (II, 6.2-3). According to his estimates, the coastline of Egypt would extend a length of 3,000 furlongs (420 miles). The actual length is about 275 miles. At another point he describes the three greatest constructions of his contemporary world. These existed in Samos (Greek island), where Pythagoras was born around 572 B.C. One is the tunnel of Samos, which resembles to our modern tunnel that links France to England, where the famous Eupalinus from Megara was the architect. The other is a pier in the sea and the third is a temple; "the largest of all the temples known to us, where Rhoecus son of Phileus, a Samian, was first architect."[4]

Herodotus (V, 51) pays particular attention to the safety of transport in order to facilitate trade. He takes the opportunity after the dialogue between Cleomenes and Aristagoras to describe the "royal carriageway" famous for its frequent stations. We are not quite sure of the dates of Herodotus's extensive travels, which are said to have covered approximately 8,000 kilometers. However, there is no doubt that it took a number of years to cover such distances. One example of these should suffice to prove the point. The royal highway from Sardes of Lydia to Susa in Persia, Herodotus (V, 52) does describe in detail: "its length was 450 parasangs (2497,5 Km)." He goes on to assure us that, in spite of the excellent security and organization of this main artery, the average distance that a traveler could hope to cover daily was 150 stadiums. A journey from Sardes to Susa required, then, no less than ninety days.

Also important are the measures of capacity and mass. We know very well that Lacedaemonians granted privileges to their kings. At this point Herodotus (VI, 57) says: "Every month, on the first day, and again on the seventh of the first decade, each king receives a beast which he offers up to Apollo; likewise a medimnus (about 24 kgs. each) of meal, and of wine a Laconian quart, ... two choenixes of meal (about 500 gr. each) and a cotyle of wine sent home to him at his house."[5]

IV. PROBABILITY AND STRATEGY

The Greeks grasped various concepts of chance and choice, of strategy and risk. During an all engulfing and protracted Peloponnesean War, these ideas appear to be continually present. Later Polybius (202-120 B.C.) suggests in his *Histories* (II, 38) the prevalence of the Achaians over the other Peloponneseans did not happen by accident, but was due to specific reasons which he examines: "It is foolish to say that the Achaians prevailed by chance. We must rather search for a cause." Aristotle (384–322 BC), Plato (427–347 BC), Antiphon the Sophist (450-400 BC) and Democritus

[4]For more on these see (J. Goodfield, 1964) and the project Mathematics (1985), California Institute of Technology, Pasadena, California, written by Tom Apostol with the title, "The Tunnel of Samos."

[5]An anonymous referee comments: "On a slightly broader note, the tradition of dialectical analysis in Greece is tied to the measuring potential as the 'great balances' used in Egypt to evaluate the performance of stewards of granaries at the end of each year. This swings up and down and comes to rest on the 'truth.' The hedonic calculus—pleasure and pain—is also relativistically measured by Protagoras (S. Todd Lowry 1987, Chapter 1 and 2). The emphasis on qualification was ubiquitous in Greek philosophy although classical scholars have generally eschewed mathematical generalizations."

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(480-390 BC) refer much more to probability (K. and C. Kevorks 1986). We will consider Herodotus's observations on applied probability and strategy, as well as some observations of Thucydides (460–400 BC).

According to Jacob Bernoulli, probability is the measure of the extent of our expectations for a possible future outcome. One may argue that this is a "psychological coefficient," while according to J. M. Keynes it is not a mathematical topic and it does not concern facts, but rather judgments and propositions. Modern studies of the definition of probability offer different explanations or attribute different characteristics to it. It seems that the Greeks had initiated the study of the issue, or that they had at least set the basic framework for its study. In this sense they were familiar with the concepts of luck, chance, possible, and impossible. This is an example of Herodotus (III, 40): Amasis, king of Egypt, wrote a letter to Polycrates, Tyrant of Samos, who eventually was skewered (III, 120–123) by a satrap of Sardes named Oroetes, who snared him due to his hate, saying,

> It is a pleasure to hear of a friend and ally prospering, but your exceeding prosperity does not cause me joy, for as much as I know that the gods are envious. My wish for myself, and for those whom I love is, to be now successful, and now to meet with a check; thus passing through life amid alternate good and ill, rather than with perpetual good fortune. For never yet did I hear tell of any one succeeding in all his undertakings, who did not meet with calamity at last, and come to utter ruin.

We will see below that Solon believed the same. The foregoing is something which is very well known in statistics, the Bernoulli trials—e.g, successes and failures with a probability. After this, we recognize a strategy since Amasis advises him: "Now, therefore, give care to my words and meet your good luck in this way" (Herodotus's *Histories* III, 40).

We find such a distinction between "benevolent chance" and "malevolent chance" also in Aristotle's *Physics* (197a, 28–31), where it is mentioned that, "when we speak of good fortune, we mean that things are going well and when we speak of bad fortune we mean that things are not going well." Concerning the impossible event, Aristotle (*Rhetoric*, I, 1357a, 4) says that "there is no need to contemplate issues that are impossible, but only issues that have a solution." Aristotle's view on this is not far removed from modern approaches, namely that the probability of the impossible equals zero.

We can also refer to an account by Thucydides (II, 61), who, while commenting on the catastrophe resulting from the plague, reports that Pericles stated the following: "when things happen suddenly, unexpectedly and against all calculations, it takes the heart out of a man; and this certainly has happened to you, with the plague coming on top of everything else … In fact out of everything else this has been the only case [the plague] of something happening which we did not anticipate." Moreover, another account by Thucydides refers to the ambassadors of the Athenians, who urged the Spartans not to be driven to war against the Athenians, the outcome of which would be randomly determined because of the equal power of the two opponents. He wrote (I, 78): "The more the war drags on the greater the possibility that its outcome will depend upon random events, which neither you nor we will be able to control." The above shows the equal probability of victory and defeat

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i.e. $p(A) = p(B) = 50\%$ since $p(A) + p(B) = 1$. We note that victory and defeat are disjointed events.

Also of interest are the two inferences drawn from Herodotus's *Histories* (I, 17.2–3), again regarding strategies. Alyattes, the king of the Lydians, in order to complete his conquest of Miletus, used the following strategy:

> When the harvest was ripe on the ground he marched his army into Milesia to the sound of pipes and harps, and flutes masculine and feminine. The buildings that were scattered over the country he neither pulled down nor burnt, nor did he even tear away the doors, but left them standing as they were. He cut down, however, and utterly destroyed all the trees and all the corn throughout the land, and then returned to his own dominions. It was idle for his army to sit down before the place, as the Milesians were masters of the sea. The reason that he did not demolish their buildings was that the inhabitants might be tempted to use them as homesteads from which to go forth to sow and till their lands; and so each time that he invaded the country he might find something to plunder.

Herodotus (VII, 50) quotes Xerxes addressing his uncle Artavanus thus: "There is reason, O Artavanus, in everything which you have said; ... Success for the most part attends those who act boldly, not those who weigh everything and are slack to venture ... for great empires can only be conquered by great risks." Accordingly, experts in finance and in soldering would say that Xerxes was a "risk lover."

V. SEASONALITY—FACTOR ANALYSIS

One important component in time-series analysis is the seasonal component. The seasonal components are those which are undoubtedly due to cyclical generators, e.g., diurnal variations of temperature, the tidal movement associated with the lunar month, and seasonal variation itself. Two illustrations of seasonality are observed by Herodotus. They are very interesting and are noted by (Rubin 1968). One refers to the periodic behavior of the Nile. According to this account, the water of the Nile begins to rise at the summer solstice (June 22), continues to do so for a hundred days, and then falls again at the end of that period. The other illustration refers to the unusual three harvest seasons of Cyrene of Libya.

Kendal (1973, pp. 55–67) argues that the definition of seasonality, however, is by no means as straightforward as it might be thought. Although we must be careful not to confuse it with effects and fluctuations of a pseudo-cyclical kind, we quote another phenomenon of seasonality. Herodotus (II, 149.1–2), describing a labyrinth south of the lake Moeris that was built by the twelve kings after the reign of high priest Hephaestus, notes:

> Wonderful as is the Labyrinth, the work called the Lake Moeris, which is close by the Labyrinth, is yet more astonishing ... The water of the lake does not come out of the ground, which is here excessively dry, but is introduced by a canal from the Nile. The current sets for six months into the lake from the river, and for the next six months into the river from the lake. While it runs outward it returns a talent of

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> silver daily to the royal treasure from the fish that are taken, but when the current is the other way the return sinks to one-third of that sum.[6]

Much can be found about the meteorological conditions of Scythia where Herodotus (IV, 28) claims that the winter lasted for eight months. Moreover, he asserts (II, 4) that the Egyptians were the first to discover the solar year, and to divide its course into twelve parts.

Factor analysis has been applied to political attitudes and enables us to comprehend the method as a tool for uncovering the order, patterns, or regularity in data. The factors may also be employed to uncover casual order, explain uniformities, or classify opinions. Data can be scaled or transformed. Hypothesis and propositions, voting behavior and dimensionality of social attitudes can be tested.[7] A mass of opinions can be reduced to a parsimonious sub-opinion. This has been accomplished empirically, by trial and error, which is not certainly of factor analysis in the modern sense. Factor Analysis is a general scientific method for analyzing data, and we can find an atom of Factor Analysis in Herodotus (VII, 10). A large assembly that Xerxes held with his generals had as its subject an attack against Greece. While the generals kept quiet, unable to express their opinion, Artavanus of Hystaspus and uncle of Xerxes, said:

> O king, it is impossible, if no more than one opinion is uttered, to make choice of the best: a man is forced then to follow whatever advice may have been given him; but if opposite speeches are delivered, then choice can be exercised. In like manner pure gold is not recognized by itself; but when we test it along with baser ore, we perceive which is the better.

Undoubtedly, we can imagine the amount of opinions that have been expressed by them in order to make the final decision.

VI. INVENTIONS AND CONTRIVANCES

The origins of many inventions and contrivances that impress us today can be found in Herodotus's *Histories* (II, 14). One such method concerning farming is the following:

> but the husbandman waits till the river has of its own accord spread itself over the fields and withdrawn again to its bed, and then shows his plot of ground, and after showing turns his swine into it (the swine tread in corn) after which he has only to await the harvest. The swine serve him also to thrash the grain, which is then carried to the garner.

At another point in his writings (II, 95) about Egypt, he describes a way of exterminating mosquitoes:

> The contrivances which they use against gnats, wherewith the country swarms, are the following. In parts of Egypt above the marshes the inhabitants pass the night upon

[6]Lake Moeris was used to regulate the flow of the Nile; its size and the size of the statues are much exaggerated by Herodotus.

[7]For example, A. Somit and J. Tanenhaus (1964) use R-factor analysis determine major differences of opinion within the political science profession. Among twenty-six questionnaire items by more than 400 American political scientists, seven major differences of opinion were found, among which were dimensions of behaviorism, state of the discipline adequacy of political science, and existence of an establishment.

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> lofty towers, which are of great service, as the gnats are unable to fly to any height on account of the winds. In the marsh-country, where there are no towers, each man possesses a net instead. By day it serves him to catch fish, while at night he spreads it over the bed in which he is to rest, and creeping in, goes to sleep underneath. The gnats, which, if he rolls himself up in his dress or in a piece of muslin, are sure to bite through the covering, do not so much as attempt to pass the net. [I guess this was so because the net smelled so badly of fish.]

More wonderful is the mode in which Arabians collect the cinnamon. He reported (III, 111):

> Where the wood grows, and what country produces it, they cannot tell—only some, following probability, relate that it comes from the country in which Dionysus was brought up. Great birds, they say, bring the sticks which we Greeks, taking the word from the Phoenicians, call cinnamon, and carry them up into the air to make their nests. These are fastened with a sort of mud to a sheer face of rock, where no foot of man is able to climb. So the Arabians, to get the cinnamon, use the following artifice. They cut all the oxen and asses and beasts of burden that die in their land into large pieces which they carry with them into those regions, and place near the nests: then they withdraw to a distance, and the old birds, snooping down, seize the pieces of meat and fly with them up to their nests; which, not being able to support the weight, break off and fall to the ground. Hereupon the Arabians return and collect the cinnamon, which is afterwards exported to other countries.[8]

Herodotus (I, 75.4–6) was told that Thales the Milesian changed the flow of the Halys' river. He didn't believe it. He notes:

> The tale is, that Croesus was in doubt how he should get his army across, as the bridges were not made at that time, and that Thales, who happened to be in the camp, divided the stream and caused it to flow on both sides of the army instead of on the left only ... In this way the river was split into two streams, which were both easily fordable.

We also have Herodotus's description of the Babylonians' ingenious treatment of disease:

> Since they have no doctors, they bring their invalids out into the street, and anyone who comes along offers the sufferer advice on his complaint... Nobody is allowed to pass a sick person in silence.

Rubin (1968) characterizes this as "being in effect a sequential stratified sampling plan or scheme. The sufferer acquires a body of non-random treatment data of observation presumably from survivors, to which he must match his illness or symptoms."[9] It looks as though conceptions of drugs took place as well. This can be deduced from the following. Herodotus (II, 116) quotes Homer (*Odyssey* IV, 227–230), "Such, so wisely prepared were the drugs that her stores afforded Excellent; gift which once

[8]I believe that the story belongs to a whole class of Eastern tales wherein an important part is played by great birds.

[9]A very recent work in this vein is T. Hodgson and J. Borkowski (1998).

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Polydamna, partner of Thonis, Gave her in Egypt, where many the simples that grow in the meadows. Potent to cure in part, in part as potent to injure." Herodotus also mentions the mastic of Chios for its therapeutic qualities. Hippocrates, Cladius Galen (Greek physician, second century AD), and the Roman naturalist Plinius (23–79 AD, *Historia Naturalis*, XII 72; XXII 121), repeat this observation.[10]

VII. SOCIAL, ECONOMIC, TAXATION, AND FINANCIAL DATA

As we said in the introduction, Herodotus's *Histories* are a repository of statistical data covering a wide range of social and economic phenomena. The wages of various military personnel are often cited, such as for sailors (VII, 121), foreign sailors (VII, 96), soldiers and their servants (VII, 72) and Horse (VII, 84). As for the purpose of his journeys, there are plenty of indications that he undertook them for commercial reasons. He very often mentions various edibles, items of clothing, industrial products, spices, aromatic holy oils and other goods, as well as strange forms of trade, much like barter in West Africa. He described (V, 3) as "remarkable" the Thracian glorification of idleness, war and plunder, together with their depreciation of tillers of the soil, as "the most dishonorable." He mistakenly suggested that the Lydians were "proverbially a nation of shopkeepers" (see Spengler 1955, pp. 276–84). He said (I, 94.1–2): "They were the first nation to introduce the use of gold and silver coins and the first to sell goods by retail." In another passage (II, 35) he noted that, "The women attend the markets and trade, while the men sit at home at the loom; and here, while the rest of the world works the woof up the warp, the Egyptians work it down; the women likewise carry burdens upon their shoulders, while the men carry them upon their heads."

We should not overlook the mythical relationship between commerce and piracy which constitutes the cause of the conflict between Greeks and Persians. He says (I, 1),

> According to the Persians best informed in history, the Phoenicians began the quarrel . . . they landed at many places on the coast, and among the rest at Argos which was then pre-eminent above all the states included now under the common name of Hellas. Here they exposed their merchandise, and traded with natives for five of six days; . . . on the last day a number of women, and the daughter of the king Inachus, who was, they say, agreeing in this with the Greeks, Io. The women were standing by the stern of the ship intent upon their purchases, when the Phoenicians, with a general shout rushed upon them . . . The Phoenicians put the women on board their vessel and set sail for Egypt.

From Momigliano (1966, pp. 120–24), we learn that Herodotus rejects the claim that this is the cause; the description of events alone shows that the cause that

[10]Tradition has it that God blessed this mastic in 250 AD when the body of St. Isidorus (a martyr of the Romans) was dragged under that mastic-lentisk (tree). Incidentally, Thucydides (III, 20.3-4) refers to an incident where a city named Plataea in Beotia was under siege by Peloponnesians and Beotians. When building scaling ladders for the assault, 220 Athenians, with the leadership of diviner Theaineto and general Efpompida, were under siege too, helping the Plataeans, had to calculate the height of the walls. They had several men with extra good eyesight count the course of bricks in the walls and averaged the results. Note that the bricks were of a standard thickness. The same is done today by the slatters where they count courses of the tiles on the floor or on the wall.

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he will himself later support is mainly economic-taxation and restriction of freedom.[11]

Corinth is described by Herodotus (I, 14.50–51) as the Greek community most adapted to trade and craftsmanship, as well as a place where sacred objects were deposited by foreigners. He did not, however, attribute Corinth's prosperity, as Strabo later did, to its location at a junction point. He wrote (II, 167.1–2):

> Whether the Greeks borrowed from the Egyptians their notions about trade, like so many others, I cannot say for certain. I have remarked that the Thracians, the Scythians, the Persians, the Lydians, and almost all other barbarians, hold the citizens who practice trades, and their children, in less repute than the rest, while they esteem as noble those who keep aloof from handicrafts, and especially honour such as are given wholly to war. These ideas prevail throughout the whole of Greece, particularly among the Lacedaemonians. Corinth is the place where mechanics are least despised.

In the following we quote from Herodotus (IV, 196) an amazing description of procedure of exchange of goods (barter):

> The Carthaginians also relate the following: There is a country in Libya, and a nation, beyond the Pillars of Heracles, which they are wont to visit, where they no sooner arrive but forthwith they unloud their wares, and, having disposed them after an orderly fashion along the beach, leave them, and, returning aboard their ships, raise a great smoke. The natives, when they see the smoke, come down to the shore, and, laying out to view so much gold as they think the worth of the wares, withdraw to a distance. The Carthaginians upon this come ashore and look. If they think the gold enough, they take it and go their way; but if it does not seem to them sufficient, they go aboard ship once more, and wait patiently. Then the others approach and add to their gold, till the Carthaginians are content. Neither party deals unfairly by the other: for they themselves never touch the gold till it comes up to the worth of their goods, nor do the natives carry off the goods till the gold is taken away.

With the foregoing text Herodotus informs us that the procedure of exchange of goods in trade in micro-macro level must rest, as Thomas Aquinas (*Summa Theologica* II, Quaest LXXVII) has put it, upon the "communis estimatio" of the contracted parts. It is a form of the "silent trade."

[11]Here an anonymous referee comments: "Herodotus's rejection of the report of the Phoenician exploration sent by an Egyptian Pharaoh around 493 BC to explore the east coast of Africa. They returned after three years through the straits of Gibraltar, claiming that they had circumnavigated Africa. Herodotus thought they were lying because their irrational claim that, as they went further south the climate inverted and became colder, etc.—obvious nonsense!"

Restrictions of freedom occur today as well, as Nobel prize winner Amartya Sen (1998) argued concerning the "fear of freedom," which he called the "impelling force" of the modern world. He suggested that people in one country might fear the benefits of freedom enjoyed by people in another country and consequently attempt to restrict it. Oddly enough, freedom is not only among the most valued ideas in the world, it is also among the most feared of human conditions. Freedom is indeed a very diverse and many-sided concept, as we see in the lines from the English poet, William Cowper:

Freedom has a thousand charms to show,
That slaves, howe'er contented, never know.

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Reference is also made by Herodotus to other trading centers, such as the city of Tartessus (I, 163) and the trading port of the Borysthenites (IV, 17).[12] About Tartessus, a colony situated beyond the straits founded by the Phoenicians, he says (IV, 152):

> This trading-town was in those days a virgin port, unfrequented by the merchants. The Samians, in consequence, made by the return-voyage a profit in consequence, made by the return-voyage a profit greater than any Greeks before their day, excepting Sostratus, son of Laodamas, an Aeginetean, with whom no one else can compare. From the tenth part of the gains, amounting to six talents, the Samians made a brazen vessel, in shape like an Argive wine-bowl adorned with the heads of griffins standing out in high relief. This bowl, supported by three kneeling colossal figures in brass; of the height of ten feet, was placed as an offering in the temple of Hera at Samos.[13]

Herodotus knows very well the economic importance of various Mediterranean ports. Therefore, when he mentions Amasis, he does not forget to emphasize his trade policy, since he alloted to Greeks the port of Naucratis, the only trading center of Egypt in order to fortify their foreign trade. He says (II, 178–179), "Amasis was partial to the Greeks, and among other favours which he granted them, gave to such as liked to settle in Egypt the city of Naucratis for their residence ... In ancient times there was no trading port but only Naucratis in the whole of Egypt which had exclusive priviliges."

Yet, he also knows the economic importance of location. This becomes obvious from the following: He says (I, 165) (see also Spengler 1955, p. 279): "Arrived at Chios, the Phocaeans offers for the purchase of the islands called the Oenussae, but the Chians refused to part with them, fearing last the Phocaeans should establish a market there, and exclude their merchants from the commerce of those seas." He reports (IV, 17) on other trading towns, for instance the port named Borysthenites:

> Above the trading-port of the Borysthenites, which is situated in the very centre of the whole sea coast of Scythia, the first people who inhabited the land are the Callippidae, a GraecoScythic race. Next to them, as you go inland, dwell the people called the Alazonians ... they sow and eat corn, also onions, garlic, lentils and millet. Beyond the Alazonians, reside Scythian cultivators, who grow corn, not for their own use, but for sale.

The Borysthenes was the river which is now known as Dneiperos. The corn trade of the Scythians appears to have been chiefly with the Greeks. Its extent is indicated in Herodotus by his assignment of the whole country west, and a portion of that east, of the Borysthenes to Scythian husbandmen who raised corn only for sale.

[12]It is worth noting also that, four centuries after Herodotus, Cicero (*De officiis* III, 50-55) cites the dispute between Diogenes of Babylon and Antipater of Tarsus (early Stoics) on behavior in trade. It seems that between the virtue and the evil the subject of so-called "indifferent" goods (SVF, III.117-118) led the early Stoics to study the problems of trade and the market (Baloglou 1998, pp. 18–36).

[13]Incidently, in the Samos Museum, there is today a Couros (statue of a young man with bent knee—about to move—an unusual position for such a statue) five meters high, that was found recently by archaeologists in the temple of Hera. Visitors all over the world can admire him.

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Some interesting references are made to taxes, especially to the justification of property acquisition. He says (II, 177):

> it was this king Amasis who established the law that every Egyptian should appear once a year before the governor of his nomos (sc. province of ancient Egypt) and show his means of living; or, failing to do so, and to prove that he got an honest livelihood, should be put to death. Solon the Athenian borrowed this law from the Egyptians, and imposed it on his countrymen, who have observed it ever since. It is indeed an excellent custom.

Each nomos (νομός) was governed by a nomarch. Herodotus attributes this law to Amasis; but it appears to have been much older, since we find in the sculptures of the eighteenth dynasty bodies of men presenting themselves before the magistrates for registration. Herodotus informs us that the "satrapies" or prefectures that Dareius set up which he mentions by name, paid a yearly tax whose level depended on the productivity of the soil and the general economic state of the satrapy. He attaches a particular importance to the Dareius's reform which he praises, since the state of Persia was able in this way to secure a permanent income, while at the same time minimizing the risk of rebellion—a common occurrence because of the unjust taxation system. Because of his taxation reform Herodotus (III, 89, 3) blames Dareius, "On account of this taxation system and other like doings, the Persians say that Dareius was a huckster, Cambyses a master, and Cyrus a father; for Dareius looked to making a gain in everything; Cambyses was harsh and reckless; while Cyrus was gentle, and procured them all manner of goods."

This text emphasizes that Dareius treated everything as an internal commerce, which shows his understanding of economics. Later writers and researchers of the ancient Greek economy would positively acknowledge Herodotus's description and note the importance of the Dareius's reform for the development of knowledge. Roscher (1866), for one, admires the character of the reform. Andreades (1926) considers it as one of the most important in the history of ancient fiscal systems and recognizes in it the establishment of the four principles of taxation (equality, certainty, demand and economy) that Adam Smith (1776) proposed.[14] Herodotus (VII, 144) mentions another form of financing a fleet by the state. He notes:

> Themistocles had before this given a counsel which prevailed seasonably. The Athenians, having a large sum of money in their treasury, the produce of the mines at Laureium, were about to share it among the full-grown citizens, who would have received ten drachmas a piece, when Themistocles persuaded them to forbear the distribution, and build with the money 200 ships to help them in their war against the Aegineans.

Here Herodotus also describes a method of distribution of wealth. The same idea is reflected in Herodotus's (III, 57) discussion of distribution in the island of Siphnos (see also M. M. Austin and P. Vidal-Naquet 1972). He says: "There were mines of gold and silver in Siphnos (sc. an Aegean island) and so rich a yield, that a title of the ores the Siphnians furnished out a treasury at Delphi which was on a par with

[14]Cf. Baloglou (1995), who recognized and underlined this connection.

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the grandest there. What the mines yielded was divided year by year among the citizens."

Here, too, we see reference to the significance of "earth" as a productive factor for taxation on income. It describes how Arthaphernes, Satrap of Sardeis, taxed the Ionians under his occupation, without, however, commenting on the factor of the productivity of the soil or the subsoil. He notes (VI, 42):

> Artaphernes took the measurement of their whole country in parasangs. . .and settled the tributes which the several cities were to pay, at a rate that has continued unaltered from the time when Artaphernes fixed it down to the present day. The rate was very nearly the same as that which had been paid before the revolt. Such were the peaceful dealing of the Persians with the Ionians.

We must not lose sight of the fact that Homer (*Hymns*: Earth, Mother of All 1–2), too, recognizes the Earth as a primary factor of production, calling it "mother of all." We see that the Persian satrap himself decreed the tax that each prefecture had to pay not arbitrarily (principle of certainty), but suitably (principle of appropriateness). He adopted justice in taxation (principle of equality) basing it on land property since agriculture was the main source of wealth in Persian economy. The foregoing proves even the importance of geometry. He reported (II, 109): "From this practice, I think, geometry first came to be known in Egypt, whence it passed into Greece. The sundial, however, and the gnomon, with the division of the day into twelve parts, were received by the Greeks from the Babylonians."

From Herodotus (III, 24) we learn Persians knew very well the painting, especially "porfira." "Ethiopians knew very well moulding of crystal and they placed the dead body in a crystal pillar which had been hollowed to receive it, crystal being dug up in great abundance in their country." For the hammering of iron, Herodotus (I, 68) notes:

> Lichas . . . went to Tegea, and happening to enter into the workshop of a smith, he saw him foreging some iron. As he stood marveling at what he beheld, he was observed by the smith who, leaving off his work, went up to him and said, "Certainly, then, you Spartan stranger, you would have been wonderfully surprised if you had seen what I have, since you make a marvel even of the working in iron."

Elsewhere he says (I, 26), "We also have proof of a donation made by Lydian king Alyattes to Delfi, a big silver crater (a kind of jar) with an ironforged base, a creation of Glavkos of Chios who was the first man who found a way to forge iron."[15]

Concerning the esteem in which wealth was held in Greek and Asian thought, Herodotus systematically describes the social and economic groups of the people referred to. His conception of morality is deduced from the conclusions of a lengthy dialogue, which has sophistic influence; it attaches the two different worlds, the Hellenic and the Asiatic. He reported (I, 30.32):

[15]We should mention here that Homer (*Iliad*, XVII, vv. 468–82) too, describes Hephaistus's Antiquity's blacksmith's ironworks; he also refers to its most beautiful product. Elsewhere (*Iliad*, XVI, vv. 389–93) he describes the production at a tannery, including a realistic depiction of the division of labour: "The foreman gave his apprentices the hide of a large ox to stretch it. They, in turn, soaked it in lard which helps the hide to discard its water and stretched it in all directions."

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> Solon, the Athenian politician and poet of the sixth century BC, came to visit Croesus at Sardis. Croesus conducted Solon over treasuries, and showed him all their greatness and magnificence. Indirectly he provoked Solon to recognize him as the happiest man in the world. But Solon gave Croesus as an example of such a man first "Tellus of Athens, Sire" and second "Cleobis and Bito . . . they were of Argive race." All of them lived virtuously and reputably throughout their life and they died gloriously. Solon, therefore, opposes Croesus' material goods with the moral and spiritual values which complete man to his end. Solon's famous saying "call no man happy until he dies" was soon to come true when Croesus was beaten by the Persian king Cyrus and condemned to die at the stake. At that moment, he understood Solon's words and cried out Solon's name three times. Curious to know why, Cyrus asked to be told the story. When he heard it, he spared Croesus' life for the fear of the gods.

Following this amazing dialogue, Solon philosophizes, "Croesus, a man's life is a succession of uncertainties. I see that you are very prosperous and a king, but I cannot answer your question before I know if you had a good old age."[16] Solon the lawmaker, through Herodotus (I, 32), promotes sensible wealth with happiness and rejects great wealth. He places emphasis on the stability and duration of man's happiness. Answering Croesus, he said, "He who unites the greatest number of advantages, and retains them to the day of his death, then dies peaceably, that man alone, Sire, is in my judgment, entitled to bear the name of 'happy'." Solon's contempt for Croesus's treasures remind us of the poem of the Parian Archilohus (680–640 BC), who lived about the same time, written in iambic trimeter verse: "I am not interested in golden Gyge's riches . . ."[17]

The attitude of Greeks and Asians towards wealth is also of interest here. Greeks in general, and Herodotus in particular, were intent on traditional moral values. A Persian warrior named Tritantaechmes, son of Artavanus, in Herodotus (VIII, 26.2–3) characteristically says, "Good heavens, Mardonius (sc. Persian general), what manner of men are these against whom you have brought us to fight—men who contend with one another, not for money, but for honour." The Persian warrior compares money to virtue—the price of which was not money but just a wreath of an olive branch. He ascertains that for the Greek athlete to take part in Olympic games, victory and not money was the higher purpose and motive. Therefore, the Greek is determined to fight bravely, to the end, for his country's freedom. He does not examine, nor is he interested in making money.[18]

Certainly, no one has ever rejected the utilization of human capabilities to create wealth, not Adam Smith, not even the wise Socrates of, "I only know that I know nothing." Nevertheless, "Virtue is not made by money, but from virtue stem money

[16]This brings to mind Stephen Hawking's reply to Einstein: "God not only plays dice but also throws them where we can't see them." The reference to "dice throwing" illustrating "chance" comes from a Heraclitean statement "the universe controlled, like a child throwing dice," and surfaces in Shakespeare and in Einstein, as well as in Hawking (see Lowry 1974). I am further reminded of Nobel Prize winner Amartya Sen who distinguishes between financial expansion (wealth) and development that encompasses health, work, education and, most of all, virtue and a good death.

[17]Herodotus (I, 12.8) hints at this poem, which also refers to an eclipse of the sun that, according to astronomers, had occurred on April 6, 648 BC.

[18]Note that most of Xerxes' troops were mercenaries.

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and the other possessions" (Plato, *Apologia*, 30b). The need to create commerce is recognized by Herodotus (I, 32) in the "imaginary" dialogue between Croesus and Solon. According to Croesus "olvious" means wonderfully rich and the lord of many nations. Solon rejects great wealth and accepts middle riches. Solon neither renounces nor condemns wealth. However, he wants it to be acquired fairly because he believes in Divine Retribution (H. Diehl, Fasc, 1, Fr. I (13), 1–32), a belief that made the ancient Greeks think of him as "the model of the consummate Greek." Solon, stressing the features of an "olvious" man says: "Scarcely, indeed, can any man unite all these advantages: as there is no country which contains within it all that it needs, but each, while it possesses some things, lacks others, and the best country is that which contains the most; so no single human being is complete in every respect—something is always lacking." The shiny silver and the gold are not the sole sturdy units; virtue is what counts for all people, and happy are those who have it (Euripides, *Oedipus*, TGF, fr. 542, p. 532).

Special emphasis is put on the self sufficiency of a country and the least possible dependence upon international trade. Of course, in the particular dialogue a different problematic is also seen since, given on the one hand the jealousy and the disturbance of the Divine and on the other the "human tragedy," no man and no country on this earth, can claim to be self sufficient. To the man and the place he dwells belongs only the space and not the total which belongs to God (D. N. Maronitis 1964). While in Homer (*Odyssey*, B, 319) the word "trader" means wanderer, in Herodotus (II, 39) it takes its later meaning. By reference to known traders like Kolaios and Sostropos of the Eastern Mediterranean, he is given the opportunity to refer to the matter of the social status of the traders and the appreciation of manual work by the nobles. Thus we learn that internal trade is in the hands of the *kapeloi* who constitute one of the seven classes in Egypt. Herodotus (I, 24, 1) considers the Lydians to have been the first *kapeloi.* Concerning the "honor" attributed by various people to those engaged in manual labor, Herodotus (II, 167) notes that the Egyptians, the Greeks and other people "consider important those who are not burdened with manual labour" This applies to all Greeks and, particularly, Lacedemonians.

One wonders how wealthy a common man would be at that time. Was the Persian economy a form of capitalism? About this matter Herodotus (VII, 28) says, "Xerxes addressing Pythius with his own lips, asked him what the sum of his wealth really was." Pythius answered, "O King, I will not hide this matter from you, nor make pretence that. . . I made count of my stores, and found them to be 2,000 talents of silver, and of gold 4,000,000 of Daric staters, wanting 7,000." In order to get an estimation of Pythius's wealth, consider that when Herodotus was honored by the Athenian Parliament with "ten talenta," the value of a talent weight in gold, silver, etc., the lowest estimated weight being about 58 pounds *avoirdupois*, offered by Athens with Anytus' decision (see FGH 360); it was regarded as a significant amount of money. By comparing the two amounts one can realize the immensity of the wealth offered by Pythius to Xerxes.

> Gold and silver mines, which have been found today, were noted by Herodotus: They were masters of the gold mines at Scapte Hyle, the yearly produce of which amounted in all to eighty talents. Their mines in Thasos yielded less, [. . .] I myself have seen the mines in question: By far the most curious of them are those which the Phoenicians

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> discovered at the time when they went with Thasus and colonized the island which afterwards took its name from him. These Phoenician workings are in Thasos itself, between Coenyra and Aenyra, over Samothrace (VI, 46–47).

H. Michell (1940) has pointed out that Herodotus mentions other earlier methods of minting coins from amber. The mention (I, 94) of minting coins from gold and silver is the result of his own research, and the information that the Lydians and the Greeks had similar laws leads us to suspect that the first coins were minted in the Ionian cities of Asia Minor. This information is in agreement with that of Pollux and Xenophanes (H. Diels 1934, vol. 1, p. 130, Fr. 4). Thus he writes the following concerning the monetary policy of Asychis's reign:

> In the reign of Asychis king, money being scarce and commercial dealings straitened, a law was passed that the borrower might pledge his father's body to raise the sum whereof he had need. A proviso was appended to this law, giving the lender authority, over the entire sepulchre of the borrower, so that a man who took up money under this pledge, if he died without paying the debt, could not obtain burial either in his own ancestral tomb, or in any other, nor could he during his lifetime bury in his own tomb any member of his family (II, 136–137).

The mention of minting coins corresponds with famous metaphor, the so-called "trade image" of Heraclitus (B 90DK; Kirk's translation) that, "All things are an equal exchange for fire and fire for all things, as goods are for gold and gold for goods."

The above pictures an economy based on commodity production and constituting the basis of Heraclitus' concept of a self-regulating cycle of perpetual transformation of matter which must have been known to Herodotus. The topics related to the appearance of currency in general, like its relationship to trade, the time it was minted (possibly during the last quarter of the seventh century BC), whether it was invented by the Lydians or the Greeks are issues that interest numismatists. C. E. Hill (1964, pp. 6, 26) mentions that our interest will be confined to the significance attached to currency by Herodotus and its function in his *Histories.* Even the term "nomisma" (coin—originally derived from "nenomismenon") itself seems to refer to the abstract meaning of the minting and circulation process. However, the term used to refer to the circulation of money is "chrema." We can also find the word in earlier texts after Odyssey (it does not exist in *The Iliad*), but in the sense of food reserves or estate (Od XVII, 532; I, 375). Hesiod uses the term *chrema* in the same sense. According to Spengler (1955, p. 278), Herodotus recognizes the functions of the coin as a medium of exchange and a measure of value, but he mentions nothing about interest, neither positive nor negative. He nevertheless makes a sophisticated observation: the scarcity of money is related to a drop in economic activity. *The Odyssey* describes a society which had no currency to facilitate transactions. Instead, oxen were used as a monetary unit and precious metals for hoarding up treasures. Antimachos, for instance, kept his treasure at home in gold, bronze, and iron (*The Iliad*, XI, pp. 131–35). The ox, on the other hand, would be a "*numeraire*" in today's terminology, the monetary unit to express the price of all other goods (see L. Walras, 1874).

Herodotus also mentions the global dust of gold to be found in the river of the mountain of Tmolus that flows with the river Pactolus through the market of the city of Sardes into the Hermus river and from there to the sea. The gold dust is

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among the few marvelous things that Lydia has. This abundance of gold may possibly have led to the minting of coin. He says (I, 93): "Lydia, unlike most other countries, scarcely offers any wonders for the historian to describe, except the gold-dust which is washed down from the range of Tmolus." He also mentions (V, 101) that, "This stream [i.e., the Pactolus river], which comes down from Mount Tmolus, and brings the Sardians a quantity of gold-dust, runs directly to the market place of Sardes, and joins the Hermus (tributary), before that the river reaches the sea."[19] We also know from Herodotus (IV, 166) that Dareius made golden coins fresh from the mint as pure as possible, and Ariandis, governor of Egypt, did the same with silver. Herodotus recognizes the connection of the independence of a city-state with the currency when he connects the minting of coins with the grand plans of certain rulers. He (IV, 166) tries to interpret the displeasure of Dareius against the consul of Egypt Aryandis by the minting of silver coins and the usurpation of his fame as Persian monarch. The minting of the same coin by the *satrap* betrayed attempts of independence and was reason enough to consider him as traitor to his king, and a renegade.

The concepts of average and equilibrium were also known to Herodotus. As an example of these he refers (IV, 50) to the constant volume of the Dunabe River which he named "Istro." There are reports about petroleum fountains located in the region of Kissia on Dareius's land. At that point Herodotus notes also some kind of coordinates:

> he did them no other harm, but only settled them at one of his own stations in Cissia, a place called Ardericca, 26 miles from Susa and 5 miles from the well which yields produce of three different kinds. For from this well they get bitumen, salt, and oil procuring it in the way that I will now describe . . . It is called by the Persians rhadinace (petroleum), is black, and has an unpleasant smell (VI, 119).[20]

VIII. DEMOGRAPHIC OBSERVATIONS

Demography is a term derived from the two Greek words, "δήμος," the people, and "γράφειν" to draw or write. It was first used by Achilles Guillard in 1855, and nowadays denotes the study by statistical methods of human populations, involving primarily the measurement of the size, growth, and diminution of the numbers of people, animals, etc, the proportions of living, being born or dying within some area, and the related functions of fertility, mortality, and marriage. Herodotus (IV, 81) cited an estimation of the population of Scythia:

> What the population of Scythia is, I was not able to learn with certainty; the accounts which I received varied from one another. I heard from some that they were very numerous indeed; others made their numbers but scanty for such a nation as the Scythians. Thus much, however, I witnessed with my own eyes . . . In this place (named Exampaeus) there stands a brazen bowl . . . such as have never seen that

[19]In modern Greek the word Pactolus is used to denote affluence, i.e., "He earned a Pactolus of money."
[20]For more about public finance, money and monetary functions, prices, wealth, poverty, and happiness see Spengler (1955), I. Perysinakis (1987), and Baloglou (1995).

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> vessel may understand me better if I say that the Scythian bowl holds with ease 600 amphorae (about 6,400 gallons) and is of the thickness of six fingers (4 inches) breadth. The natives gave me the following account of the manner in which it was made. One of their kings, by name Aryandis, wishing to know the number of his subjects, ordered them all to bring him, on pain of death, the point off one of their arrows. They obeyed, and he collected thereby a vast heap of arrowheads, which he resolved to form into a memorial that might go down to posterity. Accordingly he made of them this bowl, and dedicated it at Exampaeus. This was all that I could learn concerning the number of the Scythians.

He adds that this bowl was six times as big as that at the entrance of Euxine, which Pausanias, the son of Cleobrotus, set up at the time he was besieging Byzantium in 477 BC. It is easy to realize that by dividing the total metal weight of the bowl by the weight of an arrowhead one could estimate the adult male population in Scythia. Herodotus might have done it, but he didn't cite anything about it.

Rubin (1968) declares that, "Considerable doubt arises as to the validity and accuracy of many of the statistics cited by Herodotus, a fact which did not entirely escape him." Thucydides also had doubt about what Homer said. Herodotus frequently made reference to demographic matters. Much of interest and importance are Herodotus's remarks on subjects regarding to the arrangement and compositions of the Persian and Greek armies. He notes:

> What the exact number of the troops of each nation was I cannot say with certainty—for it is not mentioned by any one—but the whole land army together was found to amount to 1,700,000 men. The manner in which the numbering took place was the following. A body of 10,000 men was brought to a certain place, and the men were made to stand as close together as possible; after which a circle was drawn around them, and the men were let go: then where the circle had been, a fence was built about the height of a man's middle; and the enclosure was filled continually with fresh troops, till the whole army had in this way been numbered (VII, 60).

He continues, "We have therefore to add to the sum already reached an exactly equal amount. This will give 5,283,220 as the whole number of men brought by Xerxes, the son of Dareius, as far as Sepias and Thermopylae." These words bear, in effect, on overestimation, and yet it was impossible to rely on the estimates given, since it is human nature to boast about the size of one's own forces. Rawlinson (1942, p. 522n) and F. Maurice (1930, p. 210n) have offered an interpretation. Herodotus mentioned (II, 177) population issues on multiple occasions, examples of which can be seen in the following extracts: "It is said that the reign of Amasis was the most prosperous time that Egypt ever saw … while the number of inhabited cities was not less than 20,000." Diodorus from Sikyon (I, 31) declares it was 18,000. In the next paragraph he writes (I, 178): "Assyria was plenty with cities, the most renowned of which was Babylon."

Presumably Herodotus, as a Greek, greatly esteemed urban society, and its standing above village societies. He stated (I, 66) in respect to the Spartans that, "their soil being good and the population numerous, they sprang up rapidly to power and became a flourishing people." He doesn't refer clearly to the relationship between good soil and population increase. Condorcet's late eighteenth century argument

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about the growth of population—the possibility that the size of population can quite conceivably "surpass their means of subsistence"—is well known, as is the Condorcet-Malthus disagreement about solving this problem. Although Herodotus does not mention these things explicitly, the following comments that he reports from Darius indicate to us that he was aware of the general issues:

> Asia abounding in men and vast sums flowing into the treasury, the desire seized him to exact vengeance from the Scythians for an earlier invasion of Media . . . On their return home Scythians, after the long absence of twenty-eight years . . . found a very difficult situation: population now was no small size because the Scythians' women, when they saw that time went on, and their husbands did not come back, had intermarried with their slaves prepared to oppose their entrance . . . Then, when Scythians come back, they blind all their slaves, to use them in preparing their milk. The plan they follow is to thrust tubes made of bone up the vulva of the mare and then to blow into the tubes with their mouths, some milking while the others blow. They say that they do this because when the reins of animal are full of air, the udder is forced down (IV, 1).

Of particular interest are Herodotus's observations on matters pertaining to population characteristics. Regarding the life's longevity of a man, he says:

> When the Fish-eaters, on reaching those people (Ethiopians), delivered the gifts to the king of the country, they spoke as follows, "Cambyses, king of the Persians, anxious to become your ally and sworn friend, has sent us to address you with gifts,", whereupon the Ethiopian, who knew they came as spies, made answer, "The king of the Persians sent you not with these gifts, . . . Also your king is not a just man . . ." Last of all he came to the wine jar . . . whereupon he asked what the Persian king ate, and what age the longest-lived of the Persians had been known to attain. They told him that the king ate bread. . . adding that eighty years was the longest term of man's life among the Persians. Then he remarked that it did not surprise him, if they fed on manure, that they died so soon; . . . The Fish-eaters then in their turn questioned him concerning the Ethiopian longevity and were told that most of them lived to be 120 years old and that they ate boiled flesh and drunk milk (III, 21-23).

Moreover, about the height of a man Herodotus (VII, 117) said, "It was while he remained here that Artachaes, who presided over the canal, a man in high repute with Xerxes, and by birth an Achaemenid, who was moreover the tallest of all the Persians, being eight feet high (sc. 2m), and who had a stronger voice than any of the men in the world."

Events and tendencies such as these caused attention to be directed to fertility, after a period in which progress in reducing mortality had seemed all-important. Theories began to be formed about social behavior which could explain the observed facts. A precursor of these populationist phenomena can be found in Herodotus's *Histories.* Of the Persians he wrote (I, 136), "Next to prowess in arms, it is regarded as the greatest proof of manly excellence to be the father of many sons. Every year the king sends rich gifts to the man who can show the largest number: for they hold that number is strength." He said (VI, 69) about the pregnancy period, "The truth is, children are born not only at ten lunar months, but at nine, and even at seven." He reported (II, 47) that the Egyptian swineherds "are forced to intermarry among

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themselves, because they are considered very unclean and nobody will give his daughter in marriage to a swineherd." Likewise, he wrote (IV, 111), "When the Amazons advanced against the Scythians, they were to retire and avoid a fight … All this they did on account of their strong desire to obtain children from so notable a race."

The desire to acquire children was very intense and adoption procedures were difficult and rigorous as they are today. We can see this in the following passage from Herodotus:

> and if a person wants to adopt a child, he must do it before the kings. They likewise have the right of sitting in council with the twenty-eight senators … Then the Ephors and Elders took counsel together and laid this proposal before the Spartan king Anaxandridas. Since you are so fond, as we see you to be, of your present wife, do what we now advise, and gainsay us not, lest the Spartans make some unusual decree concerning you. We ask you not now to put away your sterile wife … give her still the same love and honour as ever—but take another wife beside, who may bear you children (VI, 57; V, 40).

Leonidas is described by Herodotus (VII, 205) as taking with him to Thermopylae only those with sons living, in order to insure the continuance of the family of each, "He had now come to Thermopylae, accompanied by the 300 men which the law assigned him, whom he had himself chosen from among the citizens, and who were all of them fathers with sons living."

Concerning the reproduction of animals Herodotus mentions the following, which perhaps illustrates the economy of nature:

> Of a truth divine Providence does appear to be, as indeed one might expect beforehand, a wise contriver. For timid animals which are a prey to others are all made to produce young abundantly, that so the species may not be entirely eaten up and lost; while savage and noxious creatures are made very unfruitful. The hare, for instance, which is hunted alike by beasts, birds, and men, breeds so abundantly as even to conceive while pregnant, a thing which is true of no other animal … The lioness on the other hand, which is one of the strongest and boldest of brutes, brings forth young but once in her lifetime, and then a single cub (III, 108).[21]

The reference to rabbits surviving and being prolific is found also in Hesiod's epic *Theogonia* (567–570) where Prometheus hands out survival mechanisms to the different animals and gives rabbits this ability so they can survive predation:

> However, when Prometheus contrived to secure for meat of animals for the human race, the realm of Zeus did not rule in the world anymore and the people lived isolated from the gods and nature. (Ζείδωρος Ἄρουρα – Fertile Earth) had ceased to automatically bring abundant crops to people. Prometheus introduced carnivorous food which had been unknown or unacceptable to people, who were until then vegetarians (Despotopoulos, 1998). This enraged Zeus, who simultaneously gave animals the capability to escape from humans and other animals captivity.

[21]Aristotle observes that the lioness breeds once a year, and usually has three cubs; see footnote in Rawlinson's translation of Herodotus (1942, p. 264).

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And about the winged snakes of Arabia he says (III, 109):

> Now with respect to the vipers and the winged snakes of Arabia, if they increased as fast as their nature would allow, impossible were it for man to maintain himself upon the earth. Accordingly it found that when the male and female couple together, at the very moment of impregnation the female seizes the male by the neck, and having once fastened, cannot be brought to let go till she has bit the neck entirely through. And so the male perishes; but after a while he is revenged upon the female by means of the young, which, while still unborn, gnaw a passage through the womb and then through the belly of their mother, and so make their entrance into the world.

Herodotus reported (III, 65) that Cambyses, dying, said to his people: "Do this, and then may your land bring you forth fruit abundantly, and your wives bear children, and your herds increase, and freedom by your portion for ever." Concerning the national characteristics of the Greek nation, Herodotus (I, 58) informs us that: "The Hellenic race ... gradually spread and increased to a multitude of nations ... The Pelasgoi, on the other hand, were as I think a barbarian race which never greatly multiplied."

The demographer's attitude towards the analysis of mortality is somewhat different from his approach to fertility statistics, because the characteristics of the two are different. Mortality is almost entirely involuntary. When wars and pandemics are excluded, mortality may follow a reasonably well-defined trend. Regarding mortality Herodotus reported (VIII, 171), "Three generations after the death of Minos the Trojan war took place; and the Cretans ... when came back from Troy, famine and pestilence fell upon them, and destroyed both the men and the cattle."

Because of changing water conditions along the way, Xerxes' troops underwent dysentery and plague. He writes (VIII, 117), "At Abydos the troops ... they fed without stint; from which cause, added to the change in their water, great numbers of those who had hitherto escaped perished." On mortality associated with some constructions, he reported: "One hundred and twenty thousand of the Egyptians, employed upon the work in the reign of Necos, lost their lives in making the excavation of canal." Apart from deaths due to illness and old age it is impressive to note that he also mentions cases of cannibalism. About the mode of living of Massagetae he writes (I, 216): "Human life does not come to its natural close with this people; but when a man grows very old, all his kinsfolk collect together and offer him up in sacrifice; ... After the sacrifice they boil the flesh and feast on it; and those who thus end their days are reckoned the happiest."

At times the oracles, especially that of Delphi, influenced migrations and colonizations. He notes:

> Arrived at Chios, the Phocaeans made offers for the purchase of the islands called the Oenussae, but the Chians refused to part with them, lest the Phocaeans should establish a market there, and exclude their merchants from the commerce of those seas. On their refusal, the Phocaeans ... made up their minds to sail to Cymus (Corsica) where, twenty years before, following the direction of an oracle, they had founded, a city, which was called Alalia (I, 165).

Large scale oriental movements of populations are mentioned several times by Herodotus, as for instance when, "It chanced in the meantime that King Dareius saw a sight which determined him to bid Megabazus remove the Paeonians from

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their seats in Europe and transport them to Asia" (V, 12). He also reports (I, 1) that the Phoenicians, "who had formerly dwelt on the shores of the Red Sea [our Indian Ocean], having migrated to the Mediterranean and settled in the parts which they now inhabit began at once, they say, to adventure on long voyages, freighting their vessels with the wares of Egypt and Assyria." He disputed (V, 10) the Thracian contention that bees (maybe gnats) hindered colonization beyond the Istor (Danube), and attributed them rather to the cold environment: "According to the account which the Thracians give, the country beyond the Istor is possessed by bees, on account of which it is impossible to penetrate farther. But in this they seem to me to say what has no likelihood; for it is certain that those creatures are very impatient of cold."

Herodotus mentions three population displacements that seem to be similar to contemporary economic emigrations owing to wars:

> After this the Athenians . . . they crossed into Euboea, and engaged the Chalcideans with the like success; whereupon they left 4,000 settlers upon the lands of Hipobotae, which is the name the Chalcideans give to their rich men . . . Alyates waged war with the Medes under Cyaxare, the grandson of Deioces, drove the Cimmerians out of Asia, conquered Smyrna, the Colophonian colony, and invaded Clazomenae . . . Egyptians have always existed ever since the human race began; as the land went on increasing, part of the population came down into the new country, part remained in their old settlements (V, 77; I, 16; II, 15).

Migration also occured because of scarcity of food and bad climates, as in Herodotus's (I, 94, 149) report that, "half of the Lydians had migrated to Italy because there was scarcity through the whole land . . . These are the eleven ancient cities of the Aeolians. Originally, indeed, they had twelve cities upon the mainland, like the Ionians, but the Ionians deprived them of Smyrna, one of the number. The soil of Aeolis is better than that of Ionia, but the climate is less agreeable." Likewise, at that time, many countries needed foreign labor, and on the matter of foreign workers seeking employment, Herodotus writes (VIII, 26), "There came now a few deserters from Arcadia to live on, and were in want of employment"—not unlike we see in the present day.

IX. CONCLUSION

Herodotus had no intention of formulating a statistical or economic theory. However, his work demonstrates that he had a sense of random incidents, as well as an understanding of statistical and economic facts in their broader content. He is well aware of the importance of the statistico-economic factor in the political life, which, nevertheless, does not hold a primary role in history.

Herodotus (II, 125-126) provides information concerning the cost of the pyramids. For example, through an interpreter, Herodotus learns from an inscription in Egyptian characters on Cheop's pyramid that "the quantity of radishes, onions and garlics consumed by the labourers who constructed it, costs 1600 silver talents" and was wondering about "what a vast sum must have been spent on the iron tools, feeding and clothing of the labourers," till Cheops was forced to send his daughter to be part of the stews in order to gather money (it was king's custom those days). He gathered information about

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the types of cultivation in various countries and the types of commerce; he refers to commercial activities and interprets the sources of wealth of both peoples and specific known traders of his time; he recognizes the importance of mines and other resources for the economic growth of a city; he recognizes and emphasizes on the fact that the growing desire for wealth accumulation is the real motive behind war and expansion.

According to J. Andreev (1988) even Homer, two centuries earlier, gives evidence about the statistico-economic and social structure existing both before him and at his time. Furthermore, John Locke (1632–1704) writes about the "Works and Days" of Hesiod, the forerunner of the Labor Theory, in particular the Agricultural Labor. In K. Singer's (1958) opinion the "Works and Days" is a relatively short work which contains a well conceived examination of the problem of scarcity, choice, and allocation of resources on the micro-macro level, and seeks to emphasize the centrality of the issues for the well-being of people.

Maronitis (1964, p. 77) notes that whatever is presented in Herodotus's retroactive history has the ability to unite the past with his present. This is achieved by explaining everything either as fact or as a person's action. Consequently, Herodotus was obliged to follow these persons' footsteps. The "Histories" had their roots in the tradition of philosophical quest, and his poetic goal was to immortalize great deeds. S. C. Humphreys (1978, p. 227) suggests that "Herodotus followed tradition and did not decide to found a new literary genre." R. W. Macan (1985) calls him the father of criticism, and the Souda dictionary writes that Herodotus was one of the renowned.

It has been argued by C. G. Starr (1968, p. 140) and G. Lachenaud (1978 p. 474) that statistico-economic factors rarely play a role in Herodotus. However, when he wants to define the concepts of numbers, equilibrium of probabilities, survival data, sampling data, strategies, predictions, socioeconomic status and estimations, statistico-economic factors play an important role. They are also present when he acknowledges the economic importance of land and when he says that no land is self-sufficient (VI, 32). Statistico-economic factors in Herodotus are significant in the following cases: when he refers to trades and migrations, when he interprets the origins of the wealth of the Persians, Naxians, Corinthians and other important traders such as Charaxus and Kolaius. Moreover, Herodotus seems to take these factors into consideration when he describes tax-systems under which such wealth is accumulated, when he admires the gold and oil found in various places, and when he states (III, 95) the interesting ratio of 13 to 1 between gold and silver namely "if the gold be reckoned at thirteen times the worth of silver." In addition, they are traced when he acknowledges the importance of mines and wood for gradually growing a city-state, when he makes demographic observations and, finally, when he regards wealth and money as a motive for an imperialistic policy or the profusion of wealth as a basis for strategic and political predominance. In conclusion, it can be deduced that Herodotus has definitely conceived the notion of statistico-economics and recognizes the importance of the role of the political life, both for the individuals and the State.

Both of Homer's epic poems, *The Iliad* and *The Odyssey*, and Herodotus's stories, were meant to be recited to an audience. A close reading or rereading of Herodotus is an experience worth having from many points of view, not the least of which is the statistical standpoint. I trust that this discussion will stimulate further interest in quantitative aspects of the ancient world.

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