À la mémoire de Fernand Braudel..

Fernand Braudel (1902 – 1985)

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“Toute la politique part d’un grain de blé”

Honoré-Gabriel Mirabeau (1789)

᾽Αλλὰ μὴν πρώτη γε καὶ μεγίστη τῶν χρειῶν ἡ τῆς τροφῆς παρασκευὴ τοῦ εἶναί τε καὶ ζῆν ἕνεκα / But the first and most important of all needs is food, upon which our very existence and life depends.

[Plato, *Republic*, 369 d]

Κρύψαντες γὰρ ἔχουσι θεοὶ βίον ἀνθρώποισιν·
ῥηιδίως γάρ κεν καὶ ἐπ' ἤματι ἐργάσσαιο,
ὥστε σε κείς ἐνιαυτὸν ἔχειν καὶ ἀεργὸν ἐόντα·
αἶψά κε πηδάλιον μὲν ὑπὲρ καπνοῦ καταθεῖο,
ἔργα βοῶν δ' ἀπόλοιτο καὶ ἠμιόνων ταλαεργῶν.
ἀλλὰ Ζεὺς ἔκρυψε χολωσάμενος φρεσὶν ᾗσιν.

For the Gods keep men’s livelihood hidden
indeed, you could easily have worked even for a day,
to keep yourself for a year, though remaining idle.
Immediately you could hang your steering oar over the fireplace
and the toils of oxen and hardworking mules would cease.
But Zeus, because of the anger in his heart, hi dit.

[Hesiod, *Works and Days*, 42-47, translated by A. T. Edwards (2014), pp. 44-45]

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Surplus, subsistence and shortage

The grain supply of the Graeco-Roman Mediterranean, between agrarian economy, markets and civic institutions (1st -3rd c. AD)

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General introduction

Prolegomena

The Ancient Graeco-Roman world is marked by a stubborn paradox. Greek and Roman societies had attained levels of urbanization nearly unknown before the eighteenth century, with several *megalopoleis*, like Rome and its 1 million residents in the 1st c. AD, Athens, Alexandria, Carthage, Ephesos, or Antioch…; despite obvious variations over time and space, it periodically raised large parts of the population to unexpected levels of material well-being in the landscape of pre-industrial societies; it established innovative political institutions, developed sophisticated amenities, and yielded ground-breaking scientific and philosophical works that still constitute a fundamental part of European heritage. And yet it collapsed. Apart from the idea once expressed by Oswald Spengler that cultures and political constructs follow a life cycle inexorably leading to their decay, the reasons of the decline of ancient Graeco-Roman civilization and its economy has given rise to an ever-lasting debate. Some approaches have emphasized climatic changes and demographic causes (migrations, epidemics, etc.) – *i.e*. external causes – while others have underlined internal causes, such as the rise of Christianity (this was the famous thesis of Gibbon in 1776) or monetary policy. In fact, there is now an increasing consensus among ancient historians that the crisis of the Roman Empire and of ancient city-state culture involved numerous factors together in complex relationships, and it is their interplay and mutual reinforcement, rather than a single *deus ex machina*, which should be viewed as the crucial explanatory factor.

I must confess, however, that I have always been skeptical about considering that the political or institutional collapse of ancient Greek and Roman societies would equate the decline of ancient culture, economy and way of life. In many cities, and even more in rural areas, what Fernand Braudel has labeled the 'the structures of daily life' must have long remained unaffected by the political dismembering of the Empire. The idea of a continuity between before and after the fall of the Roman Empire is not new: it was already the grand theory of Henri Pirenne that the actual 'end' of Antiquity

resulted from the rupture of the of the economic and cultural unity of the Mediterranean basin in the 7th c. AD due to the rise and expansion of Islam. Fernand Braudel has shown, however, that the decrease in economic activity in the Mediterranean Sea had already begun long before the birth of the Prophet Muhammad. Yet, I think that the intuition of Pirenne, reworked later by Braudel, bears a fundamental truth: Graeco-Roman civilization was largely characterized by the intrinsic consistency of the Mediterranean Basin – beyond its ecological or cultural fragmentation – to which I would add civic political culture. It is for this reason that I have widened the geographical focus of this study, which was initially centered on Asia Minor, to the whole Eastern Mediterranean.

In the last fifty years, the focus of ancient scholarship has progressively abandoned investigating the issue of the 'collapse' of ancient Greek and Roman civilization and turned towards examining its socio-economic success instead. Much of this debate has been – and still is – dominated by the question of economic growth. I cannot provide a detailed explanation of why I think this approach can be no more than an intellectual tool to renew our methodological approaches to the ancient economy; yet, two remarks need to be stressed : first, although the concept of growth is theoretically no less applicable to the ancient economy than to ours, we lack – and will always lack – the required data to accurately measure ancient economic growth in a way that would allow comparison with other societies; second, the focus on economic growth – even in modern economics – too often overlooks the impact of the distribution of wealth between regions and social categories. Per capita output, it should be remembered, is no more than an intellectual construct to take account of population variations. It tells us nothing *per se* of how this production was appropriated, distributed, or consumed.

A more fruitful framework is perhaps to approach ancient economies in terms of living standards (or, as Braudel would say, of 'material life'[1]), and to examine them in terms of achievements and limits rather than of success and failure. In this framework, notably represented by the network *Structural Determinants of Economic Performance in the Roman World* (SDEP), questions of natural resources, environments, social groups and political institutions, are among the major factors shaping the economy. Access to food – and, above all, grain – is evidently one of the most important aspects of the material life of ancient populations, which lies at the crossroads of those determining factors.

[1] Braudel (1979), p. 10

Introduction

From grain to fuel: object and purpose of the research

In his famous *Prière sur l'Acropole*, French writer Ernest Renan described with lyricism how much he had been impressed by his visit of the Acropolis, which, he says, was the testimony of a true 'Greek miracle'. Nothing, however, of what Renan could admire of the Parthenon, or the Coliseum or any famous ancient building would have ever existed if the workers and slaves who built them had been starving. The same applies to the famous battles we love hearing about, and to the games and festivals which are so commonly used as typical embodiments of Antiquity: in an economy where labor is the principal production factor of both agricultural and non-agricultural commodities, an adequate supply of grain to the population was truly the economic pillar of the cultural, political and institutional superstructure. Since it provided the main source of calories at a relatively low cost, grain was by far the most important economic organic item of ancient Greek and Roman societies. In a sense, grain was as important to Greeks and Romans as fuel is to us: it was, by and large, their principal source of energy, since human labor was the major production factor. Moreover, the issues faced by ancient Greeks and Romans are still issues that people face nowadays in some regions of the globe: speculative hoarding, market failures, food riots...It is no surprise that such events occur today in Mozambique or India, that is, in economies which still exhibit some common features with pre-industrial societies. In a period where the world population exceeds seven billion people, the question of the relationship between Humans and their resources is more accurate than ever.

In order to shed some new light on the achievements and limitations of ancient economies, the purpose of this investigation will be to examine the *determinants* of the grain supply of ancient Greek and Roman populations, the most important of which can be listed straightaway:

- The environmental conditions (soil, climate) and the efficiency of agriculture under specific farming practices
- The exploitation of resources and the management of the produced surpluses
- The efficiency of the different supply channels and the extent of civic grain-related interventions

The subject however requires some geographical and chronological narrowing. Hence, this project will focus on the Eastern Mediterranean, and more particularly on Asia

Minor understood in the broad sense of the whole Anatolian peninsula (the Roman province of *Asia*, Bithynia and Pontus, Cilicia, Phrygia and the central plateau of Galatia; cf map on next page[2]). Anatolia is an interesting case study because it offers abundant epigraphic evidence of grain supply intervention by civic magistrates, which will form the core chapter of this research. It has also received comparatively less discussion with regard to regions like Attica of the Latium.

The three determinants listed above form the basis of the research questions which will guide this research. These questions are the following:

(1) How conducive were environmental conditions of Roman Anatolia to agricultural production?
(2) Beyond the environmental setting, what were the factors determining the size of available surpluses and how were these surpluses managed?
(3) What were the precise channels through which cities gained access to grain supply and which forms did élite involvement in these channels take ?
(4) How did grain -related intervention vary over time and across space ?

There is an obvious connection between those issues: environmental conditions set the limits of the possible and the impossible, which human activities can only offset with considerable difficulty, all the more in a preindustrial society. On this layer of ecological constraints, socio-economic factors influenced the distribution of the surplus between regions and social groups. Finally, various mechanisms – mostly markets, élite munificence and civic institutions – intervene to overcome the effects of both environmental and socio-economic forces. Michael Rostovtzeff had well understood the relevance of this interaction of factors. So much, actually, that it led him to claim that the prevalence of civic grain funds in the East compared to the moderate frequency of grain specific magistrates in the West was due to the fact that cities of the Eastern Mediterranean had outstripped the carrying capacity of their hinterland[3]. In this investigation, I will try, among other things, to disprove this claim of him.

[2] The reader may refer to this map for several regions and cities referred to in this thesis.

[3] Rostovtzeff (1927), p. 139

Administrative division of Asia Minor and major cities in AD 152 [Ref : Marek (2016), p. 340]

Structure of the argument

After briefly presenting the material on which my research has been based, I will explain in some detail the specific and quite uncommon methodologies which have been implemented in some parts of this thesis. Then, I shall concisely sum up previous views regarding ancient food supply and élite intervention before entering the subject *per se*.

I will open the discussion on the major constraints which shaped food production in Roman Anatolia: the climate and environment of the region, its population level and urbanization, and most importantly the farming practices in operation. I will argue that the productivity of Anatolian agriculture in the Graeco-Roman context has been underestimated due to misconceptions regarding the extent of intensive farming.

The second chapter will deal with the conditions of surplus production and surplus appropriation in the form of rents and taxes. In this part, I will come up with an alternative economic model of agricultural production, which will reassess the dependency of total agricultural output to the ratio of labor to land, and I will argue that, most of the time, agrarian production in the Graeco-Roman context is not governed by any insuperable principle of diminishing returns. Then, I will account for the patterns of surplus extraction by landowners and Roman taxation, through the analysis of regional and epigraphic sources.

Finally, in chapter III, I will detail the major mechanisms involved in the cities' grain supply, namely: élite munificence, civic institutions, and markets. As ancient grain markets have already been extensively discussed by previous scholarship, my contribution to this debate will be only marginal, and I will mostly focus on patterns of grain—related intervention by civic élites and civic supply systems. In this part, I will argue, *inter alia*, that (1) the lexical diversity of grain-supply intervention reflects an intense specification of tasks among city officials; (2) cities (and, less frequently, other levels of power) intervened regularly in the grain supply; (3) that civic grain funds were overall a far more sustainable system than scholars had previously thought; and that (4) there is a rationale of grain-supply interventions which accounts for both élite munificence regarding grain (or food) gifts and civic institutional frameworks.

Sources and methodology

Data and documentary sources

This research is essentially based on five types of sources. The fundamental material analyzed here consists of inscriptions. The collected corpus totalizes some 240 inscriptions, 205 of which are specifically dealing with the food supply, while the others concern connected subject such as prices, rents, landed wealth,...etc. These inscriptions are naturally crossed with literary sources, which mostly consist of *annals*, biographies, or political writings *sensu lato*. Juridical sources, namely the *Digest*, also bring important complementary information. Finally, archaeological material is used incidentally in some specific cases.

Methods (1) – Interdisciplinary approach: the contribution of philology, economics, environmental sciences, and social sciences

As far as disciplines and data analysis are concerned, the principal methodological characteristic of this investigation is its interdisciplinary character. The interdisciplinary approach is not a mere fashion. Nor is it the panacea for improving historical research. But it is of particular interest in the framework of social and economic history, *a fortiori* when dealing with the food supply and the agrarian economy. Indeed, environmental conditions, agricultural practices, political institutions, social structures, customs and social norms, economic mechanisms of resource management and demographic trends are all intertwined and thus require a comprehensive and wide-ranging approach, impossible without methodological flexibility.

It is trivial – and almost useless – to say that the starting point for historians – especially of Antiquity – is the reading of ancient sources. Philology and documentary analysis (papyri or inscriptions) are the *conditio sine qua non* for extracting information – whether qualitative or quantitative – from ancient texts[4], and constitute the inevitable first step towards other more refined treatments of the data. From there, we will use our primary sources – mainly inscriptions – and literary texts from a qualitative perspective in order to discuss the ancient 'agrarian system' (cf. below),

[4] All translation presented in this dissertation are my own, unless specified otherwise.

land management and exploitation, and above all the forms of intervention in the grain supply and the role of institutions in this matter. But we will also use both literary sources and inscriptions in a quantitative perspective, the former for undertaking a statistical analysis of grain-related offices, and the latter for reconstructing the chronological and geographical spread of grain-related interventions.

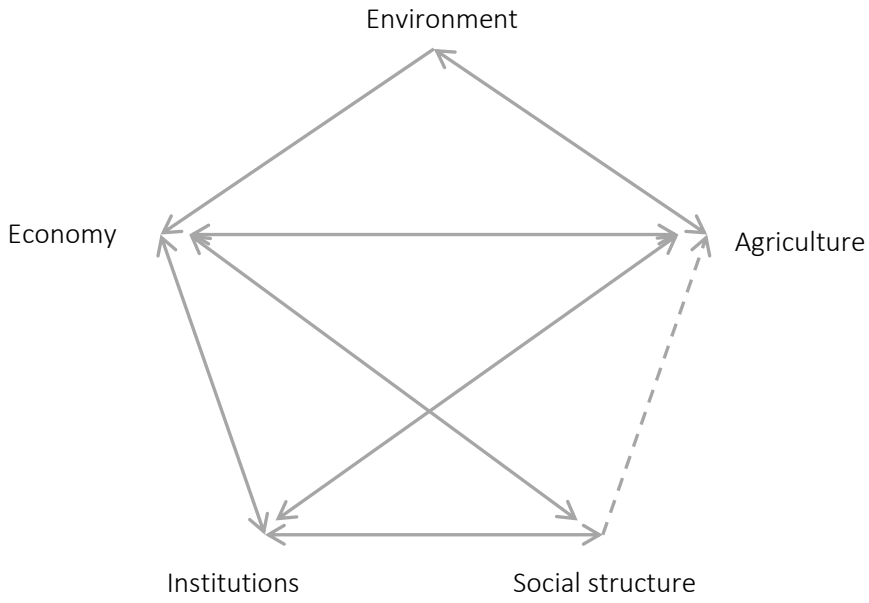
Grain supply is intrinsically connected to various crucial issues: productive capacities and consumption patterns, distribution, management of land and labor, fluctuations of prices...etc. But the changes in *grain accessibility* – a probably more relevant concept than *grain supply* as will be advocated in chap. III – have very diverse effects according to the location and social position of individuals: town residents and country dwellers, middling citizen groups and wealthy councilors never endure identically the effects of a similar cause, and do not play the same role in the channels of food supply. For all these reasons, this investigation will be conducted in a resolutely socio-economic perspective and will thus regularly leave space for the application of concepts and theories borrowed from economics, as is the case in Erdkamp's and Temin's book, although P. Temin in fact reduces 'economics' to essentially 'neo-classical economics'.

Environmental sciences – and agronomy in particular– provide a further crucial methodological tool in order to undertake an integrated approach of the subject. Of course, environmental history – for all periods – is now on a roll, due to the current issues being at stake in our societies; yet, adding this perspective to an already diverse methodological toolbox is not a fancy attitude. Accounting for the ratio of available grain to the number of mouths to feed is directly influenced by the underlying assumptions we make regarding cereal yields, which in return are heavily dependent upon the local geomorphologic and climatic conditions as well as on farming practices. The fruitfulness of the contribution of earth sciences to history and archaeology need not be demonstrated anymore, as outstanding studies have now dramatically advanced our knowledge of the past. Perhaps the better examples of such ecological-environmental history are R. Sallares *The Ecology of the Ancient Greek world* (1991), Horden & Purcell's *The corrupting sea* (2000), and more recently the book by J. D. Hughes (2014) *Environmental problems of the Greeks and the Romans*

Finally, as history is first and foremost a matter of human behavior and collective dynamics, this research will also occasionally make use of theories and concepts borrowed from anthropology and sociology, and thereby frame some of our findings in a diachronic perspective in order to understand Graeco-Roman society in its relative continuity with other civilizations. This approach follows a scholarly tradition of ancient historians who have shed some new light on Antiquity by using concepts and theories developed by modern philosophers or social scientists : G. De Ste Croix (1981)

and E. Meiksins Woods (1988), who applied a neo-marxist analytical grid to ancient Greek history; the 'Weberian' approach among ancient historians, whose most renowned representative is probably Moses Finley. This approach was further elaborated by by J. Love (1991) in his book *Antiquity and Capitalism*. Finally, more recently scholars reassessed the role and nature of gifts in ancient societies on the basis of the theories developed by Marcel Mauss and, some decades later, by Pierre Bourdieu. The use of such concepts and theories is obviously not neglecting the crucial importance of historical context; rather, it comes down to acknowledging that, 'if history never repeats itself, it often rhymes', as Mark Twain once wrote.

J. Poblome has recently advocated that future research should seek to better integrate a wide range of proxies together with theoretical frameworks opened by the increasing contribution of economic archaeology and natural science[5]s. This contribution to the ongoing debate on the food supply in preindustrial societies constitutes an attempt at addressing this salutary recommendation.



System component interactions and interdisciplinary approach

[5] Poblome (2015), p. 140

Methods (2) – Models and formalization

Beside the interdisciplinary character regarding the disciplines involved, this research will also attempt at combining a variety of methods concerning the way of analyzing and interpreting the data. Direct exposition of – and inference from – the sources will take place in some parts of the analysis, in an attempt to decode the precise meaning and functions of the various grain-related offices. Here, nothing works best than the systematic interpretation of literary or epigraphic mentions taken individually, in order to allow the potential patterns to emerge from the addition of separate examples. For the main part of the investigation, however, important place will be left to the development of interpretative models.

The concept of 'model' is somehow ambiguous: on the one hand, it may refer to a theoretical scheme in which various variables or events are linked with one another in causal relationships. This is, for instance, the case of the 'taxes and trade' model developed by Keith Hopkins. On the other hand, the notion of 'model' designates a quantitative simulation, relying on definite algorithms, which computes a series of numerical variables. These quantitative models themselves can be divided into two families: the random (or stochastic) models, and the deterministic models. Deterministic models are those in which a set of equations predicts the behavior of one (or more) dependent variable. A very famous example is the well-known model developed by John Maynard Keynes which desribes how Gross National Income reacts to changes in tax rate, government expenditure, investment, consumption, or commercial balance[6]. In historical scholarship, deterministic models have been applied, among others, by P. Bang in trying to estimate the subsistence consumption in the Roman Empire as a function of the share of surplus taken by the imperial élite, and by. A. Zuiderhoek when he calculated the proportion of élite income spent on munificence as well as its relative weight compared to the civic expenditures[7]. Stochastic models, on the other hand, are those in which the behavior of the dependent variable is not pre-defined by a stable relationship, but rather displays a probabilistic behavior. Birth and death, for instance, are typical random events. The use of such simulation models is not new in the field of ancient history: Richard Saller used a stochastic model to analyze how the distribution of patrimony would evolve among a given population of Romans according to the randomness of births, deaths and marriages[8]. Lately, M. Lavan has developed a Monte-Carlo simulation model (cf.

[6] Keynes (1936)

[7] Zuiderhoek (2009), pp. 24-27 ; 37-51.

[8] Saller (1987), pp. 21-34 & Saller (1994)

Chap. III) to quantify the evolution of the number of roman citizens before the Edict of Caracalla[9]. Both random and deterministic models share a common feature: they need the independent and dependent variables to be connected; in other words, they need equations. In the models I built, whether 'deterministic' or random, the reader might consider them overly mathematic. Yet, I do not use mathematics rhetorically to impress the reader or to overemphasize the importance of rigor. In a recent essay, American economist Dani Rodrik has very clearly explained the usefulness of mathematics in quantitative models. Allow me to quote him in full :

> 'It has little to do with sophistication, complexity or claim of a higher truth. Math essentially plays two roles [in economics], neither of which is for glory: clarity and consistency. First, math ensures that the elements of a model – the assumptions, behavioral mechanisms, and main results – are stated clearly and are transparent. Once a model is stated in mathematical form, what is says or does is obvious to all who can read it. (...) The second virtue of mathematics is that it ensures the internal consistency of a model – simply put, that the conclusions follow from the assumptions.'[10]

I must confess that some of the most famous deterministic models in ancient economy, those of K. Hopkins and W. Jongman, have often puzzled me because the actual connections between independent and dependent variables, as well as their relations of proportionality were *not* expressed in a mathematical form. Let me give an abstract example of what is problematic in keeping the mathematics implicit. Stating that 'the soil productivity increases as the number of laborers per unit of land increases' is one thing, but it does not say if this increase is linear, exponential or follows a power-law. This might seem like a detail, but as I will show in Chap. II, the actual mathematical relationship between two variables can have a dramatic impact on the conclusions of the model. It is mostly for this reason that I chose to be transparent and express my assumptions in mathematical form, even if at the cost of an apparently increased complexity or abstraction.

Whatever the way they are expressed, models respond to a legitimate question among scholars: how can we increase and refine our knowledge and understanding of past societies? There are, usually, three ways : (1) a new reading or interpretation of existing documents; (2) the discovery of new material (literary or archaeological)

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[9] Lavan (2016), pp. 3-46

[10] Rodrik (2015), pp. 31-32

which contradicts existing theories; and (3) the analysis of historical data with new methods, sometimes borrowed to other disciplines (economics, social sciences, earth sciences,…etc). The process of archaeological and historical discoveries can obviously not be planed; it is partly tributary to the survey policies and accessibility to unused material, and partly random. Hence, in the absence of a continuous inflow of new documents, the historian is confronted to the Iron law of the fragmentary nature of its data. In this situation, once all the information that could be extracted from a body of documents has been analyzed, discussed, and confronted to opposing views, and that ongoing issues cannot be solved, there are two possible attitudes: the first, and logical attitude, is to keep the questions open and apply the famous assertion of Ludwig Wittgenstein: 'whereof one cannot speak, thereof one must be silent'. The other possible attitude, in the absence of data that could bridge the gaps in our knowledge, is to 'simulate the ancient past', to borrow W. Jongman's phrase[11]. In other words, the idea is to reconstruct, through logical relationships, the way variables are likely to have influenced one another in a specific context. This of course, requires simplifying complex realities. For us historians and archaeologists who are trained to pay attention to the details of various historical and cultural contexts, and who are precisely accustomed to emphasizing the complexities of the situation we are studying, these necessary simplifying hypothesis may often seem fanciful. However, simplification in itself is no evil. Dani Rodrik, once again, has clearly discussed the conditions of validity of (economic) models. Let me quote his argument, which I follow in this study:

> 'For a model to be useful in the sense of tracking reality, its critical assumptions also have to track reality sufficiently closely. What exactly is a critical assumption? We can say an assumption is critical if its modification in an arguably more realistic direction would produce a substantive difference in the conclusion produced by the model. Many, if not most, assumptions are not critical in this sense.'[12]

In other words, some unrealistic assumptions can be fine as long as they do not have a crucial effect on the outcome of the model.

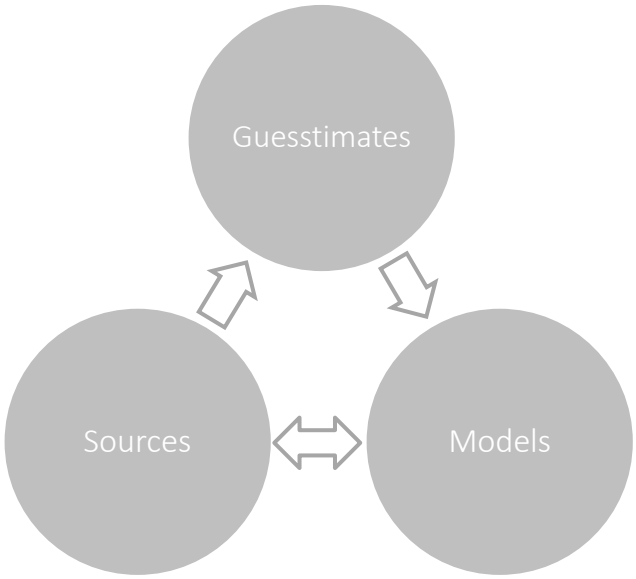
This is an important step, but it still leaves one aspect of models undiscussed: their inputs. Contemporary economists have the advantage that they can test their models by confronting them with a huge quantity of data; ancient economic historians

[11] Jongman (1988), p.19

[12] Rodrik (2015), p. 27

do not have this luxury. This means that several parameters of the model are not accessible from the documents. To overcome this problem, I will follow a widely used method among historians (notably by K. Hopkins and P. Bang[13]), which M. Hansen has labeled 'the shotgun method', and which consists of filling the gaps of our model with a set of reasonable guesstimates. Hence, the models can be run by combining the few quantitative data at our disposal in the sources – once given a critical discussion – and some reasonable quantitative speculations What we should remind here is that, unlike economists, accuracy of the result is not our main goal; what we are looking for is merely to obtain an order of magnitude. Compared to our near ignorance of the answers to some questions to which our documents alone cannot provide a solution, having at least a notion of the orders of magnitude and the rough distinctions between what is likely and what is unlikely is still better than nothing.

The methodological position I would like to defend here is that of the variety of methods. Innovation is not an end in itself. My claim is that different problems are often best addressed using different methods, or by a combination of many. In some parts of this study I will rely on the inference from the sources, while in some others I develop both deterministic and random models. To quote W. Jongman once again, 'Pure induction is an illusion, as is pure deduction'[14].



Protocol for interpreting the data and constructing information

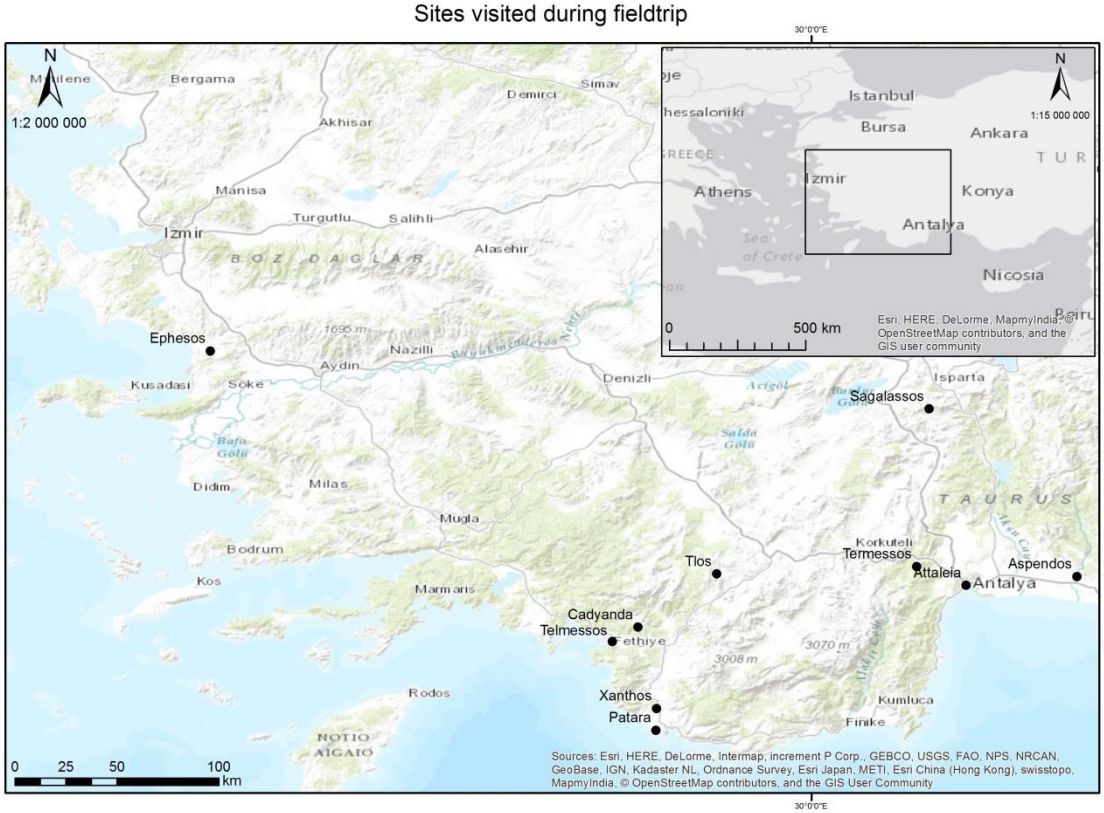
[13] For instance : Bang (2008), pp. 85-88 & 117-118

[14] Jongman (1988), p. 187

Field trip

A final methodological aspect of this investigation was gaining some field experience. Unlike archaeology, most of historical research on various subjects can yield excellent results without having ever seen the region we are studying. This is also true of economic history. However, for such a tangible matter as the agrarian economy and the consumption of food, it seemed important to go on the field and visit some of the sites discussed in the thesis. To do this, I undertook two trips in Turkey: one near Izmir in September 2014 and one field trip in South-West Turkey (the ancient regions of Lycia and Pisidia) in summer 2016. Overall, I was able to visit ten ancient cities (cf. map below), which I chose so as to a roughly equal proportion of mountain, plain and coastal sites. I do not claim that this revealed any new truth, or that it was indispensable to the project. However, this influenced the way the research questions have been structured, and definitely convinced me of the importance of integrating the study of environment and local topography in research on food supply and agrarian history.

Sites visited during fieldtrip



Historiographical debates and theoretical framework

Food: production, distribution and intervention

The study of the food supply is not a new topic of ancient social and economic history, though it probably received less attention than coins or craftsmanship, either because of the (obvious) absence of material remains, or because it belonged to a cohort of topics which were not perceived as 'noble' before the methodological revolution brought by the *Annales*. The first complete study of ancient food supply dates back to A. Jardé (1925) who undertook a systematic study of cereal production in Hellenistic and Classical Greece by successively examining agricultural conditions (crop varieties, yields, areas under cultivation, farming practices,…), the modes of land exploitation and consumption requirements for men and animals. His study constitutes a rich and erudite survey which should still be a starting point of any investigation on the subject. However, as far as agricultural conditions are concerned, it relies on the assumption of a straightforward comparability of ancient Greek agriculture with its early 20th century counterpart, which, as we will see, is questionable, to say the least.

The most wide-ranging and pioneering work on the subject is doubtless the major work by P. Garnsey (1988). By the two case studies on which he focuses – Athens in Classical and Hellenistic times, and Rome in the Republican and Imperial period – Garnsey encompasses nearly the whole Mediterranean along some eight centuries. Monumental by its scope, Garnsey's work also impresses by its comprehensiveness and consistency: it is the first study on the subject which considers at once the conditions of agricultural production and subsistence strategies of peasants, the supply channels of cities and the influence of war and politics. As far as our research is concerned, the findings of Garnsey can be summarized as follows : (1) one should carefully distinguish shortage from famine : food crisis were frequent, but actual starvation were quite rare [15]Shortages were not solely dependent upon variability in environmental conditions but were largely determined by the mechanisms of grain distribution; (2) peasant strategies to ensure their subsistence relied mostly on a combination of risk-avoiding practices, involvement in non-market networks (family, patronage, and other relationships of reciprocity), and adaptation of their demographic behavior; (3) political responses to alleviate food shortages were of moderate scope and mostly inefficient. Euergetism played the major role in addressing food shortages but was

[15] Garnsey (1988), pp. 3-17

doomed to be ineffective because speculators and benefactors belonged to the same social strata; (4) the impact of the Roman Empire on the provinces was overall neutral : increased exploitation and increased stability counterbalanced each other, while most of the time imperial governments did not intervene to undermine the effect of shortages outside Italy.

Catherine Virlouvet (1995, 2009) has undertaken the most detailed study of the legal, social and logistic aspects of grain distributions in Rome – and sketched the comparison with the provinces. – by combining literary evidence, inscriptions and archaeological material (*tessera*). She has revealed the frequent deviations from the rule defining the accessibility conditions to the *plebs frumentaria* – the recipients of the grain distributions, and shown that poverty was far from the principal criterion.

P. Erdkamp (2005) has provided the most recent and complete reassessment of the question since the book of P. Garnsey. He focuses on the grain market(s) throughout the Roman Empire, understood in the broader sense of supply mechanisms and networks. His main conclusion is that a structural responses in the form of civic infrastructures aimed at ensuring a more or less regular grain supply because markets were most of the time unsuccessful in coping efficiently with shortages.

A. Moreno (2007) constitutes to some extent an update of Jardé's pionneering study, but focused on the case of Attica. Moreno argued at once that Athens was a structural importer of cereals in the major part of its history *and* that the policies set up by the Athenian *polis* managed to overcome its demographic overload compared to the carrying capacity of its hinterland. Whether Athens was closer to the exception or the rule among ancient Greek cities is however another matter

Munificence *versus* civic finances

In parallel to the different approaches of provincial food supply in the Graeco-Roman world, the dialectical relationship between euergetism and civic funds will be a regular question during this investigation. Views on civic finances have long been pessimistic. Even the modernist Rostovtzeff argued that revenues of cities were barely sufficient to pay for their expenses, and that benefactions therefore played a major role in their food supply[16]. Similarly, for Saller & Garnsey, the weakness of civic finances rendered

[16] Rostovtzeff (1927), p. 141 sqq

private *largesse* necessary[17]. M. Sartre even considered that the cities' expenses far exceeded their income[18].

Other scholars have however countered this view of insufficient and fragile civic finances, which they present as more stable and resilient. The most representative scholar of this stream of thought is probably Léopold Migeotte. In his various works regarding the finances of ancient Greek city-states, Migeotte essentially argued that we should acknowledge the important diversity of the sources of civic funds: 'public and sacred funds, surplus management, subscriptions, loans (…) and improvising, if needed, by asking for the financial support of some notables'[19].

Following Migeotte, P. Fröhlich claimed that 'we should not envisage everything through the angle of the financial distress of cities'[20]. The most recent comprehensive revision of the relative importance of euergetism is owed to Arjan Zuiderhoek. In his book *The politics of munificence in the Roman Empire*, Zuiderhoek calculated the average élite expenditure on benefactions. Basing himself on a quantitative model of an ideal-type city's GDP which he confronts to a sample of sums relating to benefactions, he showed that the financial importance of euergetism should be revised downwards[21]. On the other hand, Hertha Schwartz presented a detailed study of civic revenues in Asia Minor during the Principate. Her investigation revealed that we can find little indices of chronic financial difficulties of the cities of the regions she analyzed, and that liturgies or *summae honorariae* did not count much in the civic budget[22].As will be seen in this research, these challenging results agree well with our reassessment of the role of civic funds and infrastructures in urban grain supply.

[17] Garnsey & Saller (1987), p. 58
[18] Sartre (1991), pp. 135sqq
[19] Migeotte (1995), p. 86
[20] Fröhlich (2005), p. 251.
[21] Zuiderhoek (2009), pp. 24-36
[22] Schwartz (2001), pp. 313-325

Chapter 1
Subsistence, populations and environments

This introductory chapter aims at sketching the broader context into which the specific issues of grain production and distribution must be set in Roman Anatolia. In it, I will discuss the main variables affecting grain needs and grain production:

(1) The population of Asia Minor, its rate of urbanization and its aggregate nutritional requirements ;
(2) The environmental conditions, namely the geomorphology of Anatolia and the climate of the eastern Mediterranean;
(3) Finally the general characteristics of the Graeco-Roman agrarian system (with the specificities regarding Asia Minor), focusing on crop varieties and the level of cereal yields;

1.1 Subsistence needs and socio-demographic constraints

1.1.1 Nutritional requirements and food consumption

The starting point of subsistence needs is naturally the physical requirements of men. A sufficient staple food intake is indeed the *conditio sine qua non* of the reproduction not only of the labor force which constitutes the foundation of the economic structure of society, but also of the perpetuation of the political and cultural activities. The matter is not as simple as it may seem at first glance, for daily subsistence requirements vary greatly between men and women, between adults, the elderly and children, well-to-do and poor people, as well as relative to an individual's degree of

physical activity. Based on FAO estimates, Foxhall & Forbes – whose study is still the most comprehensive on this subject – conclude that a very active male (agricultural laborer or unskilled worker) in his 20's or 30's requires some 3,340 cal/day.[23] Braudel reckons with a somewhat higher figure of between 3,500 and 4,000 cal/day[24]. Overall, food consumption made up some 60-80% of a household's budget.

1.1.2 Population and urbanization in Roman Asia Minor

From the household or individual level, we must know move to the aggregate level of grain requirement, which depends upon the size of the population to be fed. Several attempts at calculating the population of Anatolia in Graeco-Roman times have been made. There are, as usual, low counters and high counters: in his pioneering study on the size of ancient populations, K. J. Beloch suggested a total population of Asia Minor of 13 million people[25], hence definitely paving the way for the high counters, since the census in Turkey in 1927 yielded a population size of some 14 million inhabitants. A few decades after Beloch, in what is undoubtedly the richest and widest survey of Asia Minor, T. R. S. Broughton initiated the low count view with an estimate of 7.3 million inhabitants[26]. Some decades later, McEvedy & Jones reckoned with an even more pessimistic figure of 6 million inhabitants[27]. The first study to go beyond these mere guesstimates is that by Stephen Mitchell. By combining data on settlement patterns, land use and management, and agricultural techniques, by reconstructing the circulation of grain from production to consumption whilst taking into account the interplay of rents and taxes and the disparities between town and countryside, he suggested a total Anatolian population of 8.19 million residents, which he considers to be an underestimate[28]. An almost identical estimate has been made by Frier who posits an Anatolian population of 8.2 million residents under Augustus, but argues that the region experienced non-negligible demographic growth and reached 9.2 million people by AD 164[29]. In his massive investigation of world economic history, Maddison arrives at a total of 8 million people[30]. Finally, Scheidel suggests a somewhat intermediate

[23] Foxhall & Forbes (1982), p. 49
[24] Braudel (1979)
[25] Beloch (1886), p. 507
[26] Broughton (1938), p. 619
[27] McEvedy & Jones (1978), p. 115, 135 & 139
[28] Mitchell (1993), p. 244
[29] Frier (2000), p. 812 & 814.
[30] Maddison (2007), p. 25

figure between high counters and low counters with an estimate of 9-10 million residents[31].

How was this population distributed between town and countryside? Here estimates seem to find agreement easier. Goldsmith once suggested that the average urbanization rate in the provinces would be around 11.5%[32]. However, the East was notably far more densely settled than the West[33]. Scheidel thus suggests that the urbanization rate in the East would not have exceeded 20%[34].

1.2 Environmental constraints: landscapes and climate of the Eastern Mediterranean (100 AD – 400 AD)

The geomorphology of Asia Minor is largely shaped by tectonic forces, which gave rise to the two major mountain chains of the region: the Pontic chain to the North, on the southern coast of the Black Sea, and the Taurus chain to the South, on the northern façade of the Mediterranean Sea. Similarly, the Sea of Marmara (the Propontis depression) and the fertile valley of the Meander which irrigates the Western coast are the result of fault lines[35]. The complex geological configuration of the Anatolian Peninsula generated four main biogeographical units: the Tauric region (Pisidia, Lycia, and Cilicia), the Pontic regions (Bithynia-Pontus and Paphlagonia), the Aegean Coastland and the Central plateau (mainly corresponding to the ancient regions of Galatia and Phrygia)[36]. These geomorphological processes are not without influence on the local weather conditions, since mountains play a crucial role in blocking and cooling water laden clouds. Hence, it is no surprise if the northern and southern mountain regions are also those where the highest levels of average annual rainfall[37].

From a climatological point of view, the Mediterranean basin is a semi-arid, subtropical climate mainly characterized by a marked contrast between a hot a dry summer and a colder and wet winter – with only very short and discrete autumn and

[31] Scheidel (2007), p. 48

[32] Goldsmith (1982), p. 272 n.49

[33] Frier (2000), p. 812

[34] Scheidel (2007), pp_48-49

[35] Bresson (2016), p. 32

[36] Bridges (1991), pp. 151-152 ; Arena (2005), pp. 47-48

[37] Arena (2005), pp. 51-52

spring seasons – and subject to a strong inter-annual variability in both rainfall and temperature. In terms of regional spread, Braudel used to locate the Mediterranean climate between the northern limit of the olive tree and the southern limit of continuous palm groves[38]. Yet, these general characteristics, which are valid for most of the basin, should not conceal the instability of the Mediterranean climate, whose dynamic is extremely complex. The summer-winter alternation throughout the Mediterranean mostly obeys atmospheric features, in particular the changes in the North-Atlantic Oscillation (NAO), which has indeed widely been identified as the dominant factor affecting wind regimes and rainfall in the Mediterranean by commanding the intensity and trajectory of Atlantic depressions over the Mediterranean Sea[39]. The NAO also plays an important role with regard to the specific weather conditions in the central and Eastern Mediterranean : Atantic depressions lose energy along their eastward path, but keep carrying masses of cold air which, once they enter into contact with moister and warmer air of the oriental basin, result in atmospheric instabilities, precipitations, and cyclones. However, it is now increasingly argued by climate scientists that the NAO does not have as strong an effect on the eastern basin as it does on the western basin. As far as the eastern Mediterranean is concerned, other atmospheric features also play a very important role, such as the Persian trough (PT) the Red Sea trough (RST), the monsoon of the Indian subcontinent[40], or the North-Sea Caspian Pattern index (NCPI), which has been shown to have a better correlation with the climate of the Eastern Mediterranean than the NAO. The consequence of the combination of these patterns is that the same stimulus such as a stronger NAO could well trigger opposite responses in the western and eastern basin.

In addition to these 'external' influences, the thermic and barometric structure of the Mediterranean basin itself plays an important climatic role: the pressure gradient between western and eastern regions might 'influence climate variability and inter-annual scales'[41]. Moreover, in addition to the Atlantic depressions, local zones of cyclogenesis play also an important role, especially in the Aegean and around Genoa and Cyprus[42]. As far as Asia Minor is concerned, an important feature affecting the wind regime of the region is the difference between Balkanic and Levantine

[38] Braudel (1990 a), p. 284

[39] Harding, Palutikoff & Holt (2009), p. 73

[40] *Ibidem* ; Ulbrich et al. (2012), pp.317-319

[41] Harding, Palutikoff & Holt (2009), p. 74

[42] *Ibidem*, pp. 74-75 ; Ulbrich et al. (2012), pp. 312-313

atmospheric pressures, which determine the well-known Etesian winds blowing over the Aegean[43].

But the most important structural feature is probably the clearly warmer sea surface temperature of the Eastern Mediterranean[44], combined to its higher thermal amplitude[45]. These particular features – variation in atmospheric circulation, higher sea surface temperature – combined with the regional geomorphology, may explain to a certain extent a very peculiar characteristic of the eastern basin, in complete opposition to the dominant pattern over the largest part of the Mediterranean sea: the observed positive correlation between precipitation and temperatures[46] – while the inverse is true for the central and western basin. Hence, although general features undoubtedly allow us to characterize the Mediterranean region as belonging to a specific climate zone – given that deviations due to geomorphologic influences are characteristic of every region of the globe and not specifically the Mediterranean – it remains nonetheless true that the climate *dynamic* may exhibit considerable variations between the eastern and western basins.

What should mostly be reminded from this discussion is that, the Eastern Mediterranean basin follows a specific pattern which is only partly similar to that of the Western basin. Regarding the Anatolian peninsula more specifically, the combination of the geomorphological and climatic characteristics results is an ecologically fragmented environment[47] in terms of altitude, bedrock, rainfall or temperature. Although the hottest and driest months are July and August almost everywhere, the intra-annual distribution of rainfall and temperature may vary considerably, as can be noticed on the climatograms of Fig. 2. As we will see later on, these two aspects are of great importance for the production and circulation of agricultural commodities.

[43] Bresson (2016), pp. 37-38

[44] Bozec (2006), p. 6 ; Shaltout & Omstedt (2014), pp. 417-418

[45] Harding , Palutikof & Holt (2009), p. 70

[46] Dermody *et al.*(2014), suppl. (fig. S6)

[47] On ecological fragmentation : Horden & Purcell (2000), pp. 78-81 & 175-176

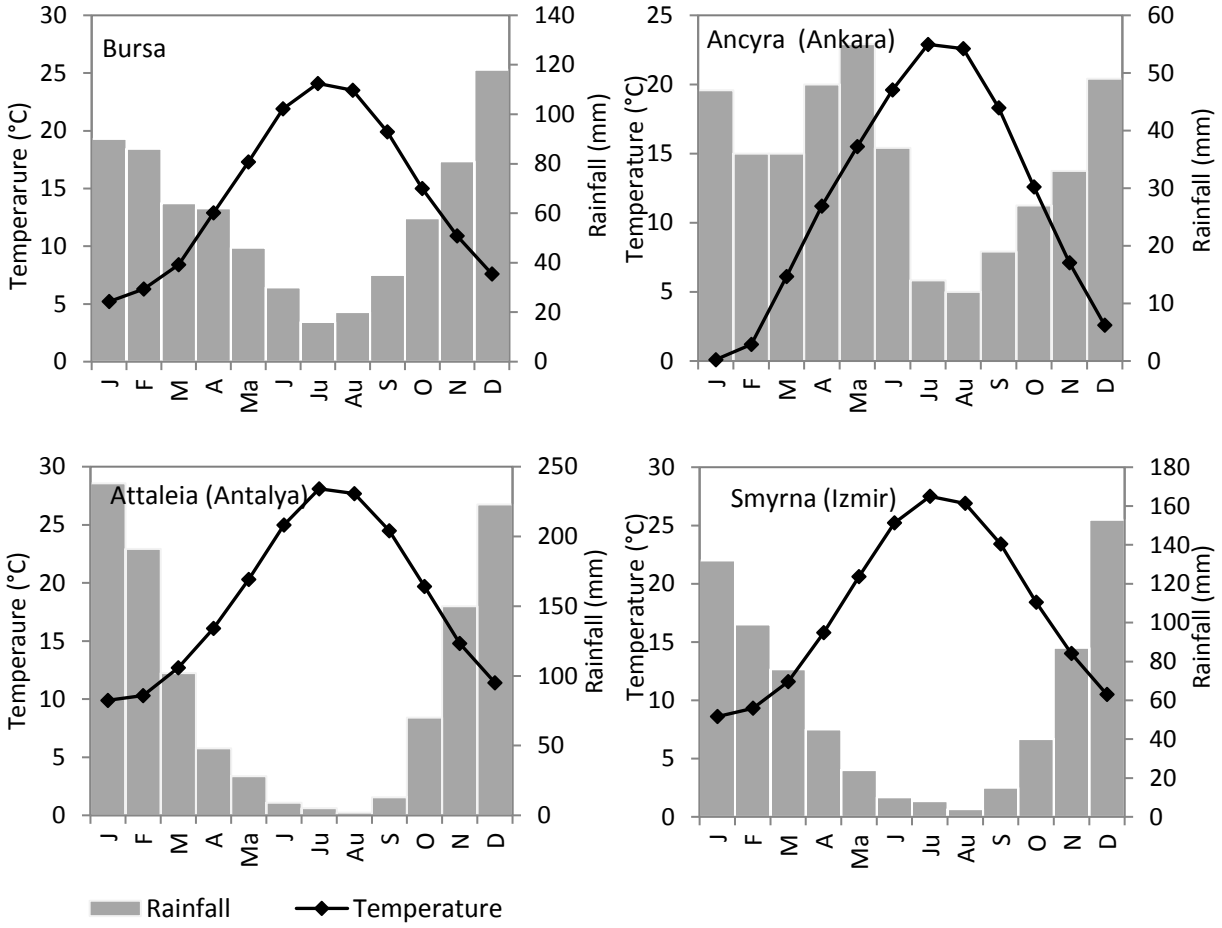


Fig.2. Present-day climatograms of four Anatolian cities (Source : Royal Meteorological Institute)

Beside these regional variations, the Mediterranean climate also experienced significant changes over time. It is therefore important to describe the global climatic conditions in Graeco-Roman times, as well as to account for the shorter climatic variations noticeable for the Eastern Mediterranean during this period. An increasingly large set of proxies from various regions indicate that the Graeco-Roman world experienced both warm, wet and stable climatic conditions compared to previous and later centuries[48] : pollen analysis, oxygen isotopes from Greenland ice cores, and tree rings (a less robust proxy, to be sure[49]) agree in identifying what has been labelled as

[48] Sallares (2007), p. 19 ; Ljungqvist (2010), pp. 344-345 ; Chen *et al.* (2011), p. 3888 ; Rossignol (2012), p. 98 ; McCormck *et al.* (2012), pp. 174-180. Although Bresson rejects, quite unconvincingly, that the Roman Optimum could have been warmer than present-day conditions : cf. Bresson (2014), pp. 56-57.

[49] Swedish dendro-climatologist Hakan Grudd has indeed demonstrated that tree rings carry an intrinsic bias as temperature indicators : younger trees tend to build thicker rings than older trees, and thus respond differently to an identical thermal or hydric stimulus.. Grudd showed than climatic reconstruction based on tree-ring thickness should be calibrated by using (taking into account ?) wood density : Grudd (2008), pp. 843-857.

the 'Roman Optimum.' The reason for this period of overall climatic stability and warmth are probably to be sought in the intensity and stability of solar irradiance – known to have been one of the principal factors in influencing the climate for the major part of Earth's history – combined with a period of exceptionally low levels of volcanic activity[50]. The precise extent and degree of this stable warm period is still debated, but growing evidence tends to point towards a climatic degradation during the 3rd c. AD, followed by a restoration of warm conditions in the 4th c. AD.

The question is, however, how this European-wide scheme is reflected in the regional climatic records of Anatolia. A full regional palaeoclimatic study involving a combination and comparison of proxies has yet to be carried out but Turkey presents very interesting material: plant residues, glaciers, lake sediments and, above all, speleothems (*i.e.* stalagmites and stalactites), by far the best preserved material. Carbon and oxygen isotopes of such speleothems in four Turkish caverns provide high resolution signals for effective moisture ($\delta^{13}C$) and temperature ($\delta^{18}O$) : the Sofular cave record broadly confirms the general evolution of the Mediterranean climate outlined above, clearly pointing towards a cooler and dryer 3rd c. AD[51], although the Kocain cave record seem to indicate that the cooling period concerned the 4th rather than the 3rd. c.AD[52]. Such discrepancies might result from the strong influence of local geomorphology on water composition and, hence, on the isotopic composition of the calcium carbonate deposits. Furthermore, these regional speleothem records exhibit significant discrepancies with other data from the Mediterranean region as to the intensity and time span of the Roman Optimum[53]. These discrepancies should thus remind us of the fragility of the notion of 'global climate', even when applied to a relatively restricted region such as the Mediterranean. If any large scale climate change has a global origin, as underlined by M. Sanchez-Goni, and W. Burroughs after her[54], 'the real question is how more rapid changes affected different parts of the world'[55]. If global dynamic commands the major trends, the intensity and shorter term fluctuations are significantly dependent upon regional or local environmental conditions.

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[50] McCormick et al. (2012), pp. 175-180.

[51] Luterbacher et al. (2012), p.105

[52] Gökturk (2011), p. 54

[53] Gökturk (2011), pp. 57-58

[54] Sanchez-Goni (1996), pp. 7-8 ; Burroughs (2005), pp. 31-32.

[55] Burroughs (2005), pp. 31-32.

1.3 Limits and potential of Graeco-Roman agriculture

1.3.1 The Graeco-Roman 'agrarian system' and the Ancient agricultural revolution

The concept of 'agrarian system' originates in the work of geographers and agronomists of the mid-20th century and describes an integrated approach to agriculture in its agronomical, environmental, social and economic context. Here we mostly follow the comprehensive definition provided my Mazoyer & Roudart. They define the 'système agraire' as :

> (…) l'expression théorique d'un type d'agriculture historiquement constitué et géographiquement localisé, composé d'un écosystème cultivé caractéristique et d'un système social productif défini, celui-ci permettant d'exploiter durablement la fertilité de l'écosystème cultivé correspondant[56].

The theory of agrarian systems is thus very useful from the historian's perspective because it analyzes agriculture in terms of its geographical differentiation and its evolution over time. As stated by Marcel Mazoyer and Laurence Roudart, this integrative approach considers agriculture as consisting of a combination of a *cultivated ecosystem* and a *productive social system*.

(a) The cultivated ecosystem consists of portions of the natural setting which are modified by human agency in accordance with various factors (technology, available resources, relationship between husbandry and vegetable cultivation…etc). It is composed of arable land (*ager*), meadows (*saltus*), pastures, forests (*silva*) and gardens (*hortus*), and characterized by the varieties of cultivated crops.

(b) The productive social system relates to the institutions and socio-economic structures (land ownership, type of labor, infrastructures…etc) with which the rural population interacts in order to produce the means of subsistence and surpluses.

Graeco-Roman agriculture was basically polyculture[57] : cereals, legumes, olives and sometimes vines were planted alongside each other in the same field. The obvious

[56] Mazoyer &Roudart, 1997, p. 46

[57] Kehoe (2007), p. 551 ; Sallares (2007), pp. 27-28

reason for this prevalence of polyculture, both in small-scale farms and *latifundia* is the attempt to minimize risk in a context of unstable environmental conditions. Similarly, as we will see in the next section, an important diversity of cereals cultivated, especially in Italy, Asia Minor and the East.

From a technological point of view, ancient agriculture was essentially rain fed (most ancient farming was dry farming). Irrigation was limited to Egypt and some areas of the Near-East. Even if recent research increasingly challenges the once widely held view that ancient technology was of limited development – for example, Hero's engine or the Anticythera mechanism– it remains that, as far as agriculture was concerned, technical means were quite rudimentary. Ancient Greek and Roman farmers used three major tools in particular in agricultural production: the spade and the hoe, handled by workers themselves, and the swing plough, which necessitated light animal traction[58]. The extent and impact of agricultural innovations by Greeks and Romans is still intensely debated, as is visible in a recent opus on the subject: some scholars argue for the presence of substantial technological innovations[59], while others claim that the diffusion of such innovations – and hence their economic impact – remained within very tight limits.[60] Alan Bowman and Andrew Wilson nevertheless reveal a clear peak in the use of water-mills throughout the Mediterranean in the 2nd and 3rd c. AD[61]. In terms of factors of production, the most important were land, human labor, and animal traction.

Perhaps the most crucial debate regarding the Graeco-Roman agrarian system concerns the relationship between livestock and arable farming. It has traditionally been quite widely argued that ancient Greek and Roman agriculture was characterized by a rather strict division between husbandry and farming, and by a biennial fallow on arable land. According to this scheme, ancient arable farming was characterized by an alternation of cereal cultivation and bare fallow. On the other hand, transhumance is seen as inevitable due to the variation in environmental conditions between highlands and lowlands along the year, while also fostered by the insufficiency of fodder production due to bare fallowing. As it is, the complementarity of transhumance and bare fallowing relies on what looks like a circular argument: transhumance partly results from bare fallow, but bare fallow is also a consequence of the limited resources of soils due to the scarcity of manure because transhumance removes livestock from

[58] Mazoyer (2002), p. 294

[59] Forni (2006), pp. 145-180 : the discussion is however resticted to Italy.

[60] Brun (2006), pp. 101-130

[61] Bowman & Wilson (2009), pp. 33-36)

the fields… As Paul Halstead noted, the assumed prevalence of bare fallow – and, hence, the rarity of crop rotation and soil fertility improvement by manuring – in Graeco-Roman farming derives from the idea that water is the limiting factor in ancient agriculture, rather than nutrients. This idea may well be true for very arid regions of the Mediterranean, but it is based on a misunderstanding of fallow's function as allowing the storage of water in the soil. In fact, a considerable part of rain water would flow, evaporate or percolate[62] through the karstic networks of calcareous regions, while a significant part of the water stored in the soil will be lost due to evapotranspiration of the spontaneous vegetation[63].

As Halstead states on the basis of an experimental survey conducted in Cyprus in the mid-20th century, cereal/pulse crop rotation and manured cropping are both far more productive than bare fallowing. The extrapolation of the widespread presence of bare fallowing into the ancient past was based on modern observations of Greek agriculture in the 19th and 20th century. Yet, the prominence of bare fallowing in Greece in the modern period resulted from specific settlement patterns and from conditions of relative scarcity of manpower. Indeed, despite smaller yields per unit of land, bare fallowing is more productive per unit of labor[64]. Therefore, the specific historical conditions in which bare fallowing became prominent in Greece in the 19th and 20th centuries cannot simply be transposed to the ancient world. .

On the basis of Halstead's criticism of the traditional view of ancient farming as overwhelmingly dominated by extensive dry farming coupling transhumance with bare fallow, a new model of ancient agriculture has been proposed by S. Hodkinson, followed by P. Garnsey[65] and more recently relayed by Kron[66], which advocates for the prevalence of intensive mixed farming where livestock and arable farming are more integrated, and where fertility improvement strategies by manuring and crop rotation frequently take place. It is not the purpose of this discussion to arbitrate between the traditional model and the "new" model, but some specific points require discussion.

The advantages of manuring, which reconstituted the nitrogen and phosphorus content of the soil, were far from underestimated in ancient farming[67]. Ancient authors make clear recommendation of the use of animal manure[68], compost[69] and mineral

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[62] Mazoyer & Roudart (2002), p. 308

[63] *Ibidem*

[64] Halstead (1987), pp. 61-62

[65] Garnsey (1988), pp. 93-94

[66] Kron (2012), pp. 157-158 ; Kron (2015), p. 161

[67] Michell (1957), pp. 53-55

[68] Xen., *Econ.*, XX, 10

fertilizers[70] such as limestone or chalk, wood ashes, bone residue, burnt marble or potash[71]. Archaeological surveys have also identified the presence of crushed pottery sherds dispersed on fields as evidence for another source of mineral fertilizers[72]. In the context of crop rotation, the cultivation of pulses (peas, lentils, and more particularly lupines) had been noticed by ancient farmers to improve soil fertility, although they did not understand the process of nitrogen fixation in the soil through the action of these vegetables[73].

The crucial role played by legumes, both as providers of crucial nutrients absent from cereals and as agents of soil fertility enhancement, raises the question of the extent to which ancient farmers replaced the two-field system of bare fallowing by crop rotation involving legumes and cereals. Some sources support the suggestion that they might sometimes have done so. An Attic inscription from the early 4th c. BC unambiguously mentions a three year rotational cycle involving the cultivation of pulses[74]; moreover, the well-known reference of Varro advising biennial fallowing does not actually refer to bare fallow, but instead recommends 'sowing the field more lightly' (*agrum alternis annis relinqui opportet aut paulo leuioribus sationibus*)[75]. While G. Kron argues that crop rotation came to replace bare fallowing almost completely, Isager & Skydgsaard are skeptical regarding the possibility of widespread development of intensive farming involving crop rotation, and stress that the model of intensive mixed farming has only a slender source-base compared with the amount of evidence that is available for the traditional model. This is indisputably right, but this argument neglects the bias of ancient agronomical sources, which overwhelmingly concern large-scale commercial farming and hardly ever mention peasant farming. The relative share of intensive mixed farming and extensive 'segregated' farming thus depends on the relative share of peasant farming and smaller scale exploitations which were far more inclined to develop intensification strategies. Such intensive practices are even more justified in a context where extensive agricultural growth is intrinsically limited by the competition between fodder crops and staple foods for agricultural land.

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[69] Theophr., *HP*, II, 7, 4 ; VII, 5, 1 ; Theophr., *CP*, III, 9, 2 ; Colum., *R. r.*, II, 14, 5-6.

[70] Plin., *NH*, XVII, 50 ; Pallad., X, 3, 2

[71] Hughes (2014), p. 121 ; Kron (2015), p. 162.

[72] Sallares (2013), p. 268

[73] Michell (1957), p.54 ; Isager & Skydsgaard (1992), pp. 42-43 ; Erdkamp (2005), p. 41 ; Kehoe (2007), p. 551

[74] *IG* II^2, 2493

[75] Varro, *De Re rust.*, I, 44, 3

In fact, although Graeco-Roman agriculture was probably more productive and sophisticated than often argued, substantial increases in per capita output might sometimes be trapped in vicious cycles. Two important cases should be considered : (1) extensive growth of agricultural surfaces, and (2) the increase of livestock. Increasing agricultural surfaces often requires clearing forests; but deforestation may in turn generate erosion (this process is attested around Sagalassos[76]) which often depletes the mineral content of soils and hence leads to lower soil productivity unless ad hoc conservation measures are taken[77]. In this case, the impact on total output is uncertain since total agricultural land has been increased while average soil productivity has dropped. On the other hand, intensive growth through manuring requires an increase of available livestock. Yet, feeding this increased animal population puts the production of cereals devoted to human consumption under stress, since they compete with fodder crops for land[78]. In this case, thus, we end up with higher levels of soil productivity due to higher levels of manuring, but with smaller available surfaces, that is, the opposite situation of the one caused by extensive growth.

1.3.2 Crop varieties and the ancient diet

The Graeco-Roman agrarian system was mostly geared towards the production of what has been labelled the 'Mediterranean triad', the three basic components of ancient people's diet : grain, wine and oil. These three elements correspond to some extent to the nutritional requirements of man based on a balance between *proteins* (provided by cereals for those who can only rarely afford meat or fish), *carbohydrates* (found in wine) and *lipids* (mostly provided by oil), although slow-burning carbohydrates are also found in significant proportions among cereals.

This investigation, though, mostly focuses on cereals, which formed the most important staple food for a majority of people, a fact that rendered its unhindered supply, especially to cities, a crucially important food-related socio-economic issue. As far as Asia Minor is concerned (even though this is also true for many other areas of the Mediterranean basin) it should be emphasized first that a wide diversity of cereals

[76] Paulissen *et al.* (1993), pp. 235 sqq.

[77] Such conservation measures are attested archaeologically around Sagalassos (Gravgaz Marsh) at some point between the 5th and 2nd c. BC : Degryse *et al.* (2008), p. 215.

[78] Braudel (1979), pp. 125-127

was cultivated, as is made clear by both literary and epigraphic sources[79]: emmer wheat (πυρός – *triticum diccocum*) is attested in numerous places such as Magnesia on the Maeander[80], in Dorylaeum of Phrygia[81], in Assos[82] (Troad) and in Cilicia[83]; barley (κρίθη – *hordeum vulgare*) is also produced in Magnesia on the Maeander[84], in Cilicia[85] and Cappadocia[86]. Spelt (*triticum spelta*), finally, was also present, of which two specific types, *zeia* and *olyra* (probably einkorn) – considered to be specific to the East[87] –, are grown around Pergamon[88]. A particular spelt-wheat called *zeopyron* is also cultivated in Bithynia[89]. Palaeobotanical studies also confirm the presence of wheat and barley, as in Sagalassos[90] and its territory (Beyşehir Gölu[91]).

Beside these common cereals, some more specific crop varieties are also known to have been grown in Asia Minor. Millet is attested on the Pontic coast[92], in Bithynia[93], in Cilicia[94] and Lycia (Telmessos)[95]. Sesame was cultivated in Bithynia, Lycia[96], Cilicia and Pamphylia[97]. Finally, sorghum is known to have been grown on the Pontic coast[98] and near Telmessos[99]. Oats were cultivated almost everywhere, but this crop was only used as fodder.

It should thus be stressed that Graeco-Roman Asia Minor did not rank below later societies in terms of the variety of cultivated cereals. This feature was not just

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79 On the various types of cereals grown in the Ancient Greek world, see : Amouretti (1986), pp. 33-41 ; Isager & Skydsgaard (1992), p. 21.

80 *Inschr. von Magn.*, 116 (2nd c. AD)

81 Diod. Sic., XX, 108

82 Strabo, XV, 3, 22

83 Xen., *Anab.*, I, 2, 22

84 *Inschr. von Magn.*, 116

85 Xen., *Anab.*, I, 2, 22

86 Galen, *De Alim. Fac.*, I, 13, 22

87 Plin., NH, XVIII, 81 ; Galen, *De Alim. Fac.*, I, 13, 18

88 Galen, *De Vict. Att.*, 40-41 & *De Alim. Fac.*, I, 13, 18

89 *Ibid.*, I, 13, 9

90 Donners *et al* (2000), p.726 in accordance with Livy, 38, 15, 9.

91 Bottema & Woldring (1995), pp. 328-329.

92 Pliny, *NH*, XVIII, 101 ; Strabo, XII, 3, 15

93 Xen., *Anab.*, VI, 4, 6

94 *Ibid.*, I, 2, 22

95 *OGIS*, 55

96 *Ibidem*

97 Colum., *R. r.*, II, 10, 18 & XI, 2, 56

98 Strabo, XII, 3, 15

99 *OGIS*, 55

important in terms of the variety of people's diet; it was also a crucial economic advantage because these different crops had different agro-ecological and nutritional characteristics: wheat has the highest nutritional value, but has also high hydric requirements. Barley on the other hand has a lower nutritional value but allows higher yields and tolerates lower temperatures and lower precipitations. Millet has a high nutritional value too, but grows only in very specific environments. Spelt, finally, has a medium nutritional value and fairly low yields, but provides the advantage of growing on very poor soils. Whatever the variety, most of these cereals were consumed either in the form of bread – for the better off citizens –, porridges (*puls*, *pulmentum*), or flat cakes. From a more general point of view, G. Kron recently argued, optimistically, that the ancient Greek and Roman diet was very varied, and that 'middle class' citizens consumed meat, eggs, fish and fruits far more often than was previously acknowledged.

1.3.3 Seed yields, soil productivity and carrying capacity

The assumptions we make regarding the nature of Graeco-Roman agrarian system, in particular the extent to which intensive mixed farming took place, the species of cereals that were cultivated, as well as the region we consider, all these factors have a dramatic impact on the level of cereal yields that we can assume to have been the norm. After the pioneering work by Jardé, who suggested a range of 600-900 kg/ha for wheat and 1020-1270 for barley[100] as average yield values, a number of influential scholars have provided quite restricted estimates for average crop yields per hectare in Greek and Roman agriculture. Sallares claimed that 650 kg/ha (averaging various cereals) was an upper limit which could only be exceeded in only very fertile places of the Mediterranean[101]. Garnsey reckoned with a 'likely' value of 770 kg/ha for barley and 600 kg/ha for wheat[102]. Agronomy specialists Mazoyer & Roudart considered both Jardé and Garnsey's assessments exaggerated and reckon with as little as 500 kg/ha for an average cereal yield. Moreno broadly followed Sallares' estimate and considered 600

[100] Jardé (1925), Ch. 3
[101] Sallares (1991), p. 389
[102] Garnsey (1988), p. 102 & 104

kg/ha as optimistic[103]. More recently, Bresson reckoned with a somewhat less pessimistic, but still moderate value of about 800-940 kg/ha[104].

These estimates are however problematic in various ways, both for our current project specifically as well as in a more general sense :

(1) We cannot simply extrapolate to Asia Minor data deriving from Italy or the Greek peninsula;
(2) The existing estimates are often based on an extrapolation of yield figures from modern extensive Greek agriculture to antiquity;
(3) The estimates mostly consist of indirect calculations of ancient yields on the basis of the probable area under grain cultivation and population figures, with no, or only superficial, discussion of soil properties, environmental conditions and the nature of ancient agrarian systems;
(4) The difference between gross yields and net yields is mostly ignored;

Let us develop these points in order:

(1) Most of the abovementioned estimates concern Greece – or even more specifically Attica (Garnsey, Moreno). Since, as we have seen above, environmental conditions differed greatly between Greece and Asia Minor, assessments regarding soil productivity in Greece, and *a fortiori* in such a dry region as Attica, cannot be simply extrapolated to Asia Minor. Secondly, some of these estimates rely on data from modern Greece (late 19th – early 20th century) to derive an upper limit that ancient yields could not have exceeded[105]. While it is true that the Medieval agricultural revolution significantly improved yields in north-western Europe, its impact on the Eastern Mediterranean was actually quite limited, and modern yields from the Aegean could thus not be claimed to be necessarily higher than ancient ones.

(2) This deterministic reasoning relies on extensive farming practices observed in modern Greece, where mineral or even organic fertilizers were not widely used (mostly due to extensive pastoralism), and extrapolates this agrarian system backwards into Antiquity. As we have argued *supra*, however, intensive practices such as manuring, crop rotation, and integration of livestock and arable farming are likely to have been

[103] Moreno (2007), p. 27

[104] Bresson (2016), p. 168. Bresson reckons with a yield to seed ratio of 6 :1 or 7 :1, which, at a sowing rate of 5 *modii* per *iugerum* (20 *modii* per hectare), is equivalent to 804-938 kg/ha.

[105] Mazoyer & Roudart (2002), p. 320 ; Moreno (2007), pp. 26-27

substantially more frequent in Graeco-Roman agriculture than in modern Greece. Moreover, even if such extrapolation of farming practices were justified, even if local environmental conditions could be approximated by conditions prevailing in early 20th c. Greece, agricultural productivity is not solely a function of soil properties or agricultural techniques. As Osborne correctly pointed out, yields also depend upon labor inputs[106], or more accurately, on the relative use of labor and land, which cannot be taken as identical between Antiquity and the modern era. Hence, yield figures from the 19th or 20th c. can by no means be taken as a maximum limit for ancient yield values.

(3) The 'pessimistic' models of ancient cereal yields are almost entirely based on calculations of the proportion of agricultural land and population figures. The argument is dangerously circular: once a population figure has been assumed, temptation is strong to try to confirm it through estimates of land under grain cultivation and yield figures. The same is true, of course, if the starting point is an estimate of the extent of arable land. This is not to say that these variables are irrelevant to a proper calculation of ancient yields. Historical data providing the range of likely population figures and agricultural land surface are crucial for the calculation of yields, but should be combined with the variables which *directly* affected ancient soil productivity, such as the agrarian system in operation (intensive versus extensive farming, labor inputs, scale…) and environmental conditions (geomorphology, temperature, precipitation, which altogether determine soil properties).

(4) Finally, most of these estimates, whether of the 'pessimistic' or 'optimistic' variety (except Garnsey and Mazoyer & Roudart) never specify whether their assessed value for cereal yields concern gross or net yields. This is a crucial aspect: gross yield, in agricultural terms, refers to the productive potential of the soil – the total amount of crops that can be produced per unit of cultivated land on the considered territory. This potential, however, is not the actual disposable quantity of grain, because a non-negligible part of the cereals (or other crops) produced will be lost, either during or after the harvesting process. Discussion of the loss rate of agricultural production (pre- or post-harvest) is probably one of the biggest blind spots of historical debates regarding ancient food sustainability.

Other scholars have in fact advocated for a more optimistic view of cereal yields in ancient agriculture. Spurr rightly underlines the misleading view introduced by the concept of 'average yield' which, by merging very unproductive and highly productive

[106] Osborne (1987), p. 44. This crucial socio-economic determinant of soil productivity will be fully discussed in Chapter II.

sub-regions, gives a distorted impression of historical reality[107]. Erdkamp provides a crucial contribution to the debate: based on a meticulous discussion of ancient evidence regarding crop yields, he claims that Columella's figure of a 4: 1 yield/seed ratio is untrustworthy and describes, at best, conditions on very poor soils[108]. Columella's agenda in this passage is to encourage viticulture, and hence he deliberately underestimated cereal yields. Using comparative data, Erdkamp, following Spurr, demonstates that Varro's and Cicero's figures of yield-seed ratios amounting to 8 : 1 or 10 : 1 were not unrealistic at all and 'provide reliable estimates of yields on fertile soils and on lands highly suitable to the cultivation of cereals'[109]. On the basis of these yield-seed ratios, Erdkamp thus widens the scale of possible soil productivity to values of 880-1100 kg/ha (if the yield-seed ratios concern barley) and 1035-1290 kg/ha (if wheat)[110]. This reassessment however mostly concerns Italy, and Erdkamp acknowledges that yields in Greece are far more difficult to estimate due to the paucity of testimonies. Yet, on the basis of a sound use of comparative data, more particularly of yields from the Ottoman period in which farming practices were most likely closer to the ones prevalent during the Classical and post-Classical eras, Osborne convincingly argues that some areas of Greece in Classical times could have experienced wheat yields in the range of 1,000-1,500 kg/ha, and that values of 900 kg/ha should be viewed as the lower end of the scale rather that as its maximum limit[111]. On the basis of comparative data from Medieval Italy and Early Modern Europe, it thus appears perfectly probable that ancient farming often equaled or surpassed cereal yields of later societies[112]. Regarding the 16th, 17th and 18th c., this appears even less surprising if we remind ourselves that, from the 15th c. onwards, Europe entered a cooler climatic period known as the Little Ice Age, which only ended in the late 18th century, when the modern agricultural revolution was taking place[113].

There are good reasons to believe that these optimistic views of ancient cereal yields certainly applied (at least) to the western part of Asia Minor. First, unlike the case of Greece, ancient sources explicitly mention the fertility of the region: Tacitus

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[107] Spurr (1986), p. 84

[108] Erdkamp (2005), p. 38

[109] Spurr (1986), pp. 84-85 ; Erkamp (2005), p. 43

[110] Erdkamp (2005), p. 43. Expressing the yields of 8 :1 and 10 :1 in *modii*, Erdkamp provides the range of 40-50 modii per *iugerum*, which, in terms of volume, gives 1,380-1720 hl/ha. The values provided here are arrived at by multiplying this range respectively by the volumetric mass of weat (about 0.75) and barley (0.64).

[111] Osborne (1987), p. 45

[112] Braudel (1979), pp.131-132 ; Erdkamp (2005), pp. 39-40.

[113] Le Roy Ladurie (1967)

counted Asia Minor among the wealthiest provinces (*opulentissimarum provinciarum*)[114], and Cicero explicitly praised the province of Asia for being among the most fertile regions :

> Asia is in fact so wealthy and fertile that, with regard to the abundancy of its fields, the variety of its produces, the large surfaces of its pastures (…), it easily surpasses all other regions[115].

Such statements on Asia Minor as a whole are corroborated by the description of specific areas. Xenophon claimed that Calpe of Bithynia was 'productive in wheat and barley'[116]. Cilicia is said to experience wonderful harvests –but while Virgil places them in Gargara, Livy and Strabo rather refer to Cilician Thebe[117]. Writing about the more westward region of Pisidia, Livy qualified the territory of Sagalassos as 'abundant and fertile in all kind of cereals' (*uber fertilisque omni genere frugum*)[118]. Even the more arid region of Galatia is said to be abundant in grain by the Historia Augusta[119], and is referred to as a *provincia optima sibi sufficiens* [120]. Finally, Aelius Aristides wrote that, in the region of Cyzicus, 'the mountains are more cultivated than the plains of others, and the plains are sufficient, not only for a city, but for entire peoples'[121]. In another discourse, he claimed that 'the Aegean alone cannot be called "unharvested" (…) It is productive in wheat and all which the seasons engender'[122]. The literature of the Second Sophistic, and in particular the works of Aristides, has often been discarded for their heavy rhetorical accents and lyricism. But Doukellis holds an interesting position in arguing that their literary characteristics cannot *per se* shed doubt on their historical validity[123] and that they most probably reflect to a certain extent the economic flourishing of the Greek cities in the second century AD, in addition to which we

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[114] Tac., *Hist.*, III, 8

[115] Cic., *Pro leg. Man.*, 14 : *Asia vero tam opima est ac fertilis, ut et ubertate agrorum et varietate fructuum et magnitudine pastionis (…) facile omnibus terris antecellat*.

[116] Xen., *Anab.*, VI, 4, 6

[117] Virg., *Georg.* I, 103 ; Livy, XXXVII, 19; Strabo, XIII, 1, 61.

[118] Livy, XXXVIII, 15, 9

[119] *Hist. Aug.*, XVIII, 8

[120] *Exp. Tot. Mundi*, 307

[121] Ael. Arist., *Or.* XXVII (*Panegyric to Cyzicus*), 9

[122] Ael. Arist., *Or.* XLIV, 16

[123] Doukellis (1999), pp. 57-58 : The exaltation of local identities and histories should be seen, he claims, as responses to the cosmopolitan nature of imperial literary production which 'dilute' Greek culture into the Roman *imperium*. This response is not, according to the author, a propagandist one, but should be viewed as an *ekphrasis*, a descriptive synthesis which seeks little more than emphasizing an existing reality.

should remind ourselves that Aristides was native of Smyrna and hence probably an eye witness of most of what he describes.

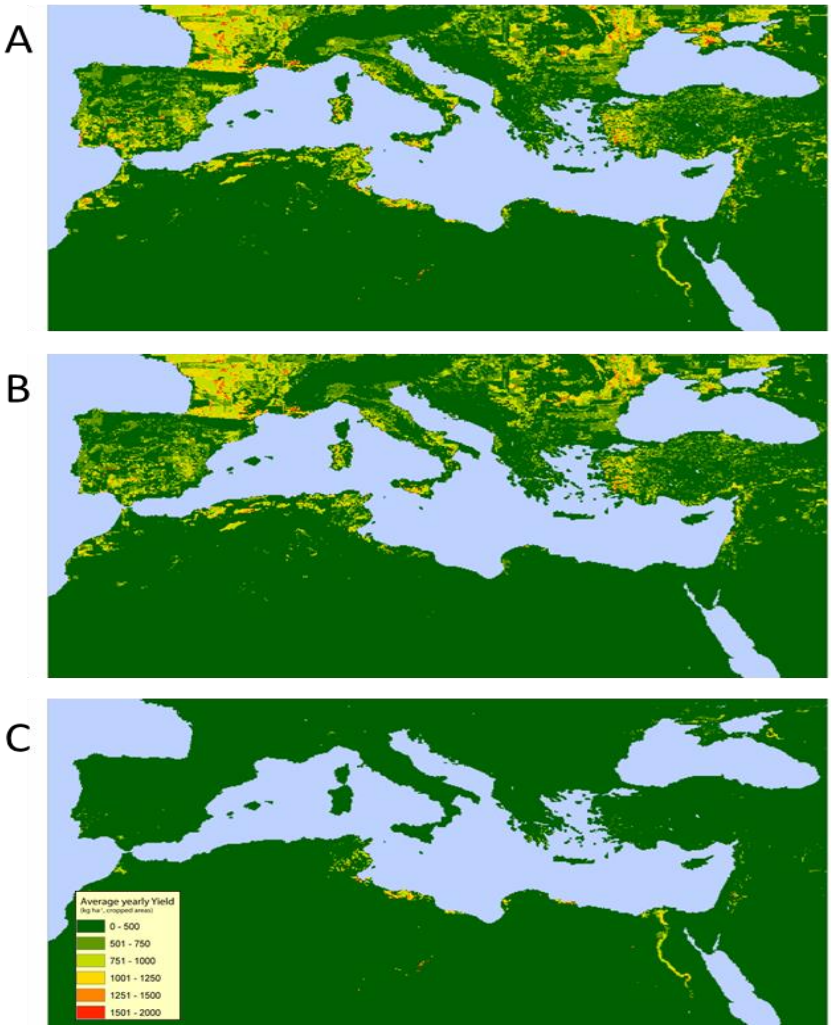

Fig.3. GIS modelling of grain yields in rainfed (B) and irrigated (C) agriculture (A = B + C) on the basis of land cover, climate forcing and water balance. [Reproduced with permission from Dermody *et al*. (2012)].

The most groundbreaking developments on the subject undoubtedly come from the contribution of earth sciences. In recent years, scholars have tried to model ancient crop yields primarily on the basis of environmental data and Geographical Information Systems (hereafter GIS). On the basis of terrain variables such as slope or solar exposure, H. Goodchild constructed an index of agricultural suitability for catchments of the Tiber valley[124]. On a much wider scale, an interdisciplinary study on Virtual Water redistribution in the Roman world, led by B. Dermody and involving a team of

[124] Goodchild (2013), esp. pp. 63-69

scholars from earth sciences and classics, attempted to model ancient grain yields on the basis of land cover, weather parameters and water balance. As far as Asia Minor is concerned, their study reveals that a considerable part of western Asia Minor must have experienced gross wheat yields in the range of 1,000-1,250 kg/ha (see Fig. 3 *supra*), with several pockets above 1,500 kg/ha[125]. Moreover, despite the intense inter-annual climatic variability affecting the Mediterranean basin, they show that the Eastern empire, in particular Asia Minor and Egypt, had much more stable yields than the western part. Their threshold of 10% margin around the average yield can of course be criticized since, due to the strong inelasticity of grain demand, even very small variations of aggregate supply could have dramatic effects on prices and hence on grain accessibility, but in relative terms it nevertheless remain that the East seems to have been 'less unstable' than the West[126]. As a parallel to this empire-wide reconstruction, the still ongoing research by M. Van Loo *et al*. focuses instead on a much smaller zone – the Gravgaz marsh, in South-West Turkey, a focus which makes this study of particular interest for our investigation – through a very complete protocol: on the basis of sediment archives extracted on the site combined with a model of water balance[127] (depending on local weather conditions and topography), they reconstruct sediment flows and hence soil thickness which has a key impact on crop yields (the study focuses on barley), as is illustrated in figure 5 [128].

[125] Dermody *et al* (2014), pp. 5027-5030. See fig S5 of the Addendum for crop yields per hectare.

[126] Dermody *et al*. (2014), pp. 5034-5035

[127] What matters for the soil development is the amount of infiltrated water that is usable for vegetation development. This volume of water is given by the following relationship : Usable water = Precipitation + capillary rise – runoff – evapotranspiration – deep percolation.

[128] For the complete methodology, see : Van Loo *et al*., (2016), pp. 2-6.

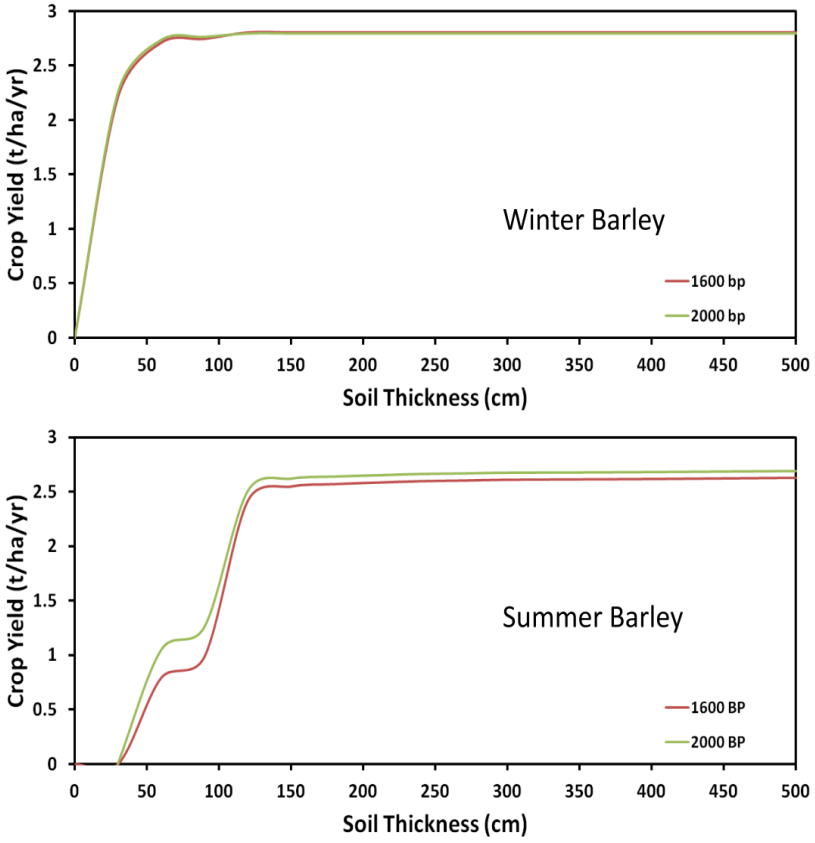

Fig.4. Relationship between crop yields and soil thickness in sediments from the Gravgaz Marsh in South-West Turkey (ancient Pisidia) [Reproduced with permission from M. Van Loo (Sagalassos project, KUL)].

While Dermody's study suffers from a lack of field data regarding local soil conditions due to the breadth of its scale, the limited area studied by Van Loo allows him to use a very complete set of data. The only aspect that might still be insufficiently examined – according to the latest update, at least – is the influence of climatic conditions on the initial production of soil (and not only on its agricultural properties)[129]. The results, of local significance of course due to the absence of similar studies for other regions of Turkey, are shown in figure 6 which displays the reconstructed barley yield from Roman times (1st & 5th c. AD), and reveal that an important part of the Gravgaz catchment could have experienced gross yields above 2,480 kg/ha (for summer barley) or even 2,640 kg/ha (for winter barley).

[129] It is widely acknowledged that pedogenesis – the production of regolith, the fundamental soil material – results from the physical and chemical alteration of bedrock, which depends upon its composition, on temperature, and on rainfall.

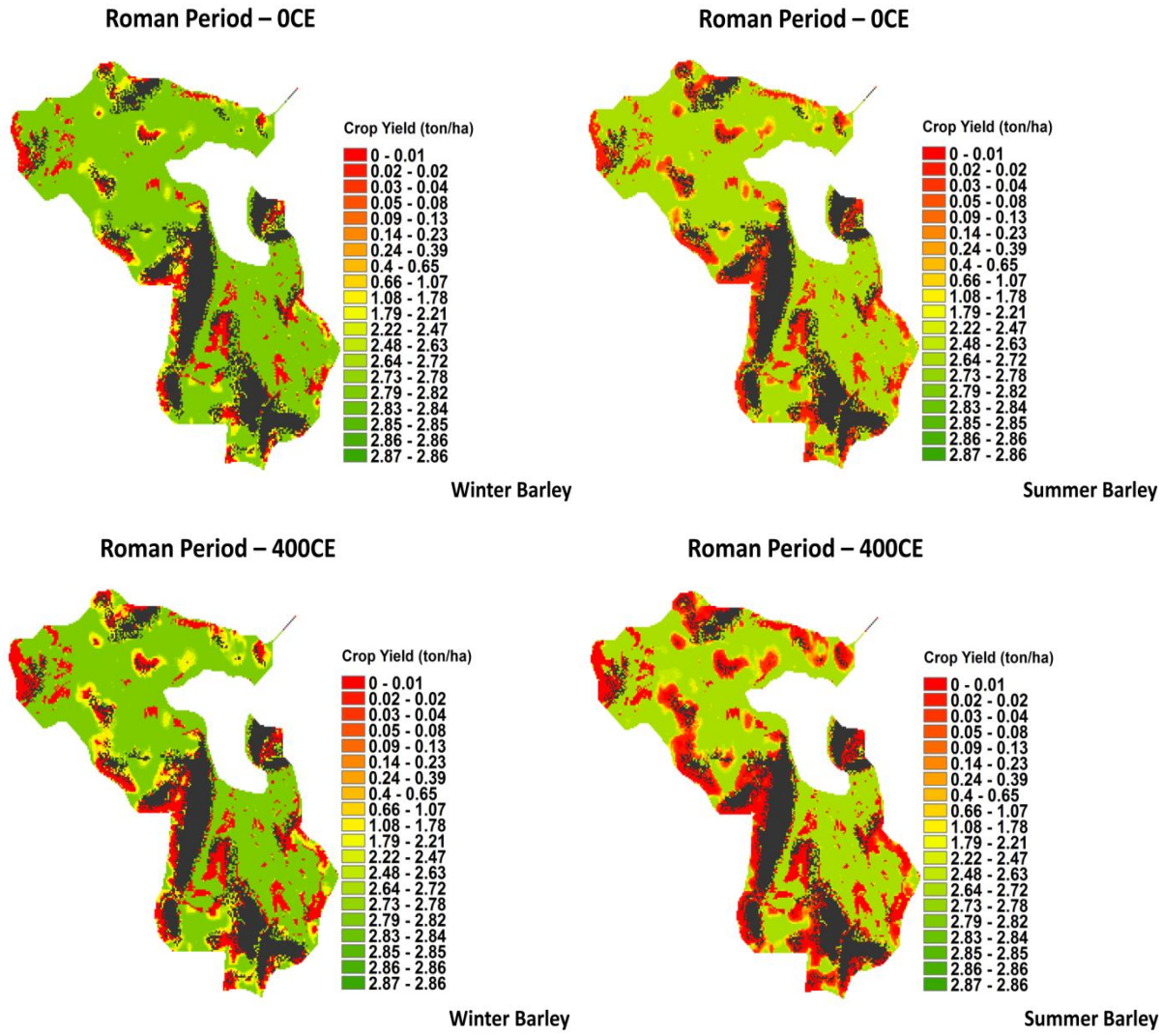

Fig.5. Reconstruction of gross barley yields from sediment archives and water balance modelling in Graeco-Roman times in the Gravgaz catchment (SW Turkey) [Source : Van Loo *et al.,* forthcoming].

These challenging figures allow us to introduce a fundamental remark regarding ancient productivities: Dermody's and Van Loo's reconstructions, unlike the assessments realized by Jardé and Moreno which are based on quantities likely to have been consumed, concern *gross* yields rather than *net* yields. Indeed, indications provided by ancient authors, or calculations made on the basis of a yield-seed ratio do not make clear whether the yield concerns the potential produce of the plant or the quantity that can actually be harvested. The difference between produced, harvested or supplied/consumed quantities is explained by the loss rate, *i.e.* the share of the crops

that is destroyed, wasted or altered during or after the harvest. This loss results from several factors: grain falling from the ears, moisture, bacteria, fungi, damages by insects, birds, or rodents, and transport[130]. Calculations have been made by the FAO, showing that such losses vary significantly depending on the cultivated crop (higher for rice than wheat), and the type of agriculture (higher losses for industrialized than traditional agriculture). In Africa, grain harvest losses prior to processing are in the range of 10-20% of primary production.[131] Since Graeco-Roman farming is undoubtedly closer to modern traditional agriculture than to industrialized agriculture, it is reasonable to assume an average loss rate of 20%. Hence, Dermody's wheat figure and Van Loo's high barley figures would respectively correspond to a net yield of 800-1,000 kg/ha and 1,984-2,112 kg/ha. Overall, besides local extremes, it seems that gross yields ranging from 1,000-1,200 kg/ha, close to the average net yield of 1,050-1,070 kg/ha reported by X. De Planhol for increasingly modernized Tukish agriculture of the period 1934-1954, must have been quite common in Roman Asia Minor[132].

If we now bring together the population data and the reassessment of Graeco-Roman agriculture in the specific context of Anatolia, it might be worth doing a quick macroeconomic calculation to see whether the region was approaching its carrying capacity. Total area of Anatolia is roughly 520,000 km^2. If only 15% of land was under grain cultivation[133], and if, on the basis of our re-evaluation of grain yields in Asia Minor, we assume an average *gross* soil productivity for cereal cultivation of 1 ton/ha (150 modii/ha), reckoning with a high loss rate of 30% and a seed requirement of 1/5[134], then total grain production would equal some 655 million modii. On the other hand, if we reckon with a population figure somewhat in between high-counters and low counters, say 10 million people, then, with an average grain subsistence requirement set at 35 modii per person, subsistence needs would be 437.5 million modii. In this arguably rather pessimistic scenario, Anatolia as a whole would still produce a 50% surplus of grain.

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[130] Griffon (2006), pp. 167-169

[131] http://www.fao.org/news/story/en/item/79444/icode/

[132] de Planhol (1960), p. 100

[133] For Attica, which is the typical region where population growth and urbanization had outsripped the agricultural carrying capacity, Garnsey reckons with a 'likely' figure of 17.5% , while for Lemnos, he arrived at the figure of 25% : Garnsey (1988), pp. 101-102.

[134] This is again a pessimistic figure : with a soil productivity of 150 modii per ha, this would imply a rather high sowing rate of 30 modii per hectare.

Subsistence requirements			Production
Population	10000000	Total area (ha)	52000000
Av. subs. Cons. per capita (mod)	35	Share of area under grain	15%
Seed	0,2	Gross soil productivity (mod/ha)	150
		Loss rate	0,3
		Seed	0,2
Total	437,500,000 mod.		655,200,000 mod.

[135]

[135] Colluvial plain near the city of Cadyanda (Lycia).

Chapter 2
Land exploitation and extraction of surplus

2.1 Introduction

"And first of all", said Socrates to Critoboulos, foodstuffs that allow us to live come out of land when we cultivate it; and all the sweets of life, it is also land that provides them"[136]. Any discussion on the factors affecting the supply of grain could not afford leaving out a discussion of the exploitation of the basic mean of grain production : land. Land is crucial to our understanding of the capacity of ancient cities to get access to an adequate provision of grain. It should be noted in this respect that gifts of land to cities – and purchase of land by cities – sometimes took place[137], and offered them a complementary source of grain, in addition to the commercial circuits connecting them with the farmers of their hinterland. Far beyond the technical or environmental constraints and agronomic techniques, which we have discussed in the previous chapter, land plays a crucial role in three fundamental aspect :

(1) First, as a production factor, in determining the size of primary production, depending on its use in relationship to labor;
(2) Secondly, because social élites derive their ability to influence the urban grain supply – either by distributions of grain or by practicing speculative hoarding – from the products of their landed property

[136] Xenophon, *Economics*, 5, 2
[137] See for instance : IGR III, 422 ; IGR IV, 915b ; BCH 45 (1921), pp. 157-158

(3) Thirdly, because the social and economic structure of land ownership and management influences the size of disposable quantities of grain both in towns and countryside depending on the perception and level of rents and taxes.

The crucial importance of land as the main factor of ancient agrarian economies can be understood from the *Economics*. The author – most likely a disciple of Aristotle – writes that, in the 'satrapian' economy – the 'regional' level – 'the revenues of highest importance and concern are those derived from land, which is sometimes called 'ground tax', sometimes 'tithe'"[138]. The text however distinguishes unambiguously between revenues 'from agriculture' (ἀπὸ γῆς) and revenues 'produced in the countryside (ἀπὸ τῶν ἐν τῇ χώρᾳ ἰδίων γινομένων). When discussing the 'civic economy', in the next paragraph, it is the latter category which is said to be 'of the first importance' (κρατίστη μὲν πρόσοδος ἡ ἀπὸ τῶν ἰδίων ἐν τῇ χώρᾳ γινομένη)[139], while regarding the 'private economy' – the estate level –, it is the former which constitutes the main source of income (κρατίστη μὲν πρόσοδος ἡ ἀπὸ γῆς γινομένη)[140]. The difference might have been made by the non-agricultural production taking place in the city's countryside but also, to a significant extent, to the mode of surplus appropriation, namely the relative share of rents and taxes. This clear distinction between 'revenues 'from agriculture' and revenues 'from the countryside' reveals how land actually lies at the crossroads of the agro-ecological setting and exploitation channels through the social structure of land ownership and through political subjection. Agro-environmental conditions (that is, the conjunction of the environmental setting and of a given agrarian system) merely defined the borders of 'the possible and the impossible', to borrow Fernand Braudel's expression, but how actual situations were shaped within these borders has everything to do with how the primary production took place through to the use of production factors, and how the produced surpluses were appropriated and distributed. Ellen Meiksins Woods has outstandingly summarized this point :

> It has been a general characteristic of peasants that a large proportion of their surplus production has been accounted for by rents and/or taxes. (…) Patterns of

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[138] Ps.-Arist., *Econ.*, II, 1, 4 :
Δεύτερον δὲ τὴν σατραπικήν. Ἔστι δὲ ταύτης εἴδη ἓξ τῶν προσόδων (ἀπὸ γῆς, ἀπὸ τῶν ἐν τῇ χώρᾳ ἰδίων γινομένων, ἀπὸ ἐμπόρων, ἀπὸ τελῶν, ἀπὸ
βοσκημάτων, ἀπὸ τῶν ἄλλων). Αὐτῶν δὲ τούτων πρώτη μὲν καὶ
κρατίστη ἡ ἀπὸ τῆς γῆς· αὕτη δέ ἐστιν ἣν οἱ μὲν ἑκφόριον, οἱ δὲ δεκάτην προσαγορεύουσιν.

[139] *Ibid.*, II, 1, 5

[140] *Ibid.*, II, 1, 6

> surplus *production*, therefore, have varied in response to the demands of surplus *appropriation*. Clearly, the need to intensify production has varied in large part according to the extent of such obligations. These patterns have been determined not only by 'objective' factors of population, ecology and technology, cultural factors and the standard of expectations, but in particular by social and political relations and the balance of power between producing and appropriating classes. In fact, demographic pressures themselves cannot be considered in abstraction from these relations. The level at which population growth begins to strain available resources and productive capacities varies *inter alia* according to how much production is syphoned off by leisured appropriators[141].

In this chapter, the notion of surplus will be essential, and therefore requires being given a clear definition. In his innovative and thought-provoking book *The Class Struggle in the Ancient Greek World*, G. E. M. de Sainte-Croix has opposed an *internal* definition of the surplus ("that part of an individual man's labor of which he does not directly enjoy the fruits himself"[142]) to an *external* definition ("something set aside by the society as a whole (…) as surplus to its needs, and made available for some specific purpose"[143]). This surplus, he writes, can be extracted in three ways: by exploiting wage labor, by exploiting unfree labor, and by leasing land to tenant in return for the payment of a rent[144] (to which we might add taxation). My definition somehow navigates between the internal and external definition: *at the individual level, surplus will be defined as the proportion of total produce which is used for the payment of rents and taxes, and – if possible – for increasing self-consumption. The overall rate of surplus is the aggregation of all individual (positive, null or even negative) surpluses as a fraction of total regional produce.*

In chapter I, the structure of Graeco-Roman agriculture has been outlined, together with its geographical variability. The analysis mostly focused on environmental conditions, technical innovations, crop diversity and yields, that is, on the agronomical side of the ancient agrarian system. In this chapter, we shall turn to the second half of the agrarian system : the exploitation of resources. The emphasis of this chapter will not be put on the various strategies and procedures of marketing of

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[141] Meiksins Wood (1988), p. 55

[142] de Sainte-Croix (1981), p. 37

[143] *Ibidem*

[144] de Sainte-Croix (1981), p. 53

the agricultural surplus[145]; rather, it will aim at understanding which factors determine the primary production of this surplus and the mechanisms through which it was appropriated. The discussion will be guided by the following set of questions :

- What were the different modes of land exploitation, and to what extent do they differ regarding their farming strategies and the use of production factors?
- How reliable is the dominant (neo-classical) economic theory for the modelling and assessment of agricultural production in the Graeco-Roman context?
- Which variables determined the value of landed wealth and its return, and are they marked by any noticeable changes over the considered period ?
- How do rents and taxes influence agricultural production and available surpluses ?

2.2 Forms of land ownership and management

In the Greek part of the Roman Empire, land could fall in either of the following six categories[146] :

(1) the *ager imperialis*, belonging to the imperial domain. Rather reduced in the first century in Asia Minor, it only attained significant extent in the Severan period[147].
(2) the *ager publicus*, belonging to the *populus romanus* – the Roman institutional apparatus – and most often leased to private tenants[148]. According to Cicero, the *ager publicus* had acquired an important amount of land in Asia Minor by the 1st c. BC[149];
(3) the *ager assignatus*, consisting of extensions of the *ager publicus* due to conquests that were redistributed to roman colonists[150];
(4) the *ager privatus*, possessed in full by landowners, either local citizens or Romans[151];

[145] On which see Erdkamp (2005)
[146] Duncan-Jones (1990), pp. 121-126
[147] Sartre (1991), pp. 280-281
[148] Bowman & Wilson (2013), p. 5
[149] Cic., *De leg. Agr.*, I, 5 & II, 50; Sartre (1991), p. 281
[150] Sartre (1991), p. 281; Mattingly (2011), p. 141

(5) civic land belonging to municipalities[152];
(6) sacred land (more frequent in the Greek part of the empire) owned by temples, which sometimes possessed considerable domains[153];

In the provincial context we are dealing with, we will mostly focus on privately owned land, *ager assignatus*, civic land and sacred land. Discussions on land transactions regarding civic and sacred land are left to section 2, and we will thus start with land owned by individuals.

In her study of agriculture in classical Greece, based mostly on literary sources, A. Burford identifies three variants of private land exploitation[154] : (1) landlord leasing his land to a tenant (μισθωτής/*colonus*); (2) landowners employing a bailiff (επίτροπος/*villicus*) ; (3) small owners working their land themselves (αυτουργόι) with their household. Implicitly, Burford's typology relies on a fundamental distinction in Roman law : the difference between *property* and *possession*, which finds a parallel in Greek law in the concepts of κυριεία and κράτησις. Property over a commodity is divided into three separate aspects: the right to *use* it (*usus*), the right to profit from its produces (*fructus*), and the right to alienate it (*abusus*). Possession (lat. : *possessio*) designates a situation where the enjoyment (*usus*) of the commodity has been transferred to another person, together with the right to claim a share of the produces (*fructus*), but without the right to alienate it. Applied to the context of land ownership, the small owner-cultivator holds both property and possession, while tenants and bailiffs hold possession but not property, and hence have to pay a share of the produce (or a fixed contribution) to the estate owner.

A different, yet complementary typology has been developed by P. Erdkamp which, instead of being based on the formal mode of exploitation, rather relies on the criteria of size and connection to the market (of both commodities and labor). Edkamp distinguishes between : (1) large-scale commercial estates, whose activity was mainly directed to the market (2) middling exploitations he calls 'market-orientated' farms, combining self-consumption with a substantial degree of commercialization, and (3) peasant farming, where production and consumption almost entirely took place within the household. His typology is quite similar to that proposed by agronomist J. D. Van

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[151] Land ownership by Romans in Asia Minor is quite well documented in the sources : Broughton (1937), pp. 549-553. See for instance : Cic. *Ep.* 234 & Cic.,*Pro Flacco*, 51.

[152] Macro (1980), p. 684; see also : Liebenam (1900), pp. 312-318. Explicit example for such city-owned land can be found in *IK-Laodikeia Am Lykos*, 47, mentioning a 'supervisor of civic land'.

[153] Strab., XII, 3, 32-36 (Comana of Pontus) & XII, 8,14 (Pisidian Antioch). Cf. Sartre (1991), p. 278-279.

[154] Burford (1993), pp. 167-181

der Ploeg who distinguishes 'capitalistic' farming, 'entrepreneurial farming' and 'peasant farming'[155].

To these categories, he adds the 'rural proletariat', the agricultural workers who were too poor to own land[156]. The first and last categories are rather self-evident, but the intermediate category of 'market-orientated' farming might seem more obscure. By this term, Erdkamp intended to designate the (wide) range of farm exploitations filling the gap between the extreme cases of small-scale owner-occupiers on the one hand, and large-scale commercial exploitations on the other.

As Erdkamp writes it, 'the basic economic difference between farming on peasant farms, wealthier market-orientated farms and large estates consists of the variation in the input of productions factors'[157]. Even if this is true, the three ideal-types also differ regarding the size of available surplus, which depends both upon primary production and the extent of surplus extraction in the form of rent payment[158]. This dimension is quite absent from Erdkamp's typology and directly relates to the form of ownership, while it also influences the relative share of self-consumption and seed in the total produce (cf. *infra*). We might therefore try to provide a synthetic typology, combining the criteria of size and market connectivity with the mode of ownership/exploitation. We could do this by constructing a two-dimensional diagram on which size and market connectivity form the Y and X axis. The surface of the diagram can then be divided into separate domains, each characterized by a specific form of ownership, consistent with a particular combination of size and connection to the market. Since small-scale farmers with high market connectivity and large estates with weak connection to the market are both highly unlikely and find no support in the evidence, we can exclude them from the beginning. The resulting diagram (Fig. 6) thus allows us proposing the three following categories :

1°) Small-scale owner-occupiers, probably best described by the Greek term *autourgos* than by the label 'peasant farming', which would require a discussion on the definition of the peasantry;

2°) Large-scale commercial estates functioning almost entirely for the market, owned by a landlord, managed by a *conductor* or *villicus* and leased to a tenant (*colonus*).

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[155] Van der Ploeg (2011)

[156] Erdkamp (2005), p. 14 & p. 58

[157] Erdkamp (2005), p. 14

[158] See below (section 2) for detailed discussion.

3°) Intermediate exploitations, which we label as 'market-connected' farms. This is not to say, of course, that small owner-occupiers are not connected *at all* to the market, but the vast majority of their production factors – above all labor – as well as the consumption of their surplus originates in the household, even more so since they do not have to pay a rent. Erdkamp's label of 'market-orientated' farms, while accurately describing the characteristics of intermediate exploitations, might be somehow confusing insofar as it would imply that these middling farms organized the *majority* of their production *primarily* for the market. A significant proportion of them, closer to the large commercial estates, must undoubtedly have done so, but countless others might be smaller farms, worked by peasant households, *epitropoi* or tenants who occasionally used some extra wage labor from time to time and commercialized a proportion of their surplus – relatively modest compared to self-consumption – mostly to pay their rent. The criteria of land ownership and mode of exploitation can be introduced with a third, implicit axis, ranging from the south-west to the north-east corner of the graph: indeed, beside the payment of the rent, the variable that distinguishes small freeholdings, leases to bailiffs, and tenancy, is the cost of logistics and management.

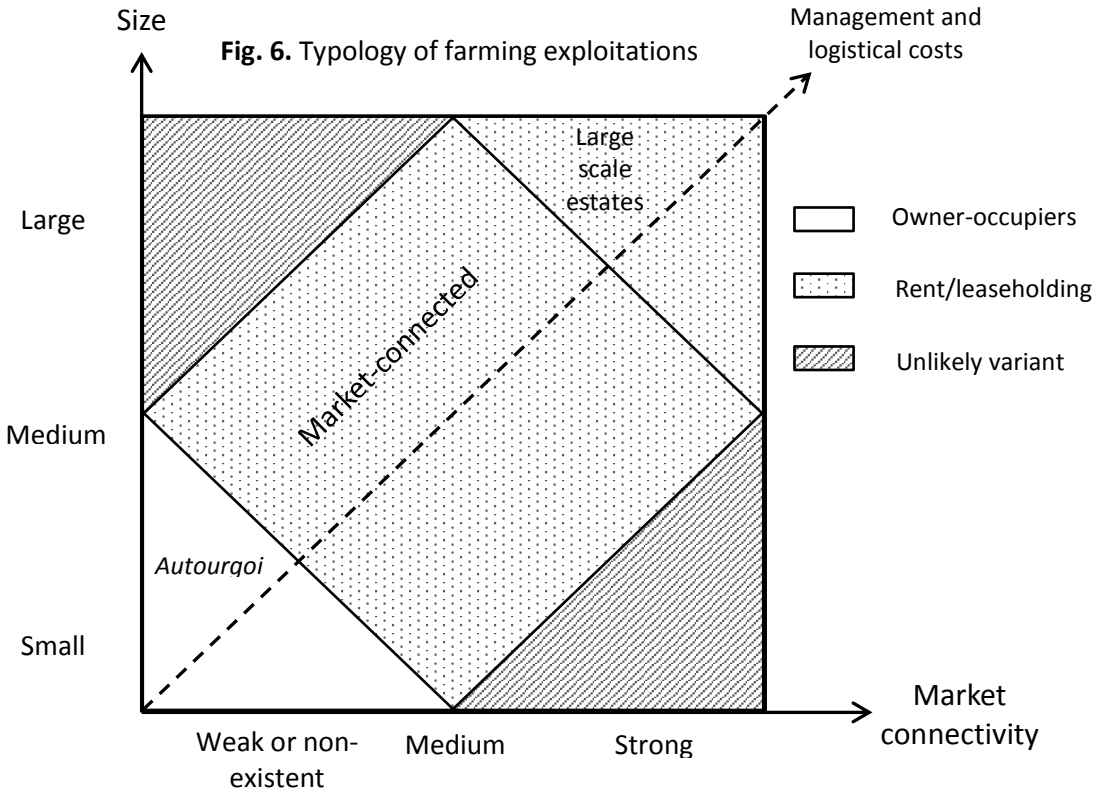

Fig. 6. Typology of farming exploitations

An important question, which I unfortunately have not enough data to discuss, is that of the relative proportions of each of these three forms of land ownership in Roman

Asia Minor, since it is likely to be a crucal parameter of both overall production and distribution of available surpluses[159].

2.3 Economic modelling of ancient agricultural production

The total produce (Y) of a leased agricultural exploitation is distributed between self-consumption for basic needs (N), seed-corn (S), rents (R), taxes (T) and a potential benefit (B) :

$$Y = N + S + R + T\ (+B)$$

The *productive basis* consists of the share of the produce which is necessary to further production, namely self-consumption (the 'reproductive cost' of labor) and seed; the remaining quantity defines the *surplus,* for which rents, taxes, and benefits have to compete. The share of each component in the total output may vary significantly according to the yield (cf. chap. I), the level of rents, and the tax rate. If we leave out the tenant's benefit out of the problem as a first approximation, the 'canonical' share of each component that we may expect on average in Roman Asia Minor is displayed in the following figure[160].

[159] For a general discussion on tenancy, see : Kehoe (1997), esp. chap. 2-4.

[160] Mitchell (1993), p. 251-253

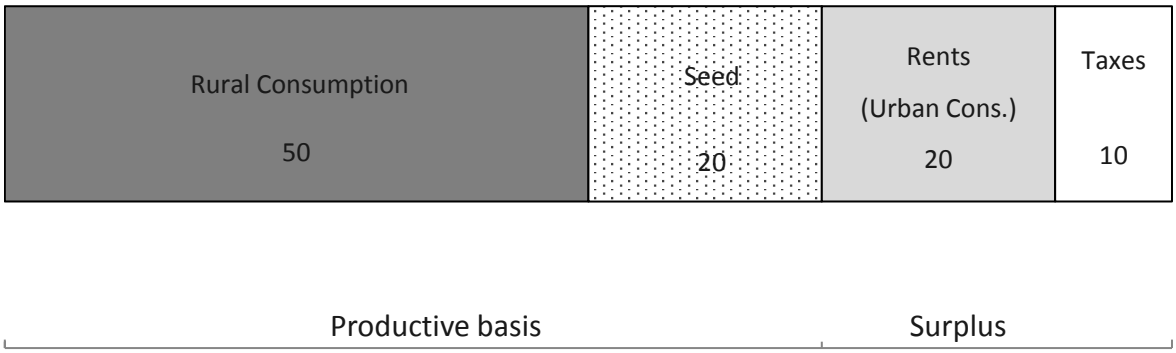

Fig. 7. Structure of grain output (in % of produce)
(Source : S. Mitchell, 1993)

Each of these values is of course only illustrative and experienced significant variations through time and across space. The 20% ascribed to the seed requirements implies a rather pessimistic yield-to-seed ratio of 5:1, while we have seen in chap. I that ratios of 8:1 or 10:1 were probably more common that usually admitted, particularly in western Asia Minor, which was more fertile than continental Greece. What matters mostly for this chapter are rents and taxes. The bulk of rents paid up by tenants to landlords (discussed in section 3) defines the quantity of grain that will eventually supply the urban market. Of course, some small-scale independent peasants also commercialized a share of their surplus, but it is unlikely that this may have represented an important part of overall urban grain supply. Yet, not all the grain paid in the form of rents end up on the market, since a small share of these must have been hoarded for (mostly) speculative purposes. Finally, the 10% taxes in kind consist of the *decuma* required for Rome, whose impact and levying .are discussed in section 4

However, before discussing the distribution and allocation of total production, we need to examine the conditions of its 'primary' production as resulting from the use of land and labor. In chapter I, we merely reassessed the productivity of Graeco-Roman agriculture (in the Anatolian context) through the perspective of farming practices and agro-climatic conditions. But, within a given environmental setting, the productive potential varies dramatically depending on how the available resources (labor and land) are used. The agronomic approach to the productive capacities should thus be followed by an economic discussion of the use of resources, which will be the concern of the first section of this chapter.

2.3.1 The neoclassical model and its shortcomings

Neo-classical economic theory has brought an important innovation with regard to classical theory by relating production factors and output by what economists call a 'production function'. The most widely used production function among neo-classical models is the Cobb-Douglas function[161], of the form :

$$Q = h \cdot L^{\eta} \cdot A_a^{\beta} \qquad (1)$$

where Q represent the total output, h is a constant capturing the technological development, L is agricultural labor and A_a is the cultivated surface. The exponents η and β are the partial elasticities of production regarding, respectively, labor and land. The sum of η and β define the returns to scale :

$\eta + \beta > 1$: growing returns to scale
$\eta + \beta = 1$: constant returns to scale
$\eta + \beta < 1$: decreasing returns to scale

The fundamental and almost pervasive assumption of the neo-classical models is that the returns to scale are constant, while marginal returns are decreasing. The returns to scale define the change in total output if *both* production factors increase in the same proportion. Constant returns to scale thus mean that doubling labor inputs and doubling cultivated area *together* will imply a doubling of total output. However, as one input (say, labor) is more intensively employed, the contribution of each additional unit of this factor to total output decreases, while the productivity of the other factor increases.

Despite its welcome mathematical simplicity and its intrinsic consistency , the neo-classical model contains substantial problems regarding 'critical assumptions'[162] : (1) decreasing marginal returns on labor (labor productivity), which implies that average labor productivity decreases linearly as labor-intensification (the increase of the use of labor relative to land) increases[163]; (2) decreasing marginal returns on land

[161] Among an enormous literature : Fruit (1962), pp. 186-236 ; Debertin (2012), pp. 171-187.

[162] Rodrik (2015)

[163] Here, some clarification is needed regarding the vocabulary used in this chapter : from an economic point of view, increasing the number of laborers per unit of land is of course an extensive process. Intensification concerns changes in the production techniques, such as changing the rhythm of crop rotation, manuring, or new agricultural technology. In this chapter, I use the term 'intensification' as

(soil productivity), implying that intensification always plays against average productivity and, hence, against per capita output. It is not to say that those statements should be dismissed *a priori*, but they deserve at least to be questioned.

One further observation regarding the Neo-classical model should be emphasized: since, as explained above, it relies on a Cobb-Douglas production function, the model only allows for linear (in the present case, hyperbolic) relationships. This feature alone, it should be noted, puts such a model somehow in contradiction with the canonical Neo-classical theory itself. Indeed, in Neo-classical economics, the law of diminishing marginal returns belongs to a more general law, known as 'the law of variable proportions', or 'law of non-proportional returns'. As illustrated by the graph below, the law of variable proportions states that, when the use of a production factor increases, total output begins by growing more than the increase of inputs, then increases linearly with inputs (the relative increase of output equals the relative increase of inputs), and only in a later phase starts increasing less than proportionally to the input increments[164]. As the input increase continues, the increase in total output will approach zero and might even ultimately decrease. Of course, it is perfectly possible that one or more of these phases would not be present in a given production process, but the generic case contains them all.

The obvious problem is that the function describing the law of variable proportions displays at least one inflexion point (the point where the convexity of the curve changes). Yet, the mathematical formulation of the Cobb-Douglas function does not allow for any inflexion point whatsoever[165] : in the case of decreasing marginal returns and constant returns to scale – the traditional assumptions of most neo-classical models –, the convexity of the curve is always turned downwards[166].

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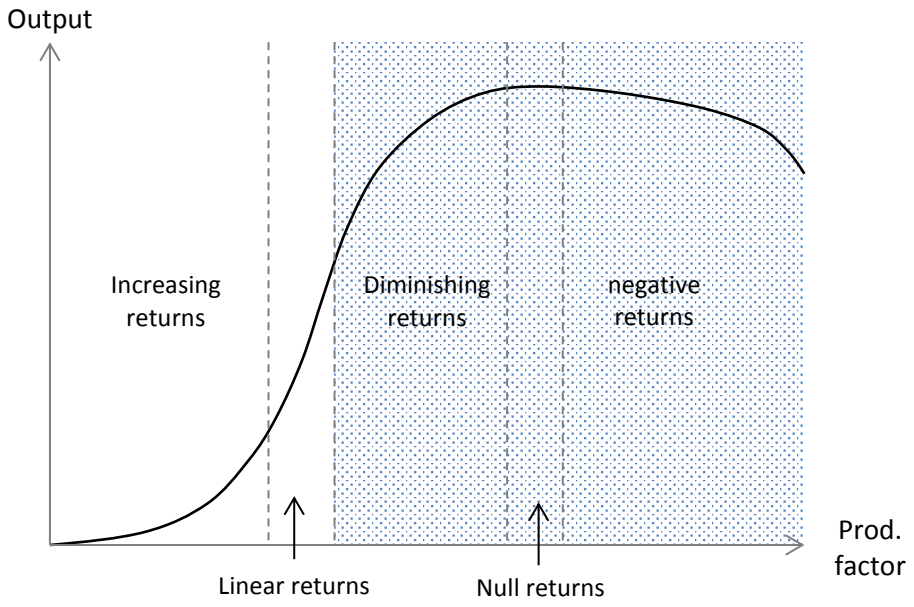
defining the increase in the use of labor inputs per units of land as opposed to an extention of the agricultural cultivated surface.

[164] Jurion (2006), pp. 105-106

[165] In mathematical terms, the inflexion point is given by the one where the second derivative of the function is equal to zero. But in a Cobb-Douglas function, the second derivative of the curve is always negative, except in the trivial point (0,0).

[166] Simon & Blume (2014), pp. 47-48



On the basis of the problems exhibited by the Cobb-Douglas production function, it might seem sounder to choose a more appropriate production function. Other functions indeed exist in the economic literature, but they do not especially solve our problems without creating new ones : some of them contain many different parameters that it would be impossible to assess in a context which does not provide statistical data, while others considers the production factors as being independent from one another, an assumption obviously untenable since *both* labor and land are required for any agricultural production to take place. The indirect goal of the current section will be to construct an alternative production function more suitable to the modeling of agricultural production, and more specifically to ancient agricultural production. We shall thus start by discussing the flaws of the Neo-classical model, the first of which lies in concept of 'diminishing marginal returns'.

2.3.2 Non-decreasing marginal returns : insights from H. C. Carey and P. Sraffa

How likely is it that constantly diminishing marginal returns would occur in agriculture, and more precisely in ancient agriculture ? With respect to the puzzles arising from the Cobb-Douglas production function, this is the question to be asked here. Yet, when speaking of agricultural returns, one fundamental distinction should be made *ab initio* in order to avoid any confusion : (1) the evolution of soil productivity resulting from an increase of the cultivated area, and (2) the evolution of soil productivity resulting from an increase in the use of labor per unit of land.

(1) It has often been argued by classical economists like Adam Smith and David Ricardo that, when a process of extensive cultivation occurred (notably as a

consequence of population growth), the best soils were cultivated first, resulting in decreasing marginal productivity of land. Yet, this hypothesis has been strongly criticized : already in the early 19th century, economist Henry Charles Carey argued that the order of cultivation did not always or even generally go from fertile to poor soils. In his book *The past, the present and the future*, he examines Ricardo's proposition of decreasing marginal land returns and argues :

> 'If man begins always with the best soils, then is this proposition true, and with every step in the process of population, he loses more and more control over his own actions, becoming the victim of an overruling necessity. If, on the contrary, he begins with the poor soils, and passes gradually towards the bests, every step should be accompanied by increasing power to select such soils as are best suited to his purpose, taking sometimes the light sands and at others the heavy marls; at one time the clay, at another the lime (…); the hilltop or the river bottom; the near or the distant; the superficial or the profound."[167]

In his other opus (*Principles of Political Economy*), he writes : 'the soils first cultivated are very frequently *not* those of highest fertility; (…) the settler prefers that which is somewhat inferior, but which is clear and ready for cultivation'[168]. Order of cultivation he claims, does not usually follow a decreasing gradient of fertility. Other factors must be taken into account such as the suitability of the soil to the specific type of cultivation, and the amount of labor required for rendering the land ready for agricultural operations[169]. For Carey, soil fertility is therefore not only a 'natural' given, but also depended upon the effects of human labor. Of course, Carey's case study is the English territory from the Middle Ages to the beginning of the 19th century, but his reasoning may well apply to any pre-industrial context. In accordance with those criticisms of mechanically decreasing marginal returns on cultivable land extension, Ph. Wicksteed himself, one of the leading figures of economic Marginalism, stated that the very label of 'marginal product' was far less applicable to land than to any other mean of production[170].

(2) Yet, doesn't marginal soil productivity decrease with the intensification of the use of labor ? In a paper that has largely been ignored by later scholarship, P. Sraffa examined the conditions of validity of the law of diminishing marginal returns. According to neo-classical theory, decreasing marginal returns in an industry broadly

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[167] Carey (1848), p. 50

[168] Carey (1837), p. 38

[169] *Ibid.*, n.2 On the effects of labor and management as determining factors of soil productivity, see : Vidonne (1977).

[170] Wicksteed (1914), pp. 18-20; Sraffa (1960), p. 2.

defined – say, 'agriculture'– will only occur if some means of production – land, for example – are considered as 'fixed'. In this case, considering the agricultural sector as a whole, without further precisions, the total quantity of cultivable land cannot be increased as fast as population – and, hence, demand for food products – grows, resulting in diminishing returns. Yet, this requires a very wide and vague definition of an 'industry'. So wide, actually, that the fundamental hypothesis of independence between demand and supply will no longer be valid : indeed, any attempt to generate an overall increase in agricultural production would change the relative prices of land and labor, since it would to a certain extent redirect labor from other industries into agriculture[171]. A S. Keen explains in his recent book *Debunking economics*, in which he reassessed the validity of Sraffa's works, this change in the relative prices of inputs will also, mechanically, change the distribution of income and, hence, modify the aggregate demand curve[172]. The logical conclusion to be drawn is that, as changes in aggregate supply of agricultural products would affect aggregate demand for such products, the induced changes in income distribution and demand might, to a certain extent, compensate for the diminishing returns, and will eventually result in a situation of multiple equilibrium points.

If, on the other hand, we reckon with a more realistic conception of an industry – say, grain production – then the hypothesis of independence between demand and supply becomes valid, but that of fixed inputs is no longer tenable :

> If we next take an industry which employs only a small part of the "constant factor" (which appears more appropriate for the study of the particular equilibrium of a single industry), we find that a (small) increase in its production is generally met much more by drawing "marginal doses " of the constant factor from other industries than by intensifying its own utilization of it ; thus the increase in cost [*i.e. the decrease in returns*] will be practically negligible, and anyhow it will still operate in a like degree upon all the industries of the group. Excluding these cases, and excluding – if we take a point of view embracing long periods – the numerous cases in which the quantity of a means of production may be regarded as being only temporarily fixed in respect to an unexpected demand, very little remains: the imposing structure of diminishing returns is available only for the study of that minute class of commodities in the production of which the whole of a factor of production is employed[173].

[171] Sraffa (1926), p. 539

[172] Keen (2011), pp. 146-147

[173] Sraffa (1926), p. 539

Under these conditions, some flexibility in the use of production factors is likely to take place : an increased demand for grain could be met by converting into grain-land agricultural surfaces devoted to other purposes, or by a reduction of fallow, or by a shift operated by other producers (wine, cattle,...etc) towards the production of grain, and only in some residual circumstances would an actual extension of cultivated land by purchases (or other procedures) occur; more likely, of course, is a combination of all processes.

Going back to the case where production would be constrained by a fixed resource, Sraffa, followed by Keen, acknowledges that diminishing returns are likely to occur, but *only from a certain level of production and beyond*, reconnecting thereby to the actual generic law of non-proportional returns[174]. Yet, he contests the idea that diminishing returns would *mechanically* occur anyway. As Sraffa, and Keen after him, explain, the idea that diminishing returns are inevitable supposes a complete utilization of the fixed resource. But this is not always the case. As Keen explains :

> Imagine that you have a franchise to supply ice creams to a football stadium, and that the franchise lets you determine where patrons are seated. If you have a small crowd one night – say, one quarter of capacity – would you spread the patrons evenly over the whole stadium, so that each patron was surrounded by several empty seats? Of course not! This arrangement would simply force your staff to walk farther to make a sale. Instead, you'd leave much of the ground empty, thus minimizing the work your staff has to do to sell the ice creams. There's no sense in using every last inch of your 'fixed resource' (the stadium) if demand is less than capacity[175].

The same is true, he says, of a farm or factory: 'If a variable input displays increasing marginal returns at some scale of output' – as is precisely claimed by Sraffa – 'then the sensible thing for the farmer or factory owner to do is leave some of the fixed resource idle, and work the variable input to maximum efficiency on part only of the fixed resource'[176]. A numerical example might usefully illustrate this point. Let us consider a farmer having 25 cultivable hectares[177] and 50 workers at his disposal, with the following levels of output per hectare for different numbers of workers per ha :

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[174] Keen (2011), p. 148

[175] *Ibid.*, pp. 148-149

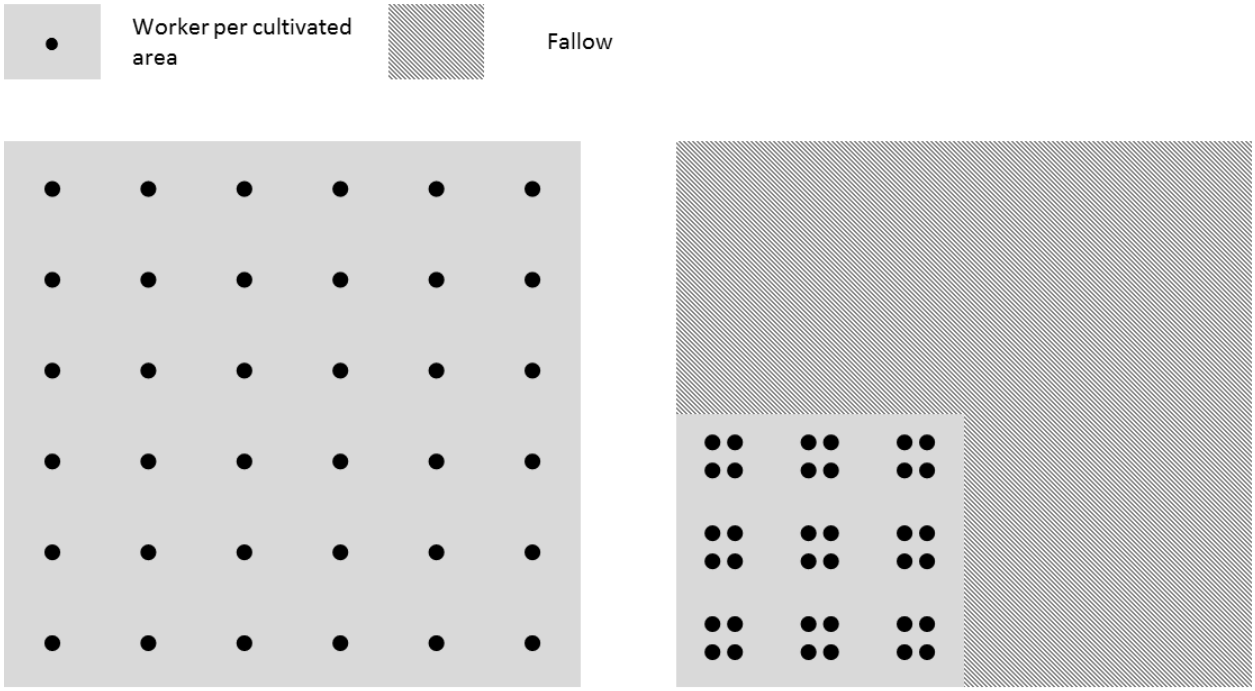
[176] *Ibid.*, p. 149

[177] In the case where fallow accounts for 50% of total surface, this implies a total agricultural surface of 50 ha.

Workers per hectare	Output per hectare (bushels)
0	0
1	0.2
2	0.75
3	1.5
4	2.5
5	3.75
6	5
7	6.25
8	7
9	7.5
10	7.75
11	7.8

According to the neo-classical model, the farmer would use his 50 workers and 25 hectares, resulting in a labor/land ratio of 2 workers per ha (50/25). As illustrated by the table above, at this level of labor intensity, average output per hectare is 0.75 bushels. Hence, total output would be equal to 25 x 0.75, or 18.75 bushels (total cultivated surface x average productivity per hectare). On the other hand, a 'Sraffaian' farmer would rather concentrate his workers on a portion only of his cultivable surface so as to obtain a higher level of productivity. He would for instance dispose his 50 workers on 12.5 hectares in order to obtain a labor-land-ratio of 4 workers per ha, resulting in a total output of 31.25 bushels, hence realizing a 12.5 bushels surplus over the neoclassical farmer.

Fig. 8 . Comparison of the use of resources between neoclassical and 'Sraffaian' models of farming



Thus, the important and somehow counterintuitive conclusion to be derived from Sraffa's analysis – in particular the non-linear response of soil yields to intensification – is that cultivating a smaller surface might be synonym of a more efficient use of resource and, hence, of a larger output. We should thus be careful in interpreting small cultivated surfaces as leading to small surpluses and precariousness of peasant living condition. This conclusion makes particular sense in a context where a substantial proportion of farming exploitations – not only small *autourgoi* but also intermediate farm tenants – do not maximize *profit*, as is continuously assumed by neo-classical models, but rather maximize *total output*[178]. As P. Garnsey states it:

> 'Production totals mattered. Every year farmers measured their harvest. Every year they decided how much to put aside as seed (…). But just as regularly they decided how much land to put under cultivation, how much to assign to each crop, and how much seed to sow for a given area.[179]

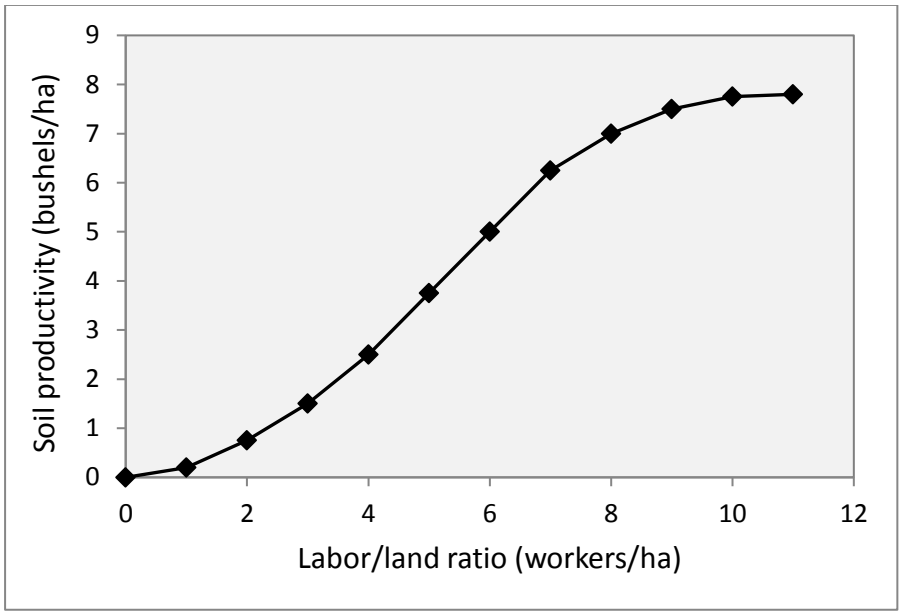
[178] This idea is also expressed by Pliny the Elder, *NH*, XVIII, 38; on output maximization by peasants, see : Fenoaltea (1976), p. 130 sqq (for preindustrial farming); Erdkamp (2005), p. 62 & p. 99 (for Roman farming) ; Van Der Ploeg (2008), p. 42 : 'the peasant way of farming is geared to the production of as much value added as possible'.

[179] Garnsey (2000), p. 708

We might thus wholeheartedly agree with J. D. Van der Ploeg when he writes : 'peasants did not maximize profit, but were not bond to subsistence'[180].

2.3.3 Cooperativity and the non-linear dynamic of labor-dependent yield

As displayed in the figure below, the hypothesis of Sraffa is that average productivity responds non-linearly to changes in the labor/land ratio :



This is, however, a *discrete* example, and the formalization of hypothesis in order to build a mathematical model was not as common a practice in Sraffa's times as it is today. In order to suggest an alternative production function, we thus need to find a *continuous* function depicting such a relationship between intensification (the labor/land ratio) and average soil productivity. The shape of the curve proposed by Sraffa is close to what mathematicians call a *sigmoidal* curve. Several types of sigmoidal functions exist in mathematics, but with very different levels of complexity and conditions of applicability[181]. In order to avoid manipulating exponential functions, we propose to model the soil yield-labor/land ratio relationship by using a slightly modified Hill sigmoidal curve.

[180] Van der Ploeg (2011), p. 46

[181] We might think, for example, of the logistical curves such as the so-called Verhulst equation or the Gomperz equation, often used to describe processes such as population or cell growth. Cf. Simon & Blume (2014), pp. 491-500.

The choice of Hill equations is not only governed by (relative) algebraic simplicity – though more complex than Cobb-Douglas functions. It is also relevant from an explanatory point of view, in so far as it helps providing an actual economic explanation to the possibility of increasing returns in agriculture which is intrinsic to the agricultural process. The Hill functions find their origin in the works of biochemist Archibald Hill who, back in 1910, formulated such equations to describe a process called 'cooperative binding', referring to the process of linkage between a ligand and a macromolecule[182]. As stated by subsequent research in biochemistry and physiology, the Hill equation expresses the level of **cooperativity** between enzymes[183]. What the notion of cooperativity expresses is that the effect of two or more ligands on the affinity of further ligands is superior to the simple sum of the effect of each individual ligand. Stated differently, the whole is more than the sum of its parts.

The concept of cooperativity, initially developed in biochemistry, has since been widely used in natural sciences and particularly in entomology for modeling the behavior of social insects in their food supply strategies. In this respect, it can find useful application to the economics of agriculture. Cultivation is, indeed, a cooperative process in which peasants not only distribute tasks between each other but also develop empirical strategies and methods to cope with their difficulties, constraints or goals. It seems thus perfectly sound to consider that the effect of intensification – the increase in the number of workers per unit of land – fosters cooperation: the impact of the addition of 5 workers per ha on average soil productivity would then be greater than the simple sum of the individual effect of each of the 5 workers. This cumulated effect on output per hectare would start decreasing from the moment when the increase in the number of workers would become an impediment to an efficient use of the resources, and as intensification would start facing the natural limit in the produce that the soil can yield (needless to say, given the level of technological development)[184]. For this reason, the function of average soil productivity (π_A) must be both proportional and conversely proportional to the labor-land ratio (γ). To depict such a relationship, we propose the following 'Hill-type' equation :

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[182] Hill's paper focused on the particular case of fixation of oxygen (O_2) on hemoglobin; see : Hill (1910), pp. iv-vii.

[183] Monod, Wyman & Changeux (1965), pp. 88-118 ; Weiss (1997), p. 835 sqq.

[184] Mathematically speaking, it would perhaps have been more accurate to describe such a phenomenon by using autocatalytic functions (such as those of Gompertz or Verhulst), but this resulted in problems that we could not overcome regarding the match between the average labor productivity function and the average soil productivity function.

$$\overline{\pi_A} = h^* \cdot \frac{\gamma^n}{\theta \cdot \bar{F} + \gamma^n} \qquad (2)$$

where h^* is a coefficient capturing technological development and intrinsic soil fertility, which together define the maximal attainable output per hectare[185], $\bar{F}$ is a function of total farm size, θ is a positive parameter defining the value of the inflexion point (the point where diminishing returns appear), and n is the cooperativity coefficient expressing the effect of intensification on productivity (with $n \geq 1$). The higher the value of n, the stronger the impact of intensification on soil productivity. The graphical representation of the average soil-productivity as a function of intensification resulting from this equation is displayed in the figure below and confronted with the Neo-classical curve.

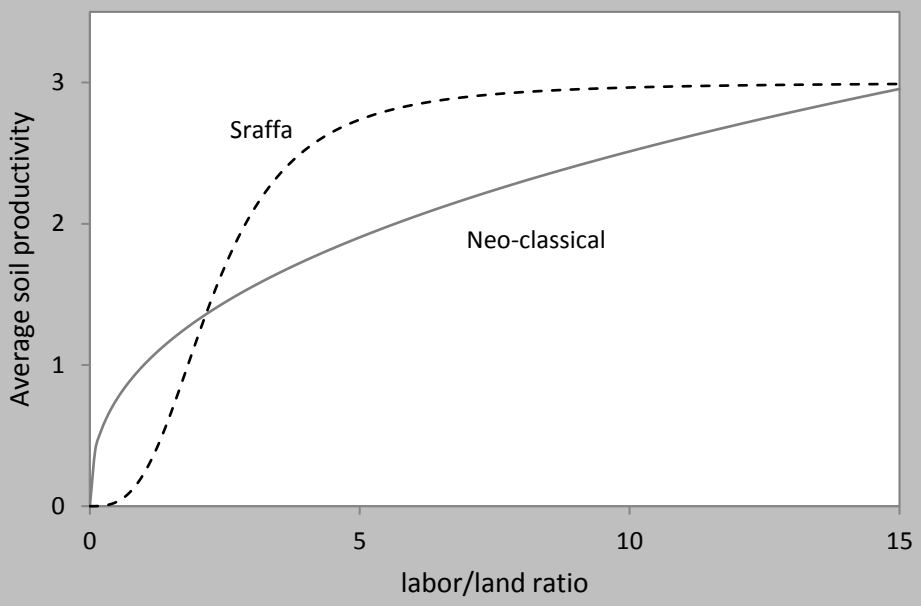


Fig.9. Comparison between the neo-classical and Sraffaian model of average soil productivity as a function of intensification | Neo-classical : α = 0.4 ; Sraffa - Hill : n = 3, m = 2

Cooperativity is of course not limited to labor, and might theoretically apply to other production factors. One might thus want to consider the extent to which additional cultivated hectares could have an increasing effect on output. The only parameter which could increase the effect of extending cultivation on output is the specific conditions of land : in the case of scattered cultivation, additional hectares

[185] Here, h^* is equal to a ratio h/μ in which h is the same technological parameter as the one present in the Neo-classical model, and μ relates to the intrinsic properties of the soil.

would be cultivated in different climatic and soil conditions, which would reduce the overall risk of harvest failure[186]. Yet, substantial land extensions might be contiguous to the already existing ones, in which case there would be no specific advantage from land extension alone. Overall thus, and taking into account the thorough critique of the concept of marginal returns – not only as resulting from labor-intensification but also from extended cultivable surface (cf. supra) – we should consider that there is no cooperativity on the increase of cultivated land, and no anti-cooperativity either.

2.3.4 Non-linear labor productivity: addressing neoclassical inconsistencies

As already explained above in the beginning of this section, the Cobb-Douglas model assumes *continuously* decreasing marginal productivity of labor; that is, from the first unit of labor. But it also assumes continuously decreasing average labor productivity (π_L) : as the labor/land ratio increases, average labor productivity drops. This can be noticed from the Cobb-Douglas function itself. Since average productivity is equal to total output divided by total labor (Q/L), expressing Q by the Cobb-Douglas equation and labelling the labor/land ratio (L/A) by γ yields :

$$\pi_L = \frac{Q}{L} = \frac{h \cdot L^{\eta} \cdot A_a^{1-\eta}}{L} = h \cdot \gamma^{\eta-1} \qquad (3)$$

This feature of the Cobb-Douglas function results in the situation in which, when the units of labor per hectare equal zero, average labor productivity is infinite. Although mathematically correct, this conclusion is obviously absurd from an economic or agronomical point of view. While it is perfectly valid to consider that, after a certain level of intensification, any increase in labor inputs relative to land would result in a decrease of average productivity, we should stick to the (trivial) constraint that average labor productivity is zero when there is no labor per unit land. Thus, the relationship between labor productivity and the labor/land ratio starts at *o*, decreases beyond a certain threshold, and, by definition, can never be negative. Combining these three constraints forces us to acknowledge that the function describing this relationship must experience an increasing phase and a maximum. This consequence is derived

[186] Erdkamp (2005), p. 73

from a mathematical principle dating back to the 17th c. and known as Rolle's Theorem[187].

If we now turn to the modeling of the curve, we have to integrate the further constraint that our function must be in accordance with our modelling of the relationship between soil productivity and the labor/land ratio. In other words, since we ultimately seek to propose an alternative production function, we must ensure that the *same* output equation will arise from *both* productivity functions (land and labor). We should therefore try to model labor productivity with the same type of function as the one used to model soil productivity : a Hill equation, modified in order to fit the specific constraints of labor productivity. We thus propose the function, with the same parameters as those defined for land productivity :

$$\overline{\pi_L} = h^* \cdot \frac{\gamma^{n-1}}{\theta \cdot \bar{F} + \gamma^n} \qquad (4)$$

The following graph compares this non-linear, Hill-type equation with the Neo-classical model :

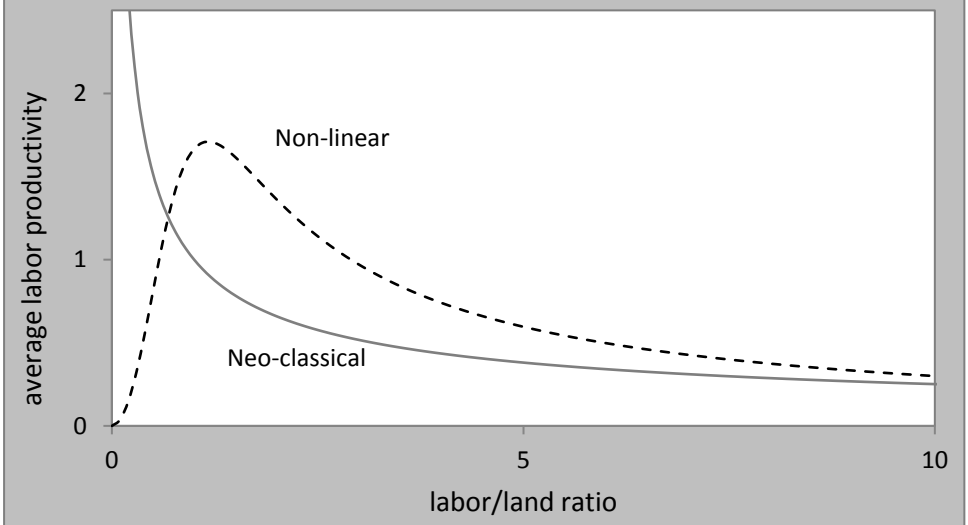


Fig. 10. Comparison between neo-classical and non-linear model of average labor productivity as a function of intensification. Neo-classical : α=0.4 | Non-linear (Hill) : *n* = 3

[187] Rolle (1690); We can think of this conclusion by imagining that we have to draw the relationship with a pen : given that we start from the point (0;0), since the line we are about to draw cannot go beyond the horizontal axis (average productivity is never negative), and since after a certain point, the curve will have to go down (in order to express diminishing marginal returns), how is it possible to draw such a curve without starting by drawing an increasing segment ? The reader will easily notice that it is not possible to do differently.

2.3.5 An alternative production function

From these two productivity equations, we may now infer a single production function which is thus of the generic form :

$$Q = h^* \cdot \frac{A_a^{\epsilon} \cdot L^n}{\theta \cdot A_a^m + L^n} \qquad (5)$$

h^* is the maximum output per ha; θ is a constant coefficient defining the skewedness of the curve; n is the coefficient of labor cooperativity; the difference m-n defines the surface maximizing total output for a given level of labor input, and ε captures the elasticity of output with regard to land. Since we argued above that total output should be considered a linear function of land, ε should be set at 1.

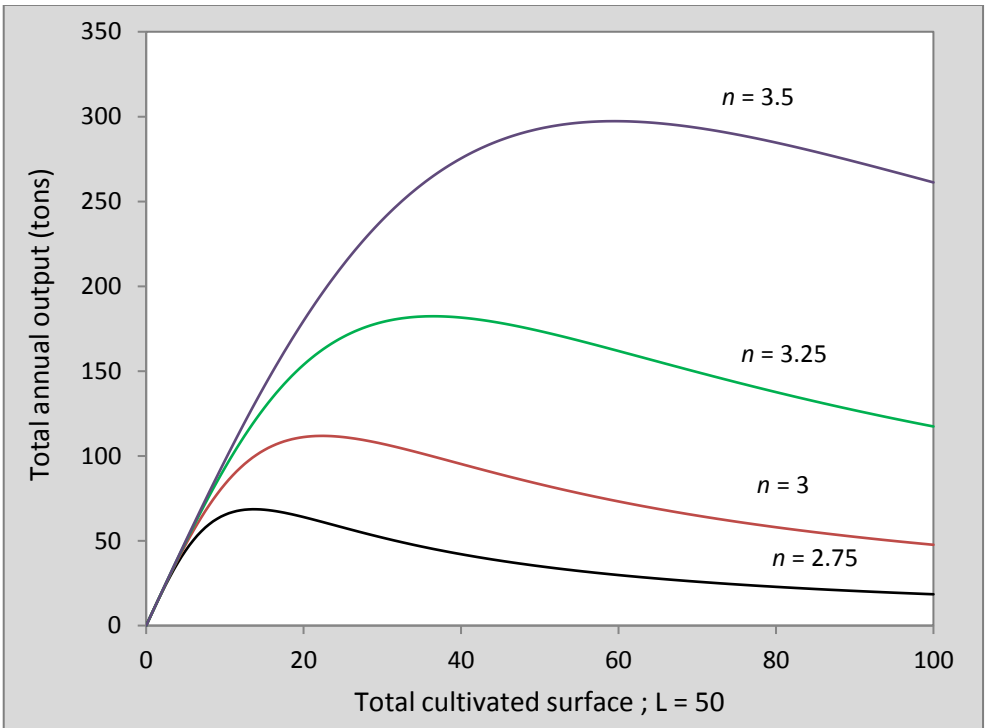


Fig.11. The Sraffa-Hill production function displaying total output as a function of cultivated surface with diffent levels of cooperativity for a farm employing 50 workers | m = 2 ; ε = 1

As displayed by Fig.11, this new production function leads us to draw the somewhat counterintuitive conclusion that, for a given level of labor input, increasing the cultivated area does not always increase total output. Yet, this is perfectly consistent with the hypothesis of Sraffa stating that soil-productivity responds non-linearly to

intensification: since there is an optimal labor/land ratio, extending the cultivated surface beyond this optimal threshold will result in a less efficient use of the resources and, hence, in a lower output.

In the light of this alternative model of primary production, an important discovery of nowadays' agro-economic research is worth emphasizing : the *inverse relationship* (hereafter IR) between farm size and yield. While our Sraffa-Hill production function implies that increasing farm size (and cultivated surface) might play against total output, an ever-growing literature in the field of agro-economics has now revealed that in developing countries larger farm size is very frequently correlated with lower yields per hectare (*i.e*. lower soil productivity) [188]. The actual explanation of this phenomenon is far beyond the scope of this discussion, and is still disputed among experts; but this recurring observation in more traditional farming strongly suggests that such an inverse correlation also applied to Graeco-Roman agriculture, as argued by G. Kron[189].

* * *

The discussion which precedes urges us to argue, following Carey, Sraffa and Keen, that, in the case of agricultural production, the law of diminishing returns should be regarded as the exception, rather than the rule. Therefore, we could not agree more with J. D. Van Der Ploeg when, discussing the common misconceptions in agricultural studies, he writes :

> 'A second series of mystifications center on the 'law of diminishing returns' as formulated by neo-classical economics. But this 'law' has already for several decades been rejected in theoretical agronomy. Whenever diminishing returns emerge this is seen as a temporary exception which after correction will make way again for constant or even increasing returns'.[190]

It is thus quite regrettable to notice the pervasiveness of this principle in the scholarly literature as well as the fact that it is never subjected to a critical analysis, either in the

[188] Among an enormous literature : Carter (1984), pp. 131-145 ; Bachta & Chebil (2002) ; Barrett et al. (2010), pp. 86)97 ; Ünal (2012), pp. 95-127 ;

[189] Kron (2008), pp. 88-89 ; contra Pleket (1993), p. 321

[190] Vand der Ploeg (2011), p. 46

broad field of agricultural economics, or more specifically in ancient economic history[191].

2.3.6 Town and countryside: modelling interactions

2.3.6.1 The spatial division of labor

So far, we have examined grain production at the farm level, that is, from a microeconomic point of view. But what are the implications of both the Neo-classical model and the 'Sraffa-Hill' model for average *per capita* quantity of grain ? What we will try to do in this section is to relate the grain output potential to easily computable parameters such as, for instance, soil and labor productivity, the urbanization rate, and ultimately the proportion of agricultural population, the rate of rents and taxation,...etc. Here, it is important to stress that we are dealing with a *potential* per capita output. Relating total output to population is actually a measure of overall production taking into account the effect of population; it says nothing at all, of course, of the quantity of grain which individuals actually consumed since we do not factor in the impact of social inequality on the mechanism of grain distribution. At best, it helps defining a ceiling.

In the course of this section, a number of assumptions will be made in order to make the construction of the model easier. The first of these assumptions is to assimilate rural population and agricultural population, and urban population with non-agricultural population. I am however well aware that ancient towns were not atolls of non-agrarian production in oceans of agriculture. Important scholarship has indeed revealed that a non-negligible agricultural production took place in the suburban areas[192] and even within city centers[193]. In Pompei, W. Jashemski has estimated that gardens and cultivated land accounted for a little less than 18% of total urban area[194]. However, most suburban and urban agriculture consisted of orchards and legumes, cereals being only marginal among them. Yet, to the extent that urban agriculture gave products that could be partly substituted to cereals, this feature

[191] Agricultural economics : Smedshaug (2010), p. 136 ; Debertin (2012 [1986]), p. 19 sqq; ancient economic history : Jongman (1988), p. 26, pp. 76-77 & p. 86 ; Erdkamp (2005), p.62 ; Temin (2013), p. 15 & p. 23; Erdkamp (2015), p. 31.

[192] On suburban agriculture : Goodman (2007), p.47, pp. 54-55,. 72-73 & 76-77.

[193] Jashemski (1979), pp. 201 sqq & 251 sqq.

[194] *Ibid.*, p.24.

undoubtedly undermined the level of dependency of urban areas with regard to their hinterland. But at the same time, significant non-agrarian production was also carried out in the countryside, hence also reducing the dependency of rural dwellers upon urban production regarding capital goods.

To be more accurate, then, we should rather speak of a dichotomy between those who produce their means of subsistence (population engaged or primarily engaged in agriculture) and those who do not (populations primarily engaged in non-agricultural activities)[195], rather than of a strict economic dichotomy between town and countryside. But in a first approximation, it does not seem unreasonable to consider that the urban agrarian population was roughly counterbalanced by the rural non-agrarian population[196], and hence that in quantitative terms, this simplification may be applied without affecting the results too much. In the last part of this section, we will try to move beyond this initial assumption and develop a more realistic approach. In the meantime, however, it is worth comparing the outcome of the Cobb-Douglas type and Sraffa-Hill models regarding the link between per capita potential output and labor-land ratio.

2.3.6.2 The Neo-classical model

Per capita output is obtained by dividing total quantity (Q) by total population (P). Since total output is defined with regard to a Cobb-Douglas function[197], we have :

$$q = \frac{Q}{P} = \frac{h \cdot L_r^{\alpha} \cdot A^{1-\alpha}}{P}$$

Yet, total population can be divided into urban and rural population, the former being mostly agriculturally non-productive. Since total population is the sum of urban and rural population, and since the rural labor force is a certain proportion (actually the employment rate, noted k) of total rural population, we can express total population in terms of the ratio of urban to rural population (φ)[198]. Injecting this expression in the per capita equation and transforming the remaining variables in terms of labor productivity provides us with a final equation for *per capita* grain output:

---

[195] Lo Cascio (2011), p. 89

[196] Despite N. Morley's skepticism regarding this assumption (Morley (2011), p. 152.)

[197] With the assumption of diminishing marginal returns and constant returns to scale.

[198] $P = L_r \cdot (1 + \phi)/k$

$$q = h \cdot \frac{k \cdot \bar{\pi}_L}{1+\phi} = \frac{h \cdot k}{1+\phi} \cdot \gamma^{\alpha-1} \qquad (6)$$

These two equations state that the grain output potential *per capita* of a production unit is directly proportional to the employment rate and to the average productivity of labor and land, and conversely proportional to the ratio of urban to rural population.

Of course, this does not imply that this quantity was the *actual* average share of grain at the disposal of one individual, since it does not take into account the mechanisms of output distribution, income inequality or fluctuation of prices and purchasing power. But this expression of per capita quantity of grain provides us with an evaluation of the grain output "potential" of a city or region with respect to the distribution of its population.

From this equation, it is now possible to assess the effect of population distribution between town and countryside on *per capita* potential supply. This can easily be done by expressing the ratio φ in terms of urbanization rate (u) :

$$q = h \cdot k \cdot \bar{\pi}_L \cdot (1-u) \qquad (7)$$

As illustrated by the graph below, this relationship implies that per capita potential grain supply decreases linearly as urbanization increases. Here, I want to be very clear for the reader: I am *not* saying that this is what actually happened. Rather, I want to stress that this is the consequence that follows from relying on the Cobb-Douglas neo-classical function to describe agricultural production.

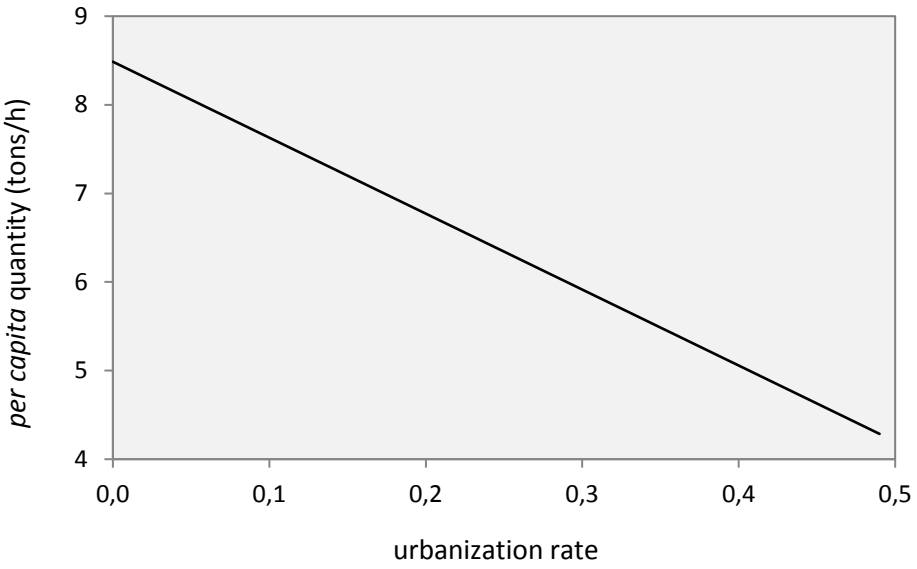


Fig. 12. Potential supply per capita decreases linearly as urbanization increases | Gross average soil productivity : π_A = 1 ton/ha ; *k* = 0.65

2.3.6.3 The Sraffa-Hill model

Here also, *per capita* potential output is obtained by dividing total production (Q) by population (P), but instead of a Cobb-Douglas function, we represent it by the Sraffa-Hill equation[199]. The expression is thus :

$$q = \frac{Q}{P} = \frac{h^* \cdot \frac{A \cdot L^n}{\theta \cdot A^m + L^n}}{P} \qquad (8)$$

Here again, we may express total population in terms of rural labor and the ratio of urban to rural population[200] which, after simplification and rearrangement provides the following equation linking per capita output to the labor/land ratio :

$$q = h^* \cdot k\left(\frac{1}{1+\phi}\right) \cdot \frac{\gamma^{n-1}}{\theta \cdot F + \gamma^n} \qquad (9)$$

[199] With ε = 1

[200] See above, n.45

This expression could likewise be formulated in terms of population density through the following transformation[201] :

$$\gamma = \frac{\alpha k \rho}{a}$$

However, at the macro-economic level, the labor/land ratio provides a good proxy for population density; displaying both equations would thus be redundant. The graph below compares the results of the Neo-classical and Sraffaian models: when modeling agricultural production on the basis of the Sraffa-Hill production function, the intensification – or, similarly, increase in population density – does not always play against per capita output, but rather exhibits an optimum value, defined by the specific conditions of production. Here again, the hyperbolic decrease exhibited by the neo-classical model results from the absurd assumption – intrinsic to the Cobb-Douglas function – that marginal returns on labor decrease continuously as the use of labor per unit of land increases, which implies that average labor productivity – or, here, *per capita* output – when there is no labor at all would be infinite…

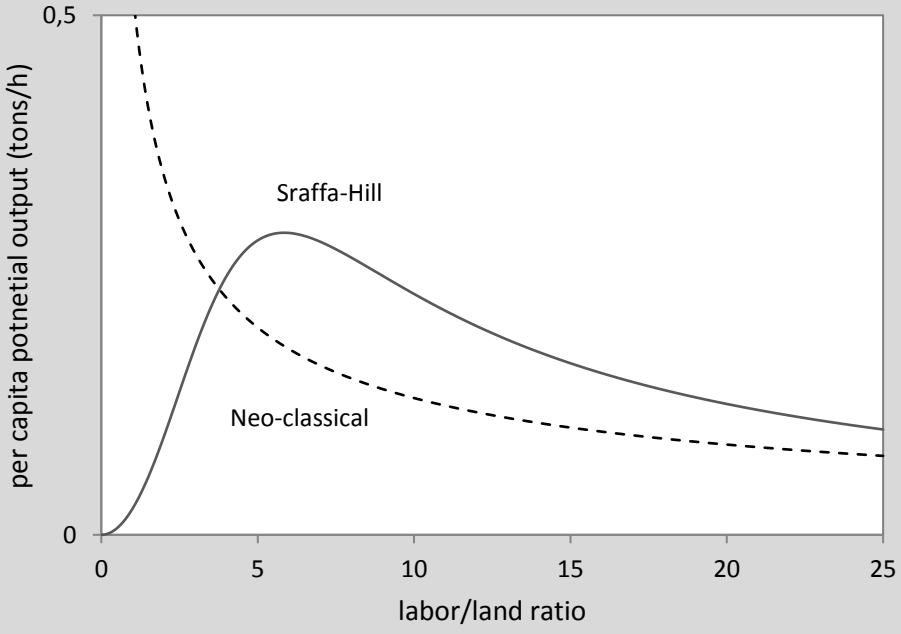


Fig.13. Contrary to the Neo-classical model, the Sraffa-Hill model shows that intensification (or increase of population density) does not always undermine per capita output.

[201] Indeed : $\frac{L}{A_a} = \frac{P_a}{P}\frac{L}{P_a}\frac{P}{A}\frac{A}{A_a}$

But what do we get if we now examine per capita output with regard to urbanization ? Let us go back to eq.(9) above. By comparison with eq. (4) defining average labor productivity we easily notice that the equation can be rewritten as:

$$q = \frac{k \cdot \bar{\pi}_L}{1 + \phi}$$

Hence, when developing the Sraffa-Hill production function at the macro-economic level, we obtain the *same* relationship than that obtained by the Neo-classical model (eq. 6), namely that *per capita* output decreases as urbanization increases. In this regard, the Sraffa-Hill model and the Neo-classical model would diverge regarding production at the *microeconomic* or *mesoeconomic* level, but converge at the *macroeconomic* level.

2.3.6.4 Urban-driven growth or diminishing returns…but not both

At first sight, it would thus seem that the process of urbanization would undermine agricultural *per capita* output – leaving out, needless to say, the effect of monetization and trade, that will be discussed in chap. III (section 4) and technological change – which prompts the question of the role of cities regarding agricultural production. This conclusion however relies on the assumption that labor productivity itself cannot increase as the ratio of urban to rural population increases too; this assumption is perfectly consistent with the Neo-classical hypothesis of monotonously diminishing marginal returns (cf. *supra*), but not with the Sraffa-Hill hypothesis of a non-linear response of productivity to intensification. A numerical example might well illustrate this point. Let us consider a city or region of 5,000 inhabitants, with a rural labor force of 3,400 workers, average labor productivity ($\pi_{L,0}$) being 1 ton/ worker/ year. Total gross agricultural production is thus 1 x 3,400 = 3,400 tons, and per capita output is 3,400/5,000 or 0.68 tons per head. If over a certain period, this same city experiences a process of increasing urbanization, this implies that, while total population would grow, the urban population will have grown more than the rural population, resulting in a higher urbanization rate and a higher φ coefficient. Let us thus assume that total population will have reached 6,500 inhabitants, and that rural labor force – which is always a share of rural population – would be 4,200 people. In this new situation, assuming that average labor productivity remained the same would make a total of 4,200 tons, and a per capita output of 4200/6500, that is, 0.64 tons/head. What would thus be the condition under which agricultural *per capita* output would remain the same, or even grow ? We can demonstrate that this condition is :

$$\pi_{L,1} = \frac{1+\phi_1}{1+\phi_0} \cdot \pi_{L,0}$$

where $\pi_{L,1}$is labor productivity after the phase of urbanization. Since urban population increased more than rural population, $\phi_1 > \phi_0$, and hence $1+\phi_1 > 1+\phi_0$, which thus implies that labor productivity has increased too. Thus, for *per capita* output to rise in parallel with urbanization, labor productivity needs to rise too ($\pi_{L,1} > \pi_{L,0}$).

This conclusion might seem obvious to the reader, but we must draw his attention on the fact that this is precisely inconsistent with the hypothesis of diminishing marginal returns ! Indeed, at the macroeconomic level, total agricultural surface may be considered as inelastic, and thus approximately constant between the two periods. Hence, the increase of the rural labor force (from 3,400 to 4,200 people) results in a higher labor/land ratio (γ). However, as we have seen above, the Cobb-Douglas model based on diminishing marginal returns and constant returns to scale necessarily implies that an increase of the labor/land ratio causes average labor productivity to drop. A parallel increase of average labor productivity *and* of the labor/land ratio is forbidden by the assumption of diminishing marginal returns, which thus renders impossible the idea of a parallel increase of agricultural *per capita* output and of urbanization rate. This, of course, is only true without significant technological change or major impacts of intensification practices (now organization of production, cultivation of other crops, or increased fertility by fertilizers). Again, I do not say that this was the case, since in the previous chapter I precisely argued that intensification techniques played an important role in Graeco-Roman agriculture. What I am trying to do here is to isolate the effect of specific variables to reveal the underlying assumptions of the process of urban-driven agricultural growth. This contradiction, under specific hypothesis, between urbanization and diminishing returns is shown on the graph before:

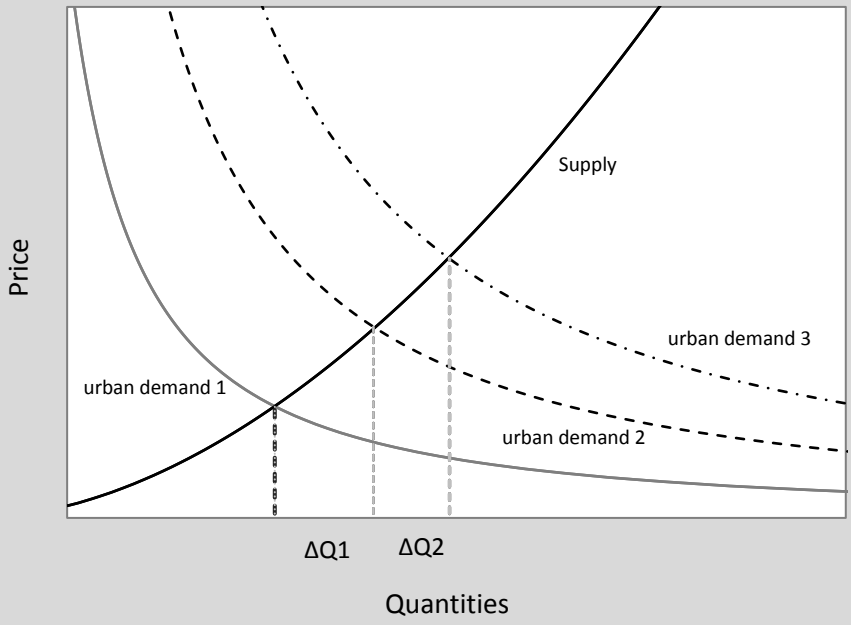


Fig.14. Market for agricultural produces under conditions of urbanization

As urban population increases faster than rural population, the demand curve is shifted towards the right of the graph (with equal absolute displacements between phase (1) and (2) and between phase (2) and (3)). In the meantime, due to the assumption of diminishing marginal returns, the convexity of the supply curve is turned upwards[202]. As the urban demand curve would shift, the price of agricultural products would be driven up, thus stimulating production. Total production would thus rise too, but due to the marginal diminishing returns (represented by the upward convexity of the supply curve[203]), equal increments on the demand side (*i.e.* equal displacements of the urban demand curve, or equal increments in urban population size) will result in less than proportional increases of production ($\Delta Q_2 < \Delta Q_1$) and, hence, in smaller *per capita* output. Leaving apart the effects of money and trade, the only way to assume that urbanization would not drive agricultural output *per capita* down is to consider that agricultural production faces constant or increasing marginal returns. Hence, W. Jongman's claims that urbanization would induce a rise of *per*

[202] Remember that the agreement in economics is to put quantities on the X axis and prices on the Y axis.
[203] Temin (2013), p. 15

capita production and that agricultural production faces diminishing returns appear as two contradictory assumptions[204].

2.3.6.5 Urbanization and agricultural production: a generalized model

In the analysis undertaken so far, the Cobb-Douglas and Sraffa-Hill models mostly concern the microeconomic level (the agricultural unit) and mesoeconomic level (a city). But we now need to consider the interplay of urbanization and agricultural output per capita at the macro-economic level (a whole region and beyond). An attempt in this direction has been done by Elio Lo Cascio, but his model suffers from important flaws. The most important one lies in his equation defining per capita income[205] (y) :

$$y = \frac{P}{P - P(U_r - R_{na})} = \frac{1}{1 - U_r - R_{na}}$$

In this equation, U_r stands for urbanization rate, and R_{na} is the share of rural workers engaged in non-agricultural activities. As the reader will easily notice, per capita agricultural output in this equation is solely defined on the basis of population aggregates. There is no parameter converting population in terms of output, that is, there is no mention of productivity. In economic terms, the ratio defined by Lo Cascio is what we might call a 'dependency ratio', *i.e.* the quotient of the consuming population by the producing population. At best, it is a proxy for the constraints lying upon the agricultural workforce, but it is certainly not per capita output.

Second, neither Lo Cascio's model nor mine (so far at least) takes into account urban agricultural production. However, while we assimilated urban population to non-agricultural population on the one hand, and rural population to agricultural population, Lo Cascio allows for rural non-agricultural production without symmetrically considering urban agricultural production, which seems particularly inconsistent to me.

Thirdly, the model developed by Lo Cascio sticks to the demographic variables, but fails to account for the impact of rents, taxes, and soil productivity. While I have also left these variables out of my model so far, I would now like to close this chapter

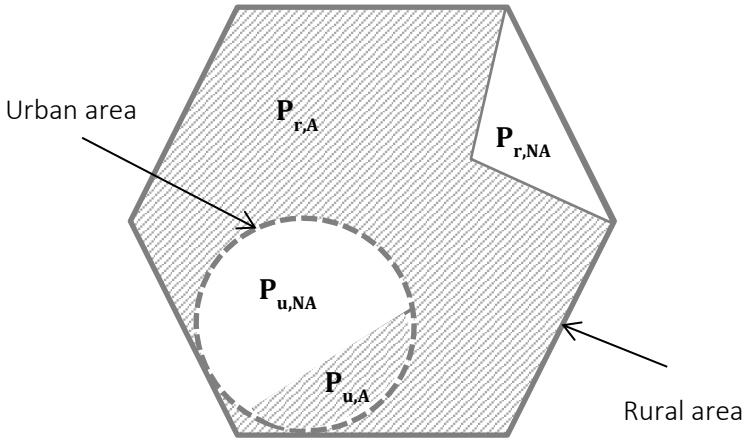
[204] Jongman (1988), p. 88

[205] Lo Cascio (2011), p. 93

on an attempt to develop a more sophisticated model of the links between agricultural output per capita and urbanization at a meso- or macroeconomic level.

To do this, I first propose to divide total population in four aggregates (cf. figure below) :

- The *urban agricultural* population : $P_{u,A}$
- The *urban non-agricultural* population : $P_{u,\,NA}$
- The *rural agricultural* population : $P_{r,\,A}$
- The *rural non-agricultural* population : $P_{r,\,NA}$



With this division in mind, let us now go back to the initial equation of this section (section 2.3.), that is, the one defining the distribution of total produce.

$$Y = N + S + R + T + B \qquad (1)$$

Both taxes and rents can be split into a part that is *extracted* (for rents : either hoarded by landlords, exchanged with another region without any 'trickle-down' effect on the local civic economy,...; for taxes : the share levied in kind and exported for the supply of Rome[206]) and a part that remains in the local economy (rents and taxes in kind sold on the urban market, or grain sold on the market to pay for rents and taxes in money). The extracted part is labelled *e* :

$$(2)\begin{cases} R = e_R R + (1 - e_R)R \\ T = e_T T + (1 - e_T)T \end{cases}$$

[206] On this, see section 2.5 below.

Injecting these relations in the initial equation and splitting the extracted grain (put to the left) and the grain circulating in the economy (to the right) provides the following equation :

$$Y - e_R R - e_T T = N + S + (1 - e_R)R + (1 - e_T)T + B \quad (3)$$

The grain output that is not extracted (the right side of the equation) can be equated with total grain consumption (C_{TOT}):

$$N + S + (1 - e_R)R + (1 - e_T)T + B = C_{TOT} \quad (4)$$

Moreover, rents, taxes and seed can all be expressed as a share of total output through the rate of rents (r), the taxation rate (τ) and she share of seed in total output or seed-yield ratio (s) :

$$(5) \begin{cases} R = rY \\ T = \tau Y \\ S = sY \end{cases}$$

Putting equations (4) and (5) into (3) yields :

$$Y(1 - s - e_R r - e_T \tau) = C_{TOT}$$

$$\Rightarrow Y = \frac{C_{TOT}}{1 - s - e_R r - e_T \tau} \qquad (6)$$

Here, we now have an expression that relates total output to total consumption as well as to the seed-yield ratio, taxation rate and rate of rents. But total output may also be expressed simply as a function of average net labor productivity (π_L) and total agricultural labor (L_A):

$$Y = \overline{\pi_L} \cdot L_A = k \cdot \overline{\pi_L} \cdot P_A \qquad (7)$$

Obviously, the two definitions of grain output must equal each other : (6) = (7) :

$$\frac{C_{TOT}}{1 - s - e_R r - e_T \tau} = k \cdot \overline{\pi_L} \cdot P_A \Rightarrow C_{TOT} = k \cdot \overline{\pi_L} \cdot P_A(1 - s - e_R r - e_T \tau)$$

However, total consumption (C_{TOT}) is simply per capita consumption (q) multiplied by population (P). Total consumption is obviously equal to the sum of the consumption of each of our four population aggregates:

$$(5)\begin{cases} C_{u,A} = q_{u,A}P_{u,A} \\ C_{u,NA} = q_{u,NA}P_{u,NA} \\ C_{r,A} = q_{r,A}P_{r,A} \\ C_{r,NA} = q_{r,NA}P_{r,NA} \end{cases}$$

Developing C_{TOT} analytically yields the following equation :

$$q_{u,A}P_{u,A} + q_{u,NA}P_{u,NA} + q_{r,A}P_{r,A} + q_{r,NA}P_{r,NA} = k \cdot \overline{\pi_L} \cdot P_A(1 - s - e_R r - e_T \tau) \quad (6)$$

From here, we need to wonder whether agricultural consumption per capita is more strongly dependent upon the economic activity of a given population or by its location. Said differently, should we consider that urban agricultural populations consume agricultural products at the level of urban consumption or at the level of the agricultural population as a whole ? Let us examine the two possibilities.

- *Geographical division*

If we consider that the geographical position defines the level of consumption, then we should apply a single level of consumption to the two urban aggregates. By doing so, the equation is simplified to :

$$q_u(\underbrace{P_{u,A} + P_{u,NA}}_{P_u}) + q_r(\underbrace{P_{r,A} + P_{r,NA}}_{P_r}) = k \cdot \overline{\pi_L} \cdot P_A(1 - s - e_R r - e_T \tau)$$

By dividing both members of the equation by P_A , it comes :

$$q_u \frac{P_u}{P_A} + q_r \frac{P_r}{P_A} = k \cdot \overline{\pi_L}(1 - s - e_R r - e_T \tau)$$

Reminding that : $P = P_u + P_r$, and dividing both the numerator and denominator by of the left member by P, we obtain :

$$q_u \frac{u}{\alpha} + q_r \left(\frac{1-u}{\alpha}\right) = k \cdot \overline{\pi_L}(1 - s - e_R r - e_T \tau)$$

Now, if we finally express urban and rural per capita consumption proportionally to the average agricultural per capita consumption (with μ equals the ratio or urban to rural per capita consumption, with $\mu > 1$ since I assume urban dwellers being better off regarding total agricultural consumption taken as a whole), we get the final equation :

$$q = \frac{\alpha\, k\, \overline{\pi_L}(1 - s - e_R r - e_T \tau)}{1 + (\mu - 1)\, u} \qquad (7)$$

What this equation states is fairly logical: average per capita consumption (or available output, since macroeconomically speaking these aggregates are equal to one another), is directly proportional to labor productivity and to the proportion of population engaged in agricultural activities, and conversely proportional to the rate of rents and taxes, to the extent that they are extracted from the economy. This equation also states that, if labor productivity and the share of agricultural population do not change, per capita available output decreases when urbanization increases. Despite the existence of urban agricultural production, this consequence is logical : since the majority of urban population is engaged in non-agricultural activities, when urbanization occurs, the bulk of non-agricultural population grows faster than the agricultural workforce which, if the share of non-agricultural population in total rural population is left unchanged, and if labor productivity is stable, results in lower agricultural output per capita.

- *Economic division*

If we now consider that the level of consumption is primarily related to the economic sector into which a given population is primarily engaged (hence either agricultural or non-agricultural), then eq. (6) above becomes :

$$q_A(P_{u,A} + P_{r,A}) + q_{NA}(P_{u,NA} + P_{r,NA}) = k \cdot \overline{\pi_L} \cdot P_A(1 - s - e_R r - e_T \tau)$$

$$\Rightarrow q_A \frac{P_A}{P_A} + q_r \frac{P_{NA}}{P_A} = k \cdot \overline{\pi_L}(1 - s - e_R r - e_T \tau)$$

Since total population is simply the sum of agricultural (P_A) and non-agricultural population (P_{NA}), we have :

$$P = P_A + P_{NA} \Rightarrow P_{NA} = P - P_A \Rightarrow \frac{P_{NA}}{P_A} = \frac{P - P_A}{P_A}$$

Here, the ratio $\frac{P_{NA}}{P_A}$ can easily be expressed in terms of the share of agricultural population : $\frac{P_{NA}}{P_A} = \frac{P_{NA}/P}{P_A/P} = \frac{1-\alpha}{\alpha}$; The final equation for per capita available grain is thus :

$$\alpha q_A + (1-\alpha) q_{NA} = \alpha \cdot k \cdot \overline{\pi_L} \cdot (1 - s - e_R r - e_T \tau)$$

Or :

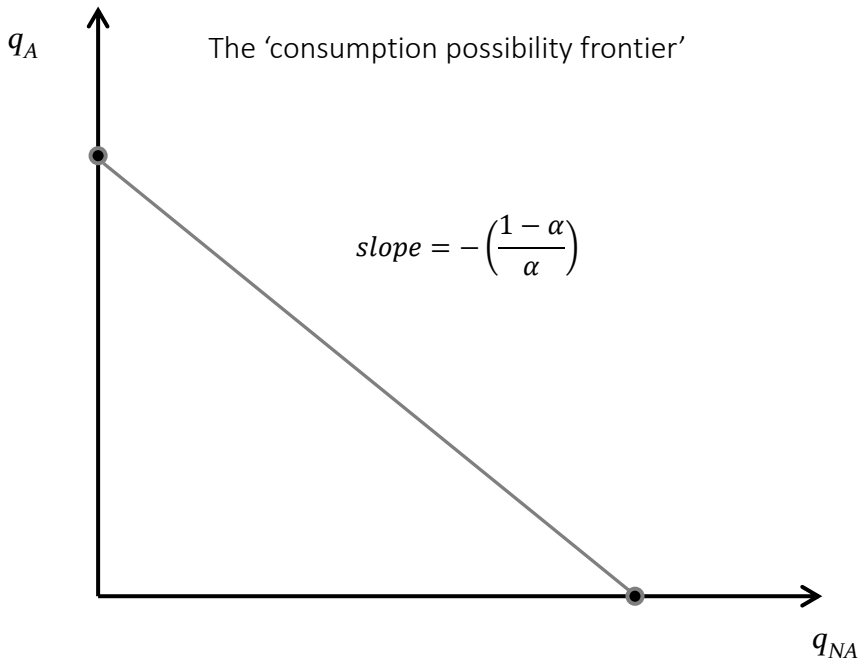
$$q_A + \left(\frac{1-\alpha}{\alpha}\right) q_{NA} = k \cdot \overline{\pi_L} \cdot (1 - s - e_R r - e_T \tau) \qquad (8)$$

Just like the former 'geographical' version, this equation integrates per capita available agricultural output, labor productivity, proportion of agricultural population, seed-yield ratio, rate of rents, and taxation rate. Logically, it states that *per capita available quantity of grain is directly proportional to labor productivity and to the share of agricultural population, and conversely proportional to the average seed-yield ratio and to the rate of rents and taxation, but only to the extent to which they are extracted from the local economy*. Writing the extraction rate of surplus as : $\lambda = e_R r + e_T \tau$, the equation reduces to :

$$q_A + \left(\frac{1-\alpha}{\alpha}\right) q_{NA} = k \cdot \overline{\pi_L} \cdot (1 - s - \lambda)$$

Regarding the division of labor, this equation also means that, at constant productivity of labor, constant extraction rate of surplus, and constant proportion of population engaged in agriculture, there is a negative linear relationship between the possibility of grain consumption per capita of agricultural populations and that of non-agricultural populations (cf. figure below). Indeed, at constant $\overline{\pi_L}$ and λ, the link between per capita grain consumption of agricultural and non-agricultural population is :

$$q_A = k \cdot \overline{\pi_L} \cdot (1 - s - \lambda) - \left(\frac{1-\alpha}{\alpha}\right) q_{NA}$$



The equation resulting from the 'economic' division of labor may also be reformulated in terms of average available grain output per capita, once we express the ratio of per capita agricultural output of agricultural populations to that of non-agrcultural populations by the letter ε :

$$\tilde{q} = \frac{k \cdot \overline{\pi_L} \cdot (1 - s - \lambda)}{1 + \epsilon\left(\frac{\nu}{\alpha}\right)} \qquad (8)$$

A quantitative assessment is now easily computable: in a region where average labor productivity is worth 600 modii of grain/worker/year[207], if agricultural labor force makes up 90% of total agricultural population (k = 0.9), if 30% of taxes and 20% of rents are extracted from the regional/local economy (with a taxation rate of 10% and a share of rents equal to 20%); if we further assume that the non-agricultural population is better off by some 25% (ε = 1.25), reckoning with a proportion of (primarily) agricultural population of 85%, average agricultural per capita output in this region approaches 340 modii/person/year, or 2.2 tons/person/year.

The fundamental equations (6), (7) and (8) refine the previous arguments: for agricultural and non-agricultural populations to simultaneously experience an increase of their available per capita quantity of grain (or, alternatively, for urban and rural per capita consumption to increase in conditions of urbanization) there needs to be either

[207] For labor productivity estimated between 450 and 700 modii of grain/worker/year, cf. Erdkamp (2005), p.47.

(1) a reduction in the rate of surplus extraction or in the level of rents (or taxes), (2) an increase in average labor (or land) productivity. These equations also confirm that if (and only if) the level of rents/taxes and of surplus extraction is constant, then, a general increase in per capita grain output both for agricultural and non-agricultural populations (or of urban and rural populations) in conditions of urbanization, without preceding technological change in agriculture, is incompatible with the assumption of diminishing marginal returns.

These equations do not mean, of course, that urbanization *itself* is necessarily or even generally deleterious to average agricultural per capita available output. H. Pleket has convincingly argued for sustained urbanization in Asia Minor under the Principate, with no signs of decrease in per capita incomes[208]. The question, however, is to understand the conditions under which such a process could have been met. Basically, there are three such conditions, which are not mutually exclusive, and which partly meet the factors of agricultural development listed by H. Pleket[209] :

(1) Change in labor productivity (either from technical improvements or by a more favorable labor/land ratio)
(2) Increase of the share of agricultural population
(3) Development of trade
(4) A reduction of the extraction rate of surplus

In order for an urbanization process to be sustainable in terms of agricultural output per capita, one or more of these changes must have been undertaken either simultaneously or prior to the increase of the share of urban population. However, each of these processes has its own obstacles to face : (1) an increase in verage labor productivity, as stated earlier, is inconsistent with the idea of inevitability of diminishing marginal returns; (2) an increase in the share of agricultural population reduces the room for non-agricultural surplus ; (3) for the case of inland cities, an increase in the volume of grain trade is limited by the cost of transport; (4) finally, reducing the extraction rate of surplus is limited by the predatory[210] and 'acquisitive mentality' of the landowning élite[211], and by the imperial requirements in the form of taxation…

[208] Pleket (2003), pp. 87-90

[209] Pleket (1993), p. 321

[210] On predation by the Roman élite : Bang (2008), pp. 204-212.

[211] Finley (1973), p. 144.

2.4 Rents, land values and grain production

The first two sections of this chapter have been devoted to the analysis of the conditions of surplus production: the forms of land ownership and management on the one hand, and the utilization of land and labor on the other. This section and the following now aim at emphasizing the main channels of surplus extraction, namely rents and taxes.

2.4.1 The economics of land resources

First of all, it should be emphasized that there is substantial evidence for the payment of rents in kind in Hellenistic and Roman Asia Minor[212]; as we will see later, this has important consequences for the differential availability of grain surpluses between town and country. Yet, before discussing the documentary evidence, we need to shed some light on the logical economic relationships between land values, rents, and grain prices by recourse to some minimal yet incompressible mathematical formalism, in order to construct a consistent interpretative framework of the sources. In order to be as clear as possible, the argument will be structured into four questions which we will be answered successively :

(1) Which variables does the value of land depend upon ?
(2) How is income derived from land related to land value and its determining factors?
(3) How do the changes in land value affect the return on land ?
(4) How is return on land related to ground-rent ?

For the sake of simplicity, we make the two guiding assumptions that (1) the considered plot of land produces solely grain ; and (2) that the land surface of the considered estate is inelastic.

1 – Which variables does the value of land depend upon ?

Two different components must be distinguished *ab initio* : the intrinsic land value, determined by aggregate demand for land and population pressure (1), and the value of

[212] LBW, 331 ; Buckler (1917-1918), p.214; De Ligt (1993), p. 136 & pp. 140-142

the agricultural produces of the land (2). The table below sums up the mathematical symbols used in the development that follows :

Symbol	Agro-economic meaning	units
p_A	price of land per hectare	*d(enarii)*
A	plot size	ha
p_g	price of grain per unit of volume	*d*/mod.
Q_g	total quantity of grain	mod.
f	proportion of land left fallow	–
π_A	average soil productivity	mod./ha
π_S	average seed productivity	–
r_S	sowing rate	mod./ha

The total value (V) of a plot of grain-land is equal to the intrinsic land value ((V_A), the price of land per hectare multiplied by the area), plus the value of the produces (V_Q), in this case, grain[213] :

$$V = V_A + V_Q = p_A \cdot A + p_g \cdot Q_g$$

Since the total quantity of grain is equal to the average soil productivity multiplied by the cultivated area (the area which is not under fallow), this equation can be rewritten as :

$$V = p_A \cdot A + p_g \cdot \pi_A \cdot (1 - f) \cdot A = A \cdot [p_A + p_g \cdot \pi_A \cdot (1 - f)] \qquad (1)$$

This equation signifies that in the limiting case where land surface is zero (if there is no land at all), the value of land is (obviously) zero; however, if the land does not produces anything (V_Q = 0), it still has an economic value.

There is of course some criticisms to address to this formula. First, the price of land cannot fully be separated from the price of the produces, for higher grain prices might stimulate the demand for land and thus ultimately raise land prices too, but this expression provides a reasonable approximation. Second, the equation implicitly assumes that fallowing is exogenous to the soil productivity; to be more accurate from an agronomical point of view, the model should consider that the soil productivity at year *t* depends upon the proportion left fallow during years *t-1, t-2…etc*. Land exploitation is indeed a dynamic process, with lots of intertwining between variables.

[213] Sartre(1991), p.81

But considering the phenomenon in a static perspective nevertheless allows formulating the essence of the structural relationships between the variables affecting the exploitation of agricultural resources.

2 – How is income derived from land related to land value and its determining factors ?

Gross income (Y) is simply the absolute variation[214] in total land value (over a certain period)[215] : $Y = \Delta V$. Total value is described as the sum of intrinsic land value and the value of agricultural produces. To express the total income derived from land, we must determine the absolute variation of the value of land according to the variables upon which it depends: grain and land prices, average productivity, proportion of fallow, and land surface. To simplify the mathematical calculus, we will make the assumption that some of these variables do not significantly vary on the short run, and may thus be considered constants:

(1) total land surface, assuming a relative inelasticity of land supply ($\Delta A = 0$)
(2) the proportion of fallowing
(3) average soil productivity

We are thus left with a function (V) of two variables : the price of grain (p_g) and the price of land (p_A). To formulate the expression of total income, we should thus examine how total land value varies according to variations in prices. This problem can therefore be summarized as that of the variation (the 'differential', in mathematical terms) of one function as a result of the variation of two separate variables. This problem can be solved by applying the basic rules of derivatives[216]. The result is expressed by the following equation relating total gross income to the variation in prices :

$$Y = A \cdot (\Delta p_A + \pi_A \cdot (1 - f) \cdot \Delta p_g) \qquad (2)$$

[214] Noted by the differential operator Δ (for a discrete variation), or d (when considering infinetisimal, continuous, variations).

[215] In economic terms, land value is a *stock*, while income from land is a *flow*.

[216] For a function z depending on two variables x and y which are multiplied between each other (z = x.y) the total variation is given by : $\Delta z = x \cdot \Delta y + y \cdot \Delta x$: the derivative of a product of two variables is equal to the sum of two terms : a first term equal to the variation of the first variable multiplied by the second variable (taken as constant) ; and a second term equal to the variation of the second variable multiplied by the first variable (taken as a constant). In case of a sum of variables (z = x + y), the total variation is the sum of the variation of each variable : $\Delta z = \Delta x + \Delta y$.

It must be emphasized that, just like total land value, gross income can be separated into two distinct components: the intrinsic income from land (Y_A), and income from produces, or **available income** (Y_d) : $Y = Y_A + Y_d$ (3)
Gross income per unit of land (y) is thus :

$$y = \frac{Y}{A} = \frac{Y_A}{A} + \frac{Y_d}{A} = \Delta p_A + \pi_A \cdot (1 - f) \cdot \Delta p_g \qquad (4)$$

As expressed by this equation, the income per hectare is directly proportional to the variation in land prices per hectare and to the variation in grain prices. On the basis of this relationship relating to income from land exploitation, we can now derive an expression for return on land.

3 – How is return on land related to the changes in land value ? Or, stated differently, how does a change in land value convert into return on land ?

Aggregate return on land is simply equal to gross income divided by the initial land value (the purchasing value). Here we make the simplifying assumption that, at the time of purchase, land value reduces to the intrinsic land value (area x price of land), either because we deal with uncultivated land, or because, when a plot of grain-land is sold, the buyer does not purchase the quantity of grain harvested on that year, which is already consumed and/or sold ; even in the case of a vineyard, the buyer purchases the land together with the vines, but in all likelihood does not buy the wine produced during the year when the transaction takes place. Return on land (in %) is thus expressed by the ratio of gross income to the initial value:

$$r = \frac{Y}{V_{A,0}} \qquad (5)$$

Yet, this way of calculating the return on land is tributary to the considered surface, since both gross income and total initial value depend upon the size of the terrain. How thus could we express the return on land independently from plot size, that is, solely as a function of prices ? Replacing total income in eq.(5) by its full expression given by eq.(2), rearranging the terms and simplifying allows writing the final equation:

$$r = g_{p_A} + (1 - f) \cdot \frac{\pi_A}{p^*_{A/g,0}} \cdot g_{p_g} \qquad (6)$$

Here, g_{p_A} and g_{p_g} are respectively the growth rate of land prices and grain prices, and $p^*_{A/g,0}$is the **relative price** of land with respect to grain. The understanding of this equation is straightforward : gross return on cereal land over a given period is directly proportional to the growth rate of land prices and grain prices over that same period, as well as to the average soil productivity, but is conversely proportional to the initial relative price of land with respect to grain (*i.e.* the price of land expressed in grain-equivalent)[217].

4 – How is return on land related to ground-rent ?

The total contractual rent paid (R) is equal to the land per hectare (l) multiplied by the terrain area : $R = l \cdot A$ (7)

As we have seen above, total gross income (from the tenant's point of view) can be divided into five main components : consumption, seed, rent, taxes, and benefit. Since taxes are an exogenous variable, they can be left out of this operation for the moment in order to simplify the calculus[218]. From the four remaining components of gross income, consumption, seed and benefit constitute the available income (Y_d), while rents are captured by the landowner. Rents thus represent the difference between gross income and available income (of the producer), since after deducting the share of his income that he will consume, use as seed, and possibly keep for himself, the tenant needs to have sufficient money to pay the rent :

$$Y - Y_d = R$$

If we recall equation (3), total rent is thus equal to the intrinsic income from land (Y_A) :

$$R = Y_A \quad (8)$$

Since, income from land is equal to the rate of return on land applied to the intrinsic land value, we may write :

[217] Another formulation of the equation would be that gross return on land is equal to the intrinsic return on the value of land (*i.e.* the growth rate of land prices) plus the return on the produces (*i.e.* the growth rate of grain prices), each of them being weighted respectively by the share of intrinsic land value in total value (V_A/V) and the value of agricultural produces in total value (V_g/V).

[218] For a full discussion on taxation, see section 4.

$$Y_A = r_A \cdot V_A = r_A \cdot p_A \cdot A \qquad (9)$$

Putting eq. (7), (8) and (9) together yields the following equation : $l = r_A \cdot p_A$, or :

$$r_A = \frac{R}{V_A} = \frac{l}{p_A} \qquad (10)$$

Return on land can thus be safely approximated by dividing total rents by total land value, or by dividing rent per hectare by the price of land per hectare.

2.4.2 Rents and land returns in historical perspective : a case study from western Asia Minor

Two series of documents inform us about the level of rents, land values and rates of return on agricultural investment in Asia Minor : a first very important group of documents from Mylasa-Olymos dating back to the late 2nd and early 1st c. BC ; and a second group of inscriptions coming from a monument in Aphrodisias dating back to the 2nd c. AD. The interest in comparing those two series of documents is that Mylasa-Olymos and Aphrodisias are all cities of Caria, which renders the comparison more robust, and that both series of documents have been quite narrowly dated.

- *Early 1st c. BC*

The cities of Mylasa and Olymos have yielded an important collection of documents related to land transactions which exhibit much complementarity and shed some interesting light on leases and purchases of landed estates in Anatolia. These documents describe three types of operations: (1) the assignment of the rent to sub-lessees by the tenant, (2) suretyship to guarantee the payment of the rent, and (3) the sale of private estates to a temple, the most frequent situation. The documents contain detailed information about the content of the estates as units of agricultural production, the practical conditions of rent payment, the level of rents, and the value of land. Advanced discussion on the conditions of rent will take place in section 2.4, so we shall mainly focus on the last two categories.

One noticeable feature of these documents is that most transactions related to these estates regard the land itself as well as all the other possessions it contains. As

explicitly stated in the contracts, terrains and fields (οἰκόπεδα [219], τας γέας,…) are clearly distinguished from vineyards, or olive trees, (σύν τοῖς ἐνοῦσι δένδρεσι πᾶσιν και αμπέλοις ,…and other similar formulations[220]). The values that we encounter in those documents – as well as in the documents from Aphrodisias which come next – are thus gross values, not intrinsic land values, and the same applies therefore to the returns that we will calculate.

An important subgroup of the Mylasa-Olymos documents concern the sales by a certain Thraseas of two pieces of land to the temple of Zeus Osogo : a first terrain of a value of 5,000 Rhodian *drachmai*[221] (or rather 'pseudo-rhodian' *drachmai*, a lighter local coinage worth about 2/3 of a denarius[222]) and a second one worth 7,000 Rhodian *drachmai*[223]. The land in question is then leased to its former owner, who, in exchange for the loss of his property rights and the payment of a modest rent, obtains the hereditary leasehold of his domain[224]. The rent to be paid on the first estate is comprised between 100 and 199 *drachmai* (the line is mutilated but ends with δραχμάς ἑκατόν…)[225] and on the second estate 300. As stated by eq. (10), this implies a gross return on land of maximum 4% in the first case and 4.3% in the second. Editors of the inscription have suggested that the low level of rents is due to the peculiarity of the type of contract passed between Thraseas and the temple. This may perhaps have played some role, but was probably not the main explanation. Indeed, the most crucial counterpart to the transfer of property was most likely the hereditary leasehold. Moreover, by two other documents from Mylasa relating a different operation, a similar return can be deduced: a certain Korris and others have assigned some land which belonged to the temple of Zeus Labraundos; the fourth share of the land was worth 700 *drachmai* on which each tenant had to pay his proportion of the total rent less one *drachmè*[226]. One such rental has been restored as 32.25 *drachmai*[227]. Total rent is thus (4 x 32.25) – 1 = 129 *drachmai*. Since total value is 4 x 700 (=2,800 *drachmai*), the rate of return is equal to 129/2800, or 4.6%. Other land values and rents, summed up in the table below, are mentioned in the Mylasa-Olymos documents, but since they do

[219] CIG, 2694b, l.5

[220] LBW, 414, l.8 & 415, l.8; see also LBW 322 & LBW, 338; BCH 12 (1886), n°9, l. 13; CIG, 2694a, l.9

[221] BCH 5 (1881), n°11 A, l.12

[222] On which see : Apostolou (1995) ; Doyen (2012), pp. 89-91

[223] *Ibid.*, n°11 B, l.4-5

[224] LBW, 415-416 (= CIG, 2699e); BCH 5 (1881), pp. 113-116; BCH 12 (1886), p.21

[225] BCH 5 (1881), n°11 A, l.18

[226] ABSA XII (1917-1918), V.β & VI.α-β.

[227] *Ibid.*, pp. 206-209

not refer to the same texts, we could unfortunately hardly deduce more return values from them.

Table 1. *Land values, rents and land returns in Mylasa-Olymos (late 2nd – early 1st c. BC)*

Land value (*drachm.*)	Rent (*drachm.*)	Return (%)	Reference
10000	–		CIG, 2694b
8000	–		ABSA XII, (1917-18), I
7000	300	4.3	BCH 5 (1881), n°11 B
6500	–		ABSA XII, (1917-18), II.γ
–	250		ABSA XII, (1917-18), II.β
–	200		ABSA XII, (1917-18), III
–	200		ABSA XII, (1917-18), IV
5000	100-200	2-4	BCH 5 (1881), n°11 A
4000	–		CIG, 2694a
4000	–		LBW, 331
3000	–		LBW, 338
2800	130	4.6	ABSA XII, (1917-18), V.β
–	100		LBW, 323-324

Le-Bas & Waddington have claimed that 'these returns were low compared to the usual interest rate of money in Antiquity'. The comparison would be valid if dealing with a foundation – indeed most often invested in land – but no such thing is mentioned in the inscription. This statement obviously confuses return on landed wealth with interest rate on cash loans. Another document from Olymos, which they also edited, clearly emphasizes the difference : it is asked to the trust-commissioners who will buy some land in the name of the temple of Apollo and Artemis to lease the land at a rent equal to at least half the value of the interest rate on the money borrowed to buy it : μισθῶσαι αὐτὰ (...)ἐνθήκης μὴ ἐλασσονος τῶν ἡμισῶν διαφορῶν τῆς τιμῆς τῶν ἐγγαί -ων [228], thus implying that interest rates were on average twice the return on landed wealth. In yet another inscription from Mylasa, the interest rate required reached 24%[229]. The editor of the text convincingly relates such high interest rates to the financial crisis of Asia Minor in the 1st c. BC and the requisitions by Rome, which explains the double advantage of the transactions between private citizens and sacred domains : citizens needed cash to pay for additional taxes required in these

[228] LBW, 332, l.6-7

[229] BCH 46 (1922), n°24

circumstances, while temples preferred to fix their capital in land in order to avoid having to lend money to the city.[230]

❖ *Early 2nd c. AD*

Another insight into the value of land in Anatolia is provided by a second group of documents from Aphrodisias recording the benefactions of a certain Attalos, son of Adrastos and member of a prominent family[231] of the city, most likely dating back to the first half of the second century AD[232]. Attalos gave 122,000 denarii to the goddess Aphrodite[233] ; this sum is established as a foundation and is lent out at interest to a series of borrowers, each sum being insured by estates (or other types of property) given as mortgages. It is this specific feature of Attalos' foundation that matters to us, since for each piece of land mortgaged, the value of the loan is specified. The inscription also records the total value of the interests generated within four years (49 months), the number of plots and their size measured by the quantity of seed they require (κύπροι σπόρου)[234], as well as the name of the borrower and guarantor[235]. Unfortunately, only a few lines of the total have remained intact and provide full information. The usable data have been summed up by the editors in the following table :

Borrower	Capital (HS)	Interest over 49 months (to the 30 of *Apellaios*; in HS)	Mortgage	Guarantor(s)
?	> 2,000	4,800 (?)	2 terrains (Apollonia S.)	Diodoros son of Musaios
Diodoros, son of Musaios	40,000	9,800	1 field (Apollonia S.)	Tydeus
Diodoros son of	40,000	9,800	3 plots of 240	P. Albius

[230] *Ibid.*, pp.422-425; see below for full discussion on the impact of the financial crisis of Asia on cash loans and land returns.

[231] His father, Adrastos, son of Nicoteimos, is known by other inscriptions testifying that he had been, among other prestigious offices, archipriest of Augusts: *IAph2007*, 12.4; 12.5 & 12. 308;.

[232] Broughton (1938), p. 667 dates it to the 2nd c. AD, but is dated by B. Laum to the reign of Hadrian (Laum, 1964 [1908]), p. 103), which is consistent with the dating of the inscriptions of Attalos' father to the end of the 1st c. AD. Attalos is also known from his funerary inscription (*IAph2007*, 1.123), but of which little remains and which is thus of little help for verifying the date; see also Robert (1966), pp. 389-390.

[233] REG 19 (1906), n°138

[234] The *kupros* is a measure of volume often in use in Asia Minor : 1 kupros = 2 *modii*

[235] REG 19 (1906), n°140

Musaios			*kuproi*	Atinetus & Apollonios
P. Albus Atinetus	18,000	4,408	1 plot of 65 *kuproi* + 1 plot of 40 *kuproi*	Diodoros & Damas
P. Albus Atinetus	6,000	1,470	1 plot of 15 *kuproi* + 1 town house	Tydeus
C. Julius C. (f.)	> 12,000	?	?	?

Let us first discuss the controversial elements of the document :

1°) In the first line, the capital guaranteed by Diodoros is uncertain; the text reads …ων * δηναρίων δισχειλίω[ν: the sum was thus of minimum 2,000 denarii, but the exact value is difficult to assess. T. Reinach considered the possibility that the first word would be μυρίων, which would make a total sum of 12,000 denarii[236], while B. Laum accepts the 2,000 denarii as the actual value[237]. Both are plausible, but none can be assured, since there is always the possibility that the text would have specified the number of *myrias* by using a letter instead of expressing it in full words. In any case, there is something wrong with the values mentioned at this line, as already noticed by Reinach, since 2,000 denarii lent out at 6% (which, as we will see, is the interest rate applied) would have generated 490 denarii over 49 months. If the sum was 12,000 denarii, the four year interest would have been 2940 denarii.
2°) A difficult issue is whether the three plots of land mentioned at line 3 are of 240 *ku. each* or *together*. In order to assess the land value per hectare, this is indeed a crucial problem, since it implies completely different surface figures. This issue is not discussed, neither by Reinach (who seems nonetheless to imply that *each* plot requires 240 *kuproi*) nor by Laum or Broughton. Yet in this case, I think the 240 *kuproi* refer to the value of the three plots of land *all together*. Assuming they are of 240 *kuproi* each would imply unlikely land prices per hectare and hence implausible returns. A careful reading of the text supports this interpretation. At lines 11-12 of inscription n°140, we read: ἐπί ὑποθήκαις κλήροις τρισίν σπόρου κύπρων διακοσίων τεσσεράκοντα (…). If the text intended to mean that *each* plot of land required 240 *kuproi* of seed, given the usual accuracy of Greek language – especially in such technical matters as conditions of credit – we would expect to have

[236] *Ibidem*, p. 238
[237] Laum (1964 [1908]), p. 175.

ἐπί ὑποθήκαις κλήροις τρισίν **ἕκάστω** σπόρου κύπρων διακοσίων τεσσεράκοντα (…), or any similar formulation.

3°) Finally, lines 2 and 6 also display missing information : at line 2, the seed value of the plot given as mortgage is not mentioned, which does not allow to estimate its income and size, while line 6 exhibits the same problem as line 1, namely that the value of the capital is incomplete. The value we read from the text is τρισχιλίων (…), *i.e.* between 3,000 and 3,999 denarii. Furthermore, neither the four year interests not the seed value is mentioned, which renders any calculation impossible. We are thus left with three lines of complete information. Leaving apart the identity of borrowers and contributors, we get the following table :

Capital (HS)	Interest over 49 months (to the 30 of *Apellaios*; in HS)	Number of estates mortgaged	Seed requirement (modii)
40,000	9,800	3	480
18,000	4,408	1	130
		1	80
6,000	1,470	1 (+ 1 town house)	15

Since the 3 pieces of land of the first line most likely are worth 480 modii of seed *together*, we might rewrite the table as if we were dealing with one single terrain. On line 3, moreover, we see that the mortgage does not only consist of one piece of land but also of one town house. The value of the terrain alone must therefore be much lower than the 6,000 HS mentioned. There is virtually no data on the price of common houses in Asia Minor, but assuming that the terrain makes up 50% of the total value, it would be worth 3,000 HS.

Capital (HS)	Interest over 49 months (to the 30 of *Apellaios*; in HS)	Seed requirement (modii)
40,000	9,800	480
18,000	4,408	130
		80
3,000	1,470	15

If, as is probably the case, we are dealing with cereal-land, reckoning with an average sowing rate (for wheat) of about 5 modii per *iugerum*[238] (or 20 modii per hectare), it is now possible to estimate the size of the plots of land as well as the price per hectare.

Total value (HS)	Seed requirement (modii)	Surface (ha)	Price per ha (HS)
40000	480	24	1,666.67
18000	130	6,5	1,800
	80	4	1,714.3
3000	30	1,5	2,000

As we can see, those are rather moderate landholdings. But most importantly, we get some insight into the price of land in Asia Minor. The estates we are dealing with range from 415 – 500 HS per iugerum, which is broadly consistent with the revision of Columella's land price figures (concerning the mid-1st c. AD) by Duncan-Jones[239].

Some further information can still be extracted from Attalos' foundation : we might now try to calculate the rate of return on those land pieces. But, since we do not know the exact mode of exploitation of those plots of land, two cases must be considered :

(1) Direct exploitation (*autourgos*)
(2) Tenancy

The main difference lies in the relative share of the different components of gross income : in case (1), no rent is paid, while in case (2) a rent is to be paid by the tenant to the landlord. This would most probably influence the share of the seed-value into the total gross income. The difference may be quite small, but has a significant impact on the calculation of return. If we suppose those terrains are leased, and thus subject to a rent, it is probably safer to estimate the return on the basis of their rent. Let us thus examine the two cases separately:

Case (1) – Direct exploitation. To estimate the return, we must first calculate the monetary value of the seed requirement. A typical grain price figure for Asia Minor is about 2-2.25 HS per modius[240] (for a more detailed discussion of grain prices, see chap.

[238] Varro, *R. r.*, I, 44, 1 ; Columella, *De r. r.*, II, 9, 1 ; Pliny, *NH*, XVIII, 198. See also : Duncan-Jones (1982), p. 49 & 328 ; Erdkamp (2005), p. 48
[239] Duncan-Jones (1982), p. 51.
[240] *Ibidem*

III). Yet, this reflects a market price, whereas what matters to us in order to assess the overall value of the estate's agricultural produces is the production price. Broadly speaking, the difference between production price and market price is made up by transport cost and the profit margin of retailers (if any).

There has been a long discussion on the relative cost of overland transport, mostly on the basis Diocletian's Price Edict on which nothing new will be added here. Colin Adams has recently criticized traditional views about the share of land transport costs in the total market price of wheat (55% of the price for every 100 Roman miles according to Duncan-Jones[241]), inviting us to a lower picture but without revised quantification[242]. Without arguing against his observations, it nevertheless remained true that overland transport of grain was very costly[243]. W. Scheidel provided a quantitative estimate of 0.035 denarii/kg/km[244]. If we assume a rather moderate distance of 5 km (*i.e.* local trade), the share of transport costs in the market price would be about 30%. In the case this figure would be exaggerated, we might hypothesize that transport costs plus the retailers' margin make up 25% of market price together. In this case, the production price per modius would be 1.68 HS. We can thus calculate the cost of the seed requirement, and deduce the overall gross income in the – rather pessimistic – case where seed represents 20% of gross yield[245]. It must be specified that the second mortgage, fragmented into two separate terrains of 6.5 ha and 4 ha respectively, has been considered as a single terrain of 10.5 ha, since this does not change anything to the rate of return. The return thus easily follows by dividing gross return by the total land value, as stated by eq. (5). The results are presented in the following table:

Value (HS)	Seed requirement (mod.)	Seed cost (HS)	Annual gross income (HS)	Gross return (%)
40,000	480	810	4,050	10.125
18,000	210	354	1,771.9	9.8
3,000	30	51	253.1	8.4

[241] Duncan-Jones (1982), p. 369

[242] Adams (2012), pp. 220-224

[243] Erdkamp (2005), p. 198

[244] Scheidel (2013), p. 4 [work in progress]

[245] As said in Chap. I, Collumella's figure of 1:4 seed/yield ratio most likely concerns rather bad soils and cannot be taken as average value for seed productivity throughout the empire. Erdkamp has shown that yields of the range of 8:1 or 10:1 provided reliable estimates for fertile soils well suited to cultivating cereals (Erdkamp (2005), pp. 34-46).

Case (2) – Tenancy. If the estates are leased to tenants, it would be safer to infer the value of the rents in order to assess the return. This can be estimated on the basis of the interest rate of the loans. We know from inscription n°142 that the interest rate applied was 6% : ὀφείλει μοι̑ (…) δηνάρια ἐ]νακι[σχειλία διακό]σια καὶ τὰ τοῦ τόκου μηνὸς ἑνὸς δηναρία τεσσεράκοντα ἓξ…The borrower owes the lender a sum of 9,200 denarii at a rate of 46 denarii per month, or 552 denarii per year, which is 6% of the total sum. This is confirmed by the expression τόκον ὀκτασσαριαῖον, mentioned further in the text: it means a rate of 8 *asses* (half a denarius) per 100 denarii per month, which makes 6 denarii for 100 denarii per year, that is, 6%[246].

It must be noted at this time that the interest practiced here are simple interests and not compound interests : the 1,102 denarii generated over 49 months at a rate of 6% on the capital loan of 4,500 denarii imply that the 4 year interest ((48/49) x 1,102 denarii, or 1,080 denarii) are simply the annual interest (6% of 4,500 denarii) multiplied by the number of years. With compound interests the result would have been about 1,181 denarii after four years.

From the interest rate (or the 4 year interest sum), we can easily calculate the value of the annual interest. If the borrowers are landowners and perceive a rent on their estates, the annual rent must in all likelihood be higher than the annual interest they pay on the capital loan, and sufficiently higher to still generate a profit. Assuming that total annual rent was on average 10-20% higher than the annual interest, we can easily derive the rate of return by using eq. (10) and dividing total rent by total value :

Value (HS)	Annual interest (HS)	Total rent (HS)	Return (%)
40,000	2,400	2,640-2,880	6,6-7,2
18,000	1,080	1,188-1,296	6,6-7,2
3,000	180	198-216	6,6-7,2

Overall, whether considering the case of possession or that of tenancy, the returns of the estates mortgaged against the capital loans made out of Attalos' foundation range between 6.5 – 10 %.

[246] REG 19 (1906), n°142, l. 28-30 (p.247).

2.4.3 The share of rents in total produce as a proxy for the degree of surplus extraction

Up to this point, the reader might well wonder what the precise purpose of these calculations is for the broader subject of grain supply. In fact, in the context of fragmentary data regarding the share of produces in the total land value, returns on land allow us to reconstruct the relative share of rents in the total income derived from land exploitation. Eventually, the weight of rents in agricultural income gives us an idea of the level of surplus appropriation This might be easily described by prolonging the model outlined as a prelude to the examination of documents. The weight of total rents (R) in total produce can be represented as a share ψ_R of income:

$$\psi_R = \frac{R}{Y}$$

As stated by equation (7), total rents are equal to the rent per hectare (l) multiplied by land surface (A), whereas the income value is the total produced quantity (Q) multiplied by its price (p). We may thus rewrite the fraction of rents as :

$$\psi_R = \frac{l \cdot A}{p_g \cdot Q}$$

If we recall equation (10), land rent per hectare is equal to the intrinsic land return multiplied by the price of land per hectare., and the ratio A/Q is nothing but the inverse of the average soil productivity (π_A). By expressing the ratio of land prices to grain prices as the relative price of land, as in equation (6), we can write the fundamental equation :

$$\psi_R = \frac{l}{\pi_A \cdot p_g} = \frac{r_A \cdot p_A}{\pi_A \cdot p_g} = \frac{r_A}{\pi_A} \cdot p^*_{A/g} \qquad (11)$$

The share of rents in the total agricultural income is directly proportional to the level of returns (and hence to the level of nominal contractual rents) and to the relative price of land with respect to grain, but conversely proportional to the average productivity of land. The value of rents is obviously not constant but fluctuates over time, according to the demand for land tenancy.

Now, what share of total produce would be captured by rents, if we applied the figures derived from our documents from Caria as if we were mostly dealing with cereal land? In these two series of documents, the lower limit of land returns are in the range of 3-

6.5%, while the range of land prices vary between 415 and 500 denarii/ha (or HS/iug). With an average price of grain of 2.5 HS/modius (= 91 d/ton), and assuming land productivity of 1 ton/ha, the share of rents in total produce varies between 13.8 and 35.7%. Refining this calculation by assuming that the price of land is correlated to its productivity (0.8 tons/ha on the cheapest land, 1.2 on the more expensive one) would narrow the margins to 17.5-29.7 %. Relying on these calculations, it would seem that the 20% given as a standard value by S. Mitchell for Roman Asia Minor[247] is closer to a low estimate, and that the share of rents in total produce may experience a rather wide margin of variation.

In particular, the weight of rents was obviously not constant over time. It must have been greatly dependent upon the population pressure on land resources. Indeed, rewriting equation (11) in real terms (in quantities) yields :

$$\psi_R = \frac{l}{\pi_A^*}$$

where π^*_A is the land productivity in volume. On the numerator, as population density increases, the level of nominal contractual rents per hectare would go up. On the denominator, however, the impact of population density (of which the labor/land ratio is a very good proxy) on land productivity, although non-linear as we concluded from the works of Sraffa, is straightforward: the lower the labor-land ratio, the lower the average yield per hectare. Documentary data on the level of nominal rents in Asia Minor are unfortunately very meagre. But hundreds of land lease contracts specifying the level of rents are known from Roman Egypt, and have been recently assembled by Kyle Harper in an impressive project of compilation of quantitative data on prices, wages and rents in Egypt (1st-7th c. AD). In order to represent the share of rents in total produce, we have taken Harper's series of nominal contract rents and divided it by the average grain yield per hectare for Egypt reconstructed by Dermody (average gross yield of 12.2 hl/ha[248]). In order to account for a likely decrease of soil productivity after the Antonine plague[249] (party due to the sharp loss of manpower per unit of land), I have scaled down this value for the decades following AD 170. The result is displayed in the following figure :

[247] Mitchell (1993), p. 254

[248] 1.15 tons per hectare assuming a volumetric mass of grain of 800 kg/m³ (=80kg/hl)

[249] On a decrease in soil yields in the end from the late 2nd .c. AD to the mid 3rd c. AD, cf : Van Minnen (2000), pp. 211-212.

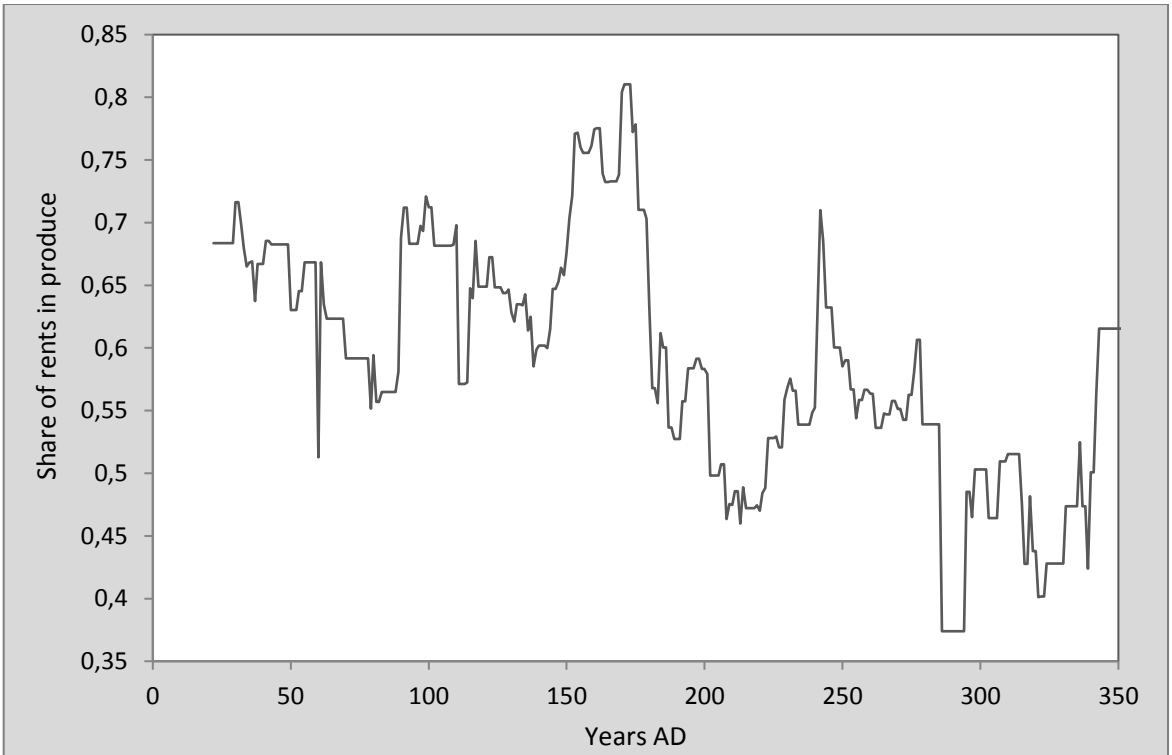


Fig.15. Evolution of the share of rents in agricultural (grain) produce in Roman Egypt (AD 22 - AD 350) on a 20 year moving average. Elaborated from : Harper (2016), Dermody (2014).

Two aspects are interesting concerning this graph. First, the share of rents in overall produce is usually very high, oscillating between 40% and 80%. This is only possible because, due to the very high productivity of land in Egypt, the remaining produce is still sufficient for rural consumption and seed. In Asia Minor, as shown above, the share of rents was clearly lower on average. Second, the evolution : the surplus extracted by rents steadily increases over the 1st c. AD, experiences an absolute peak in the mid-2nd c. AD, and falls drastically just after the Antonine plague : with the brutal decrease of population density, the demand for land was reduced, and hence the value of rents diminished[250]. This is interesting for our case study because, although the absolute value of the share of rents was lower in Asia Minor, its evolution through time, in particular as a result of the Antonine plague, must have been in all likelihood similar to that revealed in the Egyptian documents. We may indeed expect that, with the sharp contraction of population and the subsequent decrease of population density, the demand for land relative to the available surfaces dropped, hence driving the level of contractual rents down.

[250] Scheidel (2012), p. 280 sqq

2.5 Direct taxation and tribute

So far, we have only discussed the nature and effect of rents on the agrarian economy. But taxes and tributes played also a major role on the extent of available grain produce. In this section, we will not discuss the broader impact of taxes on the economy of the empire as a whole, nor shall we try to account for every type of taxation. As far as agriculture and disposable surpluses are concerned, we will mostly focus on direct taxation. More precisely, this section will account for the evolutions in tax collection between the late Republican period and the 3rd c. AD (1), and discuss the extent to which direct taxes were levied in kind or in cash in Roman Anatolia (2).

(1) Two forms of direct taxation of the provinces existed in the first c. AD : the *vectigal certum* (a fixed contribution) and the *censoria locatio* which resulted from the *Lex Sempronia* establishing the farming of the collection of all direct taxes to *publicani* in the 'frumentary' provinces such as Africa or Sicily[251]. Asia Minor did not formally belong to this category, but contributed in all likelihood to the provision of Rome[252] : its important production and 'exportation' is praised in 66 BC by Cicero (*Asia (…) multitudine quae exportantur, facile omnibus terris antecellat*)[253], who later (in 62) mentioned the tribute as one reason for inhabitants of Asia Minor to hate the Roman administration[254]. Of the *censoria locatio* resorted, during the Republican era, the *tributum soli*, a ground tax affecting all provincial land that did not possess the *ius italicum*[255], as well as the pasture tax. If the land was cultivated, the tax took the form of a tithe[256], a share of the produces, which we know to have been 10% of production as explicitly mentioned in the *Lex portorii Asiae* (δεκάτας καρπῶν[257]) and Cicero's orations (*decuma*). In this respect, the 25% tax on crops imposed by Lucullus in 70 BC (τετάρτα μὲν ἐπὶ τοῖς καρποῖς)[258] was only temporary. The question wondered by C. Nicolet as to whether additional requisitions such as the 20,000 talents required by Sylla in 74 BC [259] or those imposed by Lucullus were substituted or supplemented to

[251] Cic., *2Verr.*, III, 12; Badian (1972), p. 62; Lintott (1993), pp. 74-76 ; Mitchell (1993), p. 248

[252] Nicolet (1994), p. 223 ; *contra* Pierobon-Benoit (1994), p. 306

[253] Cic., *De Imp. Gn. Pomp.*, 14

[254] Cic. *Pro Flacco*, 19

[255] Sartre (1991), p. 81

[256] On the tithe as a farmed tax in Asia : Nicolet (1988), p. 200

[257] *EA* XIV (1989), l.72

[258] App., *Mithr.*, 83

[259] Plut.,*Syll.*, 25, 4 ; Plut., *Lucullus*, 20, 4

the *decuma*[260] is legitimate, since the *decuma* appears in Cicero's discourses about ten years later[261], but cannot be answered so far. Yet, that the tithe was farmed is in any case doubtless, for Cicero reports having seen the *decumani* – the publicans responsible for the levying of the *decuma*[262] – while on his way to Cilicia[263]. The complete and direct collection of the tithe by the publicans however concerned the province of Asia Minor only, for in Bithynia and Cilicia a slightly different system applied which originated in Pompey's governorship, following which direct collection of taxes from the communities was forbidden to the publicans[264], and since Phrygia had been exempted from taxes before its inclusion to Asia[265].

The farming of such taxes, of course, did not go without problems. The greed and extortions of the publicans, on which Plutarch, Appian and Dio agree, could hardly have been a mere *topos*[266]. The power gained by the publicans and their abuses are even well reported by Cicero[267], whose political careerism made him want to square the circle of '[preserving] the provincials from ruin without offending the *publicani*'[268]. Overtaxation and illegal requirements were indeed not uncommon (*alia exactionibus illicitis nomina publicani invenerant*)[269]. Although the farming of taxes ensured Rome with regular revenue, these troubles initiated a process of progressive revision of the publican's contracts in 61 BC which ended in 48 BC with Cesar's reform through which the publicans were dismissed[270] and the collection of taxes withdrawn from them and transferred to the communities themselves[271]. The subsequent reduction of the taxes by one third reported by Appian and Suetonius[272] might be somewhat exaggerated due to 'Caesarian propaganda'[273], but nevertheless indicate that considerable pressure was

[260] Nicolet (1994), pp. 221-222
[261] Cic., *Pro leg. Man.*, 16;
[262] Lintott (1993), p.75
[263] Cic., *Att.*, V, 13, 1
[264] Broughton (1937), pp. 537-538; Lintott (1993), p. 77
[265] App., *Mithr.* 57
[266] Cass. Dio, XLII, 6, 3 ; Plut., *Lucull.*, 20, 1; App., *Bell. Civ.*, V, 19
[267] Cic., *Ad Q. fr.*, I, 1, 32
[268] Badian (1972), p.80
[269] Tac., XIII, 51, 2 ; cf. Heller (2014), pp. 218-219
[270] Cass. Dio, XLII, 6, 3
[271] App., *Bell. Civ.*, V, 4, 19; De Ligt (2002), p. 55 ; Heller (2014), p. 219
[272] *Ibidem* ; Suet., *Caes.*, 20
[273] Badian (1972), pp. 116-118

made upon the provincials. Yet, the dismissal of the *publicani* must have been only temporary since they are mentioned under Nero as collectors of the tithe[274].

Little had changed, apparently, by early imperial times. In the early 2nd c. AD, Hyginus describes the various existing taxation regimes, which still exhibit resemblances with the republican dichotomy between the *censoria locatio* and the *vectigal certum*:

> Tax land display various regimes. In some provinces a certain share of the harvest is paid, in some one fifth, in others one seventh, while others provinces pay in money; all this according to the value of the soil. Definite values have been established for land, as in Pannonia : ploughed land of first category, of second category, meadows, acorn forest, ordinary forest, pasture…For all these lands the *vectigal* has been defined by *iugerum* according to the fertility[275].

As far as Asia Minor is concerned, direct taxation undoubtedly still took the form of a tithe on agricultural produces farmed to publicans, as stated in the *Asian Custom's law*[276]. The most important change occurred in the course of the 2nd c. AD, when the collection of taxes was once again redirected to the civic authorities : the taxes were paid for in advance by the δεκαπρότοι and εικοσαπρότοι (the 'first ten' or 'first twenty' men) who were ultimately responsible for the collection from tax-payers[277]. This, however, did not prevent abuses, for complaints from peasants and countrymen are documented until the 3rd century AD[278].

(2) The fact that the tribute was collected as a share of agricultural produces might indicate that the *decuma* was levied in kind and that, consequently, publicans managed important stocks of staple foods[279]. It seems, however, that publicans were holding cash stocks rather than grain or agricultural produces[280] and that the Roman treasury received money from them rather than grain or other commodities[281]. T.R.S. Broughton, and C. Nicolet after him thus suggested that tax-farming companies

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[274] Tac., XIII, 51, 2 ; *EA* XIV (1989), l. 73 : δημοσιώνην καρπεύεσθαι τὸ τέλος

[275] Hyg., 205

[276] *EA* XIV (1989), ll. 72-73; cf. Mitchell (1993), pp. 248-249 ; Tac., XIII, 51, 2

[277] Magie (1950), p. 648 ; Sartre (1991), p. 86 ; Sartre (1998), p. 347 ; Dmitriev (2005), p.198

[278] *AE* (1990), 949 (Pertinax) ; OGIS, 519 & TAM V, 1, 419 (Philip the Arab) ; cf. Sartre (1998), p. 348

[279] Nicolet (1994), p.223

[280] Caes. *De Belll. Civ.*, III, 3, 3 (*magnam <pecuniam> societates earum provinciarum (…) sibi numerare coegerat*) ; Ps.-Asconius, 157 (*summa pecunia*); cf. Broughton (1937), p. 541

[281] Lintott (1991), p. 77

converted the collected produces into money in the provinces[282]. L. De Ligt however, arguing on the basis of the literary references to the publican's money and on two Lycian documents implying that villages took money from their treasury to pay for the tax-requirements, claimed that publicans received most of their revenues in cash[283]. Arguing convincingly that the collection in kind did not bind the publicans to receiving their dues in money, he draws the somehow hasty conclusion that 'we can rule out the possibility that the land tax in Asia, at least, was transmitted in kind'[284].

The key element to this controversy probably lies in the interpretation of a passage of the *Asian Custom's law*[285], in which Nicolet sees an exemption from custom duties for the transportation of the tithe by the publicans, while L. De Ligt interprets it as a mere indication that customs duties applied to agricultural produces subjected to the *decuma* coming from other districts[286]. The question here is whether *at least some* agricultural produces coming from Asia Minor contributed or not to the supply of Rome; or said differently, the extent to which Asia Minor was indeed a 'frumentary province', on which precisely Nicolet relies for his argument. No such grain furniture is explicitly stated in the documents, but some indices nevertheless make this hypothesis very plausible : the reference to the abundant 'exports' of produces from Asia Minor, first, but most importantly the mention by Cicero of a *custos frumento publico praepositus* – a guardian of the public grain – in Temnos[287], a formulation which echoes the Roman institution known from the *Lex Gabinia* as the *custodia publici frumenti* – the management, storage and supervision of the grain destined for Rome[288]. Hence, Nicolet's proposition that the Custom Law of Asia actually referred to the exemption from custom duties for the transportation of the *decuma* finds some ground in the (obvious) interest of Rome to facilitate the circulation of tax-grain. Thus, if De Ligt is right in arguing that the publicans received *most* of their revenues in cash, this does not invalidate the idea that they might still receive *some* of it in kind. Nicolet's claim might thus be rephrased: instead of arguing that the disputed passage referred to 'the tithe' – in his mind, all of it –, it is probably more realistic to consider that the Custom Law exempted from custom duties *a certain share* of the tithe, namely the one which the publicans did *not* receive in money, and which was geared to contribute to

[282] Broughton (1938), p. 540 ; Nicolet (1991), pp. 476-477
[283] De Ligt (2002), pp.57-56.
[284] *Ibid.*, p. 57.
[285] *EA* XIV (1989), ll. 72-74
[286] Nicolet (1994), p. 224 ; *contra* De Ligt (2002), pp. 56-57
[287] Cic. *Pro Flacco*, 45
[288] Nicolet (1991), pp. 476-477

Italy's supply. In any case, however, primary collection of taxes undoubtedly appears to have mostly been levied in kind[289] - perhaps as much as 80% [290]- even though in certain regions some direct taxes were paid in money from the Principate[291].

* * *

This partial reconstruction of the forms and level of rents and taxes in Asia Minor suggests that the appropriation of agricultural surpluses by the Roman power and the landowning élite must have been an important factor affecting the availability of grain surpluses. The tithe and the rents together could have represented minimum some 27.5 – 40% of total production, although this estimate cannot so far be confirmed by other empirical evidence. Moreover, a non-negligible part of both taxes and rents was in all likelihood paid in kind – but how much exactly is difficult to estimate with the current body of evidence – which prompts the question of the actual management of this tax-grain or rent-grain. In any case, the primary production of such surpluses no doubt required a significant flexibility in the use of land and labor by tenant-farmers and peasants. The connection between surplus extraction and surplus production is outstandingly summed up by P. Bang when he compares the Roman and Mughal Empires:

> 'In the longer term other factors [*i.e. : than weather hazards*] take on greater prominence in shaping the size and distribution of the surplus. Chaudhuri lists conditions such as the general fertility of the area, population density and the level of technology. One factor, though, is conspicuous by its absence: surplus extraction. (...) peasant households are not normally oriented towards producing a large surplus for circulation outside the farm. They aim rather to fulfil the basic needs of the household with as little effort as possible. Usually they have not been the main beneficiaries of the production of substantial surpluses above their own subsistence needs. The bulk of their surplus produce was normally claimed by various political lords and would not have been produced without pressure from above. Changes in patterns of surplus extraction are thus likely to constitue a key factor in explaining developments in economic circulation.'[292]

[289] Duncan-Jones (1990), pp. 190-191 ; Mitchell (1993), p. 248

[290] Katsari (2011), p. 149

[291] Duncan-Jones (1990), p. 192

[292] Bang (2008), pp. 78-79

Chapter 3
The grain supply systems and their functions

3.1 Famines, grain prices and grain-related interventions

3.1.1 Introduction

Although harvest failures and food shortages were recurrent in the Ancient world, the frequency and gravity of such events varied significantly from one region to another and from time to time, due to the important environmental fragmentation an climatic evolutions emphasized in chap.I. The actual causes of food shortages should thus not solely be sought into the fragility of agricultural production, but also to an equally important extent, in the problems of distribution raised by ecological fragmentation, topographical peculiarities, prohibitive land transport costs and logistic weaknesses (though significantly improved by the roman road network), in predation by tribute and rents (cf. chap. II) and in speculative behaviors (cf. *infra*) – aspects which unfortunately cannot all receive detailed discussion here. In this respect, we should probably speak of *food accessibility restriction* rather than systematically of 'shortages' which implicitly puts too much emphasis on the *a priori* assumption of widespread insufficiencies, 'irrational' choices and the determinism of technological weaknesses in agricultural production.

Yet, it remains that food crisis were doubtless a structural feature of Graeco-Roman economy. This section will thus be opened on a presentation of ancient epigraphical and literary evidence of grain shortages in Asia Minor as avatars of the structural character of such events. After a chronological survey of shortages and grain-related intervention, we devote a separate discussion to grain prices. For the broader topic of grain availability, grain prices are both a visible symptom of shortage and a location-dependent variable. A specific discussion of grain prices is thus needed in order to make a clear distinction between the *conjuncture* of price variation

(shortage or civic subsidies) and the *structural* difference in their level between various regions of the Mediterranean. Finally, grain-related interventions will be refined by highlighting the different levels at which such interventions were undertaken. The scope, the technicalities, and the sustainability of grain supply civic schemes will be discussed in section 2, while section 3 will be devoted to the analysis of the social, institutional and political factors underlying their rationale. Section 4, finally, will be devoted to discuss some specific issues on the role of markets. Overall, as crisis in food accessibility were a *structural* feature of Graeco-Roman economies, this chapter will be geared towards the argument that grain-related interventions were similarly a *structural* response to this constrain.

3.1.2 A chronological overview

Writing a quantified history of famines and shortages in Asia Minor is no easy task. Two major problems are faced in particular : (1) contrary to Rome for which abundant literary evidence records in sufficient details the famines or episodes of dearth experienced by the *urbs*, literary testimonies of famines regarding Asia Minor can be counted on one hand; (2) among the 24 inscriptions explicitly recording episodes of shortage or famines, only 13 can be dated with a relative accuracy (in an interval of half a century or less). Since these inscriptions refer to different cities, it is not even possible to account for the evolution of the difficulties in grain supply for one single city. Some documents, however, provide valuable information on local events.

In Apameia in Phrygia, a benefactor is praised for having 'fed the city by distributions in times of shortage'[293]; the plural δυσχρήστοις καιροῖς implying that this city experienced several episodes of dearth during the career of this benefactor. The same applies to the honorific inscription for Agathemeros and his kin who are praised for having performed benefactions 'during many shortages' (σειτοδείᾳ[ις])[294], and to the inscription of Metropolis honoring Sosthenes who 'provided food cheaply many times during shortages' (ἔν τε ἐνδείαις (?) λυσιτελεῖς παρασχόντα τροφὰς)[295]. What is quite interesting with these three texts is that they all come from Phrygia and all date from the third century AD, thus suggesting a period of repeated food crisis in this region at this period.

[293] *IGR* IV, 785 = *BCH* (1893), p.302, n°2
[294] *MAMA* XI, 160
[295] *MAMA* IV, 130

Another dossier comes from Stratonikeia in Caria. A first inscription honoring the benefactor Marcus Sempronius Clemens (second half the 2nd c. AD) makes reference to a 'bad harvest' during the benefactor's priesthood (ἐν στενοχώροις καιροῖς)[296]. A second, more detailed inscription, relates to the numerous food-related interventions of a priest named Tiberius Flavius Theophanes; in the end of the text, an interesting sentence stipulates that the 'bad weather' did not undermine the generosity of the benefactor: καίτοι τοῦ καιροῦ περὶ τοὺς καρποὺς πάντας καὶ περὶ τὰ ἄλλα τειμ<ί>ωρ{ι}αν ἔχοντος[297]. In this case, the inscription can more accurately be dated between AD 164 and AD 166. Finally, another document from the same city records the gifts made by a priest and his wife or daughter, in which it is said that the city experienced 'five years of shortage' (ἔτη πέντε ἐν σιτοδείᾳ)[298]. Just like the previous inscription, this document is to be dated to the mid-second c. AD.

A similar 'cluster' of inscriptions concerns the Bithynian city of Prusias of Hypios : a benefactor named P. Domitius Iulianus is honored two times for having distributed grain, wine and oil for to the citizens during a shortage[299]. Later on, three inscriptions praise local notables for having held the office of *agoranomos* in time of shortage (or 'during urging circumstances')[300]. This same expression is mentioned in yet another document relating to an official whose curriculum specifies that he was 'agoranomos during a grain shortage'[301]. The two inscriptions of Domitius Iulianus date back to the 2nd century, but the four inscriptions mentioning *agoranomoi* in office in times of dearth are concentrated between the late 2nd c. AD and the first quarter of the 3rd c. AD. Since the inscriptions preserved are only a modest proportion of the actual number of inscriptions that once existed, it is probable that such a concentration of evidence of food crisis indicates that, in Stratonikeia in the middle of the second century AD, in Phrygia during the 3rd century and in Prusias between the late 2nd and early 3rd c. AD, several episodes of shortage seem to have occurred in a rather small time interval.

These are however the only cases of repeated evidence from a well circumscribed area. From elsewhere, only isolated evidence for grain crisis is available : in Cilicia during the Republic, where according to Cicero, 'famine (…) was rampant (…) after the

[296] *IK-Stratonikeia*, 293, ll. 13-14
[297] *IK-Stratonikeia*, 203, ll. 30-32
[298] *IK-Stratonikeia*, 254, l. 12
[299] *IK-Prusias*, 18 & 19
[300] *IGR* III, 60 ; *IK-Prusias*, 6 ; *IK-Prusias*, 17
[301] *IK-Prusias*, 13

total failure of the harvest'[302] – although Cicero might have exaggerated the gravity of events in order to emphasize his role as governor; in Aphrodisias during the Late Republic where a benefactor was agoranomos 'during the most difficult shortage'[303]; in Hierocaesarea (Lydia) under Augustus[304]; in Aspendos (Pamphylia) during the reign of Tiberius[305]; in Pergè (Pamphylia) under Trajan[306] ; in Aizanoi (Phrygia) in AD 156/167[307] ; in Apollonia (Phrygia) in AD 162, where a certain Sagaris makes a dedication to Zeus to thank him for saving his beasts from the famine by leading them to the Galatians[308]; in Ancyra (Galatia) at some point between AD 257 and AD 284[309]. It should be stressed, however, that the evidence from Asia Minor does not show any particular sign of the great famine which, according to Luke, struck 'the whole inhabited world'[310] during the reign of Claudius (around AD 45-47), and which some scholars acknowledged to have been a 'universal famine'[311]. This famine is however well documented for Egypt and Judaea[312].

In some other cases, however, episodes of shortage can be suspected due to information on prices. An imprecisely dated imperial inscription records a price of 8 HS per modius during a shortage in the city of Sebastopolis[313]. Around AD 92-93, St John's *Apocalypse* which we know to have been written in Asia Minor, makes allusion to very high grain prices :

> And I heard like a voice [coming from] the middle of four animals, [saying] : one *choenix*[314] of wheat for a denarius, and three *choenices* of barley for a denarius! [315]

As one bushel is the 48th part of the medimnos, the value of 1 denarius per bushel easily converts into a price of 32 HS per modius, or about 10 times the value of 3 HS per

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[302] Cic., *Ep.*, V, 21, 8 : *Iter igitur per Asiam feci ut etiam fames, qua nihil miserius est, quae tum erat in hac mea Asia (messis enim nulla fuerat), mihi optenda fuerit.*

[303] *IAph2007*, 12.701

[304] *TAM* V, 2, 1309 = *IGR* IV, 1355

[305] Phil., *Vita Apoll. Tyan.*, I, 15

[306] *IK-Pergè*, 58

[307] *SEG* 35, 1365

[308] Kaibel, *Epigrammata*, 793. Cf. Mühlenbock *et al.* (2015), p. 30.

[309] *IGR* III, 206

[310] Luke, *Acts*, XI, 27-30

[311] Gapp (1935), pp. 258-263.

[312] *Ibid.*, pp. 258-261.

[313] McCabe, *Sebaastopolis*, 6 = Robert, *Et. Anat.*, pp. 343 sqq.

[314] The choenix was a dry measure which was worth 1.09 liters (cf. Bresson (2016), p. 439).

[315] St John, *Apocalypse*, 6

modius fixed by Nero after the great fire in Rome in AD 64[316]. At the same period, after a shortage that affected the city of Pisidian Antioch, the governor limits the price to 8 HS, from a usual price of 4 HS, or a full 100% rise[317]. A final explicit example comes from the *Historia Apollonii Tyriensis,* dating back to the 3rd c. AD, in which a price of 100 HS per modius is mentioned (*singulos modios singulos aureos mercabantur*)[318]. Apart from the inscription from Sebastopolis, many of such instances should of course be taken cautiously, either because the price value is rhetorical, or because, when dealing with Christian authors, it may sometimes result from anti-pagan propaganda, as is probably the case in the depiction of disastrous shortages by Eusebius[319] (2,500 attic drachmai per *mètron* – in this context probably the *modius castrensis*)[320] and Lactantius (*hinc fames agris ferentibus, hinc caritas inaudita*)[321].

Beside the impressionistic picture provided by local evidence, however, we now need to look at the broader distribution of the data covering the whole Anatolia along the first three centuries AD, to see which evolutions arise on a global scale. For this, we represented the chronological distribution of the average annual number of food-related interventions (mostly grain, but some inscriptions record distributions of oil[322]) in Asia Minor, displayed on figure 10[323].

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316 Tac., *Ann.*, XV, 39

317 *AE* (1925), 126, col. II.

318 *Hist. Apoll. Tyr.*, 9-10.

319 Euseb., *Hist. Eccl.*, IX, 8, 1 ; IX, 8, 12

320 *Ibid.*, IX, 8, 4

321 Lact., *De morte persec.*, 37

322 The purpose of such oil was obviously not only or even primarily for consumption, though. Much of oil distributions concern the *gymnasium*. Yet, it was also used for cooking, and it is often difficult to determine the respective share of consumption and gymnasiarchic use.

323 This graph, by definition, focuses only on inscriptions which can receive a 'quantified' dating, since such expressions as 'late Republic' or 'early Empire' could hardly be represented on a graph. On the basis of these inscriptions, we counted the number of grain-related interventions recorded in each document, and divided this number by the number of years of the dating interval of the document. We then spread out the data in inscriptions dated by two centuries, one century, half a century, reign, precise year, or any other time interval, and we added up the value of the average number of interventions per year for each year between AD 1 and AD 301, which provided us with an index capturing the average intensity of grain-related intervention per year. On this method, see Zuiderhoek (2007), p. 18.

We then displayed the 7-years moving average of this index in order to exhibit the tendencies. The interval of 7 years was not chosen randomly: it is based on the fact that we estimated that harvest failures in Asia Minor occurred on average once over a period of 6 years (or a probability of about 16.5 %).

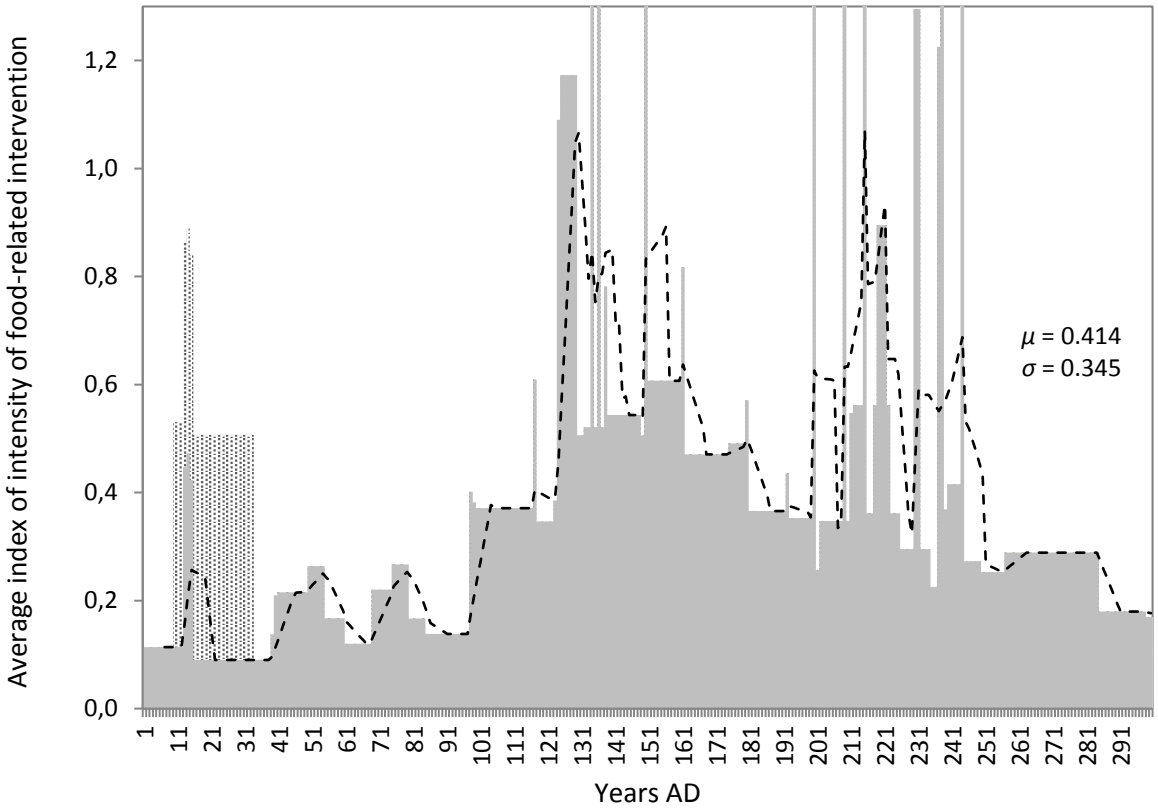

Fig. 16. Evolution of the intensity of food-related interventions in Asia Minor (AD 1 - AD 301) represented by absolute annual values (grey bars) and by a moving average over a 7-years period (dashed line) | *n* = 143; N ≥ 177.

Before even analyzing the tendencies, the reader must be aware that the graph suffers from an important bias for the period running from AD 10 to AD 33 : indeed, the rather high values of the index for this precise interval are mostly due to one single inscription from Pessinous in Galatia (*OGIS*, 533) which records several food contributions, hence distorting the distribution on this part of the graph. Removing this inscription from the data would significantly alter the average value of the index for these years (the correction is shown on the graph by the dotted zone), leaving only the important peak around AD 10-15. The technique of spreading the data over the dating period of each inscription (cf. n. 17 above) allows inferring and representing both the short term fluctuation and the general tendencies; but it remains biased regarding the density of information per document which is not constant : a single inscription may mention as many benefactions as 10 inscriptions taken together; since these pieces of evidence will most likely be dated with different levels of accuracy, this will be reflected in the chronological concentration of the information.

Overall, the sample consists of some 160 interventions recorded on 142 inscriptions. This is of course a rather small sample for studying a region as large as Anatolia over a period of nearly three centuries. Yet we are bound to what is left of ancient documents. Moreover, we might reconsider the level of representativeness of

our sample. In section 2.2.3 below, I have estimated at 30,000 the number of inscriptions of Asia Minor over the considered period. Let us assume that this is a strong underestimation, and that the actual number of inscriptions produced over the period was nearly twice as large, *i.e.* about 60,000. What proportion of this epigraphic production might have recorded interventions by officials, benefactors or Roman authorities? Mainly three categories of inscriptions are concerned: honorific decrees, dedications and the miscellaneous. In the *Inscriptiones Graecae* (II/III), these three categories together represent a little less than 25% of the total. If this proportion can roughly be extrapolated, this means that for our period, the number of inscriptions belonging to one of these three categories was about 15,000. Yet, not all these inscriptions recorded euergetism or official interventions; some of the miscellaneous (a little more than 5% of the total) as well as honorific decrees might have concerned other aspects of civic life. But if we assume that 80% of these three categories together were dealing with benefactions and/or interventions in the broader sense, this leaves us with a body of 12,000documents. Now, which proportion of these inscriptions potentially concerned food-related benefactions? In his study of civic munificence in Asia Minor, A. Zuiderhoek has calculated that 3% of his total sample of some 500 interventions was dealing with food[324]. Naturally, the proportion of *interventions* and *inscriptions* might well be different, but again, if we consider this as an underestimate by a factor of two, this would mean that total food-related inscriptions would make up at best some 6% of total euergetic inscriptions *lato sensu*. Hence, this would imply that the total potential corpus of food-related inscriptions in Asia Minor over the first three centuries AD would consist of some 720 documents. Compared to that number, our sample of 142 inscriptions does not seem so dramatically small anymore. This resulting graph, of course, is merely illustrative, and should not be expected to provide very accurate depiction of fluctuations in grain market intervention. To some extent, however, our body of evidence might be considered as converging towards the actual distribution of grain-related interventions.

What do we see on the graph, then? First, it should be stressed that the peaks of high value and thin time span should not be assigned too much importance since these crucially depend on the level of accuracy with which the inscriptions reporting them could be dated. What matters for the present data is the pattern suggested by the mid- to long-term evolutions, which are revealed by the dashed trend curve. This curve exhibits two important overall increases : the first starts from the middle of the reign of

[324] Zuiderhoek (2009), p. 172

Trajan and lasts until the end of the reign of Marcus Aurelius, the second starts under Septimus Severus and ends in the middle of the 3rd c. AD.

Since this curve represents all kinds of interventions related to grain (and, in a few cases, oil), its interpretation is not straightforward. Should we interpret a rise as a signal of increased food distress? Or rather as testifying of pervasive and recurrent civic supply systems and intense participation of benefactors, which would thus indicate increased access of urban populations to (stores of) grain? Or does this curve simply reflect the variation of the 'epigraphic habit', since the chronological distribution of Greek and Latin inscriptions as such has been shown to follow its own independent evolution[325] ? There is sufficient ground to claim that we are not witnessing the changes of a mere 'fashion'. Indeed, these long-term evolutions in the intensity of grain-related intervention broadly follows the chronology of élite munificence (all purposes together: public buildings, games & festivals, distributions of food or money…) in Asia Minor already emphasized by A. Zuiderhoek : a rapid increase in the beginning of the 2nd c. AD, an absolute peak in the first half of the 2nd c. AD, and a general decline in the first decades of the 3rd c. AD[326]. Moreover, the pattern displayed by grain-related interventions finds some similarities with those exhibited by other type of data throughout the empire: animal bones assemblages in the provinces, although rising from mid-second c. BC, reach their peak around AD 150 and decline after that[327]; even more interestingly, the evolution of the femur length, although not focused on samples from Asia Minor alone, also exhibits a double-peaked curve, with a depression between the mid-second c. AD and the beginning of the 3rd c. AD[328].

This gap, which roughly lasts from AD 165 to AD 200 is undoubtedly the key to the understanding of the long-term trends exhibited on the graph. A few years ago, François Kirbihler has argued for the presence of a subsistence crisis in Asia Minor under Marcus Aurelius[329], whose reign falls exactly in the depression visible on the graph. However, is this depression in grain-related interventions a symptom of distress, or rather a sign that civic interventions were not needed to ensure a regular and sufficient food supply? We should probably interpret variations in grain-related interventions as co-variating with the fluctuations of food accessibility; but we should not consider this covariation as being instantaneous: the fact that we argued above

[325] MacMullen (1982), pp. 243-245
[326] Zuiderhoek (2009), pp. 18-19
[327] Jongman (2007), pp. 191-193
[328] Jongman (2007), pp. 193-194.
[329] Kirbihler (2006), pp. 613-640.

that the structural nature of food crisis generated a structural response in the form of food supply institutions and food munificence does not mean that any historical occurrence of such food-related élite participation – or even most of it – is the symptom of a food crisis. Such an interpretation would reduce food-related institutions and munificence to a circumstantial, conjuncture-oriented phenomenon, while we precisely argued that they were a *structural* response to a *structural* problem. Of course, in some cases, some serious and isolated food crisis undoubtedly fostered élite munificence and stimulated a response by civic supply systems, especially in emergency situations, but it is unlikely that this was the major driving mechanism. In this respect, a rise in aggregate grain-related intervention *might* indicate a troubled access to basic foodstuffs – just as it *might* indicate particularly efficient civic supply schemes and high élite participation –, but which would not necessarily result from a contemporary disruption of supply channels. On the other hand, however, low levels of grain-related intervention are naturally unlikely to reflect a food accessibility crisis, either past or present. Therefore, Kirbihler's suggestion of a more or less global crisis under Marcus Aurelius, although well attested in his data concerning Ephesos and western Asia Minor, is not reflected by aggregate evidence.

How then can we account for the two long term peaks? It is, I think, a dead-end to seek for a single factor explaining all trends in the variation of food-related interventions. The early-second century peak should most logically be interpreted as reflecting the overall rise of munificence in Asia Minor, rather than a period of particular food distress which no comparative data supports. The early 3rd c. peak, however, should in my opinion be regarded as an indicator of increasing grain supply difficulties. Supports for this can be found when looking at the occurrences of the honorific title τροφεύς (foster-father) in Asia Minor, usually awarded to benefactions intervening in the food supply[330], often in critical situations : four out of the fifteen epigraphic references for this term can be dated between AD 200 and AD 235, precisely in the most intense part of the peak (cf. table 1).

Yet, what would have been the cause of this period of food distress? As can be seen on the graph, this supposed crisis develops at the very beginning of the 3rd c. AD, just a few years after the Antonine Plague struck the region of Anatolia. Although chronology is not an argument of itself, one might agree that the link between the epidemic and recurring food crisis is not far-fetched: the plague drastically and rapidly reduced the number of producers, while the amount of land under cultivation remained constant in the short run. As the labor-land ratio diminished, production per

[330] Dio Chr., *Or.*, 48, 10

hectare dropped, and so did aggregate production[331]. Of course, the plague also reduced the number of mouths to be fed. But the two effects probably did not compensate each other: although both supply of and demand for grain were inelastic, demand is likely to have been even more inelastic than supply – for the adjustment to the level of prices was probably easier on the production side than on the consumption side. Hence, in the very short run, equal movements of supply and demand would not have a null effect on the average level of prices: despite a combined reduction of supply and demand, the price of grain must have experienced an overall upward pressure, and even more so as the average amount of money *per capita* was increased[332]. To this, we should add the fact that, in the short run, the spatial distribution of population did not change as fast as population size, resulting in a lower population density, which must have rendered the logistics of grain supply more laborious since the unit cost of labor per capita was increased. As a result, the overall effect on grain accessibility must have been damaged by the Antonine plague, at least until a new configuration between population and resources would take place. For the moment, however, I will not further in the discussion, since a detailed analysis of the effects of the Antonine Plague on the availability of grain will be undertaken in section 3.2.4 below.

Table. 2. Occurrences of the honorific title τροφεύς in Asia Minor

City	Region	Period (AD)	Reference
Synnada	Phrygia	41 - 54	Head, BMC, Phrygia, p. xcix
Amastris	Paphlagonia	62	IGR III, 89
Attaleia	Pamhpylia	*75-125*	SEG 15.1570
Oenoanda	Lycia	135-150	IGR III, 495
Pergamon	Mysia	II c.	IGR IV, 1680
Prusias ad Hypium	Bithynia	II c.	IK-Prusias ad Hypium, 18
Prusias ad Hypium	Bithynia	II c.	IK-Prusias ad Hypium, 19
Pednelissos	Pisidia	II c.	SEG 53.1597
Ephesos	Ionia	*200-225*	IK-Ephesos, 3061
Amastris	Paphlagonia	209	IGR III, 90 & 1435 + OGIS, 531
Amastris	Paphlagonia	<209	IGR III, 90 & 1435 + OGIS, 531
Selgè	Pisidia	*215-235*	IK-Selgè, 17
Parlais	Pisidia	?	L. Robert, OMS III, 1450 (1)
Pergamon	Mysia	Roman period	IvP II, 589
Pergamon	Mysia	Roman period	IvP II, 606

[331] Jongman (2007), p. 197.

[332] Temin (2014), p. 204.

3.1.3 Grain prices in Asia Minor: variations, evolutions and ideas

Variations in the availability of – or access to – grain are strongly linked to of price-levels , but only because prices are often an indicator of grain shortages, as we saw in the previous section. Indeed, assessing a 'typical' price of grain in 'normal' circumstances is necessary for any calculation we need to make regarding the cost and efficiency of grain-related interventions. This is a difficult task, first because most documented prices are either shortages prices or subsidized prices, hence biased in one way or another, and second because grain prices, in Anatolia and elsewhere, are affected significantly by geographical variability, and experienced non-negligible changes during the first three centuries AD. Finally, the following survey of prices would not be complete (?) without a discussion of ancient Greek and Roman *perceptions* of prices, which had a significant effect on grain supply institutions and political interventions in the food market.

There was no such thing as a 'standard' price of grain that would have been universally valid throughout Asia Minor; prices differed greatly from one region to another. 'We know how much the value of things varies between different places, especially wine, oil and grain', can we read in the *Digest*[333]. A similar statement had been made by Cicero around 70 BC : when discussing the levies in kind due to Rome by the Phrygian city of Philomelium, which should be delivered at Ephesus, Cicero writes :

> I know the usual difference between the prices of corn at those two places; I know how long the journey takes; I know that it suits the farmers of Philomelium to pay, there in Phrygia, a cash sum corresponding to the price of corn at Ephesus, rather than transport the corn to Ephesus or send agents to Ephesus with money to buy corn there.[334]

Such geographical variability of prices is, according to Cicero, characteristic of some provinces like Hispania or Asia, contrary to the regularity of prices encountered in Sicily (*provinciae in quibus unum pretium frumento non solet*)[335]. This situation does

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[333] *Dig.*, XIII, 4, 3

[334] Cic., *2Verr.*, III, 191 : (...) *uideo quid inter annonam interesse soleat, uideo quot dierum uia sit, uideo Philomeliensibus expedire, quanti Ephesi sit frumentum, dare potius in Phrygia quam Ephesum portare aut ad emendum frumentum Ephesum pecuniam et legatos mittere*. See also : Rathbone & Von Reden (2014), pp. 180-182.

[335] Cic., *2Verr.*, III, 192

not only owe to the regional fragmentation and transport costs, but also results from the proximity of big cities. A similar situation is described in 4th c. AD Syrian Antioch, a city regularly supplied from Egypt, where the price of grain was double the basic Egyptian price[336]. A final mention of such typical interregional price variation is to be found in Dio Chrysostom's orations in which he claims that the price of grain in Prusa in times of crisis was still lower than the usual price in other cities[337], although Dio's statement might be less valuable since it may partly have served to calm down the angry mob accusing him of contributing to the shortage by stockpiling.

Beside this geographical and seasonal variability, how did prices evolve through time over a longer run ? For the second century AD, there are some indications of an upward pressure on grain prices, showed in the bread tariffs of Ephesos[338] (fig. 5 below). Due to the scarcity of the data, it is however impossible to know whether these price increases occur abruptly or were the results of a slow and continuous rise. What appears quite clearly from the Egyptian documents, however, is that the price of grain doubled between 170 and 190 AD onwards[339]. After this period, though, Egyptian grain prices remain very stable until the last quarter of the 3rd c. which suggest that the eastern provinces did not experience actual nominal inflation before the reign of Aurelian[340], despite the regular debasements of the silver Roman coinage that took place from the late second c. AD[341].

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[336] Jul., *Misopogon*, 369

[337] Dio, *Or.* 46, 10

[338] Duncan-Jones (1994), pp. 26-28. For a general discussion of inflation in Roman times: Jones (1953), pp. 293-318 ; Duncan-Jones (1982), pp. 7-11 & 356-357 ; Temin (2013), pp. 70-92 ; Temin (2014), pp. 189-207 (esp. pp. 189-201).

[339] Rathbone (1996), pp. 321-339 ; Rathbone (1997), pp. 183-244 ; Lerouxel (2016), pp. 296-297

[340] Katsari (2011), pp. 126-127 ; Lerouxel (2016), pp. 297-298.

[341] On the debasement of the *denarius*, see Christiansen (1988), p. 87.

Fig.17. Evolution of bread prices at Ephesos (1st - 3rd c. AD)

As we have seen, the recorded prices that reached us are almost always crisis prices or maximum prices. Added to the fact that prices varied greatly along modest distances, any attempt to derive what would have been the 'typical' price of grain for Asia Minor would seem doomed. Yet, that a precise quantitative estimate of a regular price in Asia Minor as a whole is impossible to derive, does not mean that a subjective perception of what would have been a 'normal', or 'fair' price in a specific place did not exist. The question of 'fair' or 'just' price is a recurring philosophical issue in the history of Greek and Roman societies. Plato is perhaps the first author we know of who discussed the problem. When discussing market regulations for his ideal community in the *Laws*, he proposes upper and lower legal limits for the variation of prices[342]. Later on, he explains the foundations of such limits, which must be set according to the 'reasonable profit' to be made by merchants (κέρδος ποιεῖ τὸ μέτριον)[343]. This idea of controlled profit is also found in Lysias' discourse *Against the grain dealers* in which he refers to a law forbidding the merchants to sell grain at a price more than one obol above their purchase price[344], which corresponds to a profit rate of 16.6 %[345].

[342] Plato, *Laws*, VIII, 14 [850a] : (...) τὸ δὲ ὠνηθὲν ἢ πραθὲν ὅσῳ πλέον ἂν ᾖ καὶ πλέονος ἢ κατὰ τὸν νόμον, ὃς εἴρηκεν πόσου προσγενομένου καὶ ἀπογενομένου δεῖ μηδέτερα τούτων ποιεῖν, ἀναγραφήτω τότ' ἤδη παρὰ τοῖς νομοφύλαξιν τὸ πλέον, ἐξαλειφέσθω δὲ τὸ ἐναντίον.

[343] Plato, Laws, XI, 4 [920b-c]

[344] Lysias, *Against the grain dealers*, 22, 8. One obol per drachma means a profit of one sixth, or 16.6%.

A similar, though in some respects different, view is expressed by Aristotle, when searching the foundations of 'justice'. Justice, he says, is what preserves 'equality'. But what then defines equality? In his conception of exchange, equality is first and foremost a matter of equivalence. More precisely, equality is seen as a proportion between what exchanging parties respectively had before and after the exchange, or stated differently, a relative equivalence in the gains realized through the process of exchange[346]. This is, according to Aristotle, the criterion of 'fair exchange' and hence a condition for 'fair prices'[347]. Yet, later on, he explores the possibility that such proportionality would be defined by the intrinsic properties of objects and commodities, which approaches the modern idea of an 'objective' theory of price formation.

References to the idea of 'fair' or 'just' price are also known from the Roman context, especially in the Digest through the notion of *iustum pretium*. In Roman Law, the concept of 'just' price seems rather to emerge from an 'objective' approach, according to which the price can be determined from the properties of the commodity within the process of exchange: *iusta pretia non ex praeterita emptione, sed ex praesenti aestimatione constitui*[348]. Yet, the ambiguity between the 'moral' definition and the 'substantive' definition is also present, since in book 50 we can read : 'It is naturally equitable that no one can be enriched at the expense of someone else's loss or injury'[349]. This ambiguity is well summarized in the beginning of the *Athenaion Politeia*, where the tasks of the *agoranomoi* are laid out, among which the following : 'they ensure that grain is sold at the just price' (σῖτος ἀργὸς ὥνιος ἔσται δικαίως)[350]. The word *dikaios* can be translated by 'correct, just' or 'fair, even'. The first sense refers to a substantive definition, based on intrinsic properties and/or legal processes (cf. *infra*), while the second rather reflects a moral connotation.

The interest of this discussion is that the concepts of fair price is not limited to philosophical developments or legal principles; it is also reflected in inscriptions dealing with matters of grain supply, hence showing the importance of this idea in daily operations : in the first or second century AD, a benefactor named Bassontas is said to have 'distributed grain at a fair price in time of shortage' (εὐώνω τειμῆ τὰ σεῖτα

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345 Migeotte (2011), pp. 423-424.

346 Berthoud (1991), p. 147.

347 On this development, see mainly : Arist., *Nichomach. Ethics*, V, 1131 a – c.

348 *Dig*., XLIX, 4, 3, 5. For other mentions of *iustum pretium* : *Dig*., X, 3, 10, 2 ; *Dig*. XX, 1, 16, 9; *Dig*. XXIV, 1, 36.pr. ; *Cod*., III, 37, 3.

349 Dig., L, 17, 206 *: Iure naturae aequum est neminem cum alterius detrimento et iniuria fieri locupletiorem*.

350 [Arist.], *Ath. Pol*., 51, 3

μετρήσαντα ἐνδείας οὔσης)[351]; Even more interestingly, in AD 156/157 in the city of Aizanoi, a benefactor named M. Ulpius Apullianus Flavianus sold grain below market price (an operation known as *paraprasis*, on which see below); in order to account for his benefaction, the decree reads : 'he distributed grain at the price of abundancy' (ἐπευωνίσαντα τὴν τιμὴν εὐθηνίαν)[352]. Hence, despite an emerging conception of prices based on the intrinsic properties of commodities and their relationship to others within the circuits of exchange, both Greek and Roman literature display constant references to a moral framework of (grain) price variations linked to the ancient *topos* of 'moderation', which testifies that conceptions of what a 'regular', or 'normal' price should be were not unfamiliar to citizens of ancient *poleis*; as the inscription from Aizanoi reveals, an idea of the level of grain prices in times of abundant supply was also conceived. As Jean Andreau convincingly argues, when ancient Greeks and Romans talk about the price of the year – without further reference, or without moral connotations, it should be stressed – they refer to the lowest price of the year, namely the price just after the harvest[353], which probably accounts for the τιμὴν εὐθηνίαν encountered in the inscription from Aizanoi. These facts, to a certain extent, nuance the criticisms that could be addressed to the concept of 'regular price'[354], *i.e.*, that prices followed a seasonal cycle and varied greatly from one region to another.

This of course does not allow conjecturing 'the' normal price for Asia Minor; yet, a quantitative reference point might be reached : when L. Antistius Rusticus limited the price of grain, he fixed the maximum limit at twice the price before winter (which was 8 or 9 *asses*, or 2 HS), namely at 1 denarius per modius. Similarly, the benefactor of Sebastopolis sold the grain at 1 denarius per modius. It seems, thus, that 1 denarius might have been conceived as an upper limit to what was acceptable or affordable. In the same vein, it is also broadly documented that, despite huge intra-regional variations, prices in the Roman Mediterranean also obeyed certain patterns : intense urbanization would drive the price up (as in Italy), while very fertile areas resulting in important production caused prices to drop, as was the case in Egypt. As Asia Minor was somehow an intermediate region both in terms of fertility and urbanization, and given what the scant numerical evidence at our disposal suggests, I think that in further calculations or simulations we might safely use a price of 2-2.5 HS per modius

[351] *MAMA*, VII, 11, ll. 6-9.

[352] *SEG*, 35, 1365, ll. 12-13.

[353] Andreau (2004), p. 135

[354] For a moral general discussion of the conception of prices in Roman Antiquity, see : Nicolet (1988), pp. 166 sqq (Rome).

as reflecting a regular, common price in many regions of Asia Minor in normal circumstances.

3.1.4 Levels of grain-related interventions

To cope with the structural nature of food crisis either explicitly reported in inscriptions and literary texts or revealed by price spikes, specific measures could be set up, some of which have already been highlighted in the preceding discussion of the chronology of shortages. Yet, the generic expression 'grain-related intervention', useful for grasping decisions and operations which are geared towards a similar objective, nevertheless foreshadows the different political levels at which such measures could be decided, and hence the scale at which they operated. Three levels can be identified in the sources : (1) the Imperial level, (2) the provincial level, (3) the civic level. In outlining each of these scales of intervention, we will follow a chronological order.

The first imperial intervention we know of for Asia Minor dates back to the reign of Claudius. An inscription reports important difficulties experienced by the city of Kibyra, the details of which have now been clarified : a notable of the city, Tiberius Nikèphoros, was operating 'a grain market cartel', through which he managed to extort money from the city[355]. In order to end this practices and their subsequent effect on the city's grain supply, a benefactor named Quintus Veranius Philagros undertook an embassy to Rome in order to report these troubles to the emperor Claudius. Philagros' embassy was successful, and the emperor decreed that 75 *modii* of grain should be sold per *iugum* of land, and that such sale was to take place nowhere except in the market area[356]. The most likely way to understand the measures ordered by Claudius is to consider that some landowners of Nikephoros' cartel were hoarding grain and exercising a pressure upon the supply of grain. Hence, Claudius commanded that a *minimum* quantity of grain – this is the way I think we should understand the value of 75 modii – per unit of cultivated area should be sold. As most of the grain was probably extracted through rents in kind, the imperial measure responding to Philagros' request puts legal limits to what the landowners could do with the surpluses that ended up in their hands.

A second measure to be examined is Domitian's edict on vines, as reported by Suetonius:

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[355] Kokkinia (2008), pp. 143-158.

[356] *IK-Kibyra*, 41

> One year when wine was abundant, and grain was in short supply, estimating that the exaggerated cultivation of vineyards resulted in the disregard of land, he forbade to plant any more of it in Italy, and ordered to cut off vine stocks in the provinces, leaving only half of the existing ones, at best[357].

Beside the moral connotation of this measure which finds parallel in other aspects of Domitian's policy, this edict might have been motivated by the major increase in wine production in the provinces in which vineyards had grown at the expense of cereal land[358], partly because of their higher profitability. This view is supported by the chronology: Domitian's Edict is dated to AD 90-91, almost precisely at the same time as the shortage occurring in Pisidian Antioch in AD 93 (cf. previous section), and as the reported dearness of wheat mentioned in St John's Apocalypse, which was written around AD 92. This body of converging evidence invites considering the last decade of the 1st c. AD as one of the rare phases of large scale grain crisis that can be identified in the sources.

As far as Asia Minor is concerned, Hadrian is no doubt the emperor of whom the most abundant evidence for actions dealing with the grain supply remains. The large granaries of Patara and Andriakè were constructed under his reign[359]. Besides, while Italy disposed of a monopoly on the Egyptian grain supply, Hadrian allowed several cities to officially import grain from Egypt[360], as is made clear in two inscriptions from Ephesus, one of which praises Hadrian himself for this allowance (σειτοπομπή[ας δέ] ἀπ' Αἰγύπτου παρέχοντα)[361]. An inscription from Tralleis recording *a sitonès* (cf. below) who imported grain from Egypt[362], and another one from Cyzicus[363] also indicate that

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[357] Suet., *Dom*., 7

[358] I do not claim that this is the only possible interpretation of Domitian's Edict, nor do I take for granted that it was actually set up – although we now by Philostratus the embassy led by Scopelianos of Clazomenai who appears to have been successful in preserving Asia Minor from the application of the rmoval of vines. The emperor probably did not have the means to ensure that such an Edict would be respected empire-wide. Yet, what matters for my argument here is the *intention* rather than the actual occurrence of what Suetonius describes. He might well have exaggerated Diocletian's actual measure, but the link he makes between extension of vineyards and subsistence crisis nevertheless tells us something of how these cultivations could interfere with one another.

[359] TAM, II, 397 & ILS, 5908 ; cf. Cavalier (2007), pp.51-65. The functions of these granaries are discussed in section 2.2.2. below.

[360] For a specific discussion of the related documents : Wörrle (1971), pp. 325-349 ; Garnsey (1988), pp. 255-257.

[361] *IK-Ephesos*, 274. The second inscription mentions benefactor for having been 'responsible for the carrying of the grain from Egypt' (σειτο[πο]μπὸς ἀπ[ὸ τῆς Αἰ]γύπτου) : *IK-Ephesos*, 3016.

[362] *IK-Tralleis*, 80

[363] *OGIS*, 389

these cities have been allowed to receive Egyptian grain under Hadrian. But the document which probably best describes the concern of the emperor himself for matters of grain supply of provincial cities is perhaps the letter addressed by Hadrian to the association of Dionysiac artists at Alexadria Troas in AD 134 : the beginning of the text forbids the use of the funds for any other purpose – fluidity between the finances of different sectors of civic life was indeed characteristic of ancient Greek cities – *unless*, he says, it would be for the purchase of grain in time of shortage[364]. These instructions given by Hadrian should be compared to similar dispositions mentioned in the Digest, which forbid employing money devoted to the purchase of grain for any other purpose: if the money happens to be used for any other expenditure than grain, the sum must be integraly paid back to the city[365]. The comparison of these two dispositions reveal the high concern and the particular status of matters of grain supply : while the funds for Dionysiac artists could only be redirected from their original purpose for financing grain purchases, monetary reserves for the purchase of grain cannot, in any circumstance, be affected to other expenditures.

Further authorizations to import grain from Egypt were delivered later on by Caracalla and Severus Alexander to the city of Tarsus, as is revealed by coins of this city[366]. After the Severi, the only imperial intervention on the grain supply which also influenced Asia Minor is the Edict of Maximum prices established by Diocletian in AD 301, in which he fixes a maximum limit to prices of many different commodities in order to address the ramping inflation in the empire. In this edict, Diocletian fixes the price of wheat at maximum 100 denarii per *modius castrensis*, and that of barley at 60 denarii per *modius castrensis*.

The provincial level also intervened on various occasions in matters of grain supply. The first of such provincial interventions documented in Asia Minor is the already mentioned edict taken by the governor of Pisidia Lucius Antistius Rusticus in AD 92-93 during a shortage that struck the city of Pisidian Antioch. The measures ordered by Rusticus are the following : (1) he decreed that rural dwellers should declare the quantity of grain at their disposal, the share of their grain which they will use as seed, and the quantity they need for feeding their families; all the rest should be put for sale to the official buyers of grain of the city (*emptores*); (2) he commanded

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[364] *SEG* 56, 1359, ll.9-11.

[365] Dig. L, 2, 4 : *Ad frumenti comparationem pecunia restitui civitati, non compensari in erogata debet. Sin autem frumentaria pecunia in alios usu quam quibus destinata est conversa fuerit, (…) solvi autem a curatore reipublicae iubetur.*

[366] Ziegler (1977), pp. 34 sqq ; Erdkamp (2005), p. 281.

everyone who knows of hoarding practices to report to the civic authorities[367]; and (3), he fixed a maximum price for the sale of grain at 1 denarius per modius[368]. The strategy of Rusticus is thus to maximize the available supply of grain, and to ensure its affordability for the citizens, and for this purpose resorts to coercive measures. Another interesting measure taken at the provincial level concerns the city of Ephesos, where, in the second half of the 2nd c. AD, an unknown proconsul promulgated a decree concerning the bakers of the city[369] :

> I therefore order the bakers not to gather together as a faction and the leaders not to act boldly. Rather they are to obey completely the regulations established for the common welfare and to supply the city with the necessary production of bread without fail[370].

The interpretation of the text is somehow dubious: on the one hand, it might seem that the proconsul attempted to prevent bakers from constituting a cartel, by which they might exercise upward pressures on bread prices. Indeed, as stated at the beginning of the text, the decree is motivated by troubles among the population because 'of the recklessness of the bakers on the market' (διὰ τὴν σ[ύλ]λ̣ογον καὶ ἀθρασίαν τῶν ἀρτοκόπων ἐπὶ τῇ ἀγορᾷ). On the other hand, the word ἑταιρία could also be translated by 'association' (in the sense of the latin *collegium*), which might suggest that the behavior of the bakers was not mostly speculative or profit-oriented, but that they might have stopped producing bread for other reasons which could deal with their working conditions or status, or with an increase in the price of grain[371]. This edict echoes a passage in Petronius' Satyricon, which I do not resist quoting :

> 'Thus spoke Phileros, and after him Ganymedes : 'You are telling things that make no sense, while nobody cares about how the lack of grain harms us. Today, I swear, I couldn't even find a piece of bread! And why is that? Because of this persistent drought. This hunger has been there for a year now. May these aediles be cursed, who collude with bakers : "Do me a favor now, I will serve you back

[367] *AE* (1925), 126, col. II.

[368] *Ibid.*, col. III. For a recent discussion of the decree : Dalaison (2008), pp. 139-140 ; 142-145 ; 149-150 & 156-158.

[369] *IK-Ephesos*, 215

[370] Translation by Harland (2014), p. 238.

[371] Levick (2014), p. 215 ; Harland (2014), p. 238 ; Morgan (2015), pp. 30-39 for a thorough discussion of the edict and the analysis of the role of bakers and their relationship to civic authorities.

later".This way the little people always endures, while thos large fishes keep feasting at their expense.'[372]

What is interesting in this passage is that it explicitly emphasizes that weather patterns are not the only factor to be blamed for the shortage of grain: social reactions, here the collusion of bakers and market officials to keep prices high, plays a crucial role. It is therefore not impossible that the 'cartel' against which the governor intervenes also implied corrupted *agoranomoi*….In any case, this edict reveals that food market was subject to regulations (albeit not always formally expressed) at Ephesos, and is but another illustration of the concern of political authorities for the civic food supply. These are the two instances of explicit proconsular intervention on the cities' grain (or bread) supply in Asia Minor. A third one, however less certain, is nevertheless worth mentioning: in a honorary decree of AD 170-171, the proconsul Marcus Nonnius Macrinus is referred to as 'savior of the province' (τ[ὸν] τῆς ἐπαρχείας σωτῆ[ρα·])[373]. At first, one might think of a military role in fighting threatening tribes, but F. Kirbihler recalls that Asia Minor remained rather unaffected by the raid of the Costoboces and Bastarnae. The decree is also contemporary with the plague (most likely smallpox) epidemic which struck the province under Marcus Aurelius, but we hardly see what a governor could have done against this. Hence, Kirbihler argues tentatively that we should see this expression as testifying to measures taken by the proconsul to address a period of grain scarcity[374], an interpretation which finds some ground in the fact that, at the origin of the decree for Macrinus, we find Flavius Damianus, a famous benefactor who distributed some 201,200 *medimnoi* of grain to the city[375]. Yet, the interpretation is not entirely convincing, for we fail to understand why, if Macrinus' interventions were mostly oriented towards solving grain supply issues, he was not awarded the common title of *foster-father* (*tropheus*) typically used in such events in addition to that of *savior*.

Finally, beside imperial and provincial regulations – to which should be added inter-city solidarity[376] – the civic level, whether in the form of institutions or benefactions, was the major channel of grain-related interventions : on 178

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[372] Petron., *Satyricon*, 44 : *Haec Phileros dixit, illa Ganymedes: « Narrat is quod nec ad terram pertinet, cum interim nemo curat quid annona mordet. Non mehercules hodie buccam panis inuenire potui. Et quomodo siccitas perseuerat! Iam annum esuritio fuit. Aediles male eueniat, qui cum pistoribus colludunt: 'Serua me, seruabo te.' Itaque populus minutus laborat; nam isti maiores maxillae semper Saturnalia agunt.*

[373] *IK-Ephesos*, 3029, ll. 23-24.

[374] Kirbihler (2006), pp.630-631.

[375] *IK-Ephesos*, 672 & 3080.

[376] Ael. Arist., *Or.*, 19, 12

interventions of which the agent can be identified, 170 are city-based, 2 are performed by governors, and 5 by emperors. City-originating interventions hence make up some 95% of the total. Of course, not all of these interventions were performed by citizens : some freedmen benefactors appear here and there, while some of them might not have been citizens in the city where their intervention took place. But overall, it is reasonable to ascribe the major part of grain-related interventions to citizens. These civic interventions operated mostly under two forms: (1) formally established distributions schemes and institutional systems alleviating food crises on the hand, and (2) élite individual initiative in performing distributions or contributing to existing systems. The two following sections will each be devoted in analyzing in details these two forms of civic intervention.

On a final note, an interesting observation is worth being mentioned: from comparative data assembled by Braudel in his first opus on the Mediterranean, it is surprising to see how civic measures aimed at dealing with grain supply issues in early modern Italy were strikingly similar to those undertaken by ancient cities : 16th century cities facing grain supply difficulties often made it compulsory to sell grain or flour in specifically designated public places[377], which echoes Claudius' decree forbidding the sale of grain outside the market area in Kibyra. Similarly, during shortages, most towns would start by making an inventory of available stocks – just like in the decree of Antistius Rusticus during the shortage of Pisidian Antioch – and by forbidding export of grain[378], a measure known to have been implemented in various ancient cities, like Athens[379] or Selymbria[380]. This strong similarity in urban grain supply interventions between ancient and modern cities suggests that, despite significant variations in environmental conditions, agricultural practices, institutions, or market development, grain supply issues and the way of addressing them remained a structure of the pre-industrial Mediterranean, at least until the Industrial Revolution.

[377] Braudel (1990 a), p. 403

[378] *Ibid.*, pp. 403-404

[379] Plut., *Solon*, 15 & 24; Ps.-Arist. *Athen. Pol.*, II, 2, 9, 1; Garnsey (1988), pp. 74-75; Bresson (2016), p. 404

[380] Ps.-Arist., *Econ.*, 1348b

3.2 Institutions

3.2.1 The lexical diversity of food-related offices

3.2.1.1 Preliminary remarks

The various forms and levels of grain-related interventions already outlined above strongly suggest the existence of a consistent administrative framework for food supply in the cities of the Eastern Mediterranean. Yet, so far we still do not know the details of such interventions: what exactly did the various officials do ? And first of all, which exactly are the offices related to the supply of grain? In this section, I undertake a systematic analysis of grain-related officials. This is indeed the first step in accounting for the roe of civic institutions in this matter. It consists, in other words, of a glossary of grain-related intervention. Later on, I will examine how these offices are spread throughout Asia Minor, and I will focus on two major offices for a more detailed case study.

The striking characteristic that arises from the documents when looking into the civic structure for dealing with the grain supply is the impressive lexical diversity affecting the titles of grain-related officials, from late classical times to the edge of the late Roman period. How can we explain this linguistic sophistication? Does it result from an intense specification of tasks in relation to the supply and distribution of grain? Despite their lexical distinction, different offices often appear to have overlapping tasks while similar functions are sometimes named differently, which prompts the question : why are they distinguished from one another in the first place ?

To a modern observer, such complexity for an apparently clearly circumscribed sector of civic life may seem strange. In this section, we start by exploring the numerous terms relating to aspects of the grain-supply, in order to identify the tasks associated with each official and with different supply systems. All the while, we will try to distinguish between formal-institutional terms (those referring to magistracies or liturgies) and honorific titles, as well as between regular and temporary offices. Second, we will try to account for the different meanings of grain-related terms in the inscriptions and literary sources. By doing so, we will attempt to provide an explanation for the apparently overcomplicated lexical situation regarding the grain supply and to understand what this complexity might tell us about the economic involvement of civic authorities in the post-classical Greek city.

In order to complete and the documents from Asia Minor, the overall question will be illuminated by an extensive use of comparative material coming from all over the Greek world, both in the Hellenistic and Imperial period. Here, we will be looking

at the cities of the Roman East from a wider geographical perspective, and we will consider the linguistic continuity between Hellenistic and Roman periods.

3.2.1.2 The data : grain-related terminology in the inscriptions and literature

In our epigraphic database and in the *Thesaurus Linguae Graecae* (TLG), no less than 12 different words can be found that relate to grain-related offices or supply systems. To establish this list, we deliberately dismissed the terms referring to a granary understood as the physical structure for storing grain and not as a related public charge. Similarly, our list does not include the terms *paraprasis* or *epeuonismos*, referring to sales of grain below market price (but usually higher than 'normal' price) organized by civic benefactors and which has recently received a thorough analysis by Arjan Zuiderhoek[381]. Finally, we do not take into account the term *tropheus*[382] (foster father) which, like *sotèr* (savior) or *ktistès* (builder) deserves a separate discussion focused on the rhetoric of honorific titles. Figures 1 and 2 below indicate the distribution of grain related terms according to their occurrences both in our corpus of inscriptions and in the TLG :

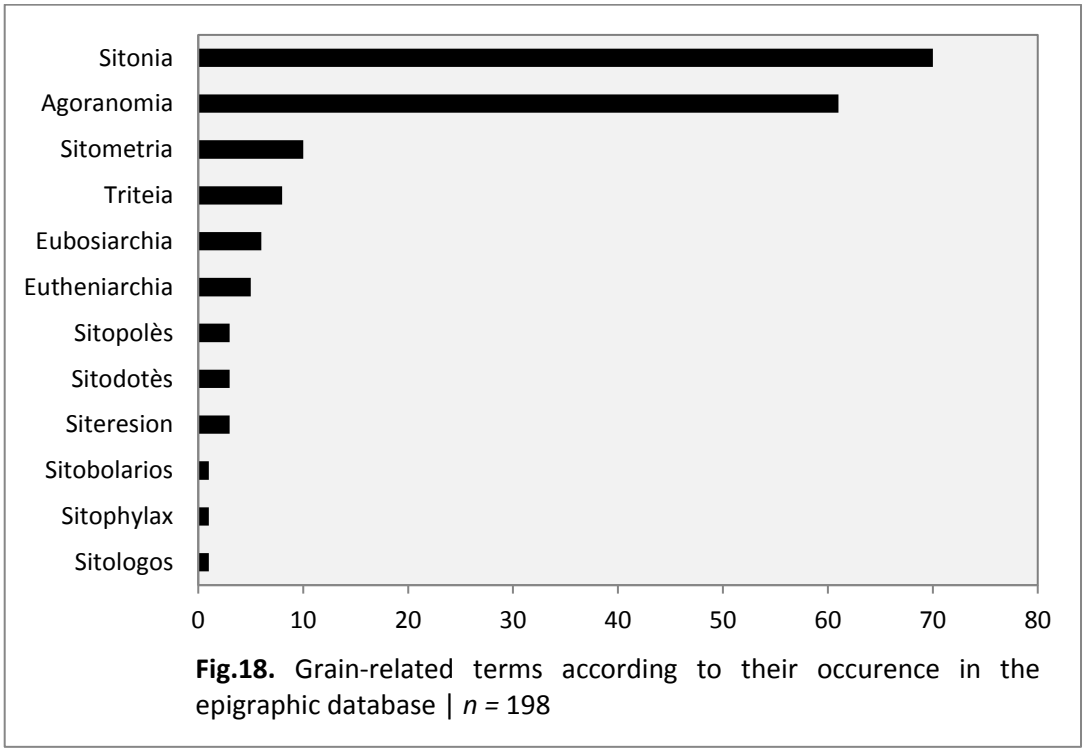

Fig.18. Grain-related terms according to their occurence in the epigraphic database | *n* = 198

[381] Zuiderhoek (2014), pp. 1-29.

[382] On which see : Robert (1948), pp. 74-81.

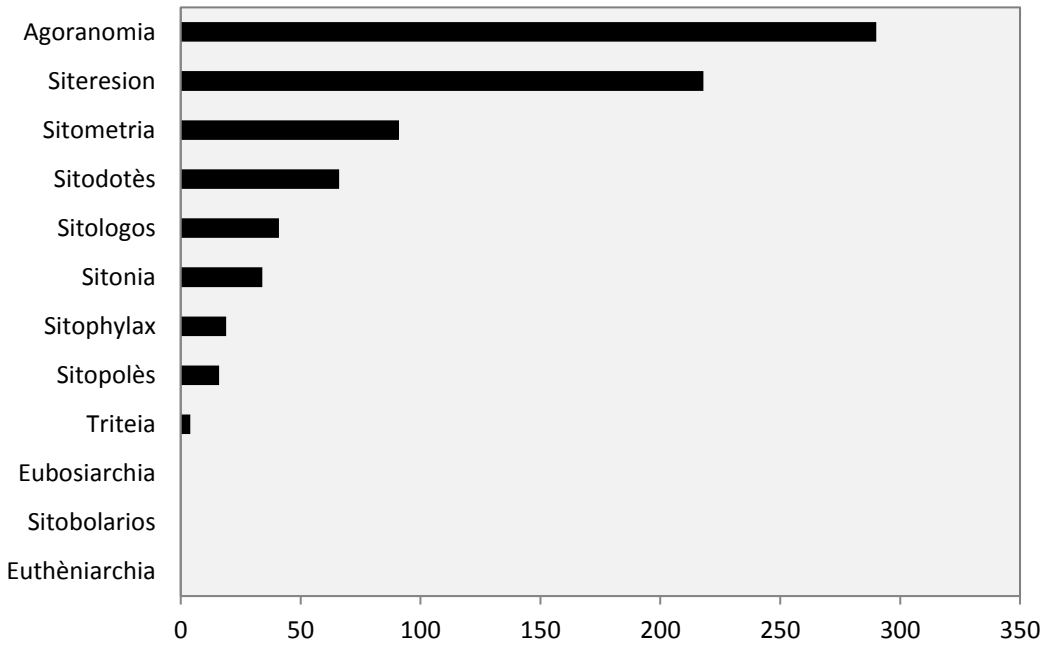

Fig.19. Grain-related terms according to the number of their occurences in the TLG database.

As we can see, despite a similar 'profile' with two leading categories and the presence of the *agoranomia* and the *sitometria* among the three most frequently attested terms, the two distributions are quite different. The offices/functions appear with significantly different frequencies in the two *corpora* : the *sitonía*, the leading category in the epigraphic database, is only a minor category in the literary sources, while the *sitodosia*, fairly rare in inscriptions, is the fourth most frequent grain-related term in the TLG. In the following sections, we shall try to identify the criteria on which the observed institutional differentiation is founded and to explain the discrepancies between literary and epigraphic sources.

3.2.1.3 Agoranomoi, sitophylakes and sitopolai

The magistrate most concerned with the urban grain supply is of course the *agoranomos*, whose first epigraphic attestation dates back to the 5th century BC in Kerkyra[383]. The *agoranomos* acted as the 'superintendent' of the market[384]. He was in

[383] Descat (2003) p. 591.

[384] The control exercised by the *agoranomos* was understood to be over the market as the *physical* location of commercial exchange; but through the regulation of prices, he also contributed to the regulation of the market in the abstract sense as we now understand it, i.e. the locus of the confrontation of supply and demand.

charge of the logistical organization of the market, the control of weights and measures, , the regularity of the supply – for the purpose of which he was managing a public fund – of price control, of the levying of taxes, and was also responsible for ensuring that transactions were conducted using the allowed currencies[385]. In case of infringements in those matters, the *agoranomoi* had the judicial prerogatives to launch lawsuits[386]. *Agoranomoi* also ensured the price and quality of the grain sold on the urban market, and often tried to exercise a downward pressure on prices by negotiating with merchants[387]. As magistrates they managed a public fund for the expenses related to their charge, but they also often used their own resources for the import of grain or for purchasing grain and reselling it at a loss to keep prices low[388].

Similar yet more specialized tasks concerning the control of grain prices were exercised by the *sitophylakes*, mentioned only once in the inscriptions of Roman Asia Minor[389] but widely attested in IVth c. BC Athens. According to the *Athenaion Politeia*, the role of the *sitophylakes* was to ensure that unground wheat and barley was for sale at the 'right' price and measured out with the approved weights[390], and that the price of bread and flour were in reasonable proportion with the price of crops[391]. They were also responsible for currency issues, registered the imported quantities of grain and ensured that grain dealers (*sitopolai*) would not buy more than the legally authorized quantity[392], in order to prevent stockpiling and speculation.

These merchants, the *sitopolai*, are best known through the famous discourse of Lysias *Against the grain dealers*, which sheds some light on the relationship between

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[385] Capdetrey & Hassenoh (2012), pp. 14-15. See also : Dmitriev (2005) p.29 & p.34.

[386] Bresson (2008), p. 30.

[387] Migeotte (2010), p. 346.

[388] Not in Classical Athens, but in various cities, especially from early Hellenistic times. See : Couilloud-Le Dinahet (1988), pp. 322-324 ; Frézouls (1991), p. 7 ; Migeott (2010), p. 346. On *agoranomoi* intervening with their own money in Asia Minor : Dmitriev (2005), p.34, p.144 & p. 148; Bekker-Nielsen (2008), p. 75.

[389] *IMT Kyz. Kapu Dağ*, 1449 = Dumont-Homolle, 378, n°64a.

[390] For a discussion of the theme of 'fair' and 'just' price, see above.

[391] [Aristotle], *Ath. Pol.*, 51, 3-4; Garnsey (1988), p. 141; Erdkamp (2005), p. 295 & 310. For the *sitophylakes* in Asia Minor : Garnsey (1988), p. 73. The ambiguity of the word *dikaios* has briefly been discussed above; it can be understood in two different, yet non mutually exclusive ways : 'correct, just' or 'fair, even'. In the first sense, it might refer to the control exercised by market officials on merchants in order to ensure that they sold their products at a price close to the one they declared when entering the city; in the second, it might rather indicate a moral connotation close to the Roman rhetoric of *iustum pretium*. Yet, this linguistic difference matters little from a political point of view : whether reflecting the idea of an *a priori* defined 'fair price', or a legal procedure ensuring that merchants would apply the price resulting from the negotiation with civic authorities, this expression merely indicates the concern of city officials to exercise a downward pressure on grain prices.

[392] Demosthenes, *Against Leptinos*, 32; *Against Phormio*, 7; Lysias, *Against the grain dealers*, 5-6 & 11-12; Couilloud-Le Dinahet (1988), pp. 324-326 ; Migeotte (2014), p. 75.

such traders and the city : grain was first imported into the harbour by the *emporoi* – wholesale dealers –, and bought from them in legally restricted quantities by the *sitopolai*. The question arises of whether *sitophylakes* elsewhere in the Greek world had similar duties to the ones they had in Athens. As will be discussed below, the tasks of grain officials throughout the classical and post-classical Greek world display considerable chronological and geographical variation, but they also exhibit common traits. At least one inscription from Asia Minor mentions *sitophylakes* having a similar role to their Athenian counterparts[393].

3.2.1.4 Sitonai and sitonia

Among the most frequently encountered terms associated with grain supply in our epigraphic sources are those relating to grain funds : the *sitònia*[394], *sitonika*, or *sitonika chrêmata*. Its mechanism has been well described: the *sitonìa* consisted of a cash reserve[395], aimed at cushioning the rising of prices in times of dearth : the *sitònai* – sometimes helped by treasurers of the grain fund (*tamiai tôn sitonikôn chrêmatôn*) – were entitled to use the fund for purchasing grain when shortages occurred[396]. This task must have implied strong negotiations with landowners who possessed stocks of grain in order to convince – or, with the help of governmental authorities, compel – them to sell their grain[397], and with merchants in order to obtain the lowest possible price. As suggested by documents from the Hellenistic period, grain was then resold on the urban market[398], either at cost price or even at a loss[399] (the gap being made up for by the personal resources of the *sitònai*), and the produce of the sale went back to the grain fund. It is interesting to note that a similar institution, though with broader functions, is known in 15th and 16th c. Italian cities (Florence, Venice, Como,…): the *Uffici del grano*, or *Uffici del Abbondanza*, which subsidized grain merchants, bought and resold grain at a loss[400]. In ancient and early modern cities alike, the purpose was

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393 *IPriene* 81, l. 4-9. Cf. Migeotte (2010), p. 347.

394 One should not confuse the feminine noun *sitonìa*, which generically describes the institution as a whole, with the neuter plural noun *sitònia* (sing. : *sitònion*), describing the grain fund itself.

395 Zuiderhoek (2008), p. 163.

396 Erdkamp (2005), pp. 269-270.

397 An example of such forced sales to the *sitònai* is given in an inscription from Pisidian Antioch in 93 AD : *AE* 1925, 126.

398 See Darmezin (1991), p. 116; Bresson (2008), p. 129; Migeotte (2014), p. 176. For the documents, see : *Syll*³, 344; *IErythrai*, 28; *ISE*, 64.

399 Bresson (2008), p. 130.

400 Braudel (1990), pp. 403-406

to increase the supply of affordable grain on the urban market and exercise a downward pressure on market prices.

The working of the cash fund required of course an initial input of money. This money could come either from the city itself, from a benefactor[401], or from a public subscription or loan[402]. As clearly attested by epigraphic sources, the *sitonìa* was funded by both civic and private funds : in a first inscription from Attaleia, a certain Dionysios is honored for having held the *sitonìa* (among other charges) 'on his personal expenses' (ἐξ οἰκείων δαπανημάτων)[403], while in a second inscription, from Erythrai, an official is honored because he 'has been *sitònès* many times on his own revenue' (πολλάκι σειτώνης ἐκ προσόδων ἰδίων)[404]. Finally, a Phrygian inscription praises a benefactor for having undertaken the *sitonìa* 'two times, without using the public money' (σειτωνήσαντα β΄ δίχα δημοσίων χρημάτων)[405]. Beside the explicit mention of civic funds in the last document, the epigraphic emphasis on private contributions is in itself an indication that such payment were unconventional and that civic finances did not play a marginal role in the constitution and upkeep of the grain funds[406].

We do not wish to reopen the debate about whether the *sitonìa* should be classified among the magistracies or liturgies, nor is this the place to discuss its financial sustainability[407]. What matters for the present argument is that the *sitonia* was an original, pervasive and long-lasting institution of the Greek cities : first attested in Attica in the IVth c. BC[408], the *sitonìa* is documented until the late IIIrd c. AD. Initially a temporary institution, some cities had already developed it into a regular

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[401] We should carefully distinguish liturgical payments from *sitonai* in office (cf. notes 20, 21 & 22 below) from spontaneous gifts of money to the grain funds by benefactors independent from the *sitonìa* : LBW, 648, 985 & 992; *IGR* IV, 1632 ; *IK-Stratonikeia*, 1028 ; *BCH*, 10, 1886, n°1, p. 500; *IDidyma*, II, 255, among other examples.

[402] For the different cases, see Bresson (2008), p. 128 & Migeotte (2014), pp. 177-186.

[403] *TAM* V, 829, l. 9-10

[404] *IK-Erythrai*, 66

[405] *MAMA* VII, 11, l. 10-12.

[406] For a complementary discussion on the *sitonia*, see also : Quass (1993), pp. 238-248 (Hellenistic) & pp. 267-268 (Roman).

[407] See : Silver (2007), pp. 95 – 104; *contra* Erdkamp (2005) & Zuiderhoek (2008)., pp. 159-180.

[408] We know that Demosthenes held the office of *sitones* in Athens in 338/337 BC (Plutarch, *Dem.*, 21, 1). For one of the first epigraphic occurrences, see : *IG* II², 1628. Cf. Garnsey (1988) p. 163 & Migeotte (2010), p. 306 & Migeotte (2014), p. 176.

mechanism in the Hellenistic period[409]; by the I[st] c. AD, the system had become permanent[410].

In the literary sources, the *sitonìa* appears as a minor category, while it is the second most frequently attested grain-related system in our body of inscriptions. Yet, the meaning of the word *sitonìa* (and its derivatives) is the same in literary and epigraphic documents, as is the case for the *agoranomia*. The discrepancy in frequency attestations between epigraphic and literary sources is explained by the area of distribution of the *sitonìa* : while the *agoranomia* is attested all over the Greek world, the *sitonìa* is geographically concentrated in Greece, in the Aegean basin and Asia Minor. Since our epigraphic database focuses on Asia Minor, it is therefore a dominant category among the registered offices, but is only represented in a modest share of the whole of Greek literature. Similarly, since much of the Greek literary sources refer to a western context, the dominance of the *agoranomia* in the textual corpus might well partly be a consequence of the common utilization of the Greek word *agoranomos* as equivalent to the Latin word *aedilis*[411].

3.2.1.5 Sitometria

Contrary to the monetary nature of the *sitonia*, it appears from inscriptions that the σιτομετρία (*sitometrìa*) consisted of an allowance of grain in kind. The term is indeed connected to the word *sitomètrion*, which must be translated as 'grain reserve', and all the inscriptions mentioning contributions to a *sitometrion* (or referring to the *sitometria* as an action) are expressed in terms of grain, not money : during the reign of Antoninus Pius, a public slave named Onesimos contributed (προσέθετο) 352 *modii* of grain a year – but for how long we do not know – to the *sitometrion* of Balbura[412]. A similar contribution was made to the *sitometrion* of Myra by a certain Amyntas[413]. As a last example, probably one of the most explicit, an inscription from Ancyra in Galatia, dated from the first third of the 1[st] c. AD, refers to another Amyntas who 'provided *sitometria* by shares of 5 *modii*' (σειτομετρίαν ἔδωκ[εν] ἀνὰ πέντε μοδίους)[414]. In most inscriptions however, the fact that grain is given in kind must be understood from the function itself : σιτομετρέω is nothing but σίτον + μετρέω, that is 'measuring – or allowing a measure of – grain'. It is therefore not surprising that explicit mentions to

[409] Darmezin (1991), p. 117; Migeotte, (2010). p. 306 sqq.
[410] Strubbe (1989) p. 118.
[411] Mason (1974), p. 19
[412] *LBW* II, 1228 ; see also : Coulton, Milner & Reyes (1988) pp. 134-139.
[413] *TAM* II, 774, l. 8-9.
[414] *OGI*, II, 533, l. 36-37 = *IGR* III, 157

grain in kind in *sitometria* inscriptions are not so frequent, for such statement would most often be redundant. On the other hand, only two inscriptions explicitly mention contributions to a *sitometrion* in money: the first, quoted by Garnsey, refers to a certain Ammias who provided 10,000 *drachmai* 'for the grain distribution'[415], while the second (dating from 152 AD at the latest) informs us of a gift of 10,000 *denarii* to the *sitometrion* of Patara[416]. However, neither of these two inscriptions can support the idea that the *sitometrion* would have been a 'grain fund' in the monetary sense, which would make it indistinguishable from the *sitònion*. Rather, these texts most probably imply that the gifts of money were intended to serve for the purchase of grain specifically devoted to the provision of the *sitometrion*, or to specific costs related to the maintenance of those infrastructures and to the logistic organization of the distribution of grain.

The question arises of whether the term *sitometria* refers to an institutionalized system or to occasional, informal distributions of grain. Evidence is ambiguous on this aspect : in inscriptions, indeed, the *sitometria* is often mentioned among the list of the different functions occupied by the official or benefactor concerned : σειτομετρήσαντα, as we can read for instance in an inscription from Kadyanda[417]. Yet, contrary to what Peter Garnsey argues[418], this is not sufficient to say that the *sitometria* was a *munus*. Besides the fact that Aristotle classifies the *sitometrai* among the *epimeleiai* and not among the *archai*[419], the aorist participle σειτομετρήσαντα is never accompanied by the usual laudatory adjectives related to the epigraphic presentation of magistracies or liturgies in honorific inscriptions, like ἁγνῶς, φιλοτείμως...etc. Secondly, there is not a single mention of any public fund that would have to be managed by the one who performed the *sitometria*, as is usually the case for magistracies. Thirdly, the language of inscriptions seems to indicate clearly enough that the *sitometria* had solely a verbal, transitive meaning, as in the inscription quoted above (σειτομετρίαν ἔδωκ[εν]), or even more explicitly in an inscription from Oenoanda honouring Gaius Licinnius Thoantianus Fronto in which we can read 'σειτομετρήσαντα πάλιν τοὺς πολείτας ἔκ τε τοῦ δημοσίου πυρο[ῦ] καὶ οὗ ἐκ τῶν ἰδίων ἐπέδωκεν'[420]. It is clear that the form σειτομετρήσαντα is implied in a relationship to another entity (here, the citizens), and may not be considered as a self-sufficient concept that could be isolated from the receivers. As we have seen above, the very etymology of the word does not refute this

[415] Garnsey (1988), p. 263. I unfortunately could not find the text of the inscription.
[416] Balland (1981), n°67.
[417] *TAM* II, 661.
[418] Garnsey (1988) pp. 262-265.
[419] Aristotle, *Pol.*, IV, 15, 3 (1299a); cf. Migeotte (2010b), p.348.
[420] *IGR* III, 493, ll.10-12.

argument. The passage of the inscription from Oenoanda should thus be translated as follows : "having again distributed grain to the citizens from the public wheat and from the one he gave from his own resources".

Complications result from the fact that the term *sitometria* is not only used in the straightforward sense of institutional distributions connected with public reserves, but also in a more common sense of an informal distribution of grain (which may be by individual or governmental initiative[421]), or to signify any role played in supplying grain (for example to an army)[422]. It is mostly in this second – vague – meaning that the word *sitometria* is used in the literary sources, which also explains the important frequency of this apparently very specific and technical term in the Greek literature of all periods and all genres. Louis Robert had therefore precisely understood the meaning of the *sitometria* when he considered it as being close to the *sitodosia*, that is, a mere distribution of corn[423] – since the *sitodosia* was no official charge and 'had primarily a social significance'[424].

Both terms, however, are by no means synonyms. A first difference lies certainly in the procedure through which they were performed : while the *sitodosia* is nothing but a fairly informal distribution of grain from private resources, the *sitometria*, understood in its primary epigraphic meaning, was linked to a municipal structure, the *sitometrion*, supplied both by 'private' and 'public' grain. But both practices/ procedures also certainly differ with regard to their receivers. Being a *sitodòtès*, as attested in an inscription from Selge and in another from Philadelphia[425], seems simply to imply organizing a distribution of grain, without specifying any restriction, which suggests that it was open to any member of the citizen body, and perhaps any resident of the city. The recipients of the *sitometria*, on the contrary, are not as easily identifiable. It has often been argued, indeed that the *sitometria* targeted a specific group of citizens called *sitometroumenoi* [426], whose status has been long debated. While some authors consider they formed an élite group who benefitted from the privilege of receiving an allowance of grain[427] – in the spirit of the *epidoseis* where higher status individuals are privileged – , Michael Wörrle argues that the term rather referred to the citizens financially able – and therefore perhaps entitled – to perform

[421] See for instance : Diodorus Siculus, *Hist.*, II, 41, 1; *Genesis* (Sept.), 47, 12, 1 & 47, 14, 3

[422] Polybius, *Hist.*, I, 68, 9 & IV, 63, 10

[423] Robert (1948), p.75.

[424] Dmitriev (2005) p. 220.

[425] *IGR* IV, 1631 ; *IK-Selgè*, 16

[426] *TAM* II, 578 & 579 ; *SEG* 27, 938 ; Balland (1981), n°67

[427] SARTRE, 1991, pp. 183-184 ; Coulton, Milner & Reyes (1988), p. 138

grain distributions and/or supply the *sitometrion* [428]. As for A. Balland, he sees the *sitometroumenoi* as the oriental counterpart to the *plebs frumentaria*[429], considering thereby the *sitometria* as an Anatolian version of the roman grain-dole.

The connection between the *sitometria* and the *sitometroumenoi* is typical of Lycian inscriptions from the Roman imperial period. In this particular context, it is probably more convincing to understand the *sitometroumenoi* as a privileged group receiving an allowance of grain rather than as entitled suppliers of this system, since we argued above that the *sitometria* was no *munus*. Moreover, the expression '*sitometroumenoi'* is the medio-*passive* form of the present participle of the verb *siometrêo*. If this group of citizens were responsible for the supply and distribution of grain, one may wonder why ancient Greeks did not refer to them using the *active* form '*sitometroûntes'* instead, unless we should imagine that they were both suppliers and receivers…Yet, the *sitometria* is attested in several places outside Lycia[430], and the association of sitometria to the sitometroumenoi andres cannot, I think, be used to support the idea that the *sitometria* was generally or even primarily oriented towards the specific category of the *sitometroumenoi* elsewhere. As Maurice Sartre argues, the 'public wheat' referred to in the abovementioned inscription from Oenoanda[431] is not likely to have been reserved to such a restricted group[432]. This same inscription, moreover, states that the receivers of the distribution were the citizens (τοὺς πολείτας), without further limitations, which is somehow confirmed by the expression σειτομετρουμένω δή[μω] in the inscription from Phrygia quoted above. Finally, a document from Patara dating from the reign of Hadrian or Marcus Aurelius refers to an 'ἔπαρ[χο]ν σειτομετρίου δήμου Ῥωμαίων[433], a Greek translation for *praefectus annonae*[434]. Although no such corn-dole as the *annona* ever existed in the Roman East, the use of the word *sitometrion* as a lexical parallel to the *annona* seems to indicate that the *sitometria* could have had a much broader target than the restricted group of *sitometroumenoi* that we encounter in Lycia. As for the *sitoumetroumenoi* strictly speaking, they include members of the *bouleutic* order as well as sub-élite or 'middle

[428] Wörrle 1988), p. 131; Dmitriev (2005), p. 323 – n. 160

[429] Balland (1981), p. 215 sqq

[430] Caria *: IK-Stratonikeia,* 227, l.8 *;* Phrygia *: MAMA* IV, 143, ll. 10-11 ; Galatia : *OGI*, II, 533, ll. 36-37 = *IGR* III, 157. In Egypt, *sitometrai* are mentioned in connection with granaries, and seem also to have been responsible for the transport of grain from granaries to harbours (WALLACE, 1969 [1938], p. 37).

[431] Cf. n. 39

[432] Sartre (1991), p. 184.

[433] *TAM* II, 426, l. 11.

[434] Mason (1974), p. 84 & p. 138

class' citizens; like Peter Garnsey writes, 'they may well have included poor people, but it is unlikely that poverty would have been a criterion for inclusion'[435].

In the cities of Lycia, the *sitometria* appears to be an institutionalized form of grain distribution in kind, provisioned though a public channel (*sitometrion*) and most often restricted to a privileged group. In other regions, the lack of evidence for the presence of a *sitometrion* or the relative infrequency of occurrences is not sufficient to argue that the *sitometria* was a mere informal distribution there. These cities most likely relied on both civic and private grain, as in the inscription from Oenoanda, in which case some public grain reserve – and thus some supervision by civic authorities – must have existed. The most striking difference the Lycian and non-Lycian cities probably concerned the recipients of this grain : although there probably was some variation over time, a specific group of citizens does not seem to have been clearly defined outside Lycia. Finally, in some cities, the word *sitometria* must also have been used in more common contexts of informal or euergetic distributions of grain, as is the case in the literary sources. In those respects, we can safely argue against the view, expressed by Peter Garnsey, of the *sitometria* being 'privately funded', having 'all the hallmarks of (yet another) liturgy', reducible to a 'Lycian system' and being restricted to a group of privileged citizens consisting of a Greek version of the *plebs frumentaria*[436].

3.2.1.6 Sitèresia

The *sitometria* understood as a formalized grain dole targeting a specific population[437] is in fact similar to another grain-related institution of the Greek world : the σιτηρέσιον (*siterèsion*; plur. : *siterèsia*). The term has mostly been used to describe a grain distribution system widely documented in Egypt between the mid IInd and early IVth c. AD, especially in Oxyrhynchus, Hermoupolis, Antinooupolis and Alexandria. The earliest Egyptian attestation of the *sitèresion* originates from Antinooupolis in 154 AD, but this case is particular since it is an imperial foundation. Despite the concentration of the evidence in the last quarter of the IIIrd century, Jean-Michel Carrié has shown that we should acknowledge the regular organization of *sitèresia* for many decades during the IIIrd and early IVth century AD [438]. Except for Antinooupolis where we might reasonably assume the involvement of imperial finances, the *sitèresia* in the other Egyptian cities seem to have been mostly a municipal concern, though local benefactors also probably intervened on occasion.

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[435] Garnsey (1988), p. 263.

[436] Garnsey (1988), pp. 263-265.

[437] In Lycia : most often a priviledged group ; elsewhere, potentially a larger body of recipients.

[438] Carrié (1975), pp. 1087-1088

As for the recipients of those *frumentationes*, their registration was slightly different from city to city. In Alexandria, they were organized in age classes, without further limitations[439], while in Antinooupolis and Oxyrrhynchus a *numerus clausus* appears. In Oxyrhynchus, three different categories are mentioned : the επικριθὲντες, the metropolitans whose civic status had been verified at the age of 14 ; the ρὲμβοι, who were granted the right to claim an allowance of grain for having performed liturgies; and the ὁμόλογοι, whose criteria of admission are still unclear (they may have received grain on special authorization, or had only one metropolite parent)[440]. When we put all categories together, the total number of beneficiaries did not exceed 4,000.

Despite notable differences between the cities, Egyptian *frumentationes* also shared certain characteristics : categories of recipients of the *sitèresia* were selected per tribe[441], and some random draw appears to have taken place, for example when a deceased beneficiary had to be replaced. Regarding the concrete organization of the distribution, the procedure is known from the material of Hermoupolis and Oxyrhynchus: recipients were given *tablai* (pieces of ceramic, similar to the Roman *tessera*) exchangeable for a definite quantity of grain[442].

In Asia Minor, the term *sitèresion* appears in seven inscriptions dating from the IIIrd and IInd centuries BC describing three different situations : grain rewards given by the city to prominent citizens[443] (1), euergetic distributions of grain[444] (2), and occasional grain distributions organized by the city[445] (3). For the Roman period, only two documents are known, both from the Antonine period. In four out of those nine inscriptions, a formalized distribution system can be assumed[446], but the evidence is insufficient for us to be certain[447].

A full parallel between Egyptian *sitèresia* and the Roman *frumentationes* cannot be established : *per capita* quantities are smaller, and the annual frequency of the distributions is different[448]. But Roman and Egyptian grain doles also exhibit resemblances : there was a finite number of beneficiaries, selected by tribe; admission

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439 Eusebius, *Hist. Eccl.*, 7, 21, 9, quoting a letter from Dionysius of Alexandria.

440 Lewis (1974), pp. 158-162; Garnsey (1988), pp. 265-267; Husson and Valbele (1992), p.241 ; Virlouvet (1995), pp. 216-218 & p.246 ; Alston (2002), p. 151 & p. 276.

441 Alston (2002)., p. 149; Virlouvet (1995), p.248.

442 *P.Lips.inv*, 483, quoted in : Carrié (1975) p. 1081. See also : Virlouvet (1995), p. 23. For a detailed discussion about the *tessera* in the Roman world : *Ibidem*, pp. 309-369.

443 *IK-Tralleis*, 21, l.19 & *IK-Tralleis*, 25, l.8

444 *IK-Erythrai*, 28, l.22

445 *IPriene*, 108, l.154

446 *IK-Erythrai*, 24, l.18 & *IK-Erythrai*, 117, l. 33

447 For the Roman period : *IGR* III, 495 and *IK-Pergè*, 181

448 Virlouvet (1995), p. 23 sqq

criteria encompassed both geographic and social parameters; and the logistic organization and procedure are remarkably similar[449]. Both in the case of the Egyptian *sitèresia* and the Lycian *sitometria*, beside the difference regarding the source of funds (municipal and euergetic *versus* imperial), further differences with the Roman *annona* seem mostly quantitative: smaller quantities and fewer beneficiaries (4,000 in Oxyrhynchus, 1,100 *sitometroumenoi* in Tlos[450]). Yet, the systems are of a similar nature : they consist of a more or less regular allowance of free grain to a definite number of (mostly) citizens.

The relative abundance of the word *sitèresion* (and its variants) in the literary sources might seem disconcerting with regard to the geographic and institutional specificity of the term, and compared to its scarcity in our body of inscriptions : it is indeed the third most frequent grain-related term in the TLG database (see Fig. 2). The reason for this lies in the generic sense in which the word *siterèsion* is used in the literature, encompassing three different situations : provisions to an army[451] (1), distributions of grain, whether as benefaction[452] or as an allowance of grain to soldiers[453] (2), and, closer to the inscriptions and papyri, the *annona*[454] (3).

3.2.1.7 Sitobolarioi and sitologoi

The description of grain distribution systems, whether from public or private stores, prompts the question of grain storage. Among the list of grain-related offices, two terms are associated with granaries in the epigraphic documents : the *sitologos* and the *sitobolarios*[455]. The function of *sitobolarios* is only attested in one inscription from Asia Minor, but most probably refers to the guardian of the granary – the σῑτοβολών or σῑτοβολεῖον[456] – in the sense of 'physical' surveillance.

In Asia Minor, the word *sitologos* appears only in one – very mutilated – inscription from Nikaia[457]. Its functions can be illuminated by recourse to Egyptian documents : *sitologoi* were in charge of public granaries where they registered the inputs of tax-grain. After bringing their grain to the village threshing-floor, peasants or

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[449] *Ibidem*, p. 250 sqq

[450] *SEG* 27, 938

[451] Demosthenes, *Phil.* 1, 28-29 ; Xenophon, *Anab.*, VI, 2, 4

[452] Plutarch, *Crassus*, 2, 3

[453] Herodotus, *Hist.*, III, 3, 8 & IV, 4, 7

[454] Cassius Dio, *Hist. Rom.*, LIX, 6, 4

[455] The word *sitodokos* is also a synonym.

[456] Cf. page 2. Several different terms refer to granaries and storage structures, and terminology varied a lot across space.

[457] *IK-Iznik*, 1260

tenants brought it to the granary, where the *sitologos* issued receipts testifying to the payment and kept records of the grain received[458]. As part of the registration, one of their important tasks was to distinguish tax-grain from grain paid as rents on public domains[459]. Finally, *sitologoi* were also responsible for organizing the transport of a share of the collected grain towards Alexandria[460], a task which required them to keep in contact with *negotiatores (nauklèroi)*[461]. The connection of *sitologoi* with the harbours, possibly for commercial reasons in Ptolemaic times, could likewise be linked to the supply of Rome with Egyptian tax grain after the Roman conquest. Support for this statement might be found in the intermittent replacement of the *sitologoi* by the *dekaprotoi*[462] as grain-collectors. *Dekaprotoi* formed a social group consisting of a Greek equivalent of the Roman *decemprimi*; the institution resulted from the integration of the Eastern Mediterranean into the framework of Roman law[463]. Here again, one may wonder whether the *sitologoi* in Asia Minor and Egypt had an identical role, especially with respect to the observation that in Asia Minor too *dekaprotoi* were engaged in tax collection[464]. In the inscription from Nikaia the term *sitologos* is surrounded by other food-related charges (*agoranomos*, treasurer of the oil fund) which most probably belong to the curriculum of a local official, indicating that it was understood in an institutional sense. This contrasts with the literary sources, where the words derived from the word *sitologein* are used in the unspecialized sense of 'collecting grain' in order to supply a specific population, often in a military context[465]; a difference which explains the discrepancy between the abundance of the word in literary texts and its scarcity in epigraphic/papyrological documents, given the widespread presence of war-related subjects in the ancient literature. But most importantly, *sitologoi* are not mentioned elsewhere except in Egypt and Asia Minor, suggesting that the term had a similar meaning in the two regions whose respective grain-related institutions – the *sitometria* and the *sitèresia* – have already displayed some resemblance.

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[458] *P. Lond.* III, 1586a, quoted in Hobson (1993), pp. 73-74 ; Herodotus, II, 109 ; *Genesis*, xlvii, 24-26 ; Wallace, (1961), pp. 34-35; Adams (2007), pp. 162-163; Adams, (2013), p. 6273.

[459] Wallace (1969), p. 37.

[460] Adams (2007), p. 171.

[461] *Ibidem*, pp. 191-194.

[462] Thomas (1975), pp. 111-119; Adams (2007), p. 170. *Dekaprotoi* replaced *sitologoi* from ca. 242-246 until ca. 303-303 when *sitologoi* reappear : Thomas (1971), pp. 60-68; Alston (2002), p. 278.

[463] Whether *dekaprotoi* were defined as a group of officials or as leading members of the city is still unclear. On the *dekaproteia* in the East, see : Dmitriev (2005), pp. 197-200.

[464] Magie (1950), p. 648 ; Sartre (1991), p. 86 ; p. 347 ; Dmitriev (2005), p.198

[465] For example : Appian, *Mithr.*, XI, 72; Appian, *Bell. Civ.*, II, 6, 42; Polybius, *Hist.*, III, 101, 4

3.2.1.8 Generic terms

Apart from all those supply systems, offices and grain-related interventions, documents also mention some slightly more obscure officials : the *eubosiarchai*/*euposiarchai* (literally 'in charge of the well-being') and *euthèniarchai* ('in charge of the abundance'), on which very little is known from the sources[466]. Scholars usually agree to describe *eubosiarchai* as chief officials in charge of the food supply[467]. As for the *eutheniarchai*, according to some documents from Oxyrhynchus, one of their functions was to exercise a control over the bakeries[468]. The fact that *eutheniarchai* and *eubosiarchai* are a middling category in inscriptions but are completely absent from literary sources suggests that they did not belong to the common language of grain supply intervention and that they were characteristic of a specific (institutional) context. As the vague signification of those terms might indicate, they were most probably circumstantial officials, appointed perhaps in particular difficulties, either as expedients in cities lacking institutional responses, or as complementary officials to existing schemes in cities already endowed with grain supply infrastructures. The use of emphatic titles probably reflects a symbolic reward which must have played a significant role in convincing citizens to undertake such burdensome charges. What Sviatoslav Dmitriev writes about the variety of terms categorizing officials in the Greek cities in general also applies to the specific case of generic grain-related officials : 'The use of these epithets by the Greeks reflected the social prestige of such offices rather than their administrative importance.'[469]

3.2.1.9 Regional variations

As we have seen with the Lycian *sitometria* and the Egyptian *sitèresion*, similar grain-supply schemes may bear different names in different regions. Besides being a product of functional differentiation, one might thus wonder to what extent lexical diversity resulted from geographical variation. A good example is that of the *triteia* and its officials, the *triteutai*[470]. Solely attested in Pergamon and Thyateira, the *triteia* appears to be a mere regional variant of the *sitometria*, since it consists of an allowance of a

[466] Migeotte (2010b), p. 348.
[467] Robert (1960), pp. 236-237 ; Schmitt-Pantel (2011), p. 372.
[468] Carrié (1975) p. 1081.
[469] Dmitriev (2005,) p. 127.
[470] Migeotte (2010b), p. 348.

ration of one third of a *medimnos* (*triton*)[471], but no clear identification of the recipients can be made from the documents. Similar geographic particularities can also be discerned in the case of circumstantial offices : all the references to *euposiarchai* come from the Aegean Basin (Thrace, Asia Minor and islands) – with the variant '*eubosiarchai*' (instead of *euposiarchai*) being restricted to Pisidia – while another generic grain-related official, the *sitothetès*, is only known from Samothrace[472]. The *eutheniarchai*, however, appear as a more widespread designation, since they are known in Asia Minor, Thrace, North Africa, Egypt and Sicily[473], even though on the whole, the office remains fairly rare.

Regional variability is not limited to the titles of grain officials; it also affects their functions. The clearest case is probably that of the *sitophylakes*. As we have seen above, in Athens *sitophylakes* were overseers of the resale of grain. In some documents from Tauromenion, however, they seem to play an active role in the storage and management of public grain[474]. This matter of *custodia publici frumenti* is also the subject of a passage of Cicero concerning the Anatolian city of Temnos[475]; in this case however, Claude Nicolet dismisses the idea that it would refer to a *sitophylax* and argues that it concerns an ephemeral official of the granary[476].

3.2.1.10 Artificial diversity ?

Beside such variations due to regional denominations of similar offices or to the attribution of different tasks to identical offices in different places, we also notice that different officials sometimes exercise the same functions in the same city. Similar interventions are indeed performed by *agoranomoi* and *sitonai*[477] : such overlap is suspected for Prusias[478], for instance, in some other cities we see *agoranomoi* adding funds of their own resources to keep prices low or to purchase additional grain, an intervention typically associated with grain funds managed by *sitonai* or to euergetic *parapraseis* (sales below market prices)[479]. The interventions of *sitophylakes* and

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[471] The evidence is the following : *TAM* V, 2, 939 ; *TAM* V, 2, 963 ;*TAM* V, 2, 982 ; *IGR* IV, 414 ; *IGR* IV, 1228 ; IGR IV, 1244 ; *IGR* IV, 1256 ; *IGR* IV, 1680 ;

[472] *SEG* 26, 1027, *SEG* 31, 803 & *SEG* 36, 788 ; Migeotte (2010b), p. 347 & Migeotte (2010a), pp. 318-319.

[473] Data from PHI inscriptions.

[474] *Syll*³, 954 ; Battistoni (2013), pp. 6273-6274 ; Migeotte, 2010b, p. 347.

[475] Cicero, *Pro Flacco*, 19 (45)

[476] Nicolet (1982), p. 88.

[477] Erdkamp (2005), p. 270.

[478] Fernoux (2004), p. 334.

[479] Dmitriev (2005), p. 148 ; Migeotte (2010b), p. 346.

agoranomoi appear to display an even greater degree of similarity: both officials act as overseers of the agora, control the price at which grain is for sale, and ensure that the right measures and weights are used.

Such overlap in the tasks of different officials within the same city could make us wonder about the extent to which the administrative diversity of Greek cities could be deliberate. Grain-related interventions were costly, both for the city and for its élites. The diversification of offices might thus represent a significant advantage : by creating distinct offices – collegial, most of the time –, the number of potential contributors from the civic élite (the social stratum to which most office holders belonged) was increased, resulting in a smaller financial charge per magistrate or liturgist, while the symbolic prestige of such offices might have represented an important incentive for wealthy citizens to undertake such charges. To examine this hypothesis, the different documented functions of grain-related offices (except generic terms) are summarized in Fig. 3 *infra*. As we can see, a clear overlap between two or more offices occurs in four out of eight types of functions (col. II, IV, VI & VII). Yet what are the underlying reasons for this overlap ? In the case of the *sitometria*, *triteia* and *siteresia*, we have already seen that their lexical differentiation derives mainly from regional idiosyncrasies. As for the apparent overlap between *sitologoi*, *sitobolarioi* and, in some places, *sitophylakes* regarding the control of the granary (col. IV), we are dealing with a mere illusion of similarity : *sitobolarioi* are responsible for the physical protection of the granaries, while *sitologoi* are officials recording the inputs of tax-grain. Although both related to the management of the granary, the details of such functions are actually clearly distinguished.

Let us now turn to the most significant cases of overlap : *agoranomoi* and *sitonai* on the one hand (col. VII), and *agoranomoi* and *sitophylakes* on the other (col. VI). As explained above, *agoranomoi* were the superintendents of the market; through this task, they often exercised a price control over the sale of grain. Like all magistrates, they managed a public fund for the expenses related to their functions. However, with the growing confusion between magistracies and liturgies that develops from the Hellenistic period and after[480], magistrates were increasingly expected to contribute from their own resources (a financial participation that was already suggested in Aristotle's *Politics*[481]). As demonstrated by Léopold Migeotte, the role of the *agoranomoi* moved slowly from a predominantly judicial function of oversight over the

[480] For a good overview of this question, see : Jones (1940), pp. 167-168 & 175-176; Dmitriev, (2005), pp. 114-119 ; Sartre (1991), pp. 139-141 ; Couilloud-Le Dinahet (1988), p. 324; Pavis D'escurac (1987), p. 120 ; Frézouls (1991), p. 8.

[481] Aristotle, *Pol.*, VI, 7, 6

transactions taking place in the agora, in the Vth and early IVth century, towards a broader involvement in the supply of foodstuffs to the city during the course of the IVth century and after, a role which often exceeded the restricted sphere of the agora[482]. This shift in the functions of the *agoranomoi* coincided with the independent development of the *sitonia* and resulted in a partial overlap between the two functions.

Even more identical are the interventions of *sitophylakes* and *agoranomoi* : leaving aside the regional variability for a moment and focusing on the Athenian evidence, both *sitophylakes* and *agonoromoi* act as overseers of the agora, control the price at which grain is for sale, and ensure that the right measures and weights are used. At this stage, it is difficult to understand how those offices differ from each other. But, as already highlighted above, *sitophylakes* were tasked with regulating transactions taking place between importers (*emporoi*) and resellers (*sitopolai*, *kapeloi*). Raymond Descat has recently clarified the specific tasks of the *sitophylakes* through a revised interpretation of the *Athenaion Politeia* and of Lysias' discourse[483] : *sitopolai* bought grain from *emporoi* in the *emporion*, and sold it on the *agora* of the Piraeus and of the city. *Sitophylakes* were present in both *agorai* and controlled the *sitopolai* on arrival: merchants were expected to show the contract of purchase realized in the *emporion* and to declare the price at which they would sell the grain. The *sitophylakes* could thus ensure that the officially allowed price margin was observed and that no *sitopolès* would hold more than the maximum quantity of grain legally authorized (50 *phormoi*).

But how can this reconstruction account for the fact that *agoranomoi* were also responsible for verifying that grain dealers actually sold their grain close to the price they declared ? A plausible solution is to consider that *sitophylakes* exercised an *a priori* control, while the *agoranomoi* exercised an *a posteriori* control. Indeed, the fact that *sitopolai* would declare a price fitting the maximum benefit allowed at the entrance of the *agora* did not guarantee that they could not sell their grain at a higher price a couple of days later. The role of the *agoranomoi*, among their various other tasks, would thus have been to ensure that the *sitopolai* would keep their prices at more or less the same level during the whole time of their activities in the *agora*. As for the *agoranomoi*, the mention – even if only narrative – by Apulleius of an agoranomos trampling the fishes of a merchant because of apparently excessive prices seems to confirm the idea of an *a posteriori* verification[484].

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[482] Migeotte (2015), pp. 34-39.

[483] R. Descat (2003)., pp. 598-599.

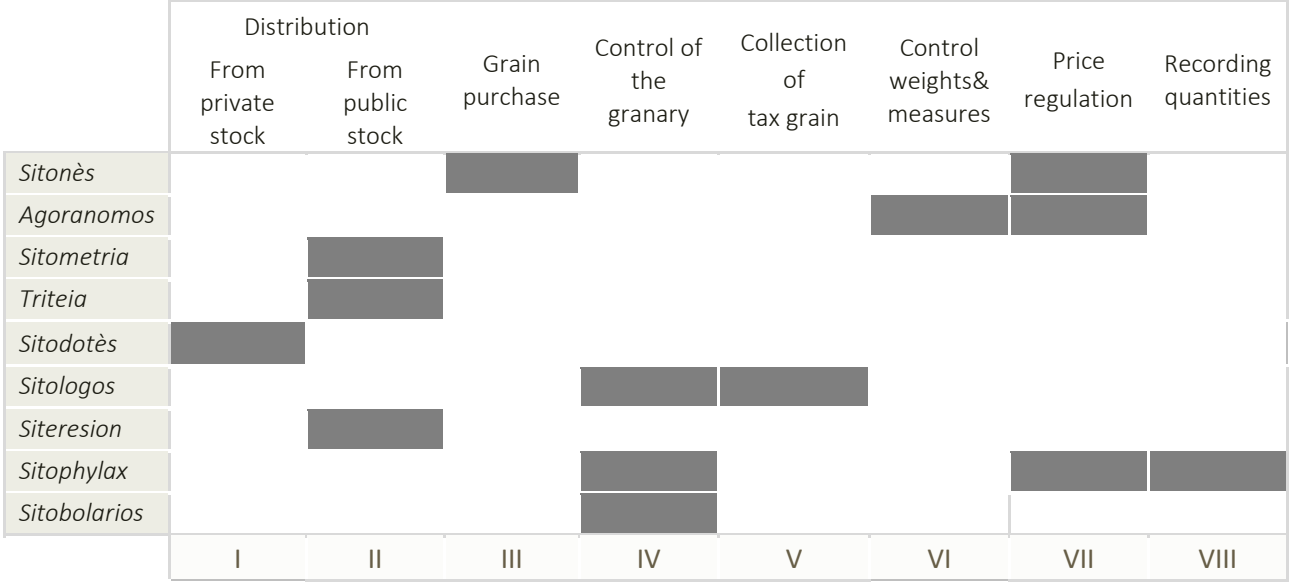
[484] Apull., *Metamorph.*, I, 24-25

Regarding the sitophylakes, however, there remains the question of whether we can generalize the Athenian case to the whole of the eastern Mediterranean in classical and post-classical times. As argued by Léopold Migeotte, the intense administrative fragmentation noticeable in Athens between *sitophylakes*, *agoranomoi* and *metronomoi*, the very specific distribution of tasks between them as well as the importance of the involvement of *sitophylakes* in the operational chain of the grain supply most likely resulted from the size of the city and its vital dependence upon commercially imported grain[485]. While this argument seems perfectly valid, it does not in and of itself imply that a similar distribution of tasks between *agoranomoi* and *sitophylakes* could not occur elsewhere, even in a smaller city. The only inscription recording a *sitophylax* in Asia Minor during the Roman period comes from Cyzicus and refers to a certain 'M. Αὐρ. Ἀμερίμνου σειτοφύλακος τῆς πόλεως'[486]. In this text, the expression '*sitophylax* of the city' seems pleonastic: *sitophylakes* were obviously civic officials, something of which the stonecutter or those instructing him could hardly have been unaware. The most logical explanation is thus to understand the expression σειτοφύλαξ τῆς πόλεως as being distinguished from the σειτοφύλαξ τοῦ ἐμπορίου, just like in Athens *sitophylakes* exercised control both at the harbour and in the city, for we know that Cyzicus had a harbour.

Even though geographical specificities cannot be denied, as in the case of the *sitophylakes* of Tauromenion, the overlap between the tasks of different officials was mostly a *trompe-l'oeil* : administrative differentiation – within the same city – was for the most part *not* artificial or irrelevant, but corresponded to distinct – though not always hermetically separated – institutional functions.

[485] Migeotte (2015), p. 28.
[486] *IMT Kyz. Kapu Dağ*, 1449, l.9-10.

Table. 3 – Main functions of grain-related offices and supply systems



3.2.1.11 Conclusion

The analysis of the evidence undertaken in this section has so far revealed two driving forces behind the lexical diversity observed in source references to grain-related interventions and institutions : an important functional differentiation on the one hand, and substantial regional idiosyncrasies on the other hand. From the functional point of view, the twelve recorded terms refer to merchants (*sitopolai*), grain distribution schemes (*sitometria*/*triteia* and *sitèresion*), and city officials. Among those offices, five appear to be regular or permanent functions (*agoranomoi*, *sitophylakes*, *sitonai*, *sitologoi*, and *sitobolarioi* – or any similar designation for the guardian of the granary), while the *eutheniarchai* and *eubosiarchai* seem rather temporary. However, the differentiation of tasks does not fully account for the lexical diversity observed : the Anatolian *sitometria* and the Egyptian *sitèresia*, although exhibiting differences regarding their technicalities, consisted of a similar feature of civic life, *i.e.* more or less regular grain distribution schemes. Even more meaningful are the differences observed between the tasks of identically named officials in different places (mostly *agoranomoi* and *sitophylakes*), which reveal that the institutional and geographic explanation cannot account for the entirety of the observed lexical diversity. As Jean Andreau explains, the distribution of tasks between officials in Greek and Roman cities was not organized on the basis of radically separated spheres of competence, but was in fact

affected by significant flexibility[487]. To which we should add the importance of the symbolic aspect of institutional divisions : in addition to fulfil objective needs, civic offices were also a mean of acquiring social prestige. To quote Sviatoslav Dmitriev : 'Greek texts divide city offices in very many ways, and it is unlikely that each of these divisions corresponded to the institutionalized structure of city administration.'[488]

Comparing the frequencies of grain-related terms between epigraphic and literary sources has shed another light on the question, beside the fact of completing our knowledge of the most frequent and universal offices or functions (*sitonai*, *agoranomoi*, *sitopolai*, *sitophylakes*). Observed discrepancies are firstly due to the differential geographical areas encompassed by both kinds of sources : our epigraphic database refers solely to the cities of Anatolia (geographically speaking : the Roman province of Asia Minor, Cilicia, Bithynia, the central plateau of Galatia and Cappadocia), while the literary sources come from all over the Greek-speaking world. A second explanatory factor lies in the type of document concerned : inscriptions register the technical, institutional life of a city, taking account of its own cultural, linguistic and political peculiarities as well as of its insertion into a broader political entity (league, *koinon*, Empire,...); literary texts, on the other hand, while also influenced by the origin of the writer, do not always use words in their precise administrative or legal meaning, regarding a specific context. Rather, they sometimes use them in the metaphorical sense – this is particularly true of religious sources of course –, or in the sense of their most 'common', colloquial use. In any case, the pervasiveness of the grain-related vocabulary in the literary sources as well as the administrative sophistication revealed by inscriptions both betray the crucial importance of the matter of the grain supply for the cities of the ancient Mediterranean : a regular grain supply was a *conditio sine qua non* for the effective functioning of civic life.

3.2.2 Grain funds and grain doles : a case study

Now that I have presented and described the different offices, whether temporary of regular, involved in the regulation of the urban grain supply, and highlighted their functional and regional differentiation, I would like to undertake a more detailed study of two of these grain-related institutions: the *sitonía* and the *sitometrìa*. I will discuss

[487] Andreau (2012) p. 263. This is particularly true in a context where no conscious distinction between legal, executive and legislative offices exists (cf. Dmitriev (2005) p. 14).
[488] Dmitriev (2005) p. 128.

each of these two systems with respect to a different issue : for the *sitonía*, I will try to reconstruct its working, identify its supply channels, and examine its financial sustainability; for the *sitometria*, I will examine the possible link between the development of this particular scheme in Lycia and the Mediterranean-wide circulation of grain for the supply of Rome. Then, I will analyze and discuss the geographical spread of these two systems throughout Asia Minor and see what we might learn from the emerging pattern.

3.2.2.1 The working of grain funds

Contrary to the Early Modern grain funds of northern Europe and Italy, the *sitónia* were cash funds; ancient Greeks and Romans stored money rather than grain[489], as attested by the expression *sitonika chrêmata* (translated by *frumentaria pecunia* in the latin texts[490]). On the one hand, this feature could be seen as a weakness since buying grain in times of dearth exposes the fund to higher prices and reduces its purchasing power; but on the other hand, it eliminates the problems induced by the difficult conservation of crops[491] : grain indeed perishes quickly, and when a succession of good harvests happened, the urban demand was firstly directed towards fresh grain rather than stored grain, making it rapidly useless[492]. Funds of stored grain, therefore, are more likely to be efficient when shortages occur on a regular, constant and short enough time interval, which is precisely inconsistent with their erratic, random and thus unpredictable nature. In this respect, cash funds seem to be a more appropriate response than stored grain to face the unpredictability and randomness of shortages.

However, would the acquisition of grain at scarcity prices not undermine the purchasing power of the fund, and thus reduce the amount that could be bought? In fact, the efficiency of grain funds was not solely commanded by the deterministic power of the inputs and outputs of money. Prices, indeed, were not completely exogenous to the *sitonía*. Officials in charge of the grain fund – the *sitónai* – were not only managers but had also a political role : they would do their best to buy grain at

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[489] Whether this was mainly fiduciary or scriptural money is a quite controversial issue, on which we cannot expand here. Indeed, the fact that the *sitonìa* consisted of a monetary system does not imply that all, or even most, of this money was actually in the form of coins. It is indeed perfectly possible that a cetain proportion of the gifts from benefactors or civic contributions was made of deposits in the form of credit, debt recognition or promises of giving an actual amount of coins later. This is even more possible since evidence from Egypt, records deposits of grain associated to a credit system : Sharp (1998), pp. 237-259 ; Adams (2007), p. 171.

[490] *Dig.*, L, 8, 2, 3

[491] See below : section 2.2.3.

[492] Erdkamp (2008), 116

the cheapest possible price from a neighboring region, and convince – or, with the support of civic authorities, compel – reluctant landowners to make their stocks available for sale at a 'reasonable' price[493] (sometimes paying the loss of income with their own money). In some cases, they were helped in this task by provincial legislation. Negotiation and coercion were therefore also part of the mission of the *sitónai* to maximize the amount of grain they could buy with the minimum amount of money so as to avoid a shortage of cash.

a) Funding

Yet, how was the *sitonía* funded[494]? The idea that grain funds were solely, or even largely, funded by private – euergetic – contributions has had a long life in the academic literature. Mainly supported by P. Garnsey and M. Silver[495], this idea has also been expressed by J. Strubbe who, while defending a rather optimistic view concerning the scope of the grains funds, nevertheless sees them as being "at the mercy of rich benefactors"[496]. Yet, such a statement can no longer be taken for granted. In his recent study of municipal grain funds, A. Zuiderhoek has convincingly argued that the epigraphic sources suffer from a congenital bias : they tend to over-represent private gifts – for obvious reasons of prestige and symbolic capital – and to under-represent the normal, usual contributions coming from public funds (*demôsia chrêmata*), well attested for instance in an inscription from Phrygia[497]. Moreover, some inscriptions emphasize the fact that a benefactor has performed the *sitonía* "from his personal expenses", or "on his own revenues"[498], implying thereby that this was unusual behavior. This strongly suggests that, *contra* Strubbe and others, civic funds normally

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493 Cf. *supra*

494 As a preliminary issue to the actual funding of the *sitonía*, one should wonder whether this function was a magistracy – a honorific charge through which the official managed a public fund, sometimes adding from his own resources, and associated with political privileges – or a liturgy – a compulsory burdensome, yet honorable, charge of public interest which the official has to finance almost entirely from his own funds. Macro (1980), 680 considers the *sitonía* as a magistracy, while Sartre (1991), 132 and Frezouls (1991), 8 classify it among the liturgies. Actually, like most graeco-roman offices in the post-classical period, the *sitonía* exhibits characteristics of both categories, which merely reflects the growing *de facto* confusion between those two types of public offices that took place in the post-classical era. The institutional analysis is therefore of little help in determining the precise channels through which the *sitonía* was financed.

495 Silver (2007), 96

496 Strubbe (1989), p. 118

497 MAMA VII, 11, l. 12

498 TAM V, 829, l. 9-10 ; *IK-Erythrai*, 66

bore the main part of the burden of financing the grain funds. The sources of money of the grain funds are therefore likely to have been of two types

(1) The monetary contributions of benefactors to the *sitónia*, either in the form of direct gifts or of interest from foundations;

(2) The public funds, most likely derived from the various taxes levied by the city ;

There is also a variant of the *sitonía* in which the capital accumulated by gifts, civic funds and/or a public subscription is lent out at interest, with the interest being used to purchase grain when needed [499]. But those circumstances where grain funds worked like foundations or through loans are unlikely to have been the standard case: such mechanisms are rarely stated in *sitonía* inscriptions and, most importantly, as far as grain funds were concerned, money needed to be available immediately. Money could occasionally be borrowed from grain funds[500], but this does not mean that the *sitonìa* consisted of foundations; it probably rather means that, in good years, cities allowed short-term loans to be made from the cash reserve, which would increase the fund through interest payment. Yet, these must have been controlled scrupulously, and the Digest states that debts towards grain fuds should be repaid as quickly as possible[501]. We should thus consider the foundation paradigm as the exception, rather than the rule[502].

b) Expenses

Now, how were the withdrawals of money determined ? In his study, J. Strubbe argues that the grain bought through the *sitonía* was distributed for free. If this was the case, there would be no clear difference between the *sitonía* and the *sitometría* (cf. *supra*): it would indeed reduce the grain-funds to mere grain-doles while we have seen above (in section.2) that the institution which most resembled Egyptian grain-doles was the *sitometria.* In *sitonía* inscriptions, no criteria of admission, no specific targeted group are mentioned, and I personally doubt that they would be a distribution of free grain to potentially everyone… Moreover, Greek and Latin are synthetic languages, putting emphasis on the economy of words. In that sense, ancient Greeks would not

[499] For example : *CIL* III, 6998 ; other such examples are known from the Hellenistic period.
[500] *Digest*, L, 8, 2 (2), 3 & 5
[501] *Ibid.*, L, 8, 2, 3
[502] Strubbe (1989)., p. 113

use two different words to describe the same institution in the same location : as the lexical analysis has revealed, for the most part, the variability in terminology for grain-related offices which is not explained by regional differentiation is due to a significant specification of tasks between offices and systems, although such specification is never completely sealed. Yet, Strubbe dismisses the idea that the grain bought buy the *sitònai* would be resold, arguing from the *a silentio* argument that such a procedure is not explicitly attested in Asia Minor. However, neither is it explicitly stated that the grain was distributed. But there is more; in fact we *do* have evidence of grain being resold: an inscription from Thespiae dated between 220 and 210 BC mentions a grain fund managed by two *sitónai* helped by a treasurer; it is said that a group of *sitopólai* (grain resellers, as explained earlier on), was actually in charge of the sale of the grain to the population[503]. For these reasons, I consider more plausible that the grain of the *sitonía* was resold rather than used for distributions, and that the value of the sale went back to the grain fund, as was already the case in many Hellenistic attestations of the *sitonía*[504].

This whole divergence is the origin of the noticeable difference between our assessment of the annual income of the grain funds and that made by Strubbe, who reckons with an average of 5,000-7,000 denarii[505]. To obtain this value, the author relies onto the fact that 'gifts of 10,000 denarii for *sitónia* were quite common'[506]. His argument then works as follows: if several such gifts were performed over a few decades, they might constitute a fund of around 50,000-70,000 denarii which, when loaned at an annual rate of 10% – as were most foundations –, would bring an annual income of 5,000 – 7,000 denarii. The problems with this argument are numerous. First, by choosing the mode of his distribution of sums (10,000 denarii) as reflecting the value of an average gift to the *sitónia*, Strubbe implicitly considers that the inscriptions we have recording monetary gifts to the grain funds mirror the actual (ancient) statistical distribution of such gifts. By doing so, he takes no account of the conspicuous character of honorific inscriptions which most probably tend to over-represent larger gifts and under-represent the smallest ones. In statistical terms, he considers our fragmentary body of epigraphic evidence as an unbiased sample of what the complete actual distribution of sums looked like in Antiquity.

Secondly, the author passes over the question of how such a fund of 50,000 denarii (at least) would have been constituted. He simply says it would require gifts

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[503] *I. Thespies*, 84, ll. 30-37. Cf. Bresson (2016), p. 334

[504] Migeotte (2014), 176

[505] As we will see below, this is 2-3 times our estimate of 2,650 denarii.

[506] Strubbe (1989), 115

'spread over some decades'. In that case, it would make the *sitonía* a rather laborious mechanism, since it would need 15, 20 or perhaps 25 years to constitute a capital able to provide the 5,000 denarii annually. Not only would this feature be inconsistent with the rather short-term nature of euergetism, but it would also imply that during this period the city would be more strenuously exposed to shortages… On the other hand, if we suppose that such a fund was accumulated more quickly, say, in 5 years, it would require an annual élite contribution of 10,000 denarii per year on average, which represents some 4% of the aggregate income of 200 councilors owning their census minimum of 25,000 denarii[507]. In his study of munificence in Asia Minor, A. Zuiderhoek has estimated that the *average* élite expenditure on public buildings represented some 3 to 5 % of aggregate élite income[508]. Since public buildings represented by far the most expensive category of benefactions, and that civic élites were, relatively speaking, more reluctant to spend money on the food supply compared to other sectors of civic life (cf. *infra* : section 2.4), it is quite unlikely that they would allocate a similar proportion of their annual income to the *sitonía* alone (that is, excluding informal distributions of grain, public banquets, interest-free loans to the city for the import of grain,…etc) and to public constructions, which were far more conspicuous than the financial support of a grain fund.

There are, of course, reasons that might explain the high value of Strubbe's estimate of the annual income of the grain funds. He assumes indeed that in most cases such funds were aimed at distributing grain for free to the citizens. As we have already seen above, this statement must be reconsidered. Moreover, he argues that grain was bought *every year* because *sitónai* were appointed annually, which seems a hasty conclusion. We can indeed think of many other roles that the *sitónai* could have had apart from negotiating with landowners and purchasing grain. In normal years, they might have been in charge of more administrative functions, such as receiving the gifts, writing down the accounts when there is no associated treasurer, ensuring that promises from benefactors (*pollicitationes*) were fulfilled, planning where and when it would be appropriate to buy grain,…etc. As far as grain funds are concerned, none of these functions can explicitly be supported by epigraphic evidence but they are fairly similar to the functions of many other officials in Greek cities. In any case, it is by no means sufficient to state that the best known functions of the *sitónai* were the only ones they exercised and that this implies an annual purchase of grain, even in years of good harvest. Absence of evidence is not evidence of absence. For all those reasons, I

[507] Again, under the assumption that élite patrimony consisted mainly of landed property, set at an annual rate of return of 5%.
[508] Zuiderhoek (2009), 27

consider that *sitónai* only bought grain when necessary – that is, when signs of a bad harvest appear– and that, most of the time at least, this grain was resold to the urban consumers[509].

3.2.2.2 Anatolian grain-doles and the supply of Rome

Apart from the *sitonìa,* the second most important grain supply system we encounter of Asia Minor on which some further discussion is needed is indisputably the Lycian distribution schemes known as the *sitometria*[510]. Although its mechanism has been quite thoroughly discussed above, the reasons of its development in that particular region remain obscure. Going back to the Lycian evidence, it was of course very tempting to see a relationship between the inscriptions mentioning *sitometria* or *sitometroumenoi andres* – most of which date back to the reign of Hadrian or after – and the construction of the storage structures (*horrea*) of Patara and Andriakè in southern Lycia, which also took place under Hadrian. From this parallel, it was tempting to argue, as did A. Balland, that the concentration of the *sitometria* in Lycia was due to the strategic position of this region as a stage in the carry-over of the Egyptian grain for the *annona* of Rome[511]. But this implies a view of these *horrea* as mere stage granaries for the supply of Rome. Recent research has however contested this statement : why would such granaries have been set up under Hadrian, while precisely during his reign, the Egyptian grain became relatively less important for the *Urbs*, since there was an increasing complementary supply from Africa[512] ?

However, the link between the Lycian storage structures, the grain distribution schemes and the supply of Rome should not be discarded too hastily. In his work *The ship or the wishes*, Lucian of Samosata, writing a few decades after Hadrian (*floruit* ~AD 165)[513] reports the tale of young man named Lykinnos who encounters in the Piraeus a huge cargo carrying grain from Egypt to Italy (ἀπ΄Αἰγύπτου ἐς Ἰταλίαν σιταγωγῶν)[514]. What is particularly interesting about this passage is that Lucian's character, Timolaos, describes in detail the journey of the ship :

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[509] The working of the *sitonía* was already understood in that way by A.H.M. Jones (1940), 216-217 and by A. Macro (1980), 680, but both authors are mistaken about its precise functioning: Jones's analysis was the basis of Strubbe's view that *sitónai* bought grain every year, while Macro considers that the main part of the grain fund was financed by the *sitónai* themselves. As we have seen, both those statements must be reconsidered.

[510] For a broader discussion of the term, see above : section 1.

[511] Balland (1981), pp. 215 sqq

[512] Virlouvet (2011), p. 19.

[513] Gonzàlez (2005), p. 137

[514] Lucian, *The Ship*, 1 (translated by A. M. Harmon (Loeb Classical Library)).

> When they left Pharos, he said, the wind was not very strong, and they sighted Acamas in seven days. Then it blew against them from the west, and they were driven abeam to Sidon. After Sidon, a severe storm broke and carried them through Aulon to reach the Chelidonenses on the tenth day. (…) I myself have sailed by the Chelidonenses and I know the size of the waves there, especially in a sou'westerly gale with a touch of south; *this, you see, happens to be where the Pamphylian and the Lycian seas divide*. (…) Then, having now lost their course, they sailed across the Aegean beating up with the trade winds against them, and yesterday, seventy days after leaving Egypt, they anchored in Piraeus, after being driven so far downwind. They should have kept Crete to starboard, and sailed beyond Malea so as to be in Italy by now.[515]

The route described by Lucian is well known : it is the traditional coastal navigation route from Egypt to Greece, starting in Alexandria, going along the coast of Phoenicia and Syria, passing between Rhodos and Cilicia, and finally entering the Aegean Sea. The last step before the Aegean Islands and the route to Attica, as clearly understandable from the text, is the Lycian peninsula – a point where the apostle Paul already stopped on his way to Rome[516].

This ship, writes Lucian through the words of Samippos, 'was said to carry corn enough to feed all Attica for a year'[517]. Whether this statement proceeds from an exaggeration of Lucian in the fictional context of his story matters little; the message is clear: this ship was a big one. And it is unlikely that this was a rare event : the ship described by Lucian, though extraordinary in size (says the story), is only 'one of its kind' (μίαν τῶν (…) σιταγωγῶν). Two important elements are thus to be learned from this passage : although probably relegated to the second position after Africa, Egypt remained a major source of large-scale grain supply towards Rome some decades after the reign of Hadrian; second, and most importantly, these cargoes passed regularly near Lycia. This does not in and of itself prove Balland's statement to be right, but it shows at least that the idea of Lycia as being one stopping point for such cargoes on their way to Rome during this period is not implausible at all. The *horrea* of Myra and Patara would thus be aimed at providing a safe storage structure during the time of the halt.

Yet, this should not lead us to reduce the function of these granaries to this purpose alone. It is also perfectly logical to relate them to Hadrian's measures allowing

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[515] *Ibid.*, 7-9.
[516] Paul, *Acts*, 27, 5-6.
[517] Lucian, *The Ship*, 6

some privileged Anatolian cities to import grain from Egypt (cf. *supra*) : the concomitance of such measures and the construction of these *horrea* could hardly be a coincidence. According to recent scholarship, those granaries could have served as temporary storage structures that facilitated the dispatching of the Egyptian grain towards these cities of Asia Minor that were granted the right to import it [518]. But what would then be the link with the Lycian *sitometria*? To understand this, we should first imagine the impact of this storage on the neighboring cities. In particular, two consequences might derive from such a concentration of available grain in Lycia :

(1) These structures doubtless necessitated very careful surveillance and hence generated logistical costs which, for some part, were to be paid by local communities. In this perspective, it is possible that a small share of these (huge) quantities of grain was granted to the neighboring cities in return for externalizing to them some of the costs of the storage; this grain might then contribute to the provision of the widespread distribution schemes witnessed in Lycia in this period.

(2) A second way to think of this situation would be to envisage the major issue represented by the storage of these large quantities of grain. For merchants and local élites, this grain must have represented an important source of greed, which most likely did not go without corruption at some point of the logistic supervision of these infrastructures. Hence, even minor leaks from these important stocks might well have allowed local élites to contribute to the Lycian distribution schemes in which, like any target of euergetism, considerable social, political and symbolic interests were at stake[519].

As is often the case, a combination of both processes is perhaps more realistic. All this remains very speculative of course, and I am unable to offer proof based on local evidence, but the reader will probably agree that they are far from implausible. In this perspective, it would thus be possible to argue that the prominent rise of the *sitometria* in Lycia was *both* due to its situation on the route of the *annona*, *and* a direct or indirect consequence of the storage of such Egyptian grain to be dispatched to some privileged Anatolian cities.

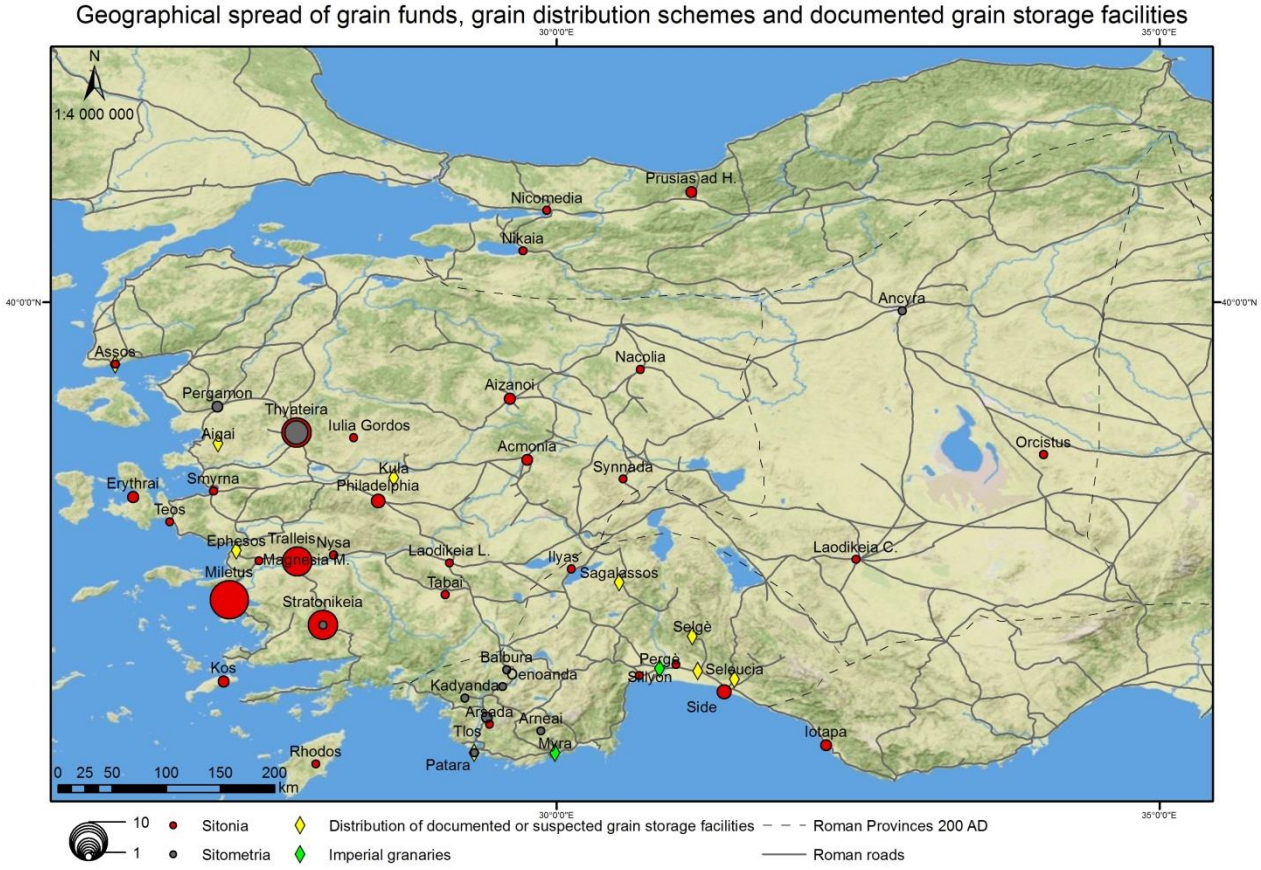
3.2.2.3 Geographical synthesis : storage, distribution and supply schemes

After this case study on two specific grain supply institutions, one might want to bring the evidence together and see how these two patterns combine with one another and how they are distributed across space. My colleague Gerben Verbrugge and myself

[518] Carre (2011), p.29 ; Virlouvet (2011), p. 19.

[519] See below : section 3.

have thus conceived and built a map (cf. below) displaying the geographical spread of grain funds (*sitonìa*) and grain distribution schemes (*sitometria*) in Asia Minor. On this map, we added the documented or suspected grain storage facilities (from archaeological, literary and epigraphic sources). The map is of course merely illustrative, since it relies on about 90 inscriptions and a handful of literary mentions and archaeological remains spread over nearly three centuries. Yet, displaying this data from a spatial point of view might nevertheless suggest some patterns, or at least bring some research questions to the agenda .



The distribution of the *sitonìa* and the *sitometria* reveals an interesting feature: the two systems only coexist in three cities, namely Thyateira, Pergamon and Stratonikeia. Elsewhere, they seem to be mutually exclusive: the cities where the *sitonìa* is documented do not have references of *sitometrìa*, and where the *sitometria* is mentioned, no grain funds are present. Regarding their regional concentration, the *sitometria* displays a cluster in Lycia, but is also documented in Lydia, Mysia and Galatia, while the *sitonía* is ubiquitous throughout Anatolia. I have already argued above that, despite a stronger institutionalization of the *sitometria* in Lycia, and although the word undoubtedly covered different realities in the different regions (different criteria for recipients, and differences in the regularity of distribution), they share the common characteristic of consisting of a distribution in kind (as opposed to the monetary system of the *sitonía*), partly financed by civic money. These two

observations strongly suggests that the sitometría *lato sensu* – a more or les regular grain distribution scheme, funded by both civic and private funds – was not restricted to Lycia, while they simultaneously support my earlier claim that the two schemes were radically separated, supplied by different channels and had a distinct functioning.

The map however also poses an important puzzle: how should we explain the prominent concentration of the *sitonía* in Caria (Miletus, Stratonikeia and Tralleis) ? Indeed, Tralleis is located in the Maeander Valley, one of the most fertile regions of Asia Minor, while Miletus is located on the coastline and must therefore have have been easily supplied. Miletus and Tralleis thus do not seem good candidates for cities experiencing recurring shortages. This is even more surprising when we notice the sharp difference between Ephesos and Miletus: Ephesos, too, is a coastal city, and the biggest of Asia Minor, but not a single trace of the *sitonìa* is present. This does not mean, however, that grain-related interventions were less frequent in Ephesos: they might well have been performed by *agoranomoi*, which I did not display on the map due to their well-known intrinsic polyvalence. We have indeed several inscriptions from *agoranomoi* of Ephesos who have been praised for keeping the price of bread or grain affordable[520]. But perhaps the assumption that *sitònai* had a rather narrowly defined task should be revised, at leats in some cities: it is indeed possible that the *sitònai* of Tralleis, Miletus and Stratonikeia had more various tasks than just purchasing grain to cope with shortages and keeping the accounts of the fund. They might have been more broadly involved in the regulation of the grain market, and hence less distinguishable from *agoraonomoi*...Another, not exclusive possibility, would be that Ephesos was more strongly connected to external trade networks[521] than the cities of Caria, and thus did not have to rely as much on the local élite for its grain supply. Finally, differences in the epigraphic habit and euergetic traditions between these cities could also have played a role.

In any case, the distribution and purchase of grain prompts the question of its physical storage. Grain storage facilities thus also appeal some commentary. I am well aware that most cities, especially in inland regions, would have had civic granaries or storage infrastructures. The ones shown on the map are only those for which either undisputable evidence or suggestive indices exist, and I do not pretend that my collection of data is exhaustive. The difficulty to locate grain storage facilities with greater accuracy arises from two major factors: first, because the buildings themselves have often disappeared; second, because in numerous cases only few architectural

[520] For example : *IK-Ephesos,* 917 ; *IK-Ephesos*, 3016

[521] Ruffing (2008), p.230 sqq. Cf. Strabo, XIV, 1, 24

characteristics are specific features of granaries[522]. The upper levels of the so-called 'market-building' of Sagalassos, for instance, are well suited to store grain – the place was ventilated, which would prevent moisture from accumulating, and sufficiently high to keep grain away from rodents and other destructive animals – although no archaeological evidence exist to back this hypothesis. A final element might well illustrate both the probable pervasiveness of grain storage facilities and the difficulty to identify them in archaeological remains. A recent study on buildings in Asia Minor has summed up the various cases in which, from the Hellenistic period onwards, the storage of grain did not take place in a specific *ad hoc* building, but rather in other structures such as *cryptoporticos* or *basilicae* (Aspendos, Smyrna, and perhaps Tlos)[523]. In any case, the daily grain supply, the purchase by city officials, and the development of specific distribution schemes would not have been possible without storage facilities.

The so-called 'market building' of Sagalassos (picture taken during field trip in July 2016)

The map we have just seen hence raises the question of a possible differential intensity of grain-related interventions between the various regions of Asia Minor. One might indeed wonder how the grain-related offices are spread over Asia Minor if we take into

[522] The reference study on the subject is still Rickman (1971).

[523] Cavalier (2012), p. 246 & p. 253-254 (Aspendos) ; p. 250 (Smyrna) ; p. 254 (Tlos).

account not only the *sitonia* and *sitometria* but also all the other offices (agoranomoi, euthèniarchai,...etc.) which have been discussed in section 2, together with the benefactions. But simply taking the absolute number of attestations, as we have done for the map of grain funds and grain distribution schemes, exposes to the problem of variations in epigraphic density and epigraphic fashion[524] : the total number of inscriptions was not the same in all cities, which means that our number of grain-related inscriptions themselves was consequently primarily dependent upon the primary epigraphic production. Furthermore, absolute values are subject to a series of bias which have been clearly summed up by Duncan-Jones:

> 'The fact that town A has left more inscriptions than town B in the same area almost never indicates in itself that A was larger, wealthier, or had a bigger population than B. (...) The local rate of survival depends on a series of variables which includes the proportion of the town area that has been excavated (if any) ; the durability of the local stone ; the extent to which later generations used the Roman town as a quarry ; how far continued occupation of the site has erased the Roman town from view;...'[525]

In order to (partly) overcome these problems, I have thought of constructing an index which more appropriately reflects the intensity of grain-related interventions per region. The major idea was to correct the number of grain-related inscriptions from their dependence to the number of remaining inscriptions. I therefore propose to use the following index (*I*) which consists of the number of grain-related inscriptions of one region (*n*), divided by a proxy of the total number of inscriptions of the considered region (*N*), multiplied by 100 in order to make the result readable:

$$I = \left(\frac{n}{N}\right) * 100$$

Naturally, the proxy of the total number of inscriptions of one region does not itself go without problems: what we are seeing is merely the number of *published* inscriptions. A lot more is still unused in the reserves of various museums and institutes. Yet, I claim that this does not jeopardize the reliability of this index : clearly, the rate of publications is not the same from one region to another, but if one region has been more (less) thoroughly surveyed, and thus yielded more (less) inscriptions, it will also have yielded more (less) *grain-related* inscriptions. In other words, if the *absolute*

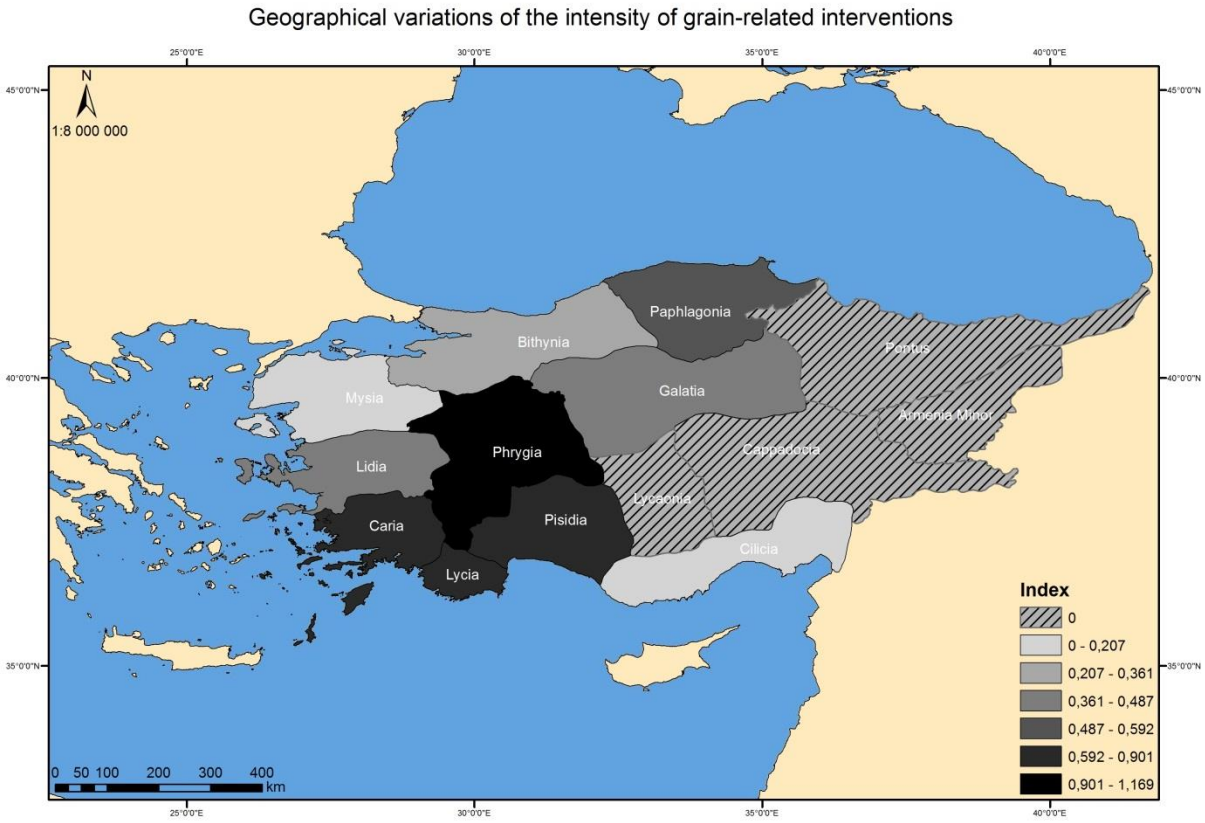
[524] Bodel (2001), p. 9; MacMullen (1982), pp.233-246

[525] Duncan-Jones (1982), pp. 360-361.

number of grain-related inscriptions is obviously dependent upon the excavation and publication process, the *proportion* of grain-related inscriptions is left unaffected. Of course, this leaves us with the practical difficulties of the counting: however surprising this may seem, obtaining data on the absolute number of (published) inscriptions from a city or region is far from easy. I thus crossed the online databases (mostly PHI) with the main regional and local corpora (*IK, TAM, MAMA, etc*...). Assuredly, my totals are not exhaustive – especially given the impossibility to find the number of published inscriptions of specific cities like Arneai, or Arsada, and most probably involved some double-counting. Overall however, it is unlikely that these gaps and duplications are significant enough to substantially overrule the effect of the law of large numbers.

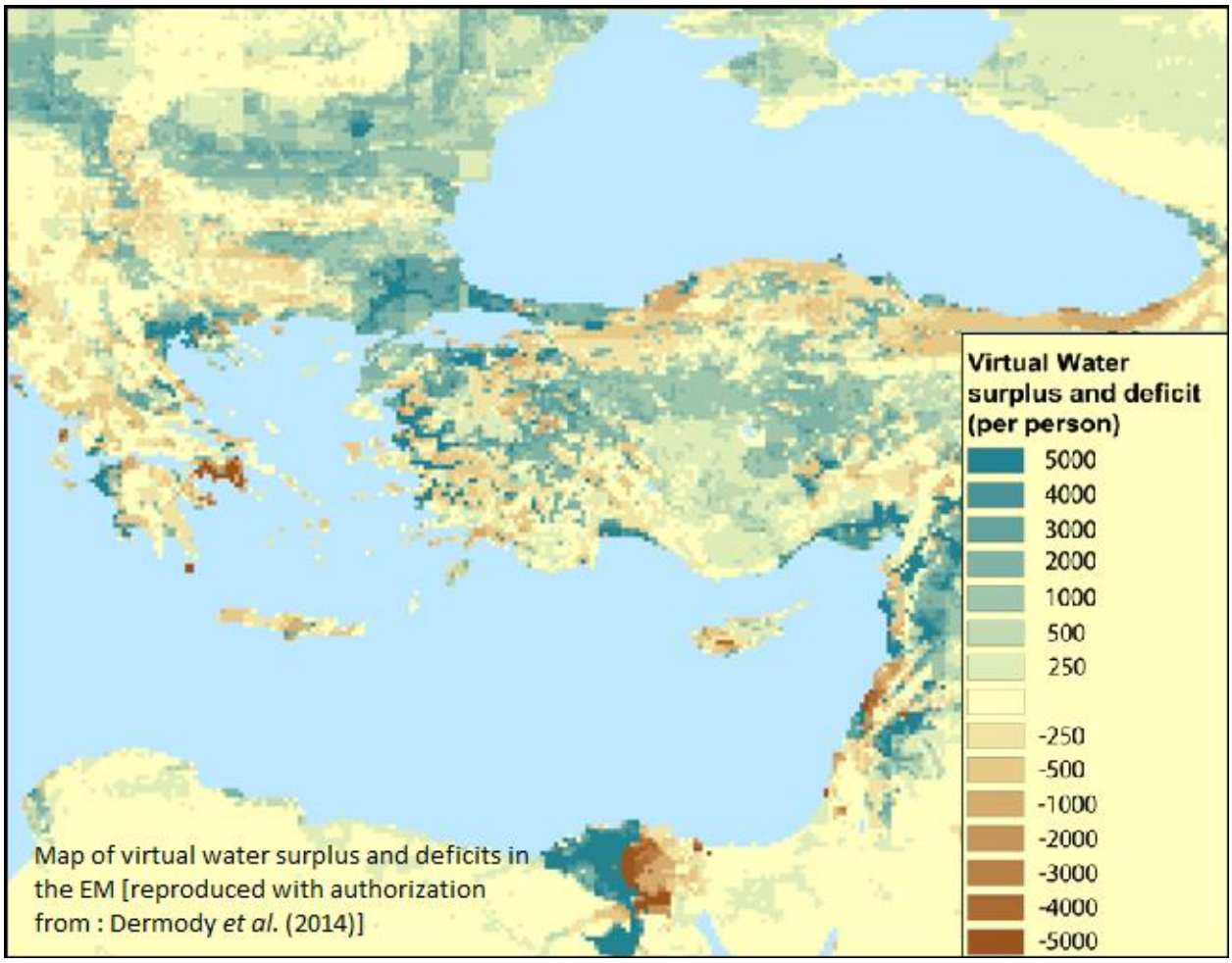
Remains one important element : on which geographical grid should this index be mapped ? My opinion was that using the Roman frontiers of the 2nd -3rd century was nonsense : the province of *Asia Minor* or *Bithynia* are so big that they would conceal more fine-grained variations. I thus preferred to use a map realized by Samuel Butler in his 1907 *Atlas of Ancient and Classical Geography*[526] displaying the historical regions of Anatolia (partly reflecting the ancient kingdoms) which has been digitized by my colleague G. Verbrugge. Some regions however, namely Pontus, Armenia, Cappadocia and Lycaonia yielded insufficient data to allow a reliable calculation and are therefore represented with dashed lines on the map. These divisions better mirror the ecological fragmentation of the Anatolian peninsula and thus allow a clearer reading of the possible influence of the environment. I am well aware that these frontiers were fictive and largely permeable, and I admit that the value index ascribed to a region mostly relies on the data emerging from the towns, and hence mostly overlooks the conditions of rural settlements. Yet, I thought realizing this map was worth the try.

[526] Posthumous publication.



Overall, the spatial distribution of the index relies on 182 grain-related inscriptions, against a total body of 31,380 counted inscriptions. As we can see, the regions with the lowest intensity of grain-related interventions are Mysia and Cilicia, while the highest value is found in the more landlocked region of Phrygia. In Western Asia Minor, moreover, there seems to be a North –South gradient of increasing intervention. The interpretation of this map is not straightforward: the contrast between Bithynia and Paphlagonia is difficult to explain, since they were equally close to the grain-producing regions of the Black Sea, and given that the same trade routes passed along their shore. Similarly, commercial routes went along the shore of southern Anatolia down to the Aegean Sea, whereas we notice a marked difference in grain supply interventions between Cilicia, Lycia and Caria. The proximity with external commercial circuits thus does not completely account for the observed patterns. Maybe then should we seek some further explanation in the internal environmental and demographic conditions? To test this hypothesis, it seemed sound to compare our map with the one realized by B. Dermody via GIS systems, which displays an index of the surplus and deficits of

Virtual Water (hereafter VW)[527]. Since cereals are the main agricultural production of the region, and the principal consumer of water, VW surpluses and deficits are a good proxy of the difference between local grain production and basic grain requirements.



Map of virtual water surplus and deficits in the EM [reproduced with authorization from : Dermody *et al.* (2014)]

A first interesting aspect of this map is that on the western coast of Asia Minor, the northern part exhibits more surpluses than deficits, while the opposite is true for the southern part. This feature hence agrees quite well with the higher grain-related intensity index observed in Caria and Lycia compared to Mysia. Similarly, we see a light blue zone of VW surpluses in Central Anatolia which broadly corresponds to the historical region of Galatia, in which the intensity of grain-related interventions is quite low. The same is true, finally, of Cilicia : its western part is either at equilibrium or in slight surplus, while its eastern part, *i.e.* the region known as Cilicia Pedias with its fertile alluvial plains of the rivers Pyramos and Saros, appears to be in massive VW

[527] Virtual Water is here defined as 'the freshwater resources embodied in food production and traded among regions' relying on the subsistence consumption of 200 kg of grain per person/year : Cf. Dermody *et. al.* (2014), p. 5025

surplus. In these regions, although Dermody's map has a higher resolution than mine, we see a rough correspondence between the VW budget and the level of intervention on the grain-supply. For Paphlagonia however, the correspondence is more ambiguous: here we notice a rather high intervention index, while the region does not particularly exhibit higher deficits than the neighboring Bithynia where interventions are notably of lower intensity. One region even more strongly departs from the overall pattern: Phrygia. Here, the intensity intervention index is the highest, whereas most parts of the region exhibit quite high surpluses of VW. Here, I cannot rule out the possibility of having severely underestimated the total epigraphic production of this region. Nevertheless, neither the potential trading connections nor the combination of demographic and environmental conditions provide definite explanation for the geographical spread of the intensity of grain-related intervention, although in some regions it appears to be a quite well correlated with the VW budget. So far, I do not pretend being able to explain the observed discrepancies, but an interesting aspect to be looked into which might provide complementary explanations would be the differential level of surplus appropriation: indeed, most of the VW surplus was in the form of grain, and hence mostly possessed by the landowning élite. Different management strategies of this surplus might therefore account for the spatial differences in grain-related intervention.

3.2.3 Modelling the financial sustainability of grain funds

Now that we have discussed the geographical spread of grain doles and grain funds, and since the structure and working of grain doles has now been quite extensively discussed, both in the lexical analysis and in section 3.2.2.2. above, it would be worth looking into more detail how the *sitonìa* actually worked and how efficient it might have been.

Beside the technicalities of its funding which have been discussed earlier, the *sitonìa* is the subject of an important controversy regarding its sustainability : 'Pessimistic' scholars have developed a strong skepticism about the ability of grain funds to constitute a viable response to grain shortages: P. Garnsey, for instance, argues that the *sitonía* consisted of a 'merely incidental response' to food crisis, while M. Silver considers civic grain funds as not only inefficient but also counterproductive since, he claims, they distorted the market and discouraged farmers and landowners from selling their produce on the urban market[528]. Recent research has however

[528] Silver (2007), 95-104.

increasingly emphasized the underestimation of the role of public money in the funding of the grain supply, and developed a more 'optimistic' view of the *sitonía* : J. Strubbe – who showed that this institution had become permanent by the 2nd c. AD – and more recently A. Zuiderhoek and P. Erdkamp. Starting from a revisionist view of the capabilities of civic funds, and downplaying somewhat the major role often ascribed to benefactors, they argue that the *sitonía* illustrates the widespread concern of pre-industrial societies for ensuring a regular affordable supply (like its counterparts in the form of the grain offices of Early Modern Europe), and therefore should be seen as a regular, structural response to food crisis[529].

From both sides of this debate, however, the arguments arise from the analysis of the same – fragmentary – material, namely inscriptions and some texts of Roman law. The problem we face here is that we have no continuous statistical series, no quantitative accounts of the grain funds that could inform us about the relative importance of their intervention or let us know how successful or durable they were from a financial point of view. All the indications we have consist of honorific decrees mentioning monetary contributions of some spontaneous benefactors or *sitónai* to the grain funds, and of some excerpts of the *Digest*. In this section, we aim at moving beyond this stalemate: in the absence of continuous series, we suggest using the tools provided by modern informatics and statistics in order to 'simulate the ancient past'[530], to borrow W. Jongman's phrase. More precisely, we will employ a Monte-Carlo model in order to simulate the financial dynamic of grain funds, based on what we know of the working of the *sitonía*'s funding channels which have been outlined in section 2.2.1 above, and relying on the quantitative data provided by ancient documents as well as some reasonable guesstimates. The main interest of Monte-Carlo simulations lies in their probabilistic nature: instead of producing a fixed quantitative assessment computing a mere set of guesses, Monte-Carlo models provide a wide range of scenarios with different probabilities of occurrence. But most importantly, perhaps, the fact that these models work with random variables appears particularly convenient for the study of the urban food supply in pre-modern societies, for it allows taking into account the average probability of shortages while specifying that their chronological distribution is random. Simple analytical models would be completely unable to integrate the randomness of harvest failures.

[529] Strubbe (1989), 118 ; Erdkamp (2005) ; Zuiderhoek (2008)

[530] Jongman (1988), 19

3.2.3.1 The solvability condition

The first criterion to deal with in order to assess the sustainability of grain funds is their solvability, *i.e.* the balance between their revenues and expenditures over a certain period. In the following sections, we will try to provide a quantitative assessment of the variables affecting the cash reserve of the fund, namely the contribution of benefactors, the amount of civic funds, and the average cost of the grain purchase in time of shortage.

3.2.3.1.1 Dynamic of the grain funds

In the preceding discussion on the funding of the grain funds, we have established that the *sitónia* were mostly funded by monetary gifts from benefactors and by civic funds, and that their only expenditure was the purchase of grain when shortages occurred. It has also been argued that this grain was then resold, most likely at a loss, on the urban grain market, and that the produce of the sale went back to the grain fund. These characteristics can be combined to construct a schematic representation of the *sitonía,* that we suggest as follows:

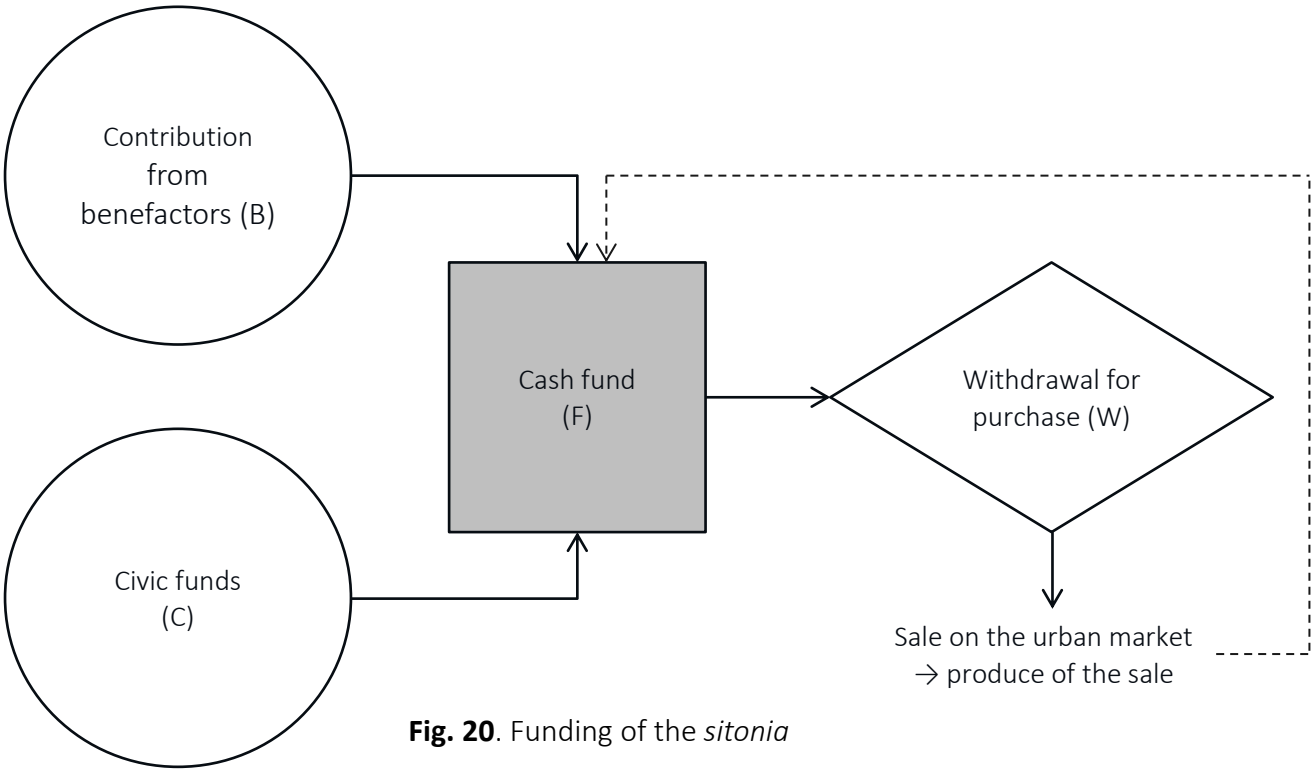


Fig. 20. Funding of the *sitonia*

In a more formal way, the evolution of the cash reserve of the fund follows a simple balance sheet equation :

$$F_t = F_{t-1} + B_t + C_t - GW_t + S_t$$

F : value of the fund
B : value of gifts from benefactors
C : value of the civic contributions
GW : value of the gross withdrawal for the purchase of grain
S : value of the sale realized on the urban market

Since the sale is made at a loss (the selling price being inferior to the purchase price), the fund's dynamic can be described in terms of its net withdrawal (NW) :

$$F_t = F_{t-1} + B_t + C_t - NW_t \qquad (1)$$

with : $NW = GW - S$

The value of the fund at year t equals its value of the year before (t-1), plus the private contributions and public money received during year t (B_t and C_t), minus the money withdrawn on year t for facing the shortage (W_t, if any). This is the fundamental equation describing the evolution of the grain fund as a function of its input and output variables. In the following section, we attempt to provide a quantitative assessment of those variables for us to introduce them into the model. In order to determine whether the *sitonia* was indeed sustainable, the system must obey the trivial **solvability condition** that its cash reserve has to be positive: $F_t > 0$.

3.2.3.1.2 The variables of the model : a quantitative estimate

- *Estimating the cost of a shortage*

In order to estimate the average amount of money that would be needed to cope with a shortage, I calculate the *gross cereal requirements* of our provincial city. Let us consider a population of 15,000 residents[531] (urban and rural) and an urbanization rate of 15%. As usual in economics, this gross cereal requirement can be approached from the expenditure side and from the production side. I will thus make both calculations and take the average value as our starting point.

[531] Here we are taking the high boundary of Stephen Mitchell's statement that in Roman Asia Minor, most cities would have had between 5,000 and 15,000 people ; see Mitchell (1993), 244.

Expenditure side – The cereal requirements can be divided in terms of rural consumption (C_r), seed (S), rents (R) and taxes. As taxes are exogenous to both urban and rural consumption, their inclusion is unnecessary for assessing the effect of shortages as long as the rate of the *decuma* did not change between before and after the harvest shock. Grain requirements can thus be reduced at :

$$Y = C_r + S + R \qquad (1)$$

Rents define the share of production which will end up on the urban market. Reminding that a small part of rents will be hoarded by landowners according to the hoarding rate r_H, urban consumption is given by :

$$C_u = (1 - r_H) \cdot R \leftrightarrow R = \frac{1}{1 - r_H} \cdot C_u$$

Finally, seed can be expressed as a share ψ_S of total produce :

$$S = \psi_S \cdot Y$$

where ψ_S is simply the inverse of the yield/seed ratio. Hence, we can rewrite equation (1) as :

$$Y = C_r + \psi_S \cdot Y + \left(\frac{1}{1 - r_H}\right) \cdot C_u$$

Re-arranging the terms, we get an expression of gross grain requirements as:

$$Y = \frac{C_r + \left(\frac{1}{1 - r_H}\right) \cdot C_u}{1 - \psi_S}$$

Total rural consumption is equal to per capita rural consumption multiplied by the rural population : $C_r = \overline{q_r} \cdot P_r$; The same applies to urban consumption : $C_u = \overline{q_u} \cdot P_u$. Subsistence consumption has been estimated by W. Jongman at 250 kg of wheat-equivalent per person per year[532]. Assuming that peasant consumption is just 20%

[532] Jongman (2007), p. 599. I admit that this value is a high count. Zadoks (2013), p. 79, has set subsistence consumption in pre-modern societies in a range of 150-250 kg of grain. Allen (2009) reached a bare bones subsistence basket in the Roman world worth 172 kg of grain per person per year (pp. 327-

above subsistence on average and that, at this level, 80% of total consumption is made up by grain, grain consumption per capita of the rural population is about 35 modii of grain[533]. Similarly, if urban dwellers are better-off with a level of consumption of 50% above subsistence on average, and if, at this level, grain forms 70% of their intake – as stated by Bennet's Law, the share of income devoted to cereals decreases as consumption above subsistence increases –, per capita grain consumption by urban resident is worth 38 modii[534]. Reckoning with a moderate yield to seed ratio of of 6:1 and a hoarding rate of 5%, gross grain requirements from the expenditure side are a little under 666,300 modii.

Production side – Since we operate at the meso-economic level of a city (nor the microeconomic level of the estate, neither the macro-economic scale of the whole region of Anatolia), we can safely use the production function constructed in chapter 2 from the works of P. Sraffa and H. C. Carey :

$$Y = h^* \cdot \frac{A_a \cdot L_r^n}{\theta \cdot A^m + L_r^n}$$

With h^* being capturing maximum attainable productivity per hectare (set at 3 tons/ha) and technological development; n is the effect of cooperativity on the productivity of labor; m and θ are constant parameters; L_r the rural workforce (derived from the urbanization rate and the share of rural population at work, that is, nearly

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345); Scheidel & Friesen (2009), p. 67, p. 67 calculated a 'respectability basket' of 175 kg of grain equivalent per capita per year. Hence, accepting Jongman's figure of 250 kg of wheat equivalent, and assuming that at this level of subsistence, grain accounts for 85% of caloric intake results in a bare bones consumption of 212,5 kg of grain per person per year. However, this does not change the outcome of my argument : since overall grain requirements (or production) is computed from per capita consumption, a lower per capita would simply induce a lower estimate of gross grain requirements. What matters for the present argument is the *change* in urban grain supply following a shortage. Ths loss in supply quantities depend upon the assumption on the average gravity of the harvest failure, not on the initial value of per capita consumption.

533 The calculation works like this : we multiply the reference level of subsistence consumption expressed in wheat equivalent (here : 250 kg) by the share of total consumption represented by cereals (c_c), and by the level above subsistence (k : if 10%, 1.1 ; if 20%, 1.2…etc). We then divide this value by the volume of one modius (8.62 liters) multiplied by the volumetric mass of grain set at 800 kg/m³ (or 0.8 kg/liter, for which see : http://www.fao.org/wairdocs/x5163f/x5163f02.htm). We thus get the actual grain consumption *(q)* in *modii* from the formula :

$$q_{g\ (mod)} = \frac{c_c \cdot k \cdot q_{s(kg)}}{8.62 \cdot 0.8}$$

534 Urban residents thus consume a little bit more grain than countrymen in absolute terms, but they consume relatively less in proportion of their income.

everyone); and *A* the total grain-producing agricultural surface, which we assume to be 25% of total surface[535]. The important aspect of this equation is that, since we are considering a 'fictional' city, total surface will be a function of population density. Obviously, we cannot extrapolate the very high urban population densities to their hinterland. On the other hand, it would be equally unsafe to apply the average population density of Anatolia (around 0.2 hab/ha). We thus reckoned with an average population density of 1 hab/ha (or 100 hab/km²). With these parameters, we reach a gross production of around 1,627,500 modii, from which we have to subtract the overall losses (assumed to be 30%[536]), as well as seed and taxes. The net available grain output from the production side thus slightly exceeds 835,000 modii. If we now average our expenditure-side and production-side estimates, we reach a value of about 750,000 modii.

From this estimate of overall grain requirements, we need to assess the part which will reach the urban market. S. Mitchell has suggested that 20% could be taken as a standard value for assessing the weight of rents[537]. As we have seen in chapter 2, the weight of rents in total produce might significantly vary, and should often have exceeded that value, but accepting Mitchell's estimate as a canonical starting point keeps the urban supply on the low count and thus makes the calculation more pessimistic. Reckoning further with a hoarding rate of 5%, the quantity reaching the urban market would be around 142,000 modii.

How then was this urban supply affected during a shortage ? To assess this effect, I constructed a simplified supply-demand model of the grain market of a provincial city (see figure 21 below). For this, I hypothesized an initial price of grain of 2.25 HS/modius (cf. section 1.2 above), and applied a fairly inelastic demand curve and a slightly less inelastic supply curve[538]. Indeed, the demand for foodstuffs, especially in pre-industrial economies, is characterized by a fairly low price-elasticity: if the price of grain increases, people cannot long consume fewer calories than they need to survive[539] ; on the other hand, if grain prices go down, after a certain threshold people

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[535] Cf. chap. I

[536] Cf. chap I

[537] Mitchell (1993), I, p. 154

[538] For the detailed model and parametrization, see Appendix 2.

[539] This might seem in contradiction with my earlier claim that intensive agricultural practices often took place in Graeco-Roman agriculture, and that agrarian production experienced a sufficient interspecific (between species) and intraspecific (within species) variation. In fact, the assumption of high inelasticity of demand plays against the point I am trying to make, namely that grain funds were overall more sustainable than previously acknowledged. Adopting a higher level of elasticity of the demand curve would actually *reduce* the cost of intervention of a grain fund in times of shortage.

will not proportionally increase their consumption of grain. The demanded quantities of grain show therefore little variation when its price fluctuates. The supply is also quite inelastic – since it is likely that most producers could only marginally adapt the quantity they produce to the level of prices – but probably less than the demand .Now, in order to represent the effect of a shortage, I considered a harvest shock implying a reduction of total grain output by 15%. Yet, the urban supply after shortage would not merely be 15% lower than our initial value, since it is unlikely that the hoarding rate remained constant: farmers and landowners would probably store some grain either for security or speculation. We have naturally no quantitative data to assess the share of grain that could have been hoarded, but for the sake of this argument, I assumed the hoarding rate would be doubled (from 5 to 10%.) The urban grain supply after shortage would thus be of 114,500 modii, or a loss of some 27,500 modii. In economic terms, an exogenous shock like this is represented on the graph by a movement of the curve concerned : here, the supply curve would be displaced upwards and backwards[540].

This reduction in supply would of course not have left prices unaffected. The equilibrium between supply and demand indeed moves from e_0 to e_1, and stabilizes at a higher level of prices for a smaller available supply. With the parameters of the model, given a loss of 15%, the new price would be 4.25 HS per modius[541]. Here is where the *sitonai* intervene: as explained earlier, their purpose is to buy this grain as cheaply as possible. What they would do in most cases is to import it from a region which does not experience a situation of scarcity, or even produces a surplus. But they would strongly negotiate with owners of grain stocks and mobilize their social and political influence in order to lower the price. It is thus unlikely, to go back to our example, that *sitònai* would buy grain at 4.25 HS. Most probably, they would manage to obtain a rebate on the price. Yet, the discount they would get would be lowered once we factor in transport costs, which were notably prohibitive, especially for land transport. All in all, and in the perspective of staying as pessimistic as possible, we assumed that the *sitónai* of our city would obtain a net discount (transport costs included) of ¼ of HS per modius, which would result in a purchase price of 4 HS per modius. As explained above, this grain was most likely sold at a price close to the initial price (2.25HS in our

[540] Remember that economists usually put the quantities on the X axis and prices on the Y axis, which means that a displacement of the curve backwards and upwards implies a smaller equilibrium quantity.

[541] This result broadly fits Arjan Zuiderhoek's and Paul Edkamp's statements that, due to the inelasticity of demand, even a minor reduction of output would provoke a significant price increase (Zuiderhoek (2008), 160 ; Erdkamp (2005), 147). Here, we neglect the positive retro-active effect of the shortage on the demand: some categories of individuals would anyway reduce their consumption, driving thereby prices downwards and counterbalancing, even if to a limited extent, the price increase. Neglecting this phenomenon, again, makes the situation we consider even worse.

simulation), but probably a little above – the *sitonìa* being, in our understanding, a form of institutionalized *paraprasis*. We thus set the resale price at 2.5 HS. Since the price differential is of 1.5 HS, the total cost of the 27,500 modii would represent an expenditure of some 41,500 HS.

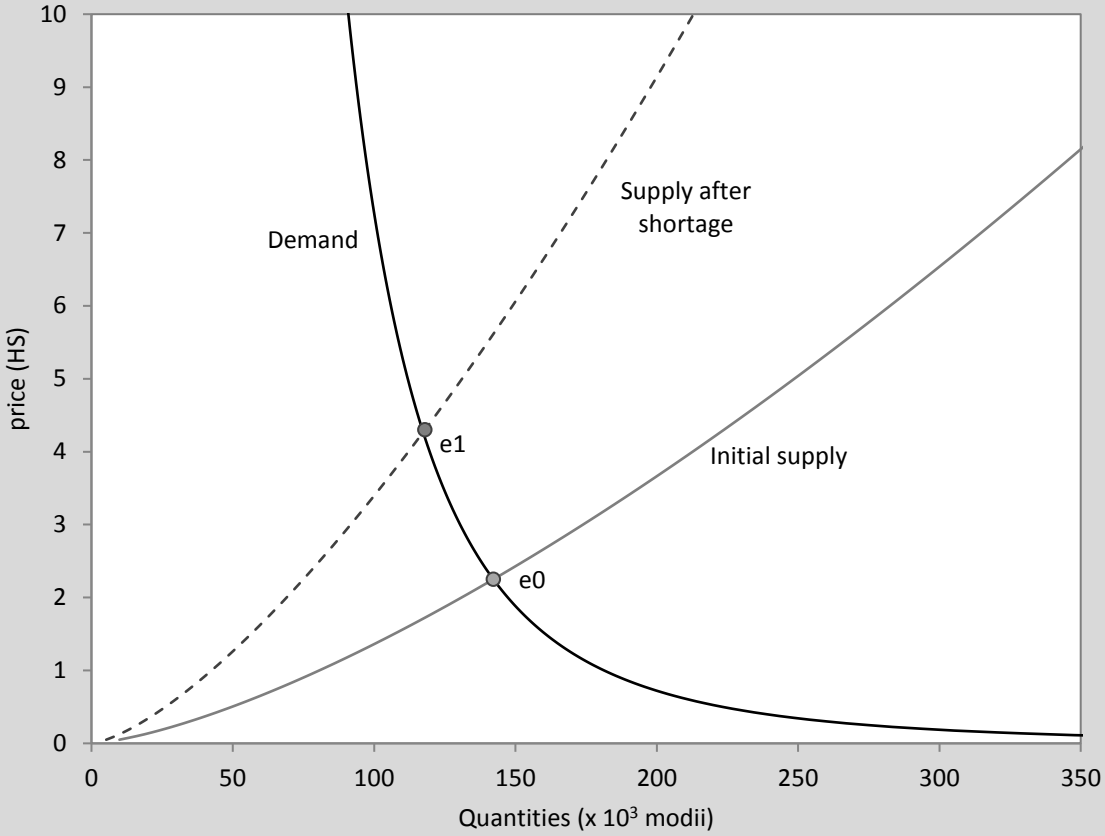

Fig.21. Supply-Demand model of the grain market in a provincial town of the Roman Empire experiencing an exogenous shock.

It is probably unrealistic, though, to consider that grain funds were the community's sole defense against shortages. Even if they constituted a structural response, in so far as they became permanent institutions with officials appointed every year, they must have represented only one solution to food crisis among various measures : the city could strengthen its relationships with neighboring regions to directly import grain from them (i.e. aside from the mechanism of the *sitonía*), use local stocks of grain, fix maximum prices, restrict exports of grain from its own hinterland, etc[542] Yet, in order to stay as close as possible to the most pessimistic situation, we will ignore those

[542] Migeotte (2010), 305-306

complementary strategies. Under those conditions (purchase at 4 HS and resale at 2.5 HS), such a shortage would thus require the withdrawal of 41,500 HS from the grain fund on average.

Yet, one parameter is still missing from the model: the frequency of shortages, defining how often money would be withdrawn from the frain fund. In his study on food crisis in Antiquity, P. Garnsey has reached the conclusion that Attica – a region known for its drought – faced crop failures every 3-4 years (or a probability comprised between 25 and 30%)[543]. In the case of Asia Minor, J. Kobes suggests rather that shortages occurred once every 5 years[544] (or a probability of 20 %) – a frequency considered pessimistic by F. Kirbihler[545]. Hence, in the following computation, and given that Asia Minor was a far more fertile region that continental Greece, as demonstrated in chapter I, we consider that harvest failures occurred on average once every 6 years (or one year for every 5 years without shortage, *i.e.* a probability of 1/6 (16.6%)). Those probabilities, it must be said, refer to the wheat harvests and are therefore particularly pessimistic since wheat requires much more water than barley. But for the sake of the robustness of our estimate, we will apply the probability of crop failures for wheat only.

As a final assumption, the model considers that the grain fund would remain unused for a short period[546] after its 'foundation' in order to ensure a starting capital before proceeding to the first withdrawals. What allows this hypothesis is first that such a procedure is widely attested for foundations[547] and, second, that even for the grain funds whose capital could be used – the majority of them –, it is likely that ancient Greeks and Romans had realized the need to allow them to accumulate money in order to increase their probability to be sustainable in the longer run.

❖ *Assessing the contribution of benefactors*

What was the sum contributed annually by the élite to the grain fund of an average provincial city ? To answer this question, we need to start with an estimate of the average sum spent annually by the élite on benefactions. This annual élite

543 Garnsey (1988), 17. This applies for wheat only ; crop failures of barley are less frequent.

544 Kobes (1999), 81-98

545 Kirbihler (2006), 617

546 Here, we assumed that grain funds would not be used during the first year only, which sets them with an initial capital of some 10,000 HS.

547 Migeotte (2014), 184

expenditure on benefactions (AEB) is equal to the number of potential benefactors, multiplied by the price of an average benefaction (all purposes mixed) and their frequency during the course of the benefactor's career, divided by the length of its career. The most complicated assessment of this equation is to calculate the value of an average – generic – benefaction.

To do this, we assembled the data provided by T.R.S. Broughton and those presented by A. Zuiderhoek, and completed them with our own database focused on food-related munificence. Through this, we collected a range of 131 benefactions whose sum is explicitly mentioned (see table 4, appendix 1)[548]. This distribution of sums cannot however be used as it is, for it is heavily biased towards expensive benefactions. What we need to bear in mind here, is that we attempt to calculate the value of a theoretical, generic, unitary benefaction that would take into account the probably numerous, common, smaller acts of euergetism which are probably concealed behind the most prestigious and conspicuous benefactions performed by the top ranks of the city's élite. We thus first decided to truncate the distribution by eliminating the 7 benefactions over 125,000 denarii – among which three benefactions are simply excessively expensive (2,000,000, 550,000 and 400,000 denarii). If those seven sums severely distort the statistical parameters, their suppression is however, from a statistical point of view, not a big problem, since they represent only about 5% of the total data. There is however, as mentioned above, another bias: the one affecting the smallest gifts. Indeed, even if the small benefactions are more frequent in the data than the more expensive ones, it is likely that, proportionally to their actual occurrence in ancient times, they have been less represented epigraphically than bigger gifts; we therefore deliberat increased the number of sums inferior to 1,250 denarii (the annual revenue of a city councilor owning exactly the required census minimum of 25,000 denarii set at 5% rate of return[549]) to reconstruct what the actual distribution might have been[550].

Through these procedures (truncation and increase), we corrected the problem of the variance of the distribution. But since we want to estimate the value of the most common benefactions, we also need to take into account their frequency. We thus organized the sums in classes of 2,500 denarii and calculated the class frequencies (*i.e.*, the number of sums of each class divided by the total number of sums of the

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[548] Some of those sums are expressed in drachmai; while this would impose a conversion for the Hellenistic period or even the 1st c. BC, for the Imperial period, numismatists largely agree on a simple equivalence between the *denarius* and the *drachma*, for which see Doyen (2012), 62 & 99.

[549] Zuiderhoek (2009), 29

[550] I am thankful to M. Maxime Fontaine, teaching assistant at the department of Applied Economics of the ULB (DULBEA) who informed us about this technique. The details are described in Appendix 1.

distribution), with which we constructed a weight coefficient equal to the class frequencies normalized from 0 to 1, and multiplied each sum by the weight coefficient of its class[551]. This leaves us with a distribution corrected from both the variance and the frequency; to estimate the value of our average unitary benefaction, we simply calculated the median of this new, corrected distribution, which provided a result of 6,170 sesterces (noted HS below) or a little more than 1,540 denarii.

Yet, how many such benefactions would be performed annually on average ? To answer this question, we first need to estimate the number of potential benefactors. Let us go back to out provincial city of 15,000 inhabitants. The most likely benefactors are of course the members of the bouleutic élite, for which a size of 200 members probably constitutes a reasonable average[552]. Here, we assume that this first category of benefactors would perform the equivalent of 4 *average* benefactions in a 25 years career, that is, a little less than two *average* benefactions per decade, which does not seem unreasonable especially if we compare the value of our average gift with the minimum wealth criterion of the *ordo decurionum*[553]. Yet, the city councilors do not make the whole population of benefactors. Indeed, there are equally wealthy households who do not belong to the decurional order, and whose number is

[551] See Apendix 1 for the full procedure.

[552] But we need to bear in mind the huge variation, between the 60 *bouleutai* of Cnidus and the 500 of Oenoanda.

[553] This equivalent of 4 average benefactions might seem arbitrary. The problem faced with the data is that, in inscriptions, the exact number of benefactions performed is almost never clearly stated, unless it refers to the trivial situation of a single act of munificence, which is the vast majority of cases. But when the benefactor has done multiple gifts, his actions are simply expressed in the plural rather than rigorously counted. In those cases, we only understand that the dedicatee of the inscription has performed 'more than one or two' acts of euergetism. We know, of course, of some exceptional benefactors, like Opramoas of Rhodiapolis, who performed dozens of different acts of munificence. But Opramoas was extraordinary wealthy, and was undoubtedly an exception, even among the highest echelons of the city's élite. Moreover, generosity and wealth must also have varied from one councilor to another. In another database focused on benefactions towards public buildings in Asia Minor in the 1st and early 2nd c. AD, we find that the most involved benefactor has intervened 9 times. This case is, again, exceptional : 64% of the recorded benefactors have performed two interventions or less, 13% have made 3 benefactions, 8% have made 4 of them, and another 8% intervened 5 times. The value representing realistically the number of interventions of the top ranks of the city's élite must therefore be somewhere between 3 and 5. Yet, since low-value benefactions are most probably under-represented in the sources (relatively to their actual frequency), and given that most of those low-value benefactions were in all likelihood performed by modest benefactors who intervened only once in their career, we must admit that the proportion of individuals performing less than 2 gifts should be increased, which would mechanically lead to reduce the proportion of individuals performing 3, 4 and 5 benefactions. In the face of this rough distribution, the number of 4 average benefactions in 25 years career seems reasonable for the members of the bouleutic order. Some might find it too low since the database considered here refers only to public buildings and does not take into accounts food distributions and festivals, but conserving this modest value tends to limit the inputs to the grain funds, which works against our argument that such funds would, overall, be financially successful enough.

estimated by W. Scheidel and S. Friesen as being at least half the number of decurions, which leaves us with 100 more potential benefactors. But we also need to account for non-elite munificence[554]. For this, we suggest to use the non-elite income scale established by W. Scheidel and J. Friesen for the Roman Empire as a whole. To estimate the number of sub-elite benefactors, we gathered the income categories of level 2 to 5 from Scheidel & Friesen (the people whose income goes from 3 to 10 times subsistence, making 3.5 % of the total population)[555] representing the benefactors who, we assume, perform 1 average benefactions in 25 years. We would thus end up with 525 sub-elite households potentially able to perform benefactions (3.5% of 15,000). Yet, Scheidel and Friesens's categories are based on households, and thereby include wives and children. If we reckon with an average number of 4 people per household, the total number of adult males potentially of this category would be 525/4, which is 131. Yet, those are not the only effective benefactors, since we know of women performing benefactions in their own name, both in the Hellenistic and Roman periods[556]. But how can we estimate their proportion? In our database of food-related munificence, only 5 out 145 benefactors are women, which makes a little less than 3.5%. However, among 98 benefactors from another database on public buildings, 8 women are mentioned, making some 8% of the total. Since we are trying to estimate the intensity of female munificence on average, generic benefactions (*i.e*. considering a basket of gifts where all purposes are mixed (buildings, food, etc…)), the proportion of women must have been somewhere between those two values, and we assumed therefore that the proportion of female benefactors was about 5%. Hence, we must increase the number of non-bouleutic élite members and that of sub-elite benefactors by 5%. The following table sums up the different categories of benefactors, their size and our assumption about the number of gifts they performed :

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554 Non-elite benefactors are clearly documented in inscriptions : *IK-Ephesos*, 3006 (cf. Halfman (2004), pp. 43-44); *IK-Ephesos*, 411 & 4123 (cf. Halfman (2004), p. 54 & Pont (2010), p. 261 & pp. 270-271) ; *IDidyma,* 140, 264 & 327 . For a recent account, see in particular : Kantirea (2016), pp. 471-494. Non-élite or sub-élite benefactors however start disappearing from the documents during the 2nd c. AD.

555 Scheidel & Friesen (2009), 83-84.

556 Bielman-Sanchez (2003) ; Van Bremen (1996)

Table 4 – Number of benefactors and gifts by social category

Category of benefactors	Size	Number of gifts per 25 years
Elite		
Bouleutic order	200	4
Non-bouleutic elite	105	2
Non-elite		
Sub-elite benefactors		
(Men)	131	1
(Women)	7	1

The average number of benefactions per year ($\tilde{n}$) is thus easily derived:

$$\tilde{n} = \frac{(200\times4) + (105\times2) + (131 + 7)\times1}{25} = \frac{1148}{25} \approx 46$$

To calculate the annual private expenditure on benefactions, we just need to multiply this number of average benefactions per year by the value of one average benefaction (6,170 HS), which yields 283.820 HS. This sum, however, concerns all targets of munificence : public buildings, festivals, food, money distributions,...etc. Which part of this sum would go specifically to food benefactions ? In the data collected by Arjan Zuiderhoek, food-related munificence makes only a little 3% of the total[557]. Taking 3% of our 283.820 HS yields us an annual average expenditure on food-related munificence of 8,515 HS. Of course, percentages in volume and in value may well differ, but since we seek a rough estimate rather than a precise number, it is not much of a problem. Yet, again, this sum concerns all the food-related acts of munificence, of which the funding of the *sitonía* is only one aspect. In order to estimate which part of this sum actually entered the grain fund, we need to know the relative weight of the *sitonía* in the landscape of food supply systems, that is, the 'probability' for a contribution to be targeted towards a grain fund[558]. In our database, the *sitonía* occurs 70 times in a

[557] Zuiderhoek(2008), 172

[558] The propensity for élites to contribute to the grain fund must have varied: in times of dearth, most municipal élites would have been concerned about avoiding the riots that could emanate from the scarcity of grain. However, the same notables who act as benefactors are also the landowners who would also make profit from hoarding grain in the case of bad harvests, waiting to benefit from higher prices.

sample of 170 food-related interventions, that is, a rough 40%. The annual average private contribution to the grain funds may thus be set at 40% of 8,515 HS, which is about 3,400 HS.

❖ *Assessing the value of civic funding*

From this sum, it is now possible to derive an estimate of the *average* amount of civic money financing the grain funds each year. Indeed, the average total annual revenue of the *sitónion* (R_{TOT}) is equal to the sum of the private contributions (B) plus the civic contributions (C) :

$$\bar{R}_{TOT} = \bar{B} + \bar{C} \quad (2)$$

Yet, both civic and private funding can be expressed as a share (θ) of the total:

$$\bar{B} = \theta_B \cdot \bar{R}_{TOT}$$
$$\bar{C} = \theta_C \cdot \bar{R}_{TOT}$$

with $0 < \theta < 1$ and $\theta_C + \theta_G = 1$, by definition ; rearranging the terms of these two equations and isolating C gives us :

$$\bar{C} = \frac{\theta_C}{\theta_B} \cdot \bar{B} \qquad (3)$$

The share of private and public contributions (θ_C / θ_B) in the total is not very difficult to estimate : in our database, among the 70 attestations of the *sitonía*, 23 explicitly refer to a benefaction or to a liturgical contribution from the *sitónès* in office, that is, a mere 33% of the total. Including the *ex officio* payments in the private contributions is questionable, because financial participation from officials was, if not compulsory, at least highly recommended – despite the growing confusion between magistracies and liturgies that we notice from the late Hellenistic period[559]. Yet, doing so increases the proportion of private funds (θ_B) and therefore lowers the assessment of the public contributions – they are indeed inversely proportional to this coefficient in equation (3) – and therefore goes against our argument, for it also drives the total contributions to grain funds downwards. It is of course difficult to prove that the remaining 67% of

For the simplicity of the model, we could therefore assume that speculation and euergetism would counterbalance one another.

[559] Cf. below

the attestations of the *sitonía* were financed with civic money, since we argue precisely that most of the time such customary payments were not explicitly stated. However, inscriptions usually do not miss mentioning *ex officio* contributions (liturgic payments or *ob honorem* munifence); this is true *a fortiori* for spontaneous gifts. If it was not the benefactors or the liturgists who paid for the *sitonía* in those 67% of cases, then 'the civic government', as Arjan Zuiderhoek notes, 'is the most likely candidate'[560]. If we round those values, we can set the ratio of the share of public to private funds at 0.65/0.35. Multiplying this ratio by our estimate of the private contribution to grain funds yields a value of around 6,325 HS spent each year by the city to finance the *sitonía*. The average total sum allocated to the grain funds annually may thus be estimated at 9,840 HS, or a little less than 2,500 denarii.

However, would the city have been able to draw in sufficient revenues to finance its contribution to the *sitonía*? Contrary to the widespread pessimistic approach of civic finances, Greek cities of the Hellenistic and Roman periods had various sources of revenues at their disposal[561] : incomes from public estates, tolls and fees from public amenities, bequests, indirect taxes on commerce, sometimes direct taxation in kind, *ex officio* payments…to which public subscriptions and euergetism are probably only a complement. Let us make a quantitative assessment: given that the value of a year's subsistence for one individual roughly equals 115 HS, the subsistence GDP of our community of 15,000 people is about 1,725,000 HS. If, following Hopkins' estimate, we assume that actual GDP equals 1.5 times subsistence GDP[562], the actual GDP of our city is worth 2,600,000 HS. Reckoning with a low overall tax rate of 2.5%, the value of public revenues from taxation alone equals 65,000 HS. In those circumstances, our estimate of the civic contribution to the grain funds (6,325 HS) would make up some 10% of the city's public expenses. Even in this fairly restrictive approach of civic resources, it is not unreasonable at all to consider that the cities would devote one tenth of their budget to a system facilitating the access to an affordable supply of grain to the citizens. On the other hand, table 3 sums up the range of variation of the proportion of civic funds spent for the *sitonía* for different shares of taxation in civic revenues. As we can see, in the middling situation where taxation accounts for 75% of all civic incomes, the city's expenditures on grain funds would represent only 7.3% of its budget.

[560] Zuiderhoek (2008), 170

[561] Migeotte (1995), 86 ; See also Fröhlich (2005), 251

[562] Hopkins (2002), 200-201

Table 5 – Proportion of civic expenses for the grain funds as a function of the share of taxes in civic revenues

	Share of taxation in civic revenues		
	2/3	3/4	4/5
Proportion of civic expenditures for the *sitonía* (%)	6.5	7.30	7.78

❖ *Feedbacks*

As it has been conceived up to this point, the model is dynamic but does not account for the possible feedbacks in the propensity of civic governments or benefactors to modify their contribution to the grain fund according to its cash reserve. In other words, so far we have considered that the civic and euergetic contributions to the grain funds were independent from the value of the fund. As far as civic expenditures are concerned, grain supply was likely too important a subject to take the risk to deviate strongly from their average contribution. But the same does not apply to private munificence, and it is probable that benefactors would be tempted to increase their contribution when the fund's reserve was being eroded. Similarly, as the fund would experience significant cash surpluses, benefactors would likely feel their participation as less indispensable and hence would probably contribute less. I thus added a retroactive effect of the cash reserve upon private munificence according to the following formula:

$$B(F) = \frac{\Lambda}{F_t} \cdot \bar{B}$$

B(F) is the benefactor's contribution as a function of the cash reserve F_t, and Φ is a threshold value set at 7,000 HS[563]. This equation means that, if the cash reserve F_t is lower than the critical threshold (Λ), the contribution of private munificence would be higher than its average value $\bar{B}$. Conversely, if the cash reserve is higher than the threshold value, the benefactor's contribution would be lower than average.

[563] This value is critical since, if the fund stays at or under this value for 6 years (the average time span during which one shortage occurs), it would not be able to face the average withdrawal of about 42,000 HS. In other words, the threshold value can be seen as the average withdrawal multiplied by the probability of a shortage to occur (42,000 x (1/6) = 7,000).

Here, I need to insist on the fact that the whole argument which has been constructed so far is based on quite pessimistic hypotheses. In every case, my assumptions tend to lighten the income of the grain funds and to drive up its expenses as much as possible, but not so much as to counter my own reconstruction of the working of the funds. Firstly, my calculation relies on the value of an average, generic benefaction, which was calculated by using two statistical procedures (truncation and correction of frequency) which *both* tend to drive the result downwards. Since, in this model, the estimate of the average value of civic expenditure on the grain funds is derived from the value of the average private contribution to the fund – cf. equation (3) – , this downwards tendency also affects the value of the total contributions to the *sitónia*. Secondly, it is based upon the assumption that each of the wealthiest benefactors of the city, namely the bouleutic elite, would only perform the equivalent of four average gifts in 25 years[564]. Thirdly, it reckons with a ratio of public to private funds that is quite favorable to the latter[565], which also tends to limit the result of my assessment of the yearly public contribution to the *sitonía*. This set of assumptions, therefore, makes it even more difficult for me to prove that grain funds were overall financially sustainable in the mid and long run.

3.2.3.1.3 Basic principles of Monte-Carlo simulations and settings of the model

Let me now expose the working of this Monte-Carlo simulation[566]. It is of major importance to understand that the model which has been constructed does not simply introduce our set of assessments and guesses as they are. The values I obtained for the average income of the grain funds and for the average withdrawal in times of shortage are considered by a Monte-Carlo simulation as *random* variables. We must therefore specify – or assume – what probability distribution best describes them[567] (Gaussian, binomial, uniform, Poisson,...etc.). How the model proceeds once this specification is done is quite simple: for each variable, the model will simply generate random numbers along the variation margin of its probability distribution. It will then

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[564] Four such gifts would represent a little 24,700 HS, or 6,200 denarii. If the patrimony of this bouleutic élite consists mostly of landed property set at a 5% rate of return (cf. Duncan-Jones (1982), 33), and if they own no more than their census minimum of 25,000 denarii, their patrimony would yield 1,250 denarii per year, or 31,250 denarii in 25 years. Our guess then assumes that such members of the élite would spent maximum 19% of the income they would accumulate during their career on benefactions.

[565] Since we included the liturgic payments as 'private contribution', which is debatable in itself because liturgies could be seen as a classical mechanism of civic finances rather than a helpful financial assistance of the citizens in their own name.

[566] The model has been coded on MATLAB – 2011

[567] See appendix 3 for the discussion

determine the value of the dependent variable (the amount of money inside the grain fund) following the initial equation. However, in order to acquire a statistical significance, the model will run this procedure thousands of times and will then derive the average scenario among all those which have been generated. Said differently, a Monte-Carlo simulation runs a huge number of different scenarios within the variation margin of the considered variables. The outcome they produce, therefore, is not a 'fixed' result, but an average scenario with a statistically significant probability.

In those respects, Monte-Carlo simulations are more analytically sophisticated than the procedure of mere computing of a series of parameters and guesses: they actually strengthen the picture they provide by running a calculation that takes into account the variation margin applied to each variable. As we can see from table 2, we have applied fairly large variation margins to our input variables in order to consider a wide range of scenarios:

Table 6 – Inputs of the model

Variable/parameter	Value	Error margin	Distribution
Private contributions (B)	3,400 HS	75%	Uniform
Civic contributions (C)	6,325 HS	25%	Uniform
Withdrawals (W)	41,500 HS	50%	Binomial[568]
Probability of shortage (P)	1/6	——	——

With those parameters, the model has simply computed the value of the cash reserve (F) of the grain fund, as expressed by equation (1) :

$$F_t = F_{t-1} + G_t + C_t - NW_t$$

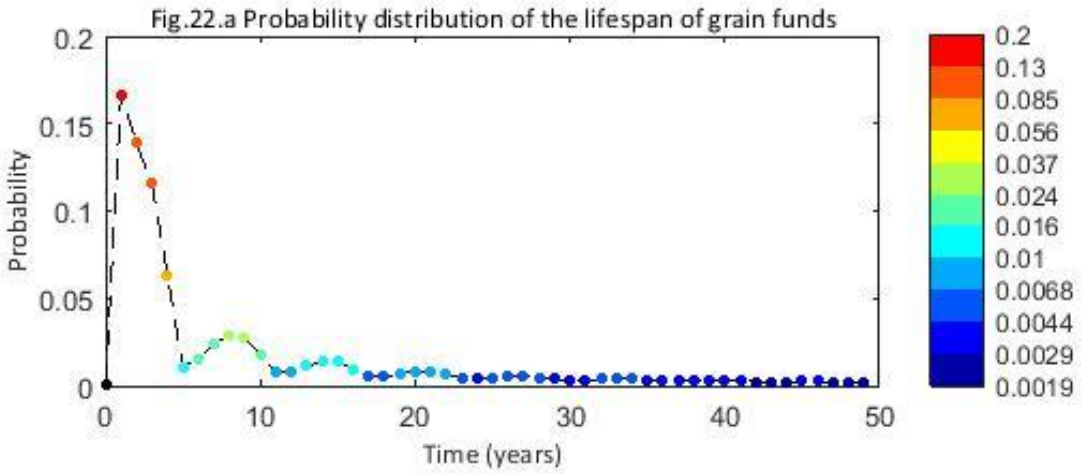
We have thus run this computation for 1,000,000 scenarios over 50 years. This means that our model examines the evolution of the cash reserve of 1 million grain funds during 50 years, and then calculates how many of them have collapsed over this time lapse and when they did.

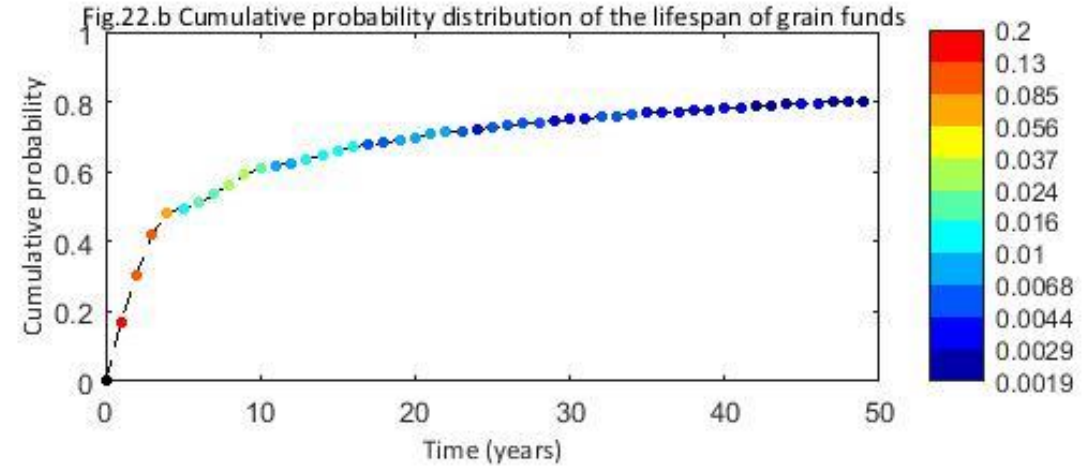
3.2.3.1.4 Analysis of the model (I) : how long could grain funds survive ?

The first and most important outcome of the model is to display the probability of survival of the grain funds according to their lifespan. Stated differently, what is the probability that a grain fund would remain in operation for, say, 15 years? Or, after how many years and how frequently would the reserve of the grain fund become

[568] For the explanation, see Appendix 3

insufficient to face the next shortage? This result is illustrated in figures 22a and 23a (the probability distribution curve) and 22b and 23b (the cumulative probability curve), where each point represents a group of scenarios (all the funds collapsing at age *t*), the probability of which is indicated by its color.





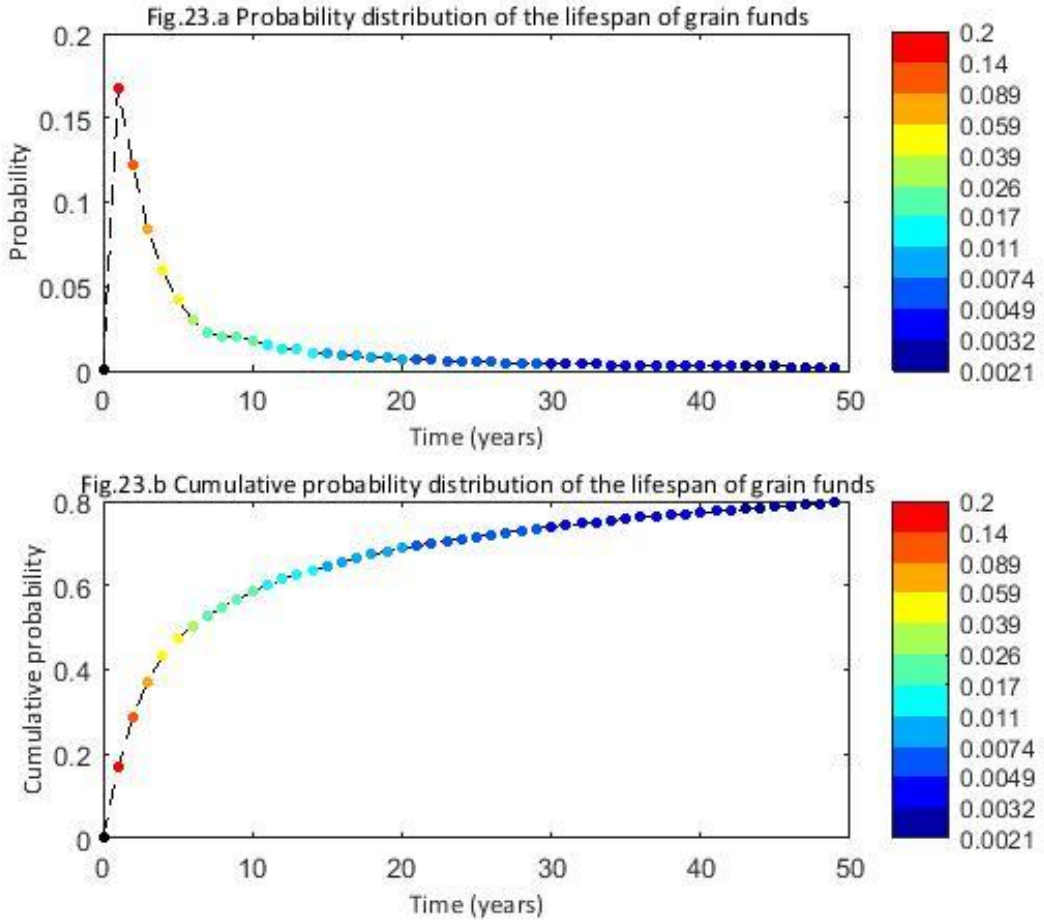


Fig. 22 displays the survival probability distribution of grain funds with an alternative error margin of 25%, while Fig. 23 represents the probability distribution with the standard error margin of 50%. On both graphs, the probability distribution takes the form of a hump-shaped curve, massively skewed in favor of the earliest ages. What these graphs reveal is that grain funds with long lifespans are less likely to occur than grain funds of shorter lifespans. However, although most grain funds would collapse between in their first ten years of operation, we still observe on the cumulative probability curve that about 20% of the funds could survive more than 50 years, since the maximum value on the Y axis is 0.8.

A striking characteristic of those figures is the important number of grain funds crashing in their early development: a little less than 50% of them collapse within the first 5 years, and the probability for a fund to crash in its first year is about 17% (one

year of shortage for 5 years without, or, once in 6 years)[569]. On the cumulative probability curves – the maximum value is approximately 0.8. This means that in our simulation, which, as we saw, is based on quite pessimistic assumptions, 80% of the funds would crash in less than 50 years. But this also means that in this pessimistic scenario, still 20% of the funds could *theoretically*[570] survive more than half a century. Moreover, despite the significant mortality of grain funds in their first years of working, some 20% of them could survive for a period between 10 and 50 years.

The different shape between Fig. 22a and 23a requires an explanation. One could expect the probability distribution to be continuously decreasing on both figures, meaning that funds which survived for longer periods were less common than those which survived for shorter periods. Yet, this is not exactly what appears on the Fig. 22a, since we can clearly see oscillations of the curve : the probability for a fund to survive exactly 6 years is lower than the probability to survive 8 years, just like the probability for a fund to survive exactly 12 years is lower than its probability to survive 15 years. The explanation for those oscillations is to be sought in the random distribution of shortages through time as well as in the width of the error margin. An example could make things clearer to the reader : let us consider a first grain fund of 50,000 HS and a second of 75,000 HS. Since the average withdrawal generated by a shortage is roughly 40,000 HS, both these funds would crash after 2 shortages. However, it is less probable that those two shortages would occur in 6 years than in 8 years. The oscillations of the probability distribution curve are therefore a consequence of the discontinuous – or *discrete* – character of the event commanding the withdrawals. Yet, mathematically speaking, increasing the margin of error on the withdrawals is the same as increasing the randomness of the occurrence of shortages, or, said differently, as spreading the withdrawals over a higher number of years. The result is that differences occurring from the *discrete* character of shortages are evened out.

A final feature of these figures worth emphasizing is that there is no marked decrease in the probability of survival of grain funds between a lifespan of 25 years and one of 50 years. This seems to imply that, after a determined threshold, the grain funds

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[569] In this case, we notice that the probability for a fund to collapse in its first year is simply equal to the probability of occurrence of a shortage. This is simply because the average withdrawal required during a shortage largely exceeds the money accumulated after one year : after the 1 year security period, the fund has accumulated a little more than 10,000 HS. If we add the money accumulated in the first year during which the fund can be used, its cash reserve reaches some 20,000 HS. Yet, the average withdrawal equals some 42,000 HS.

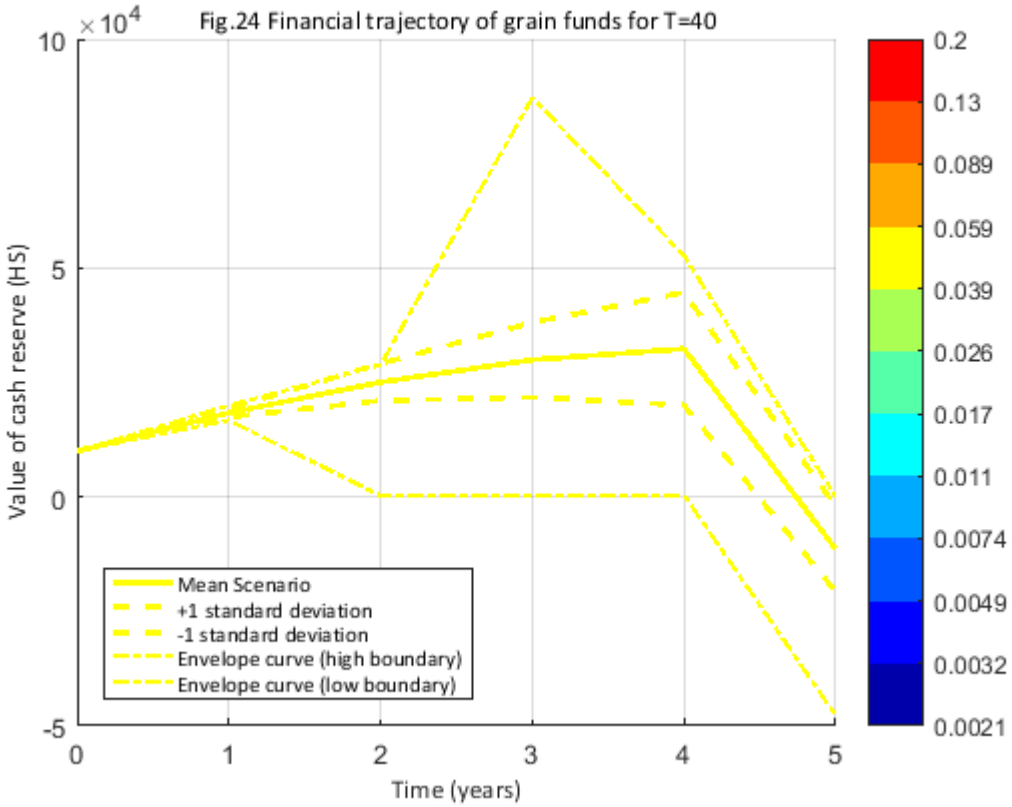
[570] The emphasis is important: that those funds could be financially solvable over half a century does not mean that they could not be removed or shut down by an administrative decision. Economic sustainability does not prevail over institutional changes.

become financially more stable, but at the cost of a huge number of funds collapsing in their early years of working.

3.2.3.1.5 Analysis of the model (II) : scenarios of financial trajectory of grain funds

Now that we have seen the relationship between the lifespan of grain funds and their probability, we need to examine how the cash reserves of grain funds of different lifespans evolved through time, from their foundation to their collapse. For this, we examine 4 scenarios : the grain funds collapsing at the age of 5, 10, 20 and 40 years.

- *Grain funds with a lifespan (T) of 5 years*

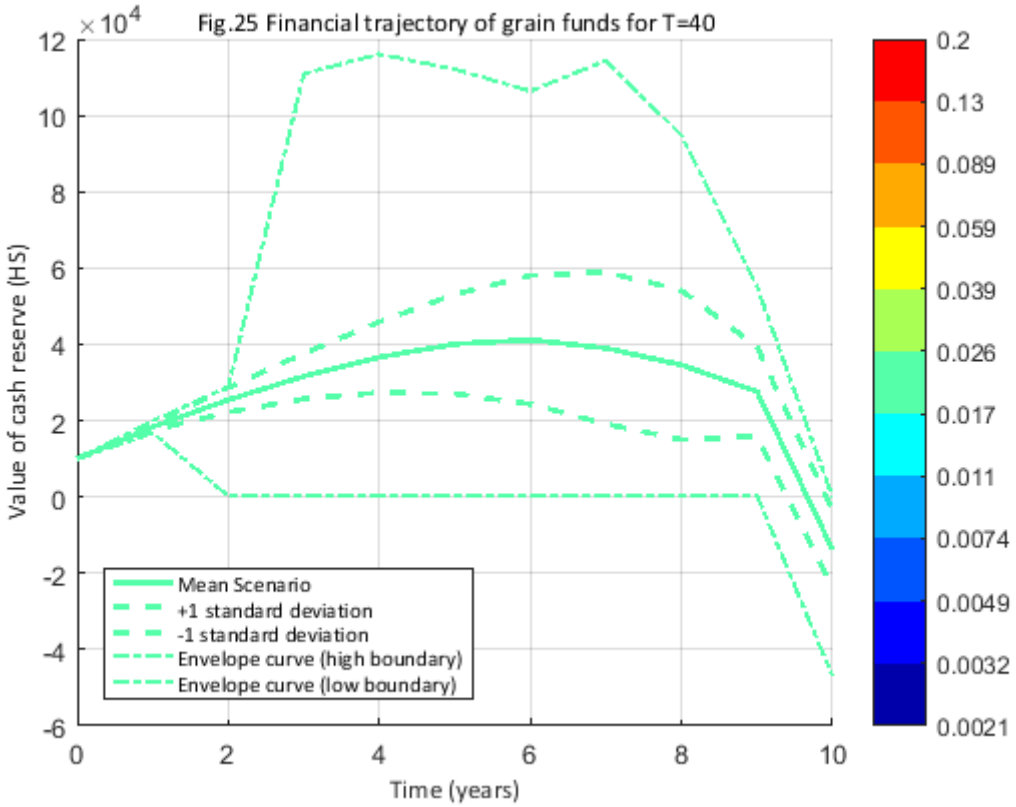


How has this graph been produced? The procedure is quite simple: among the 1 million grain funds simulated, the model considers all the grain funds that collapse at the exact age of 5 years. It then determines the average financial trajectory of this sample of funds (the middle curve). Yet, to analyze a wider number of situations, we required the model to produce the curves defining an interval of one standard deviation around the mean scenario. According to fundamental statistics, about 68% of the grain funds with this lifespan are comprised between the limits of those curves. As for the top and bottom curves, they simply define the limits encompassing 100% of the trajectories of those grain funds (in mathematics, they are called 'envelope curves'). In this graph, as well as in the others, the color of the curve represents the probability of the scenario

(scaled on the color bar), or here, the probability for a grain fund to collapse after exactly 5 years. In the present case, this probability is approximately 5%.

Two features are noticeable on this graph: first, we see that the average trajectory of the funds is concave, meaning that money accumulates in the grain fund until a critical point from which the value of the fund drops sharply. Secondly, we see that, for the main part of the graph, the surface comprised between the lower envelope curve and the lower standard deviation curve is greater than that between the upper standard deviation curve and the upper envelope curve. This means that, in this pattern, only a small proportion of funds experienced an average financial trajectory much better than the average, while the majority of them experienced a rather precarious situation.

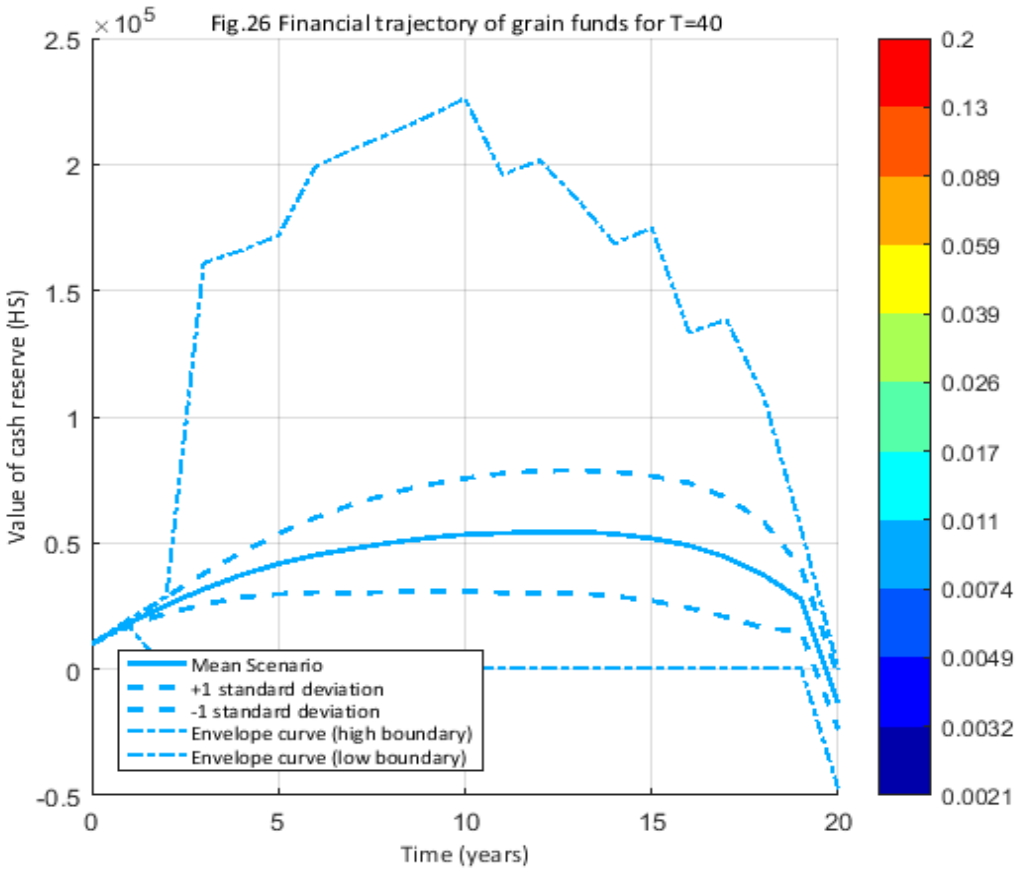
❖ *Grain funds with a lifespan of 10 years*

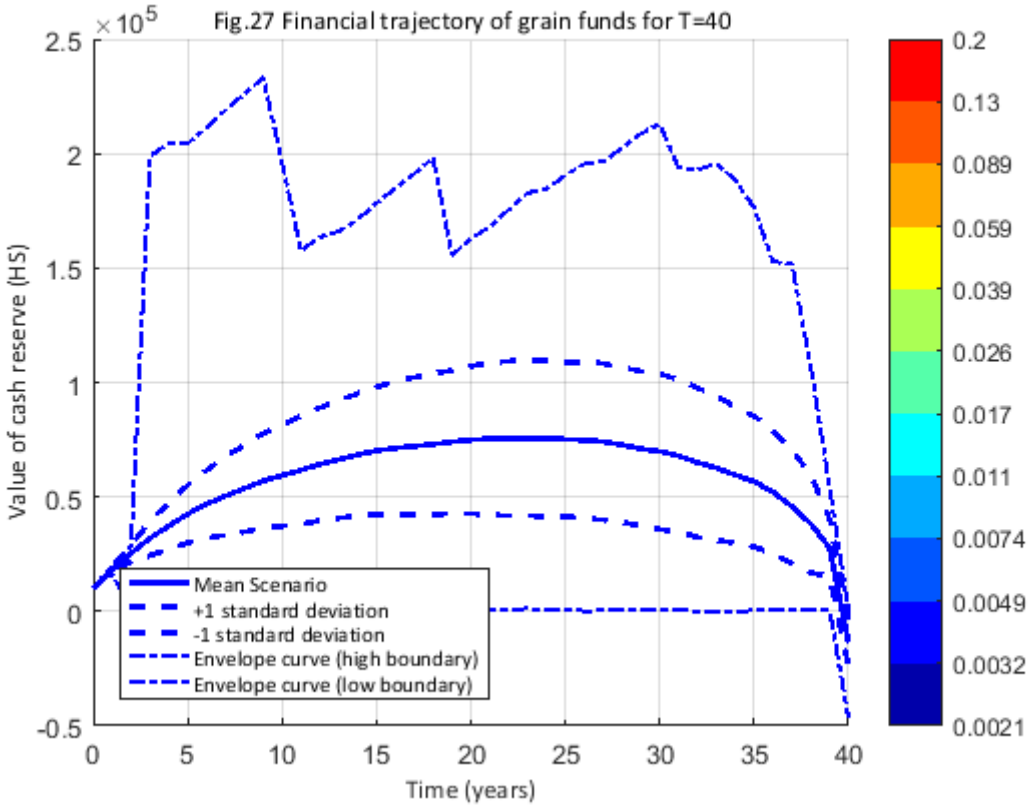


In this pattern, we find the same overall concave trajectory, but with an interesting difference with the previous scenario: on the lower standard deviation curve and on the upper envelope curve, we see that a certain proportion of funds might experience a small relief after a phase of decline, resulting in a non-linear trajectory. In that sense, a downward tendency of the account of the grain funds does not seem to be irreversible.

❖ *Grain funds with a lifespan of 20 and 40 years*

Let us now turn to patterns of grain funds with longer lifespans, namely 20 and 40 years:





The main difference appearing on those figures lies in the area between the standard deviation curves and the envelope curves. As we can see on the graphs, the space between the top envelope curve and the upper standard deviation curve is much greater than the space encompassed by the lower standard deviation curve and the bottom envelope curve, contrary to what appeared on the graphs referring to grain funds with a shorter lifespan. As I have already argued, this indicates that, in those two patterns, a bigger proportion of grain funds followed a better-than-average financial trajectory. This result confirms the analysis of figures 22 and 23: it looks as if, once a certain age threshold is reached, grain funds become financially more sustainable, with some of them accumulating quite large amounts of money. Even if, from a critical point, they get into a declining path leading to their collapse – the facing of shortages being, over the long run, stronger than the inputs of money –, grain funds become increasingly successful and secure as they persist through time. This can be understood quite easily with an analytical example: a fund that survived 15 years have received 150,000 HS on average, and normally experienced two shortages (one in 6 years, as stated above), occasioning a withdrawal of some 80,000 HS. The value of its cash reserve is thus 70,000 HS. For this fund to crash, it would require 2 (average) shortages. Let us now consider a fund that survived 25 years: the total sum received over that period is 250,000 HS. In 25 years, this fund must have experienced 4 shortages, generating an expenditure of some 160,000 HS on average. The remaining

cash reserve of the fund is thus worth 90,000 HS, and would thus require 3 shortages to collapse. This can be generalized to different lifespans:

Table 7. Sustainability of the grain funds (all sums are ins HS)

Age of the fund	Average input of money[571]	Number of experienced shortages	Average output of money	Value of the cash reserve	Required number of shortages to crash the fund
10	100,000	1	-40,000	60,000	2
15	150,000	2	-80,000	70,000	2
20	200,000	3	-120,000	80,000	2
25	250,000	4	-160,000	90,000	3
30	300,000	5	-200,000	100,000	3
35	350,000	5	-200,000	150,000	4

Of course, we speak here of average scenarios (average inputs of money and average gravity of the shortage) and we consider a restricted number of cases; the actual evolution of the sustainability of the funds is not linear, but the overall tendency is upwards. Therefore, as we can deduct from table 3, the longer a grain fund survives, the more shortages it is able to endure.

3.2.3.1.6 A reliable enough and long-lasting institution

Earlier on, I tried to reconstruct the institutional and technical working of the *sitonía*. I then tried to quantify the value of private (euergetic) and civic contributions of the grain funds, challenging the widespread opinion according to which they were almost solely financed by benefactors and, hence, suffered from a chronic financial instability. However, if our reconstruction is probably more optimistic than that of Garnsey and Silver, for they deny to a large extent the role of civic money, it is nevertheless more pessimistic than Strubbe's assessment, who, in our opinion, overestimates the contribution of benefactors. As we have already argued, this mistake of his owes much to his assumption that grain funds would be used every year and aimed at distributing grain for free rather than selling it at a loss.

The analysis undertaken with the aid of our Monte-Carlo simulation allows suggesting another reconstruction of this innovative system developed by the Greek cities, which simultaneously challenges both Garnsey and Silver exaggerated pessimism and Strubbe's misunderstanding of the *sitonía's* purpose. Grain funds often seem to have collapsed during their first few years of operation. At the same time,

[571] All sums are in sesterces (HS)

however, a significant proportion of them appears to have remained in operation over the mid- to long-term. What actually allowed those funds to become financially sustainable was precisely that they were *not* used every year: it is the accumulation of money in normal years (and of potential surpluses in the case of soft shortages) that allowed the constitution of a cash reserve that would become large enough to face an important shortage. The longer the fund continued in operation without the occurrence of a serious shortage, the greater the probability that it would succeed in facing such a shortage. Moreover, when they managed to survive withdrawals of money during their early years, we have seen that a certain proportion of grain funds could experience a relief and a new (although brief) phase of accumulation. From a critical point, however, the majority of grain funds would see their cash reserve decline inexorably as they had to cope with more shortages. What actually must have been fatal to almost any grain fund was the occurrence of a succession of serious shortages over a relatively short period of time. Yet, despite the significant frequency of crashes in the first years, and even though most grain funds would collapse at some point, this institution appeared sufficiently resilient to ancient Greeks and Romans to be kept in use. Case studies of grain funds of the Hellenistic period seem to confirm these conclusions: at Delos, J. Sosin has challenged the idea that the *sitonía* suffered from a chronic deficit[572], while L. Migeotte reached similar conclusions with regard to grain funds of Samos[573]. Epigraphic documents also provide empirical examples of very long term survivals of civic funds: the *sitonía* of Delos lasted for about a century and a half[574], while the famous foundation established by Demosthenes of Oenoanda a little before AD 124 for the funding of a festival (the *Demostheneia*) was still in operation by AD 260[575]. In this respect, the long institutional life of the *sitonìa* (4^{th} c. BC – 3^{rd} c. AD) is probably due to the fact that, in spite of being an unstable system, it allowed a significant proportion of funds to remain sustainable over a sufficiently long period to provide a shield against the effect of shortages

3.2.3.2 The efficiency condition

That a significant proportion of grain funds remained financially *sustainable* does not mean, however, that the system was *efficient*. Sustainability relates to the difference between revenues and expenditures, while efficiency concerns the number of mouth that can be fed through this mechanism, *i.e.* the *per capita* quantity of grain

[572] Sosin (2003), 78-79

[573] Migeotte (2014), 665-667

[574] Bresson (2016), p. 335

[575] Initial foundation : Mitchell (1990), pp. 183-193 ; mention in AD 260 : Hall & Milner (1994), p. 30

purchasable via the fund. Thus, we should turn towards the question of whether the *sitonìa* could have been an efficient system. Or, to phrase it differently, to examine under which conditions the efficiency of grain fund was preserved or altered.

Let us consider an initial cash reserve of the fund (F_0) made of several monetary contributions (both public and private). The quantity of grain that can be purchased with this sum is :

$$Q_0 = \frac{F_0}{p_0}$$

Where p_0 is the price per *modius* of grain at initial time; the evolution of the cash reserve of the grain fund is a function of the difference between the monetary contributions to the fund and the withdrawals of money to buy grain in times of shortage. The aggregate income represented by the contributions (*B, C*) and the withdrawals (*W*) expresses the absolute variation of the cash reserve (ΔF).

$$F_t = F_0 + B_t + C_t - W_t = F_0 + \Delta F$$

The quantity of grain purchasable at time *t* is thus :

$$Q_t = \frac{F_t}{p_t} \qquad (1)$$

where p_t is the price at time *t* ; the evolution of prices through time is simply given by :

$$p_t = p_0 \cdot (1 + \tau)^t$$

where τ is the annual growth rate of prices. Through linear interpolation, we can estimate p_t using the aggregate rate of price increases over the period :

$\bar{\tau} = \sum_t^T \tau_t$ $\qquad$ $p_t = p_0 \cdot (1 + \bar{\tau})$ $\qquad$ (2)

Injecting equations (2) into (1) yields :

$$Q_t = \frac{F_t}{p_0 \cdot (1 + \bar{\tau})} \qquad (3)$$

The *per capita* purchasable quantity (q) can now simply be obtained by dividing both members of the equation by the population of potential recipients (P) :

$$q_t = \frac{Q_t}{P_t} = \frac{F_t}{p_0 \cdot (1 + \bar{\tau}) \cdot P_t} \quad (4)$$

Similarly, the initial purchasable *per capita* quantity is :

$$q_0 = \frac{Q_0}{P_0} = \frac{F_0}{p_0 \cdot P_0} \qquad (5)$$

For the per capita purchasable quantity to remain constant over time, q_o must be equal to q_t; after isolating p_o in equations (4) and (5), equalizing them, and rearranging, we obtain :

$$q_t = q_0 \cdot \frac{F_t}{F_0} \cdot \frac{P_0}{P_t} \cdot \left(\frac{1}{1+\overline{\tau}}\right) \quad (6)$$

The equation can be further transformed by accounting for the variation in population. Population growth obeys a simple exponential function of the form : $P_t = P_0 \cdot (1+g_p)^t$ which can be approximated using the aggregate population growth rate over the period, as we did above for the simplification of price increases : $P_t = P_0 \cdot (1+\overline{g_p})$

After rearranging, we can rewrite equation (6) [576] :

$$\frac{q_t}{q_0} = \frac{1+g_F}{(1+\overline{\tau}) \cdot (1+\overline{g_p})}$$

In order for purchasable quantity of grain to remain at least constant, we must have :

$$q_t \geq q_0$$

The **efficiency condition** of the grain funds is thus :

$$\frac{1+g_F}{(1+\overline{\tau}) \cdot (1+\overline{g_p})} \geq 1$$

$$\Rightarrow 1 + g_F \geq 1 + \overline{\tau} + \overline{g_p} + \overline{\tau} \cdot \overline{g_p}$$

Since $\overline{g_p}$ and $\overline{\tau}$ are rather low, the expression $\overline{\tau} \cdot \overline{g_p}$ can be taken as negligible; after simplification, the efficiency condition reduces to :

[576] Since: $\frac{F_t}{F_0} = 1 + g_F$, where g_F is the growth rate of the cash reserve.

$$g_F \geq \overline{\tau} + \overline{g_p}$$

We thus arrive at the following rule :

For a grain fund to remain efficient (i.e. to be able to purchase a constant per capita quantity of grain), the annual growth rate of its cash reserve must be superior or equal to the sum of the aggregate rate of price increases and of the aggregate growth rate of the number of recipients over the considered period.

We naturally have no more data on the efficiency of grain funds than we do concerning its sustainability. A full assessment of the question would require an extended Monte-Carlo simulation which would take into account population growth and price dynamics. This was unfortunately beyond the scope of this investigation.

3.2.4 The decline of grain-related institutions in the 3rd c. AD : an attempt of explanation

3.2.4.1 The demographic and economic impact of the Antonine Plague

After this thorough discussion on two specific grain supply institutions, it is now worth going back to the chronological graph presented at the beginning of this chapter (section 3.1.2) and trying to explain the observed pattern. The first 'peak' around AD 130-150 largely results, in my opinion, from the general flourishing of the Roman economy and of élite munificence in the mid-second c. AD, which are also exhibited in various other datasets, albeit not always with the same sequence. For what regards the second peak, in the early 3rd c. AD, I have suggested above that it might be a side-effect of the Antonine Plague. In order to properly examine this hypothesis, let us open a digression on this subject and assess the evidence we have regarding the plague in Asia Minor and its impact.

As far as documents are concerned, recent accounts of literary (Aristides, Galen and Lucian) and epigraphic evidence of the plague in Anatolia have been presented and discussed separately by Alfredina Storchi-Marino[577] and Danielle Gourevitch[578].

[577] Storchi Marino (2012), pp. 37-44

Despite the fact that no palaeopathological study has yet (to my knowledge at least) definitely confirmed the presence of smallpox in Roman Anatolia, and although much of the literary evidence is indirect, it is in my opinion very difficult not to admit that the province has indeed been struck by the epidemic.

How grave its demographic and economic effects were, though, is debatable. An important prerequisite for this is the ever-increasing confidence in the identification of the plague as smallpox[579], which allows narrowing the range of the intrinsic mortality rate of the epidemic. Estimates of its *actual* mortality rate however vary significantly: from about 1-2% [580] to 50%[581]. With a cautious and critical calculation, Littman & Littman nuance those extremes and arrive at an overall mortality rate of 10%, while Harris considers a 16% mortality rate (for the first wave) as optimistic[582]. Yet, in what is the only stochastic model of the plague's diffusion (that is, a model accounting together for the intrinsic properties of the disease, some quantitative data and assumptions regarding the Empire's population size and density, *and* the randomness of contagion through human-to-human interactions), Yan Zelener concluded that the mortality rate ranged between 22% and 24% in the first 20 years. Moreover, as Asia Minor was among the most densely populated regions of the Empire, and since smallpox is a density-dependent disease, it is probable that its effects were closer to the higher mortality estimates, and that mortality rates were higher in cities than in the countryside.

These estimates, however, only regard the 'direct' mortality rate, that is, the mortality due to the plague specifically. But one should also consider its *indirect* mortality. Indeed, as Braudel noted concerning the preindustrial era, a disease is only rarely diffused alone: more often, epidemics involve various pathogenic agents[583]. This is a very important aspect because, while the surviving population has gained a higher level of immunity regarding the diseased by which it has been infected (here, smallpox), it ends up with a lower degree of immunity regarding other infections or pathogenic agents, as several immunological studies tend to demonstrate[584]. This means that people who were not killed by the Plague itself were more likely to die from

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[578] Gourevitch (2013), pp. 85-95

[579] Littman & Littman (1973), pp. 243-255 ; Haas (2006), p. 1093 sqq.

[580] Seeck (1910), pp. 398 sqq

[581] Gilliam (1961), pp. 228 sqq

[582] Harris (2012), p. 336

[583] Braudel (1979), p. 81

[584] See for example : Zavitz *et al.* (2010), pp. 2001-2013 ; Mehsen-Cêtre & Cazanave (2017), pp. 29-33. One typical example is that of the *Staphylococcus Aureus*, most often contracted by immunocompromised individuals.

other pathogenic agents against which, in normal circumstances, they would have been more resistant. As a consequence, starting from the relatively low estimate by Littman & Littman, the total mortality rate of the epidemic must have been higher than 10%.

Yet, mortality rate alone does not account in and of itself for the economic consequences of the epidemic, and an important stream of scholars has precisely contested the seriousness of such an impact on the Roman economy. Therefore, in order to avoid mere speculation and allow us to identify a quantifiable behavioral mechanism, we need to examine how our Sraffa-Hill model of agricultural output evolves under conditions of population contraction. At this stage of the argument, this is, at least, the contribution I would like to bring to this debate, in the absence of any new dataset. To do this, mathematics provides us with a powerful tool: differential calculus. From a mathematical point of view, the impact of a demographic contraction on agricultural production can be expressed as the derivative of our production function with respect to population, that is : dQ/dP. In doing so however, two different time spans should be considered: a first phase where the demographic contraction occurs faster than any possible adjustment of the cultivated area or proportion of agricultural labor, and a second phase where agricultural labor and cultivated area can be extended or reduced.

- *Short run*

In chapter 2, the following function has been proposed :

$$Q = h \cdot \frac{A_a^{\epsilon} \cdot L_a^n}{\theta \cdot A_a^m + L_a^n}$$

Yet, at the macroeconomic level, we may consider that land and labor are governed by the same coefficient of cooperativity, implying that they don't evolve fully independently and with the same flexibility as they do at the microeconomic level. Hence, for the macroeconomic case, we should consider the production function for: $m = n$ and $\epsilon = 1$, that is :

$$Q = h \cdot \frac{A_a \cdot L_a^n}{\theta \cdot A_a^n + L_a^n} \qquad (1)$$

In order to express total output in terms of population, we may express cultivated surface and agricultural labor the following way :

$$\begin{cases} A_a = a \cdot A & (2) \\ L_a = k \cdot P_a & \\ P_a = \alpha \cdot P & \\ \Rightarrow L_a = \alpha k P & (3) \end{cases}$$

Where a is the share of total land (A) devoted to agriculture (in %), k is the share of agricultural population at work (that is, roughly 90% taking into account young children and elderly people), and α is the proportion of agricultural population in total population. The equation can thus be rewritten as :

$$Q = h \cdot a \frac{A \cdot P^n}{\Phi A^n + P^n}$$

Where :

$$\Phi = K \cdot a^n \qquad with \quad K = \frac{\theta}{(k \cdot \alpha)^n} \quad (4)$$

By applying the rule of quotient derivatives, we can now calculate dQ/dP :

Setting :

$u = h \cdot a \cdot A \cdot P^n$
$v = \Phi \cdot A^n + P^n$

We may apply the rule of quotient derivatives : $\frac{dQ}{dP} = \frac{v \cdot \frac{du}{dP} - u \cdot \frac{dv}{dP}}{v^2}$ considering that, in the short run, a, k and α are constants. The result is the following differential equation :

$$\frac{dQ}{dP} = h \cdot a \cdot n \frac{\Phi A^{n+1} \cdot P^{n-1}}{(\Phi A^n + P^n)^2}$$

This equation however only provides a relationship between the *absolute* variation (dP) in population and the *absolute* variation of output (dQ). In order to infer the evolution of per capita output, we might want to compare the relative variation of each of these variables, that is, their growth rate: $g_Q = dQ/Q$ and $g_P = dP/P$. The link between the derivative dQ/dP and the growth rate is a straightforward one and is expressed by a measure known in economics as the elasticity (here noted ζ) : the elasticity of output with regard to population is simply the ratio of the output growth rate by population growth rate:

$$\zeta = \frac{\frac{dQ}{Q}}{\frac{dP}{P}} = \frac{dQ}{dP}\frac{P}{Q}$$

Hence, the elasticity is simply the derivative of total output with respect to population (dQ/dP), multiplied by the (initial) ratio of population to output (P/Q). We thus have :

$$\zeta = \frac{dQ}{dP}\frac{P}{Q} = h \cdot a \cdot n\frac{\Phi A^{n+1} \cdot P^{n-1}}{(\Phi A^n + P^n)^2} \cdot \frac{P}{Q}$$

As Q is simply the initial output function, the equation becomes :

$$\zeta = h \cdot a \cdot n\frac{\Phi A^{n+1} \cdot P^{n-1}}{(\Phi A^n + P^n)^2} \cdot \frac{P}{h \cdot a\frac{A \cdot P^n}{\Phi A^n + P^n}}$$

Which after simplification yields :

$$\zeta = \frac{n\Phi A^n}{\Phi A^n + P^n}$$

By dividing the numerator and denominator by A^n in order to make population density ($\rho = P/A$) apparent, and expressing Φ in terms of its components (eq. 4), we get :

$$\zeta = \frac{n \cdot K \cdot a^n}{K \cdot a^n + \rho^n}$$

Finally, we may once again divide both the numerator and denominator by a^n in order to express the output-population elasticity in terms of the agricultural population density (noted $\omega = \rho/a$) measuring the number of inhabitants per *cultivated* hectare :

$$\zeta = \frac{g_Q}{g_P} = \frac{n \cdot K}{K + \omega^n}$$

In order to assess whether the per capita output increased, decreased or remained unaffected by the demographic contraction, the only thing to do is to calculate whether the elasticity is inferior or superior to 1 : if $\zeta = 1$, per capita agricultural output remained unchanged ; if $\zeta > 1$, the reduction of output is higher than the population contraction which means per capita output decreased, and the opposite is true for $\zeta < 1$. Obviously, what matters here is the order of magnitude rather than the exact value

of ζ. Now, the computation is farily easy : average population density in Asia Minor has been estimated at 15 hab/ha (or 0.15 hab/km²); if the proportion of land under grain approaches 0.3, this sets ω somewhere near 0.5; as for the parameters: *I have set n* at a rather modest level of labor cooperativity with $n = 2$, k equals roughly 0.9, and α is set at 0.85 (meaning that we assume 85% of population is engaged in agriculture). With these values assessed, we obtain that $\zeta \cong 1.99$...This means that a contraction of 10 % of total population would have reduced grain production by approximately 20% (–0.1 x 1.99). From this, it is now possible to calculate the impact on the growth rate of per capita production. Per capita output is simply total output divided by population : $q = Q/P$. Following an elementary rule of mathematics, the growth rate of a quotient of variables is equal to the subtraction of the growth rate of the denominator from the growth rate of the numerator :

$$g_q = g_Q - g_P = -0.2 - (-0.1) \cong -0.1$$

In these conditions, the short run, a mortality rate of 10% due to the Antonine plague would have caused a reduction of grain output per capita by a little less than 10%. If, taking into account indirect mortality, we set the mortality rate at 12.5 %, then, per capita grain output would have been reduced by some 12.3 %. Of course, such a generic conclusions obviously conceals different situations between town and countryside, as urban areas would be more damaged by the epidemic: an interesting passage in the *Life of St-Nicholas the Sionite* relates how the town of Myra has suffered important grain supply difficulties in the aftermath of the Justinianic Plague because many peasants stopped travelling to the city to sell their grain because they were fearing for their health[585].

❖ *Long run*

Now, what happens in the longer run? Basically, two important things change: first, the demographic decline has to a certain extent been compensated by new births; second, two parameters which were considered fixed in the short run are now variable: the extent of cultivated surfaces and the share of agricultural labor in total population,

[585] *Vita Nicolai Sionitae*, c. 52. Although peasant farmers did not represent the majority of urban grain suppliers, a general cessation of their activities might still hav a significant effect on the total available quantity of grain (cf. De Ligt (1993), pp. 212-213).

while the employment rate of agricultural population and the level of agricultural technology might still be considered constant. In order to provide a mathematically and economically accurate theorization of the mechanisms involved, the logic applied is exactly the same as the one developed for the short run case, that is, calculating the derivative of total output with respect to population. The mathematics are however substantially more complex, and for this reason I present only the final result (the full mathematical proof is at the reader's disposal in the Appendixes). After developing the derivative dQ/dP in the long run, we obtain the following equation :

$$g_q = H \cdot g_\alpha + (1 - H)g_s + (1 - H)g_A + (H - 1)g_P$$

In which g_α, g_A, g_s, and g_p are respectively the growth rate of the proportion of agricultural population, of total land surface, of the share of land devoted to agricultural activities, and of population, while H is a parameter measuring the effect of a change in one of these variables upon per capita output. The meaning of this equation is that *the growth rate of per capita agricultural output is a weighted sum of the growth rate of the share of agricultural population in total population, of the proportion of land devoted to agricultural activities, of total land surface and of total population.*

Since it is an equation containing four unknown (population growth rate is considered exogenous), there is no straightforward solution, and hence no single interpretation. But we may envisage a series of scenarios in which we consider some possible values of each variable, and hence compute the value of the fourth variable. Said differently, this equation may answer questions such as : 'If the output of grain per capita is considered unaffected in the long run (*i.e.*, if its growth rate equals 0), what should have been the values of the relative change in agricultural population and in agricultural surfaces ?'; or 'if the share of population engaged in agriculture remained unchanged and if total land surface was reduced by 5%, how did per capita output evolved?'.

However, this equation contains a non-negligible element of complexity, because the factor H is not a constant. Indeed, H represents the elasticity of output with respect to agricultural labor force, that is :

$$H = Elast.(Q, L_a) = \frac{dQ}{dL_a}\frac{L_a}{Q}$$

Since Q is the initial production function, the mathematical expression of H is :

$$H = \frac{n\theta}{\theta + \gamma^n} = \frac{n}{\overline{K}\,\omega^n + 1} = \frac{n}{\frac{k^n}{\theta}\left(\frac{\alpha\rho}{a}\right)^n + 1}$$

In economic terms, the parameters H, 1–H and H–1 respectively represent the 'impact' of a relative change in (the share of) agricultural population, agricultural surfaces, total land surface and population on per capita output. The ratio α/a is simply the quotient of agricultural population (P_a) to agricultural surface (A_a), divided by population density; if we label σ the ratio P_a / A_a, and M the constant k^n/θ, then, the expression of H can be reduced to :

$$H = \frac{n}{1 + M\sigma^n}$$

With :

$$\sigma = \frac{P_a}{A_a} = \frac{\alpha\rho}{a}$$

As we notice, thus, H is conversely proportional to the ratio α/a : when the share of agricultural population grows faster than the proportion of agricultural surfaces, the effect of increasing the share of agricultural population is reduced, while the impact of a change in agricultural surfaces is increased. The opposite is true, of course, if a grows faster than α. Each change in α or a has thus a feedback effect on their specific impact upon per capita agricultural output, but not necessarily so as to cancel (or considerably multiply) this impact.

For the sake of the argument, let us consider the first question : what does the equation implies in the case of no sensitive effect of population contraction on per capita agricultural output in the long run ? In this situation, the equation becomes :

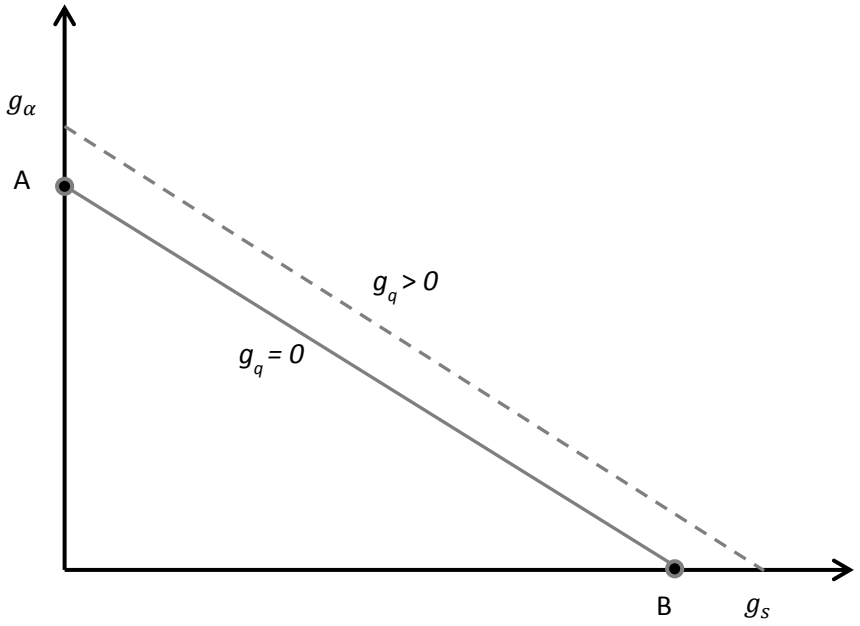
$$Hg_\alpha + (1 - H)g_s + (1 - H)g_A + (H - 1)g_P = 0$$

As we are considering the question at the macroeconomic level, total land surface (that is, devoted to all sorts of activities) can be taken as fixed (g_A = o). This reduces the equation to :

$$Hg_\alpha + (1 - H)g_s = -(H - 1)g_P$$

Population growth rate on the long run, even compensated by increased fertility rate, remains negative; If we start with an optimistic population contraction (for the first

generation only) of minimum 10%, we may posit this initial demographic shock to have been reduced by half in the long run. Since H always superior to 1,it implied that the right side of the equation if a positive term (a multiplication of two negative terms). This equation, therefore, describes a straight line of negative slope, showed on the graph below by the line AB :



What this graph and its corresponding equation mean is fairly simple : *in order for per capita agricultural output to have remained roughly constant in conditions of population contraction over the long run, then either the proportion of agricultural surfaces, or the share of population engaged in agriculture, or both, must have increased.* If that is the case, we may well admit that the consequences of the Antonine Plague have been successfully overcome in the long run, but since this requires either the conversion of surfaces previously devoted to non-agricultural production into agricultural land, or an increased share of the population (primarily) engaged in agriculture, this would have lowered the proportion of total surplus available for urban/non-agricultural activities. As I have said previously in developing arguments of this sort, I am not saying that this is actually what happened in the first half of the 3rd century AD, since I have no archaeological or historical data to back this claim so far. I am arguing, however, that this is the *necessary* consequence of positing a roughly negligible effect of the population contraction due to the Antonine Plague on per capita agricultural output.

Yet, several arcaheological surveys have stressed that there is no reliable trace of agricultural crisis in the eastern provinces in the 3rd c. AD and after; on the contrary,

many of them point towards an expansion of rural occupation[586] and lively rural production. If our scattered evidence is in any way representative of a general trend, it might be argued that the 3rd c. saw a progressive and relative de-urbanization of Asia Minor – partly as a consequence of the solutions set up as responses to the demographic changes of the late 2nd and early 3rd century – but which does not necessarily indicate that material conditions were in any way damaged.

3.2.4.2 The disappearance of the *sitonɪa*

I have argued above that the *sitonìa* was probably a less fragile system than has been previously assumed. Yet, grain funds disappear from the documents in the course of the 3rd c. AD, and this is only one the manifestations of the general decline of grain-related interventions. How should we explain the disappearance of this 700 years old institution? Several causes can be suggested, which I unfortunately can only briefly sketch out. Many aspects of this issue deserve further research, and I can do no more than suggest some potential dynamics.

The reasons of the disappearance of the *sitonía* should be sought, I think, into changes in the conditions determining its efficiency and sustainability. These conditions are summed up in the equation I have derived above (section 3.2.3.2) :

$$g_F \geq g_{P^*} + \bar{\tau}$$

The growth rate of the cash reserve of the fund must be equal or superior to the sum of the growth rate of the population of beneficiaries and of the "inflation" rate (more accurately the rate of increase of grain prices).

On the basis of the preceding analysis of the consequence of the Antonine Plague, I think it is reasonable to argue that a non-negligible pressure has been put on available grain output per capita in the aftermath of the Antonine Plague, even if these effects might have been softened in the long run at the cost of important changes in labor and land use. As far as grain funds are concerned, the first consequence of a reduced per capita available output is an increase of the proportion of the population which occasionally or regularly relied on the intervention of grain funds on the market.

A second effect, however, should not be disregarded: the rate of price increases. Here, it should be made very clear that we are not considering any general increase of

[586] Lewit (1991), p. 48 & p. 86.

the price of grain *itself* – since available evidence shows an overall stability of grain prices during the most part of the 3rd c. AD – but on the cost of grain purchase by the grain funds. Broadly speaking, the price of grain can be divided in two components: its intrinsic price (p_o), and the unit cost of transport (c):

$$p = p_0 + c$$

Regarding the funding of the *sitonía,* it is rather unit transport costs *per capita* that matters, that is : c/P. A very simple model might usefully illustrate this point. Since unit transport cost can be seen as a linear function of distance ($c = \beta^*\delta$, where δ is distance), unit transport cost per capita can be described by the following equation :

$$\bar{c} = \frac{c}{P} = \frac{\beta \cdot \delta}{P} = \frac{\beta \cdot \delta}{\bar{A} \cdot \rho}$$

In which β is the unitary cost of transport per unit of distance, ρ is population density, and A is total surface, taken as a constant since we operate at a macroeconomic level. From this equation, one easily understands that unit transport cost per capita increase as population density decreases, unless imports are operated from shorter distances. Said differently, because of the sharp decrease in population density, the dispersion of population through space maintained roughly similar levels of transport costs with fewer people to pay for them, resulting in a higher unit cost of transport per capita. Since the grain of the *sitonia* was often resold at a loss on the urban market, this phenomenon allows explaining why grain funds started facing higher costs whereas the overall level of grain prices remained stable.

In addition to that, as argued in Chap. II (section 3.3.4), with the reduction of population density, the level of contractual rents must have fallen. Since towns were largely supplied by the commercialization of a share of those rents, this must have put the urban grain market under stress. Furthermore, civic finances were probably not left unaffected: with the decrease in output and population, the amount of taxes collected by the cities is likely to have been reduced too, as well as the level of rents collected on city-owned land.

Further, and more general effects, should also be considered : as stated in Chap.I, in the 3rd c. AD the favorable climatic conditions which had prevailed during the Roman Optimum started to fade away in different regions of the Mediterranean, although in Asia Minor it is still unclear whether the climatic pattern mostly changed in the 3rd or 4th c. The progressive end of the warm, wet and stable climatic period which had lasted some two centuries probably resulted in a lower productivity of land and in a higher frequency of bad harvests. The disappearance of the *sitonìa* in the 3rd c. AD is broadly concomitant to the overall decline of civic munificence which was

probably not unrelated to the Antonine Plague either, although fundamental changes in political culture seem to have taken place[587]. As far as grain-related institutions are concerned, the first effect of such decline in civic munificence was to reduce the number of potential candidates to the office of *sitónès*. A final, yet speculative explanation may be found in the monetary context. C. Kastari recently argued that the mid-3rd c. AD inaugurated a period of progressive demonetization in the eastern provinces of the Roman Empire[588] – although partly compensated in Asia Minor by civic mints. If she is right, this decrease in the available money supply might also have jeopardized the efficiency of grain funds, since the *sitonia* was a monetary mechanism. At a time when the population relying on grain funds likely increased, less cash would have been available…None of all these factors gave a fatal blow to the *sitonía*, but their combination explains largely, I think, the disappearance of this civic institution.

* * *

On the basis of our digression regarding the economic impact of the Antonine Plague, it is now time to reconsider the graph of fig. 16 displaying the chronological evolution of grain-related interventions. I have argued above that the two peaks (125-160 AD and 205-240 AD) should be explained by different dynamics. In fact, there is only one governing variable: the propensity for élites and civic institutions to intervene – against, of course, the evolution in epigraphic fashion. However, the reasons why such interventions took place may well vary through time. I think that the early 2nd c. peak is largely explained by the increasing prosperity in the Roman Empire as a whole[589], and among its élite classes in particular. Civic revenues likely followed the general upward trend. Since benefactions and contributions to existing supply schemes were two major outlets of élite and municipal incomes, in a context of reassertion of civic ideals, it is logical that the overall index of grain-related intervention went up.

The 3rd c. peak is however, in my opinion, another story. Two factors should be presented separately: (1) I have claimed above that, despite increasing skepticism, the Antonine plague probably had deleterious effects on average per capita agricultural output. This effect was stronger in the short and medium run, and may have been softened in the long run at the expense of a higher proportion of agricultural labor and of extended agricultural surfaces; (2) As argued in Chap. I, there is substantial evidence indicating that the 3rd c. was one of progressive climatic cooling, inaugurating the end

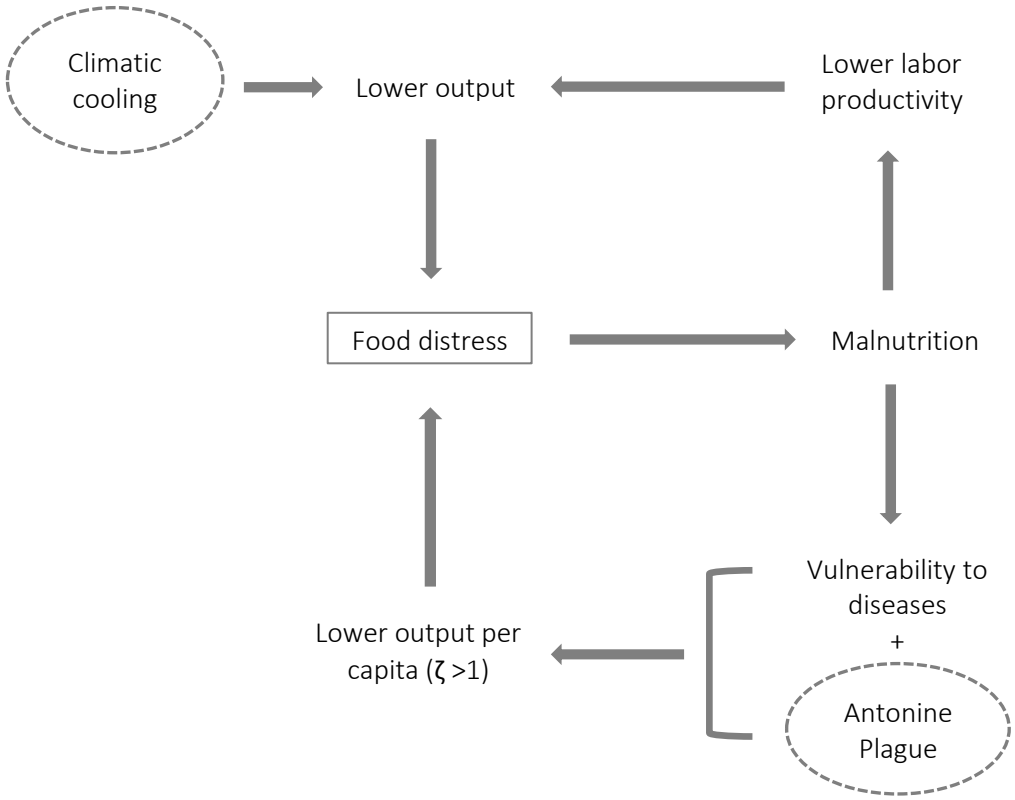
[587] On the decline of civic munificence : Zuiderhoek (2009), pp. 155-157

[588] Katsari (2005), p. 270 sqq ; Katsari (2011), pp. 129-136 & 165-166

[589] Jongman (2007 b), pp 183-199; Jongman (2012), pp. 257-258

of the Roman Optimum. The first consequence of this colder and dryer climate was to increase the probability of bad harvests and to exercise a downward pressure on aggregate output.

As a corollary to these two external variables, two feedback mechanisms likely took place : *(a)* because agricultural per capita output was put under strain, episodes of food distress were probably more frequent, hence increasing the occurrences of malnutrition. But, as Garnsey rightly pointed out, malnutrition affects labor productivity[590], which in return would add further constraints on output; *(b)* moreover, as is widely supported by medical research, malnutrition also lowered immune defenses, which raised the direct and indirect mortality of the Plague.



As described by the above scheme, it is likely that the aftermath of the Antonine Plague was a period of increased food distress, before its resolution over the long run by different possible adaptive strategies involving a new configuration between population and resources. I think therefore that this period of 'frumentary' difficulties fostered élite and governmental intervention, although a (temporary) urban revival under the Severi also played a role. However, as for why did grain-related intervention

[590] Garnsey (1999 a), pp. 59-60; Garnsey (1999 b), pp. 18-21

started decreasing from the mid-2nd c. onwards, I have no definitive answer. Part of the explanation may be that, precisely because of an *acme* in living standards, such interventions became less needed; or perhaps, after an increasing phase of grain-related interventions, civic élites were in search for benefactions which would be more rewarding in terms of *symbolic capital*[591]. But none of these suggestions can so far be firmly ascertained.

3.3 Benefactors and officials: two sides of the same coin?

3.3.1 Patterns of civic grain-related munificence

In section 1 of this chapter we highlighted the different levels at which grain supply interventions took place, with civic interventions being the most frequent. Yet, interventions by citizens took many forms, which now need to be discussed in some detail. We have already seen in the previous part that a major form of intervention consisted in holding one or many of the numerous grain-related offices recorded in inscriptions and literary sources, the tasks of which have been described as accurately as possible. Yet, this still leaves out of the discussion the various types of benefactions that could be performed either by officials or by 'spontaneous' benefactors – i.e. those not bound by any public charge – outside the framework or grain-related offices. These can be organized into six categories :

1° – Closer to the working of grain fuds already described above, we encounter gifts of money to the different funds managed by grain-related officials – mostly the *sitonia* but also the *agoranomia*, as is the case in the city of Illyas in Pisidia during the 3rd c. AD, where a woman named Ammia provided money 'for the *sitonia and* the *agoranomia*'[592], or in Phrygia somewhere after AD 165 where a *chreophylax* provided money for the grain fund[593]. Another example, also from Pisidia, records a certain Kleon who gave 500 denarii for the *sitonìa*[594]. The common feature of these three examples is that none of the three benefactors has ever held the office of *agoranomos*

[591] On this notion, see below : section 3.3.4

[592] Ramsay, *CB*, n° 146

[593] LBW, 992 = OGIS, 511

[594] BCH 10 (1886), n°1, p. 500

or *sitonès* during his career (except perhaps in the case of the individual mentioned in the Phrygian inscription, which is mutilated to such an extent that we cannot rule out that it contained references to other offices). In some other cities, however, no specific institutional mechanism is mentioned, as in Adada in Pisidia where a benefactor simply provided '2000 denarii for the provision of grain', perhaps because this city did not develop the system of a grain fund[595].

2° – Monetary contributions of the first category were channeled through one of the civic funds dealing with the grain supply. But we also encounter monetary gifts to the population : in Sardis in the first quarter of the second century AD, a benefactor gave '2 denarii to each citizen for buying grain'[596]; a similar distribution of money to the citizen was performed in Prusias during a shortage by a benefactor named P. Domitius Iulianus[597].

3° – The third category of benefactions consists of sales of grain – or other foodstuffs – usually in time of shortage, at a price below the current crisis price but still higher than the market price before shortage. Such operations are known as *parapraseis, paratima* or *epeuonismoi*[598]. In only very rare cases are the details of such operations mentioned, as in Sebastopolis where an unknown benefactor is said to have 'sold 4,000 modii of grain below their value at a price of 1 denarius per modius, while it costed 2 denarii per modius'[599], thus spending 2,000 denarii from his own resources.

4° – Another important category, which has already been analyzed in some detail *supra* is that of contributions (mostly in kind) to the *sitometria* or *triteia*. As explained in the beginning of section 2 above, the word *sitometria* has often been used in the straightforward sense of a simple and direct grain distribution to a specific population, while in some specific cases such as that Lycia or the *triteia* of Pergamon and Thyateira, it referred to a civic system which more closely resembled the Egyptian grain-doles (*sitèresia*).

5° – Apart from gifts of money and sales, direct distribution of grain in kind by benefactors are also a major category of grain-related euergetism which, just as in the case of monetary contributions, should be treated separately from the contribution to civic institutionalized mechanisms. Apart from unspecific benefactions such as the distribution of 1,220 medimnoi of grain (about 8,280 modii) by Titus Flavius Damianus

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595 Sterrett, *WE* 293, 414

596 *Sardis*, VII, 1, 56

597 *IK-Prusias ad Hypium*, 19 = Robert, *Hell.*, VIII, p. 76

598 The evidence is : *SEG* 35, 1365; *TAM* II, 671; *IK-Ephesos*, 815 ; *SEG* 56, 1194; *Didyma* II, 248 & 296; Robert, *Et. Anat.*, pp. 343 sqq; *IK-Stratonikeia*, 210; *SEG* 38, 1462 B; *TAM* V, 2, 942; *IK-Stratonikeia*, 672; *IK-Ephesos*, 3071 (for oil).

599 McCabe, *Sebastopolis*, 6

in Ephesos in the second half of the 2nd c. AD, two different forms should be distinguished :

- *Banquets* or *public meals* : The recipients of such meals might however vary from one case to another : in Stratonikeia during the mid-second c. AD, the priest Demetrios and an unknown priestess organized a meal 'for citizens, strangers and slaves, both men and women'[600]; in the same city, in the second half of the second century, a benefactor named T. Flavius Aeneas 'provided meal to all citizens, to Romans, to *paroikoi*, and to slaves'[601]. The very specification of such non-civic categories seems to suggest that such public meals were generally reserved to citizens.

- *Distributions targeting specific social sub-groups* : in Oenoanda in AD 127, the benefactor Licinnius Longus distributed annually 4 modii of grain (but for how many years we do not know) to each of the 500 members of the *Gerousia*[602]; and in Sillyon (Pamphylia), in the first quarter of the 3rd c. AD, the benefactress Menodora gave 1 modius of grain to each councilor, senator and member of the Assembly[603]; finally, in Xanthos around AD 152, the great benefactor Opramoas of Rhodiapolis distributed 10 modii of grain to each bouleutès[604].

6° – Finally, the sixth and far less frequent category consists of gifts of grain-land to the cities by benefactors, which undoubtedly facilitated its grain supply by allowing the city to be provisioned from civic land, most likely in the form of a rent in kind on the domain's produces: an unknown benefactor of Thasos in the 1st c. AD gives grain-land to the city[605]. Similarly, in Kibyra in AD 72-73 the unused funds of the gymnasiarchic foundation established by Quitus Veranius Philagros are to serve for purchasing grain-land for the city[606]. Finally, in AD 238, Dioteimos of Samos establishes a foundation by purchasing a plot of land, among which grain-sown land, which he gives to the city for possession and use of all produces[607].

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[600] *IK-Stratonikeia*, 254
[601] *IK-Stratonikeia*, 210
[602] *IGR* III, 492
[603] *IGR* III, 802
[604] Balland, *Fouilles de Xanthos*, VII, n° 67
[605] *BCH* 45 (1921), pp. 157-158
[606] *IGR* IV, 915b
[607] *IGR* III, 422

3.3.2 Liturgies, magistracies, and euergetism : beyond the public/private opposition

However, did all these food-related benefactions emanate from citizens operating outside civic charges (spontaneous benefactions), or did they proceed from some kind of customary expenditure related to magistracies or liturgies (munificence *ob honorem*, to use Paul Veyne's concept[608])? The question is legitimate, since it is tempting to interpret contributions to the grain supply taking place independently from any civic office as an index of the share of 'private' funding, while food-related benefactions performed by magistrates would rather indicate the action of the city – magistrates were indeed managing a civic fund for their expenditures. This approach is however inappropriate. Indeed, how should we interpret a distribution of food by a gymnasiarch, for instance? Formally, this is not part of his attributions. Yet, he is holding magistracy when he provides this gift. I have grouped these examples under the label of 'cross-functional' benefactions, to refine Veyne's typology. But the interpretation of such examples is far from easy. Moreover, as we can learn from the curriculum of the benefactors, we are sometimes facing the case of acts of euergetism performed by *former* officials, who are not in office anymore. Again, is this 'spontaneous' or 'ob honorem'? In my opinion, it is not possible to say. If we look at the data with these criteria in mind, and if I ignore for the moment the time of the benefaction - not always clearly understandable from the documents, it should be said – we obtain the graph displayed on Fig.30 (below), based on a sample of 68 explicit grain gifts. As we can see, spontaneous benefactions account for some 30% of cases, *ob honorem* benefactions also make up 30% of the total, while the dominant category is that of 'cross-functional' benefactions. The interest of this figure is that it shows us the limits of categorization. The purely institutional analysis is therefore of little help here.

Another approach would be to examine whether grain related offices (here, let us focus on the *sitonía*) belonged to the liturgies (*leitourgeiai*) – compulsory burdensome, yet honorable, charges of public interest – or to the magistracies (*archai*) – honorific charges through which the official managed a public fund, sometimes contributing from his own resources, and associated with political privileges. Liturgists have to pay for their expenses almost entirely on their personal funds, while magistrates had a civic fund at their disposal, despite being already encouraged to add money from their own funds by Aristotle[609]. Hence, whether an office was a magistracy or a liturgy would give

[608] Veyne (1976), p. 21

[609] Arist., *Pol.*, VI, 7, 6

us an idea of the role played by civic finances in its funding. In his seminal study about the cities of Asia Minor under Roman rule, A. Macro places the *sitonia* among the magistracies[610]. However, the occurrence of individuals being exempted from the *sitonia* under the reign of Hadrian[611] seems to imply that – at this time – the office was a liturgy, as it is considered by E. Frézouls[612]. Also, two instances are known of individuals choosing to finance public buildings *instead* of undertaking the *elaiothesia* (the provision of oil)[613], which suggest that this matter was closer to the liturgies. The same applied, perhaps, to the *sitonia*...In fact, since the Hellenistic period, the distinction between magistracies and liturgies was increasingly blurred from the financial point of view[614]: the former became more and more costly, the latter more and more prestigious as wealth was becoming an almost indispensable springboard to the leading offices of the city. Moreover, the legal pressure on promises of benefactions (*pollicitationes*) became more and more formalized under the Empire[615].As P. Erdkamp writes: 'the line between voluntary *[private]* gifts and coerced contributions often becomes very thin'[616].

Hence, neither the distinction between spontaneous, 'ob honorem' or even 'cross-functional' euergetism, nor the distinction between magistracies and liturgies can help us much in determining the relative share of public and private funds. The dead-end that we are facing here results from a fallacy of the question asked: we are trying to apply to ancient cities the modern dichotomy between public and private funds. I am well aware that the concepts of public and private existed already in Antiquity, albeit not exactly with the same meaning as today. For the Greeks, the private sphere was defined by the *oikos*, while Roman Law already introduced the distinction between *ager privatus* and *ager publicus*. However, the fact that this distinction existed as a concept and as an element of society does not imply that it was already as prominent as today, or that the boundaries of what was 'public' and what was 'private' were the same. But more importantly, it does not imply either that the dichotomy between public and private was radical or that it was the basis of a political conflict. This is, for instance, the fallacy in M. Silver's reasoning regarding the *sitonía*, when he depicts a

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[610] Macro, (1980), p. 680.

[611] Erdkamp (2005)., p. 273.

[612] Frézouls (1991), p. 8.

[613] IGR III, 484 & *IK-Ephesos*, 3065

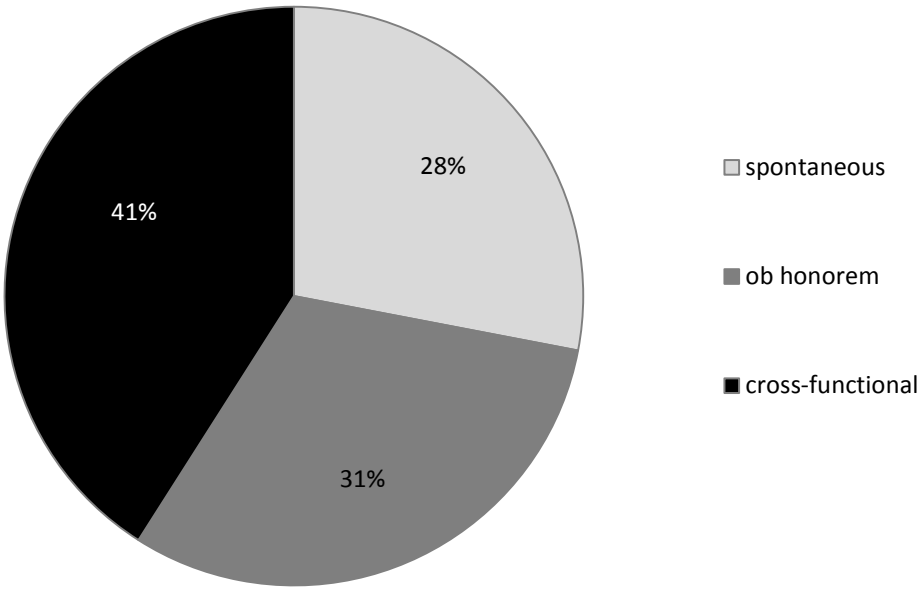
[614] For a good overview of this question, see : Jones (1940),pp. 167-168 & pp. 175-176; Dmitriev (2005) pp. 114-119 ; Sartre (1991), pp. 139-141. See also : Couilloud-Le Dinahet (1988), p. 324.

[615] Dig. L, 12, 3 ; Pliny, X, 40, 1

[616] Erdkamp (2005), p. 278.

struggle between a private sector reluctant to contribute to the civic expenses and roughly inefficient coercion measures set up by civic governments[617]. The idea of a radical and regularly conflictual separation between private and public funds, both attempting to extend their 'living space' is inherited from the development of modern States – that is, of *juridical persons* imposing a sovereign power onto *physical persons*. This view, in other words, confuses the existence of a public/private division with the existence of the concept of legal person, which only emerges in the 11th century[618]. Silver's analysis, in this respect, appears somewhat anachronistic. In the model I developed for analyzing the *sitonía*, I may have given the impression of radically separating the contributions of benefactors from the civic funds. This was largely done for the sake of simplicity, in order to identify clearly the sources of funds of the mechanism; yet, the public/private dichotomy which, to a large extent, shapes the institutional structure of the world we live in should not be incautiously transposed to the context of ancient cities, where the major distinction remained between civic and non-civic elements, even though our current views of the public and private spheres owes much to Roman law.

Fig. 30. Percentage of benefactions according to the function of the benefactor (n = 68)



[617] Silver (2007), pp. 95-104
[618] Picq (2009), p. 125

3.3.3 Social profile, status and institutional role of benefactors

Citizens were by far the most prominent actors and recipients engaged in munificence, whether related to grain or to public buildings and festivals[619]. In order to understand the factors determining grain-related interventions, it is thus worth analyzing the 'profile' and status of liturgists or benefactors, as well as their position in the city's institutional apparatus. In this section, we shall not engage in a proper prosopographical study of benefactors – which could undoubtedly shed an interesting light on the subject –, nor shall we discuss in detail a restricted number of benefactors; rather we will focus on studying the curriculum of individuals intervening in the grain supply from a statistical point of view in order to see whether or not some patterns emerge.

In the absence of a detailed prosopography, very little can be said of the real socio-economic status of these benefactors and officials, except when explicit mention is made, as is the case for the 'public slave' Onesimus in Balbura[620] and the freedman Publius Aelius Onesimus in Nacolia[621]. But these are the only two such cases in our total sample of 156 identifiable benefactors. Female benefactors, similarly, are recorded six times, and thus represent some 3.85 % of the total – to which must be added the two cases where the benefaction is being performed by both husband and wife[622]. This is significantly less than the percentage of 8.15 % women (8 out of 98 benefactors) recorded in a complementary database relating to public buildings in Asia Minor (3rd c BC – early 2nd C. AD). The relevance of the comparison of the two dossiers is however limited by their differential chronological span: even though female 'private' euergetism emerges simultaneously to the rise of civic benefactors in the early 4th c. BC[623], it is likely that the development of the imperial political framework influenced the participation of women in acts of munificence or fostered their association to their husband's benefactions, in the form of what R. Van Bremen identifies as the construction of an 'image of the couple'[624]. Although Van Bremen minimizes the role

[619] The notion of citizenship might of course be considered relative since a benefactor might well be citizen in his native city but not in the one where he performs his benefaction(s).

[620] LBW, II, 1228

[621] *CIL*, 6998

[622] *IK-Stratonikeia*, 227 & 527

[623] See for instance the dedication of a statue to Korè and Demeter in Cnidus by a certain Chrysina : *GIBM*, 813 (on which Dignas (2006), pp. 76-77), or the construction financed by Kourasiô in Aspendos in the 3rd c. BC (Brixhe (1978), n°17)). Also, there is no difference in the treatment of female munificence compared to that of male benefactors : Bielman-Sanchez (2003), p. 189 ; Pont (2010), p. 337.

[624] Van Bremen (1996),

of Augustan ideology in this process, it is likely that the imperial couple embodied an important exemplum of the Empire which the provincial élite both imitated and re-interpreted[625]. In this respect, it is possible that public buildings – and their corollary: dedications on stone, visibility and durability – provided a more conspicuous support to the display of couple or family euergetism than grain distributions or contributions to grain-supply schemes, explaining to some extent the discrepancy in the participation of women between grain-related benefactions and public buildings.

[625] Gordon (1990), p. 202 ; Zanker (1990), pp. 335-336.

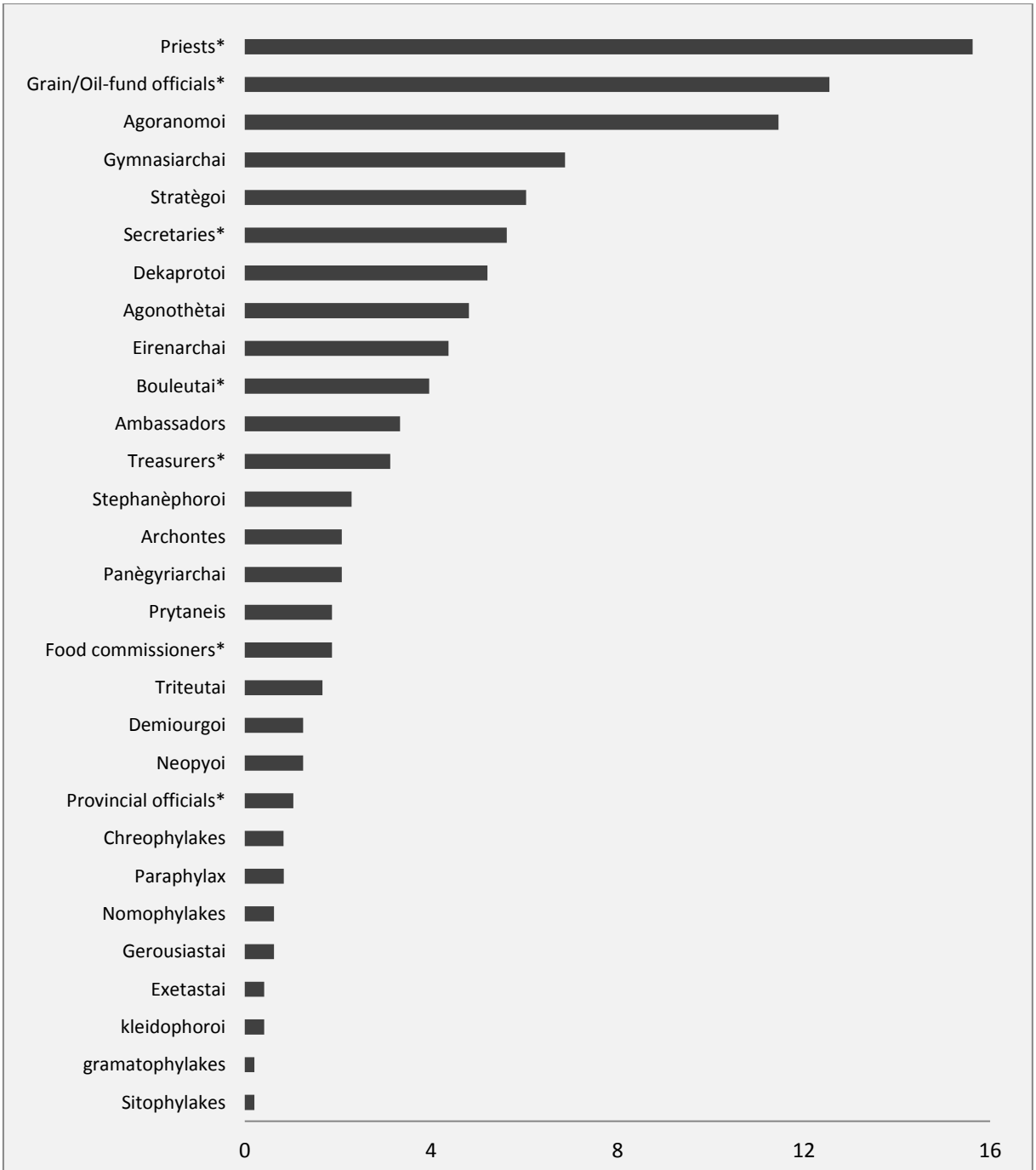


Fig. 31. Frequency (%) of civic offices mentioned in the curriculum of individuals intervning in the urban grain supply as a percentage of the total number of attested charges (liturgies or magistracies)| (*n* = 478)

Leaving the 'gender-focused' analysis in order to turn towards the institutional characterization, one might wonder what the civic curriculum of the officials and benefactors engaged in the grain supply might tell us. In a sample of 152 benefactors, a total of 478 civic offices (whether liturgies or magistracies) are mentioned[626]; the frequency of each category of office is shown by figure 7 above. Some of these categories already proceed from a first 'grouping' ('secretaries' include secretaries of the *boulè*, of the *demos* or of the *Koinon*, food commissioners contain *euthèniarchai* and *eubosiarchai* (on which see *supra*, section 1.1) etc..) but broadly speaking, the list details the different civic charges as clearly as possible. Nearly all existing civic offices are attested in this list. Grain-fund or oil-fund officials (*sitonai*, *elaionai* and their treasurers) belong to the three most frequent categories, which seems perfectly logical if we remember that they already constituted the two most frequent categories among specifically grain-related terms (cf. section 1.1). Priesthood is the most frequently mentioned office, which in itself is not surprising either given the pervasiveness of religious offices in civic life. For the rest, the list displays quite obvious features: offices such as the strategy, the *gymnasiarchia*, or the *agonothesia* are quite frequent, which is consistent with their importance among civic institutions.

From this stage, it is difficult to extract any more meaningful information from this ranking of offices. Yet, we might want to know what the distribution would look like if we proceed to a more generic – and hence, more coarse – grouping of the attested offices. On a slightly more restricted sample of inscriptions (127 instead of 152), I thus divided the 416 mentioned offices into six main 'spheres' of civic life : (1) the 'decisional-deliberative' sphere (*bouleutai*, *prytaneis*, *archontes*, *demiourgoi*, provincial officials and *gerousiasts*), (2) the 'administrative' sphere (secretaries, treasurers, account managers, *chreophylakes, grammatophylakes*, and *nomophylakes*), (3) the 'cultural-festive' sphere (gymnasiarchs, *agonothetai*, *panègyriarchai*, and *stephanèphoroi*), (4) the 'market regulation' sphere (*agoranomoi* and *sitophylakes*), (5) the grain supply sphere (*sitonai*, food commissioners, and *triteutai*), and (6) the 'religious' sphere (priests and temple officials such as *neopyoi*, *kleidophoroi*, etc...). To some extent, of course, such a classification is artificial since it is unlikely that ancient Greeks thought of civic offices in this way, and since we have already seen that there were no strict boundaries between the tasks of different officials. Yet, that ancient Greeks and Romans did not subjectively divide civic institutions along these lines does not hamper our highlighting of objective similarities. In this respect, *sitonai* are in any

[626] See technical appendix for the frequency distribution of offices.

case closer to the *triteutai* than to gymnasiarchs or *prytaneis*. Looking at the data from this perspective yielded the following pie chart:

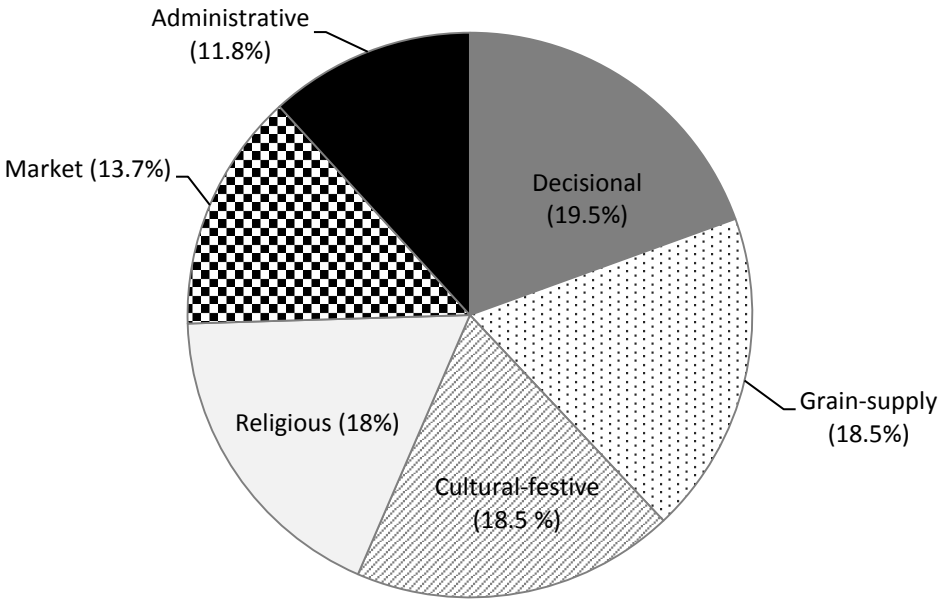


Fig. 32.1. Sectorial distribution of the functions associated to officials intervening in the urban grain supply (1st - 3rd c. AD) | *n* = 416

As we can see, the six spheres that we defined seem to take a roughly similar share of the total number of offices recorded among our sample of benefactors involved in the grain supply. Yet, in the absence of comparative data, it is difficult to determine whether the observed pattern is in any way particular or meaningful. We thus proceeded to the same analysis on an – unfortunately – smaller sample of about 45 inscriptions recording benefactions on public buildings in Asia Minor between 28 BC and 117 AD, and totalizing some 73 offices, which provided the following results:

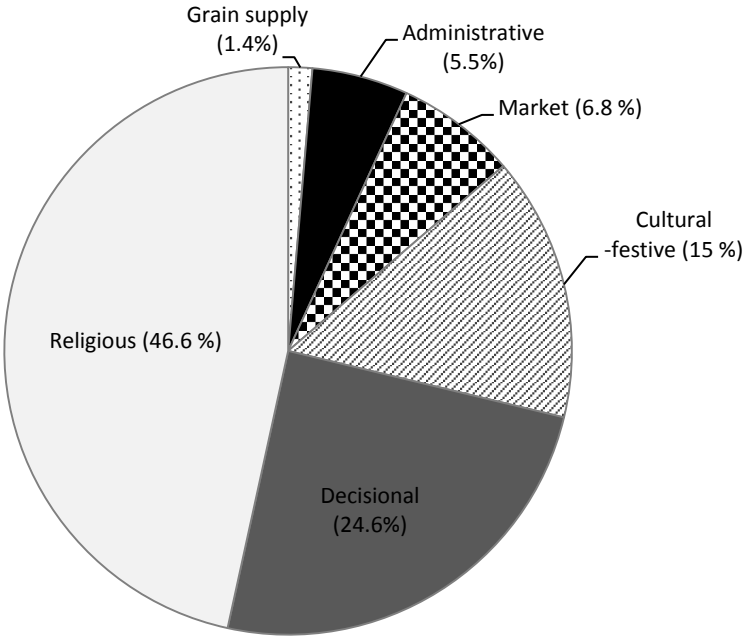


Fig. 32.2. Sectorial distribution of the functions associated to officials intervening in public buildings (28 BC - 117 AD)| *n* = 73

Here, religious offices are overwhelmingly dominant, representing some 46% of all attested offices while grain supply officials are only a very minor category, and the variation in the relative share of the different spheres is clearly more intense. In statistical terms, the *dispersion* of the data is much larger, with a standard deviation of 15.36 compared to the 2.86 in the sample of grain-related benefactors. Yet, since the two samples do not have the same size and mean, we might want to consolidate the comparison by a second indicator taking account of these differences. To do this, statisticians usually rely on an index called the 'variation coefficient' (*VC*, usually expressed in percentage), which is equal to the ratio of the sample's standard deviation (σ) to its mean (μ): $VC = \sigma/\mu$. For the sample of grain-related benefactors, the variation coefficient is equal to 17.2 %, against 106.5 % for public building benefactors. Given the difference in sample size, the error margin on the first sample is about 3.8 % against 14.3 % on the second[627], which as we can easily calculate is unlikely to affect the significance of the variation coefficient.

[627] The formula which allows to determine the error margin (ε) as a function of the total number of observations (the sample's size, written n) is the following : $\epsilon = \kappa \cdot \sqrt{\left(\frac{p \cdot (1-p)}{n}\right)}$;
where p is the probability for the considered event to occur, and κ is a parameter corresponding to the confidence interval we want to assess. In most statistical tests, the usual confidence interval is 95% - the parameter of which is equal to 1.96. The probability of occurrence (p) for each sample is simply the

Yet, one might rightfully argue that there is an intrinsic bias to the record of offices of public building benefactors: since many of these inscriptions consist of dedications, they usually have to be quite short for obvious reasons of limited space, cost and maximum visibility. Benefactors would thus be inclined to mention only their most recent offices, or those which they consider the most important in their career, or those which are most suitable to be displayed on the building they are contributing to; since temples are the most frequently donated buildings, it is thus quite logical that religious offices would also be the most frequent when dealing with public buildings. However, temples are not sufficiently more frequent compared to other types of buildings in order to explain the discrepancy between religious offices and cultural-festive offices for example. Moreover, since we are discussing the *variability* between institutional spheres rather than the *absolute frequencies*, the belonging of a specific office to one of the six institutional sectors should be considered as a random process which would thus be independent from the number of offices mentioned per single inscription. Thus, neither these objections nor the error margins can invalidate the conclusion that offices of grain-related benefactors display a particularly uniform distribution among the major spheres of civic institutions. The most straightforward and logical way to interpret this result is probably to argue that élites of each sphere of civic life were more or less equally concerned with matters of grain-supply, while interventions on public buildings were more strongly connected to the specific sector to which the concerned building was related.

3.3.4 The determinants of munificence and civic intervention: interpretative frameworks

So far, this chapter has emphasized *inter alia* the widespread concern for grain supply in the cities of the Graeco-Roman East, both at the imperial, provincial and civic levels. What were, however, the specific reasons of such concern? In this final section, I would like to discuss the question of the motivations for civic élites to contribute – or not – to the city's grain supply. Indeed, although civic interventions in the channels of grain supply are ubiquitous, grain-related benefactions are still a very minor category of euergetism as a whole. In order to understand the determinants of élite propensity to contribute to the grain supply, we will start by summarizing the determinants of euergetism as a whole, before turning to the specificities of grain-related interventions.

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probability that the considered type of benefaction would take place; or, said differently, the respective frequency of benefactions towards public buildings and grain-related benefactions.

In doing so, we will try to shed some light on the underlying determinants of generic and grain-specific munificence by framing it into the useful contribution sociology and anthropology theories.

3.3.4.1 Euergetism as a social behavior : development, functions and ethics

In his pioneering study on the subject, Ph. Gauthier has suggested that the rise of civic benefactors in the Eastern Mediterranean is simultaneous to the decline of Hellenistic kingdoms (late 3rd – early 2nd c. BC) which, in the 4th and 3rd centuries BC, had regularly undertaken acts of euergetism – whether on public buildings or food distributions – towards the Greek cities. With the decline of royal euergetism, wealthy citizens progressively became the main providers of benefactions[628]. To this should be added the consequences of the integration of the Greek East to the Roman political and administrative framework as emphasized by J.-L. Ferrary[629], and more particularly the diffusion of the relationships of clientele and patronage[630] largely unknown to Greek political culture, as well as the tendency for the Romans to promote oligarchic regimes[631].

This chronological-institutionalist explanation accounted for the rise of civic euergetism as a large scale phenomenon. But it does not explain why this phenomenon lasted, or why civic élites, either in the context of independent 'city-states', in Hellenistic kingdoms, or under Roman republican or imperial rule, continued performing benefactions; why, in other words, is this social conduct *structural*. The most thought-provoking study on the motives of euergetism is undoubtedly Paul Veyne's monumental work *Le pain et le cirque*. Despite numerous contradictions which it would take too long to list, the central claim of Veyne's book can be summarized as follows: munificence did not bear any function whatsoever and did not proceed from social relationships. In his view, euergetism consisted of the expression by élite members of a 'social distance' towards their fellow citizens, and nothing more. Munificence was, in this sense, disinterested. 'Any other explanation', he says – *potlatch*, redistribution, taxation otherwise labelled, (…) are inadequate explanations, or *rationalizations*.'[632] This sentence summarizes the key issue of the subject : was munificence a rational behavior or not? Veyne categorically answers negatively. But

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[628] Gauthier (1985),pp. 54-55 & p. 72 ; Gauthier (2011), p. 323

[629] Ferrary (1988), pp. 124-132.

[630] Ferrary (1997), pp. 207-212.

[631] Ferrary (1987-1989), pp. 203-216 ; Ferrary (1997), pp. 201-202.

[632] Veyne (1976), p.335 (emphasis is ours).

such a statement assumes that there would be a transcendental, universally valid definition of rationality. The sharpest critique of this assumption is owed to French philosopher Cornelius Castoriadis, when discussing the legitimacy of capitalism on the basis of its 'rational' character :

> (…) ce critère – être rationnel (…), est proprement *institué* [par le capitalisme]; et tout se passe comme si ce fait, d'avoir été très récemment institué, au lieu de le relativiser, l'avait rendu indiscutable. Pour peu que l'on réfléchisse, on ne peut pas éviter la question : qu'est-ce donc que la rationalité, et quelle rationalité ?[633]

Castoriadis' reasoning also applies to other historical contexts than modern capitalism: the *criteria*, the values defining rationality are always endogenous to a given society or political system. A native American tribal chief ruining himself by performing *potlatch* in the form of banquets, games, and gifts instead of investing this money might seem completely irrational to a 20th century businessman whose activities are considered with regard to the notion of profit maximization, but it is perfectly rational in the context of a society in which the conquest of political power and the ousting of opponents went hand in hand with a rivalry of expenditures. This *substantial* aspect of rationality depending upon the values of a specific context has been labeled *Wertrationalität* (or axiological rationality) by Max Weber. This rationality is however complemented by a *formal* aspect (*Zweckrationlität*, or instrumental rationality in Weber's theory) in which rational behavior is defined, following Hegel, by the degree of conformity of a specific operation to its goal(s); a perspective which, however, as Castoriadis underlines, only displaces the problem from the rationality of the means to the rationality of the goal itself…

In order to determine whether or not euergetism proceeded from a rational conduct and the extent to which it was disinterested and external to the social relationships of ancient *poleis*, we should thus examine the phenomenon of munificence – and more particularly grain-related interventions – in relation with the set of norms and values of Graeco-Roman societies, as well as its place and significance among the social relationships between individuals and their communities. What should be highlighted first is that ancient attitudes towards euergetism are not always welcoming. Although recipients of munificence may naturally show gratitude towards benefactors, many authors exhibit a rather temperate or even reluctant attitude

[633] Castoriadis (1996-1997), pp. 628-629

regarding euergetism. In his *Nichomachean Ethics*, Aristotle criticizes excessive and conspicuous behaviors in performing benefactions, and values a moderated munificence, both in size and frequency[634]. Cicero goes even further and considers the practice of munificence as a 'necessary evil' :

> As a consequence, the whole system of such *largesse* is by its very nature vicious, yet inevitable due to the circumstances, and should thus be adapted to its means and moderated by a sense of good measure[635].

Later on, however, Cicero explains why munificence is to some extent attractive: generosity, he says, is the community's 'safety net' (*commune perfugium est omnium*)[636]. Benefactions, when performed with a large scope, thus do not allow remaining ungrateful (*ingratis esse non liceat*)[637]. The couple of *beneficia* and *gratia* is also attested in Pliny's Letters to Trajan as well as in Seneca's *De Beneficiis*. In fact, ancient views on euergetism, whether in an epicurean or stoic context, have always emphasized the idea of reciprocity.

Anthropologists have provided an invaluable contribution to the understanding of munificence as a process of reciprocity through the gift/counter-gift theory developed by Marcel Mauss and Bronislaw Malinowski in the early 20th century when studying west-pacific tribes, and best summed up by the principle of 'donner oblige'. Any gift, they argue, implies and generates a counter-gift[638], not always – it should be highlighted – to the initial giver. But since gifts and their direct counter-gifts are never perfect equivalents, the system provokes a continuous indebtedness of individuals with one another, which only reaches certain equilibrium at an aggregate level[639], resulting in the fact that the gifts constitute the actual cement of society. Although initially dealing with insular societies, this theory has proven to be an anthropologic axiom – yet of variable intensity – as Mauss himself had already framed it into a comparative perspective with native American societies and their ritual of *potlatch*. Ancient evidence is also explicit about the importance of this principle in antiquity. A verse of

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634 Arist., *Nichomachean Ethics*, 1107b, 16-19

635 Cic. *De Off.*, II, 17, 60 : *Tota igitur ratio largitionum, genere uitiosa est, temporibus necessaria, et tum ipsum et ad facultates accommodanda et mediocritate moderanda est.*

636 Cic., *De Off.*, II, 18, 63

637 *Ibidem*

638 Mauss (1925), p. 138 ; Malinowski (1933), pp. 28-29 & p. 45

639 Malinowski (1933), pp. 38-39.

Hesiod's *Works and Days* reads : 'One gives to a giver; to whom who does not give, nobody ever gave'[640]. Even more explicit is the *Rhetoric to Alexander* :

> 'Those who make gifts are those who expect that we will be grateful, or those who pay back for a debt they contracted earlier on; when we serve others, it is always by interest, to obtain some sign of honor, by pleasure, or by fear.'[641]

By crossing ancient literary evidence with the modern findings of anthropological theory, it appears that munificence only echoes the far more general principle of reciprocity which, in preindustrial societies constituted an important channel of circulation of commodities, as Polanyi rightly pointed out From which it also follows that munificence could hardly be seen as a 'disinterested' behavior, as is made very clear, *e.g.*, in the *Rhetoric to Alexander*.

Yet, what is it concretely that benefactors might obtain from their munificence? What is it which is worth the considerable sums they spent on buildings and games ? Which form did the 'gratitude' of their communities take? To understand this, we should go beyond Mauss' and Malinowski's pioneering works, which focus on the gift of material commodities against other material commodities, and look at the theory of interest developed by French sociologist Pierre Bourdieu. One of the major contributions of Bourdieu to the sociology of élite behavior is no doubt his concept of 'symbolic capital' which is defined as the value granted by social agents (individuals or groups) to any type of pre-existing capital (whether physical, economic, or cultural)[642]. Symbolic capital is, in other words, the social value ascribed to material *or* immaterial capital, the value of goods and deeds insofar as they are socially recognized. With recourse to the concept of symbolic capital – by far more efficient and relevant than Veyne's odd 'social distance' – the loop of munificent behavior can be closed : benefactors (or officials) spent material capital and received in return symbolic capital, of which prestige and honor were two major forms.

Euergetism was thus indisputably a matter of symbolic exchange, of interest, and of reward; it was a structural feature of ancient Greek cities that echoed the dynamic of reciprocity so pervasive in preindustrial societies. As a matter of collective action and mobile of social enterprise, euergetism can definitely not be considered disinterested and external to conflicts and relationships, as in Veyne's central statement. Of course,

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[640] Hesiod, *Works and days*, 355-356

[641] [Arist.], *Rhet. Alex.*, 38, 21

[642] Bourdieu (1972), p. 238 ; Bourdieu (1994), p. 116.

benefactors, institutions, and recipients of euergetism might often not have been *conscious* of the issues that were at stake, and the rewards to munificence might not always (or not even often) have been consciously calculated by benefactors; but the unconsciousness of the social dynamic that underlined operations of munificence does not allow arguing that this dynamic did not exist or that it has no explicative power. In Bourdieu's words, this dissonance between social facts and their perception is a disjunction between subjective truth and objective reality. In other words, some benefactors might well have been convinced that they acted disinterestedly, while some others attempted to create the illusion of selflessness – an illusion facilitated, as Bourdieu notes it, by the temporal disjunction between benefaction and reward, between gift and counter-gift. In this respect, Veyne was not so much 'wrong' as he appears to have been mystified by the subjective perception or communicational strategies of benefactors.

3.3.4.2 The rationale of grain-related interventions

Since benefactions generated obligations, they should be seen as a matter of rational decision and, most importantly, as having a function within ancient cities. We thus need to briefly review some aspects of these 'functionalistic' approaches to euergetism as a whole before focusing on the specific functions of grain-related munificence and civic intervention. Apart from the view considering euergetism under the angle of charity and philanthropy[643], which finds little ground before the rise of Christianity, the major recent reinterpretation of euergetism is no doubt A. Zuiderhoek's *Politics of munificence in the Roman Empire*, in which the author argues convincingly that the rise of euergetism during the first two centuries AD responded to the dissonance between the civic discourse of Greek cities and the ever-increasing social inequality[644]. The key idea of Zuiderhoek is that munificence consisted of a way of **legitimation** of the élite's leading political position by contributing to the upkeep and enhancement of symbolic structures common to élites and non-élites. This type of legitimation, developed by David Beetham, is indeed fruitful to explain euergetism, but does not tell the whole story. Indeed, the repeated emphasis of benefactors's family lineage in inscriptions, the emphasis on their prestigious ancestors, and their regular performing of benefactions with other members of their kin less suits Beetham's scheme than Max Weber's concept of 'traditional legitimation'[645].

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[643] Hands (1968) ; on the euergetism as *philanthropia*, see : Schmitt-Pantel (1992), pp. 207-208.

[644] Zuiderhoek (2009)

[645] Weber (2003), pp. 119-120 ; Weber (1978), p. 226 : 'Authority will be called traditional if legitimacy is claimed for it and believed in by virtue of the sanctity of age-old rules and powers'.

Legitimation, however, was naturally not the only reason why benefactors provided gifts; more straightforward motives of prestige undoubtedly played a role. Moreover, we should also be cautious not to over-interpret munificence in terms of voluntary actions, for benefactions were also bond by significant **constraint**, both informal and legal. Informal constraint often took the form of the *summa honoraria* and other customary expenditures which went along with various magistracies, while legal constraint mostly concerned the promises (*pollicitationes*) that benefactors had done, and which they were compelled to perform, as attested by many passages of the Digest[646]. Finally, **élite rivalry** also played a significant role in fostering benefactions : ancient literary sources provide records of situations of jealousy and intra-élite competition related to benefactions[647], echoing the ancient Greek mentality of the *agôn*. Such type of élite behavior have been studied in Thorstein Veblen' famous *Theory of the Leisure Class*, which he conceptualized through the concepts of 'pecuniary emulation'[648] and, more importantly, 'conspicuous consumption' :

> Conspicuous consumption of valuable goods is a means of reputability to the gentleman of leisure. As wealth accumulates on his hands, his own unaided effort will not sufficiently put his opulence in evidence by this method. The aid of friends and competitors is therefore brought in by sorting to the giving of valuable presents and expensive feasts and entertainments. Presents and feasts had probably another origin than that of naïve ostentation, but they acquired their utility for this purpose very early, and they have retained that character to the present.[649]

Legitimation, prestige, constraint and rivalry are however 'generic' motives for euergetism, to which should be added the specific opportunities related to each type of benefaction. As far as food munificence is concerned, festivals, especially religious ones, seem to have been a very suitable occasion for performing food distribution, although for Asia Minor the number of examples is limited to 4 records (3 of which are found in Stratonikeia, probably because of the sanctuary of Panamara where many

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[646] *Dig.*, 39, 5, 19 ; *Dig.*, 50, 12, 1 (1) & 50, 12, 3. See also : Plin., *Ep.*, X, 40, 1.

[647] Dio Chrysostom, *Or.* 46, 9 ; Pliny, *Ep.*, VI, 31, 3

[648] Veblen (1953), pp. 38-40 : 'as the self-regarding antithesis between man and man reaches fuller consciousness, the propensity for achievements (…) tends more and more to shape itself into a straining to excel others in pecuniary achievement. Relative success, tested by an invidious pecuniary comparison with other men, becomes the conventional end of actions.'

[649] Veblen (1953), pp. 64-65.

festivals would have taken place). In two of these three cases, benefactors' curriculum specifies that they were 'priest during the feast of Hera', which would seem a rather useless indication unless we consider that the festival in honor of the Goddess went along with expenses, among which food, that were to be paid by the religious officials. Which specific reasons stimulated or dissuaded benefactors and civic institutions to perform grain-related euergetism ? This question allows us to consider the paradox of grain-related intervention : as has been shown along this chapter, ensuring a regular and affordable grain supply to the city was a constant concern of different levels of power and various social groups, yet food-related benefactions remain a very minor category of munificence. Which factors might thus explain the apparent reluctance of civic élites to contribute to the grain supply ?

Arjan Zuiderhoek has recently proposed one reason that might discourage benefactors to provide gifts of food. Civic food-related munificence, he claims, should be interpreted within the framework of 'oligarchisation' combined to the growing paternalistic relationships between cities and their élites. In this respect, food benefactions, despite a rather low level of conspicuousness, provided considerable short-term prestige and important popularity to the benefactor. In a context where civic élites increasingly formed an oligarchic order – the *ordo decurionum,* or τάγμα βουλευτικόν – such acquisition of prestige by members of the civic élite could threaten the cohesion and position of the group[650]. This dynamic finds parallel, Zuiderhoek argues, in the Roman context, where food distribution were often conceived as betraying a monarchic temptation[651]. With the growing imperial involvement and control in matters of grain supply, Zuiderhoek's statement might be prolonged and confirmed, as performing food benefactions would increasingly risk being seen as an act of challenge to the emperor's authority and *providentia*[652]. As far as the Greek part of the empire is concerned, to this dynamic might be added the propensity for euergetism – and food munificence in particular – to reflect demagogic behavior and hence attract a pejorative view[653].

However, this might not tell the whole story. Reasons for the low frequency of food munificence should probably be sought in the core motivations of euergetism as a whole. Indeed, it has been argued that symbolic capital was one major reward of benefactions. If grain-related benefactions would, like any other, result in honorific decrees which could provide the same dose of prestige as decrees for other type of

[650] Zuiderhoek (2014), pp. 312-313.

[651] Zuiderhoek (2014), pp. 313-314

[652] Cf. Scapini (2016), esp. pp. 235-237

[653] On food munificence as demagogy : Schmitt-Pantel (1992), pp. 203-206.

benefactions, the gift itself is far less conspicuous than, for instance, public buildings. For benefactors do not only seek conspicuousness in their reward, they also expect their gift to remain visible, to attract admiration and a favorable consideration for as long as possible. All such things are clearly easier to find by donating or contributing to public buildings than to the food supply, games and festivals being somehow intermediary in this respect. This becomes even truer if we consider the financial burden that grain-related gifts might represent. Buildings are very expensive of course, but even the cheapest contribution to public infrastructure, the donation of a column, provides an important reward relative to the expense. The inverse is true when dealing with grain : even large-scale distributions of grain, or impressive sums spent on importing grain, remain discrete acts of munificence, and are in any case rather ephemeral contributions. As far as grain is concerned, the ratio of symbolic reward to financial expenditure is quite unfavorable. This statement finds even more ground if we turn our attention to gifts of food in societies of hunter-gatherers analyzed by anthropologists. Marshall Sahlins have extensively demonstrated that, in these societies too, food was considered an exceptional commodity whose exchange often obeyed radically different social rules[654]. But, even more interestingly, Maurice Godelier explains that, in the Melanesian and Polynesian societies that he studied, *the level of prestige of objects increased with their distance from the sphere of subsistence* : prestige objects had to be rare, unused, and most importantly, they needed to be suitable to embody symbolic attributes of power and religion, characteristic which were less easily found among foodstuffs[655]. Despite the structural differences between nomadic societies and the post-Neolithic societies to which Graeco-Roman civilization belonged, this particular status of food within the exchange of gifts is somewhat similar, and thus perhaps betrays a universal ambiguity.

Yet, in order to conclude this section, we also need to highlight the reasons why food benefactions and more particularly grain-related munificence still continued to be performed. First, as we have already seen, some circumstantial opportunities (like religious festivals) happened more favorable for the performing of grain-related gifts. But most importantly, the reason for the continuity and pervasiveness of grain-related intervention should probably be sought in the converging interests between benefactors and civic institutions. We should indeed be reminded that, in the post-classical and increasingly oligarchic cities of the Graeco-Roman East, most benefactors and officials belonged to the top echelons of the city's élite, and alternatively appear as

[654] Sahlins (1976), pp. 273-276.
[655] Godelier (1996), pp. 222-224.

spontaneous benefactors, devoted liturgists, or generous magistrates. Benefactors and civic officials were, in this respect, two sides of one and the same coin.

Arjan Zuiderhoek's theory that euergetism played an important role in the upkeep of the civic ideology in a context of growing social tensions has already been outlined, and certainly accounts for a part of grain-related munificence. But, besides the indirect, symbolic aspect of élite conduct, a second reason undoubtedly lies in the direct, straightforward dialectical relationships between élites and their communities. Ancient sources provide clear evidence for the troubles that can result from situations of food distress, and in particular the political *and* physical threat for local élites in case of riots[656]. Avoiding uprisings and social turmoil was thus an additional reason to preserving the legitimacy of social and political leadership[657]. However, and even more interestingly, food riots were not merely an expression of violence derived from hunger and deprivation, but also the political reaction to what was felt as the betrayal of a certain idea of justice and fairness, partly derived from customary political regulations. Studying the English crowd of the eighteenth century, British historian E. P. Thomson has labelled 'moral economy' the settings of beliefs, norms and values determining the crowd's political reactions to various situations, the most crucial being the conditions of the food-supply[658]. Élites, however, did not act upon the mere pressure or expectations of the masses, but were themselves penetrated by the standards of such 'moral economy', as indicated by reflections on the idea of 'fair prices', more extensively discussed earlier in this chapter. Grain-related munificence was thus also the manifestation of élite action as resulting from the ethical set of norms and values framing market interventions and took part, to a certain extent, to what we might call the 'ancient social contract'. Needless to say, the rationality that drove civic élites to perform grain-related munificence converged to a certain extent with the rationality of the Roman power apparatus as a whole, which, like Hellenistic Kingdoms and other large-scale political constructs, relied to a significant extent upon its municipal basis.

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[656] Dio Chrysostom, 46, 4 ;6 ;11(Prusa) ; Philostr., *Vi. Apoll. Tyan.*, I, 15 (Aspendos) ; *IK-Ephesos*, 215 (Ephesos)

[657] On food riots, see : Erdkamp (2002), pp. 93-115.

[658] Thompson (1971), pp. 76-136.

3.4 Markets, traders and money

For the most part of this study, I have largely overlooked the place of market exchange. This was done partly on purpose, in order to isolate the different factors affecting the grain supply, and partly because for avoiding useless repetition with earlier scholarship. Markets have been discussed above in terms of their regulation by city officials, and regarding their reaction to a contraction in supply due to an exogenous shock. But their actual functioning in relationship to the urban grain supply has yet to be highlighted. I would like to make my purpose clear and not let the reader build expectations I would not be able to fulfill: my point here is not to provide a comprehensive account of the nature of ancient markets (not even in the specific context of Asia Minor), neither to account in detail for logistic issues (the most obvious of which is overland transport), nor to provide a thorough analysis of the economic strategies of tenant farmers, landowners, merchants, consumers and civic authorities interplaying with one another on the grain market. These aspects are beyond the scope of my study, and have already been the subject of extensive discussion by scholars[659]. My main concern here is rather to provide some reflections on two specific questions: the efficiency of markets as a channel of urban grain supply on the one hand; on the other hand, the role of urbanization and urban markets as a stimulus of agricultural production. In order for me to develop those aspects as concisely as possible, I will phrase each of them through a specific question:

(1) How did the grain merchants' strategies influence the efficiency of markets as channels of urban grain supply ?

(2) To what extent could urbanization have fostered agricultural production?

3.4.1 Grain merchants and their strategies:

What was the economic behavior of the grain merchants? What were their interests? And most importantly, how did these interests and the merchants' strategies to pursue them interact with the cities' needs in terms of grain supply? First of all, the generic label of 'grain merchants' or 'grain traders' conceals an important distinction which should be emphasized from the beginning. Not all merchants operated at the same

[659] Most importantly : De Ligt (1993), pp. 64-70 ; 122-126 & 211-217; Erdkamp (2005), pp. 106-141 & 143-206.

scale, nor did they all have the same role in the commercial process. B. Levick distinguishes four levels of trade: local, inter-city, regional and inter-regional[660]. This distinction partly overlaps that between wholesale merchants and retailers[661], or importers and resellers. K. Ruffing could identify no less than eight different terms for grain merchants and seven for bread merchants[662].Two important elements should be stressed regarding this specialization of tasks in the commodity chain. First, the distinction between farmer/producer, trader and merchant is not always very strict[663]: There were professional merchants of course, but a lot of farmers or landowners would on occasion sell grain on their own on the urban market. Second, resale by third buyers would eventually increase the retail price.

Evidence for the economic action of merchants is given by the famous discourse of Lysias *Against the grain-dealers* in which clear distinction is made between καπήλοι, σιτοπῶλαι (resellers) and ἔμποροι (importers). The discourse mostly focuses on the practices of the resellers, accused by Lysias of practicing speculative stockpiling and exercising an upward pressure on prices by cartel arrangements. I shall not reconsider the actual relevance of the accusation, nor question the partiality of Lysias who demonizes resellers while leaving importers' reputation intact– perhaps because the city had less means to constrain their activity and was heavily dependent upon external supplies…What is actually interesting in this discourse is the 'economic psychology' that Lysias attributes to the merchants, which reveals potential conflicting interests between importers, resellers, and consumers:

> 'Their interests are opposed to those of the public. When do they make the biggest profits ? When the signs of a disaster allow them to sell at a high price. They look on your misfortune with such a favorable eye that, sometimes they are aware of if before anyone, sometimes they make it up.'[664]

This passage echoes another text from the *Life of Apollonius of Tyana*. In a dialogue with Apollonius, a young man exclaims:

> 'But what more godforsaken class can you name than merchants and ship's captains? First of all, they sail around, looking for a depressed market; they

[660] Levick (2004), p. 183
[661] Katsari (2011), p. 180
[662] Ruffing (2008), p. 118 & pp. 746-747
[663] *Ibidem* ; Erdkamp (2005), 118-127 &. 134-142
[664] Lysias, *Agains the grain dealers*, 13-14

> mingle wiith agents and retailers; they buy and sell, submitting their own persons to unwholly rates of interest, and striving after their capital'[665].

Three important things should be stressed regarding these texts: first, although they are separated by roughly six centuries, they depict very similar behaviors by merchants; secondly, they provide further illustration of market distortions resulting from cartel practices or collusion with agents or officials similar to the ones already mentioned concerning the bakers of Ephesos; thirdly, even if importers and retailers must have been in conflict for the price at which the former group would sell grain to the latter, they both profiteered from local shortages. This third aspect, namely the impact of grain trade in the context of harvest failure, requires some further discussion.

As P. Erdkamp reminds us, the price differences between regions, partly resulting from the ecological fragmentation of Asia Minor that I underlined in Chap.I, form a major driving force of interregional or even inter-city trade[666]. Here, I would like to focus on the precise short–term dynamic of grain trade as resulting from price differentials between neighboring regions or cities. Let me consider the case of two cities, A and B: A experiences a bad harvest while B experiences a 'normal harvest', that is, with moderate surpluses. As Paul Erdkamp rightly emphasizes, the intensity of grain exports from B to A will not solely depend upon the price of grain in place A, but also upon the transport costs[667]. If the unit cost of transport is higher than the price difference between the two cities, it is worthless for merchants or commercial farmers of place B to export. On the other hand, if the price difference is higher than the unit cost of transport, this will stimulate exports of grain from B to A. Yet, if a large number of merchants apply this reasoning, they will significantly affect the supply of grain in place A and hence lower its price. But as the price in A would be lowered, the profit margin will be reduced, and the exported quantities will eventually decrease, a phenomenon already described by Braudel for Mediterranean regions of the 16th century[668]. What we are facing here is what chemists and biologists call an *autocatalytic* process, that is, a process which is progressively hampered by the same interplay of variables which had initially triggered it. This can be represented by a simple model:

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[665] Philostr., *Vita Apoll. Tyan.*, IV, 2

[666] Erdkamp (2005), pp. 143-146

[667] Erdkamp (2005), p. 199

[668] Braudel (1990 b), pp. 269-270

On the one hand, the inflow of grain imports from B to A (Q_M) over time as a function of the difference between the price differential in A and B (p_{AB}) and the unit cost of transport (c_T) can be described by the simple differential equation:

$$\frac{dQ_M}{dt} = \kappa \cdot (p_{AB} - c_T)$$

Where κ is a constant of proportionality. On the other hand, let me assume, for the sake of simplicity, that the price of grain in place A (and hence the price differential) decreases linearly by a factor ξ as imports of grain from B increase :

$$\frac{dp_{AB}}{dt} = -\xi \cdot \frac{dQ_M}{dt}$$

Finally, available quantity of grain in place A is equal to the local quantity after the (bad) harvest (Q^*) plus the quantities imported from B :

$$Q_{A,t} = Q^* + Q_{M,t}$$

Solving the system of the two differential equations and injecting the result in the third one yields a final equation describing the evolution of available quantities in place A through time :

$$Q_{A,t} = Q^* + \left(\frac{b_0}{\eta}\right) \cdot (1 - e^{-\kappa \cdot \xi \cdot t})$$

In which b_o is simply the differential between the unit cost of transport and the price difference between A and B before the harvest shock. The short-term evolution of the available quantity of grain in place A is displayed on Fig 32 below.

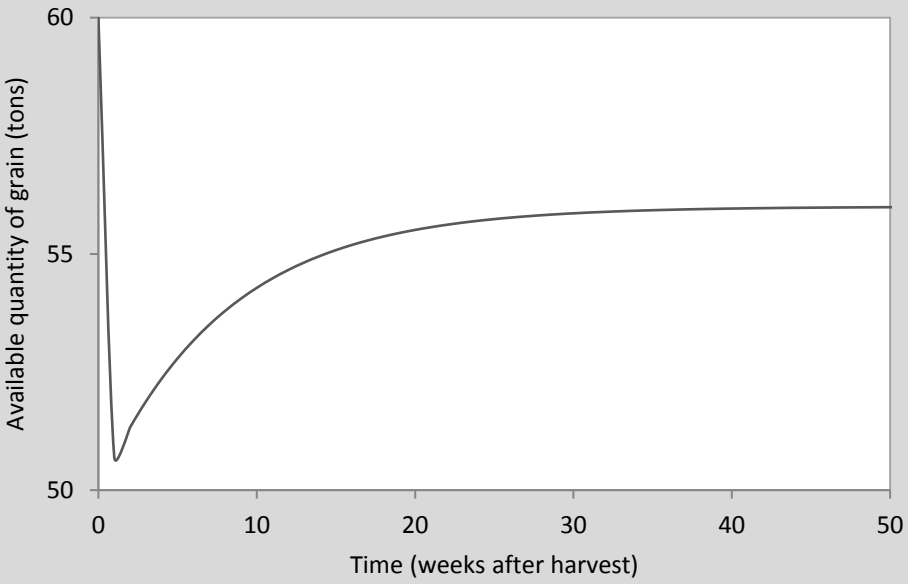

Fig. 33. Short-term evolution of the available quantity of grain in a city through imports after a bad harvest.

This graph has been constructed with arbitrary values of course. What matters for the present issue is the dynamic: depending on the gravity of the initial harvest shock, on the response of prices to increased supply (*i.e.* of the elasticity), and on the initial differential between the price difference and transport costs, the traded quantities will or will not be sufficient to bring the supply of grain in place A at its pre-shortage conditions.

3.4.2 Cities: money and the commercialization of grain

It has been a widely held view among ancient economic historians that urbanization actually stimulated grain production by creating a strong solvable demand[669]. I have already emphasized in Chap. II that, let alone the hypothesis of technological change, this would only be possible if we abandon the idea of ancient cereal agriculture as being doomed to face diminishing marginal returns. Now, I would like to add the following remarks concerning this point:

(1) First of all, although this is only a minor objection, claiming that urbanization generates an incentive to increase agricultural production reduces all grain

[669] Hopkins (2000), pp. 253-267

production to either market-connected farming or commercial farming, and thus neglects the share of smaller-scale agricultural exploitations that were largely isolated from the market of goods.

(2) Second, this statement overlooks the fact that, depending of course on the local level of demographic pressure upon the environmental resources, there is an upper limit to the increase of production, which is set by the level of ancient agricultural technology, the effect of innovative farming practices such as manuring, or crop rotation, and by the capacity of farmers to adapt their use of production factors. Raising total output levels requires changes in the quantity of production factors used, or changes in the productive process in order to increase average productivity, or both. Yet, changes in the quantity of input factors and changes in the level of productivity are not independent from one another: as we have seen in Chap. 2 when discussing the influence of the labor-land ratio on overall levels of production in a 'Sraffaian' perspective, it appeared that a reduction of cultivated area might well generate a higher level of total output depending on the quantity of labor used. On the other hand, an unlimited increase of labor inputs with a constant cultivated area will eventually make the producer reach the point from which diminishing marginal returns start to arise.

(3) Most importantly, there a crucial element which is left undiscussed when arguing that urbanization represented intrinsically a stimulus to agricultural production : money. Money is indeed the reason why farmers would produce more grain in order to sell it on the market. Let me take the reader to a purely deductive reasoning in order for me to explain why this point is crucial to the validity of the argument.

As it has been repeatedly argued along this study, the total harvest of grain producers can only be divided among four main purposes : the peasants' self-consumption, seed-corn, the quantity of grain used to pay the rents to the landowner, and the share to be paid as taxes. The element which actually connects rural producers and urban consumers is rent. Whether the grain is given as a rent in kind and only resold afterwards by the landowner on the market, or whether it is commercialized by farmers in the first place to obtain the money with which to pay the rents matters little here : in the end, the money end up in the hands of the landowner.

In either of the two options, the sale of grain will take place in town. Who, then, will buy this grain ? Essentially the urban consumers which represent the whole diversity of existing professions and occupations : craftsmen (potters, tanners, blacksmiths,...), fishermen, innkeepers, merchants, unskilled workers...etc. But where do they get the money with which to purchase grain

from? This money has three origins: (a) the internal transactions occurring in town, in which these consumers are in turns buyers and sellers; (b) the wages paid to workers; and (c) the purchases made by the social élites, which are essentially the landowners receiving the payment of rents.

Let us leave out these purchases for a moment and focus on the internal transactions and wages. These monetary salaries, as well as the sums used in the transactions between urban dwellers can obviously not arise *ex nihilo*. Wages would have been either paid by civic authorities in case of 'public works', or by wealthy silent partners (themselves likely members of the local élite) at the origin of the project in which workers are employed. Internal transactions between dwellers, on the other hand, must at some point find their monetary counterpart in relationship with owners of monetary capital, mainly, again, the local landowning élite *or* the bankers and usurers. In every step of this process, thus, we see that the local élite should have played a crucial role in the input of liquid money on the urban market. But in this case, the argument of the urban stimulus of agricultural production becomes circular: the monetary income of landowners derived from the commercialization of the surplus extracted from farmers would arise, largely, from money that these landowners would have injected themselves in the first place through other networks (purchase of commodities, payment of wages, etc…). Interstingly, C. Katsari envisages the actual means through which landowners could have substantially benefitted from trading surpluses:

> 'The economic nature and profitability of trade in antiquity prompt us to suggest that commercial activities seemed to facilitate the accumulation of an increasingly important volume of wealth in coined money. The sale, transportation and marketing of goods could have been carried out in a variety of ways with the involvement of a range of people from different social strata (…). At each stage the person involved may very well have been dealing not with the principal but with the representative, a slave or freedman, or a member of the élite acting as an *institor* (…)
>
> By means of these institutions also the rich landowners could have reaped the rewards of trade indirectly by creaming off the profits from the use of his or her representatives at each of the key stages in trade. In this model we should envisage a relatively closed market in which profits largely returned directly or indirectly to the wealthy landowners.'[670]

[670] Katsari (2011), pp. 179-180

Moreover, in the Graeco-Roman world unlike nowadays, no continuous monetary creation exists, as we now know through the system of central banks. Monetary emissions are erratic, and often depend upon conjuncture (mainly military campaigns), mining resources, and political agenda. I am not saying, of course, that money was rare: there is now increasing consensus on the fact that the level of monetization of the Graeco-Roman world was much higher than previously acknowledged[671]. But emissions are neither continuous nor regular. Hence, if we are to consider possible sources of increase of local money supply to support the commercialization of agricultural production, I would be left with only three hypotheses :

(a) The minting of local (provincial) coinage;
(b) The inflow of credit through bankers;
(c) The sale to neighboring regions or to Italian merchants of local staple foods, which would bring us back to the 'taxes-and-trade model', but which I personally fail to reconcile with the sharp critiques of R. Duncan-Jones[672] and with the identification of 'monetary circulation pools'[673];

If, on the other hand, we are to abandon the hypothesis of the potential increase of money/credit supply, in other words if money supply is constant, then the whole argument of urbanization driving grain cereal production up is seriously damaged: what would indeed be the incentive for farmers to produce more grain since a larger output could in any case not be converted in an equivalent amount of money? I am aware that very little of the abovementioned statements of mine are backed by ancient sources. Yet again, this does not *per se* refute my reasoning. What one should wonder to counter my argument is rather to reveal how else could have things happen and suggest an alternative scenario. How would a constant money supply have nevertheless represented an incentive for increased agricultural production in the context of growing urbanization? Or, on the other hand, what were the sources of increased money emissions that might have allowed a higher level of production to be profitably converted on the market? On this last aspect, however, I do not claim that such increased money supply did not take place; I simply allow myself to raise this – in my opinion – crucial question.

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[671] Duncan-Jones (1994), pp. 168-170
[672] Duncan-Jones (1994), pp. 172-178; A somehow intermediate position is offered by Howgego (1995), pp. 108-109
[673] Katsari (2011), p. 199

My overall point here is not to argue that cities did not or could not represent an incentive to raise agricultural production, and were therefore a mere burden upon the shoulders of the countryside. What I intended to do with this thought experiment is rather to reveal the *underlying assumptions* – the 'critical assumption', as D. Rodrick would have written –which render this mechanism possible. Leaving these conditions unchecked necessarily implies to revise the now common dismissal of ancient towns as 'consumer cities', at least from the viewpoint of food resources.

As far as urbanization and cities are concerned, I will leave the last words of this section to Moses Finley, whose nuanced statement I widely support :

> ''Imports of food and other bulk commodities permitted a substantial increase in the size of population, no longer held down by the limiting factor of local agricultural production. (...) there might also be a feedback effect on the countryside in that imported necessities allowed more efficient exploitation of larger landholdings (though not of peasant holdings) through specialization, not really possible in more or less isolated, self-sufficient communities''[674]

* * *

It has been argued that markets and private merchants were in fact responsible for the main part of the daily grain supply of cities[675]. I do not wish to refute this claim, nor do I have sufficient evidence to do so. Market exchange was indeed crucial to the supply of grain, in two major aspects: (1) they were the necessary risk-taking entity, while famers usually were risk-avoiding actors; (2) as Dermody *et al*. suggested, one major achievement of the Roman economy is precisely to have interconnected regions of Virtual Water surplus with regions of Virtual Water deficits[676]. This is an interesting suggestion, even more since political conditions in the context of the *Pax Romana* are known to have fostered trade, but the authors probably overestimate the degree of

[674] Finley (1973), p. 128
[675] Garnsey (1988), pp. 233-234
[676] Dermody (2014), pp. 5036-5037

integration of the grain market[677], while they also seem to confuse integration per se with market integration.

Yet, these two aspects seem undisputable to me. What I merely meant to stress here, is that (1) market supply channels, albeit necessary, were not always fully separated from the sphere of production or from the civic institutions (as we have seen above with the *sitonìa*), and that (2) just like civic schemes, they also had their drawbacks: stockpiling, cartel arrangements and collusion with agents or civic officials might result in upward pressures on prices, while aggregation of individual profitable behaviors is likely to have a retroactive effect on the initial stimulus of grain exports from a region in surplus to a region under shortage, and hence will probably tend to progressively reduce the inflow of imported grain.

[677] Cf. Bransbourg (2012) (ISAW Papers 3 : http://dlib.nyu.edu/awdl/isaw/isaw-papers/3/)

General conclusion

Research perspectives

This study is naturally only one more brick in the wall. Many aspects are yet to be examined, following the methodologies and conceptual framework which have been applied here.

- As far as the *primary production* of surplus is concerned, it would be particularly interesting to develop a Monte-Carlo simulation model of Graeco-Roman agricultural production in a specific region: integrating, , soil productivity, the potential adjustment of sowing rates and consumption per capita to the size of the harvest, the fluctuations in the level of rents, as well as short term adjustments of the cultivated surface and labor input, would provide us with a dynamic model of agricultural production, instead of the deterministic model we have developed here. Such an approach would be particularly suitable to reconstruct the evolution of a region's agricultural production through time within a range of variation determined by the uncertainties of the input variables.

- If we now move to the *appropriation of surplus*, the most important aspect to be further examined is the exploitation of land and the details of the management of rents in produce. Here, a wide-ranging collection of literary and epigraphical data on landed property and tenancy in Asia Minor, together with the inclusion of archaeological information on estates and villas would be required to narrow our uncertainties regarding the level and the mode of perception of contractual rents and their evolution over time, and help us reconstruct this fundamental aspect of surplus extraction.

- In order to improve our understanding of the connection between rural production and urban consumption of grain, an interesting complement to the

topic would be to undertake a geographical study of the ceramics of cereal storage and transport in Anatolia during the first three centuries AD.

- Concerning urban grain-related interventions *sensu stricto*, the main gap yet to be filled is the connection of benefactors and officials with extra-civic networks of food supply, in particular money-lenders, merchants (*mercatores*, *negotiatores*), and Roman authorities. To do so, a full prosopographical study of all individuals involved in the grain supply should be carried out, and its outcome would deserve scrupulous statistical analysis. Following this protocol, it will then be possible to reconstruct the actual 'social network' of grain supply intervention.

- Finally, in order to address the broader question of how far Graeco-Roman society succeeded in creating the conditions for its urban and rural populations to have access to an adequate supply of staple foods, the most objective approach, in my opinion, remains the analysis of skeletons. While palaeoanthropological analyses do exist for other parts of the ancient Mediterraean, to my knowledge, no such study exists for Graeco-Roman Asia Minor. Yet, the analysis of traces left by palaeopathologies due to dietary deficiency provide one of the most reliable pieces of evidence on the actual physical well-being of ancient populations. Obviously, samples are small and not representative of past populations, but it is probably possible to overcome this problem by calibrating the results via an interdisciplinary approach combining literary, epigraphical, archaeological, and palaeoanthropological evidence.

Conclusions

The time has come to sum up the empirical and conceptual findings of the three parts of this investigation.

I

In the first chapter, it has been shown that the productivity of cereal cultivation in Asia Minor has been underestimated. Asia Minor ranged among the most fertile regions of the Mediterranean, and its grain yields should most likely be placed closer to the upper limit experienced in ancient Mediterranean agriculture. The reasons for this underestimation mainly lie in the incautious extrapolation of the agro-climatic

characteristics of continental Greece as well as in the projection onto Antiquity of the agrarian system observed in early 20th c. Greece. Combined with existing estimates of the Anatolian population in the early or middle Empire, this reassessment of agricultural productivity in Anatolia reveals that the region did not outgrow its maximum carrying capacity. However, an equally important finding of the environmental setting is that Asia Minor was marked by a strong ecological fragmentation, which results in drastic geographical differences in terms of access to grain, even across relatively short distances.

II

The second chapter considered the economic factors which were superimposed on the environmental conditions and farming practices, mostly the use of land and labor and the consequences of tenancy as the dominant form of land management. The results of this analysis can be divided into two sub-categories: the first one regarding the conditions of *surplus production*, the second dealing with the modes of *surplus appropriation*.

(a) Concerning the primary production of surplus, our analysis aimed at testing the consistency of Neo-classical economic theory in the economic modelling of cereal production in the pre-industrial context of Graeco-Roman farming. Relying on the critiques of marginalism developed by Italian economist P. Sraffa, it has been revealed, *inter alia*, that 'diminishing marginal returns' should not be seen as an iron law of agricultural production, but rather as a particular and reversible case arising only after a certain level of the labor/land ratio has been passed *and* if there is no change of farming practices or technology in the meantime. Moreover, the non-linear response of soil productivity to increases of the labor/land ratio implies that smaller plots of land are not *necessarily* synonymous with smaller surpluses.

(b) Regarding the appropriation of the surplus produced, the reconstruction of the level of rents based on a sample of documents from Caria suggests that rents may have taken minimum 17.5-30% of the total produced. Added to the tithe (*decuma*) imposed by Roman authorities, it means that some 27.5-40% of the total produced was extracted from the primary producers as rents and taxes alone – of which a non-negligible part must have been paid in kind –, and this, without considering additional extortions. Of course, the share of rents in total produce varied according to many different parameters: the mode of exploitation, the level of population density, soil yields, and the relative price of grain with regard to land.

III

In the third chapter, which forms the core of this study, I showed that grain-related interventions were performed by all levels of power: imperial, provincial and civic, with the latter by far the most frequent. I then analyzed the various mechanisms of the cities' grain supply. These mechanisms are three in number: civic grain-supply systems (civic funds and distribution schemes) (1), munificence (2), and markets (3).

(1) Regarding the grain-supply systems set up by the cities, I showed that their extreme lexical diversity is partly due to regional idiosyncrasies and partly to a strong specification of tasks between officials, which betrays an intense institutionalization of the matters of grain-supply. Of these grain-supply systems, two have been the object of a more thorough case study : (1.1) the *sitometria* (in kind) and (1.2) the grain fund system known as the *sitonía* (in cash).

(1.1.) Outside Lycia, the *sitometria* might have targeted a larger group of recipients than the privileged group of the *sitometroumenoi* attested in Lycian inscriptions. In Lycia, the development of the *sitometria* should be interpreted in connection with the construction of the imperial granaries which served both as stage granaries for the supply of Rome with Egyptian grain *and* as storage structures for the supply of Anatolian cities granted the imperial authorization to receive a share of Egyptian grain production.

(1.2.) Grain funds were ubiquitous in Asia Minor, and represent one of the most visible civic grain-related supply channels. However, for reasons that are yet to be discovered, an important concentration of grain funds is attested in Caria.

Concerning its funding, the *sitonía* received both civic and private funds, and it appears from inscriptions that civic money probably was the major source of funds. Most importantly however, it arises from our Monte-Carlo simulation model that, despite a huge proportion of funds collapsing in their first years of operation, a significant proportion of grain funds turn out to be sustainable over the mid- to long run; or stated differently, that their probability of survival in the mid- to long run was significant : some 20% could theoretically outlive 50 years, while another 20% could have survived between 10 and 50 years. What actually must have been the most deleterious situation for grain funds was a succession of (even moderate) shortages over a rather short period of time.

Overall, the geographical spread of the intensity of grain-related interventions appears in several regions to be quite well correlated with the Virtual Water budget. However, the remaining discrepancies are sufficient to argue that, let alone miscalculations, other phenomena were engaged, perhaps differential levels and modes of surplus extraction and distribution.

(2) Regarding grain-related munificence *stricto sensu*, the analysis of the social profile and status of the individuals engaged in grain-supply interventions further revealed that the proportions of offices of the six major spheres of civic life were more or less balanced.

Finally, I have investigated the reasons why benefactors or officials would provide grain-related gifts. It appeared from this analysis that there existed both incentives and counter-incentives to grain-related benefactions: the fear of challenging the imperial authority and to echo the monarchic temptation, as well as the low prestige/cost ratio due to the less conspicuous character of grain gifts, conflicted with the principles of the 'moral economy' and the necessity of avoiding food riots. To a certain extent, imperial and provincial interventions were also a way for Roman authorities to ensure political stability at the municipal level.

(3) Finally, I tried to offer some reflections on the working of markets in relation to the urban grain supply. These are of course only a modest contribution to a far larger debate, but I think that one overall remark should be kept in mind: market exchange, though crucial in making grain circulation more fluid, did not *necessarily* imply an easier access to grain per se : *(a)* markets may also leave space for the development of oligopolistic behaviors which could artificially keep prices up at the expense of consumers; *(b)* grain imports driven by price differentials, once considered at an aggregate scale, turn out to be a self-catalytical process. Depending on the difference between transport costs and the inter-regional price difference, the subsequent inflow of grain may or may not be sufficient to offset the effects of a local shortage.

* * *

I now would like to attempt to interpret those factual conclusions, on three major aspects: (1) chronology (2) the town-country interaction and (3) the structure and rationale of the grain-supply process.

(1) In terms of chronology, the evolution of grain-related interventions in Asia Minor appears to roughly follow the global pattern of overall munificence: a sustained

rise in the late 1st c. AD, a peak in the mid-second century, and a general decline in the late third century. However, short-term variations are more complex. In particular, it seems that the Antonine Plague significantly disrupted the grain supply mechanisms: the sharp drop in population density reduced the grain output per capita. It also reduced the mouths to be fed, but as transport costs per capita increased due to the inertia of settlement patterns, it rendered the circulation of grain more complicated and costly. This applies, of course, only in very rough terms, that is, without considering the political responses or the differentiated effect on urban and rural grain supply. Over the long run, the deleterious effects of the Antonine Plague were likely reduced, due to the compensation of the initial demographic loss. The negative impact of population contraction of per capita agricultural might even have been canceled, but only at the cost of a higher share of agricultural surfaces in total available land, or of a larger share of the population engaged in agricultural activities. In any case, the demographic and economic consequences of the Antonine Plague as well as the end of the Roman climatic Optimum, combined to changes in élite behavior, probably increased grain supply difficulties and account for much of the decline of civic grain-supply systems such as the *sitonía*.

(2) The interaction between town and country was not a topic I intended to study initially, but it arose from the analysis as an unavoidable subject. I do not pretend to have brought much new information, but I think two aspects should be underlined.

> (2.1.) Roughly speaking, there was an intrinsic contradiction in the interests of urban dwellers and peasants: the grain available for urban producers (to the extent to which they were agriculturally non-productive) largely came from rents, but the perception of these rents precisely reduced the available (grain) income of producers (inasmuch as they did not buy their grain on the market). Hence, from a strictly mechanical point of view, the available grain per capita of urban residents and the available grain per capita of rural dwellers responded differently to similar economic or demographic changes.
>
> (2.2.) Urbanization might have represented an incentive to increase agricultural production, but only under definite conditions: *(a)* either technological change, intensification practices, or the dismissal of the law of diminishing returns as a governing principle of agricultural production; or a bit of all three; *(b)* an increase of money supply (either via inter-regional trade, minting or credit) equal or superior to the increase in solvable demand of agricultural produces. Yet, it would be equally possible to argue that growth of agricultural production

was the *primum mobile* of the process of which increased urbanization was only a consequence.

(3) There is in my opinion a fundamental consistency between the high level of institutionalization of the grain supply, the relative reluctance of the élite to provide grain gifts, and the limitations of markets. To a significant extent, it is, I think, precisely *because* élites were more inclined to perform munificence related to public buildings or festivals rather than grain, and *because* in many regions trade alone was not sufficient to ensure a regular access to grain (with notable exceptions, I admit) that cities developed a sophisticated framework of grain supply intervention made of grain funds, public distribution schemes to groups on varying criteria, and market regulation. In a way, they were also incited to do so because of environmental vagaries, but as far as Asia Minor is concerned, I think that, following the findings of Chap. I, the frequency of shortages did not primarily arise from the inefficiency of agriculture or from any Malthusian ceiling, since the region did not outstrip its carrying capacity. Hence, in a context where agriculture is far from unproductive – and thus enables important surpluses to be built –, and which was not the theatre of considerable military operations (except perhaps during the reign of Marcus Aurelius), what would have been the main reason of the endemic character of shortages? I can only think of three possible candidates: either a lack of efficiency of arguably well developed food markets, taxation by the Roman power, or the predatory behavior of the landowning élite whose mentality was, to quote Finley, 'acquisitive, not productive'[678]. Or, perhaps, a little of all three aspects. I might willingly nuance Finley's statement by saying 'mostly' acquisitive, or 'more acquisitive than productive', but this would not change the fact that patterns of surplus extraction must have been a crucial determinant of grain accessibility. What was actually done afterwards with this appropriated surplus is, however, the major puzzle. Some of it was commercialized, but perhaps not at the best time and place, hoarded for speculation, sold far away to purchase luxury commodities…. Overall, I am much tempted to agree with P. Bang when he writes that 'the role of market exchange and interregional trade is not first and foremost that of coordinating and organizing the economy in an interregional division of labor. Rather, its task is the subordinate one of acting as transformer and conveyer of the extracted surplus'[679]. My own evidence alone, however, is not sufficient demonstrate that for the moment and I can do no more than leave the question open.

[678] Finley (1973), p. 144

[679] Bang (2008), pp. 119-120.

More than half a century ago, Karl Polanyi argued that pre-industrial economies were structured by three 'forms of integration': reciprocity, redistribution and exchange[680]. It has already been discussed, here and elsewhere, that munificence consisted of a form of reciprocity. Redistribution, as Polanyi defines it, 'designates appropriational movements towards a center and out of it again'[681]. As we have seen above, civic finances played an important part in the funding of civic supply systems. But this money itself was largely derived from the taxes and fees levied by the city; hence these grain-funds and supply schemes fit the definition of a redistributive process. Exchange, finally, straightforwardly refers to market exchange. Ancient responses to grain supply issues thus fairly well fit into Polanyi's tripartite typology, although one striking feature of the cities' grain supply, and of the ancient economy as a whole, is perhaps the intense fluidity that seems to have existed between the three forms of integration.

On the other hand, through the works of Fernand Baudel, one realizes both the relative rigidity of Mediterranean structures[682] as well as the considerable permanencies between Graeco-Roman antiquity and early modern times regarding grain supply systems. I see no incompatibility between Braudel and Polanyi on this subject, as I think we are dealing with one marvelous illustration of the interactions between *structures* and *institutions*, between exogenous and endogenous factors of historical change: none of them can independently account for the ability and difficulties of ancient cities to ensure a regular grain supply. It is the interaction of a given set of very slow-evolving structures with a specific set of institutional responses, and the relative suitability of such responses, which determined the achievements of ancient economies – understood as the improvement of the material conditions of an ever larger part of the population, rather than the sole performance of élites. Institutional and political settings, however, have their own life and historical trajectory, so as to often become a *structure* themselves. As Braudel outstandingly summarizes :

> 'C'est un fait que chaque univers de peuplement dense a élaboré un groupe de réponses élémentaires et a une tendance fâcheuse à s'y tenir, en raison d'une force d'inertie qui est l'une des grandes ouvrières de l'Histoire'[683]

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[680] Polanyi (1957), p. 250 sqq

[681] Polanyi (1957), p. 251

[682] Braudel (1990 b), pp. 88-89

[683] Braudel (1979), p. 642.

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Appendix 1: grain-related benefactions

Technical appendix – Estimate of an average benefaction

In the following table, we provide our collection of 131 sums (all expressed in denarii) for benefactions in decreasing order of value :

Table 4 – Distribution of sums given for benefactions

Sum	Purpose	Reference
2000000	B	IGR 3, 604
550000	F	IGR 4, 1632
400000		IGR 4, 915
300000	B	IGR 3, 248-249
300000	F	IGR 3, 800-801
200000		BCH 28 (1904), 39
165000	D	Lanck. II, 123
125000	B	Balland (1981), 67
122000	A	REG 19 (1906), 231-243
105000	B	CIG, 2782
100000	B	IGR IV, 1700
100000	B	
75000	B	F.E. II, 37
70000	B	IGR IV, 501
70000	B	IGR IV, 337
61000	D	TAM II, 671
60000	D	IGR 4, 1632
60000	B	IGR 3, 739
60000		
56058		TAM II, 15
56000	B	Balland (1981), 67
54000	A	IGR IV, 914
50000		Milet I,7 261
50000	F	MAMA V, 202
50000	B	IGR 3, 66
50000		IGR 3, 492
50000	D	IGR 3, 739
50000	B	Balland (1981), 67
50000	B	IGR 4, 1637
45000	B	Balland (1981), 67
40000		S.B.Berl., 1888, 884
40000		IGR 3, 794
35000	B	IGR 3, 739
35000	B	P.A.S. III, 426
30500	B	Lanck. II, 201
30000	B	IGR 3, 739
30000		Balland (1981), 67
27100	B	TAM II, 550-551
25000	B/A	IK-Ephesos, 5113
21500	A	F.E. II, 27
20000	A	LW, 1006
20000	A	F.E.
20000	B	Jahresh. 28 (1933), 100
20000	A	
20000	B	IGR 3, 739
18000	B	IGR 3, 739
15000	B	IGR 3, 833
15000	B	SEG 28 (1988), 1462
15000		
13000	B	IGR 3, 351

12100	B	Lanck. II, 83
12000	F	IGR 3, 739
12000	A	IGR 3, 739
11200		
11000		LW, 1603
11000	F	SEG 27, 938
10000	F	P.A.S. I, 25
10000	F	IGR IV, 941
10000	A	F.E. III, 66
10000	F	BCH 11 (1887), 379
10000	D	BCH 11 (1887), 383
10000	B	IGR 4, 1632
10000		IG4 4, 1637
10000		IGR 4, 1342
10000		IGR 3, 492
10000	B	IGR 3, 704
10000	B	IGR 3, 704
10000		IGR 3, 342
10000	F	IK-Stratonikeia, 203
10000	F	Balland, Xanthos, VII, 67
10000	F	BCH 11 (1887), 45
10000	B	IGR 3, 739
10000		IGR 3, 739
10000	B	IGR 3, 739
10000	A/F	IGR 3, 739
9000	B	BCH 28 (1904), 30
8000	D	F.E. IV, 1, 23
8000	B	IGR 3, 739
7000		IGR 3, 739
7000	B	IGR 3, 739
6500	D	IGR 4, 1222
6000	B	BCH 44 (1920), 94
6000		IGR 3, 739
5000	F	F.E. III, 71
5000	A	F.E. III, 58
5000	D	CIG, 2836b
5000	F	IK-Ephesos, 3071
5000		OGIS, 485
5000	D	IGR 3, 739
5000	B	IGR 3, 739
5000		IGR 3, 739
5000		IGR 3, 739
4500		BCH 16 (1892), 425
4000	A	SEG VI, 647
4000	D	CIG, 3417
4000	F	McCabe, Sebastopolis, 6
3500	B	W.E. 426
3000	D	BCH 14 (1890), 611
3000	A	IG4 4, 1637
3000		A.M. 16 (1891), 146
3000		IGR 4, 227
3000	B	IGR 3, 639 & 642
3000	A	LW, 1381-1383
2800	D	IGR 4, 1629
2545	D	CIG, 2817
2527	D	
2500	B	F.E. III, 66
2500	A/F	
2370	D	CIG, 2774
2000	F	W.E. 414
2000		IGR 3, 739
1750	B	IGR 3, 407
1670	D	BCH 9 (1885), 76
1575		Sardis VII, I, 48
1500		CIG, 2817
1500		BCH 16 (1892), 425
1200	D	MAMA III, 50
1025	B	IGR 3, 833
1000	D	IGR IV, 182
1000		IGR 4, 195
1000	F	TAM II, 578-579
500	B	CIG, 3841
500	F	BCH 10 (1886), 1
300	D	IGR 4, 209
300	D	IGR 4,278
300	D	IGR 4, 293
250	B	KP III, 87
200		IGR 4, 342
150		IGR 4, 133
150		IGR 4, 342
50	B	A.M. 20 (1895), 344

A	Advertisement	B	Public Buildings
D	Distributions	F	Food supply

1. Correcting the variance : truncation of the series and increase of the number of low sums

After taking the 7 highest sums out of the distribution (the lines highlighted in black in table 1), we multiplied the number of sums inferior to 1,250 denarii with the following coefficients[684] :

Thresholds	Multiplication coefficient
< 500 denarii	x 3
< 1000 denarii	x 2
< 1250 denarii	x 1.5

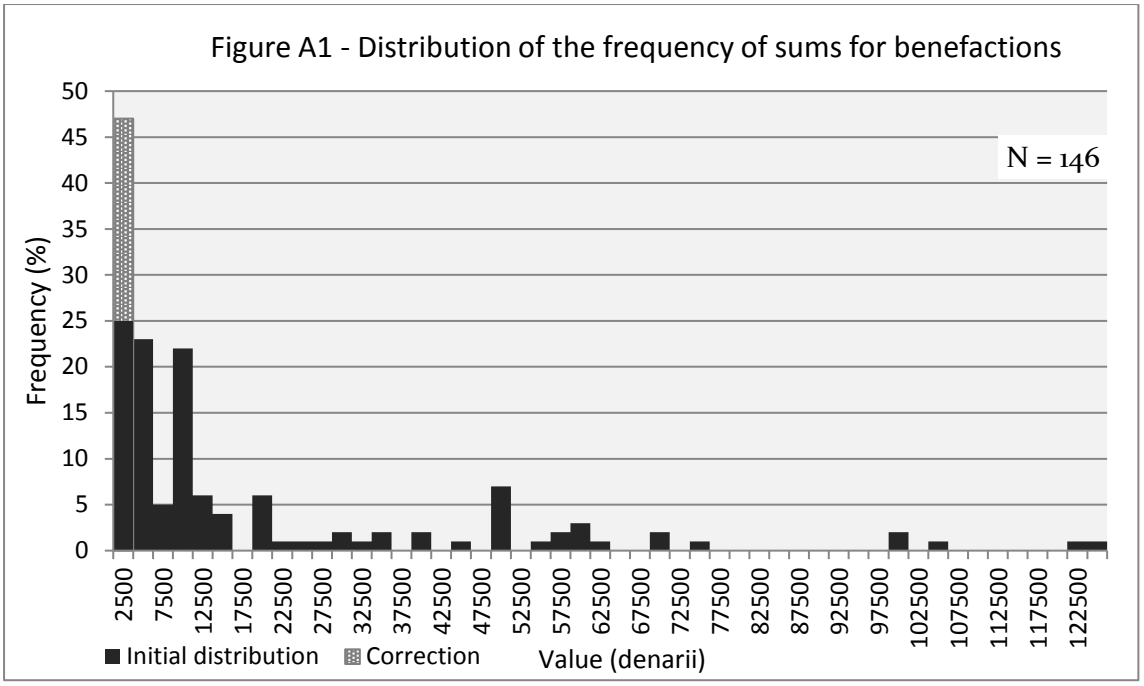
We then organized the sums in classes of 2,500 denarii[685] and calculated the class frequencies (f_j) :

$$f_j = \frac{n_j}{N}$$

where n_j is the number of observed sums in class '*j*' and N is the total number of observations (N = 146). The histogram of the class frequencies, before and after correction, is illustrated in figure 1.

[684] In the table, we rounded up the non-integer products of the multiplication. The coefficients are, in a sense, arbitrary, but hey rely on an argument of common sense : it is probably unrealistic to consider that the smallest sum would have been 10 times less represented than their actual frequency. A coefficient from 3 to 5 would thus seem more reasonable. Yet, one could have chosen a coefficient of 3.5, or 4,...but this actually does not change much to the consequent calculation of the average benefaction. Since we assume that the smallest sums have been less epigraphically represented, and since they are also less frequent among the data, the multiplication coefficient for higher thresholds are lower, hence our table. The multiplication coefficient for the threshold of 1,250 denarii should have been 1 according to the linear decrease, but a coefficient of one simply reproduces the current distribution of the sums figuring in the sources? We therefore set this last coefficient at 1.5.

[685] The relative small size of such classes brings the problem that many classes are empty because the material is fragmentary and comes from different periods and different locations. But taking larger classes, say 5,000 denarii would reduce too much the resolution of the distribution.



2. Weighting by the frequencies

On this basis, we constructed a weight coefficient normalizing the class frequencies between 0 and 1. This weight coefficient for class *j* (w_j) is simply given by :

$$w_j = \frac{f_j}{f_{max}}$$

were f_j is the frequency of class *j* and f_{max} is the frequency of the largest class (0.322), that is, the frequency of the class comprising the largest number of observations (the sums inferior to 2,500 denarii). Applying this technique makes the weighting coefficients range from 0 (a class with a frequency equal to 0, that is, an empty class) to 1 (the weight coefficient of the first class – the largest –, equal to 0.322/0.322, which gives 1). By multiplying all the sums by the weight coefficient of their class affects them proportionally to their relative frequency and generates a new distribution of weighted sums (S^*) :

$$S_i^* = w_j \cdot S_{i \in j}$$

The weighted sum (S_i^*) is equal to the initial observed sum S_i belonging to class *j*, multiplied by the weight coefficient of class *j*. The reader must bear in mind that the modification we apply to the sums is only aimed at accounting for their frequency of occurrence in the distribution. The new distribution of the sums multiplied by their weight coefficient is therefore not to be considered as a distribution of actual 'sums' but as a series of numbers the median of which will provide an estimate of the value of an average benefaction that takes into account the frequency of the different categories of sums.

Appendix 2 : mathematical appendix

The derivative of our production function with respect to population is :

$$\frac{dQ}{dP} = \frac{(\theta \cdot A_a^n + L_a^n) \cdot \left[h \cdot n \cdot A_a L_a^{n-1} \cdot \left(\frac{dL_a}{dP}\right) + h \cdot L_a^n \cdot \left(\frac{dA_a}{dP}\right)\right]}{(\theta \cdot A_a^n + L_a^n)^2} - \frac{h \cdot A_a L_a^n \cdot \left[\theta \cdot n \cdot A_a^{n-1} \cdot \left(\frac{dA_a}{dP}\right) + n \cdot L_a^{n-1}\left(\frac{dL_a}{dP}\right)\right]}{(\theta \cdot A_a^n + L_a^n)^2}$$

$= \cdots$

$$= \frac{h \cdot \theta \cdot A_a^n L_a^n \cdot \left(n \cdot \frac{A_a}{L_a}\frac{dL_a}{dP} + (1-n)\frac{dA_a}{dP}\right) + h \cdot L_a^{2n}\frac{dA_a}{dP}}{(\theta \cdot A_a^n + L_a^n)^2}$$

Dividing the numerator and denominator by $A_a{}^{2n}$ yields :

$$= \frac{h \cdot \frac{L_a^n}{A_a^n}\left[\theta \cdot n \cdot \frac{A_a}{L_a}\frac{dL_a}{dP} - \theta \cdot (n-1)\frac{dA_a}{dP} + \frac{L_a^n}{A_a^n}\frac{dA_a}{dP}\right]}{\left(\theta + \frac{L_a^n}{A_a^n}\right)^2}$$

But just like for the short run situation, we now need to calculate the ratio of the relative change (i.e. : growth rates) of population and total output, that is, the elasticity (ζ). This operation is done by multiplying the derivative dQ/dP by P/Q, where Q stands for the initial production equation (for algebraic simplicity, we divide the numerator and denominator by A_a^n):

$$\zeta = \frac{dQ}{dP}\frac{P}{Q} = \frac{dQ}{dP \cdot \frac{Q}{P}} \frac{h \cdot \frac{L_a^n}{A_a^n}\left[\theta \cdot n \cdot \frac{A_a}{L_a}\frac{dL_a}{dP} + \left(\frac{L_a^n}{A_a^n} - \theta \cdot (n-1)\right)\frac{dA_a}{dP}\right]}{\left(\theta + \frac{L_a^n}{A_a^n}\right)^2} \frac{1}{\frac{h}{P}\frac{A_a L_a^n}{A_a^n}}{\left(\theta + \frac{L_a^n}{A_a^n}\right)}$$

After simplification, we obtain the following expression :

$$\zeta = \frac{\theta n \cdot \frac{dL_a}{dP}\frac{P}{L_a} + (\gamma^n - \theta(n-1)) \cdot \frac{dA_a}{dP}\frac{P}{A_a}}{\theta + \gamma^n}$$

From here, we may convert the labor/land ratio into population density by using the transformation :

$$\gamma = \frac{\alpha k \rho}{a}$$

$$\zeta = \frac{\theta n \cdot \frac{dL_a}{dP}\frac{P}{L_a} + \left(\left(\frac{\alpha k \rho}{a}\right)^n - \theta(n-1)\right) \cdot \frac{dA_a}{dP}\frac{P}{A_a}}{\theta + \left(\frac{\alpha k \rho}{a}\right)^n}$$

We then divide the numerator and denominator by θ :

$$\zeta = \frac{n \cdot \frac{dL_a}{dP}\frac{P}{L_a} + \left(\frac{1}{\theta}\left(\frac{\alpha k \rho}{a}\right)^n - (n-1)\right) \cdot \frac{dA_a}{dP}\frac{P}{A_a}}{1 + \frac{1}{\theta}\left(\frac{\alpha k \rho}{a}\right)^n}$$

Here, we need to remember that what we actually look for is an expression of the growth rate of per capita output. Since :

$$\zeta = \frac{g_Q}{g_P} \qquad \text{and} \quad g_q = g_Q - g_P$$

It follows that :

$$\zeta = \frac{g_q + g_P}{g_P}$$

We might now replace ζby this expression in the general differential equation :

$$\frac{g_q + g_P}{g_P} = \frac{n \cdot \frac{dL_a}{dP}\frac{P}{L_a} + \left(\frac{1}{\theta}\left(\frac{\alpha k \rho}{a}\right)^n - (n-1)\right) \cdot \frac{dA_a}{dP}\frac{P}{A_a}}{1 + \frac{1}{\theta}\left(\frac{\alpha k \rho}{a}\right)^n}$$

On the right side of the equation, we see that the variables appear under the form of growth rates :

$$\begin{cases} g_{A_a} = \dfrac{dA_a}{A_a} = growth\ rate\ of\ cultivated\ surfaces \\ g_{L_a} = \dfrac{dL_a}{L_a} = growth\ rate\ of\ agricultural\ workforce \\ g_P = \dfrac{dP}{P} = Population\ growth\ rate \end{cases}$$

From here, we easily observe that population growth rate can be put forward, and hence eliminated from the denominator on both sides of the equation :

$$\frac{g_q + g_P}{\cancel{g_P}} = \frac{1}{\cancel{g_P}}\left(\frac{n \cdot \dfrac{dL_a}{L_a} + \left(\dfrac{1}{\theta}\left(\dfrac{\alpha k \rho}{a}\right)^n - (n-1)\right) \cdot \dfrac{dA_a}{A_a}}{1 + \dfrac{1}{\theta}\left(\dfrac{\alpha k \rho}{a}\right)^n}\right)$$

We are thus left with :

$$g_q = \frac{n \cdot g_{L_a} + \left(\dfrac{1}{\theta}\left(\dfrac{\alpha k \rho}{a}\right)^n - (n-1)\right) \cdot g_{A_a}}{1 + \dfrac{1}{\theta}\left(\dfrac{\alpha k \rho}{a}\right)^n} - g_P$$

The growth rate of agricultural workforce and of agricultural surfaces are however problematic variables because they evolve on two dimensions : an *extensive* dimension (the increase in total population or total surface) and an *intensive* dimension (the increase of the *share* of agricultural labor force in total population, or of the *share* of land devoted to agricultural activities). If we express their growth rate from equations (2) and (3) above, we get (with *k* constant):

$$g_{L_a} = \frac{dL_a}{L_a} = k\alpha\frac{dP}{L_a} + kP\frac{d\alpha}{L_a} = k\alpha\frac{dP}{\alpha kP} + kP\frac{d\alpha}{\alpha kP} = \frac{dP}{P} + \frac{d\alpha}{\alpha} = g_P + g_\alpha$$

$$g_{A_a} = \frac{dA_a}{A_a} = a\frac{dA}{A_a} + A\frac{da}{A_a} = \ a\frac{dA}{aA} + A\frac{da}{aA} = \frac{dA}{A} + \frac{da}{a} = g_A + g_s$$

Injecting these expressions into the equation yields :

$$g_q = \frac{n \cdot (g_P + g_\alpha) + \left(\frac{1}{\theta}\left(\frac{\alpha k \rho}{a}\right)^n - (n-1)\right) \cdot (g_A + g_s)}{1 + \frac{1}{\theta}\left(\frac{\alpha k \rho}{a}\right)^n} - g_P$$

Two further simplifications can be operated : first, we may recall the parameter K introduced above (eq. 4) : $K = \frac{\theta}{(k \cdot \alpha)^n}$ and consider its inverse $\overline{K} = 1/K$. Here, since the parameter α has been taken as a variable, its occurrence in the equation refers to the conditions prior to the differential calculus, that is, at the initial time; hence K should be re-labelled K_0. Finally, we may once again express the agricultural population density (noted ω) as the ratio of population density to the share of agricultural land. We thus have :

$$g_q = \frac{n \cdot (g_P + g_\alpha) + (\overline{K_0} \cdot \omega^n + 1 - n) \cdot (g_A + g_s)}{\overline{K_0} \cdot \omega^n + 1} - g_P$$

$$g_q = \frac{n \cdot (g_P + g_\alpha) + (\overline{K_0} \cdot \omega^n + 1 - n) \cdot (g_A + g_s) - (\overline{K_0} \cdot \omega^n + 1) g_P}{\overline{K_0} \cdot \omega^n + 1}$$

$$= \frac{g_P + g_\alpha + \left(\frac{\overline{K_0} \cdot \omega^n + 1 - n}{n}\right) \cdot (g_A + g_s) - \left(\frac{\overline{K_0} \cdot \omega^n + 1}{n}\right) g_P}{\left(\frac{\overline{K_0} \cdot \omega^n + 1}{n}\right)}$$

From here, we might do some re-labelling and re-arranging of the terms order to make this equations more easily readable. Let us write :

$\overline{K_0} \cdot \omega^n = \Omega$
$\Omega + 1 = Z$

This re-labelling yields :

$$g_q = \frac{g_P + g_\alpha + \left(\frac{Z-n}{n}\right) \cdot (g_A + g_s) - \left(\frac{Z}{n}\right) g_P}{\left(\frac{Z}{n}\right)} = \frac{g_\alpha + \left(\frac{Z-n}{n}\right) \cdot (g_A + g_s) - \left(\frac{Z}{n} - 1\right) g_P}{\left(\frac{Z}{n}\right)}$$

If we label : $\frac{Z}{n} = H$, the equation can be rewritten as :

$$g_q = \left(\frac{n}{Z}\right) g_\alpha + \left(\frac{Z-n}{Z}\right)(g_A + g_s) + \left(\frac{n-Z}{Z}\right) g_P$$

After elementary algebraic simplification, we obtain the final formula :

$$\boxed{g_q = H \cdot g_\alpha + (1-H) g_s + (1-H) g_A + (H-1) g_P}$$