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Extending Cliometrics to Ancient History with Complexity*

Laurent Gauthier[†]

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Abstract

Traditional cliometrics usually focus on economic data from the modern and contemporary periods, and do not have much to do with ancient history, mostly due to a lack of relevant data. Separately, the field of cliometrics and complexity, by looking at data in the light of complex systems analysis, gives access to a broader range of sources. Concentrating on the distinction between cliometrics and historical economics, we explore the epistemic gap between economics and history, which we reduce to two fundamental differences: the relationship to primary sources, and the presence of a nomothetic framework. Using this gap as a guide, we argue that a logical expansion of cliometrics and complexity, which do not have to be about the economy, but can operate on primary historical sources, could address a much broader set of periods, societies, and phenomena, leaning on microeconomic models. Redefining cliometrics in that way gives them access to the extensive corpora of historical material that digital humanities have produced. Working closer to primary sources contributes to bridging the epistemic gap between economics and history, and the systematic and explicit way in which cliometrics and complexity tackle data contributes to making historical research more scientific.

Keywords: Cliometrics, historical economics, historical method

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The etymological components of “cliometrics” refer to history on one hand, and more precisely to the Muse Κλειώ, who inspired poets when they sung the glory (κλέος) of past heroes, and to the taking of a measure on the other hand. Although there is no relation with economics in this etymology, cliometrics have nevertheless become a synonym for “quantitative historical economics”. As a consequence, where there is no economic data, there are no cliometrics; in particular, there is little research in cliometrics concerned with ancient history: the field’s manual, Diebolt and Haupert (2019), does not even mention the Antiquity. One critic that has been raised towards cliometrics is also their lack of concern for history: this lack has been commented as a form of loss from the standpoint of economists (Fenoaltea 2019), and also as an opportunity for historians to try and use more economic tools in their analyzes (Boldizzoni 2011; Gauthier 2022). While cliometrics seemingly suffer from a lack of interest in history, economics interest themselves in an ever-increasing range of fields. Indeed, economics in general appear to sege into many aspects of social sciences, from toilet seat etiquette (Choi 2011) to the use of contraceptive sponges in *Seinfeld* (Dixit 2012), going much further than a strict focus on the economy. This very varied range of questions that economics may look are often posed through simple stylized facts or observations, such as with both examples above. In cliometrics, however, one needs to have the relevant historical data, in the right form, in order to carry out any analysis. This necessity may account for the fact that cliometrics have not looked into historicizing questions of that sort.

New perspectives into data, in particular historical data, may constitute an opportunity to reassess what cliometrics are about, and what questions they may ask. The use of complex systems analysis in cliometrics, coalescing into the new field of cliometrics & complexity, has effectively set forth new hermeneutics to data, relative to traditional cliometrics (Abry et al. 2022; Le Riche, Parent, and Zhang 2022). Relying on complexity analyzes, one can allow the data’s full granularity to percolate through, without having to reduce it to aggregate or stylized facts. Although research in the field has largely remained concentrated on the history of the economy, it has also expanded beyond, for example with an examination of the optimality of particular military allocation decisions (Gonzales-Feliu and Parent 2016).

In this article, we will try and understand how cliometrics effectively cover much less ground than economics in general, and, based on the differential epistemology between economics and history, propose an expanded version of cliometrics and complexity that could address these limitations. In the first section, we will focus on defining history in contrast with economics, and show how historical economics and cliometrics are defined along the same contrasting lines. The

second section will more specifically concentrate on the epistemic differences between history and economics, focusing in particular on the use of primary sources as opposed to stylized facts, and on the nomothetic aspect of economics and cliometrics, which is not compatible with the historical method. Then, in the third section, we will examine the potential for new and expanded cliometrics & complexity, using the epistemological gap between economics and history as a guide. We will show how cliometrics could still be fully relevant to economics, but without having to be about the economy. Freed from this constraint, they can more directly operate on primary sources, and become epistemologically closer to history. In a world where large swaths of historical material have been digitized, and in which digital humanities have become a necessity, cliometrics & complexity, by formalizing its operations on data, can further make the historiographical process more scientific. Finally, we discuss an example in the field of ancient Greek religion modeling.

1 History, Economics and Cliometrics

In order to best understand and analyze the epistemic differences between history and economics, we begin by defining some of these terms. Equipped with these definitions, we will then turn to analyzing the differences between cliometrics and economic history.

1.1 Defining History and Economics

The positivists of the second half of the nineteenth century, starting with Auguste Comte, were the originators of modern definitions of history. Comte believed that history should be based on the techniques of the hard sciences, a viewpoint that was reflected in the first historiography course, which was offered in 1896 at the Sorbonne (Langlois and Seignobos [1898] 2014). In the 20th century, historians' perspectives on the definition of history changed and converged. Marrou just stated: "history is the knowledge of the human past" (Marrou [1954] 2016, 24). This perspective on history differs from past positivist approaches because it places the human back into the science and indicates that knowledge was constructed from the ground up. History can be considered not as a science but as the scientifically developed narrative of humankind's actions and inventions, according to Lucien Febvre's definition of history, more general than Marrou's¹. Both definitions highlight history's aim toward science while also effectively isolating

¹See Febvre ([1952] 1992), "l'étude, scientifiquement conduite, des diverses activités et des diverses créations des hommes d'autrefois, saisis à leur date, dans le cadre des sociétés extrêmement variées et cependant comparables les unes aux autres (c'est le postulat de la sociologie)", and also "je qualifie l'histoire d'étude scientifiquement menée, et non pas de science".

it from the hard sciences. This viewpoint is reinforced in Raymond Aron’s seminal work on the philosophy of history².

Economics can be understood to mean a fairly wide range of things. One manner to define economics is as “the social science that studies the production, distribution, and consumption of goods and services” (Krugman and Wells 2015). Implicitly defining the economy, Krugman and Wells (2015) also define economics as “the social science that studies the economy”. Microeconomics, which pertain to “the study of how people make decisions and how these decisions interact”, are a subfield of economics but, thanks to their broad definition, appear to encompass a wider range of topics than economics itself. Microeconomics and economics in the classic sense are hence somewhat distinct fields of study, microeconomics being nevertheless sometimes employed as a tool to support economics in the traditional sense. The popular notion “freakonomics” (Levitt and Dubner 2009), which apply microeconomic analysis to non-economic conditions, such as sumo wrestling, gang member strategies and a whole gammut of other situations, have somewhat stretched the bounds of conventional economics, such as Choi (2011) and Dixit (2012) do. Although these topics would all be considered fairly typical areas of research in sociology or psychology, the “freak” element of freakonomics comes from the idea of linking these topics with microeconomics. Fine and Milonakis (2009) have examined this “freak” extension of economics into the social sciences in its historical context, and qualify it as a kind of economic epistemological expansionism.

1.2 Cliometrics and Historical Economics

Cliometrics and historical economics are not the same thing. According to Diebolt and Parent (2011), cliometrics are a subfield of economics that apply econometrics and economic theory to the data constructed by historical economics. Historical economics is concerned with the study of past economic occurrences. Cliometrics is seen by many as an extension of economic history rather than a separate science, the “new historical economics,” where “new” may be interpreted to imply “more formal” (Hauptert 2019). In particular, this perspective is apparent in Douglas North’s work (Brownlow 2010), and the shift in how economic history has been researched is well documented (Margo 2018), but for some, cliometricians have lost a certain historical perspective in this evolution (Cesarano 2006). The definition effectively states that cliometrics put historical economics within the context of economics. The importance of temporal seriality

²See Aron ([1938] 1991), p. 13: “notre livre conduit à une *philosophie historique* qui s’oppose au rationalisme scientifique en même temps qu’au positivisme.” This is also in line with Marrou’s understanding of what constitutes historical truth: “ni objectivisme pur, ni subjectivisme radical”, in Marrou ([1954] 2016), p. 221.

also distinguishes cliometrics from historical economics because, as Parent (2004) discussed, while economics in general may be nomothetic and postulate laws that are presumed to be universally valid, applying them in history has focused on changes through time more than on the specific circumstances at a given point in the past, which is often of interest to historians. Thus, we might say that one important distinction between historical economics and cliometrics is that the latter have been primarily studied by historians, whilst cliometrics have tended to remain the domain of economists.

One of the first significant historiographic schools to specifically focus on economic and social history was the French *Annales* endeavour. Four decades of history were dominated by the historical economics that the *Annales* promoted. Though on a smaller scale, historical economics had existed before to that; Hauptert (2019) situates their origins to the late nineteenth century in Germany and England. At the end of the 1960s, the significance of historical economics for historians was put into question, and it lost some of its prominence due to competition from other fields, such as anthropological history and the history of mentalities in particular. From the perspective of historians, using concepts and techniques from anthropology or psychology as opposed to orthodox economics started to provide more intriguing findings. From the standpoint of economists, historical economics has still remained a very active topic, which is why cliometrics and historical economics may now appear to be identical. Nevertheless, because it concerns itself with producing historical analysis, even if it is focused on the economy, and because it is assumed to employ the historical method, historical economics fundamentally makes up a branch of history.

For Diebolt and Hauptert (2019), cliometrics “represent the quantitative projection of social sciences in the past.” Even if this may be etymologically correct, it is not actually the case, unless the social sciences were completely reduced to classical economics or the economy was the only meaningful quantification in the social sciences. Despite having a universalist etymology, cliometrics only focus on the history of the economy, ignoring other elements of social interactions, even though many of these other aspects of social life may fall under an expanded purview of economics. Human capital, financial and monetary trends, or growth and cycles, in particular, have been important focuses in cliometrics and their study is presented as a means of resolving significant historical concerns. If they certainly are broad concerns, they are all nevertheless strictly related to the study of the economy. Even as it pertains to ancient history, cliometrics are presented as fundamentally linked to the analysis of the economy. Diebolt (2011), for example, lays out the debate about applying cliometrics to ancient history as revolving around whether

there was a market economy or not. In cliometrics and complexity, the focus has for the most part also been on economic or financial phenomena, but the use of complex systems analysis has afforded a more systematic and more general perspective on the underlying data. Using complexity economics notions, whether they relate to networks, to time series, or to the emergence of patterns, has indeed renewed the cliometric perspective on economic or financial questions in the contemporary period (Bastidon et al. 2019, 2020; Bastidon and Parent 2022; Abry et al. 2022). Combining complexity economics, such as networks and non-linear econometrics, with institutional economics also gives us new angles into existing cliometric issues (Le Riche, Parent, and Zhang 2022). As we mentioned earlier, some work also extends beyond concerns about the economy, with for example Gonzales-Feliu and Parent (2016), who examined military strategy from the perspective of an optimal allocation on a road network, in order analyze the logic that prevailed in some specific military choices.

It is useful to compare and contrast cliometrics with cliodynamics. Belonging neither in history nor in economics, cliodynamics do share certain methodological features with cliometrics, but they do not rely on economic models and concern themselves with a much wider range of subjects than the economy. Contrary to historical economics, cliodynamics approach history as a hard science, using mathematical models, often borrowed from the biological sciences and quantitative sociology, to general data and stylized facts (Turchin et al. 2013; Turchin 2018). Although cliodynamic technique does not involve theoretical economic models, it is not dissimilar to cliometrics from a methodological perspective, in that it frequently takes into account economic and demographic factors. It is possible to compare how cliodynamics approach history to how econophysics approach economics. Cliodynamics often use data that is very remote from the sources and spans a wide range of time periods and geographical regions. These data may comprise multiple categorizations, including population estimates, conflict statistics, or economic production, for example. Therefore, it is best categorized as a collection of stylized facts for each era or nation being studied. The sorts of problems investigated by cliodynamics recoup to a considerable degree with the study of meta-history started by Arnold Toynbee in the 1930s, as developed in Toynbee ([1954] 1987) and Toynbee ([1934] 1987), despite their methodologies being significantly different.

Historical economics may concern themselves with ancient societies, because in the historical approach, one may study very particular aspects of economic relationships, such as with the study of the setting of certain prices in ancient Greece (Chankowski 2020). In cliodynamics, one may study very broad evolutions, addressing multiple aspects of human society, ranging from the

size of armies to territory distribution, for which there is some cross-sectional data, such as in the case of the Roman Empire, for example (Roman and Palmer 2019). Cliometrics, however, has typically not covered these grounds because there is not enough data pertaining to the economy which may be studied in a systematic and serial manner. The new perspectives on data afforded by cliometrics and complexity, however, may constitute an opportunity to expand cliometrics towards ancient history.

2 Epistemic Distinctions Between History and Economics

At the core, the distinction that can be drawn between cliometrics and historical economics stems back from the one between history and economics, broader and more fundamental. The space between history and economics, in which cliometrics and historical economics reside, is indeed not a continuum. Fundamental epistemic differences prevent a smooth transition from one to the other. One may consider that the fact that economics are highly formal may deter historians, untrained in mathematics, from studying, and relying on, economics. Since the middle of the 20th century, economics have indeed developed to become more mathematical (Boulding 1948; Weintraub 2002). While this could be a contributing element, we also consider other, more essential causes, such as the use of stylized facts as opposed to actual raw data and the tendency to draw general conclusions as opposed to specific ones.

2.1 Stylized Facts and Primary Sources

Economics frequently use stylized facts: patterns, summaries of reality, that presumably capture the components of that reality deemed valuable for modeling, in order to test ideas or draw inspiration. For Hirschman (2016), stylized facts are indeed “empirical regularities in search of theoretical, causal explanations”, and they are useful heuristic tools in the social sciences in general, although in some cases their relevance has been opened for debate, such as in political sciences (Narang and LeVeck 2020). In their methodological study of stylized facts, Arroyo Abad and Khalifa (2015) distinguished them from what they defined as base facts. Both base and stylized facts claim to describe phenomena, and both are expected to be explained by an economic theory. However, while base facts need to be “validly inferred from reliable data”, stylized facts do not, and are the results of a degree of interpretation or summarizing of the facts. According to these definitions, it appears that neither stylized nor base facts actually consist of the raw underlying information, they are, by definition, interpreted. Economics, when applied in a historical context, typically only rely on stylized facts. For example, in the case of ancient

Greek history, some research has looked into political regime transitions across various *poleis*, using aggregated data from secondary sources, which are effectively stylized facts (Fleck and Hanssen 2006, 2013; McCannon 2012).

Historical economics, in contrast, consist of the writing of elements of history that pertain to the economy, essentially using primary sources. In their own view, as we have seen, historians produce knowledge of the human past, following a method that aspires to being scientific, based on historical material. The apparently simple notion fact, from a historical perspective, is in and by itself questionable. “It is not something buried that one just uncovers, ready for use³.” Marrou clarifies this further: a document does not constitute history (Marrou [1954] 2016, 45). Therefore, the foundation of any rigorous theory of history must be the manner in which documents are described, followed by a method for connecting that description to the justification that establishes it as historical fact. Carroll (2017) vividly illustrated the discrepancy between the data on violence in the medieval and modern periods and its actual meaning; if one simply considers stylized facts devoid of detailed historical context or one tries to serialize observations that are inherently different, the results are largely counter-factual.

The historical method, first and foremost, relies on historical documents, and in particular on a corpus of such documents, not on data or facts, because historical facts actually need to be constructed (Gauthier 2021b). Historical theory sees a continuum between the archive, the document, the source and the corpus, and all essentially recoup with the notion of “documents produced by the actors of the history under study⁴”. A simple definition of a *corpus* is a set of documents assembled with a specific purpose. Constituting a corpus to carry out historical analysis is part and parcel of historical work and has even been considered to sufficiently define the very fact of writing history (Febvre 1934, 149). History writing has come to rely on constituting corpora as the centerpiece of its methodology: “the centrality of the archive” (Boutier 2014, 10–11). Since the very act of seeing events served as the basis for history writing, there could not be a notion of corpus or document in ancient historiography, as Bermejo Barrera (2001) noted. The importance of relying on one’s personal experience as a witness to events suggests that history writing was mostly focused on recent history and that texts were regarded as second-class witnesses (Boutier 2014, 12–14). Historians did not take into consideration the value of a text

³See Febvre ([1952] 1992), p. 115, “Les faits, pensez-vous qu’ils sont donnés à l’histoire comme des réalités substantielles, que le temps a enfoui plus ou moins profondément, et qu’il s’agit simplement de déterrer, de nettoyer, de présenter en belle lumière à vos contemporains ?” Aron is also very clear: “il n’existe pas une *réalité historique*, toute faite avant la science qu’il conviendrait simplement de reproduire avec fidélité”, Aron ([1938] 1991), p. 147.

⁴“Les documents produits par les acteurs de l’histoire étudiée”, see Offenstadt (2011), p. 68.

corpus until the history of the Church was recognized as a field of study. The direct testimony of Christ's contemporaries bore more weight than personal witnesses from the ancient Greek tradition, because this body of text had a materiality, much like sacred relics (Bermejo Barrera 2001, 194). At the core of the 18th and 19th century crystallization of a historical technique, close reading of the ancient texts evolved into hermeneutics. In the view of the 18th-century philosopher Pierre Bayle, as Gunther Pflug points out, the document's predominance initially prevented any kind of deductive operation: "The scholar's goal consisted of surveying the factual data, penetrating the historical givens, without attempting to impose any order unless it were for mere purposes of clarity" (Pflug 1971). Voltaire and later Turgot pulled history away from straight facts towards scientifically inspired analysis, relying on reason and common sense, thereby making the notion of pure document-based facts less central. Still critical and essential, the corpus then functioned with the application of reason, and inserted itself in the context of the question asked by the historian (Pflug 1971, 9–12). As the writing of history became professionalized in the 19th century, the methodology of source critique converged towards current practice (Offenstadt 2011, 70).

At that juncture, historical knowledge acquired "a new configuration thanks to the introduction of two notions: that of document [...]; and that of the scientific method" (Bermejo Barrera 2001, 198). This perspective effectively established the document and the aspiration to a scientific approach as two facets of the same coin. Indeed, in a Foucauldian approach, analysis that is specifically historical as well as a more general form of analysis common in the social sciences at large both stem from the same source: "the questioning of the *document*⁵". Bermejo Barrera stresses the primordial place that the corpus holds in current historiography: "History builds its object starting from the constitution of its documentary corpora; it then develops different methods of reading and interpreting the texts, methods that are sometimes contradictory and that are not reducible to a common factor" (Bermejo Barrera 2001, 204). This view largely recoups with Foucault's perception of historiography's position with respect to the document: it seeks not to interpret it, but to work it from the inside and elaborate it⁶; hence the document should not to be seen as inert material. Foucault defines the writing of history as the manner in which a mass of documents is organized⁷. In this perspective, the actual historical work

⁵"La mise en question du *document*", see "Foucault (1969), p. 13.

⁶"[L'histoire] a changé sa position à l'égard du document : elle se donne pour tâche première, non point de l'interpréter, non point de déterminer s'il dit vrai et quelle est sa valeur expressive, mais de le travailler de l'intérieur et de l'élaborer [...]", see Foucault (1969), p. 14.

⁷"L'histoire, c'est une certaine manière pour une société de donner statut et élaboration à une masse documentaire dont elle ne se sépare pas." Foucault (1969), p. 14.

carried out in the context of economic history stops once the historical documents have been contextualized and organized, which is the step at which economic “facts”, and cliometrics, begin. Hence, by not operating directly on primary sources, cliometrics are somewhat disconnected from history. Resorting to stylized information, or facts in the economic sense, eliminates the massive amount of meta-information that comes with establishing any historical “fact”. As a result, from the viewpoint of a historian, the findings are not historically valid since they may be seen as a restatement of some historians’ prior claims. Some cliometricians have come to realize that cliometrics had drifted away from the history-grounded field of historical economics, and in one such critic Fenoaltea (2019) regretted the increasing distance between cliometricians and the sources. In their *riposte* to Fenoaltea, Diebolt and Hauptert (2020) argued, among other things, that modern cliometrics had helped further both economics and history by providing carefully grafted datasets, thanks to the importance of data for the cliometricians’ uses, and thanks to their advanced econometric techniques. From a historian perspective, we can see that the issue is not so much in the range of data that may have been gathered by economists, but in whether this was done according to historical method. Although the association of cliometrics with complexity may appear as a simple praxeological distinction, it has therefore deep epistemological consequences. Using complex systems approaches makes it possible to directly operate on very raw data, and hence typically on primary sources, that do not have to be pre-processed by historians or historical economists. In that sense, cliometrics and complexity approaches can exploit the data’s full granularity, which makes them by nature more historical. Epistemologically, cliometrics & complexity could hence be placed between history and traditional cliometrics.

2.2 Nomothetic Perspectives

While the relationship to primary sources contributes to distinguishing economics from history, and in turn cliometrics from historical economics, it is not the only such distinction. In fact, cliometrics search for universal rules, either deductively, beginning with general economic theory, or more inductively, searching for the formal model that best fits the data. They look for more or less universal set of principles, or try to verify them. This search for a set of rules is carried out through the use of formal modeling, which is based on data organized in a way that illustrates the connections under research. Hence, the fundamental distinction between history and cliometrics, which can make their approaches unintelligible to each other, is one between nomothetic and idiographic visions of history. This distinction does rely on the nature of the relationships with data: the search for universality in economics requires the use of manageable data, and cliometrics

must operate on entities that have been pre-defined in some way, and in relation to a theory, and operates on base or stylized facts. Both base or stylized facts in economics are only derived from underlying data, and they are both conceived of within the perimeter of a theory. What economists may call base or stylized facts may in fact be called “general laws” by historians, and invoke the concept of a Weberian *Idealtypus*. These stylized facts are not mechanically derived from raw data or information, they necessarily are the result of some analysis and interpretation, when they are immersed in a theoretical apparatus. Economic “facts”, in the sense of Arroyo Abad and Khalifa (2015), when they pertain to history therefore are best viewed as the output from some historical work. Hence, traditional cliometrics typically use these base or stylized facts, which have been theoretically oriented.

However, one should build structures, rather than hypothesize them, in history (Marrou [1954] 2016, 166), a perspective which mostly rejects any “grand explanation” as well as the use of generic notions. Indeed, it cannot be assumed that a broad model of the world would provide a satisfactory explanation for all aspects of reality. Since history is defined as the study of distinctive and singular phenomena, Marrou believes that it is useless to develop historical “laws”. Parallels and analogies do not make up these rules; they are simply examples that draw on a few common characteristics. The purpose of social sciences, and especially of economics, is to reduce a complex situation down to a simple model. According to Ober, an historian of ancient Greece: “the social scientist’s goal of theory testing, aimed at some more general understanding of human behavior, may be strictly irrelevant for the historian who remains focused intensively on the Greek past” (Canevaro et al. 2018, 6). Modern economic thought is used by economists as a framework for analysis, which goes against the historiographic culture of the majority of historians. It is indeed erroneous to try to generalize behavior models based on the specific experience that we are familiar with, according to Bourdieu’s anthropological view of economics, in particular his viewpoint on the theories of rational action⁸. Therefore, the pursuit of universal rules is irrelevant to history. Febvre’s critique of Toynbee’s book is also quite revealing. Febvre asks⁹, from the perspective of an historian, “why bother?” Indeed, whether one analyzes meta-history with formal models or with the perspective of classical sociology, it is, for most historians, non

⁸In Bourdieu (2017), p. 16: “En partant du cas particulier de l’action économique dans des sociétés d’un type particulier comme les nôtres, et plus précisément de régions particulières de ces sociétés particulières, ils commettent, me semble-t-il, l’une des erreurs les plus funestes en sciences sociales : celle qui consiste à universaliser sans le savoir le cas particulier, c’est-à-dire à donner pour universelles des particularités d’un cas particulier qui s’ignore comme tel.”

⁹See Febvre ([1952] 1992), p. 134: “Si on résiste à la séduction du magicien ; si on se refuse à l’attitude sentimentale du croyant assistant au culte ; si on examine les idées froidement, et les conclusions : quoi de neuf, en tout ceci ; quoi de vraiment neuf et qui puisse, historiens, nous inciter à un retour sur nous-mêmes, à une condamnation de nos méthodes, à l’adoption de méthodes neuves ?”

historical.

Cliometrics tend to restrict themselves to the modern and contemporary periods, because economic data for earlier period is quite sparse; there are few series of base facts. For example, Hobson (2014) discussed the debate between neo-primitivists, who saw the Roman empire as a “developing country,” and modernists, who see the Roman empire as having benefited from institutions that provide incentives for economic success. He emphasizes that this conflict has polarized the discussion on the ancient Roman economy and draws attention away from the reality that it is unrealistic to assume that we could accurately know and evaluate every aspect of the Roman economy. The scarcity of data on the subject is such that there is an impossibility of knowledge. This focus on the modern and contemporary periods is also a consequence from the fact that cliometrics, as we stressed earlier, deal with traditional economic questions: this is cliometrics’ natural focus. In economics, most of the theoretical apparatus deals with issues pertaining to the economy. Hence, coming from this body of knowledge, when one considers the application of economics to history, this application must concern itself with the study of the economy, which mechanically restricts the range of periods and cultures under study.

The epistemic differences between economics and history are substantial and fundamental enough that it is difficult to imagine research that could truly further both fields at the same time. The discontinuity, in particular in relation to the nomothetic aspect of economic modeling, cannot be simply bridged. Nevertheless, it can provide cliometrics with a new angle, and room for expansion, if we consider this epistemic distinction as a direction towards which to progress, in particular starting from cliometrics & complexity.

3 New Cliometrics With Complexity

We propose to extend the definition of cliometrics, by making them broader in terms of their relationship to economics. We will first discuss how cliometrics can expand the range of questions they may address by not restricting themselves to purely economic questions. Doing so widens the gammut of historical data that may be studied, and, in particular, allows cliometrics to directly drill into primary sources, connecting the field with complexity sciences. In that sense, the extension of cliometrics to primary sources and to a broader notion of economic questions, by nature, corresponds to cliometrics & complexity. Then, we look into how the epistemological gap between history and economics may be bridged, in some cases, by being able to focus on the same historical material as historians. Next, since primary sources are available in large quantities

in the form of electronic data, we examine how corpora of historical material are constructed by historians. We point out how, through a more systematic and programmatic approach, and through the perception of corpora as processes rather than data, cliometrics & complexity can make historiography more scientific. finally, we discuss an example of these new cliometrics, in an application to the study of ancient Greek religious practice.

3.1 Cliometrics & Complexity Can Offer New Perspectives on Historical Data

The association of cliometrics with the study of the economy is strong, to the point that even those who seek to criticize the field take it as a given and do not question it. When he raised some strong criticism against cliometrics, Boldizzoni (2011) still remained within a paradigm of cliometrics strictly applied to the economy. For Boldizzoni, the use of microeconomics could broaden the applications of cliometrics, but only as (Boldizzoni 2011, 87): “an investigation of the past from a micro-economic point of view, with an analysis of decisions taken with regard to production, consumption, and exchange at the level of producers and households, and naturally of the consequences of these decisions.” A collection of essays in Rawski et al. (1996), in order to “broaden and deepen the exchange of ideas between economists and historians”, proposed to “show how to apply the core ideas and methods of economics to a wide range of historical issues.” However, the subjects addressed from an economic perspective in this book, ranging from economic trends to international economics, would be fairly irrelevant and inexploitable for anything else than European societies after the Middle Ages.

This focus on the economy is not, however, a proper reflection of the range of domains in which economic models, and in particular microeconomic models, have brought new theories, paradigms and methods in the social sciences. After Maynard Smith (1972) applied game theory to biology through evolutionary stable strategies, he revolutionized the study of evolution, not only in biology but also in numerous evolutionary aspects of social sciences (Boyd and Richerson 2005). This approach, indeed, was further applied to behavioral ecology, evolutionary psychology, and to the notion of cooperation (Axelrod and Hamilton 1981; Axelrod 2006). Within social sciences, economics-grounded approaches have reached across the board. For instance, issues related to religion have been explored with a microeconomic angle, both by economists (Iannaccone 1998), and by specialists of religious studies, for example developing costly signal models for rituals (Henrich 2009; Bulbulia and Frean 2010). A model accounting for the advantages of group identification through symbols (Carr and Landa 1983) and the definition of a generalized utility function accounting for identity-related preferences (Akerlof and Kranton 2000) are two

examples of how the concept of identity has been investigated from an economic perspective. Game theory has also been applied to the study of literature: Brams (1994) offered a review on the subject, and de Ley (1988) developed some examples of applications to contemporary French literature. As evidenced by Posner ([1973] 2014), the economic analysis of law, first used by Coase (1960), has also completely. Microeconomic tools have also been used to investigate argument structure and rhetorics (Beigman Klebanov and Beigman 2010; Lipman and Seppi 1995; Matthews 1989). All these examples of fields in which economics have been applied may benefit from a historical perspective, which would devolve to cliometrics.

Cliometrics, just like economics in general, do not have to be about the economy. They can use economics to address numerous historical questions that are not, *per se*, economic, but on which one can shed light through the application of microeconomic models. In consequence, when analyzing historical documents, one may use these approaches in order to enhance one's understanding of these documents. This idea's fundamental tenet is that, by design, microeconomic methods should be applied to historical materials that are closests to original sources, not to the end product of the historians' interpretations. By not being tied to specific models about the economy, the range of data tat may be analyzed in cliometrics becomes more varied, and may pertain to all aspects of human life. As a result, the same documents that historians work on may be used, albeit with a different angle. Such historical material may be both particular and general at the same time. Each individual atomic component of historical data can be used independently of the rest, but it can also be used in conjunction with other related components, which is, in essence, the logic underlying the analysis of complex systems. Through the features of the distribution of these components, the meta-analysis of the set of elements as a whole contains information beyond the mere sum of the information belonging to each element. Cliometrics & complexity can be used to identify the generative processes that may have produced the distributions one can observe in the data. Considering generating mechanisms fundamentally connects cliometrics with complex systems analysis, which fundamentally focus on explaining the emergence of patterns (Boccaro 2010). Cliometrics, relying on complexity modeling in conjunction with microeconomic models, can therefore help determine, following a constructive view, according to what process the data has been generated. Taking this process into consideration allows for a much improved understanding both from an economic mdeling perspective and from an historian perspective.

3.2 Extending Cliometrics & Complexity Towards History

While cliometrics do not necessarily have to be fungible with history, the extension of the field to non-economic questions and to the use of primary sources afforded by a complex systems perspective can, in certain conditions, constitute an epistemological bridge. In effect, the use of atemporal economics-based approaches on historical phenomena is compatible with establishing structures, rather than postulating them, provided that the economic approaches in question are constructed from historical data rather than being postulated as an application of a particular economic theory. This corresponds to seeing microeconomics from a historian's perspective as an auxiliary instrument rather than as an application of particular economic theories. Since the historian must in any case make a fundamental assumption of rationality in order to understand the actors, the economic approach does not need to make this additional assumption. The notion of an optimality of behavior, which is what rationality presumably should pursue, does not strictly require that the actors be self-aware. Indeed, Foley (1985) showed that optimality is a useful transversal concept in order to describe the behavior of early humans. This is also an important aspect of Bourdieu's argument against *homo oeconomicus*¹⁰: accounting for behavior perceived as rational does not require the assumption of conscious reasoning. Maynard Smith (1982) too provided numerous examples of optimal behavior not as the result of an explicit or conscious calculation, but attained by some evolutionary process.

Trying to perceive the rationality of the actors in a historical situation is, in fact, precisely how Aron (1981) defined "understanding", as opposed to "explaining". Understanding the optimality of some people's or groups' behavior in the past based on some data, a behavior that may be relative to any aspect of life, using a microeconomic model, would hence not only pertain to cliometrics, but also to Aron's notion of understanding in historiography. It is conceivable to use a model that explains the behavior of these actors and from which one might infer links between these observed "facts" whenever circumstances involving rational agents would result in the generation of historical "facts". Cliometrics & complexity may provide historians with a more in-depth understanding of the actors as well as the historical sources on which they base their study with this approach. According to Parent (2004), the focus of economic theory, and microeconomics in particular, is often not on how things may have developed but rather on how they are, in some equilibrium. These models do not require that causes and effects be seen from a temporal dynamic perspective.

¹⁰See Bourdieu (2017), p. 15: "je défendrai une anthropologie tout à fait différente, fondée sur l'idée que, pour rendre compte des conduites perçues comme rationnelles, il n'est pas besoin de faire l'hypothèse qu'elles ont la raison, ou l'intention consciente de rationalité, pour principe."

We can hence expand the territory of cliometrics to the application of economics, and in particular microeconomics, to all facets of human life that involve rationality and optimal behavior, directly through the use of historical documents, thanks to the use of complexity sciences. The models that would be applied to this larger territory, to the extent that they are close to the data and only rely on minimal rationality arguments are, at least in principle, epistemologically compatible with the field of history.

3.3 A New Notion of Corpus in Cliometrics & Complexity

Historians work on historical documents, arranged in corpora, often in electronic form, off of which they produce their historical analyzes. Cliometricians who would want to analyze a particular set of historical documents as a complex system would, presumably, operate in the same way. If the economic models used by the cliometricians are to be applied to some data, that data, most likely, is in electronic form. Digital humanities have penetrated every level of historians' work (Gauthier 2021b). Thanks to many large-scale efforts in the digitization of historical material, a wealth of historical documents is now available electronically. These digitization efforts do not systematically require the formal modeling of complex links between the elements that compose the data; sometimes, they mainly consists of ensuring the quality of the resulting electronic text or data, and in the storage of all relevant metadata pertaining to the original documents. In that sense, the electronic material is often raw. In ancient history, and for ancient Greece in particular, essentially all literary texts, a majority of inscriptions and artefacts, such as vases, and numismatic finds have been digitized (Barker and Terras 2016; Crane 2012; Pantelia 2020). Cliometrics should, however, consider the processing of these historical documents in a different fashion than historians do.

For Philippe Rygiel, historians are “hypertextual polygraphs, who dissimulate most of the inscriptions they produce¹¹”, stressing the fact that the majority of the historian's work is not visible from the results or the analyzes they publish. In Rygiel's view, the historian's annotations, essentially in textual form, constitute the core of their work, their production. In this perspective, the historical inquiry becomes the definition of a corpus, augmented with these annotations (Rygiel 2011, 34). The fact that the underlying data may exist in electronic form does not change the situation: in history, the creation of a digital corpus appears to be a complex exercise for which there is no clear and unique epistemological framework or methodology (Gibbs and Owens 2013; Hoekstra and Koolen 2019).

¹¹L'historien contemporain apparaît alors d'abord comme un polygraphe hypertextuel dissimulant aux regards l'essentiel des inscriptions qu'il produit", see Rygiel (2011), p. 32.

It is nevertheless fundamentally beneficial for the design of a corpus and the processing of its information to be automated, and leverage its electronic nature when possible. One can indeed make an argument linking the reproducibility of research, gained by digital processing, to its scientificity. For McGillivray, Wilson, and Blanke (2019), collecting and processing historical material with computational methods “would be a science if we could learn to automate it”. In their view, historians should clearly delineate between what they define as “evidence” and what they define as “claims”, so that one may separate evidence-based findings from other statements, thanks to the systematic analysis of evidence. There is a benefit being able to precisely understand the underpinnings of any statement, when they can be made explicit. Making processes automatic, hence, may not, *per se*, serve a fundamental purpose, but it would have the advantage of making the creation of a corpus and some of its processing reproducible, and open it to critique. Reproducibility makes any statement falsifiable, which is a fundamental feature of any scientific statement according to the Popperian logical framework (Popper [1934] 1992, 78 sq). The way in which the electronic nature of the underlying data is leveraged by historians through their use of textual research is however not made explicit. Cliometricians, when they rely on complex systems analyzes on primary sources, by being more focused on the processing of the data, can enhance the scientificity of historical enquiry.

When historians work on historical sources that are available electronically, they effectively carry out combinations of data and operations; they create their own corpus off of which they write their analysis. In practice, historians often follow such a pipeline: for example, obtain some data (in a spreadsheet), transform it, save the clean version, compute some aggregates. The resulting corpus, in spite of it being the result of a process, is considered as a *thing*, as data, focusing on the result of a series of operations rather than on the operations themselves. Hence, only the end result survives, and the details of all the steps are lost to everyone else. If this entire process is coded as a pipeline or as an algorithm more generally, every single assumption, explicit or not, becomes visible. One should therefore realize that a corpus, used for historical analysis, or for cliometric modeling, is not data, but rather a set of operations. One can consider the notion of a *pipeline*, in the context of modern data analytics, or in computational linguistics, comparable to the data analytics suites used in the hard sciences (Jockers and Thalken 2020; Wickham and Grolemond 2017, 261–268). In such a pipeline, the raw input at each stage is transformed in place, and serves as the input for the next stage. This code can be analyzed, and it can be run in whole or in part by anyone. Purely seen as a dataset, a corpus cannot be properly analyzed from an external perspective, but once its construction is made entirely explicit, then this process can

be fully subject to critique.

Hence, once defined as computer code, or as a pipeline, the corpus contains and makes explicit all the decisions, small and large, made in cleaning, filtering, completing, or arranging the raw information, in the most concise manner possible: the corpus's definition is the process, and reciprocally. Modern data analysis and text edition tools have largely converged, so that there is not such a strong distinction between the two anymore: the text a researcher produces and the computer code that gathers and processes data exist in the same document. Considering the data organization, processing, analysis and write-up of a historical corpus as a continuum in a seamless process naturally leads to reproducible research¹². Given the nature of cliometric work, most likely requiring data manipulations, the joining of various sources, and fitting some models, treating the entire process as a pipeline presumably comes more naturally to cliometricians than to historians. The fact that complexity approaches allow for the use of raw primary sources hence permits cliometrics to fully and systematically describe, through algorithms, the details of their analyzes from the ground up. This is not possible when operating on base or stylized facts which are already remote from the sources.

3.4 Extending the Range of Cliometrics & Complexity to Ancient History

As we have pointed out earlier, economic data for ancient history is quite sparse, but there is a certain amount of digitized data, a lot of it textual, that is available. In order to illustrate how the expanded view of cliometrics we have describe above can operate, we discuss an example pertaining to the study of ancient Greece, in particular votive acts, following Gauthier (2021a). In ancient Greece historiography, the study of divine onomastic sequences, inscriptions mentioning the gods to whom people would appeal, started at the end of the 19th century, and is an active field of research (Brulé and Lebreton 2007; Lebreton et al. 2014; Bonnet and Lebreton 2019). The raw information, listing all such sequences that have been found, is usually accessed by historians at an atomic level; the philological analysis of a handful of inscriptions can provide historical insight on the perceived relations between divine entities (Bonnet 2021). The BDEG database (Lebreton et al. 2014), containing over 11,000 records of votive acts, is in fact not designed for any access other than on a one-by-one basis. Each entry represents a group of attested observations of invocations of the gods in Greek language. Creating a dataset that can lend itself to cliometrics & complexity analysis, in this case, can be done by automatically

¹²The RMarkdown language, for example, combines the data and statistical modeling infrastructure of the R language with the editorial capabilities of the Markdown syntax and LaTeX system; it has been suggested as a good framework for reproducible research, see Calero Valdez (2020).

extracting all the relevant data from the BDEG’s website, joining it with some other sources of information on ancient Greek *poleis*, and tabulating the occurrences of god names as needed. Going from the historical sources to the analytic results, in this case, can be clearly seen as a process, expressed as a replicable algorithm, such that if any of the inputs changed, all the resulting analyzes would be updated accordingly.

A cliometrics & complexity-based perspective on epigraphic observations of votive acts can rely on a microeconomic model, using game theory, addressing individual choices to worship one god rather than another at a point in time, if the benefit from these acts are considered as a shared resource. Indeed, in this case, it is a form of “Kolkata Restaurant Problem” or “El Farrol Bar Problem” (Chakrabarti 2007). Simple randomized strategies are optimal, based on the gods’ perceived strength. Using the formal model, one can derive an expected distribution shape for the votive acts across gods, which expresses how, under minimal assumptions on atomic choices, the numbers of observations for each god stack relative to each other. The empirical form of the distribution, at the *polis* level, can be obtained from the raw data and compared with the model’s predictions. It is also possible to try and relate certain characteristics of each *polis* to its local votive distribution. In this instance, the distributional information emerging from the raw data, which historians do not take into account, has the potential to become fact similarly to other historical material, when seen through the lens of microeconomics. The new data might then be questioned, for instance, are there any times or places where the distributions significantly deviate from the baseline expectation? Are the systematic differences caused by factors at the *polis*-level? The data, in fact, shows surprisingly regular patterns for a large range of *poleis*, although the most popular god names vary significantly. Using distribution fitting techniques from complexity sciences, we can show that local votive acts follow power laws, whose generating mechanisms can be modeled in different ways.

4 Conclusion

Cliometric methodology and ancient history, do not, at first sight, appear to have much in common. We have argued that, in fact, they should, through complex systems analysis. The study and close reading of ancient sources is a prerogative of historians, but the digital tools that have been developed for these purposes are often underutilized from a data analytics perspective, and the new approaches developed in the field of cliometrics & complexity are particularly well adapted to these data. Cliodynamics and quantitative history, to some extent, exploit this data but without a theoretical framework that seeks to explain the underlying phenomena. If one

considers that cliometrics do not have to be about the economy *stricto sensu*, then large swaths of primary sources, in particular in ancient history, can be analyzed in the light of microeconomic models.

Progress in the digital humanities has brought a large quantity of historical documents to an electronic form. This extends the notion of cliometric analysis in two ways: first, cliometrics could concern themselves with any kind of human behavior, as far as there are grounds to believe there is some optimality in it, with a kind of “cliofreakonomics”; and second, by not having to be specific to the economy, the data can be directly drawn from primary sources, thanks to complexity sciences. The lesser the distance to the sources, the lesser the epistemological distance to historiography, which makes cliometrics more intelligible to historians. A cliometrics & complexity approach looks at historical material in a way that is fundamentally different from historians, potentially bringing new light on a range of historical issues. This focus on data processing may also significantly improve the manner in which historical document corpora are processed, by making systematic and explicit many aspects of data analysis that are usually hidden by historians, hence reinforcing the scientific validity of statements. New cliometrics & complexity may in fact be the answer to Lucien Febvre’s definition of history as an endeavour aspiring to scientificity.

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