SOCIETAL ECONOMIC PERFORMANCE OF PRIMARY CIVILIZATIONS

A quantitative, comparative analysis of Mesopotamia, the Aztec empire, ancient Egypt and ancient China

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Societal economic performance of primary civilizations

A quantitative, comparative analysis of Mesopotamia, the Aztec empire, ancient Egypt and ancient China

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ABSTRACT

Whereas for the industrial revolution many studies have been conducted about its economic underpinnings and the potential effect of the industrial revolution on economic performance levels, very few studies investigate changes in economic performance levels of societies during that other, human history changing transformation, namely, the “urban revolution”. Though cities play an increasingly important role in modern life and the UN has proclaimed the current millennium the ‘Urban millennium’, it appears that the economic impact of the first wave of urbanization that human mankind encountered is still largely a black box. In this exploratory study, the economic performance levels through time for four primary civilizations have been reconstructed. The main conclusion of this research is, contrary to what is often assumed, that economic growth ánd decline were far from nonexistent in primary civilizations. Even before the existence of secondary civilizations as Ancient Greece and Ancient Rome, significant economic growth and decline processes took place in primary civilizations both with respect to total food and non-food output and non-food output per capita. Additionally, growth accounting exercises showed that the assumption that economic growth in primary civilizations was either be caused by decreases in population numbers or increases in total arable land (e.g. due to conquest) does not hold for several periods and for several civilizations. Especially for Mesopotamia and Ancient Egypt, the evidence for several periods is robust enough to ascertain that on average significant productivity growth took place.

Keywords: Economic performance, primary civilizations, urban revolution, productivity growth

CHAPTER I: introduction

1.1 General background

The pyramids of Egypt, the ziggurats of ancient Mesopotamia, Aztec temples, the Inca city Machu Picchu, the Wall of China, the Acropolis of Athens and the Colosseum of Rome: Though spread over the world and varying in size and architecture, they have several things in common. First of all, they often appear high on popular lists ranking civilization's most beautiful and impressive legacy, they are protected or considered for nomination UNESCO heritage sites (UNESCO, 2016), and attract vast amounts of visitors every year. The following similarity is quite remarkable in the light of these first commonalities, namely that the outstanding architectural achievements are not post-industrial but date back in most cases thousands of years ago and are brought forth by world's primary and secondary civilizations (Trigger, 2003) which were fully reliant on agricultural production systems (Cameron, Neal 2003; Morris, 2010).

These relics of ancient times hint at advanced socio-political organization and might be the result of economic systems approximating the uppermost production limits of preindustrial societies (Morris, 2010; Wrigley, 1988). What the remains also seem to imply is that there must have been substantial variation from place to place and from time to time in economic performance underlying the building of these artefacts.

Despite of these clear signs of fluctuations in economic performance over time, remarkable little research with a social science approach has been conducted with regard to economic growth and development of these ancient civilizations (Manning, Morris, 2005). Though secondary ancient civilizations have become more and more a research foci of interest, studies that have tried to describe economic performance levels of *primary* civilizations in a quantitative, comparative manner appear to be even completely absent. "Primary ancient civilizations" are defined by archaeologists Bruce Trigger (2003) as those civilizations of which "its institutions do not appear to have been shaped by substantial dependence upon or control by other, more complex societies".

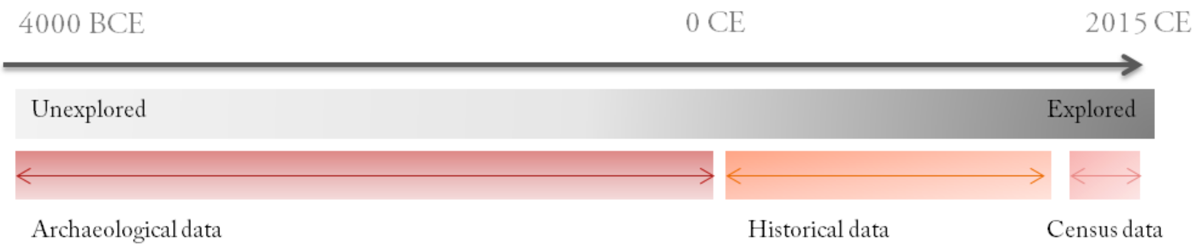
That the merits of this type of research can be substantial is indicated by insights that quantitative research to secondary civilizations (e.g. the Greek and Roman empires) has already delivered. This research has shown that advancement in economic performance does not seem to be a gradual, linear process as has been thought previously but rather a 'bumpy' one: food and non-food energy capture appeared to have reached a height in the Roman empire which only became reached again nearly two thousand years later in 18th century England (Cook, 1971; Cameron, Neal, 2003; Morris 2010; Jongman, 2014). The impact of such a finding is significant since it places all data about latter economic performance levels into perspective and thereby changes their meaning. Additionally, it has had an important role in how the industrial revolution has been perceived. Together with cross comparative studies of Western and Asian countries and studies examining the centuries preceding the 'revolution' it challenged the image of the industrial revolution as a sudden, unique, and western European phenomenon (Luiten van Zanden, Van Leeuwen, 2011; Luiten van Zanden, 2001). As a result, new questions arose as for example, "why did this "revolution" not happen in the Roman Empire with similar economic performance levels as 18th century England (Cameron, Neal, 2003; Jongman, 2014)? or in Asian countries that had economic performance levels not that different from many European countries in the centuries preceding the industrial revolution (Allen, Bassino, Ma, Moll-Murata, & Van Zanden, 2011; Broadberry, Gupta, 2006)?".

The study of the economic performance levels of primary civilizations can extend our knowledge about the nature of economic performance as well. Besides having the same effect of placing economic performance levels of latter periods into perspective, it can potentially deliver a second important contribution. Researching the economic performance of these civilizations can also give insights into changes in economic performance during that other, human history changing transformation, namely, the "urban revolution" (Childe, 1950). Together with the "Neolithic revolution" they describe the two most far-reaching changes in prehistory: the domestication of crops and animals, and the rise of state-level societies (Smith, Ur, Feinman, 2014). The urban revolution was not a revolution in the literal sense since it spanned several millennia, making the human populations living at that time most likely unaware of these changes (Morris, 2010; Childe 1950). Nevertheless, seen from a larger time scale, decisive transformations occurred in particular periods for particular regions: In several places around the world, independently of each other, the first forms of state organization evolved and all were accompanied with the rise of city systems (Trigger, 2003).

However, where for the industrial revolution many studies have been conducted about its (economic) underpinnings and the potential effect of the industrial revolution on economic performance levels, very few studies document changes in economic performance levels during the rise of primary civilizations and its associated city systems (Smith, 2004). This is remarkable since archaeologists document significant agglomeration and urbanization processes in this period (Trigger, 2003; Modelski, 2003) and theory in economic geography theory demonstrates that these processes are accompanied by economic growth (McCann, 2013). Additionally, from Keynesian growth theory it can be deducted that increases in exports and thus in commercialization and trade can be important drivers of growth as well. Signs of expanding trade networks and commercialization are found in primary civilizations which again emphasize the likelihood that significant economic growth processes took place (Smith, 2004; Hudson, 2004; Trigger, 2003). Thirdly, the in primary civilizations observed processes of economic structural change (Trigger, 2003; Smith, 2004) are in dual economy growth theory drivers of economic growth (Nelson, Pack 1999; Rodrik, 2013). Thus, even though these three strands of theory make it seem very plausible that economic growth and development in these civilizations occurred, no systematic study has been awarded to this topic yet. The rare studies that do exist focus often on small time scales, do not aggregate the data and do not make cross-cultural comparisons. Though cities play an increasingly important role in modern life (McCann, 2013; World Bank, 2009; Bettencourt, Lobo, Helbing, Kuhnert, & West, 2007) and the UN has proclaimed the current millennium the 'Urban millennium' (2001), it appears that the economic impact of the first wave of urbanization that human mankind encountered is still largely a black box.

The question rises why economic performance levels of primary civilizations have not been extensively researched before. It appears that the reasons strongly relate to institutional academic developments at the beginning of the 20th century. Due to the segregation of scientific disciplines along methodological lines (Veseth, Balaam, 2016), primary civilizations have been mainly studied by archaeologists with in general a more inductive, particularistic and humanistic approach (Manning, Morris, 2005). These works have delivered important insights into political, social, cultural and economic *structural* changes and their interrelatedness during this period but do not inform about (changes in) economic performance.

Figure 1.1: Overview of type of data exploration and usage in the social sciences



Source: own construction

Since the past has long been seen as the domain of archaeologists and historians, Economics but also the social sciences in general incorporated to a much lesser extent archaeological and historical data into their (quantitative) models. To quote the economic archaeologist Michael Smith (2004), "for most economists, Rome (or perhaps Greece) is as "ancient" as they are willing to study". Since mainly census data and to some extent historical data is considered in these models, approximately two thirds of human economic experience since the first state formations is underexplored in a social scientific way (figure 1.1). So far, it appears that the quantitative, comparative analysis of ancient economies has largely fallen between the disciplinary cracks (Trigger, 2003; Smith, 2004).

Of course, at the time of the segregation of disciplines and in subsequent decades, there were compelling reasons for why present and past economies should be studied by different disciplines. The formalist/substantivist debate lies at the roots of this long-standing dichotomy between the study of past and present economies (Wilk, 1996; Smith, 2004; Feinman, Garraty, 2010). In the debate, also known under the headers 'modernist/primitivist' and 'universalist/relativist' (Smith, 2004), it had been argued that ancient economies are completely different both in quantity (size) and quality (nature/structure) (Wilk, 1996). With respect to quantity, it was thought that growth was absent before the industrial revolution and as a result it was argued that there were no changes in performance to measure (Feinman, Garraty, Drennan, Earle, Morris, 2012; Jongman, 2014). This notion has been most likely based on the sparse historical data that was by then available of western Europe during the Middle Ages and which was then generalized as the overall situation across time and space before the industrial revolution. As for the qualitative dimension of economies, it was stated that ancient economies had an entirely different structure than the market structure and were largely redistributive in nature (Feinman, Garraty, 2010). Combining these two notions resulted in the conclusion that western economic tools could not be used for the study of 'primitive' economies in the sense that these economies are fundamentally different (Wilk, 1996).

This stark dichotomy between the nature of past and present economies both in quantitative and qualitative respect is crumbling under the weight of evidence derived from historical and archaeological findings (Feinman, Garraty, Drennan, Earle, Morris, 2012) and insights derived from institutional economics (North, 1977, 1990, 1991; Wilk, 1996). The economic historian Wim Jongman notes that (2014):

> *Of course modern economies are far more successful than preindustrial ones. On average we live at least twice as long, there are far more of us, and yet our standard of living is much higher than at any time in the preindustrial past. Finally, that standard of living improves virtually every year, by quite a lot, and for more and more of the world population. The past has indeed become a foreign country. And yet that does not necessarily reduce all of the preindustrial past to an unchanging world where life was forever brutish and short.*

Unfortunately, this image of ancient economies as entirely distinct from modern ones still proliferates in many disciplines. With respect to the quantitative dimension of past economies, in mainstream economics still the idea persists that before the 18^{th} century (Morris, 2010; Weil, 2013), or at most before 1000 CE "nothing happened" (Jongman, 2014). Additionally, changes in economic performance and development are simplified as though they can be fully described by the workings of the "Malthusian trap" (Smith, Feinman, Drennan, Earle, Morris, 2012; Clark, 2007).

However, the increasing amount and scale of data availability and their standardization in recent decades (Maddison, 2006) shows inevitably that economic performance levels were not constant (Foldvari, van Leeuwen, 2012) as well as its underlying economic structures (Smith, 2004). The first analyses including archaeological data on secondary civilizations (ancient Mesopotamia, Rome, and Greece) suggest that economic performance could deviate substantially across time and space with sometimes sustained increases in standards of living (Foldvari, van Leeuwen, 2012). Additionally, expectations are that the amount of archaeological data will increase manifold (Barcelo, Bogdanovic, 2015), implying even more possibilities for future research.

This is not to say that studying developments in economic performance levels in primary civilizations has become an easy exercise. Issues with data availability and especially quality are still very prominent and will be discussed in detail in chapter five 'data and methods'. Secondly, the argument of the formalist/substantivist debate that western economic tools cannot simply be applied to primitive economies still holds. Luckily, economic historians have in recent decades developed several approaches for quantifying economic performance levels in the past (De Jong, 2014; Foldvari, van Leeuwen, 2012). As for this research, the expenditure approach will be adopted which links performance levels to anthropometric and demographic data , and is thus also suitable for the inclusion of certain types of archaeological data.

However, since the theory behind the expenditure approach with its associated methods has been developed based on secondary and proto-industrial civilizations, some modifications needed to be made in order to capture economic performance processes in primary civilizations. Therefore the approach has been modified to incorporate insights developed by a small, interdisciplinary mixture of ancient historians, economic archaeologists and even geographers that have used archaeological data before in order to theorize about ancient economic performance. Their most important finding is that when looking at economic performance of primary and secondary civilizations, a distinction should be made between total food and non-food output in order to really understand the performance dynamics in pre-industrial societies (Smith, Feinman, Drennan, Earle, Morris, 2012). Since working with demographic data, another addition to the expenditure approach comes from the discipline of political demography. Literature indicates that, especially in times of fierce competition about resources within and among civilizations, it is important to make a distinction between individual and group economic performance (Goldstone, Kaufmann, Toft, 2012). Also this notion has been incorporated in the theoretical and conceptual framework as set out in chapter three.

Overall, the results of this master thesis are threefold. First of all, the bringing together of theories about economic performance stemming from several scientific disciplines has delivered a new framework for analyzing economies of primary civilizations. Secondly, a database in which data is stored on several indicators of economic performance has been constructed for Mesopotamia, ancient Egypt, ancient China and the Aztec empire. Thirdly, analysis of the data gave several findings which will be described extensively in chapter 5 ‘Analysis and Results’. Very broadly, the data strongly indicates that the assumption that economic performance was fairly constant before the rise of secondary civilizations as the Greek and Roman empire is incorrect. The data shows that economic performance could fluctuate heavily in different primary civilizations from place to place and from time to time.

1.2 Institutional/ Scientific Context

History teaches us that major economic crises usually lead to a period of soul searching followed by a radical rewiring of economic policy.

- ***John Kay (2012)***

The longer you can look back, the further you can look forward

- ***Winston Churchill***

This second section of this introductory chapter is added to portray an image of the institutional and scientific landscape in which this research takes place. It will be argued that the inclusion of archaeology data in the economic discipline and more broadly, in the social sciences in general, has several potential merits. Especially in the economic discipline, findings derived from researches using archaeological and historical data might help in resolving the ontological problems the discipline currently encounters.

That the economic discipline has an ontological problem became more and more clear in the aftermath of the financial crisis of 2008. This crisis not only shocked the world, but also hit the economic science in its core. Unexpectedly. As MIT economist Daron Acemoglu (2009) describes it, "Economists tended to think that severe business cycles had been conquered; that free markets require no regulations to constrain self-interest; and that large, established companies could be trusted to monitor their own behavior so as to preserve their reputational capital." Some economists (Colander, D, Goldber, M., Haas, A., Juselius, K., Kirman, A., Lux, T, Sloth, B., 2009) go even further by stating that not only the economic science failed to predict the financial crisis but also partly contributed to it, "with risk and derivatives models that, through spurious precision and untested theoretical assumptions, encouraged policy makers and market participants to see more stability and risk sharing than was actually present." Though this view clearly overstates the role of economics as a science in a multifaceted, complicated crisis (Stiglitz, 2009) and downplays the many positive contributions and insights deriving from economics (Acemoglu, 2009), a point is made that orthodox macromodels of perfect information, perfect competition, and perfect markets are unrealistic and can lead to harmful policy advice (Leijonhufvud, 2014).

The question rises how the economic science should proceed. It becomes more and more clear that the problem of economics may be harder to solve than initially thought (Krugman, 2014). This is because the problem lies deeper than merely contradictions in the theory or models that can be solved with immanent critiques that uses the terms and concepts of theory itself (Leijonhufvud, 2014). Economics has, so to say, an ontological problem, implying a misunderstanding of *the nature* of its main subject matter (Stiglitz, 2010; Leijonhufvud, 2014; Lawson, 1997; Krugman, 2014 ; Kay, Nash, Silim, Ormerod, Hallsworth, Fisher, et al., 2012). Economist should adapt one's methods of inquiry to the nature of its subject instead of what the economist Leijonhufvud (2014) describes as, "forcing the subject matter into the frame set by our preconceived methods of analysis, mainly optimizing behaviour and equilibrium analysis”. According to him, economists create in this way an “utterly distorted image of economic reality”.

Because of these ontological problems, both Nobel prize laureates Joseph Stiglitz and Paul Krugman indicate that the current orthodox economic paradigm is not feasible anymore. However, where Krugman sets out that, though imperfect, there is currently no alternative for the reigning paradigm (2014), Stiglitz is positive for the prospects of a new paradigm and argues that better insights in the nature of the economy has to come from opening up to a variety of (new) ideas (2010). He is a member of the advisory board of the Institute for New Economic Thinking (INET) which has been founded after the start of the financial crisis with exactly this goal: to create an “open market for ideas” in which the monopoly from mainstream economic ideas has been removed. However, as the famous work of Thomas Kuhn indicates, paradigm shifts do not happen overnight and can encounter high resistance by the established order (1962). This seems especially the case in the economic discipline since vested interests might be highest of all social sciences and many professional careers have been build on the current paradigm (Kay, Nash, Silim, Ormerod, Hallsworth, Fisher, et al., 2012; Stiglitz, 2010). Therefore, the re-evaluation of its core tenets goes very slowly (Kay, Nash, Silim, Ormerod, Hallsworth, Fisher, et al., 2012; Feinman, Garraty, 2010). At the moment, there seems to be a kind of vacuum in which it is admitted by economists that there are flaws in main theory but in which the new paradigm is not formulated in a way yet that it can be used to develop new theory upon (Krugman, 2014).

The question rises in what way economic historical or economic archaeological analyses can help in gaining insights in the *nature* of core economic concepts. This argument in favour of such an approach is derived from the classical work ‘The structure of scientific revolutions’ of Thomas Kuhn (1962) and the recent work by Jo Guldi and David Armitage (2014) called ‘The history Manifesto’. Kuhn argues that history is too often seen as a purely descriptive discipline while historical study can possibly lead to conceptual transformations (p.8). Historical study might indicate that the traditional paradigm is somehow askew (Kuhn, 1962, p. 121). In the case of the economic discipline, Adam Smith and Karl Marx both made extensive use of historical data and at the same time transformed and created core concepts in economic theory (Erskine, 2013). Guldi & Armitage phrase it as follows, “Historians have special powers at destabilizing received knowledge, questioning, for instance, whether the very concepts they use to understand the past are of themselves outdated.” (2014).

However, why would one want to go back further in time than 1000 CE if data becomes more scarce, possible causality relations weaker, and the development of theory more difficult? The article ‘Archaeology as a social science’ of the economic archaeologists Michael Smith, Gary Feinman, Robert Drennan, Timothy Earle and Ian Morris gives the answer (2012). In their plea for the inclusion of archaeology in the broader social sciences they argue that: 1. Archaeology gives scholars access to the full range of human experience. 2. archaeological findings prove a long-term perspective on change, documenting the origins of the agricultural ‘revolution’, the urban/state formation ‘revolution’, and other transformational social changes. 3. Archaeology is crucial to the renewed interest into “Deep History”. 4. Archaeological data is suited for cross-comparisons and thereby gives insight into societies independent of the western cultural tradition and places western (pre-)history thereby into perspective.

One of the main contributions of economic archaeology so far with regard to the nature of economic growth and development has been to debunk the Malthusian view as an overarching vision of pre-industrial history. Based on the idea of Geoscientist Earl Cook that there is a distinction between food and non-food calories (1971), it has been shown that while food calories remained largely restrained throughout history, non food calories increased greatly on average but could also fluctuate to a large extent over time and over space (Morris, 2010). Also there are signs that food-calories per capita also fluctuated to quite some extend and not per see in the opposite direction of population growth as one would expect with Malthus theory in mind (Jongman, 2014). Additionally, by making the distinction between food- and non-food energy capture, economic performance gains an additional dimension. It becomes clear that by using an aggregate of both or only food energy capture, economic performance dynamics are misunderstood.

Though the previous arguments underline the importance of economic archaeology and economic history, fact is that in the past, research into these areas often has not been translated into direct policy advice. Fortunately, the Institute for Public Policy Research (IPPR), one of the leading UK thinkthanks, indicates in their report ‘Complex New World: Translating new economic thinking into public policy’ (Kay, Nash, Silim, Ormerod, Hallsworth, Fisher, et al., 2012) that a new trend is upcoming in which an increasing number of economic history work is published with direct public policy relevance. This work does not only relate to the financial crisis but to a wide range of topics such as climate change, innovation and growth, inequality, poverty, economic development and so forth. The biggest challenge is not to make economic historical work relevant for current times, but to actually bring this promising but still early-stage work into the policy environment (Kay, Nash, Silim, Ormerod, Hallsworth, Fisher, et al., 2012).

CHAPTER II: objectives and research question

The broad objective of this Masterthesis is to make a modest contribution to the formation of the new economic paradigm in line with INET at the Oxford Martin school. The Oxford Martin school promotes visionary interdisciplinary research as the key to solve multifaceted problems related to the economy and to solve ontological problems. To quote the economist Ha-Joon Chang (2014), "The economy is too important to be left to professional economists alone". This is because "Economic growth and development" is one of those issues that extends way beyond a certain discipline mainly drawn upon methodological lines (Dinerstein, Schwartz, Taylor, 2014; Lee, Leyshon, Smith, 2008; Wilk, 1996). The call for interdisciplinary research does not only come from INET but also from those subdisciplines that are already balancing on the edges of two bigger disciplines, namely; economic geography (Lee, Leyshon, Smith, 2008), economic anthropology (Hann, Hart, 2011; Wilk, 1996), economic archeology (Feinman, Garraty, 2010; Smith, 2004) and economic sociology (Dinerstein, Schwartz, Taylor, 2014; Brown, Spencer, 2014). The economic geographers Lee, Leyshon and Smith (2008) describe it as the need "to move towards a post-disciplinary imagination for understanding economies/economic geographies".

The part on which this master thesis can contribute to the paradigm building is to give insights in the *nature* of economic growth and development with a particular focus on the time periods of state formation and the economic transformations in performances accompanying the 'urban revolution'. In this way, knowledge on economic growth and development extends from a primary focus on the industrial revolution and the period thereafter.

Up to this moment however, macro-economic concepts, models and methodology are not directly suitable for describing and explaining economic performance on the very long-run (meaning even the period before 1000 AD) or in contexts different from the modern capitalist one. Economic historians as for example Angus Maddison (2006) have circumvented this problem and provided very useful techniques for estimating economic performance largely independent of time and place, however the minimal accuracy of price level and wage level data often goes not back further than 1000 AD. Therefore, my second objective has been to develop a framework more directed at the inclusion of archaeological data as well in order to get insight in the economic performances of primary civilizations.

My third objective has been more specific and demarcated and intends to get an answer to the main research question and its derived sub questions. The main research question entails:

What are the characteristics of societal economic performance over time in the four primary civilizations of Mesopotamia, ancient Egypt, the Aztec empire and ancient China and how do these civilizations perform compared to each other?

* note: comparisons are made on a ‘interval time line’ and a ‘ratio time line’. The first time line is the commonly used time line in the western world in which the birth of Christ two thousand years ago indicates the starting point. At the ‘ratio time line’ the year 0 indicates the starting point of the urban revolution/state formation of each primary civilization. Since it is assumed that these primary civilizations evolved to the most important extent independently of each other (Trigger, 2003), the comparisons on the ratio time line might give more insight in the nature of the urban/state formation revolution. The interval time line on the other hand displays the chronological order of events and delivers insights in the course of world history.

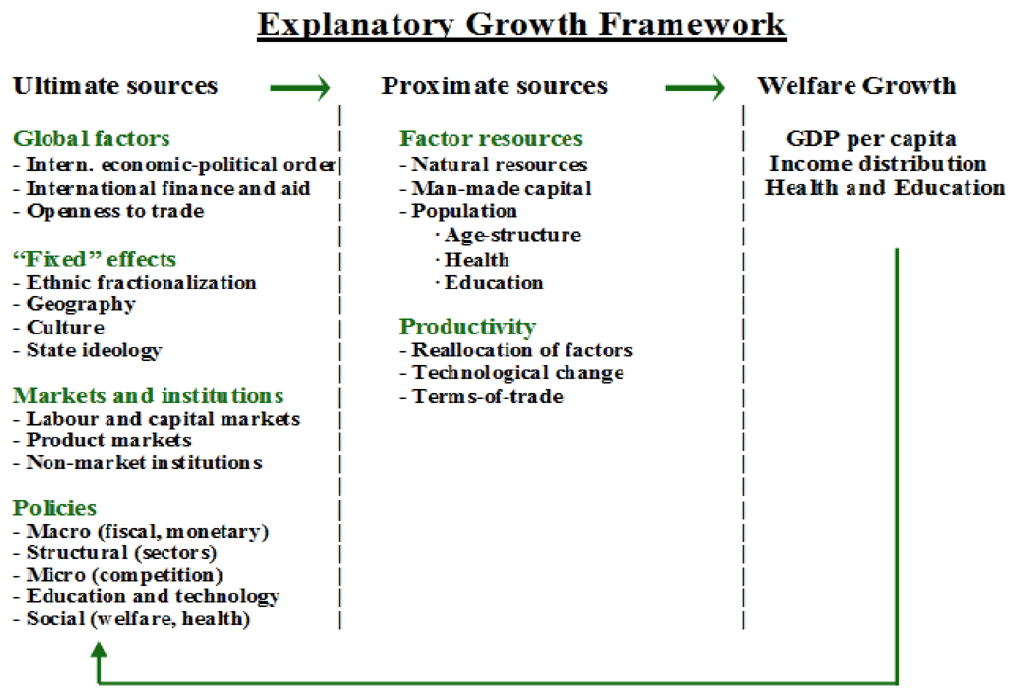
Several sub questions relate to this main question and are listed as follows:

1. How to go “Beyond GDP” and translate societal economic performance into indicators where archaeological data is available for?
2. What are the societal economic performance levels over time for each of the civilizations separately?
3. How do the societal economic performance levels of these civilizations compare in an absolute way and relatively to the amount of resources they have available?
4. To what extend can increases in output be explained in terms of increases in available land?

Instead of using the often used phrase ‘growth and development’ from mainstream economics, deliberately the terminology of Douglass North is adopted, who explicitly makes the distinction between economic performance and economic structure. With performance is meant “how much is produced” and with structure “those characteristics of society which we believe to be the basic determinants of performance” (North, 1981). According to him, this basic structure is formed by institutions which have the potential to lower transaction costs. Since the term ‘growth and development’ implies that both performance and the drivers of performance are researched, the term is too broad for the intend of this thesis which main focus is on describing performance levels. However the term “economic performance” is to a certain extent also too broad to reflect what has been researched. Instead of using the term ‘economic performance’, the term ‘societal economic performance’ is used to make clear that the focus is on total output produced by a society (GDP) and not on average economic output per person (GDP per capita red.). In economics, the term ‘extensive growth’ is applied to denote only aggregate output growth whereas ‘intensive’ growth reflects per capita output growth (Manning, Morris, 2005). However, the term ‘extensive growth’ would be to narrow again since this thesis does not focus on growth per see but also on decline of performance levels. Therefore, the term ‘societal economic performance’ is used.

Where the main research question and the first three sub questions are merely aiming at establishing an image of economic performance levels and societal economic performance relative to resources (e.g. land), only the last subquestion goes one step further from mere description to explanation of societal economic performance levels. As shown by the explanatory growth framework of Bezemer & Timmer (2014) in figure 2.1, welfare growth (and thus economic welfare as part of total welfare) can be *explained* by proximate and ultimate sources.

Figure 2.1: Explanatory Growth Framework – proximate and ultimate sources



Source: Bezemer, Timmer 2014

The development economist David Weil sets out that GDP per capita growth in preindustrial societies could be either induced by increases in the amount of land, a decline in population, or by productivity enhancements (Weil, 2013). Since it is often assumed that the level of productivity enhancement was low before the industrial revolution (Clark, 2007), an important role is then ascribed to growth of the proximate source "land" as the driver of total output growth. Sub question four wants to test this hypothesis and determine to what extend increases in the proximate source of land accounted for total output growth.

CHAPTER III: Theoretical framework, A multi-disciplinary overview of economic performance theory

In this chapter, a theoretical overview will be given with respect to the study of the economy in general and the topic of economic performance in partictular. The ways in which the theory is used in subsequent parts is manifold. Part of the theory in combination with archaeological evidence will be used in the literature review (section 3.2) to indicate the likelyhood that significant economic growth processes took place in primary civilizations. Other parts of the theory will be used for the construction of a conceptual framework in section 3.3. Lastly, theory related to methods of analysis stemming from Economics and Economic History will be used in the next chapter 'Research Design'.

3.1.1 The fragmented theory on long-run economic performance

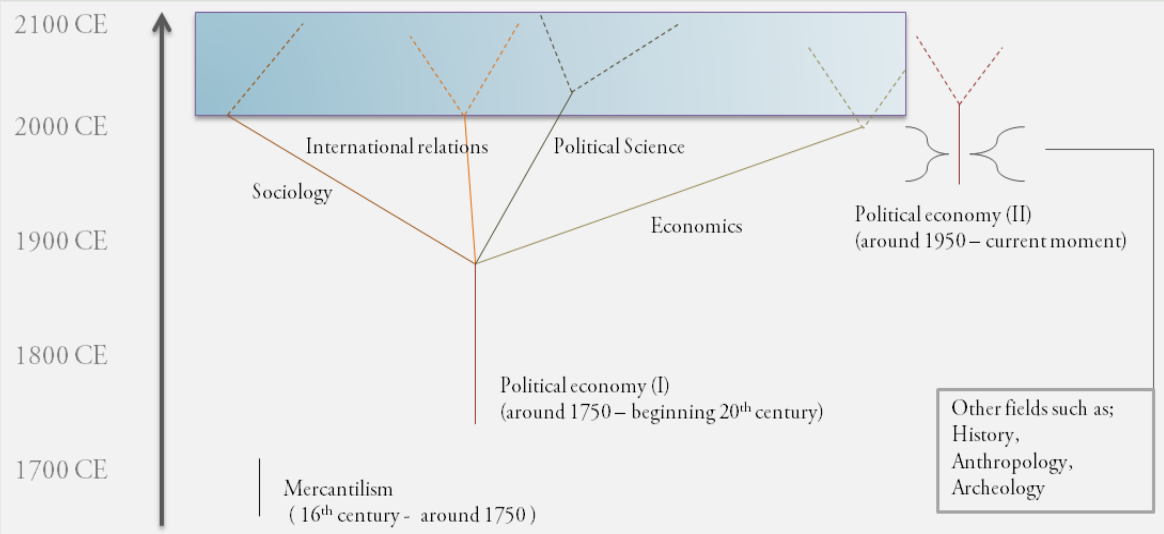
Though the study of the economy in general and the topic of economic performance in particular receives many scholarly attention and is at the fore of public debates, the subject-matter has been studied in a remarkable fragmented way (Wilk, 1996; Smith, 2004; Feinman, Garraty, 2010). Concerned disciplines as economics, economic geography, political economy, economic history, economic sociology, economic archeology, and economic anthropology often study this topic in different geographical contexts (western/non-western), time frames (recent decades, history, pre-history) and in relation to different societal realms (e.g. political, social, and cultural realm). In addition, the main goals, focus, approach, methods and definitions of core concepts can differ significantly across the disciplines making findings from different academic fields difficult to compare or aggregate into more extensive theories (Manning, Morris, 2005; Feinman, Garraty, 2010).

In 'The ancient economy: evidence and models' the authors suggest that not so much true qualititative dichotomies with respect to the nature of the economy in different times and places exist and therefore makes them studied in different disciplines. Instead they argue it is the other way around: namely, that these dichotomies appear to a certain extent from the disciplines themselves due to differences in methods, data availability and academic traditions (2005). For example, by focusing on different *aspects* of economic performance due to a difference in data availability, different disciplines may conclude that in *general* mechanisms and phenomena are completely different. The workings of this process of "compartmentalization" are shown in figure 3.2 where disciplinary divisions at the beginning of the 20th century (see box 3.1) enforced the idea of dichotomies for subject matters depending on place, time and societal realm (Veseth, Balaam, 2016) while in reality differences rather reflected a *scale* or spectrum (Smith, 2004; Feinman, Garraty, 2010). Current research, for example on the topics of economic markets (Feinman, Garraty, 2010; Swedberg, 1994; Minc, 2006) and commercialization (Smith, 2004), supports this view by indicating that the nature of these topics

Box 3.1: the development of the social science disciplines in relation to each other over time

In the previous chapter, arguments were brought forward in favor of the relevance of including historical and archeological data into the broader social sciences as well as reasons why it has barely been done before. This section will set out more detailed how the disciplinary histories of the social sciences and humanities affected the study of ancient economies. Towards the end of the 19^{th} century, a general academic trend existed in which specialization along societal realms, geographical location, time frame, and methodological lines took place (Veseth, Balaam, 2016). The following simplified figure gives some insights into the development of the social science (and humanity) disciplines in relation to each other over time.

Figure 3.1: The formation and transformation of intellectual disciplines over time

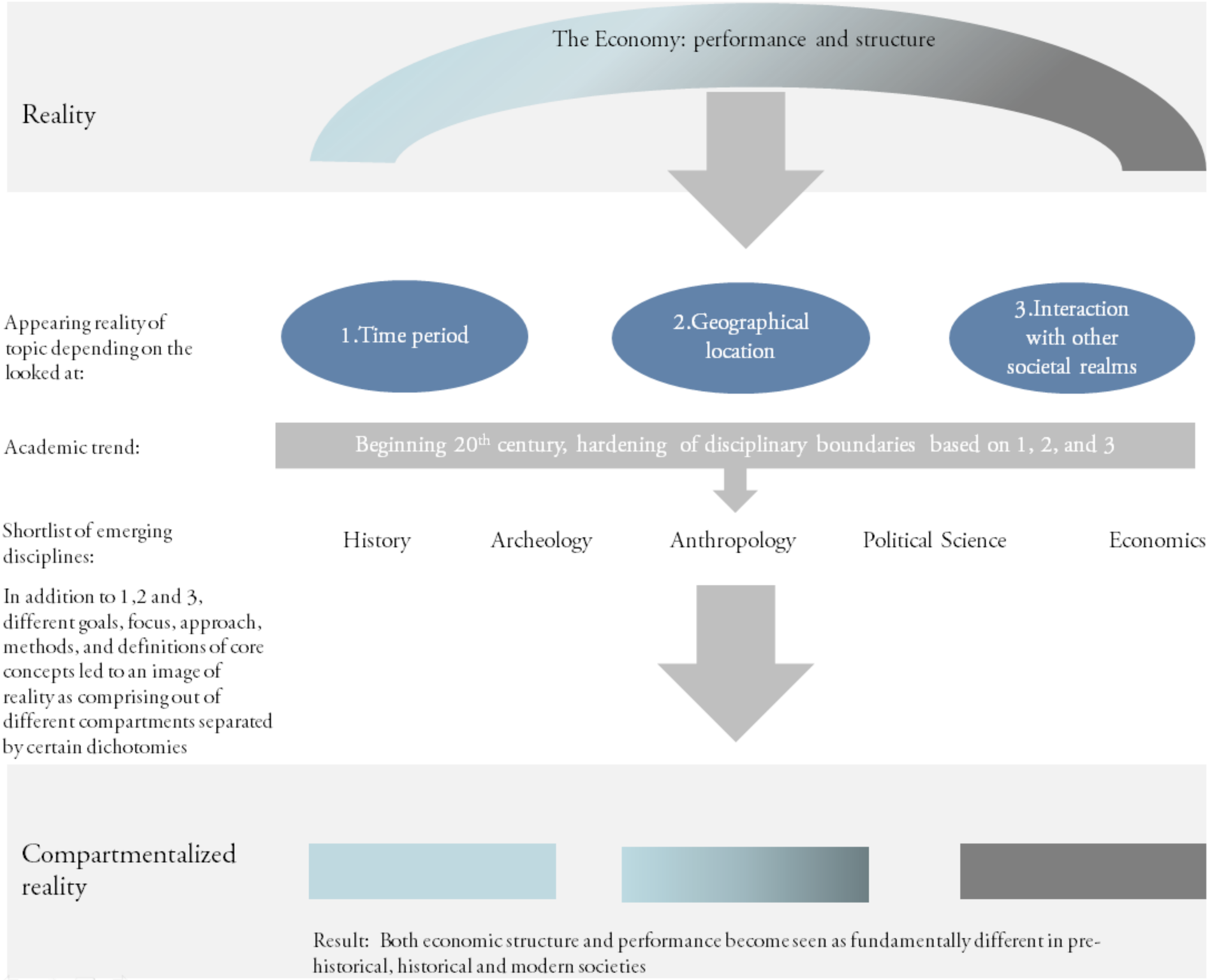


Source: own construction through literature review (Veseth, Balaam, 2014)

This new trend for narrowly focused and methodologically conventional disciplines had clear advantages and substantial merits. The clarity in methodology, theory and goals enabled scientists to begin research where it left off instead of building the field anew every time again with the obligation of justifying first principles and each concept (Kuhn, 1962). These more articulated disciplines proved to be more successful than previous broader scientific movements with respect to solving a few problems that were specified as most acute by the discipline itself. In the case of the social sciences, these narrowly focused and methodologically conventional disciplines had each the attempt to specialize on particular elements of society. Whereas previously, economics had always been studied in relation with politics and history under the header “Political Economy” it became now segregated from the study of economic history and political economy (Findlay, 2005; Wilk, 1996).

Besides the advantages, the segregation of disciplines in the social sciences had also serious disadvantages which become more and more clear. The ‘separate’ elements of society along which specialization took place appear not to be that separate at all and where previous research focused on processes within these elements of society there appears to be a shift of interest towards relations between these elements in order to reflect reality more accurately. The blue box in figure 3.1 reflects the potential future trend in which different disciplines start to conduct more inter-disciplinary research in order to solve the aforementioned issues.

Figure 3.2: Simplified model of the formation of compartmentalized views with respect to nature of economic growth, decline, and development



Source: construction based on Manning & Morris (2005), Feinman & Garraty (2010) and Smith (2004)

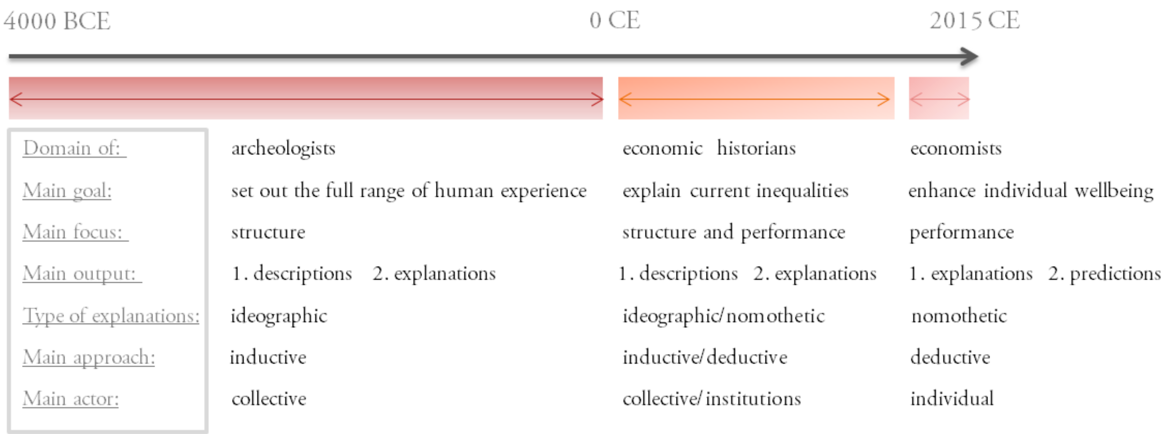
is qualitatively different from time to time and place to place but can be ordered along a spectrum and therefore do not comply to the dichotomies advocated in theories by Karl Polany and associates.

Nobelprize winner Douglas North in his book 'Violence and social order' calls for a new approach in the social sciences to overcome this compartmentalization. He formulates the main goal of the social sciences as, "to explain the performance characeristics of societies *through time*" (2009, p.1). In order to accomplish this, new conceptual frameworks need to be formed (North, Wallis, Weingast, 2009). However, the issue of observational equivalence (Overman, 2004) lurks when several disciplines (with different paradigms on the nature of humans and society) investigate the same phenomena and try to build new overarching frameworks. Therefore, it is uttermost important that reevaluated core concepts are turned into measurable constructs and are logically consistent (McCann, 2007; Feinman, Garraty, 2010; Manning, Morris, 2005). Feinman and Garraty (2010) describe this as the challenge to "develop working definitions that neither stultify research nor become the central focus of academic discussion and that encourage analytical practice as well as dialogue across a range of disciplines".

The goal of subsection 3.3 'conceptual framework' is to develop these working definitions and come to an overarching conceptual framework in which the nature of the subject-matter economic performance is acknowledged as reflecting a spectrum and comprising out of different components. However before this can be done, an overview is needed of what theory has been developed allready in relation to the topic of economic performance. Additionally, in order to make this knowledge compatible wherever possible, first an overview has to be made on what crucial axes the theory differs among disciplines and whether these differences are insurmountable or actually higlight another dimension of the topic and are rather complementary.

This will be an important aim of the following subsections on theory and a brief overview is given of theory developed in the fields of economics, political demography, economic geography, economic history and economic archeology with respect to the economy in general and the topic of economic performance in particular. Each sub-subsection's theory will at the end be evalueted on two important axes: main focus (e.g. economic structure or performance and how they are researched in relation to eachother) and main output (e.g. description, nomothetic explanations, ideographic explanations). Figure 3.3 allready gives a simplified overview of how economies are divided among the disciplines based on time period and what the different axes are that cause the generation of different types of literairy output that are not directly compatible. It should be noted though that this is a generalized and simplified image of the disciplines reflecting main tendencies. Since disciplines as economic geography and political demography have developed theory that is less bound to time and space, they are not included in this figure.

Figure 3.3: The division of the study of economies based on time period



Source: own construction based on Manning, Morris, 2005

The aim of subsection 3.2, literature review, is then twofold. First, literature is set out that in accordance with the aformentioned theory makes a case for the likelyhood that significant economic growth processes occured in primary civilizations. Secondly, an overview is given of knowledge that is allready available about societal economic performance in primary civilizations. However whereas the literature about economic *structure* (economic development) is quite extensive with respect to ancient economies and the study of individual economic performance is advancing, research about *societal* economic performance in a comparative fashion is still in its infancy (Manning, Morris, 2005; Jongman, 2014).

3.1.2 Economic theory in Economics (a.k.a. Growth and Development theory)

Economists view 1776 as an important year. Not because of some political event that affected the market of goods or some cultural, social shock that influenced trade. This year is important because a new way of thinking was born with as founding father Adam Smith, who wrote the magnum opus '*The nature and causes of the wealth of nations*'. In this year, economics as a 'modern science' has been initiated. Economics is a science inasmuch it comprises analytical principles that work with consistent regularity (Ekelund, Hébert, 1984). However, in contrast to physics or mathematics, it is a social science in the sense that human behavior is the focus of research and not the disembodied working of nature. Mathematical models are constructed to enhance the comprehension of human behavior and what its consequences might be (Ekelund, Hébert, 1984).

What differentiates economics from other social sciences is that it studies human behavior in the context of markets. The reason why human behavior is studied in the context of markets is that it is assumed that all economic activities in modern nation states take place in markets or in relation to the market system (Feinman, Garraty, 2010). Several (implicit) assumptions are often made about what a market constitutes. When an economist refers to a "market", what is mostly meant is an institutional arrangement that fosters free trade and exchange or it should be defined else wise. Often when the market under study does not comply to the basic assumptions, mostly in developing countries, it is called "a disfunctioning market" and suggestions for improvements are made (Fox, 2009). Another assumption is that individuals have private property and have the incentive and ability to enlarge this through the participation in markets (Fox, 2009). But maybe the most important assumptions is that economic actors behave rational in order to optimize individual income. As a result of these, often silent, assumptions the scope of economic research has been for a long time limited to the western world since this is the area where these 'optimal' markets exist and for which economic theories mainly holds true.

Though the range of questions that the economic discipline tries to answer is broad, one of the main questions from the earliest moment that economics constituted a modern social science has been, “why are some nations rich and others poor?”. For over more than two hundred years, this interest has never ceased with as a result that there is at the moment a bourgeoning literature on economic growth and development (Cameron, Neal, 2003).

Within this literature three important traditions of growth economics can be distinguished. The first tradition originates from macroeconomics and is broadly neoclassical in nature (McCann, 2013; Rodrik, 2013). Exogenous and endogenous growth theories derive from this tradition. The second tradition has its roots in development economics and is to a large extent influenced by the dual economy approach of Lewis (1954) and Ranis and Fei (1961). Economist Dani Rodrik argues that the neoclassical and the dual economy tradition, rather than being contradictory, offer complementary perspectives on economic growth where the neoclassical models represent growth processes within modern sectors and dual economy models represent growth processes due to structural changes in inter-sectoral relationships (2013). Lastly, the third tradition is largely Keynesian in nature and in extended models economic growth can be related to interregional income flows (Blanchard, 2011). Also this approach using extended Keynesian models can be seen as complementary to the previous two approaches since it adds the dimension of the extent of openness to economies as potential driver or inhibitor of economic growth.

3.1.2.1 Exogenous and endogenous growth theory

For decades, the neo-classical approach was the most dominant and influential strand with respect to policy making. Neo-classical economists attribute the causes of growth in a time- and contextless theory of economic development. Incentives to save, accumulate physical and human capital, and innovate by developing new technologies play a large role in establishing growth (Rodrik, 2013). Political organization on the other hand only plays a minor role in this growth model. Politics should not interfere in the market and only establish a stable macro-economic environment in which the market can flourish (Nelson, Pack, 1999).

The most famous neoclassical growth model is the Solow-Swan model, being in the core an aggregate production function of a Cobb-Douglas type (Bosworth, Collins, 2008). This production function specifies the relation between aggregate output and the inputs in production (Blanchard, 2011) and in its most basic form can be described by the following formula in which Q stands for aggregate output, K for capital, L for labour, ‘α’ and ‘1-α’ for the capital and labor share in output respectively and ‘A’ is a constant : $Q_t = A\ K^a\ L^{1-a}$. This formula has two main properties. First of all, the assumption of constant returns to scale implies that if both inputs double in quantity, output will double as well. The second property is called ‘decreasing returns to capital and labor’ meaning that increases in capital or labor will lead to diminishing returns. In this model, GDP per capita can only grow by increases in capital. However since capital has diminishing returns, the growth curve is decreasing and becoming more and more flat and will eventually come very close to zero as shown in figure 3.4 (Blanchard, 2011).

Figure 3.4: Steady state of the Solow production funtion

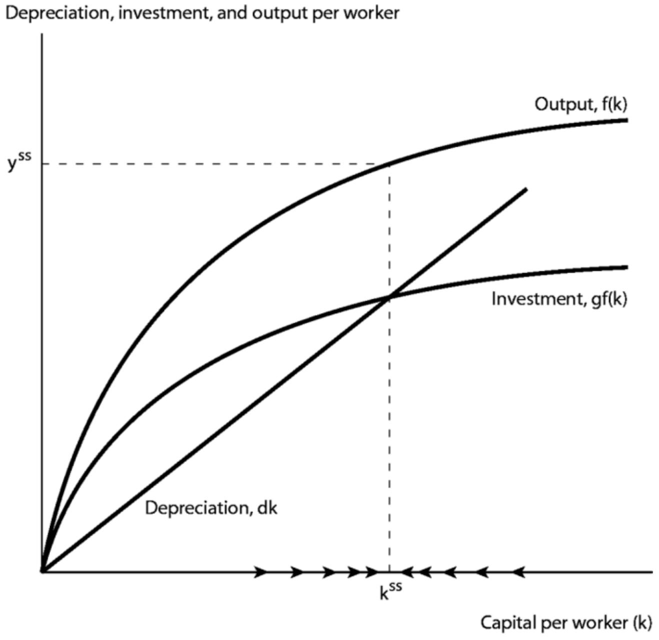
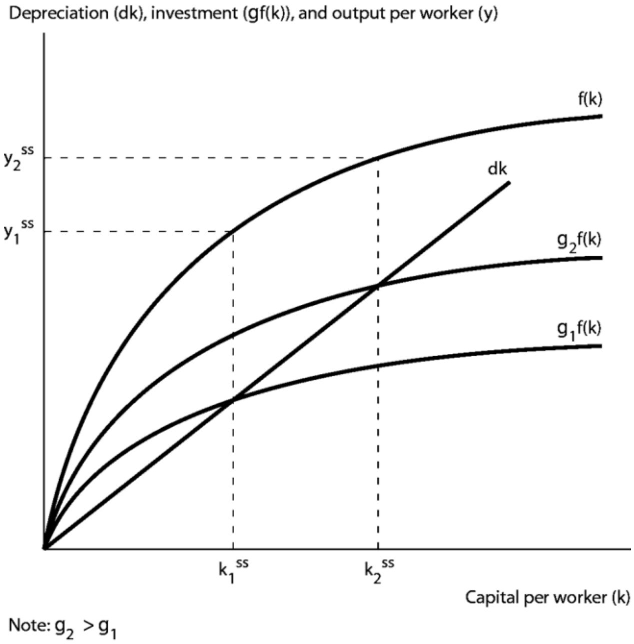


Figure 3.5: Impact on total output of increase in saving rate



Source: Weil, 2013

More precisely, when taking depreciation of capital into account, the accumulation of capital will eventually stop when reaching the equilibrium expressed by the following formula: gf $(\frac{K*}{L}) = \delta \frac{K*}{L}$, where 'g' stands for the investment rate, 'K*/L' for some level of capital per worker, 'f $(\frac{K*}{L}$') for output per worker, and 'δ' for the depreciation rate. Therefore, capital accumulation by itself cannot sustain growth (Blanchard, 2011).

Also an increase in the saving rate cannot increase the growth rate permanently, however this does not mean that a countries saving rate (assuming savings equal investments equal increases in capital) is irrelevant. Though a higher saving rate is unable to let output and GDP per capita grow permanently, it can sustain a higher, absolute level of both. This is shown in figure 3.5.

An important modification to this production function in order to reflect reality more accurately has been to include technological change over time. The function including a variable reflecting constant technological change over time has the following form: $Q_t = A\, e^{\phi t} K^a L^{1-a}$ in which '$e^{\phi t}$' is a simple technological trajectory (McCann, 2013). Technological improvement leads to an upward shift of the whole production function by a factor $e^{\varphi t}$. Therefore, this model implies that for permanent growth of aggregate output and of GDP per capita sustained technological progress is a prerequisite. Accordingly, the main outcome of this production function is that enduring technological progress is the key to permanent GDP per capita growth (Blanchard, 2011).

This can be shown more clearly when the production function is transformed into a model of growth by converting it into natural logarithms and then differentiate with respect to time (McCann, 2013). The outcome is the following function: $g_{Qt} = \varphi + \alpha\, g_{kt} + (1-\alpha) g_{Lt}$ in which 'g_{Qt}', 'g_{kt}', and 'g_{Lt}' stand for the growth rates of output, capital and labour at time 't'. This model lays at the basis of growth accounting exercises, a method commonly applied in this tradition. In a growth accounting exercise, economists try to determine the relative contributions of growth of inputs with respect to growth in aggregate output (McCann, 2013; Blanchard, 2011). The economists Richard Nelson and Howard Pack (1999, p. 425) write that, 'by weighting the proportional growth of inputs that occur over a period of time by estimates of their partial output elasticities (α and $1-\alpha$) over that period, one can calculate how much output growth was attributable to factor accumulation in the absence of a shift in the production function. The contribution of technological advance is calculated as a residual (φ)." This residual is called the 'Solow residual'.

Differentiating again with respect to labour determines the relative contributions of the inputs with respect to GDP per capita growth: $g_{GDP\ per\ capita} = \varphi$. This outcome implies that growth in GDP per capita equals the growth rate of technology/growth of total factor productivity assuming that the savings rate is constant over time and capital investments per worker and capital depreciation per worker in year t are in equilibrium. Therefore in a steady state situation, individual income growth simply depends on growth in total factor productivity (McCann, 2013).

So far, the models discussed in the neo-classical tradition have been exogenous growth models in which sustained, long term economic growth can only come from sustained technological progress. However, economists Robert Lucas and Paul Romer have challenged these traditional growth models (Blanchard, 2011; McCann,2013) and developed endogenous growth models in which long term growth is not depended on some exogenous technological factor (McCombie and Thirlwall, 1994) but on variables that are determined in the model itself (Weil, 2013).

The outcome of Romer's models is that the portion of output growth that would be dedicated to technological progress can in fact be attributed as a whole to increases in the amount of capital. In his models, capital is not seen as some aggregated stock but as the aggregate of specialized goods. Directly increasing in line with this capital specialization is labour specialization in terms of firm specific human capital. The associated benefits of labour specialization make the output elasticity of capital increase, transforming the growth model into: $g_{Qt} = (\alpha + \psi)\ g_{kt} + (1-\alpha) g_{Lt}$. When '$(\alpha + \psi)$' equals one , output grows at a constant rate and whereas '$(\alpha + \psi)$' is bigger than one the output growth is cumulative (McCann, 2013).

Where Romer focused on firm-specific capital related to capital specialization, Lucas (1988) focuses on human capital as a factor that dispenses the need of a technological residual. According to him, steady growth can take place in the absence of technological growth and can be generated by the possibility that physical and human capital increase in tandem (Blanchard, 2011). His growth model has the following form: $g_{Qt} = \alpha\ g_{kt} + (1- \alpha)(g_{Lt} + \lambda)$, where growth in labour units can be traded off with growth in human capital ‘λ’.

The growth theory that evolves from these endogenous models can be linked to theories and arguments evolving from the discipline Economic Geography (McCann, 2013). Economic growth and development theory evolving from this discipline will be discussed in the subsection 3.1.4 and gives several important insights into the nature of growth and thereby broadening our view on the spectrum that the subject matter of economic growth and development entails. Though theory from economic geography supports the existence of these agglomeration externalities described in the models of Romer and Lucas and points out their significance in understanding economic growth processes, the theory also indicates the weaknesses of *aspatial* endogenous growth theory.

3.1.2.2 Dual economy growth theory

Economists in the dual economy tradition have a rather different approach with respect to explaining growth processes. They distinguish between within and between sector growth and argue that in quite some contexts (e.g. developing countries) most growth can be accounted for by positive structural change: people and capital transfer from the traditional to the modern sector (Nelson, Pack 1999; Rodrik, 2013). Not the accumulation of resources is most important, but the assimilation of new technology, which is the result of a the transfer of resources from the traditional to the modern sector. Assimilationists emphasize the importance of political organization in establishing this change in economic structure. This process namely implies risk and learning, and political interference is seen as crucial to create the right circumstances for entrepreneurship to flourish (Nelson, Pack, 1999).

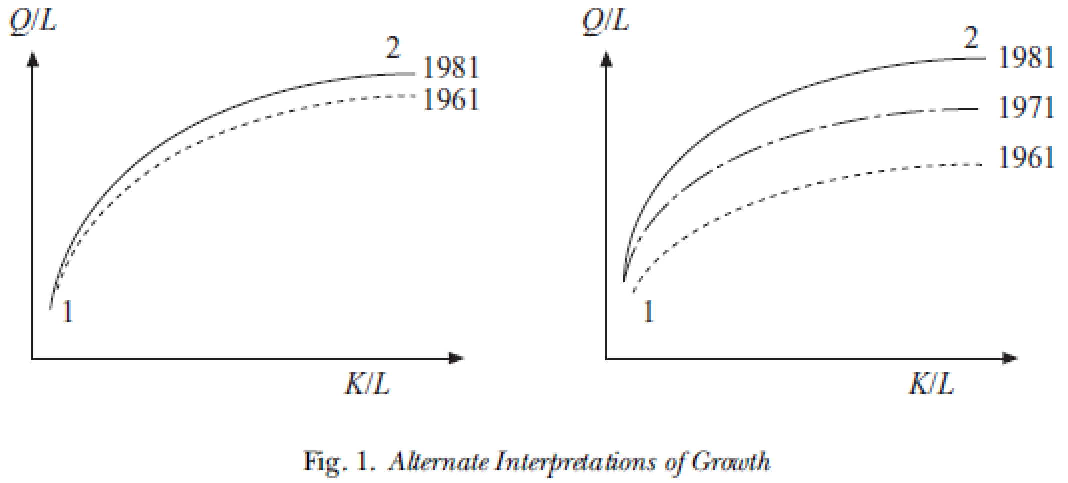
The sharp distinction that dual economy economists draw between the modern and traditional sector of an economy is usually referring to the industrial and agricultural sector. The logic behind why this distinction is important is that in the words of McMillan and Rodrik (2011), ‘As labor and other resources move from agriculture into modern economic activities, overall productivity rises and incomes expand. The speed with which this structural transformation takes place is the key factor that differentiates successful countries from unsuccessful ones’. Development in this way, is a process driven by disequilibrium (Nelson, Pack, 1999). Neoclassical economists on the other hand argue that different types of economic activities (in modern) economies are usually similar enough to be combined into one representative sector (Rodrik, 2013).

However in order to determine scientifically how much of productivity growth can be attributed to either within or between sector growth, the economists McMillan and Rodrik developed a framework in which the relative contribution of structural change and within sector productivity changes in relation to total productivity growth can be measured (2011). The decomposition of total productivity growth comes down to the following two terms: $g_{Ptotal,t} = \Sigma\ \theta_{i,t-k}\ g_{Pi,t} + \Sigma\ P_{i,t}\ g_{\theta i,t}$,in which ‘$g_{Ptotal,t}$’ stands for total and ‘$g_{Pi,t}$’ for within sector producitivity growth at time t, ‘$\theta_{i,t-k}$’ is the employment share in sector i at time 't-k', '$P_{i,t}$' is the productivity level in sector i at time t, and '$g_{\theta i,t}$' denotes the change in employment levels in sector i at time t. In this manner, the first term in the decomposition expresses the weighted sum of productivity changes *within* individual sectors and the second term reflects the effect of labor reallocations on total productivity growth and thereby captures the effect of 'structural change'.

Overall, the outcomes of these frameworks is that developing countries are characterized by large productivity gaps between different sectors and that the elevation of certain barriers causing these allocative inefficiencies can be reasons for long run economic growth (McMillan, Rodrik, 2011). Even in the absence of within sector productivity growth, growth enhancing structural change can be very important in contributing to overall economic growth (Rodrik, 2013). Currently, developing countries that experience high growth rates are also the countries that underwent significant growth-enhancing structural change (McMillan, Rodrik, 2011).

The outcomes of these models are not without consequences for neoclassical growth models. Research by the economists Nelson and Pack clearly shows what biases occur when neoclassical growth models and growth accounting exercises are applied to economies who experience substantial structural change (1999).

Figure 3.6: Descrepancy in reconstructed growth trajectory by growth accounting and actual growth trajectory



Source: Nelson & Pack, 1999.

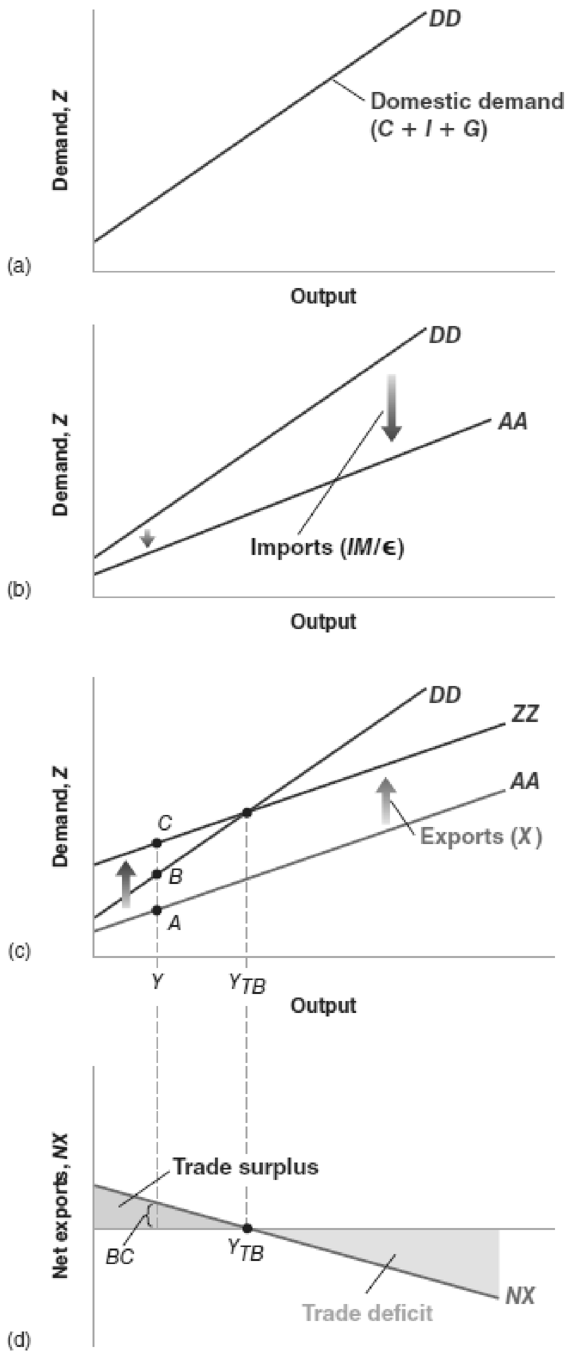
One of the main points is that in these economies the neoclassical growth accounting formula "$g_{Qt} = \varphi + \alpha\ g_{kt} + (1- \alpha)g_{Lt}$" is not able to disaggregate the relative contributions made to overall output growth by either productivity gains 'φ' or (human) capital growth. Namely, the elasticity measures with respect to capital and labor are uncontaminated measures only if , in the words of Nelson and Pack, 'the assumed underlying translog production function exhibits constant returns to scale and Hicksneutral technical change". However the disequilibrium in productivity between different sectors and the rate at which this is removed influences capital's share over the development course. Capital's share, and thus it's elasticity, is high when capital and total output are growing most rapidly due to the structural change. A growth accounting exercise would then actually assign again a significant part of total output growth to (human) capital accumulation itself and thereby diminishes the role played by technological assimilation 'φ. Figure 3.6 expresses this problem. The left side shows the growth trajectory of a country experiencing positive structural change as would emerge from a growth accounting exercise while the right side reflects the actual growth trajectory.

In the 'Analysis and Results' chapter, a growth accounting exercise will be conducted based on the theory discussed in the previous subsection, however, dual economy growth theory will be used to interpret the significance of these results. Additionally, the dual economy growth theory will be linked to archaeological evidence in the literature review section, building a case for the likelihood that significant economic growth processes took place during the "urban revolution".

3.1.2.3 Keynesian growth theory: a balance of payments approach

Where the growth theories of the previous two traditions focused on economic performance and its proximate sources as within one isolated economy, extended models of Keynesian growth theory can be used to stress the interrelatedness of different economies and how interregional trade, monetary, and capital flows can be additional drivers or inhibitors to output growth (McCann, 2013). One of the key tenets of this approach is that a part of the output produced in a certain unit (e.g. city, region, country) is consumed outside that unit. The more open an economy is, the more impact external demand has on total output and output growth (Blanchard, 2013).

Figure 3.7:Decomposition Keynesian income-expenditure model and its relation to trade deficits and surpluses



Source: Blanchard, 2013

The relation between the aggregate demand for domestic goods and domestic demand and foreign demand can be described by a basic Keynesian income-expenditure model of the form:

Y = (C + I + G – (IM/e)) + X, where 'Y' stands for the aggregate demand of domestic goods, 'C' for consumption, 'I' for investment, 'G' for government expenditure, 'IM/e' for imports divided by the real exchange rate, and 'X' for exports,. The first term in the equation expresses the aggregate *domestic* demand for domestic products while the whole formula expresses the aggregate demand for domestic products. Figure 3.7 shows for different levels of output whether domestic demand (DD) exceeds the demand for domestic goods (ZZ). In the cases that DD is bigger than ZZ the particular economy develops a trade deficit while if ZZ is bigger than DD the country builds up a trade surplus (Blanchard, 2013).

A trade deficit is directly linked to the balance of payments on the current account and when the current account has a negative value this can only be compensated by a reduction in foreign assets or by an increase in indebtedness to foreign citizens (McCann, 2013). Since both 'solutions' cannot continue indefinitely (especially in the case of regions due to its inability to adjust interest rates), the long run maintenance or growth of an economy's income depends on the level of exports. To be more precise, in the case of regions the long-term growth rate equals long-term world income growth times the income elasticity of foreign demand for domestic goods divided by the income elasticity of domestic demand for foreign goods. Thus, regions with a low income elasticity of domestic demand for foreign goods and a high income elasticity of exports will tend to have a high level of long-term income growth (McCann, 2013).

What the Keynesian income-expenditure model in combination with the balance of payments approach shows is that, depending on the openness of the economy, international trade might be an important driver of economic growth and development. The qualitative composition of the production sectors again determine the income elasticities of domestic and foreign demand, thereby influencing the level of imports and exports. Of course, this extended model has been based on modern-nation states, but nevertheless the fundamentals of this theory might likely also hold for primary civilizations with early state forms. Additionally, theories of absolute and comparative advantage seem to come to the same conclusion of the predominantly positive effect of commercialization and expanding trade networks on total output in an economic system (Suranovic, 2010; Samuelson, 1969; Ricardo, 1817). Since expanding trade networks and increasing commercialization have been observed in primary civilizations, as will be set out in the literature review section, this theory supports the notion that there is a very high likelihood that significant economic growth processes took place with the rise of primary civilizations.

3.1.2.4 Insights and gaps in economic growth and development theory in Economics

The discussion of the traditions in economic growth theory within the discipline of economics has delivered several useful insights with respect to conceptually framing and measuring economic performance. It can be said that exogenous and endogenous growth theory are historically important intellectual starting points in determining the input sources of growth and their relative importance in relation to total output growth. Important to note is that, with respect to Bezemer and Timmer's growth framework (figure 2.1), the input sources in these growth models are 'proximate' sources. Though factor accumulation, technology and efficiency directly affect income, they do not fully answer the question of *why* a country experiences output growth or decline (Weil, 2013). In order to answer this main question it is vital to understand the ultimate sources that steer the outcomes in the proximate sources.

As argued before, rather than being contradictory, neoclassical growth theory and dual economy growth theory can be seen as offering complementary perspectives on economic growth in which the exogenous and endogenous models of neoclassical growth theory represent the nature of growth and growth processes within modern sectors and dual economy models represent growth processes due to structural changes in inter-sectoral relationships (Rodrik, 2013). The extended models stemming from the Keynesian tradition add again to these theories that economies (though some more than others) are not isolated and the interrelatedness of different economies with their interregional income flows can be additional drivers or inhibitors to output growth.

Though the traditions focus on different aspects of growth, the paradigmatic thinking and the methodological approaches are largely consistent. Figure 3.8 gives an overview of the tendencies in focus and output of economic growth theory in economics.

Figure 3.8: generalized view of main focus and approach with respect to the economy in Economics

Main output↓ / Main focus⟶	Performance	Structure
Description	X	
Nomothetic explanations	X	
Ideographic explanations		

Source: own construction through literary review

In general, the theory provides tools for measuring and describing performance (GDP, GDP per capita) and has the tendency to give nomothetic explanations for the subject under inquiry, meaning that theory seeks to identify a few key factors that generally impact a class of conditions (e.g aggregate growth) (Babbie, 2010). One of these key factors can actually be ‘institutions’ or ‘economic structures’, however, the intend is not to describe and research these structures but rather they appear as categorical variables in statistical analyses. Therefore, the structure box is not ‘checked’ since apart from the subfield institutional economics, mainstream economics has no deep interest in fully describing these structures and setting out their underlying mechanisms. Additionally, economic theory appears to depend more heavily on a deductive approach than an inductive one, implying that, in the words of social scientist Earl Babbie, ‘It moves from a pattern that might be logically or theoretically expected to observations that test whether the expected pattern actually occurs.’ However, the danger of more leaning on the ‘logic’ pillar of science than on the ‘observation’ pillar as noted by the dual economy economists Nelson and Pack is that new phenomena (e.g. large, positive structural change in NIC’s) and their consequences are not observed and its impacts are ascribed to other factors (1999). Especially with respect to neoclassical growth theory, the risk is that proximate sources become seen as ultimate sources of growth (Weil, 2013).

Another important point with respect to economic growth theory in economics is that ‘output’ and ‘output per capita’ in these models are measured by the variables GDP or GDP per capita and these are often seen as adequate measures to represent the concept of (individual) welfare as well. However currently, there is much debate about to what extent these measures of economic performance actually capture the concept of ‘welfare’ in an adequate way and what would be better, additional measures (Jones, Klenow, 2010; Stiglitz, Sen, Fitoussi, 2009; Fleurbaey, 2008). This is not a minor discussion since increasing individual welfare is seen as one of the highest goals of the economic discipline (Goodwin, Harris, Nelson, Roach, Torras, 2014), and a high priority of economists is to detect and explain mechanisms that increase individual welfare (Weil, 2013; Blanchard, 2011).

As general remark, in his thesis a clear distinction is made between ‘economic performance’ and ‘progress’ and these two terms are seen as related though not directly interchangeable. The scope of this master thesis is to measure societal economic performance of primary civilizations and additional research is needed in order to make inferences about progress in individual welfare in these economies. Nevertheless, as literature in political demography and international relations notifies, the measure of economic performance at societal level, namely ‘total output’(GDP), is a indicative measure in itself even though its relevance and some of its properties are often neglected.

3.1.3 Economic theory in political demography and international relations

What is the value then of reconstructing levels of societal economic performance while in economics and economic history the movement ‘Beyond GDP’ (Jones, Klenow, 2010) becomes more and more popular? It is a fact that an increase in societal economic performance (e.g. total output growth) is not per see correlated with an increase in individual economic performance or individual welfare in general (Cameron, Neal; 2003). Growth in societal economic performance can be namely caused by either growth in average individual economic performance and/or by growth in total population as shown by the following formula: $GDP = GDP_{per\ capita} \times P$, where GDP stands for total aggregate output, $GDP_{per\ capita}$ for aggregate output per capita, and ‘P’ for total population.

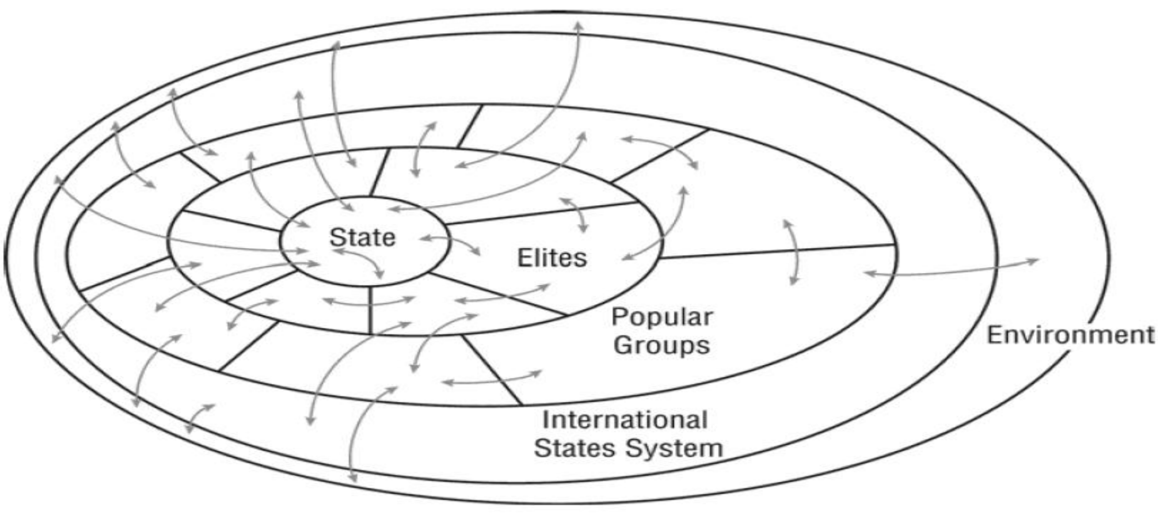
However, what GDP does indicate is the possible political/military power of a certain society, irrespective of having a low or high GDP per capita. For example, Russia, China, and India are in the top ten of biggest economies in the world (World Bank, 2014; UN, 2015; IMF, 2015), are among the most powerful countries in the world (Hurrell, Sengupta, 2012; Bayles, Smith, Owens, 2014), while at the same time standing on the GDP per capita ranking list of the IMF of 187 countries on place 55, 88, and 125 respectively (IMF, 2015). Focusing on the case of China illustrates this even better: China has the second biggest economy in the world, is seen as the biggest challenger of US political/military hegemony (Woods, 2014), and at the same time ranks on place 88 of GDP per capita, below countries as Macedonië and Colombia (IMF, 2014). Overall, studies in international relations show that, especially in times of increased competition and conflict, belonging to the group with the largest economic base has clear advantages with respect to political and military power and belonging to such a group contributes thus indirectly to individual wellbeing (Bayles, Smith, Owens, 2014).

Research in political demography underlines this (Goldstone, Kaufmann, Toft, 2012) and goes one step further. Countries with a large economic base have in absolute terms more means to employ for military or political purposes. Additionally, countries with a large GDP based on a large group size and not on a high GDP per capita have more people to mobilize in times of conflict. Thus, total output of a group (measured as GDP) has political and military consequences, however, whether this GDP is largely based on a relatively high GDP per capita or on a relatively high population number does matter as well with respect to political and military power (Goldstone, Kaufmann, Toft, 2012). Both increase the GDP of a society, however, case studies show that in times of heightened conflict and competition, investing in a larger group size has advantages over having a higher GDP per capita, especially if technology levels are too low to turn increases in GDP per capita into military power (e.g. capital that can replace humans) (Goldstone, Kaufmann, Toft, 2012).

Since in times of conflict it can become rather a matter of ‘to exist or not exist’, investing in a larger group size contributes more to individual wellbeing through safety than investing in individual economic wellbeing through having a higher material living standard. The term used in political demography for this phenomenon is “wombfare”(Toft, 2012). Opposed to Malthus’ deterministic theory of the “Malthusian trap” it emphasizes that humans/societies are to a large extent able to determine whether to invest in individual economic wellbeing (e.g. increase in GDP per capita) or political group wellbeing (e.g. increase of group size) which indirectly effects individual wellbeing as well.

It should be noted though that these processes occur not only on the national level but also within societies; for example, different ethnic/religious groups rival for power in a certain society (Goldstone, 2012). Figure 3.9 reflects these processes of within- and interstate competition for power.

Figure 3.9: Processes of within- and interstate competition for power



Source: Goldstone, 2012.

The paradox that occurs in societies with high *internal* competition is then that for the different (ethnic) groups the growth of population of the particular ethnic group is to its advantage but for society as a whole it can be detrimental as population expansion exceeds the carrying capacity of the economy as a whole (Goldstone, 2012). Since in previous eras competition for survival was fierce, it seems logical that this phenomenon of attaching great importance to investing output (e.g. food) into a larger group size over investing it in higher individual living standards (e.g. more food per person) has played an important role in primary civilizations (Trigger, 2003). Additionally, the importance of this theory from political demography lies in the better comprehension and insights it gives in of one of the most important concepts of theory on the economy, namely, total size of an economy. These insights will be used in the construction of the conceptual framework in subsection 3.3.

3.1.4 Economic theory in Economic geography

In one of the previous subsections, the endogenous growth theories of Romer and Lucas were discussed and it has been mentioned that theory evolving from economic geography supports the existence of these agglomeration externalities and underlines their significance in understanding economic growth processes. Alfred Marshall (1890, 1920) identified three main agglomeration externalities, namely; knowledge spillovers, local non-traded inputs, and a local skilled labour pool. These three characteristics of agglomeration economies enable firms in the cluster to achieve increasing returns to scale. Nevertheless, the findings and theory from economic geography indicate the weaknesses of *aspatial* endogenous growth theory as proposed by Romer and Lucas.

One of the main weaknesses is that without the incorporation of diminishing returns of capital or human-capital accumulation into the models, growth will be 'explosive' and has the implication that all economic activities would in the end center in one place (McCann, 2013). However in reality this is clearly not the case. The reason is that the spatial nature of the economy inhibits such explosive growth since negative externalities as congestion, rising land prices, and problems related to the acquisition, generation, exchange, and exploitation of knowledge put brakes on cumulative clustering (McCann, 2013). As a result, the spatial economy is characterized by both concentration and dispersal which is reflected in a system of cities according to an urban hierarchy. The area of research known as 'central place theory' is concerned with studying this spatial and hierarchical pattern of activities that appear to be non-random (Krugman, 2000). More specifically, in the words of economic geographer John Parr (2007), "Central-place theory is concerned with the size, spacing, frequency, and functional composition of urban centers, and how the overall urban system emerges in response to economic (usually market) forces."

There are several approaches within central place theory with respect to describing and explaining the formation of urban (spatial) hierarchies and their possible effect on and interrelatedness with economic performance. There are two classical approaches, known as the Christaller and Löschian models, which are directed at giving a descriptive and explanatory account of the spatial patterning of the urban hierarchy though under rather restrictive assumptions. Then there is the more recent school of models known under the banner of 'New Economic Geography'(NEG) which has become highly influential (McCann, 2013) and focuses on explaining the evolution of the spatial economy in relation to city systems (Krugman, 2000).

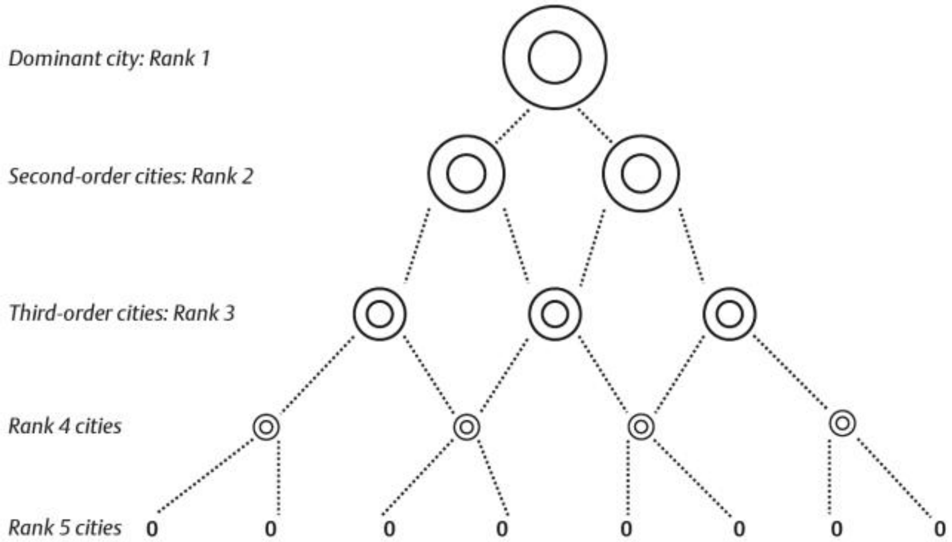
As for the classical approach of the Christaller models, these have been initially developed by the geographer Walter Christaller (1933) who took an inductive approach while developing his theory (Badcock, 2002). Observations of the size and spatial distribution of settlements in the south of Germany inspired him to develop a model in which all locations are supplied with all possible goods from a minimum number of supply nodes (Beavon, 1977). Though the emergence of this spatial pattern rests on strict assumptions that never that perfectly occur in reality, the model does show that a hierarchical urban system with different sized spatial market areas can exist independent of time and place based on logical assumptions (McCann, 2013).

Where Christaller adopted a rather inductive approach, August Lösch (1944) developed his models deductively with a microeonomic approach. The main difference between the models is that in the Christaller model the spatial market areas are supplied by a minimum number of spatial production points while in the Löschian model the geometrical features reflect the maximum number of supply points by making the assumption that the real economy is competitive (McCann, 2013). According to the economist Paul Krugman (2000) it depends on the context to determine which of the two models better reflects reality, "Once the number of cities has become sufficiently large, the size of and distance between cities tends to settle down at a roughly constant level determined by the relative strength of centripetal and centrifugal forces, providing some justification for the central-place theory of Lösch (1944). If there are multiple industries that differ in terms of scale economies and/or transport costs, the economy tends to evolve a hierarchical structure reminiscent of Christaller (1933)*"*. Nevertheless when comparing these classical models to modern microeconomic models and modern general equilibrium frameworks of analysis, the limitations of the Christaller and Löschian models become increasingly apparent (McCann, 2013). Since rather restrictive assumptions are made and little attention is payed to the significance of labor mobility, consumption patterns, and trade creation effects, the models fall short in explaining the *evolution* of city systems. Another critique is that the theory is only preoccupied with the 'force of centrality' and thereby leaving out other locational principles associated with types of economic activity that are less influenced by centres of market areas or centres of supply areas (Parr, 2007).

The NEG school of analysis is concerned though with evolutionary processes of the spatial economy and has provided models that give insight into processes of interregional convergence and divergence (McCann, 2013). The total amount of literature that emerged from the NEG tradition is large and beyond the scope of this master thesis. However, there are some basic, fundamental elements that underpin all these NEG models (Ascani, Crescenzi, Iammarino, 2012). These particular elements are: increasing returns to scale, monopolistic competition, transaction costs, and the existence of external economies. These basic building blocks shape the location behavior of workers and firms and by using specific parameter values for these theoretical concepts in NEG models it is enables one to explain the equilibrium situation of economic unevenness across space (Ascani, Crescenzi, Iammarino, 2012). For an example of a NEG model delivering the most important insights see 'Krugman & Venables 1995' (McCann, 2013). Overall, what NEG models mainly explain is that the geographical structure of an economy is simultaneously shaped by centripetal forces that bring economic activities together and by centrifugal forces that push it apart (Krugman, 2000). These 'forces' are not described as mere abstractions but rather in terms of more fundamental, micro decisions (Krugman, 2000). In terms of larger scale scientific contributions, the primary impact of NEG has been with respect to theory rather than empirical developments (Ascani, Crescenzi, Iammarino, 2012; McCann, 2013).

Though very useful, what these theories do not deliver are clear-cut methods for measuring the effect of endogenous spatial growth mechanisms on total economic performance. A theory that has more opportunities for empirical testing is the 'rank-size rule'. This 'rule' is based on the observations of apparent regularity to the size distribution of cities within a country. The most common used model of the rank-size rule reflecting observations most accurately is called 'Zipf's (1949) law' and corresponds to the following formula: $x\ R(x) = M$, where 'x' is the individual city population size, 'R(x)' is the rank within the urban hierarchy of the particular city, and 'M' stands for the population size of the dominant city. The city with the largest total population is assigned rank 1, the two cities that come after rank 2, and the three cities thereafter rank 3 etc (see figure 3.10)

Figure 3.10: The hierarchical organization of cities within a country



Source: McCann, 2013

The rank-size rule is rather a regularity than a rule or a law. Many observations are in line with the rank-size rule but whether this is due to economic or statistical processes is still not entirely clear (McCann, 2013). What argues in favor of an economic process is the fact that despite complex patters of growth and decline across cities the distributions remains robust (Duranton, 2007). Additionally, in the long-run simulations of Fujita et all. (1999) it comes to the fore that the rank-size rule approximates the spatial distributions of a mature spatial system (McCann, 2013).

To summarize, figure 3.11 gives a generalized overview of the main focus in economic geography with respect to studying 'the economy'.

Figure 3.11: generalized view of main focus and output with respect to the economy in Economic Geography

Main output ↓ / Main focus ⟶	Performance	Structure (spatial)
Description		X
Nomothetic explanations		X
Ideographic explanations		

It shows that economic geography is mainly concerned with describing and explaining the spatial configurations of economic activities and thereby has a deep interest in the *spatial* structure of economies (Clark, Feldman, Gertler, 2000). Additionally, theories often link the spatial economic configurations to total economic performance. However, as the NEG literature shows, to determine the *exact* impact of endogenous spatial processes on economic performance empirically is rather difficult. Therefore the box 'performance/description' in the table is only half colored. Nevertheless, a direct link in theory exists between the spatial structure of economic activities and the local economic performance levels. When theory stemming from economic geography is combined with archaeological evidence as will be done in the literature review section, a firm basis can be formed for the likelihood of significant economic growth processes in primary civilizations. Additionally, the theory on the 'rank-size rule' will be helpful in evaluating the quality of one of the data sources in the chapter four 'research design'.

3.1.5 Economic theory in Economic History

As shown in the previous sections, there exists a variety in approaches in relation to studying the economy. However what makes the economic historical approach unique is that it does not aim at producing general theories capturing universally applicable laws of economic growth and development, but rather gives insight into both the variability and uniformity of economic growth and development trajectories of different time frames and different regions. Knowledge about (different) trajectories enables economic historians to answer questions related to one of the main aims of the discipline, namely, *explaining* current levels of economic inequality (Cameron, Neal, 2003; Maddison, 2006). Additionally, by regarding attention to economic growth and development processes over longer time spans, the economic historical approach is able to detect the *fundamentals* of eg&d, also known as the ultimate sources of growth and examine their particular role in certain time and place with respect to changes in economic performance (Weil, 2013).

Thus overall, models in economic history are more directed at including ultimate sources of growth. In economic performance models where time intervals are relatively small, factors as tastes, technology, and social institutions are merely seen as constants. However in more extensive time frames, these parameters become the major variables (Cameron, Neal, 2003). As a result, a broader classification scheme of the determinants of economic performance is needed in order to determine in a particular case the sources and their relative importance. The following model envisages the total output and its rate of change, in the words of Cameron & Neal, 'as functions of the "mix" of population (P), resources (R), technology (T) and social institutions (X)"(2003): $Q = f(P,R,T,X)$. Each of these four factors are not seen as single variables but rather as a cluster of variables. For example, 'P' includes population numbers, age, sex distribution, biological characteristics, human capital, and labor force participation rate. In the case of resources, 'R' entails the amount of land, soil fertility, natural resources, availability of water, climate, topography, and other (social) locational features. Social institutions 'X' is seen as the factor that conditions the interrelationship of population, resources, and technology and is also referred to as 'the sociocultural context' or 'the institutional matrix' (Cameron, Neal). 'X' embraces the social structure (absolute number, relative size, fluidity of social classes, tax incomes), the type of state/political regime, the religious structure of a society but also voluntary associations, the educational system etc. The economic historian Angus Maddison developed a slightly different economic performance model in which he explains advances in economic performance over the past millennium by three interactive processes (2006):

1. *"Conquest or settlement of relatively empty areas which had fertile land, new biological resources, or a potential to accommodate transfers of population, crops and livestock;*
2. *International trade and capital movements*
3. *technological and institutional innovation.."*

Summarizing an extensive amount of research in economic history leads to the general conclusion that the relationship and interaction between these factors is complex, interdependent, and is in no way fully predictable (Cameron, Neal, 2003). An additional important notion is that certain *combinations* of the factors of production increase productivity, stressing that technological change does not occur in a vacuum.

Besides the fact that in economic history a heavier emphasis is placed on the ultimate sources of growth and the interrelationships among them, there is another important difference with the economic discipline which is mostly the result of different amount and type of data availability (census versus historical data). Whereas in economic models one of the main elements is the quantification of the in- and output variables, in economic history models changes in variables are often at best reflected at an ordinal scale (e.g decline, constant, increase) especially the further one goes back in time. As a result of the scarcity of quantifiable data, research in economic history tends to be rather descriptive, specific and detail rich (Smith, 2004) making absolute comparisons across time and space with respect to performance quite hard.

However, this view of economic history as mainly being a humanistic, descriptive discipline has been changing over the last decades. This is largely due to the pioneering work of the economic historian Angus Maddison. In his work 'The World Economy' a comprehensive view is given of world GDP per capita growth and population growth from 1000 CE onwards with a wide geographic reach (2006). By gathering and standardizing data on economic performance in a systematic way, he set the stepping stones for the quantitative macroeconomic analysis of history. It should be noted though that where the dependent variable in the models (GDP, GDP per capita, welfare measures) can in increasing circumstances be quantified, it remains way more difficult to quantify the independent variables (the proximate and ultimate sources) and determine their relative contributions. Also, large part of the quantitative research still continues to be restrained to Europe from 1500 onwards (Maddison, 2006).

Clearly, the economic history discipline has developed over time a strong tendency to adopt economic theory and practice its quantitative methods and techniques (van Zanden et all., 2014). Nevertheless, data quality is a much bigger issue in economic history and researchers have to rely on data sources and assumptions that are cruder than those made by economists. As a result, a whole section of theory developed in economic history rather focuses on how to construct and retrieve values for key economic/welfare indicators from a large variety of sources and how to deal with uncertainties. Theory in this sense is theory about *methodology*. As for constructing measures of economic wellbeing, there are three main approaches that can be used (also to crosscheck each other): the production, income, and expenditure approach (Foldvari, Van Leeuwen, 2012). The income approach, also called the real wage approach, is often used as the approach to compare standards of living across space. However the expenditure approach, also called the output approach, displays how households adopted to relative prices and can be constructed out of anthropometric and demographic data (de Jong, 2014). As for the production approach; this requires much reconstructions and assumptions about national accounts, especially in the period before 1900 (Allen, 2003). In a way, the construction of the data itself is already a difficult task and might even be the hardest task. In a report of the OECD it is mentioned that in order to make advances in data retrieval, "a collaborative effort is needed to deal with the complexities involved in gathering, systematising and analysing data from a wide variety of disparate sources. This requires teamwork, in which experts on various topics, regions and periods work together to create standardised datasets of key historical variables"(van Zanden et all., 2014).

Despite some of these difficulties with data retrieval and quality, the quantification of data has already had substantial merits. One of the main advantages of the quantification of historical data is that it enables scholars to compare economic performance and wellbeing across time and space in a more direct way. Additionally, quantified data is more easily contested and thereby intensifies and sparks scholarly discussions enhancing the dynamics of the research process (Maddison, 2006). As a result of the enhanced methods for quantifying and standardizing historical data, also more and more knowledge has become available about income per head (GDP per capita) and other indicators of wellbeing at certain times and places (van Zanden et all., 2014; de Jong, 2014). Previously, it had been assumed that before the industrial revolution, GDP growth on average over long trajectories was slow but sustained while at the same time GDP per capita growth was nonexistent or unsustained. This process could then again be fully explained by the discipline's most well-known theory: the Malthusian trap. This theory envisages that short-term improvements in income through for example technological advances were immediately offset by population growth (Clark, 2007). However, now novel data becomes available about GDP per capita and other welfare indicators the assumption that change in these indicators across time and space was absent before the industrial revolution does not longer seem to hold (Jongman, 2014; Foldvari, van Leeuwen, 2012). Also, more and more comments and additions are made with respect to the "Malthusian trap" theory.

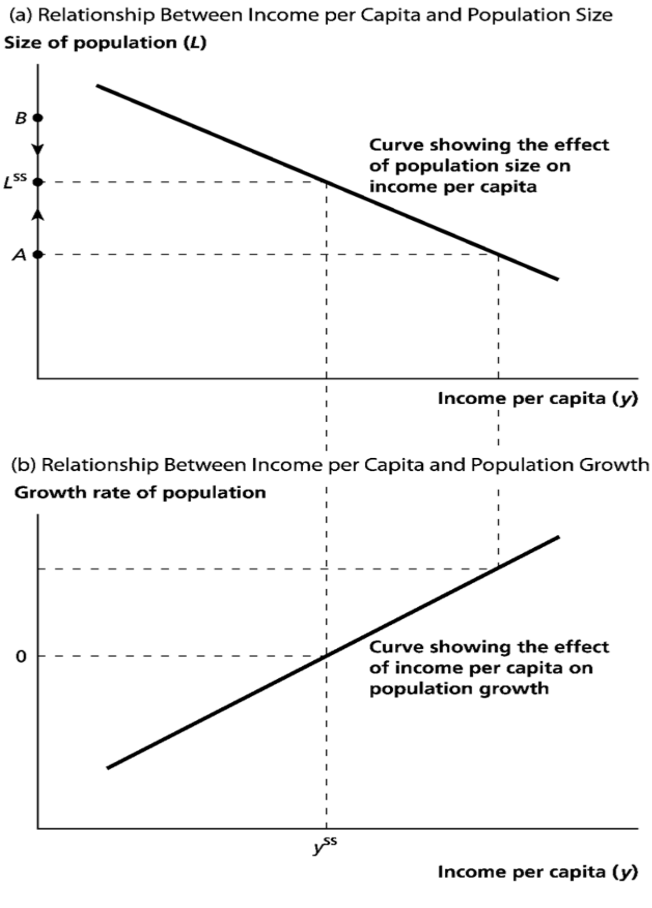
The influential book 'An Essay on the Principle of Population' was written in 1798 by the clergyman Thomas Robert Malthus (Cameron, Neal, 2003). The first part of the book sets out a simple model describing the economic logic of all societies before 1800 (Clark, 2007). The model rests on three premises, explaining the assumed long-run population stability and the constant, near subsistence level of economic wellbeing :

"1. Each society has a ***birth rate****, determined by customs regulating fertility, but increasing with material living standards.*
2. The ***death rate*** *in each society declines as living standards increase.*
3. ***Material living standards*** *decline as population increases." (Clark, 2007).*

The idea is that humans can breed at a prodigious rate if the quantity of available resources, especially land, would not put a brake on this process (Weil, 2013). Societies would be better off in terms of individual economic welfare the smaller the population relative to land. However, the higher the individual economic welfare the faster population growth thereby 'trapping' people in welfare levels near subsistence level (see figure 3.12). As a result, productivity enhancements through institutional or technological innovations as well as an increase in available resources will not lead to healthier, happier people but just to more of them (Weil, 2013).

While some economic historians still fully adhere to the Malthusian theory for describing and explaining the level of wellbeing before the industrial revolution (Clark, 2007; Weil, 2013), others place more and more nuances, acknowledging the existence of longer time frames at certain places with both sustained GDP and GDP per capita growth (Cameron, Neal, 2003; Luiten van Zanden, 2001; Jongman, 2014; Manning, Morris, 2005; Foldvari, van Leeuwen, 2010; de Jong, 2014). Some of these scholars argue that a high population density was more likely the result of a higher standard of living and thus the product of economic success and prosperity rather than being the depressor of labor productivity and the standard of living (Jongman, 1988; Scheidel & Friesen, 2009).

Figure 3.12: The workings of the Malthusian trap

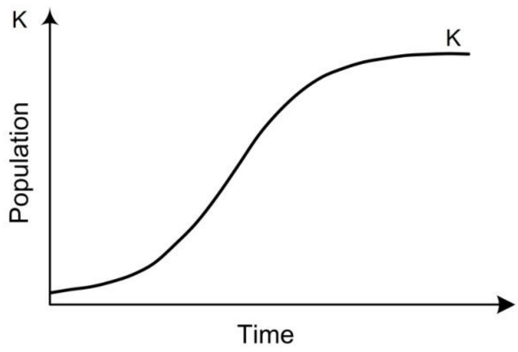


Source: Weil, 2013

These observations are more in line with the theory of 'the logistics of economic growth'. In this theory the logistic curve is used to describe social processes, especially population growth (figure 3.13). As far as for Europe, this theory seems to hold. Long periods of population growth have been identified and all have been followed by periods of relative stagnation and sometimes even decline (Cameron, Neal, 2003). However most interestingly, this phenomenon of population growth adhering to the logistic growth curve has the characteristic that each accelerating phase of population growth in Europe was accompanied by both increases in total *and* per capita output (Cameron, Neal, 2003). However without further productivity enhancements, the process of diminishing returns sets in and a society reaches the ceiling of production. During the decelerating phases of the logistic curve, evidence suggests that life became increasingly hard since growth in GDP per capita stagnated and GDP per capita might even decline. Only new epochal innovations might have again the effect of raising the ceiling and thereby allows further growth in population and individual economic welfare (Kuznets, 1966).

Another important nuance added to the Malthusian trap theory is with respect to human agency in relation to the fertility rate. Though Malthus acknowledges that customs can regulate fertility, human agency is very low and will according to him,

Figure 3.13: The logistic growth curve



source: Cameron, Neal, 2003

over time still lead to welfare levels just above subsistence. Though potentially true in many cases, historical demographical studies have shown that from the earliest records birth rates in northwestern Europe were well below the biological possibilities (Clark, 2007). However not only in Europe, but in most pre-industrial societies fertility was limited to a certain extent. This indicates that human populations did not breed at a prodigious rate whenever higher welfare levels allowed it but sometimes kept using preventive checks through social customs. These ranged from late marriage, eschewing marriage, abstinence from sex outside marriage, the non-remarrying of widowed or divorced women, and even female infanticide (Clark, 2007; Lee and Feng, 1999; Lee and Campbell, 1997). Additionally, as the subsection 3.1.3 on international relations and political demography showed, individuals, ethnic groups, and elites can also deliberately aim for a higher fertility rate which can be a good tactic in the rival for political and military power. Thus depending on the situation, a higher or lower fertility rate can be advantageous or disadvantageous for individual wellbeing and signs are there that depending on time and place humans had a certain control with respect to steering the fertility rate (Goldstone, 2012).

As a recapitulation, figure 3.14 displays an overview of the main tendencies with respect to focus and approach in economic history. The green boxes reflect tendencies in the more humanistic, descriptive economic history field and the red box displays the tendency in the more economic, quantitative oriented economic history research groups.

Figure 3.14: Generalized view of main focus and approach with respect to the economy in Economic History

Main output↓ / Main focus⟶	**Performance**	**Structure**
Description	X	X
Nomothetic explanations		
Ideographic explanations	X	

Originally, economic history has mainly been concerned with determining the basic determinants of performance and thus focused mainly on the underlying structure. However, structure is broader than in the notion of Douglass North who mainly focuses on institutional structures. Rather the ‘ultimate sources of growth' are researched as displayed in the economic growth framework of Bezemer and Timmer (2014). These ultimate sources/structures of growth are then brought in relation with economic performance. However due to a lack of quantifiable data for these ultimate sources, they are rather given as ideographic explanations displaying the range of potential influences on economic performance levels.

The box 'performance/description' is coloured red since it refers to the tendency in recent decades to adopt economic theory and practice its quantitative methods and techniques and therefore is in a way quite distinct from the traditional more descriptive and humanistic oriented economic history field. Due to improvements in data retrieval and availability, performance levels can in increasing circumstances be quantified. However, it remains nearly impossible in most cases to quantify the proximate and ultimate sources and determine their relative contributions. Therefore the boxes 'performance/nomothetic explanations' and 'performance/ideographic explanations' are *not* coloured red.

To summarize, what the theory from economic history contributes to this research is that it gives insights with respect to the nature of economic performance in the previous centuries and sometimes even millennia. Additionally, its tools and approaches for measuring economic performance in times where no census data is available will appear very useful as will be further explained in the chapter 'Research Design'.

3.1.6 Economic theory in Archaeology and economic theory based on archaeological data

Overall, the tradition in archaeology that is concerned with 'the economy', namely economic archaeology, is small and tends to focus on structure of the economy rather than on its approximate size and growth (Smith, 2004). Additionally, since most effort goes to classifying and analyzing primary sources, archaeologists in general as well as ancient historians have the tendency to leave aside model building and relating these models to empirical outcomes (Manning, Morris, 2005). Due to the difficulties in retrieving and interpreting past data, technical expertise in reading ancient texts or the retrieval of artifacts is highly praised and less emphasis is placed on methodology, comparison and the development of models (Manning, Morris, 2005). However as a result, Manning & Morris (2005) argue that, "the field remains radically undertheorized". Nevertheless, this does not imply that the field does not use theory. Only, the archaeological discipline tends to borrow ideologies and 'patterns of interpretation' from other disciplines (Davies, 2005) instead of deepening in a cumulative fashion own theoretical perspectives (Bintliff, 1991).

Even more than in the history discipline, the theory that is developed is theory about methodology. Since archaeologists gather the 'detritus of ancient life' and never get direct access to ancient economic activities, all archaeological data is proxy data (Morris, 2005). This proxy data can then be affected by two type of processes: depositional and postdepositional processes. Depositional processes relate to cultural processes of the ancient societies themselves, influencing the way people used the artifacts. The way people used specific objects determine whether or not the artifacts enter the archaeological record; e.g., past people did not necessarily leave examples of everything that they used behind on a specific site, and the fallacy that they do is called 'the Pompeii premise' (Binford, 1981; Schiffer, 1985). Postdepositional processes relate to processes that affect the artifacts after they have been discarded, abandoned, or deliberately buried (Morris, 2005). Postdepositional forces (e.g. erosion, soil conditions, human interventions, etc) may significantly alter the situation of objects and even destroy entire sites and disperse the original depositional context. Therefore, it is of importance to develop methods that are most suitable to recover and reconstruct artifacts, sites and landscapes most accurately by dealing thoroughly with the associated depositional and postdepositional processes.

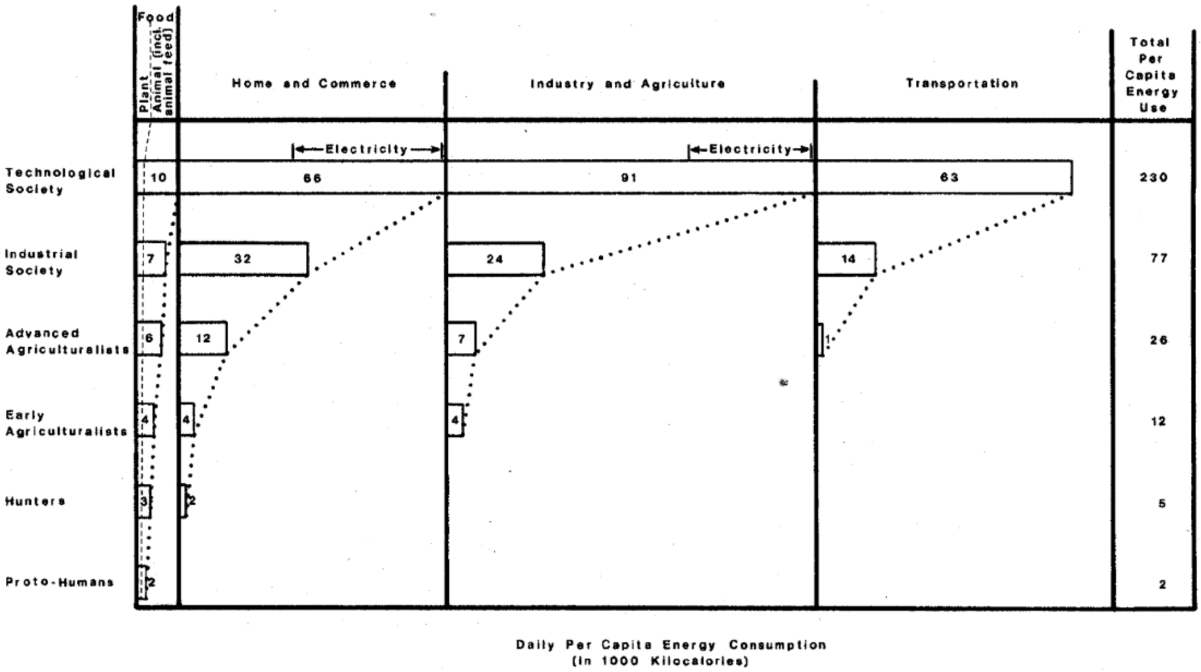
Though the discipline in general is characterized by inductive, particularistic approaches, and most theorizing is directed at improving methods, within several subdisciplines advancements are made with respect to theorizing in relation to the data. In the small sub discipline 'economic archaeology' models and theories are developed describing the structure of the economy in relation to the political system (Liverani, 2005; Davies, 2005), the nature of markets (Feinman, Garraty, 2010), and the relation between commercialization and the type of political system (Smith, 2004). Additionally, in the broader archaeological discipline theory is developed on levels of social, political and economic complexity and their interrelatedness (Brumfiel, Earl, 1987; Trigger, 2003; Smith, 2004). However, due to the quality, type, and the unstandardized nature of the data, but also due to the attitudes and ideologies of archaeologists themselves, the theories focus largely on economic structure and the nature of important economic concepts, thereby leaving economic performance as a topic of inquiry aside (Morris, 2005). Also, very few theorizing is aimed to link theory on economic structures to economic performance as is the case in the field of economic history.

Nevertheless, there is a small, interdisciplinary mixture of ancient historians, economic archaeologists and even geographers that use archaeological data in order to theorize about ancient economic performance. First of all it is argued by them that archaeological data has a huge potential for revealing long-run trends in standards of living since mortality, morbidity, stature, nutrition, and housing are all archaeological observable (Morris, 2005). These anthropomorphic and additional measures of welfare relate to the expenditure approach as described in the previous subsection and this approach is in time frames and locations with less/absent data on total aggregate output and price and wage levels the most reliable approach (Jongman, 2014; Morris, 2010).

As for the economic dimension of wellbeing (excluding dimensions as life expectancy, sustainability of wellbeing, free time, stability, etc), the geoscientist Earl Cook (1971) lay down an important framework for standardizing a wide variety of archaeological and historical sources, thereby enhancing the comparability of the expenditure approach with the income and output approach most often used in economic history. Data from a wide range of sources is translated into the indicator ‘energy capture per capita’ and since ‘energy capture per capita’ can again be translated in ‘GDP per capita’ the comparability of the outcomes of the three approaches greatly improves.

Besides comparability, the usage of the indicator ‘energy capture per capita’ in combination with the expenditure approach has delivered some substantial theoretical insights. Since Cook subdivided ‘energy capture per capita’ into the categories ‘food’, ‘home and commerce’, ‘industry and agriculture’, and ‘transportation’, he enabled one to distinguish between food and non-food energy capture. This distinction appears fundamental: whereas food energy capture per capita appears to remain over time rather constrained, consumption of energy in non-food forms has changed and fluctuated more dramatically (Morris, 2010).

Figure 3.15: Energy consumption at different stages of social development



Source: Cook (1971)

As graphically shown in figure 3.15, non-food energy per capita has had the tendency to increase over time and as a result total energy capture per capita as well. In addition, it appears that people have been largely unable to convert non-food energy capture per capita into food energy capture per capita (Morris, 2010). Though Cook’s estimates in this diagram have only been a starting point rather based on logic than observations, the large bulk of writings on energy consumption that have been produced afterwards all appear to conform this general trend (Morris, 2010):

“The basic pattern — a very long period of extremely slow growth from the end of the Ice Age to the rise of the state (i.e., from about 14,000 to about 3000 BCE), accelerating but still very slow growth in the age of early states and empires (roughly 3000-1 BCE), fluctuations pressing against an agrarian

ceiling slightly above 30,000 kcal/cap/day (roughly 1–1600 CE), a brief period when the agrarian ceiling was pushed upward (1600–1800 CE), and finally a (so far) brief period of explosive growth (1800 to present) —is very clear."

Even though the expenditure approach signifies that the distinction between food and non-food energy capture is very important in signaling changes in economic performance levels over time, economists and most other social scientists often ignore or are unaware of this distinction. By solely focusing on food energy capture per capita as a proxy for economic wellbeing over long time spans, they come to the wrong conclusion that 'nothing happened' (Clark, 2007) between the invention of agriculture 10.000 years ago and the industrial revolution in the eighteenth century (Jongman, 2014). Whilst every category of historical and archaeological data has its own difficulties, the amount of evidence is too large to state that GDP per capita remained rather constant between the agricultural revolution and the industrial revolution, especially when one takes non-food energy consumption also into account (Bowman, Wilson, 2009; Scheidel, Friesen, 2009).

Up to this moment, only very broad patterns have been sketched with this expenditure approach standardized by the measure 'energy capture per capita', and only for some large areas and time frames, while for example the rise of *primary* civilizations is still being underexplored. Whilst the expenditure approach has large potential for gaining insights in time frames and places were historical data is lacking or as an addition to estimates reconstructed from historical data, there are also several hindrances. Though depositional and postdepositional processes still pose substantial threats to making inferences from the archaeological data about general wellbeing, another large hindrance appears to be the institutional archaeological context itself (Manning & Morris, 2005).

First of all, anthropomorphic data is rarely submitted to systematic analysis (Morris, 2005). While precisely the systemization of the analysis would allow one to compare data and make inferences of relative changes in welfare across time and space. Another danger is the lack of systematic sampling. Archaeological recovery is always incomplete and for many purposes this does not matter; However when one wants to quantify data or make generalized statements about wellbeing in an area, a randomized, representative sample becomes of uttermost importance. Even when in two different archaeological projects systematic sampling and analysis is applied, a different way of data collection within the sampled area may still make comparisons impossible when not controlling for this variation in data collection. Unfortunately, many (classical) archaeologists see little to gain from systematic analysis, sampling and data collection or at least providing information on the manner they collected and analyzed the data (Morris, 2005). Besides possibly higher costs, the main reason is that often a rather humanistic or interpretive approach lies at the basis of their research or even nationalistic sentiments for which archaeological evidence serves as a proof of a high culture having deep roots in the past.

So far, the potential of archaeological data for constructing levels of economic performance over time has been discussed. It appears that *individual* economic performance (e.g. GDP per capita) is the main dimension of economic performance where a substantial increase in scientific interest can be detected for (Foldvari, Van Leeuwen, 2012). Figure 3.16 gives a generalized overview of the main focus and approach in economic archaeology.

Figure 3.16: Generalized view of main focus and approach with respect to the economy in Archeology

Main output↓ / Main focus→	Performance	Structure
Description	X	X
Nomothetic explanations		X
Ideographic explanations		X

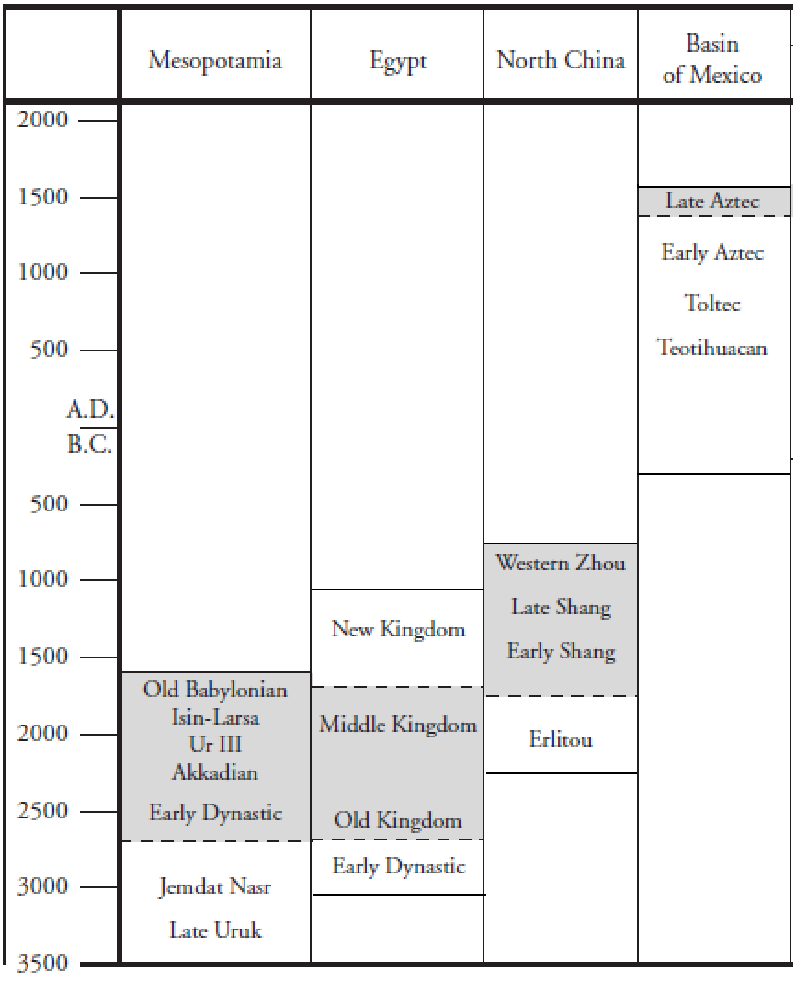
The table shows that theory largely focuses on the institutional structure of economies. Additionally, nomothetic explanations (theoretical models) or ideographic explanations (extensive description of factors underlying particular structure) are given for the occurrence of such a structure. Opposed to in economic history, ideographic explanations have the aim to explain the particular structure and not to explain certain economic performance levels. The box 'description/performance' has been given another color since several scholars use archaeological data to increase knowledge about economic performance in ancient times but this largely occurs without the archaeological discipline itself involved and therefore little congruence exists between knowledge evolving out of archaeological data on performance and on structure. Additionally, when economic performance is researched, the focus is wholly on individual economic performance and little insight is gained on societal economic performance. Nevertheless, the most important contribution stemming from the previously discussed theory is that it gives highly significant insights with respect to the nature of economic performance in preindustrial societies. These insights will again be used in the construction of the conceptual framework in subsection 3.3.

3.2 Literature review

In stark opposition to the extensive amount of *theory* available about economic performance in general as set out in the previous subsections, *literature* about societal economic performance (e.g. aggregate total output) of primary civilizations is practically nonexistent. As noted by the archaeologist Bruce Trigger, there is a trend in archaeology of a declining interest in the comparative study of early civilizations, especially in a systematic, statistical way (2003). If comparisons are made, these focus mostly on cultural aspects or economic structure but not on performance (Trigger, 2003). Additionally, the variegated group of social scientists using archaeological data focus on 'individual' economic performance as is currently the trend in the broader science of economics and thereby leave the topic of societal economic performance aside.

Luckily, the previously described theory in addition with knowledge stemming from archeology on the four studied primary civilizations can already shed light on potential changes in their societal economic performance levels. Especially theory from economics and economic geography can indicate the likelihood that significant growth processes in these periods took place relating to several characteristics of these civilizations. Additionally, theory from political demography combined with literature from archaeology can shed led on the interrelatedness of individual and societal economic performance in primary civilizations. Discussing these will be the intend of this literature review. The civilizations of interest are the four primary civilizations Mesopotamia, ancient Egypt, the Aztec empire and ancient China. Figure 3.17 shows the estimated time periods during which these primary civilizations existed (Trigger, 2003). The shaded areas are the time frames for which the archaeologist Bruce Trigger conducted his comparative research (2003). Thus when using his research in this literature review to shed light on performance characteristics, these facts relate to these specific periods.

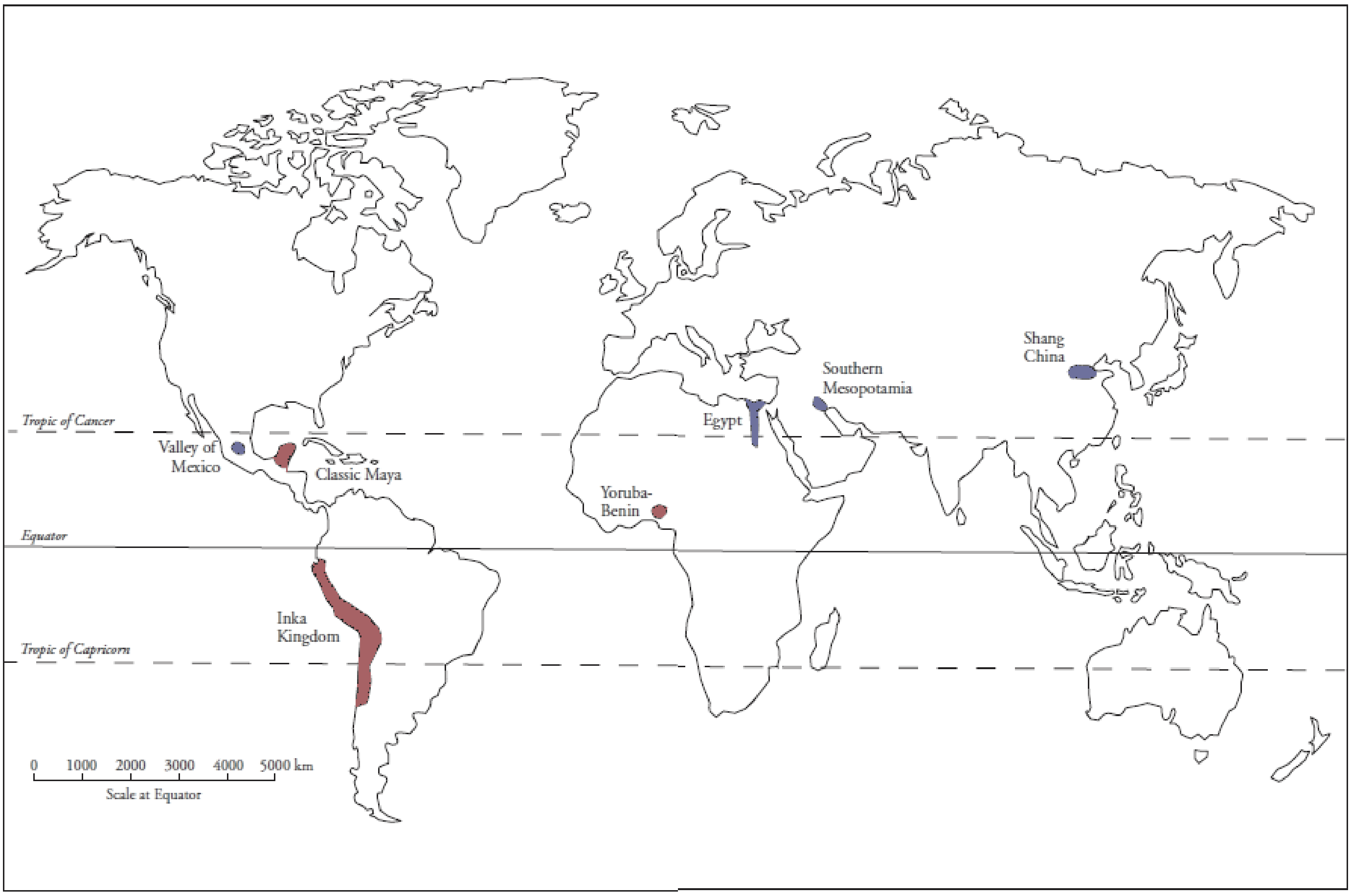
Figure 3.17: Chronology of early civilizations –periods studied by Trigger shaded



Source: Trigger, B. (2003).

The following figure is added to give a geographical impression of the primary civilizations under study. Whereas Trigger includes seven primary civilizations in his analysis (in blue and red), this research focuses on four primary civilizations (in blue) due to data availability on indicators of societal economic performance.

Figure 3.18: Locations of seven primary civilizations



Source: Trigger, B. (2003).

However in contrast to Trigger's research, the time periods during which these four primary civilizations are researched are then more extensive. For example, not only southern Mesopotamia civilization is researched but also the subsequent period which reflects the rise of northern Mesopotamia. In the case of ancient China, not only the rise of northern Chinese civilization is included but also the subsequent expansion further into the mainland is covered.

3.2.1 Indications of increasing societal economic performance levels in accordance with economic theory

The previously discussed theories stemming from economics each set out proximate or ultimate sources influencing economic performance levels. Therefore, even if societal economic performance itself is not measured yet in primary civilizations, the occurrence of certain drivers of economic growth can at least signal whether it is likely growth occurred or not.

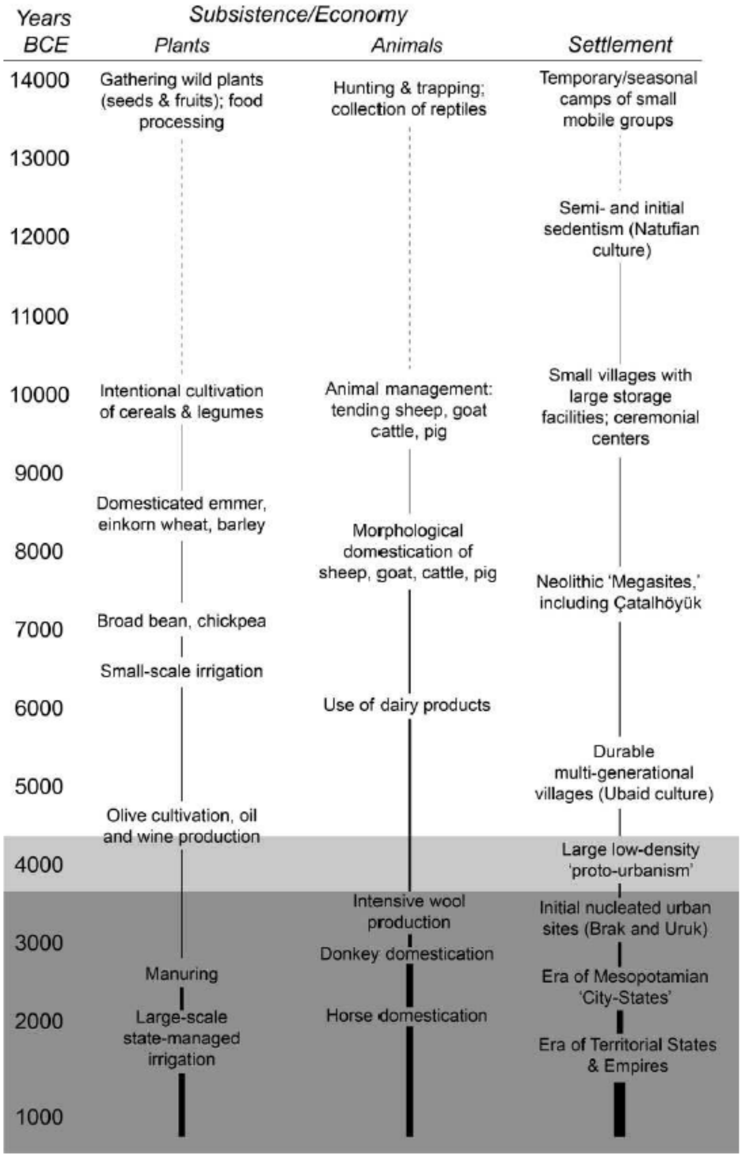
Exogenous growth theory stemming from the neoclassical tradition can give insights with respect to proximate drivers of economic growth in primary civilizations. In general, all these neoclassical growth models are based on industrial modern societies. Nevertheless, the economist David Weil developed an exogenous growth model with respect to capturing performance and its proximate sources in preindustrial economies (Weil, 2013). Instead of including capital ‘K’ he includes land ‘X’ which transforms the production function into: $Q_t = A\, e^{\phi t}\, X^a\, L^{1-a}$. The reason for this is that before the 19th century, the most important factor besides labor was not capital stocks but land. Based on a study of Kremer (1993) the partial output elasticity of land is estimated to be around 1/3 in preindustrial economies which implies that one third of national income was paid to land owners. Thus overall, increases in societal economic performance are in this model caused by the proximate sources productivity enhancement, population growth, and growth in the amount of land available.

Transforming this function into an equation reflecting the impact of proximate sources on individual economic performance (GDP per capita), the following formula can be obtained: $g_{GDP\ per\ capita} = \varphi + \alpha\, g_X - \alpha\, g_{L,}$ in which φ stands for productivity growth (either through enhanced efficiency or technological improvements). This seems to imply that income per capita growth in preindustrial societies could be either induced by increases in the amount of land, a decline in population, or by productivity enhancements (Weil, 2013). However, research by the economic historian Michael Kremer places an important note with respect to the role of population size and its growth/decline on individual economic performance by stating that technological improvements are positively related to population size. He empirically tested this endogenous growth model and found that those societies with larger initial populations with no possibility for external technological influences have had faster technological change ánd population growth (Kremer, 1993). An important example that a decline in population does not have to lead to an increase in individual economic performance is the economic collapse of the late second century of the Roman empire. Both population numbers and average welfare levels declined significantly (Jongman, 2014).Therefore, the effect of population size and population growth on individual economic performance has not to be negative per see and can even be positive. As for societal economic performance, a larger initial population size seems to have an extra positive effect by also positively influencing technological growth (Kremer, 1993).

Whereas signs of the occurrence of technological growth (Modelski, 2003; Trigger, 2003) and increases in total land available (McEvedy & Jones, 1978) are certainly prevalent for most primary civilizations, the proximate source ‘population’ shows the most incontrovertible growth spurt (McEvedy & Jones, 1978; Modelski, 2003). The signs of increasing population numbers based on settlement findings go hand in hand with evidence of agricultural intensification and are used to signify economic change (Trigger, 2003; Smith, 2004). Agricultural intensification is indicated archaeologically by the finding of various forms of irrigation and agricultural terraces. Figure 3.19

graphically displays the co-evolution of the subsistence economy and settlement patterns in the case of Mesopotamia.

Figure 3.19: The co-evolution of the subsistence economy and settlement patterns in the case of Mesopotamia



Source: Smith, Ur, Feinman, 2014.

From a social-political perspective indications of population growth is also what would be expected. One of the hallmarks of the first civilizations is their heightened organizational complexity and social scientists from a wide range of disciplines have repeatedly demonstrated the cross-cultural relationship between the size of human groups and their organizational complexity (Carballo, 2013). This 'size-complexity rule' is based on the principle of interaction: the greater the number of person-to-person contacts the larger the chance of social conflicts and tensions and as a result the higher the likelihood that institutions arise to mediate and keep order (Feinman, 2013). As one of the proximate sources of societal economic performance, this phenomenon of demographic growth thus lays a firm basis for the probability of the occurrence of significant economic growth in primary civilizations.

Besides from neoclassical exogenous and a-spatial endogenous growth theory, signs that significant economic growth occurred in primary civilizations can also be deduced from the extended models of Keynesian growth theory. Export and thus commercialization and trade are in these Keynesian models seen as important ultimate sources of economic growth for a certain region (Blanchard, 2011).With commercialization is mend the increasing role the market system plays in a certain society. The archaeologist Leah Minc describes the role of market systems as following (2006):

Typically, market systems are seen as supporting increasingly specialized production in both agrarian and craft sectors by mobilizing resources directly from producers, and enabling households to provision themselves with needed items. Further, market systems coordinate these activities both spatially and temporally, by concentrating exchange in a predictable time and location that allows participants to schedule.

More specifically then, the synthetic concept commercialization relates to the extent a price-making market allocates commodities and the factors of production; the interwovenness of institutions as credit, banking and money with society; and the prominence of entrepreneurial initiatives (Neale 1971 Smith 1976).

Archaeological evidence suggest that in all four civilizations trade started to play a more important role and most civilizations also experienced increasing levels of commercialization (Smith, 2004).The archaeologist Michael Hudson notes that classical antiquity was not the start of commercial practices (2004). Classical antiquity was influenced by commercial prototypes whose roots lay in Mesopotamia with its early monetary and commercial institutions (Hudson, 2004). Rather than being absent, commercialization appears to be one of the key dimension of variation in ancient civilizations (Smith, 2004). Though ancient Greece in and Rome stand out in relation to many early states, in the classification of the archaeologist Michael Smith (table 3.1) the Aztec and the Mesopotamians (red. Sumerian city-states) already had intermediate commercialization levels. In Shang China commercialization levels appeared to be still low and in ancient Egypt even absent.

Table 3.1: Classification of ancient state economies by commercialization and political system

TABLE 1 Classification of ancient state economies by commercialization and political system

	Political system			
Commercial level	**Weak states**	**City-States**	**Territorial states**	**Empires**
Uncommercialized			Egypt, Tiwanaku	Inka
Low commercialization	Angkor	Classic Maya	Shang, Great Zimbabwe	Teotihuacan
Intermediate commercialization	Indus	Sumerian, Mixtec, Aztec		Tarascan, Assyria, Vijayanagara
Advanced precapitalist commercialization		Old Assyrian, Swahili, Classical Greece		Rome

Source: Smith, 2004.

Even though commercialization is an indicator of increasing interregional trade flows and exports, this is not to say that Egypt and China did not experience an increase in trade with the rise of their civilizations. Whereas commercialization levels remained low, state-led trade did expand significantly (Trigger, 2003). Nevertheless, it is unlikely that exports played as big a role with respect to economic performance levels as in the Aztec and Mesopotamain city-state systems.

Lastly, processes of structural change are observed in all primary civilizations and as mentioned earlier in the subsection 3.1.2.2 about dual economy growth theory, these are important drivers of economic growth as well. Though out of necessity still between 70 and 90 percent of the labour input in early civilizations was devoted to food production, not all labour was situated in agriculture anymore (Trigger, 2003). As well as in highly commercialized as in uncommercialized state-controlled institutional settings, high levels of craft intensity tend to be found compared to earlier periods (Smith, 2004; Trigger, 2003). Hierarchies of craft workers evolved in all early civilizations. Additionally, agricultural activities themselves also underwent structural transformations. More complex segmentation of agricultural activities had as a result a greater division of labour which promoted the development of expertise and had a higher food production as a result (Fussell, 1966).

3.2.2 Indications of increasing societal economic performance levels in accordance with economic geography theory

The reason for why theory from economic geography can be seen as important for understanding economic performance in ancient economies is that it has developed several well articulated theories describing endogenous economic growth processes and their relation to space and spatial transformations. Of primary ancient civilizations it is known that they underwent significant spatial transformations since this is well archaeological observable (Trigger, 2003). Namely, the rise of these first state forms has in all parts of the world been accompanied by the coming into existence of networks of cities and therefore is also referred to as the “urban revolution” (LeGates, Stout, 2011; Trigger, 2003; Bairoch, 1988; Wilson, 1960). Since a city is an type/important form of an agglomeration economy (McCann, 2013), it is likely that agglomeration externalities have played an important role with respect to increasing societal economic performance levels.

The previously discussed central place theories set out the workings of endogenous spatial growth mechanisms and thereby provided insights in the mechanisms that probably have played an important role with respect to economic growth during the “urban revolution”. Additionally, in these theories the spatial formation of urban hierarchies is always accompanied by economic growth due to increasing spatial efficiency and increasing returns to scale. By concentrating a wide range of specialized functions in major centers, significant economies of scale have been achieved in primary civilizations as well (Trigger, 2003).

That the rise of primary civilizations was in all cases accompanied by the rise of city systems has already been made clear. However, significant differences can be observed between cities of different primary civilizations with respect to size, layout, and function (Trigger, 2003). In the case of large city-states (Aztec, Mesopotamia), capital cities appear to encircled by smaller secondary administrative centers which are again surrounded by tertiary centers (Trigger, 2003). The territorial states (Shang China, ancient Egypt) have a different urban structure with numerous centers in nested hierarchies. Larger cities are fewer in number but provided higher-level services for larger adjacent areas (Trigger, 2003).

With respect to urban population numbers, capitals of city-states on average ranged from a few to as many as fifty thousand with sometimes exceptions of population numbers of hundred thousand or more. Of primary civilizations with a city-state structure it is also known that a high proportion of the population tended to live in the main urban centers. In Mesopotamia, depending on the region, 70 to 80 percent of the people lived in towns or cities (Adams, 1981). For the Aztec civilization, in certain regions urban population ranged between 30 to 50 % of total regional population (Sanders, Parsons, Santly, 1979). Workers specializing in a particular craft regularly lived adjacent to another in the same part of the urban center (Trigger, 2003). However, approximately 75% of these city populations were farmers who farmed the surrounding countryside. Some of these farmers also worked on a part-time basis as craft specialists. The reason why these full-time/part-time farmers lived in cities was the greater protection these urban centers offered in times of intercity conflict. Exemplary of this is that in Mesopotamia in the Early Dynastic period rural population increased however that when the Amorite invasions started around 2000 B.C. their villages were abandoned again (Postgate, 1992). Overall, when the urban centers of city-states housed more than 15 percent of the civilizations total population, there must have been some full-time farmers living in these cities (Trigger, 2003). As for territorial states, urban population numbers tended to be more modest in size. Since the state as a whole was protected by the government against armed attacks, farmers preferred out of practicality to live closer to their fields. The urban centers then were almost exclusively inhabited by the ruling class, administrators, craft specialists, and their servants (Trigger, 2003).

The three main characteristics of agglomeration economies, namely knowledge spillovers, local non-traded inputs, and a local skilled labor pool, enable producers in the cluster to achieve increasing returns to scale. Since the previously mentioned literate indicates that significant agglomeration economies started to develop in primary civilizations, these theories from economic geography give a solid theoretical foundation for the assumption that economic growth took place as a result or in accordance with the urban revolution. Even though part of the urban inhabitants are likely to have been still full-time/part-time farmers, an increasing amount of the population started working as craftsmen and lived in adjacent parts of urban centers.

3.2.3 The interrelatedness of individual and societal economic performance in primary civilizations

As subsection 3.1.3 on international relations and political demography showed, a higher or lower fertility rate can be desirable for individual wellbeing depending on the political situation. In times of conflict, a high fertility might contribute more to individual wellbeing through increasing political power and safety. In this case, societal economic performance might rise while at the same time individual economic performance levels remain the same or even decline. In stable times, however, a low fertility rates could contribute more to individual wellbeing by increasing food and non-food consumption per capita. As a result, individual economic performance rises while the effect on societal economic performance is more uncertain (e.g. can decline, remain stable, or increase). In addition, literature suggests that depending on time and place humans had a certain control with respect to steering the fertility rate (Goldstone, 2012).

Having a certain control on the fertility rate also appears to be the case in three of the studied primary civilizations. Unfortunately, for Shang China, no data is available (Trigger, 2003). For each of the other civilizations, a prolonged nursing of infants is reported: approximately two to four years in the Aztec empire (Clendinnen, 1991; L'opez Austin, 1988), and around three years in ancient Egypt (Robins, 1993) and Mesopotamia (Harris, 1975). Thus, most mothers in primary civilizations have breast-fed their offspring longer than necessary with birth-spacing as a result since sexual intercourse was avoided by women while nursing (Trigger, 2003). Additionally, in the case of Mesopotamia certain stories about their gods reflect the belief that increasing population numbers could pose a threat to the stability of their society (Postgate, 1992). This suggests that population increase in these civilizations has likely been not as rapid as is generally thought or as potentially possible. Also, the ability to limit population growth to a certain extent indicates that individual economic wellbeing could have fluctuated instead of being constantly in a phase of bar subsistence.

In addition, there is also evidence for primary civilizations that controls on reproduction were relaxed quickly and for short periods in times of political competition and warfare (Warrick, 1990; Trigger, 2003). To quote the archaeologist Bruce Trigger (2003):

Perhaps the most important incentives for population increase, however, were political competition and warfare. Where such competition occurred, greater numbers meant more security. Under these circumstances, families, communities, and whole societies may have been anxious to outnumber their competitors even if feeding more people required investing greater effort in producing food.

The elite appeared to stimulate population growth in order to expand their tax base and increase the supply of soldiers (Trigger, 2003). There are indications that the elite desired population growth also in more stable political times, but that this could conflict with the reproductive constraint implemented by the rest of the population (Trigger, 2003).

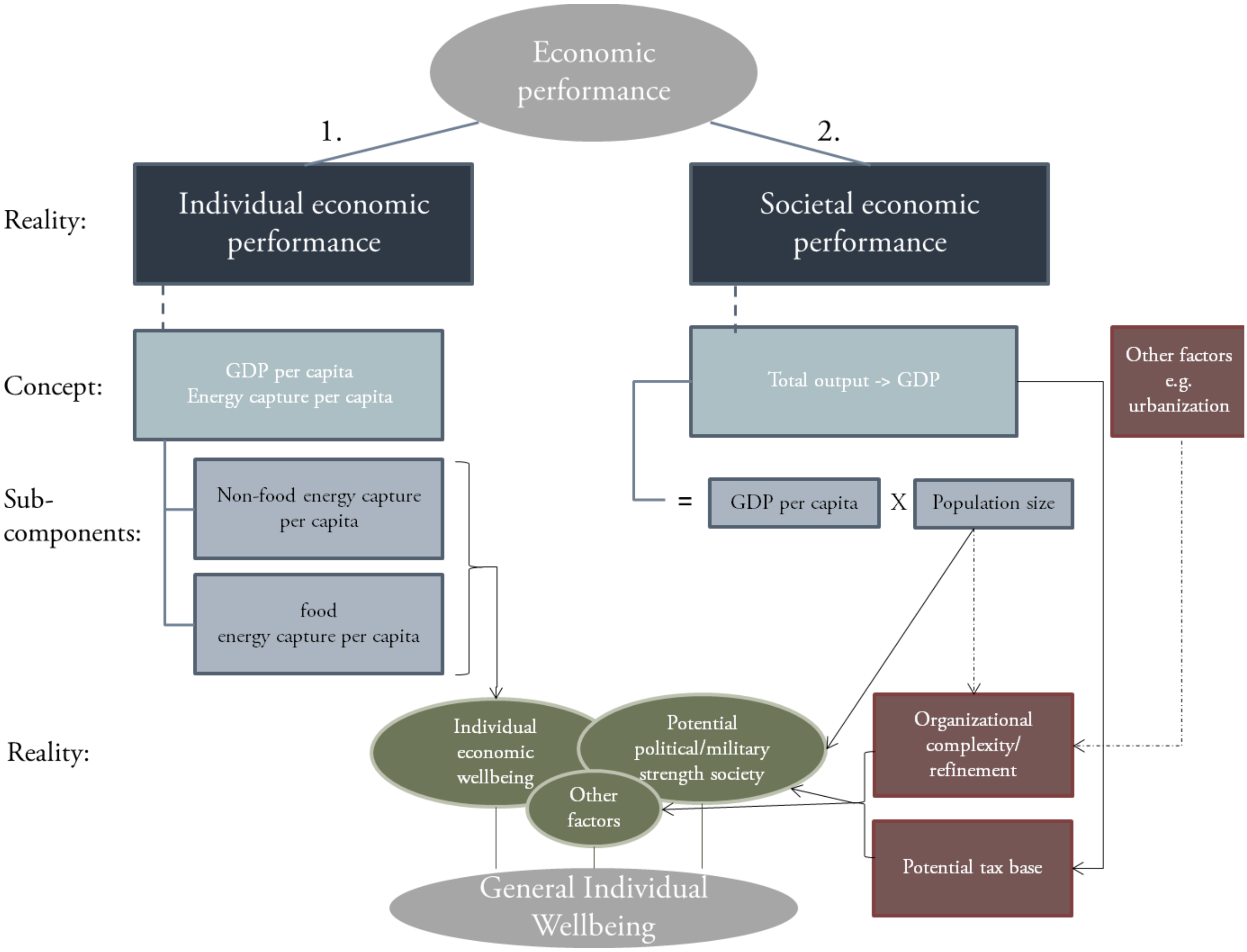
3.3 Conceptual framework

The previous literature review section combined theory from economics, economic geography, international relations and political demography with literature from archaeology to build a case about the likelihood that significant economic growth processes took place accompanying the rise of primary civilizations. These several strands of theory in addition with archaeological literature each underline that significant economic growth processes must have taken place during the "Urban revolution" of each of these civilizations. The aim of this section is then to build two conceptual frameworks which can be used in the subsequent chapter to operationalize the measurement of economic performance in primary civilizations.

The first conceptual framework reflects the nature of economic performance and the second framework links this conceptualization of performance to its drivers/inhibitors. The previously discussed theory from political demography and economic performance theory based on archaeological data is used to form the first conceptual framework since both strands of research convey concepts that probably better reflect performance processes in primary civilizations than mainstream economic theory. The second framework is based on an amalgam of the previously discussed theory and displays the meaning and function of economic performance in relation to other facets of the economy. Both a clear understanding of the nature of economic performance and its linkages to other economic concepts is needed in order for the systematic temporal and spatial comparative analysis that will be conducted.

As shown in the first framework, economic performance comprises out of two main dimensions: Individual economic performance and societal economic performance. This distinction is based on theory and literature from political demography and international relations which indicate that each contributes in a different way to general individual wellbeing and are not just the inevitable outcomes of the process known under the header 'Malthusian trap' but can to a certain extent be influenced by societies and individuals themselves. In economics, the term 'extensive growth' is applied to denote only aggregate output growth whereas 'intensive' growth reflects per capita output growth (Manning, Morris, 2005). However, these concepts would be to narrow again since this thesis does not focus on growth per see but also on decline of performance levels.

Figure 3.20: Conceptual framework 1, the nature of economic performance and its relation to general individual wellbeing



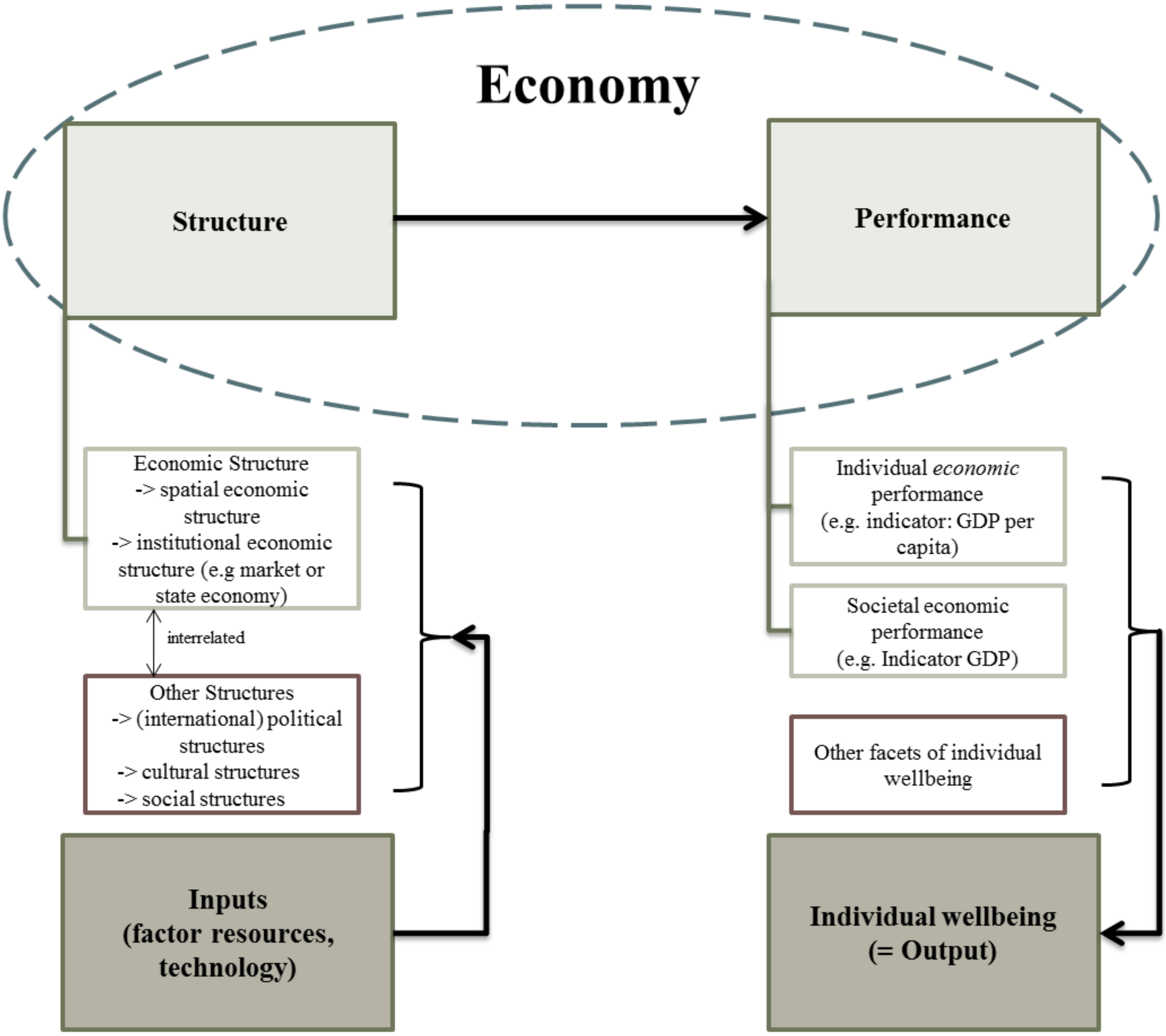
What this framework also displays is how these dimensions of economic performance are generally translated into the well-known economic concepts 'GDP per capita' and 'GDP'. However, as economic performance theory based on archaeological data indicated (subsection 3.2.5), the distinction between food- and non-food output per capita becomes uttermost important in order to understand economic performance processes in pre-industrial times. Therefore, in the framework these sub-components are added. These sub-components are then linked to general individual wellbeing. They affect general individual wellbeing through the material, economic component of wellbeing. The three facets of general individual wellbeing are displayed as overlapping since they are not mutually exclusive and the boundaries between them can sometimes be rather blurry. For example, non-food energy capture per capita might rise due to an average increase in housewares per capita but also due to a heightened amount of weapons per capita. In the second case, the potential military strength of a society can increase as well.

However, as the theory and literature in the previous sections showed, total output, population size and organizational complexity are most important with respect to the potential political/military strength in primary civilizations and are therefore directly linked to this facet of general individual wellbeing. Sub-components of societal economic performance thus influence general individual wellbeing by mainly influencing the safety aspect through political/military power of the respective society. As indicated before, the higher the total output, the higher the potential tax base and therefore the higher the absolute means that can be invested into political or military purposes. However, the tax base can also be used to invest in other factors that relate to general individual wellbeing (e.g. educational, health related investments). Therefore is the box 'potential tax base' in figure 3.20 also linked to the 'other factors' facet of general individual wellbeing.

The population sub-component of societal economic performance is linked in two manners to the 'potential political/military strength' facet of general individual wellbeing. The first link is intuitive: the larger the population, the larger the amount of potential soldiers. Especially in times that capital cannot or only limited replace humans in war as is the case in primary civilizations, population size might have been one of the decisive variables in predicting the outcomes of wars (Goldstone, Kaufmann, Toft, 2012; Trigger, 2003). In addition, as has been shown in the literature review, population size of a respective society is also strongly related to its organizational complexity (Carballo, 2013). The organizational complexity influences again the efficiency with which the tax base can be used. Therefore, population size also indirectly contributes to the facets 'other factors' and 'potential political/military strength'. However, important to note is that organizational complexity is not determined by population size alone. The spatial distribution of the population also influences the organizational complexity to a large extent with processes as urbanization increasing complexity levels through agglomeration advantages (Modelski, 2003). Therefore, the dark red box 'other factors, e.g. urbanization' is added and linked to the 'organizational complexity' box. What the framework overall shows is that, besides by individual economic performance levels, general individual wellbeing can also be served by increasing societal economic performance and organizational complexity levels. However, this might in some cases be at the cost of individual economic performance levels and thus the individual material wellbeing facet of general individual wellbeing.

The second framework links this conceptualization of performance of conceptual framework 1 to its drivers/inhibitors. By doing so, the meaning and function of economic performance in relation to other facets of the economy are displayed.

Figure 3.21: Conceptual framework 2, the meaning and function of economic performance in relation to other facets of the economy



The terminology of Douglass North is adopted, who explicitly makes the distinction between economic performance and economic structure. With performance is meant "how much is produced" and with structure "those characteristics of society which we believe to be the basic determinants of performance" (North, 1981). Structure and performance are displayed as the two main characteristics of an economy in general. Furthermore, structure is displayed as driving performance of a certain economy. The inputs of production (factor resources, technology) which can be seen as the proximate sources of economic performance are imbedded in both economic structures (spatial and institutional) and other structures (political, cultural and social) through which they determine economic performance levels. Though it is beyond the scope of this research to determine the ultimate and proximate sources of economic performance levels in primary civilizations, this framework gives a conceptualization of the nature of an economy independent of time and place. Most importantly, it places the role of economic performance levels in a broader perspective and thereby enhances the understanding of this concept.

CHAPTER IV: Research Design

4.1 Type of research

As already set out in the previous chapter, research about societal economic performance (e.g. aggregate output) of primary civilizations is practically nonexistent. Even though demographic data distinguished by urban and rural population is suited for estimating the *baseline* of total aggregated output, no such research has been conducted yet over longer time spans and in a comparative fashion for primary civilizations. One of the reasons might be, as noted by the archaeologist Bruce Trigger, the trend in archaeology of a declining interest in the comparative study of early civilizations, especially in a systematic, statistical way (2003). If comparisons are made, these focus mostly on cultural aspects or economic structure but not on performance (Trigger, 2003). Additionally, the variegated group of social scientists that use archaeological data focus on 'individual' economic performance as is currently the trend in the broader science of economics and thereby leave the topic of societal economic performance aside.

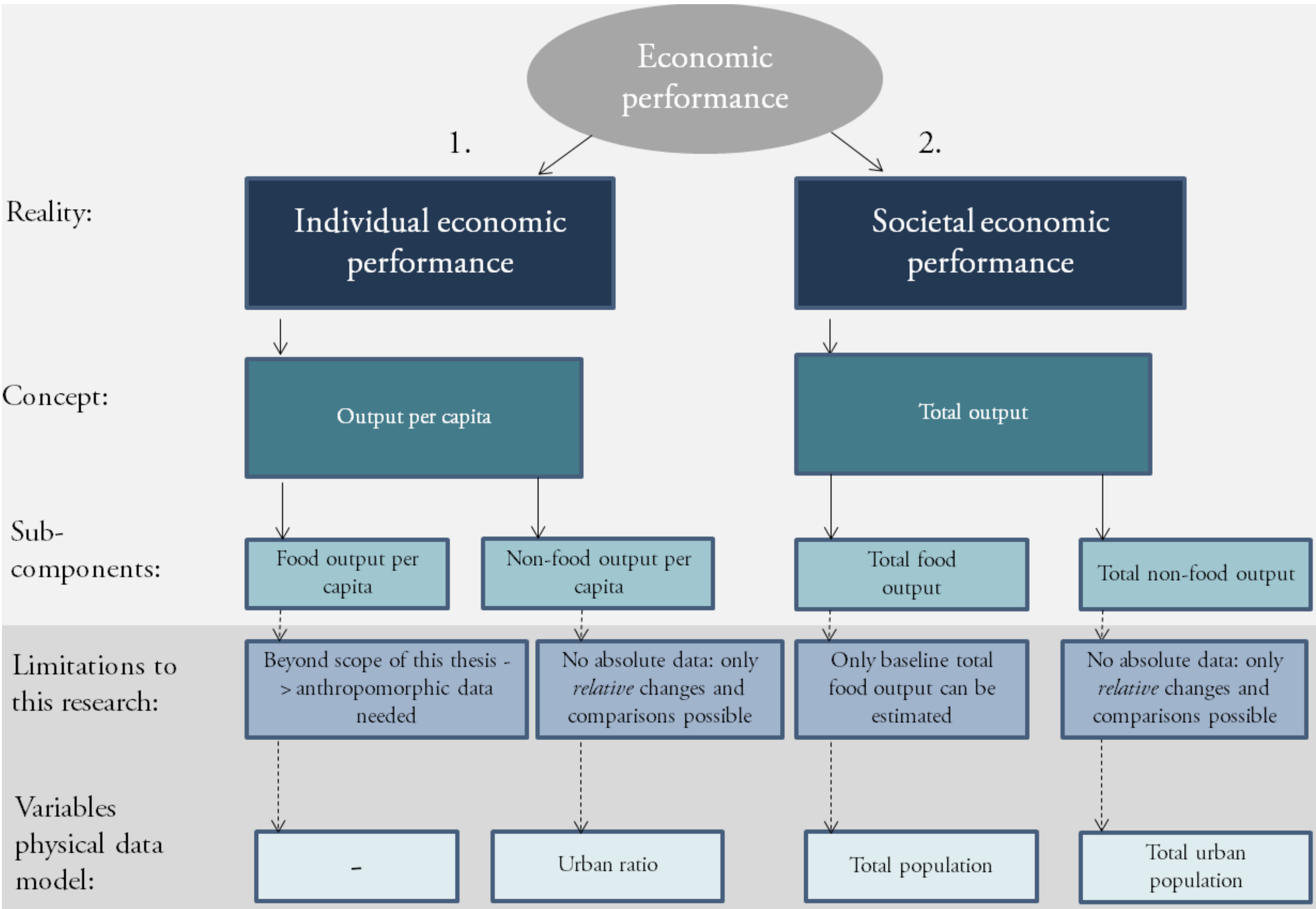
As a result, the research for this master thesis is exploratory in nature since it comprises a relatively new area of study. Methods of data collection and analysis are 'borrowed' from several disciplines. One of the accompanying outcomes of exploratory research is that its tests the feasibility of conducting more extensive research on the particular topic. The feasibility of future research on this topic is discussed in the concluding chapter.

A second main characteristic of the research is that it is quantitatively oriented. The economic historian Angus Madison describes the additional merits that quantitative research can have, despite difficulties with data retrieval and quality, as that it enables scholars to compare economic performance and wellbeing across time and space in a more direct way. Additionally, quantified data is more easily contested and thereby intensifies and sparks scholarly discussions enhancing the dynamics of the research process (Maddison, 2006). Furthermore, it can be added that it opens up the possibility of the usage of statistical analyses which can range from simple averages to complex models (Babbie, 2010). This is not to say that quantitative research is superior in general in the social sciences or any more objective than qualitative research with respect to studying the economy. Potentially arbitrary distinctions must always be made (Morris, 2005). However, for the topic of economic performance it is the most appropriate approach when quantifiable data is available since it forces one to be explicit and to formulate reasons for choosing one option rather than another (Morris, 2005).

4.2 Definition and operationalization of concepts

An important next step in order to be able to conduct the analysis in the next chapter is to operationalize the concepts mentioned in the aforementioned chapters. Figure 4.1 shows the subsequent steps that are taken in order to reflect economic performance reality in primary civilizations as closely as possible with the currently available data.

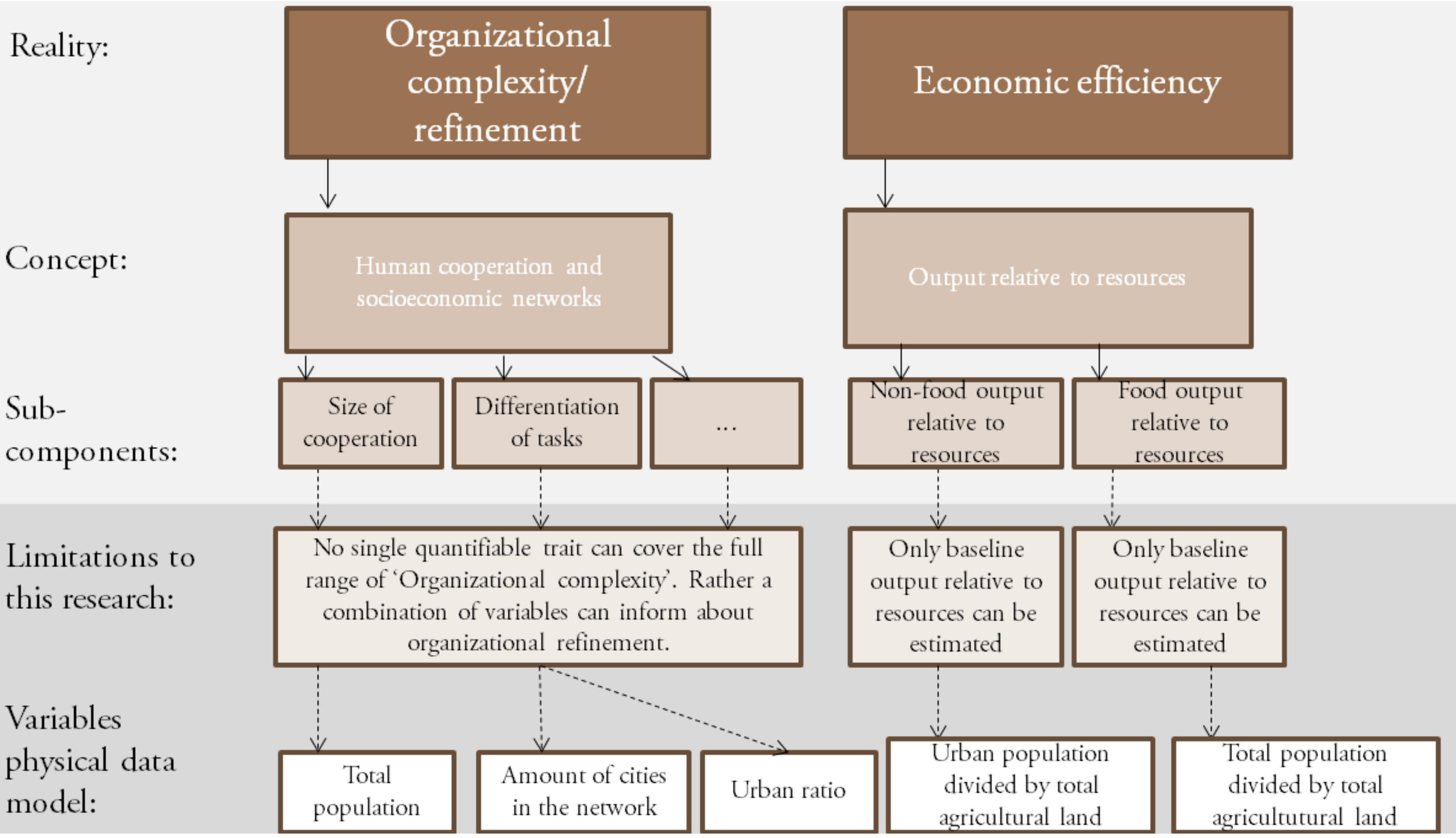
Figure 4.1: Operationalization of economic performance concept



The light grey upper part of the figure shows the economic performance concepts that have been defined and discussed in the previous chapter. In this section, the variables of the physical data model will be defined and discussed. These are shown in the dark grey lower part of the figure. The variables of the physical data model are chosen based on the criterion to reflect as closely as possible the concepts with its associated subcomponents that have been formed in the previous chapter. However, due to the data availability and quality it is important to discuss the limitations of these variables carefully: it is important to underline what they do ***not*** tell as well as what they do tell or might tell.

Though the main focus of this thesis is to research and compare societal economic performance levels, part of the operational variables formed for this analysis also reveal insights with respect to non-food output per capita, economic efficiency, and organizational complexity. Therefore, these results will be discussed as well though less extensively. Figure 4.2 shows the steps from reality to operational variables for the terms economic efficiency and organizational complexity.

Figure 4.2: Operationalization of organization complexity and economic efficiency concepts



4.2.1 Linkages between concepts and operational variables with respect to economic performance

As for both sub-components of societal economic performance there are certain limitations as depicted in figure 4.1. The sub-component 'total food output' can with the available data most closely be represented by the variable 'total population'. However, rather as representing total food output as a whole it actually indicates the *baseline* of total food output when certain assumptions are made. The following formulas demonstrate this and show the relation between total food output and total population:

$$\textit{Total food output (calories)} = \textit{food per capita (calories)} \times \textit{total population}$$

Additionally, several assumptions are made:

1. Food per capita is in all civilizations the same.

2. Food per capita is set to the 'bare bone consumption basket' equaling the minimum amount of calories needed for survival (Allen, Bassino, Ma, Moll-Murata, Van Zanden, 2011).

With these assumptions in place the formula becomes:

$$\textit{Total food output}_{\textit{baseline}} = \textit{Total population}$$

Since food per capita is for all civilizations set the same, it is excluded from this formula. Including it would express 'Total food output $_{\text{baseline}}$' in calories, however that would not change the relative position of the several civilizations but only make the numbers much larger which might be at the cost of interpretation. Therefore 'Total food output $_{\text{baseline}}$' is expressed and compared in the unit 'population number'. The variable 'total population' also logically fits as an indicator for the total production of food: food has been produced to feed the population, and though of course a part of it might have been lost due to an inefficient supply chain, the main part of the production ended up literally in the bodies of people.

The two assumptions needed to be made since no data is available about the average amount of food per citizen for each of the civilizations for each time period. Though the idea that food per capita was constant and near subsistence throughout pre-history (Clark, 2007) has been disproved (Jongman, 2014; Smith, Feinman, Drennan, Earle and Morris, 2012) exact estimations of food per capita in primary civilizations are still absent and are rather expressed nominally as 'having potentially more /less food in a certain period and place'. Additionally this measure does not give insights with respect to the average quality and the variety of the diet at certain place and time.

With the absence of this data, the comparison of primary civilizations is automatically reduced to comparing baselines of total food output. A consequence might be that for example it becomes concluded that one civilizations has twice as high a total food output compared to another civilization while in reality that other civilization has a twice as high food per capita level and thus actually equals that other society with respect to total food output. However, such big differences between early civilizations in food per capita are very unlikely to occur since food per capita was still largely restraint in preindustrial times while non-food per capita to a much lesser extent (Cook, 1971). Therefore, the baseline of total food output is likely to represent quite accurately relative differences in total food output for different civilizations and only when the baselines of two civilizations are very close, differences in food per capita might play a decisive role in determining which civilization had a higher total food output.

The second sub-component 'total non-food output' of societal economic performance is represented by the operational variable 'total urban population'. However, as was also the case with concept-variable translation in the previous paragraph, instead of representing total non-food output as a whole the variable 'total urban population' actually rather is an indication of the *baseline* of total non-food output when certain assumptions are made. The following formulas show the relation between 'total urban population' and 'total non-food output':

$$\textit{Total non-food output (monetary unit)} = \textit{Total population} \times \textit{non-food production}_{\textit{per capita}}\textit{(monetary unit)}$$

Which can be re-written as:

$$\textit{Total non-food output (monetary unit)} = \textit{Urban population} \times \textit{non-food production}_{\textit{per urban capita}}\textit{(monetary unit)} + \textit{Rural population} \times \textit{non-food production}_{\textit{per rural capita}}\textit{(monetary unit)}$$

However, since non-food production per capita for society as a whole is unknown for each of the primary civilizations, the research is again restricted to estimating a baseline. Since total urban population of each primary civilization is approximately known, this data is used to construct the baseline for total non-food output. It can be assumed that this is a baseline since the rural population also produced non-food output. In their spare time, many farmers manufactured clothing, sandals, furniture, tools, baskets, and ornaments either for themselves or to trade them with others (Trigger, 2003). The larger scale part-time specialization of farmers that took place in primary civilizations required broader exchange networks with villages, towns, and cities functioning as hubs. Therefore, rather than producing the bulk of non-food output, cities can be seen as 'the tip of the iceberg' in which the top of the craft hierarchy settled who on a full-time basis produced goods of high quality for the state or elite groups (Trigger). Overall, what an expansion of urban ratios *does* indicate is that the non-agricultural component of economic activity is increasing (Maddison, 2006; Van Zanden, 2001). Therefore, comparing total non-food production of cities for each of the civilizations might still hint at the rank and relative differences between civilizations with respect to 'total non-food output'. Transforming the previous formula to a formula for the baseline of total non-food output gives the following:

$$\textit{Total non-food output}_{\textit{baseline}}\textit{ (monetary unit)} = \textit{Total urban population} \times \textit{urban craftsmen (percentage)} \times \textit{urban craft production}_{\textit{per urban craftsman}}\textit{ (monetary unit)}$$

Again, due to data limitations certain additional assumptions have to be made:

1. The first assumption is that the percentage of urban population working as full-time craftsmen is the same in each of the four civilizations. Though we know this is not true, especially in the case of city-states where part of the inhabitants are full-time/part-time farmer (Trigger, 2003), exact numbers for each time period and each city are not available. However, the actual bias

might be limited since in city-states also a larger part of the rural population was actually involved in craft production for urban markets than in territorial states due to a higher overall level of commercialization (Smith, 2004). These two opposing facts might partially cancel each other out.

2. Average urban craft production per urban craftsman is across primary civilizations the same. This assumption is made since no knowledge is available about the average craft production per urban craftsman for each of the civilizations. It is known that urban craftsman in 'territorial state' primary civilizations produced higher quality goods while in city-state civilizations craftsmen produced per capita more goods (Trigger, 2003). However, it is unknown whether these differences would cancel each other out if their production per capita would be expressed in some monetary unit.

With these assumptions in place the formula becomes:

$$\textit{Total non-food output}_{baseline} = \textit{Urban population}$$

This final formula no longer expresses total non-food output for each time frame and each civilization in monetary units since the factor '*urban craft production*$_{per\ urban\ craftsman}$ *(monetary unit)'* has been excluded due to a lack of data. One of the main limitations is thus that this baseline for total non-food output only reflects *relative* economic performance levels with respect to non-food output but gives no *absolute* indication of the minimum value of what has been produced by primary civilizations. For the 'total food output' component of societal economic performance this was still possible since multiplying total population with the amount of calories prescribed in 'the bare bone basket measure' would express the baseline of total food output in calories. Even though this is not possible for the 'non-food' output component, there are still several things the indicator 'total urban population' does tell. Even though the indicator rather reflects the top of the iceberg with respect to total non-food output, it can still be used to predict the rank of each civilization for each time period with respect to total non-food output. Additionally, relative differences in urban populations between time frames and/or civilizations might reflect relative differences in total non-food output.

Actually the same story holds for the formation of the variable for the sub-component 'non-food output per capita. Since it equals 'total non-food output' divided by 'total population', the same limitations hold as described in the previous paragraph: Only a baseline estimate can be made in interval measurement.

Thus, there is not an absolute zero that is meaningful as in ratio measurement. The following formula reflects the steps in which it is showed that with the limitations in place the variable 'urban ratio' is an indicator of the baseline of 'Non-food output per capita' on an interval scale.

$$\textit{Non-food output}_{per\ capita} = \textit{Total non-food output / Total population}$$
$$\textit{Non-food output}_{per\ capita,\ baseline} = \textit{Urban population / Total population}$$
$$= \textit{Urban ratio}$$

4.2.2 Linkages between organizational complexity and the operational variables

Part of the previously formed operational variables or data needed to form these variables can also reveal insights with respect to organizational complexity of the respective civilizations. Since these variables and associated data are already available, they will shortly be discussed in the 'Analysis and results' chapter though not extensively and mainly with the intend that it might spark further research with respect to organizational complexity levels of primary civilizations. Figure 4.2 shows that organizational complexity can be seen in the broader comparative context of human cooperation and socioeconomic networks (Carballo, 2013). Since no single quantifiable trait can cover the full range of the concept of organizational complexity, rather a combination of variables can inform about organizational refinement. The variable 'total population' is used as an indicator to determine the approximate size of cooperation of a human group whereas the variables 'urban ratio' and 'amount of cities in the network' might signal the extent of differentiation of tasks within the group. Especially increasing urban ratios, also known as the process of urbanization, denote the state of community formation by showing the transition to communities of substantial size and thus with a higher degree of organization (Modelski, 2003). Higher levels of each of these indicators can signal increasing levels of organizational complexity.

4.2.3 Linkages between economic efficiency and the operational variables

When dividing 'total non-food output' or 'total food-output' by the amount of available natural resources, insights are gained with respect to the efficiency levels of resource use of the civilizations. However, this analysis does not tell whether increases in efficiency levels are due to technological, organizational, or any other type of advancement, and further research would be needed to determine the main causes. Most of the variables needed for this analysis have already been constructed in the previous subsections. The only additional variable needed is a variable that reflects the available natural resources to a civilization. Since in primary civilizations arable land was the most important factor of production in addition to labor (Kremer, 1993; Trigger, 2003), this indicator will be used to represent the available natural resources of a society.

For the operational variables 'food output relative to resources' and 'non-food output relative to resources' basically the same limitations still hold as for 'Total food output' and ' Total non-food output'. Only the baselines for 'food output relative to resources' and 'non-food output relative to resources' can be estimated, and in the case of 'non-food output relative to resources' it can only be measured on an interval scale. Overall, what these two indicators can be used for is to compare the baseline of food- and non-food output per standardized unit of the most important resource of each of the primary civilizations, namely, arable land. In a way, these indicators denote the efficiency by which the civilizations used their most important resource and as a result might reflect differences in technological/organizational advancement.

4.3 Working definitions of the operational variables

For constructing the data for each of the operational variables, clear working definitions are necessary. In the words of the archaeologists Feinman and Garraty this is the challenge to "develop working definitions that neither stultify research nor become the central focus of academic discussion and that encourage analytical practice as well as dialogue across a range of disciplines" (2010). The formation of the operational variables requests data on total population, urban population, and arable land per civilization. In order to demarcate total population, urban population, available land, and arable land two concepts need to be defined more extensively:

1. Civilization
2. City

First of all, when aiming to determine the total population of a civilization and the arable land available to them , a clear definition is needed of what a civilization is, what the criteria are to be part of a certain civilization, and what defines its territorial size. The same holds true for determining urban population numbers for each of the civilizations. In order to decide which part of the total population was urban at a certain time and place, a definition is required of what a city is, and which people count as its inhabitants.

With respect to defining 'civilization', the definition of the political scientist David Wilkinson has been adopted who uses a transactional definition with a criterion of connectedness rather than uniformity for locating the spatiotemporal boundaries of an urbanized society (1995). With this criterion, cities whose people are interacting intensely, significantly, and continuously are seen as belonging to the same civilization. This can even be the case if their cultures are dissimilar and if interactions are from time to time hostile. Chosen is for this definition rather than the uniformity definition of civilization since it is more useful for identifying the areas that are economically integrated and that are part of a larger, even if oppositional, association. It acknowledges that peoples, groups and organizations which are in close touch with each other are thereby linked irrespective of cultural/political uniformity.

In the civilizations under study, political, cultural, and economic association regularly coincided (Trigger, 2003). Additionally, the archaeologist Bruce Trigger Each recognizes each of them as states whether comprising out of a city-state system or merely reflecting a territorial state. Though repeated cycles of political unity and disunity in each of the city- and territorial states occurred in the time periods under study, signs are there that cultural relatedness was more stable (Trigger, 2003).

Nevertheless, it should be noted though that inherent to the concept of civilization is a certain kind of “frustrating vagueness” which seems to be partly due to the fuzziness of the actual boundaries of civilizations, especially at the cultural level (Sanderson, Hall, 1995). Reconstructing who adhered to a certain civilization and what territory belonged to the civilization from archaeological evidence alone can be rather difficult and in some cases even impossible (Trigger, 2003). Since the borders of pre-industrial states tend to be fuzzy, and change often frequently (Scott, 1998), the estimated territorial areas of the different civilizations at different times can more be seen as a representation of a sphere of influence of a certain civilization. Population has been counted as part of total population if the population was living in the approximate territory of the civilization. Additionally, all the arable land within the approximate territory of the civilizations has been counted as available resource to that civilization.

The second concept that needs to be defined more clearly is that of the city. Much debate has already taken place on what cities are and what they are not. An influential demographic definition is that of Louis Wirth (1938) in which urbanism requires a high population size and density, coupled with social heterogeneity (Smith, Ur, Feinman, 2014). This definition focuses on the performance side of a place: If a place is above a certain criterion of population size and density it counts as a city.

However, a great obstacle for a generally accepted definition of a city based on performance appears to be to reach agreement on a set of indispensable criteria which can be applied across cultures and time periods (Blanton, 1976). The archaeologist Richard Blanton opts for a functional definition of a city since this approach avoids the necessity for discovering indispensable criteria, and instead focuses on the hierarchy of central places in a society (1976). He sees a city as “A manifestation of the growth of institutions capable of organizing vast regions into integrated systems”. The archaeologist Bruce Trigger hands a definition of the city that focuses even more on the function of a place and leaves criteria related to population size and density out. According to him, “The key defining feature of an urban center is that it performs specialized functions in relation to a broader hinterland (1972).” He sees definitions based on arbitrary quantitative divisions as bearing little relation to concepts used in early civilizations and not contributing to the understanding of urban phenomena.

Though it is true that cities, towns, and villages in reality are units of a continuum of size and function instead of adhering to structurally or functionally distinct entities, this does not render the setting of quantitative criteria for cities with respect to population size and density meaningless (Modelski, 2003). According to the political scientist George Modelski the advantage of setting a quantitative criterion is its simplicity, clarity, and selectivity, which makes it suitable for comparisons. Additionally, size is in most cases an important signal of the importance of a place with importance being again a functional criterion of a city. This is based on the assumption that a large population allows more specialization, and hence a greater degree of the division of labor which impacts again the capacity for institutional organization. Overall, it is a good but not unfailing predictor of importance and surely does not hold right across all cases, but as long no better information comes along Modelski opts for the usage of this operational criterion (Modelski, 2003).

The argument made by the archeologist Bruce Trigger that what is seen as a city differs per time frame and culture can to some extent be incorporated in setting the quantitative criterion. Modelski uses a different criterion for a city in different time frames (2003). In the literature that did survive from primary civilizations, settlements described as urban had in most cases a size in between 10.000 and 100.000 inhabitants. Though these settlements would be regarded as small by today's standards and would rank as small villages, Modelski marks them as cities since these places fulfilled functions in essence similar to places that today are seen as cities and they were also perceived as such by inhabitants at that time. In this thesis, this minimum threshold of 10.000 inhabitants will be adopted as well for marking places as cities. A place is also marked a city if it has been perceived as such by its inhabitants at that time even if total population is less than 10.000. However, only in a few cases this happened. Overall, the functional definition of Wheatley (1963) does not contradict with this criterion and is best suited as working definition of a city for this thesis. He sees cities as "nodes of concentration of people and shelters in the continuum of population distribution over the face of the earth. Such of these as attain a certain size and perform appropriate functions are designated by the terms appositely translated in English as 'city' or 'town'".

4.4 Data availability, quality and the associated methods of collection

A database for social scientific purposes with regard to measuring economic performance of primary civilizations in a comparative way does not exist yet. The historian Ian Morris did build a quantitative database with the intend to study historical processes in a social scientific way (2011). However, this database is different in the sense that it compares 'Western' civilization with 'Eastern' civilization and formulates the concept 'performance' in a different way. In his work, the score on performance is composed of different measures on the degree of civilization while I focuses purely on economic performance.

Another database that does exist related to historical data on performance is the History Database of the Global Environment also known as HYDE (Klein Goldewijk, Beusen, Janssen 2010). Unfortunately, just as with the previously mentioned database, the data cannot be used for the intend of this research. The HYDE database seems useful for this research since it provides time series of population and land use for the last 12.000 years. However, the estimates of population and land use are the result of modeling methods that use hindcasting techniques. Though this method might be useful for estimating world averages or averages for larger regions, it appears that the data does not accord closely with archaeological data that is available for population and land use of primary civilizations. This might not come as a surprise since primary civilizations were not the 'status quo' but special forms of human organization at those times which makes it characteristics hard to estimate with a general model. Therefore, the HYDE data is not used to fill up gaps if archaeological or historical data fell short.

Hence, a new database has been formed for this research project. The data needed has been brought together by conducting a thorough literature review. Though for most primary civilizations no written records of economic activities are available, their material remains can give us insights. New methodologies in archaeology resulted in increased resolution of modern detailed excavation and more extensive fields surveys in the field of settlement archaeology (Jongman, 2014). Especially field survey research has made contributions to economic analysis with respect to regional demography and agricultural systems (Smith, 2004). According to the economic historian Willem Jongman, ‘With the shift from cultural explanations to actual performance the use of archaeological proxies for classic variables like population or production and consumption is more relevant than ever’ (2014). Therefore, the conducted literature review was merely aimed at finding archaeological proxies for the constructing the data for the operational variables of interest.

4.4.1 Data availability

The first version of the database included information on seven primary civilizations. However due to the fact that for some primary civilizations data was largely non-existent for most of the period under study, in the end only those civilizations are included for which data was at least available for the most important variables and for most of the time. These civilizations are: Shang/Zhou China and subsequent periods, ancient Mesopotamia, the Aztec empire, and ancient Egypt. Data on the Yoruba, Inca and Maya civilizations are not included anymore since the data was scattered, largely absent, and more prone to measurement errors than data for the other civilizations. Additionally, the first version of the database contained anthropomorphic data which can be used to give insights into individual economic performance with respect to food-output. However, due to the large absence, scatteredness, and doubtful quality of the data, this part of the database has also not made it to the final version. It would simply take too much time and medical expertise to verify the anthropomorphic data.

The data that is included in the final database thus refers to four primary civilizations and lays at the basis of forming the operational variables ‘total population’, ‘urban population’, and ‘arable land’. The time span of the data over thousands of years is subdivided into periods of hundreds of years since for this time interval urban population data is available. With this time interval however, not for every civilization data could be collected for the variables “total population” and “arable land”. As a solution, a linear function is used to fill up the gaps. The function used is the same as the one applied in the HYDE database for extrapolating population and arable land numbers (Klein Goldewijk, Beusen, Janssen, 2010). To indicate the difference between a calculated and an archaeological estimate, the calculated values are indicated in the database with a different color.

If different data sources indicated different values for some variables at a particular point of time then they were all included, indicating the possible range in where the ‘true’ value might lie. However, if strong arguments were given by other authors against a certain estimate then this estimate was not used in the final analysis. The following table indicates for each of the operational variables and for each of the civilizations which sources have been found. It has to be stressed that this is presumable a limited overview of actual data that is available and has to be seen as a first exploration. The reason for this is that gathering this type of archaeological data is quite time consuming since in quite some archaeological research this type of data is not seen as a main outcome but as a side product which is useful for sketching the context. Therefore, terms related to 'population', 'urban population', and 'arable land' do often not appear in titles, subtitles or abstracts while the article or book might actually contain information with respect to the operational variables.

Table 4.1: Sources per civilization and operational variable

	Total population	*Urban population*	*Arable land*
Ancient China	McEvedy & Jones, 1978 Trigger, 2003	Modelski, 2003	McEvedy & Jones, 1978 Trigger, 2003
Aztec empire	Madisson, 2006 McEvedy & Jones, 1978 Cook & Borah, 1963 Rosenblat, 1945	Smith, 2005 Modelski, 2003	Trigger, 2003 Sanders, Parsons & Santley 1979
Ancient Egypt	McEvedy & Jones, 1978 Strouhall, 1992 Butzer, 1976 Nunn, 2002	Modelski, 2003	Nunn, 2002 Butzer, 1976 McEvedy & Jones, 1978
Mesopotamia	McEvedy & Jones, 1978 McC. Adams, 1981 Pollock, 1999	Modelski, 2003	McEvedy & Jones, 1978 McC. Adams, 1981

As can be seen in the table, two sources are displayed frequently: McEvedy & Jones (1978), and Modelski (2003). This is the case since the first authors wrote a summary work on world population in history and the second author wrote a book on the evolution of cities from 3000 B.C. to the present for which he assembled an extensive database with respect to urban population. Because both books play an important role with respect of data usage in this thesis, the quality of these sources will be discussed more extensively here. This is not to say however that these data sources are in all cases used as best estimates for the operational variables. In various instances, especially with respect to the 'McEvedy & Jones' source, other sources are deemed to have applied more appropriate methods or had better quality data on which their estimates have been based. In some cases, a composite time series has been made with the best estimates used for a particular civilization. When exactly which estimate of which source is used and for what reason will be described in the next chapter 'analysis and results'. The following paragraphs however will give a short overview of the general quality and issues of the main sources.

4.4.2 Data quality of two key publications and the associated methods of collection

The work of McEvedy & Jones (1978), though already several decades old, is one of the most used sources for population numbers in preindustrial times (Madisson, 2006; Sanderson, 1995; Klein Goldewijk, Beusen, Janssen, 2010). Though the data they used and calculated is far from perfect and some judge them rather speculative (Clark, 2007), they appear to represent the most detailed and best documented overview of what is currently available (Madisson, 2006). The historical sociologist Sanderson describes their data for ancient times as threshold population estimates that resemble minima and not ranges (1995). Therefore, their data is mainly suitable for identifying large leaps and collapses over bigger time spans but is not detailed enough to indicate smaller increases or declines over shorter time spans.

In the case of the primary civilizations under study this also holds true. As for Mesopotamia, only five data points for 'total population' are available for a period spanning 4000 years and are provided on the basis of urban and rural densities. For ancient Egypt as well five data points could be used for a period spanning 3000 years. These estimates were derived from archaeological research. In the case of ancient China five data points could be derived for a period spanning 3000 years which McEvedy & Jones based on Wolfram Eberhard's history of china (1967) and the census figure that has been preserved from the Han period in 2A.D.. As for the Aztec civilization, 2 estimates are given for a period spanning 1000 years that can be used for this thesis and these are based on average density figures when looked at cultural, economic, and archaeological evidence.

As can be seen, the data provide only a very broad sketch. Another issue with the McEvedy & Jones data is that, though they give the sources of their data, it is unclear by exactly which method and which assumptions an estimate is made. Additional research would be needed to find out for each source in what way population numbers are calculated. This would be a first step for being able to standardize the data and being sure that the systematic error part of the error term for each estimate is at least of the same size. In this way, relative differences for the operational variables between different time frames and civilizations still hold. However, due to the time intensiveness of this exercise it is beyond the scope of this research.

The second key publication that will be used for this research is the book by George Modelski named 'World cities: -3000 to 2000' in which he assembled an extensive database with respect to urban population numbers. The work represents a successful effort to re-examine and improve upon Tertius Chandler's (1987) estimates of city population numbers (Chase-Dunn, Pasciuti, 2004; Thompson, 2004). One of the main contributions of Modelski is that he fills in gaps in Chandler's ancient world database and adds in this way considerable depth to the coverage of the Bronze Age (Chase-Dunn, Pasciuti, 2004;Thompson, 2004). According to the comparative historical sociologists

Christopher Chase-Dunn and Daniël Pasciuti, it is the best comprehensive compilation of estimates of urban population numbers currently available and a huge step forward for scholars of urban and world history (2004).

Luckily, unlike McEvedy & Jones, Modelski did conduct a standardized methodology for making his estimates of urban population numbers in ancient times (Modelski, 2003; Taylor, 2012). He used as the principal source of relevant data knowledge of the extent of the relevant site. This information he could find in the work of archaeologists. Then he used the site-density formula as a method to form his estimates. Data about two basic elements is needed to apply this formula: an assessment of the areal extent of a urban site and a population density factor. The extent of the site is multiplied with the population density factor which then yields an estimate of the population for that site.

This approach can result in systematic errors when it ignores local conditions. Different localities and time frames might require a different population density factor (Modelski, 2003). As a result density estimates have ranged widely in specialist literature. Hence, even for the same city for the same point in time specialists often disagree about the density factor that should be applied. The mean for all these estimates in ancient times is around 350 inhabitants per urban hectare (Modelski, 2003), and to be save, Modelski applies a little more conservative estimate of 200 inhabitants per hectare (Thompson, 2004). He stresses that no especial significance should be attributed to the particular numbers that result from this procedure and in the appendix he gives the raw site data so that readers can make their own estimates. Though the method applied might not be the best to estimate absolute urban population numbers and estimates should not be seen as definitive, it is at the moment with the current data availability the best method for estimating relative differences in urban population numbers in different localities and different time frames (Taylor, 2012; Thompson, 2004).

In addition to this method, Modelski used a supplementary method: the rank-size rule. This method has been described in theory section 3.1.4 about economic geography. In the case of ancient economies, the possible value of this rank-size regularity captured in Zipf's law can be threefold. First of all, it can be used as a crosscheck for archaeological data to determine whether estimates are unusually large/small compared to what would be expected from Zipf's law (Modelski, 2003). Secondly, outcomes can tell something about the maturity of the spatial economic system and its degree of specialization/diversity. Lastly, the rank-size principle can be employed selectively to improve the estimate of , or in fact help predict, the population of individual cities. It is this last application of the rank-size rule that Modelski uses selectively. Two things need to be known before he deems it appropriate to use the method to fill in gaps or improve estimates: significant textual or archaeological evidence is needed to determine the rank-order, and secondly, there should be proof of log-normality which implies an integrated city system in which there is a movement away from primacy or dependency and toward less inequality, but not one of total equality (Modelski, 2003). In this way, he argues, he corrects to a certain extent for the "flat" estimates that are the result of his conservative estimate of urban population density. The portrayal of the world of cities as from time to time more peaked, he deems to reflect reality more accurately.

Two notes can be placed by this additional method Modelski uses. The first note he already makes himself: the Zipf conjecture about city sizes may not be working for instance for the world system as a whole. A second issue with Modelski's adoption of this method is that he does not indicate in his tables for which estimates he applied this method. He only mentions that he uses the method selectively. As a result, the reader is not able to see in one instance which estimates are purely based on archaeological data and which are modified by the rank-size rule method. Of course, Modelski gives the raw site data in the appendix and thus estimates solely based on archaeological can be made . However, this would be a time consuming task and beyond the time horizon of this masterthesis.

4.5 Methods of analysis

Whereas the collection and the verification of the quality of the data has been a daunting task, the application of the methods that are needed to transform the data into the required operational variables has been rather easy. As described earlier, not for every civilization data could be collected for the variables "total population" and "arable land" for each point in time. To fill up the gaps, a linear function is used which is the same as the one applied in the HYDE database for extrapolating population and arable land numbers (Klein Goldewijk, Beusen, Janssen, 2010). An assumption that underlies the justification of this method is that if there would have been a large swing in either 'total population' or 'arable land' this would have been archaeological observable. It should be stressed though that no especial significance should be attributed to the particular numbers that result from this procedure since it is based on data that is mainly suitable for identifying large leaps and collapses over bigger time spans but is not detailed enough to indicate smaller increases or declines over shorter time spans.

Once estimates have been filled in and constructed for each of the operational variables, for each civilization and for each point in time, mainly simple calculations have been applied ranging from computing averages, percentage changes and fractions. For example, aggregating the estimated city sizes per civilization gives an impression of the total urbanized population per civilization. As for the operational variables 'urban ratio' and the economic efficiency variables, estimates are calculated by using two types of data. Since both types of data have already its own uncertainties, combining them gives estimates with larger error margins. Therefore, these estimates have to be interpreted with care. Overall however, the calculations give a cross-cultural, longitudinal and comparative overview of economic performance in primary civilizations.

With respect to Ancient Egypt and Ancient China, data was detailed enough to apply an additional, more sophisticated method, namely a growth accounting exercise. Nevertheless, researching the relative contributions of growth of inputs with respect to growth in aggregate output poses several problems in earlier periods. Data is quite sparse with respect to the accumulation of physical and human capital. As a result, there are still some stringent assumptions in place with respect to these growth accounting exercises.

4.6 Issues & Ethics

The previous sections have shown that data for this kind of research is available and the potential is there to build even larger data sets. However, in the words of George Modelski (2003), 'That is not to say that the data collection is now in every sense complete an might not in future be supplemented by new information, but it is to maintain that every effort has been made to make it as reliable as is presently possible'. As he makes clear, these databases should be seen as continuing work in progress and by making them, though not perfect, at least it encourages researches to keep researching these issues and improve estimates. This also holds true for the database constructed for this thesis.

However, when working with data that is nearly always on the edge of being an 'estimate' and a 'guesstimate', it is tempting for researchers to portray their findings as more robust than they actually are and not to provide metadata so that colleagues can not crosscheck the data. The motivation behind this behavior might be the fear to be seen as a 'fantasist' who is only building houses of cards (e.g. placing weak assumption on weak assumption etc). However, Angus Maddison (2006) argues that even though the evidence on the more distant past is weaker, 'the exercise in quantification is not a product of fantasy. The strongest and most comprehensive evidence is that for population, and the population component is of greater proportionate importance in analysis of centuries when per capita income growth was exiguous'.

Hence, it is of uttermost importance that researchers are being honest about the assumptions they make and about the limitations of the data. Only then, data can to some extent be standardized and corrected for previously made assumptions. In this way, at least the error term in *relative* comparisons can be minimized and the systemization of the data collection and analysis would enhance one's ability to compare data and make inferences of relative changes in economic performance across time and space.

With the growing need for large data sets in social and historical science, cooperation among researchers has become more useful and necessary (De Moor, Van Zanden, 2008). According to De Moor and Van Zanden, 'an academic career is often not long enough to gather all the data necessary to support a hypothesis'. Though researchers are not always willing to share their data due to large time and labor investments, new initiatives are coming up to improve scholarly communication and cooperation (De Moor, Van Zanden, 2008).

CHAPTER V: Analysis & results

In the previous chapter the operational variables have been formed that are needed to investigate the various components of economic performance for primary civilizations. In the subsequent sections, each of these components will be analyzed. Emphasis lies on reconstructing societal economic performance levels. Hence, since the non-food component of individual economic performance could also be constructed from the data this delivered it has been included as well. The same story holds for the reconstruction of an index for organizational complexity and for estimating efficiency of resources use levels.

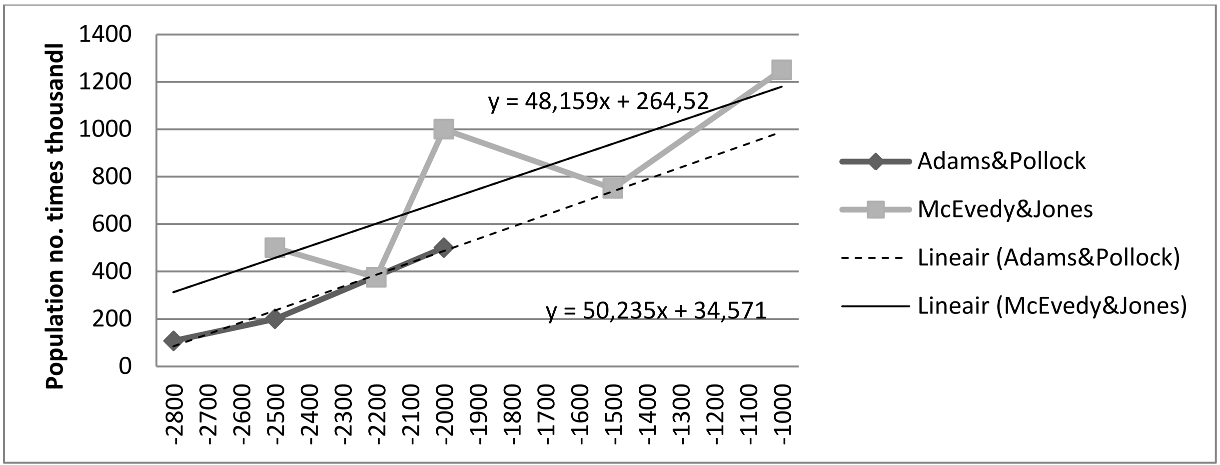
5.1 Societal economic performance levels: baselines of total food output

The following section analyses the data with respect to the total food output component of societal economic performance. The proxy variable ‘total population’ represents the baseline of the total amount of food produced by each civilization. However, before the different civilizations can be compared, it has to be decided which data sources delivered the best population estimates for different time periods for each civilization. In some cases, a composite time series has been made with the best estimates used for a particular civilization. When exactly which estimate of which source is used and for what reason will be described next. As for Mesopotamia, the Aztec empire, and Ancient Egypt, the availability of various sources has led to the construction of a time series displaying the lower boundary and a time series representing the upper boundary of the baseline of total food output. This is useful in order to determine the robustness of the results when different civilizations are compared.

5.1.1 Mesopotamia

Besides the McEvedy & Jones source, Trigger (2003) mentions the data of McC. Adams (1981) and Pollock (1999) as conservative estimates of total population and population densities in the Mesopotamian region. Their estimates do not refer to the nomad population living in the area and appear to focus on the territory that currently is known as Iraq. When a composite time series of the conservative estimates is compared with the estimates of McEvedy & Jones for the core Mesopotamian region, it appears that the main difference between the conservative estimates and McEvedy & Jones’ estimates lies in the intercept and not so much in the average growth pattern of total population. This is shown in the figure 5.1 below where trend lines are added for the different sources.

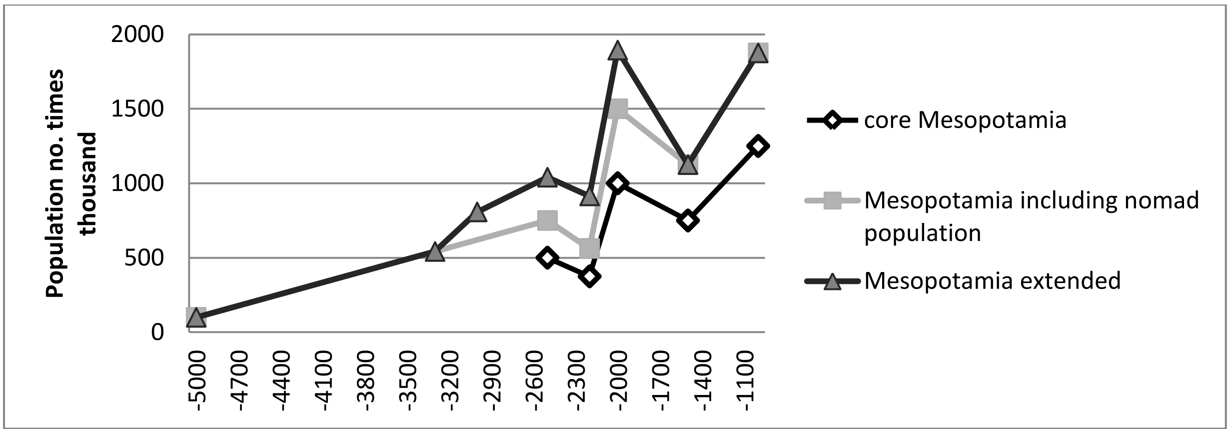
Figure 5.1 : Population estimates and trend lines for the core Mesopotamian region



As the figure shows, on average the conservative estimates have a population number that is 230.000 lower. Compared with differences in estimates for other civilizations this is relatively small. A second feature is that McEvedy & Jones have more estimates over a longer period with a higher sensitivity for population booms and collapses. Therefore, the McEvedy & Jones estimate for the core Mesopotamian region will be used in subsequent analyses as the *lower* boundary for the baseline of total food output. This time series is used as the lower boundary since it only displays population numbers for the core Mesopotamian region.

The upper boundary for the baseline of total food output for Mesopotamia is also formed on the basis of McEvedy & Jones data. In addition to data for the core Mesopotamian region, they also give data on the nomad population living in the region and population data on regions that in some periods could be seen as part of the Mesopotamian civilization. McEvedy & Jones refer to the Braidwood & Reed estimate in 2500 B.C. where they estimated the proportion of nomad population to be around one third (1957). This ratio is then in this research applied for the whole period of Mesopotamian civilization due to the absence of further estimates of the nomad population.

Figure 5.2: Time series for core Mesopotamia, Mesopotamia and nomads, and extended Mesopotamia

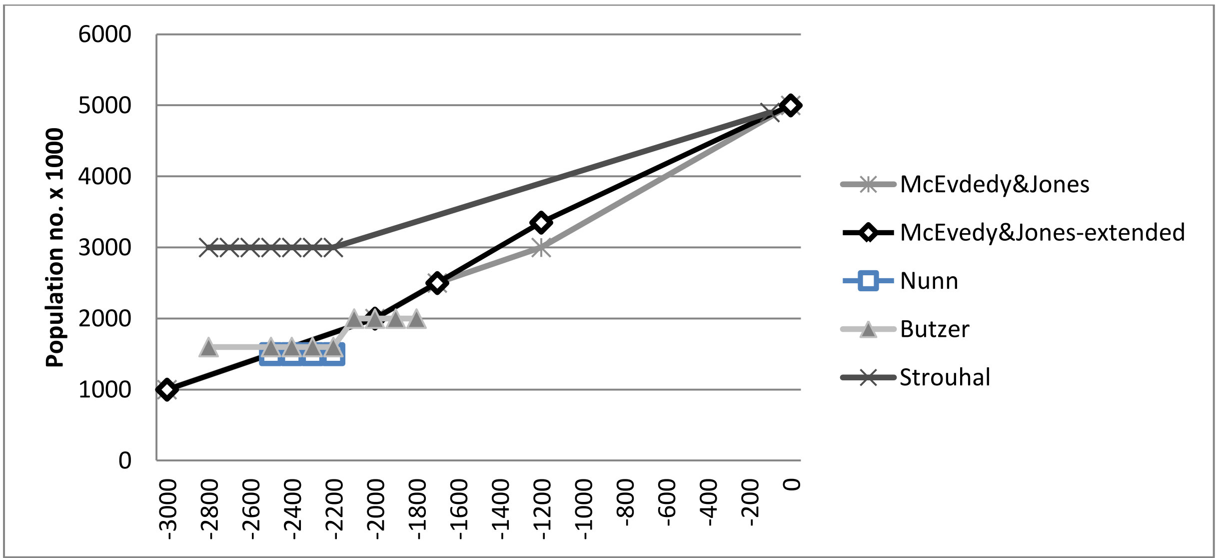


Since Trigger (2003) indicated that significant trade occurred between the nomad population living in the region and the urban/agrarian population, it seems appropriate to include the nomad population as part of the Mesopotamian civilization. In figure 5.2 a trend line is displayed which includes the nomad population. Additionally, since Mesopotamia in some time frames also extended into territories now known as being part of Syria it seems appropriate to include in these periods McEvedy & Jones population estimates for these areas. The third trendline ‘Mesopotamia extended’ adds the population numbers for these areas to the population numbers for the core of Mesopotamia and includes nomad population estimates as well. This third trendline can be seen as the upper boundary for the baseline of total food output for Mesopotamia. Hence at the same time, it might also be seen as potentially most accurate in displaying reality.

5.1.2 Ancient Egypt

As for ancient Egypt, several authors have published estimates with regard to population numbers. As can be seen in the figure, the estimates of Nunn (2002) and Butzer (1976) accord quite well with the estimates of McEvedy & Jones (1978). The estimates of Strouhal (1992) are compared to the other estimates quite high in the early period but are at the same level in the later period. Trigger (2003) sees Strouhal’s estimates for the early period as rather high but not as impossible. Therefore, Strouhal’s estimates will be seen as representing the upper boundary of the baseline of total food output for ancient Egypt. As for the lower boundary, the time series ‘McEvedy&Jones-extended’ will be used. This time series also included the population of regions that in some periods could be seen as part of ancient Egypt due to conquests (McEvedy & Jones, 1978).

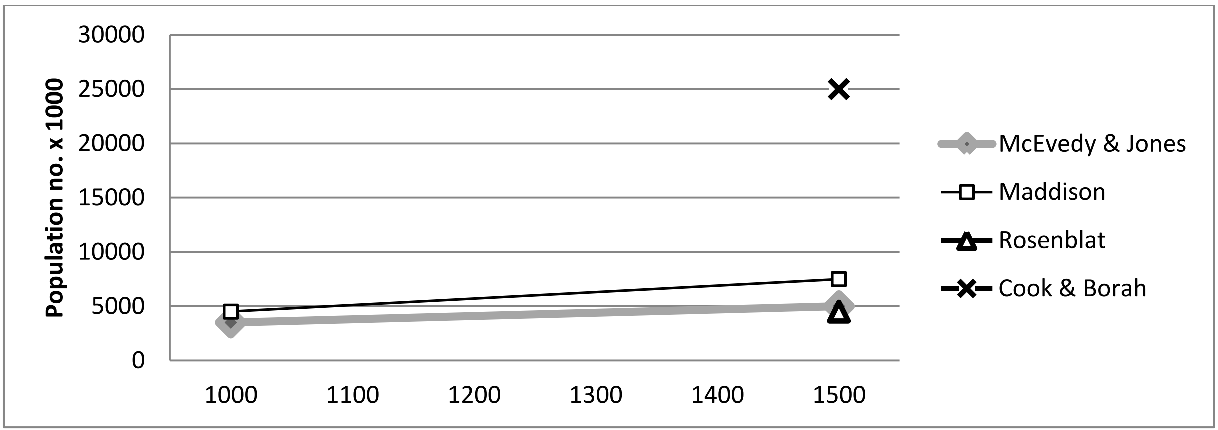
Figure 5.3: Time series based on estimates of different authors



5.1.3 Aztec empire

In the work of Angus Maddison (2006), several estimates of different authors for the total population of the Aztec empire are brought together. The estimate of Angel Rosenblat (1945) has been based on a careful survey of literary evidence and the assumption of a rather modest rate of depopulation after the Spanish conquest. The estimate of Cook & Borah (1963) is based on, in the words of Maddison (2006), 'ambiquous pictographs describing the incidence of Aztec fiscal levies'. Their estimate would imply a de-population rate of 95% after the Spanish conquest with population size only returning to its previous level in 1970 .This is also seen by other authors as very unlikely (McEvedy & Jones, 1978; Maddison, 2006).

Figure 5.4 : Time series based on estimates of different authors

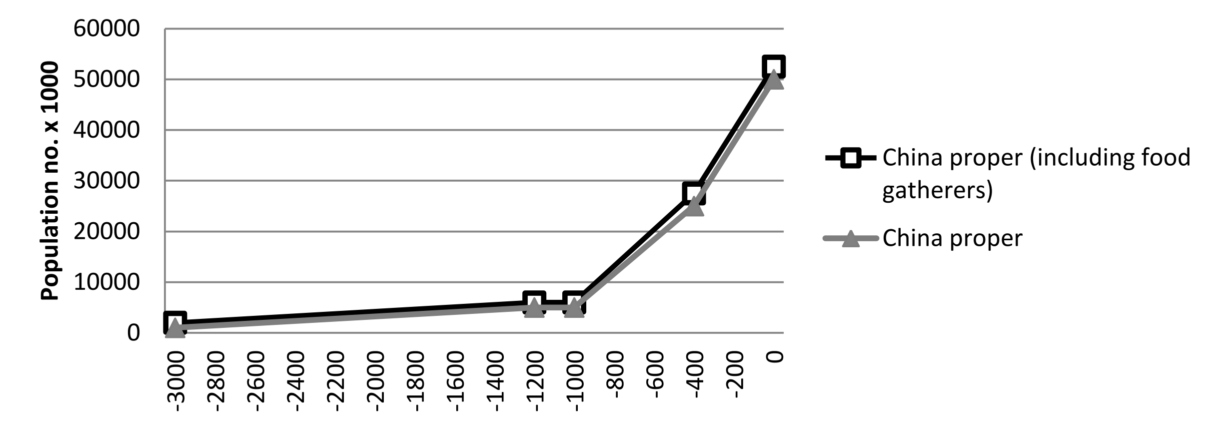


Therefore, the McEvedy & Jones estimates which accord with the Rosenblat estimate are taken as representing the lower boundary of the baseline of total food output of the Aztec empire. The time serie of Maddison is used for representing the upper boundary since he convincingly argues that the Rosenblat estimate is probably too low due to a underestimating of the de-population rate. Maddison bases his estimates on the range of 5-10 million for the year 1500 proposed by Zambardino (1980) by taking the midpoint of this estimate

5.1.4 Ancient China

Unfortunately, population estimates for ancient China are very rare. No data on population numbers is available for the Shang or Western Zhou period (Trigger, 2003). Only McEvedy & Jones provide data by which time series can be constructed. Their most reliable estimate is based on the earliest surviving census in the world for 2 A.D. which seems to imply a population density of forty to sixty persons per square kilometer on the central plain (Trigger, 2003). They also estimate the amount of hunter-gatherers in the territory of ancient China. By using these data, two time series are constructed: One including and one excluding hunter-gatherers.

Figure 5.5 : Time series based on estimates of different authors



5.1.5 Cross-comparisons of total food output

Now that for each civilization time series have been constructed and for most civilizations an upper and lower bound time series have been formed, cross-comparisons with respect to the baseline of total food output can be made. Two types of comparison will be made. First of all, comparisons are made along an 'interval time line'. This type of time line is most commonly used in the western world in which the birth of Christ two thousand years ago indicates the zero point. 'Time' in this respect can be seen as an interval variable since the difference between two values has a fixed quantifiable difference, while simultaneously there is no 'real' zero since the starting point is arbitrary. The interval time line has the advantage that it displays the chronological order of events and delivers insights in the course of world history. The following table gives an approximation of the 'starting point' of the urban revolution/state formation of each civilization along the interval time line (Trigger, 2003).

Table 5.1: Approximation of the 'starting point' of the urban revolution/state formation for each civilization

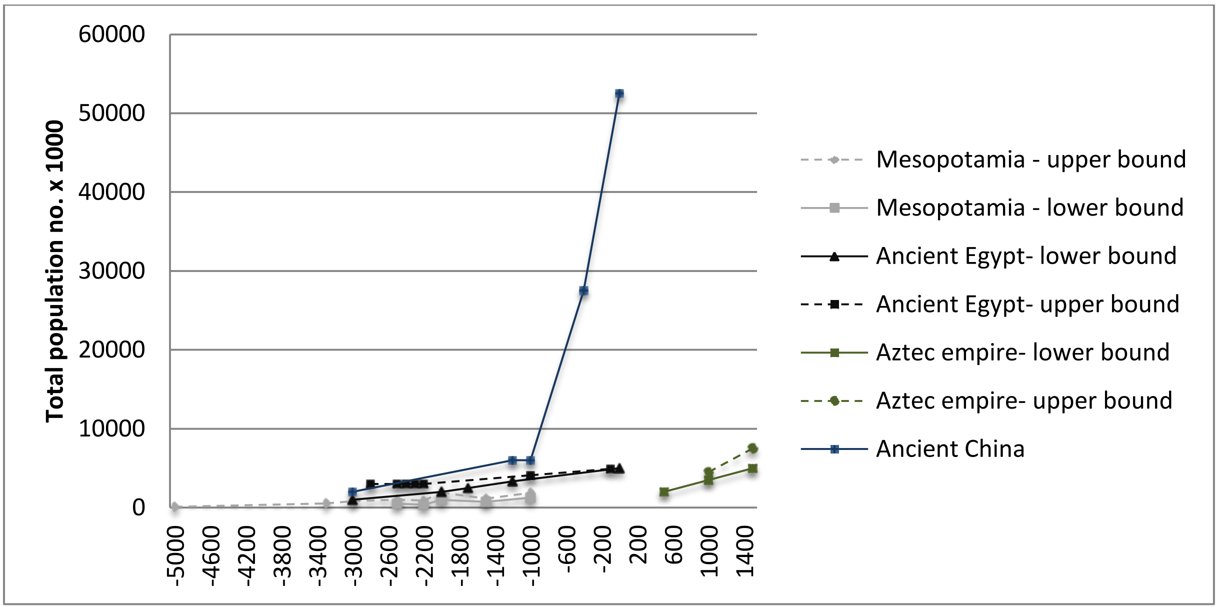
Civilization	Year
Mesopotamia	3700 B.C.
Ancient Egypt	2500 B.C.
Aztec empire	500 A.D.
Ancient China	1700 B.C.

The second type of comparison implies the usage of a 'ratio time line'. With the 'ratio time line' the year 0 indicates the starting point of the urban revolution/state formation of each primary civilization. In this case, the zero value is thus meaningful. Since it is assumed that these primary civilizations evolved to the most important extent independently of each other (Trigger, 2003), the comparisons along the ratio time line give insight in the patterns and speed of economic processes and organizational complexity after the first city of a particular civilization has arisen.

5.1.5.1 Comparisons along the interval time line

Combining the upper and lower bound time series of the different civilizations along the interval time line gives the graph displayed in figure 5.6

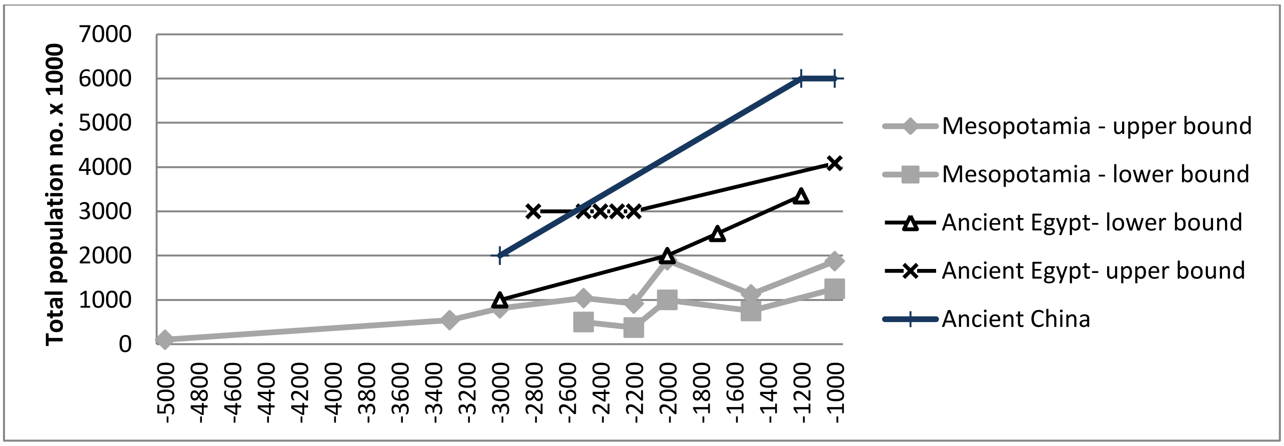
Figure 5.6 : Upper and lower bound time series of the different civilizations for 'total food output'



As the figure indicates, up till around 1000 B.C. the Mesopotamian, Egyptian, and Chinese civilization have all population estimates in the range of half a million till six million. However, after 1000 B.C. the total population number of Ancient China soared up to around 52,5 million, leaving the other civilizations far behind. The interval time line also shows that the rise of Aztec civilization took place in a substantial later period than in which the other civilizations came up.

Hence, due to the fact that Ancient China has such a higher baseline of total food output than the other civilizations from 1000 B.C. onwards, details got lost in this figure. The following figure focuses on the period before the population growth of Ancient China took a flight.

Figure 5.7: Upper and lower bound time series for 'total food output' from 5000 – 1000 B.C.



In this more detailed figure, it becomes clear that irrespective of using the upper bound of lower bound time series, Mesopotamia has the lowest baseline for total food output of all the civilizations from 3000 B.C. till 1000 B.C.. However, it should be noted that in the previous subsections the upper bound time series for Mesopotamia and the lower bound time series for Egypt has been marked as most reliable. Taking this notion into account, there are two points in time the baselines of total food output for Ancient Egypt and Mesopotamia nearly overlap, namely in 3000 and 2000 B.C. Due to the uncertainties inherent in the data and the fact that differences in food output per capita are unknown for each of the civilizations, it would be too stringent to conclude that total food output in Ancient Egypt was indisputably higher than in Mesopotamia in *all* time periods from 3000 B.C. onwards. Though it is likely that this has been the case, more robust evidence is needed to support this statement. Another remark that has to be made related to Mesopotamia is that it was the only region in the world that adheres to the conditions to be called a civilization from 3700 B.C. till 2500 B.C.. From this it logically follows that during that period Mesopotamia was the civilization with the highest baseline in total food output even though population numbers are available for Ancient China and Ancient Egypt as well in this period and are higher than that of Mesopotamia. These cannot however be called civilizations yet and the population numbers are rather referring to the population living in a certain area that would later become the territory of these civilizations. To clarify which *primary civilization* had the highest baseline of total food output in which period, the following table has been constructed. The rank of each civilization is displayed and a '-' signifies that the civilization did not exist in a particular period

Table 5.2: Primary Civilization with the highest baseline of total food output for a certain period

	3700-2500	2500-1700	1700-1000	1000-0	500-1500
Mesopotamia	**1**	**2**	**3**	**-**	**-**
Ancient Egypt	**-**	**1**	**2**	**2**	**-**
Ancient China	**-**	**-**	**1**	**1**	**-**
Aztec empire	**-**	**-**	**-**	**-**	**1**

A second observation that can be made from this figure is that though the lower bound time series for Ancient Egypt is during the entire period lower than the time series for ancient China, the upper bound time series is higher from 2800 till 2500 B.C.. However, in subsection 5.1.2 it has been concluded that the upper bound time series is less reliable than the lower bound time series. Therefore it is most likely that Ancient China has a higher baseline of total food output for the entire period. Nevertheless, it should be noted though that only from 1700 B.C. onwards the first settlements arose in Ancient China that can be marked as cities and therefore mark the beginning of Chinese civilization. Therefore, it can be stated that from 2500 B.C till 1700 B.C. Ancient Egypt has had the highest baseline for total food output of all civilizations.

Though the previous figure revealed more details by focusing on the period before the population of Ancient China grew rapidly, it does not allow one to compare at the right level of detail the baselines of total food output of Ancient Egypt and Mesopotamia with the baseline of the Aztec empire since the rise of this civilization took place in a later time period. The following figure enables this comparison by excluding the time series on Ancient China.

Figure 5.8: Upper and lower bound time series for 'total food output' – excluding Ancient China

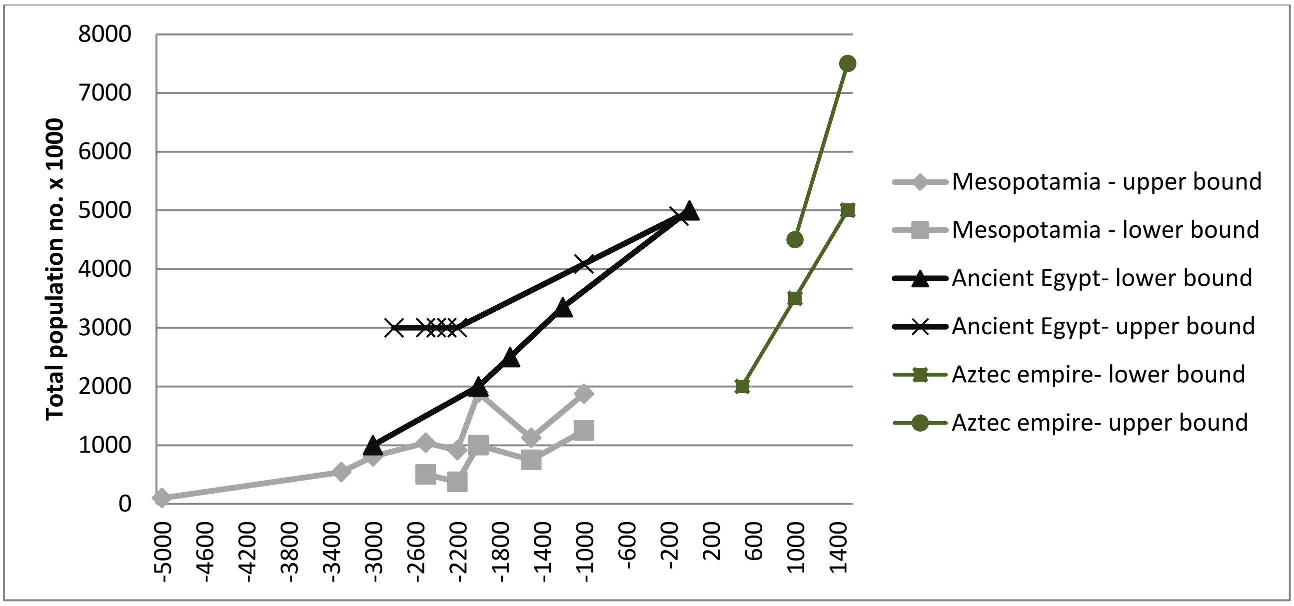
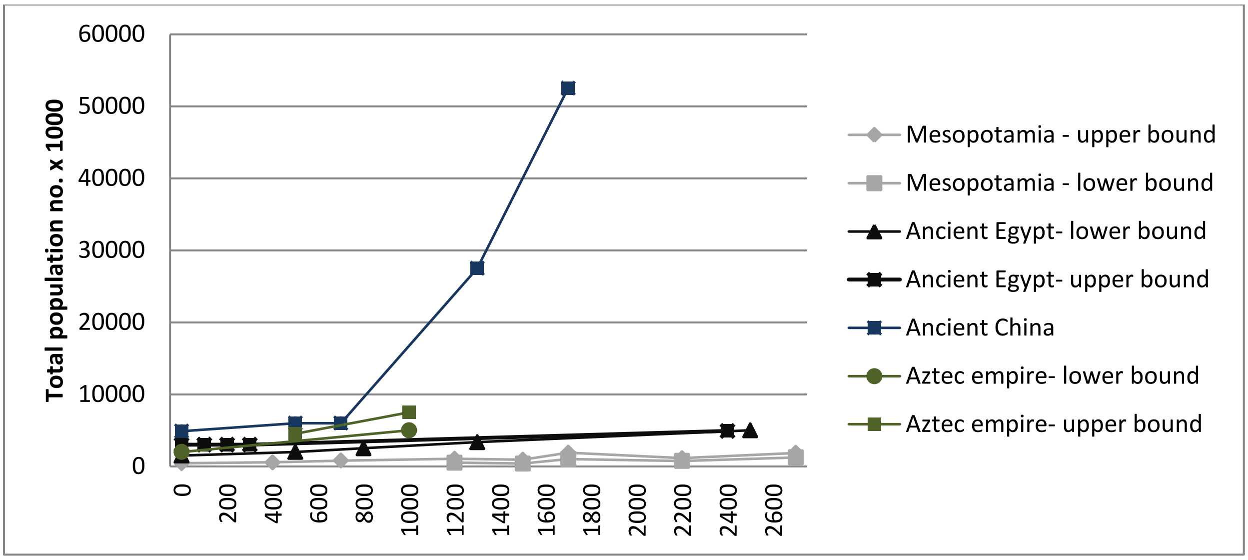


Figure 5.8 shows that, though starting in a later time period, the upper and lower bound time series of the Aztec empire overlap to some extent with the time series of ancient Egypt but appear to be on average at a higher level. Since the lower bound time series of Ancient Egypt and the upper bound time series of the Aztec empire have been marked as most reliable in the subsections 5.1.2 and 5.1.3, a cautious conclusion could be that the Aztec empire appears to have on average a higher baseline of total food output during its existence than Ancient Egypt. However, because of the fact that the rise of the primary Aztec civilization took place in a later time period in which already way larger secondary civilizations existed, it cannot be stated that the Aztec empire had the largest food output of all civilizations in the world at that time. In this instance, to value the economic performance with respect to total food output of the primary Aztec civilization in the right way, a comparison along a ratio time line would be more appropriated. This comparison will be made in the subsequent subsection.

5.1.5.2 Comparisons along the ratio time line

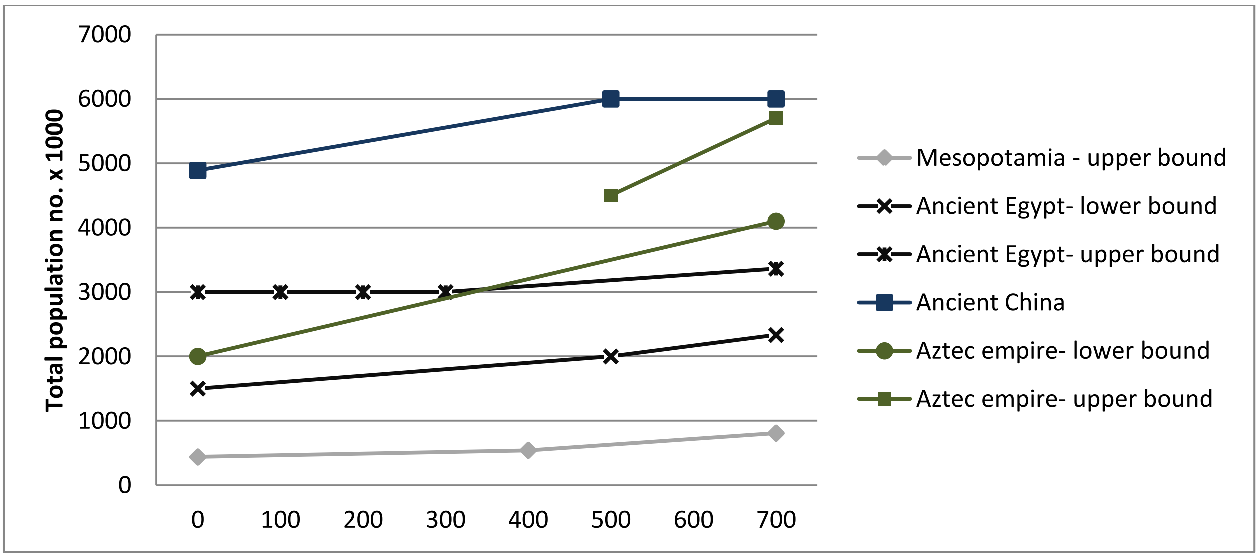
Along the ratio time line, the economic performance of the different civilizations with respect to total food output will be compared from the moment that each group adheres to the conditions to be called a 'civilization' and thereby gives insights in the patterns and speed of economic performance of the different civilizations after their initial formation. From a theoretical perspective, this type of comparison might be more useful since it gives the range of possible developments with respect to economic performance of civilizations that developed independently of each other (Trigger, 2003). The following figure presents an overview of the developments of the baselines of total food output from each of the civilizations after their initial formation.

Figure 5.9: Development of the baselines of total food output after each civilization's initial formation



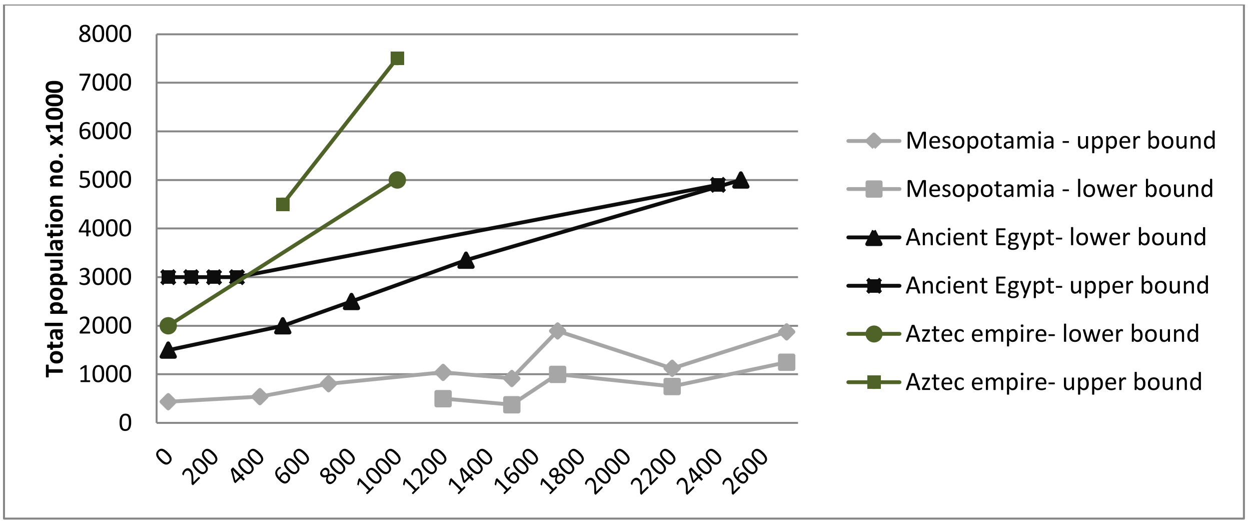
Again, Ancient China appears to have the highest baseline for total food output during the entire period. After 1600, no data for China has been inserted since from that moment on it became seen as a secondary civilization. Only in the period 0 till 700, the upper bound time series of the Aztec empire comes close to the time series of Ancient China. Looking more closely gives the following figure.

Figure 5.10 : Upper and lower bound time series for 'total food output' from 0-700 along the ratio time line



Around 700 years after the initial state formation, Ancient China and the Aztec empire nearly reach the same level of total population, with values of 6 million for China and 5,7 million for the Aztec civilization. However, when the lower bound time series of the Aztec empire is compared with the other time series, it becomes more ambiguous whether total food output in the Aztec empire was higher and grew faster than in the Ancient Egyptian civilization. Hence, since the upper bound time series of the Aztec empire and the lower bound time series of Ancient Egypt have been market as more reliable, it appears that the baseline of total food output for the Aztec empire has a higher intercept and coefficient. Overall, all time series have in common that they appear to follow a linear, positive function. Lastly, the data supports the notion that during the 0-700 period, the Mesopotamian civilization has the baseline for total food output with the lowest intercept and coefficient. Re-scaling to the entire period again and excluding the time series of Ancient China in order to not lose the level of detail, does not alter these preliminary conclusions as shown in figure 5.11.

Figure 5.11 : Upper and lower bound time series for 'total food output' along ratio time line – excluding Ancient China



5.2 Societal economic performance levels: baselines of total non-food output

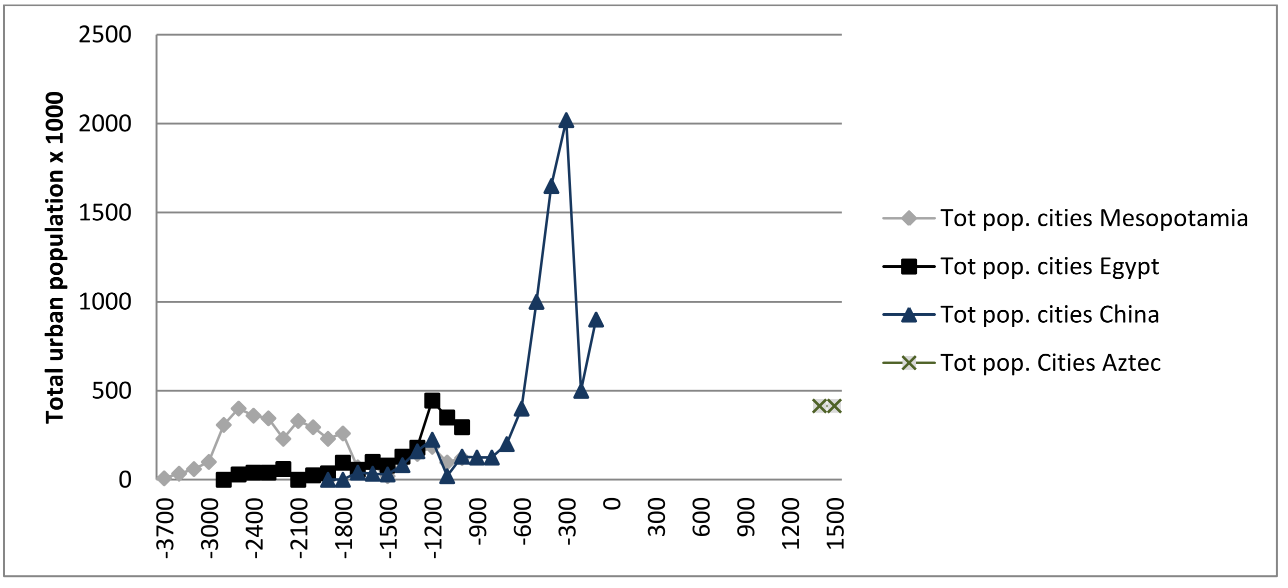
Unlike as in the previous section, there is no need to construct time series out of different sources since for Mesopotamia, Ancient Egypt, and Ancient China, Modelski (2003) data is available at a 100-year time interval, and for the Aztec empire Smith (2005) delivered most reliable estimates. Analysis of these data gives insights with respect to the non-food output component of societal economic performance with the proxy variable 'total urban population' representing the baseline of the total amount of non-food output produced by each civilization.

5.2.1 Comparisons along the interval time line

Unlike the overview graph for the baselines of total food output, this overview graph for total non-food output is harder to interpret at a first glance since the baselines of the different civilizations are in some periods quite close to each other and even cross each other several times. Only at the end of the time frame, differences become more clear. From 600 B.C. to 300 B.C., Ancient China's output approximately increased fivefold and reaches a total non-food output that has been unprecedented before. In the hundred subsequent years however, this total non-food output decreased drastically again with nearly 80%. Only a partial recovery took place from 200-100 B.C. in which total non-food output rose to 45% of 300 B.C. levels. Since no data has been inserted for the Mesopotamian and Egyptian civilizations in this later time frame since they by then are collapsed or do not classify as primary anymore, it is in this case not possible to compare the development trajectory of Ancient China with these regions.

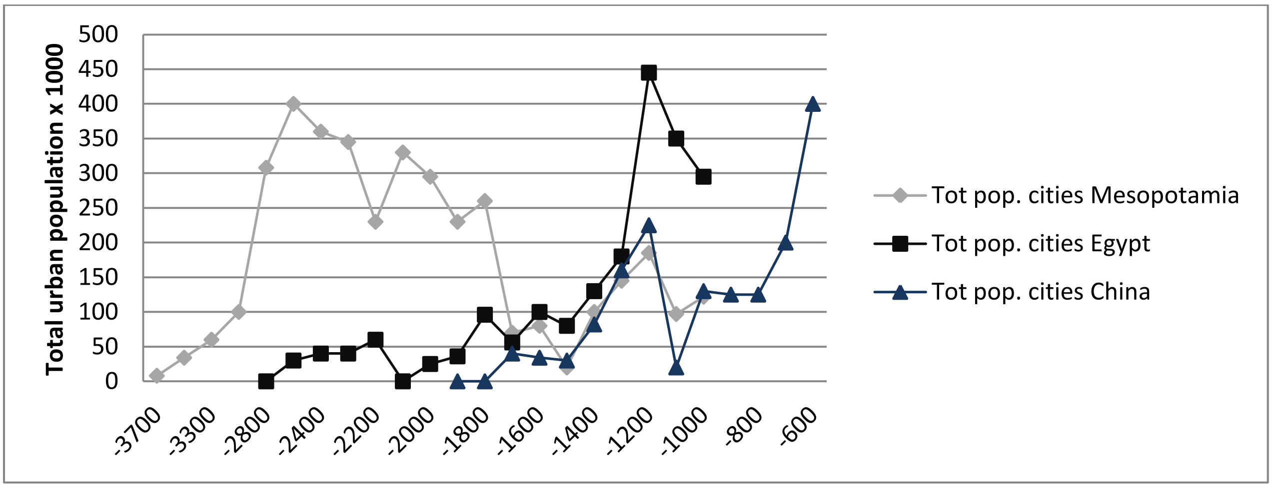
Lastly, when looking at the spare estimates for the Aztec empire, it appears that the non-food output was quite high compared to the other civilizations. The highest data point for Ancient Egypt is just slightly above the estimate for the Aztec empire, and the highest estimate for Mesopotamian civilization is just slightly below.

Figure 5.12 : Time series of the different civilizations with respect to 'total non-food output'



A close-up figure of the period before the baseline of total non-food output of Ancient China increased drastically is more useful to compare the civilizations in the period that baselines are close to each other and are even crossing. Figure 5.13 shows that in the period 3700-1800 B.C. Mesopotamia had by far the highest total non-food output. The average Mesopotamian non-food output in this period was even in the later 1800-600 B.C period with difficulty met by the other civilizations.

Figure 5.13 : Upper and lower bound time series for 'total non-food output' from 3700 – 600 B.C.



Around 1700 B.C., total non-food output of Mesopotamia collapsed while for Ancient Egypt and China it kept slowly increasing. In 1600 B.C., Ancient Egypt has taken over the lead which is till 1300 B.C. closely followed by the Mesopotamian and Chinese civilization. Between 1300-1200 B.C., the total amount of Egyptian non-food output grows more rapidly than that for the other civilizations, even reaching a level that has been unprecedented before. In the subsequent two hundred years, for all civilizations non-food output starts to decline. This period is by archaeologists also known as a period of momentous change, signified by climate change, war and cultural destruction (Drake, 2012). This simultaneous decline of highly organized and powerful states suggests environmental causes likely to operate over sizeable areas (Weiss, 1982; Drake, 2012). In the case of Ancient China, the drop in total output is dramatic: approximately a decline of 90% takes place. From the year 1000 B.C. onwards, total non-food output for Ancient China starts to recover at an increasing speed. In 600 B.c., Ancient China reaches a level of total non-food output that it has not reached before, and which equals the highest output of Mesopotamia and is slightly below the highest output of Ancient Egypt in the previous period. To sum up, the following table gives an overview of which primary civilization had the highest non-food output in which time period.

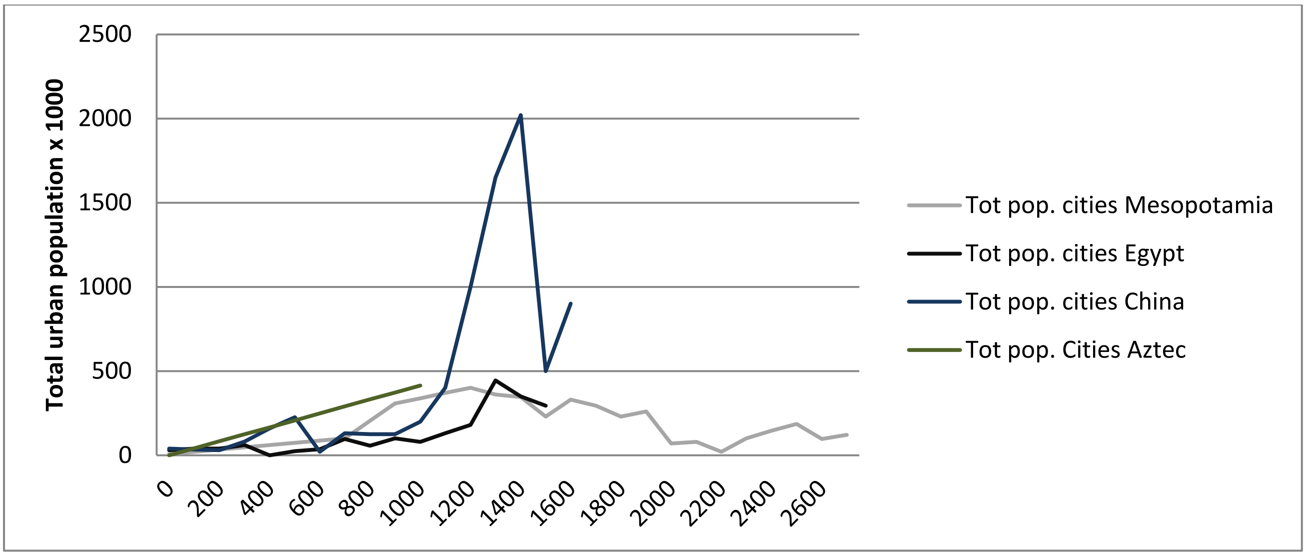
Table 5.3:Primary civilization with the highest baseline of total non-food output for a certain period along the interval timeline

	3700-2700	2700-1700	1600	1500	1400	1300	1200	1100	1000	900-0	500-1500
Mesopotamia	**1**	**1**	**2**	**3**	**2**	**3**	**3**	**2**	**3**	**-**	**-**
Ancient Egypt	**-**	**2**	**1**	**1**	**1**	**1**	**1**	**1**	**1**	**-**	**-**
Ancient China	**-**	**-**	**3**	**2**	**3**	**2**	**2**	**3**	**2**	**1**	**-**
Aztec empire	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**

5.2.2 Comparisons along the ratio time line

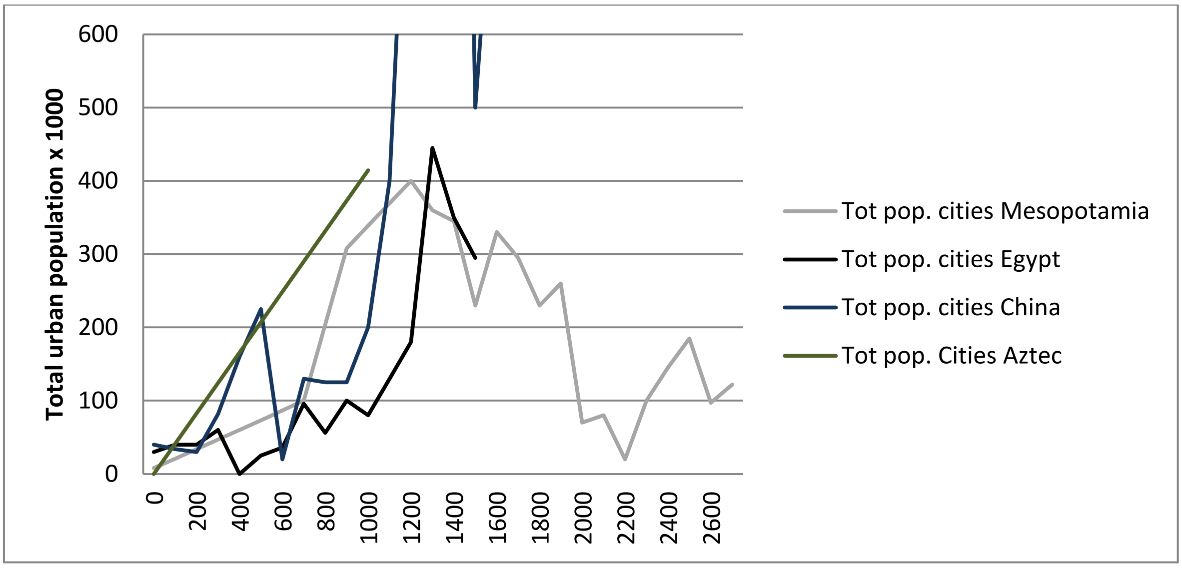
Along the ratio time line, it appears that in the first 1100 years of their formation, all primary civilization's had an urban population ranging between 0 and half a million. In the subsequent 300 years, Ancient China's total urban population increased dramatically up to two million while for Mesopotamia it increased only marginally. Compared to previous urban population numbers, total urban population in Ancient Egypt also increased significantly in this period. However from around 1300 years onwards, for all civilizations a decline in urban population numbers starts setting in. From 1200 to 2200, urban population declines gradually in Mesopotamia. In Ancient Egypt, declines start setting in around 1300. Unfortunately, data for Ancient Egypt is only incorporated till 1500 so it does not become clear whether this is only a temporary or a long term trend. As for Ancient China, a deep recession takes place starting in 1400 with a small recovery from 1500-1600. This outcome seems at odds with the cause of urban population decline presented in the previous sub-section which was environmental change. However rather than neglecting the impact of climate change, these similarities in patterns along the ratio time line seem to suggest that something more fundamental inherent to the development of organizational complexity might have played a bigger role.

Figure 5.14 : Time series with respect to 'total non-food output' along the ratio timeline



Detecting one pattern to which the development of all baselines of total non-food output for each civilization adhere appears to be too simplistic. However, a more close examination does allow one to observe some trends. First of all, it appears that growth in total non-food output was slow and volatile in most cases in the first 700 years after their formation. From 700 to 1200-1400, total non-food output grew at an increasing rate for all civilizations and deep recessions seem to be absent. Then from 1200-1400 onwards, all civilizations started to experience declines in total non-food output. In the case of Ancient China, this decline could be called a 'collapse'.

Figure 5.15 : Time series with respect to 'total non-food output' along the ratio timeline – close examination



Since this is rather a first exploration, further research would be necessary to deliver more insights in these patterns and their significance. Table 5.4 gives again an overview of the ranking of the different civilizations with respect to the baseline of total non-food output.

Table 5.4:Primary Civilization with the highest baseline of total non-food output for a certain period along the ratio timeline

	0	100	200	300	400	500	600	700	800	900-1000	1100-1200	1300-1500	1600	1700-2700
Mesopotamia	**3**	**4**	**3**	**4**	**3**	**3**	**2**	**3**	**2**	**2**	**2**	**3**	**2**	**1**
Ancient Egypt	**2**	**2**	**2**	**3**	**4**	**4**	**3**	**4**	**4**	**4**	**3**	**2**	**-**	**-**
Ancient China	**1**	**3**	**4**	**2**	**2**	**1**	**4**	**2**	**3**	**3**	**1**	**1**	**1**	**-**
Aztec empire	**-**	**1**	**1**	**1**	**1**	**2**	**1**	**1**	**1**	**1**	**-**	**-**	**-**	**-**

Compared to the ranking table along the interval time line, more periods reflect a switch in ranking, the civilizations themselves switch rank more often, and these switches in rank are on average bigger. This indicates that when civilizations are compared from their initial formation, their performance levels with respect to non-food output are way closer to each other.

5.3 Individual economic performance levels: baselines of total non-food output per capita

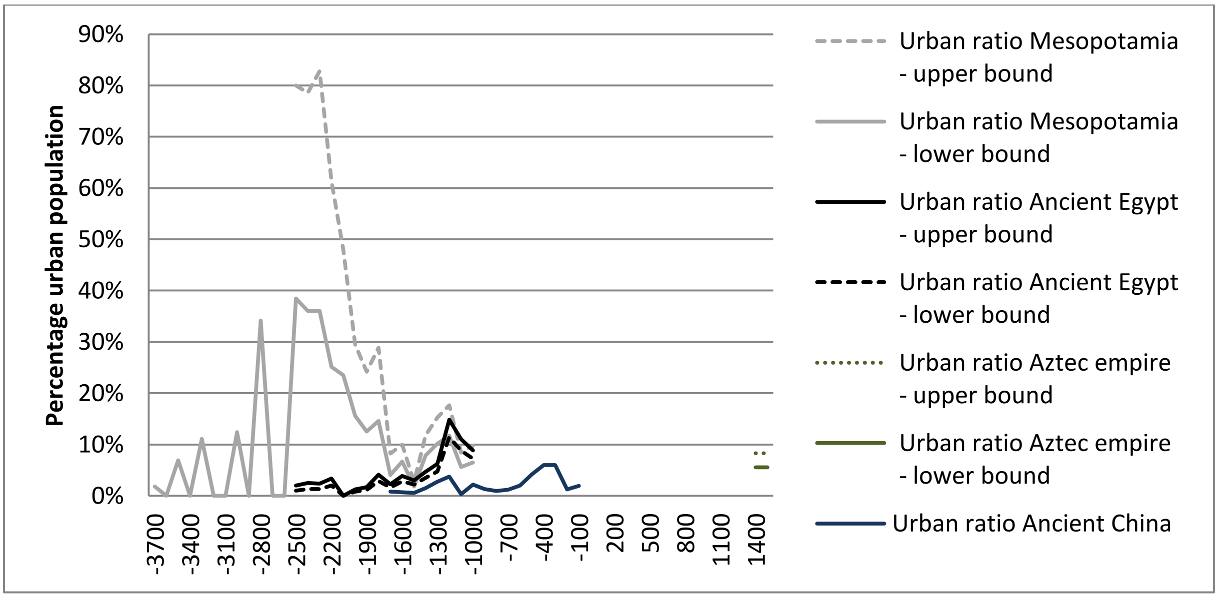
As mentioned in subsection 4.2 ‘definition and operationalization of concepts’, the formation of the previously used operational variables can also be used to construct a variable that reflects the baseline of total non-food output per capita. By dividing the variable ‘total urban population’ which reflects the baseline of total non-food output by ‘total population’, the proxy variable ‘urban ratio’ is constructed that reflects a baseline for total non-food output per capita.

5.3.1 Comparisons along the interval time line

The following figure indicates the upper and lower bound baselines for non-food output per capita for each of the civilizations. The solid lines are the baselines that are based on total population estimates that were evaluated in the previous sections as most accurate and reliable. The dashed lines reflect the baselines that have been marked as less reliable.

The overview graph indicates a remarkable high upper and lower bound urban ratio for Mesopotamia. Though such a high number might at first glance seem unlikely, Trigger (2003) mentions the Early Dynastic period of Mesopotamia the period where the highest concentrations of population in cities were achieved of all civilizations. Depending on the exact region in Mesopotamia, 70 to 80 percent of the population has been estimated to live in cities, from which a substantial part farmed the surrounding fields (McC. Adams, 1981). Since the upper bound baseline for Mesopotamia is based on the population number for the core Mesopotamian region which was most urbanized, this seems to adhere to McC. Adams findings. The upper bound baseline reaches at the highest point also an urban ratio of 80 percent.

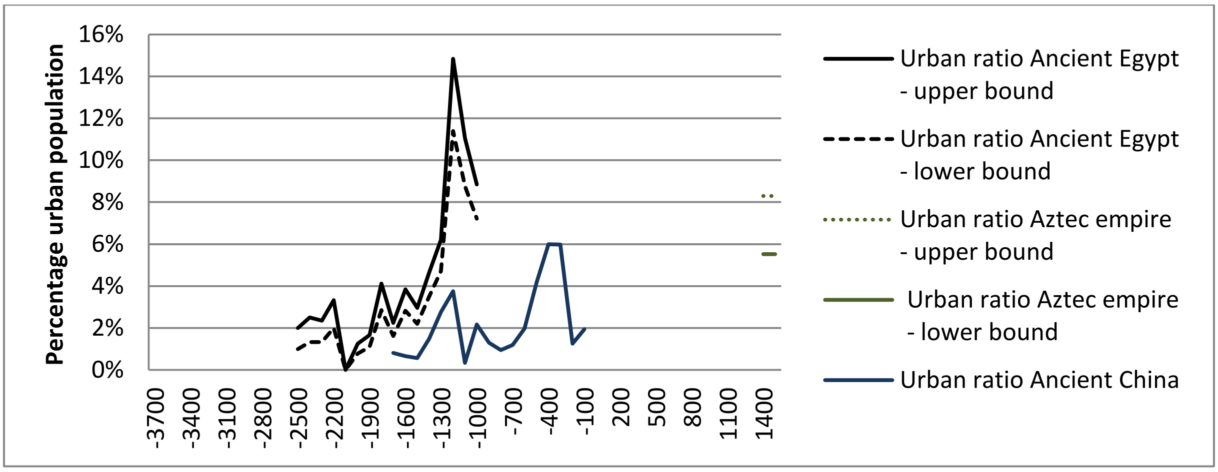
Figure 5.16 : Time series of the different civilizations with respect to ‘total non-food output per capita’



Hence, since for the lower bound baseline the population number is used that was deemed to reflect reality most accurately, this urban ratio, though still high, most likely reflects the actual situation at that time. What the figure also shows is that total non-food output per capita for Mesopotamia fluctuated heavily over time. These reductions in non-food output per capita would nowadays be marked as deep recessions.

Only in 1500 B.C. and from 1200 B.C. onwards, when urban ratio's for Mesopotamia declined, Ancient Egypt starts taking over the lead with respect to the baseline for non-food output per capita. However, it should be taken into account that Ancient Egypt, and even potentially Ancient China, actually reached higher levels in non-food output per capita than Mesopotamia already earlier, since in Mesopotamia a substantial amount of urban population was part- or full-time farmer.

Figur 5.17: Upper and lower bound time series for 'total food output per capita' – excluding Mesopotamia



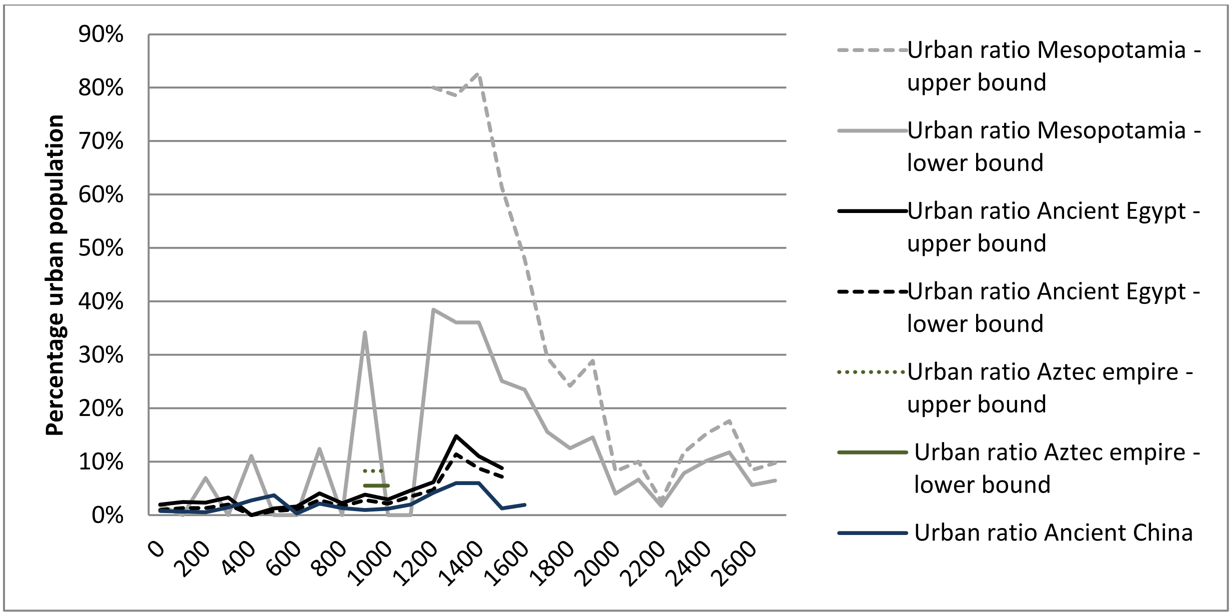
Excluding the baselines of Mesopotamia gives figure 5.17 displayed above which reveals more details of individual economic performance of the other civilizations. Ancient Egypt and Ancient China also underwent quite some declines and collapses with respect to non-food output per capita, though not as many and as severe as in the case of Mesopotamia. As for Ancient Egypt, the baseline appears on average to follow a positive trend. Though this seems also to be the case for Ancient China the trend is less clear.

The data for the Aztec empire is way more sparse and only an estimate can be made for the hundred-year period before the Spanish Conquest. Using the most reliable baseline it appears that the Aztec empire had a non-food output per capita that nearly equaled the non-food output per capita of Ancient China at its highest point. Compared to Ancient Egypt, this estimate of the Aztec empire appears also to be in its higher spectrum of values for non-food output per capita.

5.3.2 Comparisons along the ratio time line

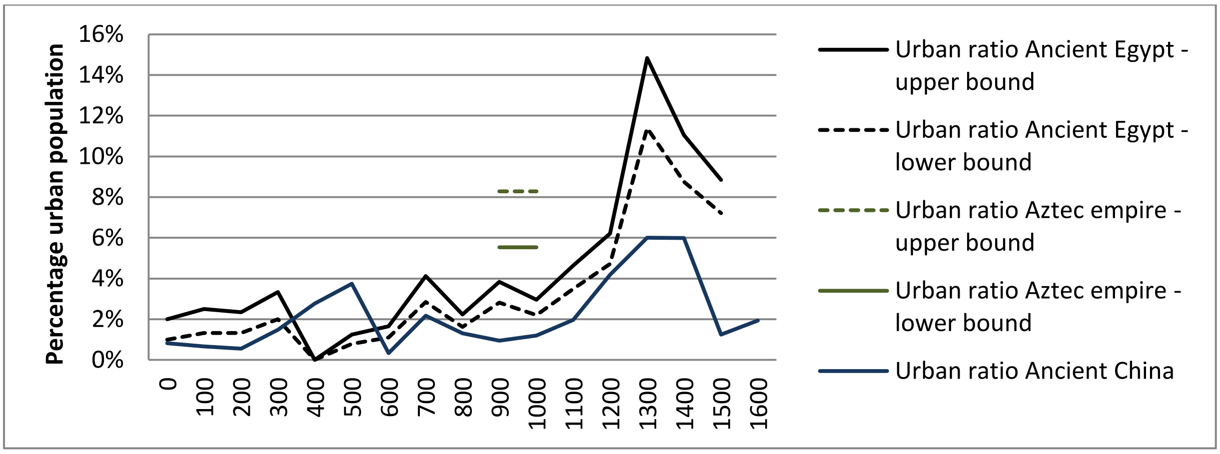
A comparison along the ratio time line delivers some very interesting insights. It reveals that Mesopotamia, Ancient Egypt, and Ancient China all experienced most volatility with respect to non-food output per capita in the first 1000 years after their formation. Secondly, after 1000 years the total non-food output per capita of the three civilizations grows more fast and reaches the highest peak between 1200-1300 years after the initial formation. From then on, the three civilizations appear to experience again the same trajectory: for each of them, non-food output per capita starts to (gradually) decline.

Figure 5.18: Time series of the different civilizations with respect to 'total non-food output per capita' along the ratio time line



The similarity of the pattern for each civilization is remarkable, and further research could deliver more insights with respect to the nature of 'economic recessions' and growth patterns in ancient times. Unfortunately, there is too few data for the Aztec empire yet to get insights in its performance pattern with respect to non-food output per capita. However, what the figure does tell is that as well its upper as lower bound baseline is above that of Ancient Egypt and Ancient China, indicating relatively high non-food output per capita for the respective period. A closer examination as in figure 5.19 shows that even clearer. Further, it appears that during the entire period Ancient Egypt has had a higher baseline than Ancient China with one exception for the period 400-500.

Figure 5.19 : Upper and lower bound time series for 'total food output per capita' along the ratio timeline – excluding Mesopotamia



5.4 Organizational complexity: A composite index of variables

Just like the construction of the operational variable 'urban ratio', the index variables for organizational complexity can be constructed out of the variables that were formed to study societal economic performance levels. Hence, since the main focus of this thesis is on economic performance levels, these results will be discussed less extensively.

Two sub-components of organizational complexity were linked to three operational variables in sub-section 4.2 'definition and operationalization of concepts'. These sub-components that together form the index are 'size of cooperation' and 'differentiation of tasks'. The concept 'size of cooperation' is represented by the proxy variable 'total population'. The data about total population numbers are also already used in subsection 5.1 to construct the baselines for total food output for each of the civilizations. The graphs will not be displayed here again, but analysing them gives the following conclusions:

1. From 3700 to 2500 B.C., a period of 1200 years, the Mesopotamian civilizations was the first and biggest form of human organization that he world had ever experienced.
2. Around 2500 B.C., a second civilization arose that until 1700 B.C., a period of 800 years, was the largest form of human organization. Mesopotamia ranks second with respect to size of human organization, however, estimates for Ancient Egypt and Mesopotamia are quite close during this period especially around 2000 B.C..
3. From 1700 onwards, Ancient China classifies as a primary civilization and directly takes over the lead with respect to size of human organization. Whereas the extent of human organization keeps increasing for Ancient Egypt from 1700 B.C. onwards, the size of human organization of Mesopotamia keeps in between the one and two million range before the civilization falls apart.

4. From 1000 B.C onwards, the pace of the extension of human organization for Ancient Egypt stays constant and positive, however for Ancient China, the scale of human organization increases rapidly, leaving the other forms of human organization far behind in size.
5. The rise of the Aztec empire is more rapid and reaches a higher size of human organization than in the case of Mesopotamia and Ancient Egypt. Additionally, the size of human organization is bigger than that of Ancient China before its size sky-rocketed in 1000 B.C.
6. Overall, all civilizations appear to follow a quite stable pattern of linear, positive growth of the size of human organization with only Mesopotamia having some stagnant or constant phases.

However, as noted before in subsection 4.2.2, organizational complexity is not determined by the size of the human organization alone. The other sub-component of the index for organizational complexity is 'differentiation of tasks'. Two proxy-variables have been selected to inform about the differentiation of tasks in primary civilizations, namely 'urban ratio' and 'number of cities'. The urban ratio informs about the spatial distribution of the population. The higher the relative spatial concentration in cities, the higher the potential organizational complexity through agglomeration advantages inherent to urban structures (Modelski, 2003). The proxy variable 'urban ratio' has also been used in section 5.3 to construct the baselines of non-food output per capita for each of the civilizations. Again, these graphs will not be displayed a second time but rather the conclusions that can be derived from them will be set out.

1. Based on this indicator Mesopotamia appears to reach during its entire existence the highest level of organizational complexity compared to the other civilizations. However, this outcome might be misleading since other authors (Trigger, 2003) indicated that Mesopotamia potentially has the highest level of full-time and part-time farmers living in the cities. In this case, a high urban ratio does not reflect a high level of differentiation of tasks. From 1500 B.C. onwards, urban ratios of Mesopotamia, Ancient Egypt, and Ancient China are more close to each other and it appears likely that from that moment on, Ancient Egypt has a higher level of differentiation of tasks than Mesopotamia.
2. Ancient Egypt has a higher level of differentiation of tasks than Ancient China during its entire existence.
3. The Aztec empire has in 1500 A.D. an urban ratio that is quite high for a primary civilization which represents a level of differentiation of tasks nearly equal to the urban ratio of Ancient China at its highest point and in the higher spectrum of urban ratios for Ancient Egypt.
4. All civilizations show quite some variation in differentiation of tasks over time and therefore it is likely that there has been quite some variation in organizational complexity levels as well.
5. Maybe the most important conclusion is that all primary civilizations appear to have reached at some point urban ratios that have always been seen as impossible to reach for non-western pre-

industrial civilizations. The following table, derived from Broadberry and Gupta (2006), shows that only from 1644-1736, China reached urban shares equal to that of Ancient China from 400-300 B.C.. In the early 19th century however, it is even lower again than urban shares in 400-300 B.C..

Table 5.5: Urban ratios of the population in China and Europe, 618-1820

	Tang *618–906*	*Song* *960–1279*	*Ming* *1368–1644*	*Early Qing* *1644–1736*	*Early* *19th century*
China					
All urban	4.7	5.2	6.5	6.8	5.9
Cities > 10,000	3.0	3.7	4.9	6.0	3.8
Europe					
Cities > 10,000	—	—	7.6	9.2	10.0

Note: Urbanization ratio for cities of at least 10,000 inhabitants derived from Rozman, *Urban networks*, level 1–4 cities.
Source: China: Derived from Rozman, *Urban networks*, pp. 102, 279–83. Europe: Table 4.

Source: Broadberry & Gupta (2006)

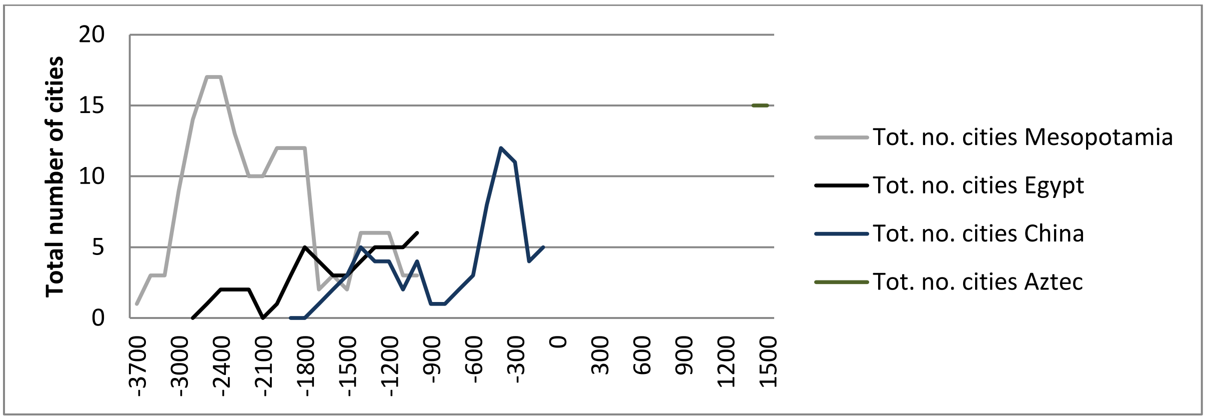
When urban ratios of Ancient Egypt are compared with those of Europe in the early 19th century, it can be noted that from 1200 to 1100 B.C. Ancient Egypt had higher urban ratios with values of 14,83 % and 11,05% respectively. As for the Aztec empire, its urban share in 1500 is with 5,53 % lower than that of that of Europe in this period but also not substantially lower. Overall, this might indicate that the urban shares (and thus indirectly organizational complexity) of primary civilizations at the peak of their existence was not per see substantially lower than urban shares of Europe and China at the start of the industrial revolution.

However, a second proxy variable has been calculated to inform about the differentiation of tasks as well. Whereas the previous proxy variable rather looked at the differentiation of tasks between people of the civilization as a whole, the next proxy-variable represents the differentiation of tasks between cities. The idea is that the more cities in an urban network of a civilization, the more the mechanism of comparative advantage sets in with cities specializing in certain sectors. This differentiation of tasks between cities again denote a higher level of organizational complexity. The subsequent subsections set out the development of this proxy-variable along the interval and ratio timeline.

5.4.1 Comparisons along the interval time line

The overview graph indicates that nearly during its entire existence, Mesopotamia has had the highest number of cities. From 3700 to 2500 B.C. its number of cities increased rapidly, reaching levels that will also in a later period not be reached by the other primary civilizations. From 2400 to 2200, the first collapse occurs and the number of cities decreases with 41 percent. The second collapse in urban numbers is even more dramatic: in only 100 years time from 1800 to 1700 B.C., the number of cities decreases with 83 percent. However, only when the civilization of Mesopotamia itself nearly collapsed, from 1100 to 1000 B.C., Ancient Egypt surpasses Mesopotamia with respect to number of cities.

Figure 5.20: Time series of the different civilizations with respect to 'total number of cities'

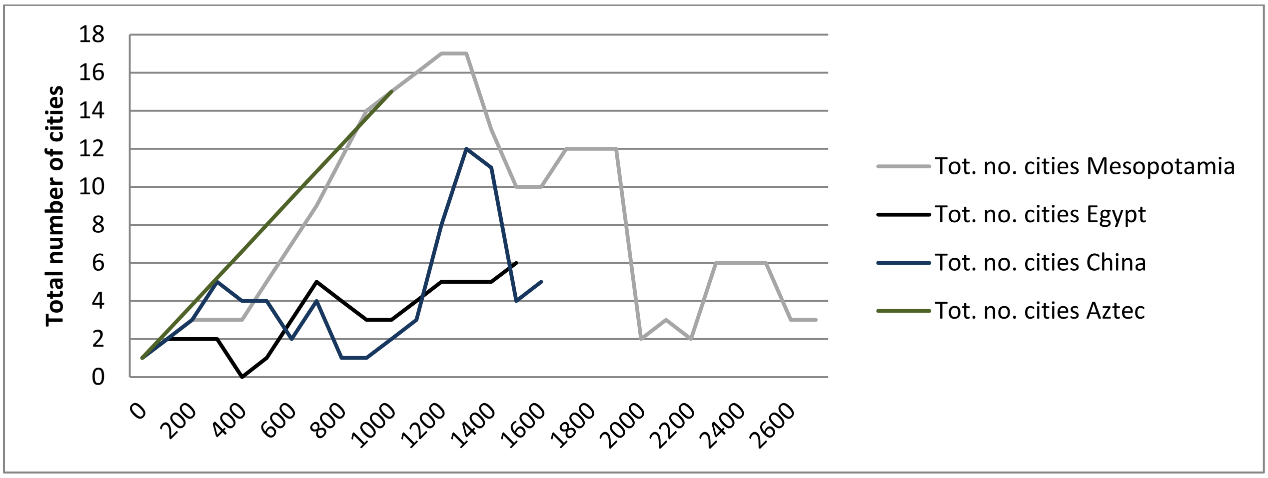


Though Ancient China has a lower number of cities than the other civilizations in the period up to 1000 B.C. and only surpasses Ancient Egypt once in 1400 B.C., the other civilizations do not outrun China by far from 1600 B.C. onwards. From 600 to 400 B.C, the number of cities of Ancient China start to increase more rapid and reaches higher levels than Ancient Egypt in the previous period. However very soon after, from 300 to 200 B.C. , urban numbers of Ancient China fall by 64 percent. Albeit for the Aztec empire only one data point is available, it appears that this civilization had a very high number of cities, only slightly below the highest values reached by Mesopotamia. A general impression of this figure is nevertheless that the formation of cities in a civilization does not follow a stable linear pattern, but rather appears 'bumpy' with each civilization experiencing several large collapses.

5.4.2 Comparisons along the ratio time line

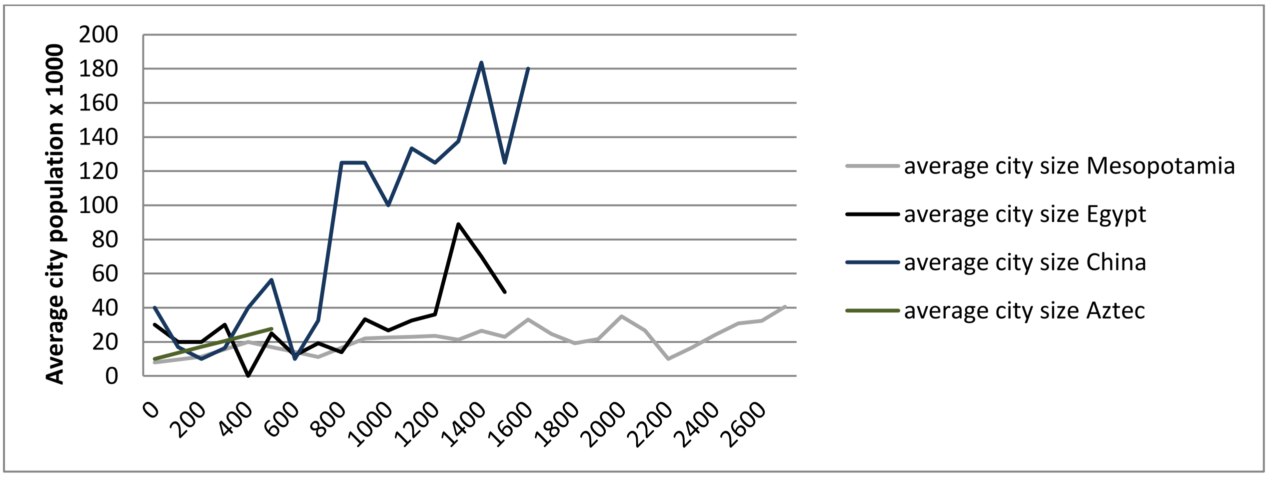
Ranking the civilizations along the ratio time line does not deliver radically new or different insights. Again, Mesopotamia and the Aztec empire have the highest growth and at some point the highest number of cities. However, Ancient China and Ancient Egypt change more often rank than along the interval time lime.

Figure 5.21: Time series with respect to 'total number of cities' along the ratio timeline



Trigger (2003) remarks however that in territorial states, as are Ancient Egypt and Ancient China, city's tend to be fewer in number but larger. This statement is confirmed by the data and a more nuanced image emerges when data on average city size is plotted. A higher average size might namely also indicate higher organizational complexity levels since it requires organization to limit the 'push factors' (e.g. congestion) that are bigger in larger cities and that make people relocate to the country side (McCann, 2013).

Figure 5.22: Time series with respect to 'average city size' along the ratio timeline



Though Ancient Egypt and China may have on average fewer cities than the other civilizations, the graph clearly shows that from around 600 years after their initial formation onwards, their average city size is larger than that of the other civilizations and appears to follow a positive linear trend.

To conclude, from the proxy-variables that are used to form an index of organizational complexity no clear-cut conclusive image emerges in which for a certain period a certain civilizations scores highest on each of the indicators. Further research would be needed to place the provided data in the right perspective and give the right interpretations.

5.5 Economic efficiency I: baselines of total food output relative to resources

The following section compares the civilizations with respect to 'food output relative to resources'. If 'total food output' is divided by the amount of available natural resources, new insights can be acquired concerning the efficiency levels by which the different civilizations used their (natural) resources to produce food. What this analysis does not tell however, is what the causes are of increases in efficiency levels (e.g. environmental, technological, organizational). Further research would be needed to determine this.

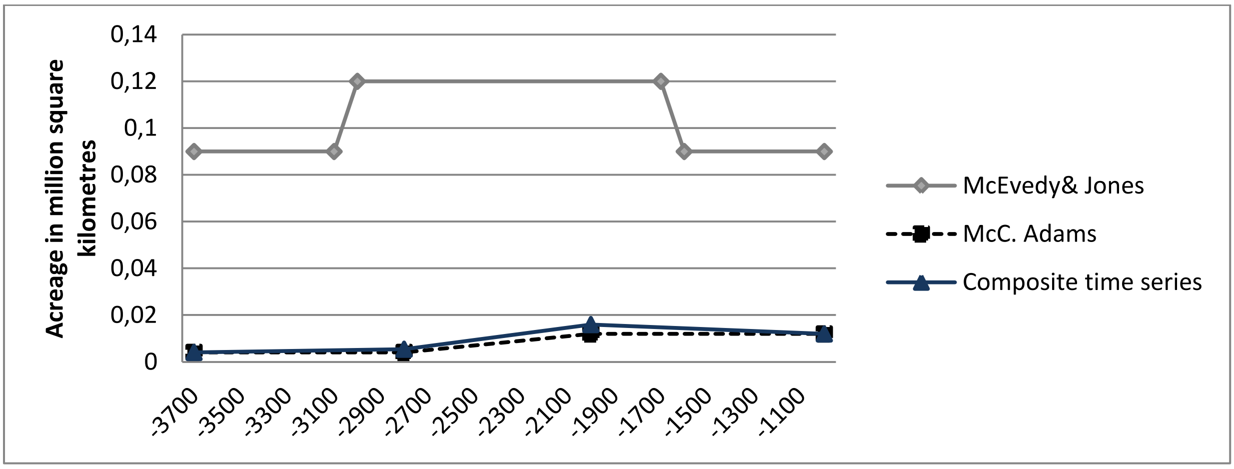
The proxy variables needed for this analysis have already been constructed in the previous sections and only the preparation of additional data is needed with regard to one new variable, namely 'total arable land'. Though not perfect since it does not take into account other natural resources than land and it does not reflect differences in soil quality, with the current data availability this appears to be the best representation of 'natural resources' that is currently possible. Also, the impact of not including other dimensions of natural resources than land might be limited since in primary civilizations arable land was the most important factor of production in addition to labor (Kremer, 1993; Trigger, 2003).

Before the levels of 'food output relative to resources' of the different civilizations can be compared however, different data sources on 'total arable land' need to be evaluated. As was the case with the construction of time series for the variable 'total population', also with this variable in some instances a composite time series has been made in which the best estimates are used for a particular civilization in a particular period. When exactly which estimate for 'total arable land' is used of which source and for what reason will be described next. Overall, for each civilization an upper bound and a lower bound time series have been constructed. Important to note is that, except for Ancient Egypt, the quality of the data is very doubtful and further research would be needed to confirm or reject the outcomes of this subsection.

5.5.1 Mesopotamia

In the case of Mesopotamia, two sources can be used to estimate the total arable land that was available. First of all, from the McEvedy & Jones data a time series can be constructed. This time series however is not very useful since it equals the total amount of arable land of that region in the 1960's. Thus, it can rather be seen as an upper bound time series that lies way above the true value since agricultural techniques have by that time multiplied the available land by manifold. The increase in arable land that the time series of McEvedy & Jones shows relates to the Mesopotamian expansion into the region that is nowadays known as Syria. Hence, also the estimate of arable land of Syria equals data on arable land of the 1960's. Nevertheless, the McEvedy & Jones data will proof to be useful for the construction of a composite time series.

Figure 5.23: Time series 'total arable land' for Mesopotamia

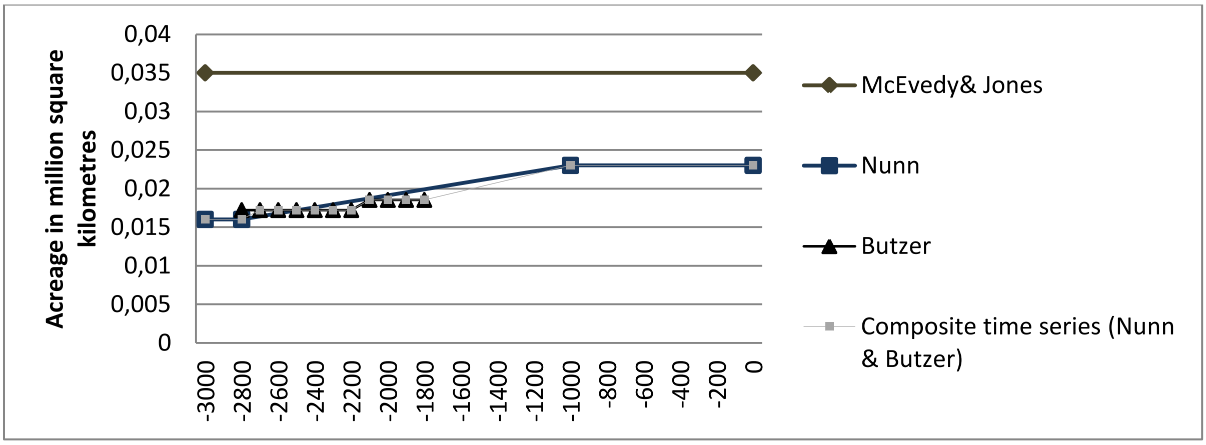


McC. Adams (1981) also delivers data for the construction of a time series. His estimates appear way more reliable since they are based on re-constructions of the fertile floodplain of the Euphrates and expansions of land due to irrigation practices. However, his estimates relate to the core Mesopotamian region and does not include land that was added due to the Mesopotamian expansion into the Syrian region. Here, the McEvedy & Jones data comes in again. A simple calculation shows that the expansion into the region that is nowadays Syria added one third to the stock of total arable land. Multiplying the time series of McC. Adams by (1+1/3) in the period that the Mesopotamia stretched into Syria, gives a composite time series that potentially most accurately reflects the actual situation.

5.5. 2 Ancient Egypt

For ancient Egypt as well, the data from McEvedy & Jones is not very representative since it equals the total amount of arable land of that region in the 1960's. Luckily, the time series that can be composed on the basis of the data of Nunn (2002) has a more robust basis due to the fact that it is based on estimates of the fertile floodplain of the Tigris in Ancient Egypt at that time and its expansion due to irrigation practices. Butzer's (1976) estimates are close to that of Nunn and appear to fall on the trend line reflecting Nunn's data.

Figure 5.24: Time series 'total arable land' for Ancient Egypt

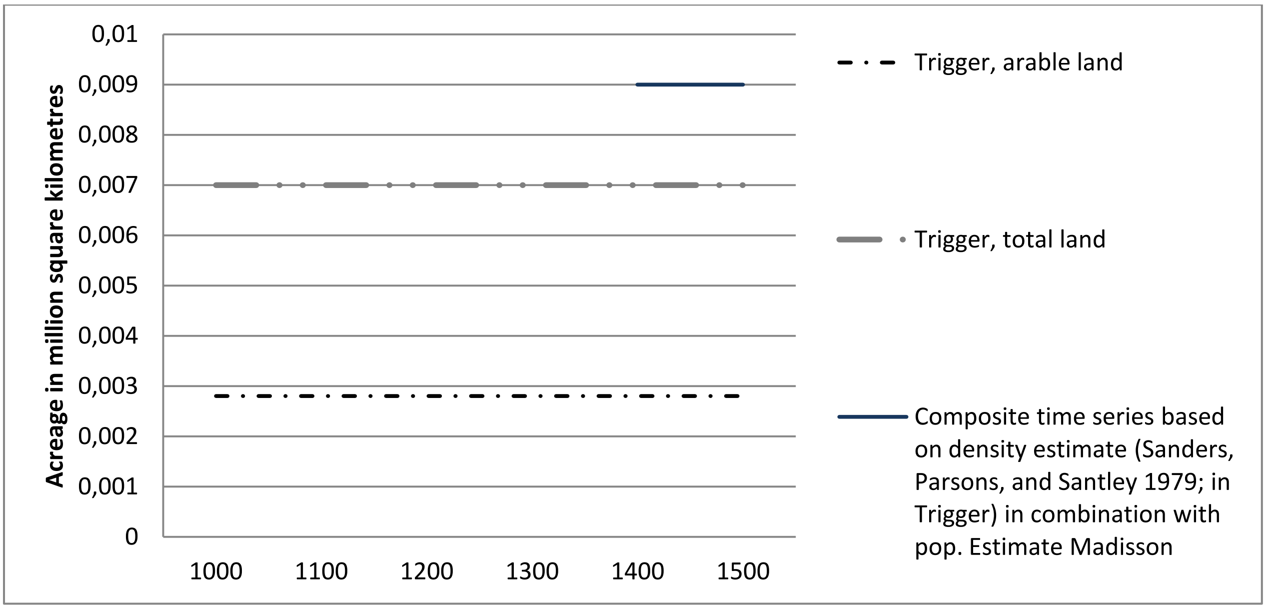


Due to the fact that the data of Butzer seems to align quite well with the trend line of Nunn, and represent a time period for which no data from Nunn is available, a composite time series might again reflect reality most accurately. The composite time series is shown in figure 5.24 and will in subsequent sections be marked as most reliable.

5.5.3 Aztec empire

For the Aztec empire, even fewer data points are available with respect to total arable land. Trigger (2003) describes the Valley of Mexico as an elevated plain that is separated from other regions of highland Mexico by mountain ranges. The total area of the elevated plain is around seven thousand square kilometres. On the basis of subsequent data that Trigger gives it can be calculated that the total area of arable land compromises around 2,8 thousand square kilometres.

Figure 5.25: Time series 'total arable land' for the Aztec empire

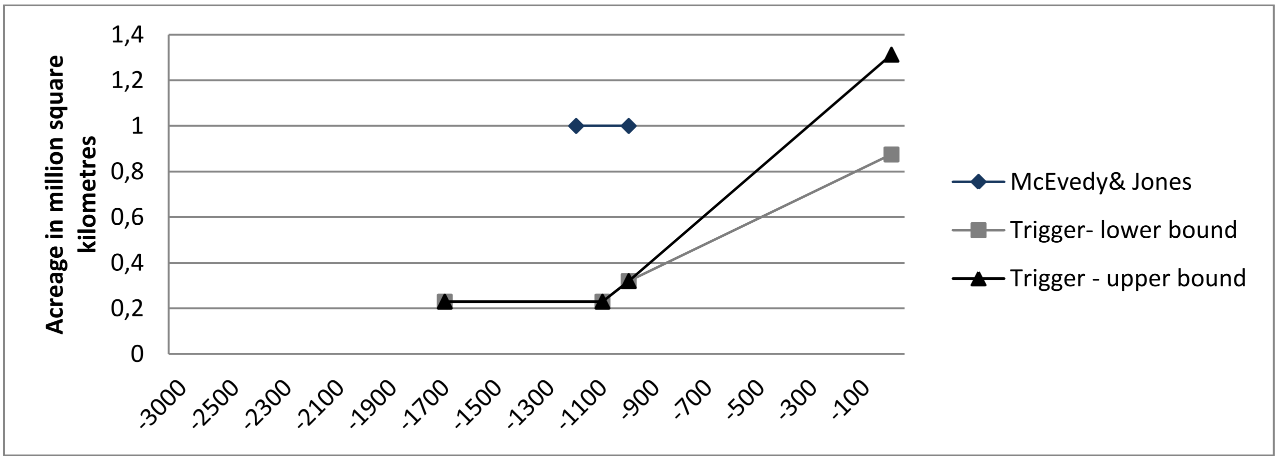


A problem arises however by using these time series of arable land in subsequent calculations about efficiency. The estimates of 'total population' and 'total city population' are based on a larger region of influence of the Aztec empire, stretching beyond the Valley of Mexico. However for this entire region, no data has been found. Therefore, the actual amount of arable land within the territory of the Aztec empire is likely a multiplication of the data presented here. As a solution, a composite time series has been constructed based on the population estimate of Madisson that has been marked as most reliable and on a density estimate of Sanders, Parsons and Santley (1979) for the entire Aztec empire. This estimate most likely gives a better representation of available arable land for the entire Aztec civilization.

5.5.4 Ancient China

Unlike as for the previous civilizations, McEvedy & Jones do give an estimate of the total arable land at some point in time for Ancient China instead of using total amount of arable land of that region in the 1960's as a proxy. They estimate that during the Shang Dynasty, the territory comprised the Huang Ho area and that total arable land did not exceed 1 million square kilometres. Their estimate for this time period can thus best be seen as an upper bound estimate. Additionally, they mention that in subsequent centuries territory expanded into the valley of the Yangtse and that agriculture intensified due to the development of irrigation systems in the Yellow River basin. Unfortunately, they do not present acreage estimates for this subsequent period.

Figure 5.26: Time series 'total arable land' for Ancient China



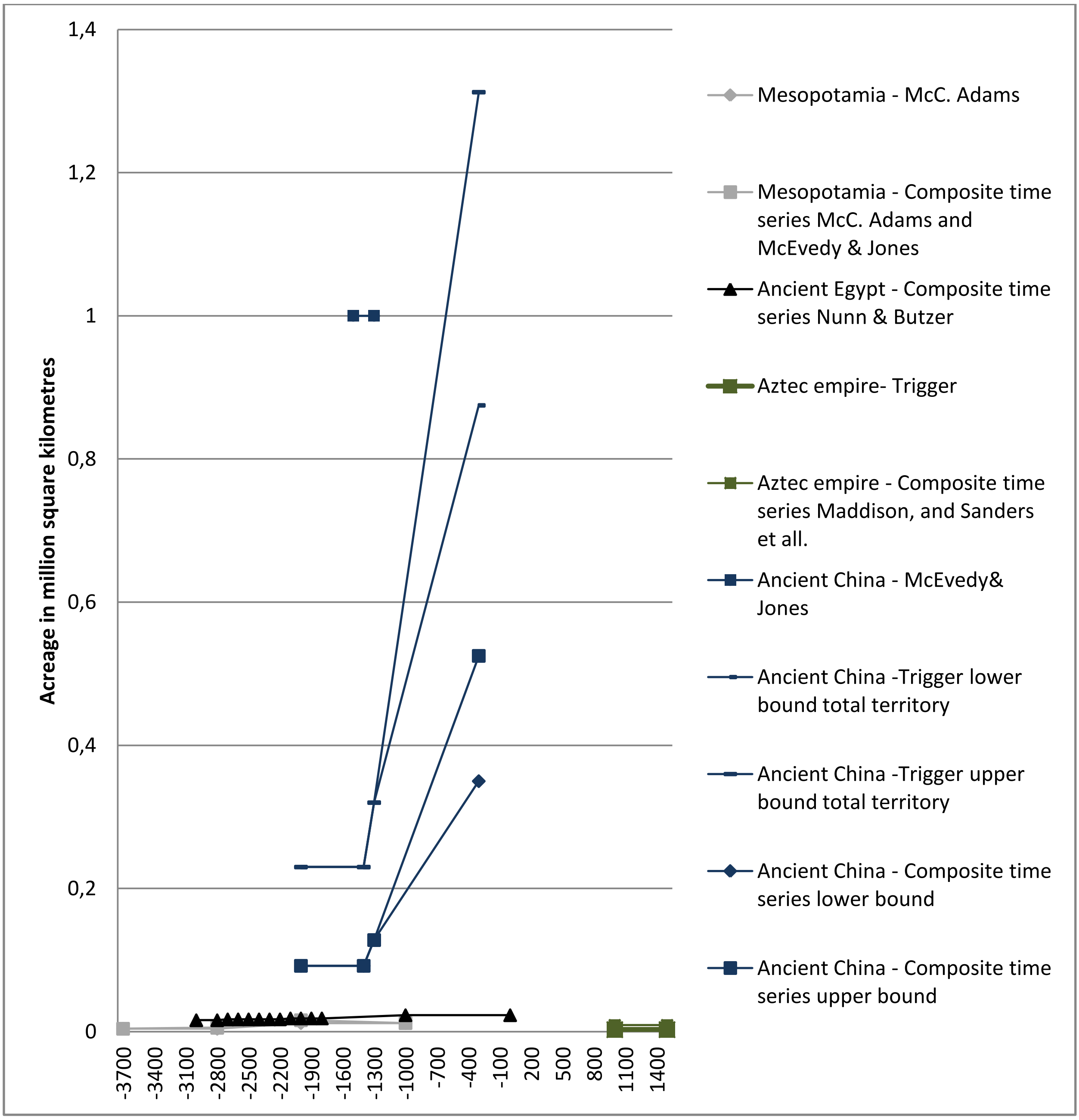
The estimates of Trigger (2003) have luckily a more firm basis. According to him, there is substantial evidence that the Shang kingdom was a territorial state that controlled about 0,23 million square kilometres (Trigger, 2003, p. 108). At the height of the Shang period, the state may have controlled 0,32 million square kilometres which was mainly rich farmland (Trigger, 2003, p. 111). In subsequent decades the territory could extend rapidly due to the absence of ecological restrictions for desirable farmland to the south. Around 2 A.D., Trigger estimates a population density of around 40 to 60 persons per square kilometre (2003, p. 289). With a total population of circa 52,5 million this indicates a territory in between 0,875 and 1,313 million square kilometres at that time. Two time series have been constructed based on Trigger's data displaying this possible range. It should be noted though that Trigger's estimates represent total territory and not total arable land. Both time series can thus still be seen as upper bound constructions for actual arable land. However, Trigger remarks that the total territory mainly comprised out of farmland (2003).

5.5.5 Comparison of available arable land

Combining the data on arable land of the four civilizations gives the overview as displayed in figure 5.27. Since for Ancient China only estimates for total territory were available, a reconstruction has been made of total arable land based on the ratio of arable land to total territory of the Aztec empire. It is likely that the actual share of agricultural land to total territory of Ancient China is higher than that of the Aztec empire since Trigger writes that the total territory of Ancient China comprised largely out of agricultural land. Hence, the true values for arable land of Ancient China are thus probably higher than shown in the composite time series, but lower than shown in the time series of total territory.

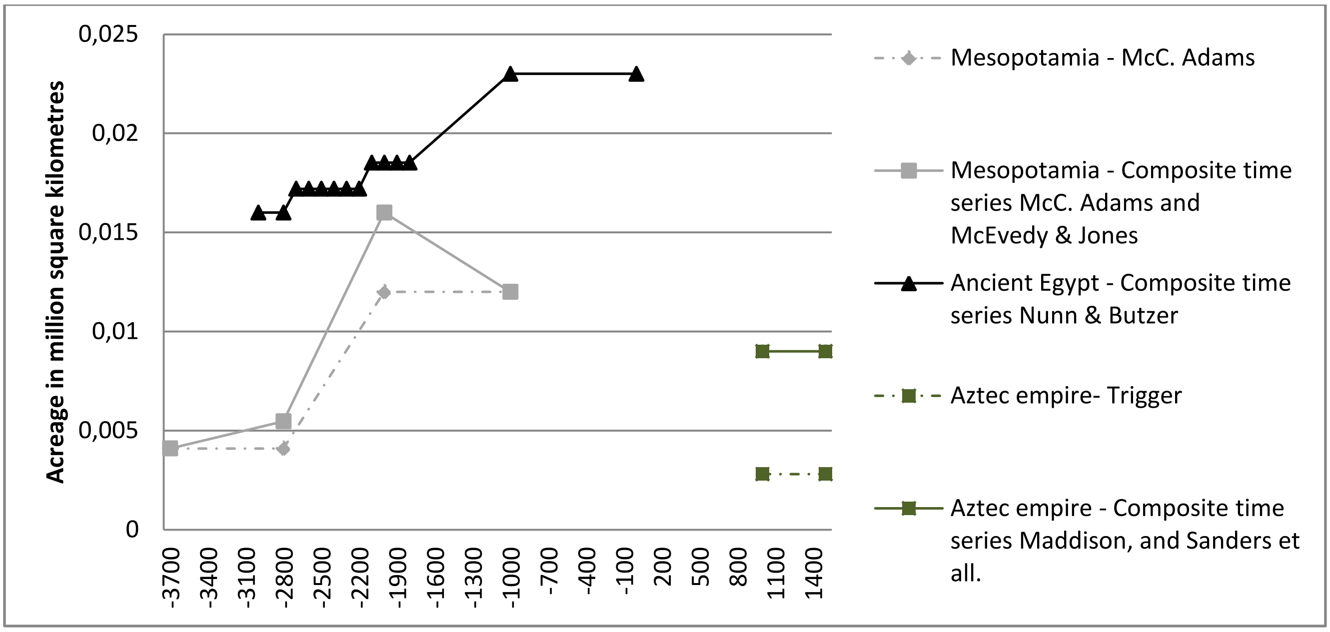
One feature of the overview graph that cannot be missed however, is that Ancient China has during the entire period by far the largest resource pool with respect to total arable land irrespective of which estimate is used. Additionally, this resource pool increased rapidly from 1300 B.C. onwards.

Figure 5.27: Upper and lower bound time series of the different civilizations for 'total arable land'



However due to the fact that Ancient China has such a higher amount of total arable land to its disposal, details for the other civilizations got lost. The following figure (5.28) leaves the data for Ancient China out. The time series that have been marked in the previous subsections as most reliable are displayed by a solid line. For Ancient Egypt, only the composite time series has been included due to the fact that this time series has a firm basis which aligns well with several different sources.

Figure 5.28 : Upper and lower bound time series for 'total arable land' – excluding Ancient China



The figure shows that the Ancient Egyptian civilization had a higher amount of total arable land to its disposal than Mesopotamia and the Aztec empire. Additionally, when using the most reliable time series, the Aztec empire appears to have the same amount of arable land to its disposal as Mesopotamia around 2500 B.C..

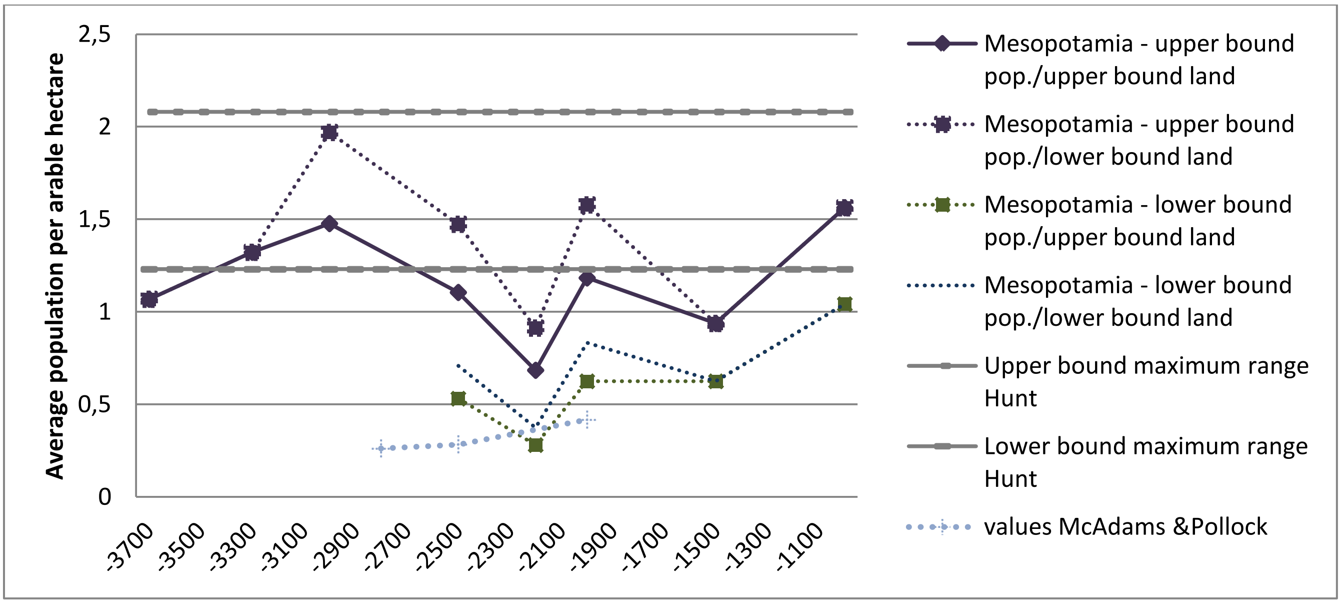
5.5.6 Comparisons along the interval time line

Now that for each civilization time series have been constructed for 'total arable land' the variable 'food output relative to resources' can be formed and is expressed in average population per hectare. However since for nearly all civilizations a lower and upper bound time series have been constructed for both 'total population' and 'total arable land', four estimates can be made for 'food output relative to resources'. Additionally, estimates of average population per hectare of other authors have been added as well. Hence as has been shown earlier, some time series for both the variable 'total population' and 'total arable land' are more reliable than others. The time series for 'food output relative to resources' that has been based on the most reliable time series for 'total population' and 'total arable land' will be represented by a solid line.

The following figure (5.29) displays the estimates for Mesopotamia. The time series of arable land that is used as upper bound is the composite time series that has been constructed in subsection 5.5.1.

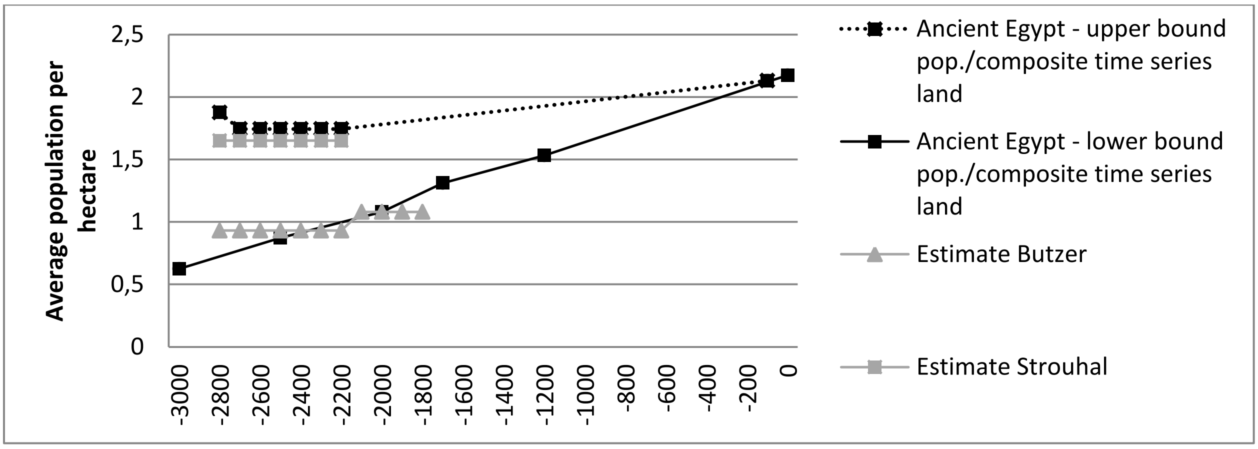
For the lower bound time series of arable land the time series based on McC. Adams is used. The most reliable time series has values in between values of more extreme time series. Additionally, the time series that is formed based of the most reliable estimates for both 'total population' and 'total arable land' accords also best with the range set by Hunt (1991). Hunt has set a range for maximum values that could have been achieved by Mesopotamia with respect to average population per hectare. The time series based on population density estimates of McAdams & Pollock lays substantially lower. Trigger however describes their estimates as quite conservative (2003).

Figure 5.29: Time series for 'food output relative to resources' – Mesopotamia



In the case of Ancient Egypt, two time series have been constructed with respect to average population per hectare. Only the composite time series on 'total arable land' has been used due to the firm methodological basis these estimates were based on. Additionally, population estimates of Butzer and Strouhal have been incorporated in the graph

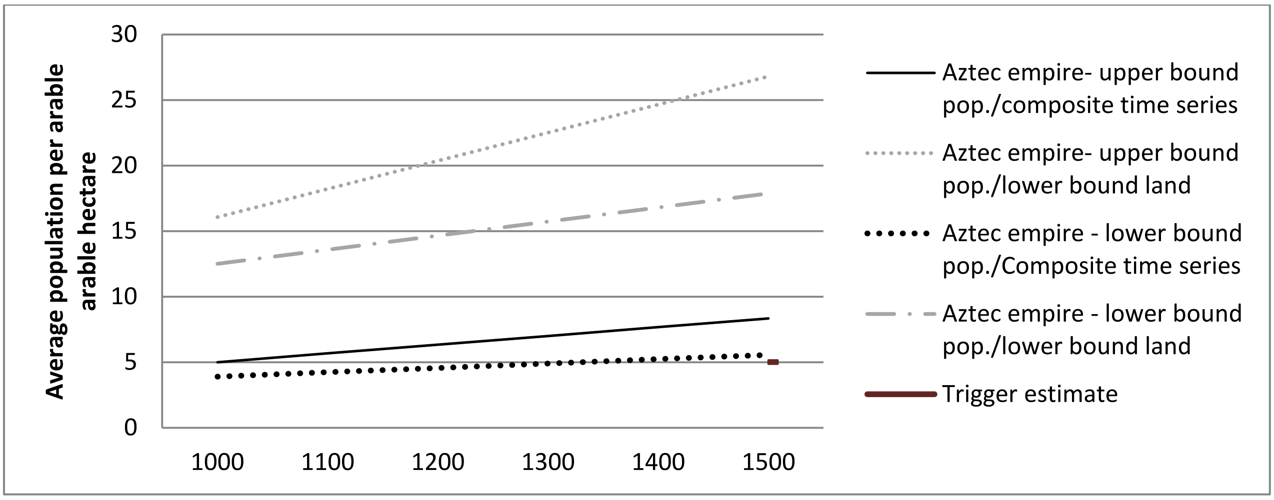
Figure 5.30 : Time series for 'food output relative to resources' – Ancient Egypt



The estimates of Butzer (1976) are close to the estimates on the time series that has been marked as most reliable. This is not a surprise since both use Butzer's data on total arable land. In the case of the estimates of Strouhal (1992), these are close to the other constructed time series. The reason is that both use the same data on total population.

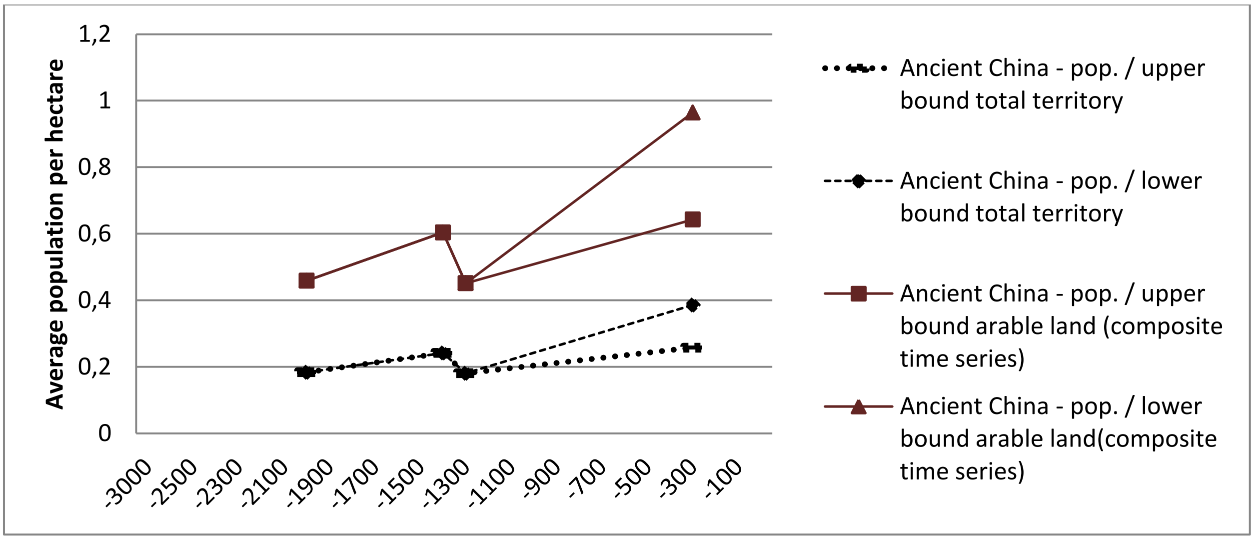
When plotting the data for the Aztec empire, it appears that the values are quite high. The time series that has been marked as most reliable is rather on the lower spectrum of values, close to the density estimate of Trigger (2003).

Figure 5.31 : Time series for 'food output relative to resources' – Aztec empire



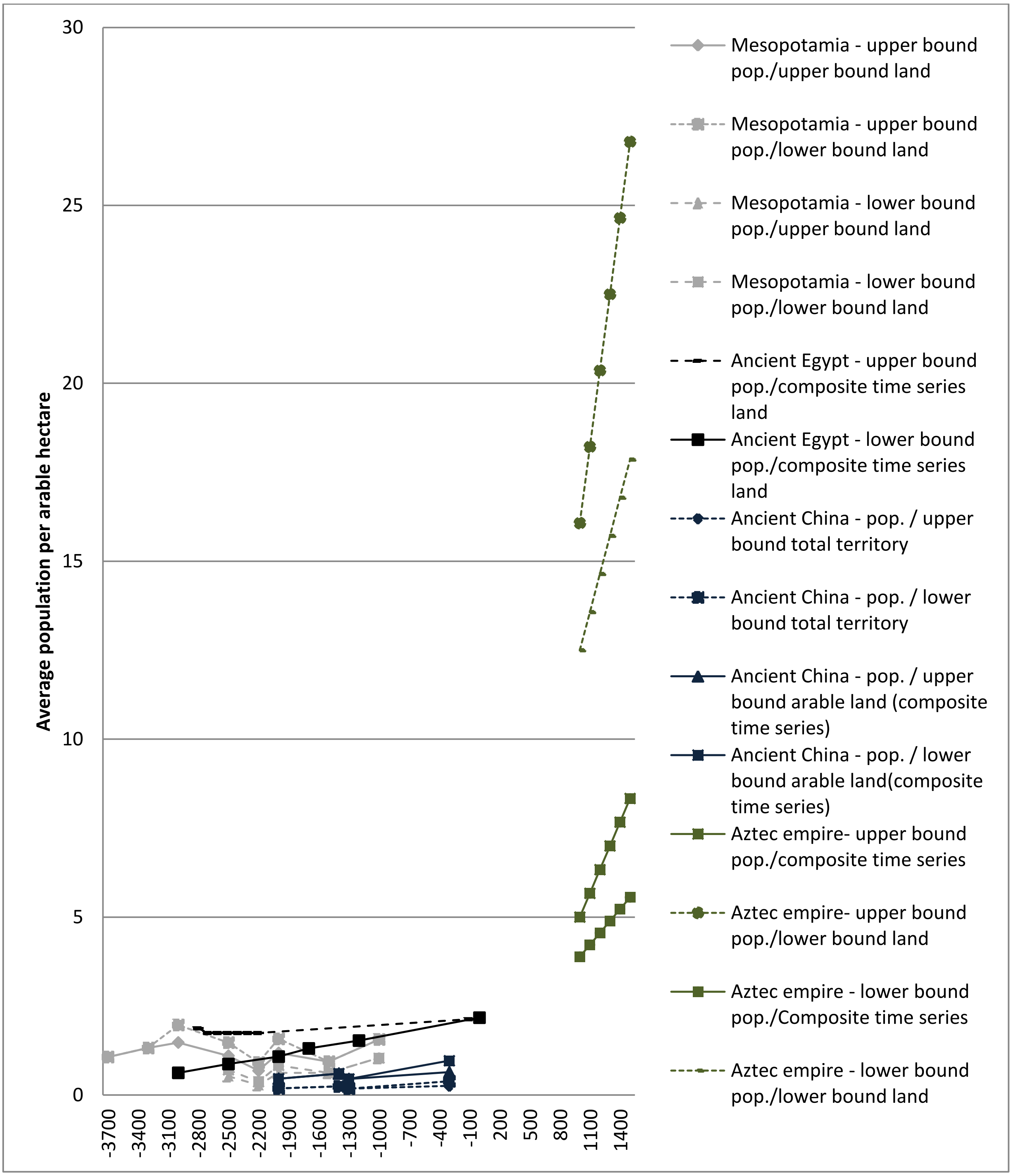
Finally before the civilizations will be compared with respect to 'food output relative to resources', the time series for Ancient China are presented here. Since Trigger (2003) only delivered estimates with respect to total territory, the two time series for 'food output relative to resources' which are based on the composite time series for total arable land are marked as most reliable

Figure 5.32 : Time series for 'food output relative to resources' – Ancient China



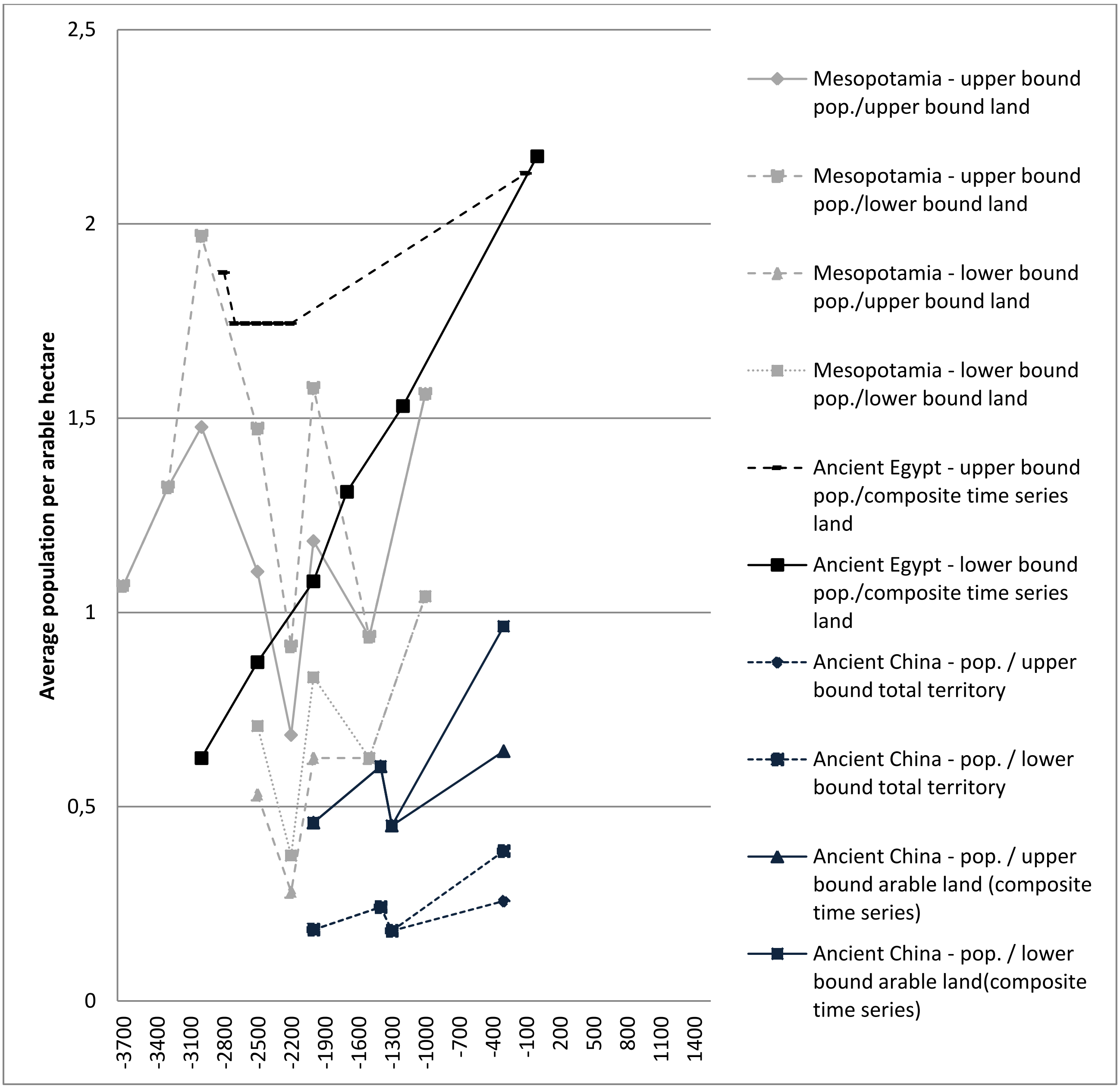
Combining the time series for 'food output relative to resources' for the different civilizations gives the overview graph displayed below (figure 5.33). The only thing that becomes clear from this figure is that, no matter which time series is chosen, the Aztec empire has the highest levels of food output relative to resources. However, the time series for the Aztec empire that is most reliable is not that far off of the time series of the other civilizations.

Figure 5.33 : Overview of the time series for 'food output relative to resources' of the different civilizations



The following figure (5.34) is more useful with respect to comparing the other civilizations with each other. The figure indicates that irrespective of using which time series for Ancient China, its values fall below that of the other civilizations. Nevertheless, the time series of Ancient China that are presented as most accurate (solid lines) do around 1400 B.C. approach the lower bound time series of Mesopotamia. The time series of Mesopotamia that is marked as most reliable (solid line) however stays at all times to quite some extent above that of Ancient China.

Figure 5.34: Time series for 'food output relative to resources' – excluding the Aztec empire

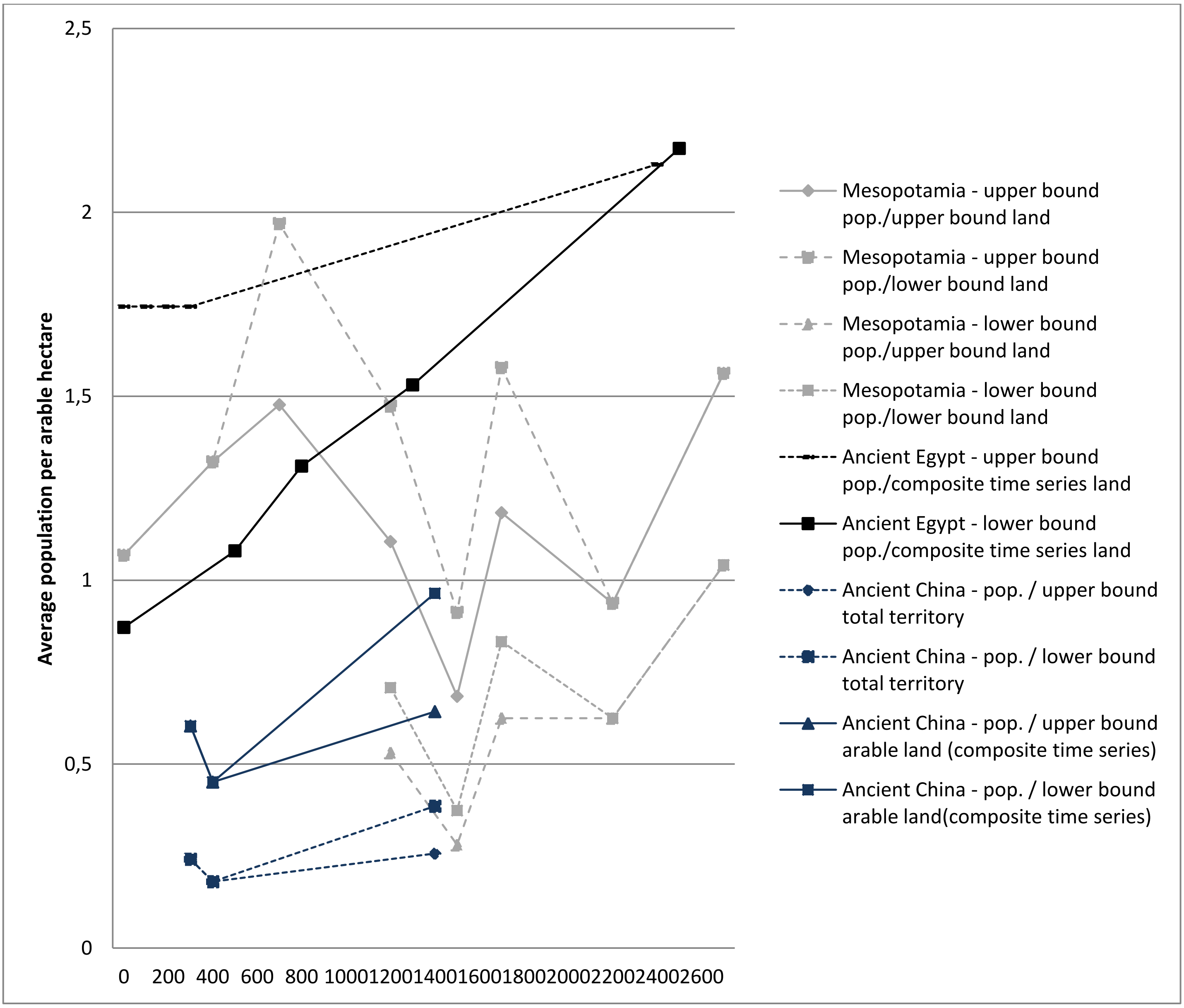


Opposed to the other civilizations, the trend line of Mesopotamia shows considerable more fluctuations. Secondly, the Mesopotamian time series that are most accurate do not appear to follow a positive, linear trend per see. The other civilizations on the other hand do appear to follow a quite stable, positive trend. Lastly, the time series for Mesopotamia and Ancient Egypt do overlap quite regularly. Due to the quality of the data it is difficult to state which civilization had at which point in time a higher 'food output relative to resources'. It seems however that somewhere in the second millennium B.C., Ancient Egypt starts having higher efficiency levels than Mesopotamia.

5.5.7 Comparisons along the ratio time line

A comparison along the ratio time line delivers some new insights. However before the civilizations are compared, the time series of the Aztec empire are excluded since the values are at any point in time so much higher that every detail in the graph gets lost.

Figure 5.35: Time series for 'food output relative to resources' along the ratio time line – Excluding the Aztec empire



Comparing the remaining civilizations reveals that at any point in time after the start of state formation processes, Ancient China has had lower levels of 'food relative to resources' than Ancient Egypt. Less firm statements can be made when Ancient China is compared with Mesopotamia. When only looking at the time series of both civilizations that are presented as most accurate, it appears that only around 1400 years after their initial formation Ancient China reaches approximately the same levels of 'food relative to resources' as Mesopotamia. Hence when looking at the lower bound time series for Mesopotamia, these are lower than the most reliable time series for Ancient China. Due to the fact that several time series for Mesopotamia and Ancient China overlap, it is not possible yet to state a strong conclusion. Differences between Mesopotamia and Ancient Egypt are more clear. Approximately thousand years after their initial formation, Ancient Egypt appears to surpass Mesopotamia with respect to efficiency levels.

The question remains how it is possible that Ancient China could expand its total food and non-food output so rapidly in the first millennium B.C. while at the same time ranking rather low with respect to productivity. An explanation might be that compared to the other civilizations in this research, arable land could relatively easily be added to the existing resource pool either due to conquest or natural availability (Trigger, 2003). Thus, it is likely that the high societal economic performance levels are particularly due to the relatively easy access and large availability of natural resources in the form of arable land instead of high levels of efficient resource use. Nevertheless, further research would be needed to confirm this.

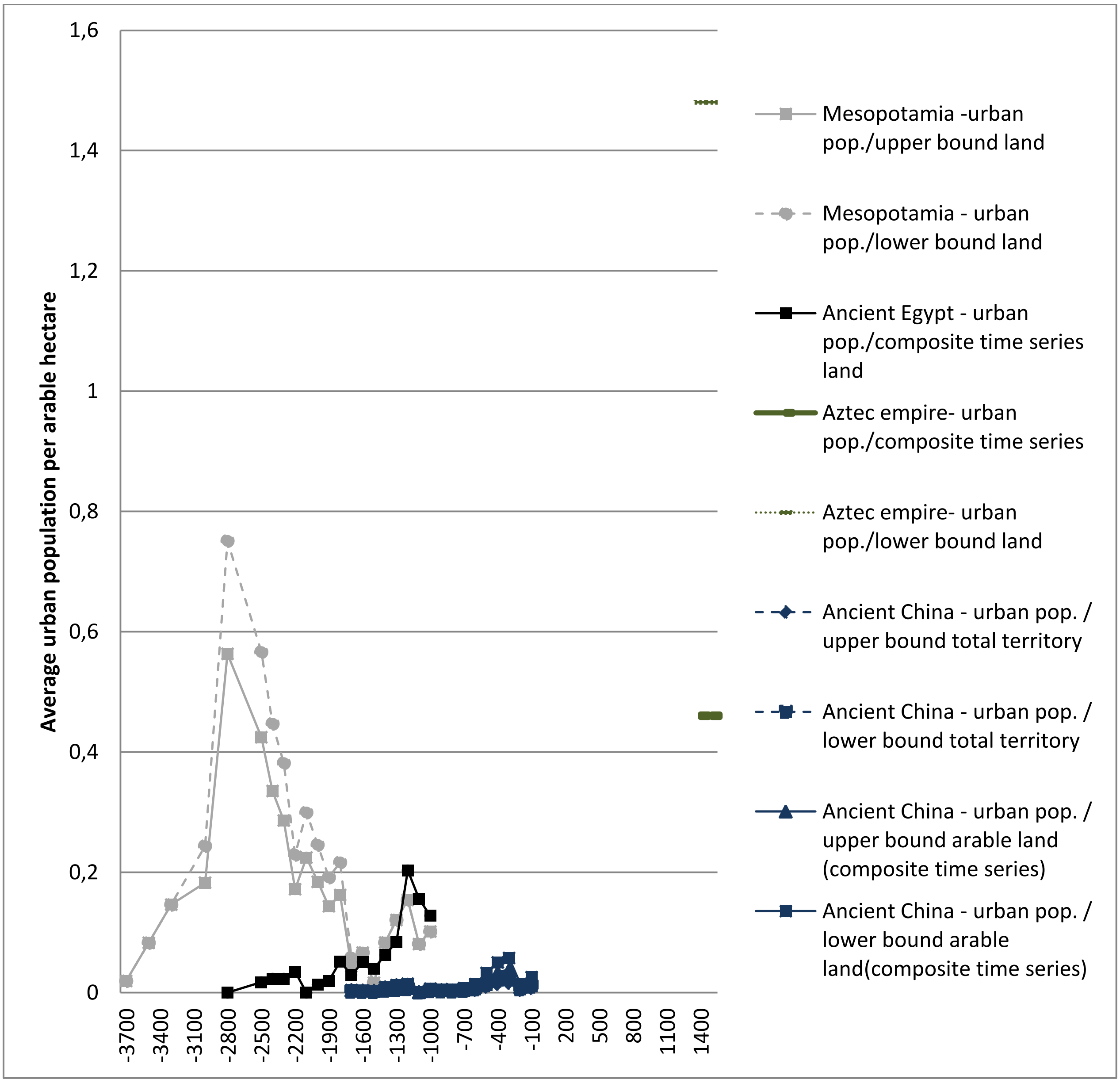
5.6 Economic efficiency II: baselines of total non-food output relative to resources

The same type of analysis will be conducted with respect to non-food output. In contrast to 'food output relative to resources' the differences between the civilizations are more clear.

5.6.1 Comparisons along the interval time line

The overview graphs shows that up to 1800 B.C. Mesopotamia had by far the highest non-food output relative to resources. From 1800 to 1000 B.C., Mesopotamia and Ancient Egypt have approximately the same levels. However, these levels are lower than what Mesopotamia had reached in the previous period. Irrespective of what time series is used for Ancient China, its time series are substantially lower than that of the other civilizations. As for the Aztec empire, when using the most reliable estimate it appears that its non-food output relative resources was approximately at the same level as the higher spectrum of values for Mesopotamia. Hence, the upper bound time series of the Aztec empire lays to quite some extent above all time series of the other civilizations.

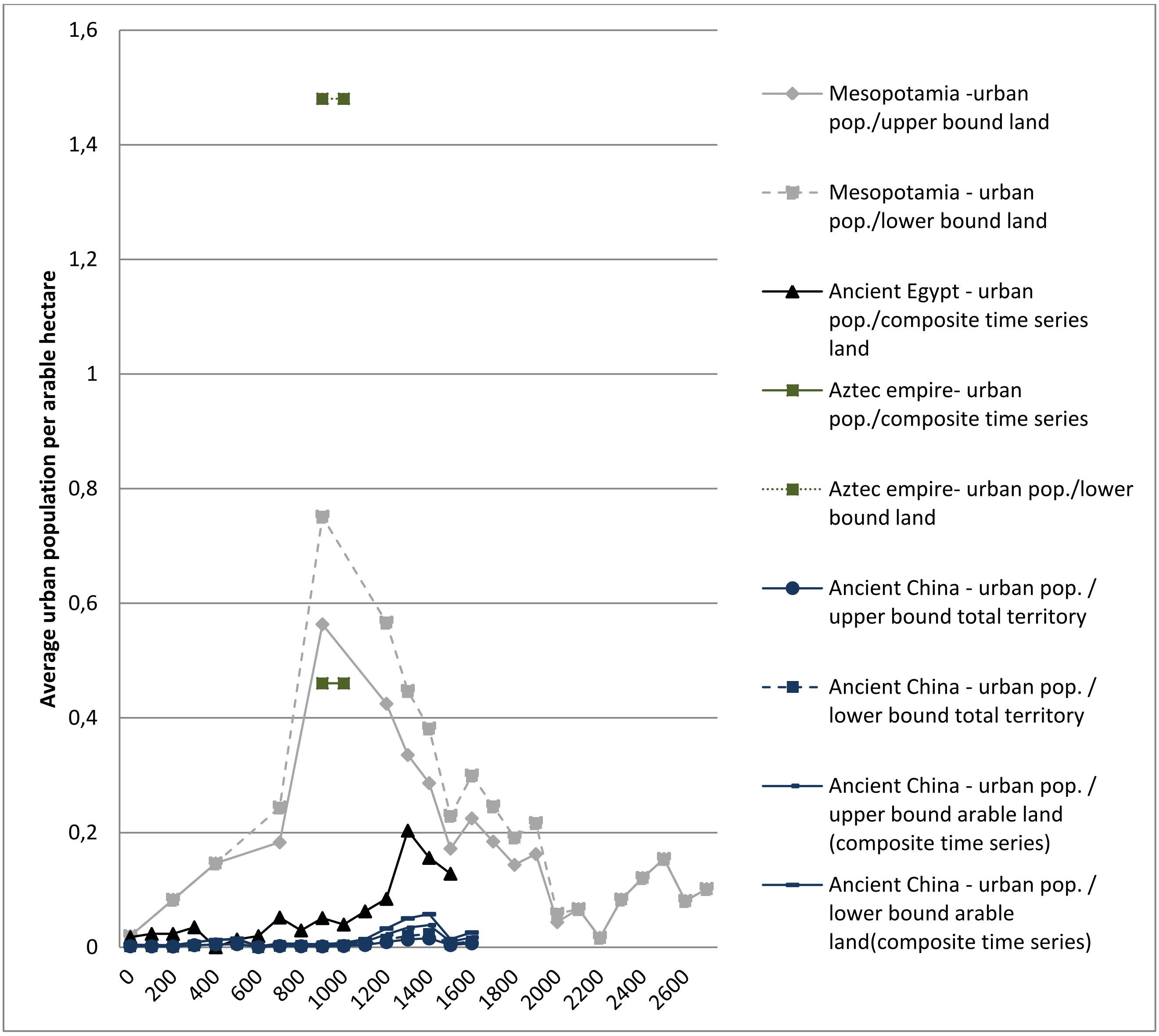
Figure 5.36 : Overview of the time series for 'non-food output relative to resources' of the different civilizations



5.6.2 Comparisons along the ratio time line

Comparing the civilizations along the ratio time line indicates an interesting pattern. All civilizations seem to follow a pattern of gradual increase with respect to non-food output relative to resources in the first period after their formation. From 700 onwards in the case of Mesopotamia and from around 1200 onwards for the territorial states of Ancient Egypt and Ancient China, values increase for a short period of time at a higher pace. After these short periods of faster increase, all civilizations start to encounter only decline in levels of non-food output relative to resources.

Figure 5.37 : Time series for 'non-food output relative to resources' of the different civilizations along the ratio timeline



5.7 A growth accounting exercise

As final part of the analysis, a growth accounting exercise will be conducted whenever data quality is high enough to allow such an exercise. As for the Aztec empire, no data has been available to conduct such an analysis. More information over a longer time span is needed on population numbers and developments in the amount of arable land.

In the literature review section an aggregate production function for pre-industrial civilizations was transformed into an equation reflecting the impact of proximate sources on individual economic performance (GDP per capita): $g_{GDP\ per\ capita} = \varphi + \alpha\ g_X - \alpha\ g_L$, in which φ stands for productivity growth (either through enhanced efficiency or technological improvements). Additionally, the partial output elasticity of land is estimated to be around 1/3 and that of labor to be 2/3 (Kremer, 1993). Implementing, these values gives the following function:

$g_{\text{GDP per capita}} = \varphi + 1/3\ g_X - 2/3\ g_L$

From this formula follows that income per capita growth in preindustrial civilizations could either be induced by increases in the total amount of land, a decline in population, or by productivity enhancements (Weil, 2013).

Weil used this formula with the same elasticities for land and labor to conduct a growth accounting exercise, and came to the annual growth rates of productivity for Europe in previous millennia as shown in the following table.

Table 5.6 :A growth accounting exercise for Europe from 500-1700 A.D.

Period	Annual Growth Rate of come per Capita, $\hat{Y}$	Annual Growth Rate of Population, $\hat{L}$	Annual Growth Rate of Productivity, $\hat{A}$
500–1500	0.0%	0.1%	0.033%
1500–1700	0.1%	0.2%	0.166%

Source: Weil (2013)

The same exercise can be conducted for Mesopotamia, Ancient Egypt, and Ancient China in order to estimate average annual growth rates of productivity. However, one assumption has to be made, namely that average annual GDP per capita growth equaled zero. This assumption is made out of necessity since no data is available on GDP per capita for the civilizations. As already stated in the theory and literature review section, GDP per capita in food terms not necessarily declined with population increases and could even increase. Additionally, as shown in section 5.3 non-food output per capita fluctuated significantly. Though it is thus likely that GDP per capita could (positively) diverge from bare subsistence levels, this cannot be taken into account yet in the calculations. Therefore, the estimated average annual productivity growth rates can rather be seen as lower bound estimates due to the assumption that GDP per capita was continuously at bare subsistence levels.

First, a growth accounting exercise for Mesopotamia has been conducted. The blue column in the table displayed below gives the values for average annual productivity growth for several periods that can be compared with the data of Weil (2013) since the same partial elasticities are used. During five of the seven displayed periods, Mesopotamia had a higher average annual productivity growth than Europe during the Middle Ages and the early modern period with growth rates ranging from 0,335 to

0,672 percent. This means that Mesopotamian productivity growth was in these periods two to four times higher than productivity growth in Europe during the early modern period. What also can be noted is that during two time intervals, average annual productivity growth was negative. Especially the period 2500-2200 B.C. reflects a sharp decline in average productivity.

Table 5.7: A growth accounting exercise for Mesopotamia

Period	**Annual growth rate of GDP per capita**	**Annual growth rate of population**	**Annual growth rate of land**	**Annual growth rate of productivity X = 1/3 L= 2/3**	**Annual growth rate of productivity X = ½ L = ½**	**Annual growth rate of productivity X = 2/3 L= 1/3**
3700-3300 B.C	0	1,008	0,000	0,672	0,504	0,336
3300-3000 B.C.	0	1,013	1,012	0,338	0,001	-0,337
3000-2500 B.C.	0	1,007	1,008	0,335	0,000	-0,336
2500-2200 B.C.	0	-1,008	1,013	-1,010	-1,010	-1,011
2200-2000 B.C.	0	1,024	1,015	0,344	0,004	-0,335
2000-1500 B.C.	0	-1,007	-1,006	-0,336	0,000	0,335
1500-1000 B.C.	0	1,008	0,000	0,672	0,504	0,336

Though these numbers can be used in a comparative fashion to indicate relative differences between time periods and civilizations, in absolute terms they are less reliable. Changing the values of the partial output elasticities as a robustness check shows that the outcomes are quite sensitive to the values chosen. When partial output elasticities of one half are used, in three of the five periods that had earlier relatively high positive values the numbers come close to zero. This effect is even stronger when the initial values for the output elasticities of land and labor are reversed. In three periods were earlier growth in productivity was positive, it becomes negative and in one period that productivity was negative it turns positive. Weil (2013) does not apply this robustness check for Europe, thereby making it difficult to determine the reliability of his results in absolute terms.

The following table (5.8) shows the outcomes of the same growth accounting exercise for Ancient Egypt. It shows that in all five periods Ancient Egypt has had higher average annual productivity growth than Europe in the Middle Ages and early Modern period. From 2000 to 1200 B.C. this average productivity growth was approximately four times higher than that of Europe in the early modern period. Though it has to be noted that these growth rates are still small compared to modern standards, they are higher than have ever been imagined for a primary civilization.

Table 5.8 : A growth accounting exercise for Ancient Egypt

Period	Annual growth rate of GDP per capita	Annual growth rate of population	Annual growth rate of land	Annual growth rate of productivity X = 1/3 L= 2/3	Annual growth rate of productivity X = ½ L = ½	Annual growth rate of productivity X = 2/3 L= 1/3
3000-2500 B.C.	0	1,008	1,004	0,337	0,002	-0,333
2500-2000 B.C.	0	1,007	1,004	0,337	0,001	-0,334
2000-1700 B.C.	0	1,011	0	0,674	0,505	0,337
1700-1200 B.C.	0	1,007	0	0,671	0,504	0,336
1200-0 B.C.	0	1,003	1,003	0,335	0,0003	-0,334

When changing again the partial output elasticities as a robustness check, it shows that the results for Ancient Egypt are more firm in absolute terms than those of Mesopotamia. The period 2000 to 1700 B.C. keeps standing out as having high average annual productivity growth of at least twice the size of Europe in the early modern period. Nevertheless, for the other periods results change quite drastically implying that the results in absolute terms are less reliable.

Since for Ancient China data was more sparse, only for three periods average annual growth rates of productivity could be calculated. During each period, average productivity growth was positive and approximately twice as large as average productivity in Europe in the early modern period. However, these results appear to be very sensitive to which output elasticity is used: with partial elasticities of one half, average annual productivity growth nearly equals zero, and when partial elasticities for labor and land are reversed productivity growth turns negative.

Table 5.9: A growth accounting exercise for Ancient China

period	Annual growth rate of GDP per capita	Annual growth rate of population	Annual growth rate of land -lower bound	Annual growth rate of land - upper bound	Annual growth rate of productivity	Annual growth rate of productivity X = ½ L = ½	Annual growth rate of productivity X = 2/3 L= 1/3
3000-1200 B.C.	0	1,003	1,002	1,002	0,335	0,000	-0,334
1200-400 B.C.	0	1,007	1,006	1,007	0,336	0,001	-0,335
400-0 B.C.	0	1,011	1,005	1,005	0,339	0,003	-0,333

To conclude, what needs to be emphasized with respect to the results of these growth accounting exercises is that the numbers are lower bound estimates of actual average annual productivity growth.

As stated before, GDP per capita has likely fluctuated instead of being constantly at bare subsistence levels. However since no data on GDP per capita has been available, for these exercises it was assumed to be at bare subsistence levels. Another important point that has to be made is that productivity growth and growth of arable land has been positively related in various cases. Especially in the case of Ancient Egypt, increases in land were mostly due to technological improvements with respect to irrigation. In Mesopotamia and Ancient China, increases in land were also regularly due to positive developments in irrigation practices. Hence, conquest played a significant role in these civilizations with respect to increasing the stock of total arable land as well. What these examples show is that in various cases average annual productivity has actually been higher than displayed in the tables due to the fact that increases in arable land were itself the results of technological innovations.

CHAPTER VII: Conclusion and discussion

During this research, the economic context took shape in which the impressive architectural achievements of primary civilizations could arise. It is this legacy that hinted at increasing economic performance levels and organizational complexity, however no one actually tried to *measure* these performance levels. It is even the case that in many disciplines, especially in mainstream economics, the idea still proliferates that before the 18th century and at most before 1000 CE "nothing happened". This image has been based on economic performance levels of Western Europe during the Middle Ages which has then been generalized for other regions and preindustrial periods. The main conclusion of this research is however, that economic growth ánd decline were far from nonexistent in preindustrial societies. Even before the existence of secondary civilizations as Ancient Greece and Ancient Rome, significant economic growth and decline processes took place in primary civilizations both with respect to total food and non-food output and non-food output per capita.

These results confirm and extend the view that has emerged from research on secondary civilizations with respect to the broad, generalized nature of economic performance: advancement in economic performance does not seem to be a gradual, linear process as has been thought previously but rather a 'bumpy' one, reaching peaks in primary civilizations which only became attained again and probably surpassed in secondary civilizations hundreds or even thousand years later whereas economic performance levels of secondary civilizations which reached a height in the Roman empire became only surpassed again nearly two thousand years later in 18th century England. Additionally, the fact that most of these primary civilizations are located on different continents indicates that these initial economic growth and decline levels are not bound to a specific region but rather appear to be a more universal phenomenon.

However by distinguishing different components of economic performance based on different linkages to general individual wellbeing (fig. 3.20), even more detailed insights could be acquired with respect to the nature of economic performance in primary civilizations. The framework that enabled to give these more detailed insights was the outcome of answering the first sub question of this research which entailed "How to go 'Beyond GDP' and translate the concept of economic performance into indicators where archaeological data is available for?". With the more general definition of economic performance and with the developed methods for measuring economic performance in Economics, it appeared impossible to research and understand the economic performance dynamics in primary civilizations.

Combining theory on economic performance from different disciplines denoted that two important distinctions needed to be made: between individual and societal economic performance, which could then be further subdivided into food and non-food output (per capita). In the chapter 'research design' these components were then translated into indicators where archaeological data has been available for. This interdisciplinary framework in itself is one of the outcomes of this research since it deepens the concept of 'economic performance' and enables one to reflect differences between preindustrial and industrial on several scales instead of presenting them as stark dichotomies. This framework can be seen as an approach to overcome compartmentalization and to head towards explaining performance characteristics of societies through time.

With the framework in place, the subsequent two sub questions of this research could be answered. A short summary will be given of the main economic performance characteristics of each civilization and how these compare to those of the other civilizations. First, a profile of Ancient China with respect to economic performance is outlined. Focussing on societal economic performance, Ancient China ranks highest on total food output during its entire existence with differences with the other civilizations becoming especially large from 1000 B.C. onwards, feeding a population of around 52,5 million people in 0 A.D.. With respect to the total non-food output component of economic performance, Ancient China does not rank particularly high initially, however, from 600 to 300 B.C. it reaches levels of total non-food output that have been unprecedented before. In 300 B.C., around 2,02 million people live in cities, approximately four times as much as the highest values reached by Ancient Egypt and the Aztec empire. Ancient China's societal economic performance levels both in terms of food and non-food output were thus exceptionally high for those times, especially in the first millennium B.C..

Linking this to theory from political demography and international relations, this seems to imply that Ancient China had a high level of (potential) political and military strength influencing the general wellbeing of its inhabitants through the safety aspect. Additionally, the relatively high potential tax base this seems to suggest could also have been used to invest in other public factors that relate to general individual wellbeing. Hence, when looking at individual economic performance with respect to non-food output per capita, the image reverses. Compared to the other civilizations, Ancient China ranks lowest during its entire existence with urbanization ratios as a proxy varying between one and six percent.. Further research would be needed to determine whether these relatively low levels of non-food output per capita were a tradeoff of the relatively high societal economic performance levels. Another remarkable feature is that Ancient China ranks lowest both with respect to food and non-food output relative to resources, ranging between values of 0.4-0.9 and 0.004-0.058 of average population and urban population per arable hectare respectively. Also with regard to these variables the connection with the high societal economic performance levels requires further research though an explanation might be that arable land was relatively easily added to the existing resource pool either due to conquest or natural availability. Thus, it is likely that the high societal economic performance levels are particularly due to the relatively easy access and large availability of natural resources in the form of arable land instead of high levels of efficient resource use.

An overview of economic performance levels of Mesopotamia appears to give the inverted image as sketched previously for Ancient China. Where the food output component of societal economic performance was highest for Ancient China during its entire existence, total food output for Mesopotamia ranked lowest compared to the other civilizations. Over time, total food output rose to feed initially around half a million to in the end two million people, though values fluctuated over time. Only in the period that Mesopotamia was the only existing civilization it obviously ranked highest but these levels were later quickly surpassed by the other civilizations. With respect to the total non-food output component of societal economic performance, Mesopotamia had on average quite high performance levels for extended periods of time, not far below the performance levels of Ancient Egypt and the Aztec empire in their heydays. Nevertheless, its highest reached level with an urban population of 400.000 people falls below the highest levels of the other civilizations, even though on average over extended periods of time it does seem to have a higher value than Ancient Egypt and the Aztec empire.

When looking at individual economic performance levels, again the reversed image appears as for Ancient China. Though fluctuating heavily, highest levels of non-food output per capita have been reached in Mesopotamia with the most reliable estimates of urbanization as a proxy ranging between 0 and 38,4 percent. Even when taking into account that potentially a higher fraction of the urban population in Mesopotamia was farmer than in the other civilizations, these urban ratios are quite high and probably higher than that of other civilizations.

In the light of the available resources, the societal economic performance levels Mesopotamia reached are relatively high. Though Mesopotamia has reached lower levels of total food and non-food output than the other civilizations, it did use it's available resources quite effectively. With respect to 'non-food output relative to resources' it reaches far higher levels than the other civilizations, even over extended periods of time. Only with respect to the Aztec empire it is unclear whether Mesopotamia has reached higher levels since for the Aztec empire only two point estimates are available for one point in time giving a large range in which the true value might lie. When looking at food output relative to resources, Mesopotamia scores lower than the Aztec empire, but appears to rank second together with Ancient Egypt most of the time. Only during the second millennium B.C., Ancient Egypt starts having more clearly higher efficiency levels than Mesopotamia.

Overall, Mesopotamia thus likely had the lowest potential political/military strength in comparison with the other civilizations. However during the period that it was the first and only civilization in the world its potential military strength must have been unique if the different city-states not fought each other but joined forces. Additionally, non-food output per capita was high, especially with respect to the natural resources in the form of arable land that were available. Also, total food output was relatively high when looked at the resource availability.

Thirdly, a short summary of the economic performance characteristics of Ancient Egypt is presented here. Overall, Ancient Egypt has a profile of less extremes with respect to the different components of economic performance. When looking at societal economic performance levels, during its entire existence Ancient Egypt ranks higher than Mesopotamia but lower than Ancient China and the Aztec empire with respect to total food output, feeding initially a population of around one million which gradually without large interruptions increases to 4,9 million. With regard to total non-food output, it changes rank several times with the other civilizations. However with respect to highest reached level of total non-food output, it ranks second with the proxy variable 'total urban population reaching a value of 0,445 million. Focusing on the non-food component of individual economic performance, Ancient Egypt has a relatively high value for the highest reached level namely an urban ratio of 14.8 percent, ranking second behind Mesopotamia. Taking into account the available natural resources in the form of arable land, Ancient Egypt scores quite high with respect to food output relative to resources: it shares the second place with Mesopotamia below values of the Aztec empire but above those of Ancient China. Looking at the most reliable time series, food-output relative to resources in terms of average population per arable hectare steadily increased from 0.6 to around 2.2. When looking at non-food output relative to resources it scores lower: Most of the time Ancient Egypt ranks third with a highest value of 0.2, only surpassing Mesopotamia on the relative time line when Mesopotamian civilization starts declining.

Presenting an overview of economic performance dynamics of the Aztec empire is more difficult since for most indicators no time series could be constructed and only one point estimate has been available. However with regard to total food output, time series could be constructed and imply that the Aztec empire reached the second highest level, feeding a population of approximately 7.5 million people. As for the non-food output component of societal economic performance only one estimate is available for the year 1500 A.D. With 'total urban population' as a proxy for total non-food output it has approximately the same level as the highest levels reached by Mesopotamia and Ancient Egypt. However, for the Aztec empire it is unknown whether previously higher levels were reached or that this number also represents a peak. Also, with regard to the non-food component of individual economic performance only two point estimates are available for the year 1500 A.D. The urbanization ratio that serves as a proxy has a value between the 5.5 and 8.3 percent, making it likely that the Aztec empire has reached higher non-food output per capita than Ancient China but lower than the levels reached by Ancient Egypt and Mesopotamia.

The most remarkable outcome for the Aztec empire is maybe that it reached by far the highest levels of food-output relative to resources, namely having a average population per arable hectare between 3.9 and 5.6 for the lower bound time series. Even using this lower bound time series which is marked as most reliable still gives that the values the Aztec empire reached are two to three times higher than the highest value reached by Ancient Egypt and Mesopotamia and even four to six times higher than those reached by Ancient China. Also with respect to 'non-food output relative to resources' the Aztec empire ranks high. The interval wherein the true value might lie based on two point estimates for the year 1500 A.D. is however large, making it unclear whether the Aztec empire ranks first or second just behind Mesopotamia.

Besides these short overviews of performance characteristics of the different civilizations, some general remarks can be made with respect to the nature of the different components of economic performance accompanying the rise of primary civilizations. Especially when using the re-constructions which are made along the ratio timeline, some patterns are becoming apparent. First of all, the food output component of societal economic performance appears to follow a positive linear trend over time for most civilizations. In the case of Ancient China, this trend even tends to a exponential pattern whereas in the case of Mesopotamia at some point in time it becomes hard to indicate a pattern at all. The non-food output component of societal economic performance on the other hand, shows substantial more volatility. Hence, it should be noted though that this might also be partially due to a higher availability of data for non-food output than for food output. Most remarkable however is that in the case of Ancient Egypt, Mesopotamia, and Ancient China, growth in non-food output seems to follow an exponential function up to around 1200 to 1400 years after their initial formation. In the period thereafter all civilizations start experiencing declines in non-food output levels. The most resemblance in patterns however can be found with respect to the non-food output component of individual economic performance. All civilizations experienced substantial volatility in the first 1000 years after their initial formation. Thousand years after the initial formation non-food output per capita of the three civilizations grows more fast and reaches for each of them the highest peak between 1200-1300 years after the initial formation. From then on, the three civilizations were data is available for appear to experience again the same trajectory: non-food output per capita starts to (gradually) decline.

Unlike the previous sub questions the last sub question is explanatory in nature instead of descriptive. The results of the growth accounting exercises show that the assumption that economic growth in primary civilizations was either be caused by decreases in population numbers or increases in total arable land (e.g. due to conquest) is likely not true for several periods and for several civilizations. Especially for Mesopotamia and Ancient Egypt, the evidence for several periods is robust enough to ascertain that on average significant productivity growth took place. Though it has to be noted that these growth rates are still small compared to modern standards, they are higher than have ever been imagined for a primary civilization and certainly higher than productivity growth rates of Europe in the late middle ages and possibly even higher than in the early modern period.

To conclude, the previously summarized results can best be seen as preliminary and the outcome of a research project that is explorative in nature. Thence, much work still needs to be done. First of all, it would be important to test whether outcomes are the same when slightly different definitions are used for ‘civilization’ or ‘city’. Secondly, since both the data derived from McEvedy & Jones and Modelski play such an important role a more thorough analysis of the sources they used would be appropriate. Related to this comment is that the construction of a standardized method for calculating estimates would enhance the comparability of the data of different authors. In order to do so, knowledge need to gained on the way in which they constructed there estimates. A fourth improvement would be then to test the interrelatedness of the proxy variables for the economic performance components. Though no obvious correlations seem to be in place when looking at the data of the formed database it might be that data of some authors on different variables are based on each other. For example, an estimate of total population for a certain civilization might be the result of a multiplication of urban population numbers. Checking and controlling for this potential bias would enhance the reliability of the results. Lastly, since the literature review for this thesis only entailed a first exploration a more thoroughgoing literature review could expand the database significantly especially with regard to Ancient China and the Aztec empire. Additionally, the applied approach holds the potential to be extended over a broader scale and into later timeframes.

Nevertheless, even with current restrictions on data availability and data quality, some outcomes appear rather firm when taking into account the robustness measures that have already been undertaken. As described in the chapter ‘Analysis and results’, a substantial part of the outcomes even hold when constructing upper and lower bound time series or by changing partial output elasticities. Overall, the broad outlines appear to be sketched and what awaits is further modification and confirmation of these outlines. In the philosophy of Douglass North: one step forward has been made with respect to describing performance characteristics of societies through time and what awaits is explaining them.

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