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REVISITING ROMAN ECONOMIC GROWTH: PREDATORY POLICIES, SELF-SUSTAINING STRATEGIES, AND THE LIMITS OF NEO INSTITUTIONAL ECONOMICS

ABSTRACT

This paper critically examines the traditional perspectives on ancient economic growth, specifically the Malthusian and Smithian viewpoints, which emerged within the framework of Neo Institutional Economics (NIE). By delving into recent literature, the study highlights the limitations of these perspectives in providing a comprehensive understanding of macroeconomic dynamics and empirical evidence in the context of the Roman Empire. The paper argues that sustained economic growth in ancient Rome can be attributed to a hybrid model, combining predatory actions resulting from military conquests and long-term self-sustaining strategies centered around market mechanisms. These findings challenge the predictive power of the NIE approach in accurately capturing the complexities of ancient economic growth.

Keywords: Roman Empire; Economic Growth; Malthusian Trap; Smithian Growth; Neo Institutional Economics
JEL Classification: N13; N73; O40; P40

RIASSUNTO

Ripensare la crescita economica del mondo romano: furti, rapine, strategie di crescita endogena, e i limiti dell'approccio neo-istituzionale

L'articolo esamina in maniera critica le due interpretazioni dominanti sulla crescita economica del mondo antico, sviluppatesi all'interno del quadro teorico dell'Economia Neo-istituzionale: la prospettiva Malthusiana e quella Smithiana. Mediante un'esplorazione della letteratura più recente, questo studio evidenzia le criticità legate a queste due interpretazioni, soprattutto per quanto riguarda le dinamiche macroeconomiche e le evidenze archeologiche rilevate nel mondo romano. Da questo punto di vista, l'articolo propone una visione più sfumata, che attribuisce la crescita economica sostenuta del mondo romano ad un modello ibrido basato sia su attività

predatorie strettamente legate alle politiche di conquista militare, sia ad un'economia di mercato in grado di autosostenersi e riprodursi endogenamente. Queste conclusioni sottolineano le limitazioni dell'approccio neo-istituzionale di cogliere la complessità macroeconomica del mondo antico.

1. Introduction

Almost fifty years have passed since Moses Immanuel Finley (1973) revived the dispute between modernists and primitivists, placing it at the forefront of ancient history subjects. His influential work significantly impacted the scientific approach of ancient historians and shaped the interpretation of models of growth of ancient societies. However, the rivalry between modernists and primitivists predates Finley's work. Discussions regarding the political and economic organization of the Roman Empire compared to modern European states were already fiercely debated among scholars and philosophers in the 18th century. The debate continued throughout the 19th century, with proponents like Karl Bücher arguing that the ancient economy belonged to a primitive stage, while Eduard Meyer and Karl Julius Beloch emphasized the high levels of development in Greco-Roman antiquity similar to early modern capitalist economies[1]. These debates went dormant for the first part of the 20th century, but in the post-World War II period, there was a notable shift in the dominant view towards the modernist perspective. Scholars like Michael Rostovtzeff (1957) emerged as champions of this viewpoint, emphasizing the entrepreneurial and rational mentality of Hellenistic and Roman societies, elevating the Roman economy to unprecedented levels. However, Finley challenged this viewpoint in the 1970s, advocating the primitivist perspective for the next two decades, until almost the dawn of the 3rd millennium. This debate significantly shaped the study of the ancient economy, influencing how scholars perceive the texture and nature of economic growth in the Greek-Roman world[2].

Today, ancient historians universally reject this clear categorization: the evolution of societies and economies is considered more nuanced and is impossible to catalog with a binary or all-encompassing explanation[3]. The emerging framework of Neo Institutional Economics (NIE),

[1] Bücher and Meyer (1979).
[2] For a deeper exploration of this debate, see Ghio (2015).
[3] Nowadays, historians typically reject this categorization, although they are often indirectly affected by this distinction (Temin, 2006).

spearheaded by prominent scholars including Walter Scheidel, Ian Morris, and Richard Saller, goes beyond the binary perspective of the primitivist-modernist debate. This framework, focusing on the "rules of the game", recognizes and explores the coexistence of both less efficient and more efficient institutions, acknowledging that they can lead to different economic outcomes. Specifically, this framework tends to characterize the stabilization of the Roman hegemony under the Empire as the peak of Roman economic performance, contrasting it with the period of intensive wars and instability that occurred during the Late Republican period (Bang, 2009)[4].

While NIE provides a nuanced understanding of the Roman world economy, it remains faithful to the Malthusian interpretation of the preindustrial world[5]. In fact, the majority of ancient historians (but also economists), while acknowledging the influence of markets and the technological progress of the Roman world, contend that *per-capita* income stagnation caused by population growth would have hindered long-term economic growth. This concept is often referred to as the "Malthusian trap" (Galor, 2022; Scheidel, 2019, 2009; Temin, 2013; Goldstone, 2002). Within the NIE framework, only a minority of scholars, particularly those aligned with the New Economic Archaeology (NEA), emphasize evidence from the Late Republic and Early Roman Empire that challenges the prevailing Malthusian pattern, specifically stressing the role of markets in promoting economic growth as efficient institutions in a "Smithian" sense. These studies point to indications of growth in various aspects, including population, urbanization, trade volume, real wages, fertility rates, and pollution levels (Erdkamp, 2020, 2016, 2001; Wilson, 2011, 2009a, 2009b). Both views, however, tend to fail in systematically linking macro arguments, i.e., institutions, with macro empirical evidence. There is a fundamental tendency to collect thousands of micro cases of institutions that, in various ways, seem to be more or less aimed at economic performance. While this approach may be the best way to contemplate the immense complexity of the ancient world, it also obscures the overall picture.

This paper aims to present a comprehensive macroeconomic analysis of the economic growth experienced by the Roman Empire from the 1st century BC to the 2nd century AD. By examining a wide range of economic indicators and historical evidence, we investigate whether the Roman Empire achieved genuine economic growth or remained trapped in a Malthusian cycle. To

[4] On the role of institutions on economic growth in the contemporary world Zwane *et al.* (2021).
[5] For more information on the Malthusian interpretation of the pre-industrial world, interested readers may refer to the works of Clark (2007), Ashraf and Galor (2011), and Galor (2022).

answer this question, we first need to clarify the meaning of "sustained growth". Generally, most economists have wrongly used the term "sustained or intensive growth" to refer to industrial and capitalist growth in the Western world over the last two hundred and fifty years, roughly since the onset of the First Industrial Revolution in England. However, as Kuznets (1966) observed, growth was not limited to the industrial sector or an institutional framework based on private business. Growth could also emerge in the non-industrial sector and without business auspices. It is important to avoid reading the history of the world through the lens of modernity.

Therefore, for the purposes of this paper, we define sustained growth as an increase in both production and population, resulting in *per-capita* income growth, generated by an "epochal innovation" applied on a large scale to economic activities. This growth is not expected to be reversible due to structural causes (i.e., the inability to maintain an increasing population) but may be interrupted by exogenous factors such as natural disasters, epidemics, or geopolitical events, as long as they are not related to the underlying economic structure (Malanima, 2021; Mokyr, 2018, 2002). However, it can occur regardless of the driving sector or institutional framework. Therefore, without a predetermined (and arbitrary) quantitative threshold to differentiate between economic growth and non-growth, any form of rise in *per-capita* income, even if it is gradual and modest, that is fueled by innovation (in a broad sense) and applied to economic activities that exhibit no observable signs of reversibility, may be classified as sustainable. Conversely, we define non-sustainable growth as an economic performance that is stagnant or intermittent and shows reversible trends.

In the case of the Roman world, the revolutionary innovation was a hybrid combination of inclusive and extractive (for modern standards) institutions. The expansion and integration of markets, theoretically speaking, paved the way for the emergence of inclusive institutions under the political unification of the "Roman Eagle". However, these institutions were deeply rooted in the substantial capital investments and exploitative institutions inherent in the Empire-formation process, such as wars and conquests. This unique combination of exploitative institutions preceding the establishment of inclusive ones push toward commercial activities led to unprecedented levels of economic activity, fostering the expansion and integration of markets and specialization of labor.

In this paper, our focus will be on critiquing the most traditional perspectives on ancient

economic growth, particularly the emergence of the Neo-Malthusian and Neo-Smithian viewpoints within the NIE school. Following this, we will delve into the concept of sustained growth within imperial economies and introduce a new approach to comprehending this phenomenon. To conclude, we will summarize our findings and offer insights into the implications of our research.

2. Beyond Malthus and Smith: a critique of traditional perspectives on ancient economic growth

Neo Institutional Economics and the Malthusian Orthodoxy

The "primitivist" interpretation of the ancient economy suggested that the Roman world was characterized by adverse living conditions, constrained capital accumulation, stagnant technology, a completely irrational economic mindset prioritizing social status over rationality and governed by an urban elite engaging in unlawful exploitation of resources from rural areas (Finley, 1973). Despite numerous variants, this approach generally agrees with the prominence of the agricultural sector, mainly based on self-consumption, over other economic activities, evidencing the limited importance of manufacturing and trade and the general role of markets in ancient Rome[6]. For about 20 years, Finley's views gained considerable recognition as a new "orthodoxy", particularly among Anglo-Saxon scholars.

However, Finley was later challenged by his successor in Cambridge, Keith Hopkins. Like Finley, Hopkins advocated for a deductive model-based approach. However, unlike his predecessor, Hopkins preferred a combination of demographic modeling and Keynesian macroeconomics[7]. Building upon Hopkins' work, his student Walter Scheidel took this method to greater depths. At Stanford, Scheidel, along with Richard Saller and Ian Morris, successfully gathered a diverse group of international scholars critical of the Finleian model. Together, they developed a new synthetic framework based on New Institutional Economics. This framework provides a comprehensive approach that accommodates both a pessimistic perspective, emphasizing institutional inefficiencies, and an optimistic viewpoint, highlighting institutional efficiencies[8]. This approach is based on studies of more modern societies and centers its theory on the fundamental idea that markets require clear and respected rules of the game, which helps reduce

[6] See Temin (2006) for a critical view of primitivism.
[7] Hopkins (1980).
[8] See for example Scheidel *et al.* (2007).

what Douglass North referred to as "transaction costs"[9]. The suppression of piracy in the final decades of the Roman Republic, the diffusion of a "technology of measurement", the establishment of common metrological systems, and most notably, the creation of a unitary monetary zone and common legal rules, particularly in the realm of commercial law, were all significant contributing factors that led to a reduction in transaction costs.

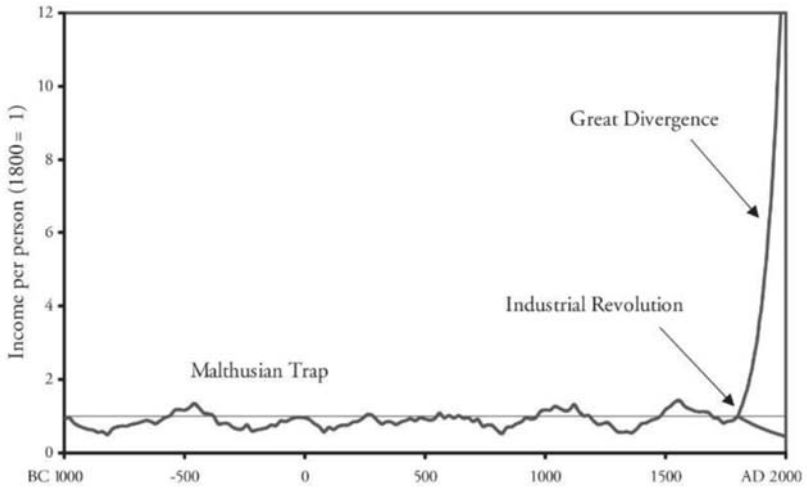
However, even though it may not be explicitly acknowledged, the notion of a non-growth orthodoxy has persisted in the study of the pre-industrial world within the framework of NIE. Indeed, while the primitivist view has been largely rejected by ancient historians, the Malthusian model, closely associated with it, has regained prominence among NIE scholars as the prevailing theory for understanding macroeconomic patterns in pre-industrial societies, including the Roman world[10]. This model suggests that sustained economic growth was impossible in pre-industrial societies due to the simultaneous occurrence of three dynamics: the preventive check (whereby fertility increases with *per-capita* income), the positive check (whereby mortality is inversely proportional to *per-capita* income), and diminishing returns for labor (whereby an increase in population leads to a fall in *per-capita* income due to fixed factors of production). As a result, any increase in productivity or income leads to a rise in population and a subsequent fall in income due to diminishing returns, resulting in a Malthusian long-run equilibrium (Clark, 2007; Lee and Schofield, 1981; Lee, 1973).

The reason why the Malthusian perspective remains prominent while primitivism has lost its influence lies in the crucial difference between these frameworks, particularly in their assumptions about economic rationality. As a neo-classical model, the Malthusian interpretation does not deny agents' economic rationality. The Malthusian stagnation is the result of technological and environmental constraints and economic irrationality is not a mandatory assumption. Under certain conditions, this crucial difference allows an alternative economic trajectory for pre-industrial societies. On the one hand, primitivism fundamentally denies any kind of economic growth in the ancient world, on the other hand, the Malthusian interpretation allows a certain kind of economic vitality in the short run, also called "efflorescence" (Goldstone 2002), while in the long run, both approaches entail economic stagnation. The discrepancy between the outcome of the short-term and of the long-term in the

[9] North (1991, 1994, 2005).
[10] Also known as "Neo-Malthusian model".

Malthusian model is related to the difference that exists between the notion of endogenous and exogenous economic growth. The concept of sustained economic growth concerns the ability of an economy to sustain itself "endogenously", while exogenous economic growth is fundamentally linked to temporary external conditions, such as the collection of tribute and spoils following wars of conquest, climate conditions able to boost agricultural productivity (good, but temporary)[11], sudden afflux of gold from subdued and controlled territories, etc. Naturally, this implies that when such external conditions shrink, then economic growth disappears, while in the modern self-sustained economy, growth is perpetual because it derives from structural conditions generated by an "epochal innovation" deeply rooted in the economic system (Mokyr, 2018, 2002; Kuznets, 1966). However, adopting this pragmatic approach, the Malthusian theory can validate the economic exceptions that happened throughout history, from the economic vitality expressed both in Classical Greece and in the Roman world to the economic performance in the Early modern age triggered by the great geographical discoveries at the end of 15th century. This pragmatic approach has made the Malthusian theory the mainstream for describing the economic performance of the pre-industrial world (Fig. 1).

FIGURE 1 - *World economic history in one picture. Incomes rose sharply in many countries only after 1800, while being trapped in the Malthusian stagnation from 1000 BC to the dawn of the Industrial Revolution, only occasionally interrupted by episodes of "efflorescence".*



Source: Clark (2007), p. 2.

[11] See Harper (2017).

Among the scholars who follow the Malthusian interpretation, we find Walter Scheidel (2019, 2009), who is also one of the founders of the NIE approach for the ancient world. He proposed a development model for the Roman Empire that attributes its growth primarily to military power, including the collection of tributes and spoils of war from conquered provinces. While Scheidel recognizes the importance of markets and innovation in the Roman world, he emphasizes the significant role played by military power in facilitating economic expansion and escaping the Malthusian constraint. However, according to the author, this was a temporary and exceptional period that would reach exhaustion with the end of the Empire's expansionary capacity, with the consequent fall in the Malthusian Trap. The author attributes the lack of sustained growth in the Roman Empire to the absence of political fragmentation and division of powers within the Empire. This led to a lack of "beneficial" competition, which hindered economic growth. In contrast, the post-Roman European miracle was characterized by strong interstate competition, fostering economic growth and innovation. This view is supported by Scheidel through the interpretation of ancient economic proxies that indicate the decline of the Roman Empire began before two major exogenous crises, the Antonine Plague and the 3rd-century crisis, suggesting that the Malthusian Trap occurred independently due to the Empire's inability to maintain population growth without further military expansion and resource exploitation (Scheidel, 2019, 2009).

However, there are potential flaws in this interpretation, both theoretical and methodological. Firstly, the NIE approach is primarily designed to explain more modern European pre-industrial societies, particularly those of the early modern age and occasionally the medieval period. Indeed, while there may be variations in scholars' interpretations, the NIE approach shares with neoclassical economics the belief that competitive free markets are crucial for promoting economic growth. From this perspective, empires inherently struggle to fulfill this requirement. The centralized and monopolistic nature of empires tends to restrict competition, potentially impeding sustained economic growth within the framework of NIE principles. As a result, the concept of transaction costs may be biased when applied to the ancient world. Generally, neo-institutionalists tend to view institutions that promote competitive free markets, such as political stability, a free labor market, and an effective rule of law, as beneficial, while considering wars, conquest, and monopolistic power as unfavorable for growth (Acemoglu and Robinson, 2012; North, 2005, 1994, 1991). While the first condition is partially important also for economic growth in the ancient world as well, the same cannot be said for the second condition

(Joshi and Beck, 2021). This is evidenced by the significant growth achieved during the Late Republic, despite frequent involvement in battles and military conflicts (Bang, 2009). The Roman world as a political unit does not always move towards inclusive institutions aimed at lowering transaction costs in modern terms. Instead, it is crucial to recognize that the Roman economy was intricately intertwined with its specific social, political, and cultural norms, practices, and institutions. The economic performance of the Roman Empire was heavily reliant on its ability to extract and utilize resources from its conquered territories, including staple crops, precious metals, and slave labor. At the same time, the Roman economy incorporated market-oriented practices that allowed for trade and commerce, facilitating the expansion of urban centers and specialized labor. The economic prosperity of the Roman world persisted over time despite its non-modern economic framework.

Secondly, it is worth noting that the assumption that sustained growth and efflorescence are mutually exclusive is flawed. While the decline of the Roman Empire may have begun before the onset of external crises, it does not necessarily mean that sustained growth was not possible. For example, while caution is advised when engaging in broader theoretical debates based on comparisons between the Roman and Chinese Empires, a recent study by Gao *et al.* (2021) suggests that sustained economic growth in China was not guaranteed, despite experiencing several periods of growth that were abruptly interrupted by exogenous events such as volcanic eruption. These events had a profound impact on weather patterns and, subsequently, on the stability of the ruling powers in 62 out of 68 dynasties over two millennia of Chinese history. Scheidel's argument faces a statistical issue referred to as reverse causality[12]. In this particular case, a decline can result in negative external events, but such events can also trigger a decline. Thus, it is possible that the decline of the Roman Empire was the result of a combination of various factors, including social, cultural, climatic, and political factors. These factors may have contributed to an external crisis that led to economic and demographic issues or vice versa. Moreover, it should be noted that these issues did not necessarily mean that economic recovery was impossible. In fact, historical examples such as the partial recovery of the Roman Empire following its 3rd-century crisis suggest that it is possible for economies to recover from such issues. If we define sustained growth as a long-term increase in economic output generated by an "epochal innovation" that is not easily reversible, then sustained decline triggered by structural

[12] "Endogeneity" is a frequently used term to describe this issue as well.

causes would be a long-term decrease in economic output that is similarly not easily reversible. Therefore, without a comprehensive analysis of all contributing factors, it is difficult to draw a definitive conclusion regarding the validity of the Malthusian model in the context of the Roman Era.

The Smithian Growth Model

Almost at the other end of the spectrum from the Malthus framework, we find Adam Smith's "optimistic" view about economic growth patterns, which is illustrated in the well-known book *The Wealth of Nations* (1776). This perspective has often been employed by a minority of scholars, especially economists interested in the ancient world, to argue for the exceptional nature of the Roman Empire's economic performance during the pre-industrial era[13]. The cornerstones of Smith's view are the division and specialization of labor, which are in turn stimulated by an increase in competition. The concept of competitive markets is strictly connected with the extension of the markets and their level of integration. According to Karl Gunnar Persson and Sharp (2015), the core of Smithian growth can be summarized as follows: specialization generated by the division and coordination of labor can lead to significant increases in labor productivity. This specialization is encouraged by the expansion of domestic markets (i.e., increases in population size and density) and strengthened market integration (i.e., higher levels of commerce). Thus, the essence of Smithian growth involves raising the overall production and productivity levels of land, labor, and capital by modifying the conditions of economic activities, without necessarily requiring significant innovation fueled by new energy sources. Market expansion and integration can be regarded as the starting point for Smithian growth (Grantham, 1999, 1993)[14]. Smith's famous statement,

"That the Division of Labor is Limited by the Extent of the Market" (Smith [1776] 2007, chapter III, pp. 18), encapsulates these phenomena.

In addition, the connections between remote geographical areas – with different climate conditions and natural resources (i.e., biodiversity, topography, presence of mineral deposits, pathogens, etc.) – further stimulate the regional specialization of labor[15]. However, this latter

[13] An exemplification of this perspective can be found in the works of Temin (2006, 2013).
[14] For a different interpretation see Bateman (2011), p. 466.
[15] For a complete overview of the relationship between geography and development see Sachs (2020), pp. 34-46.

dynamic should not be confused with a crude version of Ricardo's theory of "absolute advantage" (Schumacher 2012). Smith did not mean to elaborate a static theory based on the idea that

"countries are different in autarchy",

therefore they trade, rather, he suggested a dynamic theory. People trade because

"Trading is, quite simply, a more efficient means of producing" (Buchanan and Yong 2002, p. 400),

and this does not require any initial competitive advantages, just the expectation of the availability of gains from trade in general, which emerge as trade takes place. Consequently, the division of labor triggered by trade activities endogenously leads to an increased productivity level, which in turn encourages more trade and a deeper division of labor, creating a virtuous circle (Lampe and Sharp, 2019, p. 665). Bateman (2011) and Chilosi *et al.* (2013) demonstrated the usefulness of this model in explaining the economic performance of early Modern Europe.

In that perspective, the large geographical extent of the Roman Empire at its peak – from the 1st century AD to the middle of the 2nd century AD – the high level of population density and urbanization, the spread of efficient transport infrastructures, such as harbors and roman roads, and the presence of a suitable environment for trade following the *Pax Romana* and the clearance of the Mediterranean Sea of piracy by Gnaeus Pompeius Magnus are all prerequisites for Smithian growth[16]. Moreover, given the geographic characteristics of the Roman Empire, a high degree of regional specialization can plausibly be expected; the Empire was located in the "lucky latitudes" (i.e. locations with favorable climates) and comprised several climate zones (i.e. temperate, arid, and mountain)[17].

In the economic history literature, we find different conclusions that directly or indirectly support the Smithian growth model over the Malthusian view. Wilson, in several publications based on archaeological evidence, supports this view (Wilson 2011, 2009a, 2009b). However, his interpretation suffers from the same flaws as Scheidel's, as both adopt the same framework but arrive at different conclusions. Similarly, Paul Erdkamp (2020, 2016) attributes the ability to generate economies of scale to population growth, which, combined with market efficiency,

[16] Persson (2010), Sachs (2020) pp. 27-29 and Bottasso *et al.* (2022). For a critical view about the role of urbanization as driver to economic growth see Oddo and Zanini (2022).
[17] Sachs (2020).

allows for the avoidance of the Malthusian trap. Taking a strong neo-institutional approach, Temin (2013) argues that the modernization of Roman institutions and the presence of market economies probably enabled an increase in income due to the specialization of labor.

However, when applied to the ancient world, the Smithian framework is susceptible to misinterpretation, as the developments anticipated by this model ought not to be viewed as inevitable or automatic in nature. Indeed, it needs to incorporate many elements of modern Neo-Institutional economics, which emphasizes the importance of inclusive institutions[18] as a driving force for market competitiveness and economic success. The concept of inclusive institutions, which emphasizes factors like property rights, political participation, and equality under the law, may not accurately capture the complexities of economic dynamics in ancient societies. Applying modern criteria to evaluate ancient economic systems can overlook the unique social, political, and cultural contexts that shaped economic outcomes in the past.

In summary, while the Neo Institutional Economics (NIE) revolution was acknowledged for its beneficial contributions in incorporating both pessimistic and optimistic perspectives on the macroeconomic performance of the Roman Empire, it still has its limitations. On one hand, it tends to overlook the significance of extractive institutions in driving economic growth. On the other hand, it can overemphasize the role of inclusive institutions, potentially leading to anachronistic interpretations. This poses a challenge, especially for economists, as it may result in a distorted understanding of the economic dynamics of the ancient world.

3. The third road: imperial sustained growth

Identifying sustained economic growth from sporadic efflorescence can be a challenging task, as demonstrated in the previous section. In this paper, we propose a clear and simple alternative approach to this problem. Rather than relying on Scheidel's argument to negatively identify growth by its interruption due to an external crisis, which leaves room for uncertainty about the underlying causes of the decline and its link with the crisis, we offer a positive alternative. We aim to identify the triggers that contribute to economic performance, whether through market-oriented or predatory practices.

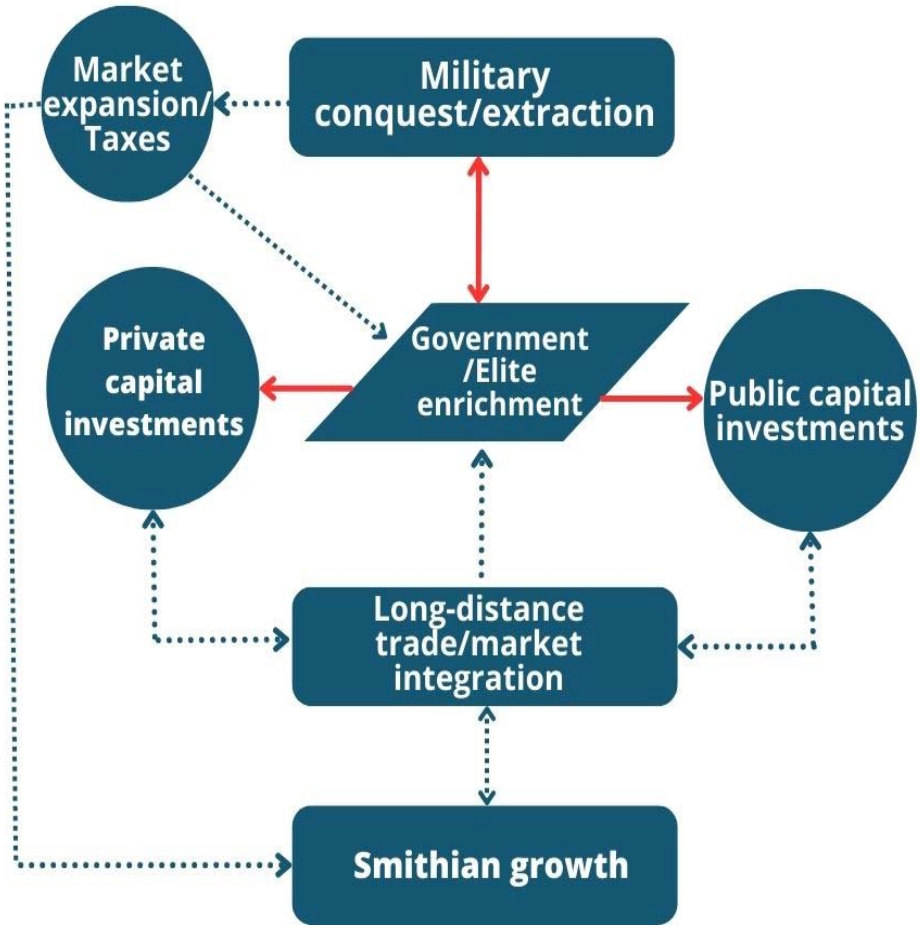
[18] Neo-institutionalists typically advocate for measures beyond promoting private property rights in order to reduce transaction costs. These measures may include the promotion of freedom of labor, democracy, and equality between individuals.

To achieve this objective, we distinguish between two types of dynamics both able to boost economic performance: short-term extraction and long-term self-sustaining economy. The former refers to depredation actions that occur after a military campaign, such as the loot, tribute, and indemnity of war. The latter encompasses the enduring effects of political unification and the creation of a unified economic region, such as enhanced market integration and the establishment of a balanced fiscal system. The rise of market integration promotes long-distance trade and specialization of labor, while a balanced fiscal system[19] supports public expenditure when revenues from wars are less effective. The interplay between these factors created a sustainable system of economic growth that was largely based on agriculture, taxation, and trade.

However, it is worth highlighting that while short-term military expansion and market-driven growth may appear to be distinct processes in the short run, they tend to complement each other over the long term. In fact, the economic benefits gained from both military conquest and public investments, as well as market-oriented growth, can reinforce each other. A prime example that exemplifies this process is the well-known Roman roads. While they were initially constructed for military purposes, over time they also became crucial infrastructure for economic activities. These roads facilitated trade, transportation of goods, and communication across vast distances within the Roman Empire. As a result, they played a significant role in fostering economic growth and integration of various regions. The transformation of the Roman roads from military infrastructure to vital economic networks demonstrates the complex interplay between military and economic factors in shaping the development of ancient societies.
Figure 2 provides a simplified representation of this complex phenomenon.

[19] The Roman authorities' approach to taxation was forward-looking, in the sense that they prioritized maintaining a stable and predictable level of revenue over imposing excessively high taxes on farmers. This perspective is discussed in detail in Verboven and Erdkamp (2022) and Kehoe (2022).

FIGURE 2 - *Imperial Sustained Growth Process*



Note: The red lines represent short-term extraction relationships and the dot green lines long-term self-sustaining economy.

Methodology

To identify these two different patterns (i.e., short-term and long-term), we use one of the most reliable data sources available for the Roman world: geographical extension. We have a clear understanding of the chronology of Roman conquests through historical sources, and given that geographical features have not changed in the past 2,000 years, we can estimate the geographical expansion, in square kilometers, of the Roman world century by century. We can expect that for each additional square kilometer (i.e., the Benefit driven by resources extraction from an extra square kilometer) that the Romans capture, *ceteris paribus*, they can acquire more resources[20].

[20] In mathematical terms, the Marginal Benefit of Expansion can be defined as $B_{E_t} = 1 - \frac{\Delta R_t - \Delta Km_t}{\Delta Km_t}$. Where B_E

Therefore, we can hypothesize that a significant increase of resources extracted in a limited timespan would correspond to high levels of short-term extraction. Conversely, economic performance that does not correspond to a significant increase in military expansion is likely to be driven by other factors, such as market-driven growth. To put it differently, if the available evidence indicates that the increase in military conquest corresponds to a rise in economic performance in the short-term, then it can be argued that the economy was primarily driven by predatory actions. On the other hand, if the evidence suggests that economic performance was not significantly influenced by military expansion, then it is plausible to suggest that the Roman economy had a greater tendency towards a market-based system. This hypothesis is further supported by evidence regarding the price of gold in the Roman world. It is expected that successful conquests, which often result in an influx of gold, would lead to a decrease in the price of gold. This trend is indeed observed throughout Roman history, where periods characterized by significant military conquests corresponded to a decline in the price of gold (Duncan Jones, 1994). The introduction of gold through conquest, trade, and mining activities increased the overall supply of gold within the empire, which, in turn, contributed to the appreciation of the *Aureus*, the Roman gold coin. The appreciation of the Aureus meant that it could purchase more goods and services compared to other currencies or commodities.

Short-Term Extraction and Long-Term Self-Sustaining Growth

The formation of the Roman state[21] was a multifaceted process that entailed various factors, with military conquest playing a particularly significant role in both political and economic terms during the Middle Republican period, though it gradually became less important during the Imperial period (Adamson, 2020; Taylor, 2017). According to Taylor's (2017) reassessment of Frank's (1932) estimates, the period spanning from 200 BC to 157 BC witnessed the ascendancy of revenues from wars as the most significant source of income for the Roman state during its expansion. In fact, Taylor's findings indicate that such revenues constituted more than 50% of the total income during this period. Specifically, out of a total of 545 million *denarii* in revenue, roughly 292 million *denarii* were generated from the spoils, indemnities, and tribute

represents a value from 0 to 1 that represents the variation of resources captured denoted by ΔR linked to the Roman Expansion, ΔKm.

[21] The term "state-formation" is used in this work for the sake of convenience. It should be noted, however, that the use of the term "state" in ancient times varies considerably from the modern concept of a state (Erdkamp, 2007).

of wars, whereas the remainder was financed through *tributum*[22] (approximately 110 million) and other general sources of income (approximately 145 million). The majority of this revenue was allocated to finance the Roman army, which accounted for approximately 75% of the budget. The second most significant expenditure was on public works, including infrastructure projects. This suggests that during the early stages of Roman development as a superpower, the construction of infrastructure was largely dependent on the extractive capacity of the Roman army.

However, distinguishing between public works financed by wars and those funded through alternative means can be challenging. Ancient sources often do not provide explicit information, except for some exceptions[23], on the destination of income generated by wars with respect to public works. One potential solution to the challenge of distinguishing economic activities[24] based on short-term extraction from those characterized by long-term self-sustaining growth is to utilize a generalized time span window. This is based on the assumption that there is usually a gap between a conflict and the construction of public works funded by the revenues generated by that conflict. However, the significant variation in timing, which can range from several decades to just a few years, makes it challenging to approximate a specific temporal range that can distinguish public works financed by wars from those funded through alternative means. It is important to note that ancient construction projects often took a long time to complete due to

[22] *Tributum* refers to a tax levied on Roman citizens, the proceeds of which were used to finance various public services and institutions, including the army.

[23] For example, it is known that the construction of the Temple of Jupiter, which was partially financed through the spoils of war obtained in the battle of Apiolae, was likely inaugurated in 509 BC (Tito Livio, *Ab Urbe condita libri*, Libro II, VIII, 7-8). This battle was fought during the reign of Tarquino Prisco, who ruled from 616 to 579 BC. Even assuming a highly conservative estimate that places the battle in the last year of Tarquino Prisco's reign, in 579 BC, the duration between the battle and the temple's inauguration would have been approximately 70 years, a notably long period of time. The Forum of Caesar was partly financed by spoils of war obtained from his Gallic campaigns (and probably also from the treasury stolen from the Temple of Jupiter), and it was inaugurated during the reign of Augustus. The construction of the forum took place between 46 BC, probably by Caesar himself, and period from 27 BC onwards, from Augustus how finished the building after Caesar's assassination (Cassius Dio, *Historia Romana*, 45.17.1). The Gallic Wars, on the other hand, took place between 58 BC and 50 BC. However, the exact timeline between the end of the wars and the completion of the forum is uncertain and estimates vary, ranging from more than 31 years to as little as 4 years, depending on the sources and assumptions used. *Portus Traiani*, the largest harbor of the Roman Empire, was built during the reign of the emperor Trajan, between 106 and 113 AD. The harbor was located near Ostia, at the mouth of the Tiber River, and played a key role in the transportation of goods and supplies to the city of Rome. It is believed that the resources used to finance the project were obtained from the Dacian wars, which occurred from 101 to 106. These wars brought significant amounts of wealth, including gold, silver, and other resources. Therefore, we can infer at least 10 years occurred between wars and the building of the harbor (Tuck, 2008).

[24] In ancient times, economic activities encompassed a wide range of practices that included religious, cultural, and common activities. For instance, temples were not only used for religious services but also served as "deposit banks", as was the case in Palmira (Gregoratti, 2020).

possible delays, interruptions, and changes in funding sources and priorities. Furthermore, the process of dating infrastructure (both public and private) or maritime activities through archaeological evidence can be challenging due to the span of time involved. The dating of structures, wrecks, harbors, and watermills often spans over a century, and even with the use of mid-points or probability functions to improve estimates, inaccuracies may still occur (see Wilson, 2009a, 2009b). Therefore, to mitigate the risk of misinterpreting the coexistence of military conquests and economic activities in ancient Rome, we adopt a conservative approach that examines descriptive correlations over a century timespan while focusing on clear and unambiguous evidence. Specifically, we assume predatory policies if the intensity of military conquests strongly correlates with economic activities. On the other hand, sustained growth is assumed if economic activities occur independently of the intensity of military conquests. This approach allows us to draw more accurate conclusions about the nature of economic activities in ancient Rome.

In Search of the Imperial Sustained Growth

In this section, we explore the "macro" nature of economic activities in ancient Rome by investigating the separate phenomena of predatory policies, driven by military conquests, and sustained growth, which occur independently of military conquests. By comparing archaeological evidence with the geographical extent of the Roman Empire at various points in time, we can make more precise conclusions about the underlying drivers of economic activities. It is important to note, however, that while archaeological evidence can provide valuable insights into the Roman economy, it is also subject to unquantifiable measurement errors that make it unsuitable for detailed econometric analysis (Verboven 2018). Specifically, we focus on:

a) the relationship between public capital investments and harbor infrastructure,
b) the relationship between private capital and long-distance trade,
c) evidence of market expansion and integration,
d) evidence of sustained growth.

Before delving into the core of our investigation, we need to clarify some key concepts. We will be analyzing archaeological evidence of harbors, shipwrecks, water-mills, and paleoclimatic data in comparison with geographical expansion, which serves as our "independent variable". However, comparing different types of evidence can be challenging as they may have distinct

properties, making it difficult to draw meaningful comparisons. This has led to the common analogy of comparing "apples and oranges" when referring to such comparisons. Harbors, water-mills, and shipwrecks are examples of fixed capital, and as such, are considered to be a stock concept, while paleoclimatic data is a flow concept. Geographical expansion, on the other hand, could be considered a stock or flow concept, depending on whether it is measured as an absolute value or a rate of growth. To ensure consistency, we calculate geographical expansion as a rate of growth (per century). In this way, we can compare each increase in geographical expansion in terms of flow and not as stock. For harbors, we estimate their age based on their date of construction, rather than their occupation timing, which avoids an accumulation of harbors (stock concept). The same approach is also used for dating water-mills. Shipwreck evidence is estimated using the mid-point method, which helps to avoid an accumulation process that could arise from adopting probability functions. By adopting this methodology, we can compare each measure as a flow.

a) Public Capital Investments and Harbor Infrastructure

The Roman Empire's economic performance was facilitated by significant investments in infrastructure, including roads, harbors, aqueducts, irrigation systems and bridges, which contributed to urbanization, trade, and the specialization of labor (Erdkamp *et al.*, 2020; Ward-Perkins, 2005). While it is suggested that the revenues from wars were instrumental in promoting infrastructure development during the Middle Republican period, reliable information is lacking for subsequent periods. However, the data related to harbor infrastructure offer crucial insights into the economic performance of the Roman Empire and the sources of financing (Tab. 1 and Fig. 4). The improvement of Rome's harbor facilities under the reign of Claudius and the construction of the harbor of *Portus* under Trajan are notable examples of Roman infrastructure investments that illustrate the importance of trade in the Roman economy. These investments allowed for the expansion of maritime trade and facilitated the movement of goods throughout the empire, contributing to economic growth and prosperity (Wilson, 2011). Similar conclusions are highlighted by Schörle (2011), who suggests that ports are, to a certain degree, an indicator of trade and facilitate its development.

"Portus was the largest artificial harbor structure of the Mediterranean and could probably host some five hundred ships in its basins, and crucially, it had approximately 13,900 m of wharfage space" (Schörle 2011, p. 95).

Some harbor infrastructures in the Roman world could potentially have contained impressive numbers of ships in their basins. The number and scale of artificial harbors and port facilities built and maintained around the Mediterranean between the 2nd century BC and 3rd century AD stands out as unusual for any period before the Industrial Revolution (Table 1).

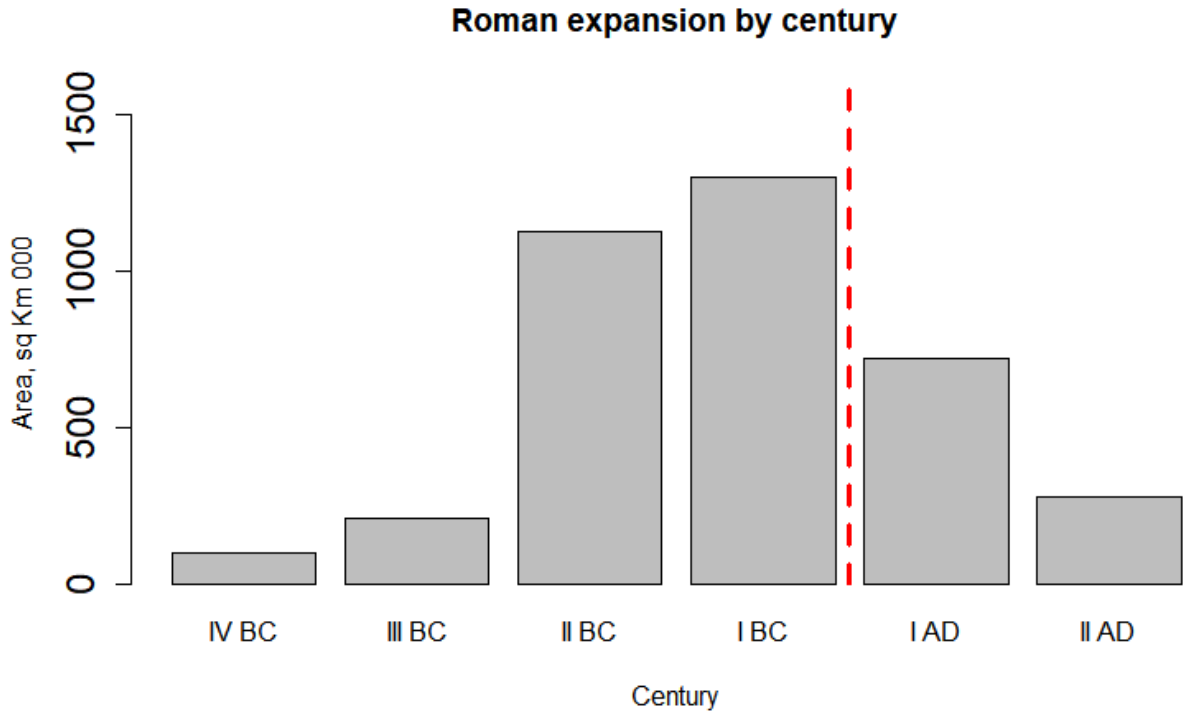
TABLE 1 - *Sizes of the Most Significant Harbors within the Roman Empire, with a few Additional Major Harbor Sizes Included for Comparison Purposes*

Site	Harbor area (ha)	Wharfage length (m)
Portus (total)	234	c. 13,890
Claudian basin	c. 200	2,860
Trajanic hexagon	33.3	2,100
Darsena	1.08	
Alexandria, Portus Magnus	>226	12,380
Puteoli (total)	67.9	
Puteoli (Portus Iulus)	53.9	
Puteoli (Portus Balanus)	14	
Antium	25-30	
Ephesus	c. 18-24	
Cesarea Maritima (outer basin)	20	
Hadrumetum	20	
Centumcellae	14	No more than 2,000
Carthage (circular and rectangular harbors)	14	
Terracina	11	
Lepcis Magna	10.2	1,200
Torre Astura	7.8	
Kenchreae (Corinth)	3	
Cosa	2.5	
Giglio Porto	c. 2	
La Mattonara	1.24	
Villa port at San Simone	0.84	
Ventotene (Pandateria)	0.7	

Source: Schörle (2011), p. 96.

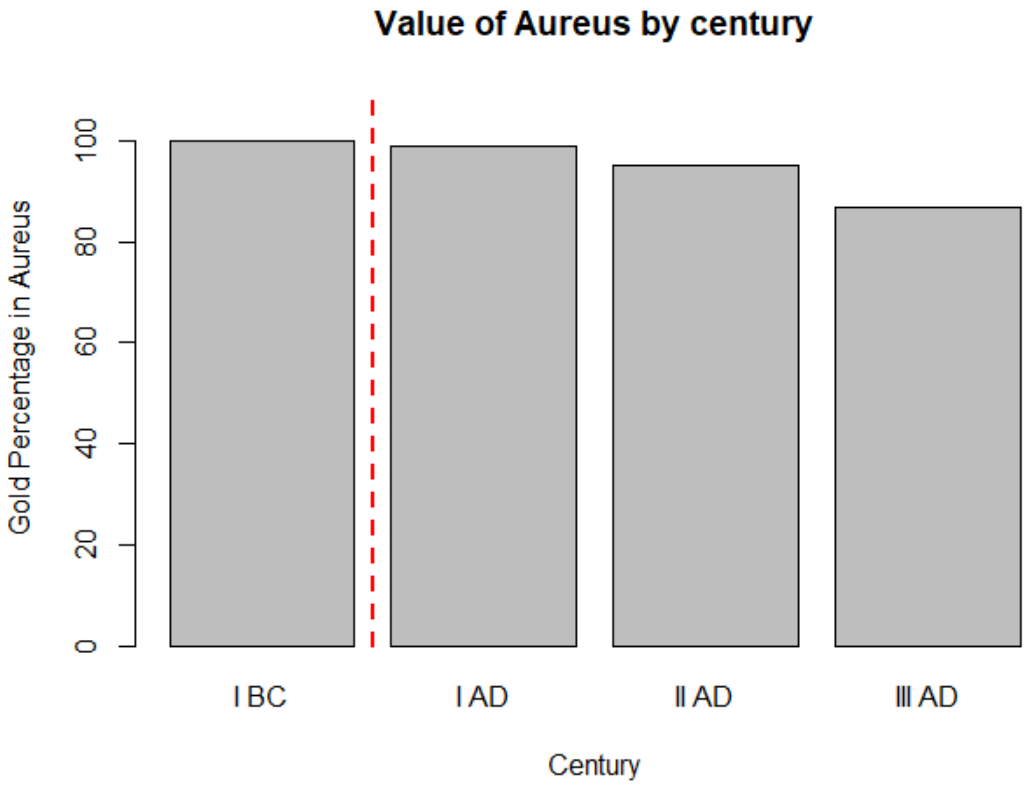
While we cannot perform a statistical correlation analysis due to the limited data available, we have observed a consistent pattern of comovement between military expansion (Fig. 2), the fluctuation in the price of gold (Fig. 3), and the development of harbor infrastructure throughout Roman history (Fig. 4). Our findings reveal that during the 1st century BC, there was a substantial military expansion of over one million and two thousand square kilometers. This expansion coincided with the emergence of over six hundred harbor infrastructures and a decrease in the price of gold. The decrease in the price of gold can be attributed to a substantial inflow of the precious metal, which led to the appreciation of the *Aureus*, the Roman gold coin. This observation suggests that an increase in Roman expansion directly influenced the rise in harbor infrastructures. While we acknowledge the limitations of working with ancient data, the clear peak in the 1st century BC supports the notion that military expansion played a significant role in the development of harbor infrastructure during Roman times, especially after the end of the Punic Wars.

FIGURE 2 - *This figure illustrates the chronological expansion of the Roman world from 4th Century BC to 2nd Century AD, excluding temporary and unstable conquests. It shows that the most significant campaign of conquest occurred in the 2nd and 1st century BC, resulting in the annexation of Spain, Portugal, Greece, France, Belgium, Austria, Switzerland, two-thirds of Turkey, Cyprus, Israel and Palestine, Syria, Lebanon, and Northern Africa. The conquest continued throughout the 1st century AD but with lower intensity, resulting in the incorporation of a third of Germany, the former Yugoslavia, Hungary, a third of Turkey, and Morocco. Expansion slowed down significantly in the second century, with only Jordan and Romania being annexed. The Roman Empire's maximum stable extension was around 3,800 thousand square kilometers, reached during this period. The figure also indicates that the Roman Empire was more engaged in defending its territories than conquering new ones from the second half of the 2nd century onwards.*



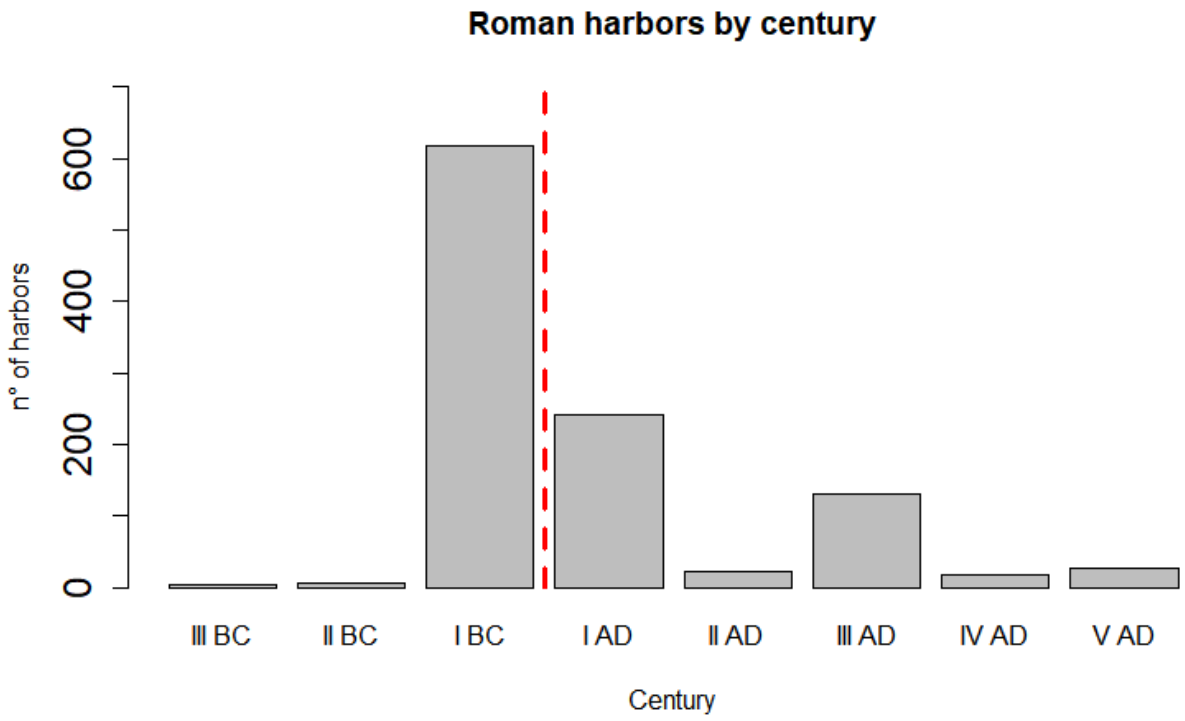
Source: Maddison (2007).

FIGURE 3 - *Percentage of Gold in Aureus Across Time Periods (IBC - III AD), indexed 100 for Augustus' reign. These data are derived from the Emperors' edict regarding the quantity of Aurei per pound of gold. The original data are based on values from the reign of Augustus to the reign of Severus Alexander and the values for each century were obtained using an average method.*



Source: Duncan Jones (1994), p. 217.

FIGURE 4 - *Roman Harbors Building from III BC to V AD*



Source: own elaborations from de Graauw *et al.* (2013).

b) Private Capital Investments and Long-Distance Trade

Long-distance trade was a crucial factor in increasing productivity, as it facilitated market integration. Recent archaeological evidence shows that long-distance trade was widespread, encompassing not only luxury goods but also a range of staple foods and other relatively low-cost commodities, such as *Terra Sigillata* (Wilson, 2009b)[25]. The elite classes played an essential role in these trade activities, as they were the greatest owners of capital goods, financial capital, land, slaves, and workshops (Kehoe, 2012, 2007, 1997; Erdkamp, 2005). The very high cost of building and arming a ship necessarily implied the involvement of members of the elite classes, who were the only ones with access to huge amounts of capital resources (Broekaert and Zuiderhoek, 2020; contra Rathbone, 2003). This elite participation in commerce persisted despite the *plebiscitum Claudianum*, which prohibited senators and their sons from owning a sea-going

[25] For a different view, Whittaker (1989).

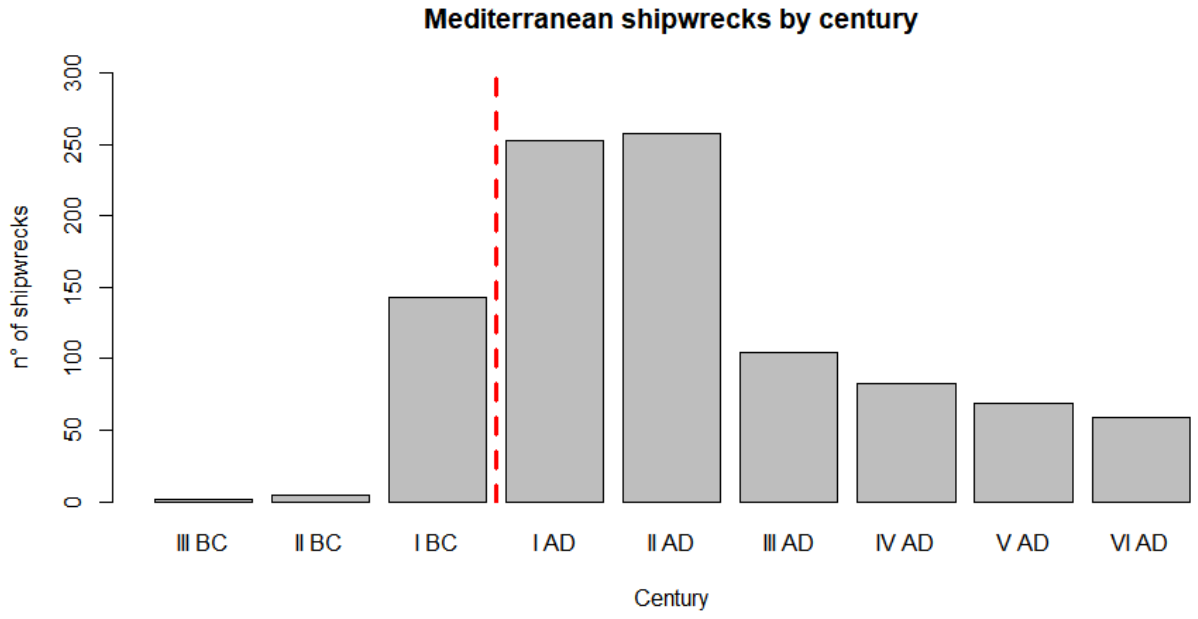
vessel of more than 24 tons in 218 BC[26]. From archaeological evidence, we know that the size of ships during the Roman age was also not smaller than in later historical periods, with ships of approximately 300 tonnages existing during the reign of Trajan[27].

Furthermore, the state demanded transport for the imperial supply system, and private shipowners were paid by the government to transport goods such as wheat, oil, and meat to feed Rome's population. In detail, we refer to the *Annona* practices, which used to provide wheat for the population of the largest city of the Empire. This wheat, and later also oil and meat, was shipped mainly from Egypt and North Africa, but also from other parts of the Empire, to feed Rome's population. In the age of Augustus, the wheat imports from Egypt were equal to 20 million *modii* per year, while under Nero, the imports from African regions probably fed the plebs of Rome for 8 months (Lo Cascio, 2000, pp. 17-56). Tchernia (2011) estimated that 786 ships were necessary to feed Rome's population.

The number of shipwreck findings[28], the most relevant proxy of long-distance trade, shows a very different trend from the development of harbors, as shipwrecks do not correspond to military expansion (Fig. 5). In fact, the concentration of trade activity, as indicated by the number of shipwrecks found, seems to be highest in the 1st and 2nd centuries AD, with a peak in the latter. This peak involved the discovery of more than 250 shipwrecks, while military conquests during the same period amounted to "just" 400,000 square kilometers. This is around one-third of the conquests that took place during the 1st century BC. This evidence suggests that long-distance trade activities were not a short-term strategy based on exploitation policies but a long-term consequence of the benefits of creating a large unified economic area. Once the Roman Empire consolidated its borders, *the Pax Romana* improved safety in the Mediterranean Sea, in line with the NIE guidelines. In turn, this facilitated the endogenous rise of long-distance trade, which fueled economic growth that was distinct from marauding activities.

[26] Livy 21.63.3-4. See Tchernia (2007) for the conversion of Livy's 300 amphorae into tons.
[27] Gibbins (2001), Makris (2002), Davis (1962), Houston (1988), van Zanden and van Tielhof (2009).
[28] Parker (1990a, 1990b, 1992a, 1992b).

FIGURE 5 - *Mediterranean Shipwrecks by Century, using Midpoints of Date Ranges*



Source: own elaborations from McCormick *et al.* (2020).

An additional analysis on the relationship between harbor infrastructure and shipwrecks was conducted by Robinson *et al.* (2020). The study found that the reduction in shipwreck evidence is linked to the increase in harbor construction, which improves the safety of long-distance trade. Consequently, the decline in shipwreck findings during the 2nd century AD can be attributed to enhanced maritime safety. Although Robinson *et al.* (2020) utilized a distinct approach, specifically the probability function instead of mid-points, their findings and conclusions are compatible with the present study. Geographical expansion of the Roman Republic triggered harbor development between the second century BC and the first century BC, while shipwrecks occurred a century later and not in the same period, even with the application of the probability function. It should be noted that harbors are fixed capital (a stock concept), which means that the upward trend in harbor construction (as presented in the data utilized by Robinson *et al.*, 2020) extends from the second century BC to the first century AD, closely associated with military expansion, despite the peak of harbor development being in the first century AD. The following stagnation in the second century AD and third century AD indicates that the building process and its financing were challenges of the first two centuries

BC. In contrast, the rise in shipwrecks (a flow concept) took place in the first century AD (according to the probability function) or the second century AD (according to the mid-points), and thus, it is not directly associated with the trend of geographical expansion, which was diminishing during that period. Therefore, while there is a clear correlation between the emergence of harbors and the reduction of shipwrecks due to enhanced safety, this dynamic must be embedded in the shift from an economy primarily based on military extraction to a mixed economy of extraction and market.

However, these archeological pieces of evidence have also sparked debate regarding their significance. While the concentration of trade activity around the 1st and 2nd centuries AD, coinciding with the wealthiest period of the Roman era, provides insight into Roman economic growth, caution must be exercised when interpreting the findings. One significant issue is the bias in observations, as wreck sites with large amphora heaps are more likely to be noticed by divers, potentially overestimating the role of larger ships (Broekaert and Zuiderhoek, 2020; Pomey and Tchernia, 1978). Additionally, the majority of discoveries are located near the coast, and the number of wrecks in open water is difficult to estimate, making it challenging to infer trade flow. A second issue concerns the role of amphorae, as the shipwrecks we know of are primarily amphora cargoes, while warships, grain freighters, and ships carrying perishable goods are less likely to be found. Moreover, the replacement of amphorae with barrels in the early medieval period further complicates the identification of the trend of trade flow and the path of Roman economic growth (Wilson, 2009b; Peacock and Williams, 1989).

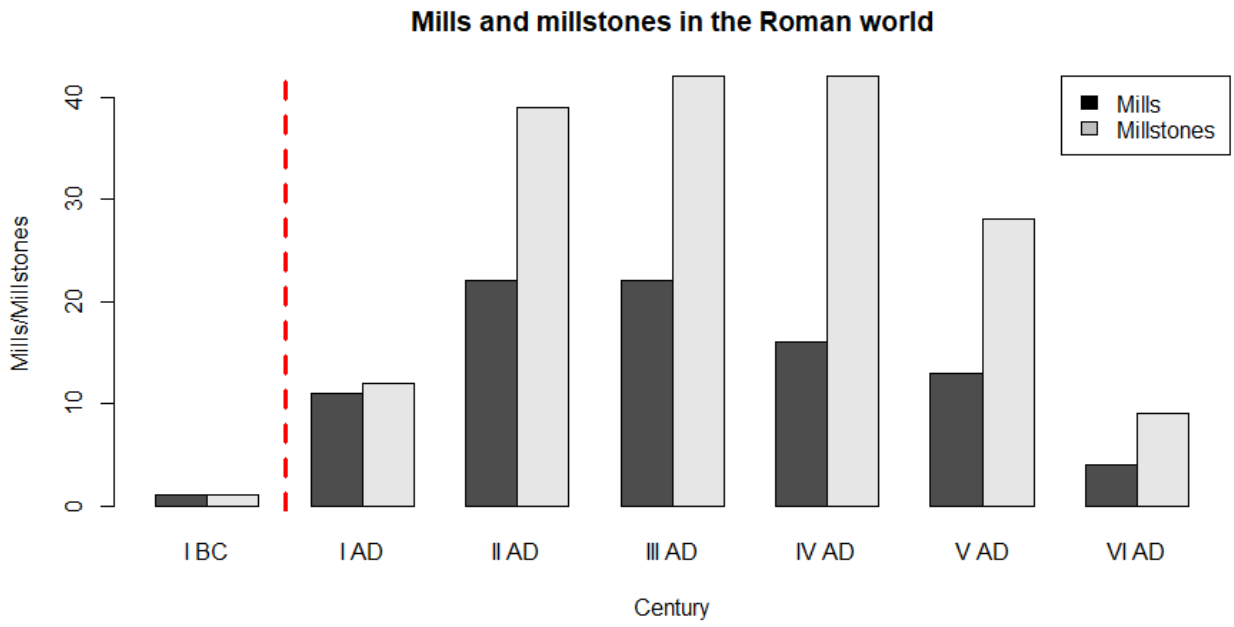
c) Market Expansion and Integration

The rise in the marketing of goods across the Roman Empire and the consequent market integration should have resulted in larger diffusion of the private infrastructures involved in the production process. In light of the most recent archaeological discoveries, Wilson (2020) argues that the diffusion of water-powered mills – one of the well-known capital goods used in the Roman world[29] – was extensive, particularly between the 2nd and 3rd centuries AD. Moreover, Wilson suggests that this degree of diffusion and technological sophistication disappeared after the collapse of the western Roman empire (while it remained longer in the eastern one). Figure 6

[29] In the Roman world, water-powered mills were used not only for grinding grain but also for tanning, crushing metals, and removing sawdust from stone and wood (Wilson, 2020).

shows archeological evidence of mills and millstones across centuries. The peak of discovery of mills evidence, a proxy for the diffusion of that technology, coincides with the 2nd and 3rd century AD, while the peak of the number of millstones, a proxy for the intensity of that technology, overlaps the 3rd and 4th centuries.

FIGURE 6 - *Aggregate estimate of the Number of Water-Powered Mills and Wheel-Mills from I BC to VI AD within the Roman World*

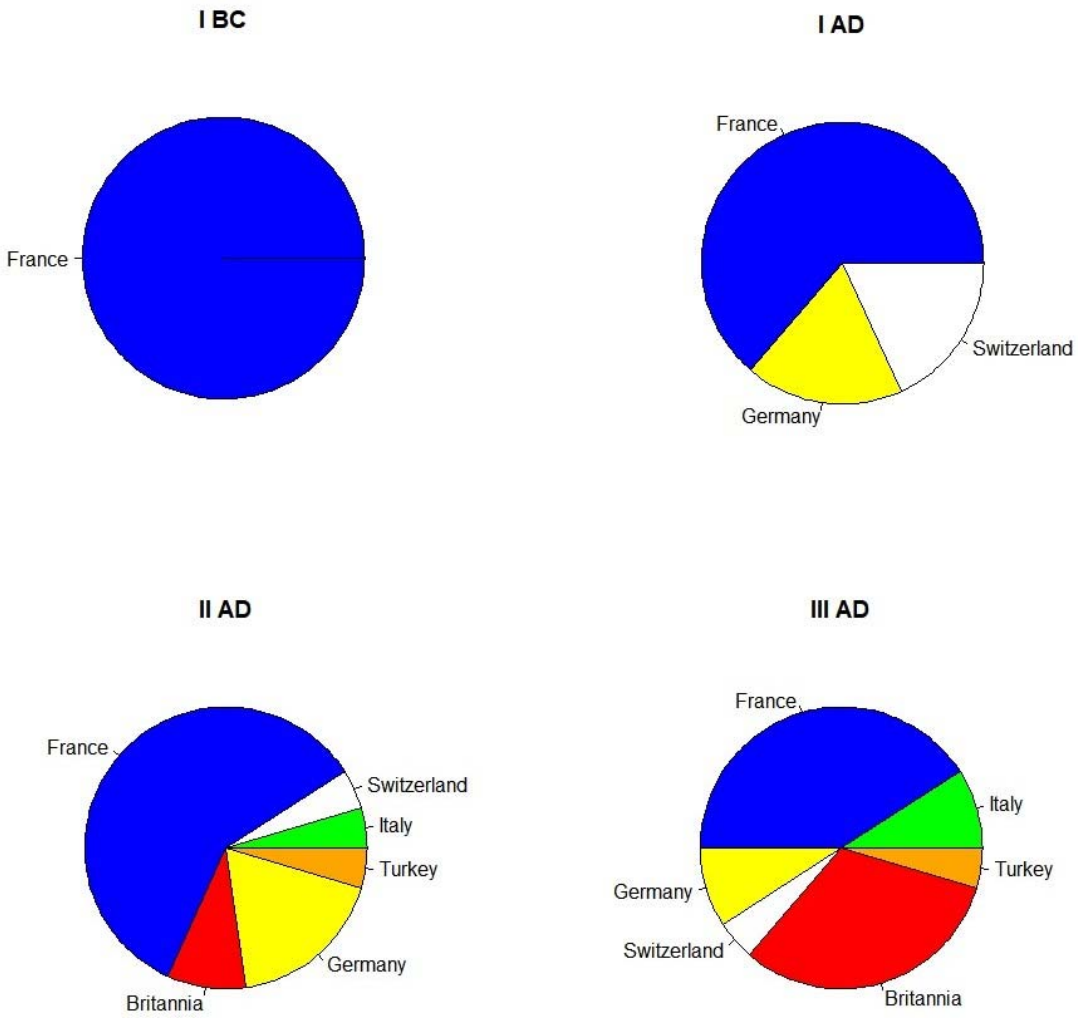


Source: own elaborations from Wilson (2020), p. 153-157.

Figure 7 shows that the diffusion of mills across countries does not follow the military expansion. During the peak of the military campaign, only 3 countries held water-powered mills (France, Germany, and Switzerland) whereas in the 2nd and 3rd centuries AD, the number of countries rose to 6 (Britain, France, Germany, Italy, Switzerland, and Turkey). Moreover, from the 2nd to the 3rd centuries, although the number of countries remained unchanged, the diffusion presents a higher degree of homogeneity among countries. In the 2nd century, more than 50% of mills were located in France, whereas in the 3rd century, this percentage is significatively reduced. Therefore, the maximum diffusion of this technology was registered from the 2nd to the 3rd century, a trend significantly more consistent with shipwreck evidence compared to military

activities. Naturally, there is also considerable regional variation, due to the intensity of archaeological excavations and the culture of publications differing from country to country. However, this evidence suggests that water-powered mills were widespread within the Roman world and that this diffusion reached its peak a long time after the peak of the Roman military campaign, whereas it partially overlaps the period of the hypothetical efflorescence of commercial activities.

FIGURE 7 - *Water-Powered Mills Diffusion across Countries from I BC to III AD*



Source: own elaborations from Wilson (2020).

d) Sustained Growth

The scarcity, heterogeneity, and discontinuity of economic records from the Roman era make it challenging to directly evaluate its economic performance. Although data on wages, rents, prices, and living standards can be helpful, they are insufficient for systematically describing the Roman Empire's economic activity[30]. Attempts to reconstruct Roman Gross Domestic Product are also limited since they are static measures that cannot capture long-run economic cycles (see Lo Cascio and Malanima, 2014; Scheidel and Friesen, 2009; Maddison, 2007; Milanovic *et al.*, 2007). However, recent studies have suggested that paleo-climatic data, such as estimations of lead pollution levels reconstructed from Greenland ice cores, can serve as an alternative proxy for the level of Roman economic activities. These yearly data, which cover a contiguous period from the 13th BC to the 8th century AD, provide indications of unprecedented accuracy about economic fluctuations in the Classical world.

During the Roman era, silver was primarily extracted from galena, a lead mineral, and processed to mint coins for use as currency. Lead was also extensively used in pipe manufacturing and the production of everyday tools. As a result, lead pollution resulting from lead and silver smelting can serve as a proxy for the level of economic activity in the Roman world. Furthermore, due to Greenland's location and the direction of permanent winds, emissions deposited in ice cores primarily reflect lead pollution produced in Western Europe, which was embedded within the Roman Empire's borders. Hence, data on lead emissions in ice cores should not be "contaminated" by the pollution produced by other civilizations located outside Europe, such as the Parthian Empire, Kushan Empire, or the Chinese Empire. Naturally, caution should be exercised when using this proxy measure. As Scheidel (2009) has argued, lead pollution is a measure of the state's capacity to extract precious metals and is not a comprehensive indicator of economic performance. Nevertheless, in the framework proposed in this study, the concept of "state power" and economic performance are intertwined. We posit that state power, in the context of the Roman world, drove economic performance. Therefore, we do not see any issues with asserting this relationship. Furthermore, in commodity money systems[31], such as that employed in the Roman Empire, the quantity of coins in circulation tends to reflect the level of

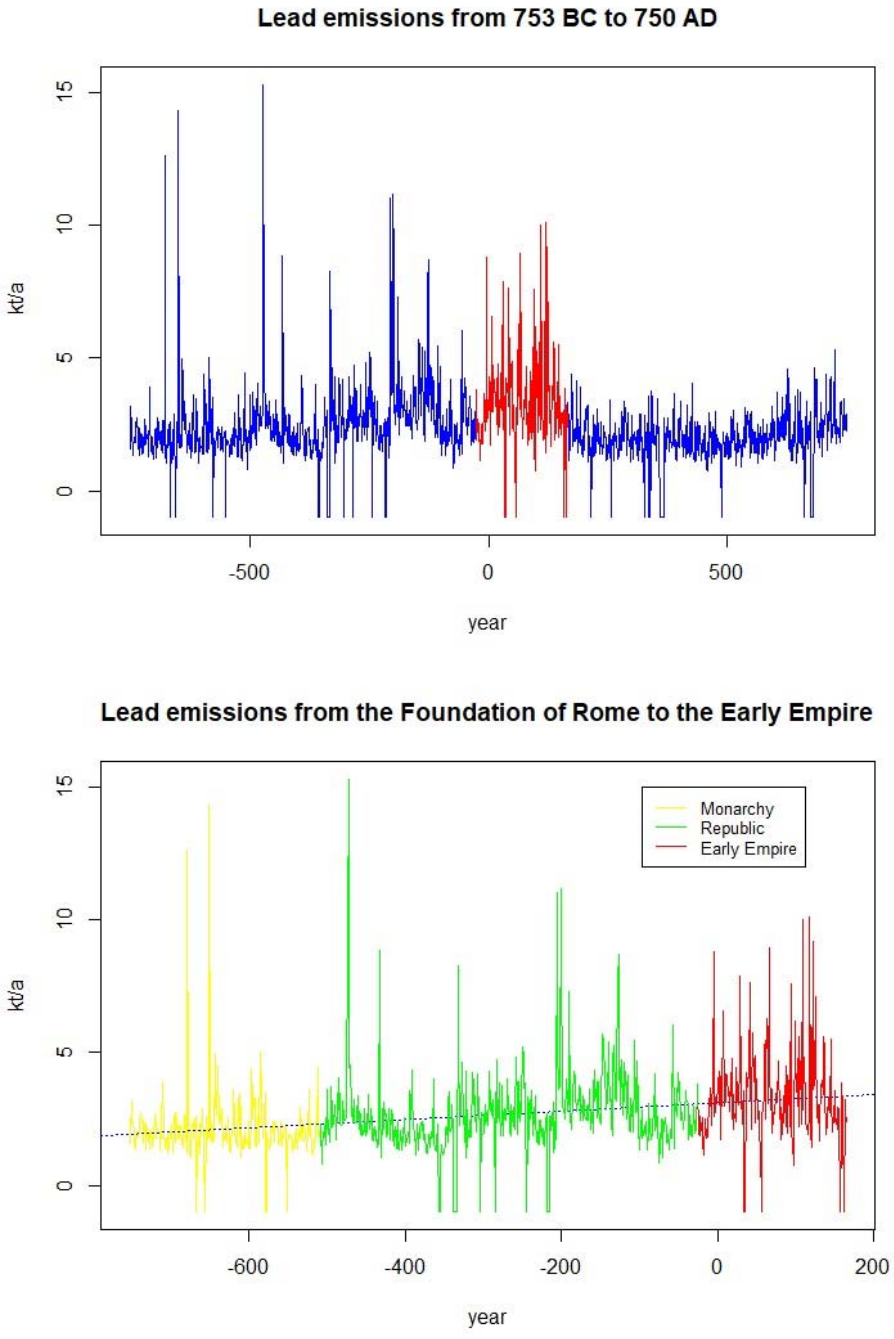
[30] For example, Harper (2016), Koepke and Baten (2005).
[31] Commodity money refers to a form of currency that has intrinsic value, meaning that the value of the currency is based on the commodity it is made of, rather than the value assigned to it by the government.

economic activity, while in fiat money systems[32], such as those used in contemporary economies, the central bank has greater control over the quantity of money in circulation. The Roman Empire relied heavily on silver and gold coins as a medium of exchange, and the production of these coins was closely tied to the mining of precious metals. Accordingly, an increase in the quantity of coins in circulation could serve as an indicator of economic expansion, as it would require a corresponding increase in the extraction of these metals. In other words, in commodity-based monetary systems without a central authority controlling the money supply (such as central banks), coinage tends to follow economic expansion rather than driving it (Seghezza, 2022; Pittaluga and Seghezza, 2021; Lennard, 2018; Meltzer, 2003 among others)

Figure 8 depicts the level of lead pollution from 753 BC[33] to 750 AD. During the both the Late Republic and the Early Roman Empire period the level of lead pollution not only followed a modest rising trend, with a yearly average growth rate of around but also represented a peak moment until the middle of the 8th century. This period of sustained economic growth lasted for around two centuries and was the longest period of uninterrupted upward trend in a timeline spanning over 1500 years. Despite the low rate of growth of lead emissions, this sustained growth in economic activity suggests that it was not merely a period of population reduction but a time of genuine economic expansion. According to scholars, the Roman population experienced a significant increase during the first two centuries AD, peaking just before the Antonine Plague. This suggests that both population and economic performance grew simultaneously for about two centuries. As a result, this prolonged period of sustained demographic and economic growth cannot be merely attributed to an "efflorescence" phenomenon. Therefore, this growth can be considered sustainable, albeit modest, as it was based on a combination of infrastructures financed on resource extraction and market integration, which in turn promoted labor specialization and productivity gains (Smithian growth). These conditions enabled the system to reproduce itself endogenously, leading to sustained economic performance over an extended period. This cycle was likely disrupted by exogenous factors, including the Antonine Plague and 3rd century crisis. However, the precise link between these events and the fall of the Roman Empire remains uncertain.

[32] Fiat money is a currency that is not backed by a physical commodity, such as gold or silver, but rather by the government's declaration and the trust of the public in that declaration.
[33] The "mythical" founding year of the city of Rome.

FIGURE 8 - *Lead measurements nearly contiguous from 753 BC to 750 AD and from the foundation of Rome to the end of the Early Empire (165 AD) in more detail.*
The dotted blue line represents the upward linear trend that culminates just before the advent of the Antonine Plague.



Source: own elaboration from McConnel *et al.* (2018).

4. Conclusions

Based on a novel approach to identifying sustained economic growth from extractive policies, our analysis of the Late Republic and Early Roman Empire economies offers some insights into the economic performance of the Roman world. One key finding from our investigation is that the Roman world experienced a basic form of sustained economic growth during two distinct periods: the era of extensive military conquests and the post-Pax *Roman* period. However, what sets these two periods apart is the source of their economic growth: the former period was characterized by extractive policies, while the latter was characterized by self-sustained economic activities.

This finding challenges the previous idea that sustained economic growth only occurred during the *Pax Romana* period thanks to the Smithian model, and highlights the importance of considering broader historical and environmental factors when studying economic performance. It also rejects the notion that Roman growth was solely based on military conquests and predatory activities. In other words, while military conquests may have been a driving force for economic expansion during the former period, the evidence suggests that the economic growth during the *Pax Roman* period was not solely due to exploitation policies following military conquests. Rather, the emergence of long-distance trade and specialization of labor in manufacturing can be attributed to flourishing economic activities that were a positive consequence of political unification.

This highlights the importance of considering the complex and multifaceted factors that contributed to Roman economic growth. Indeed, the emergence of harbor infrastructures appears to be connected to the military expansion that mainly occurred in the 1st century BC, suggesting that the Early Roman Empire would probably not have been able to stimulate a Smithian growth without military power. From this point of view, the Roman world appears to be a hybrid that combined economic performance effectively based on markets with infrastructures that remained firmly rooted in military power. This underscores the significance of examining both extractive policies and self-sustained economic activities in the analysis of the economic performance of historical societies. The idea that economic growth is unique to capitalist systems is challenged by our findings, which reveal that pre-capitalist economies such as the Roman Empire achieved sustained economic growth through a combination of predatory

actions and long-term self-sustaining strategies. This challenges the predictive capabilities of the NIE approach.

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