Chapter 4

Rome

These introductory notes are in an evolutionary state and are written for students who have no prior knowledge about the Roman Empire. While providing some historical background, they focus on economic issues.

The river basins in Mesopotamia and Egypt generated their civilizations. The Mediterranean ("between the lands") Sea gave life to the empire of the Romans who called it *Mare Nostrum*.

It could have been different. Rome grew out of a tiny village, founded in 753 BCE according to tradition, to a city of a million inhabitants around 100 CE–the size of London in 1815–that ruled over the most powerful empire of its time. For the next five centuries, the cutting edge of civilization was in the eastern part of the sea, around Greece. The Greek hive sent swarms around and to the West, in Sicily, in Marseille, but Athens was essentially a maritime power and it was not bent on building an empire with a firm rule on hinterlands.

In Rome, the small village, ruled by a king, for more than two centuries, slowly absorbed its direct neighbors. The last king, Tarquin, was expelled in 509 BC, and replaced by the "Republic" a regime that combined representation and ruling by the aristocracy and the people. While Greece was entering it's golden century, the domain of the new republic extended to little more than the valley of the Tiber from the surroundings of the city down to the nearby sea.

For the next two centuries, the republic expanded from what is today Pisae down to the toe of the Italian "boot". Across the straights of current Messina, the fertile ground of Sicily was coveted by the rising power on the southern shore of the Mediterranean. The shock was unavoidable.

The Punic Wars

The call of Sicily for "protection" against Carthage started the first of the three *Punic Wars* (264-146 BCE). In that first war (264-241), which turned out to be very expensive on both sides, Rome prevailed, conquered Sicily and collected in addition a large reparation of 3,200 talents.[1]

To recover, Carthage conquered Spain and developed its rich silver mines. (See the evidence below). That only increased the stakes between the two dominant powers of the west Mediterranean sea. The second Punic War (218-201) was the most dramatic. When Hannibal after crossing the Alps with elephants all the way from Northern Africa through Spain and Provence, invaded Italy to wipe out the 90000 strong Roman army in Cannae (216 BCE, in southeast Italy), and surrounding cities began to defect to him, Rome stared at extinction. But as other powers later in history,[2] the strategy of field battles was abandoned for fragmented struggles and, with some luck (the famous indecision of Hannibal after Cannae,[3] and the decisive moves of Scipio Africanus in

[1] One talent = 6000 denarii.**. could pay more than 30 legionnaires for one year.

[2] For example, France in the Hundred Years War, Spain against Napoleon.

[3] According to Livy (XXVI, 11, 5), during siege of Rome, a field on which Hannibal had set his camp was sold at a price that did not suffer from the presence of the enneny.

Spain and in North Africa), Rome eventually emerged as the dominant power with a complete victory on its side of the sea.

Cato the elder (234-149) ended all his addresses, whatever the issue, *Carthago delenda est*: the protracted fight that had to end with the total destruction of one of the cities. The third Punic war (149-146) led to the razing of Carthage. Thereafter, the conquests of Macedonia and Greece (146 BCE) came relatively easy. The political system of the Republic, where the dominant power was the senate of about 500 men, lasted for another century, formally ending with the assassination of Julius Caesar (44BCE).

The Republic

The territorial expansion of the Republic was fed by the standard resource of an expanding empire: the capture of the resources in the conquered territories, both treasures, and most important, manpower that was converted into slaves. Defense and conquests could be achieved only through a military culture of the people that became legendary. The citizens' army fostered that spirit and saved on tax administration as a draft is a direct taxation on the manpower. The soldiers could also benefit from significant monetary rewards in bounties and land allocation on retirement. Romans in the republic thought that there was no need for direct taxation as the tax was paid by citizens in the draft, as the Athenian citizens before and the nobility in the Ancien Régime in Europe who paid the "blood tax". In 167 B.C., direct taxation was abolished in Roman Italy.

Publicans

As in Athens, the management of indirect taxes was outsourced, farmed out, in contracts between the state and private people, the publicans (*publicani*). The name is self-explanatory. Individuals would pool their resources in societies that were the true precursors of the modern corporation (Malmendier, 2009). The main indirect tax was levied in the harbors at the rate of about 5 percent, as in Athens. Publicans handled also some taxes in the colonies. In addition to tax collections, publicans bid in auctions for contracts on the deliveries of material supplies to the army and the construction of public works.

Since they formed the intermediary between the collection of taxes that would be relatively steady with a seasonal variation, and the spending of the state that could be highly variable in military ventures or public works, they performed also a function of financing. Such financing was a central function of tax farmer (*fermier général*) in the Ancien Régime before the French Revolution.

In the Republic, the publicans were set in part to prevent politically powerful (e.g.

governors of the provinces) to appropriate public revenues. Such an appropriation could enable someone to muster sufficient military resources for a coup d'Etat. Regular revenues from, say, harbor taxes could be dwarfed by the loot in warfare over which there could be no control and could be appropriated by a victorious general (who could also buy out his legions).

The Republic was bound to die when the senate lost the control of the army recruiting. Around 100 B.C., governors of colonies could recruit legions locally. These legions would obviously develop a loyalty to their paymasters and become tools for the ambitions of these paymasters. Revenues from, say, the harbor taxes could be dwarfed by the loot in warfare over which there could be no control and could be appropriated by a victorious general.

The central figure in this evolution that ended the regime of the Republic is Julius Caesar (100-44 B.C.). While heavily in debt, he managed to have a free hand for the conquest of Gaul from 58 to 50 B.C. during which he accumulated an immense war chest (in treasures and slaves).[4] Relying on his most trusted legions that were bound to him by years of campaigns and gains, he crossed the Rubicon (river north of Rome that no legion should cross) and marched to Rome in 49 B.C. In 44 B.C., Julius Caesar who had assumed dictatorial power, was about to embark on an expedition against the Parthians, a most foolish venture that would bring defeat to all attacking foreign powers up to the present time. A group of opponents attempted to stop the march from republic to empire and assassinated him in the full senate. They acted with such precipitation that they wounded some of their own.

The Republic had in fact died before but its defenders did not know it, including Cicero who while "not in the loop" witnessed the assassination and hoped for the restoration of the republic. The leaders of the conjuration, Brutus and Cassius, had only the will to down the dictator. As Cicero explains in letters to his friend and financial advisor Atticus, they had no project and there was no general will to coordinate on the regime of the republic. The death of Caesar had just left a vacuum. People would join one faction or another that would grab for personal rule. The civil wars ended when the youngest and apparently most fragile of the rivals, yet had been the heir designated by Caesar, Octavianus, triumphed at the battle of Actium in September 31 BCE and became Augustus.

[4] If a city resisted the siege, its inhabitants would be sold to slave traders. According to Suetonus (Lives of the Caesars), Caesar set a *tributum* of 40 million HS per year in Gaul.

The Empire

The territory of the empire included the largest population seen so far under one government, about 50 to 60 million people, mainly around the Mediterranean sea, *Mare Nostrum*, as illustrated in Figure 4. Some borders of this colonial empire changed on the periphery, in "Germany" and in Asia, but these variations were not important in our time frame. Geography was essential. The Nile was the spine of pharaonic Egypt. The Roman Empire is built around the Mediterranean sea.

By a combination of ruthless assertion of power and benign neglect for local customs, the Republic had provided to the provinces around the Mediterranean sea the *Pax Romana*. The system continued after the fall of the Republic. (See the letters of Pliny). The lower classes were bought off by free wheat and shows (panem et circenses). The upper classes could have an illusion of free expression in the senate, but that institu-tion was actually an important step for a man in fostering his social and especially economic place toward a lucrative position in the provinces. The power was in the hand of the emperor and his entourage. The empire was a "soft" totalitarian state.[5]

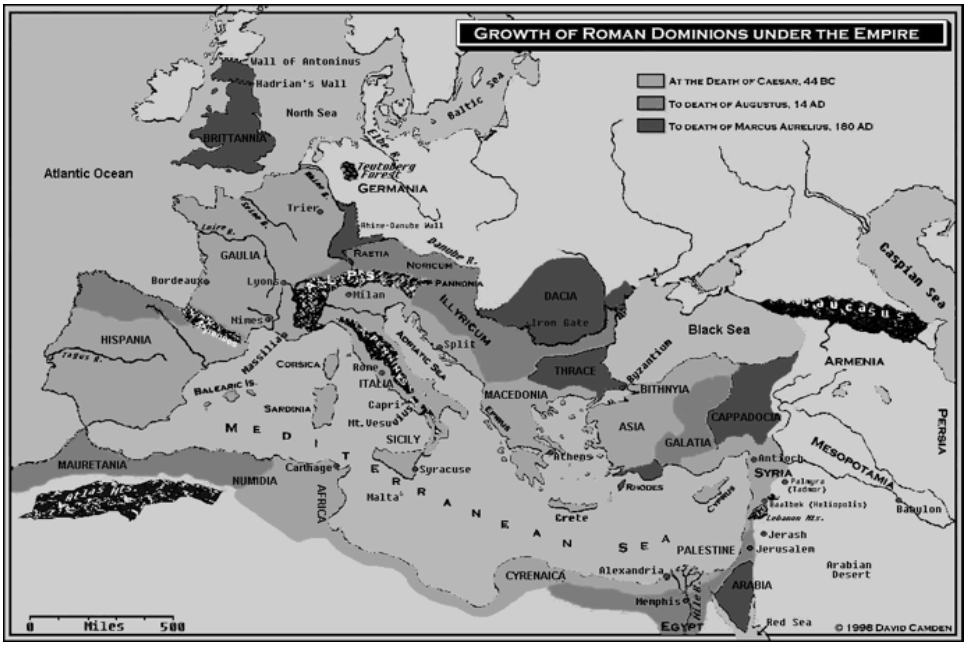

Figure 4.1: The Roman Empire

Because of the technology at the time, it did not have the resources of information and enforcement of a 20th century totalitarian state. But like a modern totalitarian

[5]Hopkins "On the Political Economy of the Roman Empire."

state, it saved on enforcement resources by a combination of strict adherence to an ideology, a"cult of personality" to the emperor, benign neglect for some local customs or exploiting them for taxation. The *Pax Romana* provided an environment in which the most resourceful and ambitious could channel their energy towards individual gains instead of local warfares, provided that personal initiative would not challenge the political stability. In latin, *res novae*, "new things", meant revolutionary activity.

By and large, the tax system of local entities were taken over and enforced by the Roman governors. Given the weight of tradition and the decentralization, such a system could not cope with financial emergencies. There was hardly the possibility to borrow on a large scale: capital markets that support a public debt will have to wait more than twelve hundred years.

The last significant inflow of the precious metal came from the conquest of the Dacians (now Rumania) by Trajan from 101 to 106. The Dacian treasure has been estimated at no less than the equivalent of 200 tons of gold. With an aureus at 8 gr of gold, that would be around 25 M aurei, or 2.5 billion HS (to be compared with the standard budget of the Empire, Table 4.2). No wonder that in the middle of the second century which according to Gibbon where the best years of human kind until the 18th century, the emperor Antonius Pius was ruling over a large treasure.

The regime of the Roman Empire can be divided in three phases, (i) stability during the first two centuries with a gradual deterioration toward the end of that phase, (ii) anarchy in the third century, (iii) reorganization but incapability to meet the challeng-es in the fourth century with eventual failure. This description applies both to the military narrative and to the public finances.

The Roman monetary system

A special case of the standard metallic monetary system is the Roman system. The system was bi-metallic and used both gold and silver to provide a real value of the coins (as the US in the 19th century). There were three types of coins by decreasing order of value, in gold, silver and bronze.

The reference coin was the gold coin, the Aureus, with 8 grams of nearly pure gold.[6]. Soldiers were paid three times a year in Aureus.[7] The silver coin was the denarius, with 25 denarii for one aureus. A denarius was made of 3.9 grams of nearly pure silver.

[6] Pure gold is too soft for a coin which must always contain a small amount of alloy.

[7] That practice is useful for the determination of the legionnaires' pay which has to be a multiple of 3 Aurei per year.

The ratio nominal values of the Aureus and the Denarius is 25 and matches the ratio between their intrinsic values if they are pure metals and the market price between gold and silver is 12.5.

The silver was reduced to 3.4 grams by Nero. Note the silver content of the denarius can be reduced while maintaining the 1:25 ratio with the Aureus and without creating inflation (provided that the total quantity of money does not change). Likewise, under the Gold Standard, paper notes have no metallic content but they can be redeemed at a fixed exchange rate against a precious metal. Each denarius was worth 4 HS, a coin in bronze. Since the sesterce has a relatively high value (see below the pay of a legionnaire), there is a coin of smaller denomination, the as, which is worth 1/10 denarius (hence the name denarius). In the first century BCE, a kg of wheat cost about 1 HS.

Denarius (19mm)

Sestertius (36mm)

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1 Aureus (8 gr of gold) = 25 Denarii = 100 Sesterces = 250 Asses

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The inflows of silver

The conquest of the Iberic peninsula in the second Punic war initiated the inflow of silver before the American mining by the Spanish in the 16th century. That inflow lasted until the end of the second century. After the death of Marcus Aurelius (180), the flow had dried up but the financing requirements for civil wars and and other wars led to increases of money that in some cases were not seen until the hyperinflations of the 20th century.

The conquest of the Iberic peninsula in the second Punic War provided Rome with an opportunity to exploit its silver mines. Some technological innovations may also have taken place. For the next three centuries, the inflows of silver, also coming from other parts of the empire, can be compared to the famous inflows from the New World to Spain in the 16th century. It is fascinating that we have three types of independent evidences for this inflow.

The record from mines

Patterson (1972) has examined the remnants of the Roman silver and gold mines[8] . His estimates are presented in the next table.

Period	Average production (tons/year)
350-250 BCE	25
250-150 BCE	60
150-50 BCE	100
50 BCE - 100 CE	200
100 BCE - 200 CE	100
200 BCE - 300 CE	30
300 BCE - 400 CE	25

Source: Patterson (1972).

Table 4.1: Estimated silver production

The cost of extraction was borne essentially by slaves who were cheap labor. (Slaves have to eat). To the profits on silver, we must add those on gold. To put this numbers in perspective, a flow of 100 tons of silver per year could pay the legionnaires of 20 legions, about half the size of the army under Augustus!

Recall the report of Pliny the Elder that the Baebelo mine provided each year to Hannibal (247-187 BCE) 110 000 Roman pounds, *i.e.*, 36 tons of silver.

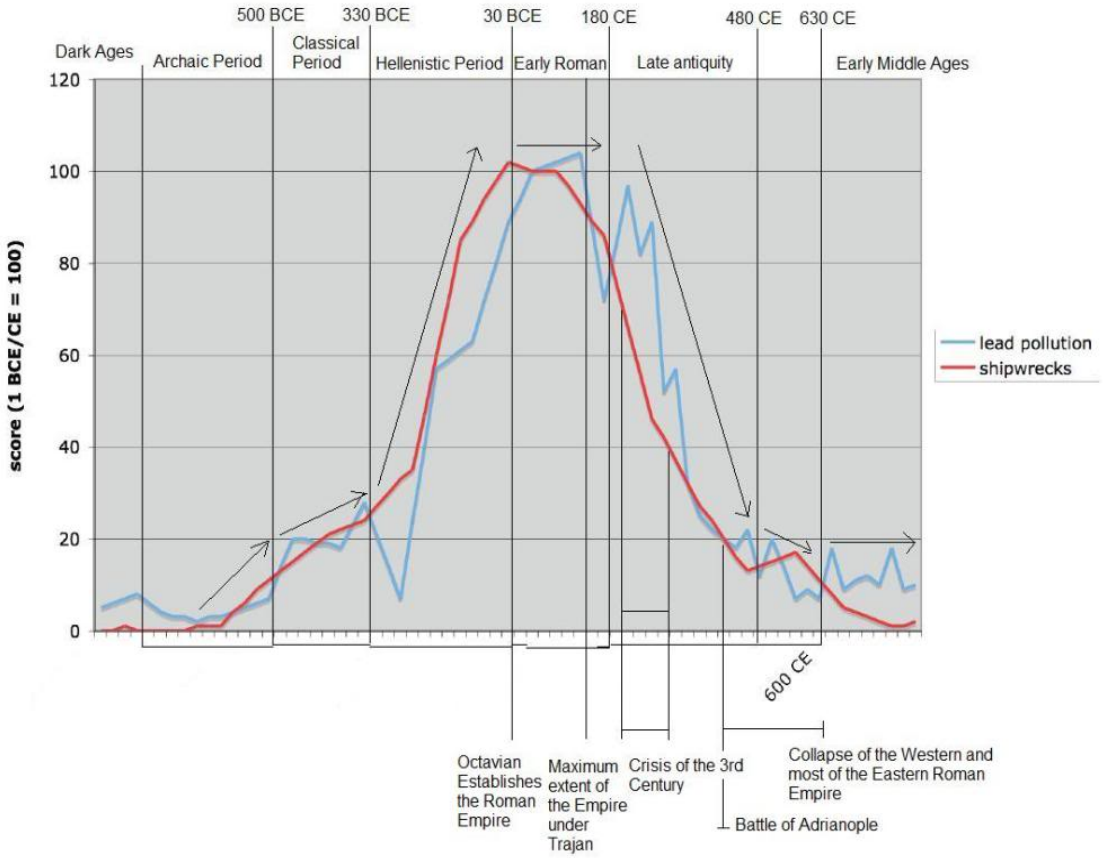
The record from lead pollution

The most recent, and possibly most striking evidence is very recent. It was not available twenty or ten years ago. In silver ore, the precious metal is mixed with lead. The separation process used by the Romans released a large quantity of lead in the atmosphere (some say about 20 percent of the lead), and this lead was carried by winds to the snows of Greenland and peat bogs in Europe. Today, cores of arctic ice and peat bogs can be analyzed. Different layers are dated with carbon 14 and the quantity of lead in each layer provides an index of the quantity of lead particles in the atmosphere at the time and therefore of the inflow of lead (assuming a relation between stock and flow). A number of studies have been published in Science and Nature very recently, and more

[8] His study is certainly informative and interesting. But, often people who present a new and striking fact tend to overemphasize it. For example, he emphasizes that the decline of the Roman Empire and the dark ages was caused by the reduction of the stock of silver. This reduction is more dramatic when the rate of wastage is high. His estimated rate of wastage (with no evidence from the Roman time) is indeed much higher than other estimates that based on actual data (Duncan-Jones, 1974).

will probably appear. These studies provide an estimate of the production of lead, not of silver. However, there is indication that the byproduct in lead of the silver extraction was so large that the Romans did not mine lead for itself. The production of lead is thus a reasonable indicator of the production of silver.

A summary of the production of lead is represented by the next figure.[9] The striking comparison with the trade index will be discussed below.



Source: Manning.

Figure 4.2: Indices of lead production and shipwrecks

The production of coins

Duncan-Jones (1994) reconstructs an estimate of the quantity of coins that were minted in different times from the evidence that is provided by coin hoards. The method, which had been used by previous authors, is to assess from the coins in the hoards some

[9] Cupellation is the process by which silver is extracted from the ore.

estimates on the number of the dies that were used to stamp the coins: in some cases, one can indeed identify the die that produced a coin, because of slight defects in the die. A critical step is to estimate the number of missing dies from the observed distribution of the production of coins per observed die. The number of coins per die is estimated from minting data in the Middle Age when the production technology was about the same as in the Roman Empire. This method has been evaluated critically over the last twenty years.[10] Duncan-Jones claims that his results are in global agreement with Patterson.[11]

The outflow of precious metals

It has been noted that there was an outflow in the trade with Eastern countries. Hoards of Roman coins have been found in India. This outflow would strengthen the argument that an inflow of new coins was important for economic activity.

A large inflow of new coins should increase the stock of money. The high quantity of money should have an impact on the price level, or equivalently the price of goods in terms of gold and silver. The most important real good at the time is wheat which is unfortunately subject to yearly variations depending on the size of the harvest. Given this caveat, there is some evidence of a secular rise of the price level during the first century.

Public expenditures

Military expenditures

The military technology at the time was very labor intensive. We do not have much data on the fleet (which is more capital intensive), but the fleet did not matter too much: there was no rival on the *Mare Nostrum*. The main purpose of the fleet was policing and transports. The army was well structured into legions of 5000 men each and which are easy to count[12]. We therefore have very good information on the size of the army. The main uncertainty comes the counting of the auxiliaries. The size of the army thus provides a fairly reliable real index of public expenditures (to be discussed later again). The placement of the legions, as described by Tacitus, is presented in Figure 4.

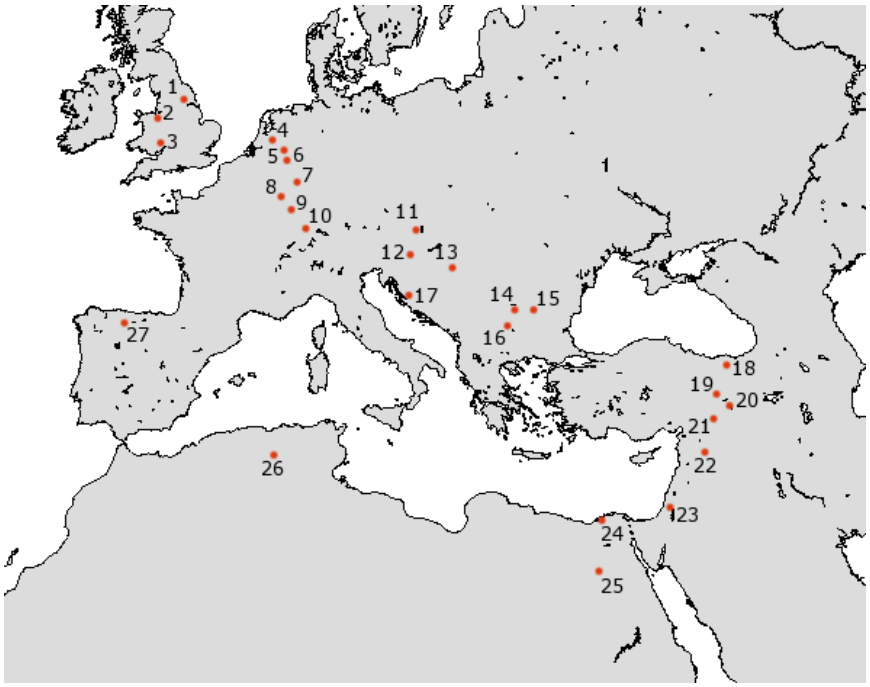
This evolution of the size of the army[13] is presented in Figure 4.

[10] See Callataÿ (2011)

[11] Harl (1996) finds the analysis of Duncan-Jones "vitiated". D-J discusses the issue of re-minting which may not have been that important before 75 A.D.. More analysis is probably required.

[12] An example is given for the year 23 CE (the ninth year of Tiberius reign) by Tacitus.

[13] The level is presented in thousands or legionnaire equivalent. (An auxiliary unit who is paid, say, 5/6 the wage of a legionnaire, is counted as 5/6 of a legionnaire equivalent). Other military expenditures



Source: Tacitus (Annals, Book IV, 4-5)

Figure 4.3: Placement of the legions in 23 CE

The figure illustrates remarkably the evolution of the public (military) expenditures for three hundred years. The principate of Augustus benefited from the "peace dividend": the size of the army was reduced, revenues could be diverted to public buildings. (The city of Rome was transformed during that period, see below). Trade was booming (see below). Expenditures grow toward the second century, but the growth is moderate and very profitable for the budget with the capture of the Dacian treasure. The years 100-150 with Trajan, Hadrian, Antonius have considered to be the best years of the Roman Empire, or for Gibbon, the best years in human history.[14] By 150, the state had accumulated a large surplus in coins.

The tenure of Marcus Aurelius is a turning point in the history of the Roman empire. Expenditures begin to grow sharply and permanently. The army size jumps from

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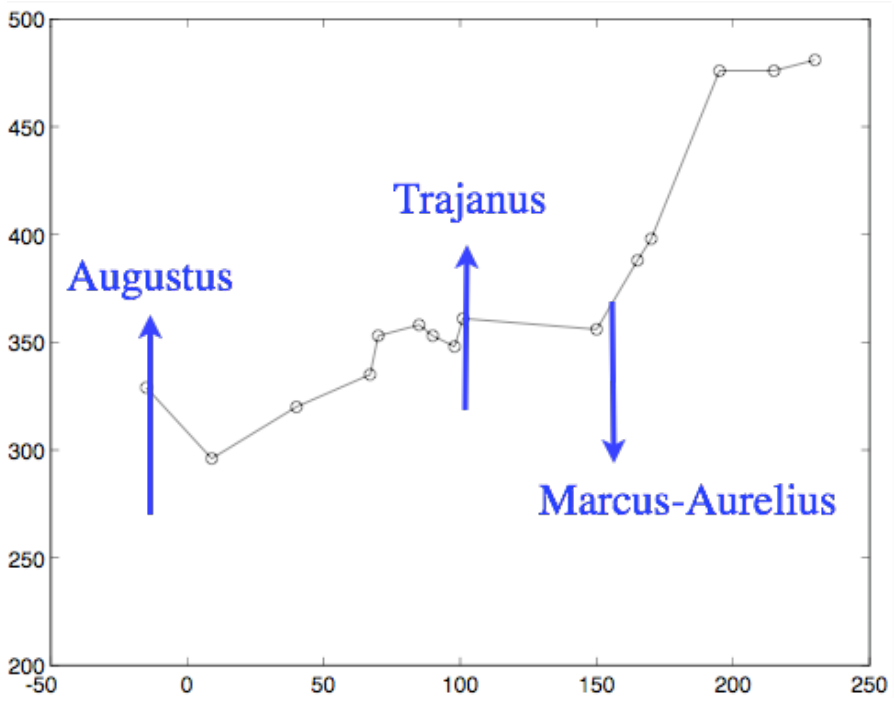
such as the fleet, or the roads (which were strategic) are not in the record. There were relatively smaller and the method for their accounting probably does not affect the general trend of military expenditures.

[14] "If a man were called to fix the period in the history of the world, during which the condition of the human race was most happy and prosperous, he would, without hesitation, name that which elapsed from the death of Domitian to the accession of Commodus" (Decline and Fall, chapter 3).



Source: Harl, (Table 9.2, p.218).

Figure 4.4: Evolution of the size of the army

350,000 to 500,000. This new level will be maintained for the next two centuries. The immediate cause is external pressure. There was inflation, but as seen above, the real cost of a legionnaire was increased at the end of the second century to probably re-gain the value it had under Augustus.

The situation continued to deteriorate in the third century which was a period of instability, politically, militarily and financially, with high inflation rates for the first time in history. Around 300, Diocletian and Constantine restored order, but external pressures on the military and therefore the public finances, continued until the final collapse of the western part of the empire around 450.

Other expenditures

Other expenditures included the (1) pay of public officials, (2) buildings, and (3) handouts. The handouts were distribution of money to citizens. The occasion was a special victory and, always it seems the installation of a new emperor. An estimate of this items, which must remain approximate, is given in the following table of Dun-can-Jones. The ratios between non army and army expenditures are about 30 percent for the low figures

and 40 percent for the high figures.

The table does not take into account circus games which were probably provided by wealthy citizens and by the free distribution of wheat or, later, bread[15]. Some public works are described in the appendix. The free distribution of wheat was obviously the first large welfare program in history.

The wheat was coming from Egypt and North Africa. It was collected through direct taxation in kind. The impact is a higher tax rate on some specific regions (which were indeed subject to rates much higher than 10 percent—see below). The surplus of Egypt had been taxed by the Pharaos because the geographical conditions favored an efficient tax system. The Romans had to make little effort to take it over. For Rome, the cereals of Egypt were vital as oil today for the US. Egypt was for Rome what oil producing countries are for the US (and other economically advanced countries), to-day.

The government had an additional source of revenues in mines of gold and especially silver. This issue will discussed below. An upper bound is probably 100 millions[16] HS in year 150 when the budget was around 900 millions HS. This mines' output was lower after 200 AD. This income may lower the tax burden for the regions that are not producing wheat. In summary, except for some regions where taxation was easy to implement (e.g., Egypt), the tax burden was low, around 6 percent (Hopkins estimates it at 8 percent).

The budget, an overview

Estimates of the overall budget are given by Duncan-Jones (1994) or two different years. His results are reproduced in Table 4.2.

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[15] According to the tutor of Marcus Aurelius, "The Roman people is held together by two forces: wheat doles and public shows". Rome was the largest city with an estimated population of one million, as London in 1800 when it was the largest city in the world. The large population Rome is obviously a consequence of the food subsidies.

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Category	150 CE Low	150 CE High	215 CE Low	215 CE High
1. Army	643	701	1,115	1,175
2. Civilian employees	75	75	75	75
3. Handouts	44	44	140	140
4. Builing	20	60	20	60
5. Others	50	100	100	150
TOTAL	830	980	1,450	1600

Source: adapted from Duncan-Jones (1994). Figures are in millions of sesterces.

Table 4.2: Estimated budget

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section at about 20 000 millions HS. Expenditures of 1000 millions HS yield an average tax burden of 5 percent. Since Italy was tax exempt, except for the harbor tax, the average rate was higher in other regions, especially in the regions with high productivity such as Egypt. In addition to the taxation by the central government, cities and regions had their own taxes to finance the local public goods such as baths of aqueducts (see the letters of Plinius).

The share of government revenues in GDP

The overall tax burden is measured by the ratio between tax revenues and total income. We have no data on total income in the Roman Empire. Any estimate is bound to begin with the size of the population and then guess some income per household and so on. The procedure is the same if we compare directly the work force in the population with the equivalence of government spending in man/years. Such a method is also independent from inflation rates.

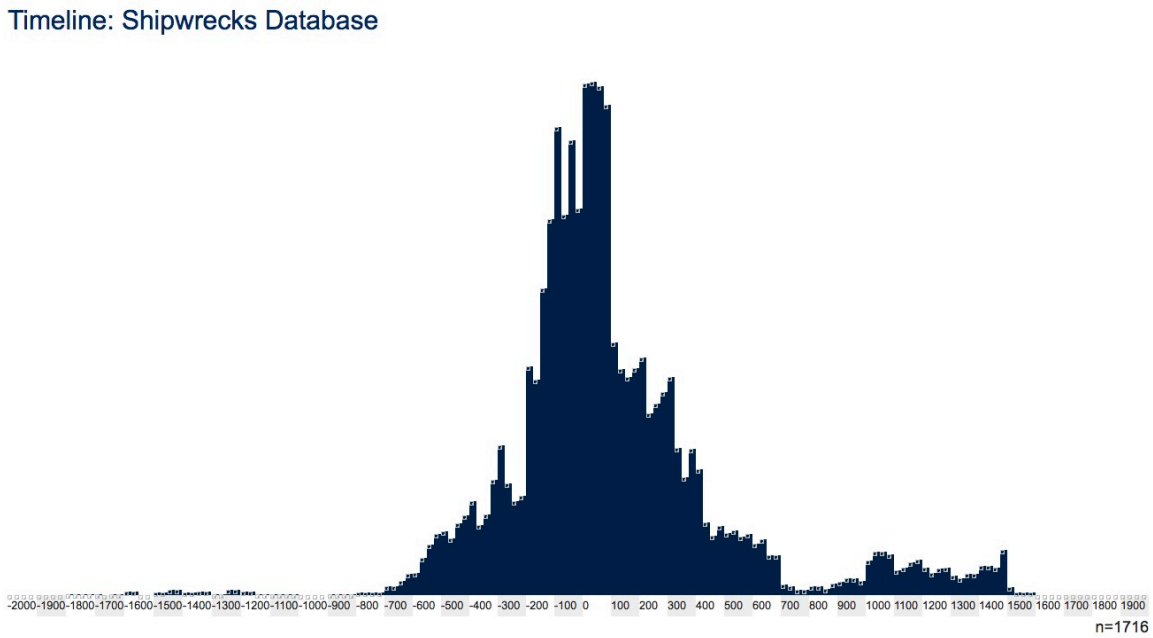
From the computation in the previous section, the spending by the government is equivalent to roughly 0.5 million men/years times (1.5/1.1) in year 215, that is 0.8 million. We know that in that year, army wages were competitive since the draft was not required anymore. We can therefore compare this number with the labor force in the Empire. Total population was about 50 millions. The labor force was not less is 12.5 millions. The ratio in this case is 0.8/12.5= 6.4 percent. If the labor force is larger or more qualified on average than the legionnaires (which could be the case), the tax ratio is lower.[19]

Trade and credit

There are very few informations on the economics of the Roman Empire. No document survived from the time, no text by any author. Any text that has come to us has been repeatedly copied by industrious monks who were more interested in copying Cicero, than economic data or contracts. We have to look for indirect evidence.

Given the central role of the Mediterranean sea in the Empire, trade was related to shipping: we would like to have some data on shipping. Assume that the fraction of ships which went to the bottom is (fairly) constant. Figure 4 summarizes the most recent data (that is constantly upgraded). The results are spectacular. Trade seems to

[19] One may comment that a large fraction of the labor force was in slavery. This should not affect the computation significantly. The income of a slave is accruing to the owner. That the implicit income is accruing the owner does not change the evaluation of national income. There is no strong obvious reason to suppose that the work done by a slave would earn in free market less than the wage of a legionnaire.



Source: **

Figure 4.5: Shipwrecks by (approximate) date

have been at its highest during the best days of the Empire (2d century)[20].

GNP and the distribution of wealth

A number of studies have attempted to measure the economic output of the Roman empire. The most recent study of Scheidel and Friesen (2009), (which includes the proper references), puts the number at about $ 700 per capita, which corresponds to Bangladesh today, between Mali ($ 800) and Burkina Faso ($ 600). These numbers show that such comparisons are meaningless. Until recently, any expat knew that with an income that was modest at home, he could afford to live on a scale with servants in a some countries.

[20] Is it possible that in the previous centuries, the seamanship was not as good as in the first two centuries C.E., hence the higher number of wrecks. Also, no allowance is made for the size of the ships. Were more recent wrecks larger? More important perhaps, as pointed by D. Piechota (private discussion) most of the wrecks that found are near the coast. All seamen know that this is were the dangers are greatest. The trade routes may have changed over the centuries. Initially, there is some evidence that routes were along the costs with many stops. If the trade has evolved toward long-haul, we would expect the numbers of wrecks to decrease, either because of the lesser dangers in high seas or the quasi nil probability of finding a wreck in high seas. Information about the type or cargo would provide some evidence on the routes. (For example, the origin of amphoras can be established by their shape, as today, a bottle of Bordeaux and a bottle of German wine).

Since we have to make approximations, let us estimate output in the Roman Empire, measured in the monetary units of the time, by a simple method. Assume that the pay of a legionnaire is about the same as the average income of a family. If the average family size is 4 (for a population that does not really grow), a population of 60 million (the estimate for the Roman Empire) is equivalent to 15M families. Given the legionnaire's pay of about 1000 HS (Figure 4.2 in the appendix), the GDP is 15B (billion) HS. This estimation may underestimate the ratio between the average production of a family, counted as four people, and a legionnaire's pay. The total output is therefore unlikely to be much below 20B, which is the very conclusion of Scheidel and Friesen.

The distribution of wealth

A characteristic of backward economy (which is the case for the Roman Empire), is the unequal distribution of wealth. Some Romans were fabulously rich. Crassus, the richest man at the time of Caesar, said that no man can call himself rich if he cannot afford an army. Besides anecdotes for particular individuals, we have some firm evidence through the wealth requirements to be a member of the senate or of the equestrian order, as shown in Table 4.3.

	Population	Wealth Requirement	Wealth mean
Senators	600	1	2.5
Equestrians	40 000	0.4	0.5
Decurionals	360 000		0.2

Wealth is in millions HS.

Table 4.3: Wealth distribution (Goldsmith)

Of course, senators had more than the requirements. How much more? The table presents the estimates of Goldsmith (1984). These numbers are most certainly too low. Here we can use a remarkable observation by Vilfredo Pareto. In different economies, the upper tail of the distribution of income (**) satisfies the following property: the mean income of people above a level w is a multiple of w, say βw, where $\beta > 1$ does not depend on w. The distribution that satisfies this property is now called the *Pareto distribution*. The property applies very well in the US around 1990 to the distribution of wage incomes of more than $ 100,000, with a coefficient β that is about 2.1.

Note that a more uneven distribution corresponds to a higher β. (Think of increasing the income of the top person). For the Roman Empire the number should be higher than the value of β should be higher than for the US economy. In Table 4.3, the mean

senators should be higher than the value of 2.5 given by Goldsmith. Let us assume tentatively that $\beta = 5$.

Given this value, the mean income of senators and knights, with a threshold of 0.4 million, should be 0.4β=2 million. Their total population is 40 600 and their total income is In that case, the mean income of the knight is

wealth above some level is a power function of that level, where the power coefficient is constant.A remarkable property of the distribution of income is For the analysis of this issue, Scheidel and Friesen (2009) use an additional tool from modern economic analysis. Pareto Let $\bar{w}$ such a level. The mass of people with wealth above $\bar{w}$ is $A/\bar{w}^{\alpha}$ where A is a constant and α is a coefficient. That coefficient α can depend on the economy. In that distribution, the ratio between the mean wealth per capita above $\bar{w}$ and the threshold $\bar{w}$ is a constant[21] that is equal to $\alpha/(\alpha - 1)$.

Table 4.3 presents the estimates of Goldsmith for the distribution of wealth (taken in the table as 1/.06 the level of income).

The wealthiest Romans were the senators. They had a wealth requirement of 1M HS and their number can be estimated at 600. The mean wealth in the Table is a guess. It assumes a β equal to 2.5. That is certainly too low from what we know about income distribution. The number of the U.S. is about 2.1 and the wealth distribution was much more uneven in the Roman economy. Scheidel and Friesen take, rightly, a higher value for β, at least5.

The top 1 percent is 150 000 people. In the US today, their income is about 12 percent of the total income. In Rome, according to Goldsmith, that would be 20 percent. According to the Pareto distribution, the top 0.1 percent income would have 15 000 people.

The unstable Empire

The Empire had 37 emperors between Commodus in 177 and Diocletian (305), not included. From these 37, only 4 died of natural death (Septimus Severus and three forgettable figures in the third century). The others were assassinated or died in battle. The middle of the third century was the period which has been called the anarchy. We have seen that the level of military expenditures jumped with Severus and Caracalla around 200. During the third century was beset by high military expenditures and civil

[21] The property of the Pareto distribution has been used in some recent studies on the optimal schedule of the income tax for industrialized countries (Saez, ***). For the wage distribution in the US, Saez finds a value $\beta = \alpha/(\alpha - 1)$ that is equal roughly equal to 2, that is $\alpha = 2$.

wars. Tax revenues and the inflow of precious metals were falling. A huge increase of debased coins provided revenues through seignorage (see Chapter 3).

During the inflation of the 3d century, some local governments issued their own money. A remarkable case is that of Asia Minor where it seems that most cities minted their own coins between 235 and 268. The practice stopped abruptly between 268 and 276. Local coins had a smaller rate of debasement compared to the coins of the empire. (Mitchell , 1993, p. 255). The observation has a simple explanation. Local money was used locally for transactions. A region may want to issue its own money to avoid the use of the money of the central government with its high inflation tax (created by the increase of coins through debasement). The minting of local coins stopped with the currency reform of Aurelian. It is probable that minting of coins was stopped by the central government under the pretext of the currency reform. But de-basement of the central government coins resumed shortly afterwards. According to the evidence, the cities of Asia Minor did not mint new coins after that date. One should verify whether the practice was stopped by a central government that wanted to increase its seignorage base.

The reforms of Diocletian and Constantine

`to be continued`

Some evidence for inflation

Here are some prices for Egypt (which was a province of the Roman empire). The currency is different from the standard Aureus-Denarius-Sestertius system, but we can assume that the nominal exchange rate was fixed between the two systems.

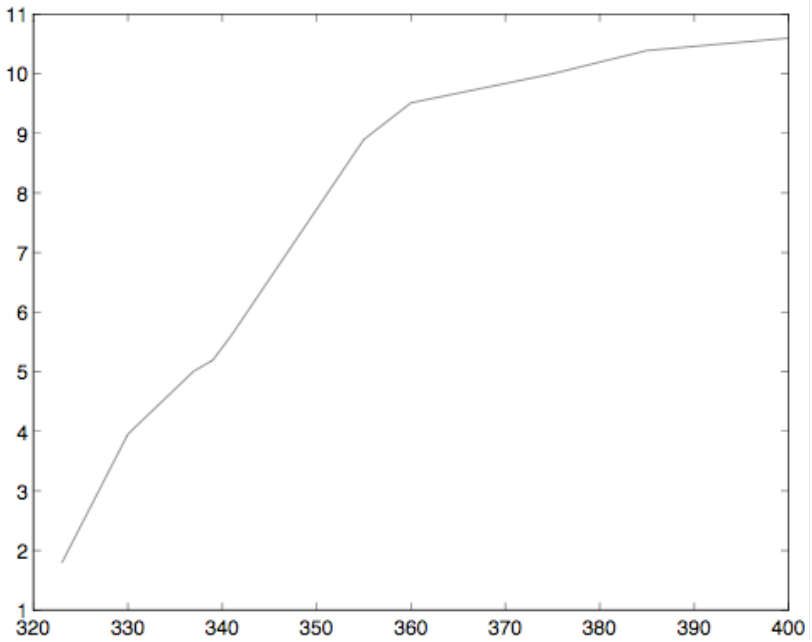


Figure 4.6: Inflation in the 4th century according to prices in Egypt
Source:

APPENDICES

4.2 The cost of a legionnaire

The Roman army is essentially the infantry, the legions. Under Augustus, the legionnaire was paid three times per year. The pay was gross: expenditures for personal arms were deducted from the gross pay.[22] The evidence is that the pay was increased three times before the period of anarchy. It is interesting to see how Develin (repeated by Alston.[23]) finds the numbers from the literary evidence.[24] The exercise shows how our knowledge of the Roman customs has been built by combining different sources.[25] The number of 225 denarii is fairly sure: Suetonius and Dio writing at different times have the same number that is expressed in two different ways. The same sources agree that the pay increased to 300 denarii under Domitian in 83-84. It seems that an Aureus (the gold standard of the time) had a special symbolic value with the troops. They may not have seen many (given the value of the coin and its impracticality for transactions). Hence, the yearly pay was most likely a multiple of 25 (denarii).[26] We know that Septimus Severus raised the pay, but we are not sure how much. The pay increase should be an integer number of Aurei per payment, three times per year, hence a multiple of three. But the increase per payment had to be a divisible by 2 (for the 50 percent increase of Caracalla to come out as an integer). This leaves an increase of 6 or 12, in denarii 150 or 300. (An increase of 18 or more can be ruled out after the following argument). We can be fairly confident that the lower number is more correct for two reasons.

First, Dio reports a letter written by Macrinus in 218 complaing that the pay cost was 70 M denarii. Take the table 3.1 of DJ below. The total army strength is 484,000 (not including severance pay). The ratio 70M/0.484 is 144.6, which fits very nicel.y[27]

[22] Explain why.

[23] Most of Alston (1994) is devoted to a refutation of the 5/6 ratio by Speidel (1992).

[24] Tacitus (Annals, I, 16-17) presents the speech of a mutiny leader around 15 AD who complains about the low benefits. This description is indicative but probably provides a lower-bound of the benefits.

[25] Unless specified otherwise, I follow Alston, 1994.

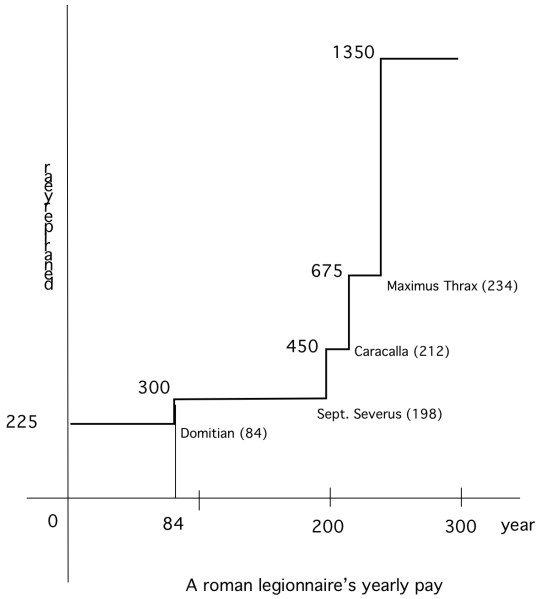
[26] An enlistment fee of three gold coins was also paid to new recruits.

[27] The 5/6 ratio for auxiliaries is disputed by Alston (1994). With a ratio of 1/1, we have an army of 0.514 million and an increase of with an increase of 136 which strengthens a little the argument for the lower number. But the difference is not significant for the problem and it may be compensated by a staffing at less than 100 percent.

Second, an increase of 300 by Severus would have meant a tripling of the pay in the span of 15 years. Severus (and Caracalla) certainly increased the pay to catch up with inflation (more below), but the evidence on inflation does not call for a tripling of the wages.

These numbers provide very useful information: there fit with some moderate infla-tion during the first two centuries. The high increases in 212 and 234 indicate a large increase of the inflation rate.

The legions were supplemented by other units some of them that were paid less. Officers were obviously paid more, sometimes much more. Finally, legionnaires re-ceived a severance pay after 25 years (if surviving.[28] The available evidence in 1994 is summarized by Duncan-Jones (1994) in a table that is reproduced in the documents,[29] with the cost of the army.[30]



A roman legionnaire's yearly pay

Source:

[28] Under Augustus, the severance pay was 12 000 HS. DJ cites sources that report a contingent of about 120 legionnaires per year per legion, i.e., 3600 per year. (Some evidence shows 240 per legion every other year). The severance pay is equivalent to 13 years pay. The total of the retirement is thus equivalent to about 50,000 men-years. Equivalence for the army is thus 550,000 men.

[29] Check Frank (1939) for an estimate of the navy cost.

[30] Numbers after 202 seem a little low after the previous discussion, but the difference is rather small. If auxiliaries were paid equally, the total number should be increased by 30,000, also a small percentage.

The legionnaire was paid in aureus three times a year

Pay in denarius withy round numbers: 9 aurei per year = 225 denarii.

Pay increase: 1 aureus = 3 aureii per year = 75 denarii (in y. 84)

About 900 HS during 1st cent. CE.

4.3 Public works

Thornton and Thorton (1983) have estimated the activity of the state in the construction of public buildings. Any estimate in sesterces hazardous. An estimate in "units of building" will be more robust. They take as standard of 60 units the Maison Carre, a temple of moder-ate size (480 square meters) that is well preserved in Nmes. One unit corresponds therefore to 8 square meters.[31] After the examination of the available sources and cross-checks, they produce an index for the beginning of the principate that is reproduced in the following fig-ure. During the fifties, public building was at a low level, but the Ostia harbor was expanded at the same time and Roman sources hint that this project may have been of a wider scale than previous construction activity in Rome.

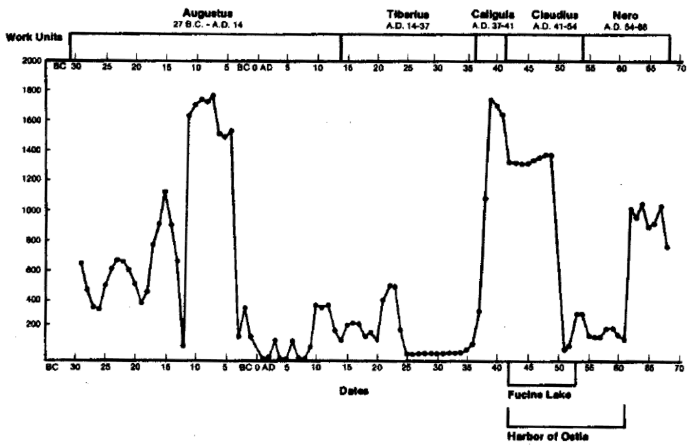


FIGURE 1

TOTAL ANNUAL WORK UNITS, JULIO-CLAUDIAN EMPERORS

Source:

[31] One should probably examine more closely the relation between surface, volumes and costs.

We learn from their work that: (i) there was a building boom during the time of the "divine Augustus", but the quantitative evaluation is not grand as the adjectives that were used the dithyrambic accounts; (ii) Tiberius deserves indeed his reputation of stinginess. The building boom took place at a time when Rome expanded and reached is maximum size of a million people. Free wheat for citizens provided an obvious incentive to move in.

Wheat handouts

Since 132 BC, wheat prices were fixed for Roman citizens. Since 58 BC, the fixed price was set at zero : frumentatio (Caius Gracchus). It is possible that only the poor citizens went to the "soupe populaire". The policy faces the standard dilemma of all such policies and provided an incentive to move away from the hard work in the field to the interesting life in the city with free food (and free "sports" games in the circus).[32] Slave owners had an incentive to free their slaves in order for them to collect the dole.

[32] Salluste, Cat 37: Juventus, quae in agris manuum mercede inopiam toleraverat, privatis atque publicis largitionibus excita urbanum otium ingrato labori praetulerat.