ISSN 1471-0498

DEPARTMENT OF ECONOMICS

DISCUSSION PAPER SERIES

HOW PROSPEROUS WERE THE ROMANS? EVIDENCE FROM DIOCLETIAN'S PRICE EDICT (301 AD)

Robert C. Allen

Number 363
October 2007

Manor Road Building, Oxford OX1 3UQ

How Prosperous were the Romans?

Evidence from Diocletian's Price Edict (301 AD)

by

Robert C. Allen

Working Paper Number 363
Department of Economics
Oxford University

Nuffield College
New Road
Oxford OX1 1NF
United Kingdom

email: bob.allen@nuffield.ox.ac.uk

2007

Abstract

The paper compares the standard of living of labourers in the Roman Empire in 301 AD with the standard of living of labourers in Europe and Asia from the middle ages to the industrial revolution. Roman data are drawn from Diocletian's Price Edict. The real wage of Roman workers was like that of their counterparts in the lagging parts of Europe and much of Asia in the middle of the eighteenth century. Roman workers earned just enough to buy a minimal subsistence consumption basket. Real wages were considerably higher in the advanced parts of Europe in the eighteenth century, as they had been in Europe generally following the Black Death in 1348-9.

JEL codes: J31, N30, O47

keywords: standard of living, real wage, Roman Empire, long run economic growth

I thank Alan Bowman and Andrew Wilson for their comments on an earlier draft of this paper. I am grateful to Professor Michael Crawford for a typescript of "The Arphrodisias copy of Diocletian's Edict on maximum prices." Remaining errors are my own.

How prosperous were the Romans? Their individual experiences ranged from wretched poverty to fabulous wealth, and that variety makes generalizations difficult. Many kinds of evidence can be used to address this question[1]. Three approaches to the problem are particularly direct and encompassing.

The first approach is to calculate the average income. This equals Gross Domestic Product divided by the population since GDP equals both the value of total production, and the sum of everyone's income. The GDP approach is appealing since it ties income into the production structure and makes explicit the connection between the standard of living and the efficiency of agriculture and manufacturing[2]. However, there is a corresponding drawback: the GDP approach requires either (1) a great deal of economic information that is either unavailable or not known with much accuracy, or (2) very strong equilibrium assumptions so that the small amount of information we do have can be used to proxy for what we do not know about the economy. In addition, the population must also be known to calculate average income, and population estimates are also controversial. Consequently, while GDP calculations help organize what we know about the Roman economy, any calculation of per capita GDP is bound to be problematic.

A second approach to ascertaining the average standard of living uses skeletal evidence.[3] The idea is that if people were better nourished during their youth, they would have been taller as adults. If large, random samples of skeletons were excavated, average adult height could be determined and the standard of living established. Promising research has begun in this area, but it is already creating controversy rather than consensus. There turn out to be serious problems in estimating average height–the prevalence of cremation, the size and representativeness of the samples, inferring height from the length of the femur, and so forth–and there is the further complexity that the correlation between height and income is not exact. So even if we could establish the 'biological standard of living,' we would still not be certain about the economic standard of living.

In view of these difficulties, this paper proposes a third approach to measuring Roman living standards. Instead of estimating the average income (or height) of Romans, I study the income of an 'average' Roman, a somewhat different concept. In particular, I study the purchasing power of an unskilled, free male labourer[4]. How much could such a person buy with his earnings? There are, of course, difficulties with this method: How representative was a labourer? What if he did not work full time? What about other people? Nevertheless, this provides us with a new approach to the problem that incorporates information that other approaches do not use. It provides a useful complement to them.

The purchasing power of wages (the real wage) is intrinsically comparative. In this case, we concentrate on the question: could workers in the Roman Empire buy more or less than their counterparts in other times and places? We can establish comparisons with medieval and early

---

[1]Atkins and Osborne (2006), Brown (2001), Jongman (2007), Ward-Perkins (2005).

[2]Hopkins (1980, 2002), Goldsmith (1984), Maddison (2001), Temin (2005, 2006).

[3]Baten and Koepke (2005), Jongman (2007).

[4]For some earlier treatments of wages, costs and purchasing power see Reece (1973), Duncan-Jones (1978) and Frézouls (1977, 1978).

modern Europe as well as with other great empires like Qing China and India under Moghuls and the Raj.

The reason that these comparisons are possible is because many researchers are studying real wages around the world in a systematic way.[5] One of the grand questions in modern economic history is why Europe pulled ahead of the rest of the world, and that question cannot be answered until we know when the 'great divergence' happened.[6] Real wages are one indicator of that separation. By using standard methodologies developed to chart the great divergence, Roman historians can avail themselves of the emerging picture of post-medieval living standards and use it to judge Roman performance. At the same time, the Roman empire will be integrated into this broader world view. This paper is a first stab at that problem.

To measure the purchasing power of wages, we need information about wages and the prices of consumer goods. The data used in this paper are all derived from Diocletian's Edict on Maximum Prices[7] in 301. There are questions about how long the edict was enforced and how the maximum prices it specified relate to actual wages and prices in different parts of the empire[8]; indeed, one way to improve on the results here is to rework the calculations with wages and prices specific to a variety of times and places. However, the price edict is such a well known source and includes most of the necessary information, that it is worth seeing what it has to say.

The approach I use is straight forward. First, I calculate from daily wages that a labourer would earn in a year if he worked full time. Second, I calculate the cost of supporting a family. This involves specifying the items–and the quantities–they would have consumed in a year. This list is called their 'consumption basket'. Multiplying the quantities by their prices defines the cost of living. Third, I compare income to living costs. Could the labourer purchase the specified basket? Doing the same calculations for the Roman empire and for other situations shows us whether the Roman labourer fared better or worse than his counterparts elsewhere in history. The remainder of the paper discusses these issues in more detail and presents the results.

Wage rates

---

[5]van Zanden (1999), Allen (2001), Özmucur and Pamuk (2002), Bassino and Ma (2005), Allen, Bassino, Ma, Moll-Murata, van Zanden (2007).

[6]Pomeranz (2000).

[7]For the prices in the edict I have used the edition of Lauffer (1971). The most importnat modern publications are Reynolds (1971), Erim and Reynolds (1970) and (1973), Giacchero (1974). See also Ermatinger (1990). The fullest English translation of the text, as it was then known, is that of Graser 1940.

[8]See Ermatinger (1990).

In the Roman empire, some workers were paid by the day and some according to the work they did. Here I only consider the day workers, although it would be worthwhile to extend the analysis to the others.

The Price Edict specifies the wage for a variety of unskilled workers (e.g. farm labourers, camel and mule drivers, water carriers, and sewer cleaners, VII,1a, 17, 19, 31, 32) as 25 denarii per day plus maintenance. A cash wage plus a food allowance has been a common payment scheme in many poor countries. According to Duncan-Jones, food allowances were about 5 Italic modii of wheat per month.[9] Since the price of wheat was set by the Edict at 100 denarii per Castensis modius (i.e. 66.67 denarii per Italic modius, which was two thirds the size), the food allowance was worth 333 denarii per month. I treat this as an increase in income rather than as a reduction in the quantity of food purchased. One could debate how to combine the money wage and the food allowance since the first is per day and the second per month. I assume that the wheat was prorated over the days actually worked. On a daily basis, therefore, the food allowance was worth 11.1 (= 333 denarii/30 days) denarii. On this reading, unskilled labour earned 36.1 denarii per day.

It is interesting to compare the wage rate in the Roman Empire to wages elsewhere. To do that, we must establish an exchange rate between denarii and other currencies. This is an ever present problem in price history. Since silver was so often the medium of exchange, currencies are usually converted according to their silver equivalents. How much silver was in a denarius at the time of the price edict? I take it to have been .032 grams of pure silver[10]. In that case, the daily wage of a labourer was 1.16 grams of silver.

Figure 1 puts that wage on a graph of daily wages for labourers in leading cities in Europe and Asia from the late middle ages through the eighteenth century.[11] There was little divergence in wages among European cities in the fifteenth century, but afterwards wages rose dramatically in northwestern Europe where the economy was booming due to the expansion in global trade.[12] Wages in Asian cities, which only become available in the seventeenth century,

---

[9]Duncan-Jones (1982, p. 146). The five italic modii used for food allowances is the amount of the Roman 'corn-dole' of the earlier empire, the use of which can be justified on the view (though not universally accepted)that the dole was not welfare for the destitute but an allowance for the more or less self-sufficient (see *The Oxyrhynchus Papyri* XL (London 1972), 8-15.

[10]According to King (1993, p. 11), the argenteus, which equaled one hundred denarii, had a theoretical weight of 3.38 grams of silver. In practice, however, the actual weight was a bit lower. It should be noted that the welfare ratios computed in this paper are independent of the silver content assumed for the denarius. The reason is that the welfare ratios are ratios. The silver exchange rate appears in the numerator where it converts the wage from denarii to grams of silver and in the denominator where it does the same for the prices. Thus, the silver exchange rate cancels out.

[11]The European and Asian wages and prices used in this paper are available on my website at www.nuff.ox.ac.uk/sociology

[12]Allen (2003a), Acemoglu, Johnson, and Robinson (2005).

were low–on a par with those in central and southern Europe where the economy was stagnant. The daily wage in the Roman Empire is shown with a star on the graph, although it does not, of course, apply to the year for which it is plotted. The wage rate in Rome was like that in India and lower than in China and Europe. Despite Diocletian's concern with inflation, wages in his Empire were not high by later standards.

The European Respectability Basket

Figure 1 shows that a worker in eighteenth century London earned much more silver per day than a worker in the Roman Empire, but does that mean that the English worker had a higher standard of living? The answer depends on the cost of living. How should it be measured? The simplest approach is to calculate how much grain the worker could buy with his wage. Sometimes 'grain wages' give the right answer, but they are problematic since neither London nor many Roman workers ate grain. Instead, they ate bread, which, as a processed food, was a more expensive source of calories. Furthermore, virtually all people consume things besides the basic carbohydrate. Ideally, one should specify a complete 'consumption bundle' and compute its cost. Many bundles are possible.

Table 1 is the 'northern European respectability' basket that I first used to compute the cost of living in early modern Europe. The basket was inspired by English and Dutch studies of working class budgets and suggests the spending pattern of 'respectable' workers. The budget is medieval, however, in that it does not include foods like sugar and potatoes that only entered mass consumption after the European discovery of America.

The budget shown in Table 1 represents the spending of an adult male. It should be noted that wheat bread was consumed in some regions, while rye bread was consumed in others. In some places, veal was eaten, in others, it was beef or pork. I have followed the maxim 'when in Rome, do as the Romans' and have calculated the cost of the basket using the price of the most widely consumed type of bread or meat. The budget's daily calorie intake (1940) would put the person in the third decile from the bottom of the English distribution in the late eighteenth century and in the fourth decile of the French[13]. Protein availability was high. This was 'respectability' rather than destitution.

Frequently mentioned non-food commodities like cloth, candles, and fuel are also included. Textiles presented a problem. The only type of cloth shown is linen, although much wool was also worn. The available price data for wool are hard to interpret, however. One needs the price of the same quality of woollen cloth in the places compared, but wool varied enormously in terms of quality, and quality differences seem to have driven the differences in the prices we have. Wool cloth is, therefore, not useful for the present exercise. Linen does not appear to suffer from the same problem. I have included enough linen in the budget, so that the share of linen in spending is what one would expect for all textiles.

Table 1 lists average prices in grams of silver for 1745-54 prevailing in Strasbourg. When the cost of the basket is calculated with these prices, it amounts to 414.899 grams of silver

---

[13] Fogel (1991, p. 45).

per year. Prices were different in other cities and in other times, but this gives an indication of the price level in eighteenth century Europe.

Table 1 also omits the cost of housing. Budget studies suggest it amounted to 5 - 10% of spending. I have not been able to find the rent of comparable housing in the cities studied, so I have dealt with this problem by increasing the cost of everything except the housing by 5%.

While Table 1 describes spending in northern Europe, it does not apply to the Mediterranean. In southern Europe, wine was consumed instead of beer, and olive oil was used instead of butter. In reckoning the cost of living in Mediterranean cities, I substituted olive oil for butter and wine for beer. In the latter case, the quantity was reduced to maintain the same annual consumption of alcohol. Table 2 shows the resulting Mediterranean budget. Its cost in Strasbourg prices was virtually identical to the cost of the northern basket. Neapolitan prices are also shown, and the Mediterranean basket cost less in Naples than it did in Strasbourg.

While the baskets in Tables 1 and 2 would support an adult male, the question we want to address is whether a man's earnings were sufficient to support a family, so the consumption bundle in Table 1 or 2 must be scaled up accordingly. The cost of the family depended on the ages and conditions of the wife and children. I have not made a close calculation of this question, but have simply multiplied the cost of the basket in Tables 1 and 2 by three. This allows for a man, a woman, and some children given that equivalence scales represent a women as eating less than a man and young children as requiring very much less.

In sum, the cost of maintain a family at the standard of the northern European respectability basket equals the cost of the basket in Table 1 or 2, multiplied by 1.05 to include rent, multiplied by 3 to scale it up to a family.

The Cost of the Basket in Diocletian's reign

To establish a comparison with the Roman Empire, we must compute the cost of the basket with prices from Diolcetian's price edict. Some of these present few problems of interpretation, while others present difficulties. These prices have been converted to grams of silver per metric unit. The particular prices were as follows (parenthetical references are to chapters and lines in the Price Edict):

beans/peas–100 denarii per Castensis modius as for crushed beans, lentils, chickpeas, crushed peas, dried kidney beans (I,9,11,13,15,21)
meat–8 denarii per Roman pound as for beef, goat, or mutton (IV, 2,3)
cheese–8 denarii per Roman pound as for fresh cheese (VI, 96)
eggs–1 denarius each as for eggs (VI,43)
oil–12 denarii per Roman pint as in oil, ordinary (III,3)
wine–8 denarii per pint as for ordinary wine (II, 10)
cloth–cover to be used as a tent, 16 feet in length and breadth, dyed (XIX,4). The cloth is 256 square Roman feet in area and priced at 2500 denarii or 9.77 denarii per square Roman foot. A Roman foot was 296.2 mm, so the cloth cost 111.3089 denarii or 5.877 grams of silver per square meter. The early modern prices are for pieces one meter long and typically about one ell (27 inches or .6858 metres) wide. A piece this size would have cost 4.03 grams of silver in 301 AD.

Fuel–'wagon load of wood, 1200 pounds' worth 150 denarii (XIV, 8) or .125 denarii per Roman pound (.32745 kg) or .012216 grams of silver per kilogram (0.032*0.125/.32745). I assume that one kilogram of wood yields 7.701 thousand BTUs.[14] The price of energy in grams of silver per million BTUs was, therefore, 1.586 = 1000*0.012216/7.701.
bread–bread does not appear in the Edict. It does give a maximum price for wheat (100 denarii per castrensis modus of 12.936 litres, I,1) and the wage for a skilled worker, in particular a baker at 50 denarii per day plus maintenance (VII, 12). I estimated the price of bread from these data using the 'bread equation' I estimated previously [15]. This is a statistical equation estimated from an early modern data set of bread prices, grain prices and wage rates. The equation fits the data well and provides a means of estimating the price of bread from the cost of its two main inputs. The equation used here is:

price of bread = .063 + 1.226 * price of wheat + .014 * daily wage of skilled labour

The prices and wages are all in grams of silver, the price of bread is grams of silver per kilogram, and the price of wheat is grams of silver per litre.

Table 2 shows the prices used in computing the cost of living in Diocletian's day. When the prices are multiplied by the quantities shown, the cost of the basket can be calculated. It came out to be 163.921 grams of silver per year. This was a much lower cost of living than in Naples or Strasbourg.

<u>The standard of living of a Roman labourer</u>

We can bring together the wage and price information to work out the standard of living of the Roman labourer. We proceed in three steps: annual income, annual consumption cost, and the ratio of income to expenditure.
Annual income–Including food allowance, the daily wage of the Roman labourer was 1.16 grams of silver. How many days per year did he work? I assume that he worked 250 days, which is what was also assumed for early modern workers. This looks a plausible number in view of the large number of festivals in the late Roman Empire[16]. In that case, annual earnings were 289 grams of silver.
Annual consumption cost–The basket in Table 2 cost 163.921 grams of silver. To get the annual cost of a family, rent at 5% must be added and the total scaled up by a factor of three. The annual cost of supporting a family was therefore:

163.921 grams silver * 1.05 for rent * 3 = 516.352 grams of silver

---

[14] Allen (2003b) tabulates the energy content of many fuels measured by weight and volume. This paper is available on my web site at www.nuff.ox.ac.uk/sociology

[15] Allen (2001).

[16] Duncan Jones (1978, p. 160).

Welfare ratio–The worker earned 56% of the cost of the basket (289/516.352). This ratio is called his welfare ratio.

Evidently, the worker did not earn enough to buy the basket. How he coped will be considered shortly. For the moment, however, we can compare his welfare ratio to welfare ratios of workers in other times and places. In all cases, we are comparing the purchasing power of their earnings.

Figure 2 plots welfare ratios for the same cities shown in Figure 1. Workers in London and Amsterdam did best. There was fluctuation in their earnings. In the worst periods they earned barely enough to buy the respectability basket, but in most years they had some excess. These workers had the highest silver wages (Figure 1). That advantage was reduced but not eliminated when account is taken of the prices of consumer goods they bought.

Workers elsewhere in Europe and Asia experienced real wage slides across the early modern period. There was a wage peak in the fifteenth century following the population drop caused by the Black Death in 1348/9 and subsequent outbreaks. As population grew from the sixteenth century onward, real wages fell. By the eighteenth century, most workers in Eurasia had earnings that only equalled half of the cost of the basket. Workers in the Dutch Republic and England were the only ones to avoid this fate as the economies of these countries grew rapidly due to their success in the global economy.

Bare bones subsistence baskets

What happened to workers in Southern Europe, East Asia, and the Roman Empire who were too poor to buy the baskets–meager as they are–shown in Tables 1 and 2? One strategy was to increase the time worked. Men could work more days and longer hours. No allowance has been made thus far for the earnings of women and children. They could work many hours, although their wage rates were usually so low that their employment could not decisively change the situation. China was an exception to this generalization, for women there contributed a significant proportion of family income.[17]

Cutting expenditure was the other strategy. That was possible because the food shown was highly processed either by animals (meat) or by people (bread and beer). Indeed, the way to cut costs was to sharply curtail most of the non-food items, eliminate the alcohol and most of the animal protein, and eat boiled grains rather than bread. Scottish highlanders ate oatmeal, Italians shifted from bread to polenta, and many Asians ate mostly rice. In the Yangzi Delta, poor peasants even ate boiled wheat in the summer.[18]

Early modern travelers accounts often depict many people subsisting on diets like this. "It appears from contemporary accounts that the articles in the diet of the common people in most parts of India consisted chiefly of rice, millets and pulses".[19] Francisco Palsaert, a Dutch East India company captain who visited the subcontinent in the early seventeenth century, called

[17]Li (1998, pp. 150-5), Pomeranz (2000, pp. 290, 319-320).

[18]Li (1998, p. 207, n 25).

[19]Raychaudhuri and Habib (1982, I, p.164).

the Indian diet "monotonous." In the Delhi-Agra region, the people "have nothing but a little kitchery [kedgeree] made of green pulse mixed with rice...eaten with butter in the evening, in the day time they munch a little parched pulse or other grain." The workmen "know little of the taste of meat." Indeed, pigs, cattle, chickens, and eggs were all taboo. Where available, fish was the only source of animal protein. It was a similar story in western India. Wheat was not eaten by the labouring population, whose main source of carbohydrates was millet. This was ground into a course flour and fried up as chapatis that were eaten with pulses and vegetables. Charles Lockyer, who toured Asia in the early eighteenth century on the English East India Company ship Streatham, observed of the Arab sailors in the Indian Ocean, "They serve for small Wages, and are Victual'd at a much cheaper Rate than our Ship's Companys: Salt-fish, Rice, Gee, and Doll, with a few Fowls, being all the Provisions they care for. Doll is a small Grain, less than Fetches, contains a Substance like our white Peas, and being boil'd with Rice makes Kutcheree."[20]

I specified such quasi-vegetarian 'bare bones' spending patterns for each of the places being compared. Oatmeal was the basis of the diet in northwestern Europe, polenta in northern Italy, and millet in western India. Table 3 shows the bare bones basket for northwestern Europe and for the Romans. The Roman diet was dominated by wheat and beans, which supply most of the calories and protein. The calorie level has been kept at 1940 calories by day, as before. While animal protein has been greatly reduced, the wheat and beans provide a diet that is comparably rich in protein.

The great thing about the bare bones diet is that it cost much less than the respectability diet–in the case of Rome, 79.094 grams of silver versus 163.921. Hence, the cost of supporting a family was cut to 249.147. This was something that the Roman labourer could afford. Indeed, the ratio of income to the consumption expenditure jumped to 1.16, so the labourer had a bit of income to spend on 'luxuries.'

All workers see a rise in their welfare ratios, when bare bones spending patterns are the basis for comparison, as Figure 3 shows. The Figure shows the same relative values as Figure 2, but the poor workers of the eighteenth century all had welfare ratios of one or a bit above. Labourers in London and Amsterdam earned three or four times the cost of the bare bones diet. They did not multiply their oatmeal consumption by four, however. Instead, they increased their purchases of non-food items and bought the more expensive foods of the respectability diet. The essence of the matter is captured by Doctor Johnson's definition of oats as "a grain, which in England is given to horses, but in Scotland supports the people."

Conclusion

The real wage evidence supports a guardedly optimistic view of Roman living standards. Certainly, the Roman worker in Diocletian's time was doing about as well as most workers in eighteenth century Europe or Asia. One lesson that price history teaches, however, is that real wages fluctuated in the past. Indeed, Roman performance looks unimpressive in comparison with fifteenth century Europe when real wages were so high. In addition, generalizations are

---

[20]Lockyer (1711, p. 258).

confounded by variation across space with workers in booming parts of the continent earning much more than their counterparts in more placid provinces. One suspects that the same was true of the Roman Empire. The next step in the research agenda should, therefore, be to use actual wages and prices (rather than legal maxima) to measure real wages in the Roman period and to do this for different regions of the empire and different time periods. That investigation might reveal as much variation as we observe in the early modern world and lead to a more complex assessment of Roman living standards.

Table 1

Northern European Respectability Basket

	quantity per person per year	price g. silver per unit	spending share	nutrients/day calories	grams of protein
bread	182 kg	.693	30.4%	1223	50
beans/peas	52 l	.477	6.0	160	10
meat	26 kg	2.213	13.9	178	14
butter	5.2 kg	3.470	4.3	104	0
cheese	5.2 kg	2.843	3.6	53	3
eggs	52 each	.010	1.3	11	1
beer	182 l	.470	20.6	212	2
soap	2.6 kg	2.880	1.8		
linen	5 m	4.369	5.3		
candles	2.6 kg	4.980	3.1		
lamp oil	2.6 l	7.545	4.7		
fuel	5.0 M BTU	4.164	5.0		
total		414.899	100.0%	1941	80

Table 2

Mediterranean Respectability Basket

	quantity per person per year	Strasbourg price g. silver per unit	Naples price g. silver per unit	Diocletian price g. silver per unit
bread	182 kg	.693	.790	.394
beans/peas	52 l	.477	.479	.408
meat	26 kg	2.213	2.571	1.290
olive oil	5.2 l	7.545	2.505	1.160
cheese	5.2 kg	2.843	2.571	1.290
eggs	52 each	.010	.127	.053
wine	68.25 l	.965	.300	.774
soap	2.6 kg	2.880	2.029	1.160
linen	5 m	4.369	4.854	4.031
candles	2.6 kg	4.980	1.405	1.160
lamp oil	2.6 l	7.545	2.505	1.160
fuel	5.0 M BTU	4.164	5.452	1.586
total		416.3583	355.9249	163.921

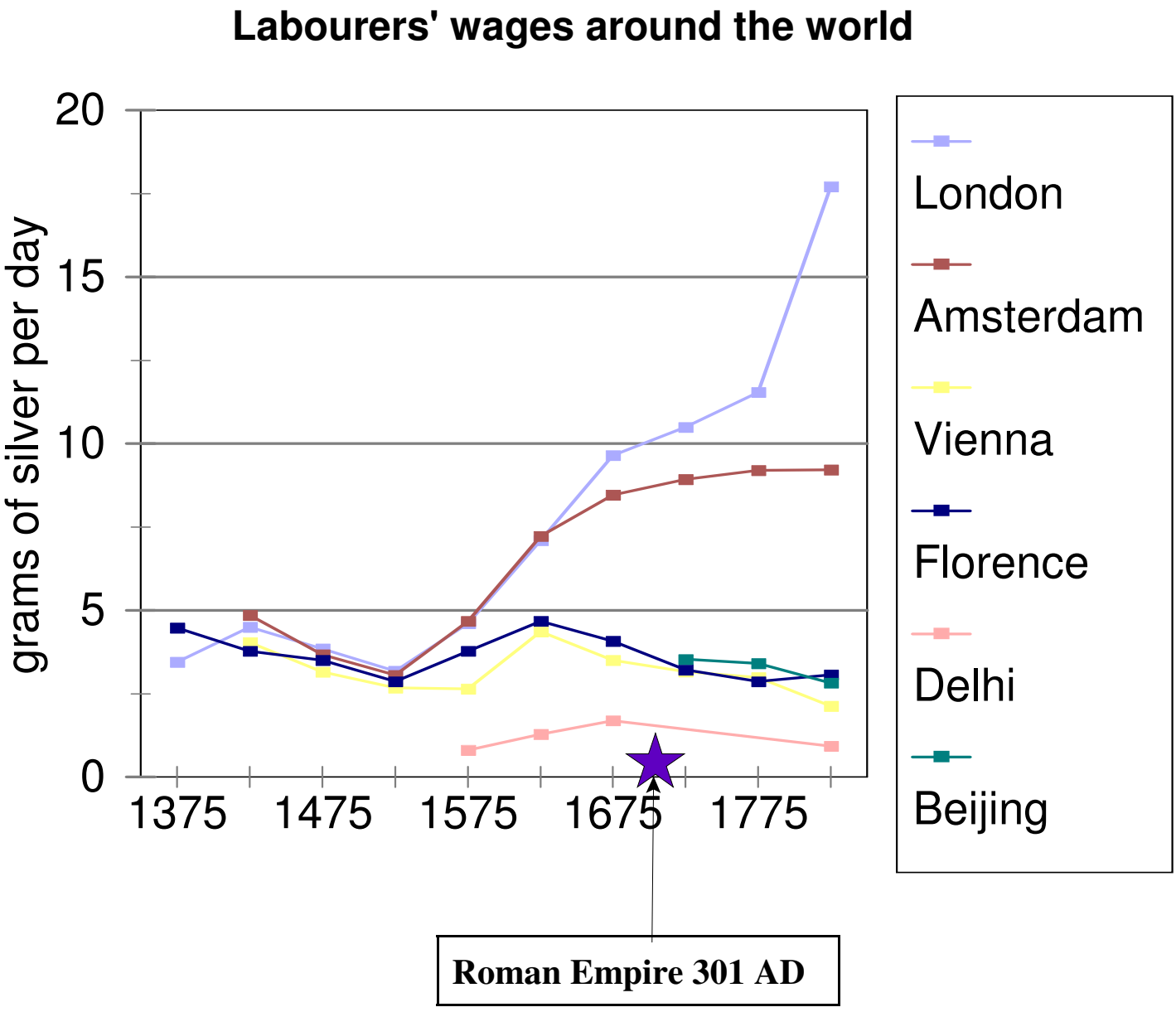
Table 3

Bare Bones Subsistence Baskets

	European oats			Diocletian wheat		
	quantity per person per year	nutrients/day calories	grams of protein	quantity per person per year	nutrients/day calories	grams of protein
wheat				172 kg	1607	50
oats	155 kg	1657	72			
beans/peas	20 kg	187	14	20 kg	187	14
meat	5 kg	34	3	5 kg	34	3
butter	3 kg	60	0			
olive oil				5 l	112	0
soap	1.3 kg			1.3 kg		
linen	3 m			3 m		
candles	1.3 kg			1.3 kg		
lamp oil	1.3 l			1.3 l		
fuel	2.0 M BTU			2.0 M BTU		
total		1938	89		1940	67

Figure 1

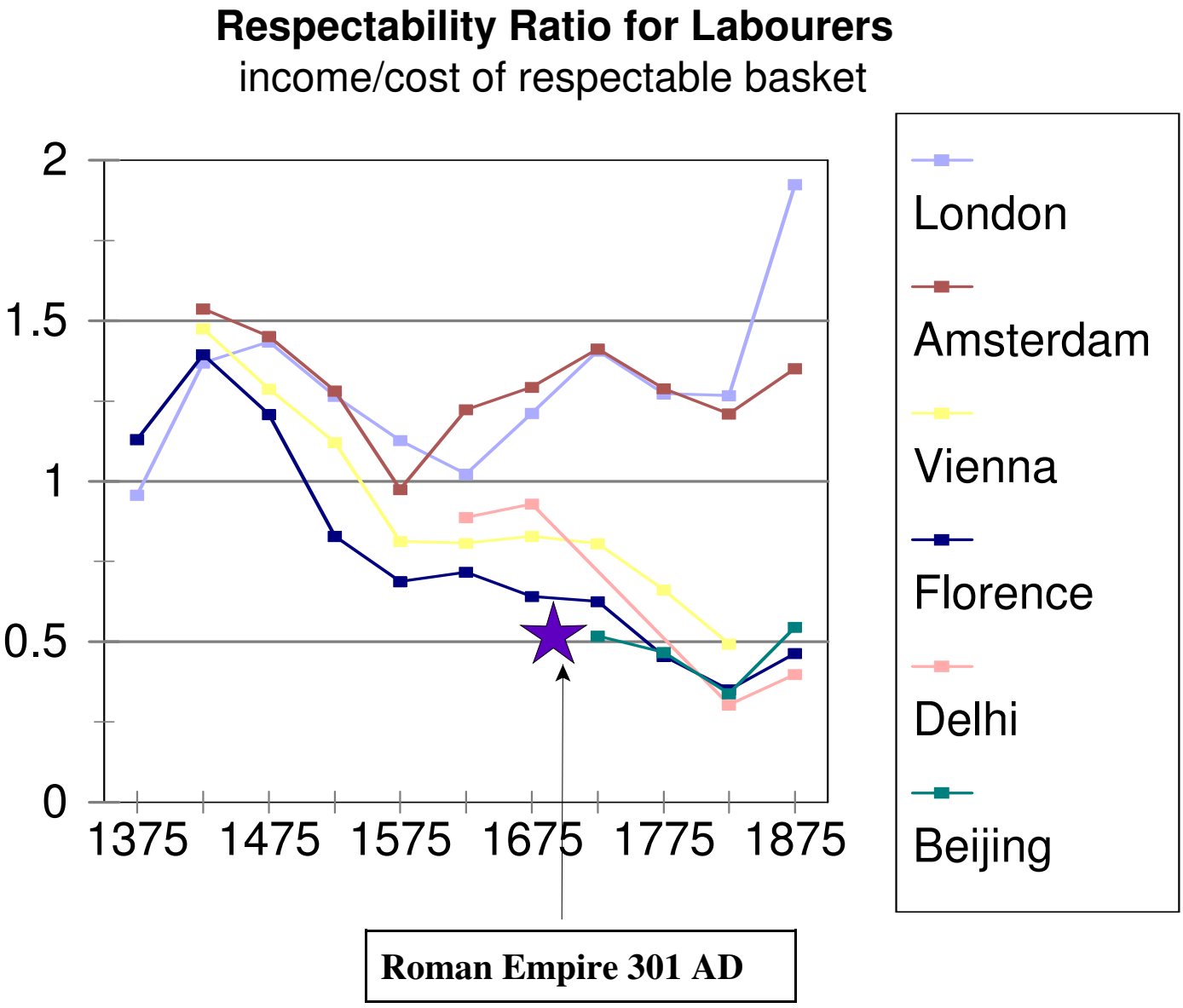
silver wages



Source: Allen, Bassino, Ma, Moll-Murata, van Zanden (2007) and text.

Figure 2

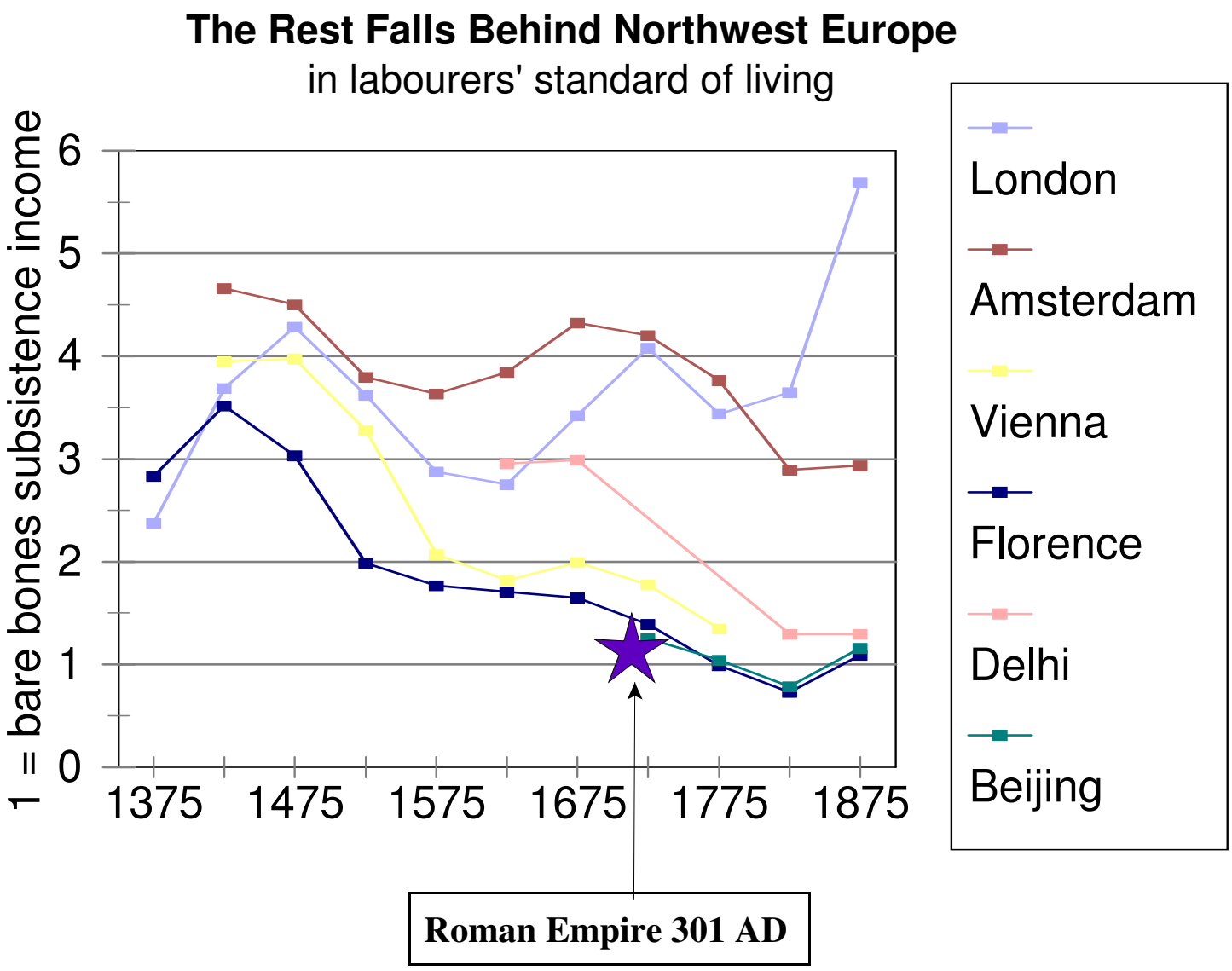
Welfare Ratios with European Respectability Basket



Source: Allen, Bassino, Ma, Moll-Murata, van Zanden (2007) and text.

Figure 3

Welfare Ratios with Bare Bones Baskets



Source: Allen, Bassino, Ma, Moll-Murata, van Zanden (2007) and text.

References

Acemoglu, Daren, Johnson, Simon, and Robinson, James (2005). 'The Rise of Europe: Atlantic Trade, Institutional Change and Economic Growth,' American Economic Review, Vol. 95, pp. 546-79.

Allen, Robert C. (2001). "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War," Explorations in Economic History, Vol. 38, pp 411-447.

Allen, Robert C. (2003a). "Poverty and Progress in Early Modern Europe," Economic History Review, Vol. LVI, pp. 403-443.

Allen, Robert C. (2003b). "Was there a Timber Crisis in Early Modern Europe?" Economia e energia secc. Xiii-xviii, Serie 'II–Atti delle "Settimane di Studi" e altri Convegni, 34, Instituto Internazionale di Storia Economica "F. Datini", Prato, pp. 469-82.

Atkins, M. and Osborne, R.G.,eds. (2006). *Poverty in the Roman World* (Cambridge 2006).

Bassino, Jean-Pascal, Ma, Debin (2005). "Japanese Unskilled Wages in International Perspective, 1741-1913." Research in Economic History, 2005.

Baten, Joerg, and Koepke, Nikola (2005). "The Biological Standard of Living in Europe during the Last Two Millenia," European Review of Economic History, Vol. 9, pp. 61-95.

Brown, P.R.L. (2001). *Poverty and Leadership in the Later Roman Empire* (Brandeis University Press).

Corcoran, Simon (2000). The Empire of the Tetrarchs: Imperial Pronouncements and Governement AD 284-324, Oxford, Oxford University Press.

Duncan-Jones, R. (1978). 'Two possible indices of the purchasing power of money in Greek and Roman antiquity,' in *Les Dévaluations à Rome, Époque républicaine et impériale* (Coll. De l.École francaise de Rome 37, 1978) I, pp. 159-68.

Duncan-Jones, Richard (1982). The Economy of the Roman Empire, Cambridge, Cambridge University Press, second edition.

Erim, Kenan T., Reynolds, Joyce, Wild, J.P., and Ballance, M.H. (1970). "The Copy of Diocletian's Edict on Maximum Prices from Aphrodisias in Caria," Journal of Roman Studies, Vol. 60, pp. 120-41.

Erim, K. T. and Reynolds, J. (1973) The Aphrodisias copy of Diocletian's edict on maximum prices. The Journal of Roman Studies 63: 99-110.

Ermatinger, J. W. (1990) Diocletian's economic revolution. Münstersche Beiträge zur antiken Handelsgeschichte 9.1: 45-9.

Figueira, T. J. (1999) review of: The ancient economy: Prices and the establishment of prices in the ancient economies - French - Andreau,J, Briant,P, Descat,R. The Classical World 92.6: 575-7.

Fogel, Robert W. (1991). "The Conquest of High Mortality and Hunger in Europe and America: Timing and Mechanisms," in Favorites of Fortune: Technology, Growth, and Economic Development since the Industrial Revolution, ed. by Patrice Higonnet, David S. Landes, and Henry Rosovsky, Cambridge, MA, Harvard University Press, pp. 33-71.

Frézouls, Edmond (1977). "Prix, salaires et niveaux de vie: quelques enseignements de *l'Edit du Maximum*," Ktema, Vol. 2, pp. 253-68.

Frézouls, Edmond (1977). "Prix, salaires et niveaux de vie: quelques enseignements de *l'Edit du Maximum* (II)," Ktema, Vol. 3, pp. 289-300.

Giacchero, M. (1974) (ed.) Edictum Diocletiani et collegarum de pretiis rerum venalium:in integrum fere restitutum e latinis graecisque fragmentis, 2 vols (Pubblicazioni dell'Istituto di storia antica e scienze ausiliarie dell'Università di Genova 8). Genova, Istituto di storia antica e scienze ausiliarie.

Goldsmith, Raymond W. (1984). "An Estimate of the Size and Structure of the National Product of the early Roman Empire," Review of Income and Wealth, Vol. 30, pp. 263-88.

Graser, Elsa Rose (1940). "The Edict of Diocletian on Maximum Prices," in Tenney Frank, ed., An Economic Survey of Ancient Rome, Vol. V Rome and Italy of the Empire, Baltimore, The Johns Hopkins Press, pp. 305-420.

Hopkins, K. (1980). 'Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400)', Journal of Roman Studies , Vol. 70, pp. 101-125.

Hopkins, K. (2002), 'Rome, taxes, rents and trade', in Scheidel, W. and Von Reden, S., eds., *The Ancient Economy* (Edinburgh), pp. 190-230.

Jongman, Willem M. (2007). "The early Roman Empire: Consumption" in The Cambridge Economic History of the Greco-Roman World, ed. by Walter Scheidel, Cambridge, Cambridge University Press, chapter 22, forthcoming.

C.E.King, C.E. (1988). 'The fourth century coinage', in L.Camilli, S.Sorda (eds 1993), 'L'"inflazione" nel quarto secolo d.c. Atti dell'Incontro di Studio 1988 (Rome), pp. 1-87.

Lauffer, S. (1971) Diokletians Preisedikt (2nd edition) (Texte und Kommentare 5). Berlin, Walter de Gruyter & Co.

Li, Bozhong (1998). Agricultural Development in Jiangnan, 1620-1850, Houndmills, Basingstoke, Hampshire, Macmillan Press Ltd.

Lockyer, Charles (1711). An Account of the Trade in India, London.

Maddison, Angus (2001). The World Economy: A Millenial Perspective, Paris, OECD.

Michell, H. (1947) The edict of Diocletian: a study of price fixing in the Roman Empire. Canadian Journal of Economics and Political Science 13.1.

Özmucur, Süleyman, and Pamuk, Şevket.(2002). "Real Wages and Standards of Living in the Ottoman Empire, 1489-1914." *Journal of Economic History* 62 (2002): 293-321.

Pomeranz, K. (2000) . The Great Divergence: China, Europe, and the Making of the Modern World, Princeton, Princeton University Press.

Raychaudhuri, Tapan, and Habib, Irfan (1982). The Cambridge Economic History of India, Vol. I, c. 1200-c.1750, Cambridge, Cambridge University Press.

Reece, R. (1973). 'Wages and prices' in D.E.Strong, ed., *Archaeological Theory and Practice* (London), pp. 240-5.

Reynolds, J. M. (1971) Libya and Diocletian's Edict on Maximum Prices. Libya antiqua 8: 33-42.

Temin, Peter (2005). "Estimating the GDP of the Early Roman Empire," in Innovazione tecnica e progresso economico nel mondo romano, ed. By Elio Lo Cascio, Rome, Bari, chapter 2.

Temin, Peter (2006). "Quantification in Ancient Economic History."

Van Zanden, Jan Luiten (1999). "Wages and the Standards of Living in Europe, 1500-1800." European Review of Economic History, 3, pp. 175-98.

Ward-Perkins, Bryan (2005). The Fall of Rome and the End of Civilization, Oxford, Oxford University Press.