GDP in Pre-Modern Agrarian Economies (1-1820 AD)
A Revision of the Estimates[*]

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Over the last decades, the works by Angus Maddison have marked a meaningful step forward in the field of applied economics. Their contribution to research will be of importance for a long time. The following comments concern Maddison's analysis of pre-modern per capita GDP, which comprises an important part of his last works. The pre-1820 product has been primarily examined by Maddison in his work *The World Economy: a Millennial Perspective*,[1] published in 2001. *Contours of the World Economy, 1-2030 AD*,[2] is a new and remarkable advance in his pre-modern research. We shall examine some of his results, following, however, his methods. In contrast with the opinion of several historians, we believe that, even in the case of past agrarian economies, for which quantitative evidence is scanty, if not almost inexistent, "quantification – as Maddison himself writes -- clarifies issues which qualitative analysis leaves fuzzy. It is more readily contestable and thus likely to be contested. It sharpens scholarly discussion, sparks off rival hypotheses, and contributes to the dynamics of the research process".[3]

We shall take the European economy into account. Maddison's view can be summarized by the following series of data (in 1990 international dollars PPP) concerning Western Europe and covering almost two millennia:

	Per c. GDP	Index
1	576	1.35
1000	427	1.00
1500	771	1.81
1600	889	2.08
1700	997	2.33
1820	1,202	2.81
1870	1,960	4.59

As can be seen, the level of per capita output until 1500 was similar to that of some less developed countries during the last 100 years and of contemporary Uganda, Niger, Somalia, Guinea, Zambia. It was still low at the beginning of the 19th century and only from then on did it increase. In any case, excluding the decline in the first millennium, the European economy grew in the following 800 years and per capita GDP almost tripled, rising by about 50-60 percent from

[1] A. Maddison, *The World Economy. A Millennial Perspective*, Paris, OECD, 2001.
[2] A. Maddison, *Contours of the World Economy, 1-2030 AD. Essays in Macro-Economic History*, Oxford, Oxford University Press, 2007.
[3] Maddison, *The World Economy,* p. 18.

1500 until 1820. The recent success of modern growth was therefore rooted in a long progressive evolution.

By contrast our view is that pre-modern agrarian economies underwent phases of growth and decline, but not of real long-term progress; although, in aggregate terms, population increase always resulted in a rise of gross product. Growth was not unknown before Modern Growth, but it came about in long cycles around an overall stability of per capita income. In our view, the Roman economy was no more backward than the early modern West European economy, and late medieval Western European economies were no more backward than 18th century economies. Only the introduction of machinery and modern sources of energy marked a sharp discontinuity and defined a new path of development from the first half of the 19th century onwards.

We will discuss Roman GDP in the first part of this paper and, in the second part, the European economy from the late Middle Ages until 1820. Our comments therefore concern the first two chapters of *Contours*. Since the focus of Maddison's book is GDP reconstruction, our remarks will refer to his analysis of product and methods and techniques of calculation.

1. *Roman per capita GDP in sesterces*

Goldsmith's estimate. Maddison's estimate of Roman per capita GDP around 14 AD, that is at the death of Augustus, is the development of the reconstruction proposed in 1984 by Raymond Goldsmith.[4] The previous estimate by Keith Hopkins (1980)[5] is discussed and criticized. The recent one by Peter Temin, put forward in 2003 and recently published (2006),[6] is briefly quoted, but not discussed.

The result Maddison reaches for the Roman Empire is on the whole no different from that of Goldsmith; only government expense and investment represent a higher percentage (while expenditure on consumption other than food represents, as a consequence, a lower percentage) (Table 1).

Table 1. The estimate of per capita GDP of the Roman Empire in 14 AD from the demand side in sesterces (HS).

		HS	Shares as to y=1	Shares as to w=1
w	**Wheat**	112	0.29	1.00
c	**Other cereals**	18	0.05	0.16
f	**Other food**	70	0.18	0.63
o	**Other consumption**	130	0.34	1.16
g+i	**Government & Investment**	50	0.13	0.45
y	**TOTAL**	**380**	1.00	3.39

Note: in the last column on the right the figures represent the percentages regarding wheat consumption. E.g. 0.16 refers to other cereals divided by wheat consumption (18:112=0.16).

[4] R.W. Goldsmith, "An Estimate of the Size and Structure of the National Product of the Early Roman Empire", in *Review of Income and Wealth*, 30, 1984, pp. 263-88. The same topic has later been discussed by the same R. W. Goldsmith in *Premodern Financial Systems. A Historical Comparative Study,* Cambridge, Cambridge University Press, 1987, pp. 34-59.
[5] K. Hopkins, "Taxes and Trade in the Roman Empire (200 B.C.-A.D. 400)", in *Journal of Roman Studies*, LXX, 1980, pp. 101-25.
[6] P. Temin, "Estimating GDP in the Early Roman Empire", in E. Lo Cascio (ed.), *Innovazione tecnica e progresso economico nel mondo romano*, Bari, Edipuglia, 2006, pp. 31-54.

The estimate by Goldsmith was based on both wheat consumption, assumed to be 253 kg per person per year, and a wheat price of 3 sesterces per *modius* of 6.75 kg, and approximately 0.444 sesterces per kg in the 1st century AD. We know that an average wheat price relative to some decades is hardly representative in pre-modern agrarian economies, given the wide yearly deviations. Medieval and early modern European series of wheat prices witness that annual changes of 50 percent in cereal prices were far from exceptional. Variability was a feature of the agrarian price history until a quite recent epoch. This is probably the reason why Goldsmith's estimate, according to the author himself, could be considered as "approximately valid from the late first century BC to the mid-second century AD".[7] The price of 3 sesterces per *modius* is therefore nothing but a plausible assumption. We know that in some regions, such as Egypt, wheat prices were lower and that, naturally, prices were in general much higher in the city of Rome. The price of 3 sesterces per *modius* was also the basis of Hopkins' estimate of Roman GDP. Peter Temin, taking the much lower Egyptian prices, reaches an estimate of per head income which is less than half the estimate proposed both by Goldsmith and Maddison. His conclusion is that "per capita GDP in the early Roman Empire was near that of Uganda today".[8]

Maddison's estimate. Goldsmith calculated per capita GDP by adding to the estimate of wheat consumption the share of other cereals, that of other food, of other consumption and finally the share of government and investment. Maddison adopts the first three estimates of Goldsmith, but lowers the share of the other consumption (from 39 to 34 percent of the total per capita income) and raises the share of government and investment[9] (from 8 to 13 percent[10] and then 45 percent more[11] as to the value of only wheat consumption).

A compact presentation of Maddison's estimate can be expressed through the following equation:

$$y = w(1 + c + f + o + g + i)$$

where *y, c, f, o, g, i*, reported in the first column of the previous Table 1, correspond to the items of the second column and represent proportions as regards wheat (*w*)(in the last column). As can be seen, the calculation depends on the value assigned to wheat consumption (*w*) which is the only known variable; or rather the only variable to which we can assign a plausible value. Replacing the letters in the equation with figures (5th column of Table 1) we have:

$$380 = 112 \cdot (1 + 0.160 + 0.625 + 1.161 + 0.446)$$

Per capita GDP is then 3.392 times (the sum of the figures in brackets) the yearly wheat consumption per person (380/112). This level is also supported by a supply-side calculation. When considering a labour compensation of 3.5 sester-

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[7] Goldsmith, "An Estimate", p. 263.
[8] Temin, "Estimating GDP", p. 49. Temin compares the estimates by Goldsmith and Hopkins, stating that "Goldsmith's approach is more satisfactory than Hopkins', that is, more in touch with modern economic theory and observations", but saying that "Goldsmith's numbers however are not as good as his methods" and in the end suggesting an estimate of per capita income closer to that proposed by Hopkins. In any case, it must be observed that Hopkins' original estimate was the estimate of the *minimum* per capita expenditure (in terms of the annual consumption of wheat or measured in wheat). In the latest version of his calculations (K. Hopkins, "Rome, Taxes, Rents and Trade", in *Kodai: Journal of Ancient History", 6-7, 1995-96, pp. 41-75), he devised a rough multiplier of 1.5 in order to estimate the actual expenditure from the minimum expenditure.
[9] The percentage refers to 5th column of Table 1.
[10] In the 4th column.
[11] In the 5th column.

ces per day and a number of 225 working days per year, together with assumptions on the dependency ratio and the share of non-labour incomes, the result tallies with the demand-side computation.[12]

Italy and Empire. Maddison improves upon the previous estimate by Goldsmith by specifying per capita Italian national product together with that of other regions of the Empire. Per capita GDP was higher in Italy than in the rest of the Empire and GNP per person was higher in Italy than GDP since the state drew various types of tribute and tax income from the provinces and the elite drew rent from property acquired outside Italy. By taking into account all these plausible assumptions, the result reached by Maddison regarding per capita GDP in the Empire and in Italy, in sesterces, is the following:

	Per c. product in HS	
Empire	380	1
Italy	534	1.41
Rest of Empire	351	0.92

It must be observed that the estimate of per capita GDP in Italy is reached by Maddison by assuming that:

1. the population of peninsular Italy was 16 percent of the total population of the empire;

2. that the slaves were more or less one tenth of the population of the empire at large and more than a third of the population of peninsular Italy, providing a per capita labour contribution much higher than that of the free men, since four fifths of the slaves were labourers;

3. that a large proportion (42 percent) of the income of the elite (26 percent of total GDP) originated in Italy.

It goes without saying that each of these estimates has a very flimsy basis: the size of the population of Roman Italy is hotly debated,[13] and all other figures are simply educated guesses. If we put the population of Italy at 14 million instead of 7 (11 million free men and 3 million slaves), and leave the estimate of the population of the provinces unchanged at 37 million (35 million free men and 2 million slaves, the figures adopted by Maddison), per capita GDP in Italy will turn out to be much lower (457 sesterces, instead of 534) and therefore much lower will be the difference with the per capita GDP in the provinces.[14]

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[12] On the income side, it is debatable that the estimate in sesterces for labour compensation of the free men proposed by Goldsmith and adopted by Maddison (3.5 sesterces per day) is much too high, as Temin would argue ("Estimating GDP", p. 46), in the light of the same scanty data used by Temin himself.

[13] See now W. Scheidel, "Roman Population Size: the Logic of the Debate", in L. de Ligt & S.J. Northwood (eds.), *People, Land, and Politics. Demographic Developments and the Transformation of Roman Italy, 300 BC-AD 14*, Brill, Leiden-Boston 2008, 17-70. We have put forward our views on Roman demography in E. Lo Cascio, P. Malanima, "Cycles and Stability. Italian Population before the Demographic Transition (225 B.C.-A.D. 1900)", in *Rivista di Storia Economica*, n.s., XXI, 2005, 3, pp. 197-232.

[14] See Maddison Table 1.10: we increased the number of slaves in Italy, in order to maintain the same proportion of 10 percent for the slave population in the empire at large and we adopted all the estimates (for labour compensation, number of working days, dependency ratio for free men and slaves and so on) proposed by Maddison; furthermore we increased the income of the elite in Italy in proportion to the increase in population, leaving the same value for the income of the elite in the rest of the empire. If we assume that the increase in the income of the elite is also to be assigned proportionally to the elite living in the provinces, the difference in per capita GDP between Italy and the rest of empire will be even lower (408 and 369 respectively).

The Roman Empire and other pre-modern economies. Looking at the procedure followed by both Goldsmith and Maddison, it can be seen that, since they start with a plausible wheat consumption for a pre-modern economy and add to it plausible shares of other consumptions, the result cannot but be a per capita product similar, both in the level and distribution among the several items, to that of other pre-modern economies. If it is assumed that Roman per capita GDP is 3-4-fold the value of the wheat consumption of about 250 kg, the product per head in real terms will be similar to that of many pre-modern economies. It is worth stressing that, simply by adopting a lower estimate of the price of wheat, but a higher estimate of the share of other food (plausible in the light of what we know of the diet of the Romans and of their average height thanks to animal bones and skeletal remains)[15] and of other consumption (again thanks to what is known of the variety of goods available to Roman consumers), we can arrive at the same estimate in sesterces of per capita GDP, thus assuming a better standard of life.

Let us accept the estimate of per capita GDP in Italy and the Empire suggested by Maddison, however, and follow him in his conversion of the ancient product in modern monetary values.

2. *Roman per capita GDP in international 1990 dollars*

Sesterces and dollars. It is not easy to compare GDP in Roman sesterces to other estimates for the following epochs. On the other hand, the exercise of calculating Roman GDP is of scarce interest if we have no possibility of comparison with other periods. England is the country chosen for the comparison both by Goldsmith and Maddison, since for 1688 is available the estimate of per capita GDP worked out by Gregory King and adjusted by Maddison to 9.958 pounds.[16] So the following step is to answer the question: what was the Roman level of GDP per head in comparison to that of 9.958 pounds in 1688 England? Both Goldsmith and Maddison follow the same methods of solving the problem and reach a similar result: per capita GDP of the Roman Empire was 50 percent (Goldsmith) or 40 percent (Maddison) that of late 17th century England. How do they establish the correspondence sesterce-pound and evaluate this difference of per capita income? This is a crucial point.

The comparison in precious metal. A first comparison consists in the conversion into gold of Roman GDP per head and that of 1688 England. This kind of comparison heavily depends on the value of gold relative to other goods. In 1751 Ferdinando Galiani wrote that a metal such as gold, "has the inconvenience (*incommodo*) of having a variable price"[17]; as does any other commodity. The finding that Roman per capita product was 50 percent or even 40 percent of that of late 17th century England may depend not on the fact that real average income was in Rome half or less than that of a following epoch, but on the fact that the value of gold was in ancient Rome twice or more than that of early Modern Eng-

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[15] W.M. Jongman, "The Early Roman Empire: Consumption", in W. Scheidel, I. Morris, R. Saller (eds.), *The Cambridge Economic History of the Greco-Roman World,* Cambridge, Cambridge University Press, 2007, pp. 592-618; Id., "Gibbon was Right: the Decline and Fall of the Roman Economy", in O. Hekster, G. de Kleijn, D. Slooties (eds.), *Crises and the Roman Empire. Proceedings of the Seventh Workshop of the International Network Impact of Empire,* Leiden, Brill, 2007, pp. 183-99; G. Kron, "Anthropometry, Physical Anthropology and the Reconstruction of Ancient Health, Nutrition and Living Standards", in *Historia*, 54, 2005, pp. 68-83.

[16] See the fine reconstruction of King's demographic and economic analysis in Maddison, *Contours*, pp. 264 ff.

[17] F. Galiani, *Della moneta e scritti inediti*, ed. A. Merola, Milano, Feltrinelli, 1963, p. 96.

land, in a period, that is, when the flow of precious metals from the New World had raised the European stock of gold. Galiani himself was well conscious of the long-term decline in the value of precious metals since the discovery of America. From then on, he wrote, the value of the European currencies had been and was still slowly declining ("va sempre, benché insensibilmente, calando").[18]

Scholars have proposed quite diverging estimates of the monetary stock in Roman imperial times. According to Goldsmith, at the end of the Augustan age the magnitude was in the order of some 7 billion sesterces, 3 billion in silver coins (that is, 2,895 tons of silver) and 4 billion in gold coins (that is, 309,6 tons of gold), plus a small amount of subsidiary coins,.[19] A much higher estimate, almost threefold, was suggested, for the '60 of the II century AD, by R.P. Duncan-Jones: roughly 20 billion sesterces, 880 tons of gold and 5,766 tons of silver.[20]

There is also some disagreement among scholars concerning the money reserves in early modern Europe. F. Braudel suggested the existence of 40,000 tons of silver in 1500, before the arrival of precious metals from America.[21] Other scholars proposed the estimates of 60,000 tons of silver plus 5,000 tons of gold, over the same period.[22] Both estimates are probably too high,[23] their magnitude, by far exceeding the ancient figures. Less uncertain are the estimates of the flow of gold and silver from America: 7,100 tons of silver between 1550 and 1600, that is more than the entire stock of money at the death of Augustus, according to Goldsmith, plus 95 tons of gold. Between 1550 and 1650, 16,000 tons of silver were unloaded in Seville[24] that is not far from the total money reserve in the Roman Empire at the middle of the second century, according to the higher estimate by Duncan-Jones.

It is apparent that the value of monetary metals could not be the same in Roman antiquity as in early modern European states.

The comparison in cereals. More reliable is the other method, chosen by both Goldsmith and Maddison, of estimating the quantity of wheat that Roman sesterces could buy, compared to the quantity bought by the 1688 pound. On the basis of the price of wheat taken from the beginning of the calculation (0.444 sesterces per kg), per capita GDP of 380 sesterces corresponded to 855 kg (HS 380/0.444). Since per capita GDP was 41 percent higher in Italy than in the Empire, Italian income per head equalled 1,200 kg (HS 534/0.444).

The problem of comparing this Roman income in units of wheat with that of England was rapidly solved by Goldsmith by taking "three wheat price quotations for 1686-90", not reported in his article.[25] On this basis, the conclusion by Goldsmith was that "the wheat equivalent of annual national product per head in the

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[18] Galiani, *Della moneta,* p. 32.
[19] Goldsmith, *Pre-modern Financial Systems*, p. 41.
[20] R.P. Duncan-Jones, *Money and Government in the Roman Empire*, Cambridge, Cambridge University Press, 1994, p. 170. Incidentally, this last estimate would suggest a much higher total GDP than estimated by Goldsmith and Maddison (unless one thinks that the velocity of circulation was sensibly lower and/or the rate of monetization was sensibly higher than in most pre-modern economies); it would suggest, therefore, a higher population or a higher per capita GDP or a combination of both: see E. Lo Cascio, "Introduzione", in Id., *Credito e moneta nel mondo romano*, Bari, Edipuglia. 2003, pp. 5-15.
[21] F. Braudel, *Civilisation matérielle, économie et capitalisme*, I, *Le structures du quotidien*, Paris, Colin, 1979, Chap. VII.
[22] M.T. Boyer-Xambeu, G. Deleplace, L. Gillard, *Monnaie privée et pouvoir des princes. L'économie des relations monétaires à la Renaissance*, Paris, CNRS, 1986, p. 137.
[23] If compared to those proposed by J. Day, *The Medieval Market Economy*, Oxford, Blackwell, 1987, pp. 60-1 for the 15th century.
[24] These data on importation of precious metals from America are the same suggested by Braudel and Boyer-Xambeu, Deleplace, Gillard in the just cited works.
[25] Goldsmith, "An Estimate", p. 281 (footnote 82).

early Roman empire of about 125 modii at a price of HS 3 or close to 850 kg was in the order of one-half the level of England and Wales in 1688".[26] So in 1688 English GDP per head could buy about 1,700 kg of wheat, that is twice that of the ancient Roman Empire.

Maddison has chosen to express the 1688 English per capita income in wheat by means of the prices recorded by the same Gregory King and reported in a Table.[27] In fact for the year 1688 King provided an estimate of English cereal production and the prices of the four main cereals: not only wheat, the price of which was 6.43 pounds per metric ton (0.00643 per kg), but also rye, barley and oats. According to King's calculations, at that time wheat represented 24 percent of the English cereal output in weight and 31 percent in value. Naturally the prices of rye (4.92 pounds per metric ton), barley (4.74), and oats (4.23) were lower than that of wheat. Minor crops always have a lower price compared to wheat. Maddison chose to express the English product per head utilizing the weighted average price of the four cereals: 4.93 pounds per metric ton. The result of the ratio between income (9.958 pounds) and cereal price (0.00493 pounds per kg) is 2,019. The average Englishman could buy 2,019 kgs of wheat in 1688, while the average ancient Roman could buy only 855 and the average Italian 1,200. The result is that the Roman Empire per capita GDP (expressed in wheat) was 42 percent of that of late 17th century England. In Italy, in the centre of the Empire, it equalled 59 percent.

The comparison in wheat. As can be seen, Maddison utilizes cereal prices in his calculations, and not wheat prices and, since prices of minor cereals are lower than those of wheat, an average income has a higher purchasing power. The ratio between 9.958 pounds and the wheat price per kg (0.00643 pounds) reported by King is, in fact, 1,548 and not 2,019, i.e. the result obtained when the average price of the four main cereals is used. Utilizing this ratio of per capita product to wheat price in 1688, the difference between the Roman world and early modern England diminishes: per capita product of the Empire and Italy rises respectively to 55 percent and 78 percent of that of England.

One may ask, however, why we should use the prices from King's calculations when English price history is well documented and many different series of prices exist; some of them recently revised. Why, furthermore, has only the wheat price of 1688 been chosen? The Roman price of 3 HS per *modius* is nothing but the approximate price relating to a long period of time. As already mentioned, Goldsmith's calculation of Roman GDP was deemed valid for a period of about one and a half centuries. During the half century spanning 1650-1700, the wheat price was at its lowest level in 1654 and 1688 when it approximately equalled that of the years of lowest prices in the 17th century: 1601, 1602, 1603, 1619 and 1620. If wheat prices are taken from three recent series, the averages for the period 1680-1700 in pounds per kg of wheat are the following:[28]

[26] Goldsmith, "An Estimate", p. 281.
[27] Maddison, *Contours,* p. 62.
[28] Data in the series we utilized are in bushels, which is the capacity measure used in England equivalent to 36.3677 litres and corresponding to 28.09 kg, in the case of wheat. In the following table data have been converted into pounds per kg. The series of wheat prices utilized here are the following: 1. J. Munro, "Builders' Wages in Southern England and the Southern Low Countries, 1346 -1500: a Comparative Study of Trends and Levels of Real Incomes", MPRA Paper 11209, University Library of Munich, Germany, revised July 2004, published also in *L'Edilizia prima della rivoluzione industriale, secc. XIII-XVIII,* S. Cavaciocchi ed., Le Monnier, Florence, 2005, pp. 1013–76 (Munro reports prices per 1.25 bushel); 2. G. Clark, "The Price History of English Agriculture, 1209-1914", in *Research in Economic History*, 22, 2004, pp. 41-124; 3. J. Thirsk (ed.), *The Agrarian History of England and Wales,* V, 1640-1750, II, *Agrarian Change*, Cambridge, Cambridge University Press, 1985, p. 864, table XVI.

1	0.00925
2	0.00775
3	0.00796

Below are the results in kg obtained by dividing 9.958 pounds by the previous three values in order to reach an estimate of English product per capita in wheat units:

1	1,076
2	1,285
3	1,244

The result is that per capita GDP in 1688 England was the same as that of Roman Italy (1,200 kg) or even lower and that in the rest of the Empire it equalled about 60-70 percent of this value; which seems plausible. Italy was far more advanced than other European regions and a 30-40 percent difference between the peninsula and the Empire as a whole is reasonable. Since Italy drew tributes and taxes from the provinces, as previously mentioned, and the average disposable income per capita (571 HS) was, according to Maddison, 7 percent higher than per capita GDP (534 HS), on which the comparison with England is based, it may even be contended that Italian per capita GNP was higher than per capita GDP in 17th century England.

The comparison in 1990 international dollars. Let us assume, however, a similar level of product per head in Roman Italy and 17th century England. Since, according to Maddison's calculations, 9.958 pounds correspond to 1,411 international 1990 dollars, per capita Italian GDP in the Augustan age was of approximately the same value: 1,400 dollars. At the end of the 17th century, the Italian per capita GDP was between 1,400 and 1,500 international PPP dollars; such as it was 1,700 years before.[29] For almost two millennia the Italian economy moved within a relatively narrow range of values; i.e. in cycles around a stable level. According to our calculations concerning late medieval and early modern history and on the basis of assumptions on the early medieval decline, it could be said that Italian GDP from the late Roman Republic to the end of the 19th century remained in the narrow range between 1,000 and 2,000 international PPP dollars. This result does not come as a surprise.[30]

On the other hand, Maddison, who rightly emphasizes the importance of the correlation urbanisation-per capita GDP, suggests an Italian urbanisation of 14 percent in the age of Augustus,[31] considering cities the centres with more than 10,000 inhabitants. If the same threshold is assumed in order to define a city, in the Centre and North of Italy it was 13 percent in 1700, such as it was in England (13.2) at the same time.[32] Urbanisation and GDP per capita correspond.

If this calculation is deemed plausible and 1,200 kg of wheat are equal to 1,411 international 1990 PPP dollars, then 855 kg of wheat, that is the average

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[29]P. Malanima, *Measuring the Italian Economy 1300-1861*, in "Rivista di Storia Economica", XIX, 2003, pp. 265-295. 2003.

[30] G. Federico already noticed the low level of Maddison's estimate of Roman GDP per head in "The World Economy 0-2000 AD: A Review Article", in *European Review of Economic History*, 6, 2002,

[31] Maddison, *Contours*, p. 41. See now E. Lo Cascio, "Urbanisation as a Proxy of Demographic and Economic Growth", forthcoming in *Oxford Studies in Roman Economy*, I.

[32] P. Malanima, *Urbanisation and the Italian Economy during the last Millennium,* in "European Review of Economic History", 9, 2005, pp. 97-122.

income (380 HS) in the Empire, had to be 940 international 1990 PPP dollars and in the European regions of the Roman Empire 978. Moreover, in this case the general urbanisation rate suggested by Maddison for the Roman Empire of 9 percent tallies very well with our revised results relative to GDP. This result does not come as a surprise, either.

A comparison is shown below between our estimates and those of Maddison, in 1990 international dollars for the age of Augustus

	Maddison	Revision
Empire	570	1,000
Italy	857	1,400
Western Europe	576	1,000

As can be seen, our results are almost twice those reached by Maddison.

The early Middle Ages. The decline from the golden epoch of the Augustan Rome until 1000, suggested by Maddison, seems reasonable. At that time, a millennium after Augustus and Christ, the difference between Italy and other regions of Europe was probably not so deep. Although the growth in stature during the early Middle Ages confirms an improvement in diet,[33] the decline in the urban structure implied a drop in the non-agricultural share of income, which, in the heyday of the Roman Empire, may have represented around 50 percent, as the estimates for the late medieval-early modern ages suggest. A recovery from the 10th century onwards, such as that proposed by Maddison, also seems reasonable.

Following the steps of Maddison, we walk on a relatively flat path, with ups and downs, but without any great change in altitude relative to sea level.

3. *Early Modern Age: different estimates*

Three different series. While the economists ordinarily utilize the figures proposed by Maddison without any comment, some historians have elaborated alternative series for the early modern age.[34] The estimates by Jan Luiten Van Zanden and Carlos Alvarez Nogal-Leandro Prados De La Escosura present quite a different profile (Table 2).[35]

Table 2. Three series of western European per capita GDP 1500-1820 by: 1. A. Maddison; 2. J.L. Van Zanden; 3. C. Alvarez Nogal-L. Prados De La Escosura (1990 PPP international dollars; and index 1500=100).

	1	**Index**	**2**	**Index**	**3**	**Index**
1500	798	100	1,105	100	1,223	100
1600	908	114	1,103	100	1,204	98
1700	1,033	129	1,177	107	1,242	102
1800-20	1,245	156	1,175	106	1323	107

Sources:

1. A. Maddison, *The World Economy. Historical Statistics*, Paris, OECD, p. 59 and *Contours*, p. 382 (data refer to 12 western European countries; the last figure of the series refers to 1820).

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[33] I. Barbiera, G. Dalla Zuanna, *"*Le dinamiche della popolazione nell'Italia medievale. Nuovi riscontri su documenti e reperti archeologici*"*, in *Archeologia Medievale,* 34, 2007, pp. 19-42.

[34] The following analysis is more widely developed in P. Malanima, *Pre-Modern European Economy. One Thousand Years (10th-19th Centuries)*, Brill, Leiden-Boston (forthcoming).

[35] See also the comments on the view of long-term trends by Maddison in Federico, "The World Economy", pp. 111-20.

2. J.L. Van Zanden, "Una estimacion del crecimiento económico en la Edad Moderna", in *Investigaciones de Historia Economica*, I, 2005, p. 27 (the last figure refers to 1800; the conversion into 1990 PPP int. dollars has been made on the basis of the figure for 1820 UK in Maddison).

3. C. Alvarez Nogal, L. Prados de la Escosura, "Searching for the Roots of Retardation: Spain in European Perspective. 1500-1850", *Working Papers in Economic History*, Universidad Carlos III de Madrid, 2007, and C. Alvarez Nogal, L. Prados de la Escosura , "The Decline of Spain (1500-1850): Conjectural Estimates", in *European Review of Economic History*, 11, 2007, pp. 319-66 (the last figure refers to 1800).

According to Maddison, between 1500 and 1820 the European per capita GDP increases by more than 50 percent and, as has already been seen, this growth is the continuation of a previous rising trend. In the 11th century, according to his estimate, per capita GDP was hardly more than 400 dollars. It doubled from 1000 to 1500. Western European economy was thus a progressing one and its per capita GDP tripled in the 8 centuries from 1000 until 1800. Maddison supports his trend by mentioning the progress in European industry and trade. Almost nothing is said, in his reconstruction, about the rural world, where, until the 19th century, novelties were, by contrast, scanty indeed. On the other hand, it is dubious that changes in institutions and culture, mentioned in *Contours* and traditionally stressed by historians, had played such an important role in the economic performance so as to determine a 50 percent rise in product per head. One may wonder if, from a cultural and institutional viewpoint, the European civilization was more advanced in the 17th-18th centuries than Roman Italy in its golden age. Many scholars of Roman antiquity would be doubtful on the matter.

The view proposed by J.L. Van Zanden about the European economic performance is more pessimistic than that of Maddison.[36] The European economy hardly increased from 1500 until 1800 and the profile is flat. In his reconstruction, per capita GDP rose from 1000 until 1300, whereas it stagnated from 1300 until 1800. This stability is confirmed by C. Alvarez Nogal and L. Prados De La Escosura, whose index barely increases by 7 percent between 1500 and 1800.

Wages. These pessimistic views are supported by the available series of wage rates and price indexes, used to deflate the series of wages. Maddison is sceptical about their utility[37] and never utilizes them in his reconstructions. Price and wages play no role in his pre-1820 series. Certainly the trend of wages does not represent the trend of GDP per capita. Maddison rightly quotes an ancestor of modern price and wage historians, Thorold Rogers, who wrote in 1884 that "society may make noticeable progress in wealth, and wages remain low".[38] Since wage series are among the longest available series on pre-modern incomes we can not ignore them in our attempts at reconstructing pre-modern product. On their basis it is even harder to accept a progressive trend of per capita income in pre-modern Europe.

An average European trend can summarize the phases of decline and growth in urban real wages (Table 3 and Figure). Although data on rural wages are scantier, the existing series confirm the long-run trend of urban wages.

Table 3. The European trend of real wage rates in the building sector 1500-1850 (1500-50=100).

1500-1550	100

[36] See also J.L. Van Zanden, "Early Modern Economic Growth. A Survey of the European Economy, 1500-1800", in M. Prak (ed.), *Early Modern Capitalism*, London-New York, Routledge, 2001, pp. 69-87.
[37] Maddison, *Contours,* pp. 317-19.
[38] Quoted in Maddison, *Contours*, p. 318.

1550-1600	83
1600-1650	77
1650-1700	83
1700-1750	80
1750-1800	69
1800-1850	77

Source: R. Allen, "The Great Divergence in European Wages and Prices from the Middle Ages to the First World War", in *Explorations in Economic History*, 38, 2001, pp. 411-47. For Florence the wages are those in P. Malanima *L'economia italiana. Dalla crescita medievale alla crescita contemporanea*, Bologna, Il Mulino, 2002, App IV. The average also includes data for Istanbul from S. Pamuk, "Prices in the Ottoman Empire", in *International Journal of Middle East Studies*, 36, 2000, pp. 451-68 and Id., "Real Wages and Standards of Living in the Ottoman Empire, 1489-1914", in *Journal of Economic History*, 62, 2002, pp. 293-321.

In the first half of the 17th century, European wage rates were 23 percent lower in comparison with the level of 1500-50. They recovered between 1650 and 1750. Subsequently they fell again between 1700-1750 and 1800, thus reaching the lowest level since the late Middle Ages. Only from about 1820 a rising trend is visible in all of the available series of wages (as we see in the last part of our graph).
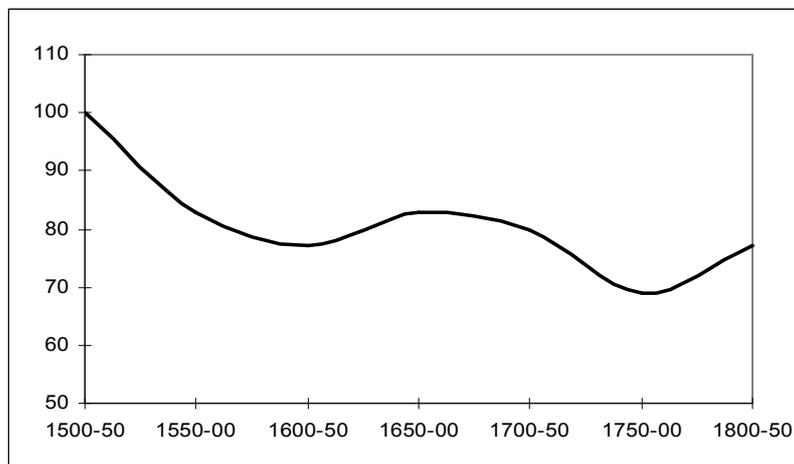

Figure. Trend of the European real wage-rates 1500-1850 (1500-50=100).
Source: Table 3.

Wage rates and product. In order to appreciate the importance of wages in macroeconomic reconstructions of pre-modern product, we can break down, as ordinarily done, per capita GDP (*Y/P*) in output per worker (*Y/L*), that is the average product of labour, and the percentage of workers in the total workforce (*L/W*) by the percentage of workforce in the total population (*W/P*):

$$\frac{Y}{P} = \frac{Y}{L} \cdot \frac{L}{W} \cdot \frac{W}{P}$$

Here rents, interests and profits are included in product (*Y*) and, in fact, they represent the difference between the value of the average product and marginal product of labour.[39]

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[39] As is seen in the following Table 4., it is known that when declining, the slope of the marginal product of labour is higher than that of the average product of labour. Here only the magnitude of the decline represented by both marginal and labour productivity is discussed. However, in pre-modern economies the difference in the slope is modest, as shown in the case of Italy by P. Malanima, "Wages, Productivity and Working Time in Italy (1270-1913)", in *Journal of European Economic History*, 36, 2007, pp. 127-74.

If wage rate represents labour productivity and if labour productivity declines by about 25 percent, as was the case from the late Middle Ages until 1820, the percentage of workers of the total population (*W/P*) or the working time of the labour force (*L/W*) –usually both-- must increase sharply, in order to keep per capita GDP stable. A much greater increase would be necessary if a 50 percent rise is assumed, as does Maddison. It will be seen that such a rise in GDP is hardly compatible with the trend of wages and labour productivity.[40]

In the following paragraphs, we will examine the agricultural production and then add the output of secondary and tertiary sectors. However, there is no doubt that the results reached can only be speculative.

4. *The agricultural product*

A demand side estimate. A method used in these last decades in order to estimate per capita agricultural product in pre-modern economies on the basis of series of wages and prices (both agricultural and non agricultural) and their elasticity as regards both wages and prices allows us to build the following series, covering the five centuries 1300-1800 (Table 4). This estimate of the agricultural per capita product from the demand side has been elaborated recently by Robert Allen for some European countries. A unique series is presented here concerning Europe.

Table 4. Per capita agricultural product (in 1990 Intern. PPP dollars), and indexes of per capita agricultural product, agricultural product and population between 1300 and 1800 (1500=1).

	Per c. agr. product (Europe) Int. 1990 $	Index of per c. agr. product	Index of Gross Product	Index of Population
1300	755	0.90	1.02	1.14
1400	860	1.02	0.84	0.82
1500	842	1.00	1.00	1.00
1600	623	0.74	0.96	1.29
1700	660	0.78	1.09	1.39
1750	684	0.81	1.40	1.72
1800	641	0.76	1.77	2.32

Sources: the Table is based on the estimations proposed by R. Allen, "Economic Structure and Agricultural Productivity in Europe, 1300-1800", in *European Review of Economic History*, 4, 2000, pp. 1-26. For Italy, Allen's data has been replaced by those of G. Federico-P. Malanima, "Progress, Decline, Growth: Product and Productivity in Italian Agriculture, 1000-2000", in *Economic History Review*, II. s., 2004, pp.437-64.
Note: countries on which the estimation of agricultural production is based: England, central-northern Italy, Germany, Spain, France, Poland, Belgium, The Netherlands, and Austria (including Hungary and Czechoslovakia). Data only refer to England and Italy for the 14th century. From the 15th century onwards the series apply to all the countries, except the Netherlands in 1400.

As can be seen, the gross agricultural product rose by almost 80 percent between 1500 and 1800, principally owing to the spread of agriculture to new lands. Whereas the population increased by 132 percent, product per capita diminished by 24 per cent.[41] These data propose the magnitude of a long-term change which is confirmed by the existing information on specific countries. The decline in 1800 is about 15 percent with respect to 1300.

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[40] See the Appendix.
[41] If we multiply 2.32 by 0.76, the result is, in fact, 1.77 (the rise in aggregate agricultural product).

Per capita GDP and the poverty line. These series of figures regarding agricultural product suggest a preliminary consideration, when compared to those elaborated by Maddison, of per capita GDP for the period from 1820 to 1870. In the previous series it can be seen that the agricultural part alone of the average product is never lower than about 600 international 1990 dollars. Comparisons with the level of prices and food consumption before the 19th century show that this level was really low and hardly covered the essential needs of the individual. If the consumption of some secondary goods and the rent of a modest house is added to this figure, 700 dollars is easily reached. The conclusion is that, in pre-modern Europe, per capita GDP could not be lower than 700 dollars (intern. PPP 1990 dollars). Considering that the conventional poverty line adopted today when expressed in the same nominal money, stands at about 2 dollars per day per person, it almost coincides with this estimate. Furthermore, considering some degree of inequality in income distribution, this figure of the average product should be higher. This level of 700 international 1990 dollars may have been lower in warmer climates outside Europe, where less clothing, houses and fuel were required. However, this does not mean that the standard of living was also lower in these extra-European regions, but simply that in Europe survival was more expensive than elsewhere, because of the difference in physical conditions of this northern civilization.

It may be noted that, according to Maddison, per capita GDP in Western Europe was 1,245 dollars in 1820 and that in about 1850, when modern growth had already begun in some regions, the level of 1,500 dollars was seldom exceeded. A maximum of a little more than twice the minimum of 700 dollars, that is of 1,500-1,600, can be assumed to be a plausible upper limit for most pre-modern economies. A level between 700 and 1,500-1,600 dollars appears compatible with the economic conditions of past European agrarian societies. Within this range lie the estimates already proposed by some historians for specific countries, during the period 1500-1800, and resumed by Van Zanden.[42]

5. *The subsistence minimum*

The basket of the poor. Thanks especially to the results reached by Maddison, we know that today there are countries in the World where per capita GDP is lower than 700 and in some cases even below 500. Why do we exclude the possibility of reaching such low figures in pre-modern economies? A reasonable hypothesis could be that the relative price of some basic goods –food, clothes, energy— was higher in pre-modern economies than today. During recent years, the price of the "basket of the poor" in several countries has risen more than the consumer price index, as a consequence of the fast rising price of some basic food items and raw materials. It was not so during the 19th and 20th centuries. The introduction of basic cheaper goods such as the potato and maize into the everyday diet in several parts of the World where they were previously unknown, the spread of cotton and later synthetic fibres, and the green revolution in agriculture, allowed for long time a rise in the prices of the "basket for the poor" lower than the consumer price indexes, which included several expensive new goods. Before modern growth, the price of some basic items relative to the consumer price index was higher than it is today, owing on the one hand to remarkable in-

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[42] Van Zanden, "Early Modern Economic Growth". The basis of Van Zanden's figures in this contribution are the papers collected in A. Maddison-H. Van der Wee (eds), *Economic Growth and Structural Change. Comparative Approaches over theLong Run*, in *Proceedings XIth International Economic History Congress,* Milano, Università Bocconi, 1994, pp. 59-70.

creases in labour productivity in modern times and on the other to the introduction of cheaper substitute goods in the basket of the poor. It could be surmised that, during the 19th and 20th centuries, the poverty line was not stationary, but bent downwards. On the other hand, Goldsmith himself noticed "the high relative price of wheat" in ancient times as regards modern economies.[43] Colin Clark, on the other hand, comparing ancient and modern prices, stressed the same difference.[44]

A stable subsistence minimum. The opinion that the "subsistence minimum is the same in quantity terms" in past and present economies, as suggested by Branko Milanovic,[45] is correct, if quantity means the weight of the basket's content. It is probably also correct in terms of the calorie input per day; although some difference in the average stature and weight between past and present populations exists. It is no longer correct in terms of the relative value of this basket; relative, that is, to the trends in the consumer price index over the last two centuries. In Byzantium around 1000 this basket of the poor was apparently composed of "wheat (bread), wine, olive oil, and meat to which were added some quantities of dried vegetables and cheese".[46] Whether this subsistence minimum in value was actually stationary during the process of growth could be subject to question and we doubt this was the case. Was the value of the subsistence minimum the same when wheat began to be replaced by maize and potatoes, the prices of which for the same caloric content were half those of wheat? What did it happen when olive oil, very expensive in past economies, began to be replaced by much cheaper fats such as margarines and by electricity; and wine by a variety of beverages, whose prices were much lower for the same energetic content? What was the effect of the change in people's clothing habits from the use of wool, linen or hemp to that of artificial fibres? Firewood, expensive and often overlooked, was the only fuel in past societies, but it was replaced by a variety of fuels (fossil fuels), whose prices, for the same emission of calories, have never been so cheap in the history of mankind as in the last two centuries. The basket of the poor is not always composed by the same goods and the importance of the goods the poor buys in standard consumer price indexes of modern economies is relatively marginal, while it was not so in pre-modern agrarian economies.

Two poverty lines. If average incomes in past agricultural economies are assumed to be "a little more than twice the subsistence minimum",[47] as supposed by Milanovic and other scholars, and this minimum is assumed to be about 400 PPP international dollars, then the result is something more than 800 PPP dollars. If, by contrast, and more correctly in our opinion, this minimum is assumed to be about 700 dollars, then the average product is 1400, thus becoming quite consistent with our results. When considering a downward bent poverty line over the last two centuries, many assumptions made by scholars, regarding per capita product in past economies based purely on the weak foundations of a stable poverty line, are likely to collapse. In relative values, the stability of the subsistence minimum is not a concept the historian is ready to subscribe to. While a stable poverty line is the support of a progressive view of pre-modern economies

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[43] Goldsmith, "An Estimate", p. 281.
[44] C. Clark, *The Conditions of Economic Progress*, London, Macmillan, 1957 (3rd ed.), p. 657.
[45] B. Milanovic, "An Estimate of Average Income and Inequality in Byzantium around Year 1000", in *Revue of Wealth and Income*, 52, 2006, p. 452.
[46] Milanovic, "An Estimate", p. 452.
[47] Milanovic, "An Estimate", p. 468. This same poverty line is assumed in B. Milanovic, P. Lindert, J. Williamson, "Measuring Ancient Inequality", *World Bank. Policy Research Working Paper,* n. 4412.

from the age of Augustus up until the Industrial Revolution, a downward bent poverty line can become the support of a different view of stability with cycles or cyclical stability. The view we prefer.

6. *The non-agricultural product*

Structural change. A subsequent step towards identifying per capita GDP in pre-modern Europe would be to add the product of secondary and tertiary activities to the agricultural GDP. Since we have data on urbanisation, on the presence of industry outside the cities and also on estimates of the proportion of the agricultural product in relation to the total GDP, this following step may appear straightforward. For instance, we could establish the statistical relationship between urbanisation and non-agricultural product during the 19th century and use this result, going back in time, to reconstruct per capita product from the secondary and tertiary sectors. However, it must be said that up to the end of the 19th century no precise evidence exists on the percentage of the agricultural product on GDP and that the estimates sometimes proposed are far from reliable. Their basis is always very weak. It is better by far to simulate different possibilities than to use little reliable data. The different plausible quota of the non-agricultural per capita product with respect to the total per capita product will therefore be reviewed.

Information regarding the late 19th century economic structure suggests that in relatively backward European economies agriculture accounted for about 50 percent of the total product. Data on other European countries suggest it was seldom less than 50 percent and that only in the United Kingdom was it already about 30 percent in 1820.[48] If we were to assume a stable percentage of 50 as the quota of agriculture on gross product, in order to reach total product from the agricultural product, we would only have to multiply the agrarian per capita product by 2 to reach the estimate of per capita GDP. In this case the trend of GDP per capita would decline in the same way as the agricultural share, i.e. by about 25 percent from 1500 to 1800. However, it is known that urbanisation progressed in early modern Europe. Considering the centres with over 10,000 inhabitants, this reached some 5.4 percent in 1500, 7.4 per cent in 1600 and 9 per cent in 1800.[49] Yet urbanisation is far from perfect as an index of secondary and tertiary activities as it can only suggest the magnitude of what we are looking for. This figure has then to be completed by further information on the importance of the non-agricultural sectors in the pre-modern world. As far as is known, proto-industries spread in the countryside from 1600 onward though their progress is not recorded by the change in the urbanisation rate.

We assume, however, that secondary and tertiary activities grew during the centuries in question. Since it is difficult to specify the relative share of the agricultural sector with relation to product, different shares, between 67 to 43 percent, will be considered.(Table 5).

Table 5. Variation in the European per capita GDP between 1500 and 1800, according to different assumptions on the weight of agricultural product in relation to GDP.

[48] See the data collected by B.R. Mitchell, *European Historical Statistics*, New York, Columbia Univ. Press, 1975.

[49] Malanima, *Pre-Modern European Economy*, Chapter VI. These urbanisation rates have been calculated on the basis of a new database also utilized in P. Malanima, "Urbanisation 1700-1870", in S. Broadberry, K. O'Rourke (eds.), *Unifying European Experience. An Economic History of Modern Europe* (forthcoming).

Shares of agricultural product on GDP (%)

1500	62	59	59	50	62	67
1800	48	45	48	50	43	48
%	0	-1	-6	-24	10	7

Note: the percentages of agricultural GDP in relation to the total in 1500 and 1800 are presented in the first two lines. In the last line the increase in total GDP per capita on the basis of the relative weight of the first two lines are shown.

If the quota of agriculture is assumed to be 62 percent in 1500 and 43 percent in 1800, per capita GDP would have grown by 10 percent in these 300 years. A modest rise of 7 percent may be reached assuming agriculture accounted for 67 percent in 1500 and 48 percent in 1800. Only a deep structural change between1500 and 1800 would result in a relatively modest rise of GDP. A more plausible assumption would be an agricultural product of 62 percent in 1500 and 48 percent in 1800. In this case the result obtained is the complete stability of per capita GDP during these three centuries: the structural change from 1500 until 1800 would have counterbalanced agricultural decline. On the basis of the data elaborated by Bairoch the increase in non-agricultural product tallies with the relationship between urbanisation and industrial production from 1800 to 1870.[50]

Per capita GDP 1500-1870. On a per capita basis, a condition of stability of the European economy seems to be more convincing than one of progression (Table 6). These results are very close to those proposed by Van Zanden and especially (both in the trend and the level) to those developed by Alvarez Nogal and Prados de la Escosura.

Table 6. Estimates of per capita and aggregate GDP in Europe 1500-1870 (international 1990 PPP dollars and indexes).

	GDP per c.	Index	GDP (000,000)	Index
1500	1,347	1.00	111,680	1.00
1600	1,246	0.93	133,760	1.20
1700	1,387	1.03	159,440	1.43
1750	1,436	1.08	205,530	1.84
1800	1,346	1.00	253,900	2.27
1870	1,974	1.46	619,970	5.55

Note: the table is based on the assumption of a per capita agricultural product of 62 percent in 1500. In 1600 it is 50 percent and in 1700-1800 48 percent. Data on 1870 are from A. Maddison, *The World Economy. Historical Statistics*, Paris, OECD, 2003.

Here we have spoken of Europe on the whole. Between 1500 and 1800 series per country reveal a more varied picture, where Southern countries are declining, while the Northern ones are progressing. The balance is changing. However the result is stability, with changes in the relative importance of the European regions (Table 7).[51]

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[50] P. Bairoch, *Victoires et déboires*, Paris, Gallimard, 1997, I, p. 404 (where a series on the level of industrialization in several European countries is presented). We used the relationship of past urbanisation-industrialization to estimate the structural change occurring between 1500 and 1800 (based on the new urban database), in the following Table 6.
[51] A view of long-term stability has been also expressed recently by G. Clark, *A Farewell to Alms. A Brief Ecoomic History of the World*, Princeton and Oxford, Princeton University Press, 2007. See also the too sharp – in our opinion – comments on Maddison's pre-modern estimated of per capita product in G. Clark, "In defense of the Malthusian interpretation of history", in *European Review of Economic History*, 12, 2008, p. 177: "I dismissed Maddison's estimates not because they are in-

Table 7. Rates of increase or decrease between 1500 and 1800 in Maddison, Van Zanden Alvarez Nogal-Prados de la Escosura and Malanima (%).

1500-1800	Maddison	Van Zanden	Alvarez Nogal Prados de La E.	Malanima
England	+178	+97	+61*	+42
Netherlands	+141	+26	+10	+28
France	+56	+6	+12	+6
Germany	+56	-2	-6	+3
Spain	+52	-17	-7	-12
Italy	0	-15	-6	-16
EUROPE	**+56**	**+6**	**+7**	**0**

* The series by Alvarez Nogal-Prados De La Escosura, "Searching for the Roots of Retardation" refers to the UK. The series by Malanima are from *Pre-Modern European Economy* (forthcoming).

Once again these results cannot but be speculative. It is impossible to exclude a modest rise in per capita GDP, however small this may be in the economy of the continent. A fast rising trend could only be justified by assuming that the agricultural per capita product did not diminish in the centuries of the early modern age, or that, if it did, urbanisation, proto-industrial growth, and trade expansion underwent a deep structural change; deeper than we are able to justify. In any case, if labour productivity declined, as the real wage trends indicate, a remarkable rise in per capita product would imply excessive (and unlikely)[52] labour intensification (more workers and longer working hours). The early modern European trend can be better described as an epoch of stability or decline rather than one of growth.

7. *Conclusion*

"Chiffrephile"[53] is a neologism created by A. Maddison to define the economists and economic historians who are fond of quantification. Part II of *Contours* is a history of the "chiffrephiles" since the origins of this branch of economic thought, in the 17th century, which was also the era of the birth of quantification in the study of both the physical and social world. Maddison's contribution to applied economics and economic history is a remarkable chapter in this history.

In the previous pages, we have tried to follow Maddison's path in revising his estimates about pre-modern European economy. According to these results, a likely poverty line in agricultural pre-modern economies is approximately 700 international 1990 dollars -- about 2 dollars per day -- and per capita GDP is ordinarily between 1,000 and 2,000 dollars. Growth was not unknown in the pre-modern world. Epochs such as the two centuries BC and the first AD in the Roman Mediterranean, or between 900 and 1250 in the Euro-Mediterranean economies, were probably epochs of growth in per capita terms. However, until quite recently, such waves of growth have not been synonymous of remarkable

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convenient to Malthusian theory, but because they are based on nothing more than Maddison's incorrect assumptions about how economies worked before 1800. They are not based on any serious historical evidence. When the facts are inconvenient to Maddison's picture of the world, then the facts are ignored".

[52] As will be shown in the Appendix.

[53] See the fine autobiography by A. Maddison, "Confessioni di un coltivatore di cifre", in *Moneta e credito*, n. 186, 1984, pp. 125-72 (the neologism is at p. 171).

and lasting rises in the standard of living. Certainly both decline and rise occurred within this narrow range of values, during the long early modern age.

A comparison between our data and those by Maddison (Table 8) can help specify our different views on the economic history of the past two millennia. The trend in the first part of our series is similar, although the level is different. As we have already stated, the level reached by per capita domestic product in Italy, in the age of Augustus, was at least around 1,400 and per capita national product higher. Part of Western Europe was still much less developed, its per capita product being much lower than in Italy. If we were to include some more advanced southern and eastern Mediterranean regions which were part of the Roman Empire, the average would be probably higher, but not if we consider Europe within its present borders,

Table 8. Per capita product in Western Europe from 1 to 1870 according to Maddison and our revision (in 1990 International $ and index 1500=1).

	Maddison		Revision	
	Per c. GDP	Index	Per c. GDP	Index
1	576	0.74	1,000	0.74
1000	427	0.55	900	0.66
1500	771	1.00	1,350	1.00
1600	889	1.15	1,250	0.92
1700	997	1.29	1,400	1.04
1820	1,202	1.56	1,350	1.00
1870	1,960	2.54	1,960	1.45

During the early Middle Ages, the collapse or weakening of the urban structure resulted in a heavy fall in the non-agricultural income; although the per capita agricultural product had probably undergone a rise, given the abundance of resources per worker and the likely rise in labour productivity. The high and late medieval urban growth implied a recovery in the non-agricultural part of product. As has been seen, per capita agricultural product fell over the following centuries while the non-agricultural part was able to counterbalance the drop and keep product per head stable. The Roman Empire was a Mediterranean political structure. In the centuries of the high Middle Ages, agricultural civilisation advanced in central and northern Europe and colonisation and urbanisation also progressed. This is the reason why the average product was higher in Late Medieval Europe than in ancient Western Europe. Levels of per capita product similar to that of Augustan Italy were reached again by the leading countries, that is by those countries "which operated nearest to the technical frontier":[54] late medieval Italy and Flanders, later Holland and 18th century England.

Pre-modern agrarian populations were homeostatic organisms able, using innovative techniques, both to change the environment they inhabited and to adapt themselves to the external world, thanks to changes in the demographic behaviour and working time (an underrated variable, always to be taken into account). A stability of past agrarian economies, together with cycles within a relatively narrow range of values, seems more convincing to us than the view of long-term slow growth spanning the period from antiquity until the 19th century. In any case, we cannot but agree again with Maddison on the "improvability" of the available figures provided by historians. There is no doubt that the "chiffrephiles" working on the pre-modern world still have before them a long and difficult path.

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[54] A. Maddison, *Dynamic Forces in Capitalist Development. A Long-run Comparative View*, Oxford, Oxford University Press, 1991, p. 30.

Appendix

Product, Productivity and Labour Time Between 1500 and 1800

How can the stability of per capita product in the early modern age be compatible with the decline in labour productivity, which, according to the movement of real wage rates, affected not only the primary sector, but also the non-agricultural ones? If productivity diminishes while product per capita is stable, the only possibility is a rise in the total time devoted to labour.

A simple equation can clarify what took place in the European economy between 1500 and 1800. The components can be thus broken down: gross product (Y) can be seen as the result of labour productivity (p) per hour worked by the population able to work (the labour force L), by the number of hours worked (h) in a year by any single worker. While labour productivity is a function of the technical level and capital per worker, the multiplication of L by the hours worked h records the simple intensity of labour by a specific society or the total labour done. Hence the following equation :

$$Y = p \cdot L \cdot h$$

Using the results obtained in Table 6 for 1500 and 1800 it can be assumed that:
1. the level of output per hour worked is the same as that obtained for 1500 calculated in 1990 PPP international dollars on the basis of the estimates in Table 6. A different level would not change our results;
2. L is equal to 60 percent of the population, which is approximately the proportion of people aged 15-65 in pre-modern societies;
3. h equals 2,000 hours per year in 1500. The assumption of a different figure for working time would not change our results seeing as the change in working time between 1500 and 1800 is of interest to us, not the actual level (which cannot be established).

Therefore to determine the magnitude of the rise in labour time in 1800 compared to 1500 we can replace the letters in the previous equation through the following figures for 1500 and 1800:

1500
$$111,684,000 = 1.122 \cdot 49,770 \cdot 2,000$$

(the figures referring to Y and L are to be multiplied by 1,000).

1800
$$253,900,000 = 0.90 \cdot 113,178 \cdot h$$

(0.90 represents labour productivity per hour worked in 1800 assuming a decline of 20 percent as regards 1500 –lower than the decline in real wage rates, since the decline in marginal labour productivity is always higher than in average labour productivity).

In order to determine the increased effort while labour productivity is declining, we have to solve the following equation for the year 1800:

$$h = \frac{Y}{p \cdot L}$$

The result is that during these three centuries working time had to rise by about 25 percent in order to reach the same per capita GDP as in 1500. Working time may be lower, if we consider some change in the proportion of the labour force as regards the to-

tal population: e.g. 50 percent in 1500 and 65 percent in 1800. However, in 1800, in order to keep the level of the per capita product constant society had to devote more hours to work: labourers worked longer hours, and more people were obliged to work. If the same level of income is attained through high labour intensification we can hardly speak of stability in personal welfare.

In agriculture different types of crop were introduced in order to increase land productivity (fruit trees alongside cereals, maize, potatoes etc.) and new kinds of activities spread, especially proto-industrial jobs, which exploited unemployed labour time. It is quite clear that an increase of 50 percent in per capita income between 1500 and 1800, as assumed by Maddison, would require much higher labour intensification: in our calculations, with respect to 1500, the result of the rise in 1800 would be 88 percent. Such an increase in personal income (that is by 50 percent) could only be compatible with a much lower decline in labour productivity (the first term of our equation); much lower than suggested by the trend of wages. If the information based on wages indexes is ignored, the situation is simplified. However, we ask ourselves how correct it actually is to disregard this information.