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" Modelling future oil production, population and the economy "

by Jean Laherrère

Paul Valery: "All that is simple is false and all that is complex is useless"

Abstract:
Most published data on energy, population and the economy are unreliable. In many cases, authors have political motives, selectively choosing data from a wide range of uncertainty to give a desired image. In addition of the uncertainty of the measurements themselves, as in the case of population or the confidentiality of the oil reserves, they often indulge in manipulation. A so-called hedonistic factor distorts the calculation of GDP in the United States; and the definition of the Proved Reserves by the Securities and Exchange Commission gives rise to "reserve growth". OPEC mis-reports its oil reserves because its quotas depend upon the reported reserves; and the reserves were overestimated in the Soviet Union because economical and technical constraints were ignored.

Our present culture of eternal growth makes the word "decline" politically incorrect, but constant growth is unsustainable in a finite world. Growth is the Santa Claus of the modern age who is supposed to provide welfare and retirement for us and our children.

All natural events, when measured over their full life, can be modelled under one of more cycles, as in the Fourier analysis. This cyclical nature corresponds with the finite nature of the Universe; everything that is born will die, whether we speak of the solar system, the Earth, or human species. What goes up must come down.

The Russian population is already declining and Europe's will soon do so too. This basic understanding was recognised by the celebrated King Hubbert when he made his famous prediction in 1956 that US oil production would peak in 1970. But, in fact, he oversimplified by showing a single peak. In reality, US oil production had a secondary peak (93 % of the first one) in 1985, reflecting the entry of Alaskan production, which itself peaked in 1988. A symmetrical oil cycle reflects a large number of independent producers, acting randomly, but in many cases economic and political factors disturb the pattern, giving one or more new cycles.

To model an event made up of several cycles extending into the future calls for an estimate of the ultimate value, which corresponds with the area under the curve up to the end of the event. For oil, the best tool to determine an ultimate value is the creaming curve that plots cumulative discovery versus the cumulative number of new field wildcats, the result being modelled by one or more hyperbolas. Another method is to plot the ratio of annual to cumulative production versus cumulative production, and extrapolate the trend to zero. When the trend is linear, it represents the derivative of the logistic curve. The fractal distribution of sizes (field reserves, incomes, urban agglomerations plotted against decreasing rank) can also be extrapolated to an ultimate value.

Population can be well modelled with two cycles, distinguishing countries with high and low fertility rates. Previous UN forecasts were too high for different reasons. Economic parameters, such as unemployment or inflation, can be correlated with oil price after a certain time-shift. Income distribution is well described by a fractal plot of population versus income.

The income fractal distribution in France is in fact the same as that in the United States, although the total of the latter is higher because of a larger population.

Many graphs are shown for each domain using the same tools. The goal is that the reader can draw his own conclusions, and make his own forecast. Ironically, it appears that the modelling is more reliable than the input data. Accordingly, the main challenge is to secure better data, but that will be achieved only if and when political influences can be removed. A neutral agency is needed, but neither the UN nor national agencies are neutral. It is hard to see how to force the actors to tell the truth, or know who would run and finance such an organisation. A step in the right direction would be to make official organisations liable to prosecution for releasing false data, as is already supposed to apply in the United States under Public Law 106-554.

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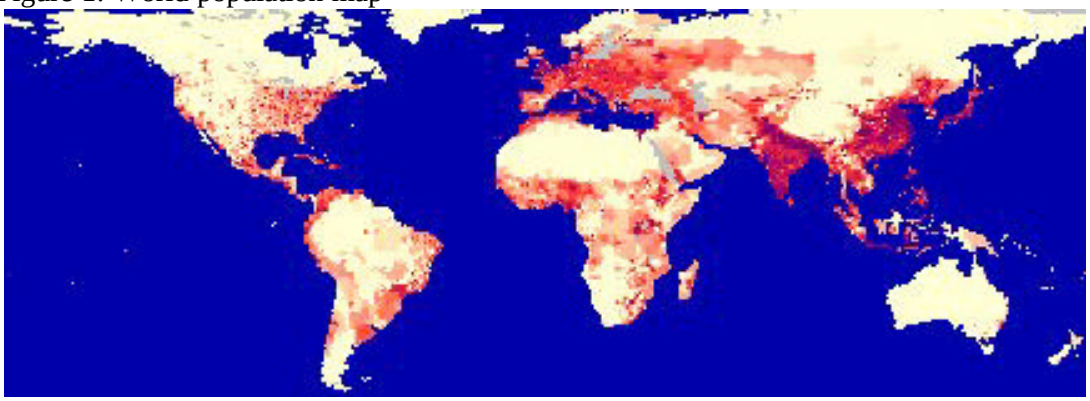
Nature is ruled by basic principles:
-cycles: what is born will die, what goes up will come down: sun, earth, mankind, civilisation will die; nothing is eternal except maybe protons
-earth (as universe) is limited: infinite (as perpetual growth) does not exist. A bacteria doubling every half an hour without constraint will occupy the solar system in a week and the universe in 11 days!
-everything is curved and linearity only exists locally
-equality may exist at the starting line, but at the finish line there is usually only one winner: inequality is the rule
-galaxies, earthquakes, oilfields, urban agglomerations present the same distribution (parabolic fractal)
-many physical objects are badly known; over 90 % of the Universe is unknown (dark matter is still unsolved since 1931), the size of a electron, quanta mechanisms does not concur with general relativity, string theory is unsuccessful for 30 years. Most of present theories will be considered false and obsolete in the future, replaced by better ones. Scientists are not humble enough and most refuse the decline of their theories.
-mathematics do not solve everything: the motion of 3 bodies (solar system) is chaotic (Poincare 1891)
Modelling is fairly easy when the series are chosen as natural and complete in location and time
Published data is usually flawed with political motives to appear higher or lower.
Usually data is manipulated in different ways by choosing deliberately:
-poor or no definition of the product

-restricted area of the event
-restricted period, selecting an high or a low as starting point
-restricted portion of the uncertainty range
-cheating by omission
A well defined event should be filed as a complete series from the beginning (as least when measured in significant values) and displayed on its full life. Most poor studies are looking at partial series.
My last modelling is the "Future of oil supplies" presentation I made on May 7, 2003 at the Swiss Federal Institute of Technology Zurich and it can be found at http://www.oilcris.com/laherrere/zurich.pdf. This paper is an improvement of my presentation last year in Uppsala with updated (2003) data. The models that I use for oil & gas discovery and production (correlation, cycles (Hubbert curves), linear extrapolation (doubtful) of growth, fractal distribution) can be used to model population and economy. Only the creaming curve is not applicable by lack of good data on activity.
But the most important principle is that perpetual growth cannot exist.
I am going to speak only about population and economy trying to show that:

What goes up must come down.
A graph is better than thousands words.

-1-Population

The distribution is very heterogeneous, concentrated in some place, almost void in others
There is an average of 46 people per square kilometre in the world excluding Antarctica, but 1000 in Java and 5 in Borneo (same country and similar climate)
Figure 1: World population map



http://www.overpopulation.net/popmap.gif

-1-1-population data is very unreliable

In 1990 the UN estimated Nigeria at 120 M people but the census of 1991 showed that the real figure was 30% lower. In 1995 China was estimated to have accounted for 30 % of the births (Kennedy 2002). As for oil reserves, publishing the population count is a political act and many cheats, by overestimation for governments to appear stronger and by underestimation for illegal immigrants who did not report in census..
On October 12, 1999 at 13h00, Kofi Annan celebrated the six billionth symbolic new born child when in fact this number is uncertain by more than 2 years (as the accuracy is about 200 million or 3%). For 1999, USDOE first reported 6003 million, then 5992 in IEO 2002; but only 5978 in IEO 2003.
The range of estimate of the world population for the 1650-1950 period from different publications (giving only the estimates between large intervals) is wide, in particular for 1850

as the range is 700 million for an average of 1350 million which gives an inaccuracy of more than plus or minus 30 %:

Table 1: World population estimate from 1650 to 1950

world estimate	range in million
1650	374 - 608
1750	511 - 844
1800	722 - 1172
1850	1017 - 1735
1900	1520 - 1593
1950	2381 - 2519

http://hypo.ge-dip.etat-ge.ch/www/cliotexte/sites/Histoire/Moderne/POP_MOND.DOC

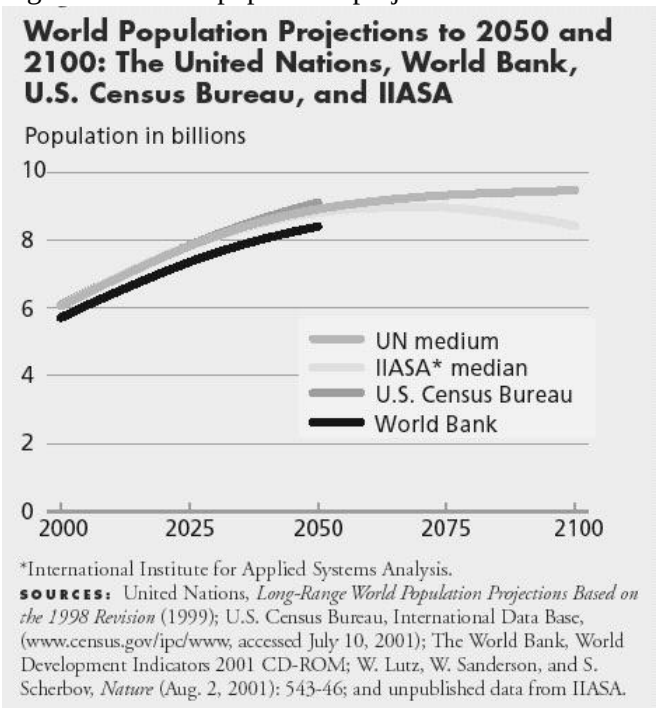
One of the best source on line for population is the USCB (Bureau of Census) giving most of demographic parameters for each country from 1950 to 2050. For energy, population and GDP the USDOE/EIA is the best database, unfortunately their forecasts are obscured by a wish for strong growth. Annual data before 1950 is not available.

Unfortunately there are very few sources of population data for the past and for present (mainly the UN). Countries are very reluctant to report population data (as energy production, consumption and reserves) for political reasons. Furthermore some report the population count on the first day (Eurostat) or the last day of the year (confusing the comparison by one year when it is not indicated), when usually (USCB) it is at mid-year.

The most complete population database is the "populstat" by Jan Lahmeyer (http://www.library.uu.nl/wesp/populstat/about.html t) with the University of Utrecht

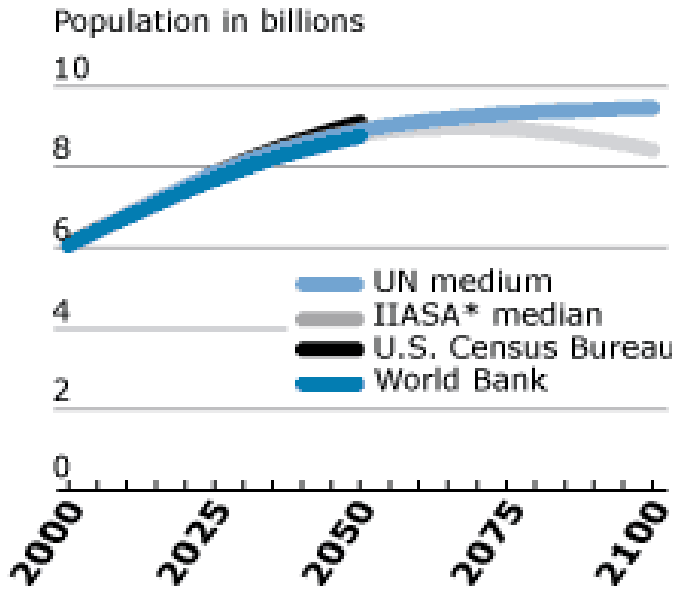
Often the data is badly plotted, even when it is obvious, as the comparison from the two following graphs from PRB (Population Reference Bureau) using the same data. The first graph misplots the World Bank data (obvious for 2000), when the second graph puts it at the right place.

Figure 2a: World population projection from PRB



http://www.prb.org/pdf/UnderStndPopProj_Eng.pdf

Figure 2b: same graph in other PRB publication



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http://www.prb.org/Template.cfm?Section=PRB&template=/ContentManagement/ContentDisplay.cfm&ContentID=7260

The comparison between the UN, USCB, IIASA and World Bank population projections to 2050 shows that they forecast a flattening or a peak around 2050.

The data on population increase is confusing and births and deaths mismatch total by more than 1 million for 2002 because of badly counted migration

Table 2: World population in 2001 & 2002

PRB: World Population clock by Carl Haub 2002 & 2003

million	World	More Developed	Less Developed
Population 2001	6137	1193	4944
Population 2002	6215	1197	5018
Births/a 2001	136	13,3	123
Births/a 2002	133	13,3	120
Deaths/a 2001	54	12,2	42
Deaths/a 2002	54	12,5	42
Natural increase/a 2001	83	1,1	82
Natural increase/a 2002	79	1,1	78
increase 2002-2001	78	4,1	74
net migration	-1,3	3,0	-4,3

Source: Population Reference Bureau, World Population Data Sheet.

In 2002 the addition of population per second is of 2.5 people with 4.2 births and 1.7 deaths:

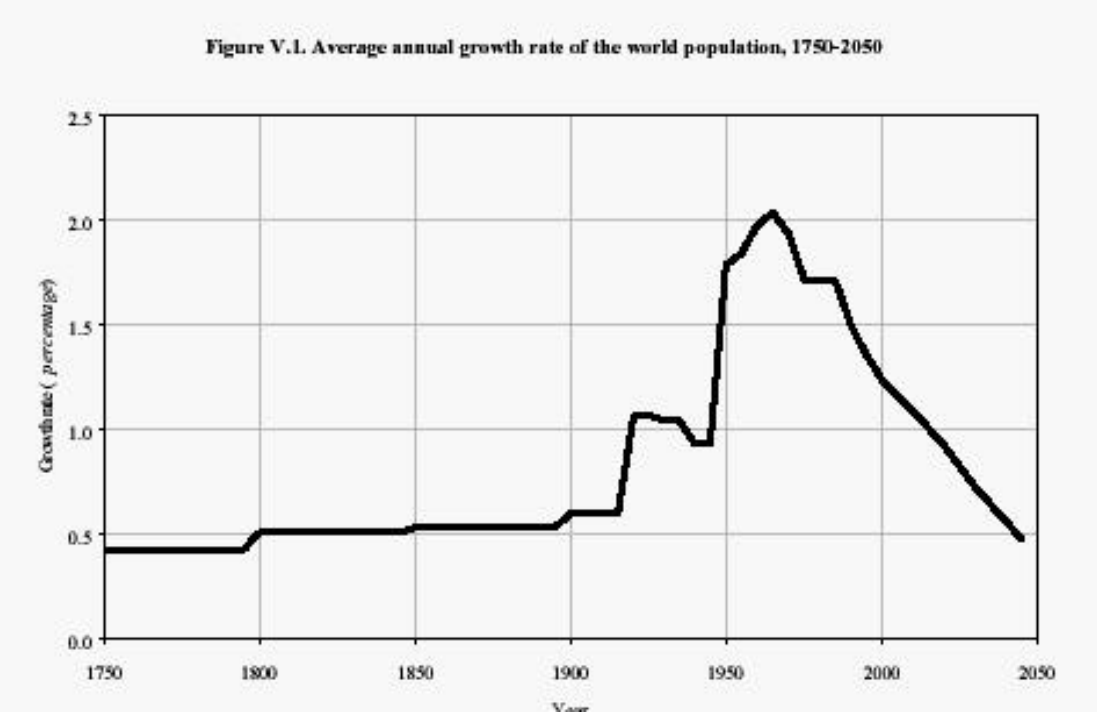
	world	more developed	less developed
births	4.2	0.4	3.8
deaths	1.7	0.4	1.3
increase	2.5	0.04	2.5

http://www.prb.org/pdf/WorldPopulationDS02_Eng.pdf

-1-2-**Population growth**

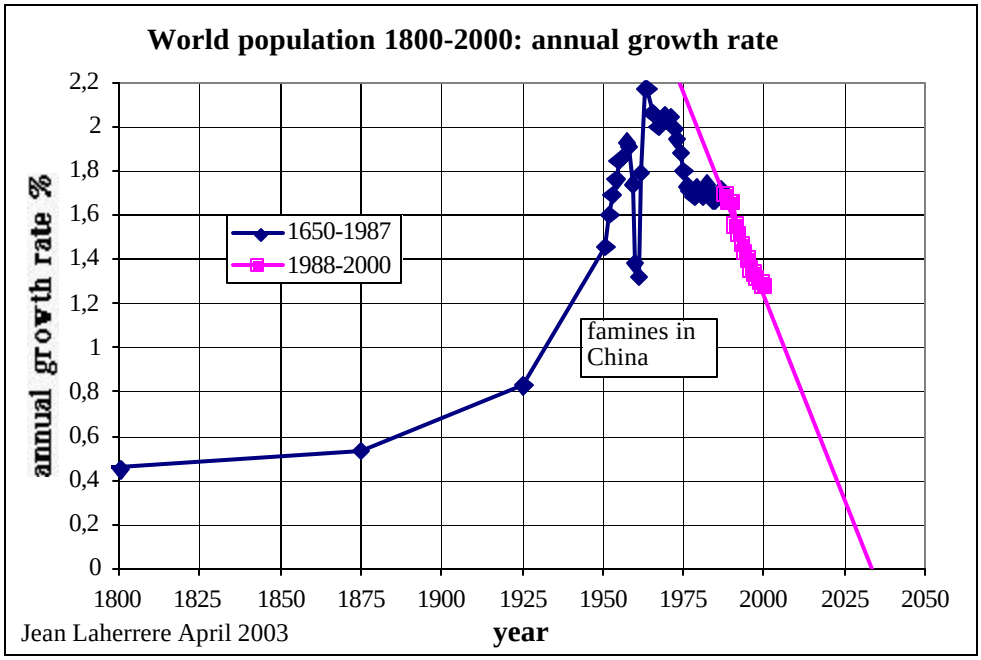
-1-2-1-**annual growth rate**

The world annual growth rate was around 0.5%/a before 1900, passed 1 % around 1925, peaked at 2.2 % in 1964 and is now at 1.2% and declining
The UN forecast (medium case) it at less than 0.5 % in 2050
Figure 3: UN annual growth of world population 1750-2050

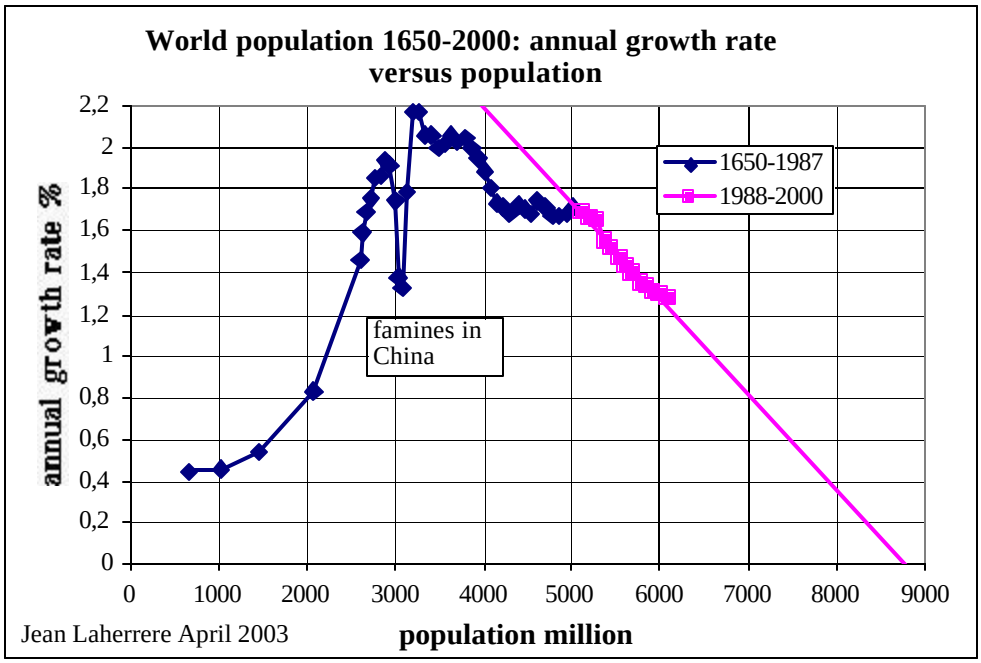


http://www.un.org/esa/population/publications/wpp2000/chapter5.pdf

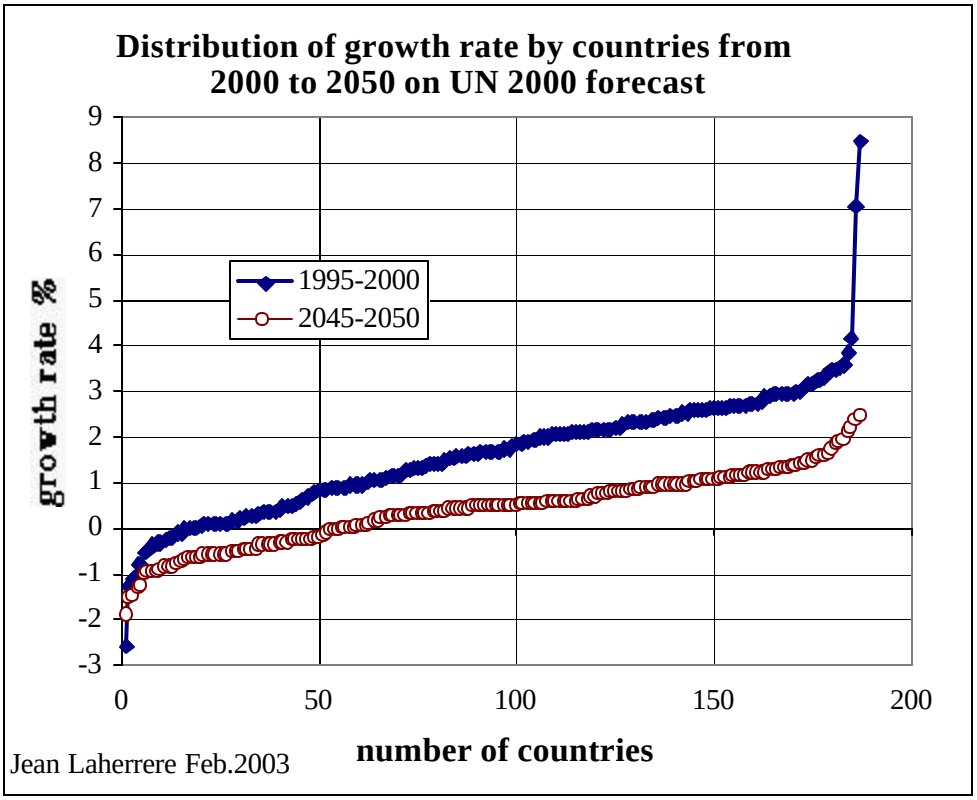
The linear extrapolation of the past trend 1988-2000 leads to a zero growth rate around 2030, meaning a peak around this date, if the trend stays linear which is unlikely. The curve looks almost symmetrical, except the trough in 1960 because of famines in China (only known much later)
Figure 4: World population 1800-2000: annual growth rate with linear trend towards 2030



The same data versus population has a linear trend to zero growth rate at around 8.7 G (peak).
Figure 5: World population 1800-2000: annual growth rate versus population with linear trend towards less than 9 billion



The distribution of the growth rate per country varies for the period 1995-2000 from -2.6 %/a to 8.4 %/a with about 25 countries with negative rate when the UN 2000 forecast for 2050 restricts the range from -2 % to 2.5 %/a with about 60 countries with negative rates.
We will see below that this UN reduction in growth range is due to a questionable assumption of fertility convergence towards 2.1 being the replacement ratio.
Figure 6: Distribution of the growth rate by countries from UN 2000



But the comparison of the forecast on annual growth rates per country between UN 2002 and UN 2000 shows some drastic discrepancies for the past period 1995-2000, demonstrating the poor quality of the data (obviously badly estimated in 2000)

Changes in percentage (medium case)

%(2002-2000)/2000	1995-2000	2000-2005	2010-2015	2020-2025	2045-2050
Afghanistan	-19	5	0	-2	-1
Yemen -	16	-13	-7	-10	-11
Saudi Arabia	-11	-6	-18	-20	-26
France	-6	32	38	65	-173
Russian Federation	-6	-11	11	15	5
Italy	0	-21	-8	-13	-19
World	0	-1	-3	-12	-30
China	1	3	-15	-35	44
Canada	1	-3	-12	-13	-23
Mexico	1	2	0	-10	-88
Nigeria	3	-3	-13	-16	-18
US	4	16	14	5	-12
India	4	-1	8	-7	-36
UK	24	76	187	230	-148
Germany	72	**-284**	-88	-67	-71
Spain	**371**	**-1267** -	79	-52	-49

For 1995-2000, Spain growth rate was given as 0.087%/a in 2000 report, then 0.41 %/a in 2002 report!

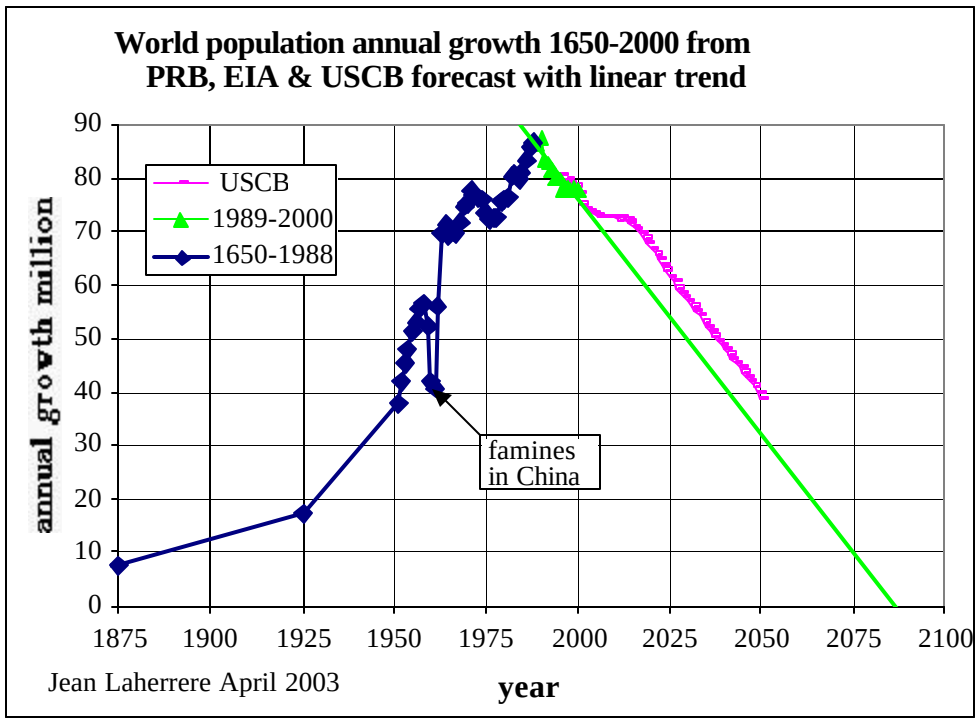
For 2000-2005 Spain rate was forecasted at -0.018 %/a in 2000 report but at +0.21 in 2002 report, Germany rate was forecasted at -0.037 %:a in 2000 report, but at +0.07 %/a in 2002 report. Most of the times these corrections are not mentioned.

-1-2-2-**annual growth**

The world annual growth shows that the peak was in 1988 at 88 million. It is funny to find that in 1990 the UN forecasted the peak of the annual growth for 1998, when it was already past. Most of the times, peaks are realised long after they have occurred. The linear extrapolation of the 1989-2000 leads to a zero growth around 2080, in contradiction with the linear growth rate (2030), meaning that a linear trend is not the right solution. USCB forecast is different f for 2000-2010 and then parallel.

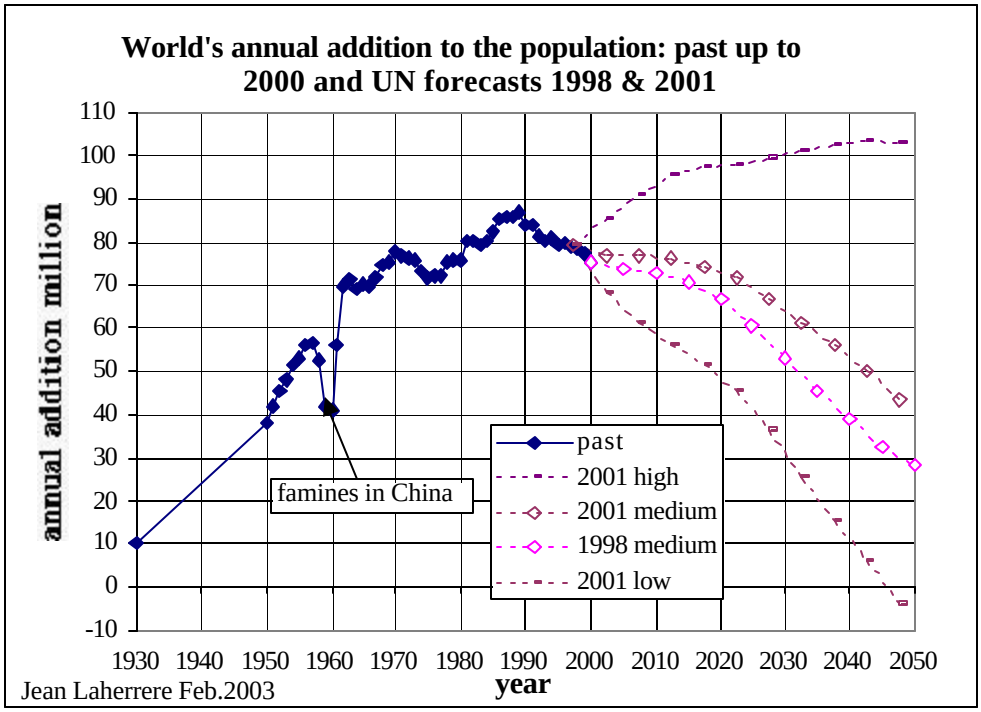
The famines in China gave a trough of about 20 million in 1960, cumulating with a loss of about 50 million. This loss was completely hidden in the media at the time.

Figure 7: World population annual growth 1875-2000 with linear trend



The UN forecast varies with time. During the 90s, revisions were declining sharply, but in 2001 the forecast was slightly up again. The 1998 (medium fertility rate) and 2001(low, medium and high fertility) are plotted. The high case is unrealistic and the most likely is between the medium and the low (called in 1998 the medium/low case).

Figure 8: World population annual growth with UN forecasts 1998 & 2001



-13-**fertility rate**

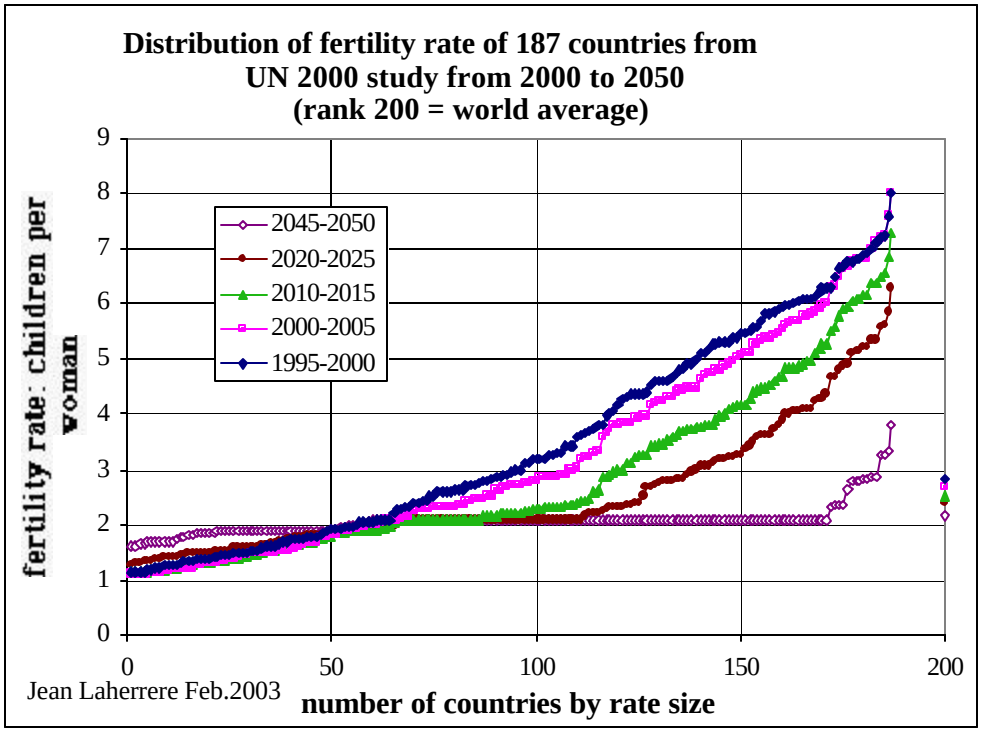
For a long time birth rate was close to death rate and population was growing slowly. Because of the progress in science and health, death rate declined sharply (mainly at birth) when fertility stayed high and it was the start of the population exponential growth. But when women were able to control their family planning, fertility fell. France was ahead of this evolution. In 1800 France had 27 million compared to 10 in UK, now both countries are about 60 million.

Future scenarios are forecast with different rates of fertility

Presently about 50 countries have a fertility rates below 2.1 child per woman which is the minimum ratio to replace the deaths and keep the population constant. The range is from 1.1 to 8 with an average of 2.7 child per woman.

The forecast by the UN is that in 2050 the rate for the reference case will be about 2.1 with a range from 1.6 to 3.8 child per woman.

Figure 9a: UN 2000 distribution of fertility rate from 2000 to 2050



The highest fertility rates now are in Islamic countries and the lowest in FSU countries with 1.1. The UN forecast for 2050 keep the same ones for the highest rates, when the lowest is for Germany and Italy with 1.61 as the FSU is assumed to build up again over 1.7?

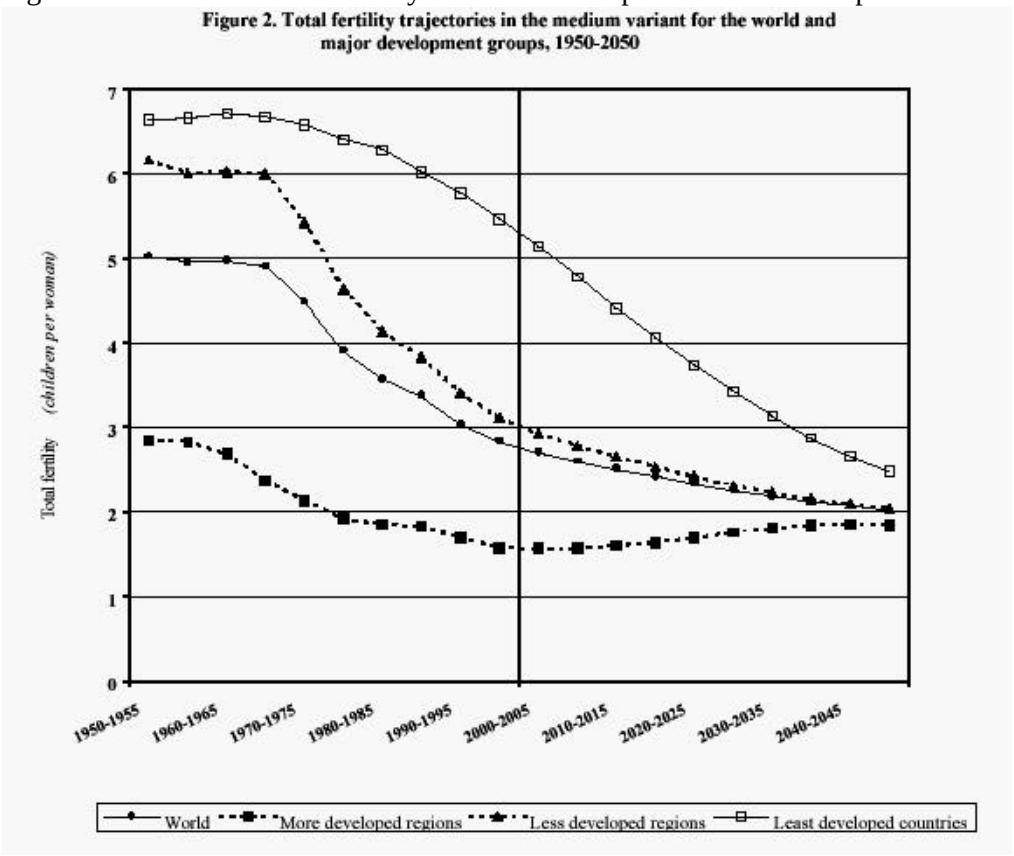
UN 2000-Table 10.					
2000-2005			2045-2050		
	Country	fertility		Country	fertility
A. **Highest total fertility**					
1.	Niger	8	1.	Niger	3.82
2.	Yemen	7.6	2.	Yemen	3.35
3.	Somalia	7.25	3.	Somalia	3.27
4.	Angola	7.2	4.	Angola	3.26
5.	Uganda	7.1	5.	Uganda	2.85
6.	Mali	7	6.	Mali	2.85
7.	Afghanistan	6.8	7.	Afghanistan	2.82
8.	Burkina Faso	6.8	8.	Burkina Faso	2.82
9.	Burundi	6.8	9.	Burundi	2.81
10.	Liberia	6.8	10.	Liberia	2.81
B. **Lowest total fertility**					
1.	Latvia	1.1	1.	Germany	1.61
2.	Armenia	1.1	2.	Italy	1.61
3.	Bulgaria	1.1	3.	Spain	1.64
4.	Macao	1.1	4.	Austria	1.65
5.	Ukraine	1.1	5.	Bosnia &Herzegovina	1.7
6.	Spain	1.13	6.	Channel Isl.	1.7
7.	Slovenia	1.14	7.	Hong Kong	1.7
8.	Russian Federat.	1.14	8.	Macao	1.7
9.	Czech Republic	1.16	9.	Slovakia	1.7
10.	Hong Kong	1.17	10.	Ukraine	1.7

	WORLD	2.68		WORLD	2.15

Most forecasts (UN, USCB) assumed that the low rates will increase and that the high rates will decrease. It is not as simple. From 1981 to 2000 (INED) some countries have increased their rate as US (1.8 to 2.1), Zaire (6.1 to 7), Mali (6.7 to 7), Yemen (7 to 7.2), Somalia (6.1 to 7.2) and Niger (7.1 to 7.5).

The UN assumed in the past (1994) for their reference case that in 2050 every country will trend to 2.1, now they assume that the more developed countries will trend to about 2 and that the less developed countries will trend to 2.2.

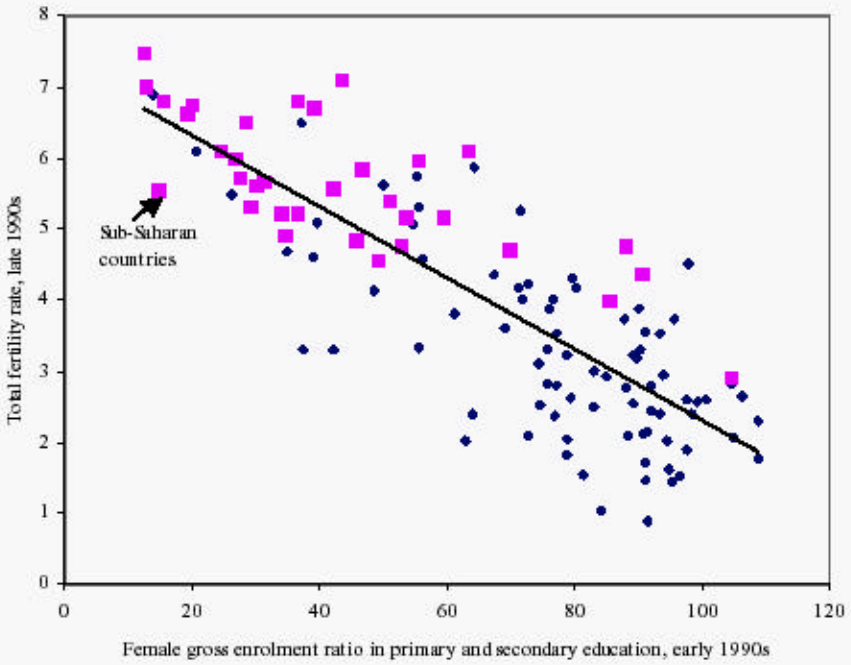
Figure 9 b: UN forecast on fertility for more developed and less developed



The developed countries when fertility decreases with education are assumed to increase their fertility in the future: it is a wild speculation.

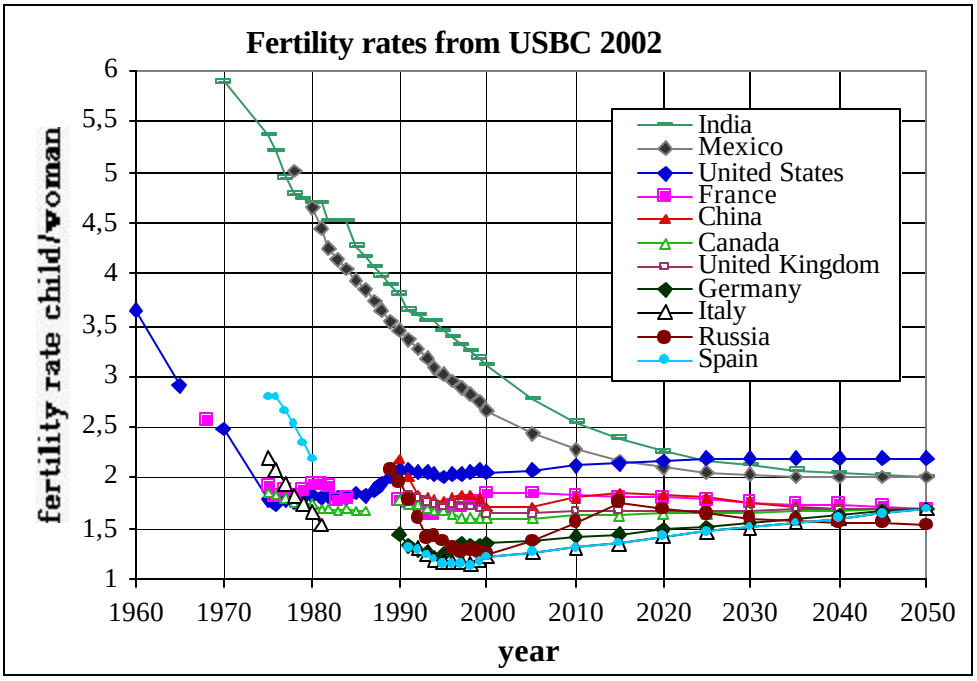
Figure 9c:relationship between fertility and education

Figure 5. Relationship between educational attainment in the early 1990s and total fertility rate in 1995-2000 for 117 developing countries



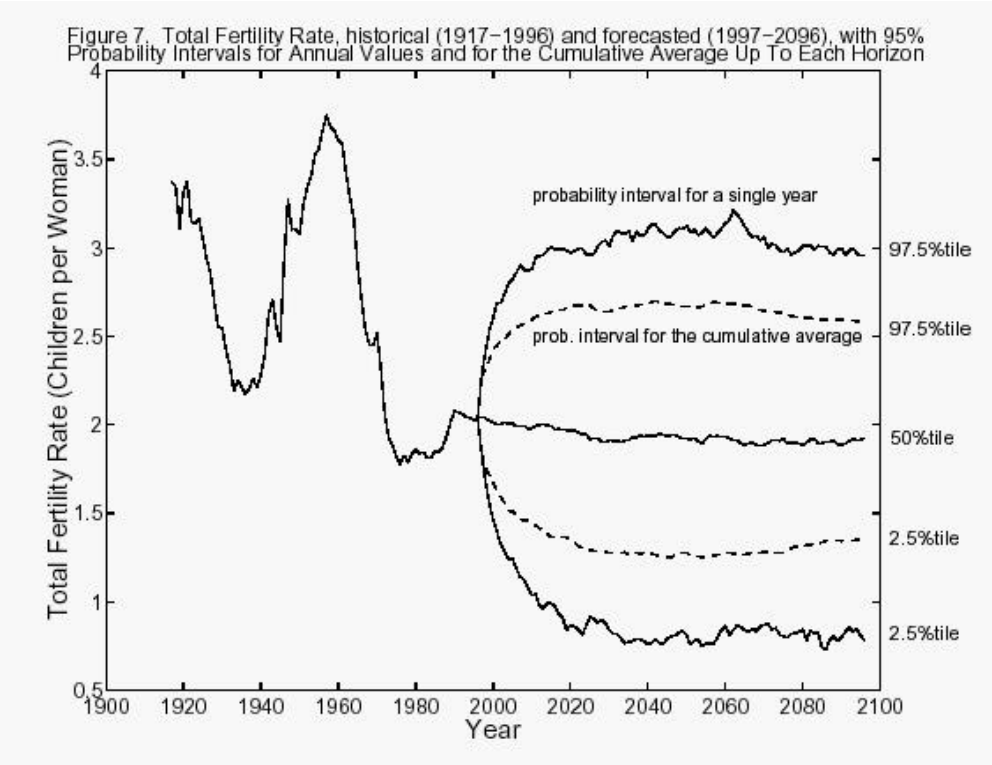
Source: United Nations (forthcoming). World Population Monitoring 2002

It seems that UN and USCB play for fertility with the last decimals, forgetting the fundamentals. It is wishful thinking, or rather mathematical thinking.
The USCB in their wish to forecast a strong growth for the US assume that in 2050 US fertility rate will be higher than the fertility in Mexico or in India as shown by the following graph. It implies that in 2050 women in the US will be less educated than in India or mexico. It is also difficult to understand why a country with a strong decline such as Spain (1.2 to day) will increase it to 1.7. It is simply wishful thinking.
The fertility rate has declined in most of educated -countries because women can now decide the size of their family and if they want one or two children, women want to go back to be busy outside their home. It is difficult to believe that the "out-of-home" behaviour of women over 40 years old will change. Only Islamic countries where women have not allowed to get out without their husband's consent can keep high fertility rates. The future world will be divided in two worlds, the free women with low fertility and the constrained women with high fertility and not the convergence dreamed by the UN around 2 to keep the world population constant.
In the following graph comparing the future fertility rates from different countries as estimated by USCB, it is surprising to see that the US women will be more fertile in 2050 than the women in Mexican or in India . It is also surprising to see Spain and Russia rates about 1.2 in 2000 rising again to 1,6 in 2050
Figure 10: Fertility rates from USCB 2002 for some countries from 1960 to 2050



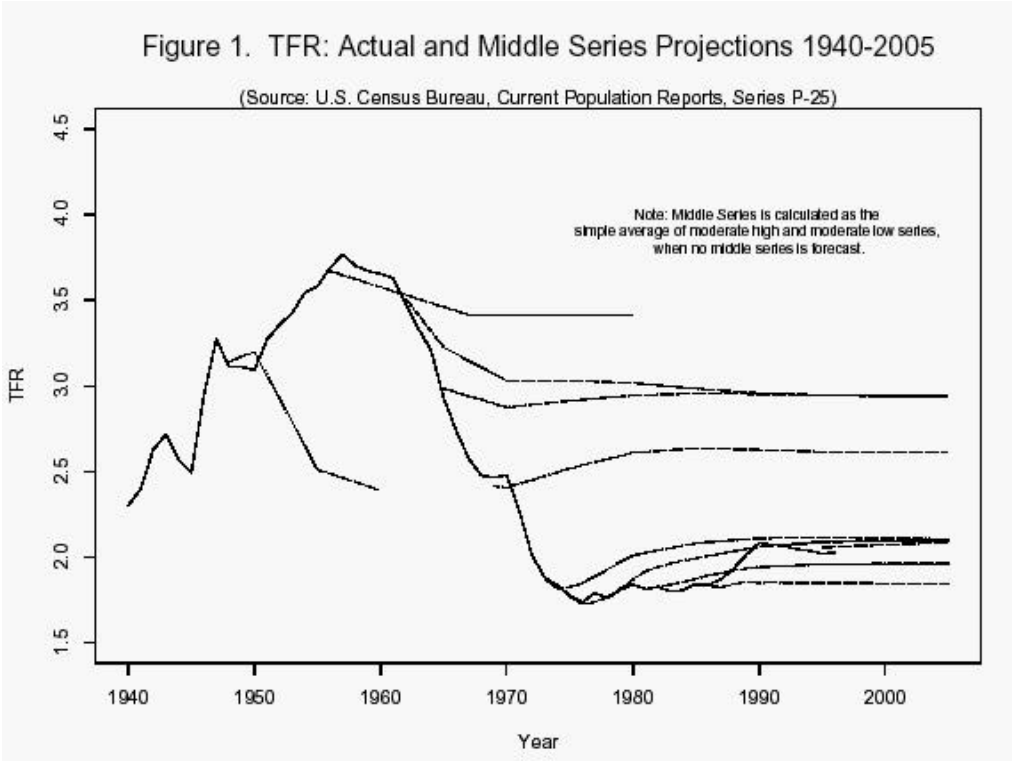
The USCB series start only from 1960 and the US declines from 3.5 but if series before are hard to find some graphs as from Lee 1998 shows that the US fertility rate has peaked in 1960 during the baby boom and Lee forecasts a lower rate for 2050 below the replacement ratio, in contrary to USCB forecast..

Figure 10 b: US Fertitlity rate from Lee UC Berkeley

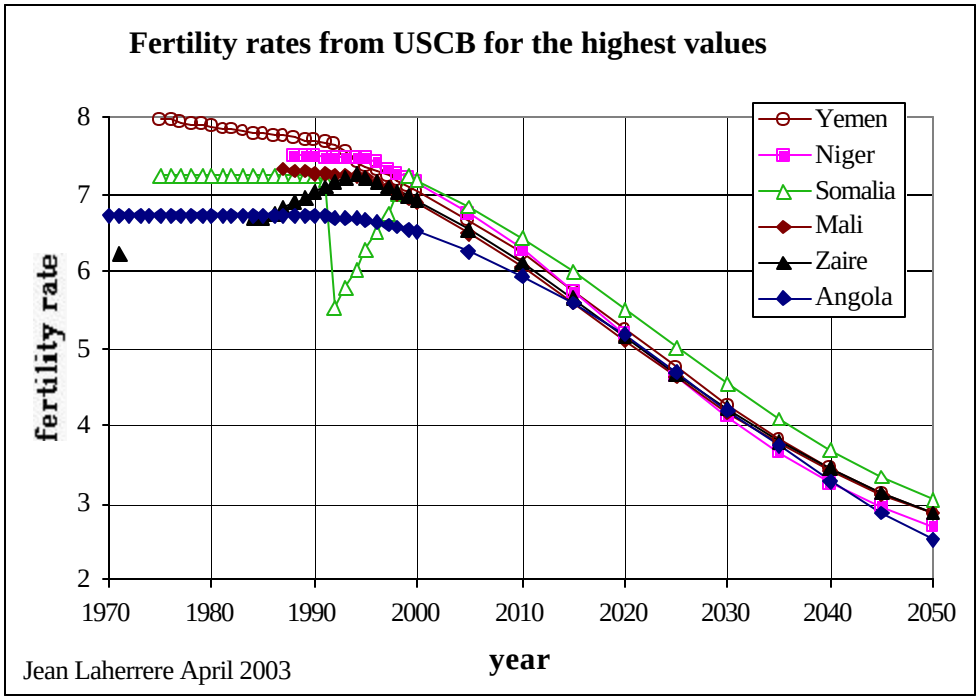


Lee shows also that the past forecasts for US fertility rate were drastically wrong in the past

Figure 10 c: US fertility rate and past forecasts



But a more careful study of the USCB values shows that these values are mainly mathematically computed, giving a value with 5 significant digit. As I often said giving to many significant digits shows that the author is incompetent and that the first digit is usually wrong. The graph displaying the USCB estimates for the highest fertility values as Yemen, Niger, Somalia, Mali, Zaire and Angola shows clearly that the values are not real but computed from some distant unreliable points and some assumed concept on their behaviour from 2000 to 2050. Even the Somalia series displays a wrong mathematical interpretation of the civil unrest in 1992 that the other sources do not support. In fact there is no measure in Somalia since 1980 and USCB reports 7.1896 for 1991 and 5.5434 in 1992: it is a joke! USCB should be sued for false data under Public Law 106-554.
Figure 11: USCB fertility rates for the highest values



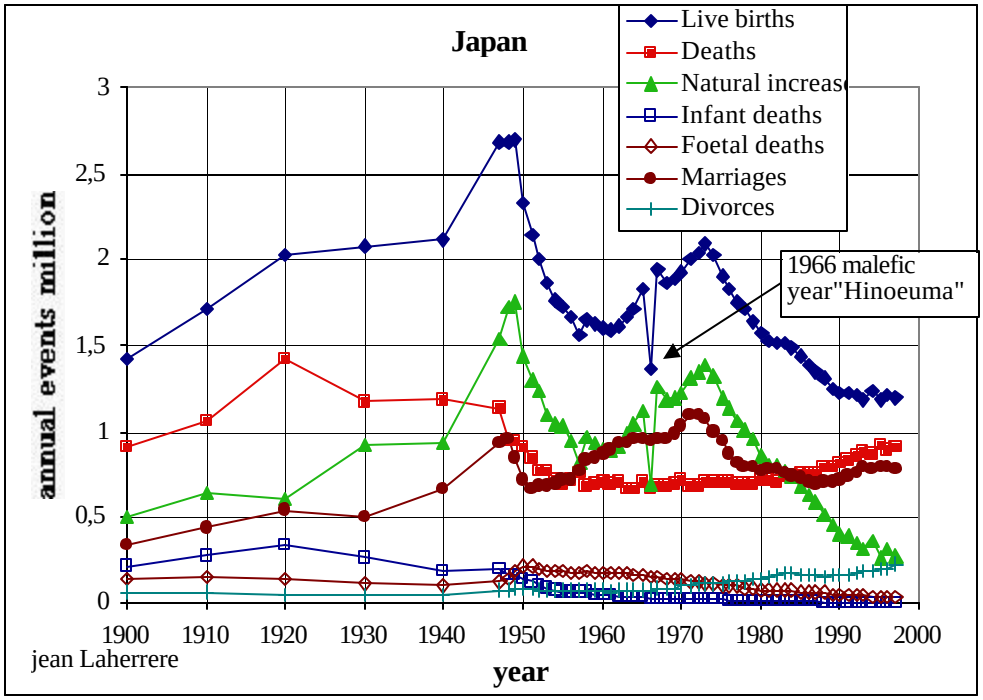
The comparison between UN, INED (Institut National des Etudes Demographiques) which reports close values and USCB shows large discrepancies with USCB values with 4 decimals!

	Angola	Mali	Zaire	Yemen	Niger	Somalia
for 2000						
USCB	6,52	6,89	6,92	7,05	7,16	7,1833
INED	6,9	7	6,6	7,5	7,5	7,3
UN	7,2	7	6,7	7,6	8	7,25
for 1981						
USCB	6,721			7,8671		7,252
INED		6,7	6,1	7	7,1	6,1

It is obvious that USCB values (past and future) are unreliable

But human behaviour is hard to understand as it can be very irrational. In Japan an educated country the number of births in 1966 dropped by one third (through abortions) as this year is assumed to be a malefic year (Hinoema) where the girls born this year are predicted to eat their husbands.

Figure 12: Japan annual events from 1900 to 2000



-1-4-**population forecast**

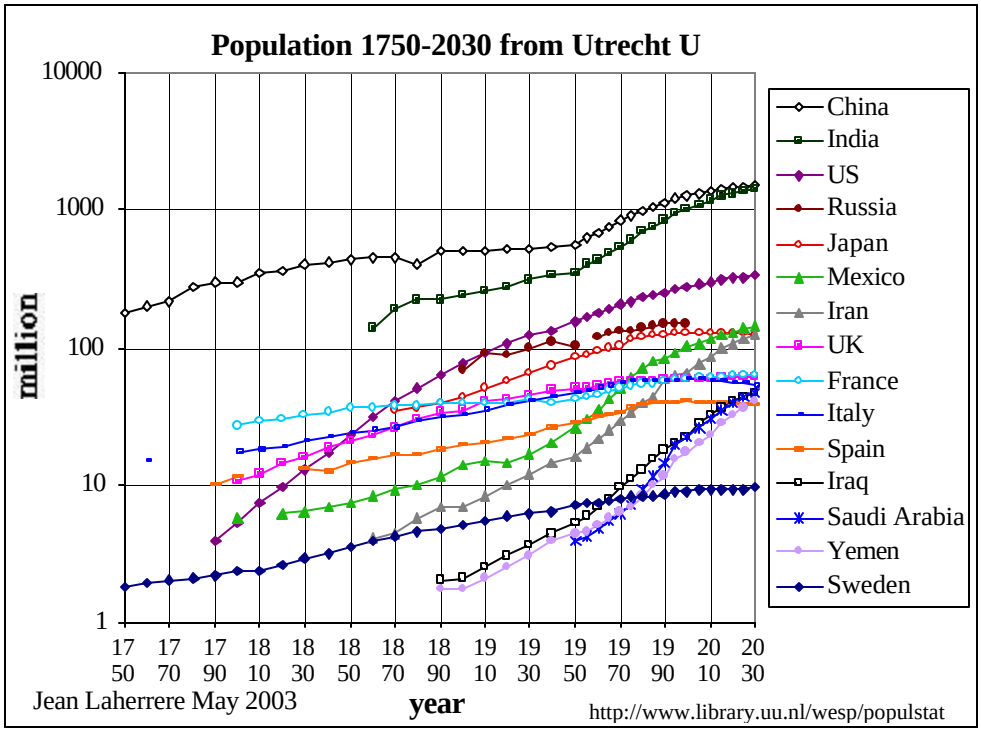
The UN is the most famous editor of population forecasts and delivers scenarios with different fertility cases from low to high. But it appears that the successive revisions for the 2025 forecast since 1980 went up and down with a peak in 1990

UN publications for 2025 in million

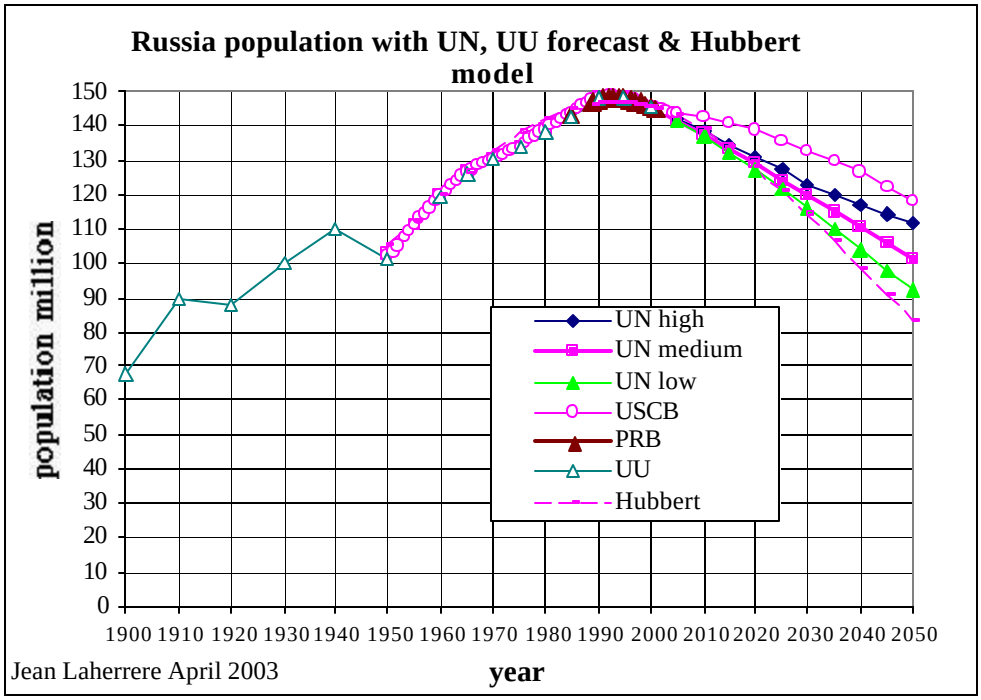
date of forecast	low	medium	high
1980	7165	8195	9132
1982	7278	8177	9185
1990	7591	8504	9444
1994	7603	8294	8979
1999	7275	7824	8379
2002	7334	7851	8365

The most complete file for population and forecast up to 2030 ids the Utrecht University (Jan Lahmeyer) and the growth of different countries shown on a log scale is very instructive. Drastic growth during the 19th century was the US, but during the 20th century the Islamic countries

Figure 13: UU data on the growth of several countries

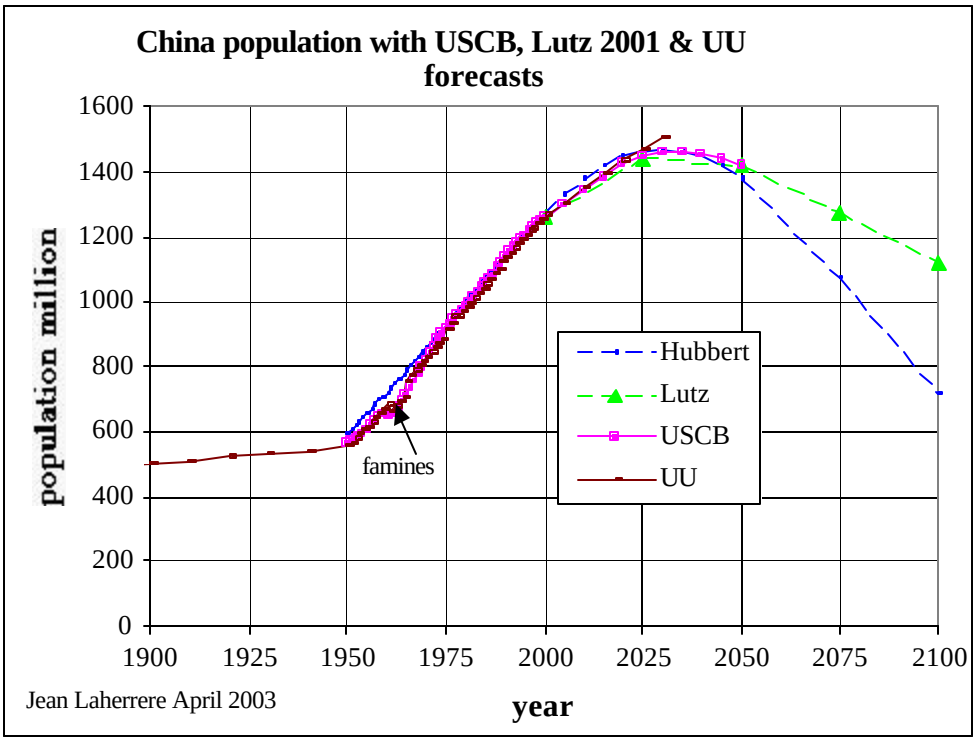


The forecast on different countries shows that many countries will peak before 2050
The 2001 UN & USCB forecast for Russia is plotted until 2050 showing a peak around 1993. The present decline in Russia is about 1 million per year but this decline was compensated partly by the return of Russians from some countries of the FSU. A Hubbert model fitting the past data is close to the low UN case for the 2010-2050 period.
Figure 14: Russia population 1950-2050 with UN, UU, USCB forecasts and Hubbert model

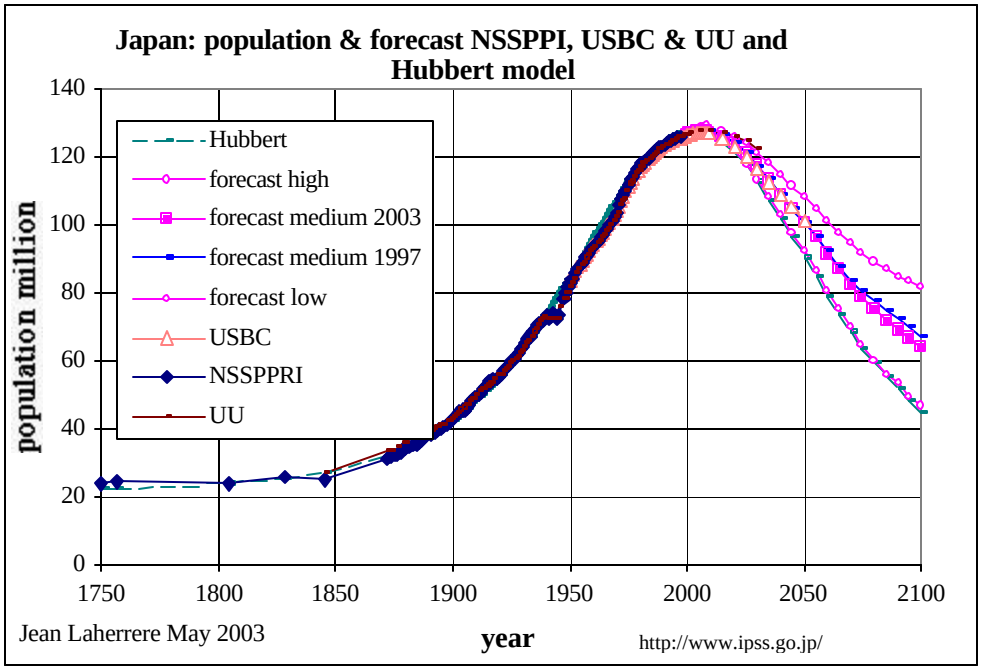


USCB forecast outranges the UN's, being since 2010 higher than the UN high case, that is 120 million for 2050, compared to the 90, 100, 110 UN range.

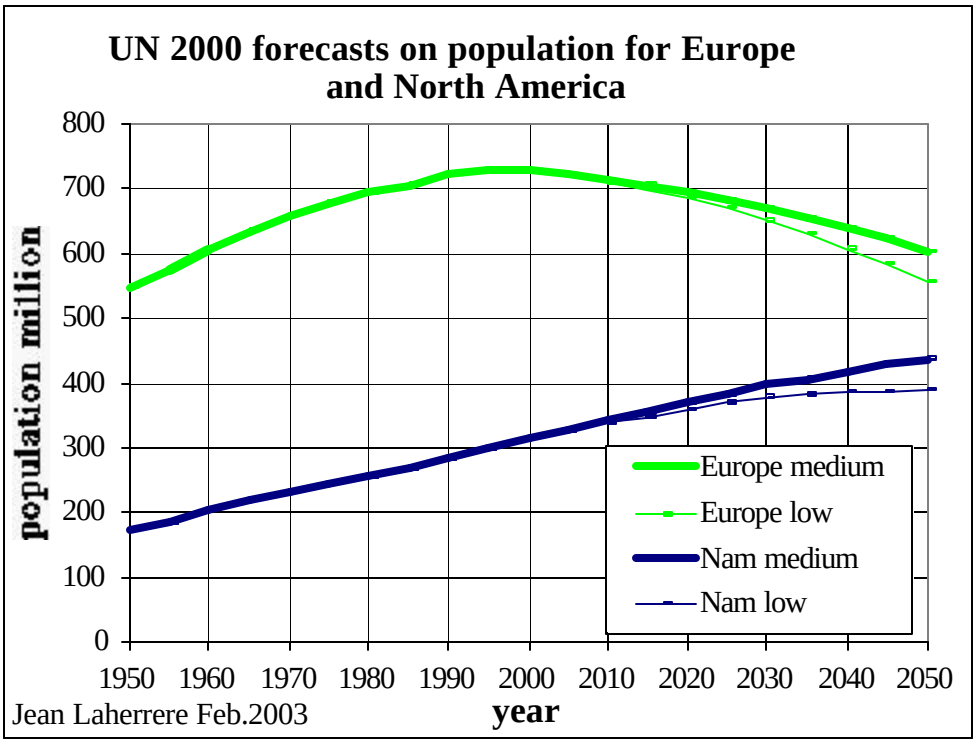
One of the most expert on population seems to be Wolgang Lutz (2001) with IIASA and he forecasts for China a peak around 2030, as for USCB.
Figure 15: China population 1900-2100 with forecasts from Lutz; UU & USCB as Hubbert model



The plot for Japan population from 1750 to 2100 from a Japanese agency (NSSPPI) displays a almost perfect symmetrical curve as immigration is almost nil and does not disturb natural trends. The Hubbert model fits perfectly with the low case. The Japanese forecast for 2100 has decreased by 3 million in 2100 from 1997 to now.
Figure 16: Japan population 1750-2100 from Japanese agency and USCB



The UN 2000 shows a peak for Europe (there are many definitions for Europe) before 2000 as opposite to the ever growing North America. Indeed Europe population peaked between 1995 and 2000, but most Europeans ignore it.
The medium is plotted, as the low case, but excluding the high case which was shown in the past to be unrealistic.
Figure 17: UN 2000 forecasts 1950-2050 for Europe and North America



In an OGJ 1999 article I wrote the following

World population

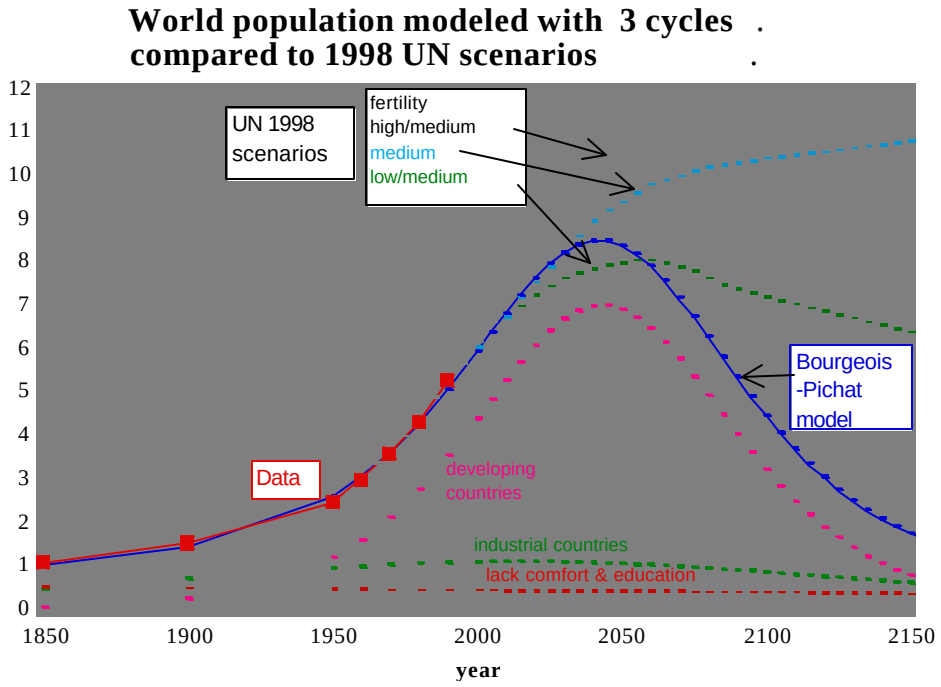
It has been shown that the parabolic fractal, developed to model the distribution of oilfields, also models the distribution of other objects in a natural domain, such as physical (as opposed to administrative) towns (agglomerations), galaxies, spoken languages, size of species etc.

National populations change over time. Population growth has been the norm, but history shows that civilisations wax and wane both in power and numbers: the Incas, Mayas, Greeks and Romans, to quote a few examples. It is the same with stars, the dinosaurs and eventually humans too. Population declines when the fertility rate of a country falls below 2.1 children per woman. There is a time lag because of the "pyramid of age", but populations do peak and decline. The curves can be modelled in the same way as discussed above.

According to Bourgeois-Pichat 1988, industrial populations will soon peak, to be followed by the developing countries some 40 years later as they try to emulate the industrial countries. Europe's population is expected by the " Observatoire Démographique Européen" 1997 to peak around 2025. Figure 10 shows Hubbert curves for three categories of people: a basic (uneducated) population; an industrial population and a developing population.

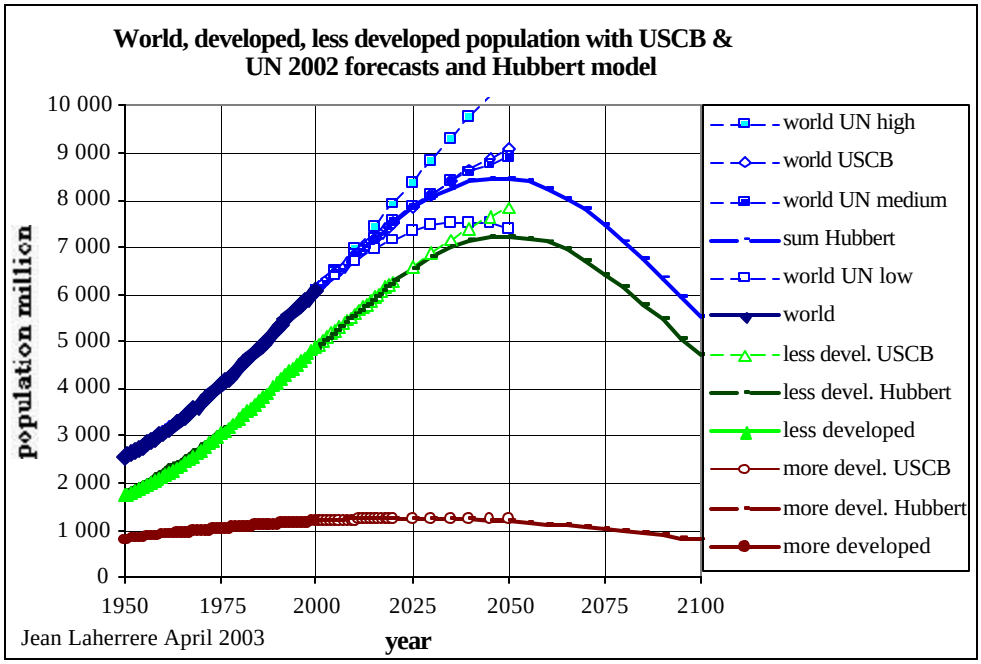
The UN 1998 forecast with a large range of scenarios is added. The scenario of low/medium fertility is in a good agreement with our multi-Hubbert model.

-Figure 10:

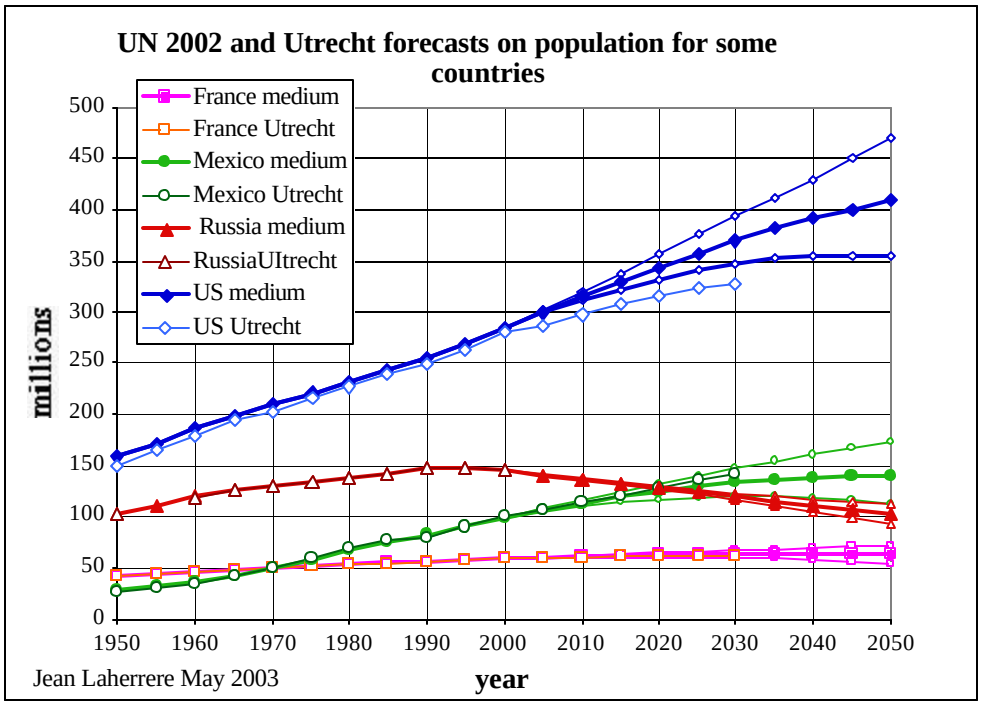


The world's population will peak around 2050 with about 8.5 billion people. If no other cycle occurs, the world will sharply decline staying only with people refusing education and progress.

Using 2002 UN forecasts, the modelling of a Hubbert curves fitting the past for the breakdown in the more developed and the less developed countries gives for the less developed a peak around 2050 at 7+ G and for the world a peak around 2040 at 8.4 G .
Figure 18: World, developed & less developed population forecast with UN, USCB and Hubbert model



It is interesting to see the range estimated by the UN 2002 study.
The low case forecast for the US (the most likely in my opinion) shows a peak in the 2040s at 350 M (+60 from now). Russia has peaked in 1990 and France and Mexico will peak around 2050
Figure 19: UN 2002 & Utrecht forecasts for some countries



Lutz 2001 displays the probability for different countries to start to decline on the indicated year
Figure 20: IIASA probability for countries to start decline

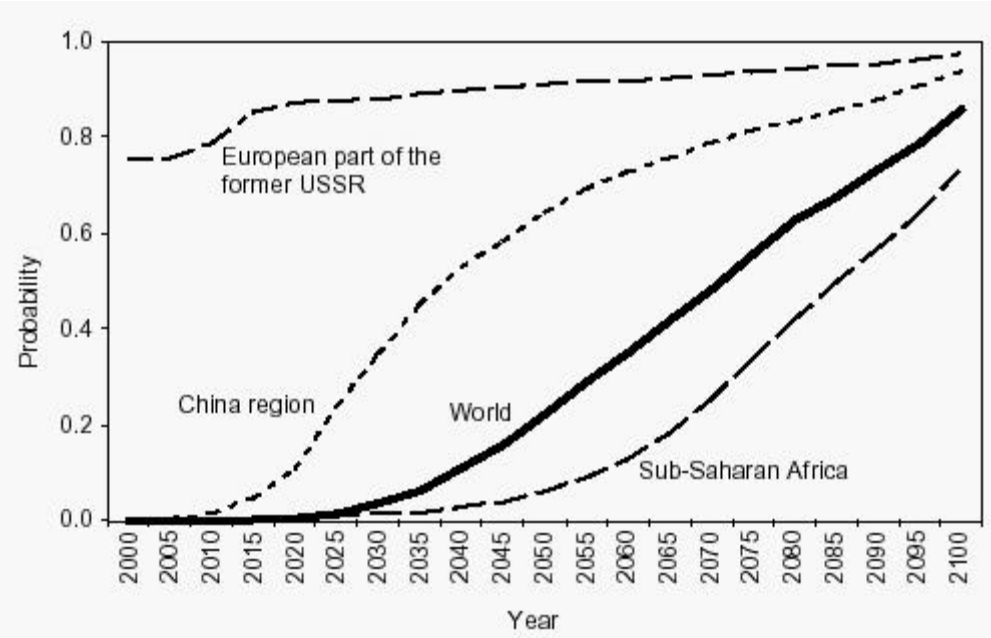
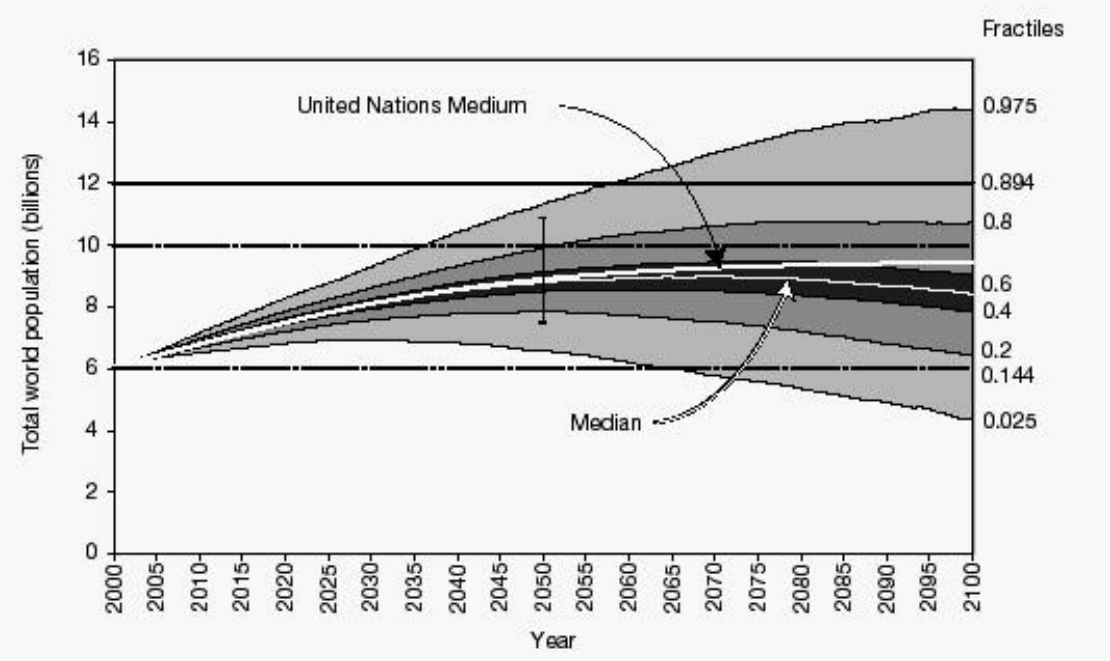


Figure 1 Forecasted probability that population will start to decline at or before the indicated date.

The range for the world with different probability is given by Lutz. For 2050 there is a 95% chance that the world will be between 6.6 and 11.4, but the US NRC (National Research Council) reports a narrow range of 7.9 to 10.9.(Keilman 2001)

Figure 21: IIASA 2001 world population forecast with probability range



But the previous forecast by Lutz in 1996 is higher. In 2100 for a probability of 50% (median) 10 G instead of 8 now, the 0,975 probability was 17 G instead of 14 now and the 0,025 probability was 6 G instead of 4 now

Figure 22: IIASA 1996 world population forecast with probability range

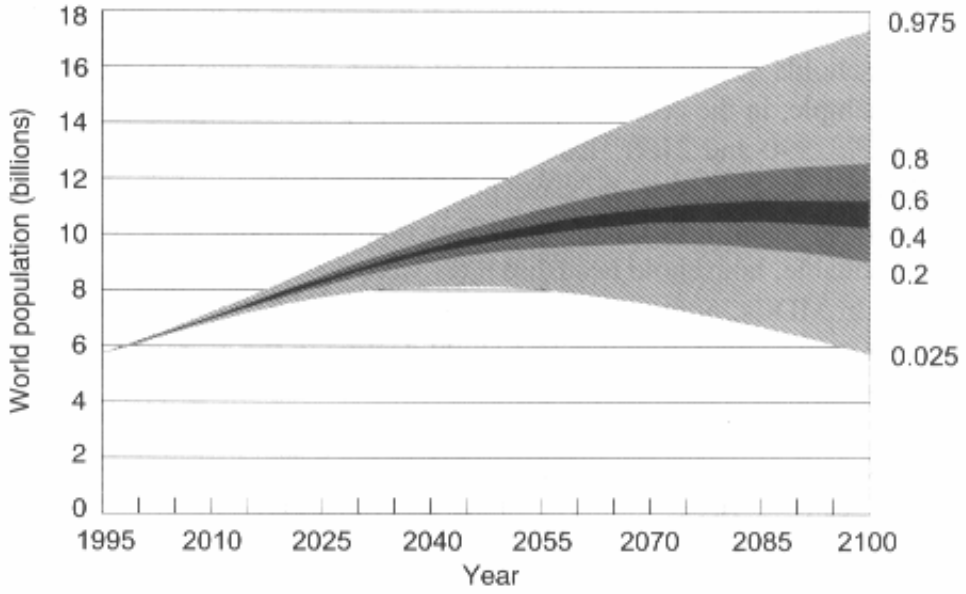
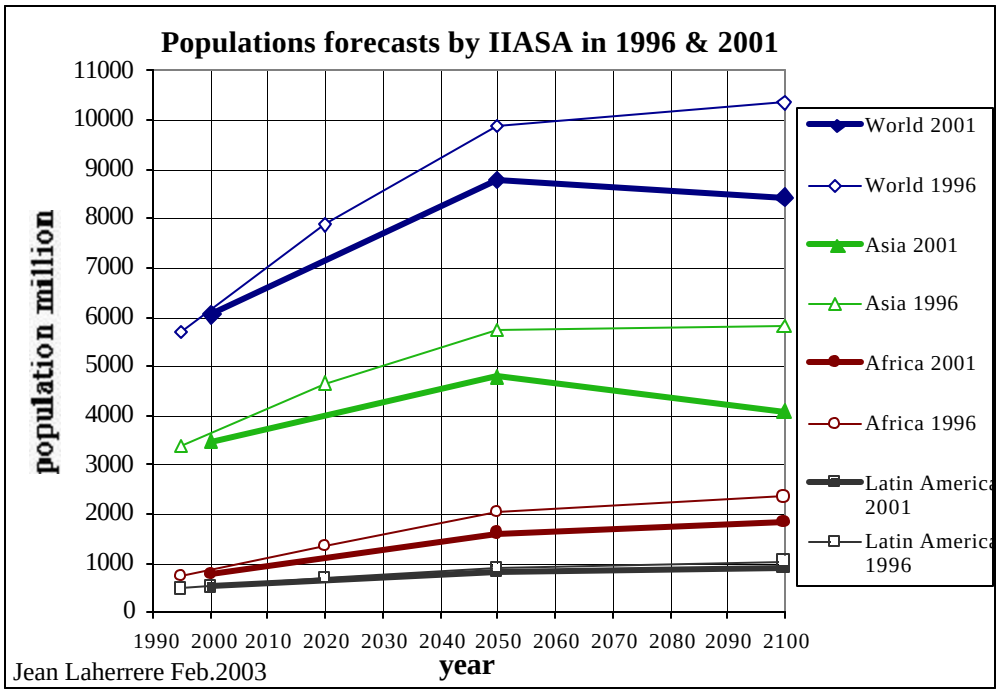
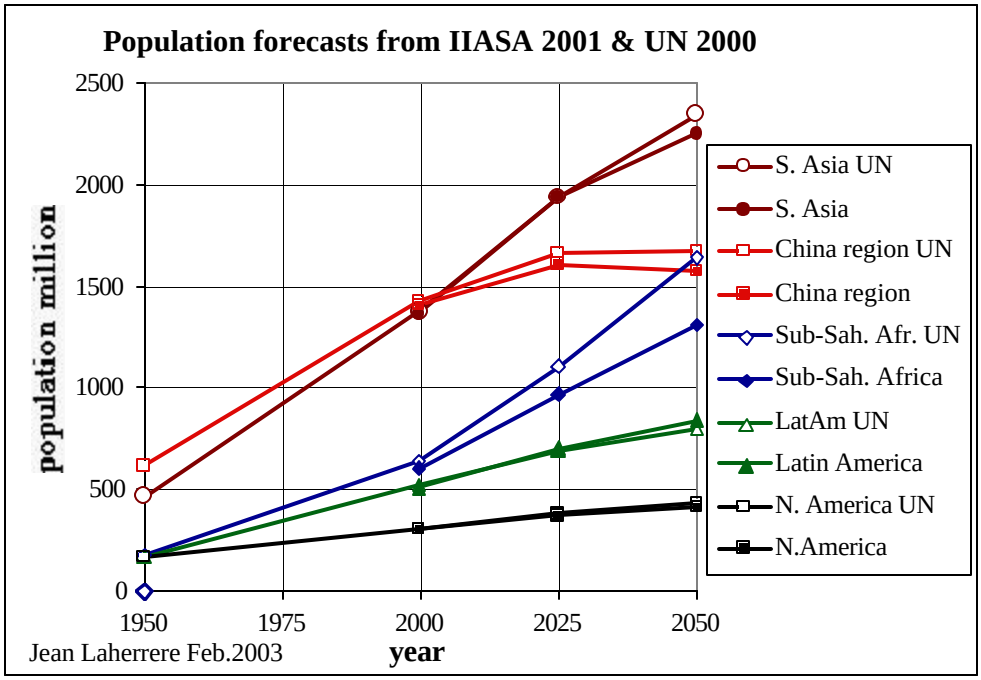


Figure 2.6. Merged distribution of the size of the world's population (in billions), 1995–2100. Source: Lutz *et al.*, 1996a.

The main change by IIASA from 1996 to 2001 as shown by the next graph was mainly a large reduction in Asia, small one in Africa and no change in Europe and North America
Figure 23: Comparison IIASA forecasts 1996 and 2001



The comparison between IIASA 2001 and UN 2002 shows that the largest difference was in sub-Sahara Africa; IIASA being mainly lower than UN.
Figure 24: Comparison IIASA 2001 and UN 2002



-1-5-Population problems

-1-5-1-Gaia in action: AIDS and other virus

In the Gaia concept, excesses of the world population are constrained by the resources but also by the life environment. Bacteria(as virus) has been, are and will be the most important part of life on earth, and their impact on human beings is large as beneficial and as detrimental. Epidemics played a great role in the past. In South America, diseases bought by the Europeans destroyed the natives more than the sword of the conquistadors. The Black Death in the Middle Age and the Spanish flu in 1918 killed tens of millions.
The impact of AIDS is estimated by the UN to reduce the 2050 forecast by 44% for the largest
Forecast (Caub) are reduced because AIDS in 2050 by %

Lesotho	44	Namibia	25
Botswana	43	Malawi	24
South Africa	39	Burundi	22
Swaziland	38	Mozambique	22
Zimbabwe	33	Zambia	22
Kenya	26	Guyana	19

Surprisingly, all of these countries are projected to have a larger population size in 2050 than at present, a result of current high birth rates.

-1-5-2-Ageing

The main problem in future is not overcrowding but ageing.
USCB Ageing world 2001
France (Dinh 1995) the number of centenarians are estimated at 200 in 1950, 8 500 in 2000, 41 000 in 2025, 150 000 in 2050

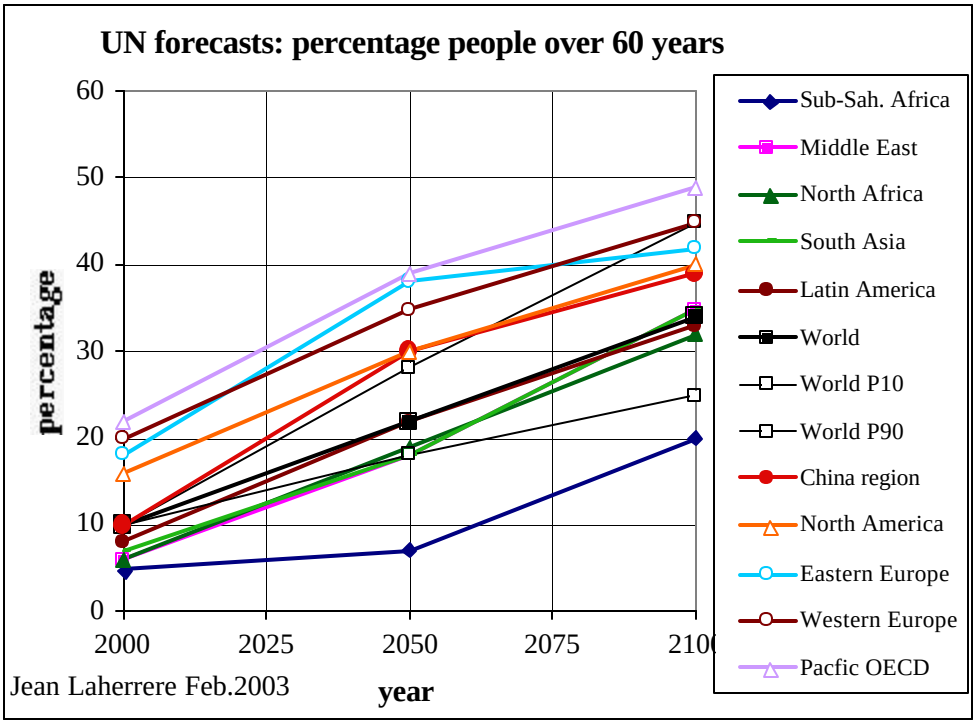
Life expectancy at birth	1900	1950	2000

France	male	45	64	75
	female	47	69	83
US	male	48	66	74
	female	51	72	80

France has done better than US in the last 50 years, is it that less energy consumption improves life expectancy?

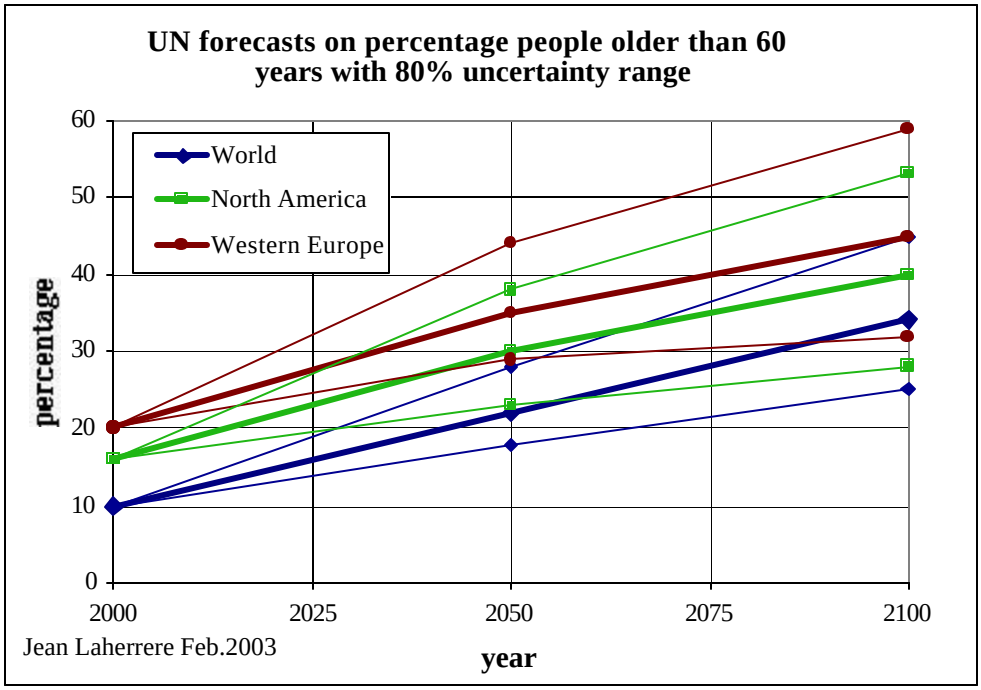
The percentage of older than 60 years is forecast to grow sharply from 10 % now in average to 35 % in 2050 (50 % for Japan)

Figure 25: UN forecasts for percentage of people over 60 years



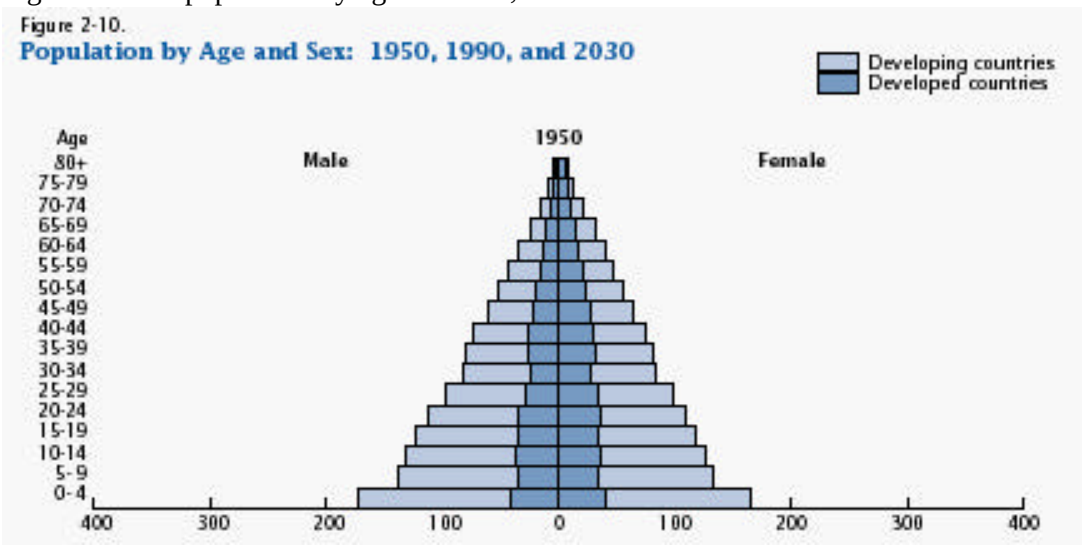
The range of uncertainty of the percentage is for the world in 2050 between 25% and 45%, which is quite large, as for Europe between 32 % and 60 %

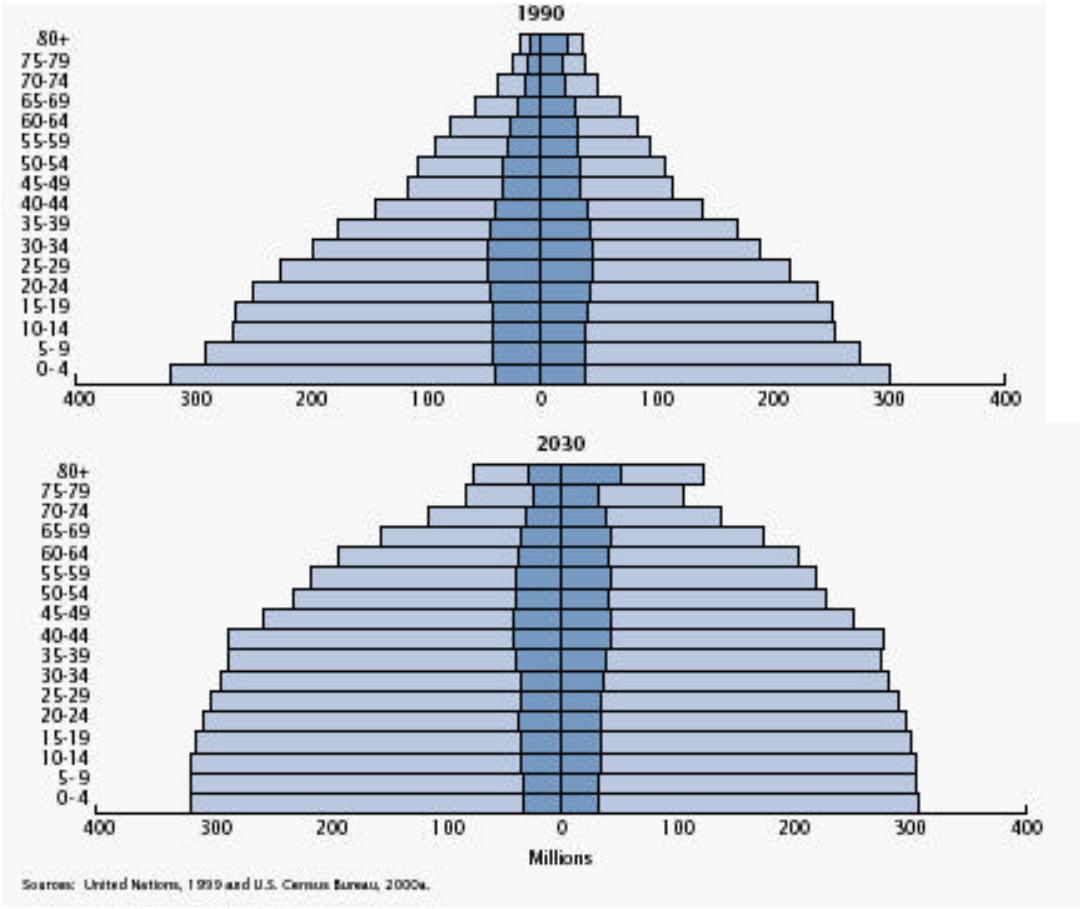
Figure 26: UN forecasts for percentage of people over 60 years with probability range



The population distribution with age giving the developed and developing shows the pyramid becoming a cylinder.

Figure 27: UN population by age for 1950, 1990 and 2030





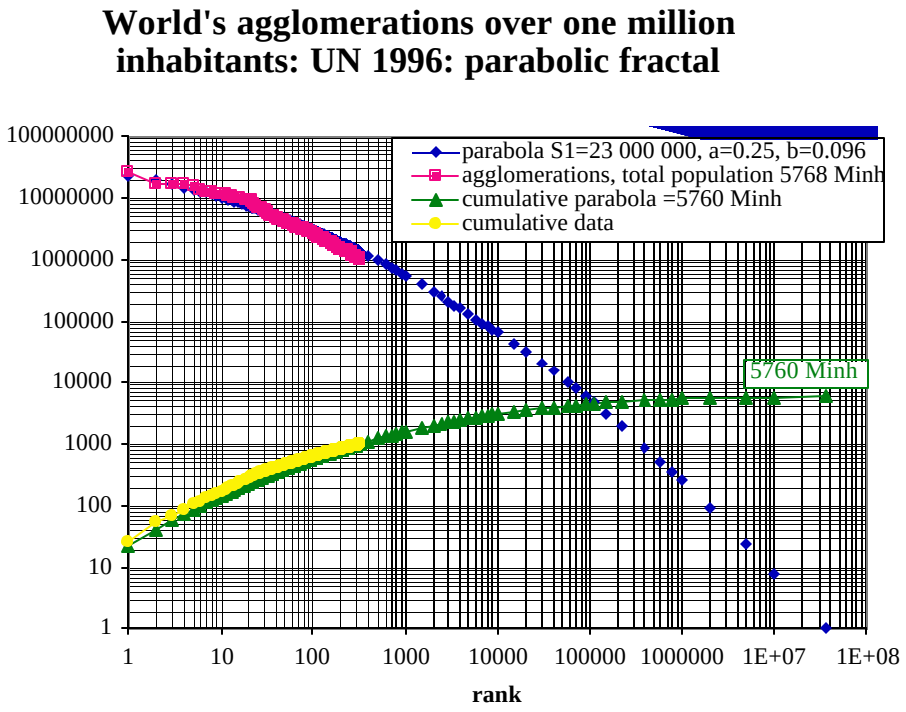
-1-6-**urbanisation**

The fractal display (size-rank, log-log) shows a parabolic curve for the agglomerations of a country (which can be extrapolated to obtain the total population) when the towns are described by morphological criteria as urban agglomerations, based on the physical extent of building, but not to by administrative criteria. It implies that the law has meaning only for objects in a natural domain. But the main pr oblem is that there is no consensus on how to define urban agglomerations. *"Because each country sets its own definition of "urban," there is a bewildering array of definitions around the world*" (World Resources Institute). The urban agglomeration threshold varies from 100 to 10 000 inhabitants or depends upon the activity or the density: In US the limit is 2500 people, in France 2000 people. The data is unreliable and heterogeneous. The best definition is the morphologic continuity of housing, but it is difficult and time consuming to define urban agglomerations from remote sensing data. In Europe some attempts have been made to estimate urban agglomeration as the "Eurostat Pilot Projects", and the results are different from the Eurostat method and the National methods. The work has not yet been done completely in any country, and of course globally with the same standards world-wide

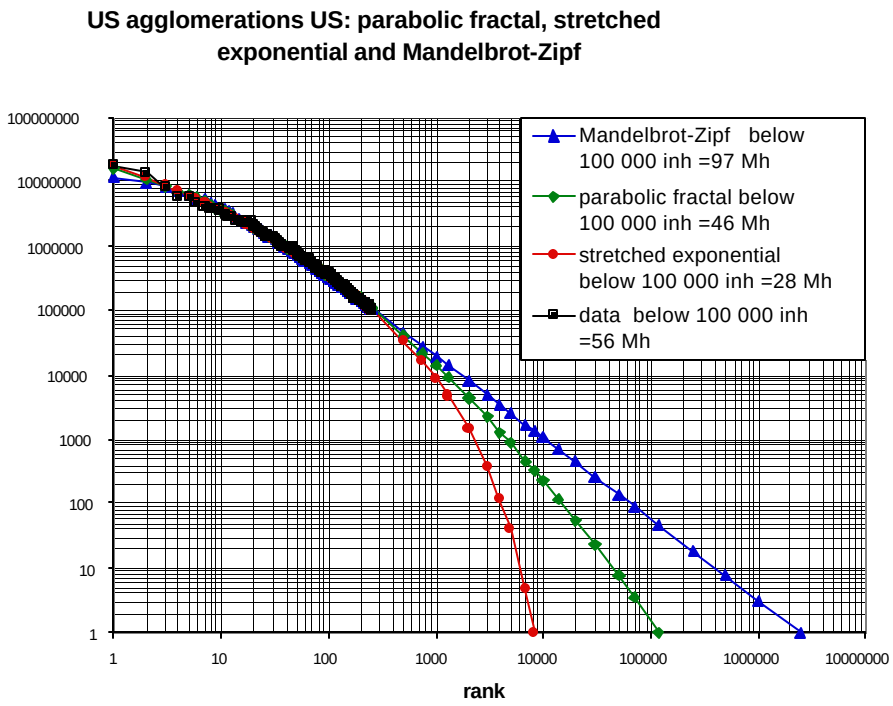
There is a 1990 world-wide Geopolis file from published data, but quite unreliable in some countries such as China and India. Even country population is unreliable because of political bias. In 1991 the population of Nigeria dropped from official UN value of 123 to 88 million inhabitants because of the first census.

We have used the 1998 UNPD data (on the Internet) to model the 1996 world urban agglomerations over one million people with a parabolic fractal which gives a total population

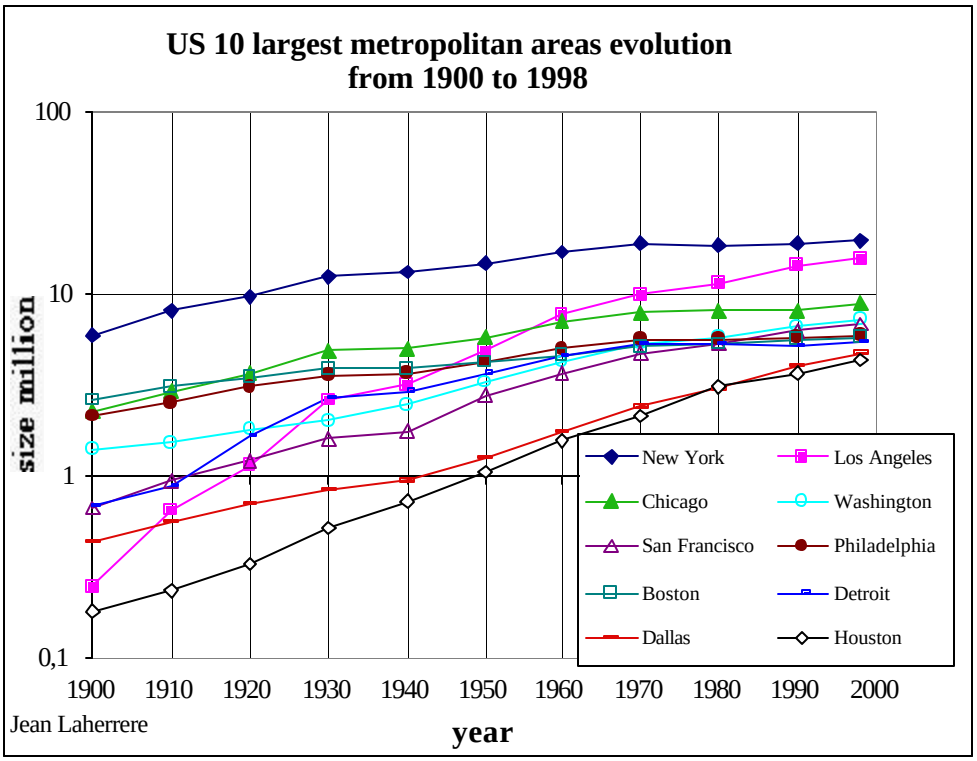
(extrapolation to the minimum agglomeration of one people) equal to the population of the world (5.8 billion inhabitants).
Figure 28:World urban agglomeration fractal display



The US urban agglomerations over 100 000 people allows with several models to estimate the total population by extrapolation towards the minimum agglomeration of 1 people. This extrapolation compared with the total population from census is the best way to tell which model is the best. As the population in agglomerations below 100 000 people is 56 M, as the stretched exponential gives 28, the parabolic fractal 46 and the Mandelbrot-Zipf (linear fractal) gives 97, it is obvious that the parabolic fractal is the best model to describe the urban agglomeration and is the best tool to compare urbanisation between countries.
Figure 29: US urban agglomerations fractal display with different models

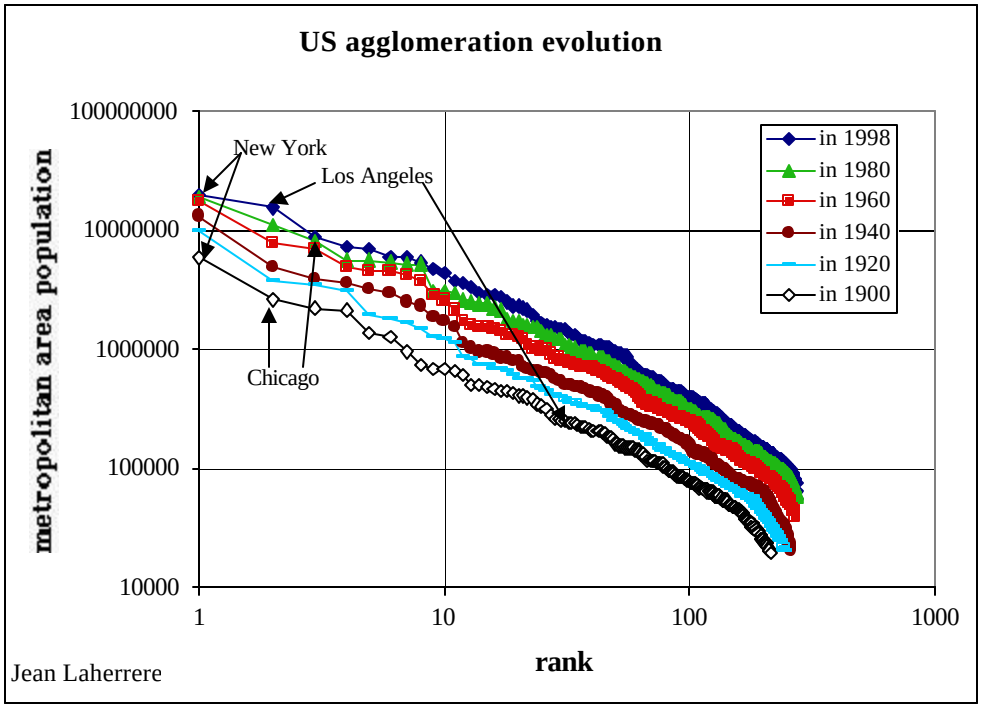


The largest US agglomerations have evolved very differently from 1900 to 1998
Figure 30: US largest agglomerations evolution 1900-1998



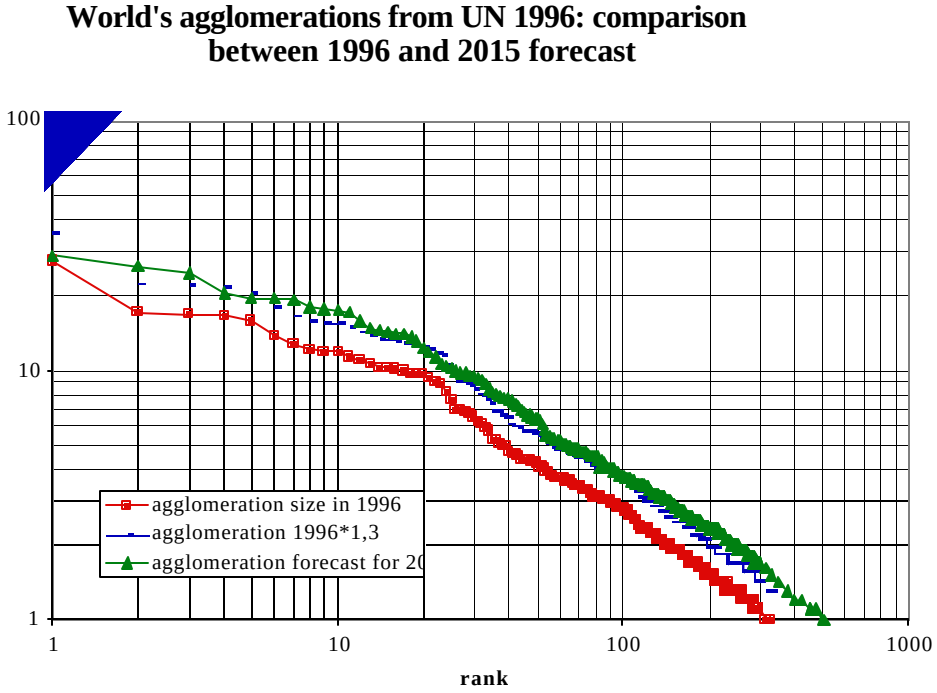
However the US agglomeration fractal display from 1900 to 1998 shows very well that the global display stays the same despite that Los Angeles was at a low rank in 1900 and moves to the second rank in 1998

Figure 31: US agglomeration evolution from 1900 to 1998



The parallelism of the consecutive distributions means that the distribution stays the same. In a log-log scale, being parallel (adding a va lue) means that in the normal scale the new population is multiplied by a constant value. It means that the growth is proportionally distributed, which means globally no change in the distribution except everybody grows together.

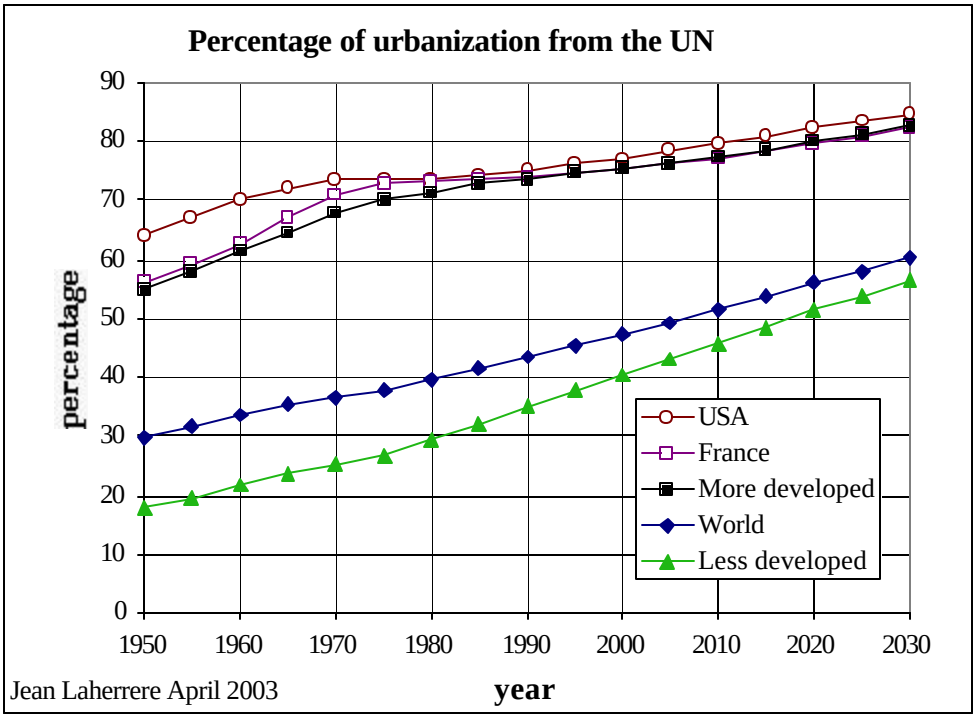
Figure 32: UN 1996 World agglomeration between 1996 and 2015 forecast



The evolution of one year to the next is that every agglomeration in average is multiplied by the same number and as the total population increases by a certain growth, the threshold of urbanisation should be multiplied by the same growth. In this case being parallel means that the urbanisation ratio stays the same, despite the estimate of the UN of increase urbanisation as they keep the same threshold (2000 people) for the last 40 years when world population has doubled.

The so-called world urbanisation moving from 30 % in 1950 to 48 % in 2000 and 60 % in 2030 is artificial representation.

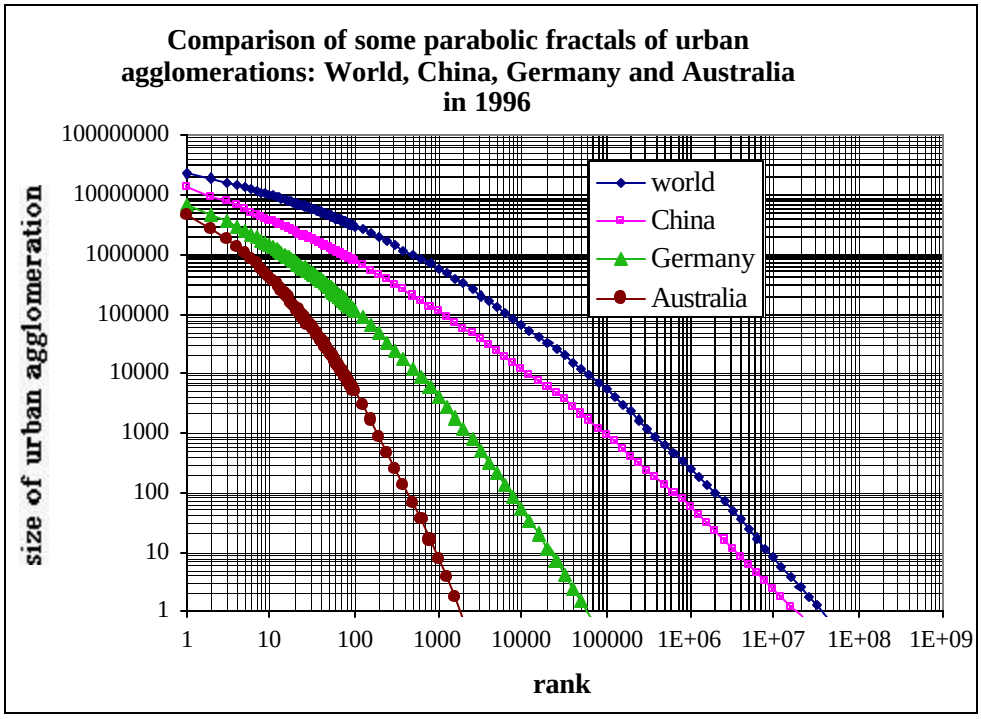
Figure 33: UN forecast for percentage of urbanisation



Instead of using this poor urbanisation ratio (with a stupid constant threshold which varies according to the country), and as the measure of the agglomeration size down to the smallest is unreliable, very difficult and almost impossible for the whole world, the best way is to use only a model based on the largest urban agglomerations (defined by the continuity of the buildings on urban maps) and to extrapolate the full distribution of the country using the census of the total population. The status of agglomeration (or urbanisation) of the country is then measured by the slope of the fractal display for the largest sizes.

In the next graph we have chosen a few examples of different habitats, as dispersed for China, normal for Germany and concentrated for Australia.

Figure 34: Comparison of parabolic fractal models for different countries

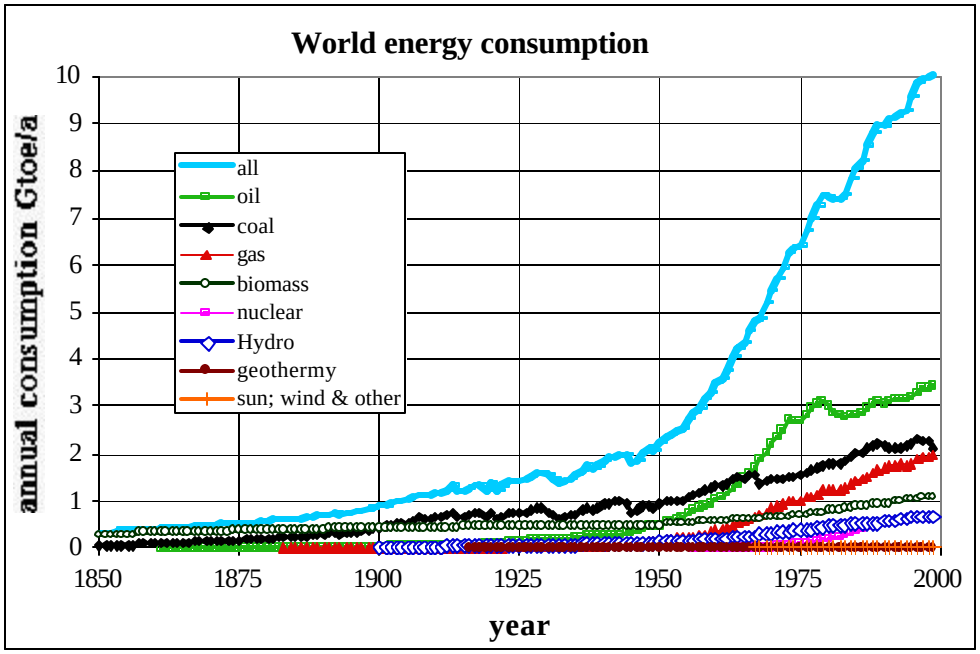


It is a pity to see how badly the world is measured in term of population distribution because of the definition problems and difficulty to measure density in rural areas.
Universities should try to convince their government that there actually is a faster way to measure the urbanisation by just concentrating in measuring the largest agglomerations and by using a dynamic threshold for urbanisation

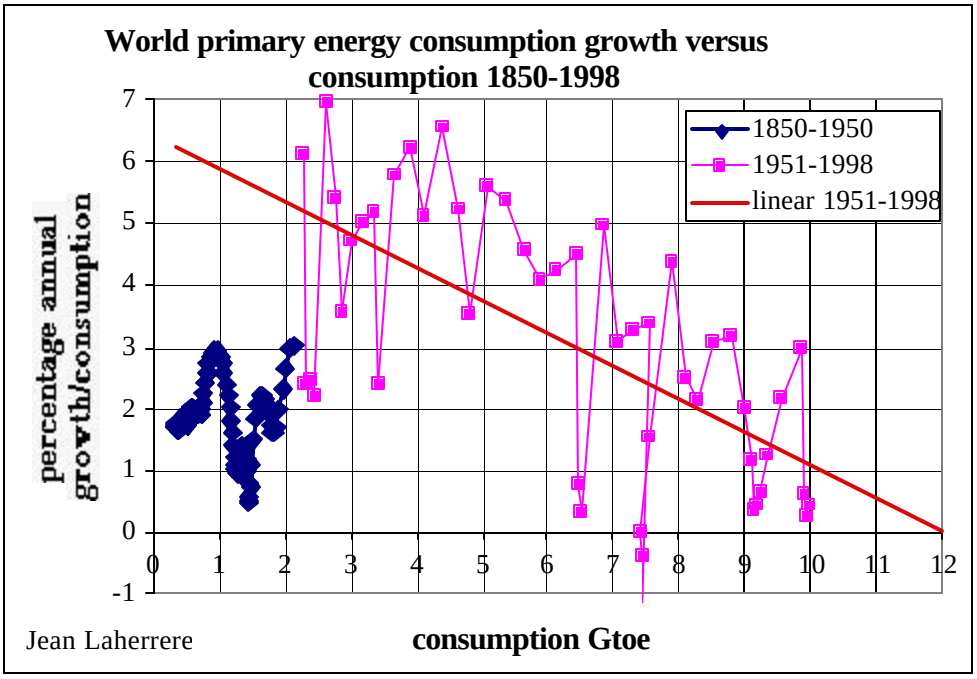
-2-Economy

-2-1-**energy consumption**

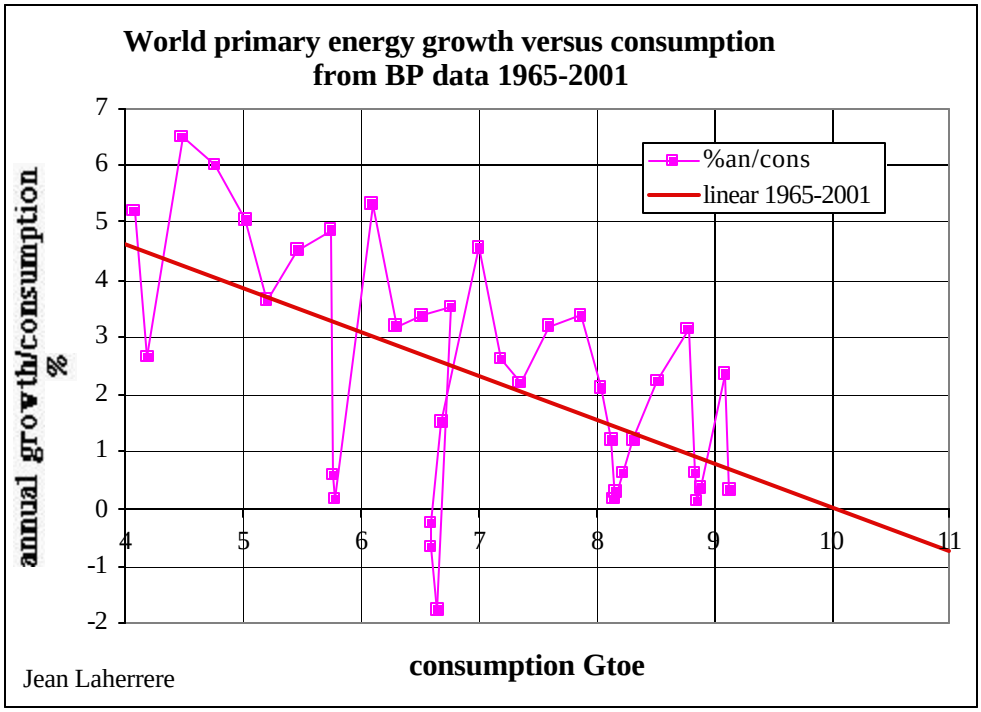
Despite the problem of energy conversion which depends upon convention mainly for electricity and which varies according to sources, the total primary energy consumption from 1850 to 1998 going from O0.3 Gtoe to 10 Gtoe in 1998, but only 9 Gtoe for some which do not include the non-commercial biomass.
Figure 35: World energy consumption



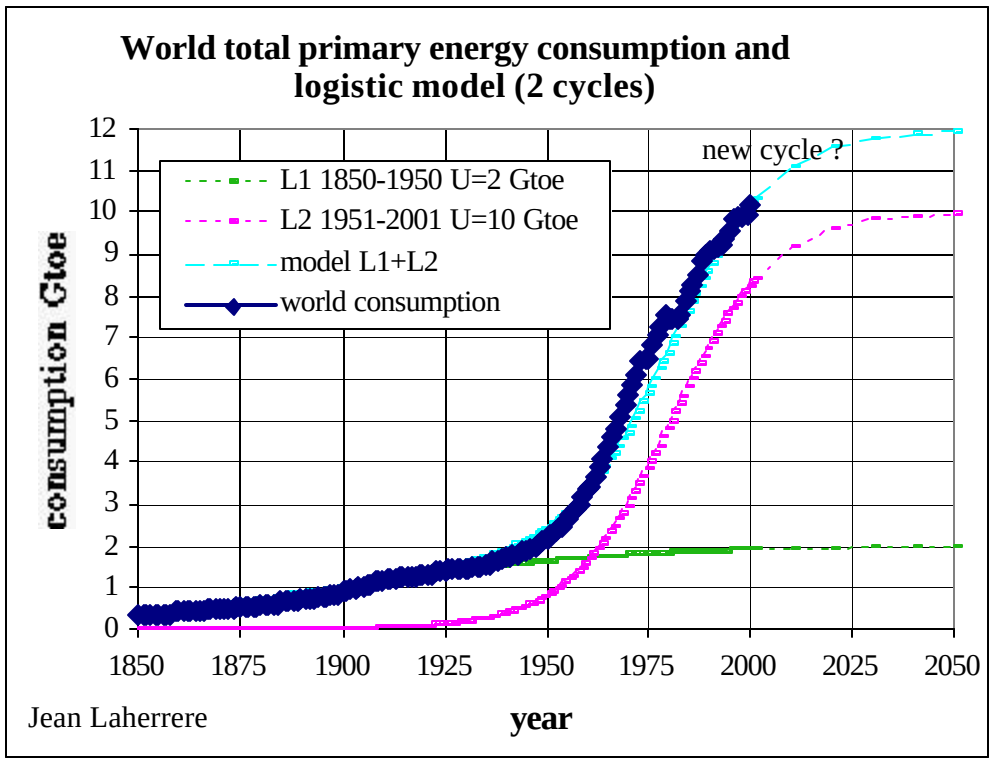
The world energy consumption (IFP source), when plotted as growth versus total, can be extrapolated linearly from 1951 to zero growth at an ultimate value of 12 Gtoe.
Figure 36: World energy growth versus consumption and linear trend giving a peak of 12 Gtoe



Using the BP Review data where non-commercial biomass is excluded (the 2001 energy consumption is 9.1 Gtoe) the linear trend gives a peak of 10 Gtoe
Figure 37: similar graph with BP data for 1965-2001

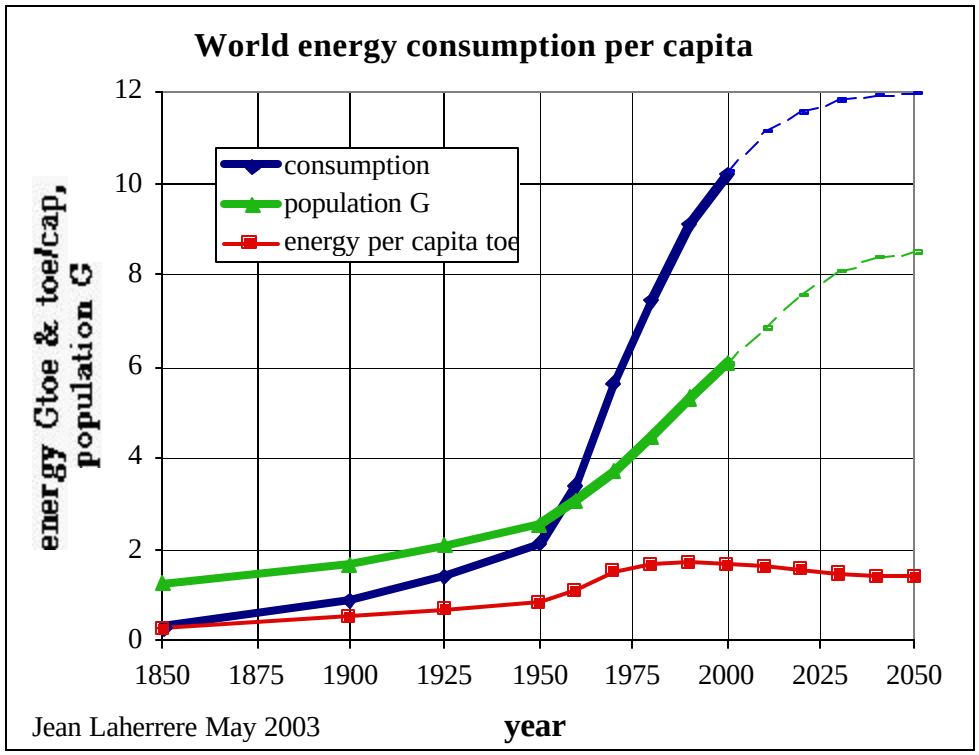


The logistic curve with an ultimate of 12 Gtoe is a very good fit of the past (IFP data) with two cycles the first at 2 Gtoe from 1850 to 1950 and the second one at 10 Gtoe starting in 1951. A future third cycle could occur. On the second cycle the part 1950-1979 started with a steeper slope but the oil shock dampened the consumption in 1979 as energy savings were figured out quickly with the belief that the oil price could go to 100 $/b. The large difference with the present high oil price is that the official long term forecast is around 20-22 $2003/b
Figure 38: World primary energy consumption with logistic model



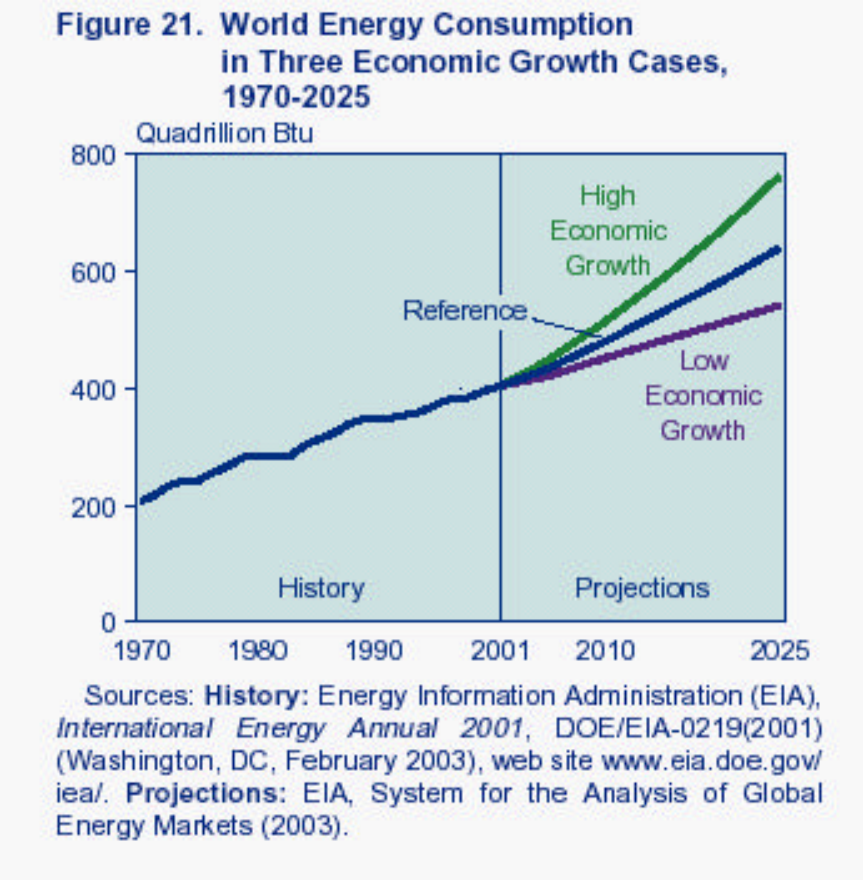
The previous forecast on energy and population allows to forecast the energy consumption, per capita on the next graph, peaking in 1990 at 1.7 toe and declining to 1.4 toe in 2050

Figure 39: Energy consumption per capita from 1850 to 2050



IEO 2003 gives 3 scenarios for the world energy consumption (in quads despite it is an obsolete and illegal unit) and the low economic growth looks more in line with the past than the reference case.

Figure 40: USDOE forecast on energy consumption



The WEC is presently studying the drivers for energy and JM Bourdaire will show you the results, but it is very interesting to see the large evolution of the main indicators in a few years.

"The drivers of the energy scene" Cairo 20-26 October 2002

Variable	1998 IIASA/WEC	2000 IIASA/IPCC	Extrapolation of the past
Population 2050	10,1	8,7	8 billion
Population 2100	11,7	7,1	<6 billion
GDP 2050/1990	3,7-5	4-9	2-3
GDP 2100/1990	10-15	11-25	3
Energy 20501990	1,6-2,8	2,3-4	<2
Energy 2100/1990	2,3-5	1,5-6,3	<2
CO2 2100	450-750	450-950	<550 ppm

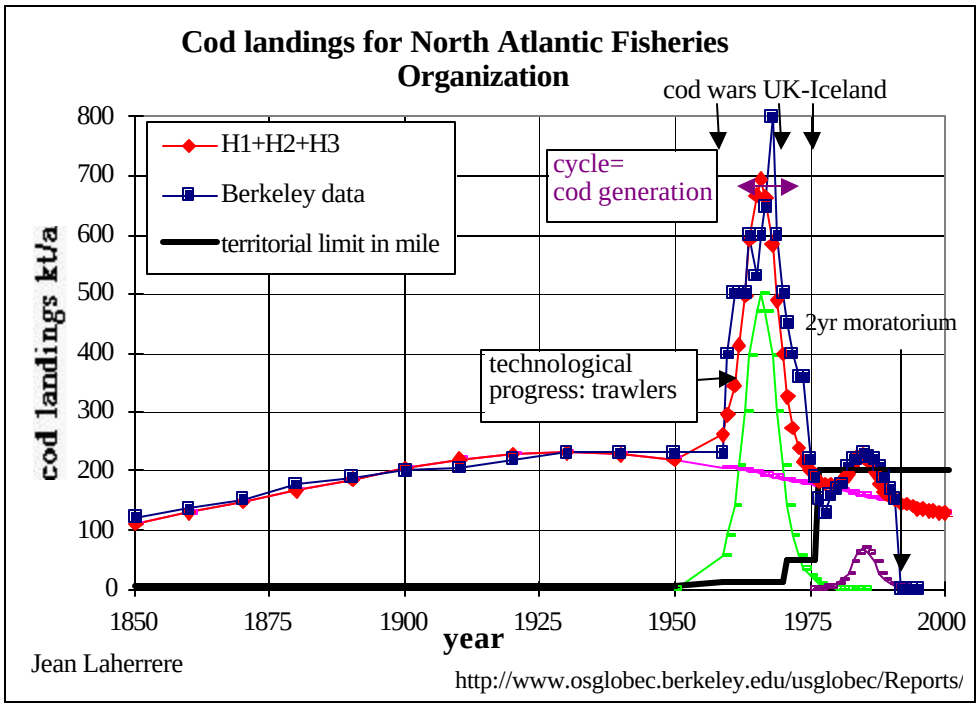
-2-2-Cycles

Some examples of historical series are displayed to show the importance of cycles.

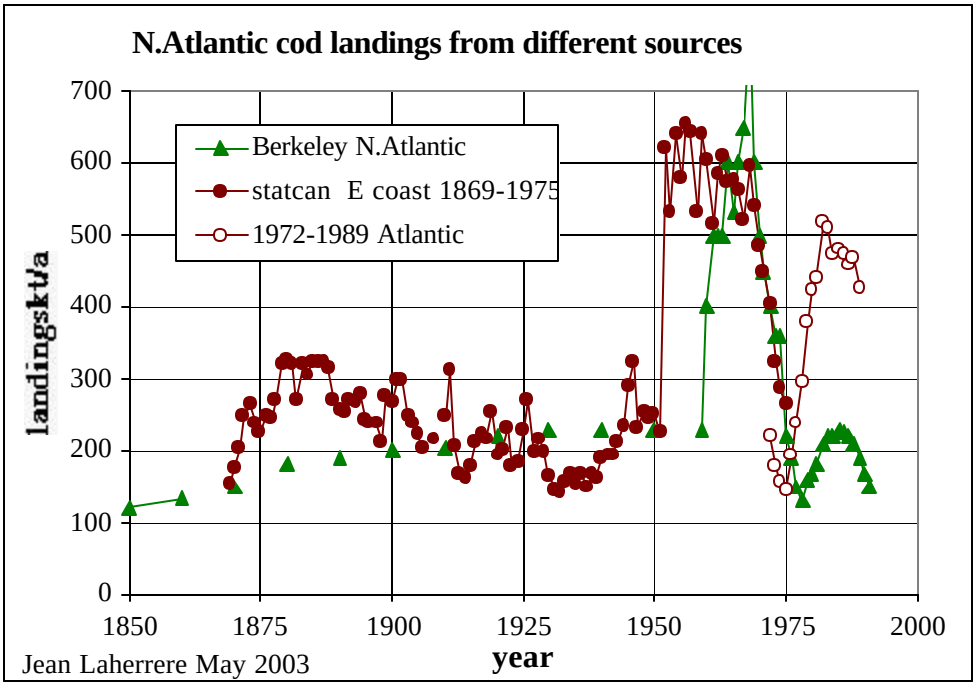
-2-2-1-**cod rise, fall and extinction**

Cod has been during centuries more important than oil, as being the main food for many people in the last 500 years (twice longer than the estimated life of oil). It brought fortunes,

bankruptcies, unemployment checks for tens of thousands people in Canada, domestic and international conflicts and wars. Atlantic cod has peaked, declined and last month the Canadian closed all fisheries in the east Coast after a moratorium decided in 1992.
In an 1999 article on what goes up must come down I have shown this graph based on Berkeley data. I added the 1992 moratorium, the cod wars between UK and Iceland (Kurlansky 1997) and the territorial limit in miles which went from 3 miles to 200 miles to protect the national fishing grounds
Figure 41: Cod landings for Northern Atlantic Fisheries Organization

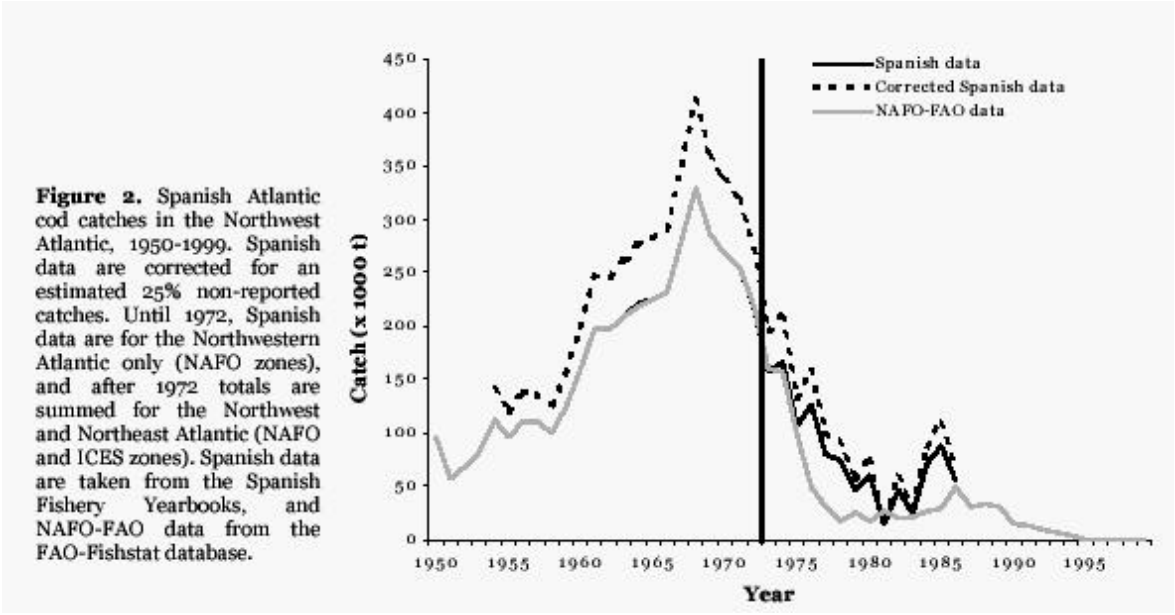


When I tried to update this 1999 graph I found that the Berkeley site http/www.osglobec.berkeley.edu/usglobec/Reports/ is not available anymore and the Canadian site statcan gives different values, as the last cycle in 1985 seems about two thirds higher than the end of the 60s peak.
Figure 42: North Atlantic cod landings from different sources



The data available on the web gives the catch from Spain (which almost went to war with Canada in 1993 for the turbot) that shows a last peak in 1985 closer to Berkeley values. It should be noted that Spain admits that the catch was underestimated and should be corrected by plus 25%

Figure 43: Spanish Atlantic cod catches



The catch of cod 1890-2000 in the US Gulf of Maine shows smaller values, since it is out of the cod rich zones, yet it shows more recent values with a collapse in 2000, but with a trough in the 60s instead of a peak in Canada

Figure 44: Gulf of Maine cod landings

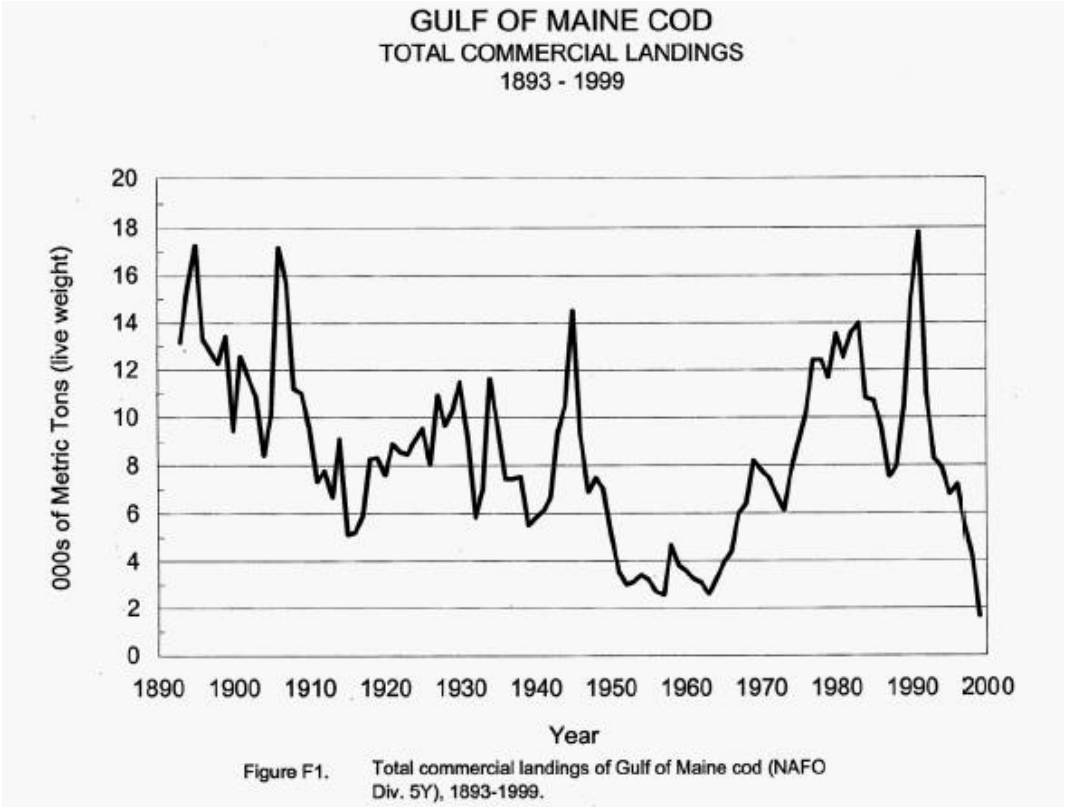
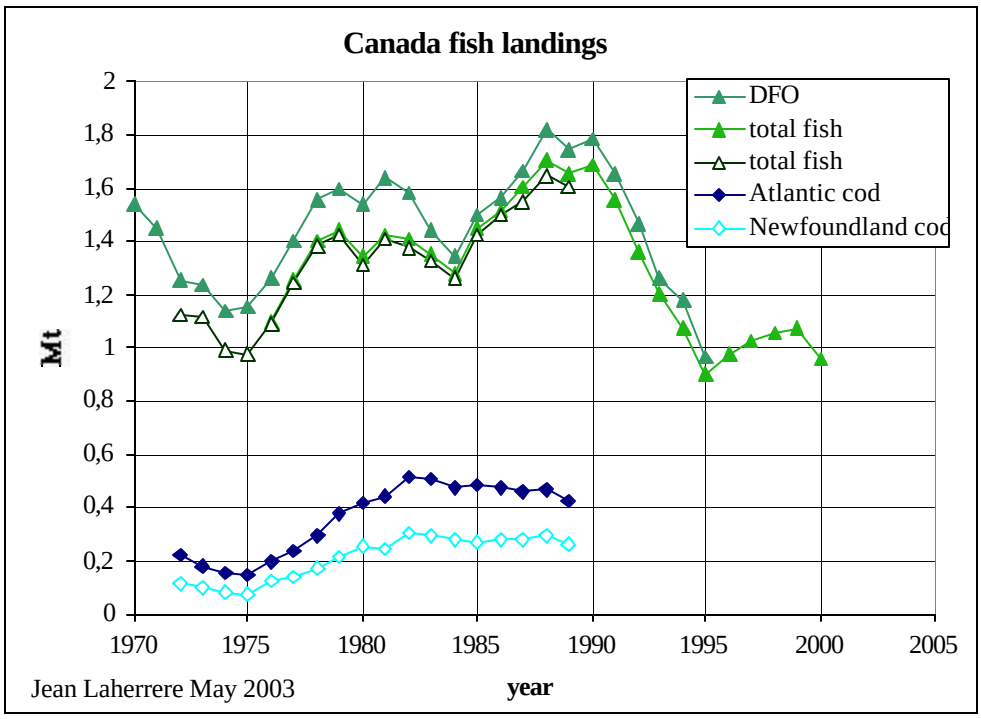


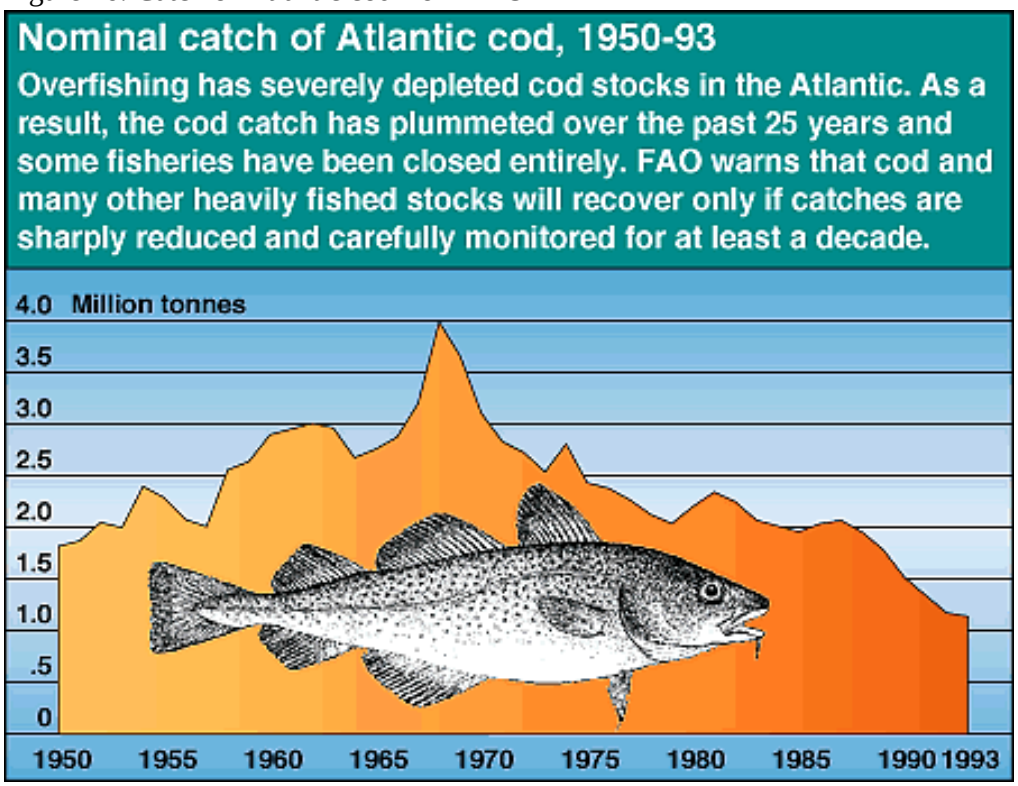
Figure F1. Total commercial landings of Gulf of Maine cod (NAFO Div. 5Y), 1893-1999.

The Canadian cod values stop in 1989, 3 years before the moratorium, but the total of fish landings shows a large collapse in 1995 due to the overfishing in high seas by foreign fleet, causing a diplomatic conflict in 1993 with the seizure of a Spanish boat.

Figure 45: Canada fish landings



The best illustration of the cod collapse is this graph from the FAO (unfortunately stopping in 1993) showing a peak of 4 Mt around 1968
Figure 46: Catch of Atlantic cod from FAO



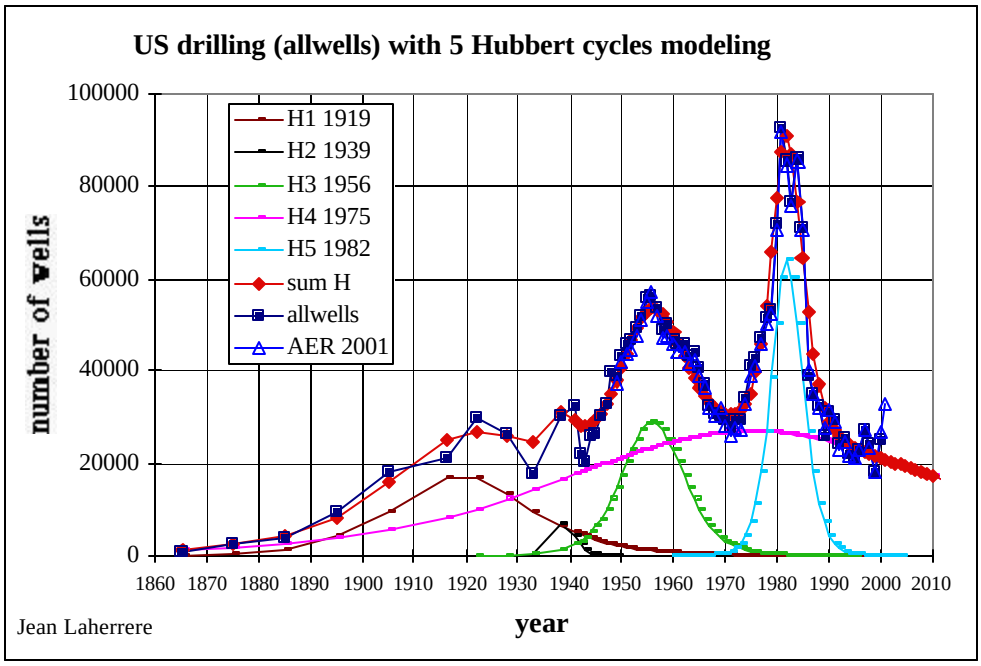
http://www.fao.org/News/FACTFILE/img/ff9603-e.gif

The Atlantic cod collapse is a drastic example (Harris 1999) of bad management with greed, selfishness, nationalism, short term politics, which refused to see the decline of resources, caring for the fishermen but not for the fish. It involved fights between optimists and pessimists inside Canada, hundred thousands of jobs, several cod wars (between UK and Iceland in 1960, 1971 1976), between Canada and Spain (1993) where warships were sent. The overfishing in the high seas by European factory-trawler float when constraints were imposed to Canadian fishermen was the cause of conflicts.
The accepted rule by all was to limit the catch at 20% of the resource, but the assessment of the resource (changing every year) was very unreliable. Canadian DFO (department of fisheries and oceans) scientists were (as presently USGS) too optimistic in their estimate with a belief of limitless resource. In fact several opinions were expressed among the DFO scientists, but DFO managers had always chosen the evaluation which would please the minister. The catch was in fact about 60% of the resource and trawlers (being a weapon of mass destruction) destroyed the spawning grounds and captured most of the cod food (caplin). At the end, Atlantic cod has disappeared. The 1992 moratorium in Canada for fishing cod in their territorial waters ended last month (April 2003) by the closure of fisheries for good.
The main responsibility weighted primarily on the scientists in their wrong estimate of resources and on the concept that the obvious decline will end one day with the return of the old days of plenty. Technology progress sharply increased depletion and led to complete destruction when not constrained by wise politics. Instead of imposing quotas, the use of trawlers that destroy the spawning grounds of cod should have been forbidden.

-2-2-2-**US drilling activity**

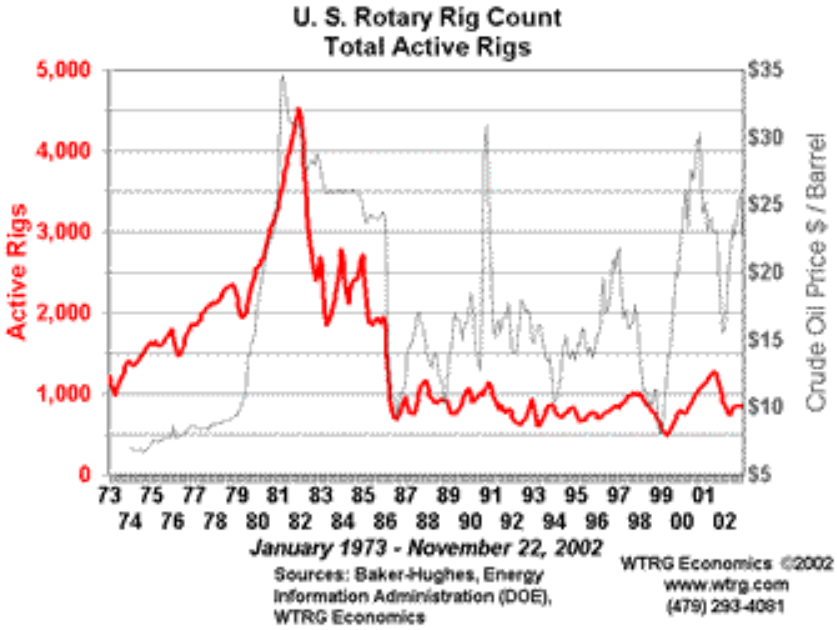
The US drilling activity when plotted from 1980 to 2000 can be obviously modelled by 5 cycles and the last recent evolutions are not important. It is interesting to notice that the present activity is right on the longest life cycle (half-life about 100 years) when the peak of activity in 1981 was on a half-life cycle of less than 10 years.

Figure 47: US total wells modelled with 5 cycles



The display of the number of US rigs shown below for US only for the last 25 years (quite more than most studies) gives a less obvious cycle despite its correlation with oil price The graph starts at 1973 as if first shock did not exist because before 1973 the price was low and the number of rigs high, contrary to what is supposed to be shown on the graph.

Figure 48: US rig count 1973-2002



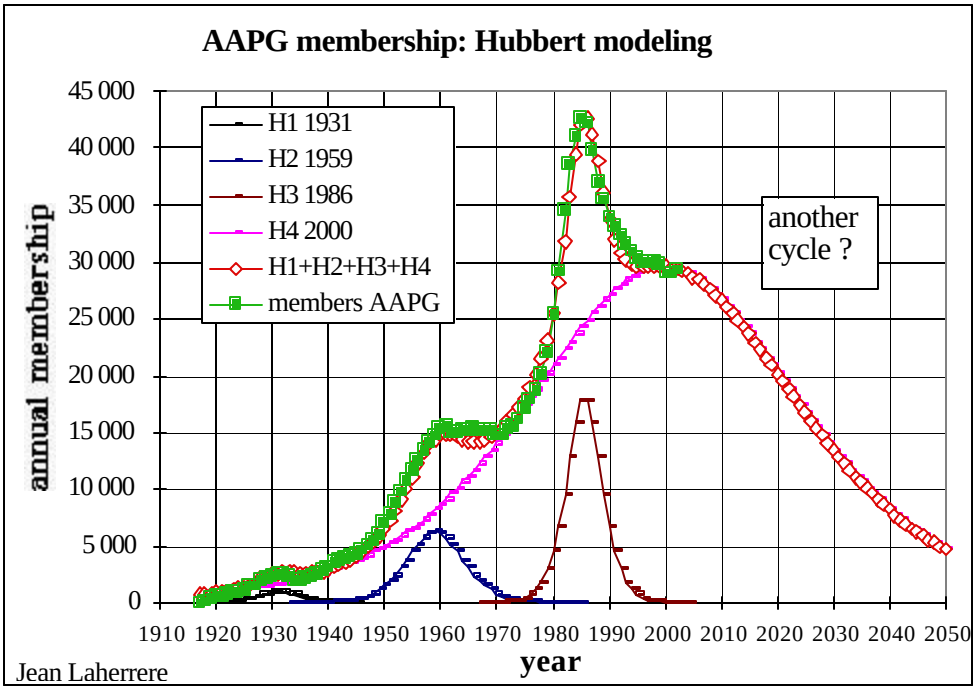
http://www.wtrg.com/rigs_graphs/world/small/Rigwld.gif

-2-2-3-Petroleum Geologists

AAPG (American Association of Petroleum Geologists) gathers a large majority of US and foreign oil geologists and varies with the size of the oil exploration. Oil exploration roughly follows the US drilling but no quite exactly. They follows both investment from the oil companies which depend upon profit, in fact the production and the oil price.

Since its beginning in the 1910s the membership can be modelled with 4 cycles and it seems that the main cycle is peaking now (like the oil production). Oil exploration follows the oil profits. The first cycle outside the main cycle peaked in 1930, stopped by the depression. The second cycle peaked in 1960 when exploration dropped, since oil discovery was too high at the time, and the main concern of oil companies was not to find but to sell oil. Activity peaked during what was called the crazy years as the oil price was so high that any exploration prospect was accepted even if mediocre. It is likely that we will not see any important new cycle.

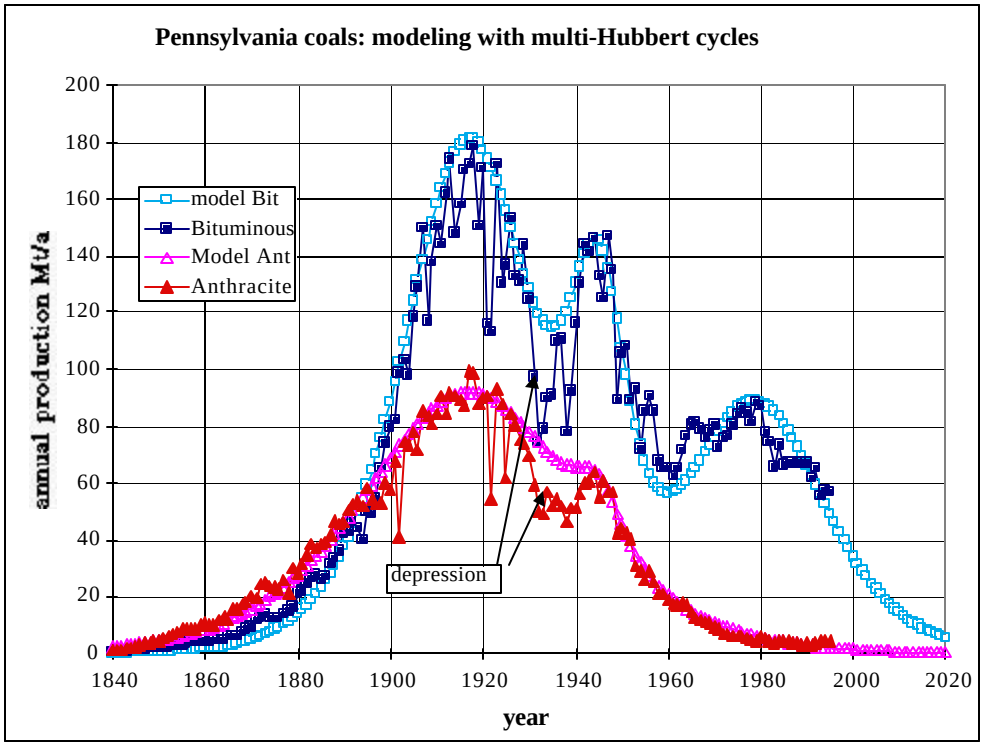
Figure 49: AAPG membership modelled with 4 cycles



-2-2-4-Pennsylvanian coal

Pennsylvanian coals (anthracite and bituminous) display amazing symmetrical cycles (because of random since there are a large number of independent producers) which can be easily modelled with Hubbert cycles except when drastic economic conditions disturbs the random behaviour of producers, as seen during the 1930 depression.

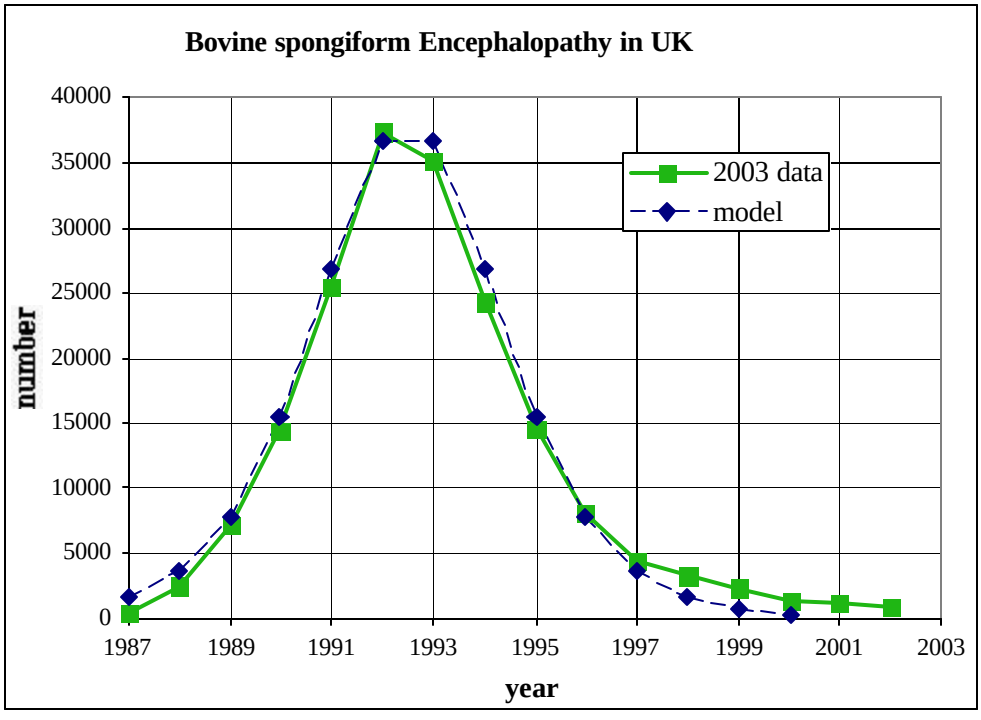
Figure 50: Pennsylvanian coals with 3 cycles



-2-2-5-**mad cow**

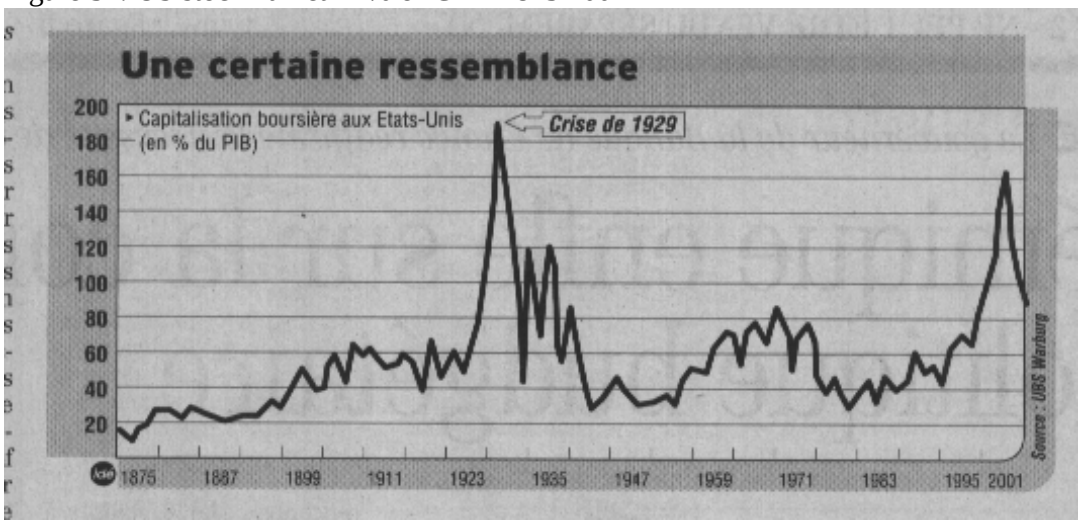
Mad cows in UK follow a symmetrical curve which is easily modelled with one Hubbert curve, hoping that it will end without a new cycle.

Figure 51: Bovine spongiform encephalopathy in UK



-2-2-6-**US stockmarket**

The US stockmarket in percentage of the GDP when displayed since 1870 shows several low cycles with two peaks one in 1930 with the depression and another a little lower in 2000.
Figure 52: US stockmarket in % of GDP 1875-2001



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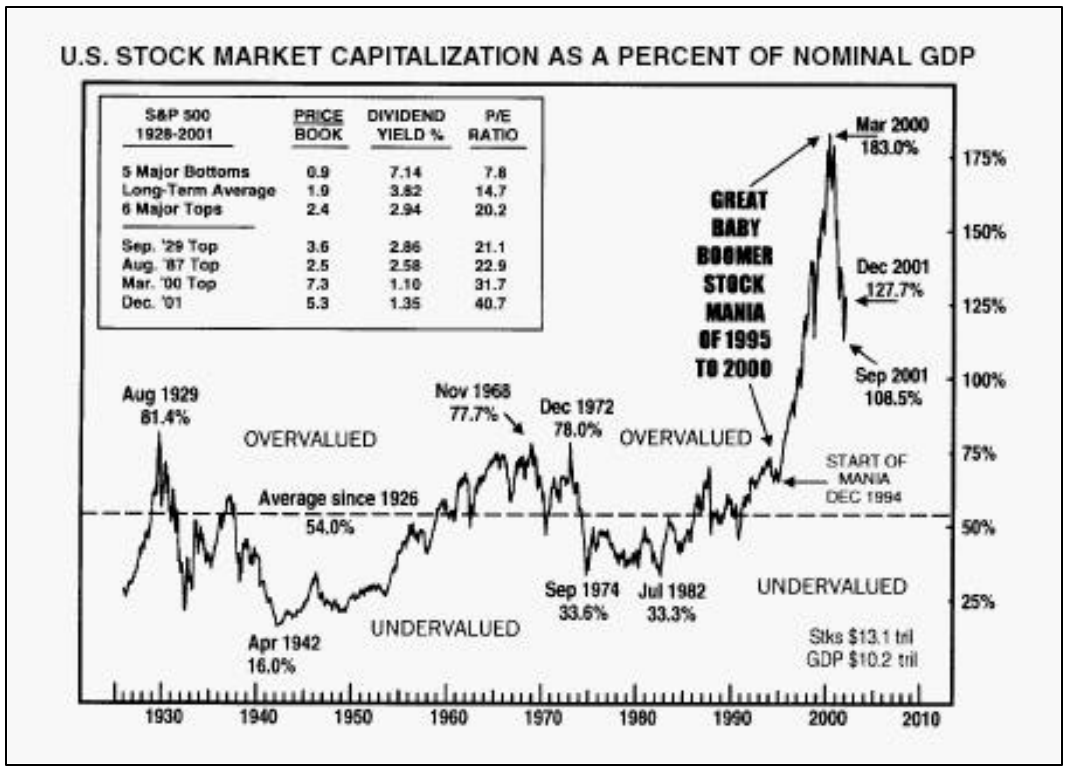
In the previous graph the peak-depression of 1930 is higher than in 2000 which looks similar, but in the next graph 1930 seems small

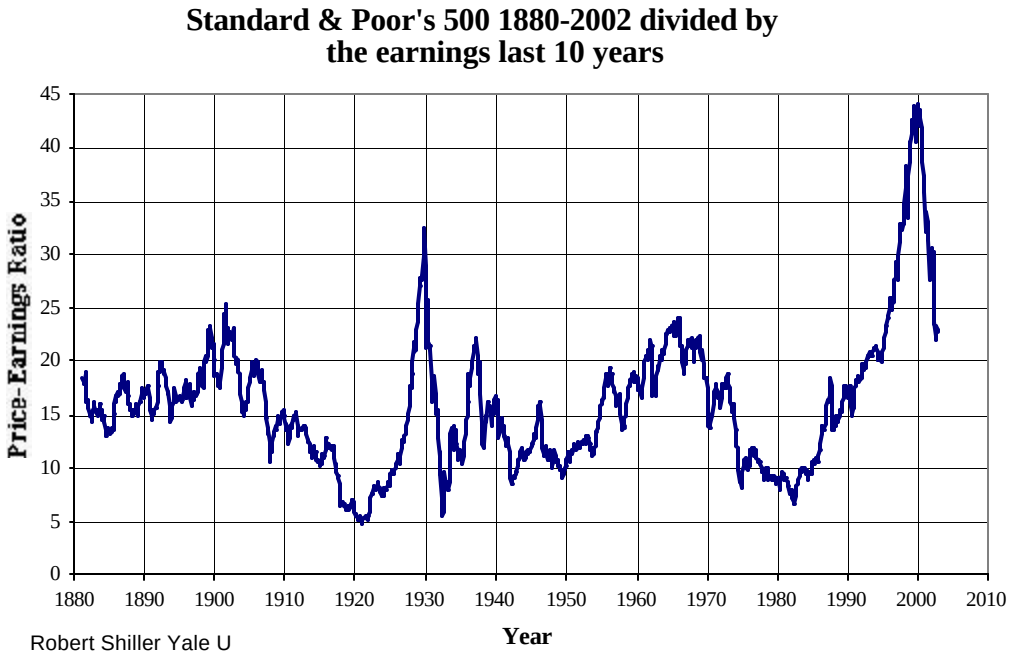
Figure 53: US stockmarket in % of GDP 1920-2001 from another source



But a similar graph of the stockmarket versus earnings 2000 looks worse than 1930

Robert Shiller (Yale University) gives on his site the series of Standard & Poor's divided by the last 10 years earnings from 1880 to 2002. Again the same long and low cycles and two narrow and sharp cycles; but here the 2000 peak is higher than the 1930, (as GDP is inflated), meaning that the stockmarket is unlikely to go up again on a long term basis to stay in the past average of 15 to 20 times the earnings. The US stockmarket future is not bright at all!

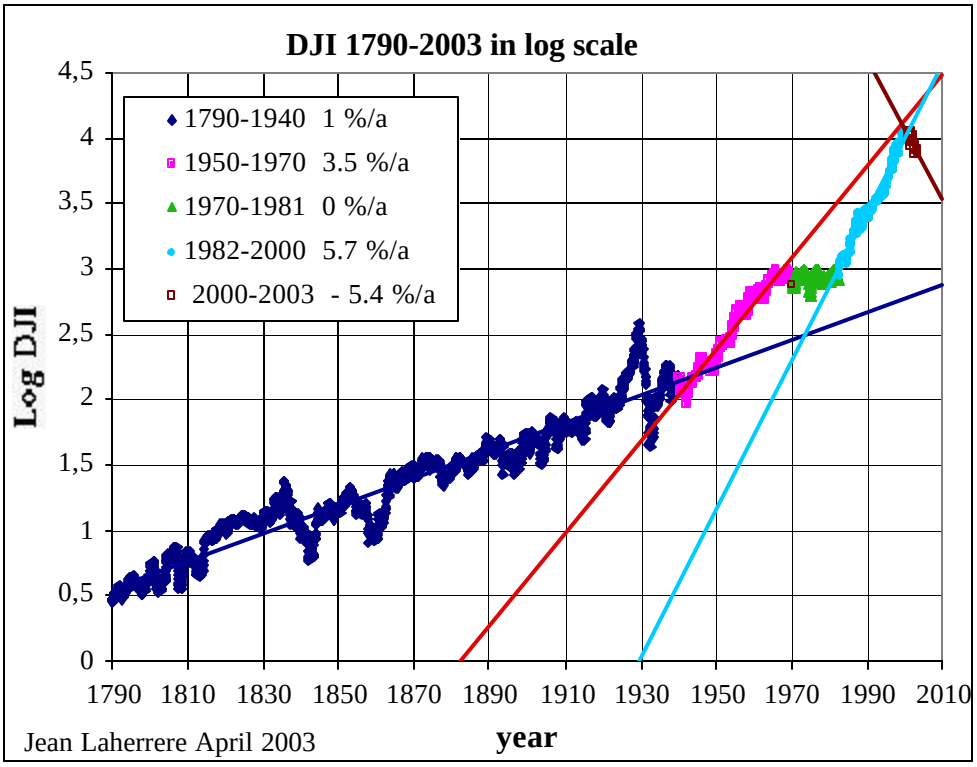
Figure 54: Standard & Poor's 500 1880-2002 divided by the earnings last 10 years



http://www.econ.yale.edu/~shiller/data/ie_data_xls.zip

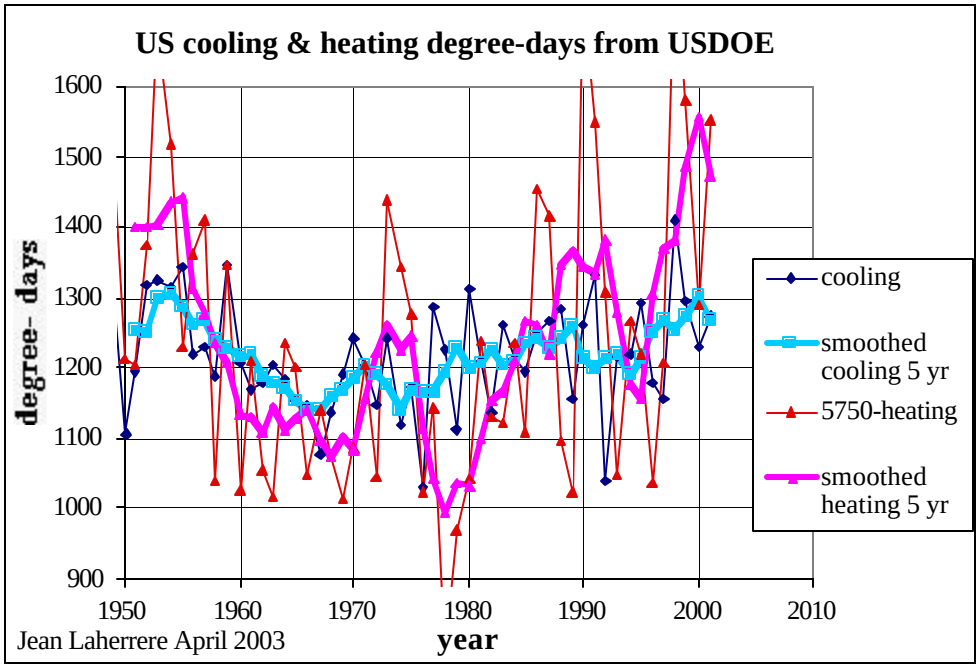
The Dow Jones Industrial is plotted from 1790 in a log scale giving the successive growth rate: 1%/a from 1790 to 1940, 3.5 % from 1940 to 1970 (called in France "les 30 glorieuses"), none in the 70s, 5.7 % from 1980 to 2000 and finally minus 5.4 % from 2000 to 2003

Figure 55: Dow Jones Industrials 1790-2003 in log scale

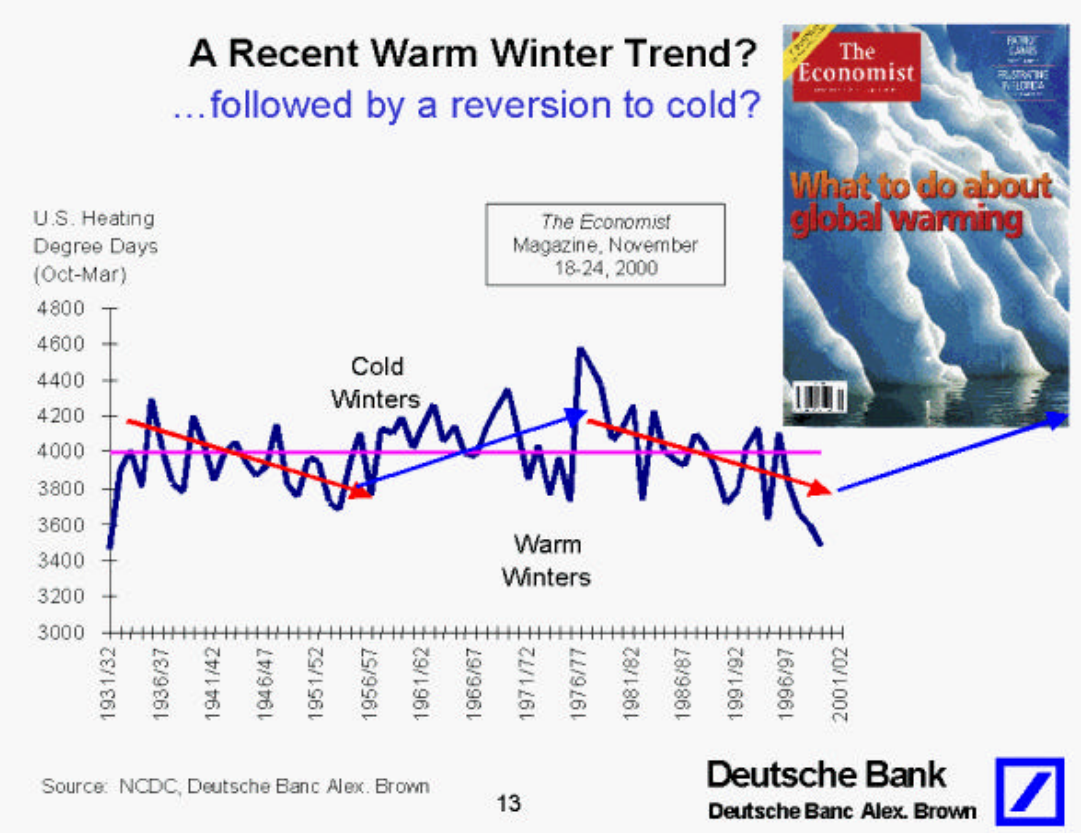


-2-2-7-**global warming**

There is a lot of worry about global warming despite that the last 10 000 years represents an interglacial within a glaciation period which stated 2 million years. 95 % of the earth time were warmer than now and we are heading towards a new glaciation in a few thousands years.
Temperature vary with location and also with urbanisation of the measure location. In the US there are precise measure of the cooling and heating days all around the country since 1930. These 1950-2001 curves (previous data is not available on the web) show a cyclic (sun cycle of around 22 years ?) down and up for the cooling degree-days where 2000 is at the same level as 1954 and the negative heating degree-days shows 2000 a little higher than 1954
Figure 56: US cooling degree-days and negative heating-degree days 1950-2000



The following graph (the Economist, 2000) shows the cycles since 1930 and forecast a new decreasing cycle soon.
Figure 57: Heating degree-days from the Economist



-2-3-US empire

-2-3-1-US = King

The ranking by energy consumption per capita is as follows:

WEC (World Energy Council) 2000 reports primary energy consumption for year 2000

Area	Consump. Gtoe	Population G	Cons./capita toe
North America	2,5	0,31	8,1
Japan/Australia/New Zealand	0,7	0,15	4,7
West Europe	1,8	0,52	3,5
FSU	1,1	0,35	3,4
Middle East	0,4	0,17	2,4
Latin America	0,6	0,52	1,2
China	1,1	1,26	1
Other Asia	0,8	0,96	0,8
Africa	0,5	0,79	0,6
India	0,5	1	0,5
World	**10**	**6**	**1,7**

North Americans (US & Canada) consumes twice as much as the rest of the industrial countries. India is less than Africa which is often considered being in the worst situation.

As shown in natural distribution, sometimes the first rank is well above the rest of the crowd and was called "King" (Laherrere 1995). In the world economy the US is a King

-US percentage of the world in 2000:

population 283/6000 Mhab	5%
oil production 8,1/75,1 Mb/d	11%
energy consumption 2,3/9,1 Gtoe/a	25 %

oil consumption 19,7/76 Mb/d	26%
immigration	30 %-
cars	40 %
military expenditures	50 %
dollar in world trade	60 %
lawyers	70 %
energy consumption per capita 7,9/1,7 toe	460 %

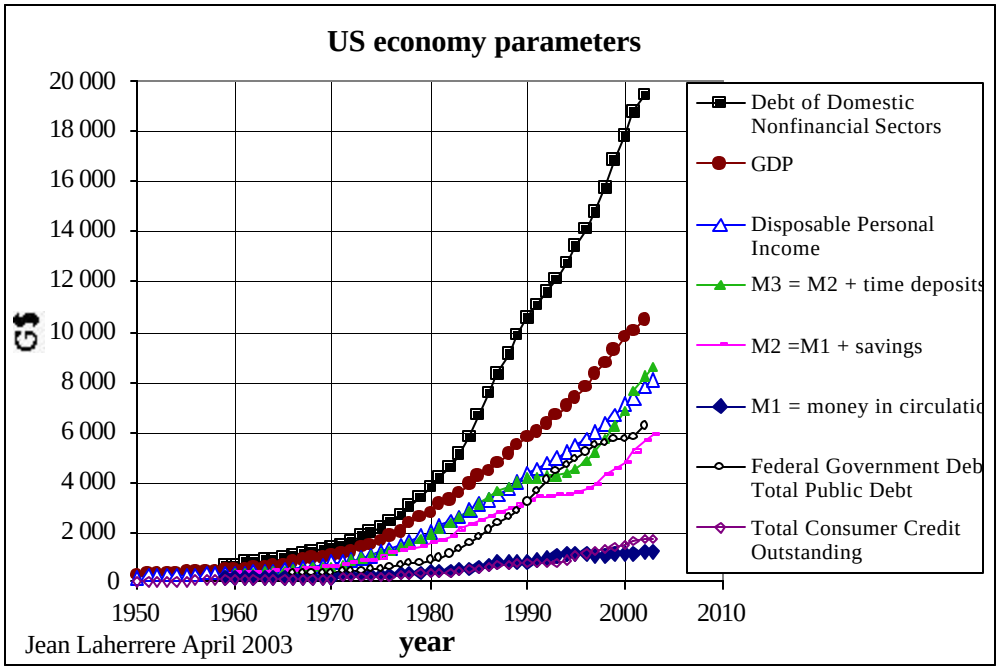
-2-3-2-**end of the US empire**

If the US largely occupies the first rank of consumption and wealth, its rise will peak one day as everybody knows that what goes up must come down (Laherrere 1999).

Since the US is the best place to gather data easily on the web (from federal agencies or Universities), contrary to many countries where the citizens can only buy the printed data, the American economy can be studied in detail. Furthermore the US leads the world being the King but also conducts an imperialist action, believing that what is good for the US is good for everyone. But numerous graphs show that the US empire will decline soon (Todd 2003)

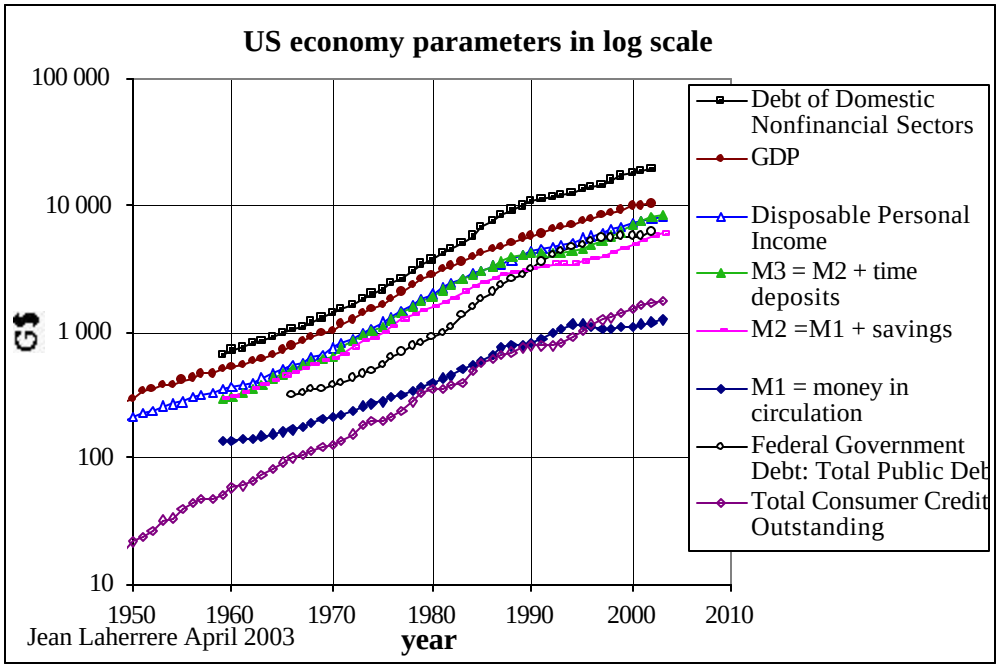
The main factor is that the US consumer borrows everyday more than 1 G$ to the rest of the world (more than the US military expenditures) and the debt of the domestic non financial sectors is about 20 T$ when the GDP is about 10 T$, and the disposable personal income is about 8 T$. The money stock M1 (about 1 T$ is in circulation), when the M3, money stock in circulation + savings + time deposits is about 8 T$ (as the disposable personal income.

Figure 58: US economy factors



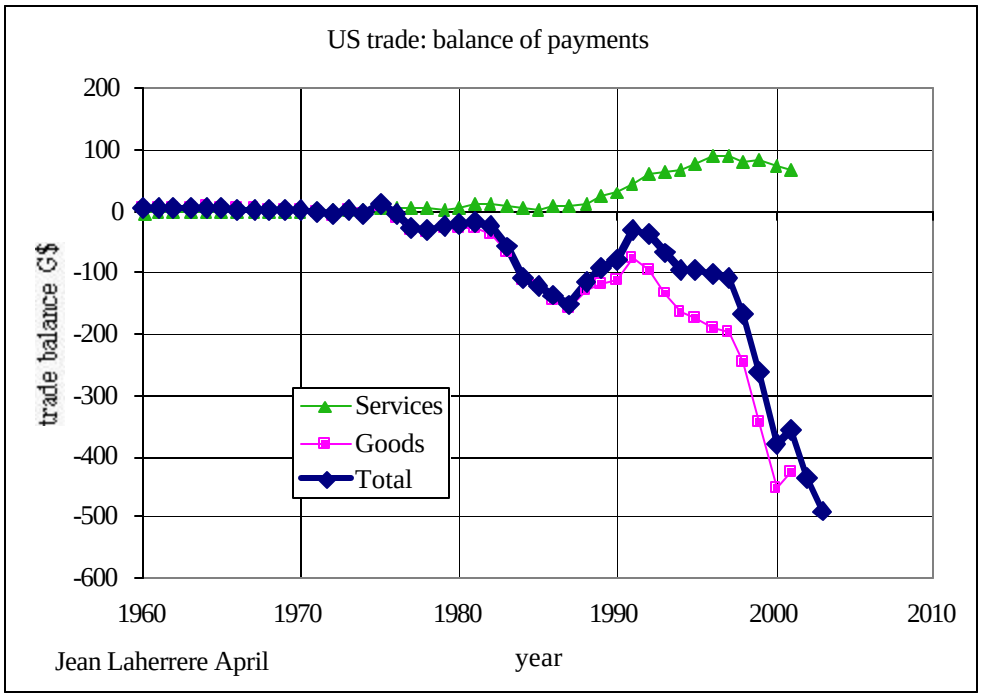
The same graph in log scale shows better the rate of growth where the federal government debt is increasing the most as well as the consumer credit outstanding.

Figure 59: US economy factors in log scale



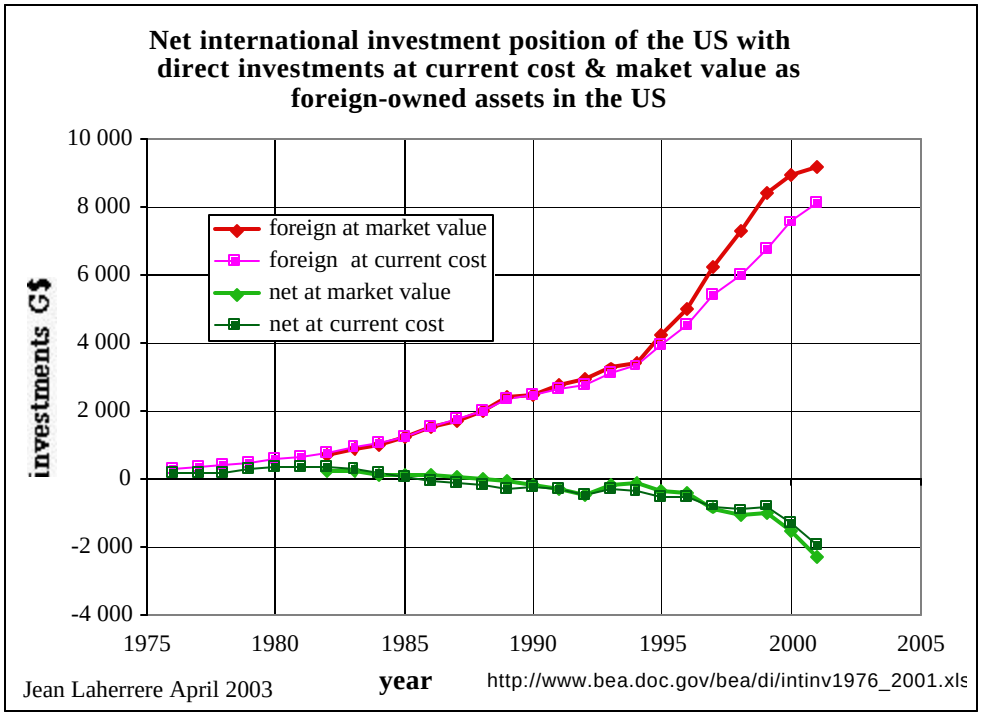
The sharp fall in the trade balance of payments (-500 G$ in 2003) started in 1991, with a frenzy wish to consume driven by the stockmarket bubble. If the consumer craziness has not declined with the stock-market as it was relayed by a new housing bubble (due to low interest rate). Every one knows that a family cannot spend more than it earns, it is true also for a country on the long term.

Figure 60: US trade: balance of payments



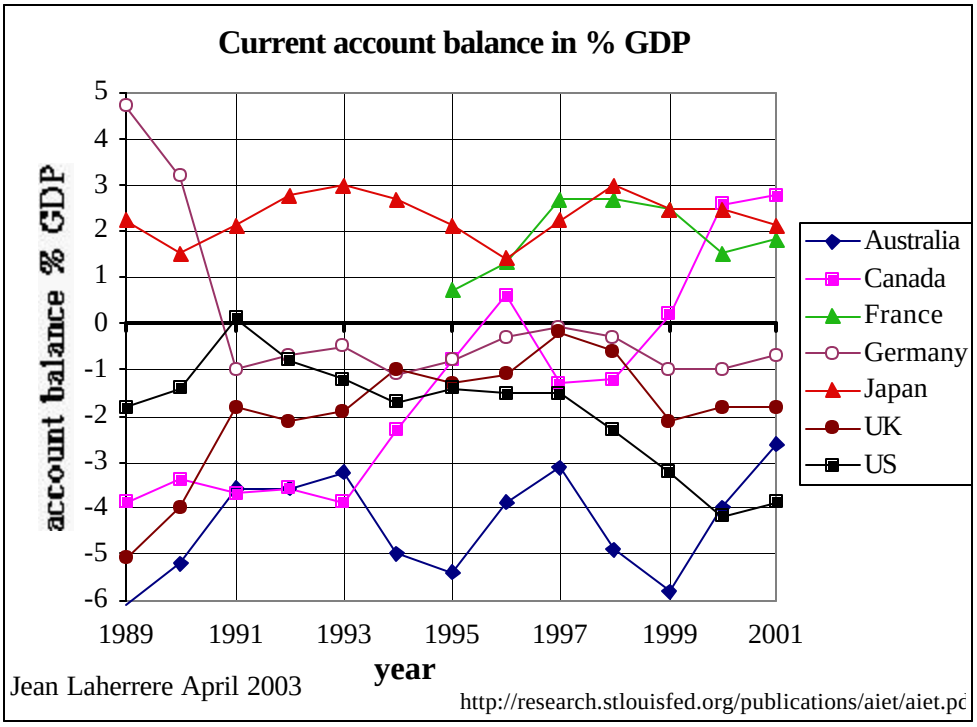
The main reason which makes this negative trade balance was that the foreign investment in the US is large about 8 to 9 T$ (current cost or market value as shown in the next graph.

Figure 61: Net international investments of the US



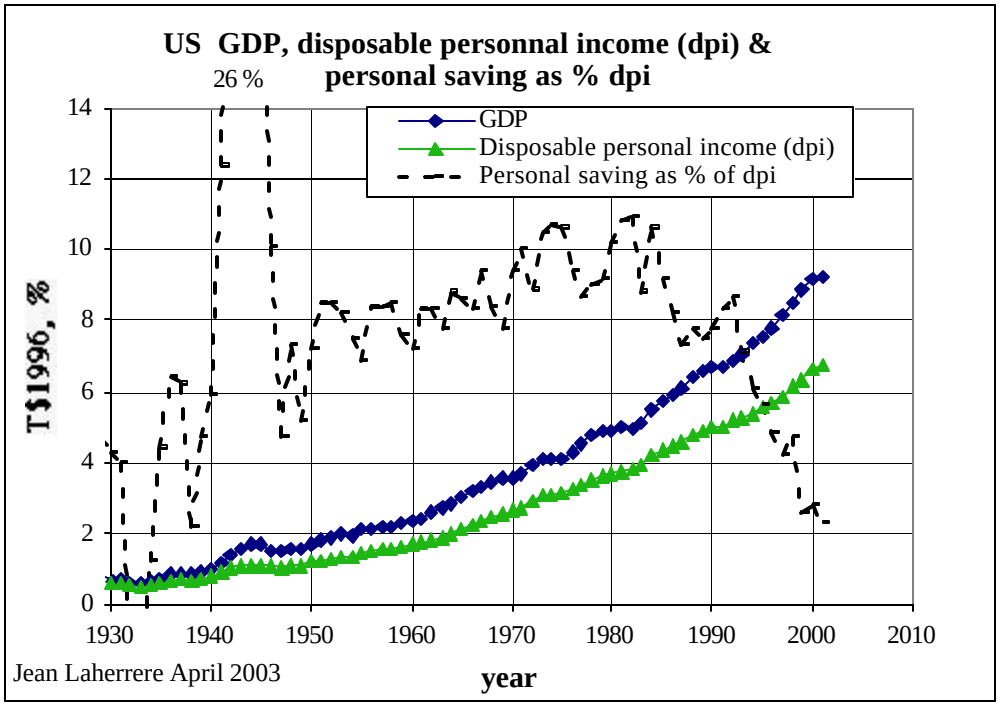
The current account balance in percentage of the GDP, from 1989 to 2001, for several countries shows that Japan is above the crowd , Australia below the crowd, Canada is improving drastically, UK up and down and US worsening.

Figure 62: Current account balance in % GDP for some countries



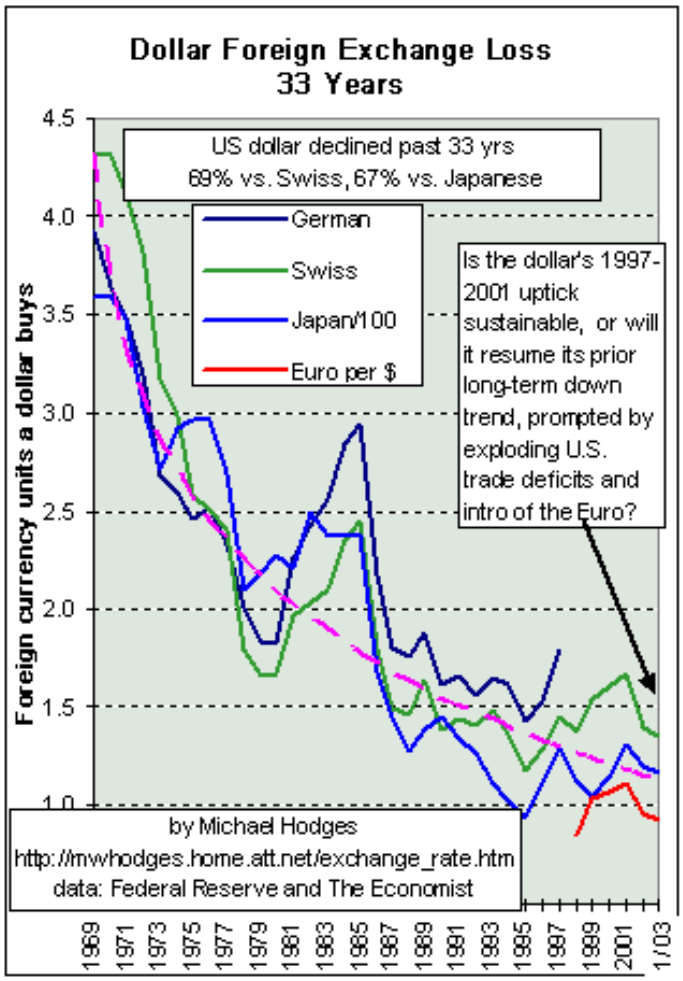
US consumer was saving money as a percentage of the disposable income going from 4% in the 30s to 10% at the beginning of the 80S, but savings dropped in a cliff since 1985 to be about 2 in 2000.

Figure 63: US GDP, disposable personal income and personal saving as % dpi



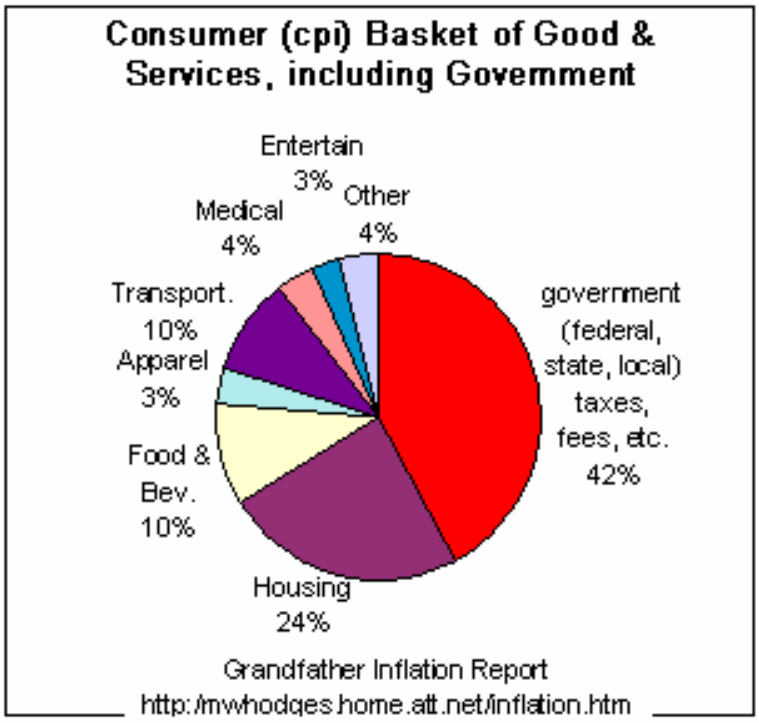
The US can borrow money since they can issue dollar and the dollar controls 60 % of the world trade, but the dollar has been falling down compared to other currency for the last 33 years as shown in the next graph provided by the site of Michael Hodges who displays in Grandfather economy (http://mwhodges.home.att.net/) many interesting graphs and comments on the US economy (and also on energy).

Figure 64: dollar foreign exchange loss 33 years

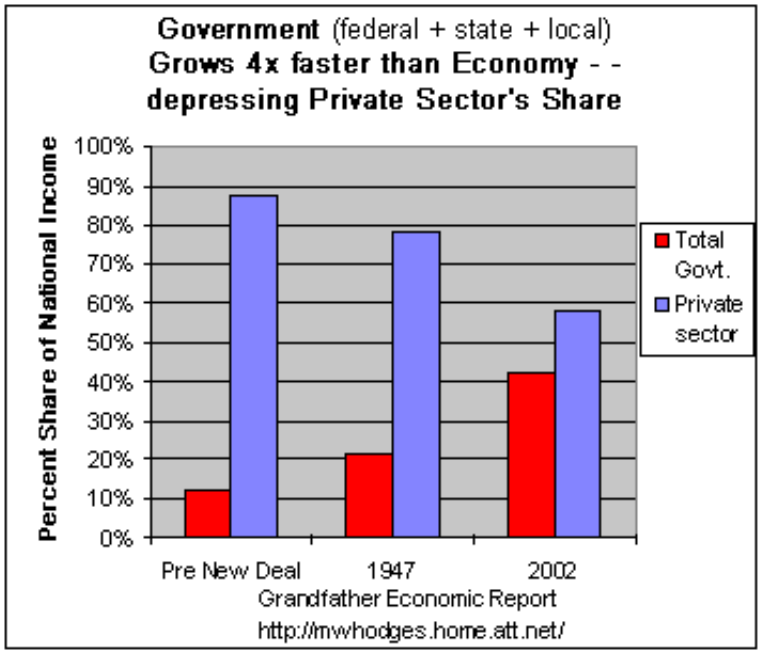


The US consumer basket is 42% for taxes, 24 % for housing, 10 % for food; 10 % for transport and only 3 % for entertainment.

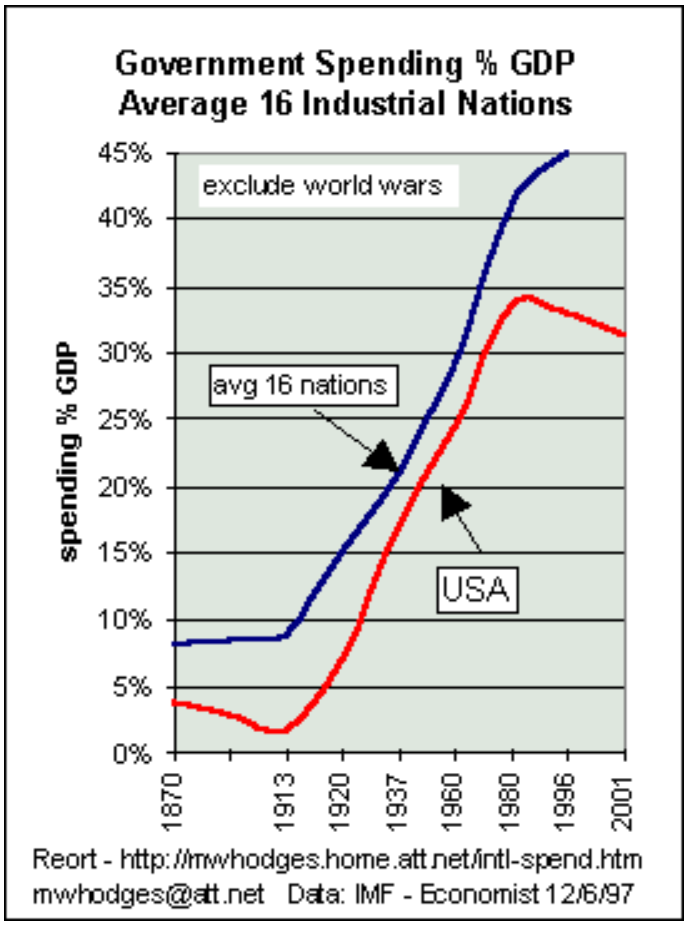
Figure 65: US consumer basket of goods and services including government



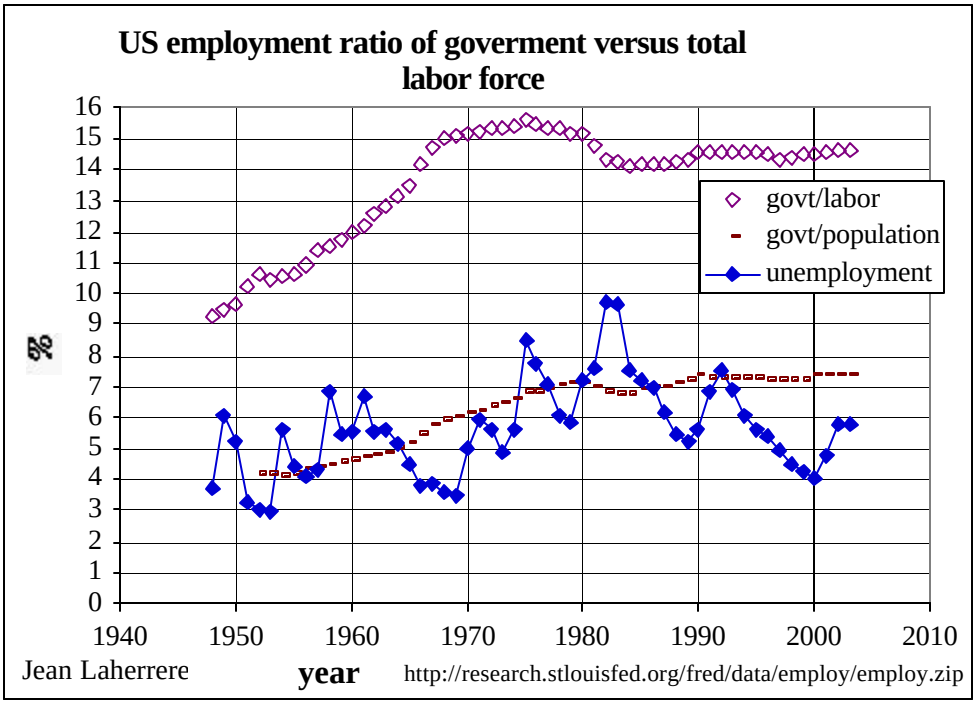
The government grows 4 times faster than the economy.
Figure 66: Government & private share evolution



However the US government spending in percentage of the GDP has grown about the same as other countries and is a little below.
Figure 67: Government spending % GDP for US and 16 industrial nations

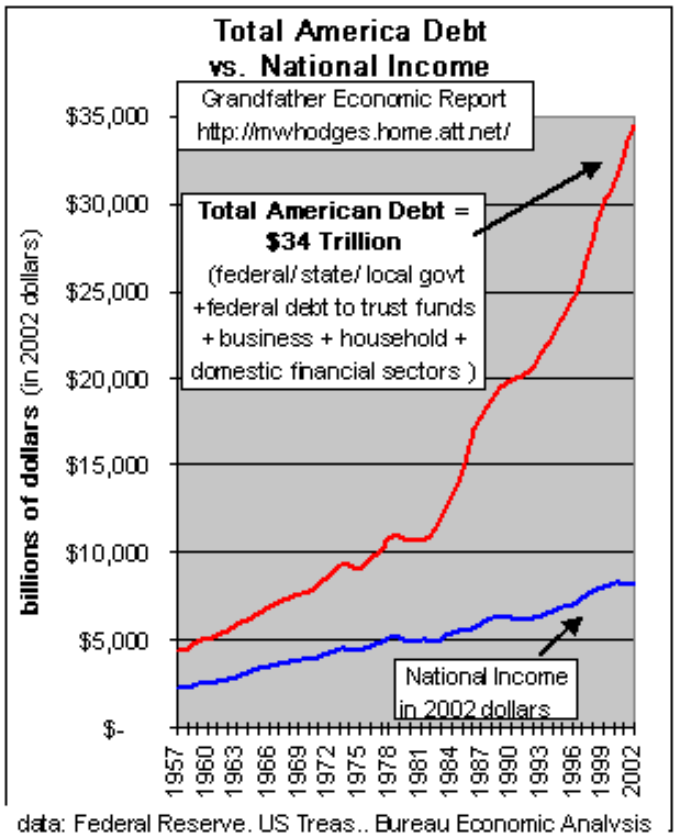


The percentage of the government in the labour force increased from 9% in 1950 to over 15 % in 1970 and has stayed between 14 and 15 % since 1980
Figure 68: US employment: ratio government vs total labour force



But the total US debt is about 35 T$ compared to 8 T$ of national income. The acceleration of the debt started around 1982.

Figure 69: US total debt & national income

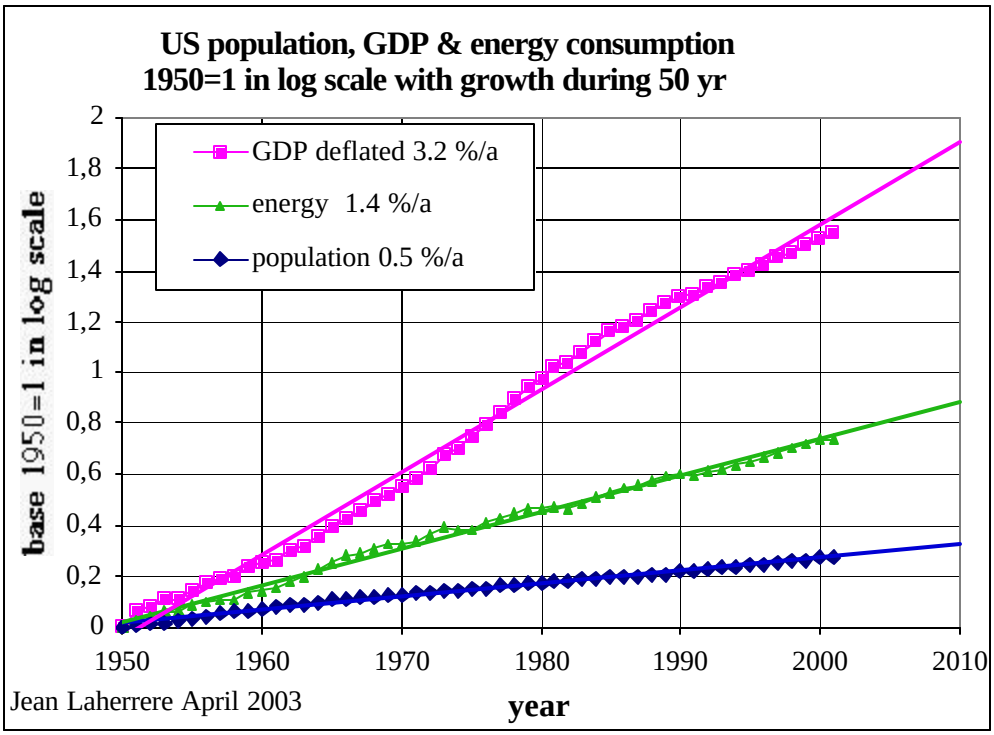


-2-3-3--US growth

The US growth for the last 50 years was about 3.2 %/a for GDP, 1.4 % for energy consumption and 0.5 %/a for population? Everybody claims that it is marvellous to see that the energy intensity (energy consumption per GDP) decreases, meaning that energy is not important anymore. But we will see below that GDP is flawed (in US and China) and the present world needs energy more than money to live. Russia lived after the FSU break-up mainly from barter trade and GDP declined sharply.

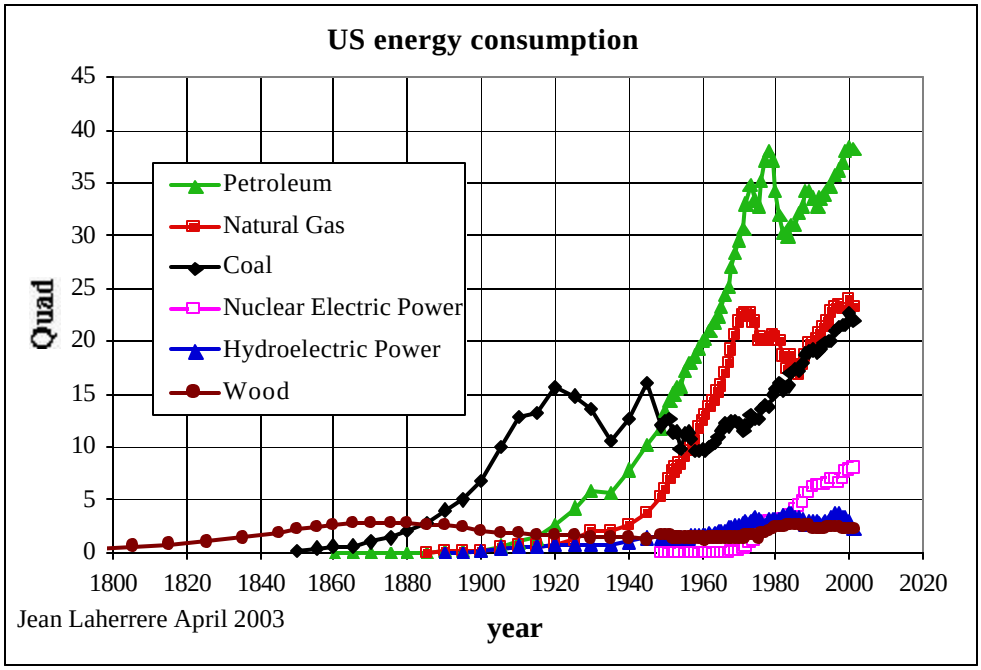
But this constant growth is unsustainable and the growth must decline one day.

Figure 70: US population, GDP & energy consumption 1950=1 in log scale



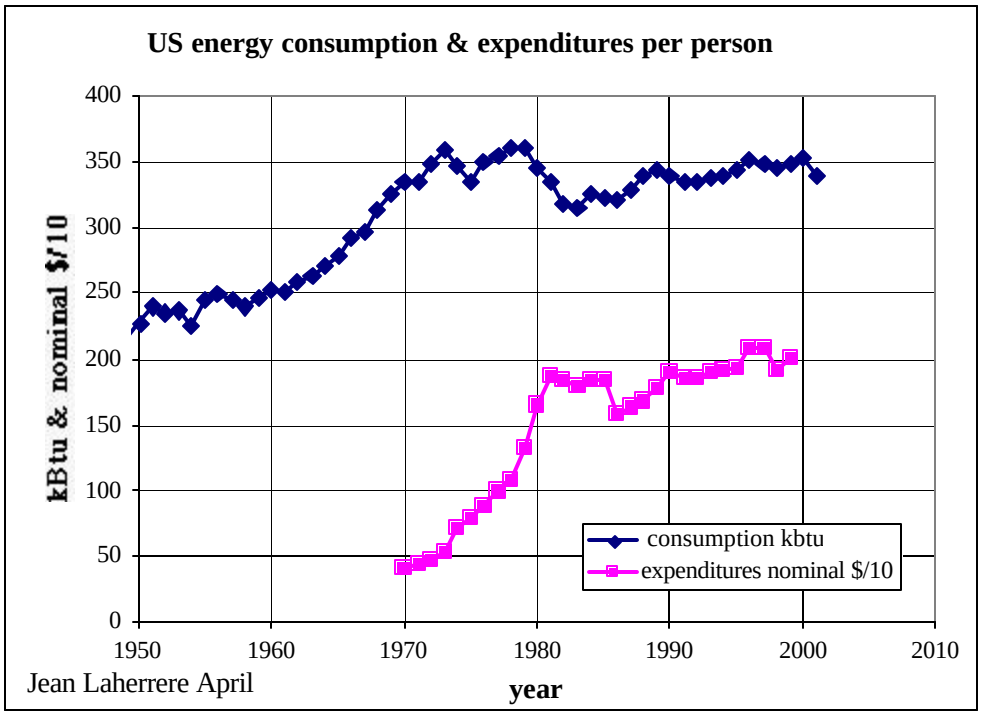
But the US energy consumption converted in quad ($10^{E}15$ Btu or 1.05 EJ) (unit obsolete and unlawful as US federal agencies must use the SI) is the aggregation of several sources (using conversion equivalents which vary according to the country) with different trends. The US consumption from 1800 to 2000 is the addition of different cycles: wood peaking in 1870 (2.9 quads) and 1983 (2.6 quads), coal peaking in 1920 (15 quads), 1945 (16) and a larger peak in the future, natural gas peaking in 1972 (22.7) and 2000 (24) and oil peaking in 1978 (38).

Figure 71: US energy consumption



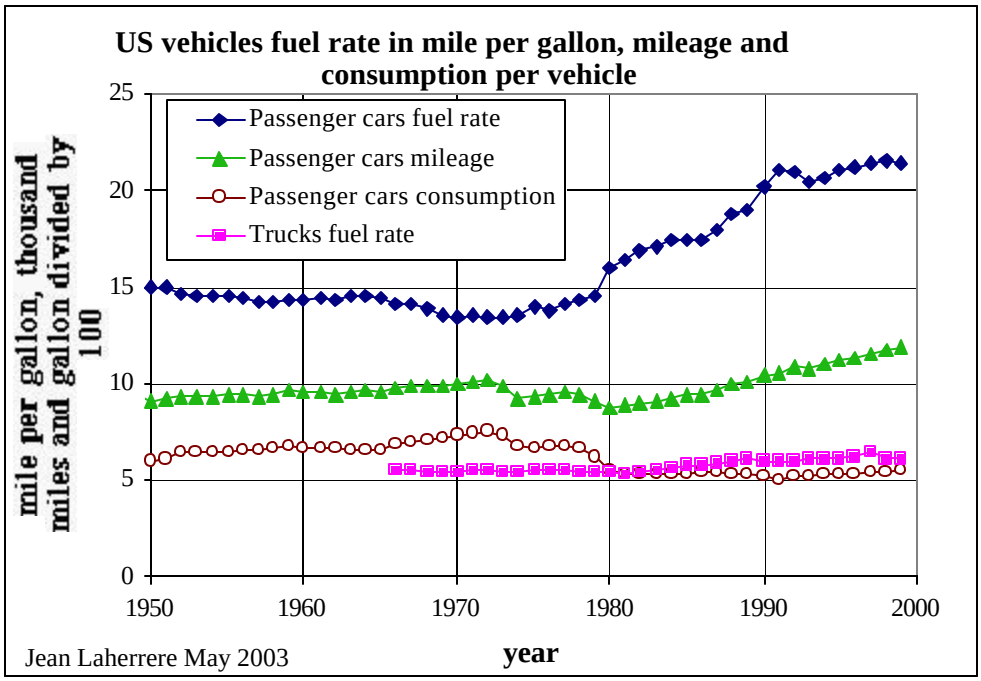
The US energy consumption and expenditures per capita shows a sharp increase in the 60s for energy followed by flat level at 350 kBtu and in the 70s for expenditures followed by a flat level at 2000 $, explaining that the US consumer is not used to save energy, neither to spend more on energy.

Figure 72: US energy consumption & expenditures per person

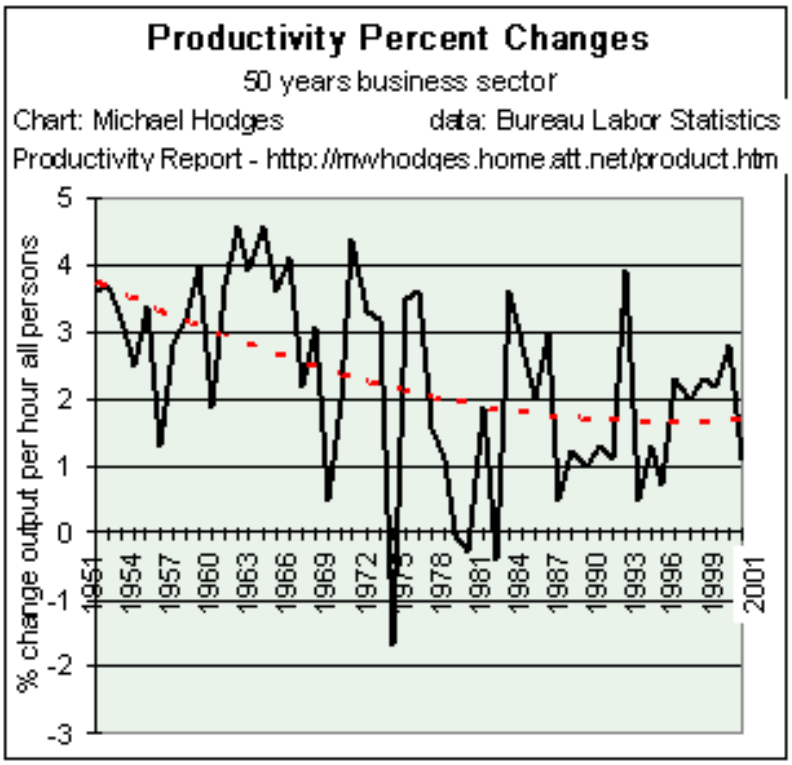


The US vehicle consumption is a good example of the impact of oil price; the fuel rate for passenger cars was 15 mile per gallon in 1950 and going down to 13 in 1973, with the oil shock cars becoming more efficient and the rate went up to 21 mile per gallon in 1991 and stayed flat, but following the Jevons paradox the US driver with a more efficient car drives more and the mileage increased from 8 800 miles in 1980 to 12 000 miles in 1999. The

consumption of passenger cars went from 600 gallons per car in 1950 to 750 gallons in 1973 and down to 550 gallons from 1980 to now. But it is amazing to see that the efficiency of trucks did not change significantly (6 miles per gallon) since 1950 despite all oil price, as the price increase is passed to the transported products.
There is no hope of improvement in fuel savings outside a drastic oil shock.
Figure 73: US vehicles fuel rate, mileage and consumption per vehicle



-2-3-4-**US productivity**
The attraction for the US (and the dollar) is often explained by the high productivity of the country.
The next graph giving the change in productivity for business sector from 1950 shows a decline steeply down up to 1979 and slowly after
Figure 74: US productivity changes 1950-2000

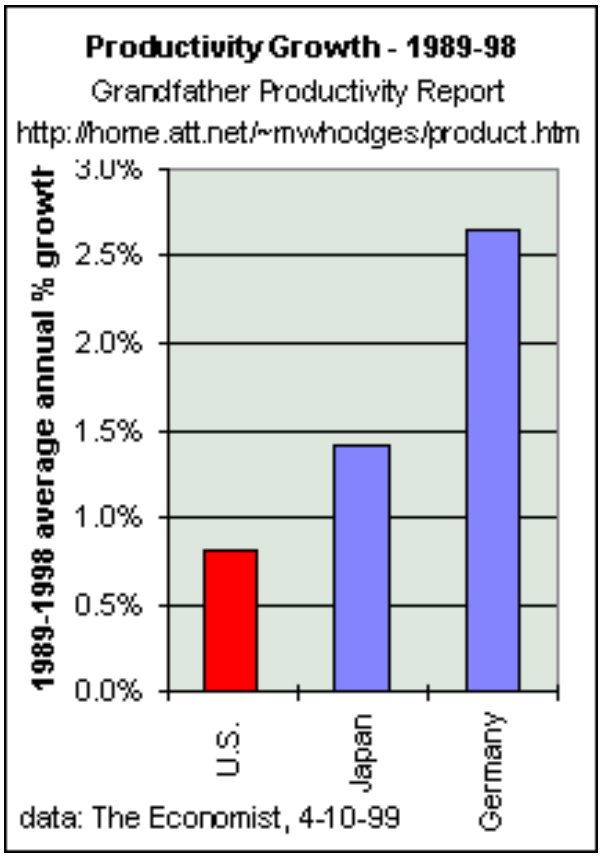


But in Hodges' site it is written

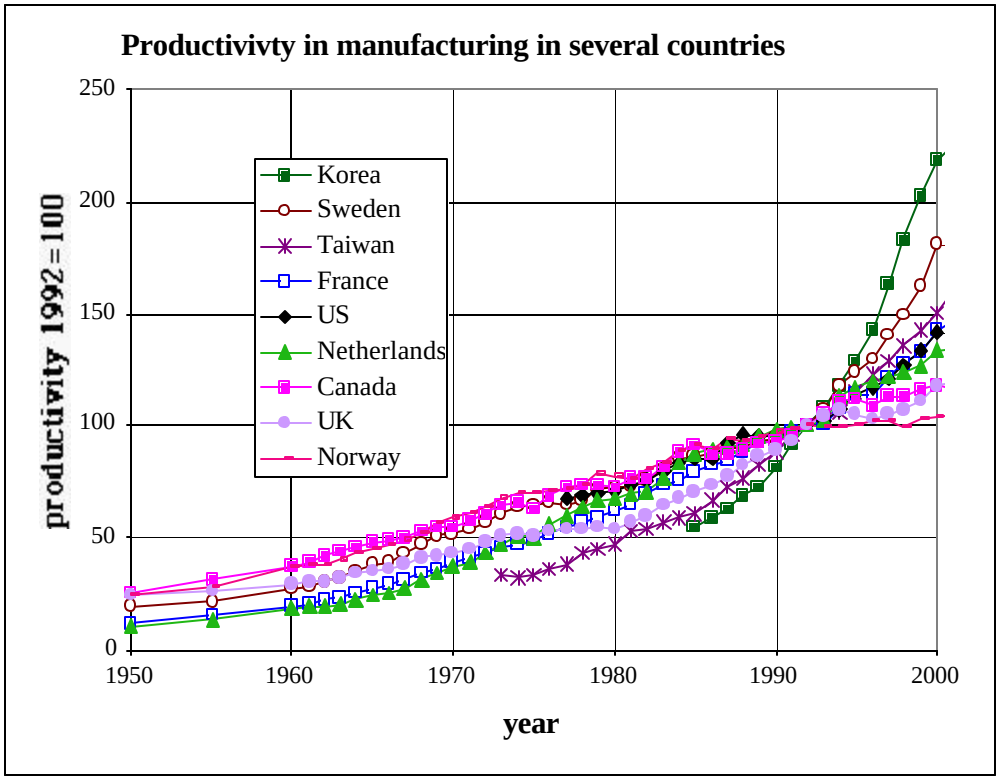
Economic Productivity Report by Michael Hodges, updated Aug. 2002, http://mwhodges.home.att.net/product.htm

The Economist, 8/11/01, reported, "revised figures now show most of the past-reported acceleration in productivity has now vanished - - past gains were exaggerated." (for example: year 2000 was previously reported as 4+% productivity, which was 45% over-stated according to latest revisions by the Bureau of Labour Standards). And productivity for 2001, originally reported at 1.8%, was revised (in Aug. 2002 per Labour Dept.) down to 1.1%, meaning 2001 productivity was 63% over-stated.

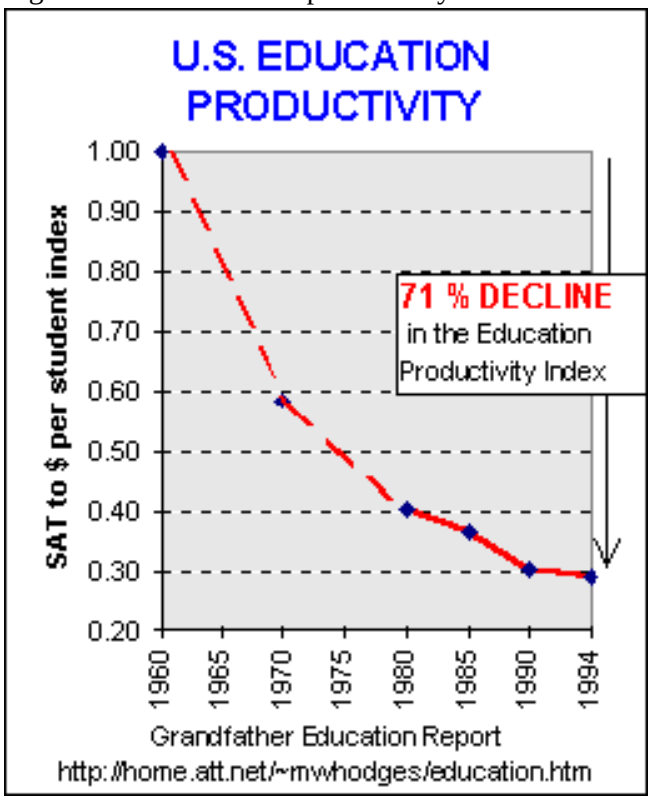
Figure 75: productivity growth 1989-1998 US, Germany and Japan



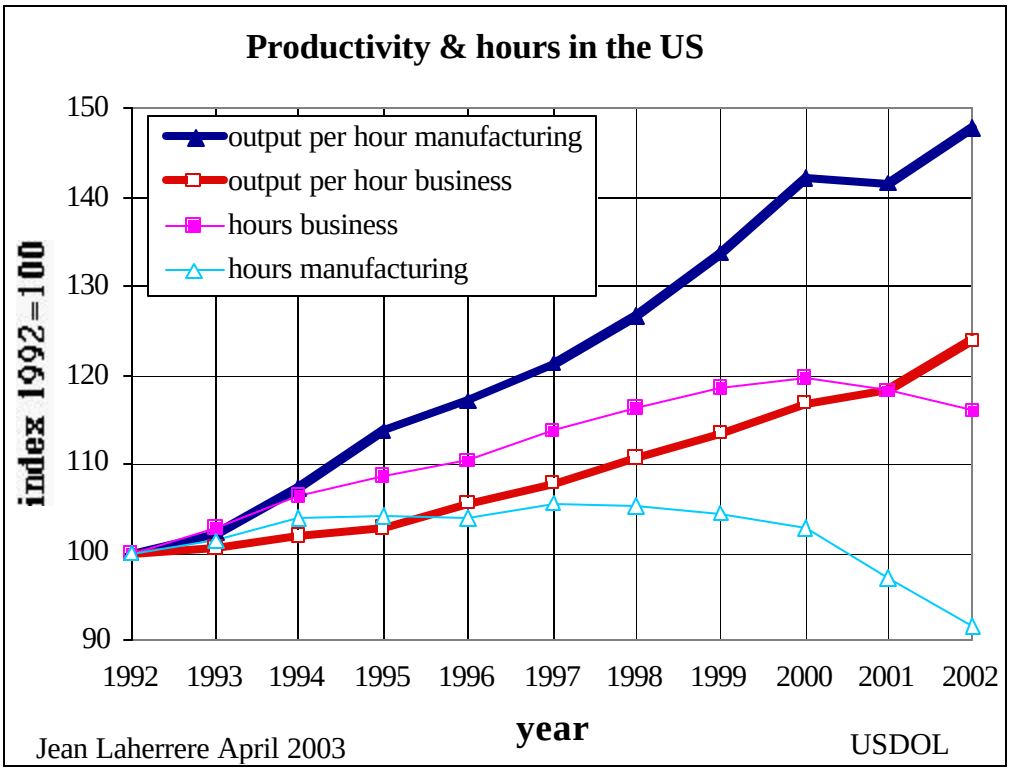
The comparison between several countries of productivity in manufacturing shows that the US is performing close to average, poorly lately compared to Korea and Sweden
Figure 76: productivity (manufacturing) 1950-2000 for several countries



The US education productivity has declined by 70% since 1960
Figure 77: US education productivity 1960-1994



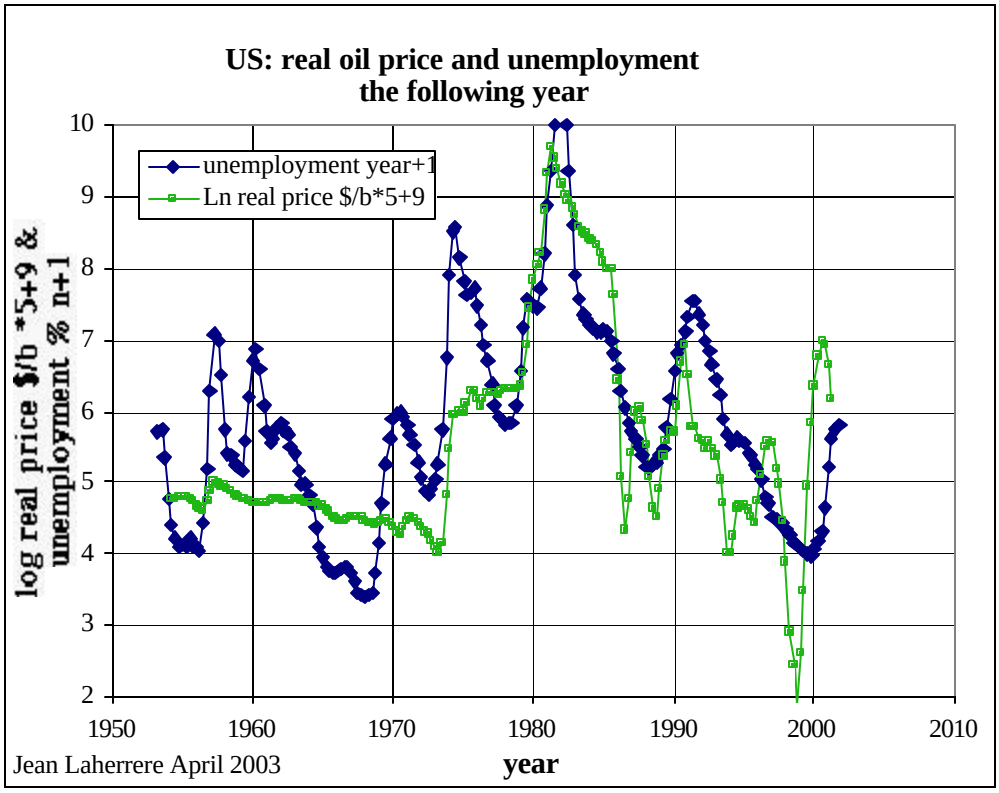
The productivity in manufacturing in blue in the next graph base 1992 has increased up to 150 in 2002 but the number of hours has peaked in 1997. For the business sector the productivity has peaked in 2000 at 120 as well as the number of hours. A peak in the number of hours is a poor sign of growth when the total population is growing.
Figure 78: Output per hour and number of hours in the US



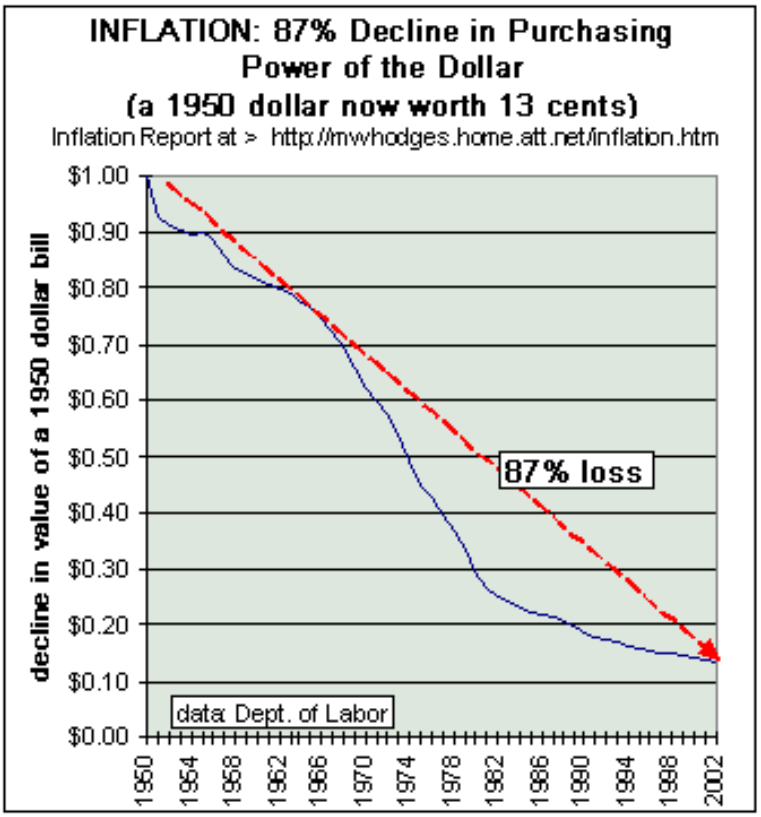
Or maybe the number of hours is under reported and the productivity is going down: it is said that there are 10 million illegal immigrants, most of them working but without being accounted for.

-2-4-Correlation with shift in time

It is interesting to compare curves. Correlation is not causality, but it means that parallel curves may have the same cause.
The correlation between unemployment and oil price (in logarithmic scale) seem strong on the following curve, when unemployment is shifted by one year. High oil price leads to high unemployment the following year as it was during the oil shocks 1973, 1981, 1991 and 2001
Figure 79: US: real oil price and unemployment the following year

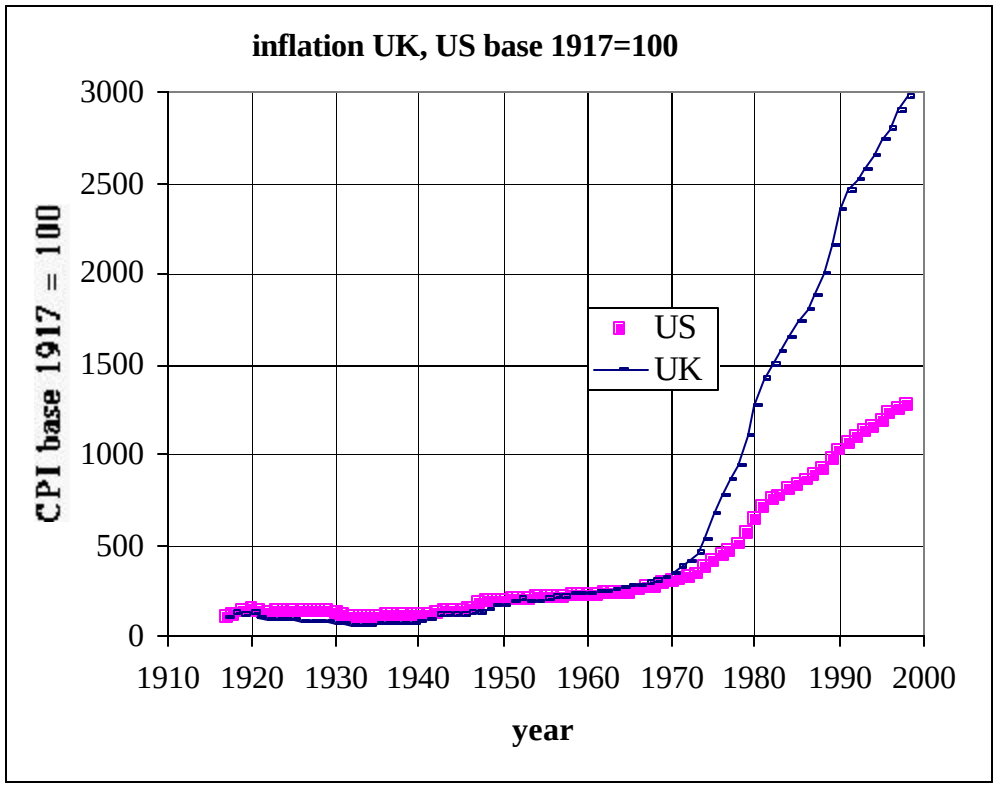


The US inflation has resulted since 1950 in a decline of 87% in the dollar value
Figure 80: US inflation decline in purchasing power since 1950



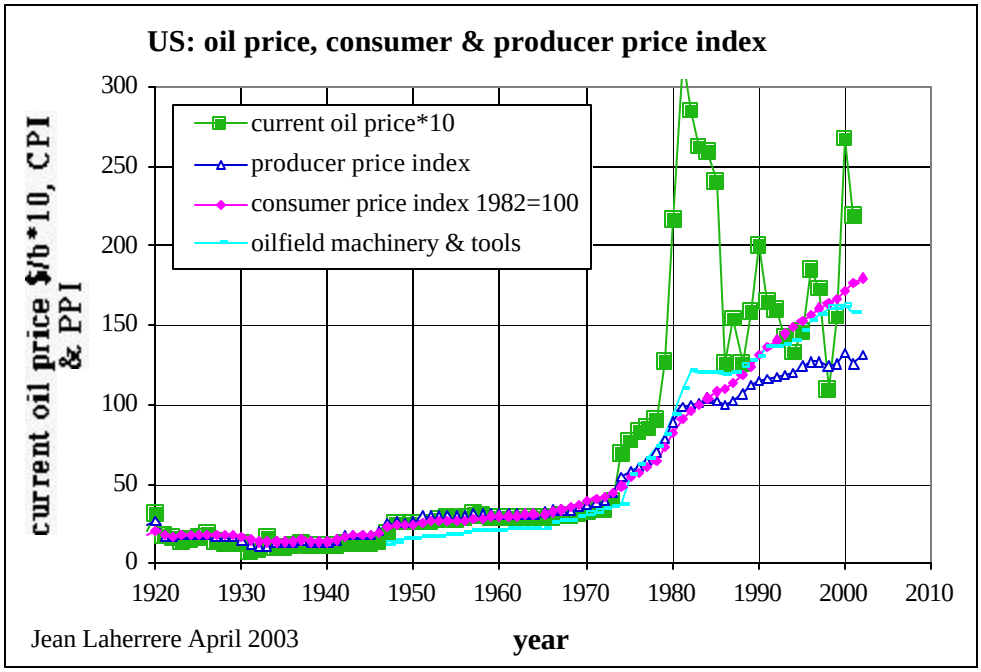
But the inflation in the US really started to grow only from 1970 on (1973 end of the Bretton-Woods gold standard and oil shock) when before it was moderate as shown by the growth of the CPI (consumer price index). However it is surprising that this US rise is quite small compared to the UK CPI rise, when they do not differ so much in way of life

Figure 81: Inflation in US compared to UK 1907-1998



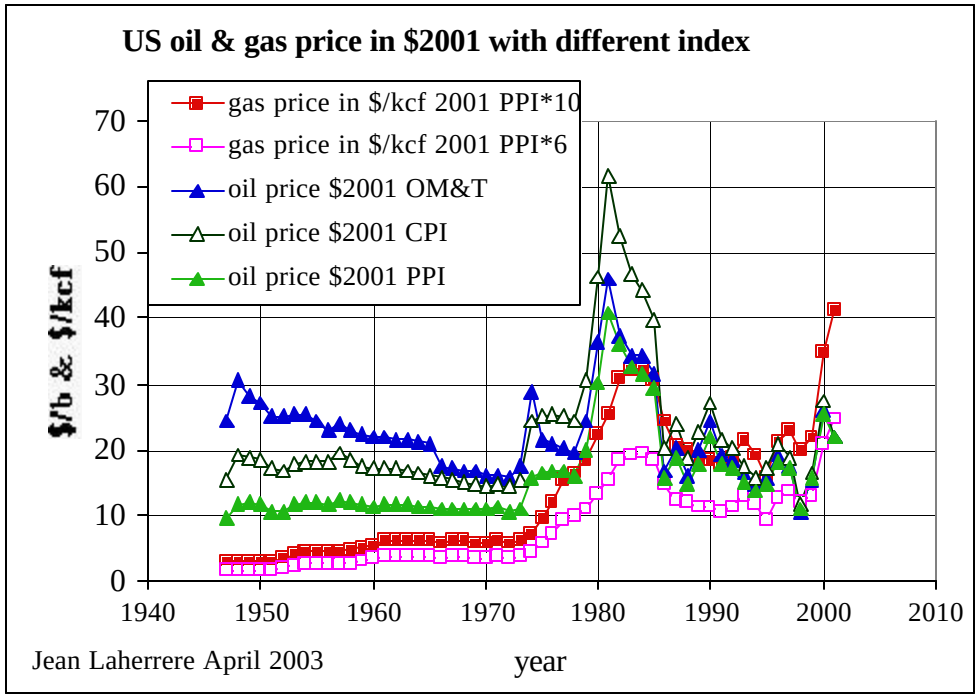
US inflation which is the growth in the CPI or PPI (producer price index) or OM&T (oilfield machinery & tools) shows a good correlation with oil price

Figure 82: US oil price, consumer & producer price index



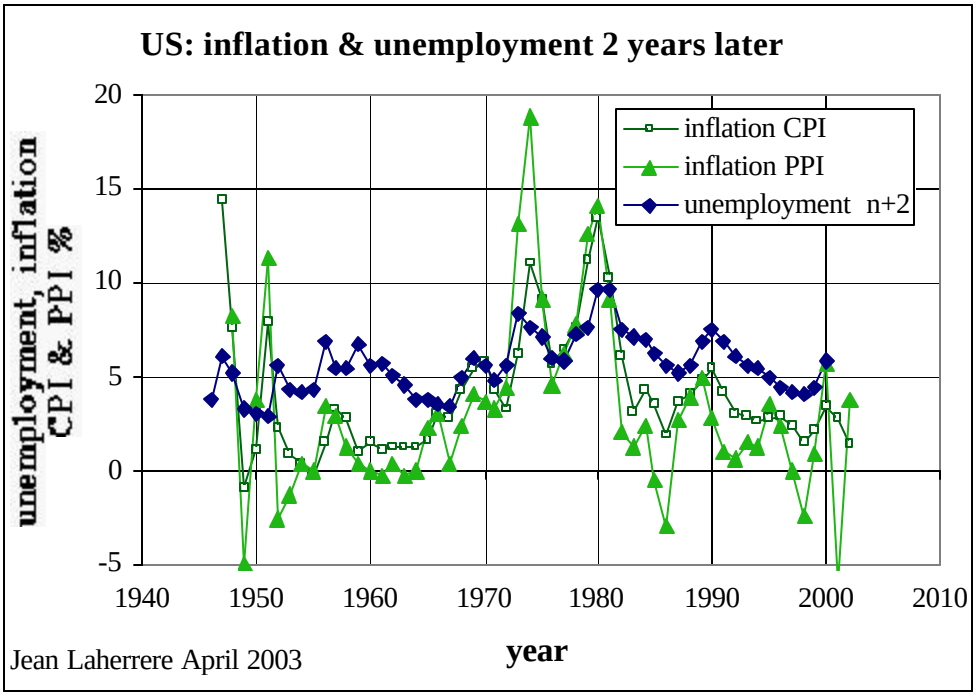
US oil & gas price is presented in constant dollar using different indexes (CPI, PPI or OM&T) and display different long term trends which in fact depends mainly on the chosen index. Any long term price is then unreliable.

Figure 83: US oil & gas price with different index



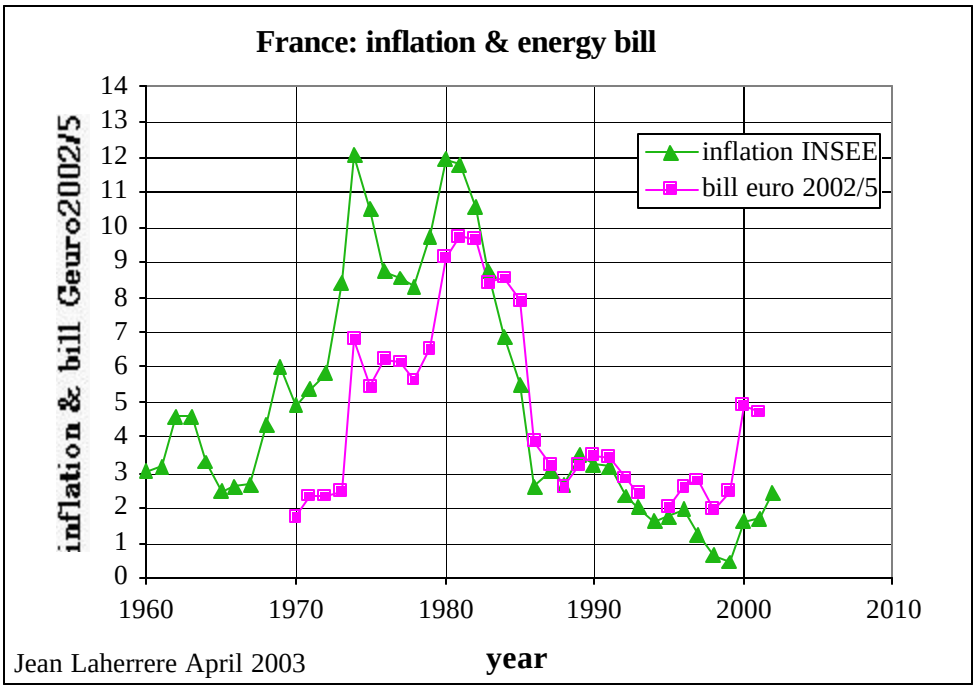
As inflation and unemployment seem to depend both on oil price it is not surprising to find that the correlation between inflation and unemployment 2 years later looks good, in contradiction with the Phillips curve where inflation and unemployment are supposed to move in contrary.

Figure 84: US inflation and unemployment 2 years later



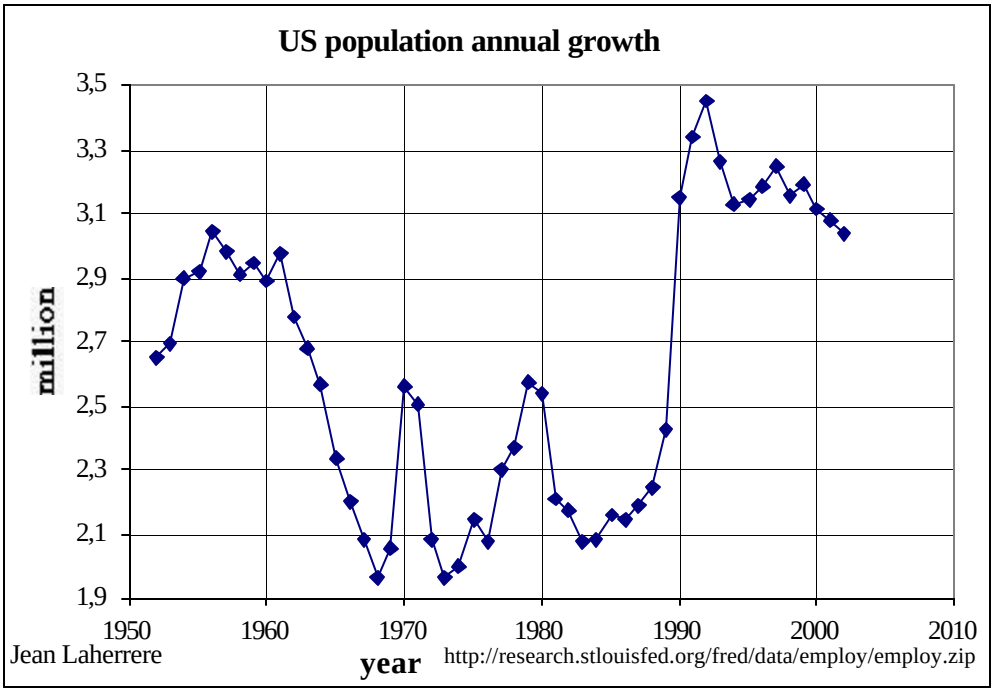
In France the correlation between the energy bill (reduced with the nuclear program) and inflation is good

Figure 85: France: inflation & energy bill

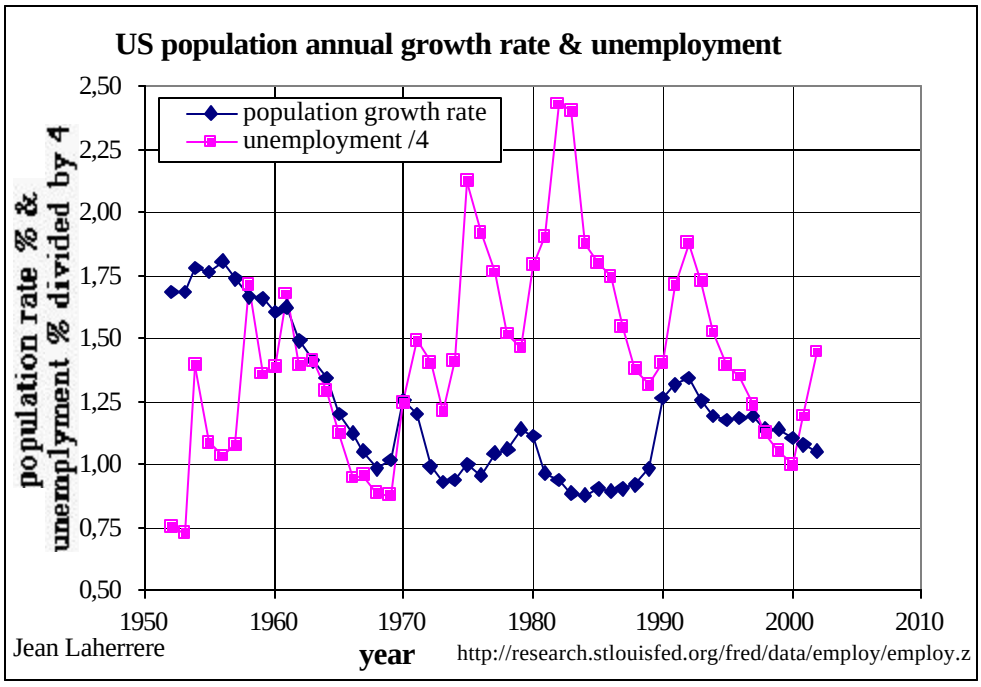


The detailed US population annual growth (source federal research of Saint-Louis) shows a sharp increase in 1990 from 2.5 to 3.5 million a year (not including the illegal immigrants). The US is estimated to be receiving 30% of the world immigration.

Figure 86: US population annual growth



There is a certain correlation between US annual growth rate and unemployment (rate divided by 4) during the 60s and the 90s but less in between because the impact of the oil shocks in 1973 and 1981.
Figure 87: US population annual growth rate & unemployment



Agriculture productivity (as given byn FAO) is connected with oil consumption as shown by the next graph plotting the variation of both parameter measured as a percentage of 1990
Figure 97: Petroleum consumption and agriculture productivity (% 1990)

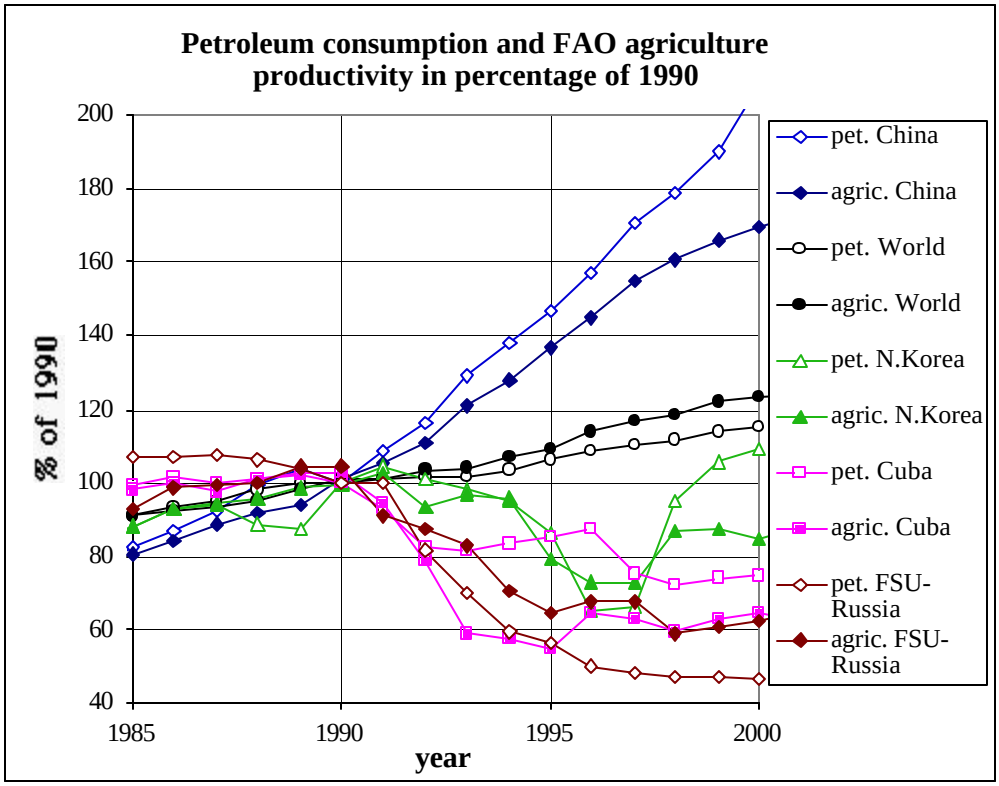
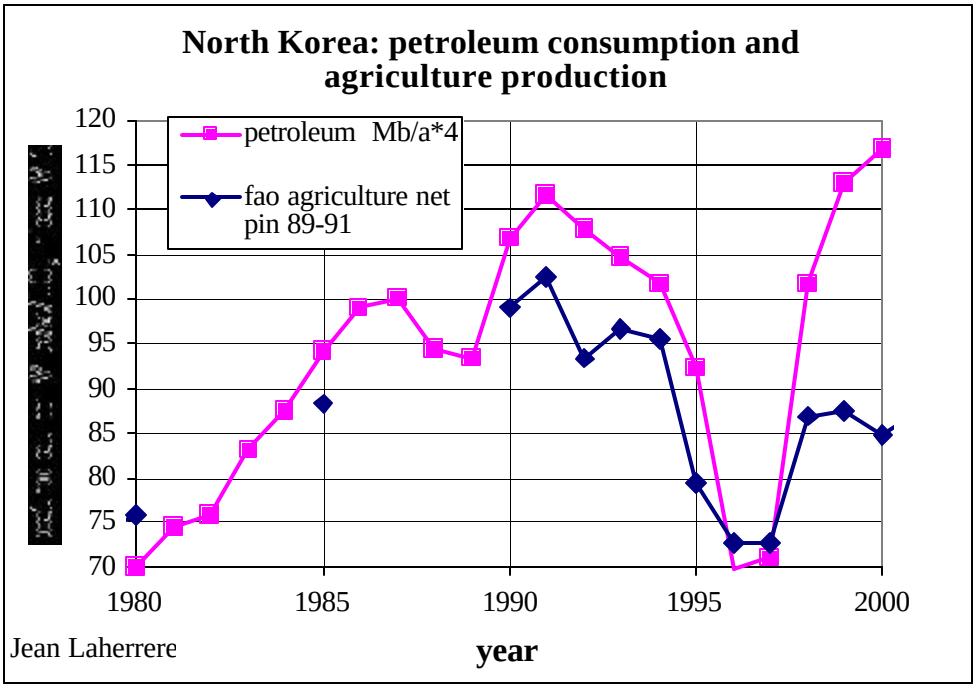


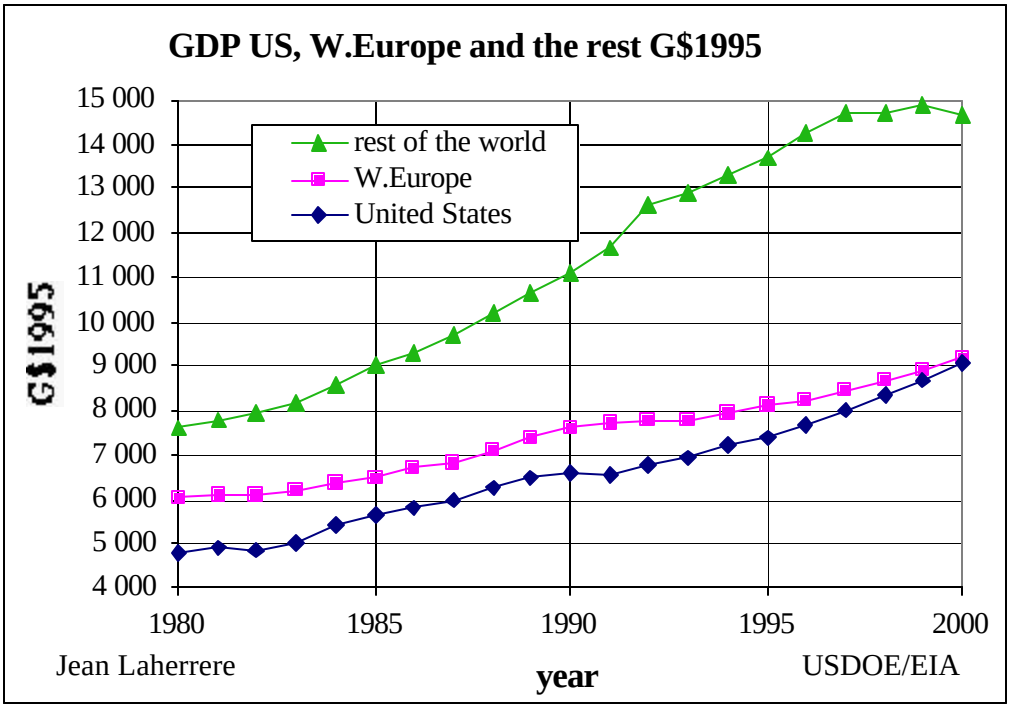
Figure 98: the graph for North Korea only is quite clear



-2-5-**world GDP**

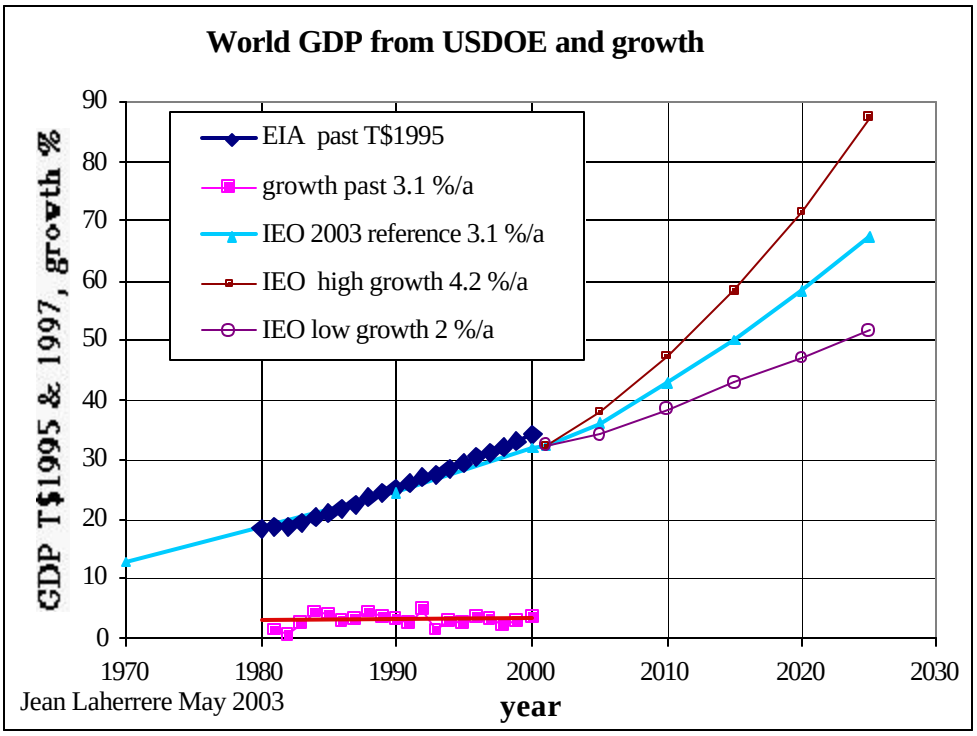
From 1980 to 1990 (previous data is not available in USDOE) the GDP in W. Europe, US and the rest of the world increased differently but since 1990, US increased sharply, more than in Europe and much more than in the rest of the world.

Figure 88: GDP, US, W.Europe and the rest 1980-2000

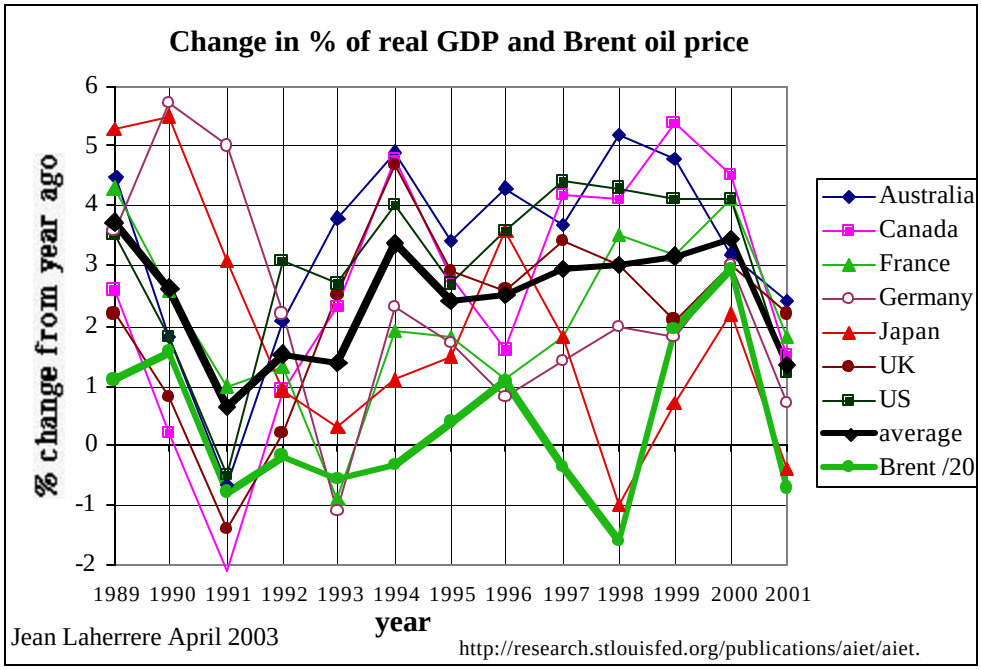


The IEO (International Energy Outlook) 2003 forecasts, from the 3.1%/a world GDP growth of the last 20 years, an increase for the next 25 years even for the low economic growth. They ignore the present slow down of the economy which can develop into depression looking at the correlation between the stock-market in 1930 and 2000. As already mentioned a constant growth is unsustainable.

Figure 89: World GDP with USDOE forecast 1970-2025



The change in GDP (in %) varies with country, but in average it follows roughly the oil price change (Brent oil price BP review) in percentage divided by 20.
Figure 90: Change in GDP and oil price



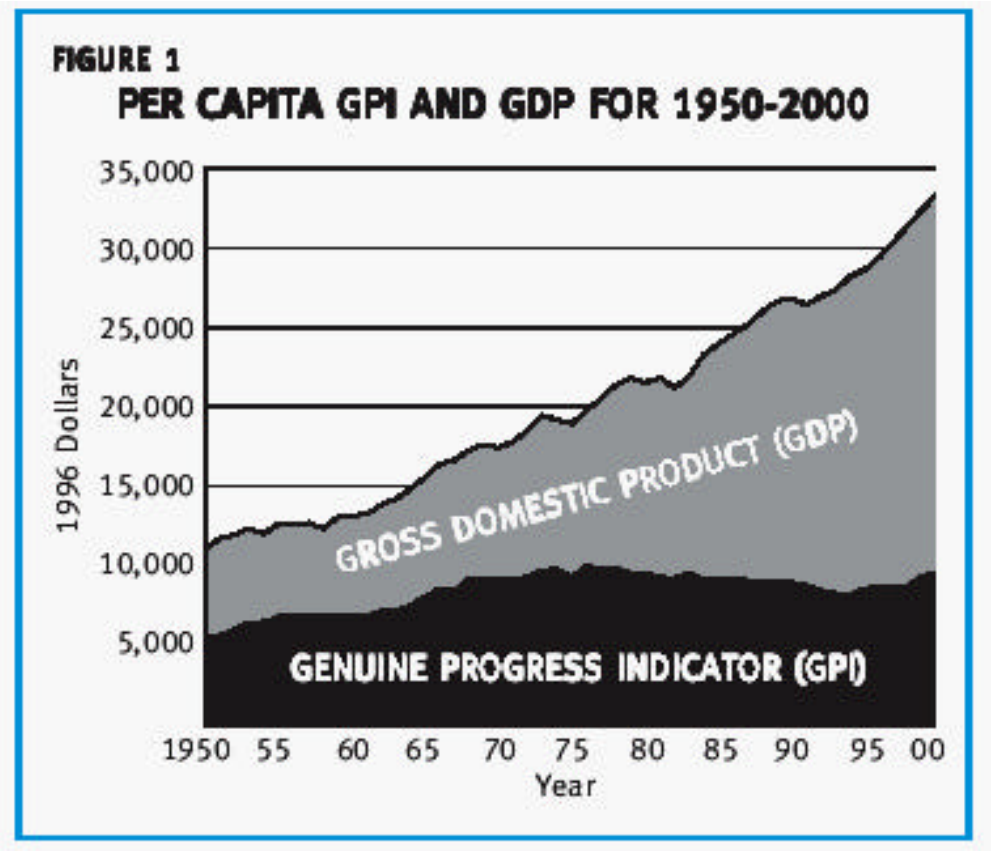
-2-6-Well-being

Many people confuse money or wealth with happiness, but in reality many poor people are much happier than many rich people. Measuring the wealth of a country with GDP is a poor practice.

GDP represents expenditures and money, but not wealth. The more drugs, crimes, pollutions, traffic jams, diseases, family breakdowns, car accidents, wars, catastrophes, depletions of resources, the higher the GDP. As politicians are judged according to the growth of GDP, this explains why war is so popular with some politicians. GDP is manipulated and that is why many other indicators have been proposed to measure the health and happiness of a country. The main problems are first which parameter has to be included in the indicator and second which weight to be put to each parameter.

The Genuine Progress indicator (Cobb 2001) presents for the US a smooth peak in 1975, a trough in 1993 and a small recovery in 2000; in contrary to the always rising GDP

Figure 91: US Genuine Progress Indicator and GDP per capita 1950-2000



The next graphs for US and UK shows the GDP and several indicators with different parameters and weights. It is obvious that the range is large, but it shows that it is far from the unique GDP

Figure 92: Well-being in the US with different indexes

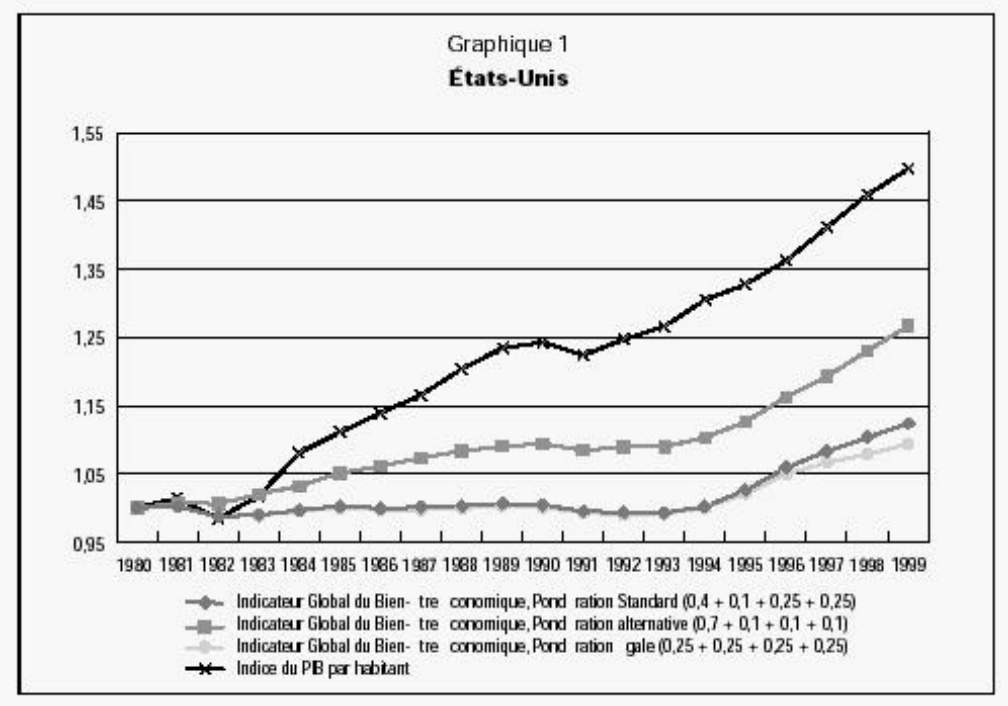
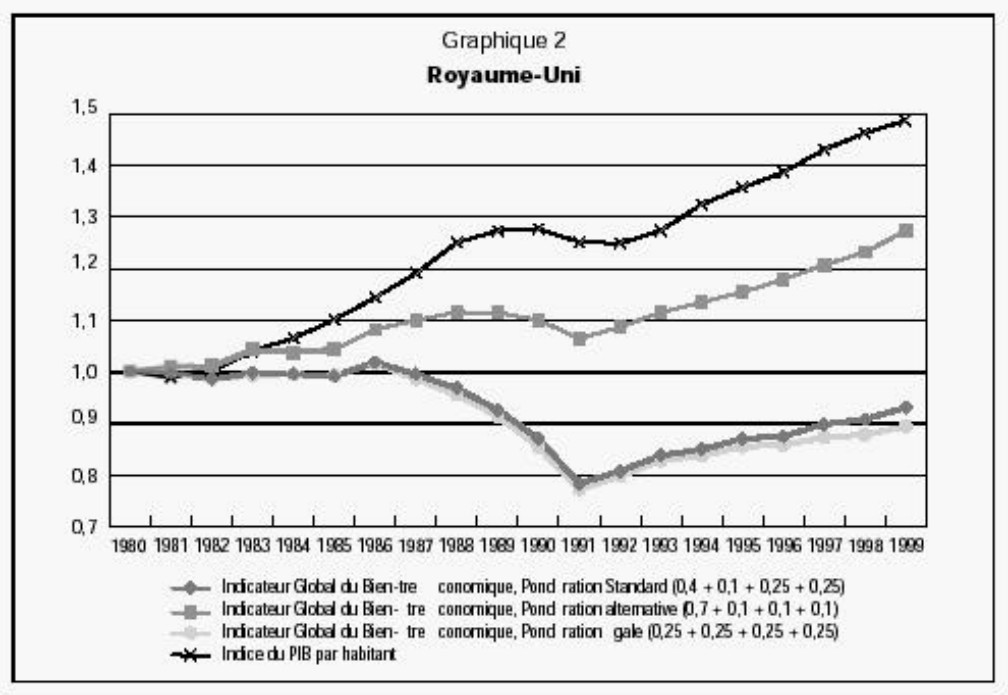


Figure 93: Well-being in UK with different indexes



It is obvious that the GDP first is manipulated in many countries being overestimated, such as the US with a hedonic factor (see annex), as in China, or being underestimated as in Russia where during the 90s a large part of the trade was on barter. It is a poor indicator of wealth and the famous energy intensity in energy per dollar is flawed.

The total of deaths by homicides or suicides per 100 000 inhabitants shows drastic differences between countries without no connection with GDP.

country date 1998	homicide	suicide	total
Colombia	73	3	76
Russia	23	35	58
Mexico	17	3	20
France	0,9	19	20
Japan	0,6	19	19
US	7	11	18
Sweden	1,2	14	15
Germany	0,9	14	15
UK	0,7	7	8

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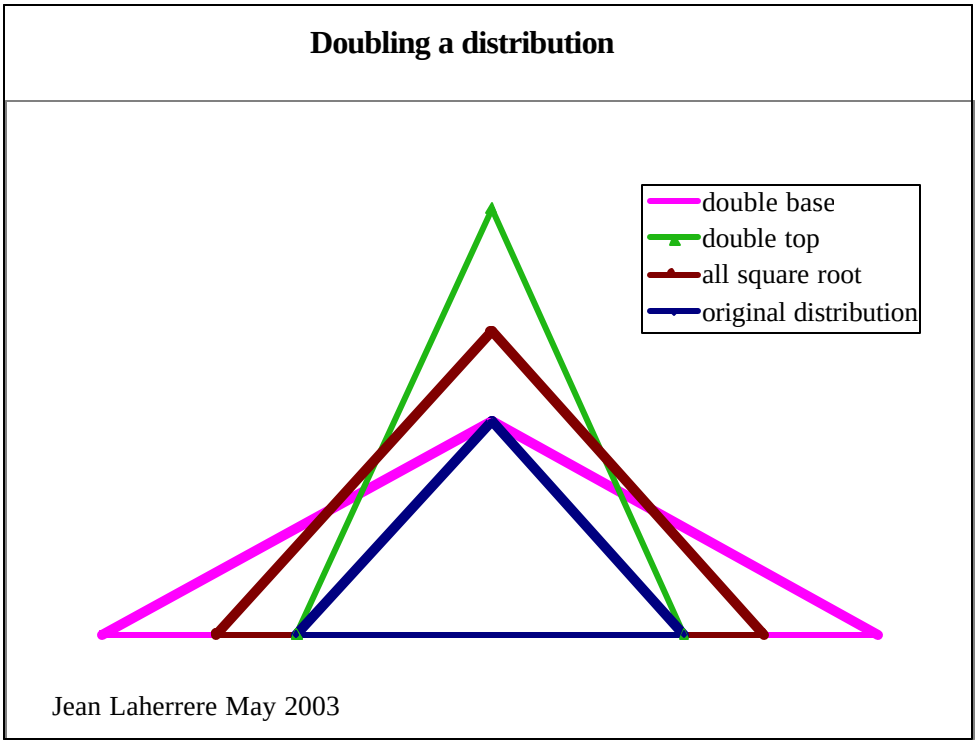
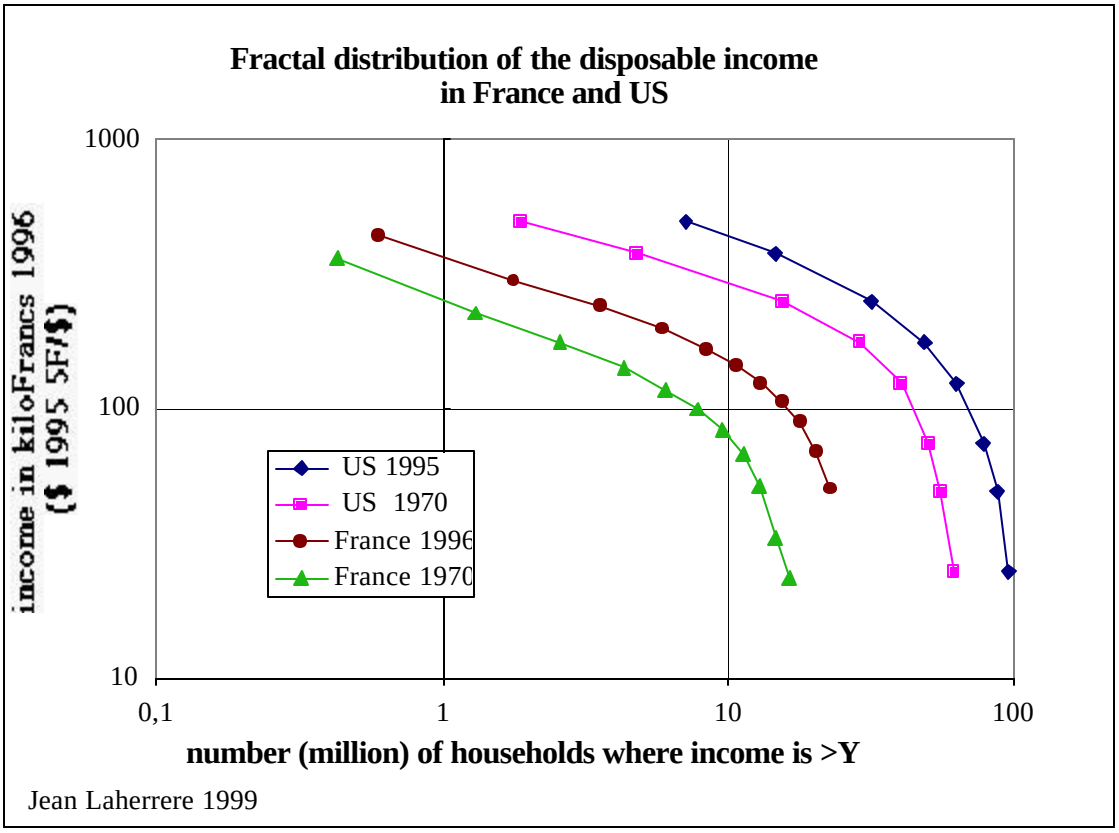
-2-7-**Income: Disposable personal income**

The distribution of wealth as personal income is very often given as an example of inequality and the ratio usually given is either the Gini ratio (area of the curve % cumulative income versus % cumulative number) or the P90/P10 (ratio of the top 10% versus the bottom 10%). It is like comparing the height with the base for a pyramid. By when the pyramid grows for example doubling its surface, there are different ways to grow. As shown in the next graph, from the original pyramid in blue, the green is a doubling of the top (being very unfair by rewarding only the best performers), or the red a doubling of the base (giving no incentive for

performers to perform and killing the growth). The most equitable is to grow proportionally as in the brown, every one growing by a ratio of square root of 2.
Figure 94: doubling a distribution



Comparing the P90/P10 without considering the growth of the population is wrong as the number of top performers increases (as the number of bad performers). The distribution of the personal income is a range which starts always from zero as the rich man of yesterday can be broke to morrow, and a new immigrant starts from scratch.
It is amazing when plotting the personal disposable income in a fractal display (log-log, size, rank) to find that the evolution of the US from 1970 to 1995 is moving in parallel, meaning that everyone is growing by the same ratio, it is the same for France from 1970 to 1996 and the most surprising is that France is parallel to US, meaning that the wealth distribution is the same in France and the US. There are richer men (or women) in the US because the population is about 5 times bigger. If France was 5 times more populated the French rich men would be as rich as the American rich men.
Figure 95: fractal distribution of the disposable income in France and US in 1970 and 1996



-Conclusions

As oil production has peaked in the US (main peak in 1979 and second one in 1985) and for the world will peak again after the first peak of 1979, as civilisations (Maya, Greek, Roman) have peaked and declined, as Europe population has peaked and declines, the western civilisation will decline in few decades because its fertility rate is falling and will be replaced by other civilisation. Roman civilisation where Romans did not work manually (even for physicians) was based on the energy of slaves and disappeared by lack of slaves.

The US empire based on consumption and borrowed money will decline soon as it cannot continue to attract the money of the rest of the world.

The Atlantic cod extinction shows that technology as ("more and faster"), combined with the bad estimate of resources, can lead to destruction for fish and for jobs.

Modelling is best when looking at events from a broader view, using the largest period, neglecting the last digits and concentrating on the first one. Any model has to accept the concept of decline instead of simple extrapolation of event on a short period. Any model using a constant growth is unrealistic and flawed. Decline is a politically incorrect word and never used by politicians and managers.

Poor data means poor modelling. Data has to be gathered by independent agencies and prevented to be manipulated for political motives. Except for a few US federal agencies and universities, it is very difficult to get reliable data on long series on the web. And when they do exist, some have already disappeared. Universities should work more on building databases (with free access and easy format to process), it is maybe not too rewarding, but more useful than new unrealistic modelling

Each human being has to accept that he will die and he will be replaced by his children. But the present way of life based on consumption and future growth to solve the present problems

has to be changed. The main revolution of mankind of the last centuries is that women can now decide about her fertility. Women want after fulfilled their desire for having one or two children (Maslov different levels) to get out of her home and live actively outside to fulfil themselves. It is difficult to prevent their desire for freedom and equality with men, except by religious constraint.
Gaia concept seems to work as far as dealing with the excesses of mankind. Some civilisations have disappeared and very little of their empire is left on earth, the spread of a virus as AIDS (also of present or future ones) is and will be a strong constraint against the large growth of the world population.
The world population will likely peak below 8-9 billion around 2050 and the demand for energy will peak too as there is a large potential of energy savings mainly in North America where the consumption per capita is double compared to Europe. The worry of filling the energy demand will be less than anticipated if the human behaviour is changed to adapt to the new conditions of decline and depletion.

-References

-Bingham Kennedy, Jr "Dissecting China's 2000 Census" http://www.prb.org/regions/asia_near_east/DissectingChinas2000Census.html
-Cobb C. , M.Glickman & C.Cheslog 2001 "The Genuine Progress Indicator 2000 update" Redefining Progress
-Harris M. 1999 "Lament for an ocean - the collapse of the Atlantic cod fishery - A true crime story " M&S
-Haub C "UN Raises World Population Projections; AIDS Continues to Devastate Sub-Saharan Africa www.un.org/esa/population/unpop.htm.
-Haub C. "Fertility Down, but Population Decline Still Not in Sight" UN
-Hodges M. "Grandfather economy " http://mwhodges.home.att.net/
http://www.prb.org/pdf/UnderStndPopProj_Eng.pdf
http://www.prb.org/pdf/WorldPopulationDS02_Eng.pdf
http://www.prb.org/Template.cfm?Section=PRB&template=/ContentMana gement/ContentDis play.cfm&ContentID=6283
-Keilman N.2001 "Uncertain population forecasts" Nature vol 412 2 August, p490-491
-Kurlansky M. 1997 "Cod - a biography of the fish that changed the world" Penguin Books 1997
-Laherrère J.H. 2003 "Future of oil supplies" Swiss Institute of Technology, Center of Energy Conversion, Zurich, May 7 http://www.hubbertpeak.com/laherrere/zurich/pdf
-Laherrère J.H. 1999 “World oil supply -What goes up must come down: when will it peak?” Oil and Gas Journal Feb.1 p 57-64 http://dieoff.com/page177.htm
-Lahmeyer J http://www.library.uu.nl/wes p/populstat/about.html University of Utrecht
-Lee R., S.Tuljapurka 1998 "Population forecasting for fiscal planning -Issues and innovation" Burch center working paper series UC Berkeley
-Lutz W., W.Sanderson & S.Scherbov 2001 "The end of world population growth" Nature vol 412, 2 August , p546-545
-PRB "Target Fertility Assumptions Used in UN Projections for 2045–2050"
-PRB "Understanding and using population projections"
-PRB "World Population Futures" by Brian O'Neill and Deborah Balk, Population Bulletin, Vol. 56, No. 3, September 2001
http://www.prb.org/Template.cfm?Section=PRB&template=/ContentManagement/ContentDis play.cfm&ContentID=7260
-PRB World population data sheet

-Todd E. 2003 "Apres l'empire -essai sur la decomposition du systeme americain" Gallimard
-UN " World population prospects: the 2000 revision volume III, analytical report" http://www.un.org/esa/population/publications/wpp2000/chapter5.pdf
-UN 2002 "World Prospects: The 2002 Revision and World Urbanization Prospects: The 2001 Revision" http://esa.un.org/unpp

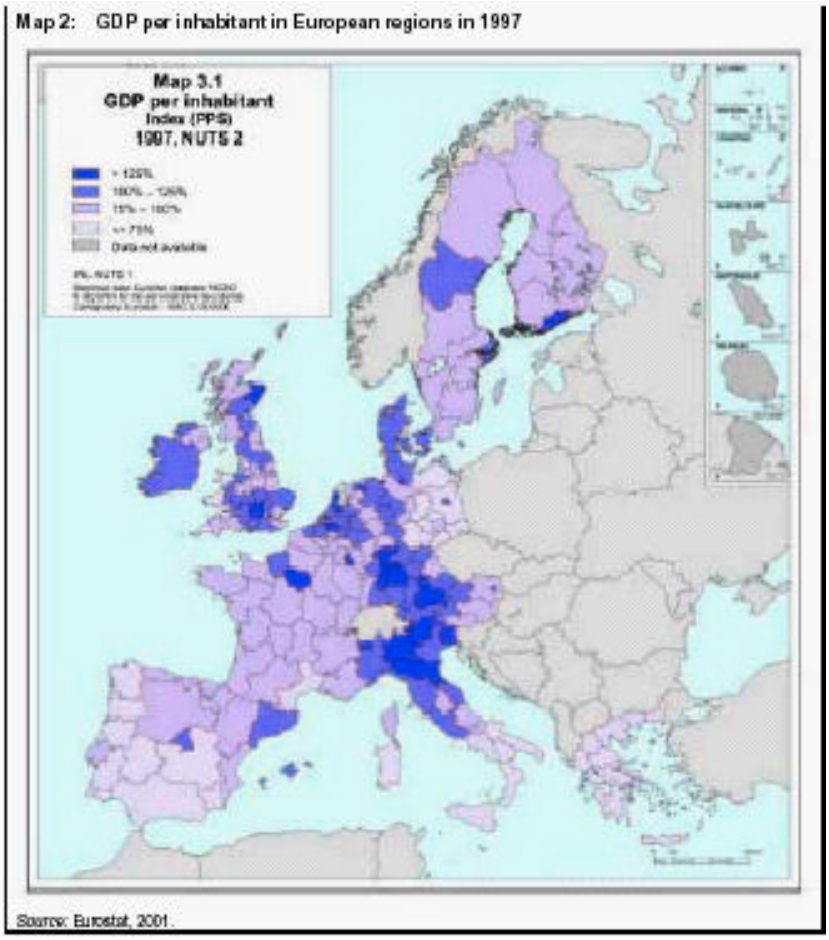
Annexes:

-grandfather economy site on hedonic factor:
hedonic factor increase in terms of speed & memory and not in productivity
investment in computers & peripheral equipment

G$	1998	1999				2000	
Qtr	4th	1st	2nd	3rd	4th	1st	2nd
Actual Dollars	86.3	88.1	92.8	97.6	98.9	104.3	114.2
Chained Dollars	171.3	186.1	208.5	230.9	243.9	264.1	298.5
Investment in software previously considered as business expense							
Chained Dollars	167.3	173.3	181.1	192.5	205.3	215	227.5

Other well-known writers from the Austrian school like Dr. Kurt Richebächer, and financial writer James Grant, a columnist for the Financial Times, have called attention to these statistical fallacies.
dated 16 October 2000, from Smithers & Co . LTD, a London firm providing advice to fund managers on international asset allocation, at http://www.smithers.co.uk/standard146.html
It is widely believed that the US has experienced a productivity miracle that has left the rest of the world behind. Reality may well be very different. The reason lies in the way that output is measured either side of the Atlantic. In general, the US statisticians use what is known as 'hedonic' pricing and Europeans don't. The difference is startling. The Office for Natio nal Statistics has estimated that over the past four years the apparent rise in British industrial output would have been three times the previous estimate had the US system been in place.

-European income per inhabitant broken down by town
The GDP per inhabitant is mapped for Europe and it is surprising to see the highest GPD surrendering the eastern sides of Switzerland
Figure 96: Europe map of GDP per inhabitant

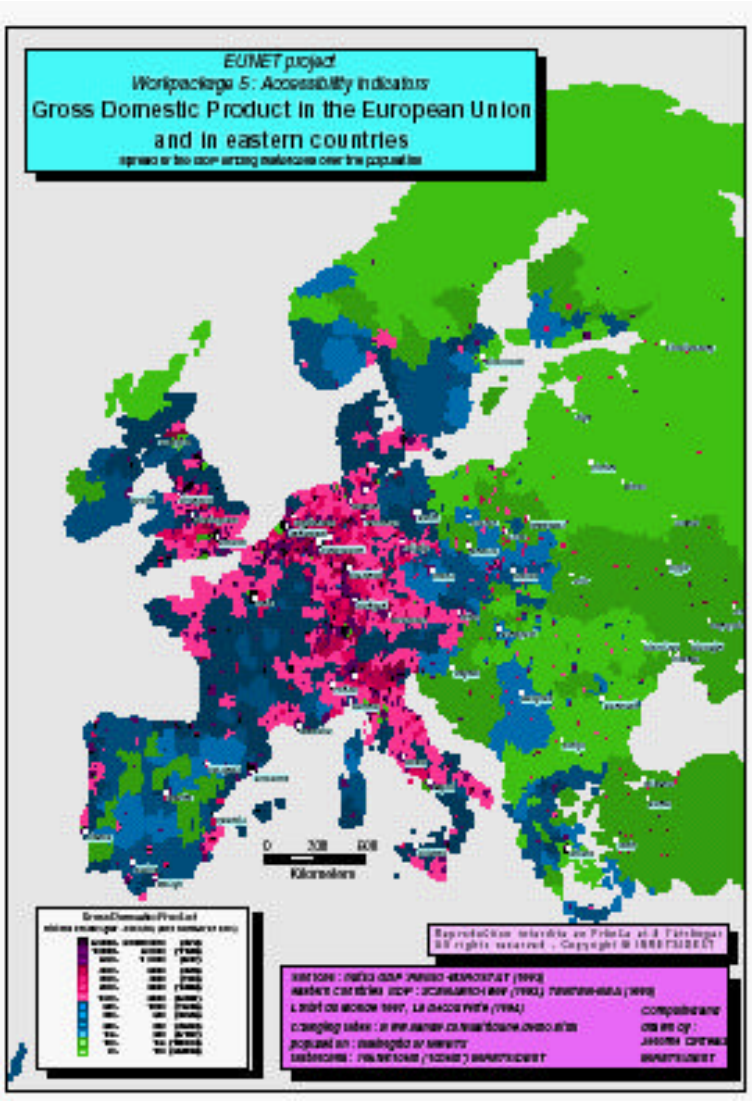


Eurostat site

A similar map is given showing GPD per square kilometre with some differences in the detail.

EU GDP per square kilometre by Jerome Carreau

Figure 97: Europe map of GPD per square kilometer



http://www.inrets.fr/ur/dest/europe/eunetpdf/gridgdp.pdf

-Petroleum consumption and agriculture production

Agriculture depends now mainly on farm machinery using oil and fertiliser derived from oil and gas sources. The relationship between agricultural production and petroleum consumption is well shown in countries as Cuba, North Korea and FSU-Russia, where consumption decreases, or China where it increases sharply. Cuba was obliged to go back to horses. It is curious to see that oil (as energy) that is used in cars to move us and in tractors to plough fields (their powers are expressed in horse-power) is counted as energy flows, whereas the energy of the food which allows us to move and the energy to feed horses which plough field are not.

SUV's, which are so popular in the United States, are not essential, but farm machinery most certainly is, if farmers are to produce enough food. Fertilisers depend also mainly upon oil and gas.

Figure 98: US past forecasts on fertility rate