The Index of Sustainable Economic Welfare (ISEW) for Italy

Giorgio Guenno* and Silvia Tiezzi**

NOTA DI LAVORO 5.98

JANUARY 1998

ENV – Environmental Economics

*Fondazione ENI Enrico Mattei
**University of Siena, Department of Economics

We thank Alessandro Lanza of Feem and Paolo Lombardi of WWF Italy for promoting this research. We also thank Andrea Beltratti for supervision and useful comments and Rosa Franzese for data collection. We are grateful to the Fondazione Eni Enrico Mattei and WWF Italy for technical and financial support. Usual disclaimers apply.

Address for correspondence:

Silvia Tiezzi
University of Siena
Department of economics
Piazza San Francesco, 7
53100 Siena
Italy
Phone: +0577+298647
Fax: +0577+298661
E-mail: tiezzisilvia@unisi.it

SUMMARY

We try to build a macroeconomic index, that includes some non-market variables, to be compared to the traditional GDP. Over the last twenty years answers to the welfare accounting problem have been different. Economists have used dynamic optimisation to rigorously derive an index that can be used to evaluate small projects and their contribution to well being. National Accountants are trying to extend the System of National Accounts (SNA) in the form of satellite accounts by increasing the system boundary. There is also a number of other studies which cannot be included in either of the previous categories and that we may call indices of welfare. They are not rigorously founded and start from common sense ideas of what should and what should not be considered as determinants of well being. This type of indices, however, has received wide attention thanks to their immediate comparability with GDP and to their characteristic of emphasising the long run trend of "welfare" as compared to GDP. Our work falls in the third category. We start from the Index of Sustainable Economic Welfare (ISEW) built up by Cobb and Daly in 1989 and we reproduce it for Italy, though revisiting the methodology associated to the construction of some of the variables. The results show that up to the seventies the Italian GDP only slightly overestimates the growth of economic welfare, but since then it seems to have been misleading, at least as compared to our index. While GDP has continued to rise, economic welfare has been stagnating. The importance of the environmental variables included seems to be decreasing over time going from the 38% in 1980 to the 31% in 1990. The cost of pollution (air, water and noise) has a greater weight in the sixties (about 13%) and falls to 8% in 1990. The ratio between GDP and environmental degradation has remained constant over the decades under consideration, thus contradicting the idea that the demand for environmental quality increases with income.

Key words: Economic welfare; Environmental accounting; Sustainability.
JEL: I31

NON TECHNICAL SUMMARY

In this paper we try to build a macroeconomic index of welfare to be compared to the traditional GDP. Over the last twenty years answers to the welfare accounting problem have been different. Economists have used dynamic optimisation to rigorously derive an index that can be used to evaluate small projects and their contribution to well being. National Accountants are trying to extend the System of National Accounts (SNA) in the form of satellite accounts by increasing the system boundary. There is also a number of other studies which cannot be included in either of the previous categories and that we may call indices of welfare. They are not rigorously founded and start from common sense ideas of what should and what should not be considered as determinants of well being. This type of indices, however, has received wide attention thanks to their immediate comparability with GDP and to their characteristic of emphasising the long run trend of "welfare" as compared to GDP. Our work falls in the third category. More precisely, we start from the Index of Sustainable Economic Welfare (ISEW) built up by Cobb and Daly in 1989 and we reproduce it for Italy, though revisiting the methodology associated to the construction of some of the variables. The calculation of the ISEW starts from the consumption base taken from standard national economic accounting and weighted by an index of income distribution. Then a number of variables is subtracted or added according to their contribution to economic welfare. The welfare index for the Italian economy refers to the period 1960-1990 and is given by 21 variables of which 14 are "market" variables, i.e. their value can be inferred from market prices, and 7 are environmental variables to be estimated. The results show that up to the '70ies Italian GDP only slightly overestimates the growth of economic welfare, but since then it seems to have been misleading, at least as compared to our index. While GDP has continued to rise, economic welfare has been stagnating. Our results are consistent with what has been found in similar studies in the US, in the UK, in Germany and in Austria. Many of the ISEW calculations show a shape opposite that of an environmental Kuznet's curve: the level of welfare decreases as income grows with the flex point arising in the seventies. However, we do not register the same significant decreasing trend after the '70. To the contrary, our index continues to rise, although at a decreasing rate.

As to the environmental variables included, their importance seems to be decreasing over time going from the 38% in 1980 to the 31% in 1990. The cost of pollution (air, water and noise) has a greater weight in the sixties (about 13%) and falls to 8% in 1990. The ratio between GDP and environmental degradation has remained constant over the decades under consideration, thus contradicting the idea that the demand for environmental quality increases with income.

The Index of Sustainable Economic Welfare (ISEW) for Italy[1].

Giorgio Guenno* and Silvia Tiezzi**

*Fondazione ENI Enrico Mattei. ** Corresponding author: University of Siena, Department of Economics, Piazza San Francesco, 7 53100 Siena. E-mail: tiezzisilvia@unisi.it.

ABSTRACT

We try to build a macroeconomic index, that includes some non-market variables, to be compared to the traditional GDP. Over the last twenty years answers to the welfare accounting problem have been different. Economists have used dynamic optimisation to rigorously derive an index that can be used to evaluate small projects and their contribution to well being. National Accountants are trying to extend the System of National Accounts (SNA) in the form of satellite accounts by increasing the system boundary. There is also a number of other studies which cannot be included in either of the previous categories and that we may call indices of welfare. They are not rigorously founded and start from common sense ideas of what should and what should not be considered as determinants of well being. This type of indices, however, has received wide attention thanks to their immediate comparability with GDP and to their characteristic of emphasising the long run trend of “welfare” as compared to GDP. Our work falls in the third category. We start from the Index of Sustainable Economic Welfare (ISEW) built up by Cobb and Daly in 1989 and we reproduce it for Italy, though revisiting the methodology associated to the construction of some of the variables. The results show that up to the seventies the Italian GDP only slightly overestimates the growth of economic welfare, but since then it seems to have been misleading, at least as compared to our index. While GDP has continued to rise, economic welfare has been stagnating. The importance of the environmental variables included seems to be decreasing over time going from the 38% in 1980 to the 31% in 1990. The cost of pollution (air, water and noise) has a greater weight in the sixties (about 13%) and falls to 8% in 1990. The ratio between GDP and environmental degradation has remained constant over the decades under consideration, thus contradicting the idea that the demand for environmental quality increases with income.

Keywords: Economic welfare; Environmental accounting; Sustainability.
J.E.L. classification: I31

[1] We thank Alessandro Lanza of FEEM and Paolo Lombardi of WWF-Italy for promoting this research. We also thank Andrea Beltratti for supervision and useful comments and Rosa Franzese for data collection. We are grateful to the Fondazione Eni Enrico Mattei and WWF Italy for technical and financial support. Usual disclaimers apply.

1. GDP as a measure of well being and proposals for reform

The Gross National Product (GNP) or Gross Domestic Product (GDP) has been largely used as an index of the social welfare of a country since the development of national accounting during the second world war. When GNP increases this is taken as a sign that the average welfare of a country is increasing. Thus, the notion of GNP as a measure of material well being has led to important consequences for political decision making. If we subtract economic depreciation from gross investment we get the Net Domestic Product (NDP). In theory NDP does give rise to an aggregate which can be considered as current well being plus increases in future consumption possibilities from current investment activities :

NDP = Consumption + Net Investment + (Export - Import)

If we assume that welfare depends on consumption possibilities, then the first term on the right hand side could be interpreted as current well being from production today, whereas net investment is the increase in capital stock which gives a higher production capacity in the future and the export surplus over imports gives the accumulation of claims on other countries which will be translated into increases in imported consumption goods in the future.

The problem with this definition is that only consumption goods bought and sold on markets are included. In fact the current level of well being is also influenced by non-market goods and services such as: environmental amenities, health, households activities. Moreover the future level of well being depends on assets that are not transacted on the market and not included in the production account such as: depletion of non-renewable resources and net changes in stocks of renewable resources.

The answer to this accounting problem has been heterogeneous. Both academics and statisticians recognise the problem, but the way it is handled varies a lot. As Maler (1996) has pointed out "the various groups proposing answers are not communicating with each other". He identifies three different approaches to the problem of environmental accounting :

Economic theorists[2] use economic theory to mathematically derive an index which can be used to evaluate small projects, i.e. to establish whether a small project will enhance human well being or not. Such an index is a marginal social cost-benefit rule as it tells us whether a project is socially desirable or not, in other words it will rank the social desirability of projects. Economic theorists do not accept any of the other approaches as valuable to reform economic accounting because of their lack of rigour. However, at least as far as we know, the economic theorists approach has received little attention at the empirical level perhaps because it is fairly difficult to translate in practical terms and a comprehensive and non-technical survey of the approach is still lacking.[3]

National Accountants are trying to extend the System of National Accounts (SNA) in the form of satellite accounts by increasing the system boundary. The main result has so far been the System of Economic and Environmental Accounts (SEEA) proposed by the United Nations in 1993.[4]

Finally there is a number of other studies which cannot be included in either of the previous groups and that we may call indices of welfare. They are not rigorously founded and start from common sense ideas of what should and what should not be considered as determinants of well being. Although strongly criticised by the economic theorists (Maler, 1996) this type of indices has received wide attention and interest especially thanks to their immediate comparability with the GDP (due to the fact that they are one-dimensional indices presented in time series), to the simplicity of the approach and to their characteristic of emphasising the long run trend (and thus the difference) of "welfare" as compared to the GDP.[5]

Our work falls in the third category. More precisely, we start from the Index of Sustainable Economic Welfare (ISEW) by Cobb and Daly and we reproduce it for Italy, though revisiting the methodology associated to the construction of some of the variables. Although we are aware of the strong limitations of the approach and especially of its lack of rigorous foundations, we think that the ISEW presents many useful qualities. First of all, the idea of the ISEW has stimulated great interest in Europe: since 1989, ISEW calculations have been presented for Germany (Diefenbacher, 1991), Great Britain (Jackson and Marks, 1994), Austria (Stockhammer, Hochreiter, Obermayr, Steiner, 1997) and in reduced form for Scotland, Denmark and the Netherlands. Thus, international comparisons of levels of welfare across time is possible.

Secondly, even though one can rightly object that what we are measuring is not welfare in a rigorous way, it does give us an indication of its difference with GDP over a fairly long period of time and thus gives some empirical evidence to the theoretical critique of the GDP as a measure of welfare. Thirdly, it is the first rough attempt at building up an

[2] Among leading authors of this line of research one can list: K.G. Maler (1974 and 1991), P. Dasgupta (1995), M. Weitzman (1976), J. Hartwick (1990), J. Heal (1996).

[3] Those who are familiar with dynamic optimisation can find a useful survey of the Economic theorists approach in Heal (1996), whereas the fundamental article to read is Maler (1991).

[4] The main authors in this area are Repetto (1989), Peskin (1989).

[5] The history of these one-dimensional welfare measures contains several empirical studies starting with Nordhaus and Tobin (1972), Zolotas (1981), Cobb and Daly (1989), Uno (1995), Cobb and Cobb (1994).

aggregate monetary index directly comparable with standard national accounts which includes important items usually neglected because of the extreme complexity of their treatment at the aggregate level.

2. The Index of Sustainable Economic Welfare

When Daly and Cobb began working on their welfare indicator there was a general unsatisfaction both with respect to traditional economic accounting and with respect to previous welfare indicators. More precisely, the initial goal of the authors was to modify the index of Nordhaus and Tobin (1972) and to reach a different conclusion. The results of Nordhaus and Tobin showed that there was no need of an indicator of welfare. Although what they called aggregate welfare was lower than GDP over the period analysed, it showed the same trend implying that the direction of economic growth was the same. The difference in the levels of the two indices was only due to subtracted items.

The ISEW proposed by Cobb and Daly is similar to that of Nordhaus and Tobin, but it also takes into account distribution issues and a number of environmental variables. Their result shows a long-run trend of GDP which diverges form the ISEW from the seventies onwards. This result has caused a series of methodological critics as well as useful hints for future research. The same methodology, with a few differences, has been applied to the Italian economy. Our purpose is twofold : to identify the main methodological shortcomings of the Cobb and Daly procedure and to propose alternatives ; to test whether the general trend shown by the American, English and German ISEW is also verified in Italy.

The calculation of the ISEW starts from the consumption base taken from standard national economic accounting and weighted by an index of income distribution. Then a number of variables is subtracted or added according to their contribution to economic welfare. The welfare index for the Italian economy refers to the period 1960-1990 and is given by 21 variables of which 14 are "market" variables, i.e. their value can be inferred from market prices, and 7 are environmental variables to be estimated. It is important to stress that all the variables included are *flow* variables and no stock variables are considered in this kind of work. The need for a long time series of data and for the inclusion of non-market variables increases the level of arbitrariness of each series. An appendix at the end of the paper provides details on each variable.

3. The calculation of the ISEW for Italy 1960-1991

3.1 The consumption base

The starting variable is total consumption expenditure by private households. This aggregate is supposed to be the main determinant of welfare. Data have been taken from the national accounting tables by Rossi, Sorgato and Toniolo (1992) who have provided a statistical reconstruction of the Italian national accounts between 1890 and 1992 that is consistent with the major revision of the national accounts undertaken by the Italian statistical office in 1989. The base year for all the variables considered in this work is 1985.

3.1.1 The Index of income distribution

Probably all would agree that the distribution of wealth and income across individuals is important and that the same level of consumption provides different levels of utility, and thus of welfare, according to the distribution of income across individuals, if the principle of decreasing marginal utility holds. How should one take that into account ? As a first step, we have followed the suggestion of Cobb and Cobb (1994) and calculated the mean of three different indices of income inequality. The first one is a sort of Gini coefficient of income distribution calculated as the ratio between the sum of the ratios between each income decile and the highest decile over 9 (number of deciles). We thus get an index with 1 as the lowest value. Through normalisation of the index with respect to the base year we get an index of income distribution. Income will be equally distributed when the index is close to 1, concentrated when the index is more than 1, little concentrated when it is less than 1. The second index of income distribution is calculated by dividing each decile (tenth) of income by the average value of all the others. Finally the third index is calculated as the ratio of the sum of ratios between each decile and the lowest one over 9. The mean of the three indices has been normalised with respect to the year 1960, i.e. we assume that income was equally distributed in 1960 and see how it has evolved since then.

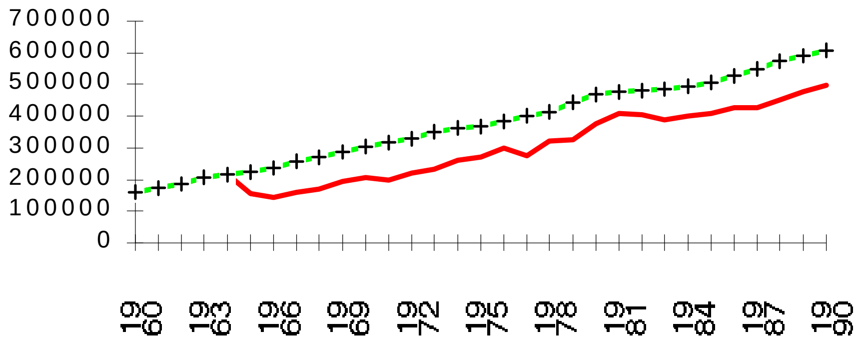
We have family income data published by the Bank of Italy with the exception of the years 1960-1964 when the only data available where those published by Istat for the year 1962. It should also be noted that data available do not allow to estimate personal income distribution, but only family income distribution, as data on individual income are not available.

This approach to the calculation of income distribution has been strongly criticised. A more reliable index of income distribution would be the Kolm-Atkinson index which specifies numerically the attitude of society to inequality, a suggestion we could adopt in a more refined version of the index.

By dividing the total consumption expenditure of private households by the index of distribution inequality we obtain final consumption weighted by income distribution.

Figure 1 shows that income distribution inequality has considerably reduced the real utility of consumption. Only during the first half of the eighties we have a better distribution of income. The coincidence of the two curves in the years 1960-1964 is not due to a perfect distribution of income, but simply to the fact that, due to a lack of data, income deciles for the year 1962 have been used throughout the period.

Fig. 1: Final private expenditure weighted by the index of distributional inequality (billion Lit '85)



3.2 Public expenditure on health and education

To this consumption base a number of items are added to have a more comprehensive measure of welfare. Among those we have considered public expenditure on health and education. Cobb and Daly considered at least 50% of these expenditures as defensive, i.e. they do not add to social welfare. As regards health expenditures, at least half of them are used as defensive against environmental pollution or other consequences of industrialisation, whereas as far as education expenditures are concerned the hypothesis underlying the choice of Cobb and Daly is the model by Thurow (1975) where it is shown that higher levels of education are used only to enter a particular labour market, but they do not really represent a gain in productivity. We have instead considered as defensive only 50% of health expenditures and thus we have added to our consumption base 100% of public expenditure in education and 50% of public expenditure on health.

3.3 Services

3.3.1 *Consumer durables services*

The value of consumer durables' services producing welfare has also to be considered. Cobb and Daly have calculated the value of these services by considering a fixed share (10%) of the annual stock of consumer durables. However we think it more appropriate to add to the stock of consumer durables also that part of capital stock invested in cars (34,9%). Both the stock of consumer durables and the stock of cars have been calculated by considering expenditure flows, i.e. we have taken the sum of net expenditures in durables and vehicles (expenditure minus depreciation) relative to a period equal to the mean life of different consumer durables (10 years). Depreciation has been calculated assuming fixed shares, both for durables and for vehicles.

3.3.2 *Services of households' labour*

Although the contribution of household labour to welfare is undisputed, its measurement raises many problems. There are at least three different approaches suggested by the literature to calculate the services of household labour :1) pricing the output (goods and services) of household labour by market prices, or pricing the inputs (labour) either by 2) opportunity cost or 3) market prices. We have chosen the third approach, by pricing the time allocated to household labour by the market price of domestic services. For the years 1960-1973 we have used data published by Giannone (1975) for the value of unpaid households labour, whereas for the years 1973-1990 we have used own estimation. The number of yearly hours devoted to household labour has been estimated through data taken from Istat (1993): "Indagine multiscopo sulle famiglie", for the years 1987-1991. The monetary component has been calculated by taking the mean hourly retribution of domestic services according to the following relation:

Unit average salary per hour = (total gross annual retribution for domestic services / total number of workers in this category) / average number of annual working hours per worker.

The quantity component of this variable has been calculated by multiplying the number of yearly hours devoted to household labour by the population older than fourteen years of age, taken from census data (Istat).

The value of unpaid households labour, so obtained, has been added to the consumption base as part of the welfare index.

3.3.3 Services of streets and highways
Even this type of services, provided by the public sector, increases our consumption base. The public sector offers infrastructures without a price being paid for them. In order to calculate the value of these services we have assumed it should be equal to their cost of production. We have thus taken public expenditure data on the economic services of streets and highways (Istat). Since the data distinguish between consumption expenditures for economic services and investment expenditures, we have just considered the current consumption expenditures.

3.4 Net capital growth
The increase in net capital stock can be seen as a source of additional future consumption and, as such, should be added to our consumption base. Stated in other words, this variable should also take into account the "sustainability" of economic growth. It tells us the increase in the stock of capital necessary to compensate for population and labour force growth in such a way that a certain level of consumption is sustainable over time. Nordhaus and Tobin (1972) had also calculated this variable by including the productivity of human capital. Net capital growth was then calculated as the variation in the net stock of capital minus the "capital requirement", i.e. the sum of variations in productivity and labour force. However this sort of calculation had produced the paradoxical result that a decrease in productivity would cause an increase in net capital growth. For this reason, Cobb and Daly have not included the productivity variation in their calculation. We have followed the latter procedure. The rate of variation of the labour force has been multiplied by net investment at constant prices for the period 1960-1990. We have thus obtained the "capital requirement", i.e. the value of annual accumulation of capital necessary to compensate for the growth in the labour force. The "capital requirement" has been subtracted from the variation in the net stock of capital to obtain the net capital growth.

3.5 Change in net international position
A surplus of exports over imports indicates a claim of the exporting country over the importing one and thus implies the possibility of increasing future consumption of imported goods. Thus the net international position of a country is important as it reveals whether a country can self sustain its growth or not. Here the net international position is calculated by taking the balance between the sum of current and capital transfers of Italy towards the rest of the world and the sum of current and capital transfers from the rest of the world to Italy. When the balance is positive, we add it to the index of economic welfare , because it signals a positive claim to future consumption of imported goods. If it is negative it will be subtracted from the consumption base as it will be the rest of the world that can claim a credit in terms of Italian goods and services.

3.6 The consumption base: preliminary results
In what follows we plot on the same diagram the main components of what we have called the consumption base. In this graph we show the long-run dynamics of each variable. Final private expenditure and the services from households' labour appear to be the most significant variables. It is particularly significant to notice that the value of households' services, a non-market variable, approximates that of private consumption over the period under consideration.

4. The Index of Sustainable Economic Welfare for Italy: subtraction items
A number of variables influencing welfare are subtracted. Let us start from those variables that can be estimated through standard national accounting and that we have dubbed "economic" as opposed to "environmental" variables.

4.1 Defensive private expenditures on health and education.
Here the considerations made beforehand for the addition of 50% of public expenditures on health and education apply. In order to account for the fact that part of the expenditures on health and education have a purely defensive nature we have deducted 50% of the private expenditure on health and education, since these kind of expenditures were already included in the private total household expenditure variable.

4.2 Expenditures on consumer durables
The amount of money spent for the purchase of consumer durables has been deducted from the private households expenditure variable. This procedure applies because it is not the utility produced by the durable good which adds to social welfare, but the services of if.

4.3 *Costs of commuting*

In order to subtract the cost of commuting from our index of welfare we have considered various methods of estimation. Cobb and Daly estimate this cost through the following relationship:

$C=0,3(A-0,3A)+0,3B$

where: A= cost of own means of transportation (mainly cars)
0,3A= cost of car depreciation;
B= cost of transport services;
0,3B= share of expenditure services due to travel to work.

However, according to the Istat (1993) survey on the use of time in Italy, about 65% of the time spent on travelling by Italians is due to work. Moreover the calculation by Cobb and Daly neglects maintenance costs of public and private transportation services. Thus we have estimated three different time series according to the considerations made about time spent to go to work (C_2) and maintenance costs (C_3):

$C_1= 0,65(A-0,3A)+0,65B$
$C_2= 0,3(A-0,3A)+0,3B+0,3C$
$C_3=0,65(A-0,3A)+0,65B+0,65C$

We have then calculated the arithmetic mean of the four different time series on cost of commuting thus envisaged.

4.4 Cost of auto accidents

The cost of urbanisation has been included. In order to estimate this variable we have considered a quantity and a price component. The number of auto accidents has been obtained from transport statistics of Istat whereas the value of accidents has been deducted from the economic accounts of insurance companies published by Istat.

4.5 Cost of urbanisation

In order to calculate the decrease in welfare due to the increasing level of urbanisation in industrialised countries the cost of urbanisation is included. This variable has been calculated assuming that, over the period under consideration, an increasing share of private households expenditures for housing was due to increasing urbanisation. We started from 18% of private households expenditures for housing in 1960 up to about 30% in 1990.

5. Environmental variables

A number of environmental variables have been considered in our index of sustainable economic welfare. The main problem with the treatment of these variables is the lack of appropriate data. It has been sometimes necessary to rely on strong approximations, not only because of the difficulty in getting point estimates, but also in extending few data to a long time series. Most of the variables included can be classified as environmental costs, namely: the cost of water pollution, the cost of air pollution, the cost of noise pollution, the loss of wetlands, the loss of agricultural land. The last two environmental variables included: exhaustible resources' consumption and long term environmental damage like ozone depletion and the greenhouse effect, should measure the sustainability of current economic practices.
A more detailed account of data sources for these variables is provided in the appendix.

5.1 Cost of water pollution

In order to estimate the cost of water pollution we have used the opportunity cost approach or restoration cost approach, i.e. the expenditure necessary to clean up polluted waters and to obtain an acceptable water quality. Water quality is determined according to a number of parameters, among which are the Biological Oxygen Demand (BOD_5) and Chemical Oxygen Demand (COD). The BOD indicates the quantity of oxygen necessary to eliminate the organic and inorganic substances contained in one litre of water. The number 5 refers to oxygen consumption in 5 days . COD instead gives the number of mg of oxygen necessary to oxidise any substance. Usually, the BOD_5 is used as a general indicator of pollution of superficial water. The level of BOD_5 is generally increased by soil drainage, soil erosion, industrial waste, urban and agricultural waste. We have considered an average amount of BOD_5 per person equal to 60g (IRSA, 1990). In order to calculate the theoretical polluting load of the industrial and agricultural sector we have used conversion factors provided by Istituto di Ricerca Sulle Acque (IRSA). For the calculation of the polluting loads IRSA provides a unique parameter called "equivalent inhabitant", its value refers to the quantity of organic substance contained in the waste of industrial sites compared with that contained in urban waste. Thus the polluting load of a particular sector of the economy is valued by turning the number of workers in each sector in "equivalent inhabitants". For the agricultural sector, the number of livestock has been turned into "equivalent inhabitants" through appropriate conversion factors.

The conversion factors allow us to calculate the potential polluting load for each sector of the economy. The number of workers in each industrial sector has been taken form Istat (Industrial Statistics) and from IRSA. Data on population have been taken from census reports by Istat. By multiplying total population plus equivalent population by 60g and then by the number of days in one year we get, for each year, the BOD_5 load. It is important to stress that the pollution load so identified is just theoretical, as it gives only the "potential" load of pollution based on population.

We have thus obtained the quantity component of the cost of water pollution, now we need to calculate the unit abatement costs of pollution. In order to do that we have used a case-study on abatement costs of water pollution based on a sample of 273 purifying plants in Italy (Federgasacqua, 1992). The BOD_5 concentration per cubic metre (Mc) of water was equal to 0,147 kg/litre, i.e. 352,297 kg/day ; the volume of water treated was equal to 869.964.959 Mc/year. If we multiply the unit BOD_5 calculated by the volume of water treated we obtain the BOD_5 totally contained in the water treated. Given the annual cost of running a purifying plant we were able to calculate the aggregate cost of purifying the water for the year 1991. The same value has been applied to the whole series. The methodology is open to many critics. First of all, not necessarily all the BOD_5 must be abated in order to obtain clean water. Secondly, BOD is only one of the parameters used to measure water pollution. Different parameters present different levels of concentration and different costs of purification. So the BOD_5 parameter can be only an approximation of the actual level of water pollution. As to the estimation of the unit cost of BOD_5 abatement, it is based on a small sample of plants and therefore the cost calculated depends entirely on the technological characteristics of the plants sampled. Moreover we get the cost just for one year, variations over the years are only due to changes in equivalent population. A more rigorous analysis would require the knowledge of the plants' management cost over the years.

Notwithstanding these drawbacks, we believe that the calculation of water pollution abatement costs through the cost of BOD_5 concentration can provide a quick and robust way of calculation.

5.2 Cost of noise pollution

The calculation of this variable was very difficult. There are no data available on the level of noise pollution for the entire national territory. Only a few studies related to the level of noise pollution in big urban areas are available (Paolella, Bilanzone, Bertetti, 1995; Cosa, 1992). However the result of these studies shows that the level of noise pollution has been decreasing starting from 1968, contrary to what is commonly believed. We have used a weighted average of data presented in Cosa (1992) and calculated the level of abatement according to the parameters indicated by the World Health Organisation (WHO). As to the monetary cost of noise pollution, we have used dose-response relationships presented for Germany in a OECD study (1995). The aggregate value of noise pollution obtained has been weighted according to the population living in urban areas with more than 50.000 inhabitants, because we have assumed that only that portion of the population is affected by noise pollution.

5.3 Loss of wetlands

Quantitative data on the loss of wetlands in Italy have been reconstructed according to two census reports by the Commissione Parlamentare speciale per i problemi ecologici (1972) and by the Ministry of the Environment (1991). It appears that from 1971 to 1990 in Italy there has been a loss of about 13.000 hectares of wetlands. We have thus calculated an average annual rate of variation which has been applied the the years back starting from 1900. It seems thus that about 66.000 hectares of wetlands have disappeared since 1990, about 30% of the total stock. We have assumed the benefits loss of this kind of environmental good to be cumulative, so that the year by year value of the loss of wetlands has been added up to the value of the loss accumulated since 1900.

The loss of economic benefits per hectare of wetland has been calculated by extending to the whole territory the valuation of recreational benefits from the Po Delta wetlands calculated by Tomasin (1990). Her valuation of the annual recreational benefits of the Po Delta wetlands for 1990 was equal to about 2 million Lit/hectare.

5.4 Loss of agricultural land

The productive capacity of the soil has been reduced over the years by two factors: 1) the growing urbanisation and intensive agricultural practices and 2) the increasing soil erosion which has reduced soil fertility. The associated loss of welfare should therefore be calculated. Data on the number of hectares subtracted to agricultural use have been taken from Istat. The value of the loss has been calculated through estimation of land values by the Istituto Nazionale di Economia Agraria (INEA) from 1960-1990. Land values have been calculated separately for each region and distinguishing among mountain, hill, coast and flat areas. The national value refers to the unit average value of maximum and minimum quotations for each area. The loss of agricultural land calculated for each year has been cumulated in each subsequent year.

The cost of soil erosion has been obtained by using two point estimates available for the years 1970 and 1979 (Gisotti-Bonettini, 1979) and by applying the rate of growth occurred between 1970 and 1979 to the other years.

5.5 Cost of air pollution

The cost of air pollution has been calculated through a separate estimate of the emission component and the cost component.

We have only considered emissions of NO_x, CO_2, TSP and SO_x as they are the most relevant in Italy. Aggregate emissions at the national level for the years 1985 to 1990 are available from the CORINAIR survey, the European methodology for air emissions data collection in each member country. In order to calculate emissions backwards (from 1960 to 1985) we have used the following methodology: NO_X, CO_2, TSP and SO_X emissions are determined primarily by combustion processes. There is therefore a strong correlation between energy consumption and emissions. Data on energy consumption in Italy have been taken from the Bilancio Energetico Nazionale (BEN) for the years 1960-1987. We have then calculated the ratio of NO_X, CO_2, TSP and SO_X aggregate emissions on aggregate energy consumption for the years 1985-1990. The arithmetic mean of the ratios obtained for the 1985-1990 years has been applied backwards to the preceding years under the assumption of a fixed technology over time. We have thus approximated the aggregate level of emissions for the thirty years under consideration.

The unit damage cost of air pollution for the four pollutants has been estimated through dose-response relationships calculated by Agostini and Clo' (1992) for Italy through a number of international studies on the damage cost of air pollution. Unit (ton emitted) damage costs (for the year 1992) used throughout the series are: SO_X= 4.5 million/Lit; NO_X= 1.75 million/Lit; TSP= 0.25 million/Lit; CO_2= 0.02 million/Lit. 1992 value have then been turned into constant 1985 prices.

5.6 Long-term environmental damage

We set out to introduce the last two variables relevant for the sustainability of the current level of welfare: the long-term environmental damage and the consumption of exhaustible resources.

Many of the current economic practices will show their ill effects on the environment after many years. This is the case, for instance, of CO_2 emissions and the green-house effect. Whereas the current generations may not be affected by the damaging effect of CO_2 emissions, future generations will be bearing the harmful consequences of current economic activities. That means that the latter are not sustainable because they fail to ensure the same level of welfare to current and future generations. We consider here those emissions that are likely to be mainly responsible for long term environmental problems: CO_2, NO_X, CH_4 and CFC. The valuation of the damage caused by these emissions follows the methodology suggested by Daly and Cobb and also used by Jackson and Marks (1992) for the United Kingdom: we assume the future damage to be proportional to the level of fossil fuels and energy consumption.

For Italy we have only considered the level of consumption of non renewable sources of energy. Since the damage we are talking about is of a cumulative nature we have considered the level of consumption since 1900 of wood, coal, natural gas, crude oil and nuclear and electric energy. We have then applied to the annual consumption an annual lump-sum tax of 291,61 Lit in 1972 (this is the equivalent of 0,5US$ in 1972 suggested by Daly and Cobb). The amount of money so calculated represents a capital stock cumulated 1900 which should compensate the future generations for the damage caused by the economic activities of their ancestors. The weight of the long-term environmental damage is considerable: 5,63% of GDP in 1990, 4,93% of GDP in 1980, 3,95% of GDP in 1970 and 3,58% of GDP in 1960.

5.7 Exhaustible resources depreciation

The depletion of exhaustible resources should be considered as a cost borne by the future generations that should be deducted from the capital account of current generations. The depreciation of exhaustible resources is calculated using the El Serafy method, i.e. we estimate the share of returns from the sale of the resource that should be saved and invested in order to produce a flow of future income equal to the rent currently produced by the resource. The El Serafy formula is given by:

$$R - X = R\left(\frac{1}{(1+r)^{n+1}}\right)$$

where :
X= annual rent
R= total returns net of extraction costs
R-X= user-cost: rent gained from resource depletion and that should be deducted from national accounting
r= discount rate
n= number of periods to resource exhaustion.

The problem with the application of the El Serafy methodology is the calculation of n. In order to avoid the problem, Cobb and Daly have assumed r=0. Discounting the utility of future generations might not be considered morally correct. The effect of a 0 discount rate upon the formula is to get X=0. Thus the entire value of total returns from sale of the resource is to be counted as depreciation. Moreover, extraction costs are “regrettable necessities” and as such should be deducted from the index of welfare.

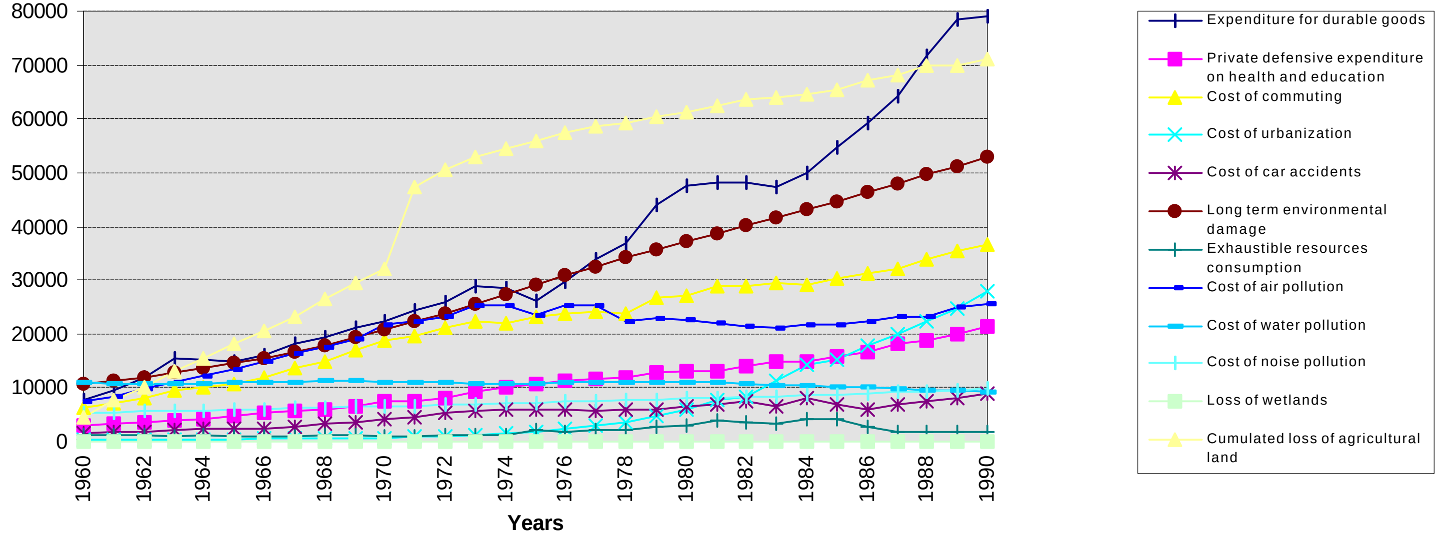
Exhaustible resource depletion has been calculated by distinguishing among energy sources, metal minerals and non-metal minerals. Energy sources considered are: lignite, crude oil, methane, endogenous vapour. Metal minerals: manganese, magnesium, aluminium, copper, lead, zinc. Non mineral metals are: sulphur, rock, pyrites, rock salt.

As to prices over time of the exhaustible resources, we have used for energy sources wholesale prices of crude oil, natural gas, coal and the wholesale price of Arabian Light oil as a price for gasoline. Prices for mineral and non mineral metals have been provided by the Ministry of Industry.

5.8 Empirical results from the subtraction items

As can be seen from figure 3, the subtraction item which weights most on the Index of Economic Welfare is the expenditure on durable goods followed by the cumulated loss of agricultural land and the long term environmental damage. While these variables show an increasing trend over time, the main environmental variables such as the cost of air pollution, of water pollution, of noise pollution and the loss of wetlands appear to be rather stable over time, thus signalling that perhaps too much importance has been attributed to environmental pollution in the decline of social welfare over time, whereas more attention should be paid to long-run phenomena of environmental degradation. It is also interesting to notice how the weight of exhaustible resources' consumption is negligible as compared to the other environmental variables. This might be due to the fact that production prices have been used for these resources and to the fact that Italy is rather poor in exhaustible resources. The value of the resources extracted for each year has not been cumulated over time. However it might be reasonable to assume that once a rent is lost, is lost for ever and not only for the current year.

Fig. 3: Composition of subtraction items (Billion Lit '85)



6. The Index of Sustainable Economic Welfare and GDP in Italy

In figure 4 we compare our per-capita ISEW and the Italian per-capita GDP at '85 prices. When we compare changes in the ISEW to those of GDP we notice a growing gap. Up to the 1970s GDP only slightly overestimates the growth of economic welfare, but since then it seems to have been misleading, at least as compared to our index. While GDP has continued to rise, economic welfare has been stagnating. One reason for this could be that long-run negative components of welfare (loss of land, long term environmental damage) have been growing much faster than the consumption base. More generally it seems that the current production processes are threatening future wealth. Our results are consistent with what has been found in similar studies in the US, in the UK and in Austria. However, we do not register the significant decreasing trend that the ISEW has registered in other countries after the '70. To the contrary, our index continues to rise, although at a decreasing rate, over the 1980s as table 1 shows.

Table 1: Per-capita GDP and ISEW growth rates, mean of decades

years	per-capita GDP	per-capita ISEW
1960-1970	4,97%	1,77%
1970-1980	3,34%	4,26%
1980-1990	2,17%	2,03%

When studying the weight that each variable has on the index the following observations apply. First of all, the weight of the final households consumption expenditures increases ever more from 1960 (57%) to 1990 (93%), thus showing that the growing relative importance of this variable has been counter balanced by the negative components of the welfare index. Moreover the weight of private households consumption expenditures on GDP has followed a U shape over the thirty years under consideration. Secondly, among the positive components of welfare, the greatest weight is given by the services of domestic labour: 62% in 1990.

Among the negative components, the most relevant variable is the loss of agricultural land, given its character of cumulated value and its double meaning of loss of productivity and loss due to soil erosion. Besides this, the strong increase in the expenditure for durable goods not associated to an equal growth in the services offered by these goods seems to indicate an ever growing 'commoditification', i.e. there is an ever faster turnover of durable goods not due to increased obsolescence, but to increased consumption.

As to the environmental variables included, although they have a considerable weight in the Index of Sustainable Economic Welfare, their importance seems to be decreasing over time going from the 38% in 1980 to the 31% in 1990. The cost of pollution (air, water and noise) has a greater weight in the sixties (about 13%) and falls to 8% in 1990. Among the environmental variables the long-term environmental damage and the loss of agricultural land have the greatest weight. However it is important to notice how the ratio between GDP and environmental degradation has remained constant over the decades under consideration, thus contradicting the economists' belief that the demand for environmental quality increases with income.

7. Concluding remarks

The aim of the ISEW for Italy is mainly to show the limitation of GDP as a welfare measure. Of course it does not pretend to be complete nor theoretically rigorous, but it may stimulate useful discussion and it provides a set of data that can be used in different contexts. It seems to us that the ISEW can be considered as a useful exercise in order to develop aggregate indicators showing qualitative growth rather than quantitative one. The main limitation of indices such as the ISEW is, we believe, their lack of theoretical foundation. Its main quality is its simplicity although each time series represents in itself a challenge and requires a lot of thinking. Since our index follows closely the initial ISEW presented for the United States and presented also in some European countries it is possible to make comparisons across countries. Many of the ISEW calculations presented (for instance for Germany, the UK, the US and Austria) show a shape exactly opposite that of an environmental Kuznets curve. In an environmental Kuznets curve environmental degradation or "consumption" follows the path of an inverted U curve with respect to changes in real *per capita* income, similar to the traditional Kuznets' curve describing the relationship between economic growth and income distribution. This means that the level of environmental degradation declines with increasing income per-capita. The evidence shown by the welfare indices presented for the above mentioned countries is against this theory as they show a decreasing level of welfare (and thus perhaps an increasing environmental degradation) as income grows with the flex point arising in the 1070s. The Italian index does not show a sharp decreasing trend from the 1970s, however, as we have mentioned before, the level of environmental degradation has remained approximately constant over time and does not show the inverted U shape suggested by the environmental Kuznets curve, thus confirming the evidence found for other countries.

References

Banca d'Italia, *Reddito, risparmio e alcuni consumi delle famiglie italiane.* In: "Supplemento al bollettino statistico", various years.

Bocola, W., M. C. Cirillo, D. Gudioso, C. Trozzi, R. Vaccaro and C. Napolitano (1989) *Progetto CORINAIR: inventario delle emissioni di inquinanti dell'aria in Italia nell'anno 1985.* Enea, studi n. 89/8.

Clo, A. and A. Agostini (1993) *I costi sociali del servizio elettrico per il sistema Italia.* ISES, 1993.

Cobb and Cobb (1994) *The green national product: a proposed index of sustainable economic welfare.* Human Economy Centre, University Press of America.

Conte, G. and G. Squitieri (1995) *Suoli e territorio.* In: "Rapporto sullo stato dell'ambiente nel bacino del Mediterraneo". Ecomed, aprile 1995.

Cosa, M. (1992) *L'inquinamento da rumore.* N.I.S..

Daly, H. and J. Cobb, (1989) *For the common good.* Beacon Press.

Dasgupta, P., S. Marglin and K. G. Maler (1996) *Current issues in resource accounting.* In: "Current issues in environmental economics". Eds. P. O. Johansson, B. Kristrom, K. G. Maler, 1996.

De Meo, G. (1967) *Redditi e produttività in Italia (1951-1966).* Istat, annali di statistica, anno 96, serie VIII, vol. 20.

Diefenbacher (1991) *The index of sustainable economic welfare. A case study of the Federal Republic of Germany.* Unpublished manuscript.

El Serafy S. (1989) *The proper calculation of income from depletable resources*. In: "Environmental accounting for sustainable development", Yusuf Ahmad, Salah El Serafy, Ernst Lutz, eds.. Washigton D.C.: World Bank.

ENEL, *Produzione e consumo di energia elettrica in Italia,* various years.

Federgasacqua, (1992) *Rilevamento statistico sulla depurazione delle acque.* Unpublished report.

Giannone, A. (1975) *Verso una misura di benessere economico.* Rivista di Politica Economica. Agosto-Settembre 1975.

Giannone, A. (1995) *Un confronto del benessere economico dell'Italia e del Regno Unito.* Studi e Informazione, Banca Toscana, 1/95.

Gisotti and Bonettini (1979) *Il dissesto idrogeologico della montagna italiana.* Tecneco, 1979.

Golinelli, R. and M. Monterastelli (1990) *Un metodo per la ricostruzione di serie storiche compatibili con la nuova contabilità nazionale (1951-1989).* Nota di lavoro 9001. (Bologna, Prometeia, 1990).

Hartwick, J. (1990) *Natural resources, national accounting and economic depreciation.* Discussion Paper n. 771, Queen's University, Kingston, Ontario.

IRSA (1973) *Elementi e criteri per la diffusione del livello di accettabilità delle acque di scarico.* Vol. 24 IRSA/CNR.

IRSA (1990) *Valutazione dei carichi inquinanti potenziali per i principali bacini idrografici italiani.* Vol. 90, IRSA/CNR.

Istat, *Annuario di contabilità nazionale.* Roma: Istat, various years.

Istat, *Annuario di statistica agraria.* Vol. XIII. Roma: Istat, 1966.

Istat, *Annuario statistico italiano.* Roma: Istat, various years.

Istat, *Censimento industriale.* Anni 1951, 1961, 1971, 1981. Roma: Istat, various years.

Istat, *Conti Economici Nazionali, anni 1970-1988.* In “Collana di Informazione”. Roma: Istat, 1989.

Istat, *Gli impieghi dell’energia in Italia nel 1980-82-85.* In “Collana di Informazione”. Roma: Istat, 1990.

Istat, *I consumi delle famiglie.* In “Collana di Informazione”. Roma, Istat: various years.

Istat, *I conti delle amministrazioni pubbliche e della protezione sociale, 1985-1990.* In “Collana di Informazione”. Roma: Istat, 1992, n. 16.

Istat, *L’uso del tempo in Italia.* In: “Indagine multiscopo sulle famiglie, 1987-1991”. Roma: Istat, 1993.

Istat, *Lavoro e retribuzioni.* In “Collana di Informazione”. Roma: Istat, various years.

Istat, *Occupazione e redditi da lavoro dipendente.* In “Collana di Informazione”. Roma: Istat, various years.

Istat, *Sommario di statistiche storiche dell’Italia, 1926-1985,* Roma: Istat, 1986.

Istat, *Statistiche ambientali.* Roma: Istat, various years.

Istat, *Statistiche dell’Agricoltura, zootecnia e mezzi di produzione.* In “Collana di Informazione”. Roma: Istat, various years.

Istat, *Statistiche della pubblica amministrazione e delle opere pubbliche.* In “Collana di Informazione”. Roma: Istat, various years.

Istat, *Statistiche Industriali.* In “Collana di Informazione”. Roma: Istat, various years.

Istat, *Trasporti e telecomunicazioni.* In “Collana di Informazione”. Roma: Istat, various years.

Istituto di Ricerca Sulle Acque (IRSA), Barbiero, Cecioni, Spaziani (1987) *Un sistema informativo per la valutazione dell’inquinamento potenziale. Un’applicazione alle regioni e province italiane.* Vol. 74, IRSA/CNR.

Istituto Nazionale di Economia Agraria, INEA, *Annuario dell’agricoltura italiana; various years*.

Jackson, T. and N. Marks (1994) *Measuring sustainable economic welfare. A pilot index: 1950-1990.* Stockholm Environmental Institute.

Kendrick, J. (1979) *Expanding imputed values in the national income and product accounts.* Review of Income and Wealth, n. 25 (4), 1979.

Maler, K. G. (1991) *National accounts and environmental resources.* Environmental and Resource economics, 1991.

Maler, K. G. (1996) *Welfare indices and the environmental resource base.* Unpublished paper. The Beijer International Institute of Ecological Economics. Stockholm.

Ministero dell’Ambiente (1991) *Inventario delle zone umide del territorio italiano.* Roma, 1991.

Ministero dell’Industria e del Commercio, Direzione Centrale delle Miniere, *Statistiche delle miniere, cave e torbiere,* various years.

Nordhaus, W. D. and J. Tobin (1973) *Is growth obsolete?* In: “Economic growth, Fiftieth anniversary colloquium”. Vol. 5, NBER, 1973.

OECD (1995) *La reduction du bruit aux abords des voies routieres.* In: “Rapport realisé par en groupe d’experts scientifiques de l’OECD”.

ONU (1993) *Integrated environmental and economic accounting.* Series F., N. 61, New York.

Ottinger, (1991) *Incorporation of Environmental externalities in USA.* In: Homeyer eds. “External environmental costs ofelectric power”. Springer Verlag, Berlin.

Paolella, A., G. Bilanzone, C.A. Bertetti (1995) *Rumore urbano, profili per un intervento strutturale.* Dossier WWF, aprile 1995.

Peskin, H. (1989) *A proposed environmental accounts framework.* In: “Environmental accounting for sustainable development”. Washington, the World Bank.

Pierantoni, F., F. Piacentini, P. Vestrucci (1978) *Un contributo alla conoscenza del problema dell’energia in Italia dal 1861 al 1978.* Comitato per l’energia nucleare, Dipartimento Reattori Veloci, Luglio 1978.

Rapporto della Commissione Parlamentare speciale per i problemi ecologici. 5 legislatura, 1968-1972, doc. XXV n. 1.

Repetto, R., W. Magrath, M. Wells, C. Beer and F. Rossini (1989) *Wasting Assets and natural resources in the national income accounts.* World Resources Institute.

Rossi, N., A. Sorgato and G. Toniolo, (1992) *I conti economici italiani: una ricostruzione statistica.* Note di lavoro del dipartimento di scienze economiche, Università degli Studi di Venezia.

Stockhammer, E., H. Hochreiter, B. Hobermayr and K. Steiner (1997) *The index of sustainable economic welfare (ISEW) as an alternative to GDP in measuring economic welfare. The results of the Austrian (revised) ISEW calculation, 1955-1992.* Ecological Economics, 21, 1997: 19-34.

Tomasin, A. (1991) *Economic valuation of the Po Delta Wetlands.* Note di lavoro FEEM 8/91.

Uno, K. (1995) *Environmental options: accounting for sustainability*. Kluwer Academic Publishers, 1995.

Weitzman, M. (1976) *On the welfare significance of national product in a dynamic economy*. Quarterly Journal of Economics, 90, 1976: 156-162.

Zolotas, X. (1981) *Economic growth and declining social welfare.* New York.

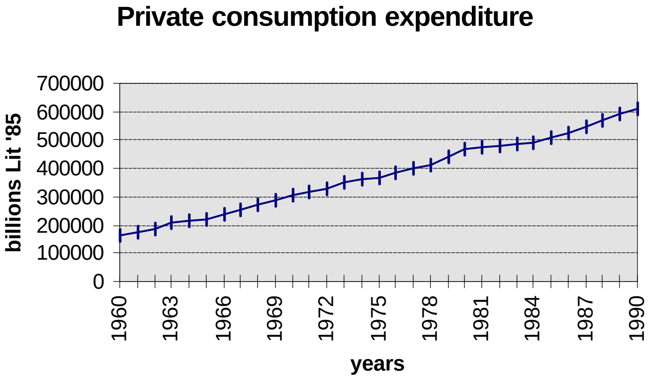
APPENDIX

In what follows a detailed description of each variable and of data used in the construction of the index is given.

1. PRIVATE HOUSEHOLDS' EXPENDITURE

Data on private consumption expenditures have been taken from Rossi, Sorgato and Toniolo (1992) where the existing national accounting statistics for the period 1890-1990 are revised providing a new coherent set of estimates of the main supply and demand components of Italian GDP.

Expenditure items for each of the ten elements that make up this category have been separately reconstructed: (i) food and beverages (ii) tobacco, (iii) clothing and footwear, (iv) rent, (v) fuel and power, (vi) furniture, furnishings and household equipment and operation, (vii) transport and communication, (viii) medical care and health expenses, (ix) recreational entertainment, education and cultural services, (x) miscellaneous goods and services.



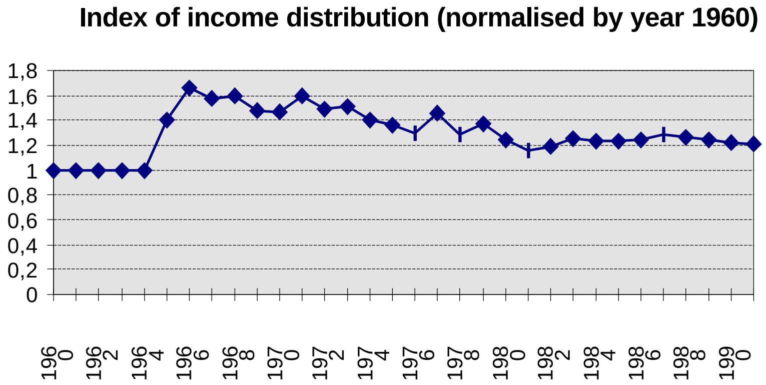
2. INDEX OF DISTRIBUTION INEQUALITY

The index of distribution inequality has been calculated as the arithmetic mean of three different indices of income inequality. The first index of income concentration has been obtained by dividing the highest decile by all the others. All the ratios have been summed up and the result divided by 9. It is a kind of harmonic mean. The second index has been calculated as the ratio between the highest decile and the average value of all the others. Finally the third index is obtained as the sum of the ratios between each decile and the lowest one, divided by 9. The index of distribution inequality obtained as the arithmetic mean of the three indices above has been normalised with respect to the year 1960. This simply means that the higher or lower income concentration over the thirty years considered has been normalised to the level of income distribution existing in the starting year of our analysis. All data on income distribution have been taken from Bank of Italy's publications except for the years from 1960 to 1964. For these years the only data available are Istat data published by Meo (1967) for the year 1963, this is why the resulting index of distribution inequality appears to be the same from 1960 to 1964.

$$\frac{\sum_{i=1}^{9} \frac{d_9}{d_i}}{9} = I^1 \qquad \frac{d_9}{\left(\frac{\sum_{i=1}^{9} d_i}{9}\right)} = I^2 \qquad \frac{\sum_{i=1}^{9} \frac{d_i}{d_1}}{9} = I^3$$

$I = (I^1+I^2+I^3)/3$

where:
d= income decile;
I= index of income distribution.



3. WEIGHTED PRIVATE CONSUMPTION EXPENDITURE

By dividing the private consumption expenditure series by the index of distribution inequality we obtain the weighted private consumption expenditure: when income is highly concentrated, the welfare value of consumption will be lower than when income is equally concentrated. That is because of the decreasing marginal utility of income. As a result, after the first half of the sixties the level of weighted households expenditure in Italy appears to be lower than its non-weighted equivalent.

4-5. HOUSEHOLDS' DURABLES EXPENDITURE AND THE VALUE OF THEIR SERVICES

The value of the services offered by durable goods is assumed to be equal to 10% of the stock value of the same goods in each year. The stock value of durable goods (including vehicles) is calculated as the sum of net expenditures (expenditure minus depreciation) for these goods over a ten years period, which is assumed to be the average lifetime of a durable good. Annual depreciation is calculated according to constant shares, both for electrical appliances and vehicles. While the value of the services is added to the welfare index, the aggregate expenditure on these goods is subtracted, as it is not assumed to increase current welfare. Data have been taken from Istat, Collana di Informazioni: "I consumi delle famiglie".

Errore. Il collegamento non è valido.

6-7. PUBLIC AND PRIVATE EXPENDITURE ON HEALTH AND EDUCATION

Only 50% of the private and public expenditures on health are added to the welfare index. This is because it is assumed that half of them have a defensive nature. Since private expenditures on health is already included in the households' consumption expenditures this means that half of them is to be deducted, whereas half of the total public expenditure on health is assumed to be necessary to fight the health consequences of an ever more hostile environment (they are defensive health expenditures). 100% of public expenditures on education has been added, whereas only 50% of the private one has been deducted. Expenditures on education are defensive when necessary to be more competitive on the labour market, although they do not really represent a gain in productivity or a source of human capital.

Errore. Il collegamento non è valido.

8. THE VALUE OF UNPAID HOUSEHOLDS LABOUR

Two sources of data have been used to calculate this variable. For the years 1960 to 1973 we have reported data by Giannone and Alvaro (1975), whereas for the years 1974 onwards we have proceeded to own calculation with homogeneous data and methodology. We distinguish a quantity component (number of hours per year devoted to domestic labour) and a value component (average hourly retribution for domestic labour). The number of hours per year devoted to domestic labour has been calculated by using Istat data from the survey "Indagine multiscopo sulle famiglie: l'uso del tempo in Italia" for the years 1987-1991. The number of hours spent on domestic labour includes time (hours per day) spent for housekeeping and child-care by the population (both male and female) over 14 years of age. Data available for these years have been extended to the remaining years of the time series and multiplied by 365. We thus got the annual number of hours per person spent on domestic labour. As to the value component, we have used the average retribution for domestic labour of a maid taken from Istat, Collana di Informazioni: "Lavoro e retribuzioni" and "Occupazione e redditi da lavoro dipendente". The average unit salary per hour (AUSH) has been calculated according to the following formula:

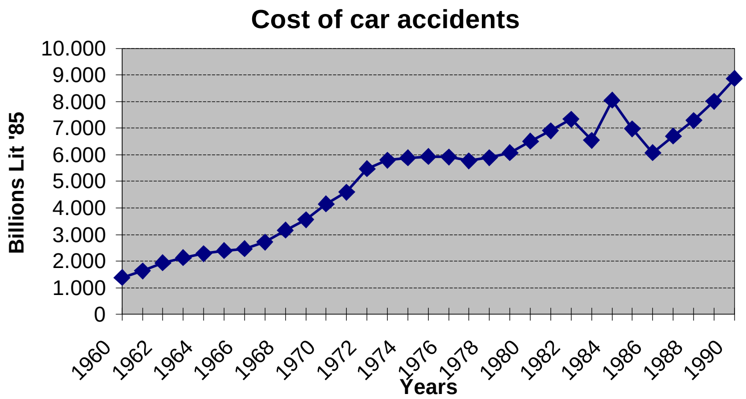
AUSH=(annual gross total income from domestic labour / total number of workers in this category) / average number of hours worked per worker.

The value of households labour as then been obtained as:

AUSH * number of hours spent on domestic labour per person per year * population under 14 in each year.

9. COST OF CAR ACCIDENTS

The cost of car accidents should be deducted from the welfare index as it represents, in fact, a reduction of welfare to the society. The cost of car accidents has been obtained from the balance sheet of the Italian insurance companies by taking the entry relative to payments following car accidents. The relevant Istat publication for these data is Collana di Informazioni: "Trasporti e telecomunicazioni".



10. VALUE OF THE SERVICES OF STREETS AND HIGHWAYS

Data relative to this variable have been obtained from Istat: Collana di Informazioni: "Statistiche della pubblica amministrazione e delle opere pubbliche. Here we find an entry for the public expenditure on economic services and a sub-entry for streets and highways. On average, over the interval 1980-1990, 15% of the public expenditure for economic services was devoted to streets and highways. However these data include both current consumption and investment on streets and highways, whereas it seems reasonable to assume that only consumption expenditure contribute to current levels of welfare. If we assume, as we have done, that the share of streets consumption expenditures over aggregate public consumption expenditure is equal to the share of total streets and highways services (including both consumption and investment) over the aggregate public expenditure for economic services, we can obtain the value of the services of streets and highways from the time series of aggregate consumption of the public administration. It is an arbitrary assumption, which could be easily improved.

11. COST OF COMMUTING

The cost of commuting has been obtained as the arithmetic mean of 4 different ways of calculation. Cobb and Daly calculate the cost of commuting as follows:

Cost of commuting=0,3(A-O,3A)+0,3B

where : A= cost of own means of transportation

0,3A= cost of car depreciation

B=expenditure on transport services

0,3B= expenditure on transport services to reach the job location.

However, if we consider the results of the survey "Indagine multiscopo sull'uso del tempo in Italia", we could guess a different share of transport expenditure and get:

C_1 =0,65(A-0,3A)+0,65B

The above calculations should also take into account maintenance costs of all means of transportation and so we get two alternative relationships:

C_2 =0,3(A-0,3A)+0,3B+0,3C

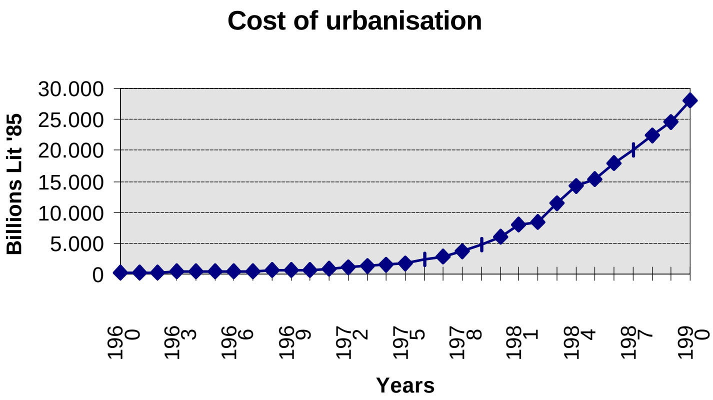
C_3 =0,64(A-0,3A)+0,65B+0,65C

The cost of commuting is then obtained as the arithmetic mean of the four different relationships.

Errore. Il collegamento non è valido.

12. COST OF URBANIZATION

Here it is assumed that part of the private consumption expenditure on housing is due to the increasing level of urbanisation, which creates environmental externalities of various kinds. Following the work of Cobb and Daly we have assumed that between 1960 and 1990 a share varying from 18% to 30% of the private expenditure on housing is due to the increasing cost of urbanisation. Data have been taken from Istat, Collana di informazioni: "I consumi delle famiglie: spesa in abitazione delle famiglie".



13. NET CAPITAL GROWTH

This variable is supposed to measure, somehow, the sustainability of economic growth. It indicates the variation in the stock of capital necessary to compensate for the increase in population and the labour force over time so that a certain level of income and consumption will be sustainable over time. In order to calculate the net growth of the Italian capital stock we have multiplied the rate of growth of the labour force by the level of net investments in each year (gross investments minus depreciation) for the period 1960-1990. We have thus obtained the "capital requirement", i.e. the annual value of capital necessary to compensate for growth in the labour force. If we then subtract from the capital requirement the changes over time in the net stock of capital we obtain the net capital growth. All data have been taken from the National Economic Accounts published by Istat.

$$NCG = \Delta K - CR$$

$$CR = \frac{\Delta L}{L} K_{-1}$$

DK=K-K_{-1}

DL=L-L_{-1}

where: *NCG*= net capital growth ; *K*= capital stock ; *L*= labour force.

The net capital growth is thus calculated by adding the amount of new capital stock minus the capital requirement, i.e. the amount of capital necessary to maintain the same level of capital per worker. The capital requirement is calculated by multiplying the percentage change in the labour force by the stock of capital of the previous year. We have used a five years average of changes in labour force and capital to smooth out year to year fluctuations.

Errore. Il collegamento non è valido.

14. NET INTERNATIONAL POSITION

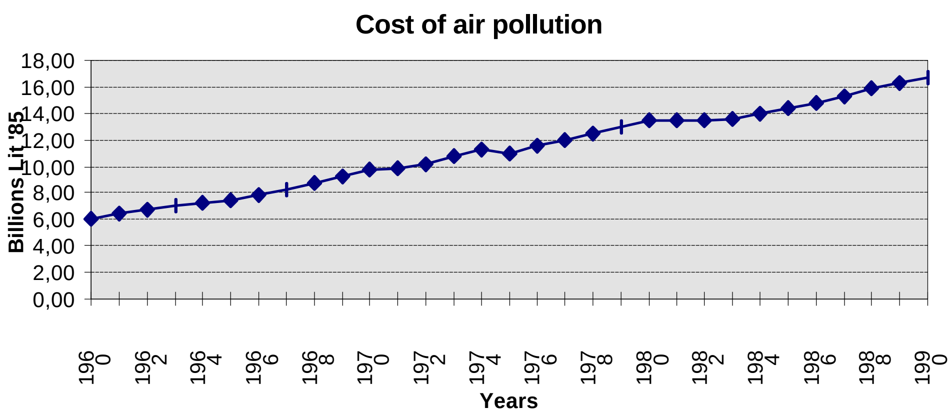
The long run economic sustainability of a country also depends on the sustainability of the source of its capital. Indeed if a country finances its capital accumulation borrowing from abroad, this indicates a basic weakness of its long-run economic growth. Thus it is important to check the level of the net international position of a country. The net international position is obtained as the balance between incoming (the sum of current operations and capital account transfers towards the rest of the world) and outgoing (transfers in the capital account from the rest of the world) of Italy with the rest of the world. Even in this case five years averages have been used to smooth out fluctuations.

Errore. Il collegamento non è valido.

15. COST OF AIR POLLUTION

In order to calculate the cost of air pollution we have considered a quantity component (emissions) and a value component (the unit damage cost of emissions). As to the quantity component we have only considered emissions of NO_x, CO_2, TSP and SO_x as they are the most relevant in Italy and also because these estimates are already available from the CORINAIR database from 1985 to 1990. CORINAIR is the European methodology for air emissions data collection in each member country. In order to calculate emissions backward (from 1960 to 1985) we have used the following methodology: the CORINAIR survey allows us to separate the share of emissions caused by combustion processes by the other emissions. When emissions are caused by combustion processes it is reasonable to assume that there is a strong correlation between energy consumption and emissions. Data on energy consumption in Italy have been taken from the Bilancio Energetico Nazionale (BEN) for the years 1960-1987. We have then calculated the ratio of NO_X, CO_2, TSP and SO_X emissions on aggregate energy consumption for the years 1985-1990. The average emissions/energy consumption ratio obtained for the years 1985-1990 has been applied backwards to the preceding years under the assumption of a fixed technology over time. For those emissions not caused by combustion processes we have correlated their lelve to the value-added of the sector producing emissions (CORINAIR data are obtained by aggregation of data from 9 sub-sectors of the economy) and applied the same procedure.

As to the value component, the unit damage cost of air pollution for the four pollutants has been estimated through dose-response relationships calculated by Agostini and Clo' (1992) for Italy. These values are mean values of international estimates of unit damage costs per ton of emissions: SO_X= 4.5 million/Lit NO_X= 1.75 million/Lit; TSP= 0.25 million/Lit; CO_2= 0.02 million/Lit. 1992 value have then been turned into constant 1985 prices. By multiplying the value component and the quantity component for each year we have obtained the aggregate cost of air pollution limited to the 4 pollutants under consideration.



16. COST OF WATER POLLUTION

In order to estimate the cost of water pollution we have used the opportunity cost approach or restoration cost approach, i.e. we calculate the expenditure necessary to clean up polluted waters. Water quality is determined according to a number o parameters, among which are the Biological Oxygen Demand (BOD_5) and the Chemical Oxygen Demand (COD). The BOD indicates the quantity of oxygen necessary to eliminate the organic and inorganic substances contained in one litre of water. The number 5 refers to oxygen consumption in 5 days. COD instead gives the number of mg of oxygen necessary to oxidise any substance. Usually, the BOD_5 is used as a general indicator of superficial water pollution. Soil drainage, soil erosion, industrial waste, and urban and agricultural waste generally increase the level of BOD_5. We have considered an average amount of BOD_5 per person equal to 60g (IRSA, 1990). In order to calculate the theoretical polluting load of the industrial and agricultural sector we have used conversion factors provided by IRSA (Istituto di Ricerca Sulle Acque). IRSA provides a unique parameter called "equivalent inhabitant" for the calculation of the polluting loads. Its value refers to the quantity of organic substance contained in the waste of industrial sites compared with that contained in urban waste. Thus, the polluting load of a particular sector of the economy is valued by turning the number of workers in each sector of the economy in "equivalent inhabitants". For the agricultural sector, the number of livestock has been turned into "equivalent inhabitants" through appropriate conversion factors provided by IRSA.

The conversion factors allow us to calculate the potential polluting load for each sector of the economy. The number of workers in each industrial sector has been taken form Istat: "Industrial Statistics" and from IRSA. Data on population have been taken from census reports by Istat. By multiplying the sum of the total population and the equivalent population by 60g and then by the number of days in one year we get, for each year, the aggregate BOD_5 load. It is important to stress that the pollution load so identified is just theoretical, as it gives only the "potential" load of pollution based on population size in each year.

We have thus obtained the quantity component of the cost of water pollution, but we still need to calculate the unit abatement cost of pollution. In order to do that we have used a case-study on abatement costs of water pollution based on a sample of 273 purifying plants in Italy (Federgasacqua, 1992). According to this study, the BOD_5 concentration per cubic metre (Mc) of water was equal to 0,147 kg/litre, i.e. 352,297 kg/day; the volume of water treated was equal to 869.964.959 Mc/year. If we multiply the unit BOD_5 calculated by the volume of water treated we obtain the BOD_5 totally contained in the water treated. Given the annual cost of running a purifying plant we were able to calculate the aggregate cost of purifying the water for the year 1991. The same value has been applied to the whole series.

The methodology is open to many criticisms. First of all, not necessarily all the BOD_5 must be abated in order to obtain clean water. Secondly, BOD is only one of the parameters used to measure water pollution. Different parameters present different levels of concentration and different costs of purification. So the BOD_5 parameter can be only an approximation of the actual level of water pollution.

As to the estimation of the unit cost of BOD_5 abatement, this is based on a small sample of plants and therefore the cost calculated depends entirely on the technological characteristics of the plants sampled. Moreover, we get the cost just for one year; variations over the years are only due to changes in population. A more rigorous analysis would require the knowledge of the plants' management cost over the years.

Theoretical water pollution load per year (ton) = BOD_5*365* total population (at time t)

where: BOD_5 = 60g average daily per person;
total population = resident population + equivalent population in industry and agriculture;

unit cost (cost per ton) of BOD_5 abatement = $C_{91}*BOD_{91}$
C_{91}= average management cost of a purifying plant in 1991;
BOD_{91} = total BOD_5 treated in a sample of about 300 purifying plants in 1991.

17. COST OF NOISE POLLUTION

There are no data available on the level of noise pollution for the entire national territory. Only a few studies related to the level of noise pollution in big urban areas are available (Paolella, Bilanzone, Bertetti, 1995 ; Cosa, 1992). However the results of these studies show that the level of noise pollution has been decreasing starting from 1968, contrary to what is commonly believed. Also for this variable we distinguish a quantity component from a value component.

The number of decibel in urban areas (level of noise pollution) has been calculated as a weighted average of data presented by Cosa (1992) for noise pollution in Rome. The degree of abatement is based on the parameter suggested by the World Health Organization (WHO) for an acceptable level of noise in urban areas. We thus get the number of decibel to be abated for each year.

As to the cost component of noise pollution we have adopted the unit damage cost calculated for Germany from dose-response relationships (OECD, 1995). The aggregate value of noise pollution obtained has been weighted according to the population living in urban areas with more than 50.000 inhabitants, because we have assumed that only that portion of the population is affected by noise pollution. We have estimated that population living in urban areas with more than 50.000 inhabitants is equal to 33,4% of the total Italian population. Thus, only 33,4% of the aggregate cost of noise pollution is supposed to represent the "true" cost of noise pollution.

$C_t = db*AB_{94}*0,334$

where: C_t = aggregate cost of abatement of noise pollution at time t;
db = number of decibel to be abated according to the WHO;
AB_{94} = unit abatement cost estimated by 0ECD in 1994;
0,334= share of total population subject to noise pollution.

18. LOSS OF WETLANDS

Quantitative data on the loss of wetlands in Italy have been reconstructed according to two census reports by the Commissione Parlamentare speciale per i problemi ecologici (1972) and by the Ministry of the Environment (1991). It appears that from 1971 to 1990 in Italy there has been a loss of about 13.000 hectares of wetlands. We have thus calculated an average annual rate of variation, which has been applied to the years back starting from 1900. It seems that about 66.000 hectares of wetlands have disappeared since 1990, about 30% of the total stock. We have assumed the benefits loss from wetlands to be cumulative, so that the year-by-year value of the loss of wetlands has been added up to the value of the loss cumulated since 1900.

The loss of economic benefits per hectare of wetland has been calculated by extending to the whole territory the valuation of recreational benefits from the Po Delta wetlands calculated by Tomasin (1990). Her valuation of the annual recreational benefits of the Po Delta wetlands for 1990 was about 2 million Lit/hectare.

19. LOSS OF AGRICULTURAL LAND

The continuous loss of agricultural land is caused by two concomitant factors: 1) the growing urbanisation and intensive agricultural practices and 2) the increasing soil erosion which has reduced soil fertility.

From Istat data on the number of hectares subtracted to agricultural use are available for a number of years, going back to the 50ies. As to the first factor contributing to land loss the value has been calculated through estimation of asset values for land by INEA from 1960-1990. Land values have been calculated separately for each region and distinguishing among mountain, hill, coast and flat areas. The national value refers to the unit average value of maximum and minimum quotations for each area. The loss of agricultural land calculated for each year has been cumulated in each subsequent year.

The cost of soil erosion has been obtained by using two point estimates available for the years 1970 and 1979 (Gisotti-Bonettini, 1979) and by applying the average annual rate of variation incurred between 1970 and 1979 to the remaining years.

20. LONG TERM ENVIRONMENTAL DAMAGE

Many of the current economic practices will show their ill effects on the environment after many years. This is the case, for instance, of CO_2 emissions and the greenhouse effect. Whereas the current generations may not be affected by the damaging effect of CO_2 emissions, future generations will be bearing the harmful consequences of current economic activities. That means that the latter are not sustainable because they fail to ensure the same level of welfare to current and future generations. We consider here 4 kinds of emissions: CO_2, NO_X, CH_4 and CFC. These are the pollutants more likely to cause long-term environmental problems. The valuation of the damage caused by these emissions follows the methodology suggested by Daly and Cobb and also used by Jackson and Marks (1992) for the United Kingdom: we assume the future damage to be proportional to the level of fossil fuels and energy consumption.

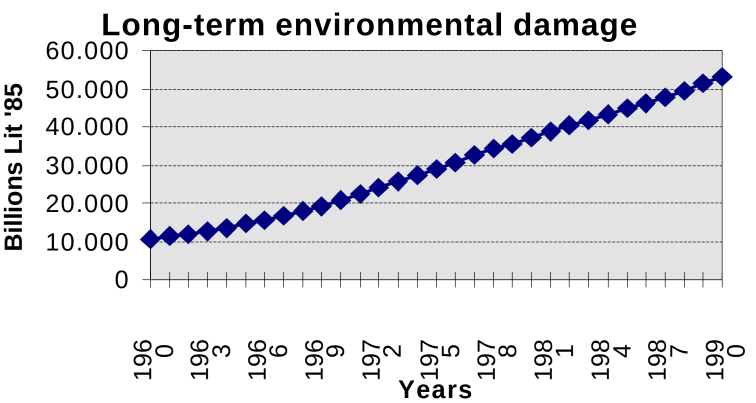
For Italy we have only considered the level of consumption of non-renewable sources of energy, i.e. wood, coal, natural gas, crude oil and its derivatives, electric energy. Since the damage we’re talking about is of a cumulative nature we have considered the level of consumption since 1900 of wood, coal, natural gas, crude oil and nuclear and electric energy. We have then applied to the annual consumption an annual lump-sum tax of 291,61 Lit in 1972 (this is the equivalent of 0,5US$ in 1972 suggested by Daly and Cobb. This procedure is obviously arbitrary also because the same tax level is applied along the whole time series, but it allows us to retain comparison with the American ISEW). The amount of money calculated in this way represents a capital stock cumulated starting from 1900 which should compensate the future generations for the damage caused by the economic activities of their ancestors. The long-term environmental damage, not discounted, is equal to 1951,31 Lit in 1985. The weight of the long-term environmental damage appears to be considerable: 5,63% of GDP in 1990, 4,93% of GDP in 1980, 3,95% of GDP in 1970 and 3,58% of GDP in 1960.

$$LTED_t = \left(C_t \cdot 291{,}61\right) + \sum_{i=1900}^{t-1} C_i$$

where: $LTED_t$ = Long Term Environmental Damage at time *t;*

C_t = consumption of non-renewable energy at time *t;*

£291,61 = unit tax on energy consumption equivalent to 0,5$ in 1972, as applied by Daly and Cobb.



21. EXHAUSTIBLE RESOURCES DEPRECIATION

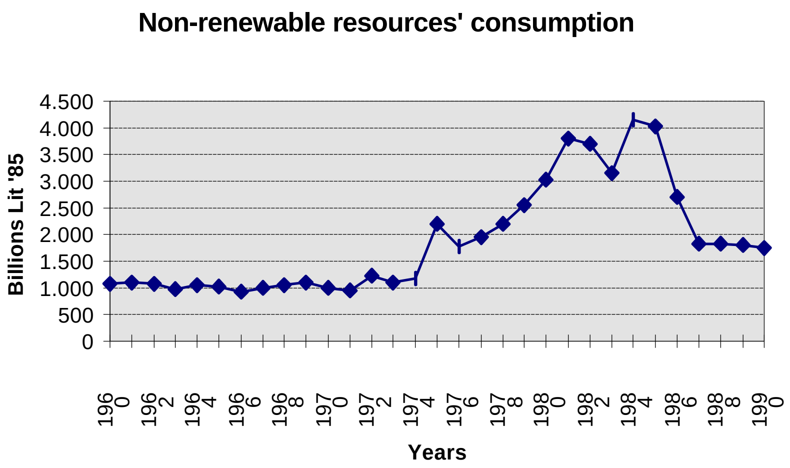
The depreciation of exhaustible resources is calculated using the El Serafy (1989) method. We estimate the share of returns from the sale of the resources that should be saved and invested in order to produce a flow of future income equal to the rent currently produced by the resource. The El Serafy formula is given by:

$$R - X = R\left(\frac{1}{(1+r)^{n+1}}\right)$$

Where:
X = annual rent
R = total returns net of extraction costs
R-X = user-cost: rent gained from resource depletion and that should be deducted from national accounting
r = discount rate
n = number of periods to resource exhaustion.

The problem with the application of the El Serafy methodology is the calculation of n. In order to avoid the problem Cobb and Daly have assumed r=0. Discounting the utility of future generations might not be considered morally correct. The effect of a 0 discount rate upon the formula is to get X=0. Thus the entire value of total returns from sale of the resource is to be counted as depreciation. Moreover, extraction costs are considered to be "regrettable necessities" and as such should be deducted from the index of welfare.

Exhaustible resource depletion has been calculated by distinguishing among energy sources, metal minerals and non-metal minerals. Energy sources considered are lignite, crude oil, methane, and endogenous vapour. Metal minerals are: manganese, magnesium, aluminium, copper, lead and zinc. Non mineral metals include sulphur, rock, pyrites, and rock salt. As to prices over time of the exhaustible resources, we have used for energy sources wholesale prices of crude oil, natural gas, coal and the wholesale price of Arabian Light oil as a price for gasoline. The Ministry of Industry has provided prices for mineral and non-mineral metals.



Errata Corrige

Page 11: the first four lines of the text are misleading, they should be substituted with the following comment.

In **figure 4** we compare our per-capita ISEW and the Italian GDP at '85 prices. Until 1965 the level of GDP only slightly overestimate the level of per-capita ISEW. Starting from the second half of the sixties though, there has been a growing gap between per-capita GDP levels and per-capita ISEW levels. Even though the ISEW growth rate is higher than GDP growth rate during the seventies (table 1), the gap between the two indices' levels continues to be high.