

An engineering approach to economic development

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Abstract:

A lot of theories and consideration have been written up to now on economic development, mainly by sociologists and economists. The purpose of this paper is to analyze the problem from an engineering point of view, focusing on quantitative aspects as well as try to point out some conditions under a proper equation, namely shifting from words to figures.

Useless to say, mathematics will never govern the economy, since the behavior of human beings is never perfectly rational, however some mathematics can help.

Keywords: economics, development, growth, statistics

1 Foreword

A lot of theories and considerations have been drawn from past to more recent times, on the economic development: in general, this has been the work of economists and sociologists, sometimes of historians.

These theories express completely different points of view, from an extreme optimists, which are often not able to give sufficient reasons for their optimism, or, on the other extreme, the prophets of doom, locked in their ideological presuppositions, not even bother to rationally justify their gloomy prophecies.

This research analyses the problem from a different perspective, that of an engineer, who, by nature and training focuses on a quantitative approach, with greater attention to the quantities and to the figures, trying to solve difficulties by analysing in the form of an equation. In plain words, shifting the focus from words to numbers .

While recognizing that, unlike engineering, economics is not an exact science, because it must take into account the irrational behaviour of human beings, we believe that mathematics and quantitative analysis are important as they can help in defining the necessary conditions, not always sufficient, to achieve a goal.

We are living in a time where economic development is badly considered, a lot of people thinks about economic decrease supposing that the standard of life of the next generations will be worst than ours, by reversing the very concept of progress without giving any rationalisation to their pessimist attitude. This is very common in Europe, where majority of people is now used to cry on themselves.

Situation becomes even more confused since generally the matter is considered under a political point of view, without considering the scientific approach or taking into consideration only those scientific data that support the view of the politician. Mass media add further confusion, sometimes in good faith.

An engineering approach will not solve the political problem, our aim in only help to understand what economic development means.

It is not for economists or engineers to decide whether economic development is good or evil, this is a political matter. However, once it has been defined, economists and technicians have to define the conditions to be met and actions to do in order to implement the choice and achieve the goal, as

well as the impediments to be removed, and to calculate costs and benefits both in monetary and real terms.

We like to remind a statement from Pope St. John XXIII, on the introductory speech to the opening session of the Ecumenical Council Vatican II:

(4.3) AT NOBIS PLANE DISSENTIENDUM ESSE VIDETUR AB HIS RERUM ADVERSARUM VATICINATORIBUS, QUI DETERIORA SEMPER PRAENUNTIANT, QUASI RERUM EXITIUM INSTET.

Whose translation is: “We seem to have to fully disagree from these prophets of doom, who always proclaim the worst, as if the end of the world would be coming”

Economic development is a long run matter, then we have to define what we mean for long run, that is a different definition from that we can find elsewhere, in other fields of science.

Namely, we define:

- **Short run**, the time span corresponding to the electoral cycle that, in democratic countries, varies from 3 to 7 years. We can assume a conventional value of 5 years.
- **Medium run** is the average duration of human life or the three to four generation time span that is needed for a family to really change its social status and behaviour or to be assimilated in a country different from that of origin, namely a time span from 70 to 120 years. We can assume a conventional value of 100 years.
- **Long run** is related to the life cycle of a nation or of a civilisation, to the duration of an empire or of a national state: it is the historical time, the time span to be considered is quite difficult to determine, it has to be measured in centuries.

There is an analogy with the theory of economic cycle, that is also articulated into two levels, the short term whose first description is found in the Holy Bible (Gen 41, 2-7) and, in recent times, that has been studied by all major economists, and whose duration can be compared with the short run defined above and, the longer term sometimes called super-cycle, first described by the Soviet economist Kondrat'ev, whose duration can be compared with the medium run described above.

2 History and roots of the economic growth

Either we like it or not, the economic growth has been a peculiarity of the Western European civilization, starting between the X and the XI century after Christ and later on exported to other parts of the world.

Among the factors, we should consider that the Western European culture is an integration of several cultures:

- **ancient Greek**, that gave the basics of science and philosophy together with the structured thinking, furthermore the Greek culture has been a connection factor with the Middle Eastern cultures (Assyrian, Sumerians, Babylonians, etc.) as well as with the Egypt
- **the Roman culture**, whose heritage are the very concept of law at all levels, from constitutional law to civil, international and criminal law, together with the concept of organization, either in government or in military. All juridical systems that exist now still can be divided into two big areas that are commonly known as:
 - **Civil Law**, that evolves from the Roman and feudal law to the modern law, through the canon law and then through codification process; the Civil Law is the continuation of Roman law, the starting point has been the **CORPUS IURIS CIVILIS** (529-534)
 - **Common Law**, that also derives from Roman law, although in its most ancient form, and evolves in England without the mediation of the **CORPUS IURIS CIVILIS**; it is mainly based on case law and is the basis of the law in all the countries of the Commonwealth and, in part, in the US, where in fact there is a mixed system. The

common law was primarily a creation of the judges, then sanctioned by the royal power; in a certain sense, it is closer to the ancient Roman law than the Civil Law.

- **Judeo-Christian**, whose heritage are
 - a religion based on a personal God as well as a linear conception of timeline,
 - trinitary theism, that has been important for the development of the European civilization in all its aspects, while the Christological dogma of Calcedonia (451) has been important on the institutional point of view
 - the dispute between Pelagius (360-420) and Saint Augustine (Aurelius Augustinus Hipponensis- 354-430), with its anthropological consequences, among them the distinction between rightist and leftist politics, that is anthropological before being politic
 - We should not forget that the very word Europe had different meanings in the past, and it's used for the first time with the modern meaning when emperor Charles the Great was defined **REX AC PATER EUROPAE** or **EUROPAE VENERANDUS APEX**.
 - However, until the XV century, would you ask to anyone "Where we are?" the answer would have been "We are in the Christianity".
- **Germanic culture**, whose heritage can be found in the concepts of freedom and feudal or anyway territory related nobility
- **Others**

The Romans in the I century after Christ and the Indians in the XVI had created a good deal of the preconditions for economic growth, however such growth, albeit started, did not develop. As far as the Romans are concerned, the main reasons have been the so called trap of slavery as well as the lack of a suitable source of energy.

The quantitative analysis is a fundamental tool to understand what happened, however it's only an auxiliary instrument to make decisions and to foresee the future, this is due to:

- the irrational behaviour of human beings, individually and collectively
- the limits of any model that, although seems to have credibility due to the use of mathematics and statistics, will never be more reliable than the theory that lies behind it
- the unforeseen and unforeseeable events (the so called black swans)

Statistics are also important; however, a statistical correlation between two variables, albeit being an important tool to understand whether there is a real dependency between them, has to be completed with thorough investigation aiming at knowing with reasonable certainty, the reality of such dependency.

As a matter of fact, correlation of variables related to events does not mean that there is a relationship of cause to effect. This is especially true in case the events are concurrent in time.

Let's bring forward as couple of examples:

- according to Max Weber, the economic development is a consequence of Protestantism but, other scholars that have made a deeper investigation into the economics in Middle Age now believe that the Protestantism has been a consequence of economic development
- apparently there is a correlation between population of storks and number of births

Also when a causal relationship exists, could be difficult or controversial to decide which is the cause and which is the effect that are sometime concurrent in the long term, as the above example on Protestantism shows.

3 The economic systems

In human history, economic and social systems have been subject to ups and downs; in the first place the transition from a subsistence economy to an economy of accumulation and finally to an economy of consumption;

In addition, in some historical periods, it predominated a local view of the economy while at other times there has been a wide interdependence of the various economy, both visions being possible

either in market or planned economy: the world since the second half of the nineteenth century until the early twentieth century was no less global than the world today, and probably the same can be said, at least for a few centuries, for the Roman Empire.
Some examples can be found in the table here below.

Relationship with other economies	Planned economy	Mixed economy	Market economy
Locally closes	Manorial and feudal economy from V to X century	Europe XI to XVI century, India XV to XVI century	
Nationally closed	Socialist economy after WW2 USSR economy before WW2	Europe XVII century, Europe 1920-1980 (corporative or keynesian economy)	Occidental free market economy 1920-1980
Global (worldwide or continental) economies	Roman empire (late), eastern empires	Roman empire	Europe XIX, XX century before 1914 and after 1980, XXI century

A further classification is between static and dynamic economies: while the growth can be present, by definition, within a dynamic economy only, this does not mean that level and quality of life are necessarily better. In the above table the dynamic economies are identified with the red colour, while the static economies are identified with the blue colour: this is a very rough classification that needs further investigation.

A further classification is between planned and market economics; in the table belowⁱ, a classification that takes into consideration the property rights and level of planning is represented. To identify an economic system along the axis that goes completely planned economy to the free market have been identified semi-quantitative measurement criteria, such as those of the Research and Documentation Centre "Luigi Einaudi".

Property rights	Private (quiritarian)			Adjusted Market Economy	Full Market Economy
	Private (subject to limitations and rules)	Corporative Economy	Mixed Economy	Adjusted Market Economy	Adjusted Market Economy
	Mixed and cooperative			Market Socialism	
	Public (means of production)	Real Socialism			
	Full communism (production and consumption)	Uthopic Communism			
		Full and binding planning	Full and binding planning limited to strategic sectors	Orientative planning	Prices and production completely free
		Planned vs Market Economy			

4 Conditions of the economic growth

While causes and conditions of economic growth are interrelated in several ways and then is quite impossible to have a complete understanding, it's worthy to take into consideration, in a summary and not complete list, some of them.

Also has to be considered the so called **eterogony of ends** (*eterogenesi dei fini*): this principle, namely the study of "unintended consequences of intentional actions" was first described by Nicolò

Machiavelli (1469-1527), albeit a more detailed theory can be found later on, in Giambattista Vico (1668-1744) as well as in Wilhelm Wundt (1832-1920). The concept of the invisible hand proposed by Adam Smith (1723-1790) is quite similar.

1. Geography, climate, environment: useless to say, economy can develop only in a favourable environment, there is no growth in the desert or Antarctica.
2. Religionⁱⁱ and Philosophy have an important impact that needs a very thorough analysis. Related to them, there is the philosophy of time that in human culture until recent time could have been either linear, like an arrow from the past to the future (due to the Judaic and Christian culture) or circular, with an eternal recourse of events (a lot of Indo-European cultures, including Persia, India and ancient Greeks, while the Romans were swinging from one to the other. A circular concept of time was also present in the Maya and other pre-Columbian cultures)ⁱⁱⁱ However, we can affirm that the concept of linear time, that is originated from the Judeo-Christian culture, is pre-condition of any economic development.
3. Ethics
4. Ideologies or dominant ideology
5. The state has not to be a monolithic entity, there have be diversification and availability of alternatives, research in any field and sound innovation have to be sustained and accepted.
 - a. Christopher Columbus (1451-1506), when rejected by the King of Portugal, could apply to the Queen of Castile and discover America.
 - b. Zheng He (1371-1434) explored the whole Indian Ocean, but xenophobia and isolationism typical of the Confucian culture of the time blocked any further exploration, so China lost the train of development.
6. Time span of political vision: the economic development need a long term vision, this is why some democratic systems are at risk of failing, since their vision cannot go beyond the electoral cycle.
 - a. In the past, the presence of hereditary kings and nobility have been a factor that has indirectly guaranteed long term vision together with safeguarding the permanent interests,
 - b. the challenge now is to find a way to integrate long, medium and short terms actors, namely to integrate the various form of government, as it was already clear to Cicero (Marcus Tullius Cicero, 106-43 before Christ)
 - c. The emphasis on “sustainable growth” is a clear indication that we are used to think with a very limited temporal vision. In the long run this concept does not make any sense: either there is development or not.
7. Knowledge capital: in the long run, a nation’s prosperity is directly related to the cognitive skills of the population. The cognitive skills can be measured by performance on international mathematics and science assessments, years of scholarship are not a sound indicator. To be noted that, according to the studies completed up to now, a general curriculum of studies seems to be better than a vocational one.
8. Demography: a moderate increase of the population is a precondition of economic growth, a static or decreasing population definitely hinders the process of economic growth, while a population that grows too fast can also create problems.
9. Property rights and legal system: the property rights must be defined and guaranteed by the law, the heritage rights too must be guaranteed by the law, the legal system has to be well defined and easily enforceable in acceptable time.
10. Fiscal system has to be defined, easy to understand and manage, related to the economic system without neither distortion effects nor limitations of economic freedom. The fiscal pressure has to be limited, so that it is felt as a contribution, not as an expropriation.
11. Political stability

12. Economic Freedom: free enterprise, free choice of the work, no work assigned by authority, no slavery or forced labour. Other conditions related to the economic system are
 - a. adequate productivity in agriculture and a minimum level of efficiency in the other sectors.
 - b. educated labour supply and capital.
 - c. demand for industrial products.
 - d. availability of entrepreneurial skills.
13. Political freedom: this is a controversial point that needs further investigation. Amartya Sen strictly related development and freedom, however we cannot deny that, in some cases, substantial economic growth, with dictatorial or semi-dictatorial governments, albeit at an higher price.
14. Personal freedom: to be kept within defined limits, in order to avoid de-structuring the society
15. Monetary: as far as the economic development is concerned, one key factor is the availability of money, while an excess of money could hinder the process. The past standards (silver standard, bimetallic standard, gold standard, gold exchange standard) are over, on the other side the so called “fiat money” has also created heavy speculative problems and exalted the economic cycles.
 - a. Some economists believe that money should be related to a defined basket of real goods, other economists support to go back to an updated version of the gold standard.
 - b. The main argument against the gold standard is that it favours countries that have gold mines. However, that argument is valid for all raw materials, not only for gold.
 - c. Other proposal, such as an energy standard, have been brought forward.
 - d. A slight inflation favours the economic development, while both deflation or high inflation hinder it.
16. Profit and interest rates: useless to say, profit rates have to be higher than interest rates.
17. Market economy seems to be better than planned economy, however we cannot deny some cases where an economy grew under planned system. While we respect the thoughts of the Austrian economist, we must accept that the market has to be adjusted in those cases where distortion elements are present.
18. Global economy seems to be better than closed or protected economy, at least in contemporary and other historical times, while this is not true in other periods. This point needs further investigation
19. Availability of infrastructures: since ancient eras (Egyptians, Babylonians, Romans) infrastructural and public work have been considered among the activities of a sovereign state, that can perform them either directly or indirectly, through privates or in partnership with them. However, it's the State that has to assure that the infrastructures or the relevant services be available to all citizen either free of charge or at a price subject to proper regulations. In modern times, the infrastructures consist in:
 - a. energy supply (gas, electricity)
 - b. water supply
 - c. transportation
 - d. communications
 - e. sanitation and waste
 - f. drainage and flood protection
 - g. schools
 - h. health service
20. Social system that allows the possibility of social escalation, with guaranteed heritage rights. As far as the heritage rights are concerned, a further investigation could define whether, on development point of view, it is better a full guarantee or a limited guarantee, where “the

heirs must justify, with their skills, the right to the preservation of inherited assets” (in reality, this is achieved through inheritance tax which, however, should not be an expropriation of assets)

21. It is not clear how income distribution can affect the economic development, apparently it has to be neither equalitarian nor too unjust. According to some scholars, it means a value of the Gini coefficient from 0.30 to 0.60, according to others from 0.25 to 0.40. Probably, it would be better to shift the emphasis from income distribution to the production of the same income; perhaps, instead of insisting on inequalities, it would be better to insist on the need for a decent standard of living for the most disadvantaged, leaving the distribution to the natural adjustment of the economic system. Otherwise we are at risk of fighting the wealth instead of fighting poverty.

5 Quantitative approach

Majority of data used in economics are based on monetary values, then they can be distorting, either if referred to different countries or to different times. The most popular index to measure the economic development is the GNP, however it would be better to use purchase power parity (PPP) that can be calculated, albeit not perfectly due to difference in terms of exchange, mainly in the long run. There are other auxiliary indices to measure the development, such as the human development index (HDI) or infant mortality, as well as technological indices such as the capability to measure time with increasing precision.

While we understand than to use the GDP as measure of the economic development is not the perfect way, we must accept that, for the time being, it is the only suitable way to do it. Other indicators, such as the proposed gross national happiness (GNH) as well as the genuine progress indicator (GPI) proposed by green economists, are based on subjective aspects and then are not a real measure.

It is also to be reminded that a lot of different formulas have been proposed in order to calculate the global power of a nation. Some of them take into account a lot of parametres and are quite difficult to manage. The Indian economist Arvind Virmani has proposed a simplified way to calculate the national power potential (NPP) as

$$NPP = P * y^a$$

where

- P is the population
- y is the pro capite GDP at purchasing power parity
- b is a coefficient whose estimate value is 1.5 to 1.6

A very important contribution to compare the GNP of the economies from different centuries has been given by Angus Maddison (1926-2010), under the auspices of the Organisation for Economic Co-operation and Development (OECD). His main work on that matter is the book “The World Economy: Historical Statistics”, published in 2004 by the OECD Development Centre, that studies the growth of populations and economies across the centuries. His colleagues are continuing is studies under the Maddison Project.

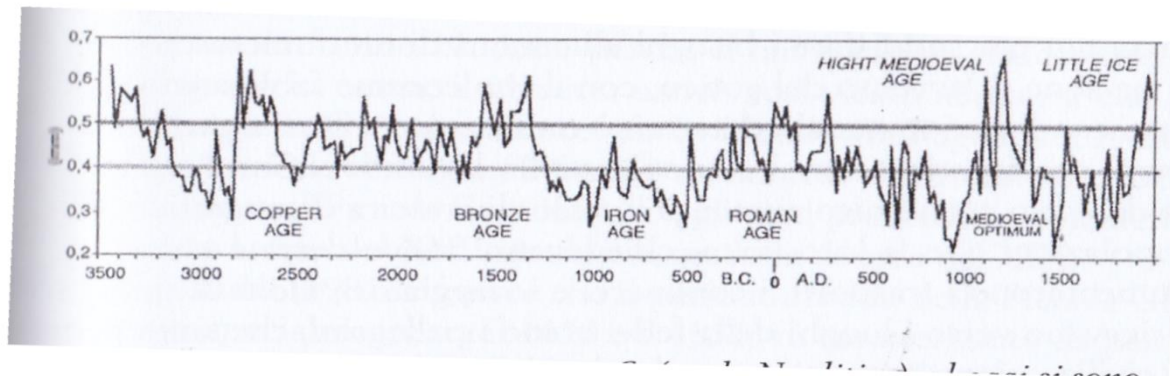
Quantitative data can give a substantial help in understanding the status and the performances of the real economy, together with the possibility of growth or the risk of decrease.

A quantitative approach or, as we like to say, an engineering approach, is needed in several fields of the human science. Mario Silvestri (1919-1994), who actually was a nuclear chartered engineer as well as a lecturer on nuclear power plants at the University of Roma, through his side activity of

history scholar, introduced the quantitative approach in historical studies and gave an important contribution to the understanding of European history relevant to the period from 1890 to 1946. Let's have a look to some examples that can explain what we actually mean for engineering approach.

Average temperatures

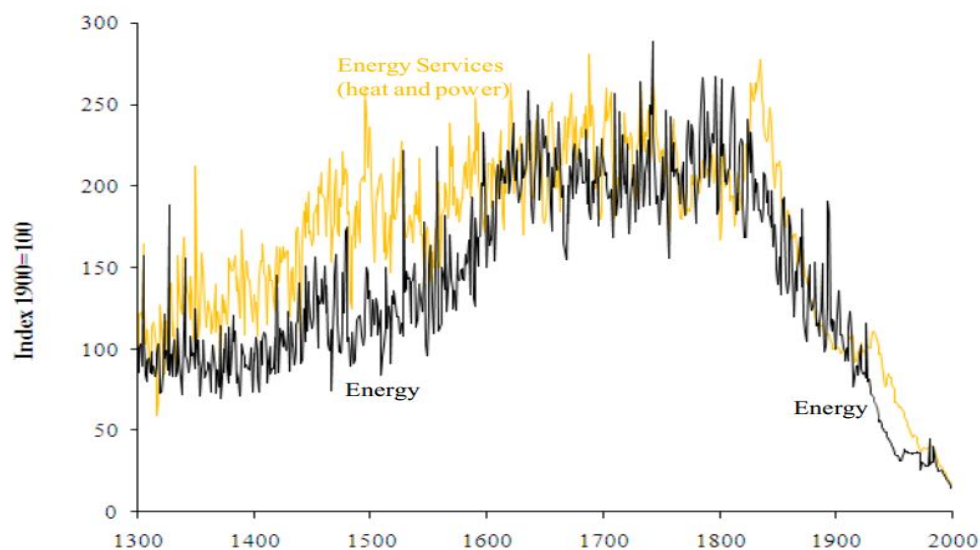
The first graph^{iv} shows the average temperature from 3500 before Christ to now. While it is quite clear that we are facing a climatic change, whose causes are still controversial, a look of the graph let us know that the economic development took place in high temperature periods, such as Roman age and Medieval optimum.



Price of energy

The second graph^v shows the price of energy and energy services from 1300 to 2000 after Christ. While it is common opinion that the energy prices is rising, a look to the graph shows that this raise is only true in monetary terms. Furthermore, this graph can let us understand, albeit partially, why the industrial revolution succeeded.

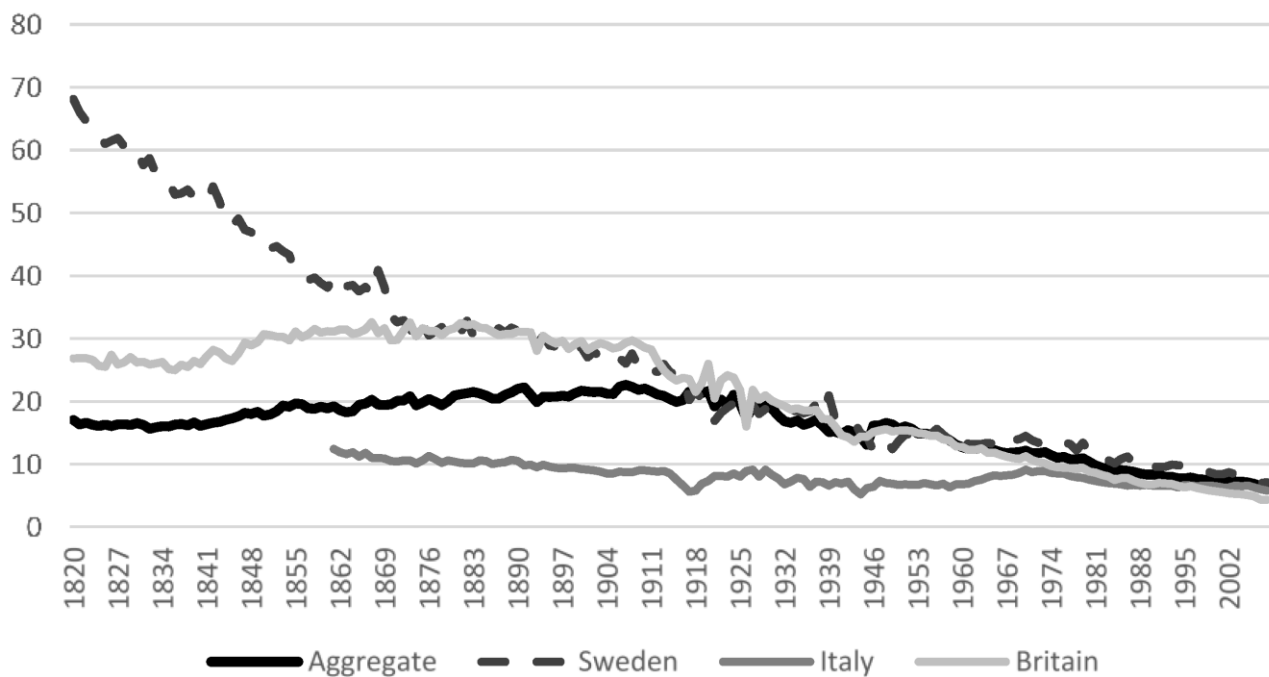
Figure 11. Average Price of Energy and of Energy Services (Heating and Power) in the United Kingdom (1300-2000)



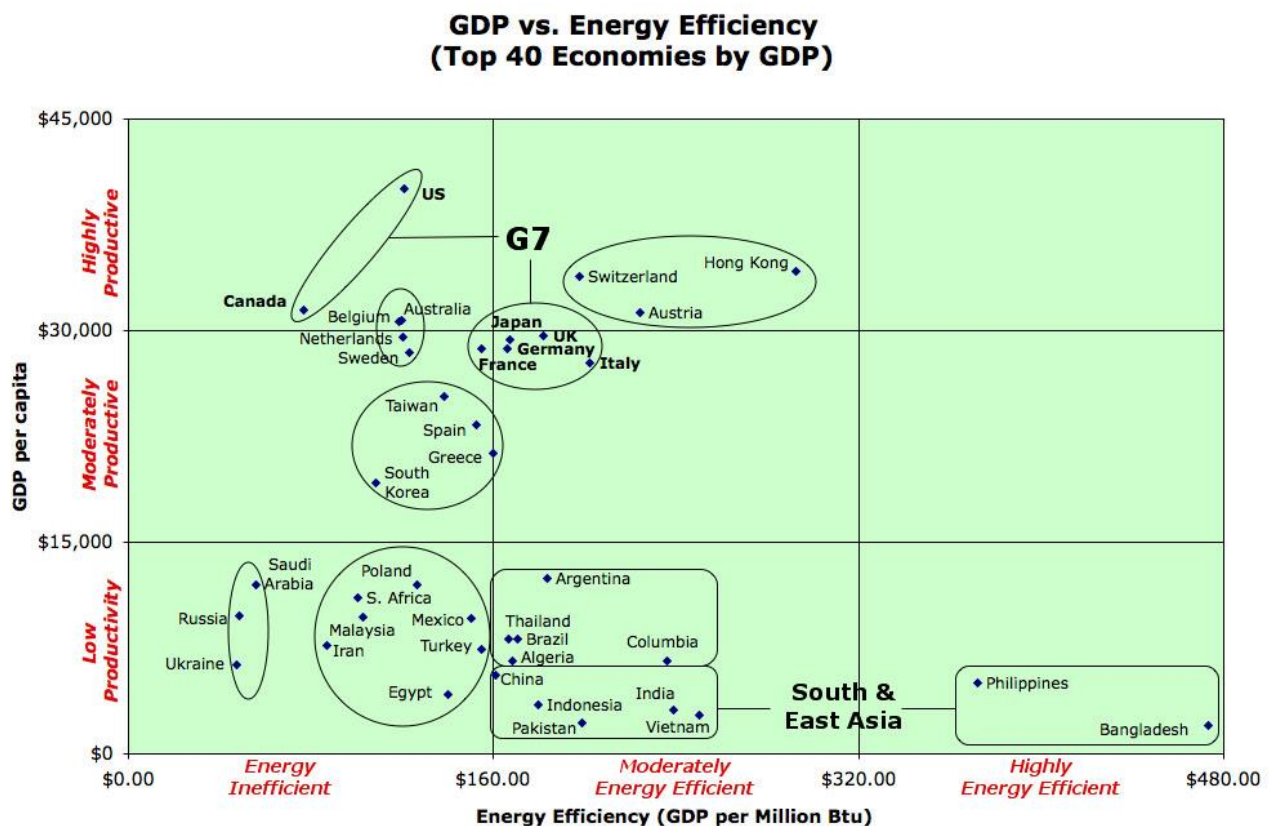
Energy intensity

The third graph^{vi} shows the energy intensity in some European states from 1820 to 2002. Besides the peculiarity of Sweden in the XIX century, from the aggregate curve we know that the energy intensity has decreased from about 20 to about 10 MJ/\$. The aggregate energy intensity includes Britain, France, Germany, Italy, the Netherlands, Portugal, Spain, and Sweden. Prices are in constant international dollars, calculated at PPP (purchasing power parity) in 1990^{vii}.

It is understood from there that energy efficiency is quite doubled in two centuries: this allow us to foresee the real constraint imposed by the availability of energy to the growth and how the importance of this constrain has been decreased and, hopefully, will be subject to further decrease in the future.

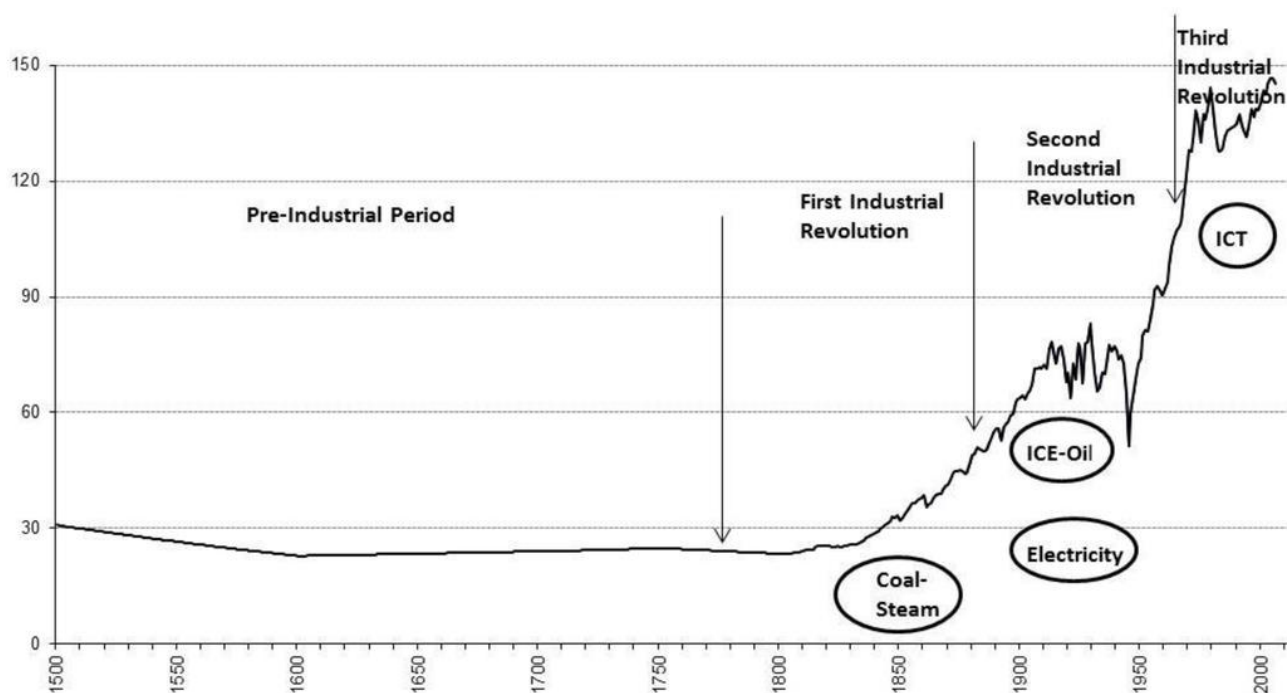


The fourth graph^{viii}, however, shows that still there is a long way to reach an energy efficient economy (to be noted that the units used for measurement are different from the previous graph).



Energy consumption

The fifth graph^{ix} shows energy consumption. It is self-explanatory.



Efficiency of lighting

The sixth graph^x shows the efficiency of lighting in the United Kingdom from 1700 to 2000, whose value in lumen-hours per kWh rose from 28 to 25000, namely in the relation 1 to 893. To be noted that a further increase has been experienced from 2000 to now, due to the diffusion of LED lighting tools.

Table 5. Percentage Share and Average Efficiency* of Lighting in the United Kingdom, by Sources**

	Candles		Whale Oil		Gas		Kerosene		Electricity	
	Share	Efficiency	Share	Efficiency	Share	Efficiency	Share	Efficiency	Share	Efficiency
1700	99%	28	1%	20						
1750	95%	29	5%	21						
1800	90%	37	10%	56		68				
1850	21%	76	1%	76	78%	186		112		
1900	1%	80			82%	497	15%	246	2%	1,310
1950					1%	887			99%	11,660
2000									100%	25,000

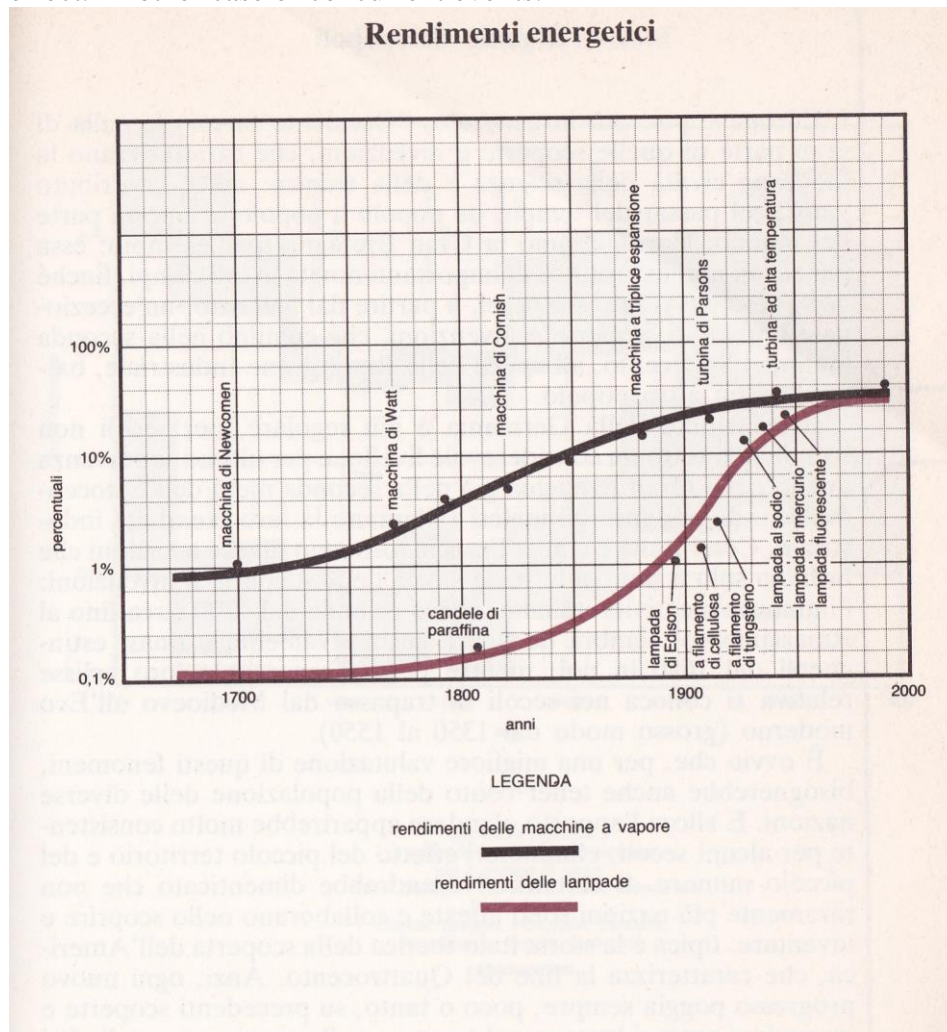
Source: authors' own estimates – see Section 2 on data for details.

* Efficiency is presented in lumen-hours per kWh.

** These estimates ignore the proportion provided by fish and vegetable oil, and from indirect sources, such as cooking and heating fires.

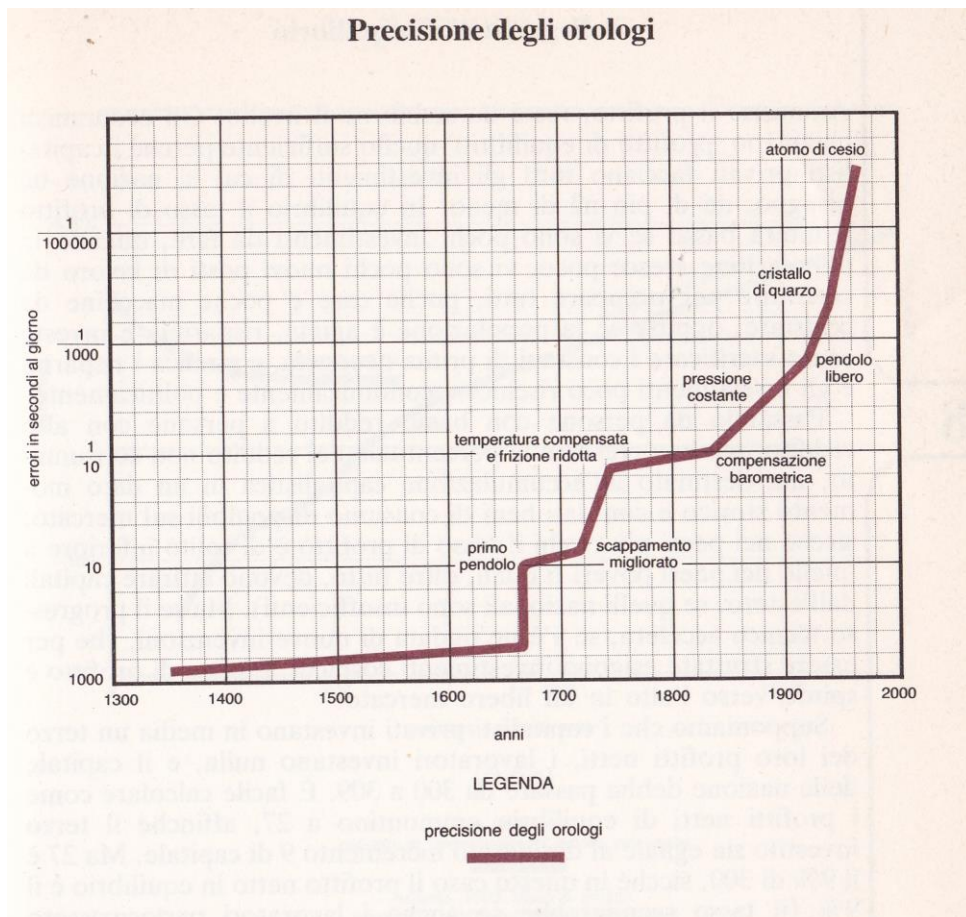
Efficiency of thermal machines

The seventh graph^{xi} shows the increase in efficiency of thermal machines, from less than 1% to 50% about. It is worthy to note that, while it's clear the relationship with the industrial revolution, in difficult to decide about which of them has to be considered on the cause side and which as an effect. Another case of concurrent events.



Time measurement

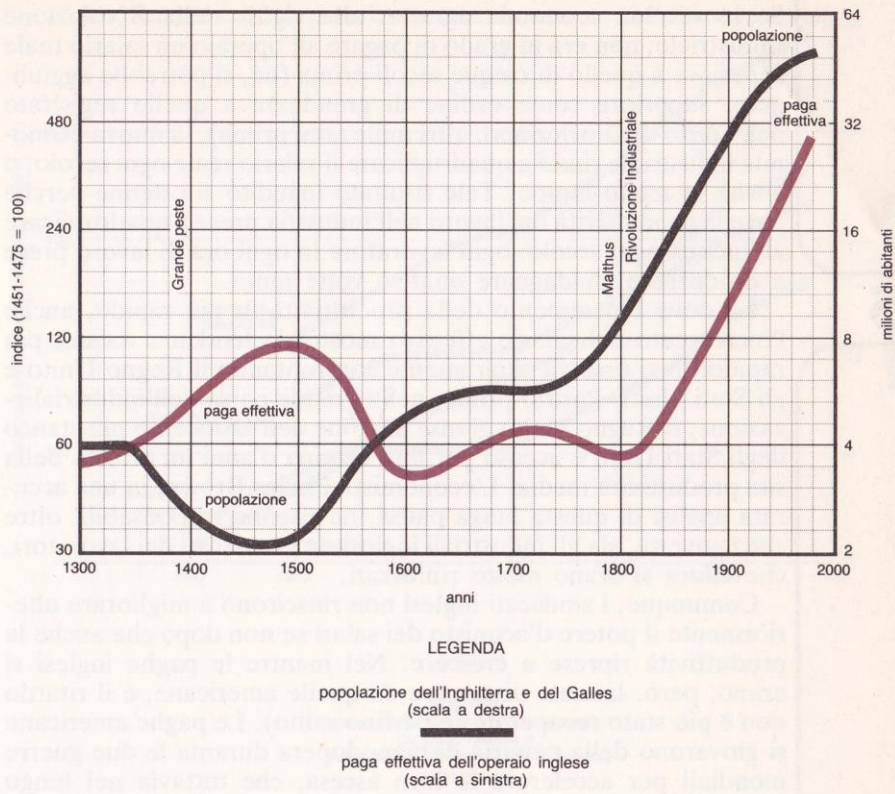
The eighth graph^{xiii} shows the increase in precision in measuring time. Precision in measuring time has strict relationship with progress: the Romans were measuring time only through sun-dial, sand-glass or water-clock, the famous clock that was sent, as a gift, by Harun al-Rashid to Charlemagne in year 807 after Christ was still a water-clock. Mechanical clock, that really allows people who could afford it to know the time, was introduced in XII century.



Salaries

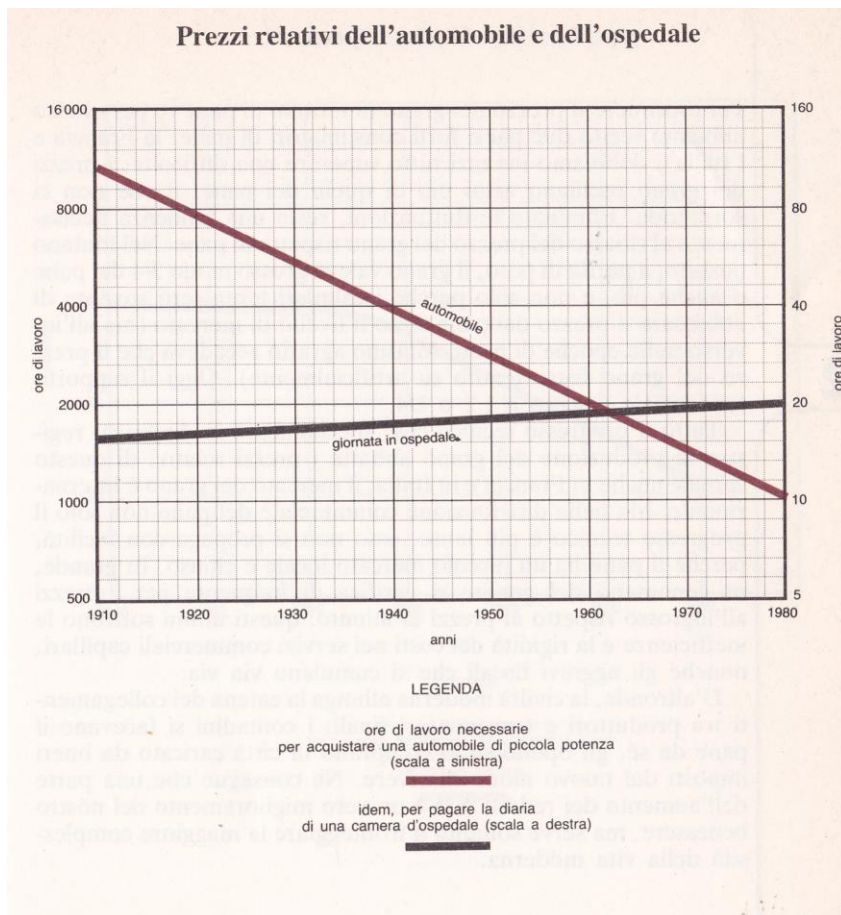
The ninth graph^{xiii} shows the relationship between population and real salaries.

Popolazione e paga effettiva



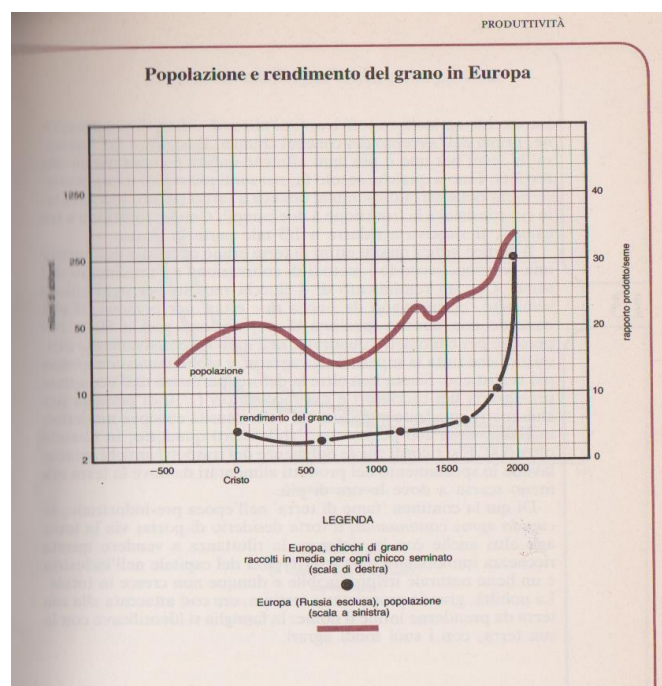
The tenth graph^{xiv} shows the prices of a car and of a day in an hospital calculated in Man-hours of corresponding salary. This is another demonstration of the distortion that can be obtained with the only use of monetary figures.

Unfortunately, statistic data for the past are quite rare, with the only exception of the United Kingdom where more information can be found, starting from Domesday Book (1086).



Efficiency in agriculture

The black line on the eleventh and last graph shows the increase in efficiency of grain production in agriculture, by giving the actual number of produced grains for each grain sown.



The ratio was 4:1 at the golden era of Roman empire, then decreased to about 2:1 after the fall of the empire. It started then to increase again up to a value of 30:1 in year 2000.

6 The Catholic Social Teaching

There is a problem in understanding on the part of economists, the Catholic Social Teaching as well as the proposals derived from it.

Any scholar realizes that the social teaching regards ethical issues, while it does not propose economic models: however, at first sight, it could appear that, many proposals, if applied, would not give the desired result, but produce an opposite effect. The economists fail to understand why there is a separation between the principles enunciated by the Catholic Social Teaching and the current economic theories.

The Italian economist Luigi Pasinetti (born 1930) has dealt with the issue, saying in his final reflections that we should reach some conclusions that cannot be incompatible with each other.

He highlights the limits and the current problems of economics, leaving to the theologians to deal with the incompatibilities and concluding that “economic theory is going through a very critical period, which really requires a strict and radical reconsideration of its foundations.”

In our opinion, a substantial part of the incompatibility we are speaking about is due to pure semantic issues, which deserve to be examined more closely.

7 Conclusions

There is a need to promote the rationalization of human behaviour, always existed in history, but particularly felt since the 90s of XX century, when the strong feeling of the crisis and the consequent affirmation of an arrogant relativism, together with the enormous and uncontrolled availability of information, have caused great confusion of consciences.

We will not discuss here the philosophical aspects: we want to limit ourselves to some application tips applicable to various fields of human activity, and in particular to land management, execution and management of infrastructure during their entire life cycle.

The starting considerations regard the history of the economy over the centuries:

- the transition from a subsistence economy to an economy of accumulation and finally to an economy of consumption let us understand that we must now achieve the creation of an economic system that balances the needs of consumption and investment.
- In addition, in some historical periods, the view of the economy was local while at other times there has been a wide interdependence of the various economy: in reality, the world since the second half of the nineteenth century until the early twentieth century was no less global than today's world, and the same can be said, at least for the first and the second century after Christ, for the Roman empire.
- It is now essential to achieve integration between the local dimension and global dimension, because only in this way it will be possible to produce locally those goods and services which are not exposed to international competition, achieving the efficiency gains that are possible by applying methodologies already widely in use for goods or services produced globally.
- It would help a worldwide scientific platform for methodological and technological innovation, based on information sharing and shared responsibility of all actors.

It is worth at this point, to add some considerations and details:

1. The evolution of economic systems based on the integration of the local economy and the global economy makes it essential to adopt appropriate land management tools and protocols that help to provide, manage and adjust, if necessary, the market mechanisms. In this perspective of integration can be framed:
 - a. land management, from limited areas, extending gradually,

- b. the construction and management of infrastructure and production facilities,
 - c. the management of urban heritage, cultural heritage in general and of cultural heritage in particular.
- 2. Today there are mathematical tools (quantitative methods, statistics, etc.) and information systems that allow the complete knowledge of all the information and data related to economics, with particular reference to a system or economic subsystem on a given territory. Those tool will not allow to fully govern the economy, due to the irrational behaviour of human beings and communities, however they can improve the management of economics. Furthermore, the same tools allow various calculations and simulations that can enable us to do a proper preparation to be able to react to unforeseen events.
- 3. We must learn that in any system or local economic subsystem there are multiple production processes, where different actors (producers, processors, distributors, consumers, investors, standardization and regulation authorities, etc.) should act in an integrated manner, as components of a system and not as opposing parties who pursue only their particular interest; the same holds true for infrastructure projects or investment.
- 4. The development of project finance allows to overturn, at least in part, the traditional investment process and therefore offers new opportunities for economic development; whereas in the past it was necessary the accumulation of capital in order to proceed with the investment, it is now possible, in some cases, obtain the capital from future funds to be derived once the investment goes into operation without any other warranty if not the project itself. Hence the need to integrate the management and control along the whole life cycle of the project.
- 5. The introduction of associative contractual mechanisms, where applicable, allows you to switch from one system to opposing parties, where each party tries, legitimately, to make most of their profit without sufficient attention to the total cost of the project, to a system based on association whose goal is the optimization of the total cost through a systemic view, acting on the total income and the distribution of income among the actors in a concerted manner.

In conclusion we can say that it is required a transition from a short-term vision (corresponding generally to the electoral cycle, five years) to a medium and long term vision, that takes into account the interests in the long term, also called “permanent interests”, in other words the interests of those who are not yet born and those who do not live any more, in a perspective of centuries and not years.

Today, unlike in the past, there are information tools, management and control that allow us to also address long-term problems in a rational manner. The enormous capacity of information systems and communications network can and should be used for human development in all its aspects.

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- i The “market socialism” is a hypothetical system proposed by the economist Ota Šik in the ‘60s.
- ii The sociologist Max Weber famously argued that religion can influence economic performance through its effect on character traits such as the work ethic. Barro and McCleary subject this view to a rigorous test. As with Barro's earlier work on growth, the unique aspect of this research is the painstaking assembly of a new data set, in this case the data on religious beliefs and attendance at formal religious services drawn from six international surveys covering about fifty countries.
- Barro and McCleary find that countries in which people have stronger religious beliefs, as reflected in a stronger belief in heaven and hell, have higher economic growth—a finding consistent with Weber's thesis. However, once the impact of religious beliefs on economic growth is accounted for, greater attendance at formal religious services lowers growth. So attendance matters to the extent that it influences beliefs, but beyond that it uses up time and resources that detract from growth.
- iii In modern times, more sophisticated theories have been proposed such as the idea of time as a spiral, that can combine recourse and progress (Vico, Hegel, Marx), while the German philosopher Nietzsche proposes again a cyclic idea of time. The idea of time in the theory of relativity shows some analogies with the spiral.
- According to Saint Augustin of Hippo (354-430), time has been created by God and then is linear, the eternity that runs. He makes a distinction between eternity (present without time) and perpetuity (endless time).
- iv Source: Marabini, 2007 – the matter is extremely controversial due to scientific as well as political reasons, however the graph shows a possibility of correlation between higher temperature and economic growth
- v Source: Roger Fouquet - Divergences in the Long Run Trends in the Price of Energy and of Energy Services – Feb. 2010
- vi Energy intensity for Europe 1820–2009, MJ/international dollar in 1990 prices. The aggregate energy intensity includes Britain, France, Germany, Italy, the Netherlands, Portugal, Spain, and Sweden. Prices are in constant international dollars, calculated at PPP (purchasing power parity) in 1990.
- vii Reference is made to the so called dollar Geary- Khamis, that in this case is the international dollar in 1990 prices.
- viii From Wikipedia
- ix The long run energy consumption in Europe 1500–2010 in relation to three industrial revolutions (GJ per capita). The sample includes Britain, France, Germany, Italy, the Netherlands, Portugal, Spain, and Sweden. The circles indicate the main technological influences on the changes in energy use associated with each revolution. There was also some continuity from older developments during these revolutions
- x Seven Centuries of Energy Services: The Price and Use of Light in the United Kingdom (1300-2000) - Roger Fouquet* and Peter J.G. Pearson** - To be noted that after 2000 the efficiency of lighting has been subject to further increase due to the introduction of LED lighting.
- xi Source: Sergio Ricossa – L'Economia in cento grafici – EST Mondadori, 1984
- xii Source: Sergio Ricossa – L'Economia in cento grafici – EST Mondadori, 1984
- xiii Source: Sergio Ricossa – L'Economia in cento grafici – EST Mondadori, 1984
- xiv Source: Sergio Ricossa – L'Economia in cento grafici – EST Mondadori, 1984