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Risk Management:

The New World Service Economy

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The New World Service Economy and the Key Role of Risk Management

By Orio Giarrini

1. From the Value of Material Products in the Industrial Economy to the Value of Performance of Systems in the Service Economy

The traditional industrial society can be described as a situation in which the privileged and by far the most important way to produce wealth and welfare is through the manufacturing process, whereby raw materials are transformed into final useable products sold on the market.

In this situation, where the main preoccupation is to produce goods, services, although sometimes recognized as important, are nonetheless secondary. In other words, they are not as important as, and generally not essential to, production.

John Stuart Mill stated explicitly that the economic process was aimed exclusively at producing "utilities fixed and embodied in outward objects." In other words, even if material objects had finally a destination and a practical use value, there was no need to consider that the process of utilization of these material objects needed any disembodied or outside economic activity. It is therefore with good conscience and efficiency that the industrial revolution concentrated on the production of material goods as the essential process to further the wealth of nations.

But if we now look at all sectors of contemporary economic activity, we can easily find out that services of any sort represent the essential part of the production and utilization systems of goods and services. A first fundamental fact to be taken into consideration is that for each product we buy, be it an automobile or a carpet, the pure cost of produc-

tion or of manufacturing is very seldom higher than 20 to 30 percent of the final price of these products. More than 70 or 80 percent is represented by the cost of making the complex service and delivery system work. Which means that service functions have become the greatest part of concern and investment even within the most traditional industrial companies.

It must therefore be clear that the service economy is not in opposition to the industrial economy, but represents a more advanced stage of development in economic history.

Service functions have become the greatest part of concern and investment even within the most traditional industrial companies.

In the same way, from the beginning of the Industrial Revolution, agricultural production was not eliminated and on the contrary remained a fundamental economic activity. But it is through industrialization, directly or indirectly, that agriculture has become more efficient. And now both agriculture and manufacturing industry have more and more to rely on the development of services in order to ameliorate their economic performance in production, distribution, and utilization.

The service functions intervene at several levels in the production and use of wealth. We can broadly classify them in five categories:

- Services performed long before any production starts, such as research and development. It should be noted that it is only since 1930 that this function has become a specific, professional one deserving a separate budget accounting. In some high technology sectors, this pre-production service function can go as far as representing more

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than 50 percent of the total cost of a full production series. Service functions such as investment programmes and marketing research studies also often intervene before any production process of any sort has started.

- Concentration and specialization of production have required a greater and greater emphasis on service functions like planning, maintenance, storage, quality control, and safety measures.

- Distribution is already per se essentially a service function of great complexity and is obviously essential for the efficient organization of systems making products and services available.

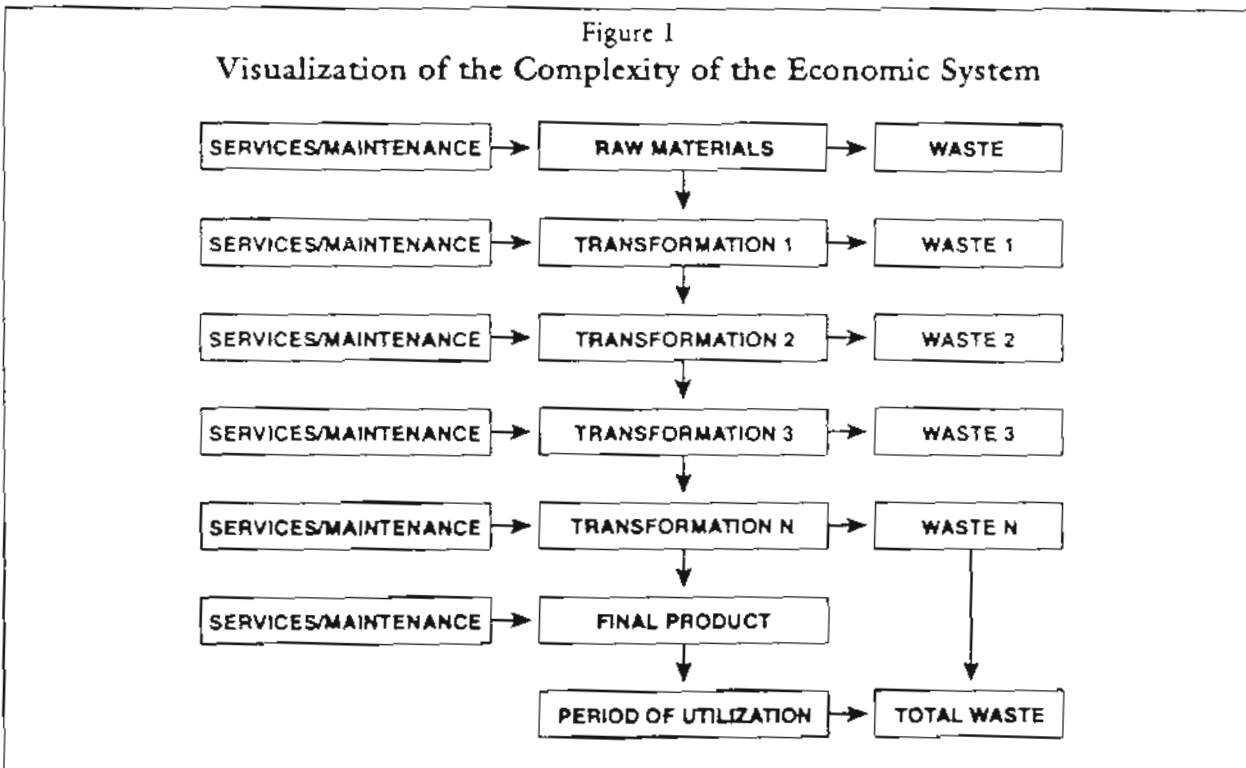
- A very specific characteristic of the service economy is the growth of service functions related to the utilization of any sort of products during their period of useful life. Users are more and more called upon to invest in their education in order to transform the potential value of any product or service into something of practical use. Users very often become part of the production system ("prosumers"), in order to make things work and yield their potential value.

- Services now come into action more and more to manage both the waste and the pollution produced at all levels of the manufacturing process, as well as at the end of the useful lifespan of products, when they become waste themselves.

Figure 1 visualizes the complexification of the economic system.

During the Industrial Revolution, the transformation process from raw materials to the final product was the key feature of the economic system. Today, the larger part of economic resources is absorbed by functions parallel to this process on the right and on the left of the graph.

Some critics of the service economy maintain that after all, products are still the essential part, and that without products there would not even be services. In the same way, two hundred years ago, the critics of the Industrial Revolution maintained the idea that agricultural production was the real priority in the economic system, and that without the produce of land, industrialization could only be considered secondary. This debate is clearly trivial and irrelevant.



It is obvious that agriculture and manufacturing industry are essential and that one cannot simply forget them — but today it is also true that any sort of product that does not rely on the functioning of services is simply not in a condition to be used or even produced. Products of any sort can only exist through the service system.

People are buying more and more performing “systems,” not just products.

We can therefore say that a key difference between the industrial economy and the service economy is that the first one gives value essentially to products which exist materially and which are exchanged, whereas value, in the service economy, is more closely attributed to the performance and real utilization (in a given time period) of products (material or not) integrated in a system. Whereas during the classical economic revolution the value of products could be identified essentially with the costs involved in producing them, the notion of value in the service economy is shifting towards the evaluation of costs incurred with reference to obtaining results in utilization.

The first approach considers, for instance, the value of a washing machine per se; the second one evaluates the actual performance of the washing machine, taking into consideration not only its cost of production, but also all other sorts of costs (learning time of people using the machine, maintenance and repair costs, disposal, etc.). The applicability of the two approaches depends in most cases on the technological complexity of the products. In the case of simple products and tools, the assessment of the value can be limited to the tool or the product per se. Nobody buying a hammer would think it necessary to take courses to learn how to use it. In the case of a computer, however, the cost of learning how to use it tends to surpass the purchase cost of the machine, especially if the costs of all the necessary software are added.

Similarly, people buying simple tools such as dishes or even a bicycle will not consider signing a maintenance contract. When the purchase concerns electronic typewriters, photocopying machines, or even television sets, maintenance contracts — even for individual consumers — are more and more common. In the service economy, the functioning of a tool is being purchased (therefore, including costs of maintenance and repair) — people are buying more and more performing “systems,” not just products.

The real change towards the service economy stems precisely from the fact that services are becoming essential in the making of products and services used to fulfill our basic needs. Services are no longer simply a secondary sector — they are moving into the focus of economic action, where they have become *indispensable production tools* to satisfy the basic needs and to increase the wealth of nations.

2. The Service Economy as a Base for a Strategy to Reduce Quantitative and Qualitative Rigidities of the Supply Side

The change from an industrial economy to a predominantly service economy is at the core of the turbulences in economic development since the seventies.

Moderate inflation already made its first appearance in several industrialized countries during the '50s and '60s. But at the moment of the oil shock of 1973, inflation made a quantum jump in all industrialized and industrializing countries. Even in Switzerland, where the coins in circulation at that time still dated from the last century, the rate of inflation rose for a couple of years to about 10 percent. At the same time, from 1973 onwards, unemployment rates started to accelerate in most industrialized countries, from “acceptable” levels to over 10 percent, where they have persisted in most countries.

A state of inflation is clearly indicative of a situation where supply is inadequate (rigid) with regard to the levels of demand. The crisis of 1973 inaugu-

rated in fact a new era of supply rigidity, which has been largely overlooked by traditional economic theory, essentially turned as it was, and still is, to scrutinizing demand. The main problem since then consists in understanding the origin and specific characteristics of this new supply rigidity, which is closely linked to the transition from the industrial to the service economy

Several phenomena converged to create the conditions of rigidity of supply. They are of quantitative, qualitative, and social nature

Firstly, quantitative conditions are linked to a situation of diminishing returns of technology in various sectors? The new technologies in the field of telecommunications and electronics, which are still in a phase of increasing returns, do often develop higher levels of productivity and new jobs, mainly in the *services* area. But if we look in priority at the manufacturing sector, we are far from the classical situation of the Industrial Revolution, when technology was not only opening new possibilities of developments in completely new areas (such as the chemical industry), but was also giving great impulses through the *whole spectrum* of *industrial production*. The iron and steel industry, the textile industry, and the mining industry which have been, in the past, the engines of important phases of the Industrial Revolution, are facing today a slower rate of technological development at the production level. They find the way for success in most cases only when they are capable — like Benetton (formerly an industrial textile company) — of becoming essentially a service-based enterprise

Secondly, the transition from the Industrial Revolution to the service economy is at the origin of another type of rigidity in supply which, however, also opens the door for new challenges and possibilities. When seventy to eighty percent of the costs of making any product available to the buyer depend on the functioning of services and systems, as it is the case in most manufacturing industries, the old schemes of stimulating simply the industrial production in order to develop the economy are overwhelmed by the preponderant part taken by the functioning of services which govern the chances of any product of reaching the market and being

used. If services are perceived as barriers to the continuous diffusion of industrialization during this phase of the new economic development, then we are in a difficult situation, for psychological rather than real reasons. Our main problem today is to concentrate and develop the service functions through which 80 percent of the wealth production and utilization really takes shape, albeit without forgetting the 20 percent of the costs linked to the manufacturing process. Certainly, costs amounting to 80 percent of sales prices for the storage and transportation of, e.g., agricultural or manufactured products can be a barrier to their development. However, considering that tomatoes as well as computers are only of value when they reach the final customer who needs them and knows how to use them, the challenge must be to stimulate productivity and improve all the service functions which are the dominant parts — in quantitative terms — of our present economic reality.

The reduction of scarcity and the increase of wealth depend much more on the proper functioning and constant improvement of service functions than on a simple increase of production.

Therefore, whereas the transition from the industrial society to the service economy certainly creates many new barriers and imparts rigidities to supply, when considered in the traditional sense, it also clearly defines the space and the battlefield where efforts can be deployed for creating wealth

Thirdly, general political and social conditions, including fiscal regulations and the degree of intervention of the state in local communities at the various levels of productive activities, are an additional element of rigidity in supply. This last argument is the favorite of the American school of "supply-siders." Of course, there are many social and political conditions which increase the rigidities that block various possibilities to develop productive activities

However, during the periods of the great technological advancements in the Industrial Revolution, these innovations always had the power to overcome social or political limitations. The growth of social security systems for old age, accidents, and illness, for instance, has had the effect of increasing demand in a situation of high elasticity of supply. If, therefore, such social achievements are considered today as not being economically sustainable, this is precisely because supply has no longer the expected flexibility or elasticity, thanks primarily to the first two sources of rigidity (diminishing returns of technology in a large part of the manufacturing sector, and inadequate attention given to the development of service functions)

In the coming decades, the key issue for economic activity will be to improve the use of available resources of any kind (from materials to knowledge, from monetarized to nonmonetarized activities), in order to control and reduce scarcity, and to approach this with a "service economy" mentality. Today, the world over, the reduction of scarcity and the increase of wealth depend much more on the proper functioning and constant improvement of service functions than on a simple increase of production. Producing meat or potatoes is not sufficient if there are no adequate storage, conservation, and distribution systems, if crops are not adequately protected against pests and animals, if delivery is not guaranteed while they can still be sold and used. The paradox of a world producing in some areas a large surplus of agricultural produce and food, while other parts of the same world are experiencing real famine, is a formidable challenge to the service economy: the elimination of such disequilibria is clearly linked to the battle to increase the productivity and efficiency of service activities (transportation costs and organization, among others)

The persistence of inflation in the monetarized world shows a lack of adequate perception of the fact that in the new service economy, the key attention has to be focused on the systems of production and of access to economic goods, where the consumer is part of the game and becomes a "prosumer."

The experiences in managing demand over the last fifty years have been a tremendous step ahead in our capability to control the economy: whenever we next are in a situation of real deflation, we should have no hesitation in reusing the Keynesian tools in order to put things straight and to avoid the waste in management that we experienced in the first 150 years of the Industrial Revolution. But with these weapons of economic management at hand, the key priority for the time being would seem to be to concentrate our efforts on stimulating and optimizing service functions and activities in order to reduce rigidities of supply.

3. The Management of Risk and the Change in the Nature of Demand

We have stressed the point that the notion of system has become essential in the service economy. Systems produce positive results or economic value (which are equal to the real "quality" increase of wealth) when they function properly.

The notion of systems operation (or functioning) requires the consideration of real time and the dynamics of real life. And whenever real time is taken into consideration, the degree of uncertainty and of probability which conditions any human action becomes a central issue.

Risk and uncertainty are not a matter of choice: they are simply part of the human condition and activity.

The importance of the notion of utilization in the service economy has a far-reaching consequence in terms of appreciation of economic value. Utilization is a process which takes place during a period of time. The duration of the utilization periods of products and services becomes therefore an important element to assess in order to optimize economic activity. Cost/benefit analysis has to be elaborated more and more with reference to different possible periods of utilization, and the cost of waste after use needs to be integrated in the fea-

tures of products at their planning or even designing stage. The optimization of duration and also of durability is de facto taken more and more into consideration when products are marketed and sold, for instance, through leasing systems. In these cases, what is sold and bought is the utilization of a product, including all the costs that are linked to make it function through its lifespan.

Any system working in order to obtain some future results is by definition in a situation of uncertainty, even if different situations are characterized by different degrees of risk, uncertainty or even indeterminism.³ But risk and uncertainty are not a matter of choice: they are simply part of the human condition and activity.

The higher level of performance of most technological advances relies upon a reduction of the margins of error that a system can tolerate without breakdown.

Rationality is therefore not so much a problem of avoiding risk and eliminating uncertainty as of controlling them and reducing them to acceptable or manageable levels in given situations.

Furthermore, the very systemic nature of the modern economy and the increasing degree of complexity of technological developments require a deeper and deeper economic understanding and control of the increasing vulnerability of these systems.

Unfortunately, the notion of vulnerability is generally misunderstood. To say that vulnerability increases parallel to the increase of the quality and performance of modern technology might seem paradoxical. In fact, the higher level of performance of most technological advances relies upon a reduction of the margins of error that a system can tolerate without breakdown. Accidents and management mistakes still happen, even if less frequently, but their effects now have now more costly systemic consequences.

Opening the door of a car in motion does not necessarily lead to a catastrophe. In the case of a modern airplane, it will. This shows that systems functioning and vulnerability control become a key economic function where the contributions of economists and engineers must be integrated. In a similar way, problems of social security and savings for the individual have to take into account vulnerability management at a personal level.

The notion of vulnerability is also relevant with regard to the notion of productivity. In fact, the notion and measurement of productivity, so of course an important issue for the service economy, is clear that if economic value depends on the proper functioning of a system, the notion of productivity cannot simply be linked to the quantity of inputs compared to the quantity of measurable outputs, but rather to the *quality of performance*. Hence, vulnerability is a factor conditioning real productivity in the industrial economy, a quality where specific indicators of "results" have to be integrated with price indicators.

In any case, it is clear that the question of measuring quality in economic terms is becoming a major issue in itself, which is an obvious additional indication of the emergence of the service economy.⁴

Risk has become more and more concentrated at levels where the vulnerability is such that the overall uncertainty of the economic process increases.

How many boards of management today dream of the decision possibilities experienced thirty years ago? Consumers are also reluctant to become increasingly consumers of "risk". The unique situation in the field of product liability and malpractice in the United States, although amplified by a specific legal environment, starts to have its effect on other parts of the world. This is a typical trend of demand in the service economy: the consumer is more and more conscious that tools and products that exist for given purposes, and even experts, are only of value when the results of their "utilization" are positive. The fact that their utilization may give negative results, is regarded as unacceptable, giving rise to requests for compensation.⁵ Product liability is a great issue in the United States, where

litigation has led in some cases to extremely high and even excessive compensations. Chemical and pharmaceutical companies have a special problem in this area.⁶

Doctors, lawyers, and other experts are sued in court for "malpractice" and have to compensate their clients if found guilty.⁷ At the European level, the Directive on Product Liability⁸ was the result of ten years of discussions and preparations to manage the expanding phenomenon of the increasing perception by the public that producers of economic wealth have to be liable when delivering a "product" yielding negative results. Once again in the contemporary economy, it is the "performance" which has economic value, which counts, rather than the simple "existence" of a product or service.

The problem of environmental hazards, which very often is linked with the question of transportation and storage of dangerous materials, is part of the same type of risk and vulnerability that our modern society has to face.⁹

4. The Notion of Risk in the Industrial Revolution and in the Service Economy

The risk-taking attitude was not studied in detail by the first great economists. It was rather taken for granted in a given cultural environment, even if Schumpeter made some more explicit references to the risk-taking entrepreneur. Only in 1921 did Frank Knight write a comprehensive book on the subject.¹⁰ But then the risks he discussed were limited to the "entrepreneurial" type. The field of the pure risks linked to the vulnerability of systems was still considered too marginal to be treated as a priority among the managerial objectives of a firm.

Later, economists such as Kenneth Arrow¹¹ have begun to take a closer look at the reality of the uncertainties that may undermine any economic policy or managerial decision. Ricardo and Smith drew practical examples of their theories from agriculture and from small-scale manufacturing, while the later generation of economists up to Samuelson took their examples from large-scale industry. Today, the most advanced economists tend to refer

more and more to the management of risk and uncertainty by insurance institutions as a natural reference point. They also study more closely the management of the social welfare of health sectors.

This has led to a widespread reconsideration of some basic concepts in economic activity. The fundamental point is the need for a better understanding of the conditions and reasons for modern economic risks and uncertainties, so as to enable entrepreneurial talent and creativity to meet present-day challenges in a more successful way. The worldwide development of risk management¹² is a sign of this process. Basically, it represents a reaction to the new nature and dimension of the risks that condition our economic and social environment.

The development of vulnerability and of pure risk is a typical characteristic of the service economy. Obviously, the more traditional risks considered in economics, i.e. the entrepreneurial risks, have also been subject to considerable change, particularly with reference to the occurrence of sudden fluctuations of increasing amplitude. This phenomenon is visible in the financial field, where it is defined as volatility. It is a consequence of concentration and of larger and larger markets, where smaller and smaller marginal variations tend to have proportionally greater and greater destabilizing effects. Hence, a general increase in uncertainty. But overall growth of uncertainty in the economy and of the need to manage risks in a more professional way, is essentially linked to the increasing relevance of pure risk. Risk management is a basic element of economic strategy and this arises from the need to manage the functioning of systems, typical of the service economy.

Modern technology is at the source of the increasing management problems of pure risks in many ways:

- a) Increases in the economies of scale have been mainly due to progress in technology. The gains in productivity throughout the period of the Industrial Revolution were enormous, but the increased concentration of production also increased its vulnerability to small disturbances.

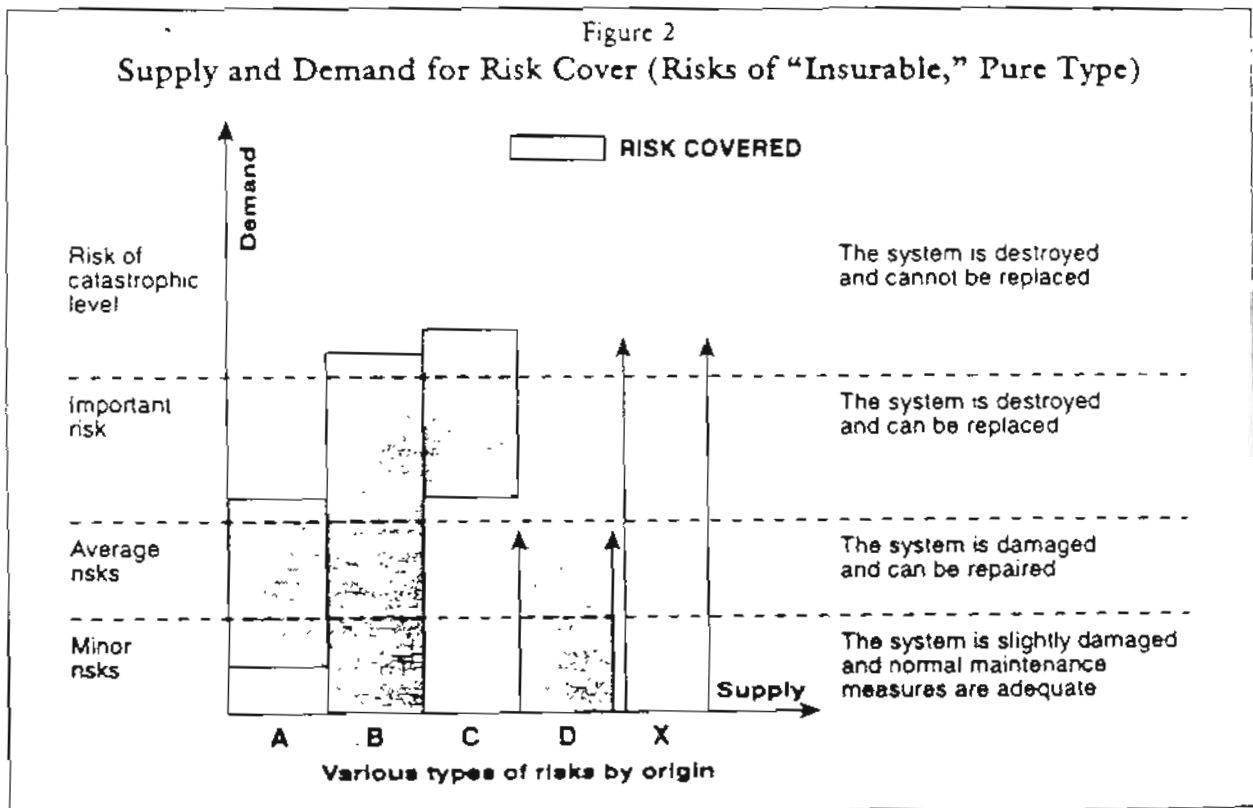
This is the area where risks and vulnerability are increasingly of the "pure," insurable type. They need a statistical universe of occurrences in order to assess probabilities in a given time and space dimension. Lower frequency and higher size of risks make them more and more difficult to manage.

b) Specialization has been a key factor in industrial progress. But an excess of specialization has resulted in systems that are increasingly interdependent and vulnerable. These result in a high growth of consequential losses — losses deriving from the nonfunctioning or malfunctioning of a system. Furthermore, specialization can reduce the adaptability of a machine or installation to changing market conditions. It can also impose more severe maintenance and repair requirements, which may be difficult to implement under specific operating requirements conditions. Gains from specialization may be partly offset or even outweighed by the resultant lack of flexibility. Specialization also might go as far as reducing risk classes to unmanageable dimensions — hence, the efforts of actuaries to develop their "credibility" theory.

c) Operating reliability has made great progress thanks to advances in technology. However, minor variations and small accidents in one component can lead to disasters in a complex system, even if these accidents occur less frequently because of higher operating reliability.

d) The quality of many products has been greatly improved by modern technology. However, this same improved quality for a specific task may increase the problem of recycling when a product is obsolete. The human and economic environment, as Alfred Marshall puts it, is more like a biological process than a mechanical one. An improvement in one area may introduce disequilibrium in another — this is the lesson brought home by the problems of pollution and hazardous waste management control.

These examples have in common a shift of emphasis from the traditional entrepreneurial risks to pure risks of the "insurable" (and uninsurable) type.¹³ We can thus expect to find a reflection of these



developments in the practice of insurance business which is now passing through a period of quantitative and qualitative change and development unequalled in its long history

One of the great differences between neoclassical economics and the new service economy is that not only is the "entrepreneurial" risk taken into account at the level of the definition of economics value and price, but the notion of the economically relevant risk is extended to include the concept of pure risk. The notion of risk, globally, has therefore two fundamentally different but complementary connotations

Insurability should become one of the main factors to be considered in defining the effective efficiency levels of productivity and of economies of scale.

For any important modern economic endeavor, the consideration of both notions of risk is on an equal strategic level (again linked to the notion of systems and of vulnerability). An appropriate risk management action needs to identify each category of risk in its own right to evaluate how they interact and to design an appropriate global risk management strategy

The demarcation line between pure and entrepreneurial risks is the notion of "moral hazard."¹⁴ This notion has long been understood by insurers when they have to face payment for fraudulent claims. The case of somebody burning his own home to collect the insurance is an example: more than twenty percent of fires are fraudulent.¹⁵ Economists also look at this notion as a spin-off of their studies on economic incentives: "moral hazard" is equivalent to studying the *negative* results of incentives. One important example concerns the level of social insurance for unemployed people who might stop looking for a job if the level of social compensation is too high.¹⁶ Many economists who have dealt with public policy are entering into the field of moral

hazard (negative effects of incentives) and could profit from the long experience of insurers in this field.¹⁷

5. The Key Economic Issues for Risk Management in the Service Economy: The Determination of the Level of Insurability and the Matching of Supply and Demand for Risk Control.

If risk management is to be fully integrated into economic theory (as is already largely the case in economic practice) the notion of insurability will become a key tool for economic analysis. Insurability¹⁸ means essentially that risk of the pure type can be rationally managed. In other words, insurability is concerned with the fact that the main risk characteristics, i.e. size and frequency, combine in such a way that the risk is predictable and economically manageable within a reasonable level of probability. Insurability should become one of the main factors to be considered in defining the effective efficiency levels of productivity and of economies of scale. This is so for two reasons:

- The protection and security costs associated with the vulnerability of a given system
- The possibility of rationally and economically controlling the level of risk in the case of any adverse occurrence

The supply-demand system in risk management is described in **Figure 2**. Here the economic demand to cover a risk is given in terms of levels of vulnerability: whatever the source or the origin of risk or damage, the demand-side is interested in adequately managing or covering its levels of vulnerability.

From the supply side, risks are covered by homogeneous classes, defined by homogeneous origins of the risks.

It is very important today to reexamine in depth what the notion of homogeneity or risk classes may mean when:

- An industrial risk might today simultaneously refer to an insurance or insurable cover¹⁹, which is offered from different risk classes. Production in a chemical plant might stop, leading to consequential losses, this loss might be linked to the identification of a product which is likely to produce damage when used. In this case, it falls under the heading of product liability. Further, an industry might be obliged to spend money to recall these products. It is obvious that in a situation in which one single accident produces opportunities for loss in many different directions, the insurance management of such a problem should strive to integrate as far as possible various risk classes: such as consequential losses, recall practices, and product liability together.

- Technology very often means specialization, and today, when one wants to cover, for instance risks associated with space activities, the problem is that each and every space programme has a different vulnerability configuration.

- A third very important aspect is the question of the time of reference related to various classes of risk, in particular those with catastrophic connotations. In order to reconstruct a usable universe of risks, it is increasingly necessary to consider time units on the basis of periods of five, ten, twenty years or more, not just on the basis of one year of activity, as is normal practice in the economic system today. This also is very often the effect of specialization and the increase of technological vulnerability. This very important issue has a lot to do with fiscal policies. The key economic question is to define which is the correct period of time (how many years) during which an economic activity should be taken into consideration. This requires a massive and fundamental dialogue between risk managers and fiscal economists. It also entails a considerable revision of the notion of the time span on which to consider and to manage economic rationality.

Up to now, when insurable risks were not an essential tool in managing the overall risks of an enterprise, or of an individual or even of society, a client could consent to adapt to the classification pro-

posed by the supply side. Once the pure risks became higher or more important for an industrial company, the profession of risk manager became necessary. Essentially this represents an effort to define the demand side, not just in terms of one type of risk but in terms of one level of vulnerability.

This is parallel to a movement where more risks in the industrial sector enter the upper categories (important and catastrophic risks) and where it becomes even more of a problem to understand, to estimate and to underwrite the risks related to new technologies. Moreover, once an industrialist analyses his risk control demands, he becomes more and more conscious of the problem of how to integrate a fire policy with a consequential loss, with a product liability, with a recall protection, etc. At this stage, the insurance supplier needs greater qualifications to understand the system that is at risk and which needs to be insured at its various vulnerability points.

It should be clear that it will always be necessary to define homogeneous risk classes, at least up to a reasonable level, in order to cover and protect pure risks rationally.

The task of the "pure risk" manager involves matching two different logics: the one referring to the indispensable technique of diluting and controlling risk occurrences and the other referring to the definition of the vulnerability level of a specific economic system. The latter is a clear characteristic of the service economy.

6. Risk as a Positive Factor and the Challenge of Uncertainty: An Attitude and a Philosophy for Stimulating Progress ²⁰

Probably the most relevant feature of these changes in the socio-economic environment tending towards a service economy is their relation to the advance of scientific thinking and discoveries in this century. Generally, this has to do with the relationship between the social and the natural sciences (soft and hard) which embody the cultural background of our

knowledge, views, attitudes, and behavior with regard to our individual and community life

When economics became a specific and recognized social science, its key inspiration and references were the cultural and scientific assumptions of the eighteenth century. Economics proved an useful tool for analyzing, understanding, and systematizing the ongoing process of the Industrial Revolution.

Let us recall just a few of these basic assumptions. Newton conceived a notion of *equilibrium* as a basic reference for understanding the universe. This equilibrium was a static one, which survived until Einstein started the modern scientific revolution by adding *time* as the fourth dimension of space.

Heisenberg and the quantum theory introduced the notion of *indeterminate systems*. These overcame the objections of Einstein who was still striving for an universal model of scientific knowledge which would eliminate uncertainty. In 1983, Ilya Prigogine wrote

We are more and more frequently encouraged to think that the fundamental laws of nature are irreversible and stochastic; that deterministic and reversible laws are applicable only in limiting situations.

He further wrote that

Over the last decade we have learned that in non-equilibrium conditions, simple materials can acquire complex behavior... Today, our interest is shifting to non-equilibrium systems interacting with the surroundings through the entropy flow. 21

There can no longer be any "scientific" justification for considering a state of equilibrium in economics (as referred to in the Newtonian model) as the sole premise of economic analysis. In some cases, equilibrium might be desirable, but economic progress could well depend much more on specific and *desirable states of nonequilibrium* in cases where the isolated industrial system opens up to a multiplicity of new functions and interactions typical of the service economy. The key economic ques-

tion of the future might well become "How shall we create or stimulate productive nonequilibrium situations?" rather than "How shall we achieve a perfect (certain) equilibrium?" Situations which, contrary to Newtonian philosophy, have a real time dimension are increasingly typical of the service economy. However, the model still pursued by the mainstream of current economic thinking has as its fundamental paradigm the hypothesis of perfect equilibrium and of certainty belonging to the static (deterministic) Newtonian scientific model. Unfortunately, this means that the current economic model refers to scientific premises which science itself has long ago abandoned.

We rather think that today economic advances depend on developing creative activities in a world where uncertainty, probability, and risks are a given condition, providing circumstances of real opportunities and choice.

Absolute poverty is a situation in which no risk can be faced, no choice taken. It is the opposite of progress.

Accepting the basic uncertainty of the world we live in should not be a step backwards towards irrationality. Quite the contrary, more intelligence, more rationality, more initiative are required to cope with situations of uncertainty, which after all are the daily experience of everybody. The simplistic vision of mechanized preprogrammed robots belongs much more to a deterministic world. The attempt to achieve abstract "certainty" and "perfect" information can only lead to dogmatic, pseudoreligious systems on the one hand or to the annihilation of all intelligence, the destruction of all hope for development and creativity on the other. It is on this very point that the communist model failed. The marriage of contemporary scientific thinking with the social sciences, and in particular with economics, in an increasingly complex and interactive world might provide a rich source of moral and intellectual stimulus for reconstructing an image of the future.

Learning to face uncertainties and to manage risks under these new horizons could in turn lead to an advance in the human condition.

Even in terms of equity or of social justice, the problem is not to produce or to distribute *security*, which is in any case a self-deceiving notion in political as well as in economic terms. State or community protection policies should avoid protecting individuals in such a way as to make them increasingly vulnerable, inefficient, and ultimately prone to greater psychological and physical insecurity. Equity has more to do with increasing the physical and cultural capacity of individuals and communities to face uncertainty. The very risks that confront all living species render them creative. *Absolute poverty* is a situation in which no risk can be faced, no choice taken. It is the opposite of progress.

And finally, in *cultural terms*, no enterprise is built by dreams alone. But equally none gets off the ground without some dreams. Successful action is by necessity guided by practical circumstances. But the goal of any action is defined, implicitly or explicitly, by the deep nature of the human species, including dreams, visions of life, and culture.

The dynamics of life and the challenge of risk and uncertainty require from us a new creative effort leading to the renewal of our philosophic approaches. Today we need to reconsider the notion of progress, which the philosophies and the ideologies of certainty have shattered so much and almost destroyed. There is no real human culture other than that to be found in the real-life process of creation. This involves the producing and continuous testing in each of our many endeavors of an image of the future which we could fashion for ourselves. It is the fundamental intellectual challenge facing a modern society. Let us face risks. Let us become conscious Risk Managers.

RMR

Footnotes

1. See his *Principles of Political Economy*, Routledge and Kegan, London, 1968 (reprint). See also, with reference to this paper, *The Limits to Certainty - Facing Risk in the New Service Economy* by Orlo Giarini and Walter Stahel, a report to the Club of Rome, second edition, Kluwer Academic Publishers, Dordrecht, 1993.
2. See *The Diminishing Returns of Technology - An Essay on the Crisis in Economic Growth* by Orlo Giarini and Henri Louberge, Pergamon Press, London, 1978.
3. The definitions adopted in this paper are the following: risk represents a probable occurrence or event of subjective (following a decision to act or not to act) or of objective nature (independent of one's decision) influencing a given system at different levels of magnitude; uncertainty measures the degree of confidence one can have in a given probability; indetermina-tion refers to systems or situations that lack any possibility of being defined.
4. See, for instance, the chapter on "Quality, Productivity and Strategy" in *Service Management*, by Richard Norman, John Wiley and Sons, New York, 1984; see also the chapter on "Services and Productivity" in *Service-Lead Growth*, by Dorothy Riddle, Praeger Special Studies, New York, 1986; Chapter on "Measurement of Output and Productivity in the Service Sector" written by John Kendrick in *Managing the Service Economy*, by Robert Inman, ed., Cambridge University Press, Cambridge, 1985.
5. See S. Shavell, *Accident, Liability and Insurance*, Harvard Institute of Economic Research, 1979, Discussion Paper nr. 685; "Liability, Insurance and Safety Regulation," *The Geneva Papers on Risk and Insurance*, nr. 43, April 1987 (special issue).
6. See Arthur Hailey, *Strong Medicine*, Pan Books, London, 1985.
7. See R. Jackson and J. Powell, *Professional Negligence*, Sweet & Maxwell, London, 1982.
8. The European Community, Brussels, Directive on Product Liability, 1985.
9. See "Transportation, Storage and Disposal of Hazardous Materials," papers from a conference at I I A S A, Laxenburg (Vienna), edited by H. Kunreuther, Wharton School, University of Pennsylvania, Philadelphia, 1986. See also "Hazardous Waste Management," *The Geneva Papers on Risk and Insurance*, Nr. 51, April 1989, Geneva.
10. Frank Knight, *Risk, Uncertainty and Profit*, University of Chicago Press, 1971 (1921).
11. See Kenneth Arrow, "Risk Allocation and Information," *The Geneva Papers on Risk and Insurance*, Nr. 8, June 1978, pp. 5-19, and its bibliography.
12. Among the first writers on this issue, see Norman Baglin, *Risk Management in International Corporation*, Risk Studies Foundation, New York, 1976; see also the special issues on "Risk Management" of *The Geneva Papers on Risk and Insurance*, Nr. 35, April 1985; Nr. 37, October 1985; Nr. 44, July 1987; Nr. 43, July 1988; Nr. 51, April 1989, and Nr. 64, July 1992.
13. Orlo Giarini, "Développement économique et croissance des risques," *The Geneva Papers in Risk and Insurance*, Nr. 22, January 1982.
14. Among many other references, this subject has been presented in "The Pure Theory of Moral Hazard," an Annual Lecture of the Geneva Association, by Joseph Stiglitz, *The Geneva Papers*, Nr. 26, January 1983.
15. See *The Invisible Bankers*, by Andrew Tobias, Pocket Books, New York, 1982.
16. There is a delicate economic and social trade-off problem here: a high level of compensation for unemployment might be socially desirable. But it is also desirable not to use working taxpayers' money beyond a certain level which might favour unemployment by eliminating the need to find a job.
17. "The Pure Theory of Moral Hazard," Joseph Stiglitz, op. cit.
18. See in particular Baruch Bernier, *Limits of Insurability of Risks*, Prentice Hall, New York, 1982; also the special issue of *The Geneva Papers on Risk and Insurance* on "Limits of Insurability of Risks," Nr. 39, April 1986.
19. The notion of insurable and of pure risks goes beyond what is actually underwritten by insurance companies. For instance, Felix Kloman (*Business Insurance*, October 19, 1987, pp. 3 and 23) estimates that by 1995, self-insurance techniques will account for half of the total cost of risk financing in commercial and industrial activities.
20. This section is taken from a report on *The Limits to Certainty - Facing Risk in the New Service Economy*, Kluwer Academic Publishers, Dordrecht, 1993.
21. Quotation from papers circulated at the Seminar on "Complexity" organized in Montpellier by the United Nations University and the IDATE (May 1984).