

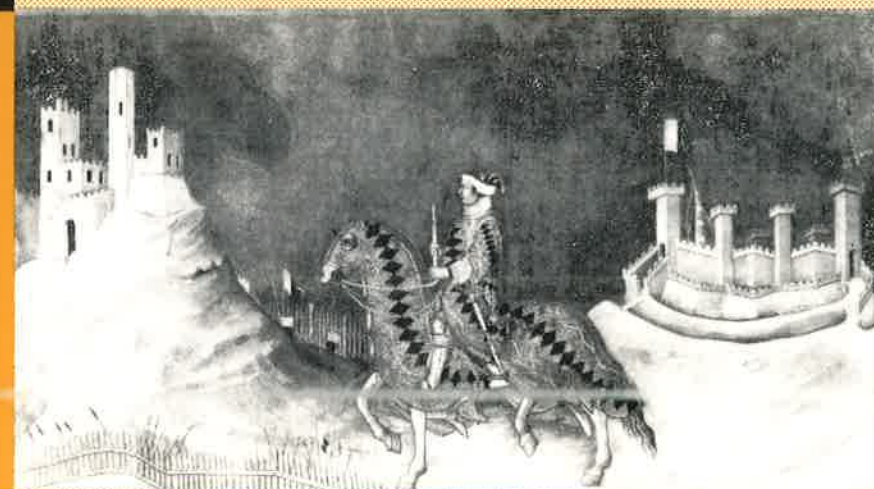
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QUADERNI DEL DIPARTIMENTO
DI ECONOMIA POLITICA

CARLO ZAPPÀ

THE NOTION OF PRIVATE INFORMATION
IN A MODERN PERSPECTIVE:
A RE - APPRAISAL
OF HAYEK'S CONTRIBUTION



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Carlo Zappia

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1. Introduction. *

Current research in general equilibrium theory is increasingly concerned with examining the problem of how to model informational differences among economic agents. The formalization of the notion of Walrasian equilibrium supplied by the usual Arrow-Debreu model does not attribute to market prices that role of information transmission and aggregation which is part of an economist's intuition as to how the market mechanism operates. Some authors have therefore examined equilibria in economies where agents, aware of having only a limited knowledge of the elements which define uncertainty in the economic system, formulate their own plans by taking into account the possibility that equilibrium prices convey information which exists in the system but which is not individually available to each of them. The notion of equilibrium commonly employed for the study of these phenomena is that of rational expectations equilibria (see Grossman, 1981, and Radner, 1982a).

The results obtained in this area of research, as regards both the conditions of existence of an equilibrium, and the related normative properties, form the new bench-mark for the analysis of general equilibrium with asymmetric information. In particular, the properties of efficiency of equilibria can now be evaluated in terms of informational efficiency (see Laffont, 1989).

In this context it may be fruitful to compare recent developments in general equilibrium theory with the Austrian approach to the study of economic equilibrium. In the Austrian tradition the central issue in economic analysis is not so much the usual neoclassical problem of the efficient allocation of given resources, but the efficient use of the knowledge dispersed among economic agents. The Austrian theorists have focused mainly on the way in which the information distributed heterogeneously throughout the economy is used, in order to explain how the agents' individual activity can turn out to be consistent on an aggregate level. In situations of dispersed information, equilibrium is regarded as a condition of mutual compatibility of decentralized plans, according to one of the most fascinating interpretations of the theory of the market since Adam Smith (Hayek, 1976).

This article analyses the notion of information used by Hayek in his study of the market process. My aim is to show that the notion of

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private information introduced by Hayek, and taken up by the neo-Austrian theorists who followed in Hayek's footsteps, differs substantially from that employed in the literature on rational expectations equilibria, despite the fact that it makes frequent reference to Hayek (see, in particular, Grossman, 1989). In particular, the information which Hayek examines can give rise to a range of economic behavior which is excluded from modern general equilibrium theory: above all, the phenomena studied in the theory of contracts and incentives. In making a distinction between these notions of information, I am not following the procedure used by most critics, who differentiate between information as defined by Hayek and information as defined in current theories, because of its dynamic content (see Thomsen, 1992). Instead, I intend to show that Hayekian information is mainly characterized by its reference to a type of knowledge which cannot be verified publicly *ex post*, contrary to the requirements imposed within general equilibrium theory. I shall argue that this feature does not necessitate the analysis of the market process in disequilibrium; moreover, it may be considered a prerequisite for the proper study of the market process in disequilibrium.

The ability to outline different notions of information is of more than marginal importance in clarifying the relationship between these two theoretical approaches. Two issues appear to be particularly pertinent.

In the first place, the reason for the current interest in the Austrian tradition is that it is a tradition based on the idea that the subject of economic theory should be the market process, rather than the equilibrium position to which this process might eventually converge. From this point of view, if we are able to show that the information which is relevant for Austrian theory is different from that used in rational expectations equilibrium models, then we do not have to apply to Austrian intuitions the customary convergence results found in models of Bayesian learning, particularly with reference to how the *ex ante* informational differences are eliminated *ex post* (see, for example, Bray - Kreps, 1987).

In the second place, the Austrian tradition of Menger and Hayek seems to propose a notion of equilibrium which is different from the standard neoclassical one. In particular, one can assume that the approach suggested by these two authors leads to a notion of equilibrium which is more elaborate than the strictly individualistic one in the neoclassical tradition. According to this approach, to base equilibrium analysis on individual actions does not mean excluding aggregate

phenomena which are not compatible with the actions of individuals, or which individuals are not able to predict (Hayek, 1967, ch.6). I wish to show that this position, too, can only be maintained if it is based on the specific notion of private information which can be deduced from Hayek, while it loses all its relevance if it is based on the notion of information employed in the current literature on general equilibrium.

Finally, let me clarify one preliminary point concerning interpretation. It is implicit in my approach that the Austrian tradition is not concerned solely with the analysis of disequilibrium, as many critics have maintained (see, in particular, Lachmann, 1976, and, more recently, Buchanan - Vanberg, 1991). On the contrary, the constant interest shown by Hayek in comparing the actual states of the market system with equilibria, or spontaneous orders, is considered here as the necessary starting point for a correct interpretation of his theory (in the tradition followed, among others, by O'Driscoll - Rizzo, 1985, Kirzner, 1992, and Moss, 1992). It is in this perspective that I shall compare Hayek's position with recent research on the informational efficiency of competitive markets.

2. The Notion of Information in Modern Economic Theory.

Smith's mechanism of the invisible hand has always been considered by economists as the basis for the economic order which emerges as the unintended consequence of individual actions in decentralized economic systems. Despite this, in the majority of cases an explanation for Smith's theory has been sought in the demonstration of the existence of equilibrium, rather than in the analysis of the way in which the equilibrium position can be reached. In a non-explicit manner, even the market mechanism – considered as the process by means of which a degree of order (or an equilibrium) is achieved within the economy – has been kept out of the analysis, as have other aspects of economic theory (that is, the usual data of economic theory: preferences, technology, initial endowments and, in situations of uncertainty, expectations). Furthermore, the market has been attributed the sole function of efficient mechanism of allocation, without considering other equally relevant functions. In the history of economic thought there has been no lack of critical and heterodox positions on the subject, but they have never played a significant role within the mainstream.

In so far as we are concerned, the main element underlying this

approach has been the inability to treat the market as something substantially different from a centralized allocative system. From a general equilibrium perspective, the difference between an economy with decentralized actions and a centrally planned economy has been a question of interpretation, rather than substance. This is mainly due to the hypotheses regarding how equilibrium prices are fixed. In the first instance they are determined by an auctioneer to whom individual agents communicate their own choices. In the second instance, they are determined by an omniscient planner, able to establish which choices agents would make if they were left free to act (for a summary, see Heal, 1986).

In this critical field of research, the most important development in the last few years has been the attempt to incorporate effectively, within formal models, the possibility that agents may have different expectations about the future behavior of the economy. This type of problem is generally examined using the Arrow-Debreu model of general equilibrium under uncertainty. As is well known, through the assumption that the system is subject to random shocks which cannot be observed directly by agents, we are introduced to the problem of the expectation of the occurrence (or non-occurrence) of states of nature at the time at which contracts take place. Therefore, in order to model uncertainty one supposes that contracts are drawn up which are contingent upon the realization of given future events. This analytical structure, introduced to study cases of imperfect information, was later developed in order to deal with the problem of asymmetric information, where each agent has private information on the possible realization of a state of nature. In practice, it is supposed that each agent observes a different realization of the state of nature, depending on the specific activity which he is engaged in. Basing himself on the information which is available to him privately, the agent makes his own forecast as to which state of nature can be carried out at the moment at which contracts take place. The type of contract through which exchanges are carried out is usually the contingent contract.

In this situation, equilibrium prices can be used to infer all the information available within the economy. Intuitively it seems that this function of the price system cannot be given up, but it is not dealt with in traditional models based on the notion of Walrasian equilibrium. In fact, since one of the determining factors in current equilibrium prices is the information which is available to all agents together on possible future states of nature, prices give rise to a form of externality whereby

information possessed individually can be transmitted to all other agents.

There then arises the problem of assessing in what measure equilibrium prices aggregate the information dispersed among agents, and make it public. In order for a price system to be considered fully revealing, that is capable of conveying all the information available in the system, it must be possible to define an invertible function, from the space of informational signals to the space of prices. In this case, each agent can infer all the information available by observing equilibrium prices. One then reaches the conclusion that, in a system in which prices completely aggregate information, the equilibrium allocation which is achieved turns out to be the same as that which would have been achieved had complete information by each agent been assumed. In this case one speaks of informationally efficient equilibrium (Grossman - Stiglitz, 1976, and Grossman, 1989)¹. The core of this reasoning owes much to the literature on rational expectations equilibria, which I shall discuss later. There is, however, one aspect of these developments which, for the purposes of this study, must be examined immediately.

The information concerning uncertainty represented through exogenous shocks, which I outlined briefly above, is a very specific type of information; it is characterized by the fact that the realization (or otherwise) of an uncertain event should be verifiable publicly on the date to which the event refers. The agents who sign contracts which are contingent on the realization of an uncertain event should be able to verify *ex post* the characteristics of the event. Apart from whether or not agents are endowed with different information on the event, what is important is that the sole information which one can take into account within these developments in general equilibrium theory is that concerning exogenous events. Henceforth I shall call this type of information "exogenous information", to borrow Radner's definition

¹ This standard of efficiency – in similar manner to the "efficient markets hypothesis" applied to financial markets, of which it represents at the same time a theoretical justification and a generalisation – is subject to criticism, not only empirically but also in terms of logical consistency. This is immediately recognised in the so-called Grossman-Stiglitz paradox (1976), and in the application of the "no-trade" theorem (Milgrom-Stokey, 1982). In particular, prices carry out simultaneously the double role of clearing the markets and making available the information which determines equilibrium supply and demand, without the opportunities for arbitrage implicit in the informational asymmetries actually being used by the agents who have informational advantages. It should be noted, however, that this criticism does not apply to the case concerning costless information, to which explicit reference is made in what follows. On this point see section 4.

(1982b).

In contrast to the type of information just described one can therefore consider as "endogenous information" the information which agents have private knowledge of and which influences how contracts are characterized, but which, unlike in the preceding case, cannot be used to define the contingent realization of exchanges, because it concerns aspects of economic activity which are not publicly verifiable. The simplest phenomena to which one may refer when examining endogenous information are those analyzed in the literature on moral hazard and adverse selection. Here we are dealing with situations in which one of the parties contracting is in possession of information which is relevant for the possible outcomes, information which is not directly observable by the other party, and so is not verifiable jointly *ex post*, such as the effort of a worker engaged in a production process subject to exogenous shocks, in the case of moral hazard, or such as the intrinsic skill of a worker, in the case of adverse selection. In these situations, the contract is designed according to the scheme known as principal-agent, where the possibility that there may exist relevant private information that is not revealed by the agent is tackled by studying incentive mechanisms or self-selection constraints (see, in particular, Arrow, 1986 and Stiglitz, 1987).

General equilibrium theory cannot take proper account of these phenomena, because of the assessment method for contracts described above, which in general cannot be made to conform with that of the contingent contract. In this context markets conditioned by events observed privately cannot exist by definition. To be precise, with private information which is not publicly verifiable, some futures markets do not exist. As we know, the lack of futures markets in sufficient numbers to enable the achievement of an Arrow-Debreu intertemporal equilibrium, and the associated normative properties, is the starting point for the analysis of sequence economies. The results reached in this area of research imply, on the one hand, multiplicity of equilibria, and on the other, the impossibility of obtaining Pareto efficient equilibria (see Hahn, 1990).

3. The Characteristics of Private Information in Hayek's Theory.

The reference to Hayek as the precursor of the theory of information is common in the literature on general equilibrium with

asymmetric information (for example, Grossman, 1989), and the theory of incentives (for example, Green - Laffont, 1987). Indeed, the bulk of Hayek's theoretical contribution can be regarded as a criticism of Walrasian equilibrium models because they neglect the informational aspects peculiar to competitive markets. In Walrasian models it is assumed that the necessary information to achieve equilibrium is fundamentally technological, and available to all the agents operating in the system. On the contrary, Hayek maintains that the primary function carried out by the price system lies precisely in making available knowledge which cannot be regarded as publicly known, and to do so in the most economic manner possible. Consequently, the central question faced by economics as a social science is, in his opinion, the following: "How can the combination of fragments of knowledge existing in different minds bring about results which, if they were to be brought about deliberately, would require a knowledge on the part of the directing mind which no single person can possess?" (Hayek, 1937, p.54).

In the light of the developments in the economics of information referred to above, it is necessary therefore to evaluate whether Hayek's objections to Walrasian models have been overcome by the results of general equilibrium models with asymmetric information. In particular, in this section I propose to analyze Hayek's notion of private information, in order to determine what type of information Hayek believes can be transmitted by prices during the adjustment process on competitive markets, and what indeed can be aggregated by equilibrium prices. We shall see that there are at least two different types of information, or knowledge, which Hayek refers to: statistical or scientific information, which can be aggregated impersonally by the market through the price system, and private information which, even where it can be aggregated, in order to be used requires the direct participation of the agent who possesses this information. The difference which can be assumed between information and knowledge – the term used by Hayek – and in particular between private information and personal knowledge, is discussed in the following section. In order to clarify this issue, it is necessary to make some preliminary comments on Hayek's interpretation of equilibrium.

From the following observation which, in the 1930s, was no doubt innovative (see Milgate, 1979), it emerges that Hayek regarded the reconstruction of the notion of equilibrium as essential. In order for the notion of equilibrium used in economic theory to be significant, it must

be capable of describing the way in which agents endowed with different information undertake actions which are compatible both with uncertainty about exogenous events and with the possible actions undertaken by the other agents operating in the system. Consequently, the problem of the definition of equilibrium is complicated by the need to bear in mind that, because of informational differences, agents may have different opinions on how the system behaves. Thus, according to Hayek, three conditions should be satisfied in equilibrium. The first two conditions are indicated explicitly, and form the basis for the current notion of equilibrium founded on individual behavior (see Hayek, 1937). In the first place, the individual plans of the agents must be individually consistent, and, in the second place, they must not be contradictory if considered jointly. The first condition may be considered part of every individualistic theory of equilibrium behavior. The second condition specifies the notion of equilibrium in the sense taken up again by Hahn (1984): in situations of uncertainty, agents' plans are based on a theory of the overall operation of the economy which concerns the influence of exogenous factors and the behavior of other agents. Therefore, equilibrium should be regarded as a state in which the activity of exchange confirms the theory formulated by each agent on the behavior of the system.

There is, however, a third condition implicit in Hayek's reasoning the relevance of which is only clarified completely in the explanation of the competitive process out-of-equilibrium (Hayek, 1945 and 1948). In order for equilibrium to be achieved it is necessary for the process of exchange to convey the information dispersed throughout the economy, so that in equilibrium all agents are capable of reaching a common interpretation of the relevant exogenous events. Prices must therefore carry out a role of transmission and aggregation of the information dispersed in the system². Evidently, Hayek believes that compatibility with exogenous factors, which is a component of the second condition for the achievement of equilibrium, can only be obtained at an aggregate level, since individuals can only assess this compatibility after having exchanged their private information with that of the other agents operating in the system. In consequence, the achievement of equilibrium requires a certain degree of knowledge to become common to all agents

² In "The Meaning of Competition" Hayek concludes: "Competition is essentially a process of the formation of opinion: by spreading information, it creates that unity and coherence of the economic system which we presuppose when we think of it as one market" (Hayek, 1976, p.106).

at the same time. This aspect of the problem is the one which is most frequently the subject of inquiry in the literature on equilibrium with asymmetric information and with agents having rational expectations (see, in particular, Bray, 1989 and Grossman, 1989).

In this context, the properties of equilibrium which may be achieved in the economy depend on the degree of knowledge, or information, which must be aggregated and transmitted by the market mechanism. The main problem which must then be examined concerns what type of information Hayek is referring to. In the first place, I shall define the characteristics of the notion of private information used by Hayek.

As we have seen, the knowledge which Hayek refers to is "the knowledge of the circumstances ... [which] never exists in concentrated or integrated form but solely as the dispersed bits of incomplete and frequently contradictory knowledge which all the separate individuals possess" (Hayek, 1945, p.77). The aim of emphasizing a specific type of information is also clearly stated: "price expectations and even the knowledge of current prices are only a very small section of the problem of knowledge, as I see it. The wider aspect of the problem of knowledge with which I am concerned is the knowledge of the basic fact of how the different commodities can be obtained and used, and under what conditions they are actually obtained and used" (Hayek, 1937, p.51). In particular, what Hayek considers essential is "the knowledge of the particular circumstances of time and place", on the basis of which "practically every individual has some advantage over all others because he possesses unique information of which beneficial use might be made, but of which use can be made only if decisions depending on it are left to him or are made with his active co-operation" (Hayek, 1945, p.80). And, as for the relevant knowledge which an agent must possess so that equilibrium can be achieved, this is "the knowledge which he is bound to acquire in view of the position in which he originally is, and the plans which he then make" (Hayek, 1976, p.53). For example, when Hayek talks specifically about production, he regards as of equal importance the knowledge of possible alternative techniques and the knowledge accumulated during production, that is the specific knowledge which is generated in a complementary manner to the production activity itself.

There are thus two general aspects of knowledge which Hayek wants to highlight. On the one hand, there is the knowledge that can be conveyed by prices and which, at the same time, can be incorporated in statistics and therefore be spread to the entire market (henceforth,

statistical information). On the other hand, there is fragmented and personal knowledge, whose possible aggregation and complete transmission is influenced by the agreement of the agent who possesses it, or requires its direct participation in the production process which is relevant to it. Hayek maintains that the most important aspect of the problem of knowledge is the second one, and it is on this aspect that we should therefore concentrate the most.

The personal knowledge of each agent – that is, the information which he has available to him privately – presents some features which differentiate it from the exogenous information used in the equilibrium models with different information, which I mentioned earlier. Firstly, the information which Hayek refers to is generated during the activity which each agent carries out typically. In other words, it is not related to exogenous events which, however much they influence economic activity, remain fundamentally external to it, and form the subject of so-called statistical information. Secondly, it is a type of information which cannot be considered costly for the agent who possesses it, since it is generated in a manner which is complementary to the activity carried out. In addition, one can suppose that it can be acquired by agents in whose interest it is to gain knowledge of it, probably by drawing up a suitable contract; this possibility, however, is not regarded as a general example by Hayek. Thirdly, since it is knowledge which can be generated during the market process, and not solely defined *ex ante*, it is a type of information which is deeply rooted in the dynamics of the economy.

If we limit ourselves to considering the first two characteristics illustrated, we may assert that the personal knowledge which Hayek intends to discuss is something very similar to endogenous or private information, in the spirit of Radner's definition which I referred to in the previous section. In this sense, it can be associated with the private information which forms the subject of modern contract theory.

It might be useful to examine this last aspect. A suitable contract should be designed to take account of the type of information which has just been defined; through this contract it should be possible to provide a consistent analysis of how this private information influences the activity of exchange. The specific nature of a contract based on private information can be better understood in the light of the literature on the principal-agent relationship. In conditions of so-called hidden information or hidden action (Arrow, 1986), the principal does not buy the services of the agent according to a price defined by the competitive

market; furthermore, the contract is not a simple contingent contract, relating to an exogenous random variable. In fact, in an uncertain environment the principal can observe, for example, the outcome of a particular production activity, but cannot assess to what degree this outcome is determined by the two components of exogenous shock and the agent's effort, in the case of hidden action (or of the worker's intrinsic skill, that is his specific capacity to contribute to the production process, in the case of hidden information). The co-existence of two elements, that is the need to share risk among agents generally adverse to risk, and the asymmetry in the information available, drastically changes the type of contract which must be used, compared to the usual contingent contract. It follows that it may not be possible to extract the elements of information dispersed among agents. Furthermore, one should also consider that the set of possible equilibria might be empty, and that part of the existing private information may not be used. This general observation is the starting point for modern contract theory.

Hayek's analysis shows an implicit awareness of this problem where he assumes that there is private information that cannot be completely revealed during the exchange process. In particular, this is underlined when he maintains that prices cannot communicate why, for example, it is cheaper to produce a given product in a certain way rather than in another. Hayek attributed to prices the capacity to indicate a change in production opportunities, for instance a technological improvement, but not to indicate what kind of change has actually taken place, that is to say which specific technological improvement (Hayek, 1945, pp.82-83). Unlike what is asserted in current interpretations of Hayek's theory, this applies not simply because the market is a mechanism which is able to economize on the resources used in the exchange process. Here, Hayek is explicitly considering the possibility that the characteristics of private information peculiar to decentralized systems are such that, in some cases at least, they cannot be completely revealed by prices. In other words, he emphasizes that there may be part of the existing information which cannot be "extracted" and made public, by using the market mechanism, as understood in the traditional Walrasian approach. Precisely because of the nature of this notion of information – which can henceforth be defined simply as private information – Hayek counters the supporters of centralized planning by stressing that "the sort of knowledge with which I have been concerned is knowledge of the kind which by its nature cannot enter into statistics and therefore cannot be conveyed to any central authority in statistical

form." (Hayek, 1976, p.83) ³.

The main question which now arises is the following: in what way does Hayek believe that a task of this nature can be carried out by the price system in a decentralized economy? It is well known that Hayek, in disputing Walrasian developments, and in the tradition of Menger, intended to re-examine the actual role carried out by the price mechanism in a decentralized system (on this subject see, in particular, De Vecchi, 1990, and Moss, 1992). It is also known that he believed that he could attribute to this mechanism the task of transmitting dispersed information. But what we are concerned with understanding here is whether there is an awareness of the fact that this mechanism may turn out not to be completely efficient; in other words, that it may not be capable of aggregating and completely transmitting the dispersed information. In practice, it is a question of assessing whether the equilibrium achieved in a decentralized economy satisfies the properties of efficiency, in particular concerning the problem of information transmission. Again, the point of comparison is provided by the welfare results obtained within general equilibrium theory with rational expectations and asymmetric information (see Laffont, 1989, pp. 146-151, and the discussion in the following section).

At the core of his discussion of centralized economies, there lies Hayek's explicit assertion that the comparative efficiency of planned economies and market economies must be measured in terms of the "fuller use [which is] made of the existing knowledge" (Hayek, 1945, p.79). This is consistent with the analysis carried out above: once the critical role of information is emphasized, then the notion of efficiency in the system must take account not only of technological constraints but also of constraints relating to the distribution of the existing information. The essays written during the thirties and forties, both those on socialist calculation and the more famous essays where Hayek defines the notion of private information, are indeed focused on the demonstration of the theoretical, rather than practical, impossibility of a single, central operator gathering the relevant information dispersed in the economic system ⁴.

³ It should be noted that this observation – which underlies Hayek's criticisms of the so-called market socialists – cannot be overcome by supposing that the planner has a sophisticated computer at his disposal which deals with setting prices in a planned economy. Lange, however, seems to suppose this in his reply to Hayek (see Lange, 1967).

⁴ According to the most widespread interpretation of the socialist controversy up

The fact that Hayek established what he believed to be the theoretical element of the market economy's superiority did not prevent him, however, from discussing whether the market mechanism, examined in its specific features, was capable of achieving equilibria in which the distribution of information was complete. In a neglected section of his famous essay, "Economics and Knowledge", he tackles this point. Even in an analysis aimed at showing that market equilibrium better achieves the objective of an efficient use of information, he recognizes that this equilibrium does not necessarily have properties of Pareto efficiency. In other words, the market process may not be capable of fully conveying the information dispersed in the system. After stressing that the "relevant knowledge" necessary to be able to achieve the equilibrium position must be that which is necessary for carrying out equilibrium plans, Hayek specifies: "While such a position represents in one sense a position of equilibrium, it is clear that it is not an equilibrium in the special sense in which equilibrium is regarded as a sort of optimum position. In order that the results of the combination of individual bits of knowledge should be comparable to the results of direction by an omniscient dictator, further conditions must apparently be introduced. While it should be possible to define the amount of

until the eighties, after acknowledging the logical possibility of Lange's market socialism, Hayek concentrated mainly on demonstrating its practical impossibility. As Lavoie has maintained (1985, pp.90-91), Hayek's observations cannot be confined to the practical problem of computation, that is how to find the solution to a system with an enormous number of equations, but refer to the impossibility of establishing how such equations could be formulated in an informational context of the type described (on this point Caldwell, 1988, Moss, 1992, and Streissler, 1992 also agree). Contrary to what has been asserted by some critics, Hayek introduced the argument of the theoretical rather than practical impossibility of economic calculation in a planned system already in his first articles on the subject, in particular in "Socialist Calculation II. The State of the Debate", which is the last essay in the collection he edited in 1935 under the title *Collectivist Economic Planning*. The argument of the practical impossibility of finding a solution for a system of simultaneous equations by a possible planner is used by Hayek in the event that one accepts "the usual theoretical abstractions used in the explanation of equilibrium in a competitive system [which] include the assumption that a certain range of technical knowledge is 'given'" (Hayek, 1935, p. 154). On the contrary, if these abstractions are not used, one is led to "another problem of even greater importance", the problem which, after the 1937 article, is identified as the Hayekian problem of knowledge. In fact, Hayek asserts at the outset of the debate on socialist calculation, "much of the knowledge that is actually utilized is by no means 'in existence' in this ready-made form" (Hayek, 1935, p. 155).

knowledge which individuals must possess in order that his results should follow, I know of no real attempt in this direction" (Hayek, 1976, p.53) ⁵.

I have attempted to show that the critical motivation on which this conclusion is based should be sought in the particular notion of private information which Hayek has in mind. In his interpretation of the competitive economy there is a certain degree of personal knowledge, or private information, which cannot be communicated to a central planning body, but which not even the mechanism based on market prices can entirely make public. Even if one gives a restrictive interpretation of the notion of information used by Hayek, as I have done here without considering the feature which binds information to the dynamic activity of the system, the Hayekian intuition is confirmed by the theoretical developments examined in modern contract theory.

There now arises the problem of comparing this interpretation of the operation of the market with the widespread view that Hayek should be regarded as one of the most convincing supporters of the efficiency of the competitive mechanism (see, for example, Eatwell - Milgate, 1992). This apparent contradiction, generated by the conclusions of Pareto inefficiency which I have drawn, is based, however, on a fundamental misunderstanding of Hayekian analysis. Hayek's interpretation of the market mechanism is undoubtedly more complex than the strictly neoclassical one. The interpretative shift from the market understood as a mechanism for allocating resources, to the market understood as a mechanism for the transmission of information produces a change of analysis both as regards the elements examined and the possible behavior of agents. The inefficiency of the market, as understood in Walrasian equilibrium analysis, may simply mean, according to Hayek, that contractual relationships other than those reached in impersonal exchange by means of prices, are part of the competitive mechanism, as I intend to illustrate in the following section.

My interpretation so far should allow a second general conclusion. The reconstruction of the notion of private information which I have outlined is, in my opinion, the sole one which is fully compatible with the methodological considerations which Hayek proposes for the analysis of aggregate outcomes of individual actions, following the

⁵ The comparative analysis ends, however, with a reference to the superiority of the market, since the conveyance of information by means of prices nevertheless remains the most effective mechanism which Hayek can imagine (Hayek, 1937, pp.53-54).

Austrian tradition of Menger. Let us see how we can reach these conclusions.

4. Private Information, Personal Knowledge and Equilibrium.

While illustrating the Hayekian view of how the competitive economy operates, in the previous section I described the specific type of equilibrium on which it is based. It involves three fundamental conditions: individual equilibrium, mutual compatibility of individual plans, and the transmission of dispersed information. The interpretation of Hayek's theory given by all the literature on general equilibrium with rational expectations focuses on this third condition, following Grossman's approach. In addition, I have reconstructed Hayek's notion of private information, examining links with recent developments in the economics of information.

In this section I shall deal with three issues which relate to my presentation of Hayek's theory. Firstly, I shall discuss Grossman's interpretative hypothesis. Secondly, I shall examine the question of whether private information and personal knowledge can be considered two equivalent notions. In an attempt to answer these two questions, I shall offer a possible interpretation of the Austrian notion of equilibrium. Finally, I shall consider whether Hayek attributes to prices any role other than that of informational signals.

The first point which I wish to raise is the following one. Can the information which Hayek is thinking of be effectively conveyed by the procedure implicit in the achievement of rational expectations equilibrium? If this were indeed the case, then Hayek's analysis would be fully reinstated in neoclassical equilibrium theory. If, on the contrary, it is possible to maintain that the respective information theories differ, then one can consider a different approach to equilibrium, one which is more in keeping with the Austrian school's traditional approach.

In his studies on the transmission of information by prices, Grossman has demonstrated that if there is information dispersed throughout the economy, then the notion of equilibrium which enables one to attribute an effective informational role to the price system is that of rational expectations equilibrium. As we saw earlier, this equilibrium is determined by assuming that agents are aware of the fact that equilibrium prices can reveal information possessed privately by other agents.

This aspect of competitive coordination in decentralized economies is not dealt with by Arrow-Debreu models of general equilibrium, even under uncertainty and asymmetric information. In an economy where information is dispersed among agents, Walrasian equilibrium generates equilibrium allocations in which each agent uses only the information which he had initially. In the same informational conditions, rational expectations equilibrium gives rise to allocations which would be those of an economy in which each agent possesses all the information dispersed in the system. This happens because, unlike the formal treatment used in traditional Walrasian models, a rational agent (in the sense introduced by the theory of rational expectations) must consider the possibility that it is profitable to recontract away from the allocations associated with those equilibrium prices which depend on plans made autonomously by other agents, each possessing a fragment of dispersed information. In fact, in this instance equilibrium prices must be considered by the rational agent as signals of the dispersed information which is the basis for these plans.

The hypothesis of rational expectations means that agents perceive correctly the relationship which exists between the information available and the equilibrium prices relating to it. In this case, agents who are aware of the role of aggregation and transmission of information carried out by prices act as if they really possessed all the information available (thus the definition of "fully informational" equilibrium). Grossman points out a corollary to this reasoning. In this situation, by interpreting equilibrium as a condition of compatibility between agents who act in the manner described, there arises a Pareto efficient equilibrium, even from the point of view of information transmission. This type of equilibrium achieves the best use possible of the information dispersed throughout the economy, in so far as the allocation which emerges is equivalent to that which one would have in the case of complete information (more precisely, the case in which each agent possesses all the existing information). Unlike what happens in the standard Arrow-Debreu model, the planner's inability to dominate the competitive equilibrium allocations now refers to a situation in which one assumes an *ex ante* informational advantage of the planner over individual agents. In fact, even if the planner possessed all the dispersed information he would not manage to obtain allocations which Pareto dominate market allocations, in which each individual agent knows only fragments of existing information ⁶.

⁶ It should be mentioned that the standard properties of optimality which can be

In Grossman's opinion, this is how one could resolve the problem, which Hayek first raised, of the actual function of prices as a mechanism to communicate information dispersed throughout the system, and of the unsatisfactory treatment which was given to it by Walrasian equilibrium theories, in the Arrow-Debreu framework (Grossman, 1981, pp.32-34, and 1989, pp.1-2).

The analysis presented in the previous section leads to a clear-cut conclusion on Grossman's interpretative hypothesis. We saw that Hayek's notion of private information is closer to the endogenous information studied in the theory of contracts, than to the exogenous information which Grossman's theory of equilibrium can only deal with. The view that the results of recent general equilibrium models correspond to Hayek's perceptive intuition is correct only if one is referring to statistical information, as defined above. However, since Hayek's theory is mainly concerned with the possibility of conveying private information, Grossman's interpretative link is not convincing.

The same argument also applies to some interpretations of the learning processes of rational expectations equilibria. Even in this case it has been maintained that the solution of a process of rational learning would correspond to the formal representation of the problem of knowledge transmission discussed by Hayek (Frydman, 1982 and Frydman - Phelps, 1983). Since the notion of private information used in these models is the same as that in the literature on rational expectations equilibria, these studies do not enable one to maintain that the Hayekian problems of information transmission can be resolved by rational agents, even in the strong sense implicit in the theory of rational expectations ⁷.

obtained in the Arrow-Debreu model with complete markets establish that if agents all have the same information on uncertain variables then the possible equilibrium allocations are Pareto optimal, given the information available: in this case, a planner who possesses all the information cannot obtain Pareto-dominant allocations compared to competitive allocations. The result reached within rational expectations equilibrium models is stronger, because it extends this fundamental theorem of welfare economics to the case of asymmetric information. As we have seen, if agents have different information on uncertain variables, with complete markets, one can demonstrate that the equilibrium allocations which can be achieved are those which one could obtain if all the agents possessed all the information dispersed in the economy. These allocations are also Pareto efficient from the point of view of information transmission in the following sense: prices convey entirely the information dispersed in the system, the agents behave as if they possessed all the existing information, and all the information is used to determine equilibrium allocations.

⁷ From a methodological point of view, the impossibility of reducing the

So far, I have focused on assessing the implications of Hayek's intuitions for current models. However, a second aspect, which is inherent in the analysis carried out must be examined: up to what point can one regard as satisfactory the approximation used in considering private information as equivalent to the notion of personal knowledge discussed by Hayek? Or, does this approximation distort his position?

There is the widespread view that, for the purposes of economic theory, there is no substantial difference between information and knowledge. Generally speaking, it is recognized that while all information can be regarded as knowledge, not all knowledge can be represented as information, thereby allowing one to suppose that knowledge is a more general notion than information; but no specific economic significance is attributed to this distinction (see Hirshleifer - Riley, 1992, ch.8, and, among the theorists of the Austrian tradition, Thomsen, 1992, p.123).

Contrary to this view, it was recently maintained that in Hayek's theory knowledge cannot be subsumed under the notion of information, because of how it is used in the literature on the economics of information. In particular, Boehm (1992) argues that Hayek's notion of knowledge is not to be regarded as an economic commodity which could be acquired at a given cost, and therefore it is not subject to negotiation, unlike the commodities studied in the theory of equilibrium, to which it is usually compared in the literature.

In this interpretation Hayek's notion of information refers to a practical knowledge of which aspects are relevant for the production process, rather than to a technological knowledge. The term practical knowledge is used to denote knowledge which, unlike technological knowledge, cannot be represented following formal rules, and which is embodied in the skills of individual agents. Clearly, it is difficult to incorporate this type of knowledge into statistics and, consequently, it is impossible to imagine that it might be communicated to a potential planner (Lavoie, 1985, pp.103-105, and Boehm, 1992) ⁸.

This type of representation of knowledge does not differ from that

cognitive process hypothesised by Hayek to a rational process of learning has already been emphasised by several authors, including Kirzner, 1984, pp.146-149 and Thomsen, 1992, ch.3.

⁸ The epistemological referent for this type of reasoning is usually provided by Polanyi's contribution. According to Polanyi, the knowledge of a working practice does not imply the capacity to represent this knowledge in an objective formal system. In this sense, practical knowledge (or tacit knowledge) can be transmitted only through apprenticeship and practice, not in a statistical form (Polanyi, 1966).

reconstructed in the previous sections, apart from on one central point. I maintained that personal knowledge can be approximated to the notion of private information used in modern contract theory; in particular, it can be subject to negotiation, and therefore its formal representation can be imagined. In order to explain this position, I shall return to the distinction between exogenous and endogenous information. As we saw in section 2, it is a characteristic of endogenous information that it is impossible to verify it *ex post*, other than by agreement with the agent who possesses it. For this very reason, the representation of the contract as a contract contingent upon the realization of exogenous events cannot be considered satisfactory. Consequently, the private information analyzed in contract and incentive theory should be considered qualitatively different from that used in the studies on general equilibrium ⁹.

Against this background, research has demonstrated that private information may be subject to negotiation, with the imposition of self-selection constraint and incentive mechanisms. Although we do not yet have a general theory of contracts in situations of informational asymmetry, a number of specific situations have been studied where it is profitable to design a contract in which it is possible to check some of the information possessed by the agent with an informational advantage. This can occur only if the agent who possesses certain information finds it worthwhile, in the contractual relationship, to communicate implicitly the private information which is available to him. In the majority of cases, this private information bears a direct relationship either with the agent's skills, or with his specific role within the production process. Furthermore, this type of information is costless for the agent who possesses it, but it contributes to defining the reward scheme, thereby proving to be subject to monetary evaluation in the drawing up of the contract.

The first step in establishing the current relevance of Hayek's theory of information appears to be as follows. To recognize that Hayek has in mind a type of information which cannot be utilized, other than by involving directly the agent who possesses it, does not necessarily entail referring to knowledge which cannot be represented formally as private information. In fact, from an economic point of view, the critical point is

⁹ In his interpretation, Boehm uses the definition of "information as a commodity", as in the re-assessment by Allen, 1990. In the introduction to her work Allen explicitly recalls that this type of information does not allow the analysis of phenomena which are the subject of incentive and contract theory (p.268). On this point, see also Arrow, 1987, pp.209-212, and Hahn, 1990, pp.238-240.

how to verify *ex post* the actions undertaken on the basis of *ex ante* informational differences. In this perspective, the problem raised by Hayek can, for the most part, be linked to the problem which is tackled in contract theory. Recent developments in the economics of information show that, if one examines private information of the endogenous type, then the general equilibrium allocations which can be obtained no longer guarantee Pareto optimality. As we have seen, this is because with contingent contracts it is not possible to open a market based on information which cannot be verified publicly. On the other hand, since the aim is to assess the influence of private information on market exchange, it is possible to conceive of other contractual forms through which information utilization is achieved.

As a final comment on this second aspect, it should be stressed that the fact that there are fragments of knowledge which cannot be communicated impersonally by the market mechanism does not imply that these fragments cannot be regarded as information, and that it is therefore necessary to use the more generic term of knowledge. As to how the economic system operates, the critical point is that, if information cannot be entirely communicated, then equilibrium is not informationally efficient. At the same time, it becomes necessary to analyze allocation mechanisms which are alternatives to impersonal allocation through the market – as understood in the narrow sense of neoclassical interpretation. Firstly, it is necessary to analyze the methods of designing contracts which provide an alternative to the contingent contract. It is essential, therefore, to determine to what degree the *ex ante* informational differences are reduced, or disappear, *ex post* in a more complex, but probably more interesting context than the Walrasian one. This involves regarding the market no longer solely as an allocative mechanism, but as an institution in which exchange, both of goods and information, takes place through several contractual relationships (see, on this subject, Dardi, 1990 and Bowles - Gintis, 1993).

We saw earlier that the Austrian analysis of market behavior emphasizes certain characteristics of economic agents such as specific working skills, techniques of thought and, more generally, entrepreneurial alertness to new investment opportunities. These characteristics are considered crucial for the definition of the competitive market mechanism, in particular as regards agents' reactions to exogenous changes in the data. However, it is worth noting that in order to study the influence of these elements on competitive dynamics, and on the equilibria which the economy may achieve, it is also necessary to

define appropriate contractual forms. In other words, there remains to be explained in what way exchange between agents can be influenced, for example, by the specific working skills of individuals. In fact, if the conclusion that Hayekian equilibrium does not entail the full exploitation of the opportunities offered by informational differences is well founded, then it is necessary to examine alternative mechanisms through which agents with an informational advantage, or more simply with personal knowledge, can get a return on it. In this context it may be fruitful to emphasize the similarities between Hayek's intuition and modern developments in contract theory.

This outline of the interpretation of how the competitive market works may be considered an elaboration of the Hayekian view of the market as an institutional mechanism through which actions undertaken in a decentralized system are coordinated. For Hayek, the coordination of economic actions depends not only on the impersonal operation of the prices system, but also on alternative exchange activities, whose emergence may be brought about by conventional behavior, and whose aggregate outcomes cannot be considered as the intended result of the actions undertaken by individuals alone (see, for example, Hayek, 1967, ch.11). In his attempt to return to the original meaning of the market process – the meaning introduced by Smith and obscured by Walrasian developments – Hayek emphasizes the role of the price system as the most effective means of conveying dispersed information. He also stresses the impossibility of interpreting the general equilibrium of the economy simply as the sum of individual behavior. In his view, the exchange of information is achieved through a process which is far more complex than that which is usually considered. In this process, forces which are different from those of Walrasian competition come into play: imitative behavior, conventional rules and traditions. This makes it impossible to maintain that every action which seems to be an *ex ante* Pareto improvement turns out to be such *ex post*, as is demonstrated, for example, by the analysis of entrepreneurial activity according to the neo-Austrian tradition (see Kirzner, 1992, pp.19-28). The complexity of these economic activities leads Hayek to believe that pure equilibrium theory is not capable of providing a convincing formal representation of the competitive market mechanism. It is mainly for this reason that, in his criticism of pure economic theory from the point of view of the philosophy of the social sciences, Hayek comes to assert that coordination through the market can give rise to states of "spontaneous order" in the economy, rather than to actual general equilibrium (see, in

particular, Hayek, 1967, ch.4, 6).

To conclude I shall look briefly at a third question: if the competitive mechanism is conceived by Hayek in the manner previously illustrated, is there room for the analysis of the market as a disequilibrium process?

Many critics – those who currently exercise the greatest influence within the neo-Austrian approach – maintain that, according to Hayek's theory the coordination of individual actions which is achieved through the competitive mechanism refers mainly to the disequilibrium process, rather than to the equilibrium position of the economy. Consequently, the role of market prices is not so much that of communicating to the operators the information dispersed in the system, but that of indicating possible opportunities which have not been exploited. In other words, they are discovery devices, rather than informational signals. This interpretation is based on an idea of Hayekian knowledge which emphasizes its aspect of knowledge which is constantly changing during the course of the market process, the aspect which is not dealt with in this study (see, among others, Kirzner, 1992).

The fact that these aspects have not been included in our discussion does not imply a denial of their importance in Hayek's theory, in so far as the analysis of the properties implicit in Hayek's notion of information is preliminary to the market process interpretation proposed by the neo-Austrian. However, it is worth emphasizing the following point: if the aspects of discovery rather than those of communication are stressed when dealing with the informational content of Hayek's market theory, then one is led to maintain that the impossibility of reaching Pareto efficient allocations is caused solely by earning opportunities which have not been exploited by economic agents. In this sense, the equilibrium of the economy not only does not have properties of optimality, but is no longer the principal subject for analysis. If this were Hayek's contribution to the analysis of the market process, one could assert that a refinement of the notion of rationality among agents, or a more thorough analysis of cognitive processes, could overcome Hayek's objections to pure equilibrium analysis, which is the kind of objection made in the neoclassical field to all the analyses based on disequilibrium. On the contrary, what I have sought to emphasize in this work is that the meaning of Hayek's criticism can already be understood in the more limited context of equilibrium theory. In particular, these criticisms are grounded in the analysis of the means of communication of private

information which is peculiar to decentralized systems ¹⁰.

5. Conclusions.

Hayek's critical attitude towards Walrasian models is based mainly on informational considerations. According to his view of how the competitive market works, a meaningful notion of equilibrium should be capable of dealing with the issue of the consistency of the plans of economic agents when information is dispersed throughout the economy. He emphasizes that only in this context can there be a correct analysis of the role of market prices as conveyors of information which is available privately to individual agents.

Recent developments in general equilibrium theory with rational expectations have taken up this question from a formal point of view. The proofs of the existence of equilibria with heterogeneous information, and their related normative properties, characterize the new bench-mark in terms of informational efficiency.

In this article I have compared Hayek's main ideas on the competitive mechanism with these modern results. I have asserted that the notion of private information used by Hayek is different from that used in modern equilibrium theory. This is not only because of its dynamic content, as stated by many critics, but also because it refers to a type of knowledge which cannot be verified publicly *ex post*, as is usually necessary in a general equilibrium framework. Furthermore, I have attempted to explain that the notion of private information used in modern contract theory may be considered a good approximation of the notion of personal knowledge used by Hayek.

From this analysis it can be concluded that Hayek's notion of equilibrium does not imply either properties of Pareto optimality, according to the Austrian tradition of Menger, or full informational efficiency.

¹⁰ To borrow Kirzner's terminology, I believe that the division between a "knowledge problem A" and a "knowledge problem B" does not grasp the essence of Hayek's contribution. This is especially because it seems to take for granted that a solution to the first problem that follows the traditional neoclassical approach does not contradict Hayek's interpretation, contrary to what I have maintained in this work (see Kirzner, pp.163-179).

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