MODELLING COGNITIVE TRANSACTIONS FOR ECONOMIC AND ACCOUNTING ANALYSIS

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Abstract: When knowledge is treated as a fundamental factor of economic activity, the development of methods for assessing its economic value becomes essential. This issue has often been discussed both in the scientific literature and for the managerial practice, but with controversial results. This position paper argues that there is need to reflect on the foundational aspects of the problem, and suggests looking at the way the exchange of knowledge between traders underpins economic transactions and enables the production of economic value. A model of *cognitive transaction*, representing the way knowledge exchanges have an economic significance *per se*, is proposed as a starting point of future research on this issue. The critical and open questions of the application of this model, as well as the points of a research agenda, are illustrated.

1 INTRODUCTION

A puzzling problem brought about by the so-called *knowledge economy* is the need to assess the economic value of knowledge. When knowledge is considered a key resource of people, companies and nations, it becomes essential to evaluate its contribution to the production and accumulation of value. This issue has been the subject of intense research, but with controversial results. At a macro level, international institutions have analysed the possibility to measure the contribution of knowledge and knowledge workers to the wealth of nations (WBI, 2008). At a company's level, there have been efforts to value the *intellectual capital* embedded in staff, organisational routines, or artefacts (Hand and Lev, 2003). More recently, the Knowledge Management (KM) field has given birth to approaches to assessing knowledge in KM practices (Kankahalli & Tan, 2004). However, a clear consensus on a specific method or conceptual approach has not been reached (Grossman, 2006).

In this position paper it is argued that there is the need to go back to the roots of the problem, with an in-depth reflection on the mechanisms by which knowledge generates economic value for companies, and on the possible ways of modelling these mechanisms.

2 FOUNDATIONS

Here, it is proposed to consider the issue from a micro perspective. As is assumed by the traditional *accounting* approaches, an economic player (i.e. a company) can be seen as a *system of stocks and flows*. Stocks refer to wealth (cash, real estate, accounts receivable, etc.) and flows refer to expenditures or receipts between two specific points in time. These two elements are observed and recorded into the *accounting charts*, i.e. stocks are shown on a balance sheet, and flows on an income statement. The creation of economic value – and its measurement – is therefore connected to two main activities: a) the *production of value* by means of operative activities over time (producing goods, selling, delivering, etc.); and b) the *accumulation of value* in appropriate *repositories* (e.g.: goods bought; financial assets, etc.).

In addition, from an accounting perspective a firm is not considered *per se*, for two main reasons: first, it produces value by interacting with other economic players (e.g. by trading with others); second, the value of assets has a meaning that depends on the *external conditions*, namely markets, trading rules, etc. (Bolisani & Oltramari, 2009). In practice, the economic value can be associated to the *economic transactions* occurring between traders.

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The notion of economic transaction is the elementary element of many theories explaining the functioning of markets, the inter-firm co-ordination mechanisms, etc. An economic transaction is defined as the activity of *exchange* between a seller and a buyer: the seller transfers the property or control of a physical object to the buyer, and obtains a *payment* (fig. 1). A transaction involving the supply of services can be defined in a similar way.

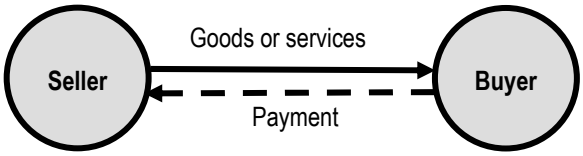

Figure 1: Economic transaction.

Although the act of exchange can be sometimes treated as an indivisible activity, there are several situations in which a transaction needs analysing in terms of its elementary *parts*, for practical or analytical purposes (Gebauer & Scharl, 1999; Sarkar *et al.*, 1995). There are two crucial aspects here:

a) trading is not only a flow of goods/services and a flow of payments: there is a third important flow, a flow of *communications*: To define the trading conditions and execute the material transfers, the parties need to exchange several messages;

b) a transaction can be split into subsequent steps (for instance: initial contact, negotiation, contract, and material execution of exchanges). Each step involves different actions and decisions, and requires the exchange of various messages.

Here, it is argued that these messages carry valuable *knowledge*, which is transferred between seller and buyer. Modelling these exchanges and assessing their value can shed some light into the meaning of knowledge as an economic resource.

3 COGNITIVE TRANSACTIONS

A cognitive transaction is here intended as an exchange of *valuable knowledge* between two traders: these exchanges occur several times during an economic transaction, and they are an essential ingredient of it. As is well known, economic transactions occur in an economy where each player specialises in a particular activity. In a barter market, the payment is another piece of goods or service: the buyer needs a particular item or service that she/he can not make on her/his own and vice versa. When the payment is in the form of money (which is, of course, the general situation), the seller can use the received money to buy other items or services from other sellers. The transaction has an economic significance when the parties are willing to accept the exchange because they expect to gain an economic value or a personal utility.

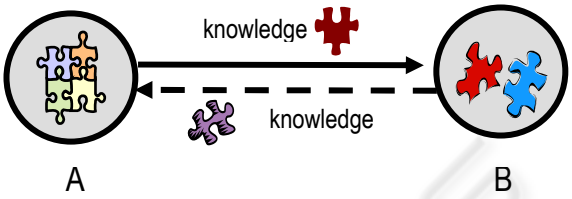

Figure 2: Cognitive transaction.

By exploiting an analogy with this concept, a *cognitive transaction* is defined as *the act of exchanging valuable pieces of knowledge* (fig. 2): a player "A", that possesses some kind of knowledge, transfers a piece of this knowledge to a player "B", and, as a payback, obtains another piece of knowledge from B. Assuming that a player gives out a piece of knowledge in the hope of receiving back another one that she/he needs but does not possess (for instance: something that completes the understanding of a phenomenon, of the functioning of a device, etc.), the situation becomes similar to the classic notion of economic transaction mentioned above, and especially a sort of *barter exchange* of knowledge.

A cognitive transaction can be seen as kind of communication, but with special characteristics compared to other models proposed in the literature. On the one hand, although the importance of communication processes between traders has already been highlighted by some economic theories (just to recall some authoritative references, see e.g. the theory of lemon markets Akerlof, 1970, or the agency theory – Spence, 1973, and others), their cognitive implications have often been neglected. On the other hand, the notion of cognitive transaction differs from that of "message communication" or "information transfer" often used in the Information Systems literature, or from that of knowledge transfer usually defined in KM (Boyd et al., 2007): in the model of cognitive transaction there is an emphasis on the economic value associated to the knowledge exchanged.

This also recalls a traditional distinction made in the KM literature (Boisot, 1998): while data just refer to measures of "facts" and phenomena, and information is the meaning ascribed to those data, we can talk of *knowledge* as data and information

which have value for taking decisions or performing actions. Therefore, the exchange of knowledge is linked to the *purposes and intentions* that the players have. When it comes to trading, since this activity requires the willing to exchange something with the purpose to achieve some goal, the economic evaluation of this goal implies a *cognitive process* and not simply an exchange of "pure" information or "simple" data. In other words, although the communication process between traders is still based on some form of messages that contain data and information, the act of trading is not just the automatic consequence of these messages, but is mediated by a cognitive process that enables the traders to evaluate the economic significance of those messages. This is what a cognitive transaction is intended to model.

4 ILLUSTRATORY EXAMPLES

To summarise, any economic transaction is not an atomic and indivisible activity, but also implies a number of communication processes *before*, *during*, and *after* the material exchange. These communications involve processes of knowledge exchange that, in turn, imply economic evaluations. It is easy to recognise that a number of cognitive transactions occur even in the simplest economic transaction. To explain the concept, we can apply it to an exemplary situation (fig 3).

Let A be a potential seller of some kind of goods (for instance, bread), and B a possible buyer (willing to buy some bread). In traditional terms (fig. 1) the interaction would be modelled just as a material exchange of a quantity of bread from A to B, and a sum of money from B to A. When we analyse the interactions between the two traders, we can identify the occurrence of a number of cognitive transactions, as described below.

1 - Before B passes by the shop, the baker has already hung a "bakery" sign out of the door, which is indeed the first part of a cognitive transaction: B passing by the shop can read the sign and de-code the message, learning that there is a shop selling bread. Supposing that B is looking for some bread, this piece of knowledge has a value for B.

2 - Entering the shop, B asks for some kind of bread. This is a piece of valuable knowledge flowing from B to A, who can now learn that a) there is a potential customer in the shop, and b) that customer likes some kind of bread. In turn, A re-pays B by picking an item from her/his knowledge (i.e. the knowledge of the available bread and its price) and gives it to B, who now learns that there is something that may be worth buying; B can use this fresh knowledge to decide whether or not to carry on the transaction; again, the piece of knowledge exchanged has a value for B;

3 - B informs A about the intention to buy the bread, and communicates the quantity; this message is useful knowledge for A, who can start the practical actions to carry out the material transaction (i.e. taking the bread, wrapping it, etc.); A then calculates the total price and communicates it to the buyer; this piece of knowledge is necessary to carry out the payment, etc.

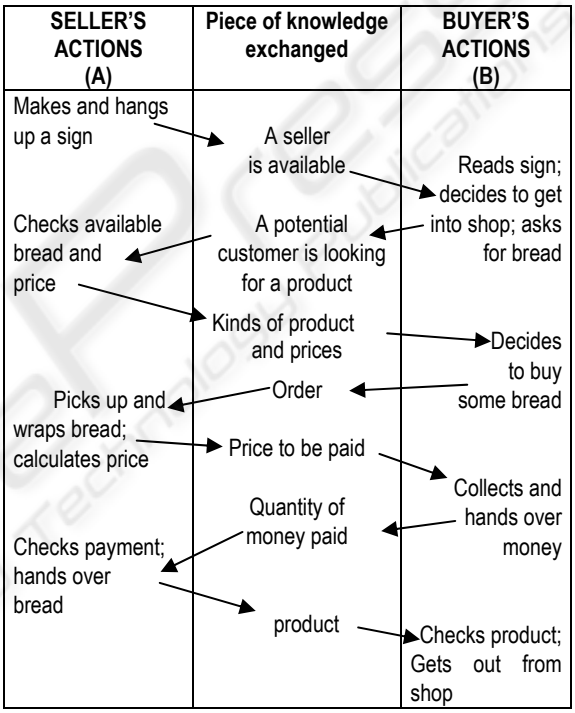

Figure 3: Example of cognitive transactions.

The representation of this process can continue, but what described is enough to make some important points. First, every communication in this process *has* a cognitive implication, which requires reflecting on the way each message is produced, received, and used: The delivery of any message implies a selection and codification of knowledge, and its reception involves a learning activity. Secondly, each transfer of knowledge involves an economic value. As the example illustrates, A and B carefully select the knowledge that they want to give or take, based on personal value judgements. Thirdly, to serve its purpose, the exchange is bi-directional: to complete the trading activity, A needs to give some valuable piece of knowledge (e.g. who

A is, what bread sells, at what price, etc.) and B repays this knowledge with other valuable contents (i.e.: what B likes, what price B can afford, etc.). Finally, we can say that the exchanges of knowledge have a value *before* and even *regardless* that the material transaction is finally carried out.

This last point is of special importance, because we can consequently argue that a cognitive transaction has an economic value *itself*: indeed, the knowledge received by one of the players can be used in other circumstances. It is therefore important to represent and study the cognitive transactions as a separate process from the material exchanges.

This can be clearer if we mention other situations, beside the hypothetical and simple example described before. Let us consider a firm whose job consists of carrying out projects for other companies (for instance: the implementation of a new plant). This activity implies a complex economic transaction, whose significance can't be restricted to the activity of delivering a product and getting a payment. The seller and the buyer need to exchange several valuable pieces of knowledge well before the material exchange is performed: customer's requirements, technical specifications, design proposals, bids, etc. These pieces of knowledge have great value for the two companies. For the seller, the experience made with a customer can be of use for future projects or to design new products, and this can happen even regardless that this specific transaction will be completed. Similarly, the buyer may use the knowledge acquired in the initial stages of the interaction to compare the offers of other suppliers. Again, we can claim that knowledge exchanges have themselves a value.

5 ANALYSING COGNITIVE TRANSACTIONS: CRITICAL ISSUES

A cognitive transaction can become the foundation of a method for assessing the economic value of the knowledge exchanged by traders. However, to achieve this goal, there is the need to clarify some open questions that derive from the recent literature.

5.1 Accounting Knowledge Flows and Stocks

A possible reference for evaluating knowledge can be the traditional accounting methods. As mentioned before, accounting assumes a view of the firm as a system of stocks and flows, that are observed and recorded into the main *accounting charts*. When a company trades with another one, the accounting charts of the two companies represent the effects of trade in terms of ongoing an incoming *flows* of value, and of changes in the companies' *stocks* of value due to those flows. This sufficiently well founded in the case of manufacturing activities and trade of physical goods.

Based on these assumptions, a first important point in the development of the model of cognitive transaction can be the exploration of the conditions under which it this stock-and-flow model can be transferred to the case of knowledge exchanged. To do that, we need: a) to define the notions of knowledge stock and knowledge flow; b) to clarify their mutual relationship, and their link with the notion of cognitive transaction, and c) to explore the application of an accounting method similar to that applied in traditional charts.

5.2 Economic Nature of Knowledge Exchanged

A second important point is that, when we treat knowledge as the *matter* of an economic exchange, this requires new concepts and analytical tools, and fresh managerial models as well. As mentioned, although this issue is still puzzling, some recent advancements in the studies of KM and knowledge economy (KE) provide fresh perspectives that can be of help for understanding how a cognitive transaction works.

To evaluate the knowledge flowing from two traders it is roughly possible to distinguish between two kinds of situations: a) *knowledge which is itself the matter of an economic transaction* (i.e.: a company that provides training services or consulting activities, a media company, etc.): in this case, what is sold is directly knowledge; and b) *knowledge which is transferred before, during and after the exchange of other goods, services, or payments*. A thorough analysis of this distinction is important

Although it is the latter case that better corresponds to the notion of cognitive transaction previously illustrated, it is the former case which has

been analysed more thoroughly in the KM and KE literature. With regard to this, let's briefly examine some important findings of this research. In the economic view, knowledge has often been considered as a *product* of the R&D departments or of other activities, products that can assume tangible aspects (e.g. patents) or are incorporated into an artefact which is then sold (e.g. a software code, a research report, etc.). In such cases, some of the economic characteristics that knowledge assumes have been identified (cfr. Lev, 2001). For instance, the notion of *replicability* and *increasing returns*: when a company acquires a valuable "piece of knowledge" from an external source (for instance, a report from a consulting company), this knowledge becomes part of the "buyer's property", but does not necessarily mean that the source has a "lower quantity" of that particular knowledge. In these specific cases, knowledge is something that can be replicated and then delivered at low or zero cost, and is not simply something whose *property* passes from a seller to a buyer, but it may be difficult to impede the copy or imitation by others.

Related to these issues is the important distinction between *public* and *private* knowledge. Once knowledge is discovered, coded and *published*, it becomes a piece of *public goods*, whose use does not consume it (Foray, 2004): there is essentially zero marginal cost to adding more users, which, therefore, do not have to compete for the use of it. The attempts to exchange this kind of knowledge in a market are problematic because, in accordance to the classic economic models, its price (i.e.: its market *value*) should be equal to zero. On the contrary, it is the private (i.e.: appropriable) use of knowledge that has a value, because it allows its owner to have a competitive use of it. In summary, the more a piece of knowledge is private at appropriable, the more has a value, but at the same time it is difficult to trade it because in doing this knowledge tends to become public and then loses its value. This can have implications for the modelling of a cognitive transaction.

The aforesaid findings have improved our understanding of knowledge as a matter of economic exchange, but as Foray (2004) argues, they also represent an attempt of economists to remain in a "comfortable world" for their analysis, while the reality is much more complex. For instance, their view requires that it is possible to identify single *knowledge objects* passing from a player to another, but as Iandoli & Zollo (2007) argue, knowledge can be intended as an object but also as a *process*. In the former case, we have *pieces of knowledge* that can be detached from the people that process them. In the latter case, knowledge has no meaning when detached from the individuals that process it. In the former case, the identification and valuation of knowledge assumes an *objective* nature. But in the latter case, knowledge has no meaning when detached from the individuals that process it. Therefore, the focus necessarily shifts: measuring the value of knowledge can require to measure the effects on the people that process them (for instance: the results of learning), which gives a subjective meaning to both the process of measurement and the value measured. Consequently, knowledge has only a partial and incomplete *tradability* and it would be difficult to ascribe a value to it without considering its effect on the *experiences* of the individuals (see e.g. the notion of *experience goods* - Nelson, 1970).

The reflection on the real nature of knowledge recalls the well known classification of explicit vs. tacit knowledge (Polanyi 1967): the former is the component of knowledge that can be more easily codified and *detached* from its creator, the latter is the component which can not be coded, and is mostly embedded in people. As the KM literature clearly shows, this concept is associated with the degree of difficulty of knowledge transfer and the possible tools (and even technologies) that can be used for this: tacit knowledge, being embedded in the mind of people and therefore less easy to transfer as an independent object. It also tends to be more appropriable and, consequently, more valuable for the owner. Conversely, explicit knowledge is more easy to transfer but, for this reason, can more easily become public and therefore less valuable (or, at least, less valuable in competitive terms). The notion of cognitive transaction should take into account these points.

6 CONCLUSIONS

In this position paper the notion of cognitive transaction is proposed as a fundamental element of economic transactions. According to this model, an economic transaction is seen as (and requires) a series of knowledge exchanges. Two traders need to exchange pieces of knowledge, which implies an exchange of economic value *per se*. Understanding the value of the exchanged knowledge helps to see the nature of economic transactions from a new perspective, and can shed light on the cognitive implications of economic activities.

The application of this concept needs a number of advancements that, in turn, can represent the

points of a future research agenda. In particular, the achievements of the studies of KM and KE about the mechanisms of knowledge transfer and the nature of knowledge as economic resource need to be systematised to be fruitfully applied to this notion.

Here, some important issues have been pinpointed. First, the nature of knowledge as the matter of an exchange, which implies a reflection on the ways the value of knowledge can be intended and measured. This is also associated with the identification of the different manifestations of knowledge (for instance: knowledge as object or process, tacit vs. explicit components, public or private nature, etc.), the practical tools that can be used to perform its transfer, and the way all these influence the mechanism of a cognitive transaction. Secondly, since the notion of cognitive transaction is applied to the economic exchanges between firms and, more generally, economic players, a more direct connection with the functioning of markets and with the nature of economic exchanges as they are studied in the economic literature or considered in the accounting practices is essential.

Another important point is directly associated with the way the notion of cognitive transaction has been explained here. In the example illustrated in section 4, this notion was applied to individuals. In that case, there is a perfect overlapping between those who exchange knowledge and those who trade. In practical situation, this may or may not happen. For instance, in the economic models the majority of business transactions are intended (and modelled) as being performed between entire firms, or at least parts of a company (for instance, the Sales department, the procurement office, etc.). This requires a reflection about the different subjects (or levels) to which the notion of cognitive transaction should be applied. Also, an identification of the various cases of cognitive transactions that may occur in the distinct cases is necessary.

All this gives the opportunity to draw an agenda for future studies, which may include:

- the application of the notion of cognitive transactions in distinct theoretical cases, to test its validity and utility;
- the validation of the notion with specific empirical situations, to test its plausibility as a model of reality;
- a more thorough analysis of the utility of the notion as a descriptive or prescriptive tool for the economic or managerial studies. It should be therefore explored what the understanding of the functioning of cognitive transactions can really add to our representations of economic activities.

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