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THE GOVERNANCE OF KNOWLEDGE COMMONS

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THE GOVERNANCE OF KNOWLEDGE COMMONS[1]

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1. Introduction

Important shifts in the economics of knowledge have occurred in the recent years. Consensus on the analysis of the public good characters of knowledge has been first contrasted and eventually substituted by the new argument about the quasi-private nature of technological knowledge. The appreciation of demand-side externalities and external knowledge at large has called for a new interest upon the mechanisms of governance upon which the production and the distribution of knowledge builds upon. The understanding of multiple equilibria and micro-macro feed-backs calls back the attention to the crucial role of the economic policy. This had important consequences on the institutional design for the organization of the production and distribution of knowledge.

This process can be summarized in three stages can be steps. The first recalls the ingredients of the great swing from the build-up of the public knowledge commons to the wave of privatizations and liberalization. The identification of the central role of external knowledge in the production of new knowledge marks the second step, where the discovery of the knowledge trade-off stresses the role of the governance in all interactions and exchanges for knowledge. The understanding of the instability of market interactions, in the production and distribution of technological knowledge, should pave the way to the third step, one where a new scope for an economic policy able to manage dynamic coordination issues is identified.

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2. The great swing

The seminal contributions of Kenneth Arrow and Richard Nelson had long shaped the debate about the economic organization for the supply of knowledge. In this approach technological knowledge was seen as a public good for the high levels of indivisibility, non-excludability non-tradability and hence non-appropriability. In this context markets are not able to provide the appropriate levels of knowledge because of both the lack of incentives, and the opportunities for implementing the division of labor and hence achieving adequate levels of specialization. The public provision of technological knowledge, and especially scientific knowledge has been long regarded as the basic remedy to under-provision.

The public provision of scientific and technological knowledge by means of the funding to Universities and other public research bodies, as well as directly to firms willing to undertake research programs of general interest, found in this argument a rationale. This lead to the actual build-up and the systematic implementation of public knowledge commons (Swann, 2002).

On a parallel ground however also ex-ante monopolistic market power has been advocated at this stage as a proper tool to foster the rate of accumulation of technological knowledge and hence of introduction of technological change. Barriers to entry in existing product markets secure the financial resources to fund research and development expenditures and, most importantly, reduce the risks of uncontrolled leakage and imitation. Competitors have yet to enter and entry is barred by substantial cost disadvantages.

The creation of intellectual property rights had been regarded originally as a complementary institutional intervention. Patents and copy-rights, if properly implemented and enforced, can reduce non-excludability and non-appropriability. In such an institutional design, intellectual property rights may also favour tradability and hence lead to higher levels of specialization and division of labour. Intellectual property rights can help increasing the incentives to the production of scientific and technological knowledge (Alchian. and Demsetz,1973).

The build-up of an economics of intellectual property rights has however eventually articulated the stronger hypothesis that appropriate implementation of patents, finely tuned in terms of scope, duration and assignment procedures, can reduce or even erase the problems raised by the public good character of technological knowledge. At the same time much empirical evidence and theoretical research has shown that appropriability is de-facto much higher than assumed. Knowledge is contextual and specific to the original conditions of accumulation and generation: as such natural appropriability conditions are far better than assumed. Imitation costs seem high as well as the costs of receptivity and re-engineering necessary to make use of non proprietary knowledge. The costs of the non-invented-here-syndrome are appreciated.

The assistance of original knowledge holders to perspective users is relevant, if not necessary.

These two strands of analysis, ex-post, contributed with complementary arguments to the new hypothesis that the supply and the demand for technological knowledge can be identified, the actual creation and implementation of markets for technological knowledge is possible and the results of such market interactions are compatible with a workable competitive system in the proximity of equilibrium conditions.

This new approach lead not only to endogenous growth theorizing but also to significant steps towards the privatization of public knowledge commons. Universities were solicited to patent their discoveries and often forced to enter the markets for the technological outsourcing of large corporations. Public funding to research activities declined and questioned if not put under strain. A closer look to the working of the public commons and the actual need to put under scrutiny the productivity of the resources invested in the public knowledge commons, both at the system and the single units level, was advocated. Some attempts to liberalize the markets were also made, especially in the new general purpose technology field of new information and communication technologies with the divestiture in telecommunications and a new more aggressive antitrust stance (David, 1997).

3. The discovery of external knowledge and the knowledge trade-off

The analysis of appropriability made it possible to the economics of innovation to understand the key role of technological externalities and the positive effects of technological spill-overs. The discovery of external knowledge, available not only by means of transactions in the markets for knowledge, but also by means of technological interactions, marks a new important step in the debate. External knowledge is an important input in the production process of new knowledge. The appreciation of external knowledge, as an essential input in the production of new knowledge, was later articulated in the systems of innovation approach, where the production of knowledge is viewed as the result of the cooperative behavior of agents undertaking complementary research activities (Antonelli, 2001).

The costs of exclusion associated to intellectual property rights, as a consequence, should be taken into account. Monopolistic control of relevant bits of knowledge, provided both ex-ante and ex-post by patents and barriers to entry in the products markets respectively, can prevent not only its uncontrolled leakage and hence its dissemination but also further recombination, at least for a relevant stretch of time.

The advantages of the intellectual property right regime, in terms of increased incentives to the market provision of technological knowledge are now balanced by the costs in terms of delayed usage and incremental enrichment. The vertical and

horizontal effects of indivisibility display their powerful effects in terms of cumulability. Indivisibility of knowledge translates into the basic cumulative complementarity among bits of knowledge. Complementarity and cumulability in turn imply that new bits of knowledge can be better introduced building upon other bits already acquired, both in the same specific context and in other adjacent ones. The access exclusion from the knowledge already acquired reduces the prospect for new acquisitions and in any event has a strong social cost in terms of duplication expenses.

Here in the economics of technological knowledge the issues of externalities on the demand side become relevant and evident. The generation of technological knowledge is now considered to be characterized by demand externalities. The notion of user-interdependence makes its foray into the scene when agents value the levels of usage of other agents of certain goods. As far as scientific and technological knowledge is concerned, interdependence among users, hence on the demand side, is in fact very strong. The actual chances of generating a new relevant bit of knowledge for each agent depend upon the levels of accumulation of skills and competence, education and access to information of the other agents in the community.

The amount of external technological knowledge, available in a given context, either industrial, technological or regional, becomes an important endowment, as well the condition of access to it and the characteristics of the relational set-up. A variety of players contributes the amount of external technological knowledge: firms, universities and research centers, as well as brokers and other undertakings specialized in the spread of technological knowledge such as knowledge intensive business service activities. The institutions of labour markets play an important role: job-seniority and wage structures can modify the flows of technological knowledge especially in a regional context (Cooper, 2001). Interindustrial division of labour and outsourcing in general also play an important role as they increase the flows of technological communication. Knowledge intensive business service activities emerge as providers of technological knowledge and complementary actors in the trade of patents and other intellectual property rights.

The issues of the distribution of knowledge become central in the debate and the notion of an actual knowledge trade-off is articulated. Uncontrolled leakage and low appropriability regimes reduce incentives and lead to under-provision. Excess appropriability, both ex-ante and ex-post, however may slow down if not impede the working of knowledge complementarity, cumulability and fungibility. A governance of the knowledge trade-off is necessary both at the firm and at the system levels (Mazzoleni and Nelson, 1998).

The analysis of the governance of both the generation and usage of technological knowledge and that is of the mechanims designed and of the conditions of access and exclusion to the flows of technological interactions, transactions, cordination and communication that are specifically designed to handle the genearation and the distribution of technological knowledge deserves a careful assessment and scrutiny (Menard, 2000; Carroll and Teece, 1999; Williamson, 1985 and 1996; Langlois, 1986).

Inclusion needs to be coordinated and managed. Free-riding can take place, although reciprocity and mutuality in interactions based upon knowledge barters, implemented by repeated and long-lasting exchanges, can help reducing the extent and the effect. Exclusion is dangerous for the risks of missing the relevant complementary input which characterizes the generation of new technologies (Swann, 2002).

The identification of the agents holding specific bits of knowledge and the assessment of their complementarity becomes an important function. This is expensive both in terms of search and opportunity costs: the costs of interacting with the wrong agents in terms of low opportunities. A specific form of knowledge transaction cost can be identified here. The selection of the firms and agents with whom technological cooperation and technological communication can take place is a relevant aspect of the governance mechanism and of the governance process. On which the creation of technological clubs and research joint-ventures as institutional organizations designed to carry on collective research within selective coalitions can take place.

Signalling becomes relevant in this context as a device to reduce knowledge transaction costs. Patents are essential tools to signal the levels and the characteristics of the knowledge embodied in each organization. Patents are also more and more bargaining devices used by firms to improve their position when dealing with other firms engaged in complementary research activities. A new chapter in the economics of intellectual property rights emerges here. Patents are no longer regarded only as tools to increase appropriability, but also as devices to increase transparency in the knowledge markets and hence facilitate markets transactions. The build-up of reputation, by means of publications and scientific sociality also plays an important role as a signalling device within the scientific community (David and Keely, 2002).

A wide range of choices in terms of governance can be analyzed and understood also with respect to the characteristics of the knowledge generation and usage processes. Technological strategies can be implemented by means of internal research and development laboratories, technological outsourcing, location of research and development centers into technological districts, technological alliances and research joint-ventures and finally actual mergers and acquisition (Antonelli and Quéré, 2002).

The firm itself is more and more regarded as an island of coordination procedures that facilitate the accumulation of knowledge. The Coase-Williamson argument, much applied to the choice between coordination and transaction in the organization of the economic activity, can now be stretched and elaborated so as to understanding the fabric of technological knowledge (Furubotn, 2001).

Within corporations the coordination of technological communication becomes a relevant issue. The organization of firms appears to be influenced also by the need to implement and valorize the complementarity of the bits of knowledge possessed and accumulated in the diverse units. The distinctive notion of the costs of technological transactions and interactions can also be identified. The trade-off between knowledge coordination costs and knowledge transaction and interaction costs contributes the understanding of the technological choices of the firm (Argyres, 1995).

In the governance of knowledge not only the traditional 'make or buy' trade-off is relevant, but also a 'make or sell' choice has to be considered. The firm in fact needs to assess not only whether to rely upon external or internal knowledge in the production of new knowledge one, but also whether to try and valorize the knowledge available internally as a good itself and sell it disembodied in the markets for technological knowledge, or to use it as an input in the production of other goods (Teece, 1986).

The economics of technological knowledge has made important progress in the identification of specific characteristics of technological knowledge. The forms and the types of knowledge matter. Different governance mechanisms and governance choices emerge according to the characteristics of technological knowledge.

The forms of the relevant technological knowledge matter: whether technological is more tacit, articulable or codified has a direct bearing on the governance of the accumulation process. Next to the forms of the technological knowledge, its types play an important role. The complexity, fungibility, cumulability and tradability of technological knowledge contribute to assessing the governance mode of the generation and usage of new technological knowledge.

4. Multiple equilibria, instability and the governance of knowledge commons

Technological knowledge can be understood as a collective good characterized by the complementarity both between external and internal knowledge and the stock of existing knowledge and the flows of new knowledge. The aggregate outcomes of the governance mechanisms at the firm level are far from being attracted by a single equilibrium point.

Once again markets appear to provide a unique set for incentive mechanisms to work swiftly, the result of such market interactions however may or may not lead the system towards stable and fair solutions.

The relationship between external and internal knowledge becomes a key issue. It is immediately clear that substitutability cannot apply. Unconstrained complementarity however also appears inappropriate. The hypothesis of a constrained multiplicative relationship can be articulated. The ratio of internal to external knowledge seems relevant. Neither can firms generate new knowledge relying only on external or internal knowledge as an input. With an appropriate ratio of internal to external knowledge instead internal knowledge and external knowledge inputs enter into a constrained multiplicative production function. Both below and above the threshold of the appropriate combination of the complementary inputs the firm cannot achieve the maximum output (Audretsch, Menkveld and Thurik, 1996; Veugelers and Cassiman, 1999; Bonte, 2003).

The amount of knowledge generated by each firm depends upon the a constrained multiplicative relationship between internal and external knowledge inputs. For any given amount of external knowledge available, however, a given amount of internal knowledge inputs, and viceversa for any given amount of internal knowledge, a given amount of external knowledge, is necessary in order to generate a maximum amount of knowledge output. The ratio of internal to external knowledge inputs plays a crucial role. This can be easily modelled as follows:

(1) $KY = IK * EK * Z$

(2) $Z = (IK/EK)$ for max $Z=1$ when $IK/EK=X$

where YK is the knowledge output for each firm, EK and IK are respectively internal knowledge and external knowledge inputs. The actual value of X depends upon industrial, technological and historical circumstances.

An important result is now obtained. Because of the complementarity, between internal and external knowledge, especially if it is specified in terms of a constrained multiplicative relationship, the aggregate outcome of both market transactions and interactions are unstable and sensitive to interactions and subjective decision-making. When both demand and supply schedules are influenced by externalities, multiple equilibria exist (Marmolo, 1999; Autant-Bernard, 2001).

The amount of knowledge each firm can generate depends upon the amount of external knowledge available, that is upon the amount of knowledge that other firms, especially when involved in complementary research projects, have generated and cannot appropriate or are willing to exchange. The amount of external knowledge available at any point in time and in regional and technological space depends upon

the amount of technological knowledge generated and upon the conditions of technological communication within modules of complementary technological knowledge. The market provision of technological knowledge is possible, provided appropriate governance mechanisms are in place, but the levels are undetermined.

A new step along this line of enquiry can be made with the full appreciation of the localized character of technological knowledge and of the implications of key role played in this context by learning processes. The notion of localized technological knowledge in fact makes it possible to stress the role of knowledge as a joint-product of the economic and production activity. Agents learn how, when, where and what, also and mainly, out of their experience, accumulated in daily routines. The introduction of new technologies is heavily constrained by the amount of competence and experience accumulated by means of learning processes in specific technical and contextual procedures (Antonelli, 1999). Agents, in this approach, can generate new knowledge, only in limited domains and fields where they have accumulated sufficient levels of competence and experience. Once again a strict complementarity must be assumed between learning, as a knowledge input, and other knowledge inputs, either internal such as R&D laboratories and external ones.

A very interesting case now emerges: in the markets for knowledge, both demand and supply externalities as well as joint-production apply and exert their effects. On the supply side, the amount of knowledge generated, depends upon the innovative behaviours of the agents as well as on the general production levels of the economic system at each point in time and in the relevant past, because of the role of learning. On the demand side, as it is well clear, network externalities among knowledge users exert an ubiquitous role. The position and the slope of the demand schedule depend on the position and the slope of the supply schedule and viceversa. The latter in turn are influenced by the aggregate conditions of the economic system: learning rates depend upon the amount of output. Needless to say however aggregate output is influenced by the amount of technological knowledge generated in the system, via the total factor productivity effects.

At each point in time any solution can be found, but such solution has not the standard characteristics of stability and replicability. In the markets for technological knowledge each equilibrium point is erratic. Little shocks, at the aggregate and desegregate levels, can push the system far away from any given values. No forces will act to push the system back towards the levels experienced in the previous phase. At the heart of the market system, the production and the distribution of technological knowledge, are characterized by multiple equilibria as well as micro-macro feed-backs and as such are sensitive to small and unintended shocks. Macroeconomic or monetary policies can have long-lasting consequences if and when they affect the joint-supply of experience and competence and hence they have an impact on the supply of technological knowledge. The strategic decision of firms to increase either the demand or the production of technological knowledge can also have long-lasting

effects changing the parameters of the system. Entrepreneurial action hence may have here direct consequences at the economic system level changing the equilibrium conditions. Both failure and success however can be the result, depending on the outcomes of chain of reactions which may take place.

Economic systems may be trapped in a low-knowledge-generation regime, while others remain in high-knowledge-generation ones. Path dependence, because of the role of learning and interdependence deploys here its powerful effects. Small events can push the system to oscillate from one regime to the other with long lasting consequences. In this context the issues of dynamic coordination among agents and institutions becomes most relevant in order to assess the general outcome of each single action.

5. Conclusion

A long process has been taking place, since the old days of knowledge as a public good. A better understanding has been elaborated of the dynamics of knowledge accumulation. Appropriability conditions seem now less relevant. Demand and network externalities play much a stronger role now. Transactions in the markets for knowledge do take place, along with systems of technological interaction based upon barter and reciprocity. A variety of governance mechanisms has been designed and implemented, or simply better understood.

Eventually however the need for economic policy seems stronger than ever. The governance of the markets for technological knowledge is not sufficient. Multiple equilibria and micro-macro feed-backs affect the working of transactions and interactions in the markets for technological knowledge and their outcome. The dynamic coordination of agents play in this context a central role.

The credible announcement of long lasting great initiatives and the implementation of large research projects based upon the framed and yet selective participation of a variety of agents in scientific and technological undertakings with direct economic and productive fall-outs should have the same positive effects, often experienced for military expenses and related spatial ventures, also when applied in peaceful activities.

A governance of knowledge commons needs to be implemented at the policy level.

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