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**PREFACE**

**TOWARDS A NEW KNOWLEDGE POLICY**

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The generation and exploitation of knowledge have become the cornerstone of advanced economic systems. The fast globalization of both product and capital markets occurred since the end of the 20thcentury has pushed advanced countries to identify knowledge as the key factor upon which to base their competitive strength. Advanced countries have progressively shifted away from the manufacturing sector, and especially from the traditional low-tech sectors and thus have experienced fast growth of the new knowledge intensive business sectors. Knowledge is at the same time the output of a dedicated activity and a key input into the production of new knowledge as much as of all the other goods. The division of labor in the generation of new knowledge has been increasing with the identification of multiple layers of specialization. The generation of knowledge as a final and an intermediary good has been itself “industrialized”. New information and communication technologies have provided the basic infrastructure to the activities that are at the base of the generation and exploitation of knowledge.

Technological knowledge is more and more traded as an intangible good and a property right, and its embodiment in other products is less and less necessary for its effective exchange in the market place. The exchange of knowledge takes place in the new markets for knowledge that have been consolidating both on the demand and the supply side. Knowledge users rely less and less on the internal generation of knowledge and have reduced the vertical integration of knowledge generating activities with selective processes of outsourcing so as to feed a growing derived demand of knowledge as an intermediary good. The entry of new specialized service firms and of public research centers that perform research activities on behalf of third parties, together with the pervasive dynamics of takeovers of knowledge intensive start-ups traded in the financial markets, has led to the birth and growth of a new industry specialized in the generation and exploitation of knowledge as an economic good (Antonelli, Link, Metcalfe, 2009).

The viability of the new knowledge growth regime depends upon the access conditions to knowledge. Knowledge in fact is at the same time the output of a dedicated activity and the necessary input of its own generation. The generation of new knowledge consists of the recombination of existing knowledge items. The limited exhaustibility of knowledge enables its repeated use. This new context unveils—next to its well-known limits—the benefits of the limited appropriability of knowledge: the better are the access conditions to the existing stock of knowledge and the lower is the cost of new knowledge and the faster its rate of generation (Link, Antonelli, 2014).

The analysis of the crucial role of knowledge calls attention on the need for a new knowledge policy. Research policies have been heavily influenced by the large consensus about the Arrovian knowledge market failure. The analysis of the negative economic consequences of the limits of knowledge as an economic good has been implemented for several decades and provided the base for an articulated set of economic policies aimed increasing the incentives to the generation of knowledge deemed to be insufficient.

Consistent with its theoretical framework, traditional research policies have privileged the focus on the supply of knowledge: the basic aim has been in fact to try and remedy the market failure, restoring the equilibrium conditions, acting on the side of the missing incentives and the unbalance between costs and revenues diminished by the uncontrolled leakage of knowledge.

The cornerstones of the research policies that stems from the hypothesis of a generalized knowledge market failure, due to the limited appropriability of knowledge, are: (i) the public support to the generation of knowledge by means of the supply of scientific and technological knowledge with the creation of a public infrastructure including academia and specialized public research centers; (ii) the provision of public subsidies designed to reducing the costs of knowledge generating activities so as to balance the negative effects of the persistent limited appropriability of proprietary knowledge even after the protection provided by patents; (iii) the public support to knowledge exploitation with the implementation of an intellectual property rights (IPR) regime designed to increase the natural appropriability of knowledge.

The results of the analyses carried out by this book suggest that a radical change is necessary. Knowledge is an economic good with special characteristics that enable economic systems and firms to take advantage of the dynamic increasing returns that stem from its limited exhaustibility and hence its cumulability and extensibility. Knowledge extensibility takes place when the same piece of knowledge can be applied to the production of unlimited quantities of other products. Knowledge cumulability takes place when a piece of knowledge is used again and again as an input for the generation of new knowledge with limited effects in terms of wear-and-tear.

Technological knowledge, in fact, is not only an indispensable input in the technology production function (i.e., for the production of any other good), but also an essential input for the recombinant generation of new knowledge. The conditions for the access and use of the stock of knowledge accumulated by the successive vintages of knowledge are crucial for the growth of output and the increase of total factor productivity. The limited exhaustibility of knowledge is in fact the key factor of total factor productivity growth. When the access conditions to the stock of knowledge are favorable and its absorption takes place at low costs, the cost of new knowledge can be lower than its equilibrium levels.

The actual cost of knowledge is determined by the quality of the mechanism of knowledge governance mechanisms at work within economic systems. The cost of access, absorption and use of the stock of existing knowledge may be so high as to limit the intrinsic advantages of its limited exhaustibility. When, however, the quality of the knowledge governance mechanism in place is high and keeps the cost of access, absorption and use of the stock of quasi-public knowledge, for perspective users, below equilibrium levels it enables the creative reaction of firms and the introduction of innovations that increase output and total factor productivity.

In this context there are strong and evident reasons for the public support to the generation of technological knowledge not only to restore the Arrovian “equilibrium conditions”, but to increase the size of the stock of knowledge with its positive consequences in terms of increasing returns. For the same token, public support to the improving the quality of knowledge governance mechanism is expected to yield positive effects in terms of lower costs of access and using the existing stock of knowledge (Antonelli, Link, 2015).

The new achievements of the economics of knowledge, as well as the new central role of knowledge in the economy of advanced countries, make necessary to overcome the limits of the traditional framework of research policies and necessitate a move towards a full-fledged Knowledge Policy.

The Knowledge Policy framework concerns the full array of the traditional tools of the Arrovian research policies, including: (i) the structure of intellectual property rights and the role of the exclusivity of patents, (ii) the additionality of public subsidies to R&D activities performed by private firms, (iii) the selection of the research agenda of public research centers that generate knowledge as a public good directly available to private users, and (iv) a new attention on the demand for knowledge with special attention to competent procurement. Let us analyze them more in detail.

The analysis of the consequences of the limited appropriability of knowledge must be framed into the new context that appreciates the potentialities of knowledge for dynamic increasing returns. IPRs are necessary to secure the appropriation of the rent stemming from the generation of technological knowledge and their use for the introduction of innovations. A system deprived of IPRs indeed risks facing the fall of the incentives, at the firm level, for the generation of knowledge even accounting for its long-term positive effects. The differentiation of IPRs according to the use of proprietary knowledge with high levels of exclusivity for the use of proprietary knowledge the technology production function and low levels of exclusivity for the use of knowledge as an input in the knowledge generation function opens the way for a knowledge policy aimed at increasing the benefits of the limited exhaustibility of knowledge. The reduction of the exclusivity of IPRs with the introduction of non-exclusive patents with compulsory licensing based upon the liability rule seems especially appropriate when existing knowledge is used for the generation of new knowledge. Perspective users of the existing proprietary knowledge can access and use it, provided that the owner of the IPRs is informed and receives a fair royalty. The support to the implementation of strategic alliances based upon the sharing of proprietary knowledge can help increasing the shared access to knowledge (Link and Antonelli, 2016).

The new understanding of the positive effects of the limited exhaustibility of knowledge has important implications for the provision of public subsidies to firms that perform research and development (R&D) activities. The traditional rationale based upon the compensation to the missed benefits triggered by the limited appropriability of knowledge by means of incentives needs to be integrated by the new understanding of the increasing returns triggered by the cumulability of knowledge. In this context it is necessary not only to compensate firms for the missing revenues but also to stir the increase of the absolute levels of knowledge output. The larger are the flows of knowledge output and the larger is the stock of knowledge that can be used as an indispensable input into the recombinant generation of new knowledge, hence the lower the costs of new knowledge. Public subsidies should be consequently granted with stronger additionality requirements so that the traditional crowding-out effect can be limited by the constraint to increase the levels of R&D activities actually performed by an amount that is at least equal and possibly larger than the public subsidy. The selective support to the generation of new technological knowledge according to differentiated levels of additionality seems an indispensable tool to implement a new frame for granting public subsidies based upon the Knowledge Policy approach.

The supply of public knowledge generated by public research centers requires to be better directed. Too often public research centers risk abandoning their research agenda and the flow of knowledge output to undertakings with a limited use by the business system. The key signaling function about the characteristics of the demand performed by the price mechanism embedded in the working of markets needs be better grafted and adapted to directing and selecting the supply of knowledge as a public good by public research centers. It is clearly necessary to preserve the indispensable research freedom and yet to finalize the delivery of knowledge inputs to the rest of the system that are actually useful. A solution can be provided by the systematic implementation of closer interaction mechanisms between users and producers of public knowledge.

Interventions on the demand side can be very effective to complement the set of supply side tools of the novel Knowledge Policy. Support for the demand for knowledge intensive products can yield important incentives to the generation of additional knowledge when it is coupled with high levels of competence. The demand of selective products that solicit the generation of new knowledge can be far more effective than generic macroeconomic demand-pull mechanisms. The support to competent procurement can be both direct and indirect. The competent procurement of the business sector can be supported and guided with selective incentives to products that are likely to increase the derived demand for knowledge in selected fields. The levels of competence of the demand of the public sector can be improved with higher levels of awareness of its powerful effects on the generation of advanced knowledge. The coupling of a competent procurement both direct by the public administrations and indirect by firms supported by public incentives with the public supply of knowledge by public research centers can boost their joint effects.

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