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The Knowledge Economy: A New Research Agenda

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Abstract

In recent years the notion that intangible assets, such as ideas and creativity, ultimately "knowledge", dominate modern production has re-focused the research of economic theory, and especially of growth theory, on knowledge and knowledge production. Knowledge production and accumulation are the source of technical change and the defining trait of the modern "knowledge economy". Most important, these factors are said to be crucial for economic dynamism and growth performance. Underneath however is a "reductionist" view of knowledge that is not very helpful to understand what a "knowledge economy" might be.

There is a broader and we would argue more satisfactory perspective on the question of the knowledge economy. A new research agenda involves among other things discussing the goals and meaning of economic progress. Another important consequence of the change of perspective is refocusing the attention on externalities and their role in supporting economic growth.

1. Introduction

Technical progress has long been an important issue in economic theory. It was, however, mainly a question of improvements of capital goods (embodied technical change). Now it concerns mainly the accumulation of knowledge and the capacity to innovate.

The change in perspective appears influenced if not determined by the real world of industry and technology. Information technology and digitalization have implied an increasing dematerialization of knowledge, thus a bias towards disembodied technical change and knowledge accumulation. In the grand rethinking of economic growth, the epoch of Modern Growth rests precisely on knowledge and technical progress [1].

Observing the US economy of the 1950s Fritz Machlup provided an early systematic account of the knowledge economy [2]. Clearly many things have changed. It is however remarkable the difference with the narrow understanding of knowledge in the recent literature. What "knowledge economy" means in a XXI century is clearly an utterly difficult and complex matter. Still, the term often appears in studies, programs and strategies elaborated by the EU and international organizations. It is often mentioned both as a necessity and a fact to be reckoned with. Economic policy, it is said, should favor positive developments and prevent undesirable results. The reasoning stretches into the question of the institutions best suited to a knowledge economy.

Machlup treated knowledge as an information source, in line with "Austrian" economics notion of capital. In his criticism of planning Hayek argues that only markets can convey the information that is essential to production.

The paper touches on theoretical notions that are the object of classic contributions. Knowledge and human capital have notoriously investigated by Gary Becker and Kenneth Boulding. It should be noted that the paper aims primarily at presenting a broader perspective on the knowledge economy that may lead research in a new direction. By no means it attempts an exhaustive investigation.

2. The Economics of Knowledge

Andersson and Beckmann observe that knowledge was rarely analyzed as such by economists before the 1980s [3]. The recent interest is related to the expansion of education, the rapid growth of knowledge-based industries (including producer services) and R&D. The many angles of the problem are examined in separate chapters. Chapter eight (Expansion of knowledge and macrogrowth) most clearly summarizes the basics of the economic discourse on knowledge.

See for example chapter six (Household knowledge Institutions) and chapter seven (Information and knowledge in decision-making of firms).

Recalling the pioneer work of Robert and Edward Denison Andersson and Beckmann present an analytical framework based on a Cobb-Douglas macro production function: Net output depends on the weighted geometric average of different inputs, *i.e.* quantities of capital. Knowledge is treated as a form of capital coming from investment in R&D (research capital, *i.e.* the stock of knowledge equal to the accumulated investments in R&D) and investment in education (human capital). The empirical analysis aims at explaining the relative importance of different inputs contributing to the rate of growth. It is based on the work of Angus Maddison who extended Kuznets macro-economic accounting data.

Andersson and Beckmann accounting equations are in the appendix.

According to Andersson and Beckmann in mature economies the rate of growth of labour supply is often close to zero. The main factors determining growth are then: the marginal productivity of material and knowledge capital; the propensity to save of households, firms and government; the rate of growth of human capital linked to investments in education.

It can be noted the rather simple way in which the new focus on knowledge is incorporated into neoclassical production theory. The supposedly epochal change in long-term growth becomes simply an addition to the forms of capital. The knowledge economy is defined by the accumulation of knowledge measured by the quantities of two forms of capital, knowledge capital and human capital. Ultimately, the economics of knowledge focuses on knowledge as a factor of production in the framework of growth accounting.

3. Knowledge, Endogenous Technical Change and Externalities

With respect to the economics of knowledge "definitional" treatment of knowledge New Growth Theory (NGT) adds a particular focus on technical progress and externalities.

NGT proposes a generation of models sharing some fundamental similarities and in particular the focus on the accumulation of intangibles and technical progress. The immaterial resources are ultimately identified with the production and accumulation of knowledge, which together with certain pivotal activities (R&D) and the education system, are the key to endogenous growth. Dissatisfaction "with exogenously driven explanations of long run productivity growth" motivated "the construction of a class of growth models in which the key determinants were endogenous to the model." Barro and Sala-i-Martin distinguish a first wave of contributions by Romer, Lucas and Rebelo that focused on the non-diminishing returns to investment from a second phase of research started by Romer and pursued by Grossman and Helpman and Aghion and Howitt that incorporates R&D theories and imperfect competition into the growth framework [4-8].

The AK model illustrates clearly the main point of endogenous growth theory [9]. The relationship between output and capital depends on a positive constant which stands for the level of technology. To sustain growth in the long-run the production function must be linear in the factor determining growth. This implies broadening the notion of capital to include all the factors of production. In other words, there is no scarcity of capital ruling over the growth process. "The global absence of diminishing returns may seem unrealistic, but the idea becomes more plausible if we think of K in a broad sense to include human capital [4]."

The accumulation of knowledge has positive external effects caused by the diffusion of technological know-how, the specialization of production the accumulation of human capital the process of product innovation [5-8,10,11].

These arguments are so many ways to maintain that the growth rates of capital, output and consumption are positive in the long-run and do not depend on any exogenous factor. This endogenous dynamics is no longer centered on physical capital, but rather on technological knowledge, human capital, product differentiation. The theory of growth is no longer a theory of capital accumulation; immaterial resources, such as knowledge and human capital, are far more important factors of growth [12].

Starting from different theoretical premises Bonifati explains the relatively weak correlation between investment and productivity, widely believed to be positive and strong, arguing that increasing returns are generated by technological development and new knowledge, which are not captured by the growth of physical capital. The test concerns the desegregated US manufacturing industry over the period 1960-1994 [9].

The role of externalities is pervasive to the idea of endogenous growth. "The model here can be viewed as an equilibrium model of endogenous technological change in which long-run growth is driven primarily by the accumulation of knowledge by forward-looking, profit maximizing agents. … new knowledge is assumed to be the product of a research technology which exhibits diminishing returns. … In addition, investment in knowledge suggests a natural externality. … knowledge cannot be perfectly patented or kept secret. … knowledge may have an increasing marginal product. The model rests on the "assumption of increasing rather then decreasing marginal productivity of the intangible capital good knowledge [5]." (ibid. p.1004)

In a further development the accumulation of knowledge is treated as a non-rival good which implies that it can be "accumulated without bound on a per capita basis" and cannot be completely appropriated determining spillover effects. What matters is "the market process by which new knowledge is translated into goods with practical value [6]." (p.72)

There are three premises to Endogenous Technical Change: 1) Technological change lies at the heart of economic growth; 2) "technological change arises in large part because of the intentional actions taken by people who respond to market incentives."; 3) "instructions for working with raw materials are inherently

different from other economic goods." (ibid.) Romer concludes that: "The only way to accept all three premises is ... to explicitly introduce market power." (ibid., p.78)

The result is therefore a competitive equilibrium with increasing returns and monopoly power. Thus the "technical" character of NGT. "The main contribution of the new growth theory so far has been predominantly technical in nature. It is now possible to deal with increasing returns and imperfect competition in dynamic general equilibrium models which are simple as those developed in the recent industrial organization literature. This technological breakthrough has in turn made it possible to formalize a number of existing ideas concerning growth and development [13]."

4. Intellectual Property and Competitive Analysis

Knowledge accumulation, and in particular the externality it creates, has reignited the debate on intellectual property.

Boldrin and Levine have argued against a "distorted extension of intellectual property rights" because it "has come to mean not only the right to own and sell ideas but also the right to regulate their use [14]." (p.209) Monopoly power (patents, copyright and other private contracts) has been widely accepted to ensure a reward to inventive activity, in particular to recuperate fixed cost. But "creation is not a fixed cost, is a sunk cost." (ibid.) That is the cost of producing the first unit. That is not new. What is new is the indivisibility associated with creative activity. ("two half-baked ideas do not equal one fully baked idea" (ibid., p. 210) Although the theory of competition with indivisibilities is not yet fully worked out competition "often yields the first best" and downstream licensing may hurt rather than help innovation (ibid.)

Downstream licensing confuses the issue of intellectual property: It grants the right to control the use of ideas after sale. Indeed, "only ideas embodied in people or products matter" (ibid., p.209) Contrary to what is argued by Romer after the first sale producers of intellectual property should not be protected against competition by their customers [6]. They must be forced to compete with them: "In a competitive environment, everyone is potentially a buyer and a seller." (ibid., p.211). That is the creative use of markets.

For a discussion of monopoly rights (patents and copyrights) and knowledge disclosure see Harison who examines Intellectual Property Rights with regard to IT and software technologies [15].

Ultimately competitive equilibrium fails to attain the first best not because of increasing returns but only because ideas are indivisible. Monopoly is neither needed for, nor a necessary consequence of innovation [16].

Boldrin and Levine have also challenged the view that pure-knowledge spillovers are non-costly [17]. Ideas have value only insofar they are embodied in goods and people. Therefore, there is no economic justification for the assumption that ideas are transmitted through costless 'spillovers.

5. Localized Knowledge: Learning and Innovation

A noticeable change of perspective is introduced by the notion of localized knowledge. It distinguishes between between science-based generic knowledge and applied (tacit, specific, industry-based) knowledge leading to technical progress. That brings to the fore the role of learning and innovation by which knowledge becomes productive.

According to Antonelli the new aspects of the knowledge economy are: a) the rise of a "new knowledge sector as the result of the institutional generation of a market for knowledge." (p.1) It includes independent firms specializing in the production of technical knowledge and competencies intertwined with the diffusion of ICTs; b) the internalization of knowledge into the social practices of production. The key point is not just information or technology, but the elaboration of codes. Elaborating codes creates interpretation and thus knowledge. The latter is a social practice, a learning process.

The notion of localized knowledge rests on the distinction between information, knowledge and competencies. Localized knowledge includes "the competencies and the capacity to both use information in the specific context and create further information." (ibid., p.3) Technical knowledge is the result of learning internal to the background and experience of the innovator. It is then an appropriable and excluding resource, subject to accumulation and path dependency [18].

In the innovation theory based on the work of Arrow technological information is a public good, a non-rival, non-excluding resource that can be transferred at negligible cost [19]. It has a vast array of applications and "it could not be traded without being revealed", which implies that its value is hard to determine [20]. Technical progress is then the result of a flow of technology information generated by scientific research and applied to specific fields by firms. Intellectual property rights permit to appropriate the benefits of innovation, but reduce their socialization. Notice however that the belief that scientific knowledge is public and technological knowledge is proprietary is questioned by research in the field of biology [21].

Learning is for its nature "localized". It has space and sectoral dimensions. That might be the basis of a proper "territorial economics" (the territory shaping learning and innovation). Localized knowledge has become part of the literature on local-regional development (the learning region) as well as into the analysis of firms and industrial systems. The institutional and social aspects of innovation are analyzed in the literature on "the national systems of innovation" [22].

Localized technical knowledge is a mix of generic knowledge, *i.e.* codified scientific information external to the firm, and tacit knowledge, mostly internal to the firm. The first is available as a public good at a limited cost. It is institutionalized with the rise of a market for knowledge. The second is based on learning processes. It is highly specific and idiosyncratic, therefore difficult and costly

to transfer. Ultimately new knowledge results from the interaction of the two. The overall process highlights the importance of externalities and technological interdependence of firms.

Antonelli stresses the systemic process in which the bottom-up inductive process based on direct experience is complemented by the top-down deductive process based on scientific principles. Localized knowledge is produced by firms, it is then sensitive to industry specific variables – studied by innovative models. But it is also the result of (local) institutions – including specialized markets for knowledge. That introduces issues of cooperation and shared knowledge, which might have increasing returns.

6. Market-Based Knowledge and the Knowledge Economy

6.1 Market-Based Knowledge

The literature above highlights the fundamental features of the economic analysis of knowledge: a) the production and use of knowledge are strictly market phenomena; b) productive knowledge is accumulated by means of purposeful R&D; c) for any analytical purpose knowledge is productive via technical progress. Public knowledge, *i.e.* the externality linked to the public nature of research findings, may become "productive" when it is turned into new products or productive inputs in industry and commerce. It is not however traded on the market.

Localized knowledge affords a clarification of a number of aspects of technological progress that are ignored (or locked in implicit assumptions) in the competitive analysis. The localized nature of cognitive processes adds to the understanding of knowledge production and use as a social and institutional phenomenon. The analysis remains however confined to the operation of the market. This is confirmed by the importance assigned to the creation of markets for knowledge and the rise of the knowledge sector.

Should we conclude that knowledge accumulation, technical progress and innovation governed by markets are the appropriate way to characterize the knowledge economy? This literature focuses on productive knowledge. But what is "productive knowledge" in advanced industrial economies? This is the starting point of a broader perspective, in fact of an analysis of knowledge in advanced industrial economies.

6.2 The Social Nature of Knowledge

A different perspective on the problem concerns in a sense the full potential of knowledge as a public good. Knowledge may be produced through non-market channels. Although it may have, and often has, market effects, that type of knowledge is not a market phenomenon.

We are looking at a kind of knowledge that flows from social interaction and participation into social networks. In particular, knowledge may be acquired through communication in some sort of "community". Quite telling is in this respect the creation and diffusion of knowledge in financial markets. Note also that one thing is technical change resulting from purposeful R&D investment, quite another is knowledge as imagination and creativity. These most likely do not depend on any commercial use, nor on markets. Knowledge in the form of ideas and creative work is the result of the development of intellect and social interaction. We could think of that as knowledge associated with the development of individuals and society. To give another example: The development of Artificial Intelligence extends into question such as: How long it might be before machines come up with something creative, something imaginative similar to that of art and culture [23].

Knorr Cetina Karin has spoken of financial markets as conversation, of transactions as a result of social communication. Ultimately knowledge depends on trust and social communication.

Ideas and creativity are the intangible assets of the "creative class" [24].

The notion of a knowledge economy should conceivably be broadened to consider also this type of knowledge that goes well beyond the accumulation of human capital and R&D investment. This aspect of knowledge is furthered in a society permeated by communication and images stimulating new ideas. All of this reminds us of social nature of knowledge, which re-proposes in a different light the question of knowledge as a public good. In the dominating approach knowledge that is not appropriated determines an externality. In this case knowledge is socially produced. As such it cannot be privately accumulated or patented, although it can become "productive", *i.e.* put at a commercial use. Therefore, not only scientific and technical knowledge is useful to production.

Concerning the complexity involved in technical change and innovation one should recall that the actual path of research and scientific discovery highlights the importance of serendipity, i.e. the casual, serendipitous nature of major discoveries. The history of scientific research and technological development is full of examples where the relationship between discoveries, ideas and new products is far from being deterministic.

To pin down the complexity of the question of knowledge a few hints from a history of economic thought may help. Socrates refused any practical attitude towards knowledge and argued against the use of knowledge by the Sophists for private gains. In XIV century Arab philosophy the notion of growth of knowledge was associated with arts and poetry. Max Weber observed that Calvinism fostered rationalization, because it envisaged an aesthetic, rational society, but the result was competition in commodities and knowledge production. We had rational progress, rather than knowledge in the sense of personal culture.

What follows is based on Bertram Schefold, *The Knowledge Society in the history of economic thought*.

The modern human capital notion introduced by Mincer implies investment with a private return on knowledge. Specialized knowledge gives rise to patents, while general knowledge is that

embodied in the National Systems of Innovation. Economists understandably focused on technical progress, but the economic and social peculiarities of knowledge must be kept in mind. New knowledge by definition creates information asymmetries and implicit knowledge. It follows that knowledge cannot be traded as other commodities. Thus, market for knowledge must be limited and requires control. Still, ideas must be financed, and the theory of innovation suggests that the process requires investments, while it might risk failure.

Ultimately there seems to be a fundamental distinction between knowledge as a mean "to gain economic power" and knowledge as personal culture. That reflects the line one can draw between knowledge for its own sake, or rather for the light and pleasure it provides, and knowledge pursued for the fruits it brings. However, early in the game Machlup warned that the distinction between light and fruits, ideas and economic utilization, might not be in the end so compelling or useful. The fruits can be a better life, with more pleasure and leisure time.

6.3 Knowledge and Economic Progress

An enlarged view of knowledge leads to consider the goals and meaning of economic progress, the topic of Marshall's unpublished last book [25].

What we learn from Marshall is that economic progress is not about wealth but also about human well-being, which is actually the true aim of progress. Technical knowledge is one aspect of knowledge, but in "industrial life" the spread of education and "a wide knowledge of the world" also matter. (Caldari and Nishizava, p.106) Note also that "a student who allows his thoughts to be much influenced by monetary considerations …is not likely to exercise the best influence of which he is capable in elevating thought or even increasing knowledge [25]." (ibid., p.84)

While consistently referring to technical knowledge when dealing with production and business, knowledge is associated with the pursuit of better life and the development of a fully rounded human being, indeed a "gentleman". Thus, the importance of education, including the arts and education beyond schooling for individuals' growth.

For Marshall "the aim of school education was not only the transfer of knowledge, but also…the education of character, faculties and activities…a variety of non-school institutions were relevant to education [26]." That knowledge is not immediately productive. It pertains rather to the idea of a "nobler life". However, it has an effect on economic progress, and an important one. "Like education, and partially by means of education, more leisure, more intellectual and moral cultivation, better social intercourse would be an independent source of productivity increase, so that the reduction of working hours (at constant wages) need not reduce output." (ibid., p.14)

Finally: Marshall's economic progress highlights the importance of institutions and individuals. Indeed, knowledge is not primarily linked to the operation of the market.

6.4 Beyond "Knowledge Production"

We could say that the economic analysis of knowledge appears to be both too narrow and too large to enhance our understanding of the knowledge economy.

It is too narrow because it leaves aside the social nature of knowledge. Restricting the attention to a theoretical analysis of technical progress it mimics the neoclassical theory of production. Knowledge becomes a factor of production. Thus, the narrow and deceitful way in which we speak of the "production" of knowledge and knowledge capital.

The discussion of economic progress indicates that knowledge is not only socially produced but has purposes that go beyond production. And yet when appropriately considered production itself is fueled by much more than narrowly defined technical progress. After all, even a better life is "productive". Lastly, innovation, like economic progress, is fueled by complex and hard to define social processes.

At the same time, the economic theory analysis of knowledge is too general to effectively focus on some distinguishing features of modern production and consumption. We are not referring to the detailed "technical knowledge" needed in specific branches of production but to the trends of transformation of industry and consumption that are more specific than the reference to production of mainstream theory. This would involve a rethinking of externalities.

7. A New Research Agenda

A broader view of knowledge helps to consider a larger spectrum of industries than the "knowledge sector" and/or Hi-Tech (ICTs, Biotech). Consider for instance the entertainment (radio, television, cinema) and culture industry. Aren't these knowledge-based industries and part of what we can call the knowledge economy? They depend however on a type of knowledge that we can characterize as general and creative. In fact, the kind of knowledge associated with art and culture. And that is not independent from the intellectual and emotional development of individuals in society.

What about education and the health industry? Aren't they another case of massive use of knowledge, in fact knowledge industries per excellence? And yet they are not science/research-based industries the way Hi-Tech is. The health industry in particular suggests a different relationship between technical progress and final services.

One cannot fail to notice that the output of these industries is largely made of collective goods and services. Here comes the question of externalities. If these industries represent a potential for positive externalities as it seems, it is then reasonable to focus the research agenda on: a) the massive "market failure" that this implies; b) the appropriate institutional framework and set of policies that can

help to secure the benefits that are otherwise simply lost [27].

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