# The Concept of Knowledge in Economics: A Historical Overview

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**Abstract**

Knowledge is now considered as the main source of economic competitiveness of enterprises, economies, and also the main force of economic development. However, the idea that economic progress and expansion depend on knowledge has been presented for quite a long time. This article reviews the concept of knowledge through researching different economic streams. The concept under recent economic theories and models can be broken down into two different dichotomies: exogenous and endogenous, explicit and tacit. This review shows that all economists are right, although incomplete, when considering the role of knowledge in the economy. From that, some implications will be discussed.

**Keywords:** Knowledge Economy, Exogenous Knowledge, Endogenous Knowledge, Tacit Knowledge, Explicit Knowledge

## 1 Knowledge in Economics

Economists and businessmen recently have discussed much about the economy depending upon knowledge and the utilization of knowledge – the so-called "knowledge economy". Indeed, it is just a reconfirmation of what has been said for centuries. Economic progress and expansion have always depended on new ideas and innovation.

Adam Smith, in the first chapter of "The Wealth of Nations" [22], recognized the role of knowledge as an economic factor. He stated clearly that economic development (an increase in per capita output) depends mainly on an increase in the productivity of labor. According to him, the productivity of labor can be gained by the laborers themselves in the process of working with labor division among them. Especially, for the case of invention, besides indicating the role of workmen in process of, we can say, "learning by doing", Adam Smith also referred to a layer of specialists and "philosophers" who are men of "speculation" and who make important contributions to the production of economically useful knowledge. Thus, even before 1776, Adam Smith had perceived the importance of learning and research done by workmen or philosophers in the processes by which everybody becomes richer.

In the late 19th century and early 20th century, many economists asserted the role of knowledge and information when they discussed economic principles such as the role of the free market (invisible hand), the government (visible hand), and the existence of an equilibrium in the economy[1]. According to Marshall [11], the scale of production benefits the economy partially through internalities within firms (i.e. specialization), and partially through externalities outside firms. He explained externalities as the case that when one man starts a new idea, this idea is then taken up by others and combined with their own suggestions to become the source of further new ideas (book IV, chapter X, part 3). Schumpeter [21] was clearer on the role of knowledge. In his opinion, innovations, which refer to the initial introduction of a new product or system (product innovation) or new process (process innovation) into the economy, become a central element of the dynamics of economic action. Hayek [7][9] emphasized the importance of "knowledge of particular circumstances of time and place" which is dispersed in individuals' minds within the economy. The combination of these "fragments of knowledge" (by spontaneous

[1] Keynesian economics, Neoclassical economics, Austrian school of economics.

actions of individuals through market mechanism) created a "social mind" which no single person could possess [7]. Boudling, in discussion of the role of knowledge in economic development, contended that capital can be essentially thought of as knowledge imposed on the material world. Knowledge, therefore, is the essential key to economic development. However, he also expressed regret when he mentioned the work of Adam Smith, realizing "how little we (he and other economists) have learned in nearly two hundred years" [5, p.6].

Through all the early works on knowledge in economy, no unambiguous mechanisms under which knowledge exerted its impact on the economy were suggested. We also cannot answer the questions suggested in Hayek [8]: What kind of knowledge is needed? How much knowledge is enough? And how to acquire necessary knowledge in the market and economy? The only thing deduced may be that knowledge can contribute to the economy under many different forms and in many different ways. Knowledge can be incorporated into labor skills and machines (Adam Smith), into managerial capability (Marshall), into innovations (Schumpeter) etc. Knowledge can be gained through the "learning by doing" process (Adam Smith) or produced by research and development (R&D) activities (Boulding[2]).

Economics of knowledge today owes its impetus to the works of these founders, but normally takes the form of a formal mathematic model (see [3][16][17][23][24]). The standard models are criticized for paying more attention to mathematic calculation and leaving the complexity of knowledge ignored, which risks omission of some important aspects of knowledge's influence on the economy (see [6]). However, they are useful to the extent that they can help to explore part of the above questions and support economic policy makers. In standard models, knowledge was named "technical change". These models make different assumptions about knowledge for building a production function of the firms and economy. For a clear overview of how differently contemporary economists see knowledge, we break down the models into two main categories corresponding to two dichotomous aspects of knowledge: Endogenous vs. Exogenous and Explicit vs. Tacit.

[2] In Boulding's [4] words, R&D is a "knowledge industry".

## 2 Exogenous vs. Endogenous Knowledge

The distinction between endogenous and exogenous knowledge refers to the source of knowledge, and relates to the development and competition of two economic strands: exogenous growth theory and endogenous growth theory (new growth theory). The source of exogenous knowledge is outside the economic process. New knowledge emerges in response to factors such as the passion or curiosity of inventors and pursuit of "knowledge-for-knowledge's sake" [20, p.347]. By contrast, endogenous knowledge emerges from within the economic process itself - in response to profit and loss.

The notion of exogenous knowledge is proposed in the Solow-Swan model [23][24][25] which is then further developed by Cass, Koopmans and Ramsey[3]. In his model, Solow called "technical change" (technical knowledge) "any kind of shift" in the production function. Following neo-classical economics with diminishing return to capital, these models state that the economy, in spite of whatever the initial value of capital-labor ratio, would finally cease to grow in terms of output per capita. Technical change in this case is the only source for continuous growth. Solow and Swan did not explicitly call the "technical change" exogenous to the economic activities, but the way they added the technical change parameter into the production function and let it grow at a certain rate indicates that the technical progress is determined outside the economy or exogenous to it. Exogenous knowledge of this type, however, is not what can be implied from knowledge mentioned in earlier works like Adam Smith [22], Schumpeter [21].

Because there are reasons to believe that the growth of technology depends on economic decisions, various attempts to endogenize technology have been made before the recent vintage of endogenous growth models (see Arrow [2],[3], Kaldor and Mirrlees [10]). In Arrow's model, knowledge is acquired unintentionally in the

[3] See Aghion and Howitt [1] for a review. Both the Solow-Swan model and the Cass-Koopmans-Ramsey model are neoclassical growth models. The former assumed a fixed saving rate while the latter relaxed the assumption and took account of permanent-income and lifecycle-savings hypotheses in the model.

production of new capital goods through the "learning by doing" process. Learning by doing is assumed to be purely external to the firms who do the producing, and to the firms that acquire the new capital goods. Nevertheless the growth of knowledge become endogenous in the economy in the sense that knowledge increases in proportion to the increase of investment in physical capital, leading to long-run growth of output per capita. That knowledge is exogenous to firms but endogenous to the industries and economy goes with the Marshall's earlier concept of internalities and externalities of knowledge in the economy.

Romer [19], the founder of endogenous growth theory, however, did not agree with Arrow and Kaldor in treating knowledge as public goods outside the firms. He argued that under this assumption technology "does not correspond to anything in the world" which would lead to a "dead end when one tries to understand the details about technology" [18, p.203]. Romer [16][17][18] divided economic production into knowledge production (research sector) and physical good production (capital good sector and consumer good sector) and knowledge is now an appropriable good which brings about profit to its producer. But knowledge is non-rival, and like a recipe, can be used over and over to become the source of long-run growth of the economy.

Also trying to endogenize knowledge into economic activities like new growth theorists, evolutionary economists, however, argued in an opposing way[4]. Inspired by Schumpeter's business cycle theory, evolutionary theorists see the economy as a dynamic system. In Nelson and Winter [13], knowledge is stored in "routines" of firms (including operating routines, investment routines, guided routines) and equated with "genes". Innovation is an inherently unpredictable "mutation" of routines [13, pp.14-18]. They criticized the way most orthodox economists bounded a firm's capacities in a given "production set" [5] which is determined by the state of firm's knowledge but changes of which are then not considered. Even when changes are considered as in endogenous growth models, production sets are not different among different firms [13, pp.59-61]. According to Nelson and Winter [13], the economic world is far too complicated for a firm to understand perfectly. As a result, firms do routines which connote behaviors deemed appropriate and effective in the settings. Through this adoption in the "environment", they develop their own routines and economic performance. Thus, knowledge is endogenous to firms.

## 3 Explicit vs. Tacit Knowledge

If the distinction between endogenous and exogenous knowledge relates to the sources of knowledge, the discussion of explicit and tacit knowledge refers to the forms/properties of knowledge and to some extent, to the possibility of transferring knowledge among different agents in the economy. Explicit knowledge, sometimes used interchangeably with codified knowledge, can be expressed in words (as in a technical document), drawings (as in a product design), and shared easily between people. On the other hand, tacit knowledge deeply rooted in individuals' actions and experience is difficult to express and is usually gained by experience or personal training[6]. The contrast between the two forms of knowledge is clear in the competition between neoclassical theory (Solow-Swan [23][24][25], Arrow [2], Romer [17][18]) and evolutionary economic theory (Nelson and Winter [13] and others).

Traditional neoclassical economists have no concern about knowledge except the existing knowledge presented by price information. Under rationality consumption, the knowledge is exposed to, and shared among all economic agents, thus explicit in the economy. When Solow and Swan [24][25] considered technological knowledge into their growth model, it is outside the economic activities, and any firms can benefit from it. This technological knowledge is also explicit. Economists like Arrow [2] treat scientific and technological knowledge as information which is articulated, and which can be reproduced and transferred among of agents in the economy with low costs.

Much of the endogenous growth theory rests on the notion that there exists a "world stock of

[4] See Nelson [12] for an overview of evolutionary theory development.

[5] Production set is a productive transformation from inputs to outputs that an organization can accomplish (Nelson and Winter [13, p.59].

[6] See Rooney and Schneider [15].

knowledge" in the economy. This is true particularly of those models in which R&D is seen as both drawing upon, and adding to a knowledge stock which enters as an input into production processes for other goods. Implicit in this literature is that this stock is codified, since part or all of it is assumed to be freely accessible by all economic agents in the system under analysis [6]. However, to evolutionary theorists, such an easily accessible world stock of knowledge cannot be an adequate assumption.

Considering the (technical) knowledge of a firm, Nelson and Winter [13] ask where the knowledge is stored and how it is accessed (freely) in the economy. They can agree with neoclassical theorists that this knowledge is stored either in a blueprint file (symbolic record) or in a "chief engineer" (knowledge specialist). However, they do not agree when neoclassical theorists ascribe the ability to effectively combine inputs to the firm itself, as an actor, and characterize that ability by the production set and leave it unchanged over time. According to Nelson and Winter [13], this approach goes implausibly far, abstracting the possession of capacity entirely from the inputs of a firm. Also, there is no reason to believe that anything known to one firm is known to all [13, pp. 62-64].

Nelson and Winter [13] proposed that organization routines are the analogue of individual skills, thus are tacit knowledge of firms [13, p.72]. They attempt to bring together two ways of thinking about knowledge- the *information-processing approach* and the *tacit knowledge tradition*. When discussing what routines are, tacit knowledge is invoked in causal terms, but when talking about how routines are used within the firms, the underlying tacit aspect can be safely ignored. To use tacit and explicit dimensions at different levels in the causal hierarchy for convenient modeling is a good method but this, unfortunately, makes Nelson and Winter only "half right about tacit knowledge" [14, p.152].

Latter, Cowan, David and Foray [6] introduced models for codifying tacit knowledge which obviously depreciates the importance of tacit knowledge. The authors are persuasive but can only provide little empirical support for their suggestions. Vast empirical evidence still suggests the opposite- that tacit knowledge is important in the economy [14].

## 4 Summary and Implication

We can summarize the different economic views of knowledge discussed above in a two-parameter matrix of endogenous, exogenous, tacit and explicit knowledge as in figure 1.

| Knowledge forms | Knowledge sources: Endogenous | Knowledge sources: Exogenous |
|---|---|---|
| Tacit | Nelson and Winter (1982) | |
| Explicit | Romer (1986, 1990)<br>Arrow (1962), Kaldor and Mirrless (1962) | Sollow (1956, 1957)<br>Swan (1956) |

Figure 1. Concept of knowledge in economic theories

It is worth here noting that the categories of knowledge considered in the long literature of economics are not mutually-exclusive. One can easily observe that some knowledge is produced by the profit motivation, such as an effort to innovate to launch a new product or reorganize a production process; while at the same time one can see more and more discoveries and innovations which are the work of some scientists who do research just to satisfy their own passion and curiosity. One can also see that some firms owe experts who are unique to them for making a big profit but whose knowledge can not easily be transferred to others; while one also notices the sales of patents and licenses among different firms in the market are growing faster than ever. This means all these categories or aspects of knowledge are complementary.

One should naturally expect that there are some models in the empty cell in the above figure, but exogenous growth theorists just assumed that knowledge is accessible to the whole economy. This is to say that everybody is right, although incomplete, in the role of knowledge in the economy.

Our purpose is not to blame the economists for not considering all aspects of knowledge and knowledge's role in the economy. Economists face a big obstacle when they try to add a complex and ambiguous factor like knowledge into

traditional general equations. That may be the reason why most economists assume knowledge as explicit knowledge. Even in the case of Nelson and Winter [13], they chose to ignore the tacit knowledge in firms' routines to build a mathematical model of the economy.

Of course, it would be desirable to look at the whole picture of knowledge when considering its role in the economy. However, when we can not mix all these aspects for explanation, then it is our ultimate purpose that should determine our priority. As noted by Nightingale [14], Cowan, David and Foray perhaps do not have it totally right about codification of knowledge, but they are reasonable in terms of policy designing for that their model has a persuasive in-built teleology.

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