

DYNAMIC MODEL OF PRODUCTION AND THE EVOLUTION OF THE KNOWLEDGE ECONOMY

PRELUDE

“Static Model of Production and the Evolution of Economics”, another report of this series, argues that the deficiency in the role of ‘knowledge’ in the process of production is a crucial shortcoming of conventional economics. However, there exists strong evidence that the deployment of knowledge is an essential source for the development of any economy.

Some recent studies have cited ‘knowledge’ as an economic resource and noted its critical role in economic development. Peter Drucker seems to be a pioneer in this respect. Back in 1968 he emphasized that “knowledge is the foundation and measurement of economic potential and economic power. Knowledge has become the economy’s central resource. Knowledge rather than science has become the foundation of the modern economy¹”. Drucker in his recent books has further developed that point of view.

In ‘*Post-Capitalist Society*ⁱⁱ’, Drucker underlines that the real, controlling resource and absolutely decisive ‘factor of production’ is now neither capital nor land nor labor. The basic economic resource is and will continue to be knowledge. In fact, knowledge is the only meaningful resource today. The traditional ‘factors of production’ - land, labor and capital - have not disappeared, but they have become secondary. They can be obtained, and obtained easily, provided there is knowledge. And knowledge in this new sense means knowledge as a unity, knowledge as the means to obtain social and economic results. That knowledge has become *the* resource, rather than *a* resource. Knowledge is what makes our society ‘post-capitalist.’ It creates new social and economic dynamics. It creates new politics. The only long-term policy which promises success is to convert manufacturing from being labor based into being knowledge based. What makes the market economy superior is precisely that it organizes economic activity around information. The central wealth-creating activities will be neither the allocation of capital to productive uses, nor “labor” - the two poles of nineteenth- and twentieth-century economic theory, whether classical, Marxist, Keynesian, or neoclassical. Value is now created by “productivity” and “innovation”, both application of knowledge to work. The

economic challenge of the post-capitalist society will therefore be the productivity of knowledge work and the knowledge worker. Drucker later elucidated 'knowledge has two incarnations: Knowledge applied to existing processes, services, and products is productivity; knowledge applied to the new is innovationⁱⁱⁱ.'

Drucker, then, continues that the organization of the post-capitalist society is a *destabilizer*. Because its function is to put knowledge to work - on tools, processes, and products; on work; on knowledge itself - it must be organized for constant change. It must be organized for innovation; and innovation is "creative destruction."

Alvin Toffler is another prominent advocate of the role of knowledge as a factor of production. "While land, labor and capital were the main 'factors of production' in the Second Wave economy of the past, knowledge - broadly defined here to include data, information, images, symbols, culture, ideology, and values - is the central resource of the Third Wave economy. Intangible assets like information have become the key resources. Information increasingly substitutes for bulk raw materials, labor, and other resources. Given the appropriate data, information, and/or knowledge, it is possible to reduce all the other inputs used to create wealth. The right knowledge inputs can reduce labor requirements, cut inventory, save energy, save raw materials, and reduce the time, space, and money needed for production. Knowledge is the ultimate substitute for other resources"^{iv}. This view is consistent with his outlook expressed in "The Third Wave": "For the Third Wave civilization, the most basic raw material of all, and one that can never be exhausted, is information"^v.

Society has now come to recognize that knowledge itself is a factor of production. Knowledge can be in the mind of a worker, embodied in software or in the working of the computer itself. Brought to the production process, it adds value. The nature of capital is changing. Once it referred to money used for investment; later it identified the range of products, including machine tools (tools used to make new tools), that were used to make new products. More and more, capital included human capital: the level and breadth of knowledge held by the population in general and workers in particular. Increasingly today one hears about the rise of the knowledge worker - people who bring to the production process complex blocks of knowledge.

The production process is itself becoming knowledge intensive. It is clear that a new economy is being put in place - an economy that produces and consumes intangibles. The new economy is being constructed in a global context.

Currently and in the coming years, the new growth area of the economy is based upon the manipulation of information on a very small scale, rather than the mass processing of raw materials. The eclipse of natural resources in the information age has been accompanied by an increase in the importance of mental work and a decrease in the importance of physical labor^{vi}.

We are building organizations around information and we need to regard information as a tool. However, most businesses have two information systems. One is organized around the data stream; the other, far older one, around the accounting system. The accounting system, though, is a 500-year-old information system that is in terrible shape^{vii}.

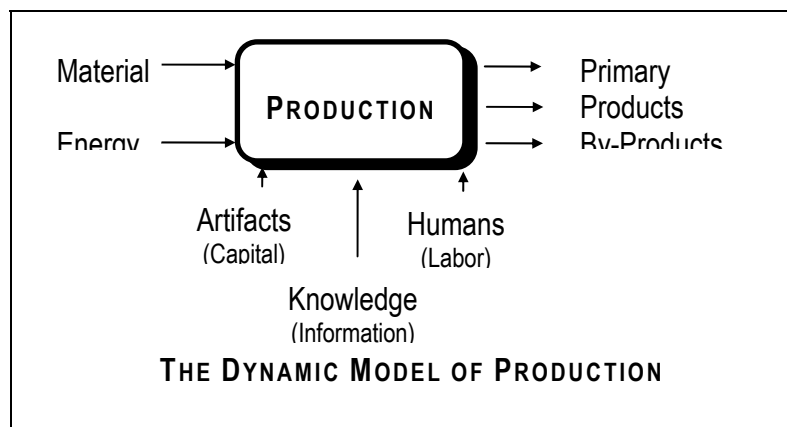
The new economy is dominated by information - generating it, processing it, storing it and transmitting it. And it is this information aspect that is the most valuable part of every business. The information economy is much more stable than the conventional economy^{viii}.

The formal growth in accounting evidence, historical accounts, and everyday experience all suggest that something extra, such as innovation, invention, technological change, or the discovery of new ideas is needed to understand and explain growth^{ix}.

Whereas Adam Smith's Wealth of Nations depended on specialization and a division of labor within nations, the new wealth of nations depends on information, communication technology, and in-depth knowledge - on a global basis^x.

Drucker then makes it clear that "we do not fully understand how knowledge behaves as a resource. We have not enough experience to formulate a theory and to test it. We can only say so far that we need such a theory. We need an economic theory that puts knowledge into the center of the wealth-producing process. Such a theory alone can explain the present economy. It alone can explain innovation. But so far there are no signs of an Adam Smith or a David Ricardo of knowledge^{xi}".

THE DYNAMIC MODEL OF PRODUCTION



To compensate for the shortcomings of the Static model, which has already been referenced, a new formation entitled the '**Dynamic Model of Production**' has been introduced^{xii}. The cornerstone of this model is adding '**Knowledge**' as a distinct resource (element of production.) Natural resources have been classified into two main groups: '**Material**' and '**Energy**'. Nature, covering land, sea, air, and

the sun, is the source of both material and energy. In this model '**Artifacts**' (Capital) is a generic term for all applications of working tools and equipment. '**Human Resources**', as another element of production, includes all the people who work in a production system. This term includes labor in conventional economic studies.

The elements of production used in the dynamic model, namely material, energy, artifacts, knowledge, and human resources, are being used inclusively. For example, knowledge includes information, data, software, experience, skill, management and organizational structure. Artifacts encompass capital, equipment and work instruments, from simple tools to complicated machinery, building and infrastructure.

In the Dynamic model, production outputs are referred to as products, further sub-divided into '**Primary Products**', '**By-Products**', and '**Side-Products**', such terms applying to both goods or services. By-products are the secondary products. They are not classified as main products, but with

effective marketing they can be sold. Side-products include secondary products for which there is no market; in addition, there are costs for their disposal. Effluent and waste materials are classified as side-products.

In the dynamic model, human resources (labor) and knowledge (information) share the principal roles. Human resources generate, refine and add value to knowledge. Knowledge and human resources are separate distinct factors of production. The unique character of the term knowledge accommodates service factors such as research, engineering and design. The Dynamic model may be applied to both macro- and micro-economics during various stages of a project, including planning, execution, operation and evaluation. The by-products of a production process include also the development of equipment capital, knowledge and human labor resources. The Dynamic model perceives the relationships between its input and output as above.

The Dynamic model, which is originally an engineering model, encompasses also the management model - "5 Ms model" - which consists of five variables: Material, Machinery, Money, Management and Man. The most recent revision to the definition of industrial engineering is also based on the dynamic model.

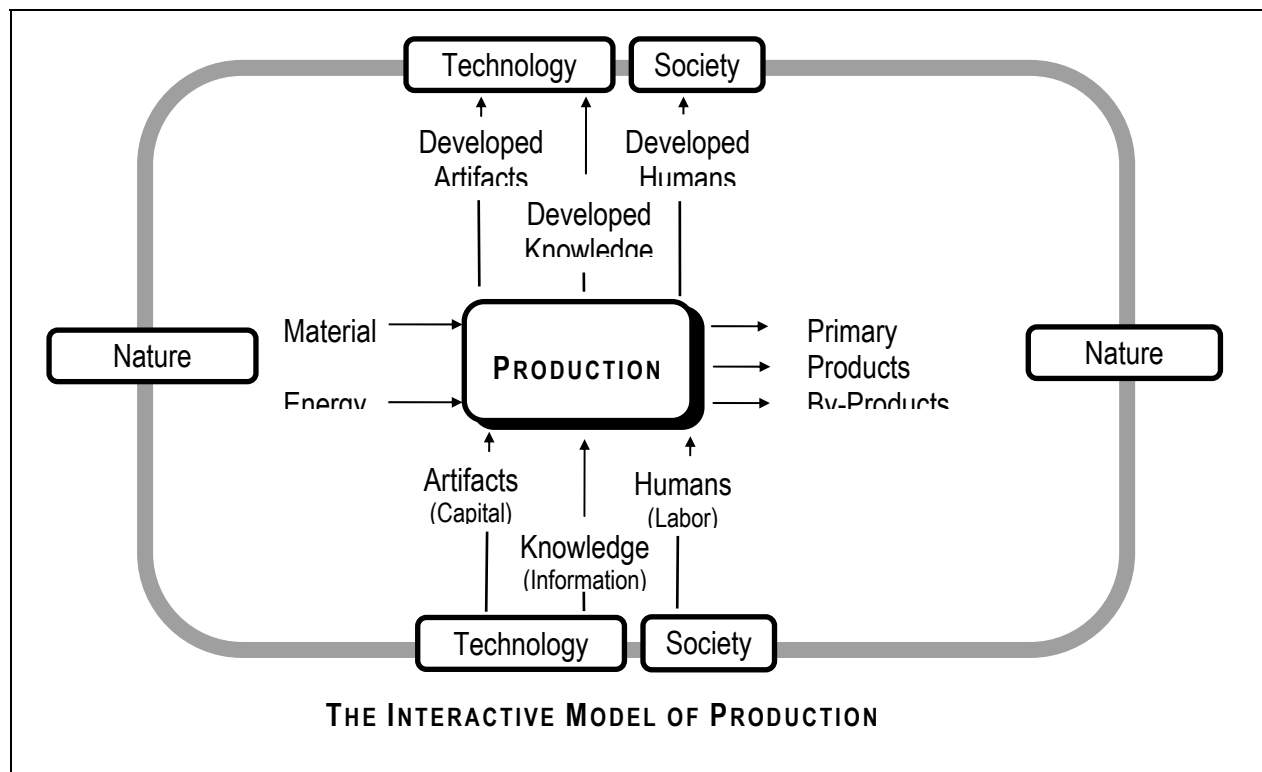
THE INTERACTIVE MODEL OF PRODUCTION

In the context of the dynamic model, technology is defined as the system that provides knowledge and equipment for a given production system. Based on this idea, on one hand, technology is a base for development and growth of the production systems. However, production is also a platform for further improvement and development of technology. Society is being considered as the origin of human resources. In the context of the Dynamic model, society is also influenced by production activities. Nature is the only source of natural resources, both material and energy. On the other hand, nature is also the final sink of the side-products of a given production as well as the wastes of primary and by-products.

Sustainable development is creating a set of livable interactions between the three environments: Natural, Social and Technological. In sustainable development, technology is a base for the economic development which is aimed at social goals and safe environment.

The hard truth is that the conventional economic evaluation system is partially blind. It sees some things and not others. It carefully measures and keeps tracks of the value of those things most important to buyers and sellers, such as food, clothing, manufactured goods, work, and indeed, money itself. But its intricate calculations often completely ignore the value of other things that are harder to buy and sell: fresh water, and clean air just to name a few. In fact, the partial blindness of our current economic system is the single most powerful force behind what seem to be irrational decisions about the global environment^{xiii}.

Consistent with the Dynamic model, the main relationships between the three environments (Nature, Society and Technology); and 'Production', are depicted in the 'Interactive' model of production. In this model, obviously, knowledge is both input and output of any production process, irrespective of scale and sector of production.



‘Market’ and ‘State’, the structures which provide organization policy and are the other systems which interact with the three environments of the Interactive model. However the coming reports of this series concentrates on the architecture of knowledge and the process of innovation. This scope does not provide a through study of the interactions between ‘Production’ ‘Nature’, ‘Society’, ‘Technology’ ‘Market’, and ‘State’.

EVOLUTION OF THE KNOWLEDGE ECONOMY

Nicho Stehr then argues that the economy of the industrial society is initially and primarily a *material economy* and then changes gradually to a *monetary* economy. Keynes’s economic theory, for example, reflects this transformation of the economy of the industrial society into an economy reflected to a considerable extent by monetary matters. However, as more recent evidence indicates, the economy Keynes described now becomes a (non-monetary) *symbolic economy*. Stehr then continues that the change in the structure of the economy and its dynamics are increasingly a reflection of the fact that *knowledge* becomes the leading dimension in the productive process. that we need to focus on the peculiar nature and function of knowledge in economic relations. Knowledge is a most peculiar entity with properties generally unlike those of commodities. In principle, a consumer or purchaser of knowledge may use it repeatedly at diminishing or even zero cost. Knowledge need not be perishable.^{xiv}

Drucker, in *Post-Capitalist Society*, delineates the main aspects of the knowledge economy. During the industrial age, one of the economists’ basic assumptions is that an economy is determined either by consumption or by investment. Keynesian and Neo-Keynesians (such as Milton Friedman) make it dependent on consumption; classicists and neo-classicists (those of Austrian School) on investment.

In the knowledge economy, neither seems to be in control. There is no shred of evidence that increased *consumption* in the economy leads to greater production of knowledge. But there is also no shred of evidence that greater *investment* in the economy leads to greater production of knowledge. At least the lead time between increased investment and knowledge production, seem to be so long as to defy analysis - and surely too long to base either economic theory or economic policy on the correlation, whatever it might be^{xv}.

Paul Romer has also endeavored to incorporate the economics of “ideas” into the economics of things. He argues that this has never been an easy task, as ideas are not like goods. If one has an idea, and can use it and so can everyone else. In technical language, goods are rivalrous while ideas are not. However, ideas and human capital are also significantly different. Human capital is rivalrous, while ideas are not^{xvi}.

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¹ Last updated: April 14, 1999