How much does Maxwell equation cost?

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Abstract. Value law that served a principal regulator of economic relations for hundred years has stopped performing this function in knowledge-based economy. Actually knowledge-based economy requires revaluating traditional categories and approaches and changing their content. Market price of a product is formed on the basis of its value, or, to be more precise, exchange value; and k*nowledge does not have exchange value*. It is well known, that knowledge is not sold and purchased, but it is produced by each person individually. Knowledge is created only in a human brain in the process of mental production. Without being necessary for a mental production, a personality, an intellect of a person, data will stay data, the storage of useless things. That is education that forms mental production of a person: his or her personality, soul, intellect. Due to this fact, education and training become the key sectors of knowledge-based economy. Market has played the subordinate role in the process of forming mental production – role of "raw materials" supplier for the production of the real treasure of the society – knowledge. The paper deals with price formation principles in knowledge-based economy, specific features of knowledge functioning as an economic asset.
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Introduction

According to the point of view prevalent in Russian scientific literature, the "main question" of knowledge-based economy should be formulated as follows: what's the price of knowledge? And how could be otherwise if "knowledge-based economy starts when knowledge becomes a commercial product; [1]; if "knowledge-based economy presents an indivisible triad of markets: knowledge market, service market and labour market" [2]; if "we call knowledge-based economy such economic state of the country when a) knowledge becomes a product; …"[3]?

If knowledge is a product that can be purchased and sold just as regular products, the question "what's the price of knowledge" is not only explicable but becomes of utmost importance - because how should we sell a product without knowing its price? As always, practice here becomes the standard of truth. And practice tells us about the following: «Do you know what the price of Maxwell equation is? No one knows it and no one is going to buy it. But thanks to Maxwell equation the whole planet can use electricity, and thus it repaid all expenditures for fundamental research of all 200 countries for 200 years ahead" [4].

So what, no one would buy the product (Maxwell equation) being extremely efficient, and thus, useful ("repaid all expenditures for fundamental research of all 200 countries for 200 years ahead")? And at the same time millions copies of crime fiction, novels, tabloids, recipe books, travel guides etc. – knowledge not being so efficient and useful – are sold out and always have their customers? It turns out that such casus – production of goods that will predeterminedly not sell out – can happen not only with Maxwell equation: «Knowledge market is very peculiar. Large part of knowledge is disseminated on a gratis basis or for a token fee" [5].

That's a market! That's a product! And how should we set a price of such product? Still, we'll try. But before we answer the question – how to sell knowledge – we have to understand what is knowledge?

Principal scope of knowledge in the field is provided by philosophy - and it is no coincidence. It is philosophy that sets a challenge of "rational settlement of the most general questions relating the essence of knowledge, human and world". Difference between philosophic and economic concepts of knowledge surely exists and is defined by different objectives of these sciences in the sphere of studying knowledge. Philosophy seeks an answer to the question "what essence is knowledge?" and economics – to the question "what product is knowledge?" Obviously there will be different answers to these questions. But in general "economic" definitions of knowledge are different from "philosophic" more in the form than in the substance. In philosophy knowledge is the result of human cognitive activity and in economics knowledge is a product of mental production.

So, from philosophy we know that: knowledge is a form of existence and

systematization of the results of human cognitive activity. As a result of cognitive activity a person creates his or her most valuable capital – personal knowledge.

Personal (ideal) knowledge

Personal (ideal) knowledge can be created only in the process of brain activity. Rational constituent of thinking (intellect) and irrational, spiritual constituent contribute to a process of knowledge creation equally. Effectiveness of thinking often depends not only on the available information and educational level of a person, but as well on his or her view of world, intuition, interests, life philosophy, social environment and religious views.

This is the personal form of knowledge that create, disseminate and apply knowledge. Existence and inseparable unity of rational and irrational sides of human thinking is reflected in modern scientific literature in the form of distinguishing formalized and non-formalized knowledge.

The part of personal knowledge that principally can't be adequately translated and codified by modern means and methods is traditionally defined as "non-formalized", i.e. "inseparable", "inexplicit", "unconscious" knowledge. Other part of personal knowledge that can be formalized and codified, that is , transferred to some tangible medium (paper, disk etc.) or verbally expressed without losing the sense and content of the translated message is often defined as "formalized", i.e. "conscious", "explicit", "codified" knowledge.

Codified knowledge

Actually codified knowledge is the only type of knowledge arousing practically no discord in scientific literature. First of all, the majority of authors unanimously distinguish such type of knowledge as codified (in some works they are as well defined as formalized). Absolute majority of authors understand codified knowledge as "saved and transferred with the use of media in the form of texts, schemes, drawings etc." and share the opinion that codified knowledge is easily reproduced, can be saved and disseminated in hard copy or on electronic media; it can be handled to create new knowledge in the form of conclusions and statements.

Basically, different opinions are expressed regarding only one question – is codified knowledge equal to information?

According to the figural expression of D. Blumenau "Himalayas of books" are devoted to description and interpretation of the phenomenon of "information" but still till present there is no common vision of the essence of this phenomenon: "everyone practices his or her own approach to information; there are as many approaches to information as authors" [6]. Analysis of existing approaches allowed D. Blumenau to define two main trends of development of information theory. The first is the so-called "attributive concept" that views information as an integral feature of matter, its attribute. In accordance with this approach, information is contained in all elements and systems of the material world, thus, it is eternal (as well as the matter), penetrates into the life of people and society; it is one of the three foundations of creation (alongside with energy and substance). As an objection we can come up with the following judgment: "information is given a status of independent entity, reality existing along with material things or in these things", whereas "no one has ever seen this mysterious information neither subjectively nor as a property. Everywhere we find only interaction of material substances endued with energy, and we never find what we tend to call information. Why? Because it does not exist in nature, as well as vibes or aether etc." [7].

Followers of the second approach suppose that information is a function of complex systems; due to this they do not accept its existence in inanimate nature and connect its existence with management. One group ("cybernetists") recognize the presence of information processes in all self-managed systems (technical, biological, social), whereas the other ("anthropocentrists") see them only in human society and human consciousness.

Information approach to cognition of reality allows to eliminate the drawbacks and "inconsistencies" of the above-mentioned concepts. By information approach we mean one of methodological approaches to studying objects of different nature (biological, technical, social) that provides for the description and investigation of these objects as a system including the source, the channel and the receiver of control actions allowing their conceptual interpretation.

The basis of this approach was laid by C. Shannon who showed that information is not a characteristic of the message itself, but of the correlation between the message and the recipient. Shannon was the first to connect information (or, to be more exact, information signal capacity) with the communication medium and to show the dependence of the "weight" of the message on the source, source characteristics, channel and recipient. As Y.M. Kanygin and G.I. Kalitich [8] note, "Information can not be detached from the communication medium like juice from apple. Quality of message, its information capacity are fully dependent on the

medium. Only interconnected with the consumer message becomes informative".

In the absence of a consumer, or at least, prospective consumer, it makes no sense to speak about information. In fact it means that amount of information in one and the same message directly depends on the consumer of information, or, to be more precise, on its subjective qualities.

It's no secret that one and the same information message (newspaper article, announcement, letter, telegram, reference, drawing, radio broadcast etc.) can contain different amount of information for different people in accordance with their experience, level of understanding of the message and interest to it. Thus, message in Japanese contains no information for a person who can't speak this language but might be highly informative for a person speaking Japanese. No new information is contained in a message in a familiar language if its content is not clear or is already known. In the context of all the above-mentioned it becomes clear why one and the same book can be interesting and informative for one person, and not at all for another.

The same approach is presented in the educational materials of the Department of Informatics of Moscow Academy of Finance and Industry: "information is not a static (constant) object – it can change quite rapidly in the course of time and exists only in the moment of interaction of data and methods. The rest of the time it (information) exists in the form of data" [9]. L.E. Mindely and L.K. Pipiya point out actually the same: "without practical application (i.e. without a consumer – author's note) codified knowledge becomes a set of data devoid of any economic value" [10]. Authors of the book "Knowledge economy" speak of the same: "Value of an invention, a scientific discovery or an operation manual for a home electrical appliance can't be determined before the moment of consumption of the relevant information – familiarizing with a formula forming a basis for the invention, studying the essence of the discovery or reading the manual[11]. It seems unnecessary to say that only a human being can "familiarize", "study" or "read" anything, and only in case he or she feels a need in it. Besides, "familiarizing", "studying" and any other kind of "practical application of codified knowledge" is carried out by a person as a result of mental activity. Thus, information appears as a result of interaction between a person and codified knowledge (data). Or – information is a result of understanding codified knowledge (data) by a person.

Anyway, all definitions make it clear that information as a product of intellectual activity of a person is a product of mental production and can't be mechanically considered equal to codified knowledge.

So, codified knowledge is not information, it is data, and it directly depends on a person if it becomes information or stays a note on a stone, paper or disk.

What is sold on a "knowledge market"?

Human being is an only bearer of knowledge. But due to the fact that for long it has not been "customary" to sell knowledge together with a person, it is necessary to study what knowledge can be sold in the market separately from a person.

In fact the environment external to a human brain (mental production) contains only codified knowledge, i.e. data. This type of knowledge can be separated from a person and can freely circulate in the external environment, including the market.

Non-formalized personal knowledge can't be separated from a person and thus can't circulate anywhere outside his or her head - including the market.

Information is a product of data processing by a person in the course of his or her mental production. Information appears and exists only in mental production – i.e. in the brain of a person. Beyond mental production (brain) there is no information – there is data.

Thus the only product in the market (no matter how it is called – "knowledge market", "information market" etc.) can be data. It means that it is useless to seek "knowledge" in the "knowledge market" (as well as "information" in the "information market") – it merely can't exist there.

It is well known, that knowledge is not sold and purchased, but it is produced by each person individually. As we've just found out, data can be sold and purchased. But data has never been considered equal to knowledge (and this is one of the few questions in which researchers are almost unanimous). Data has always been considered as a "primary" substance, actually, a "raw material" for the production of a "finished product" – knowledge.

We share this point of view, especially taking into account that it is proven by practice. Actually the fact of purchasing a book with, for instance, Maxwell equation itself does not mean that a customer will immediately (right after making a payment) "enrich" himself or herself with an amount of knowledge contained in this equation. It is clear that knowledge will not for sure become a personal "capital" of the consumer – it depends not on the fact of effecting a payment, but on the fact of his or her ability to understand what he or she paid for. If he or she is not able to understand it, no money can help to obtain knowledge. So, the deciding factor in the

process of acquiring knowledge is not a paying capacity of a customer, but an ability of his or her brain (mental production) to process the purchased data.

So, what we have here – you can pay for the "product" (knowledge) and not get the "product" (knowledge)? Why then no one raises the alarm? Because it is a well-known, natural state of things – knowledge is not sold but created.

Conclusion

So, the only product of mental production that can be traded in the market is data. In the process of knowledge creation data serves as a "raw material" – and this fact should define the price-formation policy in this case. In fact, data should be sold at the price of the tangible medium on which it is saved.

Definition of *"data"* as a commercial product makes everything, including the definition of price and price-formation mechanisms, simple and clear.

Definition of *"knowledge"* as a commercial product forces us to make a number of substantial assumptions that ultimately deny both the concept of "product" and the concept of "knowledge".

Market price of a product is formed on the basis of its value, or, to be more precise, exchange value; and k*nowledge does not have exchange value*. It is a fact that can't be changed, an *objective reality* that we cannot alter even by the most sophisticated manipulations with a nature of knowledge destined to substitute its natural properties – *universality and publicity* - by artificial rarity. *"…exchange value of knowledge totally depends on the practical possibility to limit its free circulation, i.e. using legal (patents, copyrights, licenses, contracts) or monopolistic methods to restrict the ability to copy, model, adopt the knowledge of other people. In other words, value of knowledge is not a product of its natural rarity, but a result of the limitations of access to knowledge set institutionally or by* way of accomplished facts. [12]

In fact, knowledge can become a product suitable *to be traded in the market* only in case of its *total monopolization* that contradicts the initial concept and the nature of the market, and creates a paradox that cannot be solved within the frames of the existing perceptions. Traditionally that was the market – the free market – to be contrasted to monopoly; and the free market was considered to be a necessary condition and a prerequisite for economic and social progress. But when we speak about knowledge, the market itself becomes a monopoly. In our opinion it is the price of ignoring the objective, in this case, economic nature of the phenomenon.

Basically this is how it happens: one and the same codified knowledge saved on different media will have different price; at the same time different (in terms of content and value) codified knowledge saved on the same media will have the same price. Technological development of media production (from parchment paper to disks) and relative cheapening of the media should lead (and has led already) to the dissemination of data and simplification of access to it.

But the fact of data dissemination itself does not mean the same, or similar, or at least proportional dissemination of knowledge: as a matter of fact, explosive multiple increase in the amount of codified knowledge during the last decades has not resulted in the increase in the number of intelligent or at least literate people: in many regions of the world the level of literacy has not changed (Africa) or decreased (former USSR countries). There is no paradox; it can be explained again by the technology of knowledge production that has already been discussed: knowledge is created only in a human brain in the process of mental production. Without being necessary for a mental production, a personality, an intellect of a person, data will stay data, the storage of useless things. In particular, this fact can explain market "failure" of "Maxwell equation" (as a symbol of theoretical scientific knowledge) mentioned in the beginning of the article against the background of the high rate of sales of tabloids, "pulp fiction" etc. Demand indicators on such products reflect the state of mental production of consumers: there are much less "heads" being in need of "Maxwell equation" and able to "process" it than "heads" able to "process" novels and crime stories.

In order to change this balance (in favour of "Maxwell equation") it is necessary to regulate not the market but the process of mental production: we should increase not the size of circulation of the equation, but the number of people able to understand this equation, feeling the need in it, and thus ready to pay for it.

Still, not the market, but education and training are "responsible" for these processes, in a more general sense – "evolution of a human as a sentient being" (S. Kapitsa). That is education that forms mental production of a person: his or her personality, soul, intellect. Due to this fact, education and training become the key sectors of knowledge-based economy. Market has played the subordinate role in the process of forming mental production – role of "raw materials" supplier for the production of the real treasure of the society – knowledge.

Therefore the principal question of knowledge-based economy will be not "How much does Maxwell equation cost?" but "How much does Maxwell's education cost?"

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References

1. Brinkley, I., 2006. Defining the knowledge economy, The Work Foundation 3 Carlton House Terrace, pp:31.
2. Makarov, V., 2002. Measuring and Sustaining the New Economy, National Academy Press, pp: 450.
3. Kleiner, G., 2011. System resource of the economy. Social sciences, 3: 3-15.
4. How much does Maxwell equation cost // The Russian newspaper. 13.09.2010. No. 5284 (205).
5. Maxwell, J., 1865. A dynamical theory of the electromagnetic field. Philosophical Transactions of the Royal Society of London, 155: 459-512.
6. Blyumenau, D. I., 1998. Information and information service. Publishing house science, pp: 14.
7. Setrov, M., 1975. Information processes in biological systems. Methodological sketch. Publishing house science, pp: 155.
8. Kanygin, Y.M. and G.I. Kalitich, 1987. Increase of a role of information in management of scientific and technical progress. Ukrainian NIINTI, pp:60.
9. Theory and practice of scientific and technical information. Date Views 01.01.2013 www.informatika.mifp.ru/13/.
10. Mindeli, L. E., and Pipiya, L. K., 2007. Conceptual Aspects of Formation of a Knowledge-based Economy. Studies on Russian Economic Development, 3(18): 314-327.
11. Brinkley, I., 2006. Defining the knowledge economy, The Work Foundation 3 Carlton House Terrace, pp:31.
12. Gorz, A., 2003. L'immatériel, Connaissance, valeur et capital. Galilée, pp. 13.

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