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Foundations of Information Economics Research

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Abstract

Foundations of Information Economics Research

The purpose of this study is to explore the convergence between economics and quantum physics and to show that the advance of information economics and the network societies was enabled by the developments of physics and quantum mechanics.

There is a need to establish the research departing point for information economics emerging area. The paper argues that this departing point should be in quantum mechanics, that is, by establishing connections between the shift of human knowledge paradigm and information economics.

This study briefly presents the evolution of human knowledge and science (quanta mechanics) that led to (and are an integral part of) the network societies and the information economics area as a new branch of economics.

Key words: Information, economics, knowledge, transformation, network societies.

JEL Classification: N01; O39; Z00.

Foundations of Information Economics Research

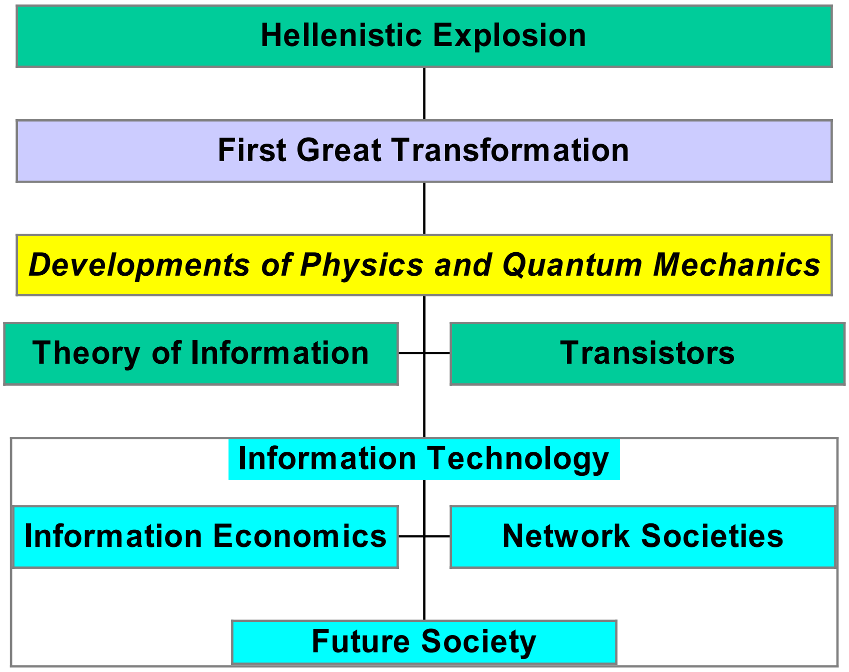
1. Introduction

The objective of this paper is to explore the genesis human knowledge and establish historical foundations of today's network societies. That is, to show that the advance of the information economics and globalisation was enabled by the developments of physics and quantum mechanics, this in turn was possible by dismantling the Cartesian philosophical view.

Literature is replete with information technology and its influence on trade, growth, (un)employment, social changes, intellectual property rights, and e-commerce. However, there are few studies of information (or informational) economics itself and even fewer studies which try to establish the connection between the shift of the human knowledge paradigm[3] and information economics.

This study briefly presents the evolution of human knowledge and science (quanta mechanics) that led to (and are an integral part of) the network societies and the information economics area as a new branch of economics (summarised in the figure 1).

Figure 1: The Evolution of the Revolution



As mentioned earlier this paper endeavours to present how it comes to what many people easily call as 'post-industrial society' or 'global village' or 'globalisation', without actually identifying what they mean by these notations. This avoidance is the main source of all types of misinterpretations and intellectual confrontations.

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[3] In Thomas Kuhn's landmark book, *The Structure of Scientific Revolutions*, he argued that scientific research and thought are defined by "paradigms," or conceptual world-views, that consist of formal theories, classic experiments, and trusted methods.

What they actually mean by globalisation is that is a process of increasing competition in world economy and as such, the source of all modern problems - loosing jobs, social alienation, health problems, et cetera.

In this paper, globalisation is considered as a process of partial interconnectivity of networked societies, which may lead to the global society. The 'partial' or 'high exclusion' feature of the process of interconnectivity is to blame for the above-mentioned modern problems. That is, we do not live in a 'global village' yet, because a larger part of the world population is excluded from the process of globalisation and has no access to the network systems. This process is related mainly to developed societies of the Triad (EU, America and Japan together with parts of SE Asia), which have developed a web of networks in most areas of socio-economic life. Further development of the information paradigm and expansion of network societies to the now excluded areas of the world economy may ultimately result in a higher level of integration of networks that may be called 'the future or global society'.

The remainder of this paper is organised as follows: in Section 2 it will be reviewing the scientific transformations that lead to the quanta mechanic discoveries which enabled the information technology transformation (Section 3), which in turn gave the rise of information economics and network societies (Section 4).

2.Scientific Transformations

This section presents the genesis of human knowledge. It was considered as a necessity to show how the way of understanding the nature was changing over the time and that it was essential to develop 'new phrasing' for the modern science. In another word, to demonstrate quanta behaviour on the sub-atomic level of experiments, that 'new way' of thinking was than adopted in all areas of the science.

2.1 Hellenistic Explosion

The Hellenistic period was an international, cosmopolitan age with advances, which were made in various fields of scientific inquiry, including engineering, physics, astronomy and mathematics. One of the initiators of the 'Hellenistic explosion" was Aristotle (384BC-322BC). Primarily, his work is important in the development of all knowledge for, as the authors write[4]:-

> *Aristotle, more than any other thinker, determined the orientation and the content of Western intellectual history. He was the author of a philosophical and scientific system that through the centuries became the support and vehicle for both medieval Christian and Islamic scholastic thought: until the end of the 17th century, Western culture was Aristotelian. And, even after the intellectual revolutions of centuries to follow, Aristotelian concepts and ideas remained embedded in Western thinking.*

In sum, the main point for Aristotle was that there was one overall principle: united sky above and earth beneath, the idea that everything has its function within a greater whole. The same principle could also help correlate differences between organs, by showing how they cooperate to maintain the organism as a whole. If all parts collaborate to maintain the whole, no part can ever change, for all would have to change at once. These principles were the scientific and philosophical pillars for the next centuries, i.e. until the Medieval, to use Marx's words, "Scientific Renaissance" or the First Great Transformation.

2.2 The First Great Transformation

The institutionalised 2,000 year-old tradition of Aristotelian science was started breaking down by discoveries of Nicolaus Copernicus (proposed heliocentric theory), Giovanni Battista Benedetti (who showed that velocity of falling bodies is not related to their weight), Tycho Brahe (*the heavens were not immutable*), Giordano Bruno (who claimed that Universe is infinite) and so forth.

Further advance of the First Great Transformation or Scientific Revolution was shaped by Rene Descartes (1596-1650), who established deductive (complimentary rather method to the inductive Aristotelian) method of reasoning, concluding that explaining the nature by only inductive method was not possible "*because all explanations were beyond experience"* which was then just speculation. His analytical method separating the knowledge of the nature on *res cognitio* and *res experientia* grossly influenced the Western thought for the more than two centuries ("*Cogito, ergo sum*" -'*je pense*, *donc je suis*', 'I think therefore I am'). From this certainty, he proceeded by arguing for the existence of God (as the first cause) and the reality of the physical world, and

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[4] J O'Connor and E F Robertson, online available at: http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Aristotle.html assessed in April 2001.

developed a dualistic theory; the world composed of mind (conscious experience) and matter. Descartes holds that the occurrence of thought guarantees the existence of a thinker. (*Prin*. 1.7, AT 8a:7).[5]

The new way of seeing the world introduced first tentatively with the publication of Copernicus's work in 1543, through Descartes's works, reached its triumphal acceptance with appearance in 1687 of Isaac Newton's *Principia* (recognised by some authors as the greatest scientific book ever written), who analysed the motion of bodies in resisting and non-resisting media under the action of centripetal forces.

2.3 The Second Great Transformation

The traditional approach is passed on the assumption that epistemological questions have to be answered in ways which do not assume any particular *a priory* knowledge. The Darwinian revolution of the nineteenth century suggested an alternative approach. The development of the new nature's method – evolution was certainly in discrepancy with Cartesian unchangeable definite mechanistic approach to the world. However, it needed further physics advances to finally break down the Cartesian mechanistic view. The work of Albert Einstein (1879-1955), Max Plank (1858-1947), Niels Bohr (1882-1962), Lorentz, (1853-1928) Werner Heisenberg (1901-1976), Ernest Rutherford (1871-1937) and many others not only disputed the mechanistic approach but also set up the foundations for the quantum leap of the science that has risen to the today's Informatics Paradigm and the Network Revolution. That astonishing far-reaching development of quanta physics was one of the most exciting periods in the human scientific history. It has had a great influence not only on the scientific inquiry but also in all others areas of human exploration – art, architecture, music, philosophy, medicine, socio-economic development, etc. of the XX century.

It started in the early 1900's, when German physicist M. Planck noticed significant flaw in Newtonian physics by demonstrating that "the electron in orbit around the nucleus accelerates. Acceleration means a changing electric field (the electron has charge), when means photons should be emitted. But, then the electron would lose energy and fall into the nucleus. Therefore, atoms shouldn't exist!"[6] This discovery was a turning point in the contemporary science which Einstein, somewhere described as it seemed that science (in Newtonian sense of word) lost its foothold. In fact, traditional physics has had no explanation for the atom's behaviour at the sub-atomic level. To resolve this problem, Planck made an assumption that energy, at the sub-atomic level, can only be transferred in small units, called *quanta*. The quantisation, or 'jumpiness'' of action as depicted in quantum physics differs sharply from classical physics, which represented motion as smooth, continuous change. However, that was only the beginning of this astounding scientific journey.

In his Ph.D. thesis of Louis de Broglie in 1923 developed fundamental concepts in modern physics that light has a wave and particle state (but not at the same time), called wave-particle dualism.[7]

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[5] Lex Newman online available at http://www.hum.utah.edu/philosophy/phil_welcome.html assessed in April 2001.

[6] Prof. James Schombert, University of Oregon, Astronomy 123 lectures available online at: http://zebu.uoregon.edu/~js/ast123/lectures/lec07.html assessed in April 2001.

[7] Ibid.

Classical physics was untied with problems of wave/particle duality, but was completely dismantled with the discovery of the uncertainty principle, developed by W. Heisenberg. Using this principle, we can summarise the main difference between the Old (Cartesian) and the New Approach. That is, the main difference is to comprehend the existence of quantum systems as *possibilities* rather than *actualities*. This gives them the property of being things that might be or might happen, rather than things that are. This is in sharp contrast to Newtonian physics where things are or are not, there is no uncertainty except those imposed by poor data or limitations of the data gathering equipment.[8]

How it is related to the information economy. Why we are studying the quantum mechanics in economics? The answer is twofold. Firstly, these developments laid foundations for all aspects of our lives and modern science and economics, as well. Secondly, one of the main features of the information paradigm is the convergence – i.e. interdependence of different disciplines. Thus if you want to understand information systems, economics or information technology, and to get used to the "untraditional" way of thinking one has to start from the beigining of these developments, which enabled the new way of thinking. In another words, principles of quantum physics facilitate our ability to comprehend and to explain for example, that for today's world economy the most certain prediction can be the state of changes. In turn (applying the convergence principle), physicists use some of the economics tools (statistics method) to explain, for example, the wave nature (e.g. position) of the sub-atomic world. ("*An electron in orbit has 'no position' other than it is somewhere in its orbit - statistical description of the 'superpositions*').

In addition, relevance of the quantum physics to the information technology can be seen through the Heizenberg's *Principle of Uncertainty* which was a corner stone of Shanon' s theory of information, which expanded our understanding of the nature of information. Through his work, we have begun to understand the fundamental relationship that appears to exist between language, information, energy, and entropy. A physics of information has begun to develop which suggests that information relationships are as important as material, causal ones mediated in space and time.

Further convergence between the information technology and economics and the quantum mechanics can be illustrated by the phenomenon called *quantum tunnelling,* which was a basis for the discovery of transistors.

Apart from its foundations in the quantum physics methods modern or information economics has its links with it through the changed way of thinking as well. We are witnessing the development of the set of 'unusual' categories that economists have to deal with (e.g. humped demand curve in the theory of network externalities, or a voice, as a response to the 'technology productivity paradox', to eliminate any job that can be measured for productivity, etc.). The whole way of thinking which has been used to be the main premise for centuries was changed by the quantum physics way of explaining the nature.

Thus, the information age marks a change in our lives, worldview, as well as our technology. The mechanistic view of the industrial era is definitely giving way to something new.

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[8] Ibid.

3. Information technology transformation

3.1 Introduction

The technical foundations of today's information technology, based on the use of the electronic valve as a high speed switch, were laid during the 1939-1945 period. However, two events in the post-war period may be singled out – Claude Shanon's work on information theory in 1948 established the criteria for data transmition and the invention of the transistor by Bardeen, Brattain, and Schokley in 1947/8. This section explores the evolution of electronics - an underlying technology of hardware (microelectronic) industry. That is, to present a background of the relevant information technologies to be able to appreciate their impact on the economics, strategy, and organisation of the modern industry.

3.2 The Microelectronics Industry

Electronics, in the strictest sense, is the science and technology of the motion of charges in a gas, vacuum, or semiconductor.[9] As emphasised by Millman and Grabel (1979) the charge motion confined to a metal is not considered electronics. This was a historical division used early in the twentieth century to separate the field of electrical engineering from the new and emerging field of electronic engineering. It deals with systems by which we can communicate worldwide, by which vast quantity of data is manipulated, and by which highly complex manufacturing processes are automated and with the elements used to realise them[10]. The area of electrical engineering also includes the devices, circuits, and systems for the generation, distribution, and conversion of electric energy. This group possesses the common property of processing information. Consequently, we view the nature of the discipline of electronics comprising components, communication, and computation.

- *Component* companies came into existence to produce the various types of electron devices (resistors, capacitors, inductors, transformers, etc.).
- *Communications* techniques used in radio broadcasting were adopted to fit other applications. Telephone systems were transformed into one major form of electronic communication.
- *Computers* - Although the transistor and the integrated circuit gave impetus to the extraordinary growth of the computer industry, their origins are found in the vacuum-tube era. There has been a great deal of interest in computing machines for over 300 years. In 1633 Schickard described in correspondence with Kepler, the astronomer, a mechanical computer to perform addition, subtraction, multiplication, and division. He designed a wheel with ten spokes on it, one spoke of which was longer than others, and this wheel was placed mechanically next to another similar wheel. After the first wheel made ten angular increments, which corresponded to the ten digits, the large spoke engaged the next wheel, and it would turn by one increment. In other word, he invented the *carry* in arithmetic. The serious effort to build a mechanical calculator was made 1833 by Babbage. The "analytic engine", as Babbage's computer was called, contained all the elements of a modern digital computer. It used punched cards - invented 30 years earlier by Jacquard, a French tapestry maker - for input and output, contained both memory and an arithmetic unit, and was a stored-program machine. However, the technology was simply not available to convert his ideas into a practical machine.

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[9] Millman, J. and Grabel, A. (1979). Microelectronics (second edition) New York, McGraw-Hill.

[10] Ibid., p.5.

The first working calculator was electromechanical and was built by IBM engineers under direction of Professor Aiken of Harvard University in 1930. It was called "IBM Automatic Sequence Controlled Calculator - Mark I." Eckert and Mauchly at the Moore School of Electrical Engineering at the University of Pennsylvania completed the first electronic calculator in 1946. It was called the ENIAC, (Electronic Numerical Integrator And Computer), which was used for computation of ballistic tables for the army.

In 1946, IBM introduced the first small commercial electronic computer, the 603 type. Two years later, the first general-purpose digital computer, the IBM type 604, was brought out and over 4000 machines were sold in 12 years. Thus, 1948 can be considered as the beginning of the computer industry. The IBM 650 was introduced in 1954, this and others vacuum-tube machines are known as *first-generation digital computers.*

Besides industrial growth, a significant and theoretical progress was made, as well. Shannon in the US and Kotelnikov in the Soviet Union independently developed information theory which has guided communications scientists and engineers in their quest for faster, more efficient, transmition of signals. The use of Boolean algebra in the analysis and design of switching circuits was another of Shannon's contributions.[11]

Shannon equates information with uncertainty (remember Heizenberg's Principle of Uncertainty?). For Shannon, an information source is someone or something that generates messages in a statistical fashion. The "entropy" can describe the randomness of an information source, which determines the smallest number of bits per symbol that is required to represent the total output.[12]

Studies of materials, particular the application of quantum mechanics to solids, led to new devices and the invention of the transistor (1947/8). The 1950's were a decade of transition. It marked the end of the development of sophisticated vacuum-tube systems and the beginning of the transistors - the semiconductor chip, which embodies transistors and many other formerly discrete components and their interconnections, enables information to be processed rapidly and cheaply using very little space and without generating appreciable heat.[13]

In 1954, Texas Instruments announced the production of silicon transistors. Shortly after that, Kilby in 1958, explored the monolithic-circuit concept, that is, the idea of using germanium or silicon to build an entire circuit *solid circuit* later called *integrated circuit*. Today, besides individual circuits, subsystems and even entire systems containing thousands of components can be fabricated on a single silicon chip. The term *microelectronics* refers to the design and fabrication of these high-components-density ICs. A founder and later president of Intel, Moore, noted in 1964 that the number of components on a chip had doubled every year since 1959 (Moor's Law), when the planar transistor was introduced.

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[11] Bell Labs celebrates 50 years of Information Theory, available online at Bell Labs Internet Site http://www.lucent.com/ideas2/perspectives/trends/ assessed in April 2001.

[12] Ibid.

[13] Langlois, R.N., Pugel, T.A., Haklisch, C.S., Nelson, R.R., Egelhoff, W.G.(1988). Microelectronics: An industry in transition. London, Unwin Hyman.

However, the most dramatic outgrowth of the microelectronics industry has been the virtual creation of an entirely new industry - the modern computer industry.

The first transistorised, special-purpose computer was developed by Cray (1956). The IBM 7090/7094 (1959) was the first general-purpose second-generation computer. Hybrid ICs characterised the third-generation computer - IBM 360 series in 1964. In 1965 another revolution in the computer industry began when Digital Equipment Corporation introduced its PDP8 minicomputer, the first machine to sell for under $20,000.

In 1980's, the fourth generation of machines is being developed and introduced. These computers employ VLSI (very-large-scale integration) chips for both processing and memory. Today, electronic computers are available in variety of sizes ranging from the simplest of microprocessors to supercomputers capable of executing millions or billions instructions per second.

Nevertheless, hardware is one side of the computing process – software is another, inseparable one. The next section takes on the software ‘story’.

3.3 The Modern Software Industry

Since its inception in the early 1950s, the computer and software industries have been characterised by a rapid and sustained technical change. They have also been characterised by continuous product innovations disturbed by major breakthroughs: the creation of new uses for computers, new markets and the coexistence between established actors and new entrepreneurial firms.

With such rapid pace, the software industry is leading the transition to the information marketplace (or the network society). That is, software and computing constitute the critical building blocks of the information marketplace. This market consists of digitised information, created and used in conjunction with software and computers, and delivered over wired or wireless communications networks. Technological change and consumers’ demands are causing computers to become more mobile and transportable, and to perform functions unobtrusively and intuitively, with minimal input from the user. Computing has evolved from the data processing centre, to the desktop and into the briefcase and palmtops.

As an integral part of hardware, software operates as the ‘brain’ of a computer and provides an important role in modern commerce as it has one very special characteristic: it improves the competitiveness of other industries, which utilise software products to make themselves more innovative, efficient and competitive. The global software and computing industries are thriving on the benefits of continuous software innovation, which permeates much of the informational economy. The industry has literally transformed the ways individuals interact with one another, how business is conducted and how we gain access to information the world over. It is transforming the way businesses manage inventory, schools educate our children, individuals pay bills, and even how we have fun on a Sunday afternoon. Today farmers use software and computers to access weather data, crop prices, and the latest developments in the use of herbicides and pesticides. Factories use information management to streamline inventories, implement robotics, speed up production and enhance precision. Teachers in the classroom, doctors in their offices and taxi drivers in their cabs all use computers and software to bring down information needed to do their jobs. The future possibilities for the use of information seem limitless.

While the early age of the computer industry was characterised by a small number of companies led by IBM, the present industry structure is comprised of thousands of companies. The structure of the industry greatly influences the organisational structure and competitive strategies. There are three different kinds of demand which are important in understanding the organisation of the computer industry:

- demand created by the buyers of large computers for business data processing,
- demand for individual productivity applications where the use mostly depends upon mass-market software, such as word processing or spreadsheet programs. This market has seen considerable growth in two ways: by replacement and upgrading, and by diffusion. In this segment, individual customers tend to buy hardware and software from a variety of vendors,
- demand for scientific, engineering and other technical computation application.

These varieties of demand have permitted the emergence of different suppliers and markets, and the development of the hardware/software industry structure that can be seen in the following figure.

Figure 2. The computer industry structure

Layer 5 Distributors	Computer dealers	Super stores	Mass Merchandisers	Clubs	Mail order	Value-added Resellers	Direct sales force	Other
Layer 4 Mass-market applications: Spreadsheets Word Processors Database	Lotus 1-2-3	MS Excel MS Word MS Access	Corel's Quattro Pro					
Layer 3 Operating systems Software	MS-DOS	Windows	OS/2	UNIX	Apple			
	Novell NetWare	Banyan	IBM	Others				
Layer 2 Computer platforms	IBM	Compaq	Other Intel-based PCs	Apple Macs	Others			
Layer 1 Microprocessor	Intel X86	Motorola	RISC	Power PC				

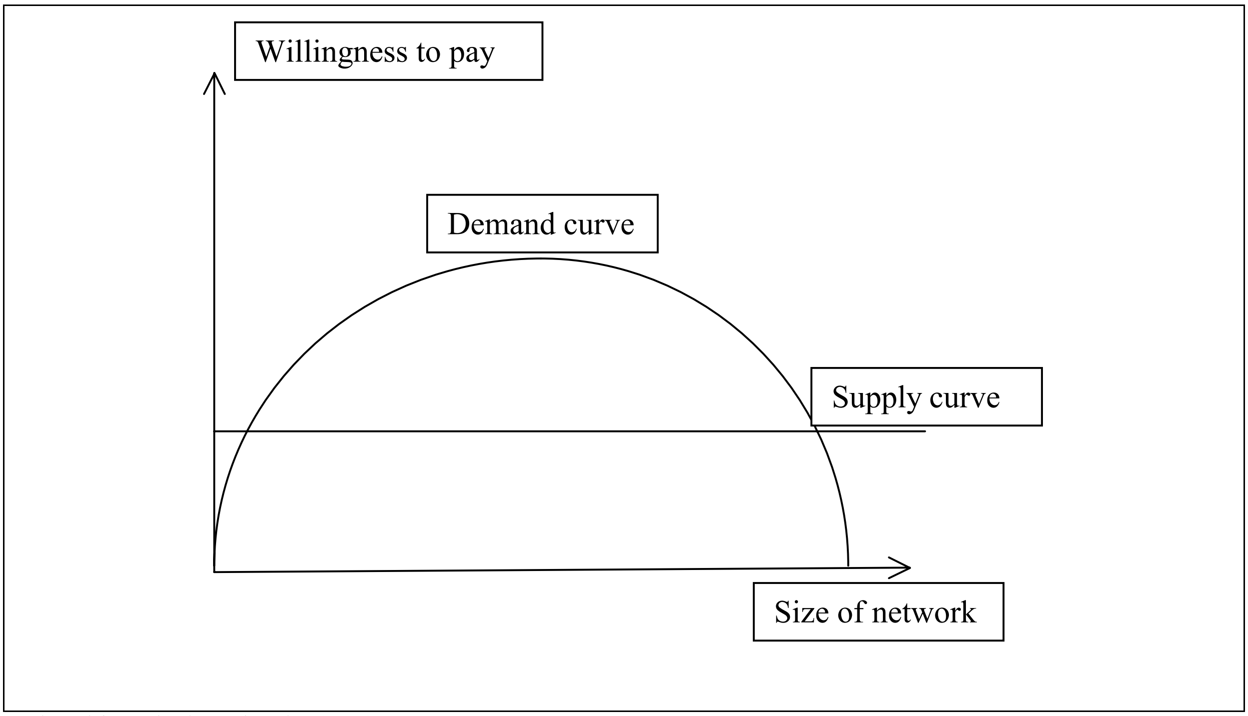
Source: Callon, D. J. (1996) p. 44.

The pace of change has recently accelerated through the Internet, online services, networking and new programming languages, such as Java and Visual Basic. The market for computer software has increased dramatically, and still growing rapidly. In addition, technical progress of the computer industry has led to the improvement in performance and decreases in prices, together with dramatic improvements in complementary technologies such as software, storage devices and telecommunications. With considerable innovations and customers' "learning-by-using" developed skills, the software industry has become a worldwide multibillion-dollar industry.

This rapid and unprecedented growth has been possible in part through economies of scale and the presence of network externalities. ("*Network externalities occur when the value of a product or service to a buyer increases with the cumulative number of other buyers"* Shapiro and Katz, 1992). When this is the case, each additional purchase raises the value to current users, and eventually to future purchasers. An important point, however, is that software, networks, communications, and information systems exhibit positive consumption and production externalities. The reason for the appearance of network externalities is the way different goods or components on the same network complement each other, which in turn increases the value of the component. In other words, positive consumption externalities arise.

Furthermore, a point should be made that the market with network externalities exhibits different characteristic than the standard market. For example, demand has quite a different shape than a standard demand curve. If the number of people who connect is low, then the willingness of the marginal individual to pay is low, because there are not many other people out there that they can communicate with. If there are a large number of people connected, then the willingness of the marginal individual to pay is low again, because everyone else, who valued it more highly, has already connected. These two forces lead to the humped shape of the demand curve depicted by the Figure 3.

Figure 3. Network externalities



Adapted from Shapiro and Varian (1998)

Following on the above discussion on the attributes of information technology, the next section takes up subject of the information economics and network societies analysis.

4. Information Economics and Network Societies

4.1 Introduction

To close the 'historical loop' this section takes on the issue of how the technological paradigm has given a rise to the new (information) economics, that is to explain this coupling that lead to the modern economies. To explain the techno-economic paradigm, Freeman and Dosi (1988) defined that relationship as: *cluster of interrelated technical, organisational, and managerial innovations whose advantages are to be found not only in a new range of products and systems, but most of all in the dynamics of the relative cost structure of all possible inputs to production, In each new paradigm a particular input or set of inputs may be described as the "key factor" in that paradigm characterised by failing relative costs and universal availability. The contemporary change of paradigm may be seen as a shift from a technology based primarily on cheap inputs of energy to one predominantly based on cheap inputs of information derived from advances in microelectronic and telecommunications technology.* (C. Freeman in Dosi, G. et al. 1988)

Similarly, Castells (1996, p. 61) emphasised that the notion of technology paradigm and its characteristics helps organise the main points of current technological transformation as it interacts with economy and society, that is, pinpointing the features of information paradigm that constitute the core of the information technology paradigm which taken together would define the material foundation of the network societies.

The first characteristic of the new paradigm is that information is its input or raw material; or as Castells (1996) put it: *these are technologies to act on information, not just information to act on technology* (as was the case in previous industrial revolution).

The second characteristic refers to the pervasiveness of effects: information is an integral part of all human activities; *all processes of our individual and collective existence are directly shaped (although certainly not determined) by the new technological medium*.

The third feature refers to the network logic of any system that is the network can now be materially implemented in all kinds of processes and organisations by newly available information technologies.

Fourthly, the information technology paradigm is based on flexibility. *Not only processes are reversible, but also organisations and institutions can be modified, altered by rearranging their components. In short turning the rules upside down without destroying the organization.*

Fifth characteristic of the technological revolution is the growing convergence of specific technologies into a highly integrated system. For example, microelectronics, telecommunications, optoelectronics, and computers are integrated into information systems. That is, in terms of technological system one element cannot be imagined without other: PCs are determined by microprocessors (chip) power which in turn depends on PC architecture. Telecommunication is now one form of processing information that is increasingly integrated, diversified and operated by computers. This technological convergence increasingly extends to growing interdependence between other informational revolution systems. For example, there is a growing interdependence between the biological and microelectronics systems – decisive advances in biological research (DNA etc.) that can only be processed because of massive computing power, etc. Furthermore, biological advances are increasingly introduced in electronic machines and computers (robots who are able to learn) using neural network theory – ("*the emergence of self-organising structures that create complexity out of simplicity and superior order out of chaos, through several orders of interactivity between basic elements at the origin of the process*" Castells 1996, p. 64).

From the discussion about this interrelation between technology and economics, the next section will proceed towards an acceptable definition of information economics.

4.2. Definitions of Information Economics

The events of the last years have transformed the social conditions and caused the breakdown of the prevailing system of the economic relations. These developments reflect substantive change in the economics foundations, that is, it emerges a new "information economics". This section presents the treatment of information as a new "product" and its characteristics in an economics milieu.

The new economics is informational because productivity and competitiveness in this economy fundamentally depend on their capacity to generate, process, and apply efficiently knowledge-based information. The information economics is about structural transformation; about doing new things and doing old things very differently in very different organisational forms. The information economy is a new reality, because it is an economy with the capacity to work as a unit in REAL TIME on a planetary scale. Although, there are replete of studies on different aspects of information technology and economics and its influences to different areas, so far no comprehensive economics of information has been developed.

This is a very wide subject area, which overlaps with many other aspects of economics and business management. Consequently, there are several names for this ongoing shift in the economic landscape: 'post-industrial society', 'innovation economy', 'knowledge economy', 'network economy', 'new economy', an 'E-conomy', 'digital economy', etc. However, we can use the 'information economics' name to define it. In doing so, let first define 'information'. Porat (1977 p. 2) define information as "data that have been organized and communicated". Machlup (1962 p. 15) defined information as "the communication of knowledge."[14] Information is "anything that can be digitised – encoded as a stream of bits" (Shapiro and Varian 1999). Another non-technical definition of information would state that it is *the presentation of facts and figures in such a way that decisions may be easily and quickly made*. These might well be considered as rather narrow definitions; however, it is an analytically useful 'tool' which allow further detailed interpretation of information economics.

Typical classical economists are concerned by what makes one country wealthier than another and how this is achieved through exchange. Applying the traditional definition it may be said that the economics of information is concerned with how data may be used to create, manage and exchange wealth.

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[14] To understand Machlup's definition of information it is useful to know Bell's definition of knowledge: "Knowledge is a set of organised statements of facts or ideas, presenting a reasoned judgement or an experimental result, which is transmitted to others through some communication medium in some systematic form." (Daniel Bell 1973, p. 175)

In another word, by "economics of information" is meant a systematic series of concepts and theories which explain the role which information plays in assisting the firm in its conception, production and delivery of goods and services in order to create wealth in society (Meneyi et al., 1993).

Furthermore, an avenue to clarify this definition is to look at the difference between the new and old economics. That is, the difference between information (intangible) goods, which are treated by the information economics and other (tangible) goods subject to the traditional economics.

For centuries Smith's Invisible Hand of the market system for organisation and distribution has rested on the following posts: excludability, rivalry and transparency; while cost structure was basis for the price of goods. Modern technologies, ideas and information are beginning to undermine the features of the Invisible Hand forces as "an effective and efficient market system", simple by their characteristics. Ideas and "information goods" have particular characteristics that distinguish them from ordinary goods. These include:

- *non-rivalry* – if I have an apple you cannot have it; but if I know something, although you can learn it and I will still know it;
- *non-transparency* (in order to buy it, you should know what the information or idea is, once you know it, in many instances, there is no need for you to buy it);
- *non-excludability* – the owner of an information will no longer be able to easily and cheaply exclude others from using or enjoying the commodity (information), digital data is easy and cheap to copy. As pointed out by De Long, B. (1997) "without excludability the relationship between producer and consumer is much more a gift-exchange than a purchase-and-sale relationship";
- *different cost structure* – marginal costs of reproducing and distribution that approach zero (e.g. cost-based pricing of a 10% mark up on unit cost makes no sense when unit cost is almost zero, therefore you have to price your information good according to consumer value, not according to your production costs);
- An information good is an *experienced good* every time it's consumed (or in another word you have to "value" it before you consume it); an ordinary good is an experienced good since consumer must experience it to value it (in short, you have to consume it to value it);
- *Costumer-driven demand* for new services and technologies rather than price-driven demand for the ordinary good;
- *Unlimited resources* - Resources for creating information are technically unlimited while resources for producing an ordinary good can be limited or exhausted (it is not a problem of accessing or producing an information it's a problem of filtering, finding, communicating what's useful and what's not). As Dosi argued: .... *decreasing returns historically did not emerge even in those activities involving a given and "natural" factor such as agriculture or mining: Mechanisation, chemical fertilisers and pesticides, new breeds of plants and animals and improved techniques of mineral extraction and purification prevented "scarcity" from becoming the dominant functional feature of these activities* (Dosi 1988, p.1129).

As to the analytical tools, the 'old' economics marginal analysis is still relevant for the new economy, but the power of economic analysis can be greatly increased by complementing traditional economics with the inframarginal analysis of the network of division of labour. A most important difference between the traditional marginal analysis of resource allocation and the inframarginal analysis of division of labour and networking decisions is that the former takes the network of economic organisation or the degree of division of labour as given. As an example of this difference, for example analysing the benefits of e-commerce by the traditional tools would result in discussion about lowering search costs and the likely higher level of competition. On the other hand, using inframarginal analysis one can cover the lower transaction costs leading to a higher degree of division of labour and the resulting economies of specialisation.

After presenting the differences between the new and old economics, lets take on some of the main points of network societies that were enabled by the techno-economics paradigm.

4.3 Advance of the Network Societies

It has become commonplace to talk of the globalisation of the world economy, but like so many such catch phrases, it is often poorly defined or poorly illustrated. If by globalisation we mean that national borders no longer exist and have no any significance then we have a long way to go. If we talk about the ratio of international trade to GDP we are close to that ratio in 1913.[15] If we are talking about global firms, there are only a handful of truly 'global' firms, if that is taken to mean a firm which does not have a clear nationality and does not have a bias towards its home base. (One of those firms in literature is Swedish-Swiss conglomerate ABB. While several recent business acquisitions (e.g. BHP-Billiton) might meet criteria for determination as truly global companies, on closer examination they will likely reveal distinctly 'national' characteristics, particularly in managerial style).

In an economic sense globalisation could be seen as meaning a world where factors of production or their output move freely across borders, with the result that the price of capital, labour and land, and the goods and services they produce is equalised across the world. This clearly does not occur; wages, prices, rents, and real interest rates differ considerably, even between countries with well-developed capital markets. What is than globalisation?

If globalisation is taken to refer to a dynamic process of interconnectivity, then there seems little doubt that it is occurring. The interconnectivity process enabled by the computing power of modern networks, which may ultimately lead, through information economics, to the future network or truly global society. For now, that informational-networking process (or globalisation) is a process structured largely, around a network of financial flows, as the only truly global (financial) network. As Castells (1996) pointed out, capital works globally as a unit in real time and it is realised, invested, and accumulated mainly in the sphere of circulation that is as financial capital. From these networks, capital is invested globally in all sectors of activity: information industries, media, services, agriculture, health, education, technology, et cetera. All other activities are primarily the basis to generate the necessary surplus to invest in global flows, or the result of investment originated in these financial networks (Castells 1996, p. 471).

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[15] As Yaffe D. (1996) argue the openness of capitalist economies today is no greater than before 1914. Merchandise trade (export plus imports) as a percentage of GDP is close to the levels of 1913. Foreign Direct investment stock has been estimated at 9% of world output in 1913 compared to 8.5% in 1991.

Thus, if we understand globalisation as a process of interconnectivity of the web of networks, globalisation refers to the establishment of networks within a society first and then connection to a higher order (transnationals) network. Over the last two decades, a number of domains of economic activity have entered a phase of rapid use of networks, firstly, applications of the use of networked computers and/or parallel computing, networks of electronic devices of various kinds, and various forms of artificial intelligence and expert systems, which enabled participation in an international higher order network system.[16]

In addition, taking globalisation as a dynamic process will make clear distinction between globalisation, as a process, information economics as a stage in the process, and the network societies as the result of that process (of globalisation).

Understanding the globalisation as a process of interconnectivity of transnationals networks means that further development of information technology and informational economics will ultimately lead to the development of a global or the future society. Once the networks 'cover' all global population and their activities and connect them in a higher transnationals network, we will live in a 'global village' or the 'future society', instead in the partially networked societies. Therefore, I may argue that the fundamental change in modern civilisation and their economic and social effects manifest themselves in the acceleration of modern history, rather than in the 'end of history'.

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[16] Ernst, (1994, pp. 5-6) identified five types of networks in contemporary economy: Supplier networks; Producer networks; Customer networks; Standard coalitions of potential global standard setters with the purpose of locking-in as many firms as possible into their product or interface standards, and Technology cooperation networks which facilitate the acquisition of product design and production technology, enabling joint production and process development, R&D and other scientific knowledge to be shared.

5. Conclusion

Information remains one of the least-explored aspects of economics activity. The recent emergence of the ‘informational-network economics’ asked for exploration of the historical genesis of the human knowledge that leads to the information paradigm and the information economics. This was the main objective of the paper.

There were few studies of information economics that explore the connection between the shift of human knowledge paradigm and information economics. In so doing, we went briefly back to Aristotle’s work, through Descartes philosophy to the quantum mechanics, technological paradigm to globalisation in an attempt to trace evolution of the human knowledge that lead to the information paradigm, and the network societies. We have tried to link information economics and physics that is, to show that development of the information economics was enabled by the development and discoveries of physics and quantum mechanics which in turn were possible by dismantling the Cartesian mechanics point of view.

In addition, we endeavoured to establish a clear cut between globalisation and network societies, defying globalisation as a process of interconnectivity enabled by information paradigm that will eventually conclude through information economics to the future network society.

Bibliography

Bell D. (1973) *The Coming of Post-Industrial Society: A Venture in Social Forecasting,* New York: Basic Books.

Bell Labs News Available online at: http://www.lucent.com/ideas2/perspectives/trends/ (assessed in April 2001)

Bradie, M. and Harms, W. Stanford Encyclopaedia of Philosophy, available online at: http://plato.stanford.edu/contents.html (assessed in April 2001)

Bradley, P. S. Hausman, A. J. and Richard, L. N. (1993) Global Competition, and Technology, in Bradley, P. S. Hausman, A. J. and Richard, L. N. (eds) *Globalization,Technology, and Competition: The Fusion of Computers and Telecomunications in the 1990s*, Harvard Business School Press, Harvard.

Callon, D. J. (1996) *Competitive Advantages Through Information Technology*, New York: The McGraw-Hill Companies Inc.

Conner, R. K. and Rumelt, P. R. (1991) Software Piracy: An Analysis of Protection Strategies, *Management Science*, Vol. 37 (2), 125–139.

Dosi, G. (1988) Sources and Procedures and Microeconomic Effects of Innovation, *Journal of Economic Literature*, Vol. XXVI, (Sept. 1988), pp. 1120-1171.

Dosi, G. (1988) (ed.) *Technical Change and Economic Theory*, Pinter Publishers: London.

Economides, N. (1995) The Economics of Networks, Forthcoming, *International Journal of Industrial Organisation,* vol. 14, no. 2 (March 1996). Available online at http://raven.stern.nyu.edu/networks/top.html assessed in April 2001.

Ernst, D. (1994) *Inter-Firms Networks and Market Structure: Driving Forces, Barriers and Patterns of Control*, Berkley, CA: University of California, BRIE Research Paper.

Langlois, R.N., Pugel, T.A., Haklisch, C.S., Nelson, R.R., Egelhoff, W.G.(1988). *Microelectronics: An Industry in Transition.* London, Unwin Hyman.

Machlup, F. (1962) *The Production and Distribution of Knowledge in the United States*, Princeton, NJ: Princeton University Press.

Millman, J. and Grabel, A. (1979). *Microelectronics* (second edition) New York, McGraw-Hill.

Newman, L. online available at http://www.hum.utah.edu/philosophy/phil_welcome.html (assessed in April 2001).

O'Connor, J. and Robertson, E.F Available online at: http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Aristotle.html (assessed in April 2001)

Porat, M. (1977) *The Information Economy: Definition and Measurement,* Washington DC.: US Department of Commerce, Office of Telecommunications, publication 77-12(1).

Schombert, J. University of Oregon, *Astronomy 123* lectures available online at: http://zebu.uoregon.edu/~js/ast123/lectures/lec07.html (assessed in April 2001)

Shapiro, C. and Katz, L. M. (1992) Product Introduction with Network Externalities, *The Journal of Industrial Economics,* March 1992, Vol. XL (1), 55–83.

Shapiro, C. and Varian, H. (1999) *Information Rules: A Strategic Guide to the Network Economy*, Harvard Business Shool Press, Harvard.

Yang, X-K. (2001) *Where Do We Stand: A Review of the Literature of Inframarginal Analysis of Network of Division of Labour*, A paper presented at the International Symposium on the Economics of e-Commerce and Networking Decisions, Monash University, 6-7 July 2001.