

Information Economics Aspires

Durad Cerk

Faculty of Economics and Informatics

University of Novo Mesto

Email: duradcerk32@yahoo.com (Author of Correspondence)

Slovenia

Abstract

Researchers in the economics of information come from a variety of disciplines. While most economics of information research appears in economics and in the library and information science, Machlup and Mansfield in *The Economics of Information: Interdisciplinary Messages* note contributions from other fields including psychology, sociology, linguistics, communication, engineering, computer science, cognitive science, artificial intelligence, and cybernetics. In this article, some important issues will distinctly be represented. Thus anybody can know about information economics and many data.

Keywords: Idea; Information; Acquisition; Tools; Distribution.

1. Introduction

Issues raised touch on additional fields including especially philosophy, political science, government, and policy studies. Within economics, the economics of information can be seen as a critique of classical models with implications for almost every kind of economic inquiry, especially decision making, forecasting, uncertainty, equilibrium theory, rational choice, and game theory. Economics of information per se first emerges as a field of inquiry in the 1960s in response to a growing awareness of fundamental changes in world economies driven by the emergence of computer technology increasingly allied with telecommunications. Mid-century concerns with the changing roles of computers, mass media, publishing, R&D, patents, education, and libraries dovetailed with previous work on the role of knowledge in economic models. Researchers at this time also began to recognize growth in information industries, growth in the commodification of information, and growth in the information sector as a percentage share of the general economy. Central issues arose about the nature of information itself and its economics. The two main sets of researchers, economists and library and information scientists, approach the economics of information from different perspectives. Library and information scientists, informed by economic theory but immersed in information as to their primary “commodity,” have tended to look at notions of what information is and at information products as items bought, sold, used, copyrighted, made public, or provided, particularly in libraries. Economists have tended to study the nature of decision making, the distribution of information, imperfect knowledge, the flow of information, and the role of the “information sector” in a market context. Both sets of researchers attempt to refine models to account for price, costs, benefits, values, and economic impacts. Basic terms for economic transactions remain the same for information as for any other commodity, but researchers agree information has special characteristics that make it more difficult to work with. Definitions of price, cost, benefit, the value that can be found in any introductory economics text apply here as well. Price is simply the amount charged in dollars, but how a market price is arrived at in terms of competition and distribution is more complex. Costs are also complex including costs of production, costs in time, the cost in wages, and costs in terms of alternatives that might have been purchased or time that might have been spent in other ways than the consumption of an item. Benefits are complex as well including benefits to the consumer, benefits to the producer and the seller, and benefits to society as a whole. The concept of value is the most difficult; some economists believe it can only be known subjectively, others have attempted complicated models of utility to account for value. In any case, value to whom and in what circumstances is a few of the complicating variables.

2. The idea of Information Economics

Economics of information, or information economics, belongs to the field of microeconomics and it studies the importance of information in Economics. The neoclassical theory was developed around the assumptions of perfect information and the absence of uncertainty, and although this simplification allows modeling the reality, it is unrealistic. Economics of information is the result of an alteration in the usual neoclassical analysis, and it integrates the possibility of imperfect information that will result in asymmetric information. An information economy is where the productivity and competitiveness of units or agents in the economy (be they firms, regions or nations) depend mainly on their capacity to generate, process, and apply efficiently knowledge-based information. It is also described as an economy where information is both the currency and the product. While we have always relied on information exchange to do our jobs and run our lives, the information economy is different in that it can collect more relevant information at the appropriate time. Consequently, production in the information economy can be fine-tuned in ways heretofore undreamed of. What makes information plentiful in this economy is the pervasive use of information and communications technology.

Asymmetric information occurs in those situations in which an agent has greater information, either before or after, the interaction between agents happens. The study of these situations is of special relevance mainly to avoid the conflicts that will arise from them. If an agent has inside information previous to the economic relations, ex-ante asymmetry, and adverse selection may occur. If the inside information is after the economic relations, post-ante, it will be considered a moral hazard.

The information has always been a valuable asset to those who possess it. Where the fish were biting was an important piece of information to tribal societies. They shared this information because it was in the interests of the community to do so, and the catch was shared by all members of the tribe. Today, where the fish are biting, is a carefully guarded secret by fishermen who store the longitude and latitude in the memories of their Loran equipment on their fishing boats. Their boats are also equipped with satellite antenna in order to obtain access to the remote sensing satellite data that discloses where the schools of fish are concentrating and what prices are offered for their catch on the global markets.

The U.S. economy has been in a state of transition from an agricultural economy in the 19th century to an information economy in the 21st century. In 1790 we were largely an economy of farmers. Today we are predominantly an economy of information workers. According to U.S. Commerce Secretary Ron Brown, about 60% of our workforce today is engaged in activities that are producing information products.

The United States has passed all too briefly, it seems, through an industrial economy that was the envy of the world. The agrarian economy was one in which information was most often cherished as a public resource that should be shared in order to enhance the collective performance of all agricultural components. These were highly disaggregated and could not be expected to fund their own research. An information society is also disaggregated, but one in which the primary foundation of the economy may become collecting, processing, distributing and archiving information as a primary source of income upon which the society must rely for its economic health. We are at that crossroads now.

Thus we have a thriving information industry that has been growing at some 20-25% per year for the past several decades. However, as we see the burgeoning growth and use of new information technologies, we also see an erosion of the traditional public institutions that support information processing and distribution.

An information economy is based upon the premise that information has economic value and requires an information marketplace in which such value can be exchanged. However, this economic reality runs counter to the popular historic notion that information is free.

3. The size distribution of the Information Economy

The size distribution of Information Economy ‘enterprises’ ONS describes a business enterprise as ‘the smallest combination of legal units (generally based on VAT and/or PAYE records) which has a certain degree of autonomy within an enterprise group’. Enterprise numbers are monitored regularly, and the latest data from the IDBR show the Information Economy comprising of approximately 131,000 enterprises in 2012 - 6% of the UK total.

	Micro	Small	Medium	Large	TOTAL
ALL ENTERPRISES	89%	9%	2%	0.4%	2,149,200
Information economy:	95%	4%	1%	0.2%	131,000
IT – games publishing	86%	10%	5%	-	100
IT – other software publishing	92%	7%	1%	0.3%	1,700
Telecoms – wired	94%	4%	1%	0.5%	1,000
Telecoms – wireless	92%	6%	1%	0.6%	800
Telecoms – satellite	93%	7%	-	-	100
Telecoms – other	89%	9%	2%	0.7%	5,400
IT – programming	95%	4%	1%	0.2%	25,400
IT – consultancy	96%	3%	1%	0.1%	68,000
IT – facilities management	94%	6%	-	-	300
IT – other	93%	6%	1%	0.1%	21,300
IT – data	89%	8%	2%	0.5%	2,900
IT – web	96%	3%	1%	-	1,300
Information services – news	95%	3%	1%	0.7%	800
Information services – other	95%	5%	1%	0.0%	1,900

Source: e-skills UK analysis of ONS IDBR data

The size distribution of Information Economy (IE) enterprises appears similar to that of enterprises as a whole, with 99% classed as Small or Medium-Sized Enterprises (SMEs). Information Economy SMEs do, however, tend to be slightly smaller (in employment terms) than other SMEs, with 95% falling under the category of micro-enterprises (less than 10 employees) compared with 89% within the wider economy.

4. Confusion about What We Mean

In discussing the information is a free notion, we often create immediate confusion. First, we apply the terms public and private to information, but without clarification of their meanings. We may mean that the information itself is from public or private funding sources, e.g., tax-funded or from foundation grants or purchase orders. Or, we may refer to the physical spaces in which information is found, i.e., either a private place for which our entry requires permission or a public space in which everyone is invited, such as a public library. Or, we may wish to suggest the uses to which information is put or the means by which it is distributed, e.g., a memorandum to a private group or public dissemination on television. Finally, we may mean what the economists mean when they differentiate between public and private goods.

Whatever we mean, economic costs are associated with discovering, gathering, processing, manipulating, archiving and even using information. We invest time, which is a constant and not variable. As much as I admire the volunteers of Project Gutenberg, who are busily rendering into machine-readable form all of the great works of literature, their efforts are not free. They are spending, and I use the term advisedly, their time and skills to assemble this gift that they are putting into the global information commons.

We also spend money on the resources we need to gather, process and distribute information. Most expensive of all, we deploy humans in the form of professionals skilled in producing computer software, designing search algorithms and developing more user-friendly interfaces to the world's cornucopia of knowledge.

Intellectual property is financed in basically three ways: by patronage, procurement, and property. Patronage refers to the funding of information producers, processors or archivists within fully funded and budgeted institutions such as the Library of Congress, the U.S. Geological Survey or ARPA.

Procurement means the contracting out of information products by institutional mandate, as, for example, the purchase of product from independent contractors who provide the information services and deliver the completed product for a stated price. This methodology is used widely in economically advanced economies and intergovernmental institutions such as the Organization for Economic Cooperation and Development (OECD) and the World Bank. Such independent contractors, often telecommuting workers, are a fast-growing segment of the information economy in the private as well as the public sector.

Financing intellectual property by property rights means the undertaking of information gathering and processing by independent entrepreneurs who anticipate that they will be able to obtain compensation for their labor on an open market when their product is made available to the consuming public. Human capital must be provided with a reasonable expectation of a return on the investment of intellectual skills as well as the use of the information processing machines that support productivity. The marketplace of information depends upon informatics professionals whose financial health depends on their ability to attract customers willing to pay either from public or private coffers for their labors.

But this form of funding, unlike patronage and procurement which provide a source of income for the writer, video artist or information providers, requires legal protection of intellectual property rights for effective performance in the electronic marketplace. And as yet, we have not managed to translate our legal system for the protection of information property into a viable system for the information age.

5. Legal Tools for the Protection of Information

A genuine marketplace of information products cannot be sustained without the existence of a fairly sophisticated and mature legal system that guarantees proprietary rights to the producers and processors of information products and the providers of information services. The legal tools for protecting proprietary information are expensive and complicated. Let us look at the legal domain in three separate ways:

Looking at creativity as property;

Looking at the public domain as a form of public ownership and control, and

Viewing privacy or control over personal information as property.

Creativity as Property

Knowledgeable information professionals understand well the differences between copyright, patents, and trade secrets as legal methodologies for protecting proprietary interests in the creative work products of the mind. But not everyone is so aware of the new concepts that are creeping into legal practice in the software industry to differentiate between kinds of users. Shareware, for example, is software that is issued without charge, with the expectation that satisfied users will send in payment. Freeware, on the other hand, is issued with no strings attached and becomes a part of the public domain, available for the taking. Copyleft is a mechanism, enforced by contract or hope by Richard Stallman, that if you take his freeware issued into the public domain and enhance it or offer value-added, you may not then appropriate it to your own proprietary domain, but must re-issue it as freeware available to the world-at-large. Misappropriation is a theory of law

that lawyers turn to when all else fails to protect their clients in the expectation that judges and juries will see the merit of their arguments and award what we call equitable relief.

Public Information as Property

Information in the public domain, at least theoretically, belongs to the body politic, although there is some ambiguity as to which body politic the information belongs. If the information is truly public domain, in other words, belonging to the global commons, and not proprietary to any government or worldwide institution, then it may meet with what is called the tragedy of the commons: either it will be overused and misused, or nobody will take care of it. If the information is public but entrusted to a public institution, then there is the difficulty of dwindling public financial support.

An issue has arisen with respect to software products developed by the government. Unlike patents which can be licensed, software-generated by the U.S. government is legally prohibited from becoming private domain under the copyright act. Where will the support come for enhancing and marketing these products?

Personal Information as Property

What disturbs many people is transaction-generated data, that which is captured from purchases of merchandise or services or from telephone calls. Such data can easily be correlated in order to produce reasonably accurate information profiles of individuals. Furthermore, there seems to be little legal control over the redistribution of this information far and wide.

One of the major inadequacies of the system of intellectual property rights is that facts are not protected. Under the U.S. Supreme Court's *Feist v. Rural Telephone* decision, Justice Sandra Day O'Connor made it abundantly clear that copyright was only intended to protect original expression, not factual information. But what we really seek to protect in today's computerized marketplace is autonomy over personal data about ourselves and our purchases, travels, activities, health care. We fear a personal dossier that knows everything anyone ever wanted to know about each of us, that may be packaged and sold to others without our knowledge or permission. There is no law that prohibits most of the private sector from doing just that.

What happens with a compilation or computer database is that facts are, in effect, withdrawn from the public domain by a user who enhances the value which itself becomes marketable. Although the facts may not be appropriated, and another user is free to take the facts, what is valuable is the manner in which the facts are organized by the searching methodology deployed to make access to the facts more useful. Since the Supreme Court has ruled that facts may not become the subject of copyright protection, regardless of the amount of labor involved in collecting and organizing them, there remains some doubt concerning the number of protection databases may maintain over the content of their products. The European Community

has proposed protection of databases with a compulsory license to be available so that the new provider of the factual data may be assured of compensation for the effort. A compulsory license is a legal technique for compelling a proprietor to share information by permitting a statutory charge for the sharing.

Deploying the concept of property to personal information does not necessarily mean that each of us would be entitled to payment for the use of our names and addresses, although at least one proposition has been offered that a few cents should be deposited into our social security accounts by direct mail marketers who intend to address us. There are other mechanisms, such as barter arrangements. Oftentimes user groups or professional peers exchange valuable information on a quid pro quo basis or barter arrangement. For example, scientists share their scientific data with colleagues in order to have it vetted and verified by a peer group which later releases it to the public through scientific journals. Much of this exchange takes place over electronic networks, such as the Internet, where lurkers who are non-scientists, and, indeed, maybe journalists, download and use it before it has received the thorough review sought by those who are sharing the information among a private peer group.

One difficulty with the application of absolute property rights to personal information is that it would inhibit governments from taking the data without compensation and due process, possibly affecting the collection of the census and other important research data needed in the aggregate to supply information both for public and private decisions. However, there is no reason why we cannot develop a theory of personal choice and control over personal data that requires a fair exchange. Indeed, a law was passed this summer in the Omnibus Crime Bill requiring state motor vehicle license bureaus to provide an opportunity for those who feel vulnerable by having their names in a public registry to "opt-out," forbidding the release of their records to the public.

6. Inhibitions and Concerns in the Electronic Marketplace

With such a rich heritage of legal concepts, why do we not find it easy to transfer the legal system which we have deployed for the agricultural and industrial economies to the electronic information marketplace?

The expense of Computerization. A primary reason is that the information technologies with which we now deal require an expenditure of funds which we are often not willing to make from public resources. We turn instead to private enterprise to provide the capital investment. This is a conscious choice within a democracy, not something which has been decreed based upon malicious or wrathful Gods. We are moving more and more into an economy based upon information processing and distribution, because most of us like white-collar jobs better than we like blue-collar jobs, and nationals in other countries are willing to provide the

output of blue-collar jobs at less pay with higher quality, so that we as consumers prefer to purchase the products of their labors rather than our own.

Whether we can sustain such an economy based upon information alone, which does not also have a substantial base in agricultural or manufacturing productivity, remains to be proven. In order to sustain such an economy, it is vital to derive value from the labors required to produce income. Thus, we are seeing much more of our information sector commercialized. We can only sustain a public information sector dedicated to the support of other primary sectors if they, and not the information section, are the primary sources of our national wealth.

The Notion That Information Wants to Be Free. The information has no desire to be free, meaning unfettered or without compensation, nor does it want to be caged, meaning contained or kept secret. The information has no persona to will either freedom or incarceration. It is inanimate, subject to the will of its users and seekers, its generators, collectors, and archivists. While some data may be free, however, capturing it in machine-readable form and turning it into information which can have value usually requires at minimum human labor and often the use of expensive equipment. For example, information about geological resources is generally in the public domain (although some countries claim legal rights to prevent the taking without compensation of data concerning their natural resources). To acquire and use the information requires the expenditure of money to fund the remote sensing satellites, the highly sensitive cameras, the computers to analyze the data and the human resources to interpret it. Thus, the information becomes valuable through the human capital and equipment invested in the effort. In this way, what was public domain information may be exploited by entrepreneurs and become a valuable commodity that can be marketed in the information marketplace.

However, if such information has been generated through the investment of public funds, maybe it should be available to all for the taking. But what of public funds that come from one nation-state intended for the benefit of its citizens? Arguably, it should be available only to citizens and companies of that nation-state. Thus, one can argue that valuable information resources, to which all of the nationals of the world lay claim, should be both funded and captured by a pool of capital supplied by contributions to a central fund and then become part of the global information commons.

The inappropriateness of the Concept of Copyright. Copyright law is turned on its ears within many of the early electronic environments such as the Internet and the bulletin board systems where there has developed a presumption that what is entered is in the public domain available for downloading or retransmitting at will. This is contrary to the current presumption of the copyright law that any original expression belongs to

the utterer and needs no notice to establish the proprietary right. What is needed is a recognition within the electronic environment that counter notions prevail, and electronic notices are needed to establish at the outset into which kind of electronic domain one is entering and the circumstances under which one may establish a proprietary claim to the information entered into an electronic conference.

Electronic markers need to be devised to warn users of the rules of the electronic highway regarding downloading for personal or secondary purposes and re-distribution of information within the network itself. Further development is needed to design a system capable of tracking uses which are permitted and to bill for the commercial transaction on the network. More than 70% of the domains on the Internet are now commercial. No doubt such developments are on the drawing boards of all commercial information providers. Inaccurate Concept. Another major problem is the paradigm of copyright, whose roots are embedded in the printing press and the notion that there is an artifact which can be copied. Although the legal regime has been able to expand its horizons to cover artistic and musical works of all kinds, the aspect of a copy as the right which is to be protected stems from the notion that it is copied which are marketable.

In the computerized environment, it is access to organized information which is valuable and everything is copied. It is impossible to use a computer program without copying it into the memory of the computer. It is impossible to use an online database without copying the electronic signals onto your disk or video monitor. Thus the use of the term is an anomaly.

7. Information Acquisition

One early strand of the literature developed search models in which individuals incur costs to acquire information for private use. Stigler's (1961) model, in which agents decide ex-ante on the number of alternatives to sample, was replaced by a sequential search formulation (McCall 1970). This formulation provided sharp and lasting intuitions about individual motives for acquiring additional information given the distribution of options but was not well suited to explain how such distributions arise in the first place (Diamond 1971). This line of research eventually grew into the matching-and-bargaining and directed-search models that are now widely used in labor macroeconomics but have little direct contact with the rest of information economics.

Of course, one can almost always push intellectual origins of any field further into the past. Hayek (1945) is an important early reference in information economics. It is likely responsible for the 1-year blip in use of the phrases in 1946 visible in fig. 1. 2 Matejka and McKay (2015) show that rational inattention can also be used to provide a micro foundation for the multinomial logit model of choice often used in empirical

industrial organization.

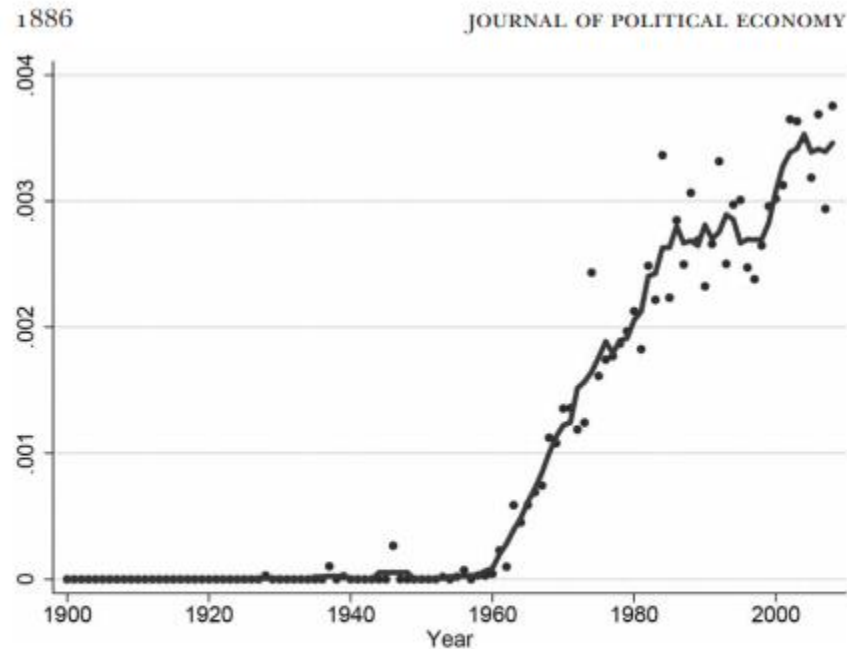


FIG. 1.—Information economics over time. Data from Google Books Ngram Viewer (Michel et al. 2011). The y-axis depicts the share of “information economics” among all 2-grams plus the share of “economics of information” among all 3-grams divided by the share of “economics” among all 1-grams (all phrases case insensitive) in books published that year. The dots indicate raw data by year while the solid line depicts a 5-year moving average.

8. Asymmetric Information

Parts of the literature that focused on indigenizing information through information acquisition tended to consider environments with limited strategic interaction. At the same time, largely separate literature on Bayesian games (with exogenously specified information) was coming of age. The early work by Harsanyi and others focused on “pure” game theory,⁵ but then in the 1970s, a series of applied theory papers—Akerlof’s (1970) market for lemons, Spence’s (1973) job signaling, and Stiglitz and coauthors’ analysis of screening (Stiglitz 1975; Rothschild and Stiglitz 1976; Stiglitz and Weiss 1981)—identified the crucial importance of asymmetric information. Remarkably, Rothschild and Stiglitz’s (1976) analysis of insurance markets opens with the sentence, “Economic theorists traditionally banish discussions of information to footnotes” (629). Yet, with hindsight, it is clear that by the mid-1970s, information economics was flourishing. While Akerlof, Spence, and Stiglitz played key roles in the “asymmetric information revolution,” related ideas were also being explored by other scholars around the same time. For example, writing in the JPE, Nelson (1970, 1974) proposed, in informal terms, a Spence-like channel through which advertising could be understood as a costly signal of a firm’s quality. Milgrom and Roberts (1986) subsequently formalized this view (and filled an important gap in Nelson’s original argument). The core

ideas about asymmetric information developed in the 1970s continue to play a key role in our analysis of health care, banking, education, and many other markets.

9. Recent Developments

The currently most active area of research in information economics is probably information design, a confluence of work on Bayes correlated equilibria (Bergemann and Morris 2013) and Bayesian persuasion (Kamenica and Gentzkow 2011). Bayes correlated equilibria take as given players' state-dependent preferences and describe the set of all possible outcomes that could arise regardless of what each player knows about the state and about what others know. Bayesian persuasion models seek to identify the best outcome from this set given some objective function.

Thus, research on information design seeks to identify the optimal informational environment (who should know what and when) taking as given the preferences of the players and some objective function over the players' actions. Information design can be seen as a parallel to mechanism design: in the latter, the designer can choose the game but has no control over the information structure, whereas in the former the designer can choose the information structure but has no control over the game (cf. Bergemann and Morris 2016; Taneva 2016). In just a few years since its inception, information design has been used to address issues in banking regulation, internet advertising, censorship, entertainment, price discrimination, traffic congestion, and so forth.⁸

In closing, it may be worthwhile to note that, over the last century, information has come to play an important role in other disciplines besides economics. In biology, we discovered that all complexity of life is encoded as information about sequences of nucleic acids. In physics, not only are informational constraints (expressed as the uncertainty principle) a central feature of quantum mechanics, a provocative "it from bit" doctrine proposes that "all things physical are information-theoretic in origin" (Wheeler 1990, 311). Perhaps in some distant future, information-theoretic approaches may reveal structures shared by biological, physical, and economic systems.

10. Conclusion

The importance and value of information within economics are huge. It eliminates risk and uncertainty, and it makes it possible to make better choices that will report higher yields. The less risk and uncertainty there is, the higher the utility will be valued.

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