The Web Economy:
Goods, Users, Models, 
and Policies
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The Web Economy: Goods, Users, Models, and Policies

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“It is the journey, not the destination.”

Homer

Abstract

The web has evolved from a piece of software code into an interdependent techno-social system of multi-purpose functionalities. From an interlinked bulletin board with low levels of interaction, a system of multiple interlocking contexts has developed which is now responsible for a substantial share of our financial transactions. Users not only post and link digital content, but also communicate, work, advertise, and exchange information. Multi-fold social and economic interactions result in a dynamic compound of moral values and code. Web Science constitutes a systematic effort to investigate the salient features and implications of this compound by studying the web as a self-standing techno-social artifact. The economic aspects of the web are fundamental but still unexplored in this agenda. The scope of this survey article is twofold: (a) to analyze how the web economy differs from traditional
settings and what the implications of these differences are and (b) to formalize a minimal common understanding on the subject of incentives and mechanisms in the web economy. Accordingly, the concept of web goods, a classification of web users and the main functions of the web economy are introduced. This effort is not, by any means, a thorough review of the economic literature related to the web. The focus is on the web as a standalone economic artifact with its own functionality and processes. Our approach is to study goods, users, models, and policies within the web perspective, hopefully contributing to the initiation of Web Economics as a field which investigates the economic motives and implications of the web. In particular, we look at how we can achieve the right balance between open access to online information while also providing proper incentives, producing content, and developing network infrastructure. Moreover, we examine how we can accelerate development by facilitating life-critical functions, transparency, and participation.

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*Web Science Subject Categorization System [171], http://webscience.org/2010/wssc.html

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Glossary

Information Goods

In economics and law, information good is generally defined as a commodity that derives its main market value from the information it contains (e.g., books). First, telecommunication technologies (e.g., radio) and later digitization enabled the detachment of information goods from the medium of transfer. This change had tremendous effects on the production, exchange, and consumption of information that could not be fully captured by the traditional conceptualizations. In 1999, Shapiro and Varian [149] redefined information goods as anything that can be digitized (a book, a movie, a record). These potentially digital information goods may be copied, shared, resold, or rented in order to provide revenues.

Digital Goods

Quah [128] organized digital goods as sequences of 0s and 1s that have economic value. They are distinguished from traditional goods by five characteristics: nonrivalry, infinite expansibility, discreteness, aspatiality (weightlessness or spacelessness), and recombination.
Network Goods

Pure network goods are defined to be goods that derive their entire value from network externalities. Pure network goods have no value in a network of zero size (e.g., telephony, Internet, the web).

Externalities

Externalities in economic theory are defined as the indirect effects of consumption (i.e., demand side) or production (i.e., supply side) activity. These are effects on agents other than the originator of such activity, which do not work through the price system. If this indirect effect (or transaction spillover) is beneficial to the other agents it is called a positive externality and in the opposite case of a cost it is called a negative externality. For example, the addition and interconnection of new information on the web may result in positive externalities if it is educational or joyful, or may cause negative externalities if it is privacy threatening or libelous.

Network Externalities

Network externalities in economic analysis are defined as the externalities involved in network goods.

Network Effects

Network effects are participants in the market that internalize network externalities. Usually, in the presence of network effects, a user takes into account only her own utility in her decision to join or not join the network. Consequently, the extra utility he provides to all other users is overlooked in his decision. Network effects can be elaborated in four main categories: direct, indirect, two-sided, and learning network effects.

URI — Uniform Resource Identifier

URI[2] is a short string that identifies resources on the web. These can be documents, images, downloadable files, services, electronic mailboxes,

and other resources. It makes resources available under a variety of
naming schemes and access methods such as HTTP, FTP, and Internet
mail addresses in the same simple way. They reduce the tedium of “log
on to this server, and then issue this magic command” down to a single
click. Every URI is owned by a physical or a legal entity that has the
right to sell it or to provide access for any other entity it wishes (refer
to [63] for a detailed discussion of identity and references on the web).
URI is the specific part of digital information contained in a web-being
that identifies exclusively and enables direct linking and transfer to
other web-beings. URI identifies strictly one web good. It is the most
profound and stable technology to create communication channels on
the web. It requires the minimal description of invariant elements in
communication through the web and acts like a fingerprint of the web-
being because it is directly connected to a person’s existence (birth,
access, navigate, edits, and death). Each web good has one generic
URI, but can be identified through many other URIs. URI is the bor-
derline{derline} and the interlocutor of web goods. It enables “teleportation”
of navigators (i.e., direct access), as well as automatic exportation and
importation of content from other web goods.

Web Goods (WGs)

Web goods are defined as sequences of binary digits that (a) are iden-
tified and communicated by an exclusively assigned URI and (b) affect
the utility or the payoff of an individual in the economy. Their market
value stems from the digital information they are composed of and a
specific part of it, the hyperlinks, which connect resources and facilitate
navigation and editing over a network of web goods with minimal costs.
Pure WGs include goods that are basically exchanged and consumed
on the web and are not tightly connected to an ordinary good or a
service (pre-) existing in the physical world. For instance, a blog entry
that comments on the market of used cars is a pure WG but a car sales
advertisement is not. According to a production incentives-based cate-
gorization, WGs are categorized as commercial (e.g., sponsored search
results) and non-commercial (e.g., Wikipedia entries). Based on their
excludability, WGs could be divided into public (e.g., Open Data) and
private (e.g., subscription to the online version of a magazine). A WG
is considered to be public if it is non-excludable. WGs can be made excludable, and in that case become purely private goods through the institutional setting of provision. Private WGs are excludable because of a financial fee (e.g., subscription paid for a web service), a personal data fee (e.g., submit email address), or a social fee (e.g., Facebook friendship).

**Web Users**

The distinction of users is based on the motivations and economic impact of their actions in the web ecosystem. First, users are partitioned to navigators and editors of WGs. Navigators consume information by navigating the web. Editors produce WGs by creating, updating or deleting online content and links on the web network. Editors are categorized as amateur and professional based on their production incentives. In contrast to amateur editors (e.g., Wikipedia editors), professional editors are profit maximizers and take into account direct financial compensations in producing WGs (e.g., a blog with paid advertisements). The service pluralism of Web 2.0 calls for a function-based distinction among editors that is economically relevant. Editors, on the basis of their aggregation capability, can be further divided into the categories simple and aggregators. Aggregators are characterized by their automated mechanisms for selecting and presenting WGs and are further divided into search engines, platforms, and reconstructors. Their function is more focused on creating content-based WGs than on filtering and linking existing WGs.

**Net Neutrality**

The provision of Internet services is considered to be neutral if Internet users pay ISP(s) only for the right to access the network at their end (one-sided pricing). In contrast, the access is characterized as non-neutral if editors and developers of Internet applications should also pay ISP(s) for the “right” to reach navigators and other Internet users (two-sided pricing). The question is which of the two pricing policies maximizes the social welfare.
1

Introduction

1.1 The Web in Short

The web initially emerged as an answer to the rapidly increasing quantity of accumulated knowledge in the 20th century, which has been caused mainly by scientific progress and digitization technology. Human memory and processing power are extended through the storage and interconnection of online content. The web limited the time for an innovation to become mainstream technology. It took 38 years for telephone technology to reach the threshold of 50 million users, while television needed 13 years, Internet 4 years, iPod 3 years, and Facebook just 2 years. The web became the new “promised land” for quick fortunes and unlimited business growth in the late 1990s because of browsers and search engines that enabled user-friendly navigation. Overwhelming expectations and excessive enthusiasm drove the economy of 2001 to a noisy burst of the 5 trillion dollars dot-com bubble.

In the mid-2000s, the web enabled mass participation and was reborn from the ashes of the dot-com bubble. After this lesson, the new business models were updated in order to include advertising revenue from web navigation and provision of value added services. At this moment, the web economy is bigger and more robust with new services
ranging from search to social networking, virtual entertainment, and giant multi-stores. On the side of demand, most of the population in the western world is involved on the web economy. While Silicon Valley is, at the time of writing, focused on the Initial Public Offerings of the leading social networks, President Sarkozy introduces the e-G8 summit and includes the web in the agenda of the traditional summit. The web strengthens its development by empowering people in life-critical functions and enabling participation and transparency. It has been transformed into a battlefield of winner-takes-all fights among titanic firms affecting not only business but also consumer choice globally. Public and personal info spheres and their interplay are reinvented under new privacy, trust, and security laws, ethics, and practices. In this new web ecosystem, researchers and governments are asked to create new policy mixtures that will balance market power with personal and social development.

1.2 Web and Economic Research

The emergence of the Internet, and later the web, has had an important influence on the research agenda of Economics and Business literature. The massive participation of users in a variety of social and economic functions created a new terrain of field experiments and analysis concerning consumer behavior, market structure, and policy implications. New forms of economic data (e.g., co-purchase networks, real time linked data from Eurostat, etc.) have given the researchers the ability to conduct new or existing investigations that are less expensive. For example, the estimation of demand for thousands of different products is now feasible with only a few weeks of time-series data from web mass merchants [33].

The available data for research are however just a tiny fraction of the collected data from search engines, mass merchants, social networks and others on the web. In contrast to physical and life sciences, where massive amounts of open data revolutionized fields like biology and physics, this does not happen for economic and social research [92]. The exclusive exploitation of behavioral data on the web is an issue of primary importance with scientific, economic and social
aspects. First, it limits academic research to the inside of companies and government agencies, excluding open scientific research and dialogue. Secondly, companies that hold data and afford to analyze them have built comparative advantages to (potential) competitors or they have simply been selling them with a high profit. Finally, privacy and security risks (e.g., personal data leaks, almost full profiling practices) create negative externalities, on both a personal and a social level, which are not compensated. It is possible that the exclusive and limited data exploitation will become, if it has not already happened, the major source of negative externalities in the online world.

The economic analysis of the Internet and the web economy follows, with a small time lag, technological improvements and mass phenomena. It also includes the study of new products, services, business processes, market structures and macroeconomic issues such as taxation theory, labor economics, regulatory economics, public goods, and development. The first important issue has been related to the optimal pricing of Internet traffic [102]. The lack of agreement on access pricing was leading in inefficient allocation of limited resources at that time (i.e., bandwidth) [105]. The web as a universal platform for representing and communicating information in digital form has initiated the microeconomic analysis of information, network, and digital goods including pricing, bundling, sharing, versioning, switching costs, network externalities and standards, economies of scale and scope, and antitrust regulations.

1.3 The Web Science Perspective

The enormous impact, scale and dynamism of the web in time and space exceed our abilities to observe and measure its evolution process. The complex interplay of social and technological entities occurring simultaneously in the micro and macro level calls for a huge and systematic research effort in order to understand it, model its stylized facts, and engineer its future uses in more prosperous ways. Apart from Economics, web-related studies can be found in many other disciplines such as Computer and Information Science, Mathematics, and Social and Law Studies.
The common characteristic of these studies is the lack of focus on the web as a techno-social and standalone artifact. Usually, they refer to conventional questions and apply existing methodologies in their field. But the web changes some of the underlying assumptions of the human society. It is a powerful social machine [71] that partially depreciates cost and removes institutional barriers. As a result of this, the practical potential to exploit the inputs and outputs of the information economy is increased. The economic paradigm is enriched since peer production emerges as the third mode of production, governance, and property. Thus, it is important to select the fundamental issues, and to set new priorities, to organize and expand the efforts of web study.

The trans-disciplinary field in this area has been titled Web Science. Web Science considers the web as its primary object of study. It is focused on the significant reciprocal relationship among the social interactions enabled by the web’s design, the scalable and open applications development mandated to support them, and the architectural and data requirements of these large-scale applications [71]. One of the major questions in Web Science is: what changes need to be incorporated in the web ecosystem to best serve humanity? Practically every discipline is focusing its research efforts on the most important issues during specific periods of time. Nowadays, economists put their efforts in discovering new ways for estimating systemic risk because of the severe financial crisis [172] while biologists try to find new personalized cures to diseases after encoding DNA and so forth. Concerning the web ecosystem, scholars are faced with two major research challenges:

1. To obtain the right balance between open access and processing of online information, on the one hand, and, on the other hand, providing the proper incentives to produce content and to develop network infrastructure.

2. To accelerate socio-economic development by facilitating life-critical functions in the developing world, and by enabling the publication, interlink and re-use of valuable datasets and services in the developed world.

Issue related to Web Economics and Business are indexed under the Web Society (E) category of the Web Science Subject Categorization
1.4 Studying Goods, Users, Models and Policies on the Web Ecosystem

In the first 20 years of its existence, the web has had a fundamental and transformative impact on all facets of our society. While the Internet was introduced twenty years earlier, the web has been its most successful application with more than 2 billion users worldwide accessing some trillion web pages. Searching, social networking, video broadcasting, photo sharing, blogging and micro-blogging have become part of everyday life whilst the majority of software and business applications have migrated to the web. In this survey, the term web ecosystem, or simply web, is used to describe three interconnected parts: (1) Internet infrastructure, (2) web technologies and online content, and (3) users. Users navigate, create and edit existing content on the web, i.e., the web goods. Web goods are networked information goods in digital form built by web technologies.

The web has been initiated as a software program of interlinked hypertext documents that are accessible through the Internet. Using a browser, users access web pages that may contain text, images, videos, or other multimedia and navigate among them using hyperlinks. The web constitutes an information space in which the items of interest, referred to as resources, are marked up by a set of rules (i.e., HTML\textsuperscript{1}), identified by global identifiers (URI\textsuperscript{2}), and transferred by communication protocol (HTTP\textsuperscript{3}). The web has become the most successful and popular piece of software in history because it is based on a technical architecture, which is simple, free or inexpensive, networked, based on open standards, extendable, tolerant to errors, universal (regardless of the hardware and software platform, application software, network

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\textsuperscript{1}HyperText Markup Language.  
\textsuperscript{2}Uniform Resource Identifier.  
\textsuperscript{3}HyperText Transfer Protocol.
Introduction

access, public, group, or personal scope, language and culture operating system and ability), powerful, and enjoyable.

This survey analyzes the economic aspect of the web ecosystem. The goal is to understand how the web economy differs from the traditional setting and what implications these differences have. Secondly, we establish a minimal common understanding about the incentives and properties of users and goods on the web. This survey is not, by any means, a thorough review of the economic literature related to the web. The primary focus is on its relevant part that models the web as a standalone economic artifact with native functionality and processes. This study is composed of nine parts. After the current introduction, the second part is devoted to understand the properties of goods on the web. Analysis is established upon the tradition of economic analysis of information, knowledge, and digital and network goods to introduce a new type of goods, the web goods. Web goods are defined as sequences of binary digits, identified by their exclusively assigned URI. They affect the utility of or the payoff to at least one individual. Their market value stems from the digital information they are composed of and a specific part of it, the hyperlinks, which link resources and facilitate navigation across a network of web goods. Our analysis includes the consideration of web goods as commodities, and search and experience goods.

The third part refers to the users of the web network. In the Web 2.0 Era, users are the protagonists of the cyberspace because they can easily edit, interconnect, aggregate, and comment on online content as never before. In this part, a simple and comprehensive categorization of web users is provided in order to facilitate the comparative analysis of existing literature in economics of the web. The distinction of users is based on the motivations and also on the economic impact of their actions on the web ecosystem. Web users are discriminated to navigators and editors of web goods. Navigators consume information by navigating the web. Editors produce web goods by updating online content and are classified as amateur and professional based on their motivation. In the last section of the third part, we identify the core function of the web economy. In short, navigators explore the web to acquire utility by consuming web goods. This navigation creates traffic streams for editors. Amateur editors are concerned to attract traffic
1.4 Studying Goods, Users, Models and Policies on the Web Ecosystem

for their content, even if they do not actually own it (e.g., personal profile page on Facebook). In contrast, professional editors, who own or/and administer web goods, can transform some parts of this traffic into income through selling it to third parties, advertising, or directing sales of both physical and web goods. The resulting income acts as an incentive for editors to update the already existing web goods and create new ones, producing the new web network with novel possibilities for navigators so as to maximize their utility. Finally, the aforementioned functions are integrated into a more general framework of four interconnected networks, namely: users, topics, queries, and the web.

The fourth part analyzes the characteristics of production and consumption on the web. What the web primarily contributes to the economy is a new source of increasing returns which arise from the provision of more choices with less transaction costs in production and consumption. More choices in consumption range from a larger variety in available goods to online consumer reviews and ratings. Despite the fact that more energetic and connected consumption on the web helps consumers to make better decisions, they are often forced to consume both information and contextual advertisements. Attention, as approximated by the logged traffic, is the currency of the web that gives both amateur and professional editors the incentive to update and develop the web network. Moreover, attention has become a primary part of the value chain in the web economy because it can be more efficiently contextualized. The emergence of energetic and connected consumption blurs the borders between production–consumption and reintroduces the concept of prosumption. The fifth part is devoted to the production side. In the Web Era, many business operations have been virtualized, gone online, and became less hierarchical. Also, niche online markets and services have emerged, and traditional industries have been revolutionized. Peer production communities are based on information sharing mechanisms concerning inputs and outputs, which create public knowledge repositories to store the community’s aggregated preferences and expectations. Peer production as a new form of decentralized intercreativity outside the traditional market redefines two economic orthodoxies: diminishing marginal productivity and increasing returns to scale. We also discuss how digital and web technologies

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drive the demassification of the media by lowering the access barriers to the production, distribution, and consumption of online information. Moreover, apart from private and public, peer production arrives as the third mechanism in production, governance, and property.

The sixth part presents four representative models of the web economy. Despite the fact that there are many research efforts that address web-related issues, these models analyze the web as a standalone economic artifact. The primary object of study focuses on the basic economic functions of the web and the implications for consumer preferences, firms’ choices on the web, and social welfare. Since these studies originate from diverse research communities and use different systems of symbols and definitions, we analyze them based on the common understanding for web goods, users and core functions of the web economy that will be discussed in the second and third parts.

First, the Stegeman model provides an initial step of understanding the transition from mass to network media. It concludes that firms could widen total surplus by increasing quality, supplying less advertising and reducing access fees. The welfare results are mostly robust in the presence of small to moderate negative externalities from advertising. Second, the Kouroupas–Koutsoupias–Papadimitriou–Sideri model (KKPS) is the next attempt to account for the basic economic functions on the web by specifying the interplay of three out of four main factors (user-queries, topics, and web) of the web function. The KKPS model focuses on understanding how the interaction of users with search engines leads to a hierarchical power structure of law of the web. Third, the Katona–Sarvary model extends Stegeman’s analysis of content exchange between producers and consumers, to hyperlinks exchange among different producers. It focuses on the commercial web, where advertising is used to increase traffic and revenues. The goal is not to inform or signal quality but to increase brand loyalty. The analysis of hyperlink incentives provides guidance to marketing managers on how to specialize their business models on the web. In particular, competition in the commercial web creates motivation for content producers in order to specialize in specific topics. The pattern of out-links is different for both advertising and reference links. Fourth, the Dellarocas–Katona–Rand model is the first to account for the economic
implications of free reference hyperlinks placement to content nodes. They have found that (a) linking can sustain market entry of inefficient players, (b) the main benefit of aggregators to content producers comes from traffic expansion, and (c) the presence of aggregators incurs social costs that must not be overlooked.

The seventh part describes market regulation and antitrust issues in the web economy. In particular, we examine the basic antitrust issues raised by the “information gatekeepers” of the web (i.e., search engines) and the “infrastructure gatekeepers” of the Internet (i.e., ISPs). With respect to the first issue, Pollock argues that the search engine market is characterized by two stylized facts: (a) a cost structure, which involves high fixed costs and low marginal costs and (b) pure quality competition for users that is likely to feature very high levels of concentration and underprovision of quality by a single dominant firm. He demonstrates that since the market mechanism cannot provide socially optimal quality levels, there is space for regulatory engagement. Regulatory policies on the other hand, may involve the funding of basic R&D in web search, or even more drastic measures like the division of SEs into two separate parts: software and service. With regard to the second concern about infrastructure gatekeepers, the net neutrality debate is briefly presented. Economic arguments from both sides of the opposition are paired with the engineering perspective of providing neutral access under effective QoS.

The eighth part raises the issue of web-based development. The role of ICTs is discussed in relation to social inequality, and major development drivers are highlighted in the context of networked economy. It is argued that the one-dimensional direct connection of ICTs with social inequalities should be now replaced by the more relevant question “what changes are required to be incorporated in the web ecosystem so as to serve humanity in the best way?” The first step in answering related questions should be the identification of connections among the web functions and economic development. Existing theories about the role of ICTs in social inequality are reviewed. The second step in understanding the web’s developmental potential is to consider a

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4 Quality of service.
Introduction

minimal framework of relevant policies. The third step is to identify some representative initiatives. In this direction, we describe two different types of projects concerning web-based development with different tasks. The Web in Society program was initiated by the Web Foundation to enable content sharing about life-critical functions through mobile phones in developing countries. In developed countries, however, the primary focus in content sharing is to unleash the economic potential of Open Government Data. In conclusion, the final part discusses issues for further research in the web economy.
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