Telecommunications Policy 39 (2015) 14–37

Contents lists available at ScienceDirect

Telecommunications Policy

URL: www.elsevier.com/locate/telpol

Assessment of the gap and (non-)Internet users evolution based on population biology dynamics

Ioannis Neokosmidis [a,b,*], Nikolaos Avaritsiotis [b,1], Zoe Ventoura [c,2], Dimitris Varoutas [b,3]

[a] INCITES Consulting SARL, 130, Route d' Arlon, L-8008, Strassen, Luxembourg
[b] Department of Informatics and Telecommunications, University of Athens, Panepistimiopolis, Ilisia, GR 157-84 Athens, Greece
[c] Department of Business Administration, Athens University of Economics and Business, 77 Patission Street, 10434 Athens, Greece

ARTICLE INFO

Available online 17 December 2014

Keywords:
Artificial bee colony
Divide
Ecological evolution
Forecasting
Internet
Policy
Population dynamics
Swarm optimization
Users

ABSTRACT

The evolution of Internet and non-Internet users as well as the dynamics of their divide is studied using population biology concepts. Users' evolution and future trends are estimated by applying Lotka–Volterra model. The parameters of the proposed model are determined by both an analytical and a simulation method. The presented model is applied to two cases; Greece and Lithuania. The accuracy of the obtained results is confirmed through actual data. Internet users are constantly increasing while they outperform non-users in the last years. It is confirmed that the maximum growth rate of Internet users in both countries coincides to periods with effective regulation, broadband promotion, provision of bundle products and alternative operators' investments. Model's estimation and forecasting ability can be used as a valuable tool for decision and policy makers. Several policy guidelines are provided helping to achieve higher penetration levels.

1. Introduction

In the last decades, ICT technologies and especially Internet[4] have experienced an unrivaled evolution. Advanced applications such as e-commerce, teleconference, e-learning, telemedicine, video on demand and online gaming were implemented facilitating and improving human lives. The significant growth of Internet in terms of traffic volumes and users can be mainly attributed to the progress occurred in the field of computers and networks. Faster systems with increased memory have been designed and implemented allowing the production and processing of high amounts of information. At the same time broadband networks with high capacity have been adopted as a means to accommodate the increased traffic.

* Corresponding author. Tel.: +30 2107275184; fax: +30 2107275214.
E-mail addresses: i.neokosmidis@incites.eu, i.neokosmidis@di.uoa.gr (I. Neokosmidis), nickava@di.uoa.gr (N. Avaritsiotis), ventura@aueb.gr (Z. Ventoura), D.Varoutas@di.uoa.gr (D. Varoutas).
[1] Tel.: +30 210 7275184, fax: +30 2107275214.
[2] Tel.: +30 210 8226205.
[3] Tel.: +30 210 7275318; fax: +30 2107275214.
[4] A global computer network providing a variety of information and communication facilities, consisting of interconnected networks using standardized communication protocols.

http://dx.doi.org/10.1016/j.telpol.2014.10.006
0308-5961/

The extreme evolution of Internet can be described by several statistical data such as penetration rate and Internet users. It should be highlighted that the global growth rate of Internet users[5] for 1/7/2000–1/7/2013 is 556%.[6] Furthermore, the new figures show that, by the end of 2014, there will be almost 3 billion Internet users.[7] However, there are also billions of people who have never used Internet because they do not want to or they have no access to it. The low average Internet penetration rate of only 38% for the first half of 2013 is highly indicative. Furthermore, a huge divide of Internet penetration rates is noted in 2013 between developing (29.9% of the population use Internet) and developed (75.7% of the population use Internet) regions.[8]

It is a common belief that Internet and generally ICT is a major factor leading to socio-economic development (OECD, 2004). Furthermore, ICT can also play a significant role in economic growth (Jung, Na, & Yoon, 2013; Koutroumpis, 2009; Sassi & Goaied, 2013) and competition (WEF, 2009) for countries, enterprises and individuals. In detail, the use of ICT has a great impact on several fields such as trade, health and education and a power in creating new job possibilities. The creation of around one million jobs in Europe due to ICT and a broadband-related growth of economic activity of 850 billion Euros are expected between 2006 and 2015 (European Commission, 2009). On the other hand, ICT can help individuals and enterprises to remain competitive by doing things in a more efficient and effective way (European Commission, 2009).

However, inequalities of ICT investments, usage, skills and availability of infrastructures are detected affecting human development, economic growth and the creation of wealth (ITU, 2006). These inequalities are observed among both developing (Gulati & Yates, 2011) and developed (Cruz-Jesus, Oliveira, & Bacao, 2012) countries. Although diffusion keeps increasing, there are still inequalities in the rates of adoption as well as in the level of the provided digital opportunities (Mariscal, 2005).

It has then become evident that more effort should be made towards this direction. This endeavor can be exemplified by the numerous programs implemented all over the world in order to boost the use of new technologies bridging the digital divide. Taking into account the observed gap, the European Union incorporated both digital convergence and the role of ICT in socio-economical structure in its strategic plans (European Commission, 2010a). The European structural funds spent almost 5.5 billion Euros on information society programs in the period 2000–2006 (Vicente & Gil-de-Bernabé, 2010) while 1 billion Euros of extra spending for broadband investments (especially for high-speed connections in rural regions) has already been budgeted (European Commission, 2009).

In the last years, there has been an increased attention for qualitative and quantitative investigation of Internet diffusion and usage (Chinn & Fairlie, 2006). Statistical information regarding individuals who regularly use Internet (at least once a week i.e. every day or almost every day or at least once a week but not every day, on average within the last 3 months before the survey) either at home, at work or at any other place (via fixed or mobile access), hereafter called Internet users, and those who have never used Internet before (hereafter called non-Internet users) is of great importance and high interest for the government, private and public sector to academics. These data are extremely useful in determining the current status and monitoring future evolution.

Special interest has also been paid for the investigation of digital divide. As described in the following section, several studies have been conducted regarding ICT inequalities (Cruz-Jesus et al., 2012) and digital convergence (Doong & Ho, 2012). It has been shown that several factors affect digital divide while a digital gap does exist even within developed countries (e.g. among countries of the European Union).

However, the majority of previous studies are limited to (a) individually investigate Internet or non-Internet users (Modis, 2005); (b) model and forecast Internet diffusion and/or digital divide as a whole (Mariscal, 2005; Michalakelis, Christodoulos, Varoutas, & Sphicopoulos, 2012) and (c) study the factors influencing both users and divide evolution (Li & Shiu, 2012), using statistical methods while ignoring the interaction between Internet and non-Internet users. Motivated by this literature gap, the evolution of Internet and non-Internet users is studied in the present work. Using historical data, this work aims to study the competition of these populations and answer the following research questions:

- How Internet and non-Internet users evolve?
- Which are the dynamics of their interaction?
- Is there an equilibrium?
- Will non-Internet users survive competition at the equilibrium?
- Is this the “end” of Internet diffusion?

Based on the evolutionary theory of population biology and dynamics, the evolution and competitive dynamics of Internet and non-Internet users are modeled, investigated and forecasted. In detail, the proposed model is based on Lotka–Volterra model describing the competition between species (Begon, Townsend, & Harper, 2006; Murray, 2007). The results obtained by the model can be supportive to other already used techniques providing a comparison reference confirming their results.

[5] According to Internet Word Stats, “An Internet User is anyone currently in capacity to use the Internet that is having: (a) available access to an Internet connection point and (b) the basic knowledge required to use web technology”.

[6] Internet live stats. Available [http://www.internetlivestats.com/internet-users].

[7] http://www.itu.int/en/ITU-D/Statistics/Documents/facts/ICTFactsFigures2014-e.pdf.

[8] http://www.itu.int/en/ITU-D/Statistics/Documents/statistics/2014/ITU_Key_2005-2014_ICT_data.xls.