

1. Introduction

“The change from atoms to bits is irrevocable and unstoppable”
(Negroponte 1995, 4)

1.1 AIMS AND RESEARCH QUESTIONS

The main aim of this book is to study the geography of the Internet infrastructure in Europe and highlight not only the strong spatiality of the Internet, but also how it affects and is affected by real-world geography. Using Castells's (1996) “space of flows” as the main theoretical vehicle and drawing upon his seminal work, effort is spent in order to understand and explain the geography and highlight the regional economic impacts of the Internet infrastructure in Europe. The infrastructural element which is under study here is the international backbone network in Europe, aggregated at the level of the city-region. This backbone network consists of the long-haul links, which connect long-distance destinations and are responsible for the global character of the Internet (e.g. Malecki 2004). The resulting outcome is a study of the participation of the European city-regions in this global infrastructural network.

Epistemologically, this book is placed in the emerging field of Internet geography or cybergeography, which is a branch of the field of communications geography focusing on the geographical aspects of the Internet. It feeds the discussion about the relationship between geographic space – the cities and regions – and this supporting layer of the cyberspace identified as the cyberplace (Batty 1997). Using Castells's (1996) framework, this book is concerned with the first and supporting layer of the space of flows.

More specifically, this book aims to answer three research questions (RQ):

RQ1: How is the Internet infrastructure scattered across European city-regions?

RQ2: Which are the geographic and socio-economic factors that shape the distribution of the Internet infrastructure across European city-regions?

RQ3: What are the impacts that the Internet infrastructure can generate on the development of city-regions in Europe?

The first research question is a clear geographic one and aims to explore the geographic pattern of the Internet backbone linkages in Europe. As the Internet backbone is firstly a network, the topology of this network is important. However, because this study has a clear geographic starting point, what is more important is to link the topology of the Internet backbone network (IBN) with the geography of the city-regions. This difficulty is raised by the fact that the Internet and, consequently, its underpinning infrastructural layer were designed to support data communication and therefore its spatiality is mostly a hidden element, which this book aims to explore.

The second research question follows from the results of the first one and intends to explain the geography of the Internet backbone links in Europe. As will be explained later in this book, these long-haul Internet links are mostly privately developed and owned. Consequently, the location decisions behind the installation of this infrastructural layer reflect the perceptions of the telecommunications companies (known as telcos) about the demand for such facilities in order to maximize the returns of their investments (Gillespie and Robins 1989). Based on this, effort is spent in finding these socio-economic and geographic factors that explain the geography of this infrastructure in Europe and consequently the perceptions of telcos for higher demand for their networks.

The third question goes one step further and seeks to examine whether the Internet infrastructure generates economic development impacts at the regional level. As will be discussed in Chapter 3, research has been concerned with the impacts of the expansion of Internet usage in the economy through productivity growth. However, research has not yet focused on the localized economic impacts of the supporting layer of the Internet infrastructure. This book aims to research whether this infrastructure can generate such impacts and also address the issue of the direction of causality between the Internet infrastructure and regional economic development. The latter is a well-known problem in regional science and it will be extensively discussed.

In order to address the above research questions, this study draws upon three different research areas. Firstly, as mentioned above, the basis of this study is the Internet geography research field. It provides the fundamental theoretical and empirical background in order to pursue the above research questions. However, because of the importance of this infrastructural layer in the postmodern economy and society, there is a need to also employ theoretical and methodological tools from other fields to approach the current research questions.

The world city literature is the second theoretical pillar that this study is based on. Telecommunications (just like transportation) is a friction

reducing technology because of its ability to reduce the cost of distance (Cohen et al. 2002; Cohen-Blankshtain and Nijkamp 2004). Because of this attribute, the Internet and Internet infrastructure enable global interaction and facilitate global economic activity (Malecki and Wei 2009), supporting the emergence of a world cities network. This theoretical pillar will provide the necessary input in order to understand the importance of this infrastructure from a global (inter)urban perspective.

Last but not least, this book also draws upon regional science and the digital economy as it attempts to map the regional economic impacts of the Internet infrastructure. The digital economy is the main theoretical framework used here in order to explain the link between the new technological paradigm reflected in the expansion of the Internet and economic development through productivity gains. However, as will be highlighted in Chapter 2, this link mostly refers to the scale of the national economies. In order to transfer this argument to the scale of the analysis used in this study, economic geography and regional science literatures and methods are employed.

To approach the above themes, secondary data about the Internet backbone links in Europe and quantitative data analysis methods are utilized. Briefly, the main dataset used in this study contains information about the international intercity Internet backbone links and their capacity, which are present in European cities for the six-year period 2001–06 (TeleGeography 2007). In order to fully exploit the structure of the data, network analysis methods have been utilized. At a first level, the results (global statistics) of the network analysis comment on the topology of the backbone network and effort is spent in introducing a geographic perspective in this exercise. At a second level, the local-level results of the network analysis are translated to attributes for the city-regions which participate in this global network. The geographic and socio-economic factors behind the distributions of these local-level statistics are explained with the use of econometric modeling such as probit regressions and spatial interaction models. Lastly, these city-level attributes, which reflect the Internet infrastructural capital, are used in order to model the impact of the Internet infrastructure on regional economic development. For the latter econometric modeling is employed and, more specifically, panel data analysis and Granger causality tests for panel data.

1.2 RATIONALE FOR THIS STUDY

The main motivation for researching this subject is the growing importance of information and communication technologies (ICTs) in the

economy. ICTs, which include the Internet and its infrastructural networks, are the backbone of the new – digital – economy (Antonelli 2003), with processes of production, distribution and exchange increasingly reliant on them. Thus, the Internet is the most essential development as regards the distribution and exchange of information after the telephone (Moss and Townsend 2000). Shiller (1999) goes a step further by suggesting that the Internet might be the most rapidly spreading technology in human history.

From a macro perspective, it is established nowadays that the Internet and the ICTs affect the economy by improving its productivity (Atkinson and McKay 2007; Cairncross 2001). Additionally, ICTs and the Internet along with the aviation network can be said to be the supporting layer of globalization, as they are responsible for the transportation of the weightless goods and the main actors of the global economy, but also for the transportation of the ideas which underpin this global process (Taylor 2004; Graham and Marvin 2001; Rimmer 1998; Cieřlik and Kaniewska 2004). In such a global economy, a country's importance depends upon the cities located within it, the importance of which depends in turn upon the multinational firms located within these cities (McCann and Acs 2011). The function and the global extent of these firms is supported and enabled by ICTs.

However, ICTs and consequently the Internet are more than just new technology, despite the rapid pace of their expansion and the wide range of the impacts they generate. Hence, the wide adoption of these technologies appears to create a new technological paradigm (Perez 1983), which affects not only production and the economy, but society in general. Upon this element Castells built his theoretical work about the network society (Castells 1996).

In terms of geography, ICTs and the Internet are not a homogenous system equally spread around places (Gorman and Malecki 2000). From an analytical point of view, despite what average users experience as a placeless cyberspace, the latter depends on the real world's fixities, which are found on cyberspace (Kitchin 1998a, 1998b). From a more economic perspective, neither the outcomes that ICTs and the Internet generate are homogenous in space. On the contrary, it seems that ICTs can generate different impacts on different regions. And this differentiation is due not only to the different level of ICTs' infrastructural capacity, but also to the different regional capability to exploit benefits from them (Antonelli 2003).

More specifically, the backbone network is one of the most interesting elements of the Internet infrastructure from the geographical point of view as it is responsible for the Internet's global reach. From an urban

viewpoint, the structure of the backbone network can potentially provide information about the intensity of the participation of cities in the digital economy. From an analytical perspective, the geography of the backbone networks can provide insights about the determinants of these networks. From a more policy-oriented standpoint, the geography of the backbone links but also (and maybe more importantly) their capacity might have an impact on local economic activities as they can directly affect firms which are highly dependent on global Internet communications (Greenstein 2004). Hence, the Internet's performance between any two places is not dependent on the physical distance between them but mostly on the installed capacity of the backbone connections – known as bandwidth – between them (Gorman and Malecki 2000).

The last argument is fundamental for understanding the importance of the Internet in the frame of the digital economy. However, such argumentation has created misconceptions about the impacts of ICTs and the Internet on spatial structure: early commentators have expressed positions according to which these technologies will result in the “death of cities” (Gilder 1995; Drucker 1998), the “death of distance” (Cairncross 2001), the emergence of “electronic cottages” (Toffler 1980) and in general the “end of geography”. All the above rather deterministic approaches foresee the devitalization of centralizing forces and the growing dominance of centrifugal forces, which will eventually result in a decentralized spatial pattern of economic activities. However, as has been proved, the Internet is an urban phenomenon (Rutherford et al. 2004) and consequently the same applies to the IBN, which is characterized as an urban infrastructure (Moss and Townsend 2000).

The above preliminary discussion verifies the importance of ICTs and the Internet from a geography viewpoint. However, in spite of their established importance, it seems that there is still a long way to go in order to further comprehend this new technological paradigm from a geographical point of view. As will be extensively discussed in Chapter 2, ICTs have not been among the leading research subjects among geographers, planners and regional scientists, mainly due to their inherent technical complexity (Bakis 1981; Hepworth 1989; Kellerman 1993). As a result, regardless of the various theoretical geographical approaches concerning ICTs, which emerged even prior to the establishment of a digital economy, it seems that there is a scarcity of empirical studies researching the geography of ICTs. Such a study can shed light on the geographical distributions of ICTs, can explain the factors behind these (centralized) distributions, and also explain the impacts that this new technological paradigm can generate on local economies. The latter, apart from its academic importance, can provide valuable insights to the local and regional development policy agenda.

1.3 STRUCTURE OF THE BOOK

The structure of the book goes as follows: Chapter 2 provides the necessary literature background to reach the research questions. It starts with a brief technical description of the Internet. In spite of the geographical starting point of this study, it is necessary to gain an understanding of the Internet function from a technical point of view. Then, the three main theoretical pillars of this study are critically presented. First, the literature of the emerging field of Internet geography is analyzed. This is the core and the most influential part of the literature for this book. The main subject of this study, the Internet infrastructure, is defined here. Then, the world cities literature is analyzed and the importance of ICTs is highlighted. Thirdly, a theoretical framework is built in order to comprehend potential regional economic impacts of the Internet infrastructure.

Chapter 3 is dedicated in analyzing the data and methods used for this study. As mentioned above, in order to approach the research questions, secondary data about the IBN and quantitative methods have been employed. The rationale of choosing the specific methods is illustrated here as well as the main methodological points. This chapter ends with this book's research framework, where all the research questions, methods, data sources and theoretical pillars are schematically presented together.

The empirical research takes place in the next four chapters (4–7). Chapter 4 presents a descriptive network analysis and it is the chapter where the fundamental analysis of the IBN takes place. The network topology is built and both global and local statistics are calculated. This chapter concludes with some initial results from the exploratory analysis both for the global level of the whole network and for the local level of city-region attributes.

Chapter 5 uses the complex network analysis to perform a structural comparison between the Internet backbone and the aviation network in Europe. As will be highlighted in Chapter 2, the first layer of the space of flows is formed by these two infrastructural networks. The comparison takes place both at the global level of the whole network structure but also – and probably more interesting from a geographic point of view – at the level of city attributes. The latter indicates the different roles that different cities perform in these two networks.

Chapter 6 is dedicated to the explanatory analysis of the IBN. Econometric modeling, such as probit and spatial interaction models, are introduced in order to explain the geographic and socio-economic factors behind the spatial distribution of this infrastructure. The chapter concludes with a set of significant predictors of regional connectedness and installed backbone capacity.

Chapter 7 is the final empirical chapter of this book and focuses on identifying the regional economic impacts that the Internet infrastructure can generate. The analysis explores the direction of causality between the Internet infrastructure and economic development with the use of Granger causality tests.

This book concludes by providing the empirical answers to the research questions stated in this first chapter. Additionally, in this last chapter the further contributions of this research to the relevant literature are highlighted. Drawing on the empirical results some policy recommendations are also stated in order to promote the inclusion of Internet infrastructure in the local and regional policy agenda.