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The diffusion of the Internet: A cross-country analysis

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ABSTRACT

This paper analyzes the process of Internet diffusion across the world using a panel of 214 countries during the period 1990–2004. Countries are classified as low- or high-income and it is shown that the diffusion process is characterized by a different S-shaped curve in each group. The estimated diffusion curves provide evidence of very slow "catching up". The paper also explores the determinants of Internet diffusion and shows that network effects are crucial to explain this process. One important finding is that the degree of competition in the provision of the Internet contributes positively to its diffusion.

1. Introduction

The process of technological adoption and diffusion has been extensively studied in the literature.[1] A casual look at data on the diffusion of different technologies reveals that, at a given point in time, there are significant differences in the degree of diffusion or adoption across countries.[2] This paper studies these differences for one technology in particular: the Internet. Understanding the process of Internet adoption and diffusion as well as the main determinants of cross-country differences in this process seems to be of particular interest since, as it has long been acknowledged, the Internet is a key tool of economic development (Kenny, 2003; Röller & Waverman, 2001; Sánchez-Robles, 1998).

Fig. 1 illustrates the significant disparity in Internet diffusion in five countries during the period 1990–2004. Although the number of Internet users per capita was very low in the United States in 1990 (0.8%), the use of this technology increased to 22% in 1997, and jumped to 63% by 2004. France had a low adoption rate for most of the time interval covered here, but this rate grew very rapidly, especially after the year 2000, reaching 39% in the year 2004. These accelerations were clearly not observed in the three other countries of Fig. 1. Brazil had a modest rate of 12% by the end of the period. In China, although Internet use grew very rapidly—from a level of 0.03% in 1997 to 7.2% in 2004, the penetration rate was still remarkably low in that year. Finally, Internet adoption in Tanzania was virtually zero in 1997 and it increased to only 0.9% by 2004. The observed difference in the levels of Internet adoption across countries raises important policy questions.

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[1] See for instance Keller (2001), Comín and Hobijn (2004), Caselli and Coleman (2001), Comín et al. (2006), Barro and Sala-i-Martin (1997), and Jovanovic and Lach (1989).

[2] Chinn and Fairlie (2007) show that, in the year 1993, many developing countries had computer and Internet penetration rates that were 1/100th of the rates found in North American and Europe.

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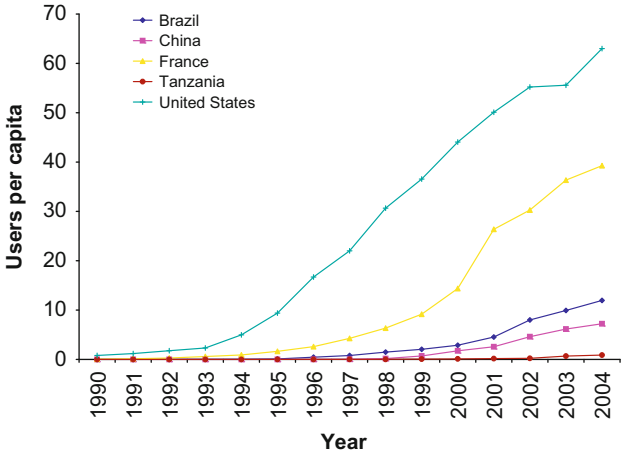

Fig. 1. Internet diffusion in different countries.

Of particular interest to policymakers in developing countries is the need to understand the process of diffusion in order to anticipate if their countries will eventually catch up and close the digital divide and, more generally, to implement the right policies to increase the speed of Internet adoption.

This paper makes use of a comprehensive dataset to study the process of Internet diffusion in a large set of countries for the period 1990–2004. The analysis includes both developed and developing countries and provides separate results for distinct income levels. The paper is broken down to two parts. The first confirms previous studies by showing that the process of Internet diffusion across the world is well described by an S-shape pattern. An important advantage of the dataset used in this exercise that distinguishes it from many previous papers is that it includes data for the initial years in which Internet was adopted and hence it facilitates the estimation of a complete S-shape curve. These curves are estimated for different groups of countries and it is found that low-income countries have a much steeper adoption profile and their curve lies to the right of that of high-income countries. This finding provides support to the hypothesis that Internet adoption follows a leader–follower model whereby low-income countries, as followers, have lower adoption costs.[3]

The second part of the paper identifies variables that explain the differences in cross-country patterns of Internet diffusion. The most innovative finding is the presence of significant network effects in Internet diffusion: the number of Internet users (in a given country) in the previous year is a powerful determinant of the number of Internet users in the current year. The presence of network effects as a determinant of Internet adoption has been largely ignored in existing literature[4]—a striking fact considering that the utility derived from Internet consumption is clearly affected by the number of people using it (Shy, 2001). In addition, this paper studies one determinant that has not been much explored in the literature: the competition in the market for the provision of Internet services. Controlling for different relevant variables, the results suggest that in countries where there is more competition in the distribution of Internet, the number of users increases more rapidly.

The remainder of this paper is organized as follows. Section 2 briefly summarizes the existing literature on technology diffusion and, in particular, on Internet diffusion. Section 3 describes the main dataset used throughout the paper. The empirical estimation of Internet diffusion curves is presented in Section 4. Section 5 explores the determinants of Internet diffusion across countries. Finally, Section 6 offers concluding remarks.

2. Related literature

There exists a vast literature exploring the process of technology diffusion across countries. Since the emphasis of the present paper is empirical, the following summary will omit most of the theoretical analysis.[5]

The majority of the empirical papers on technological diffusion focus on identifying variables that can explain some features of the diffusion process of different technologies. For instance, Gort and Klepper (1982) trace the history of diffusion for 46 new products and correlate it with several economic indicators. Caselli and Coleman (2001) analyze the case of personal computer adoption and provide a comprehensive cross-country analysis that attempts to identify its main

[3] This hypothesis is developed in Chong and Micco (2003).

[4] Estache et al. (2002) is an exception as these authors include a lagged variable of Internet users but find it not significant as a determinant of Internet adoption.

[5] A summary of the theoretical literature can be found in Keller (2001). His review argues that "technology" has been mostly modeled as "technological knowledge". The main theories belong to two groups. The first one (endogenous technological change) views technological change as the outcome of intentional private actions (Aghion & Howitt, 1992; Grossman & Helpman, 1991; Romer, 1990; Segerstrom, Anant, & Dinopoulos, 1990). The other group of theories models technological change as a pool of available resources to the entire world (Mankiw, 1995; Parente & Prescott, 2000).