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Diffusion of digital mobile telephony: Are developing countries different?

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Abstract

Factors determining the diffusion of digital mobile telephony across developed and developing countries are studied with the aid of a Gompertz model. After controlling for other factors, the speed of diffusion *per se* is not significantly different between the two groups of countries. Standards competition hinders and market competition promotes diffusion in both groups. Various factors are, however, more important in a developing country context: having a large potential user base, accumulating network effects, being open, commanding a high (non-telecom) technological level, and introducing innovation(s) complementing mobile telephony. Late entrants experience faster diffusion promoting cross-country convergence.

JEL Classification: L96; O30; O10

Keywords: Mobile telephony; Technology diffusion; Gompertz model; Developing countries

1. Introduction

In recent decades wireline (fixed) telephony has increasingly been complemented and also replaced by wireless (mobile), which currently dominates in terms of worldwide usage (ITU, 2002a, b). It should be pointed out that while the role of the Internet in economic development has been emphasized (see, e.g., Clarke & Wallsten, 2004; Kenny, 2003; Lucas & Sylla, 2003; Petrazzini, 1999; Qureshi, 2003), mobile telephony—with well over twice as many users worldwide – also holds considerable potential in this respect.

This paper addresses some deficiencies in the previous literature in studying the socio-economic factors driving the diffusion of digital mobile telephony. The possible differences between developed and developing countries with respect to these factors are of particular interest.

In both fixed and mobile telephony analog technologies have been replaced by digital ones. Indeed, the worldwide breakthrough of mobile telephony is associated with the commercial introduction of digital technologies in the early 1990s. Among the developed countries the average penetration rate (users per population) of analog mobile telephony peaked at less than five per cent in the mid-1990s, whereas the

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penetration of digital mobile telephony is currently some fifty per cent. The corresponding penetration rates among the developing countries are some ten times lower. Although the switch from analog to digital mobile telephony has also been somewhat slower among developing countries, the diffusion patterns *per se* seem to be more similar in the case of digital mobile telephony.

There are many reasons for the success of digital mobile telephony. First, by economizing on the use of the limited radio spectrum, digitalization made the current levels of mobile telephony usage technically possible. Secondly, combined with other industry developments, digital mobile telephony offered end users a more attractive bundle in terms of price, quality, and services. In many countries competition was first introduced in digital mobile telephony with direct consequences for user cost: since the basic 2G offering was fairly standard (a voice call of reasonable quality), this naturally lead to a price competition among two or more operators.

Further, Digital mobile telephony had advanced data transmission (short messaging service etc.) and improved voice quality. In part thanks to the lower power consumption of digital mobile telephony, smaller and lighter end-user terminals (handsets) became available. Thirdly, with the expanding user base, network effects and economies of scale in both production and use rapidly accumulated. In short, with digitalization mobile telephony truly became a worldwide consumer market.

Dekimpe, Parker, and Sarvary (1998), Ahn and Lee (1999), Burki and Aslam (2000), Gruber (2001), Gruber and Verboven (2001a, b), Liikanen, Stoneman, and Toivanen (2001), Koski and Kretschmer (2002), and Madden, Coble-Neal, and Dalzell (2004) are among the studies modeling cross-country mobile telephony diffusion. Some aspects of these studies are summarized in Table 1.

Several things are noteworthy in Table 1. First, with the exception of Dekimpe et al. (1998), and Gruber and Verboven (2001a, b), the number of countries included in the analyses are relatively low, and none of the studies explicitly focus on comparing developed and developing countries. Secondly, with the possible exceptions of Liikanen et al. (2001), and Koski and Kretschmer (2002), the sets of (non-telecom) socio-economic explanatory variables remain rather modest, and only GDP per capita and a population measure are shared across studies. Thirdly, again with the exceptions of Liikanen et al. (2001), and Koski and Kretschmer (2002), the dependent variable combines both analog and digital mobile telephony, although most studies acknowledge their important differences.

2. The model

Mobile telephony diffusion is studied with the aid of a Gompertz growth model, which in the past has been used to study, for example, the spreading of computers (Stoneman, 1983, Ch. 10) and the Internet (Kiiski & Pohjola, 2002). Although a wealth of alternatives exist (see, e.g., Stoneman, 2002), the Gompertz model is parsimonious, linear in parameters, and allows for simple inclusion of socio-economic explanatory variables. Furthermore, interestingly Madden et al. (Madden & Coble-Neal, 2001; Madden et al., 2004) end up with a specification that is identical to the one derived below, although their starting point is a dynamic optimization problem of an economic agent rather than a diffusion model.

Let $N_{i,t}$ be the number of mobile telephony users in country i at time t. Over time it tends towards its post-diffusion or equilibrium level $N^*_{i,t}$ along an S-shaped path. The Gompertz growth model specifies the rate of change as

$$\ln N_{i,t} - \ln N_{i,t-1} = \alpha(\ln N^*_{i,t} - \ln N_{i,t-1}) \tag{1}$$

where α is the speed of adjustment. The equilibrium level $N^*_{i,t}$ is a function of past supply and demand factors (denoted by a vector $X_{i,t}$) including—but not limited to—availability, disposable income, and user cost

$$\ln N^*_{i,t} = X^{\beta}_{i,t} \tag{2}$$

where β is a vector of coefficients. Inserting (2) into (1) yields

$$\ln N_{i,t} - \ln N_{i,t-1} = \alpha\beta' \ln X_{i,t-1} - \alpha \ln N_{i,t-1} \tag{3}$$

which is estimated with an appropriate econometric method as soon as $X_{i,t-1}$ and the stochastic error structure have been specified. The strict interpretation of β s in the above model is that they shift the equilibrium stock of adopters.