Telecommunications Policy 36 (2012) 762–782

Contents lists available at SciVerse ScienceDirect

Telecommunications Policy

URL: www.elsevier.com/locate/telpol

Impact of spectrum management policy on the penetration of 3G technology

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ARTICLE INFO

Available online 7 September 2012

Keywords:
Spectrum management
Spectrum auction
Technology standardization
Spectrum refarm

ABSTRACT

Diffusion of 3G cellular technology varies widely across countries and regions. Past studies have shown that lower levels of diffusion of previous technologies and higher levels of income are significant factors in accelerating the take up of 1st and 2nd generation of mobile telephony. In addition, spectrum management policy plays a significant role in shaping 3G diffusion. Regulatory policies regarding spectrum management include mandating band and technology and decisions to hold spectrum auctions. An econometric analysis over a multi-country panel dataset shows that these spectrum management policies do have significant influence on the take-up of 3G. Findings suggest that the presence of multiple technologies for the previous generation is associated with rollout delay. The estimations indicate that countries that mandated a specific frequency band for 3G saw faster roll out, but in the long run those countries experienced a slower growth rate. Also estimations find that 3G diffusion is not significantly affected by the choice of auctions vs. alternative license award processes. Insights gained from this study of the 2G to 3G transition can provide guidance to regulators now contemplating the transition to newer generations.

1. Introduction

Wireless communication uses electromagnetic spectrum as its conduit. Spectrum is a scarce natural resource. However, unlike many other resources it is non-depletable and non-storable. The telecommunication regulatory authorities around the world allocate spectrum licenses to operators for the best use of the resource. In recent years, mobile telephony has become one of the most prominent uses of spectrum. The wireless industry has consistently maintained a high growth rate despite the downturn in the global economy (Fig. 1). Facilitating this growth, mobile communication technology has continuously improved through several generations of standards.

Analog mobiles (1G) of the 1980s became digital (2G) in the 1990s and the dawn of the millennium saw the introduction of 3G—enhanced technology with better data and voice capacity than 2G. With the improvement of technology, demand has grown and operators require more spectrum than ever before. To cater to the needs of operators and consumers, regulators around the world adopt spectrum management policies to ensure efficient use of this scarce resource. These policies have played a significant role in shaping the technology evolution path as spectrum is vital to the widespread deployment of mobile service.

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http://dx.doi.org/10.1016/j.telpol.2012.06.012

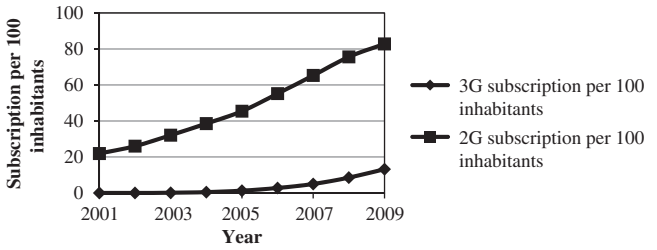

Fig. 1. Worldwide subscription of 3G and 2G per 100 inhabitants.
Source: ITU (2010).

This paper endeavors to examine the role of spectrum management policies on the diffusion of 3G technology. Since its inception, 3G has not been homogeneous in deployment. Some countries embraced the system earlier than others. Various authors argue that this diversity is influenced by the prior existence of a robust mobile market, and the economic characteristics of the countries (Lee, Chan-Olmsted, & Kim, 2009; Finn, Arvid, & Kristin, 2010). But little has been reported about the role of spectrum management policies.

A spectrum management scheme is a set of policies and procedures that enables national regulatory authorities to select which band of spectrum is to be assigned to which operator for what use. Among various regulatory decisions, the most crucial are: the choice of spectrum band, the decision regarding technology standards and the method of awarding licenses. In most cases, the regulators make available a new specific band of spectrum for the introduction of newer technology or to respond to spectrum need. This decision depends on various technical and policy oriented issues such as channel interference,[1] competition, and social needs. Based on these criteria the regulators may award operators a new spectrum band or allow them to reuse their existing licensed spectrum for a new generation.

The regulators mandate a specific spectrum band for a specific generation of technology to ensure global roaming, economies of scale and to avoid the problems of non-compatibility (Bohlin, Madden, & Morey, 2010). However, this decision can hinder operators from repurposing an already acquired band and may also create path dependence that can lead to an inferior technology standard that is costly to change (Cramton, 2002).

The regulators allocate new spectrum using auctions or hearings, or let the operators repurpose their previously owned spectrum whenever a new generation of technology is introduced. In auctions the operators bid for spectrum lots and the highest bidder gets the license for that specific lot. In hearings, operators propose their spectrum usage plans to the regulator. After hearing the proposals the regulators award spectrum to the most attractive bid (Cramton, 2002) Repurposing does not require the operators to pay for new spectrum. Auctions, while applauded by cash-strapped governments, are criticized by operators because the resulting high prices raise operators' costs. However, capital debt due to auctions might also act as an incentive for fast rollout.

Regulatory policies directly affect the course of certain technologies in specific countries (Peha, 1998). Hence using only demographic and economic factors to explain differences in the diffusion of telecommunication technology seems incomplete. One measure of the success of regulatory policies lies in the rate of diffusion of the affected technology. Correct polices can increase the speed of diffusion whereas flawed policies can hinder growth. Therefore, this research examines the effect of regulatory policies regarding spectrum band, technology, and the award process on the diffusion of 3G around the world.

This paper is structured as follows. Section 2 introduces the technology, spectrum management schemes and the hypotheses. Section 3 presents the model for analysis. Section 4 gives empirical analysis of the data and presents the main results, which is followed by the conclusions in Section 5.

2. Mobile telephony and spectrum policies: Background and hypotheses

2.1. The technology generations

The two prevalent technologies of 2G[2] telephony are GSM and cdmaOne. GSM is based on TDMA and FDMA while cdmaOne is based on CDMA.[3] To support higher data rates and multimedia services the International Telecommunications Union (ITU) created IMT-2000 as a family of standards popularly termed 3G. The goal was to enable the provision of both

[1] In wireless system, interference caused by extraneous power from a signal in an adjacent channel is termed *channel interference*.

[2] 2G systems are predominantly voice based with limited data transport capability. GSM supports data rate of 9.6 kb/s and with advanced GPRS and EDGE technology the data rate goes up to almost 160 kb/s per user while cdmaOne data rate can range up to 115 kb/s (Karim & Sarraf, 2002).

[3] TDMA (Time Division Multiple Access) is a digital RF link where multiple devices share a single carrier frequency by taking turns. Each device gets the channel exclusively for a certain time slice, then gives it up while all the other devices take their turn. FDMA (Frequency Division Multiple Access) refers to the separation of multiple digital RF links by frequency. CDMA (Code Division Multiple Access) is a digital RF link that allows several devices or base stations to send information simultaneously on a wideband channel. Transmiters are assigned separate codes; recievers use these codes to separate out a single signal from the several being transmitted simultaneously.