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Bass model estimates for broadband diffusion in European countries

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ABSTRACT

The paper presents a broadband diffusion analysis for European OECD member countries. The Bass diffusion model is used to estimate the total number of potential adopters, the coefficient of innovation and the coefficient of imitation. The analysis shows that if the present trends continue broadband services will not reach the 100% penetration rate in the near future. Based on these findings, the question of a possible revitalization is discussed with a focus on those segments of the population which are slower to adopt broadband. A survey of households in rural areas provides preliminary investigation of reasons for continuing non-adoption, such as social habits and lack of both knowledge and interest.

1. Introduction

While the adoption of new technologies in households is always a complex process, the diffusion of broadband ('BB') has attracted unprecedented attention in the research and political community [1]. It continues to be a salient social, economic and political issue and the development of statistical approaches to forecast its future distribution is important [2].

Despite this strong focus and governmental efforts in many countries, diffusion levels vary considerably. If we consider European OECD member countries the diffusion level varies from 37.8% in Netherlands to 11.9% in Poland [3]. While the relative differences between countries are decreasing the absolute differences are still increasing [4]. Although national governments are aware of these [5], they find it difficult turning good intentions into effective action [6]. Therefore, an analysis of past trends is needed along with a prediction of future trends and an analysis of reasons why some segments of the population may not adopt BB in the near future.

While previous studies are an important contribution they often suffer from certain shortcomings. First of all, most studies identify either the current state or study past trends but do not estimate future trends and/or potential full penetration. They often stop at an analysis of differences between countries without a detailed analysis of the reason for non-adoption in certain segments. The findings are rarely used as an input in a discussion of political implications.

Aggregate diffusion models, like the well known Bass diffusion model, are often chosen to estimate future trends of new products and services. Furthermore, the knowledge of the aggregate parameters of the BB diffusion processes would also enrich the analysis of diffusion of complementary services (e.g. Voice over Internet Protocol or Internet Protocol Television) [7]. The main contribution of our paper is therefore that it not only identifies the current situation but also tries to indicate the most likely future trends by applying the Bass diffusion model. As the application of the Bass model is widespread in business and research [8], the estimation of parameters for BB adoption can be important for further research in the area.

We estimated Bass diffusion parameters on the basis of OECD data for 20 European countries from 2001 to 2010. Our analysis is not focused on specific countries but is rather a general analysis of the diffusion process in all 20 European countries. Since the BB

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diffusion process is not over yet, our estimates are preliminary in nature – the exact parameters will be known after the diffusion is complete. Despite the preliminary nature, our estimates show that previous diffusion models for durables in a single market can be generalized to the telecommunications industry [9] and that the 100% penetration of BB may not happen any time soon.

Due to this finding, the reasons for the non-adoption of BB within households were investigated. Since households in rural areas are typically slow to adopt BB, the analysis is based on a sample of households from rural areas. The results of both the Bass modeling and the survey serve as an input for a discussion and conclusion where several important findings and considerations for public policy decision-makers are presented. Finally, the paper shows that despite all the attention some basic questions regarding BB diffusion are still unanswered, such as what constitutes full diffusion and the start year of BB.

The structure of the paper is as follows: in the next section the need for further BB studies is established. Then the diffusion of BB in OECD European countries is analyzed with the Bass diffusion model. After that, the methodology and main findings of the household survey are presented. Finally, the implications of our findings are discussed.

We use the term BB adoption when focusing on users' decision to adopt a BB at the individual level of analysis. BB diffusion is a similar term, but it is used when explaining the adoption process at the aggregate (e.g. country) level.

2. The need for BB adoption studies

Several companies and governments are prioritizing their core strategies around BB [10]. Access to advanced communications services is considered crucial for economic and social development and a higher quality life [11]. Constant changes and innovations even increase this importance [12]. Some estimates have even gone so high as to predict that one-third of all economic growth up to 2011 will be connected with BB diffusion [13].

BB adoption is clearly one of the most studied phenomena in the last few years and several different conceptual frameworks intended for a more structured approach have been proposed [1,14]. Both the differences between countries (e.g. [14–16]) and the socio-demographic characteristics of a population that is slow to adopt BB (e.g. [17,18]) have been widely studied. A review of the main findings shows that economic development (personal income, GDP or similar indicators), prices and effective regulation are the most important determinants of the level of BB diffusion. The research results differ on the impact of other factors such as competition, education level, English language proficiency, level of democracy, social networks, age and appeal of the contents [19–22]. In addition to studies about the decision to adopt BB, studies on the continued use of technology are also important (see e.g. [23]) – no benefits can be realized if the consumer stops using the technology soon after having adopted it.

The main unanswered question concerns adoption patterns over time and when (if) the full diffusion of BB may be expected. Addressing the digital divide will likely be very beneficial in bringing the last set of potential adopters along or identifying the reasons for their continued decision not to adopt [24]. However, most of existing research papers were limited to only a descriptive analysis of a limited set of scenarios. For example, [25] only gives a very general description without any deep analysis or prediction of future trends. [26] again offers only a textual description of current trends in EU countries with some very general predictions. [27] only analyzes four basic scenarios of BB development in the EU for the period up to 2012; the scenarios are estimated on the empirically unsubstantiated data of BB and economic growth.

The research papers that go beyond simple textual description often only focus on a certain subset of BB adoption. For example, [28] predicts the potential market penetration of wireless Internet services onboard trains in Belgium and estimates the size and nature of different adopter segments.

The single exception we were able to find was a recently published paper which used a method of exponential smoothing, the Holt's damped trend with a modification, to analyze and predict the trends of BB adoption in OECD countries [29]. While the results are extremely interesting and similar to predictions of our model, such an approach is less suitable with the diffusion process that comes close to saturation [29]; furthermore it doesn't give meaningful parameters which could be interpreted and used in further studies of innovation and imitation processes.

Another benefit of numerical studies is that they can be used to analyze whether further stimulative political efforts are needed and to then study their efficiency as the difference between achieved and predicted adoption patterns. Namely, in spite of the overall rapid growth of BB diffusion many countries are still in the early stages of BB deployment and are assessing policy strategies to promote its even faster [30,31]. The same finding applies to EU member countries – despite the strategic importance attributed to the topic, BB rollout and take-up has been patchy [27].

The reasons for such trends have been analyzed in various contexts. A global analysis of BB adoption reveals that the amount of compelling content, services and applications is an important driver of BB diffusion [30]. Similar findings have been made in a US case study, namely infrastructure diffusion *per se* only has a small impact on the adoption process and, over time, even household income has become a less important factor in adoption decisions [32]. Indeed, the income elasticity of the demand for the Internet has fallen below 0.5 [33], which shows that differences in either infrastructure access or income alone cannot be used to explain the decision to adopt in relatively developed countries.

It is therefore important to develop an understanding of how and why technology is introduced, how and why technology is diffused, and how and why technology is accepted [34]. The simple claim that regulation efforts in the EU have been successful based solely on the growth of BB penetration and reduction in prices [35] is not convincing. Finally, several claims have been made that the diffusion of BB follows a completely different pattern to previous technologies. Yet this claim has not been tested [36].

Consequently, it is vital to study the diffusion patterns of BB over time by taking a rigorous methodological approach and analyzing the underlying reasons for non-adoption by some parts of the population. In this study, the specific focus is on the estimation of the total number of potential adopters. Since the access to advanced communications services is considered crucial