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Segmental new-product diffusion of residential broadband services

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Abstract

Aggregate models of innovation diffusion do not capitalise on valuable consumer adoption dynamics that may be useful to policy makers and market planners. The non-diffusion choice literature shows quite clearly that these dynamics may indeed be very important factors in the diffusion process. The authors present a segmental broadband diffusion model that is estimated from consumer survey data that measure the effect that household income has on its propensity to adopt this technological product. The results suggest that early broadband adopters are mostly made up from wealthy households and only as time progresses do less well off households adopt. The findings presented in this paper will be important to market planners and policy makers requiring a relatively simple technique that forecasts segmental innovation diffusion.

Keywords: Internet; Broadband; Diffusion; Gompertz; Forecasting; Innovation

1. Introduction

The established route to the modelling of innovative new-product penetration throughout the early stages of a product lifecycle relies on the use of diffusion models. Some examples of where diffusion models have been applied to forecast innovative product lifecycles are IBM mainframe computers (Mahajan & Muller, 1996), residential high-speed internet services technology (Vanston, 2002) and mobile phones (Botelho & Ligia Costa Pinto, 2004). These papers show that diffusion models can form an important part of the armoury of the policy maker and market planner.

Diffusion models provide an estimate of the hazard rate, defined as the probability that an innovation will be adopted at a particular time by a particular individual within a given social system, providing that the individual has not yet adopted the innovation. This definition suggests that each potential adopter has an equal probability of adopting the product as it launches (Roberts & Lattin, 2000). This must be viewed as an unrealistic assumption, however, as for many product types early adopters can be characteristically different from late adopters (see Robertson, Soopramanien, & Fildes, forthcoming). This implies that the hazard rate is potentially non-homogeneous. Evidence for this hypothesis in technology markets is abundant. Analyses of

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the digital divide show that there are individuals in society who use information and communication technologies (ICTs) effectively when others do not, whether voluntarily or involuntarily (Cabinet Office, 2005). Although academic models that measure residential ICT markets are relatively hard to find, those that have been published highlight strongly that the characteristics of adopters and non-adopters of ICTs vary systematically. Determined via the application of probabilistic internet choice models (see Chaudhuri, Flamm, & Horrigan, 2005; Kridel, Rappoport, & Taylor, 2002; Robertson et al., forthcoming), households excluded by the digital divide tend to be poorer, older and less well educated. This is a firm evidence that the product lifecycle is not homogeneous in hazard rate as aggregate diffusion models assume. Given this compelling evidence, this research introduces a segmental broadband diffusion model that is estimated using household penetration rates, to take into account income differences.

One of the major constraints faced by researchers exploring new-product penetration dynamics is the lack of data from which *time-dependent* segmental analyses can be made. Recent publications (Chaudhuri et al., 2005; Kridel et al., 2002; Robertson et al., forthcoming) show how multivariate probabilistic choice models (e.g. logit) can be applied to predict broadband penetration. Although these techniques are useful to an understanding of the interior mechanisms of the market, they cannot easily be applied to forecast future technology penetration, nor explain past temporal patterns. To overcome the problem of predicting future broadband penetration the authors use survey data to measure the time scale to adoption. The advantage of this process is that they are also able to estimate Gompertz broadband adoption curves for different household income levels that characterise the reality of income-related digital division. The advantage of this method over aggregated approaches is that the planner can observe and estimate consumer activities that conform well to existing understanding of the underlying economic processes of demand; it is therefore easily described to non-technical policy makers. A second advantage to this method is that the choice of segmentation variable is left open to the analyst to decide. Although this technique is exemplified by applying it to forecast segmental broadband penetration, the technique that is described could be re-applied to most types of technology where survey data are available, from which consumer segments may be derived (e.g. residential VoIP, online shopping).

This paper is organised as follows. The literature review introduces the research on diffusion that is used to develop the model that is presented in Section 3. A description of how the data are collected and managed is then provided under Section 5. This leads to Section 6 that provides a detailed description of the segmental Gompertz results. Sections 7 and 8 offer a discussion of the findings, limitations and avenues for further research with final conclusions.

2. Literature review

The process of diffusion of innovative products can be defined as the cumulative sales or distribution pathways that some new products take from the point of market entry to the time that the market becomes saturated. Observation suggests that diffusion processes tend to follow a sigmoid shape (Bass, 1969; Mahajan, Muller, & Wind, 2000). Based on this Rogers (1962, 1995) selected the normal density to model markets as this provided a close fit to product penetration patterns. Further developments in diffusion were provided by Bass (1969) who built on the Rogers' conceptual framework by developing a mathematical model that captured the non-linear structure of S-shaped curves. One of the more complex algorithms to estimate the product lifecycle, in its original form, produces a model that at 50% market saturation also accounts for 50% of the time to complete the product lifecycle (i.e. it is symmetric like the normal distribution). A problematic issue arises however. When the model is estimated prior to the 50% saturation point it tends to over-estimate market demand (Meade & Islam, 2001), a serious limitation for policy makers and market planners needing reliable demand estimates. Only when the point of inflexion is reached, i.e. the maximum rate of adoption, do the parameter estimates of the model converge. Of course, this usually happens too late in the product lifecycle to be of use to practitioners and policymakers. Although the Bass model has been amended in a number of ways that relax the normal curve assumption, this has led to models of high complexity that carry forecast accuracy penalties (Meade & Islam, 2001).

Meade and Islam (2001) describe a number of algorithmic models that may be employed to forecast innovative product demand. A fundamental problem they warn of is that forecast accuracy generally falls as