NEW PRODUCT DIFFUSION IN THE BALTIC STATES

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Abstract
Innovation diffusion theory has been a subject of considerable research among marketing management and consumer behaviour for the last four decades. The best-known first-purchase diffusion model is the Bass model, where potential adopters are divided into two groups: innovators and imitators. There are many empirical studies where the parameters of the model have been estimated for different countries for several products. Due to the fact that the values of these parameters depend on a country (wealth, trade) and its cultural effect, it is useful to apply this model in those countries that have not yet been investigated. The purpose of this paper is to estimate the coefficients of innovation and imitation in the Baltic States in order to compare the consumer behaviour in these countries and to examine the similarities and differences between the Baltic States and other European countries. To accomplish this objective a time-series of telecommunication services are used. The estimation results can be used to forecast the diffusion pattern for analogous products and are useful to firms, which operate in the Baltic market or have such plans.
Keywords: innovation diffusion; Bass model; telecommunication services.

Introduction

Nowadays many managers use model-based results for marketing decisions. The increasing availability of empirical data offers chances for researches to build models that augment the knowledge about customers' behaviour and help to improve the marketing judgement.

One class of such models are diffusion models. They provide a mathematical model to underlie the shape of the cumulative sales pattern of innovative products (consumer durable goods, electronic devices, telecommunication services, electronic payments, etc.), and they can take different forms. During the last 30 years there have been several reviews of diffusion models (Meade, 1984; Mahajan, et al., 1985; Baptista, 1999; Mahajan, et al., 2000; Lilien, et al., 2006). Meade and Islam (2006) have brought a substantial list of research works related to this topic in their paper "Modelling and forecasting the diffusion of innovation - A 25-year review".

These models are applicable to forecast first purchase sales of different products and services (Srinivasan, et al., 1986; Hardie, et al., 1998). Wenrong, Xie and Tsui (2006) used a diffusion model to forecast the number of mobile service subscribers in major countries in the Asia-Pacific region. Chu and Pan (2008) applied it to estimate the growth pattern of the mobile Internet subscribers in Taiwan. Wu and Chu (2010) analysed mobile telephone subscribers' data for Taiwan, during 1988-2007, and compared performance of four models: three popular diffusion models (Gompertz, Logistic, Bass), and a time-series autoregressive moving average (ARMA) model. Morrison (1996) has given very practical guidelines how mature products can be used to determine the growth pattern of new products, using the Logistic and Gompertz curves.

Diffusion theory's main focus is on communication channels, which are the means by which information about the new products or technology is transmitted within the social system. Consumers have different propensities for relying on mass media or interpersonal channels when seeking information about new technology. On that basis, the new product diffusion models can by classified into at least three major groups: pure innovative models (Fourt, et al., 1960), pure imitative models (Fisher, et al., 1971), and combination models (Bass, 1969).

The Bass (1969) model is the most popular model and has received extensive attention by academics and practitioners. The model assumes that new product adopters are influenced by two types of communication: mass media (external influence) and interpersonal communication (internal influence). An external influence is described by the coefficient of innovation, and an internal influence is described by the coefficient of imitation. The coefficients vary across products and countries (Bass, 1969; Takada, et al., 1991; Dekimpe, et al., 2000; Sundqvist, et al., 2005). Due to its simplicity and forecasting power there are over 700 estimations or applications of the Bass model throughout the literature. Knowing the values of these coefficients and the estimated market capacity, one can forecast sales over the projected time. For such purposes it has been used by a number of large corporations, such as IBM, Kodak, AT&T (Rogers, 2003). In addition to the application in forecasting, the estimated values of innovation and imitation coefficients can give us the information about the cultural similarity of countries (Sundqvist, et al., 2005; Van den Bulte, et al., 2004; Huang, et al., 2010).

The aim of this paper is to estimate the coefficients of innovation and imitation for different telecommunication services in the Baltic States and to determine consumers' behaviour as similar, or not, in these countries. Such information could be useful to develop marketing strategies by firms, which operate in the Baltic market or have such plans.

The Bass Model

Frank Bass (1969) divided potential customers into two groups: innovators and imitators. Innovative customers tend to acquire information about a new product from mass-media and other external channels. Their decision to adopt the product (or service) does not depend on other users. Imitators have a tendency to get such information from interpersonal channels and observation and, on the contrary, their decision depends on the number of existing adopters. Therefore, the probability of an initial purchase consists of two parts:

$$v(t)=p+q\frac{N(t)}{m} \qquad (1)$$

where N(t) is the number of previous buyers and m is the ultimate market size. The timing is based on a common time period of introduction, rather than calendar time. Parameters p and q are the innovation and imitation coefficients, respectively. Since N(0)=0, the parameter p is equal to the probability of an initial purchase at time t=0. Consequently, its value reflects the importance of innovators in the social system; whereas, q is related to the pressure on imitators.

From Eq. (1) follows that the cumulative number of adopters at time t is:

$$N(t)=m\frac{1-e^{-(p+q)t}}{1+\frac{q}{p}e^{-(p+q)t}} \qquad (2)$$

The curve N(t) has a typical "S" shape. When both p and q are large, product sales take off rapidly and after reaching a maximum, fall off quickly. When the innovation effect is negligible, the Bass model degenerates into the logistic model, in which the imitation effect equals growth rate.

There are different methods to estimate the values of p, q, and m: such as, Ordinary Least Squares, Nonlinear Least Squares, Maximum Likelihood (Bass, 1969; Srinivasan, et al., 1986; Wenrong, et al., 2006). If the values of the parameters are established, the analyst can apply the model to other analogous products. Thomas (1985) specifies that five bases of likenesses should be considered when selecting a similar product on which to base diffusion model components: environmental context (e.g., socioeconomic environment); market structure (e.g., number of competitors); buyer behaviour (e.g., buyer situation, choice attributes); marketing mix strategies of the firm (e.g., promotion, pricing); and characteristics of the innovation (e.g., relative advantage over existing products, product complexity).

Method and data

In this analysis we applied Nonlinear Least Squares to fit the time-series data and estimate the parameters of the model (2). For this purpose the econometric software STATA 11 was used.

The main source of data was the World Telecommunication/ICT Indicators' database. The database contains annual time series data from 1975-2009, for around 150 telecommunication/ICT statistics covering fixed telephone networks, mobile cellular services, Internet, and others. In addition some data was obtained from Statistics Estonia, the Central Statistical Bureau of Latvia and the Communications Regulatory Authority of Lithuania. The description of datasets is given in Table 1.

Table 1

Time series data

	Estonia	Latvia	Lithuania
Mobile cellular subscriptions	1991-2009, 19 obs.	1992-2009, 18 obs.	1993-2009, 17 obs.

Proportion of households with a computer	1996-2009, 14 obs.	2001-2009, 9 obs.	1999-2010, 12 obs.
Proportion of households with Internet access at home	2000-2010, 11 obs.	2002-2009, 8 obs.	2002-2009, 8 obs.

Results and discussion

As we see from Table 1, the time-series of mobile cellular subscriptions are the longest. Figure 1 presents the actual and predicted data for Estonia, Latvia and Lithuania. Coefficients of determination, which indicate goodness of fit, are 0.9986, 0.9992, and 0.9974, respectively. The estimated value for market capacity in Estonia is 1.694 million, in Latvia 2.441 mln, and in Lithuania 5.246 mln. For all three countries it is greater than the actual population: the Estonian population is 1.3 mln, Latvia's population is 2.3 mln and the population of Lithuania is 3.2 mln. The reason is that many people have different mobile numbers for business and personal calls. Estimated values for innovation coefficient p and imitation coefficient q are as follows: Estonia p=0.00172, q=0.482; Latvia p=0.000709, q=0.560; Lithuania p=0.000278, q=0.694.

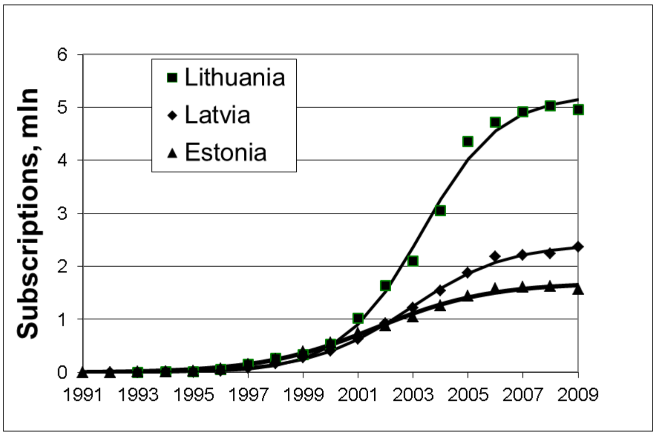

Figure 1. Mobile phone subscriptions, actual and predicted

As the historical data of mobile cellular subscriptions are completely available for many countries it was interesting to compare the estimated parameters for Baltic States with other European countries. After working with the data of other countries, for 13 of these countries we got a model where all three parameters were statistically significant at the 5% level. A graphical representation of the innovation and imitation coefficients for the 16 European countries is proposed in Figure 2. We see that the distance between the Baltic countries is quite large and they do not band together. Note that the Nordic countries Sweden, Denmark, and Norway are very close, but Finland is situated apart from them.

Among these countries, Estonia takes the 3rd place in the importance of innovation, Latvia is the 7th and Lithuania is the 12th. The order of these countries by the imitation coefficient is just the opposite: the imitation effect is largest in Lithuania. This means that interpersonal communication is more important in Lithuania, and the fraction of imitators amid the potential consumers is the greatest. Latvia takes the 3rd place and Estonia the 6th. In addition we estimated regression models for two other time-series: proportion of households with a computer and proportion of households with Internet access at home. Table 2 summarises the estimates of the parameters p and q for the different services in all three countries. All the parameters are statistically significant. Comparing the results we see that the importance of mass media is the largest in Estonia, where the innovation coefficient is greater than in Latvia and Lithuania for all three diffusion paths.

Consider the q coefficient values; the impact of imitators on the sales growth is greater in Latvia and Lithuania. It means that in the two countries the number of previous adoptions has more influence on future sales.

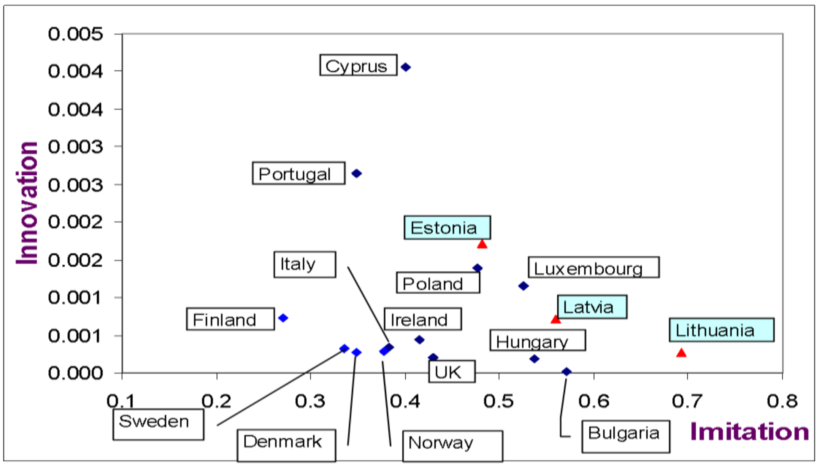

Figure 2. Imitation and innovation coefficients for 16 European countries, mobile phone subscriptions' diffusion.

Table 2

Comparison of innovation and imitation coefficients of diffusion curves across the different technological products in Baltic Sates

Country	Mobile phone subscriptions		Proportion of households with a computer		Proportion of households with Internet access at home	
	Innovation coefficient p					
	Estimated value	Std. err.	Estimated value	Std. err.	Estimated value	Std. err.
Estonia	0.001716***	0.00036	0.01471***	0.00096	0.0351***	0.0059
Latvia	0.000709***	0.00014	0.00540**	0.00123	0.0301**	0.0073
Lithuania	0.000278**	0.00013	0.00582***	0.00075	0.0192**	0.0069
	Imitation coefficient q					
Estonia	0.482***	0.025	0.258***	0.028	0.369***	0.076
Latvia	0.559***	0.022	0.396***	0.052	0.825**	0.106
Lithuania	0.694***	0.052	0.427***	0.024	0.691**	0.140

** significant at the 1% level
*** significant at the 0.1% level

In Figure 3 we presented the computed sales curves – the cumulative percentage of the potential market versus time. To calculate these curves we used Eq. (2), where the market capacity (m) =100% and the coefficients of innovation and imitation have the mean values, obtained from the three models for each country (averages of rows in Table 3). For Estonia $\overline{p}=0.01718$, and $\overline{q}=0.3699$, for Latvia $\overline{p}=0.01207$, $\overline{q}=0.5936$, and for Lithuania $\overline{p}=0.008432$, and $\overline{q}=0.6040$. Entrance to the market is simultaneous in all three countries. The inset depicts the early growth.

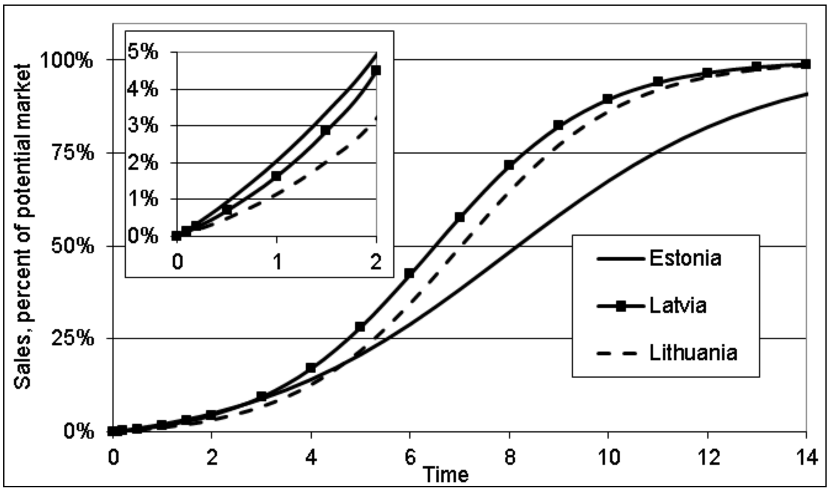

Figure 3. Computed growth curves with mean values of the innovation and imitation coefficients

We see that initially the growth rate is largest in Estonia. But after a little time the growth rate in Latvia and Lithuania become greater and the corresponding curves pass Estonia's curve. An explanation for this is that in Estonia the value of the innovation coefficient is greater and the relative impact of innovative customers is higher. The impact of innovative customers is more important especially at the outset of the product launch. When some number of purchases has been done, the relative importance of imitative costumers grows (see Eq. (1)). Consequently, when the entry to the market has been done at the same moment in all three countries, in Latvia and Lithuania the ultimate market is reached earlier than in Estonia.

Conclusions

The diffusion models are important tools for effectively assessing the merits of investing in new technologies and to forecast growth of first time purchasers. In this paper we analysed the time series of three different ICT services - mobile phone subscriptions, the proportion of households with a computer, and proportion of households with Internet access at home - in the Baltic States. Our results show that there is a difference in costumers' behaviour in the three selected countries. In Estonia there are more potential buyers who receive information about new technologies from mass-media. In Latvia and especially in Lithuania the interpersonal communication is more important and the imitation effect greater. Therefore it can be assumed that when a new product launch takes place simultaneously, at the beginning the total sale (as per cent of maximum level) grows faster in Estonia. After some time the growth rate becomes greater in Latvia and Lithuania and the maximum number of adoptions will be obtained earlier in these two countries.

It is always better to have more information for obtaining the most accurate forecast possible. We believe that our results could help ICT and other companies to forecast the sales of new goods and services and to develop their marketing strategy in the Baltic market.

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