FORECASTING METHODS AND LONG-TERM EVALUATION OF THE ELECTRONIC COMMUNICATIONS MARKET IN LATVIA

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Electronic communications market is one of the most rapidly developing and prospective branches of the national economy. It directly influences economic and political situation of the country as well as the level of well-being of each citizen and the society on the whole.

Already now it is becoming obvious that the life cycle of many telecommunications technologies and services is rapidly decreasing. Besides, traditional telecommunications services are replaced by more advanced information services. Therefore, under the circumstances of constantly evolving market, it is very important to realize the possible ways and prerequisites for further development, their influence on private entrepreneurship, government policy of regulation and on the whole society.

The above-mentioned targets can be partly reached by purposeful forecasting. The paper considers the most popular forecasting methods used to evaluate the development of electronic communications market – analogy method, Delphi method, logistic regression and trend extrapolation of the actual data. The authors carry out the calculations and quantitative forecasts for the prospective sectors of the Latvian telecommunications market – mobile telephony and Internet.

Keywords: telecommunications, forecasting, trend extrapolation, Delphi method, analogy method

1. INTRODUCTION

Forecasting of technology development comprises a set of various methods, which allow forecasting technological capacities and foreseeing the diffusion of technical inventions or the degree to which one technology substitutes another, due to the fact that it is more advanced. Uncertain and unreliable data as well as inability to foresee the forthcoming of external factors and their direct influence on the development of a technology often complicate the process of forecasting.

In order to solve the evident problems caused by the uncertainty of forecasting, experts in this field created a number of different techniques with the aim to facilitate the forecasting process and to increase reliability of the obtained results. We examine the most popular of these methodologies (forecasting by analogy with other countries, the Delphi method and extrapolation) further in the paper.

These techniques were applied in obtaining the forecasts for the most prospective and rapidly developing sectors of the Latvian telecommunications market – mobile telephony and Internet.

2. METHODS OF TECHNOLOGY DEVELOPMENT FORECASTING

2.1. Analogy with Other Countries

The use of analogies with other countries involves a systematic comparison and further forecasting of the development of a technology by analogy with development of this technology in another country with similar socio-economic conditions. In addition, the chosen country must have experienced the development stage of the given technology a long time ago. In order to obtain the best results, the time gap between the two compared countries must be at least ten years. Concrete calculations and forecasts based upon this methodology are shown in the next section.

2.2. Delphi Technique (Method of Expert Opinions)

The Delphi technique refers to a systematic evaluation and generalization of the opinions of experts regarding further development of a concrete parameter. Many variations of this methodology have been offered since its introduction at the *Rand Corporation*. The conventional Delphi procedure comprises the following stages:

1. The design of a questionnaire, choice of a group of experts, sending a questionnaire to the members of the group;
2. Summarizing the received responses;
3. Sending the summarized responses back to the respondents. During the second, and sometimes even the third round of questioning, the respondents have an opportunity to defend their original opinion or change it and agree with the majority opinion.

A forecast obtained by the Delphi method is an intuitive consensus of a group of experts. Despite its wide popularity, many forecasters consider that reliability of the obtained forecasts is greatly influenced by the qualification of the respondents and by their specific knowledge of the given topic.

2.3. Trend Extrapolation

Extrapolation is one of the most common methods in technology forecasting. It is based on the assumption that the present development will continue in the same direction with unvarying, steadily increasing or steadily decreasing speed.

Trend extrapolation requires a complete awareness of the factors which have influenced the development of a technology in the past, as well as confidence that these factors will be continuing to affect the progress in a similar way in the future. The obvious drawback of this technique is that it takes into account only those processes and circumstances which already exist at present. This technique always ignores those new conditions and impacts which might appear in the future. Often there will be gradually increasing number of such new impacts, and in this case extrapolation can give a reliable forecast only for a relatively short period of time.

If the number of observations to be analysed is rather large (in other words, in the case of *trend* extrapolation), it is necessary to apply the regression analysis. Such computer software as STATISTICA and MATHCAD can significantly facilitate this process with their build-in functions for the calculation of linear and non-linear regressions.

One commonly used approach to describe the diffusion of a technology or a substitution of one technology by another is the use of the arctg-shaped curve. The most popular model of this type is the logistic curve (the Fisher-Pry model). It includes both lower and upper limits of the technology development, which should be either estimated or selected from other criteria. Obviously, if the upper limit is incorrectly selected, the technique may produce an erroneous forecast.

The formula for the logistic curve is the following:

$$y(t) = \frac{L}{1 + e^{-b(t-a)}}, \tag{1}$$

where L – the natural limit of the diffusion of technology;
t – time;
a – time when a penetration rate reaches 50 per cent of its natural diffusion limit;
b – a parameter which governs how fast the adoption proceeds.

Thus, the logistic curve is symmetrical towards the penetration point given by the a parameter. The logistic model is usually applied to technology-driven adoptions where new technology replaces the old technology because it is superior from the technical and economic point of view.

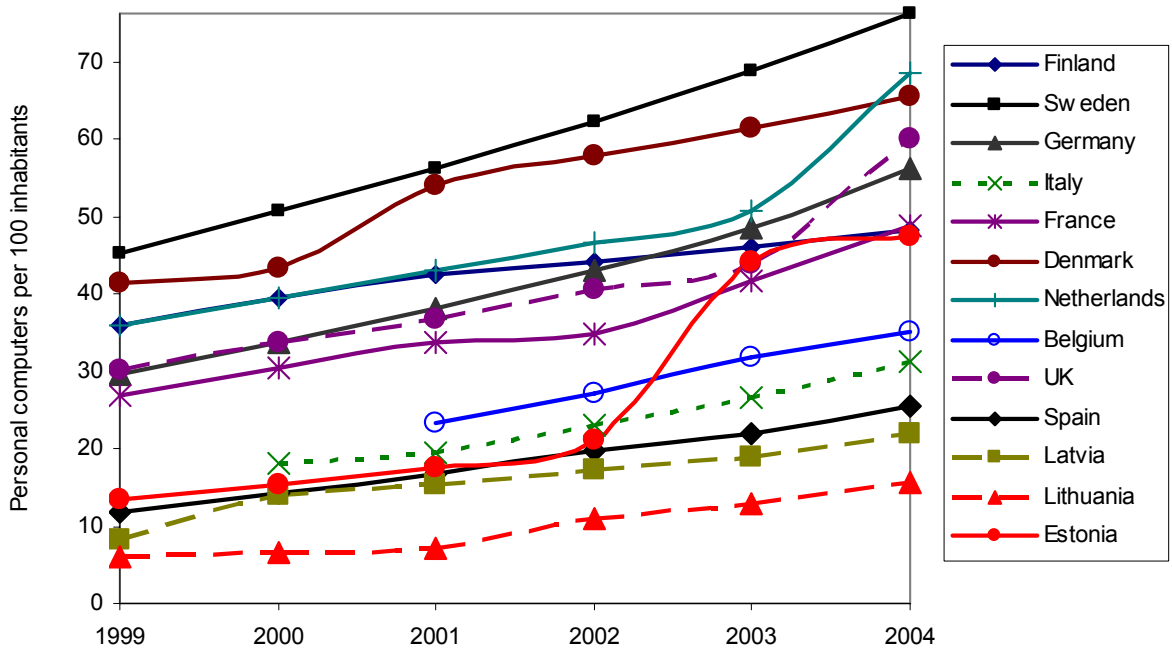
3. LONG-TERM EVALUATION OF THE ELECTRONIC COMMUNICATIONS MARKET IN LATVIA

3.1. Availability of personal computers

At the present moment, provision of access to broadband Internet for private persons is one of the most topical and widely discussed issues in the countries of the European Union, including Latvia. At the same time this sector of electronic communications is one of the most dynamic and rapidly growing. It is also important to mention that the number of Internet users in a country is closely related to the access to and availability of computers.

In Latvia the number of personal computers per 100 inhabitants is one of the lowest among the countries of the European Union. The growth of computer penetration in some of the „old" EU countries is shown in Figure 1. As we can see, a value of this parameter in Latvia is much lower than the average level of the developed EU member states.

Two different methodologies were used in forecasting the computer penetration rate, one of which is the analogy method, and the other – the Delphi method along with the Fisher-Pry method (logistic regression).



Source: Eurostat, ITU

Figure 1. *Number of computers per 100 inhabitants*

The Analogy Method

Two countries – Sweden and Denmark – were chosen for forecasting by analogy, as the socio-economic conditions in these countries are similar to Latvia, and as the stage of technology adoption took place much earlier in these countries. The analysed data and the forecasting process are shown in Table 1.

Developing a forecast for Latvia by analogy with Denmark

1. The values of computer penetration rate which are equal to 15 and 21.9 are chosen as the start and end point of the calculations.

$y_{t1}^{Latvia} = y_{t1}^{Denmark} = 15$,

$y_{t2}^{Latvia} = y_{t2}^{Denmark} = 21.9$.

2. We calculate a coefficient which shows how much the growth rate in Latvia differs from the growth rate in Denmark.

$$ratio = \frac{t_2^{Latvia} - t_1^{Latvia}}{t_2^{Denmark} - t_1^{Denmark}}, \qquad ratio = 1.25 .$$

3. Original Danish data in Table 1 (column 3) $(y_{t2}^{Denmark}, y_{t3}^{Denmark} ... y_T^{Denmark})$ are transformed to $(y_{t2*}^{Denmark}, y_{t3*}^{Denmark} ... y_{T*}^{Denmark})$ taking into account that

$t_2^{Denmark} = 1994.3$,

$t_2^{*Denmark} = t_2^{Latvia} = 2004$,

$t_3^{*Denmark} = t_2^{*Denmark} + (t_3^{Denmark} - t_2^{Denmark}) \cdot ratio = 2004.8$,

$t_j^{*Denmark} = t_{j-1}^{*Denmark} + ratio, if \ \ j = 4, 5...T$.

The results of calculations are displayed in column 4 and 5 of Table 1.

The forecast by analogy with Sweden was obtained in a similar manner. Original data and the forecasting process are shown in Table 2. Both curves obtained by the analogy with Sweden and Denmark are displayed in Figure 2.

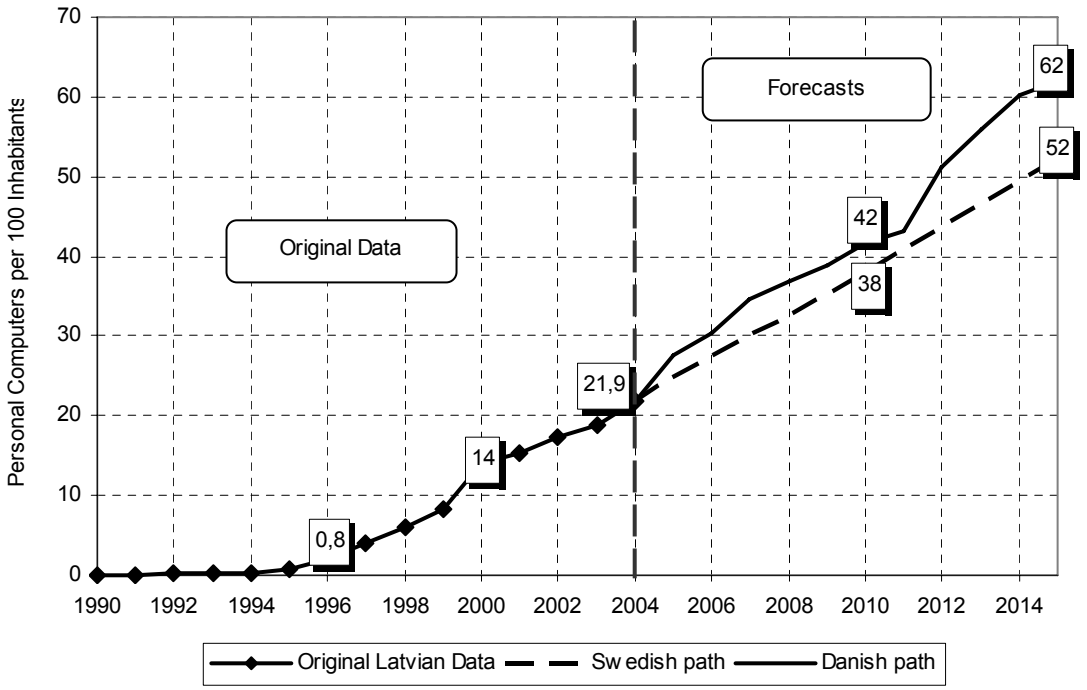


Figure 2. *Forecasting the number of computers per 100 inhabitants in Latvia by the analogy method*

Table 1. Forecasting the number of computers by the analogy with Denmark

Year	Original Data		Danish Path by Danish Raw Data		Interpolation for Danish Path		Latvian Forecast by Danish Path	
	Latvia	Denmark	Year	Values	Year	Values	Year	Values
1	2	3	4	5	6	7	8	9
1990	0,1	11,7					1990	0,1
1991	0,1	13,4					1991	0,1
1992	0,2	15,5					1992	0,2
1993	0,2	18					1993	0,2
1994	0,3	19,2					1994	0,3
1995	0,8	27,1					1995	0,8
1996	2	30,5					1996	2
1997	4	36					1997	4
1998	6,1	37,8					1998	6,1
1999	8,2	41,4					1999	8,2
2000	14	43,2					2000	14
2001	15,3	54					2001	15,3
2002	17,2	57,7					2002	17,2
2003	18,8	61,4					2003	18,8
2004	21,9	65,5	2004	21,9			2004	21,9
2005			2004,824	27,1	2005	27,58	2005	27,58
2006			2006,077	30,5	2006	30,29	2006	30,29
2007			2007,329	36	2007	34,56	2007	34,56
2008			2008,581	37,8	2008	36,96	2008	36,96
2009			2009,834	41,4	2009	39,00	2009	39,00
2010			2011,086	43,2	2010	41,64	2010	41,64
2011			2012,338	54	2011	43,08	2011	43,08
2012			2013,590	57,7	2012	51,08	2012	51,08
2013			2014,843	61,4	2013	55,96	2013	55,96
2014			2016,095	65,5	2014	60,19	2014	60,19
2015			2017,347		2015	61,91	2015	61,91

Table 2. Forecasting the number of computers by the analogy with Sweden

Year	Original Data		Swedish Path by Swedish Raw Data		Interpolation for Swedish Path		Latvian Forecast by Swedish Path	
	Latvia	Sweden	Year	Values	Year	Values	Year	Values
1	2	3	4	5	6	7	8	9
1990	0,1	10,6					1990	0,1
1991	0,1	12,8					1991	0,1
1992	0,2	13,9					1992	0,2
1993	0,2	15					1993	0,2
1994	0,3	18,3					1994	0,3
1995	0,8	23,9					1995	0,8
1996	2	29,4					1996	2
1997	4	33,9					1997	4
1998	6,1	39,6					1998	6,1
1999	8,2	45,1					1999	8,2
2000	14	50,7					2000	14
2001	15,3	56,1					2001	15,3
2002	17,2	62,1					2002	17,2
2003	18,8	68,8					2003	18,8
2004	21,9	76,1	2004	21,9			2004	21,9
2005			2004,688	23,9	2005	24,78	2005	24,78
2006			2006,648	29,4	2006	27,58	2006	27,58
2007			2008,608	33,9	2007	30,21	2007	30,21
2008			2010,568	39,6	2008	32,50	2008	32,50
2009			2012,528	45,1	2009	35,04	2009	35,04
2010			2014,488	50,7	2010	37,95	2010	37,95
2011			2016,448	56,1	2011	40,81	2011	40,81
2012			2018,408	62,1	2012	43,62	2012	43,62
2013			2020,368	68,8	2013	46,45	2013	46,45
2014			2022,328	76,1	2014	49,31	2014	49,31
2015			2024,288		2015	52,11	2015	52,11

Delphi Method and Fisher-Pry Method

At present the penetration rate of computers in Latvia is rather low and the forecasts obtained by the extrapolation can appear to be erroneous. In order to increase the reliability of forecasts calculated by extrapolation methods and to determine the direction of further development of a technology, the Delphi method was applied as well.

During our inquiry, Latvian experts agreed to the opinion that the penetration rate of computers would be increasing by 10-15 per cent each year during at least the next five years. Basing on this, we offered two development scenarios – optimistic (the growth rate corresponds to 15 per cent a year) and pessimistic (the growth rate corresponds to 10 per cent a year).

Then we obtained two curves extended until 2015 by means of the logistic regression (see formula 1). The MATHCAD software was used for these calculations. As the shape of the logistic curve is influenced by all the data points, it can be very useful to exclude some points at earlier diffusion stages; this is what we did in this case.

As we can see, by the year 2015 the penetration rate of computers in Latvia would reach 50 per cent according to the pessimistic scenario, and almost 70 per cent according to the optimistic scenario. The results of our calculations are shown in Table 3, and their graphical presentation – in Figure 3.

All three methods gave similar results. Basing on this, we can conclude that the number of computers per 100 inhabitants would increase to 40-45 per cent by 2010 and to 60-65 per cent by 2015.

Table 3. Forecasting the number of computers per 100 inhabitants by the Delphi method and the logistic curve

Original Data		**Delphi**		**Logistic Curve**	
Year	Value	Optimistic Case	Pessimistic Case	Optimistic Case	Pessimistic Case
1990	0,1			1,2	2,4
1991	0,1			1,5	2,9
1992	0,2			1,8	3,5
1993	0,2			2,3	4,1
1994	0,3			2,9	4,9
1995	0,8			3,6	5,7
1996	2			4,4	6,8
1997	4			5,5	7,9
1998	6,1			6,8	9,3
1999	8,2			8,4	10,8
2000	14			10,3	12,5
2001	15,3			12,6	14,5
2002	17,2			15,3	16,6
2003	18,8			18,3	18,9
2004	21,9			21,8	21,4
Forecasts					
2005		25,2	24,1	25,8	24,1
2006		29,0	26,5	30,1	26,8
2007		33,3	29,1	34,6	29,7
2008		38,3	32,1	39,4	32,5
2009		44,0	35,5	44,3	35,4
2010		50,7	38,8	49,1	38,2
2011				53,7	40,9
2012				58,0	43,5
2013				62,0	45,9
2014				65,6	48,1
2015				68,8	50,1

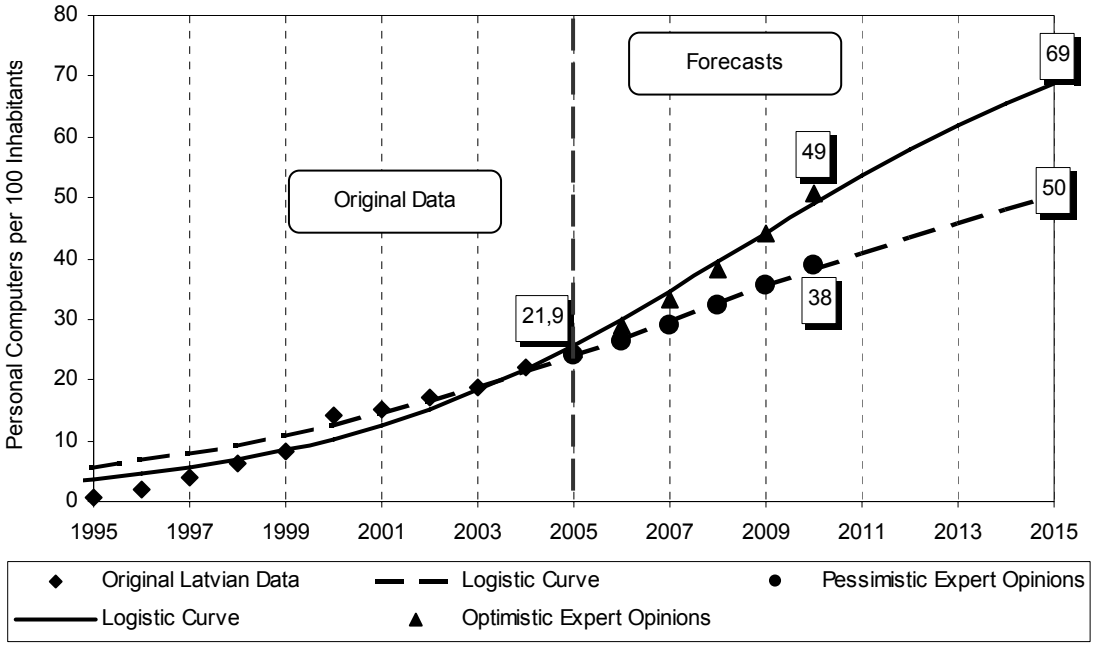


Figure 3. *Forecasting the number of computers per 100 inhabitants by the Delphi method and the logistic curve*

3.2. Internet Access

The analogy with Denmark and Sweden was applied again in order to forecast the number of Internet users in Latvia. As it is shown in Figure 4, by 2010 the penetration rate of Internet users in Latvia might exceed 75 per cent. The second forecast was obtained by means of the logistic model (see Figure 5). In our case the second forecast practically coincides with the first one – by 2010 the number of Internet users per 100 inhabitants can reach 80. It can be seen that this parameter would increase by more than 40 per cent as compared to the present value, and would practically reach its limit, after which it would continue to increase only slightly.

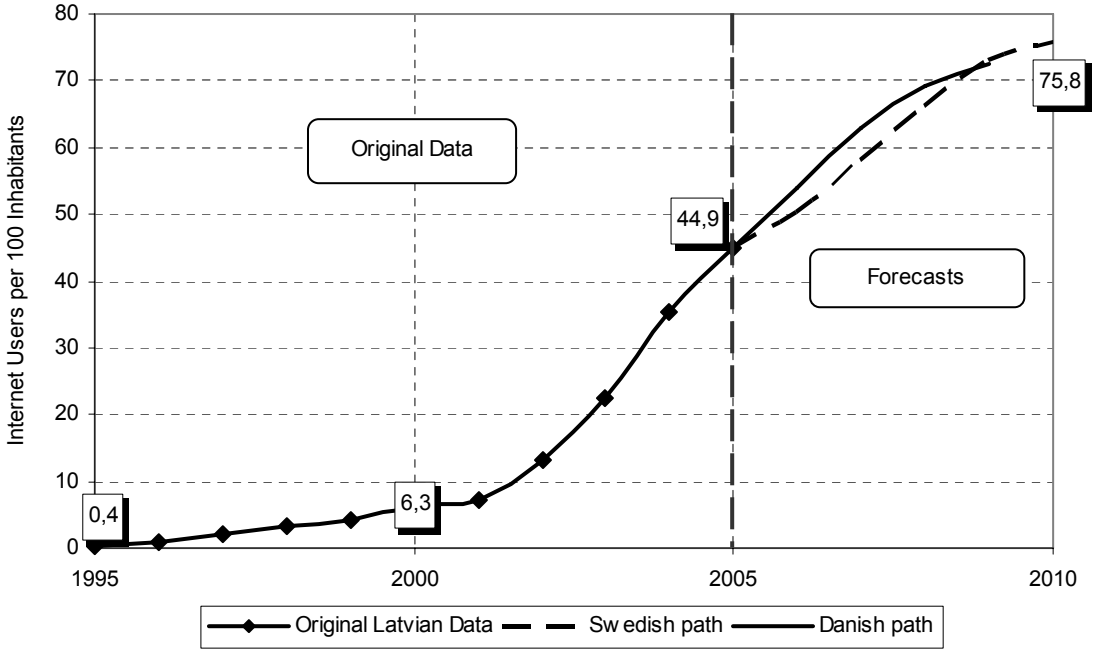


Figure 4. *Forecasting the number of Internet users per 100 inhabitants in Latvia by the analogy method*

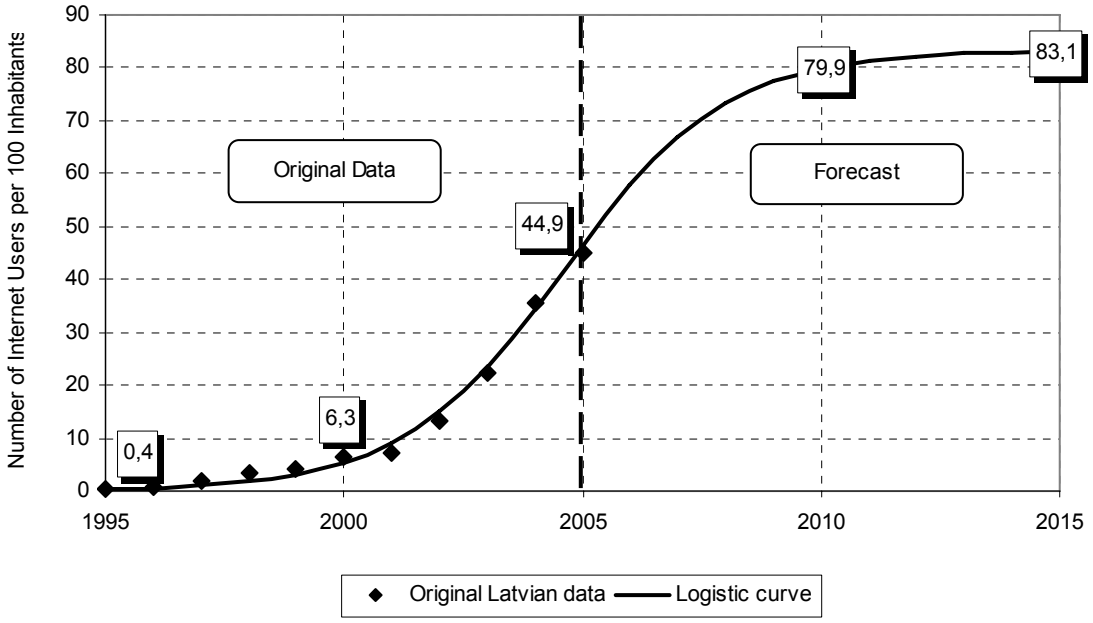
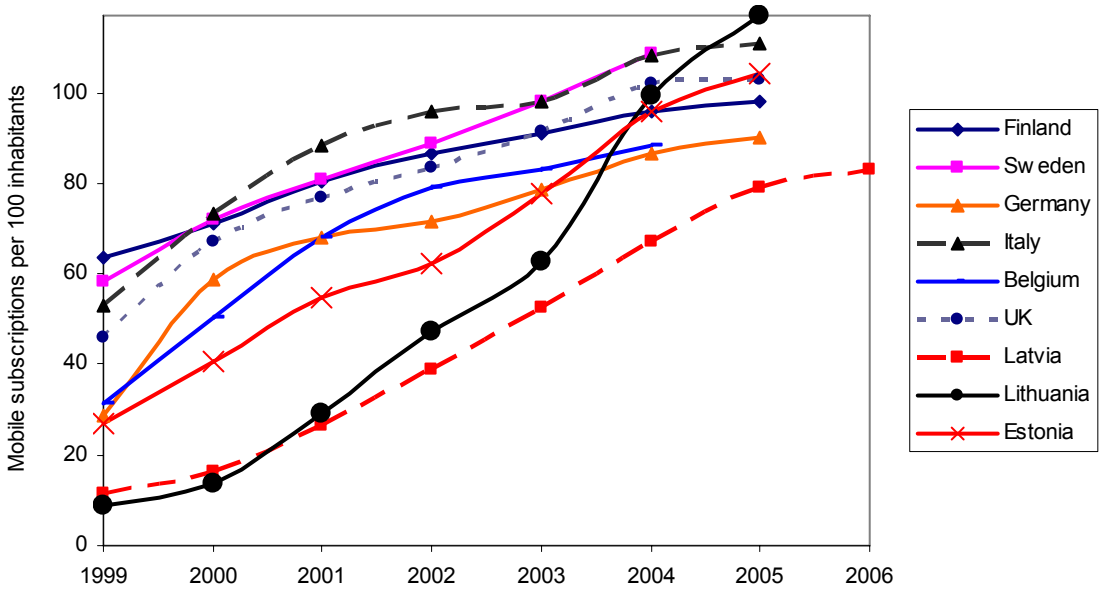


Figure 5. *Forecasting the number of Internet users per 100 inhabitants in Latvia by the logistic curve*

3.3. Mobile Telephony

At present the penetration rate of mobile subscriptions in Latvia equals to 88 per cent (see Figure 6). The development gap of mobile radio communications between Latvia and the „old" EU countries is only two-three years. Therefore, in this case the forecasting by analogy with other countries cannot give a long-term forecast. The method of the logistic curve (Fisher-Pry method) was applied in order to forecast the number of mobile subscriptions by 2015. Apparently, already in 2008 this parameter would exceed 100 per cent, but in 2015 it would reach 130 subscriptions per 100 inhabitants (see Figure 7).



Source: Eurostat, Telecommunication Association of Latvia

Figure 6. *The number of mobile subscriptions per 100 inhabitants*

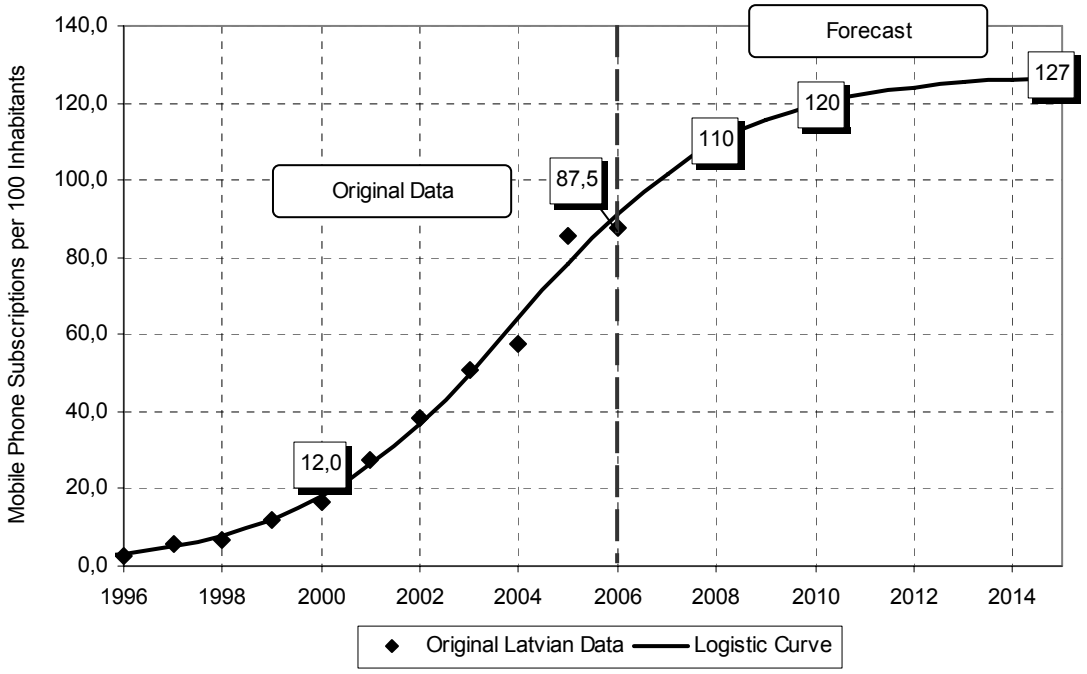


Figure 7. *Forecasting the number of mobile subscriptions per 100 inhabitants by the logistic curve*

CONCLUSIONS

Forecasting of technology development is a complicated task which requires a complex approach. Reliable results, which would turn out to be true in the future, can be obtained only by using a whole set of methods.

Developing a forecast by analogy, it is important to choose carefully the country to be analysed, taking into account its socio-economic conditions. In our case, in order to forecast the number of computers and Internet users, we chose those countries where values of these parameters increased evenly and smoothly, without sudden changes. It is important to keep in mind that diffusion of any technology can be directly influenced by political decisions of the government and purposeful regulatory policy. We can see such situation, for example, in Estonia where the number of computers per 100 inhabitants increased by more than two times during the period from 2002 to 2003 (see Figure 1).

As regards mobile telephony, the European Commission constantly emphasizes that the mobile telephony services are available to all the inhabitants of the European Union. However, one should not confuse country-wide accessibility of the infrastructure and financial availability of services. A penetration rate which exceeds 100 per cent does not mean that all 100 percent of the population of a country use the services of mobile telephony as one subscriber may have several subscriptions. In any case, we adhere to the opinion that by the year 2010-2015 at least 5-10 per cent of all the inhabitants of Latvia will not have access to mobile telephony because of its financial unavailability for them.

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