Paper

Diversity of Temporal and Territorial Social Penetration Rates of Information Technology in Europe

Beata Ziewiec

Abstract—This paper presents the diversity of social penetration rates of information and communication technologies (ICT) among selected European countries according to European statistics on diverse ICT indicators. The data considered cover the 2006–2010 time range and was obtained from the Eurostat portal. The scope of the study selected EU countries – Belgium, Germany, France, Finland, Sweden, Bulgaria, Czech Republic, Poland, Slovenia, Spain. The following ICT indicators were analyzed: percentage of households or corporations with broadband access to the Internet (HHBAI), percentage of individuals who are regularly using the Internet (IRUI), percentage of individuals who ordered goods or services over the Internet (IOGSI). These indicators of ICT penetration rate in the countries examined were analyzed in terms of the following aspects: forecasting (estimates until the year 2035), maximum speed of change of these indicators (the pace of social penetration of information technology), delays or advances (in years) as compared to the averages in EU. The results are presented in tables and graphs. General conclusions and directions of future research are indicated at the end of the paper.

Keywords—ICT technology, maximum speed and delays or advances of social penetration rate of information technology, social penetration rate of information technology.

1. Introduction

There is a number of commonly accepted indicators, generally called the ICT indicators, that characterize the scale of adoption of new information technologies in societies of a new civilization – called information society, or network or knowledge civilization [1]. Indicators illustrating progress in the digitalization of the economic and social life of a country are associated with various business areas, such as the overall level of development of the country (e.g., estimated on the basis of their gross domestic product per capita, or some quality of life indicators), Internet access, Internet-based social activities in business, government, education and others.

The development of information society is a continuous and progressive process. However, it is a long term process while the speed and efficiency of this development depend not only on the level of technical infrastructure and efficiency of the telecommunications market. Both these factors generally allow access to the Internet and its various information resources and services. But the role of government policy in this area is undeniable. Government policy influences the digitalization of the economy and this in turn translates into offering new services using new ICT techniques. The development of new services contributes to the development of the economy and in the result – to the development of the information society.

The paper presents an analysis of the dynamics of the development of several selected ICT indicators – the percentage share of households with the access to the broadband Internet, the scale of purchases made by and commercial use of the Internet, and the percentage of individuals accustomed to a regular use of the Internet for diverse purposes (obtaining information, educational activities etc.).

The informational revolution – related to the fast development and slower social acceptance of ICT technologies – resulted in diverse new social phenomena, not all being positive. One of the most important negative phenomena is the so called "digital divide" or digital exclusion, an increasing social exclusion related to inability of using information technologies. This phenomenon has also temporal and territorial diversity and requires a deeper study. However, this paper does not address the problem of analysis and comparison of the digital divide in various European countries. An optimistic assumption (perhaps too optimistic) is that the level of saturation of diverse ICT indicators will eventually reach 100%. The possibility of smaller estimates of the saturation of these indicators and related analysis of digital exclusion will be the subject of further work. In the following sections of this article, the dynamics of social rate of penetration of ICT technologies is analyzed, while including in this analysis selected indicators of ICT penetration and a comparison of selected EU countries, together with an assessment of the place of Poland in such comparisons.

2. Area and Scope of Research and Analysis

The analysis was based on Eurostat data[1]. The historical data available concern the dates of 2006–2010 years. This six year period might be deemed as too short for reliable predictions, but it will be shown that the statistical significance of the obtained predictions is high. The results are presented in national terms, in order to demon-

[1] http://epp.eurostat.ec.europa.eu/

strate the diversity of rate of absorption (penetration) of selected social indicators of ICT in selected European Union countries.
As representatives of the Nordic countries, Sweden and Finland were selected. The core of EU is represented by France, Belgium and Germany. These two groups of countries are also counted as a group of the economically most developed EU countries. Less developed are: a group of post-communist countries of Middle-East Europe, with selected representatives: Poland, Slovenia, Czech Republic. Bulgaria was selected as the representative of Southern Europe group of former communist countries. In addition, Spain was selected to represent Southern Europe and the Iberian Peninsula.
The rate of penetration of ICT is examined in terms of the following aspects:

- Forecasting (with estimations of data until 2025).
- Analysis of the maximum speed the rate of social penetration of information technology (counted for estimated data, in order to smooth out statistical divergences).
- Analysis of delays or advances as compared to the averages of European Union.

In summary, a discussion of the place of Poland in terms of the rate of absorption of new information technologies in comparison to selected countries and to the average value calculated for the 27 EU countries.
The following indicators of ICT penetration were analyzed:

– households with broadband access to the Internet (HHBAI),
– individuals who regularly are using the Internet (IRUI),
– individuals who ordered goods or services over the Internet (IOGSI).

There are diverse models that can be used to estimate the development characterized by temporal data, see the analysis of different models in [2], [3]. The classical logistic function method was selected and thus the data were estimated by the formula:

$$v_2 = a/\left(1 + b\exp(-cv_1)\right)$$

with v_1 representing the time (in years) and v_2 – a selected ICT indicator, coefficients b and c determined by using the software package "Statistica 8". After estimation, it is possible to compute the maximal speed of change:

$$V_{\max} = ac/4\,.$$

The source data covers the period 2003–2010, the estimations were computed for the period 1991–2025. The coefficient a was optimistically assumed $a = 100\%$, while it is admitted that this assumption requires further detailed analysis, particularly when addressing the problem of digital divide, cf. [3].

3. Estimation of Development Curves

3.1. HHBAI Indicator

Raw data were drawn from the database Eurostat – presenting the percentage of households with broadband access to the Internet, called HHBAI indicator. These data are available for years 2006–2010 (Table 1).

Table 1
Historical data by Eurostat for the HHBAI indicator, [%]

Country/Year	2006	2007	2008	2009	2010
Belgium	0.0	0.0	59.6	62.9	69.3
Bulgaria	9.1	14.0	19.5	25.1	24.9
Czech Republic	0.0	27.8	36.1	49.0	53.6
Finland	52.4	61.9	65.0	72.4	75.4
France	0.0	0.0	53.8	54.1	64.9
Germany	38.0	53.6	51.7	61.5	73.3
Poland	0.0	29.2	38.0	51.2	57.0
Slovenia	0.0	0.0	50.0	56.0	62.0
Spain	29.2	38.5	43.7	49.9	56.8
Sweden	0.0	0.0	70.0	78.3	81.3
Av. EU 27	33.0	41.4	46.8	54.1	58.4

As a result of estimation by the logistic function Eq. (1), the estimated data presented in Table 2 were obtained. The estimation period starts with 1991, in order to illustrate the beginnings of development for which there are no historical data, and ends with forecasted data for 2025. In the analysis shown by next figures we see that the estimated data revolve closely around or even coincide with historical data. This confirms the preliminary estimation accuracy. Moreover, the estimated results have a 95% confidence level (the "Statistica" program has a built-in mechanism to analyze the confidence levels). It should be also noted that the phenomenon studied concerns a long term development, slow but showing clear trends. Of course, a different model, cf. [3], possibly with an independent evaluation of the coefficient a, might give different results, but except for the problem of digital divide the estimations presented in Table 2 are significant.
Estimations of data for the HHBAI indicator, concerning households with broadband Internet access, show significant differences in the rate of penetration between countries. Figure 1 presents the graphs of the logistic function for HHBAI in the countries studied.
We see that while Belgium starts first, it has a slow development, whereas Sweden starts from lower levels but much faster and becomes the best; Finland is slightly slower. Definitely the worst results, according to the logistic function prediction of the HHBAI rate of penetration, were shown for Bulgaria in the post-communist region of Southern Europe. The strongest penetration according to the HHBAI indicator, as shown by graphs, have Scandinavian and core EU countries. The penetration in Poland, compared with

Table 2
Estimated data for the HHBAI indicator, [%]

Year/ Country	Belgium	Bulgaria	Czech Republic	Finland	France	Germany	Poland	Slovenia	Spain	Sweden	Av. EU 27
1991	4	0	0	2	2	1	0	2	1	1	1
1992	5	0	0	3	3	1	0	2	1	1	1
1993	6	0	0	4	4	1	0	2	1	2	2
1994	7	0	0	5	4	1	0	3	2	2	2
1995	9	1	0	6	5	2	0	4	2	3	3
1996	11	1	1	8	7	3	0	5	3	5	4
1997	13	1	1	10	8	3	1	6	4	6	5
1998	15	1	1	13	10	5	1	8	5	9	6
1999	18	2	2	16	12	6	2	10	6	11	8
2000	21	2	3	20	15	9	2	12	8	15	10
2001	25	3	4	24	18	12	4	15	10	20	12
2002	29	4	6	29	22	15	5	19	13	26	16
2003	34	5	8	35	26	20	8	23	16	32	19
2004	39	7	11	41	30	26	11	27	20	40	24
2005	44	9	16	47	35	32	16	32	25	48	29
2006	49	11	21	54	41	40	22	38	31	56	34
2007	54	14	28	60	46	48	30	44	37	63	40
2008	59	18	37	66	52	56	39	50	43	71	47
2009	64	22	46	71	58	64	49	56	50	77	53
2010	69	27	55	76	63	71	59	62	57	82	59
2011	73	33	64	81	68	77	68	68	64	86	66
2012	77	39	73	84	73	82	76	73	70	90	71
2013	80	46	79	87	77	86	83	77	75	92	76
2014	83	53	85	90	81	90	88	81	80	94	81
2015	86	59	89	92	84	92	91	85	84	96	84
2016	88	66	92	94	87	94	94	88	87	97	87
2017	90	71	95	95	89	96	96	90	90	98	90
2018	92	77	96	96	91	97	97	92	92	98	92
2019	93	81	97	97	93	98	98	94	94	99	94
2020	95	85	98	98	94	98	99	95	95	99	95
2021	96	88	99	98	95	99	99	96	96	99	96
2022	96	91	99	99	96	99	99	97	97	100	97
2023	97	93	99	99	97	99	100	98	98	100	98
2024	98	94	100	99	98	100	100	98	98	100	98
2025	98	96	100	99	98	100	100	98	99	100	99

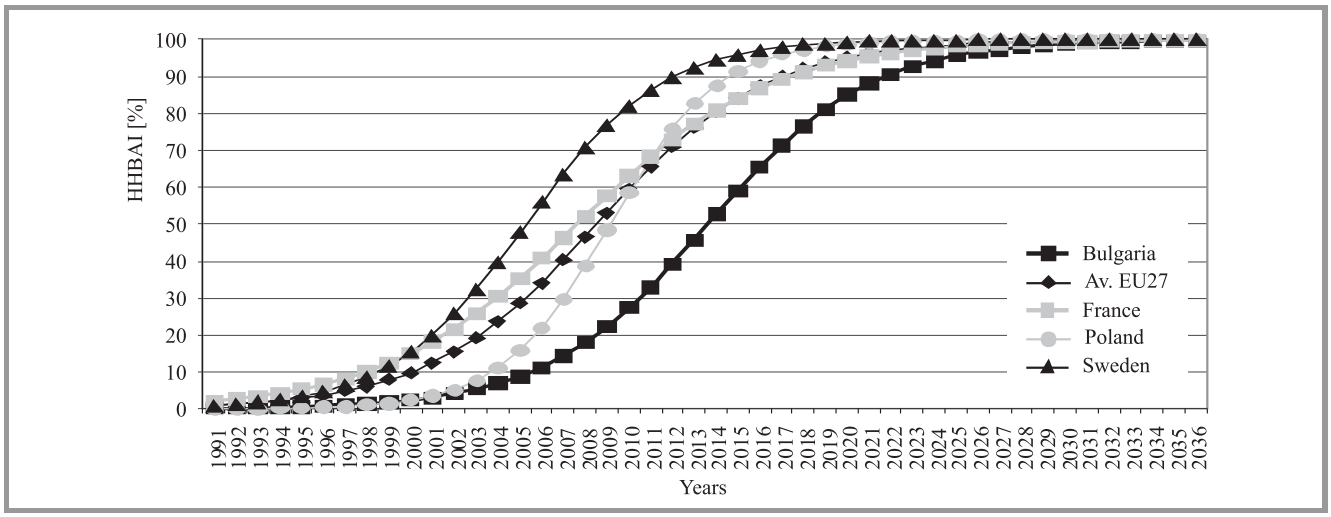

Fig. 1. Estimated data for the HHBAI indicator.

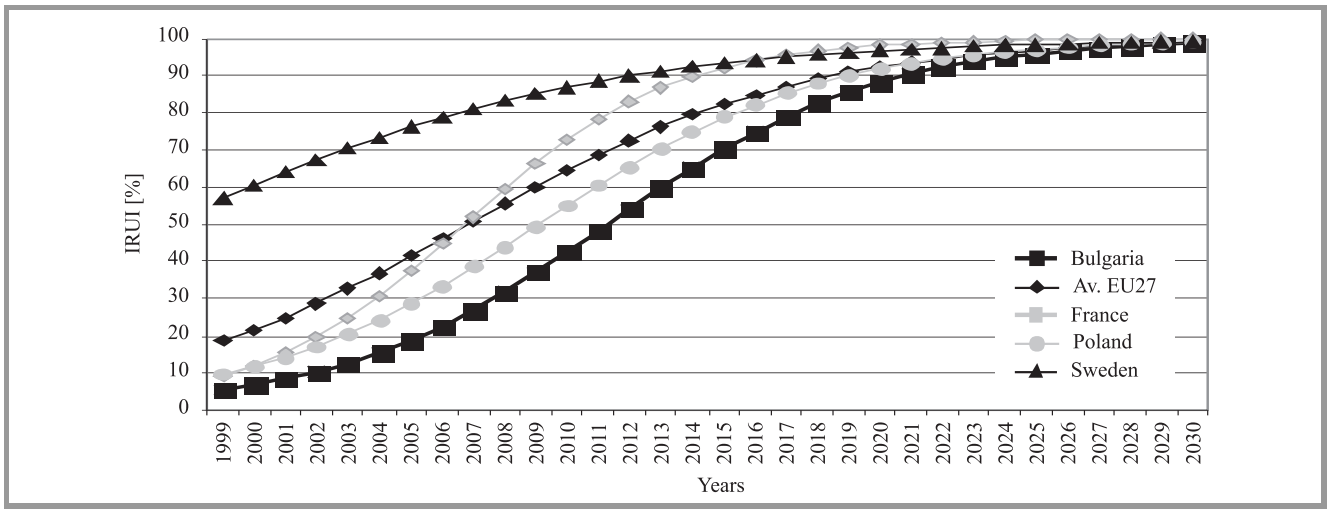

Fig. 2. Estimated data for the indicator IRUI.

Table 3
Historical data by Eurostat for the IRUI indicator, [%]

Country/Year	2003	2004	2005	2006	2007	2008	2009	2010	2011
Belgium	0.0	0.0	53.0	58.0	63.0	66.0	70.0	75.0	78.0
Bulgaria	0.0	13.0	0.0	22.0	28.0	33.0	40.0	42.0	46.0
Czech Republic	20.0	25.0	26.0	36.0	42.0	51.0	54.0	58.0	63.0
Finland	58.0	63.0	62.0	71.0	75.0	78.0	79.0	83.0	86.0
France	0.0	0.0	0.0	39.0	57.0	63.0	65.0	75.0	74.0
Germany	44.0	50.0	54.0	59.0	64.0	68.0	71.0	75.0	77.0
Poland	0.0	22.0	29.0	34.0	39.0	44.0	52.0	55.0	58.0
Slovenia	0.0	33.0	40.0	47.0	49.0	52.0	58.0	65.0	64.0
Spain	29.0	31.0	35.0	39.0	44.0	49.0	54.0	58.0	62.0
Sweden	69.0	75.0	76.0	80.0	75.0	83.0	86.0	88.0	91.0
Av. EU 27	0.0	36.0	43.0	45.0	51.0	56.0	60.0	65.0	68.0

the average measured for the 27 EU countries, occurs in two phases. In the first phase Poland is below the European average, in 2010–2013 it catches up to the average and strongly accelerates to achieve predicted results above the EU-27 average in the second phase of development.

3.2. IRUI Indicator

Primary data for the IRUI indicator were obtained from the Eurostat base and they represent the percentage of all users between the ages of 16–74 years, who have access to the Internet and regularly use it (assuming average – at least 1 time per week; all access methods and every possibility of using from the network, e.g., Internet cafes, were taken into consideration). These data, available for the years 2003–2011 (Table 3), were estimated by the logistic function Eq. (1) for the period 1991–2025 year (even until 2035, but in Table 4 are shown only data until 2025). The estimated data were again (similarly as in the case of HHBAI indicator) very closely oscillating around, or even coinciding with historical data, and the confidence level was over 95%. Thus except for the issue of digital divide, the data in Table 4 are highly significant.

Estimations of data for the IRUI indicator, concerning a regular use of the Internet, show significant differences between the social rate of penetration of information technologies in European Union. The graphs of the logistic function for IRUI and for the countries examined are presented in Fig. 2.

We see that Sweden and Finland are the best in this indicator, although France develops very fast and might overtake them after 2018. Again, the least developed between the examined countries and with a very slow rate of development is Bulgaria. Poland is not much better, with a similar curve to Bulgaria, only shifted in time ahead by two to three years, but Poland is similarly delayed to the European Union average, as Bulgaria is to Poland.

3.3. IOGSI Indicator

Raw data were obtained from Eurostat database for IOGSI indicator that shows the percentage of users purchasing goods and services over the Internet. These data were available for years 2002–2010 (Table 5).

Above data were estimated by the logistic function for the period 1991–2025 (again, even to 2035, but only data until 2025 are shown in Table 6). The estimated data are

Table 4
Estimated data for the HHBAI indicator, [%]

Year/ Country	Belgium	Bulgaria	Czech Republic	Finland	France	Germany	Poland	Romania	Slovenia	Spain	Sweden	Av. EU 27
1991	7	1	1	16	1	9	2	1	5	5	29	5
1992	9	1	2	18	1	11	2	1	6	6	32	6
1993	11	1	2	21	2	13	3	1	7	7	36	7
1994	12	2	3	24	2	15	3	2	8	8	39	8
1995	15	2	3	27	3	17	4	2	9	9	43	10
1996	17	3	4	31	4	20	5	3	11	11	46	11
1997	20	3	6	34	5	23	6	3	13	13	50	14
1998	23	4	7	38	7	26	8	4	15	15	54	16
1999	27	5	9	42	9	30	10	5	18	17	57	19
2000	31	7	11	46	12	34	12	6	21	20	61	22
2001	35	8	14	51	15	38	14	7	24	22	64	25
2002	39	10	17	55	20	42	17	8	27	26	67	29
2003	44	13	20	59	25	46	20	10	31	29	71	33
2004	48	16	25	63	31	50	24	12	35	33	73	37
2005	53	19	30	67	38	55	29	15	40	36	76	41
2006	58	23	35	71	45	59	33	18	44	40	79	46
2007	62	27	41	74	52	63	39	21	49	45	81	51
2008	67	32	47	77	60	67	44	25	53	49	83	55
2009	71	37	53	80	66	71	49	29	58	53	85	60
2010	74	43	59	82	73	74	55	34	62	57	87	65
2011	78	48	65	85	78	78	60	39	67	62	89	69
2012	81	54	71	87	83	81	66	44	71	65	90	73
2013	84	60	75	89	87	83	70	49	74	69	91	76
2014	86	65	80	90	90	86	75	55	78	73	92	79
2015	88	70	83	92	92	88	79	60	81	76	93	82
2016	90	75	87	93	94	89	82	65	83	79	94	85
2017	92	79	89	94	96	91	85	70	86	82	95	87
2018	93	83	91	95	97	92	88	74	88	84	96	89
2019	94	86	93	96	98	93	90	78	90	86	96	91
2020	95	88	95	96	98	94	92	81	91	88	97	92
2021	96	91	96	97	99	95	93	84	93	90	97	94
2022	97	92	97	97	99	96	95	87	94	91	97	95
2023	97	94	97	98	99	97	96	89	95	93	98	95
2024	98	95	98	98	99	97	97	91	96	94	98	96
2025	98	96	98	98	100	98	97	93	96	95	98	97

Table 5
Historical data by Eurostat for the IOGSI indicator, [%]

Country/Year	2002	2003	2004	2005	2006	2007	2008	2009	2010
Belgium	0.0	0.0	0.0	11.0	14.0	15.0	14.0	25.0	27.0
Bulgaria	0.0	0.0	1.0	0.0	2.0	2.0	2.0	3.0	3.0
Czech Republic	0.0	3.0	3.0	3.0	7.0	8.0	13.0	12.0	15.0
Finland	11.0	14.0	24.0	25.0	29.0	33.0	33.0	37.0	41.0
France	0.0	0.0	0.0	0.0	19.0	26.0	28.0	32.0	42.0
Germany	17.0	24.0	29.0	32.0	38.0	41.0	42.0	45.0	48.0
Slovenia	0.0	0.0	4.0	8.0	8.0	9.0	12.0	14.0	17.0
Spain	2.0	5.0	5.0	8.0	10.0	13.0	13.0	16.0	17.0
Sweden	24.0	21.0	30.0	36.0	39.0	39.0	38.0	45.0	50.0
Av. EU 27	0.0	0.0	15.0	18.0	20.0	23.0	24.0	28.0	31.0

Table 6
Estimated data for the IOGSI indicator, [%]

Year/ Country	Belgium	Bulgaria	Czech Republic	Finland	France	Germany	Poland	Slovenia	Spain	Sweden	Av. EU 27
1991	0	0	0	2	1	4	0	0	0	6	2
1992	1	0	0	3	1	5	0	0	1	7	2
1993	1	0	0	3	1	6	0	1	1	8	2
1994	1	0	0	4	1	7	0	1	1	9	2
1995	1	0	0	5	1	8	0	1	1	10	3
1996	1	0	1	6	2	9	0	1	1	12	3
1997	2	0	1	7	2	11	1	1	2	13	4
1998	2	0	1	8	3	13	1	1	2	15	5
1999	3	0	1	9	4	15	1	2	2	17	5
2000	3	0	1	11	5	17	1	2	3	19	6
2001	4	1	2	13	6	19	2	3	3	21	7
2002	5	1	2	15	8	22	3	3	4	24	9
2003	7	1	3	18	10	25	3	4	5	26	10
2004	8	1	4	20	13	28	4	5	6	29	12
2005	10	2	5	23	16	31	6	6	7	32	13
2006	12	2	6	27	19	35	8	8	9	35	15
2007	15	3	8	30	24	38	10	10	11	39	18
2008	19	4	10	34	29	42	13	12	13	42	20
2009	22	6	13	38	34	46	17	14	16	46	23
2010	27	7	16	42	40	50	21	17	18	49	26
2011	32	10	20	47	47	54	26	20	22	53	29
2012	37	13	24	51	53	58	32	24	25	56	33
2013	43	17	29	56	59	62	39	28	29	60	36
2014	48	21	35	60	65	66	46	33	34	63	40
2015	54	27	41	64	71	69	53	38	39	66	44
2016	60	34	47	68	76	73	60	43	44	70	48
2017	66	41	54	72	80	76	67	48	49	72	52
2018	71	48	60	75	84	79	73	54	54	75	56
2019	75	56	66	78	87	81	78	59	59	78	60
2020	79	63	71	81	90	84	83	64	64	80	64
2021	83	70	76	84	92	86	86	69	68	82	68
2022	86	76	81	86	94	88	90	73	73	84	71
2023	89	81	84	88	95	89	92	78	76	86	75
2024	91	85	88	90	96	91	94	81	80	88	78
2025	93	89	90	91	97	92	95	84	83	89	80

again (similarly as for HHBAI and IRUI) very close to historical data and with high confidence level. This fact confirms the estimation accuracy again, except for the issue of digital divide, see Table 6.

Estimations of data for the IOGSI indicator that concern purchases of goods and services made by the Internet, show significant differences in the rate of social penetration of this indicator between examined countries. Figure 3 shows the graphs of the logistic function for the examined countries.

There is a large disparity between EU countries according to IOGSI indicator, even greater than for HHBAI and IRUI indicators. Sweden and Germany are the best, but France might soon overtake them. Bulgaria is again on the weakest position among the tested ten EU countries. However, the development of this index in Bulgaria is fast and it appears that after the year 2020, the percentage of users purchasing goods and services over the Internet in Bulgaria might reach the average level of EU 27, and then – might rise above the average, overtaking even Slovenia and Spain.

Second to last place in the IOGSI index, just before Bulgaria, would be the Czech Republic. However, the Czech Republic accelerates its IOGSI development in recent years, has fast growth of the IOGSI logistic curve, which might result in overtaking the European Union average around 2017. Not much better results than for the Czech Republic can be recorded for Spain – slightly higher today, but much slower in development, thus overtaking the EU average around 2021.

Sweden played the leading role in IOGSI index until 2008. Starting with 2009, Germany is gradually beginning to overtake the Scandinavian countries in the intensity of their purchases of goods and services over the Internet. However, the fastest development in the Internet commerce has

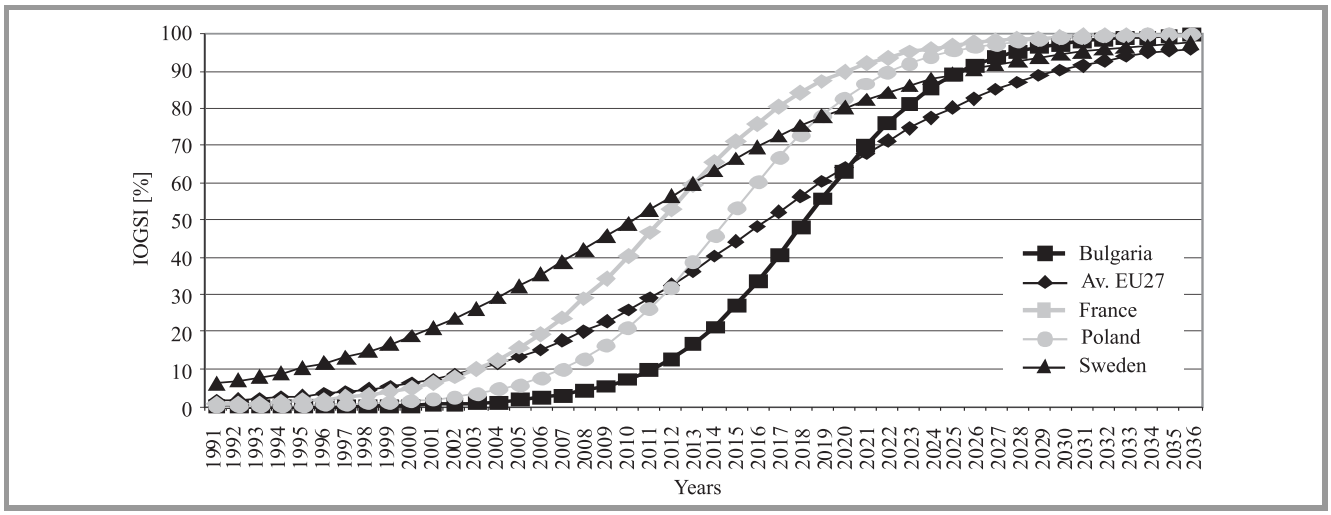

Fig. 3. Estimated data for the indicator IOGSI.

France that might overtake Germany around 2014–2015, to become the undisputed leader in IOGSI indicator.

Poland has also very fast, similar to France, development of IOGSI indicator, although starting at a lower level. Poland might achieve the average EU 27 already currently, in 2012, and in 2015 even overtake a core EU country – Belgium. Even more surprising is the fact that Poland might overtake in the year 2019 Sweden, an undisputed leader in other indicators. Thus, from 2020, according to estimation by the logistic function, leading countries in Europe in the number of users purchasing goods and services over the Internet, might be France – representing the core EU countries and right behind her Poland representing former communist countries of Central and Eastern Europe.

4. The Maximum Speed of Social Penetration of Information Technology

The formula (2) was used to determine the maximal speed of change (smoothed out of statistical perturbations) of the three indicators (HHBAI, IRUI, IOGSI) of social ICT penetration. Since we assume $a = 100\%$, the estimated parameter c determines this speed that is counted in % per year. In [3] it was observed that, for processes of social penetration of new technologies, this speed is strongly limited and rarely exceeds 10% per year. While using the results of estimations from previous section, the following Table 7 is easily computed.

We observe that the maximum speeds, even if they confirm the general conclusion of [3], are very diversified. For HHBAI indicator, fastest development is observed in Poland and Czech Republic; for IRUI, in France and Czech Republic, while the absolute values of the speeds are lower; for IOGSI, fastest development is observed in Bulgaria and Poland. This is illustrated in Figs. 4–6.

Table 7
Maximum speeds of development for indicators, [%]

Country	HHBAI	IRUI	IOGSI
Belgium	5.2	4.7	5.9
Bulgaria	6.8	5.8	7.7
Czech Republic	9.5	6.2	6.5
Finland	6.4	4.2	4.4
France	5.7	7.5	6.4
Germany	8.1	4.4	4.1
Poland	10.1	5.6	7.2
Slovenia	6.1	4.6	5.4
Spain	6.9	4.3	5.1
Sweden	8.1	3.7	3.6
Av. EU 27	6.4	4.7	5.2

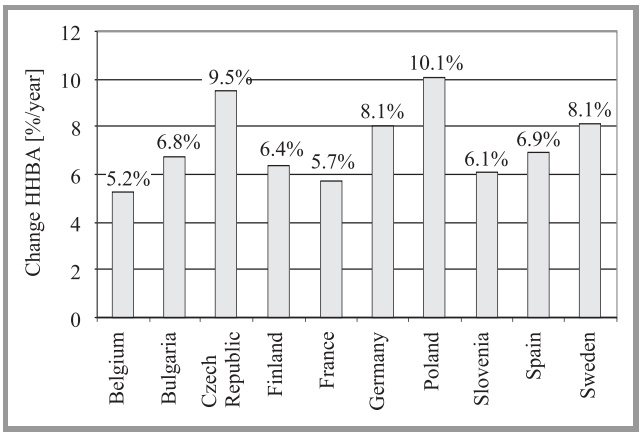

Fig. 4. Maximum annual rate of change for the HHBAI indicator.

Thus the maximal speed of growth of HHBAI indicator is in the range 10.1% per year (Poland) – 5.2% per year (Belgium). The same range for IRUI indicator is 7.5% per year (France) – 3.7% per year (Sweden); for IOGSI indicator 7.7% per year (Bulgaria) – 3.6% per year (Sweden).

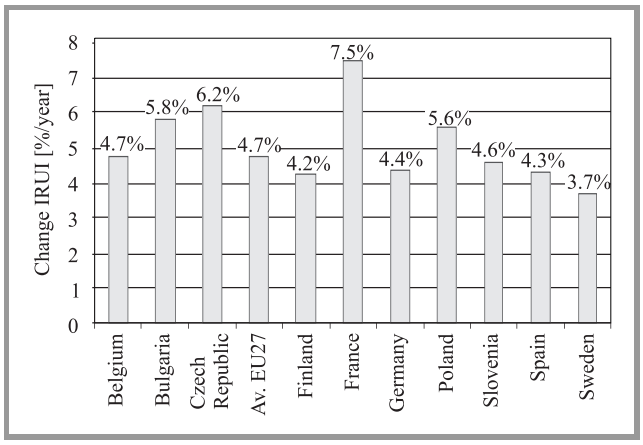

Fig. 5. Maximum annual rate of change for the IRUI indicator.

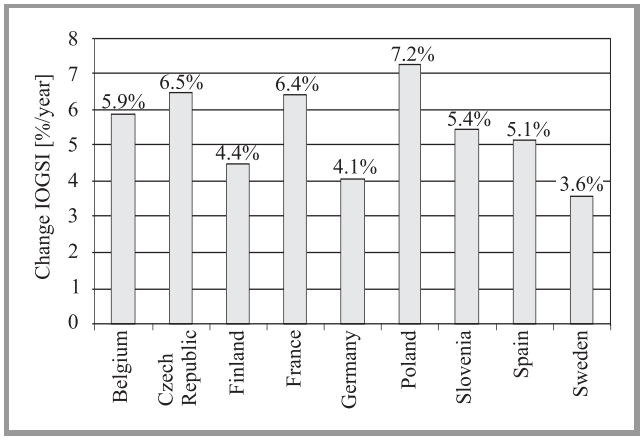

Fig. 6. Maximum annual rate of change for IOGSI indicator.

It can be concluded that even if the range of statistical data is rather limited (six to seven years), the forecasts using logistic curves can give quite interesting information with high confidence. Statistics on the development of ICT indicators were apparently not carried out before 2002 (or even before 2006 for HHBAI indicator), and we can judge upon earlier developments only by backward "forecast" – estimated logistic values for earlier times. For example, the estimation of the HHBAI for the year 2001, see Table 2, indicate, that Belgium and France had the largest percentages of households with broadband internet access – and considerable above the average EU27, while Poland and Bulgaria were well below average.

All the above analysis indicates that while the starting situation was very diversified, countries such as Poland or even Bulgaria do catch up, with smaller or larger delays, which will be analyzed in the next section.

5. Advances and Delays in Comparison to the Current EU Average

To determine the delay or advance of an EU country, we can use diverse approaches, e.g., compare the estimated time of reaching a given threshold. However, the simplest approach is to assume that the threshold is the current average calculated for the 27 EU countries, see [2], [3].

The data for selected European Union countries have been thus analyzed in terms of advances or delays in social penetration of ITC technologies, as compared to the average of the 27 EU countries, in terms of HHBAI, IRUI and IOGSI indicators. The resulting advances or delays for HHBAI indicator are presented in Table 8. The most interesting is the current result – for the year 2011 – when Sweden has 4 year advance over av. EU27, while Bulgaria has 6 year delay; Poland, due to recent fast development, has caught up with European average, better than Spain which has 1 year delay. Forecast for 2015 gives Poland 2 years advance over European average, while the advance of Sweden grows to 5 years, Spain maintains 1 year delay and Bulgaria reduces it's delay slightly to 5.5 years. Further forecasts – to 2020 – might be less reliable, but show an increasing advance of Poland and delay for such core European Union country as Belgium. These results are illustrated in Fig. 7.

For IRUI indicator, the resulting delays or advances of examined countries as compared to the EU27 average are shown in Table 9. We see that currently (2011) Sweden has the largest advance of 6 years, Poland and Spain have delays of 2.5 years, Bulgaria a delay of 5.5 years. Predicted for 2015 is a slight reduction of the delay of Poland to 2 years, while Spain maintains delay of 2.5 years. The situation will not change qualitatively until 2020, with a slight reduction of delay for Poland, a somewhat stronger reduction of delay for Bulgaria. It can be seen that IRUI indicator characterizes a weak point of Poland.

These results are illustrated in Fig. 8. It can be seen that France has the fastest development of IRUI indicator and will advance over EU27 average to over 10 years.

For IOGSI indicator, the resulting delays or advances of examined countries as compared to the EU27 average are shown in Table 10. We see that currently (2011) Sweden has 4.5 year of advance, while Bulgaria 8 years of delay, Czech Republic and Spain 3.5 years of delay, Poland only 1.5 years of delay. According to IOGSI indicator, Poland has a fast growth and in 2015 is predicted to have 1 year of advance, with growing advance until 2025.

These results are illustrated in Fig. 9. We can see the increasing forecasted advances of France and Poland.

6. General Conclusions

The examples of Belgium and Poland will be discussed here in more detail to stress the comparison of a core EU country and a post-communist EU country. The synthetic information for Belgium is summarized in Figs. 10, 11, and 12. We can see that Belgium is good on IRUI (social attitude to Internet) and HHBAI (broadband infrastructure), while it was delayed on IOGSI (broad social commercial use of Internet), but accelerates on IOGSI considerably.

Table 8
Advances and delays of the growth of HHBAI indicator as compared to the av. EU27 average, [year]
(negative entry denotes delay)

Year/ Country	Belgium	Bulgaria	Czech Republic	Finland	France	Germany	Poland	Slovenia	Spain	Sweden
1995	2.50	–5.00	–5.00	1.00	0.00	–4.50	–5.00	–2.00	–4.00	–2.50
1996	2.50	–6.00	–6.00	1.00	0.00	–5.00	–6.00	–1.50	–5.00	–2.00
1997	2.50	–6.50	–6.50	1.50	0.00	–4.50	–7.00	–1.00	–4.50	–1.00
1998	2.50	–7.50	–7.50	1.50	0.50	–4.00	–7.50	–1.00	–4.00	–0.50
1999	2.50	–8.50	–8.50	2.00	0.50	–3.00	–8.50	–1.00	–3.50	0.00
2000	2.50	–9.00	–9.00	2.00	0.50	–2.50	–9.00	–0.50	–3.00	0.50
2001	2.50	–9.00	–8.00	2.00	0.50	–2.00	–8.00	–0.50	–2.50	1.00
2002	2.00	–8.50	–7.00	2.00	0.50	–1.50	–7.00	0.00	–2.50	1.50
2003	2.00	–8.00	–6.00	2.50	0.50	–1.00	–6.00	0.00	–2.00	2.00
2004	2.00	–8.00	–5.00	2.50	0.50	–0.50	–5.00	0.00	–2.00	2.00
2005	2.00	–7.50	–4.00	2.50	0.50	0.00	–4.00	0.00	–1.50	2.50
2006	1.50	–7.00	–3.50	2.50	0.50	0.00	–3.50	0.00	–1.50	3.00
2007	1.50	–7.00	–3.00	2.50	0.50	0.50	–2.50	0.00	–1.00	3.00
2008	1.50	–6.50	–2.00	2.50	0.00	1.00	–2.00	0.00	–1.00	3.00
2009	1.00	–6.50	–2.00	2.50	0.00	1.00	–1.50	0.00	–1.00	3.50
2010	1.00	–6.00	–1.00	2.00	0.00	1.00	–1.00	0.00	–1.00	3.50
2011	0.50	–6.00	–1.00	2.00	0.00	1.50	0.00	–0.50	–1.00	4.00
2012	0.50	–6.00	–0.50	2.00	–0.50	1.50	0.00	–0.50	–1.00	4.00
2013	0.00	–6.00	0.00	2.00	–0.50	2.00	1.00	–0.50	–1.00	4.50
2014	0.00	–6.00	0.50	2.00	–1.00	2.00	1.00	–0.50	–1.00	5.00
2015	0.00	–5.50	1.00	2.00	–1.00	2.50	2.00	–1.00	–1.00	5.00
2016	–0.50	–5.50	1.50	2.00	–1.00	3.00	2.50	–1.00	–1.00	5.50
2017	–0.50	–5.50	2.00	2.50	–1.00	3.00	3.00	–1.00	–1.00	6.00
2018	–1.00	–5.50	2.50	2.50	–1.00	3.50	4.00	–1.00	–0.50	6.50
2019	–1.00	–5.50	3.00	2.50	–1.00	4.00	5.00	–1.00	–0.50	7.00
2020	–1.00	–5.50	4.00	3.00	–1.50	4.50	6.00	–1.00	–0.50	8.00
2021	–1.00	–5.50	5.00	3.00	–1.50	5.00	7.00	–1.00	0.00	8.50
2022	–1.00	–5.50	6.00	3.00	–1.50	6.00	8.00	–0.50	0.00	9.00
2023	–1.00	–5.50	6.50	3.50	–1.50	6.50	9.00	–0.50	0.50	10.00
2024	–1.50	–5.00	7.50	4.00	–1.50	7.00	10.00	–0.50	1.00	10.00
2025	–1.50	–5.00	8.50	4.00	–1.00	8.00	11.00	0.00	1.00	11.00

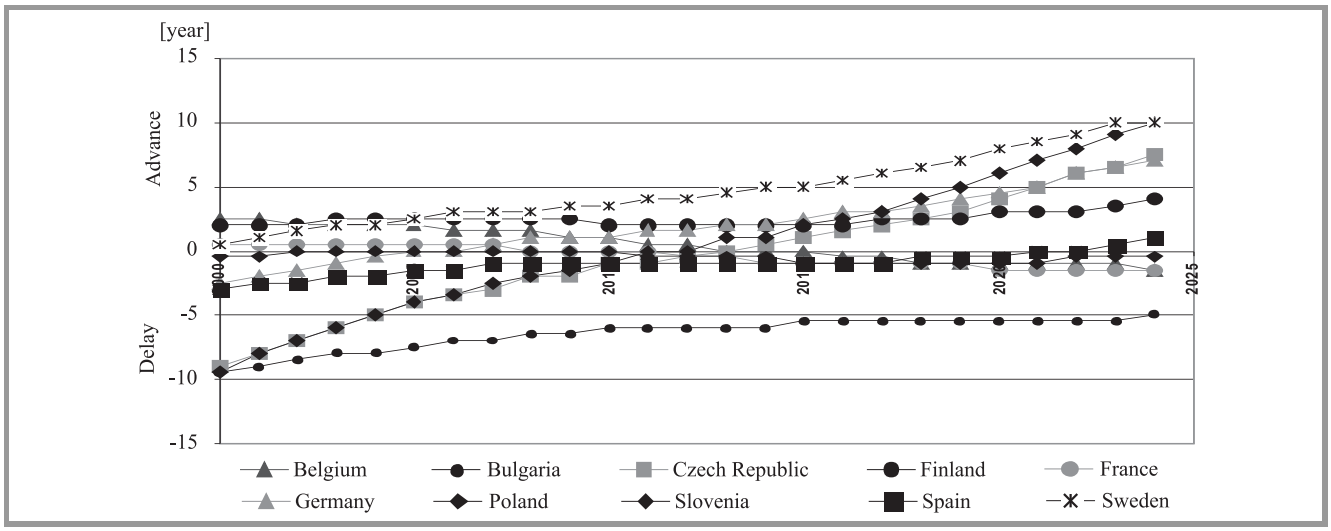

Fig. 7. Penetration of ICT in selected EU countries according to HHBAI indicator.

Table 9
Advances and delays of the growth of IRUI indicator as compared to the av. EU27, [year]
(negative entry denotes delay)

Year/ Country	Belgium	Bulgaria	Czech Republic	Finland	France	Germany	Poland	Slovenia	Spain	Sweden
1995	0.5	–9.5	5	–10.5	1.5	–8	–12.0	–3	–3	9
1996	0.5	–9	5	–9.5	2	–8	–11.5	–2.5	–2.5	9
1997	1	–8	5	–8.5	2	–7.5	–11.0	–2.5	–2.5	9
1998	1	–8	5	–8	2	–7	–11.0	–2	–2.5	9
1999	1	–7	5	–7	2	–6.5	–10.5	–2	–2.5	8.5
2000	1	–7	5	–6	2	–6	–10.0	–2	–2.5	8.5
2001	1.5	–6	5	–5	2	–6	–9.5	–2	–2.5	8
2002	1.5	–5.5	5	–4.5	2	–5.5	–9.0	–2	–2.5	8
2003	1.5	–5	5	–3.5	2	–5	–8.5	–1.5	–2	8
2004	1.5	–4.5	5	–3	2	–5	–8.0	–1.5	–2	7.5
2005	1.5	–4	5	–2	2	–4.5	–8.0	–1.5	–2	7.5
2006	2	–3.5	5	–1	2	–4	–7.5	–1.5	–2	7
2007	2	–3	5	–0.5	2	–4	–7.0	–1.5	–2	7
2008	2	–3	4.5	0	2	–3.5	–6.5	–1	–2	7
2009	2	–2.5	4.5	1	2	–3	–6.0	–1	–2.5	6.5
2010	2	–2	4.5	1.5	2	–3	–6.0	–1	–2.5	6.5
2011	2	–1.5	4.5	2	2	–2.5	–5.5	–1	–2.5	6
2012	2	–1	4.5	2.5	2	–2.5	–5.0	–1	–2.5	6
2013	2	–1	4	3	2	–2	–5.0	–1	–2.5	6
2014	2	–0.5	4	4	2	–2	–4.5	–1	–2.5	5.5
2015	2	0	4	4.5	1.5	–2	–4.0	–1	–2.5	5.5
2016	2	0	4	5	1.5	–1.5	–4.0	–1	–3	5
2017	2	0.5	4	6	1.5	–1.5	–4.0	–1	–3	5
2018	2	1	4	6.5	1.5	–1	–3.5	–1	–3	5
2019	2	1	4	7	1.5	–1	–3.0	–1	–3	4.5
2020	2	1.5	4	8	1.5	–1	–3.0	–1	–3	4.5
2021	2	2	4	8.5	1.5	–0.5	–2.5	–1	–3	4
2022	2.5	2.5	4	9.5	1.5	0	–2.5	–1	–3	4
2023	2.5	3	3.5	10	1.5	0	–2.0	–1	–3	4
2024	2.5	3	3.5	11	1.5	0	–2.0	–1	–3	4
2025	2.5	3.5	3.5	11.5	1.5	0.5	–1.5	–1	–3	3.5

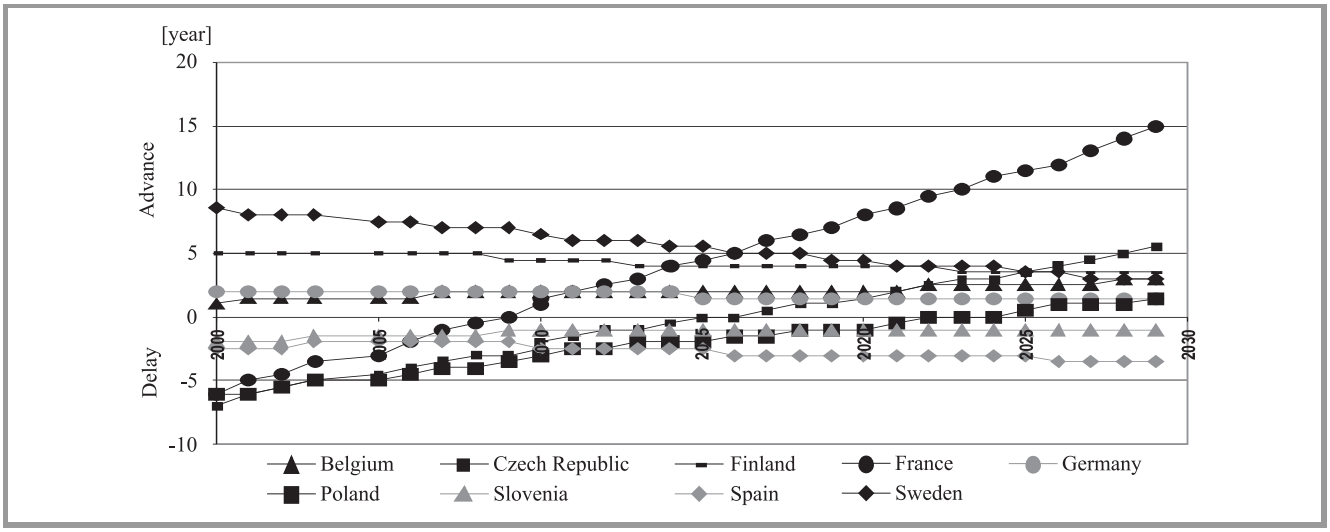

Fig. 8. Penetration of ICT in selected EU countries according to IRUI indicator.

Table 10
Advances and delays of the growth of IOGSI indicator as compared to the av. EU27, [year]
(negative entry denotes delay)

Year/ Country	Belgium	Bulgaria	Czech Republic	Finland	France	Germany	Poland	Slovenia	Spain	Sweden
1995	–8			3.5	–5.5	7		–11	–8	8
1996	–7			3.5	–4.5	6.5		–10	–7.5	8
1997	–6		–15	3.5	–4	6.5	–16	–9	–7	8
1998	–5.5		–13.5	3.5	–3	6.5	–14	–8	–6	7.5
1999	–5		–12	3.5	–2	6.5	–12	–7.5	–6	7.5
2000	–4		–11	3.5	–1.5	6.5	–10.5	–7	–5.5	7
2001	–3.5		–9.5	4	–1	6	–9	–6.5	–5	7
2002	–3	–1	9.–9	4	–0.5	6	–8	–6	–4.5	7
2003	–3	–17.5	–8	4	0	6	–7	–5.5	–4.5	6.5
2004	–2	–15.5	–7	4	0.5	6	–6	–5	–4	6.5
2005	–2	–14	–6.5	3.5	1	6	–5.5	–5	–4	6
2006	–1.5	–13	–6	3.5	1.5	6	–4.5	–4.5	–3.5	6
2007	–1	–12	–5.5	3.5	2	5.5	–4	–4	–3.5	5.5
2008	–1	–11	–5	3.5	2	5.5	–3.5	–4	–3	5.5
2009	–0.5	–10	–4.5	3.5	2.5	5	–2.5	–4	–3	5
2010	0	–9	–4	3.5	3	5	–2	–3.5	–3	5
2011	0	–8	–3.5	3.5	3.5	5	–1.5	–3.5	–3	4.5
2012	0	–7.5	–3	3.5	4	5	–1	–3	–3	4.5
2013	0.5	–6.5	–2.5	3	4	5	–0.5	–3	–2.5	4
2014	1	–6	–2	3	4.5	4.5	0	–3	–2.5	4
2015	1	–5	–2	3	5	4.5	1	–2.5	–2.5	3.5
2016	1	–4.5	–1.5	3	5	4	1	–2.5	–2	3.5
2017	1.5	–4	–1	3	5.5	4	2	–2	–2	3
2018	1.5	–3	–1	3	6	4	2	–2	–2	3
2019	2	–2.5	–0.5	3	6.5	4	3	–2	–2	2.5
2020	2	–2	0	3	7	4	3.5	–2	–2	2.5
2021	2.5	–1.5	0	3	7.5	3.5	4	–2	–2	2
2022	3	–1	0.5	3	8	3.5	4.5	–1.5	–2	2
2023	3	0	1	3	9	3.5	5.5	–1.5	–2	2
2024	3.5	0.5	1.5	3	10	3.5	6	–1	–1.5	1.5
2025	4	1	2	3	11	3.5	7	–1	–1.5	1.5

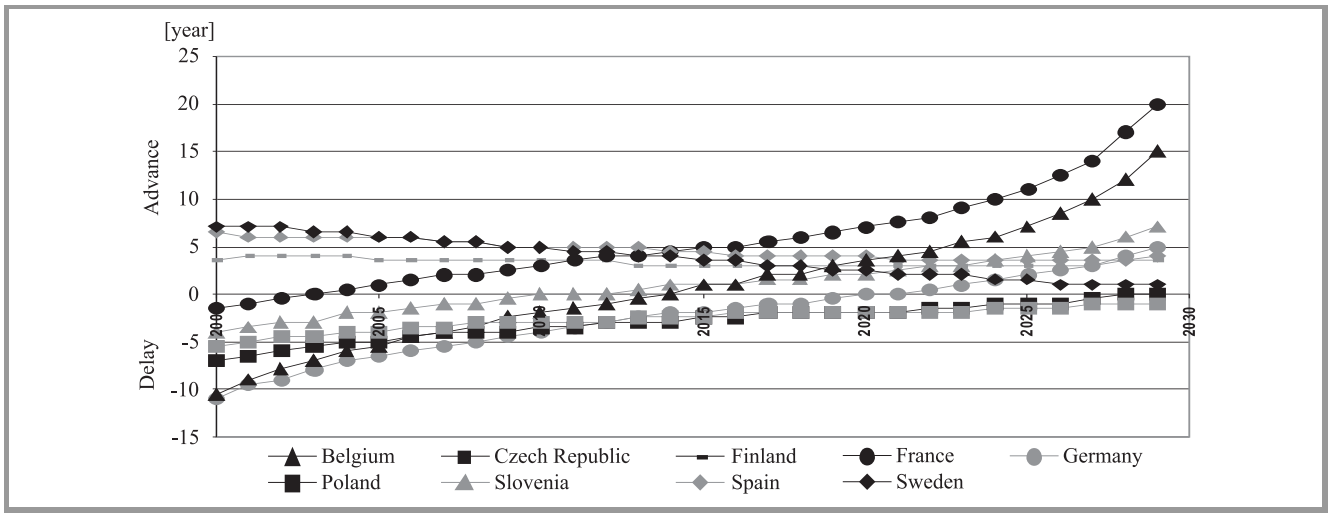

Fig. 9. Penetration of ICT in selected EU countries according to IOGSI indicator.

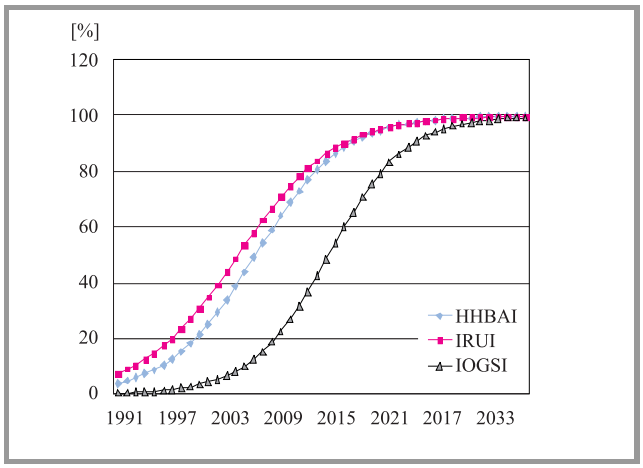

Fig. 10. Estimation for Belgium for the HHBAI, IOGSI, IRUI indicators.

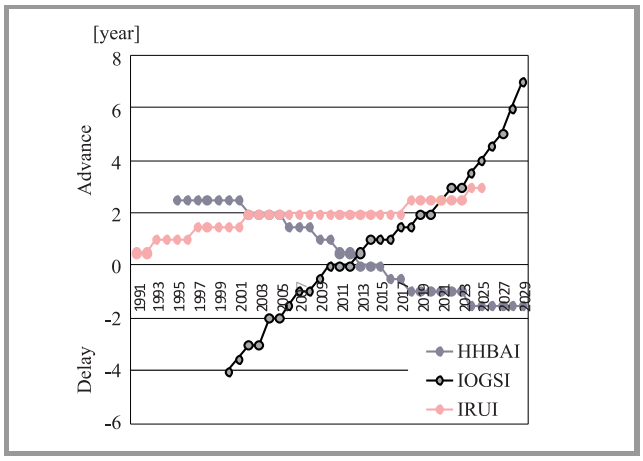

Fig. 11. Penetration of ICT for Belgium for the HHBAI, IOGSI, IRUI indicators.

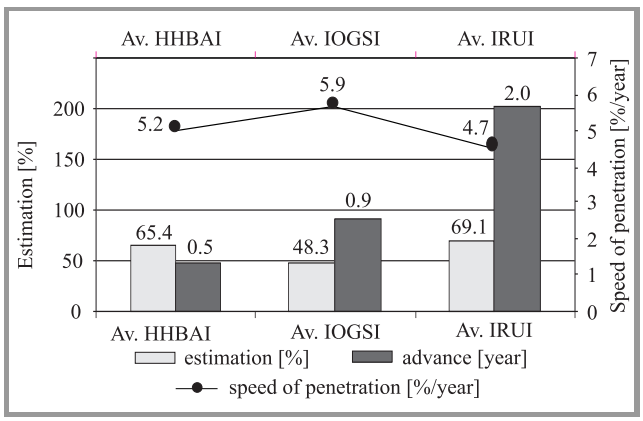

Fig. 12. Development of ICT for Belgium in relation to the av. EU27. Graphs for all indicators based on average values of each indcators over several years.

In Fig. 12, we see again that Belgium is the best in IRUI rate of the general use of the Internet. The same IRUI rate achieved the best result in terms of advance or delay – two years advance ahead of the EU average. However, in the category of the maximum rate of change (annual growth) – the highest rate of change has been an indicator of the development of the commercial use of the Internet – IOGSI, though, of course, percentages in this category are small and much smaller than in other countries. Generally, the pace of social adaptation of new ICT in Belgium is slow.

In Poland, the situation is quite different, as illustrated in Figs. 13, 14, and 15. In terms of the delay or advance, indicators and IRUI and IOGSI look poorly – IOGSI has the delay of 0.7 years to the EU average and IRUI the delay of even 2.8 years to the average. However, HHBAI and IOGSI have large speeds of development, as commented before. In general, Poland has the chance to catch up to the core EU countries in ICT development.

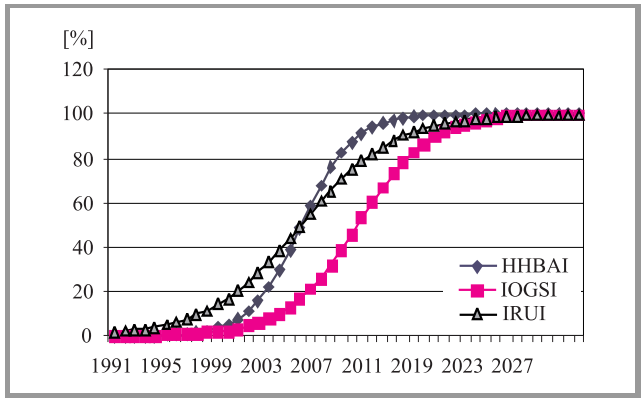

Fig. 13. Estimation for Poland for the HHBAI, IOGSI, IRUI indicators.

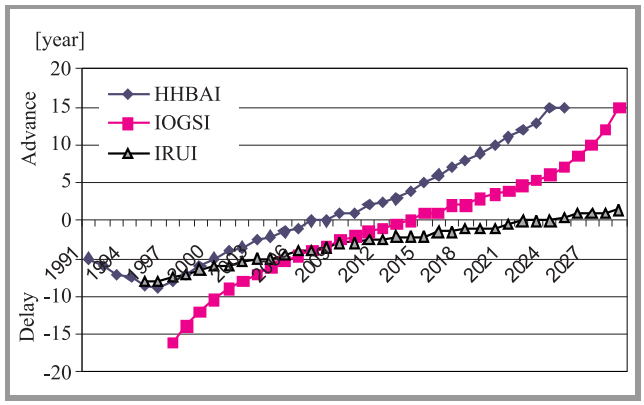

Fig. 14. Penetration of ICT for Poland for the HHBAI, IOGSI, IRUI indicators.

Generally, a graphical presentation of the development of several ICT indicators for a given country, such as in Figs. 10 or 14, gives a convincing kind of "digital signature" of this country. There are many further issues of research that could not be addressed in this paper because of volume limitations. To such issues belong the problem of correlation or causal link of the growth of gross domestic product and the use of ICT. Another already mentioned problem is the issue of statistical estimation and fore-

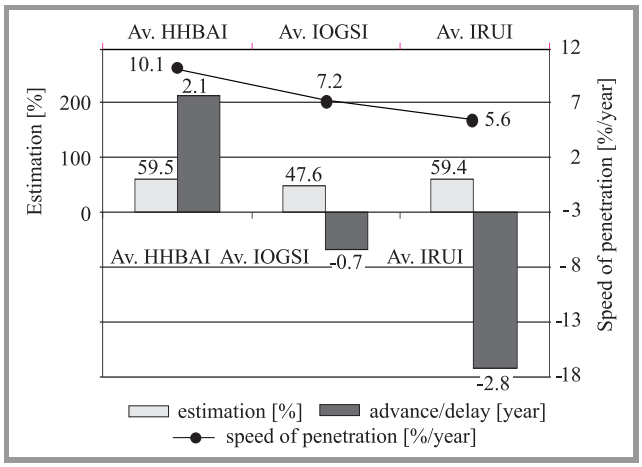

Fig. 15. Development of ICT for Poland in relation to the av. EU27 Graphs for all indicators based on average values of each indicators over several years.

casting of digital divide or exclusion. The richness of these subjects justifies separate articles in this respect.

References

[1] M. Castells, *Information Society*. Warszawa: PWN, 2009.

[2] J. Grzegorek and A. P. Wierzbicki, "New Statistical Approaches in the Systemic Analysis of Regional, Intra-regional and Cross-Regional Factors of Information Society and Economic Development: The Case of Mazovia", *Mazowsze: Studia Regionalne*, no. 3, pp. 117–128, Warszawa, 2009.

[3] J. Grzegorek, "Zastosowanie zaawansowanych metod statystycznych do badania rozwoju społeczeństwa informacyjnego Polsce traktowanej jako system regionów", Ph.D. thesis, Instytut Łączności – Państwowy Instytut Badawczy, Warsaw, 2012 (in Polish).

Beata Ziewiec studied at Faculty of Electrical Engineering and Automation of Kielce University of Technology and received the M.Sc. degree in 1988. She completed postgraduate studies Management, Marketing, Information and Communication Technology – at the Faculty of Information Systems Institute in Warsaw under the auspices of the Polish Academy of Sciences (PAN). She studied at postgraduate Projects Management at the Organization and Management Institute under the auspices of the Polish Association of IT (PTI) (2001–2002). She took part in doctoral seminars including, among others lectures on the development of new technologies – ICT, the characteristics of the information society, research methodology, research including mathematical models and programming tools (2007–2009)

E-mail: beata.maria0962@gmail.com