Cross national technology convergence. An empirical study for the period 2000-2010.

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An empirical analysis for the period 2000-2010.

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A preliminary version

Abstract:

The paper discuses most current issues on technology implementation dynamics observed across nations, as well as it focuses on the problem of suppose technology convergence (or divergence) among nations. The author implements and verifies the hypothesis on β-convergence*,* as well as on the *quantile* convergence. The analysis is run for the sample consisted of 145 economies from all around the world. The time coverage is 2000-2010. All data applied in the research is drawn from the International Telecommunication Union statistical databases.

Key words: technology, convergence, ICTs, quantile convergence

JEL codes: C22, O11, O50, 033

1. TECHNOLOGY CONVERGENCE – SOME THEORETICAL OUTLINE.

As can be easily concluded from the preliminary descriptive analysis results, cross country levels of ICTs implementation vary significantly. To conclude more precisely about the technology distribution across countries there is a need to investigate the convergence patterns in all five dimensions. Such analysis shall give a basic idea about the technology distribution evolution over the past decade.

Looking at the technical and strictly analytical side of the paper, the main aim of the author is to verify the hypothesis on existing – or not – convergence process, across countries, when solely the ICTs levels of implementation are taken into account. The convergence hypothesis strictly derived from the growth theory is applied in the paper. The author applies the classical β-convergence, as well as the notion of q-convergence (quantile convergence) is used.

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The central idea of the β-convergence, mostly used in growth theory, is very simple. It assumes the existence of negative correlation between GDP per capita growth rates and initial GDP per capita level (natural logarithm of GDP to be precise). In fact it has much to do with the catching-up hypothesis (see Abramowitz 1986), which asserts that being backward in the GDP level carries a great potential (possibility) of rapid advance. According to such notion of the catching-up hypothesis this would be right to state that – in long run perspective – the growth rates are inversely related to the initial level of the GDP or any other economic indicator. But, what is an obvious deficiency, the catching-up hypothesis and/or convergence hypothesis, they do not explain any causality between the indicators` level changes. The results are of purely statistic kind.
In the paper, this widely recognized idea of the β-convergence is investigated applying the data of ICTs implementation. If so, it is right to call the idea of technology β-convergence. The author refers to the unconditional β-convergence. In the case the analysis purpose is to learn about the negative relationship between the growth rate and initial level of the 5 different ICTs indicators. Following the idea, 5 separate regressions shall be run (see section 4). The authors assumes that the dependent variables would be the growth rates of the selected ICTs indicators in the period 2000-2010, while as a explanatory variables the initial levels (in the year 2000) of the respective indicators would be included. So, we limit the analysis to the only one regressor.
However the estimated coefficients will let confirm – or not – the hypothesis on unconditional technology β-convergence, the results give just a simple notion of an average evolution of growth behavior over time. The notion of β-convergence has some widely known limitations, especially because it concentrates solely on the central tendency of the distribution ignoring the whole complexity of the issue. To draw more detailed conclusion about technology distribution the author runs an additional q-convergence (quantile convergence). The q-convergence (see Catellacci, 2006 and 2011), a non-parametric method applying the quantile regression (see Koenker et Bassett. 1978, 2001, 2005, see also Hao and Naiman, 2007) idea, provides some information about the behavior of the ICTs distribution in a set of j quantiles (percentiles)[2], which means analyzing the distribution including the tails.

The q-regression is especially useful when the distributions of some variables are highly asymmetric (skewed), and the estimation of standard β-convergence coefficients tells us only about the behavior of the average of a certain distribution. It shall be stressed, the calculating a traditional regression based on conditional mean, has some obvious limitations. One cannot deny that the traditional regression coefficients are easily to estimate and interpret, but at the same time the interpretation cannot be extended to non-central location of a give distribution. Usage of

[2] The numbers of quantile is set arbitrary by the author.

solely traditional regression models is often insufficient to answer questions about the behavior of the mean in non-central locations. In a quantile regression analysis, it is possible to specify any number of quantiles. Since any of a quantile can be applied in the analysis, it allows modeling any predetermined position of distribution[3]. Thanks to that, the analysis outcomes are of better quality and tell us more about the variable`s behavior in noncentral locations of a given distribution.

2. INDICATORS AND THE DESCRIPTIVE ANALYSIS.

In order to verify the hypothesis on existence of convergence or – just the opposite – divergence, between countries, on the field of ICTs implementation, a numerous country data sample is applied. The sample covers 145 different economies, and the authors applied a set of 5 technology indicators. The indicators can be arbitrary treated as proxies of the country`s development on the field of new information and communication technologies. The indicators chosen are the following:

a) Fixed telephone lines (FTL)per 100 inhabitants – defined as "a fixed telephone line which is active[4] line connecting the subscriber`s terminal equipment to the public switched telephone network[5]".
b) Fixed internet subscriptions (FIS) per 100 inhabitants – defined as "the number of total Internet subscriptions with fixed (wired) Internet access[6]". Only active[7] subscriptions are included in the statistics.
c) Fixed broadband subscriptions (FBS) per 100 inhabitants – defined as "total fixed (wired) broadband Internet subscriptions to high-speed access to the public Internet at downstream speeds to, or greater than, 256 kbit/s[8]".
d) Internet users (IU)per 100 inhabitants – defined as an estimated number of Internet users in a total population. The statistics include any user of Internet from any device in the last 12 months. In a great number of countries this is calculated based on the household surveys[9].

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[3] Hao L., Naiman D.Q., Quantile regression, SAGE Publications 2007
[4] In the case „active" stands for „registered and used in the last 3 months", compare www.itu.int
[5] „Definitions of the Word telecommunications/ICT indicators" International Telecommunication Union, March 2010
[6] „Definitions of the Word telecommunications/ICT indicators" International Telecommunication Union, March 2010
[7] "Active" stands for lines being used in the last 3 months, compare www.itu.int
[8] „Definitions of the Word telecommunications/ICT indicators" International Telecommunication Union, March 2010
[9] „Definitions of the Word telecommunications/ICT indicators" International Telecommunication Union, March 2010

e) Mobile cellular subscriptions (MCS) per 100 inhabitants – defined as the "subscription to a public mobile telephone service and provides access to Public Switched Technology Network, using cellular technology[10]".

The indicators presented above constitute a set of data commonly used to assess a country`s level of implementation of basic ICTs tools, devices and services. They measure direct population access to that form of ICTs. Although the indicators are not pretty sophisticated, they are a good material to study the diffusion of the new information and communication technologies across countries. It is also an appropriate to mention that the chosen indicators constitute some proxies of country`s access and usage of ICTs, while they tell as almost nothing about the country`s (society *in fact*) ability to create and use effectively the ICTs. The ability to create and use the ICTs effectively could be named as countries "technology capabilities". In the following context the author understands that effective use of ICTs occurs in a case when ICTs usage enables a society to generate income. In other words it enhances economic growth, by direct creation and selling new technologies or by use of ICTs in a wide array of economic activities. However the effect of ICTs use on economic growth and development is interesting itself, is does not constitute the main target of the following analysis and will not be studied in the following sections of the paper.

It also needs to be underlined that the sample covers 145 economies, which stands for a great majority of the world economies. Such approach enables to draw conclusion for a set of countries where the level of technology development varies significantly.

In the following part, there are presented main results of the descriptive analysis outcomes.

[10] „Definitions of the Word telecommunications/ICT indicators" International Telecommunication Union, March 2010

Table 1. Summary descriptive statistics and basic measures of distribution. Selected ICTs indicators. Period 2000-2010.

Variable	No. of Obs. (number of countries)	Mean	Std. Dev.	Variance	Min	Max	Skewness	Kurtosis
FXTEL2000	145	23,6	21,9	483,63	0,019	86,07	0,76	2,47
FXTEL2010	145	22,6	18,7	351,86	0,063	82,06	0,77	2,86
FXINTER2000	145	4,71	7,6	58,95	0,0037	39,30	2,28	8,32
FXINTER2010	145	12,0	12,5	156,89	0,010	47,35	0,94	2,69
FXBROAD~2000	145	1,3	3,12	9,75	0	22,58	3,64	19,8
FXBROAD~2010	145	11,1	12,2	150,35	0	63,83	1,18	4,18
INTUSERS2000	145	10,03	13,7	189,18	0,0059	51,3	1,56	4,30
INTUSERS2010	144	39,7	27,4	753,82	0,72	95	0,28	1,87
MOBILES~2000	145	20,2	24,29	590,32	0	81,48	1,16	3,00
MOBILES~2010	145	96,5	39,3	1547,66	3,526	206,42	-0,016	2,96

Source: own calculations using STATA 11.0. Raw data drawn from ITU databases 2011.

The five indicators presented above will enable us to analysis cross-country differences in the basic ICTs implementation differences. The sample consists of 145 world economies, which makes the analysis results rather representative. As analyzed period (years 2000-2010), is widely recognized as the one when fast and dynamic diffusion of new technologies is observed worldwide. According to the basic descriptive analysis results, the hypothesis of fast diffusion of the ICTs is confirmed with no doubts. Changes in the means of the sequent variables tell us about the general changes in the ICTs implementation level worldwide, and additionally the standard deviation levels give us a general idea about the cross national differences the level of ICTs implementation. The observed increase in the mean level of each variable proofs wide and fast spread of the mentioned ICTs across countries. Only in one case – the number of fixed telephone lines per 100 inhabitants (FTL), the mean has slightly decreased, which probably caused by the substitution of the fixed telephone lines with the mobile ones or any other electronic means of telecommunications. However the changes from 23,6 to 22,6 says that the FTL`s implementation is almost stable. In each of the following four indicators, the changes in their means are significant. The greatest changes is reported for implementation of the fixed broadband which refers to the Internet subscriptions. In 2000 is was only 1,35, which 10 years later the results is almost 10 times higher – 11,1 of an average. In case of FIS, IU and MCS averages the changes are not astonishing however very high. What shall be also stressed here very clearly, is that despite fast diffusion of ICTs across countries in the period of 2000-2010, also there is parallelly observed an increase in differences of the averages (for the indicators) in particular countries. This can be concluded from the increase in standard deviations, in each case despite FTL indicator (the standard deviation has diminished in the case).

To conclude a bit more on the world distribution of the ICTs, the kernel densities function are presented below. The 5 following figures (Fig 1to5, see below on Chart 1) report on the Kernel densities estimates of the 5 factors in 2000 and afterwards, in 2010. The Fig1, reports on the distribution of the fixed telephone lines in 2000 and 2010. As can be concluded the distribution characteristics did not change significantly over the 10 sequent years. The density function line has "moved" slightly to the right side of the plot, which proof that the use of FTL has improved a bit. That is also confirmed by the results of the mean values (in 2000 – 23,6; in 2010 – 22,6) and standard deviation (in 2000 – 21,9; in 2010 – 18,7).

A crucially different picture is observed on the plots Fig2, Fig3 and Fig4. Generally speaking, the observed tendency is very similar in each of the following figure. In each case, in 2000, the densities plot show a long right tail, while in the left side of the plot a high "peak" is revealed. That proofs, that in each of the three cases, in low income economies the implementation of the ICTs (FIS, FBS, IU) is very poor, while in the middle and high income economies, the implementation of the ICTs is higher but at the same time the level of the implementation is highly uneven. That is also confirmed by a significant increase in standard deviation in each case.

Going to a more detailed analysis, the plot (Fig2, Fig3 and Fig4) report on:

- See Fig2 – referring to the Fixed Internet Subscription per 100 inhab. – in the year 2000, the density function (long dash line), shows a one "high" peak, but also some other two on the right side of the tail can be observed. That proofs that in low income economies, the implementation of the fixed internet was pretty poor (high peak), while in middle and high income economies (two sequent peaks on the right side of the tail) the implementation was at much higher level, but at the same time the distribution was more unequal. The 3 peaks can be also interpreted as the existence of three country groups of different characteristics each (when the only criterion of classification is the implementation of the fixed Internet). In year 2010, the density function is different proofing great changes in the level of implementation of the fixed Internet across countries. It can be concluded that the greatest changes in the level of implementation of the fixed Internet are reported in low income countries. The disappearance of the "high" peak proofs that.
- See Fig3 – referring to the Fixed Broadband Subscription per 100 inhab. – in the case the extreme change in the densities functions lines can be observed. It reports enormous changes in the implementation of the FBS over countries. In year 2000, the density line shows that very few countries could enjoy the fixed broadband. Additionally it is possible to conclude that in low income economies the implementation was close to 0, or even equal 0. While in the middle and high income countries, the implementation was also highly diversified. A

complete change in the density line shape in the year 2010, shows crucially different situation than it was in 2000. Despite a great increase in the average level of the FBS implementation, we can observe an enormously high inequality in FBS implementation across countries irrespectively to the level of income. The changes in the density lines also show a great progress in fixed broadband implementation levels especially in low income countries.

- See Fig4 – referring to the Internet Users per100 inhab. – the shapes of density lines in 2000 and 2010, are both very similar at is was in the case of fixed Internet. Likewise in the Fig2, in the year 2000 the function`s shape shows that 3 country groups could be identified. Low income group where the number of Internet users was very low, but at the same time the group was rather homogenous (according to the given criterion). Also groups of – probably – middle and high income country were distinguished, where the number of Internet users was higher than in the low income countries. According to the density function line in 2010, the 3 peaks – each referring to different country group – disappeared, and we note a significant increase in the diversification of the number of Internet users in the whole country set (145 countries). Despite the increase in diversification (the standard deviation has increased more than twice – from 13,75 to 27,45), it is observed a significant increase in Internet usage in low income countries, which is definitely a positive change.
- See Fig5 – referring to Mobile Cellular Subscription per 100 inhab. – in the case, the density line in 2000 shows a twin-peak shape, which can indicate the existence of the 2 country groups differing significantly. This is rather similar to what was observed in case of FIS and IU. However in year 2010, the density function line shape has changed significantly. There is a huge increase in the mean of the indicator (from 20,2 in year 2000 to 96,55 – in 2010),while the standard deviation has changed 1,6 times. Those proof a great increase in a number of people using mobiles cellular phones – in low, medium and high income countries. The emergence of one-peak in a density line (for year 2010), shows a formation of a quite homogenous groups consisted of middle income countries, when only MCS is taken into account.

Chart 1. Kernel epanechnikov densities functions for selected indicators. Years 2000 and 2010.

(Fig1. Fixed Telephone Lines; Fig2. Fixed Internet Subscr.; Fig3. Fixed Broadband Subscr.; Fig4. Internet Users; Fig5: Mobile Cellular Subscr.)

Fig1.

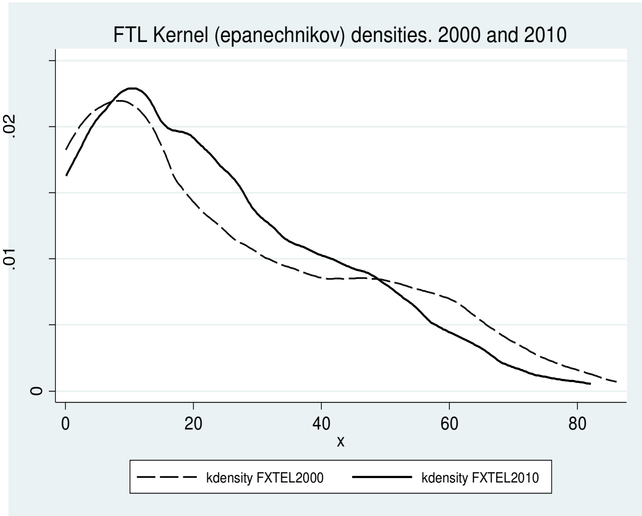


Fig2.

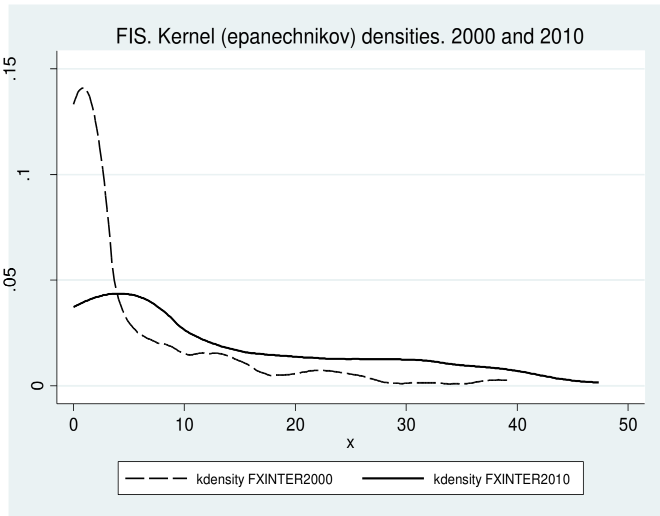


Fig3.

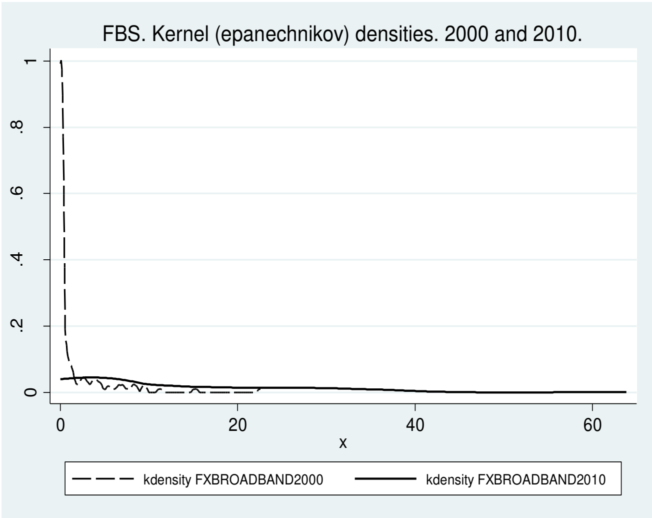


Fig4.

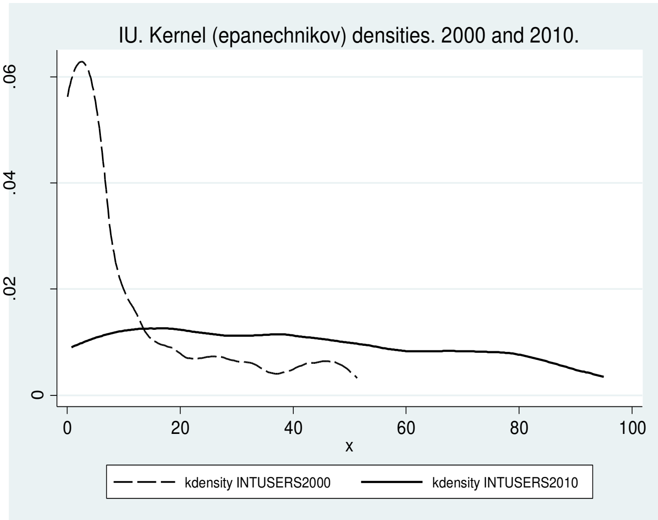
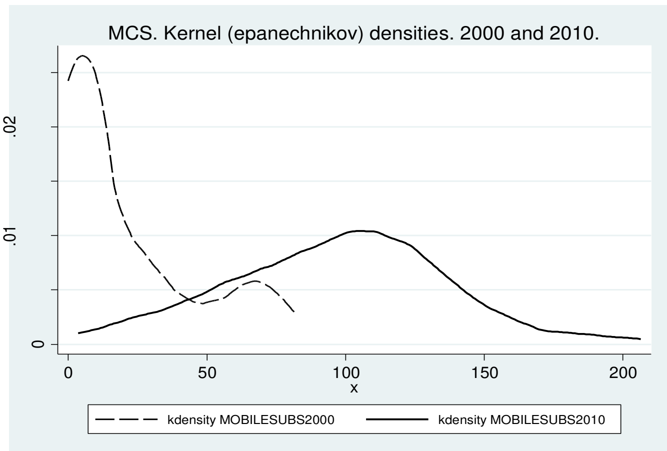


Fig5.



Source: own elaboration using STATA 11.0.

Along with the great diversification observed across nations, the changes in levels of ICTs adoption – in time span 2000 – 2010, is astonishing. The growth rates in ICTs implementation – in terms of per 100 inhabitants – have increased in each case, despite the changes in fixed telephone lines adoption. In the last case, in some countries, even negative growth rates were reported. That is not surprising, having in mind the fact, the fixed telephone lines are rather substituted by mobile phones. Such tendency is especially typical countries with very low initial level of FTL implementation.

3. ANALYSIS AND RESULTS.

The final part of the paper is purely empirical. The author runs a set of analysis on convergence hypothesis on the field of new technologies implementation. The analysis is divided into 2 sections, each consisted of:

a) β-convergence analysis,
b) q-convergence analysis,

a) The β-convergence testing.

The major assumption considering the β-convergence is that there exists a negative – statistically significant – relationship between growth rates of a depended variable, and an initial level of covariate. If so, the response and predictor variable shall be negatively interrelated. It is assumed that the regression function is a function of just one predictor. There are followed 4 regression – for the ICTs indicators independently. Purposely the author omits in the analysis the estimates using the data of Fixed Broadband Subscriptions[11].

The model is identifiable as following:

$g_j = a + \beta ln(x_j) + \varepsilon_i,$

where, g denotes the average annual growth rate of a given technology indicator j, x_j stands for initial level of a following indicator in the year 2000. The β coefficient reported in a set of regression is crucial to verify the hypothesis on existence the convergence among the set of countries. If the β coefficients result to be negative and statistically significant, that would suggest the convergence.

[11] In the case, some variable values in 2000 are „0", which indicates that the natural logarithm of zero shall be taken, which is mathematically undefined.

The following table (see Table 2 below), reports on the estimation results in case of all 4 ICT indicators. Additionally compare scatter plots showing the statistical relationship between annual growth rate and initial level of a given indicator (compare charts 2,3,4 and 5).

Table 2. β-convergence estimation results.
Data for 2000-2010.

Regress FTLexpgrowth LNFTL2000						
Number of obs	*145*	*R-squared*	*0,4386*			
F(1, 143)	*111,7*	*Adj R-squared*	*0,4346*			
Prob > F	*0*	*Root MSE*	*3,734*			
FTLexpgrowth	***Coef.***	***Std. Err.***	***t***	***P>t***	***[95% Conf.***	***Interval]***
LNFTL2000	**-1,96**	0,18	-10,57	0,0*	-2,32	-1,59
_cons	6,33	0,53	11,86	0,0	5,27	7,38
Regress FISexpgrowth LNFIS2000						
Number of obs	*145*	*R-squared*	*0,307*			
F(1, 143)	*63,34*	*Adj R-squared*	*0,3021*			
Prob > F	*0*	*Root MSE*	*9,9577*			
FISexpgrowth	***Coef.***	***Std. Err.***	***t***	***P>t***	***[95% Conf.***	***Interval]***
LNFIS2000	**-2,99**	0,37	-7,96	0,0	-3,73	-2,25
_cons	15,89	0,82	19,20	0,0	14,25	17,53
Regress IUexpgrowth LNIU2000						
Number of obs	*145*	*R-squared*	*0,775*			
F(1, 143)	*494,0*	*Adj R-squared*	*0,774*			
Prob > F	*0*	*Root MSE*	*5,95*			
IUexpgrowth	***Coef.***	***Std. Err.***	***t***	***P>t***	***[95% Conf.***	***Interval]***
LNIU2000	**-5,43**	0,24	-22,24	0,0	-5,91	-4,04
_cons	28,43	0,54	51,93	0,0	27,34	29,51
Regress MCSexpgrowth LNMCS2000						
Number of obs	*145*	*R-squared*	*0,93*			
F(1, 143)	*2197,06*	*Adj R-squared*	*0,93*			
Prob > F	*0*	*Root MSE*	*4,43*			
MCSexpgrowth	***Coef.***	***Std. Err.***	***t***	***P>t***	***[95% Conf.***	***Interval]***
LNMCS2000	**-8,14**	0,17	-46,86	0,0	-8,48	-7,80
_cons	41,29	0,47	87,52	0,0	40,36	42,2

Source: own estimations using STATA 11.0.

* *- 0,05 significance level.*

As it was already stated, the author has run four different regressions to confirm – or reject – the β-convergence hypothesis. The analysis also reports on existing of the so called "catching-up" effect among the selected group of countries, in terms of the ICTs indicators.

To conclude from the results in Table 4. In all 4 cases, the β coefficients are negative and statistically significant, while the *p-value* < 0,05. That let us to confirm the hypothesis on existence of the convergence among world countries in terms of ICTs implementation. According to the FTL indicator, the *β=(-1,96)* and it is relatively the lowest out of the 4. It refers to the "traditional" mean of communication – fixed telephone line, and it is no surprise that its implementation does not play an important role in comparisons to other modern means of communication. Note that the average number of FTL has slightly lowered in the period 2000-2010. That is probably mainly due to the rather reverse tendency than it was supposed to be. In 63 countries the growth rates for FTL adoption are negative, which means that the use of FTL per 100 inhabitants has diminished in some countries (for details see Annex). This shall not be interpreted as a decrease in the telephone usage, but rather that the fixed lines are consequently substituted by mobile phones.

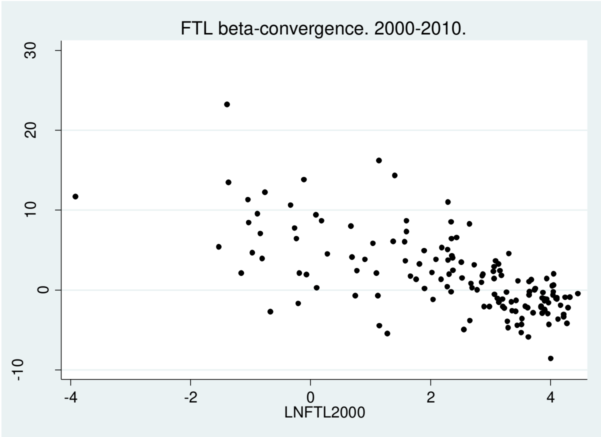
Turning into the FIS statistics. From the regression model estimates it can concluded that the catching-up process does take place also in the case. The *β=(-2,99)*, confirms the hypothesis on conditional convergence when FIS is taken into account.

In the next two cases – Internet Users and Mobile Cellular Subscribers – the estimated coefficient results to be very high. That proofs that the catching-up does take place and the processes of the selected ICTs means adoption is astonishingly dynamic across. Also in both cases the statistical relationship between the growth rates and initial level of the given indicator is negative and strong (see plots on chart 4 and 5). In case of MCS the correlation coefficient equals (-0,96) which stands for almost perfect statistical relationship between variables. The number of mobile cellular subscribers is has accounted for extremely high growth rates in the analyzed period. The lowest average annual growth rate of MCS was noted in San Marino and it was about 3,5% annually. The two best performing countries in MCS adoption were Nigeria – the average annual growth rate at 77,3%, and Iraq – 68,6%[12].

For the IU indicator the correlation coefficient is (-0,88) which also stands for very high and strong relationship. Together with high and negative coefficients in the estimated regressions, the statement on the convergence – in terms of IU and MCS indicators – is fully justified.

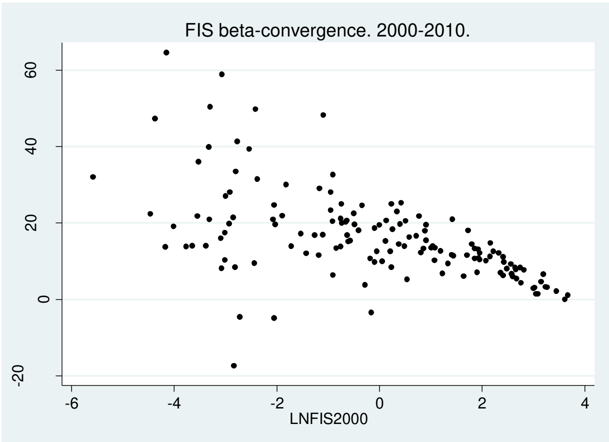
[12] For full list of countries – see Annex.

Chart 2. Scatter plot FLTexpgrowth vs. LNFLT. Period 2000-2010. The coefficient R = (-0,66).



Source: own elaboration using STATA 11.0.

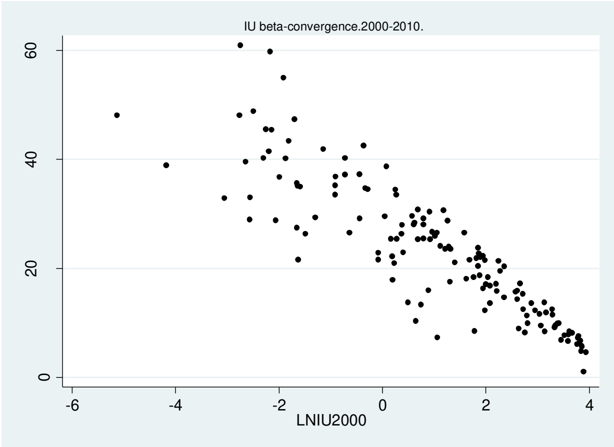
Chart 3. Scatter plot FISexpgrowth vs. LNFIS. Period 2000-2010. The coefficient R = (-0,55).



Source: own elaboration using STATA 11.0

Chart 4. Scatter plot IUexpgrowth vs. LNIU.

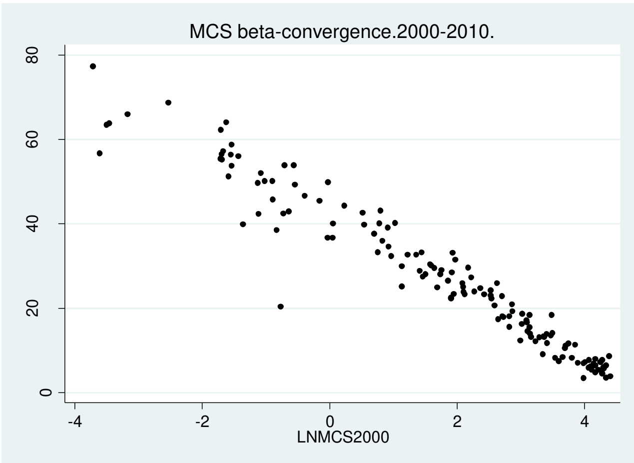
Period 2000-2010. The coefficient R = (-0,88).



Source: own elaboration using STATA 11.0.

Chart 5. Scatter plot MCSexpgrowth vs. LNMCS.

Period 2000-2010. The coefficient R = (-0,96).



Source: own elaboration using STATA 11.0.

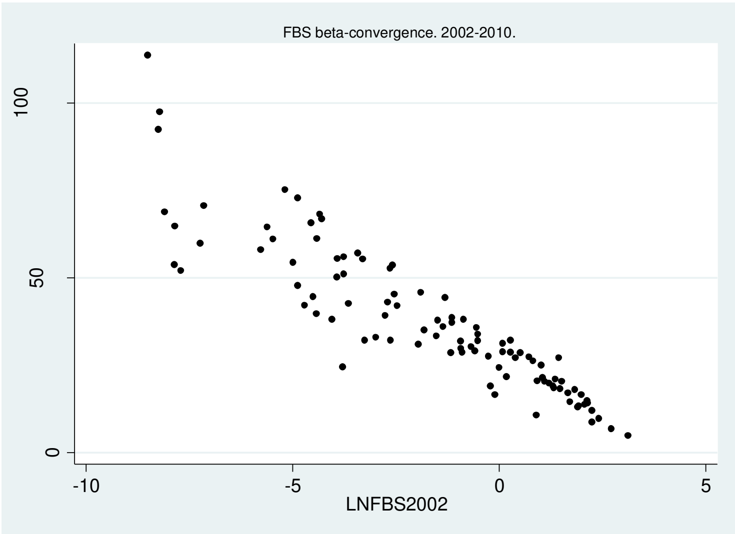
Analogue estimation has been completed for the Fixed Broadband per 100 inhabitants' statistics. Considering the FBS data, in the year 2002 in case of some countries there was reported "0", and for technical reason they had to be excluded from the regression analysis. Finally, 46 economies were excluded, and the sample for the FBS statistics consists of 99 countries. The results of the β-convergence estimations are put in Table 3 (see below). Additionally see chart 5, to learn about the statistical relationship between the annual growth rate of FB per 100 inhabitants and it initial level in 2002.

Table 3. Fixed Broadband per 100 inhabitants. β-convergence. Period 2002-2010.

Regress FBSexpgrowth LNFBS2002						
Number of obs	*99*	*R-squared*	*0,81*			
F(1, 97)	*432,73*	*Adj R-squared*	*0,81*			
Prob > F	*0,0*	*Root MSE*	*8,89*			
FBSexpgrowth	***Coef.***	***Std. Err.***	***t***	***P>t***	***[95% Conf.***	***Interval]***
LNFBS2002	**-6,14**	0,29	-20,80	0,0	-6,72	-5,55
_cons	26,93	1,02	26,18	0,0	24,89	28,97

Source: own estimations using STATA 11.0.

Chart 5. Scatter plot FBSexpgrowth vs. LNFBS. Period 2002-2010. The coefficient R = (-0,903).



Source: own elaboration using STATA 11.0.

In the case of FBS adoption the estimated regression reports the *β=(-6,14)*, which let us confirm the convergence in terms of the given ICTs indicator. The coefficient is high, negative and statistically significant. Additionally, the coefficient r = (-0,903), which also proofs that the annual growth rate are strongly related to the initial level of the variable.

The general results report on catching-up effect in terms of new information and communication technologies application in the group of 145 world economies. As it was supposed, countries with low initial level of ICTs implementation in the year 2000, tend to adopt ICTs at significantly higher pace than countries with high initial level of ICTs adoption. The ICTs absorption in low developed countries is relatively high as they try to catch-up with the high developed ones. That is also due to relatively low cost of implementation of new technologies. The low developed countries in a great majority just imitate and adopt already existing technologies. They usually do not create technologies which require high finance resources. The catching-up effect in terms of

ICTs is also possible thanks to the great ability of ICTs to spread at high speed. The new technologies are easy to adopt and use, which make them a great incentive for development in low developed countries.

Additionally, what can be concluded, the dynamics of the technology adoption is astonishingly high in each case (excluding FTL). The average annual growth rates in some cases achieve extraordinary high levels, especially for the MCS and FBS.

b) The *q*-convergence testing.

In the following section, the author runs a set of quantile regressions for each of the ICTs indicators. Applying the non-parametric method, it is possible to learn more about the indicators` values behavior in the sequent part of the respective distributions. The general mathematical formula is:

$$g_{jy} = a + \beta ln(x_{jy}) + \varepsilon_{iy},$$

where *y* stands for an y_{th} quantile of the growth distribution of the indicator. The author arbitrary assumes the estimations of 20th, 40th, 60th and 80th quantile of the respective ICTs indicators distribution. The *q*-convergence regressions provide a more detailed characteristic of the dynamics of the ICTs indicators in cross country study.

The results of the quantile regressions are presented in the Table 4 (see below).

Table 4. Fixed Telephone Lines, Fixed Internet Subscribers, Fixed Broadband Subscribers[13], Internet Users, Mobile Cellular Subscribers. The q-convergence. 145 countries. Period 2000-2010.

	Q-convergence (*the β coefficients*)			
Indicator	*20th quantile[14]*	*40th quantile*	*60th quantile*	*80th quantile*
Fixed Telephone Lines	-1,28 *(-5,10)[15]*	-1,73 *(-8,79)*	-2,06 *(-10,18)*	-2,52 *(-18,37)*
Fixed Internet Subscribers	-1,85 *(-3,82)*	-2,25 *(-7,04)*	-3,47 *(-17,30)*	-5,20 *(-16,56)*
Internet User	-4,24 *(-13,73)*	-5,22 *(-30,05)*	-6,29 *(-38,79)*	-6,95 *(-38,52)*
Fixed Broadband Subscribers	-4,89 *(-10,21)*	-5,55 *(-23,38)*	-6,47 *(-25,58)*	-7,58 *(25,52)*
Mobile Cellular Subscribers	-7,71 *(-41,37)*	-8,38 *(-50,06)*	-8,63 *(-57,61)*	-9,03 *(-47,71)*

Source: own estimations using STATA 11.0.

[13] For the MCS the regressions are run for 99 economies, in the period 2002-2010.
[14] The estimates for the sequent quantiles are always run in the whole country sample.
[15] The *t* statistics are put in the parenthesis.

As it was already stated, running a quantile regression enables us to look more closely to the variable behavior is the certain parts of its distribution. To understand the analysis correctly, it shall be stressed in here that convergence in each sequent quantile is estimated jointly with the each previous ones. For example, the regression for the 3rd quantile is estimated actually together with the 1st and 2nd quantile. We just estimate the convergence on the nth quantile just by adding some more cases (countries).

The quantile regression analysis completes the previous ones and shades more light on the characterization of the dynamic of the technology convergence. In table 4, there are reported quantile regression coefficients on the 20th, 40th, 60th and 80th quantiles of the sequent variables distribution. As in previous cases the regressions consist of just one predictor variable. In each of the cases, the regression coefficients are the lowest in the first (20th) quantile. Then the coefficients are increasing in the following 3 quantiles, reaching the highest level in case of the 4th quantile. Such results show us rather clearly that in low income countries the overall elasticity of ICTs implementation is pretty low. That suggests low ability of these countries to acquire and use new ICTs tools. However, we must remember – see again Charts 2,3,4 and 5 – that also in the first two quantiles – 1st and 2nd quantile, the scatter of the dots (each dot presenting a country), is high. In case of the MCS indicator, the coefficients result to be the higher starting from the 1st quantile. That reports on relatively highest speed of diffusion of the mobile phones across countries. This is probably to relatively low cost of adoption and a great ability to use it with no special skills. The convergence in the case results to be strongest of all 5 analyzed cases.

4. FINAL REMARKS.

The main scope of the paper was to report – or not – on the hypothetical convergence among world countries, on the field of implementation new information and communication technologies. There were 5 different, basic ICTs indicators taken into account. In the first part of the analysis, a traditional descriptive statistical analysis was introduced. The general conclusion is that in each case – apart from Fixed Telephone Lines – the growth of the mean adoption of the ICTs was significant. The greatest changes are observed in the case of Fixed Broadband Subscribers. Afterwards, the classical β-convergence was estimated. In each case the regression coefficients were negative, which allows us to confirm the hypothesis on existence of beta-convergence in terms of ICTs adoption in countries. Analogues conclusions can be drawn from the novel quantile-convergence analysis. Based on the q-regression results, also the hypothesis on the world wide convergence can be confirmed.

Taking the issues more generally, from the world wide perspective the convergence process in terms of ICTs adoption can be easily derived. That leads to simple conclusion the low income countries – which are also the ones with initial low ICTs implementation, have a great ability to catch-up with high developed ones, which is mainly due to unique ability of ICTs to spread at a high pace.

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