CZECH HOUSEHOLD COMPUTER FACILITIES AS A RELIABLE VARIABLE IN A LIFE EXPECTANCY FORECAST MODEL UP TO THE YEAR 2060

Ondřej Šimpach, Jitka Langhamrová

Department of Demography
Faculty of Informatics and Statistics
University of Economics Prague
ondrej.simpach@vse.cz, langhamj@vse.cz

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Abstract

The standard of living is one of the key variables that significantly affect the trend of some demographic indicators. When modelling the trend of monitored demographic indicators, the problem that arises is that it is very difficult to quantify the living standard with the aid of specific variables or a specific coefficient. So the question arises how to express the living standard differently and whether a significant correlation exists between the imaginary "living standard" variable and some other variable which we can express realistically. The trend that is incorporated in the time series of the trend in Czech household computer facilities can be applied as quantification of the living standard trend in the case of the Czech Republic. These time series will be used to draw up models on which alternative forecasts of life expectancy at birth can be constructed for males and females up to 2060 when this model will probably stop working properly. It will be shown that alternative forecasts will correspond to the theoretical assumptions for the trend in the mentioned indicators however they will be far simpler.

1. Initial assumptions

The study will apply the classical polynomial regression approach (see. e.g. Hindls et al., 2007) and in addition the approach of authors Box and Jenkins (Box, Jenkins, 1970) for the time series analysis. An important explanatory variable that can help explain the great amount of variance in the imaginary "living standard" variable will be household computer facilities to whose future forecast the logistic "S" curve approach will be applied to achieve the saturation point (see e.g. Hušek, 2007). Data on the state of household computer facilities are determined every year by the CZSO (Czech Statistical Office) and it can be said that currently our country is in the inflection point. This approach in estimating life expectancy based on specific explanatory variables (household computer facilities) will, in practice, applied especially to the Czech Republic because after the fall of the last political regime, the standard of living began to rise for various reasons. A great amount of hidden information is concealed in households equipped with a "computer". A household that decides to procure a computer must have an electricity connection and must have

enough money to operate a computer. A household equipped with a computer and probably an internet connection must also know how to operate a computer, i.e. not only how to switch it on and off, but also how to use its graphic interface and installed software. Currently having more PCs as such is not enough, a computer needs to have its software extended to include new versions of programmes and their upgrades. This places further and further demands on the household that owns a PC and these demands involve the need to be educated in this area. The fact that households become educated, gain experience means that this helps them not only in their private but also in their professional life. As time goes on, PCs become more sophisticated placing greater demands on the knowledge of their users and these users become more advanced in their knowledge. Better knowledge brings the higher probability of finding work, saves valuable time, earns more money and last, but not least, makes life more pleasant. All these factors contribute one way towards the rise in the standard of living, so we can claim that the increase in household computer facilities very closely corresponds to the rising living standard. The increasing living standard, among other things, is also connected with increased household consumption, increased household incomes and households being equipped with an increasing amount of durables. It will be shown that a simple approximation will help construct reliable models in a simple way, and these models will have sufficient explanatory power.

The output of the study will be estimates of life expectancy at birth using a different approach than currently used for statistical and demographic laboratories. In other countries, the authors attempted to construct the estimates of life expectancy at birth, such as Sullivan method (see Sullivan, 1970), but it is a method, that is partly based on life tables and partly on mathematical statistics. Until now nobody attempted to publish a completely different way of estimation of life expectancy at birth, and we believe that the approach with growing living standard, expressed by specific explanatory variable could be relevant for the Czech Republic. The relationship between life expectancy at birth and Czech household computer facilities can really exist, even if it is a risk, that there could be an apparent correlation. The household computer facility is one of the indicators of growth of living standard and growth of life expectancy at birth is largely the result of this growth. The impact of growth of Czech household computer facilities has the effect on the economy, because it is closely linked with the growth of living standard and life expectancy at birth. Healthier people live longer and represent more significant potential for the economy of the country.

The study of Fiala et al. (2011) expected to increase life expectancy at birth to 86.2 years for men and 90.7 years for women in 2050. The other publications talk about the possibility of convergence in life expectancy at birth for men and women (see e.g. Miskolczi et al., 2011). Our study will not consider this convergence in life expectancies. It is also important to note, that the study does not expect the change in migration policy. E.g. Arltová, Langhamrová (2010) argues, that “it is very difficult to project the future development of migration”. Migrants may have different levels of life expectancy compared with the domestic population and the sudden change in immigration policy (e.g. doubling the inflow of migrants to the Czech Republic), could disrupt the assumptions of this model.

2. Saturation of Czech household computer facilities

The time series of Czech household computer facilities has been published at annually since 1989. The last available value that the statistics contain is for 2010. In view of the above-mentioned assumption that the Czech Republic is now in the inflection point in the course of saturation of Czech households with these durables, an estimate was made of the computer facilities trend up to 2060, which is the time horizon of this study, by using the “random walk” model (see Arlt, Arltová,

2007). Let us assume that the horizon is about 48 years (i.e. up to 2060), computer facilities will rise to 94–97%. This condition is determined for the need to make further calculations and may be confirmed or refuted in future. To illustrate, this forecast is shown in fig. 1. In addition, we can expect that there will be a statistically significant rise in life expectancy at birth up to 2060 then we are no longer able, with sufficient certainty, to deduce the relevant values. Given that we expect a statistically significant rise in life expectancy at birth up to 2060 in both time series, we can also expect a relation between the 100% saturation limit of Czech household computer facilities and fulfilled potential life expectancy at birth in males and females.

Given the fact that the life expectancy trend of males and females is developing differently (and that the life expectancy of males is always lower than that of females), a differentiation will be made based on the following relations of the "PC" time series – Czech household computer facilities depending on gender by two time series:

- PC_M – Czech household computer facilities as the explanatory variable for male life expectancy, and
- PC_F – Czech household computer facilities as the explanatory variable for female life expectancy.

Therefore, we will calculate PC_M as

$$PC\_M = 1 + (0.515 \cdot PC)$$

for males, and as

$$PC\_F = 1 + (0.485 \cdot PC)$$

for females. The value of 0.515 or 0.485 is the share of boys and share of girls at birth that the CZSO currently recommends for selection.

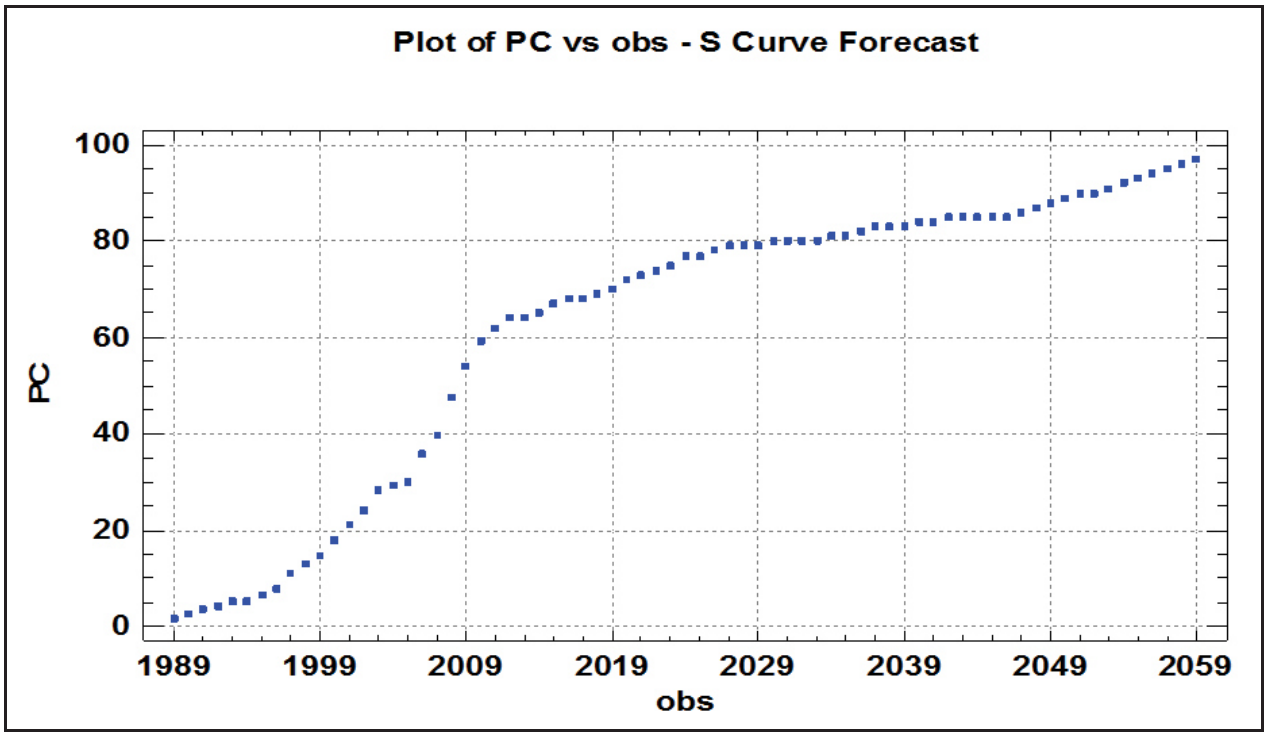

Fig. 1: Chart of the computer equipment trend in the Czech Republic up to 2010 and the subsequent "S" curve forecast; Data source: CZSO, own construction

3. Distortion of assumptions using the estimating technique of ARIMA methodology

Based on the methodology of authors Box and Jenkins (Box, Jenkins, 1970), it is often useful to apply time series modelling with the use of the trend contained in the past of these series. In case of the estimate of life expectancy at birth for males, and for females, this approach is not right. If it were to work, it could be unequivocally declared as the simplest estimating technique and the complicated approaches used, for example, by the CZSO, would not be necessary. But this approach, after being applied to the ex_M, ex_F time series (male life expectancy at birth, and female life expectancy at birth), does not work unfortunately, as, incidentally, is shown in fig. 2, and in fig. 3. By using automated sophisticated software the optimum model form was selected for capturing the trend and subsequent forecast up to 2060, or to the time of the 100% limit of saturation of Czech households by computer facilities. The ARIMA (0, 2, 2) model form is for the time series ex_M, while only the simple linear trend model has been selected for the time series ex_F. According to these models at the time of saturation of Czech households by computer facilities the male life expectancy at birth would be about 77 years, and female life expectancy at birth would be about 82.5 years, which is slightly more than today.

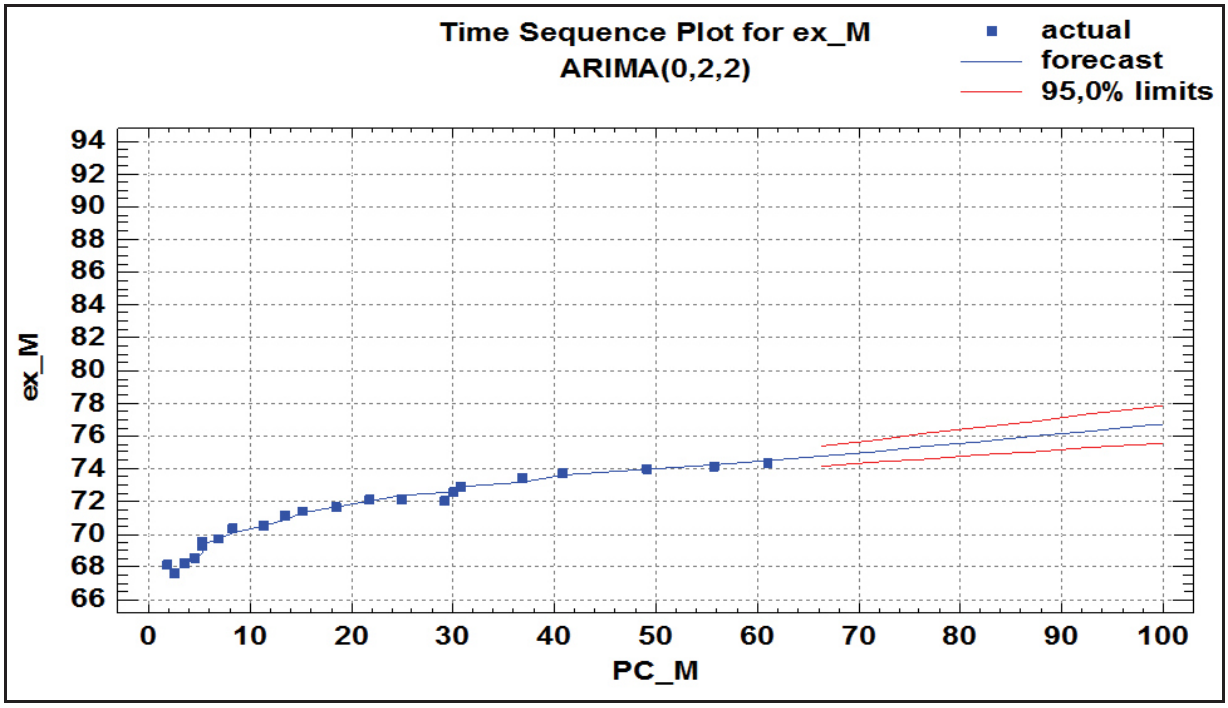

Fig. 2: Forecast of the male life expectancy at birth trend using the ARIMA model (0, 2, 2); Data source: CZSO, own construction

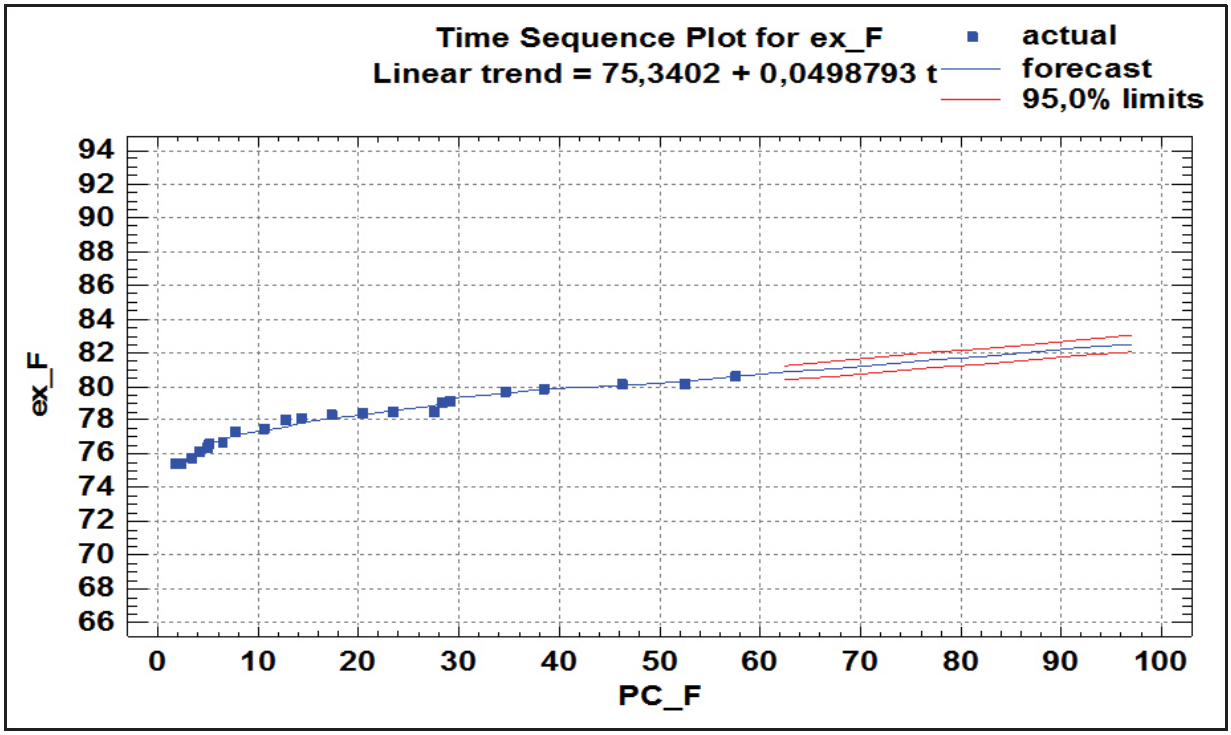

Fig. 3: Forecast of the female life expectancy at birth trend using the linear trend model; Data source: CZSO, own construction

4. Polynomial regression model for estimating life expectancy at birth

Polynomial regression appears much better and perhaps a simpler estimating technique for the male life expectancy at birth trend, and the female, respectively. From observed experience, the third order polynomial was selected for males and for females. The estimated parameters of the model for males are presented in tab. 1

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	67.4002	0.250418	269.151	0.0000
PC_M	0.347988	0.0436322	7.97548	0.0000
PC_M^2	-0.00736566	0.00177904	-4.14024	0.0006
PC_M^3	0.0000590041	0.0000194149	3.03912	0.0071

Tab. 1: Estimates of parameters for the "life expectancy at birth – males" model; Source: own construction

and we can write the resulting model in the following form

$$ex\_M = 67.4002 + 0.347988 \cdot PC\_M - 0.00736566 \cdot PC\_M^2 + 0.0000590041 \cdot PC\_M^3.$$

The parameters of the model for female life expectancy at birth were calculated the same way as presented in tab. 2.

Parameter	Estimate	Standard Error	T Statistic	P-Value
CONSTANT	75.0645	0.187971	399.34	0.0000

PC_F	0.281642	0.034853	8.08086	0.0000
PC_F^2	-0.00649184	0.0015129	-4.29099	0.0004
PC_F^3	0.0000572164	0.0000175639	3.25761	0.0044

Tab. 2: Estimates of parameters for the "life expectancy at birth - females" model; Source: own construction

We can write the resulting in the following form

$$ex\_F = 75.0645 + 0.281642 \cdot PC\_F - 0.00649184 \cdot PC\_F^2 + 0.0000572164 \cdot PC\_F^3.$$

The diagnostic tests of the model indicate that the unsystematic component of the model is not auto-correlated, is homoscedastic and has roughly a normal division. So it is possible to calculate the forecast of male life expectancy at birth, and female respectively, by using the explanatory variable of Czech household computer facilities with regard to the share of males and females in the population of the Czech Republic. The resulting estimates are shown in fig. 4 for males, and in fig. 5 for females respectively, with the calculated 95% reliability intervals.

Our assumptions are clear. At the end of 2010 the standard of computer facilities in Czech households was about 60%, (62% is about the standard in the time series PC_M, 58% is about the standard in the time series PC_F). An interval of 48 years (2012-2060) remains for the future from the mentioned 60% of facilities to the limit value of 100% of household facilities. During this time, life expectancy at birth will rise to the value of almost 88 years in males and the value of almost 94 years in females.

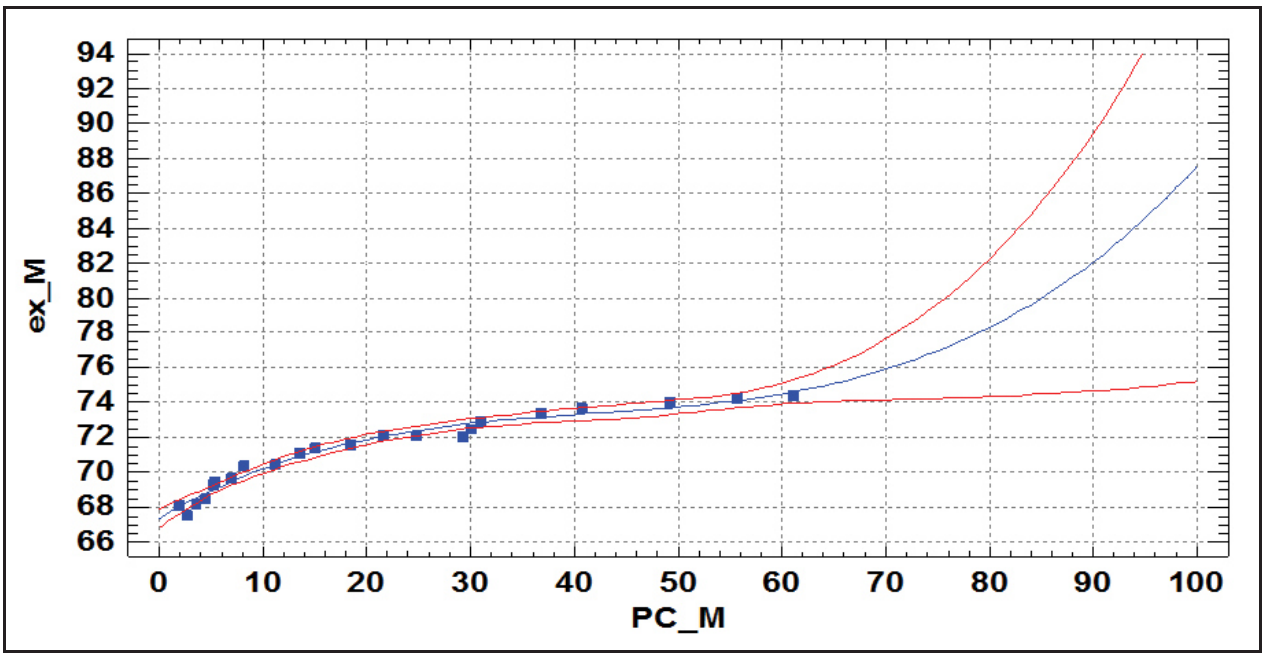

Fig. 4: Forecast of the life expectancy at birth trend in males using third order polynomial regression (+/- 95% estimate reliability interval); Data source: CZSO, own construction

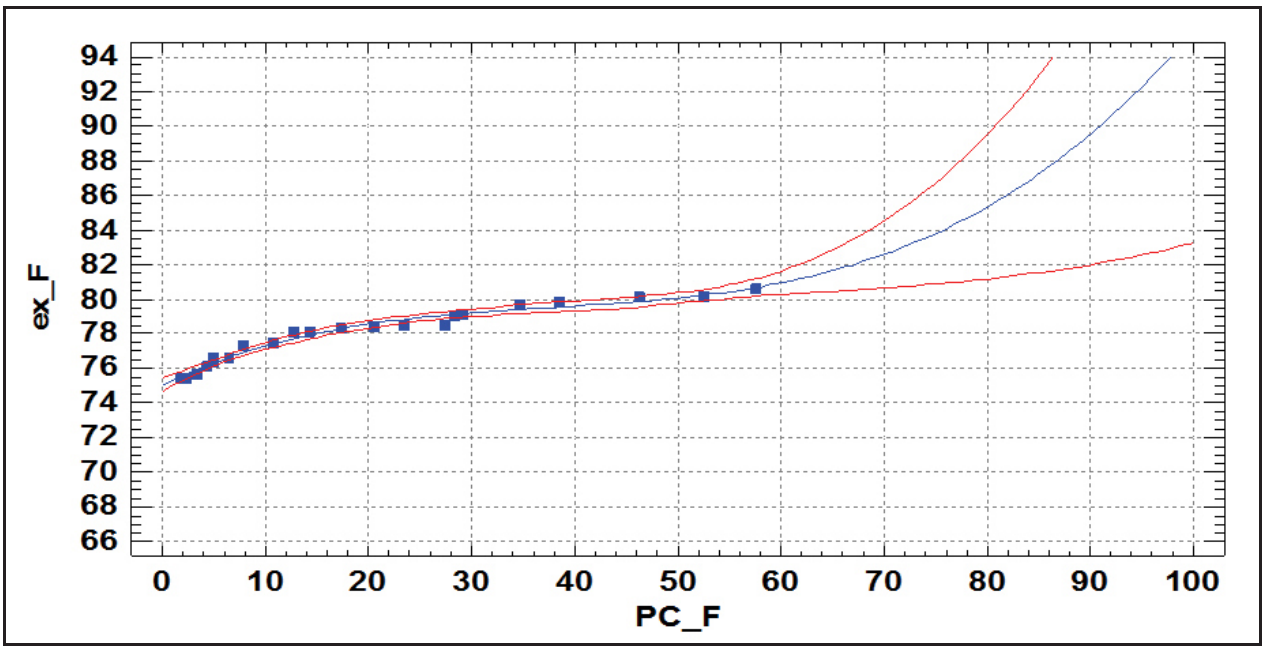

Fig. 5: Forecast of life expectancy at birth trend in females using third order polynomial regression (+/- 95% estimate reliability interval); Data source: CZSO, own construction

5. Conclusion

One important conclusion arises from the above facts. When confronting the values forecasted by the polynomial regression model in tab. 1 and tab. 2 which are shown in the charts in fig. 4 and fig. 5, we can claim that the values perfectly correlate with the officially estimated values of male life expectancy at birth, and female respectively, published in a high variant of the demographic projection of the Czech Republic compiled by the Czech Statistical Office. In the event of the revision of the computer facilities trend, it would most probably be possible to even arrive at mean values, or even lower variants. This is a very simple method of how to arrive at the explanation of the life expectancy at birth trend using a different method. The assumptions about the connections of the imaginary "living standard" variable and some realistic one by which we can numerically quantify, (in our case the computer facilities of Czech households which began to accelerate with the fall of the last political regime), apply. Therefore, we are also able to estimate life expectancy at birth in another than the traditional demographic method.

Given that we found the relationship between our estimated expectations of life expectancy at birth and life expectations, which are published by CZSO and as well as by Fiala et al. (2011), we can claim, that the dependence of acceleration of living standard, explained by specific variable could exist. The relationship between living standard and Czech household computer facilities could be duplex and therefore may affect the outputs of the market economy, which includes the people and their increasing life expectancy at birth.

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