Club convergence in health outcomes in OECD countries

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Motivation

Dynamics of life expectancy in different countries throughout the process of human development is quite different:

- As a rule, less developed countries catch up with more developed ones, but the speed of this process can significantly differ for different countries;
- Not all national life expectancies have increased, some countries have stagnated or even decreased;
- There is substantial heterogeneity in life expectancy even among the most developed countries of the world.

Motivation

The aim of our research is to single out groups of countries which converge to different steady-states (convergence clubs).

Highlighting a club of countries which achieved a success in life expectancy increase might help in investigation of such a success and other countries failure. Hence, these results can be useful for health care policy.

Detailed analysis of life expectancy by age groups shows which age groups benefit the most in «leading» clubs and which age groups remain behind in «lagging» clubs.

This might reveal range of problems concerning longevity in clubs falling behind and help these countries by providing healthcare policy recommendations.

A review of research in club convergence in health outcomes

Most often researches devoted to existence of convergence clubs at life expectancy allocate two or three clubs.

Mayer-Foulkes (2003)

Theoretical part: the Solow–type model with physical, human and health capital and exogenous technological progress. Author shows that life expectancy dynamics can be modelled using the theories of economic growth with multiple steady states (the convergence clubs).

Empirical part: The data supports the existence of at **least three** large-scale **convergence clubs**:

Methodology: a fixed-effects convergence model with dummies for three clubs.

Sample: *159 countries, 1962-97*

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McMichael et al (2004) after **Caselli et al (2002)** identify **three groups** of the countries in relation of trends of mortality.

Methodology: Qualitative (descriptive) research, 1950 – 2005

Becker et al (2005) provide evidence that **convergence** in life expectancy has been taking place (**no clubs, single steady-state**).

Methodology: σ-convergence analysis and unconditional β-convergence regression analysis . Sample: 49 countries with different levels of development, 1965 -1995

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Bloom and Canning (2007) and **Canning (2012)** reject the hypothesis that these changes reflect a simple convergence process and provide evidence of existence of the **two convergence clubs**: a high-mortality club and a low-mortality club.

Methodology: quadratic modification of β-convergence regression and nonparametric model with jumps between clubs.

Sample: 192 countries at 5-year intervals over the period 1950–2005.

Chung and Muntaner (2007): population health indicators in wealthy industrialized countries are **"clustered" around 4 different types** welfare state regime types even with control by the level of economic development and intra-country correlations.

Methodology: the conditional hierarchical regression models with welfare state type as a fixed effects indicator at the country-level.

Sample: 19 wealthy countries 1960 to 1994.

A review of research in club convergence in health outcomes

1. The researchers specify the number clubs before quantitative research (various kind of the regression analysis typically) from general considerations.

   Suppose the choice of researcher - to test the existence of three clubs.

   Data may not contradict the assumption that there are three clubs.

   However alternative hypotheses - that there are 2, 4, 5 ... clubs are not tested. It is possible that the data would not reject the existence of a different number of clubs than three.

Our choice: the allocation of groups of countries converging to different equilibria (convergence club) on life expectancy using the *log-t* test methodology proposed by Phillips and Sul (2007).

This methodology allows to allocate countries by clubs (and determine number of clubs) based on panel of countries behavior over time.

A review of research in club convergence in health outcomes

2. Different samples and the different periods of time - different results.

Whether there are theoretical bases for a choice of the period of time and selection of the countries?

A review of research in club convergence in health outcomes

Meslé and Vallin (2011):

There is no simple story of convergence in life expectancy throughout human development.

Observed picture in dynamics of health outcomes around the world is the interaction of periods on convergence and divergence both among most developed countries (MDC) and less developed countries (LDC) and among each group over the last 200 years.

Meslé and Vallin point out three such phases (or waves) from the eighteenth century to the present.

Authors emphasize distinguishing features of dynamics of life expectancy at a different age during each phase.

A review of research in club convergence in health outcomes

Meslé and Vallin (2011):

Three waves:

The first wave is named Pandemic Receding (*end of the eighteenth century – the 1960s).*

This wave fits into the Omran's (1971) theory of "epidemiologic transition".

The main driver: fight against infectious diseases and reduction of respiratory diseases.

Progress in life expectancy related to the strong **reduction of mortality at age 0–4 and fall mortality at age 5–19.**

The second wave is The Cardiovascular Revolution (*1960 – 1980?).*

This wave can be explained by the fourth stage of the epidemiologic transition which introduced by Olshansky and Ault (1986).

The main driver: successful fight against cardiovascular diseases.

This wave is associated with **reduced mortality in middle age**.

A review of research in club convergence in health outcomes

Meslé and Vallin (2011):

The third wave: (1980 - now)

The authors also suggest the possibility of the beginning of the third wave of divergence–convergence process in developed countries after 1980.

The main driver: Meslé and Vallin talk about new process of divergence–convergence based on a completely different approach to health. The success of this process depends on capacity of the society to implement it through improved social conditions, behavioral changes, and health policies.

This is associated with **reduced mortality at old and very old age.**

More confident we can assume the existence of this wave for women because women adopt useful habits in the field of health faster and use more frequent the advances of medicine.

A review of research in club convergence in health outcomes

We accept the **Meslé and Vallin** theoretical concept of dynamics of life expectancy.

It is not surprising that previous authors obtained different results in the existence of the club convergence depending on the time interval and a sample of countries.

The period of these research could contain different phases of processes of convergence-divergence which besides differ for developed and developing countries.

We concentrate on our research on the beginning of a third phase of the convergence-divergence process in developed countries in the early 1980-s.

We expect a various dynamics of LE for different ages and genders.

Methodology
Club Convergence t-test approach

- Let we have panel data for a LE X_{it} , *i = 1, ...N* and *t = 1, ...T* where *N* and *T* are the number of countries and the sample size respectively.
- We can construct the **relative transition parameter** as:

$$h_{it} = \frac{X_{it}}{\frac{1}{N}\sum_{i=1}^{N} X_{it}}$$

- This parameter measures in relation to the panel average at time *t* and describes the relative departures of economy *i* from the common growth path .

Methodology
Club Convergence t-test approach

- If panel units converge, the relative transition parameters converge to one $(h_{it} \to 1 \text{ for all } i \text{ as } t \to \infty)$.
- Then, the cross-sectional variance of h_{it}, denoted by H_t converges to zero:

$$H_t = \frac{1}{N}\sum_{i-1}^{N}(h_{it} - 1)^2 \to 0 \ \ as\, t \to \infty$$

Methodology

Club Convergence t-test approach

Phillips and Sul test the null convergence hypothesis using the following *log t* regression:

$$\log\left(\frac{H_1}{H_t}\right) - 2\log L(t) = a + b\log t + u,$$

where *L(t) = log(t+1)*. The fitted coefficient of *logt* is $\hat{b} = 2\hat{\alpha}$, where $\hat{\alpha}$ is the estimate of the speed of convergence. A one-sided *t-test* robust to heteroskedasticity and autocorrelation is applied to test the inequality of the null hypothesis $\alpha \geq 0$.

The null hypothesis of convergence is rejected if $t_b < -1{,}65$ (at the 5% significance level).

Methodology
Club Convergence t-test approach

- Phillips and Sul develop an algorithm for detecting of club convergence based on log-t test. They develop a four-step procedure:
- *Step 1 (Ordering).* Cross-sectional units are sorted in descending order on the basis of the last period in the time series dimension of the panel. In the case of significant volatility in X_{it}, ordering can be based on the time series average over the last 1/2 or 1/3 periods.
- *Step 2. (Core Group Formation).* Selecting the first *k* highest units in the panel to form the subgroup G_k for $k=2,\ldots,N$, run the *log t* regression and calculate the convergence test statistic t_k for each subgroup. The core group is the one with the maximum *t*-statistic, given that it is statistically significant, i.e. $t_k > -1.65$. If condition $t_k > -1.65$ does not hold for the first two units in the sample, drop the first unit and continue the procedure from second unit and so on. If there are no a pair of units with $t_k > -1.65$ in the entire sample, conclude that there are no convergence clubs in the panel.
- *Step 3. (Club Membership).* One unit at a time is added to the core group and the t-statistic from the *log t* regression is calculated. A new unit classify as member of the club if the *t*-statistic of the associated *log t* regression exceeds some chosen critical value *c*. Based on Monte Carlo simulation, Phillips and Sul (2007) recommend to use $c = 0$, in order to reduce the risk of including a false member into a convergence group. Run the *log t* test for the entire group. If $t_k > -1.65$, this group forms a convergence club. Otherwise, increase the critical value c for the club membership selection, form a new group and check a condition $t_k > -1.65$ for this group. If there are no units except the core group with $t_k > -1.65$, conclude that the convergence club consists only of the core group.
- *Step 4 (Recursion and Stopping).* All units that have not been included in the club identified in the previous steps are tested to chek whether they form another club, that is, where $t_k > -1.65$. If not, repeat Steps 1–3 on this group to determine whether the panel includes a smaller subgroup that forms a convergence club. If no core group can be found, then these countries display a divergent behavior.

Methodology
Data

- Sample: 34 OECD countries except Canada and Chile + Russia where it is possible

  We should point out that the sample chosen contains 6 countries (Czech Republic, Hungary, Slovenia, Slovakia, Poland, and Estonia), experienced drop in life expectancy in early 1990-s.

- Time period 1980-2011

- We use the following indicators:

  - Life expectancy at birth, total population,
  - Infant mortality,
  - Life expectancy at birth, 40, 65, 80, by sex.

- The data source is OECD Health Data 2013

Results

If club has higher rank, its steady state of LE is higher than that of a club with lower ranking.
Bold letters denotes countries which are in core club.

Life expectancy at birth, total population.

Club	Club members	$\hat{b}$	*t-stat.*
1	Australia, Austria, Finland, France, Germany, **Iceland**, Ireland, Israel, **Italy**, **Japan,** Korea, Luxembourg, New Zealand, Portugal, Slovenia, Spain, Sweden, **Switzerland**	0.803	4.148
2	Belgium, Czech Republic, Denmark, Estonia, Greece, Hungary, Mexico, Netherlands, Norway, Poland, Slovak Republic, Turkey, UK, US	-0.037	-0.566

The core of the first club contains Iceland, Italy, Japan, Switzerland.
Slovenia catch up with equilibrium of first club.
Czech Republic, Hungary, Slovenia, Slovakia, Poland, and Estonia catch up with equilibrium of second club.
Russia's inclusion in the sample showed that this country does not converge to one of the two equilibrium states.

Results

Infant mortality*[1]*.

Club	Club members	$\hat{b}$	*t-stat.*
1	Australia, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, Mexico, Netherlands, New Zealand, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, Turkey, United Kingdom, United States, {+Russia}	0.131 {0.096}*	0.727 {0.576}

[1] Korea is not included as infant mortality data for this countries contains numerous missings.

The developed countries are already enjoying the benefits of reducing the infant mortality rate for the period of the study. Inclusion of Russia doesn't change the results - infant mortality rate in Russia approaches the same steady-state as OECD.

Results

- ***Life expectancy at birth, male***

Club	Club members	$\hat{b}$	*t-stat.*
1	**Australia**, Austria, Finland, France, Germany, **Iceland**, Ireland, **Israel**, **Italy, Japan,** Korea, Luxembourg, **Netherlands, New Zealand**, Norway, Portugal, Slovenia, **Spain, Sweden**, **Switzerland,** UK	0.662	3.488
2	Belgium, Czech Republic, Denmark, Estonia, Greece, Hungary, Mexico, Poland, Slovak Republic, Turkey, US	-0.067	-0.726

Life expectancy at birth, female

1	Estonia, **France, Japan,** Korea, Portugal, Slovenia, **Spain,** Turkey	0.063	0.554
2	**Australia, Austria**, Belgium, Czech Republic, **Finland**, Germany, Greece, **Iceland,** Ireland, **Israel, Italy,** Luxembourg, Netherlands, New Zealand, Norway, Poland, **Sweden, Switzerland,** UK	0.196	4.328
3	Denmark, Hungary, Mexico, Slovak Republic, US	-0.087	-0.814

Results

Life expectancy at 40, male

Club	Club members	$\hat{b}$	*t-stat.*
1	**Australia**, Austria, Finland, France, Germany, **Iceland**, Ireland, **Israel, Italy, Japan,** Korea, Luxembourg, Netherlands, **New Zealand,** Norway, Slovenia, Spain, **Sweden**, **Switzerland**, UK	0.541	3.287
2	**Belgium, Czech Republic, Denmark, Greece,** Mexico, Poland, **Portugal**, **US**	-0.050	-0.500
3	Estonia, Hungary, Slovak Republic, Turkey	0.269	0.621

Life expectancy at 40, female

1	**Australia, Austria,** Belgium, Czech Republic, Denmark, Estonia, **Finland**, **France,** Germany, Greece, Iceland, Ireland, Israel, **Italy,** Japan, **Korea,** Luxembourg, Netherlands, New Zealand, Norway, Poland, **Portugal,** Slovenia, **Spain, Sweden,** Switzerland, UK, US	-0.141	-1.080
2	Hungary, Mexico, Slovak Republic, Turkey	0.717	3.702

Results

Life expectancy at 65, male

Club	Club members	$\hat{b}$	*t-stat.*
1	**Australia, Denmark**, **France,** Ireland, **Israel,** Korea, **Switzerland**	0.507	2.369
2	Austria, Belgium, Czech Republic, Finland, Germany, Greece, **Iceland, Italy, Japan** Luxembourg, Netherlands, **New Zealand** Norway, Portugal Slovenia, **Spain** Sweden, **UK,** US	0.188	1.286
3	Estonia, Hungary, Mexico, Poland, Slovak Republic, Turkey	0.418	2.534

Life expectancy at 65, female

1	Finland, **France,** Ireland, Korea, Slovenia	0.481	1.975
2	Australia, Austria, Estonia, Israel, **Italy**, Poland, Portugal, **Spain, Switzerland**	0.122	0.751
3	**Belgium**, Czech Republic, **Germany,** Greece, **Iceland**, **Luxembourg,** Netherlands, **New Zealand, Norway**, **Sweden,** UK	0.387	2.031
4	**Denmark**, Hungary, Slovak Republic, **US**	0.403	4.942
div.	*Japan, Mexico, Turkey*		

Results

Club	Club members	$\hat{b}$	*t-stat.*
Life expectancy at 80, male			
1	Australia, Austria, Belgium, Czech Republic, Denmark, Estonia, Finland, France, **Germany,** Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Luxembourg, **Mexico**, Netherlands, **New Zealand**, Norway, Poland, Portugal, Slovenia, Spain, Sweden, **Switzerland,** UK, US	0.115	0.909
div.	Slovak Republic, Turkey		
Life expectancy at 80, female			
1	**France,** Korea	0.513	1.460
2	Australia, Austria, Finland, Iceland, Ireland, Israel, **Italy**, Poland, Portugal, Slovenia, **Spain, Switzerland**	0.470	3.587
3	Belgium, Czech Republic, Denmark, Estonia, **Germany,** Hungary, **Luxembourg** Mexico, **Netherlands, New Zealand, Norway, Sweden, UK**, US	0.465	2.859
div.	Greece, Japan, Slovak Republic, Turkey	-1.798	-17.545

Conclusion

- Our research reveals existence of several LE clubs at various age groups for OECD countries.
- Infant mortality rate approaches the unique steady-state, and there are no clubs with a high steady-state level of infant mortality rate.
- For females LE at middle age, there are two clubs, and the second club is not numerous. For male, there are three clubs, and the first one is very numerous. **It testifies in favor of the fact that for the middle age a transition to higher steady-state level for the developed countries is practically finished for females and it is close to end for males.**

Conclusion

- For the old age, we have received the greatest quantity of clubs – three for males and four – for females (in case of women some countries show divergence).
- Thus the structure of the first club in both cases is not numerous – there is small group of the countries which outperforms all the others at LE at 65.
- For the oldest old age, we have received two clubs for the males, thus the first club contains 30 of 32 countries of sample, and for females there are three clubs with two leading countries in the first club.
- In our opinion, it testifies in favor of the fact that in group of the developed countries there is an essential heterogeneity in LE in old age, and, the new phase in divergence among these countries in LE has started and this phase is related to reduction in mortality rates in old age for both genders, thus females are on the front line of this process.

Conclusion

- Analysis of behavior of LE in the 6 East-European countries showed that these 6 countries, unlike Russia, do not show divergence, and showed a convergence to the steady-state of developed countries club.
- Russia does not converge to one of the steady-states, except for a case of infant mortality rates.
- Slovenia approaches the steady-state of the first club of the most developed countries in LE, and Estonia shows the similar behavior for females, but the opposite for males. Hungary and Slovak Republic enter into clubs with the lowest steady-state level for different age (except for males at 80), other countries from this group can enter into clubs with average value of steady-state level of LE at different age.

Conclusion

- At last, the structure of clubs-leaders and clubs-outsiders at LE at 65 and at 85 might be useful for research of the reasons allowing them to achieve such progress or, on the contrary, to lag behind in this process. Among such reasons the most probable candidates are development of medical technologies and bad habits.

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