Mortality convergence across industrialized countries.

Paris Seminar in Demographic Economics

Héctor Pifarré i Arolas (with Hippolyte d'Albis and Loesse Jacques Esso)

Toulouse School of Economics

December 3, 2013

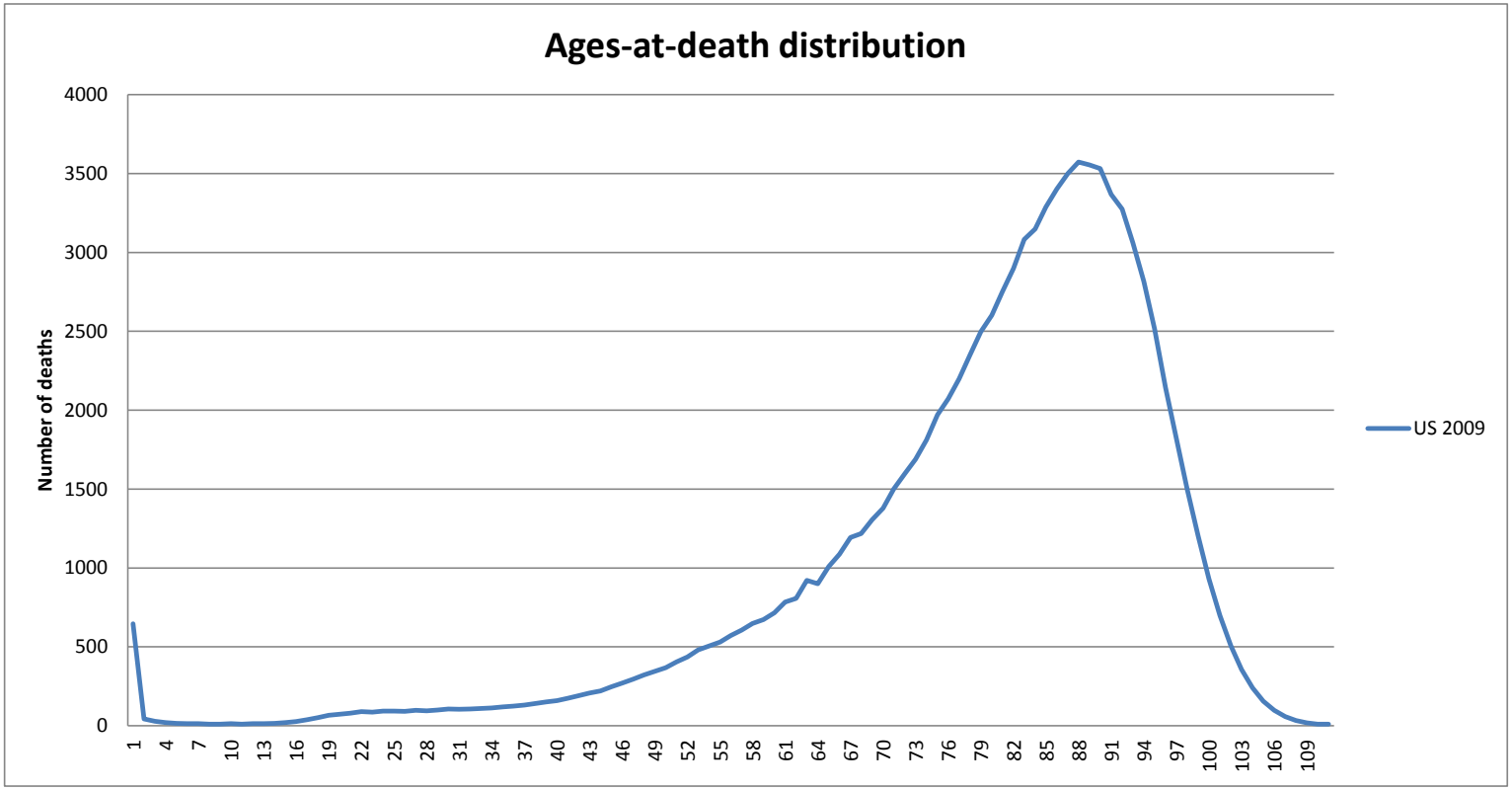
Question

The question: Has there been convergence in mortality patterns across industrialized countries since 1960?

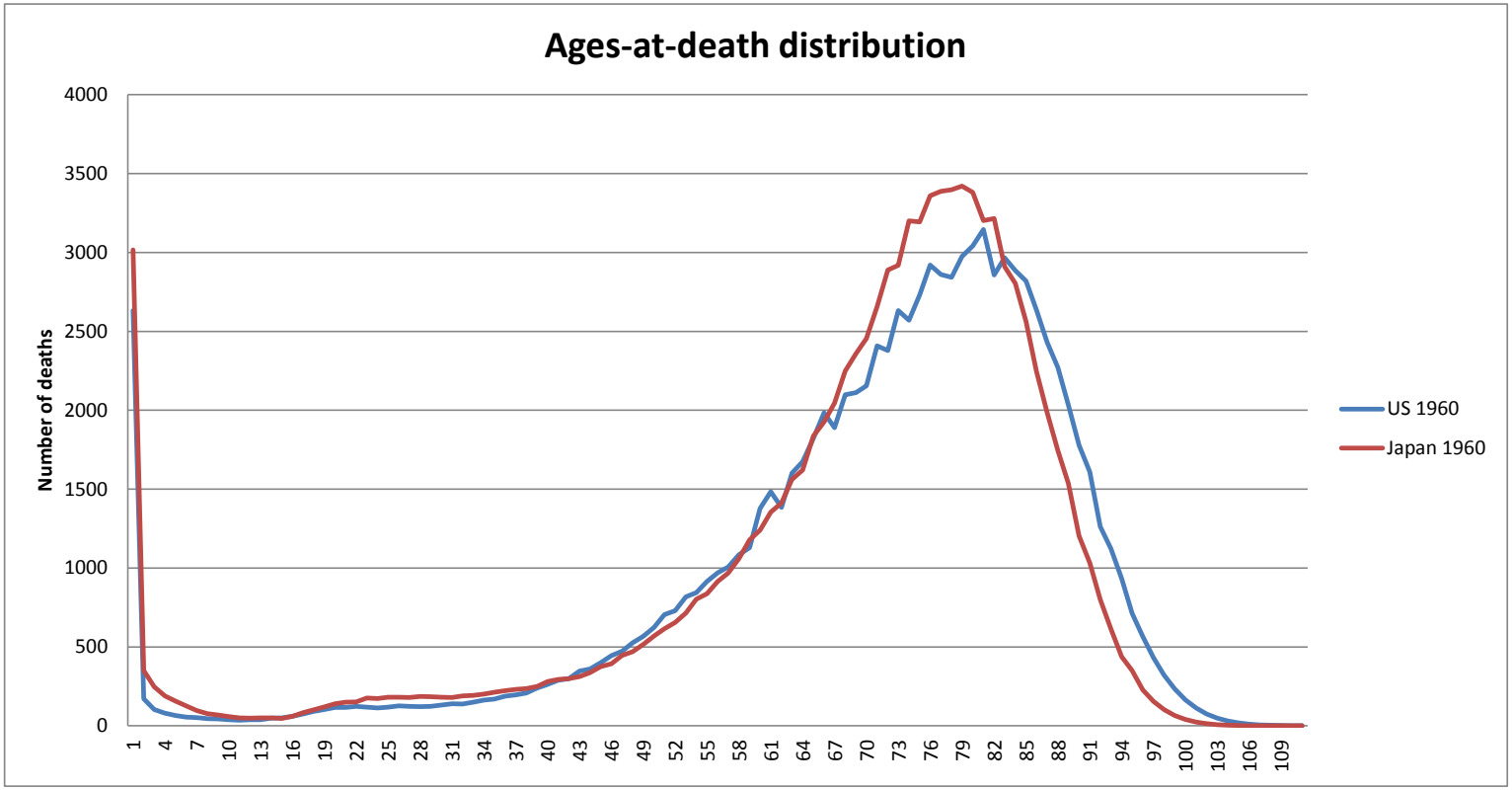
Question

- In particular, we study the convergence of the distributions of ages-at-death extracted from the period life tables.

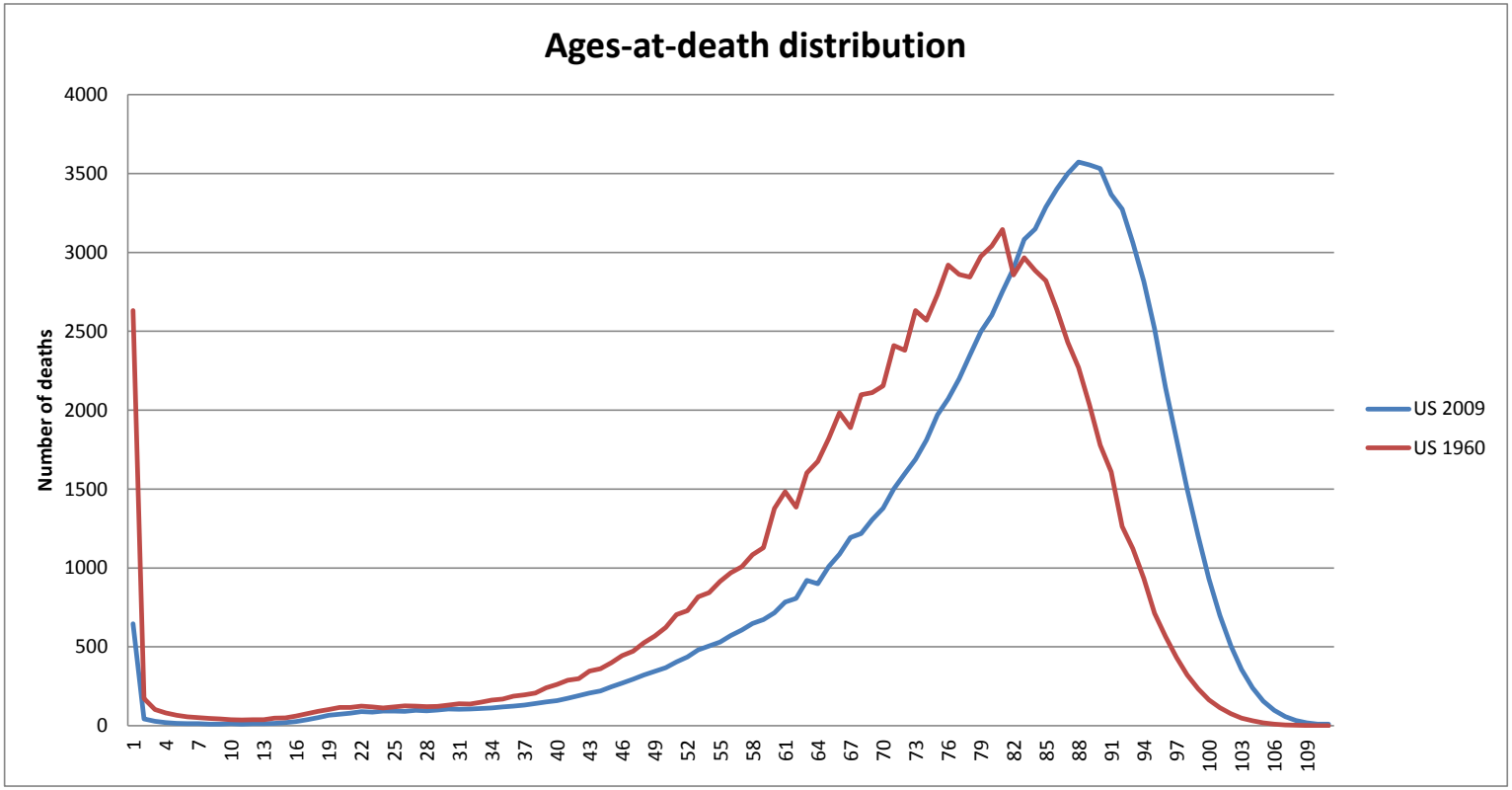
Ages-at-death distribution, US 2009



Ages-at-death distribution, US and Japan 1960



Ages-at-death distribution, US 1960 and 2009



Motivation

- Why do we care?
  - Important for the assessment of *welfare* convergence between countries (Becker et al., 2005).
  - It can be used to improve demographic projections (Li and Lee, 2005).

Motivation

Currently, two different approaches:

- Study convergence of certain moments of the distribution: life expectancy, inequality / dispersion (Wilson, 2001 and Peltzman, 2009).
- Assess convergence considering the whole distribution (Edwards and Tuljapurkar, 2005). This is our approach

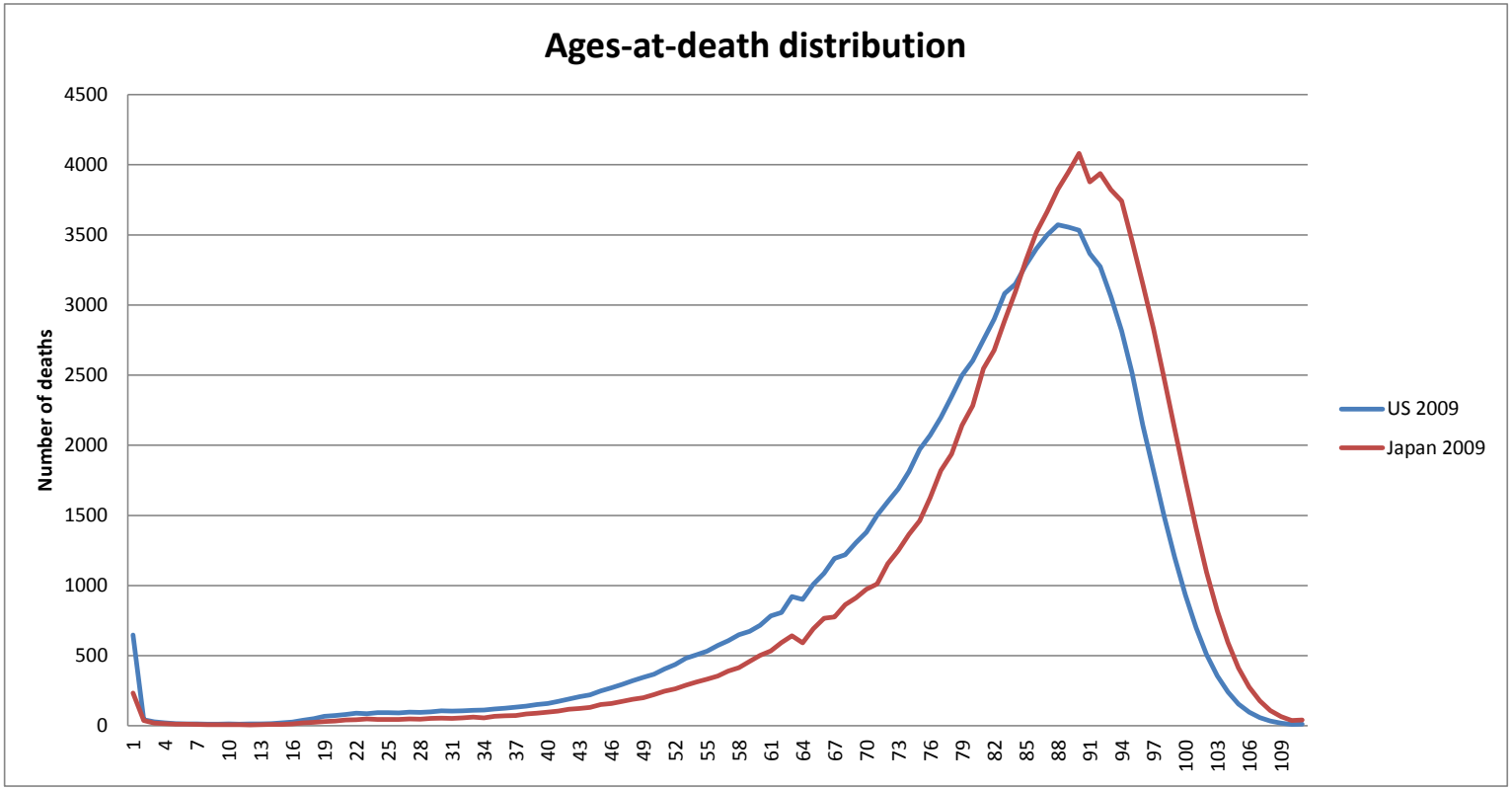
Roadmap

- Methods: Kullback Leibler divergence
- General trends
  - Western and Eastern countries (and EU)
- Explaining the trends
- Convergence clubs
- Conclusions

Methods

- The problem: to find a measure of dissimilarity between two distributions

Methods


Ages-at-death distribution
Number of deaths
4500
4000
3500
3000
2500
2000
1500
1000
500
0
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
100
103
106
109
US 2009
Japan 2009

Methods

- We use a measure of dissimilarity between distributions, the Kullback-Leibler divergence (KLD) (Kullback and Leibler, 1951; also used in Edwards and Tuljapurkar,2005)
- For two discrete probability distributions, the divergence of P from Q is given by
  $KLD\left(Q \parallel P\right) = \sum_i \ln\left(\frac{P_i}{Q_i}\right) P_i$
- whereP_i, Q_i are the probability masses in $i = 1, ..., N$

Methods

- Our concept of convergence: any group of countries converges in mortality if the *dissimilarities* across their ages-at-death distributions are reduced
- We compute the sum of KLDs each year from individual distributions to the period's average distribution
  - It is a shortcut to compute the sum of pairwise KLD between all the countries in the sample.

Data

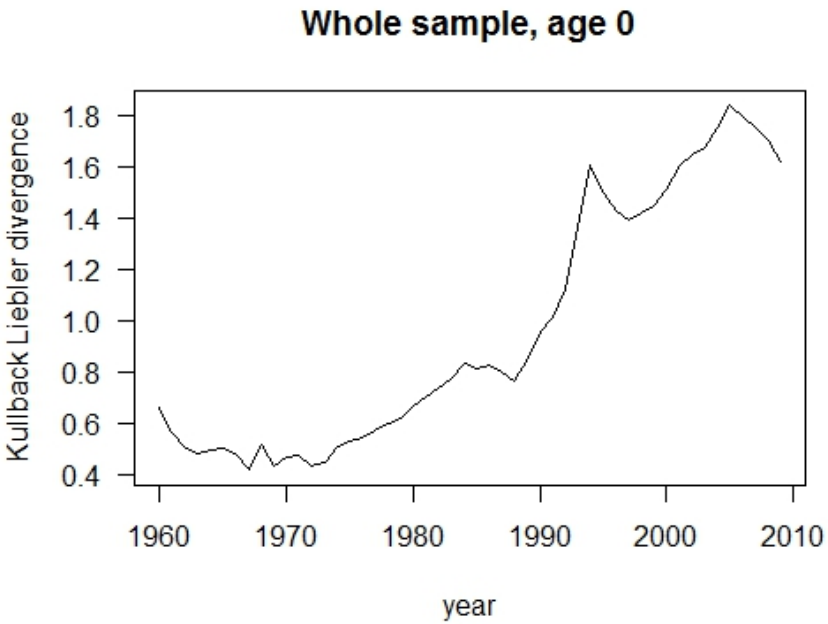
- We use data from the Human Mortality Database (mortality.org).
- Our full sample has 35 countries (and regions)

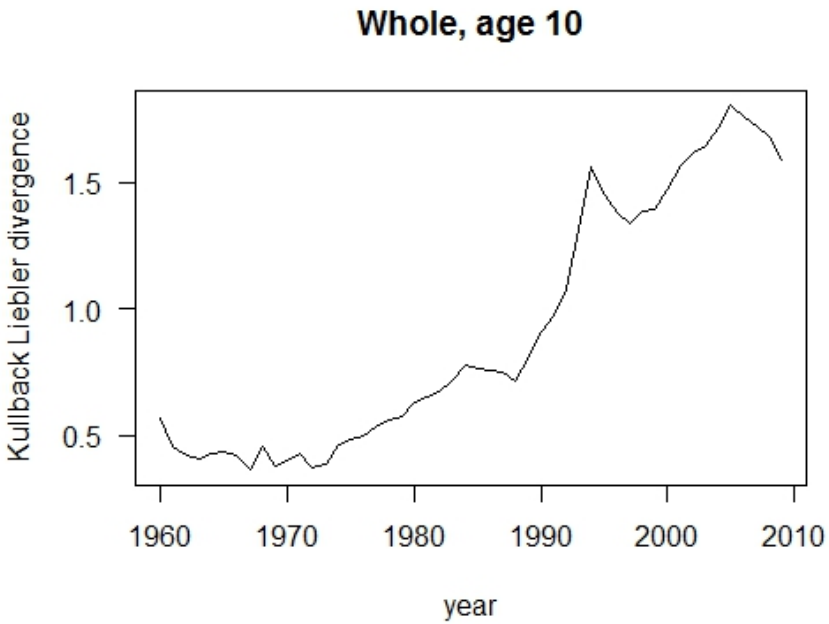
  Australia, Austria, Belgium, Bulgaria, Belarus, Canada, Switzerland, Czech Republic, East Germany, West Germany Denmark, Spain, Estonia, Finland, Civil France, Northern Ireland, United Kingdom, Scotland, Hungary, Ireland, Iceland, Italy, Japan, Lithuania, Luxemburg, Latvia, Netherlands, Norway, Poland, Portugal, Russia, Slovakia, Sweden, Ukraine, USA

General trends

- There has been a clear process of divergence in both mortality at age 0 and adult mortality.

General trends

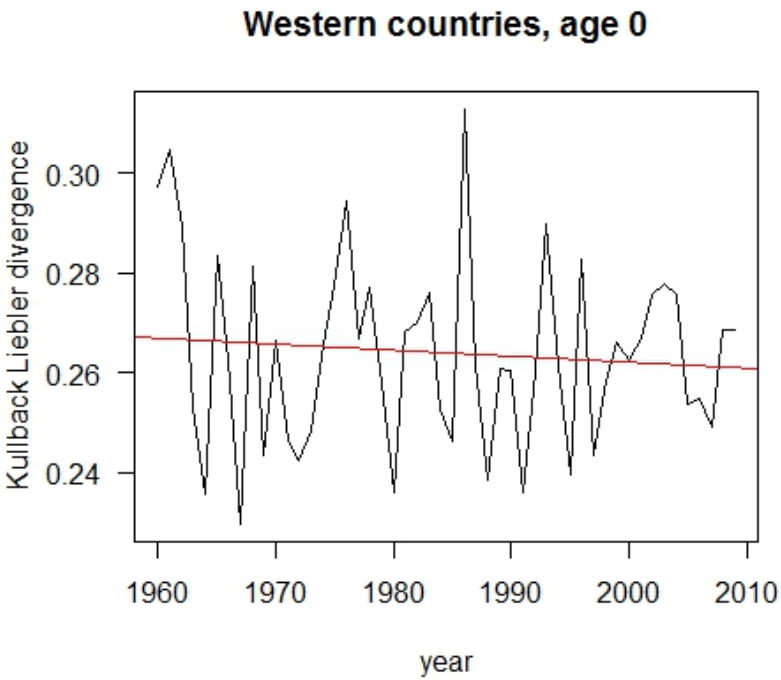


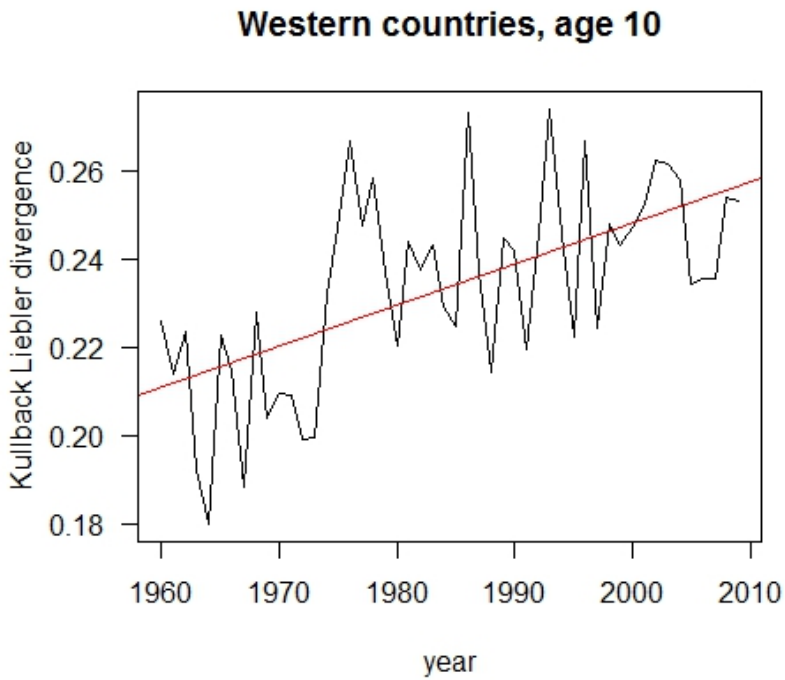


General trends

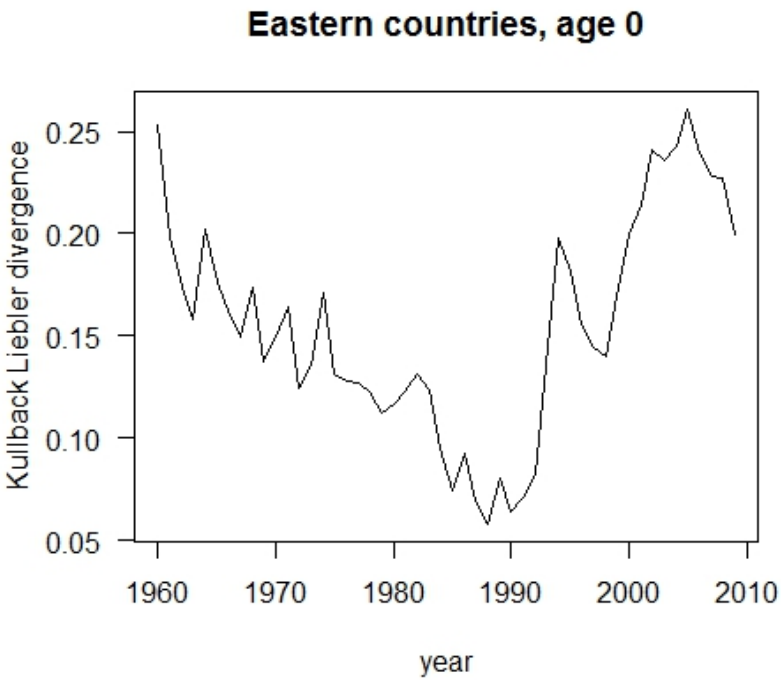
- However, the overall trend is the result of the interaction of different trends for different groups
- For example, western and eastern countries have marked differences.

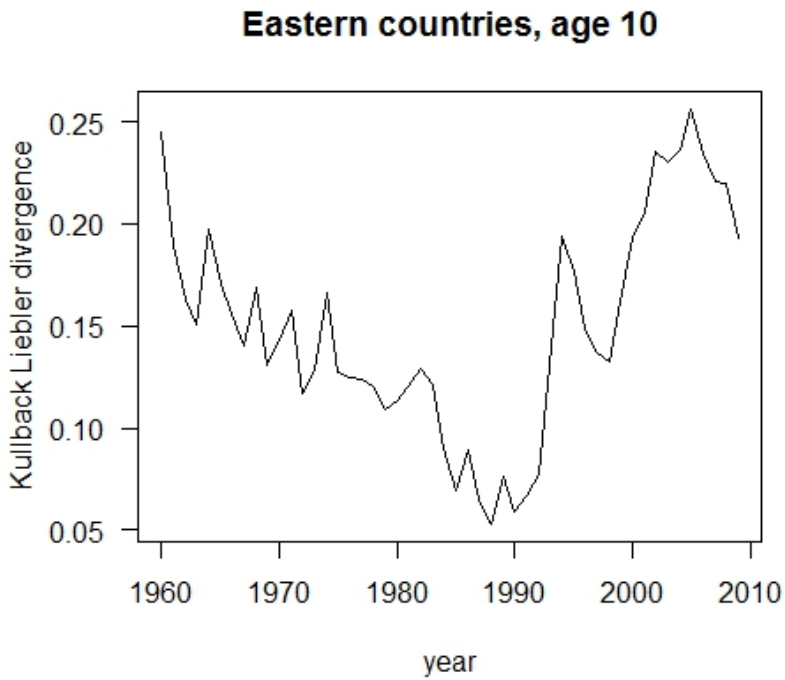
General trends





General trends

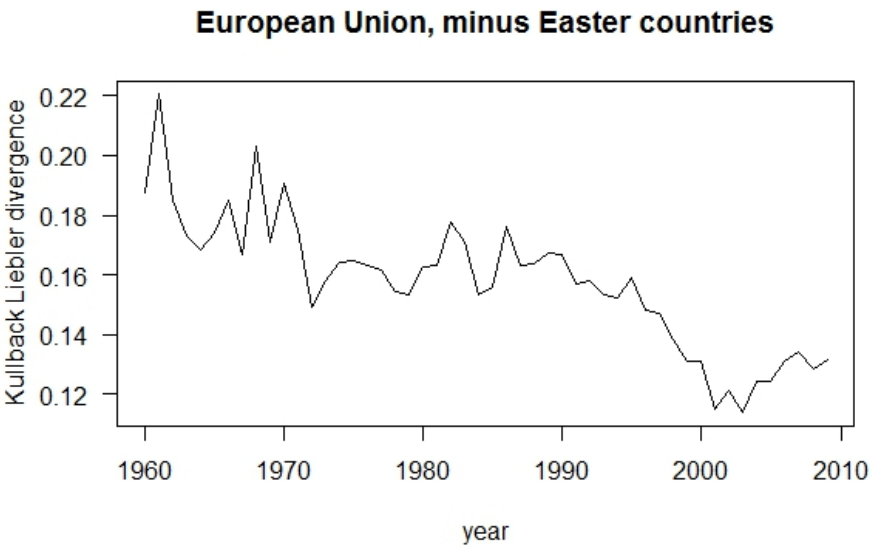


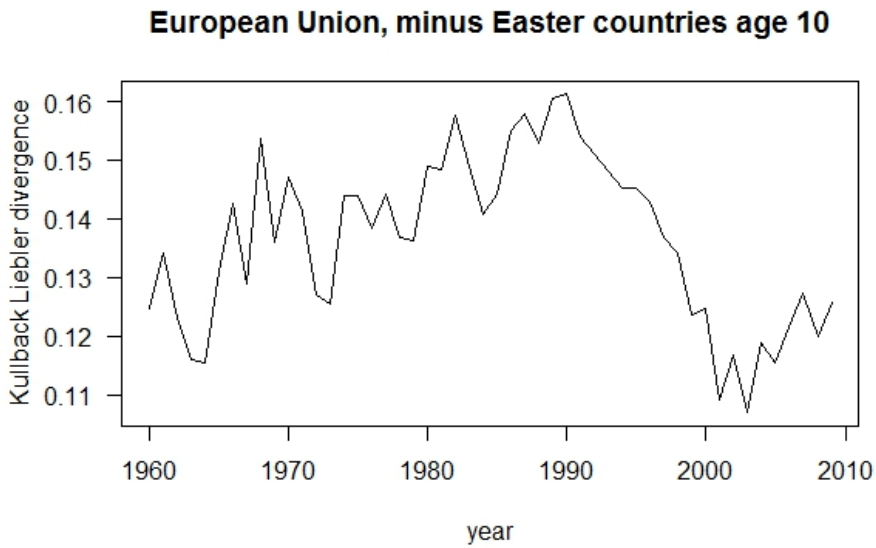


General trends

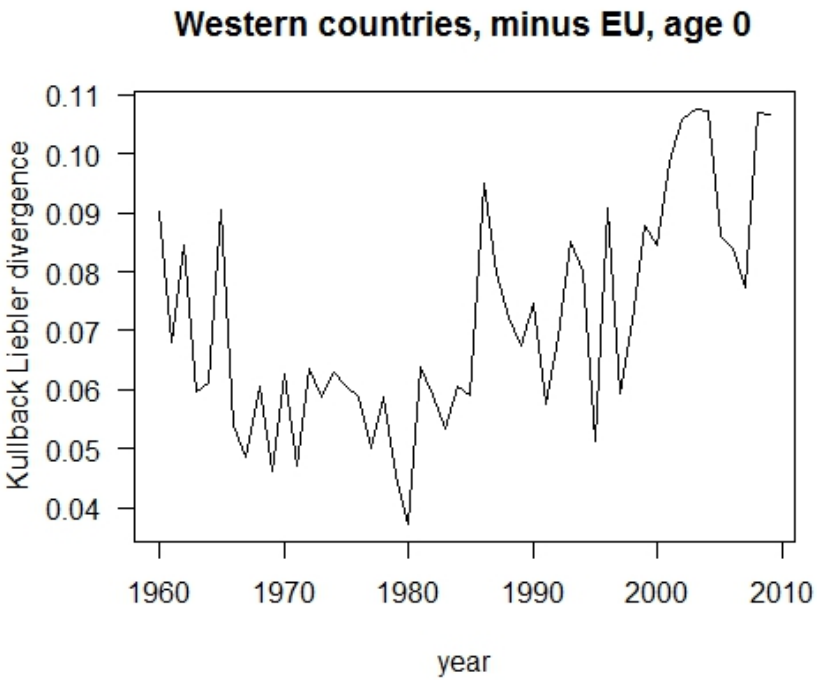
- However, within Western countires, the EU has converged.

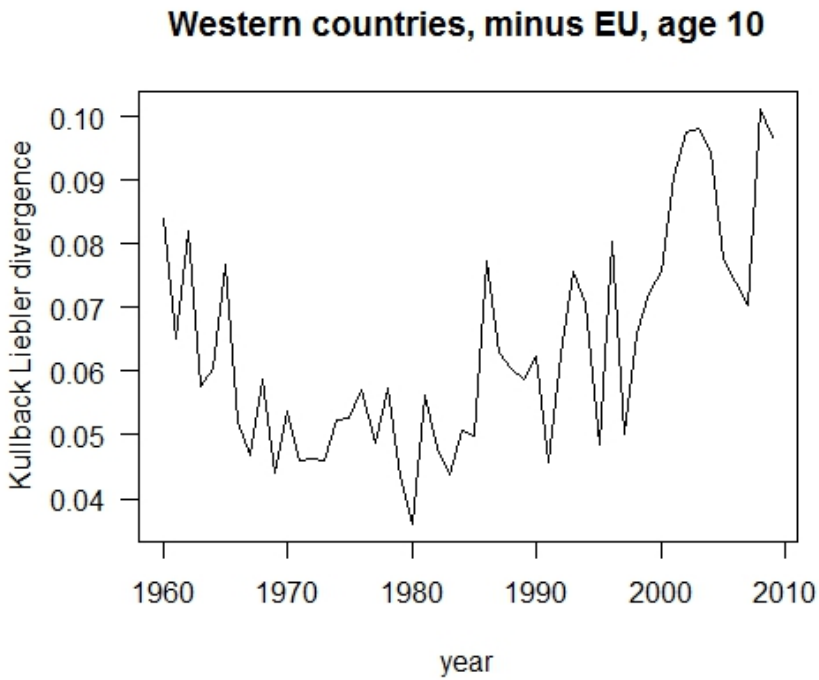
General trends





General trends





Explaining the trends

- We study separately western and easter countries to unveil the forces behind the trends in KLD.

  Australia, Austria, Belgium, Canada, Switzerland, West Germany, Denmark, Spain, Finland, France, Northern Ireland, Scotland, Ireland, Iceland, UK, Italy, Japan, Luxemburg, Netherlands, Norway, Portugal, Sweden, USA

  Bulgary, Belarus, Czech Republic, East Germany, Estonia, Hungary, Latvia, Poland, Russia, Slovakia, Ukraine

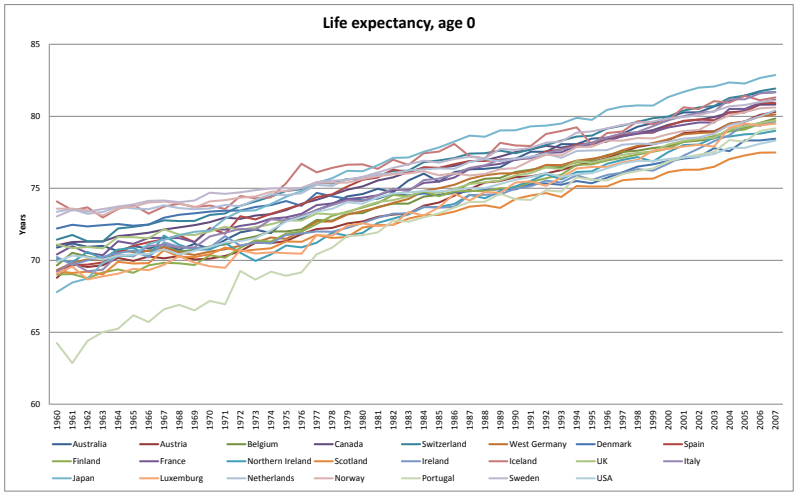
Explaining the trends

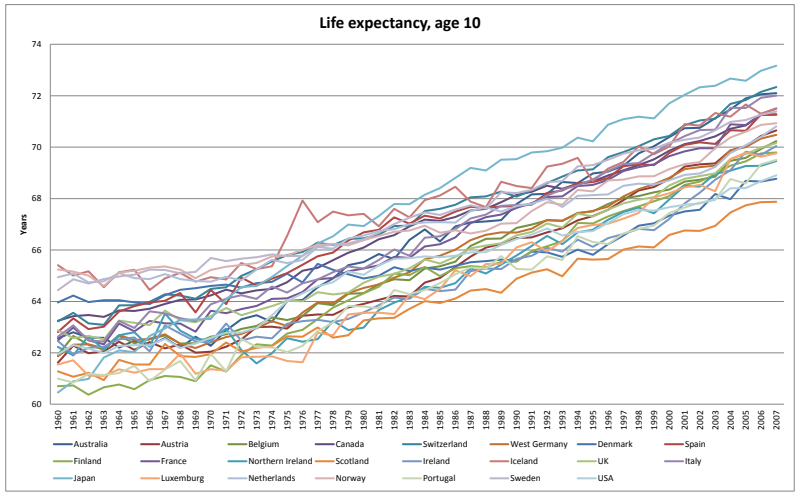
- For normal distributions, it is possible to compute the KLD as a function means and variances (Roberts and Penny, 2002).
  $KLD\left(Q \parallel P\right) = \frac{1}{2} \ln\left(\frac{\sigma_P^2}{\sigma_Q^2}\right) + \frac{1}{2} \frac{\mu_Q^2 + \mu_p^2 + \sigma_Q - 2\mu_Q \mu_P}{\mu_p^2} - \frac{1}{2}$
- Age-at-death distributions aren't statistically normal, but this allows to interpret the contributions of mean and variance to overall trend.

Explaining the trends

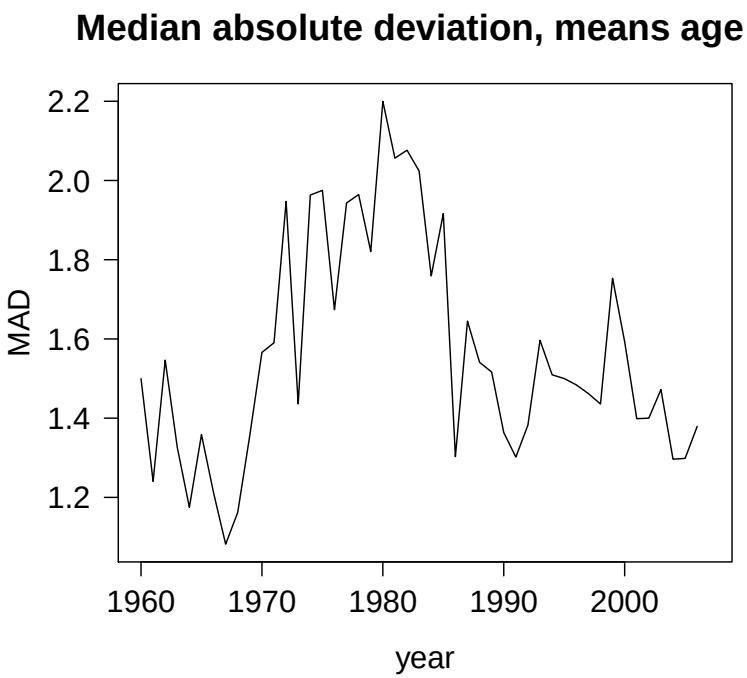
- A caveat: the effect of changes in the variance is not straightforward.
- When comparing two normal distributions (P with respect to Q), the term
  $\left[\sigma_P^2 - \sigma_Q^2\right] - \left[\mu_Q^2 + \mu_p^2 - 2\mu_Q\right] \lesseqgtr 0$
- determines the sign of $\frac{\partial KLD}{\partial \sigma_P^2}$.
- When the means are different, a decrease in the variance may increase the KLD.

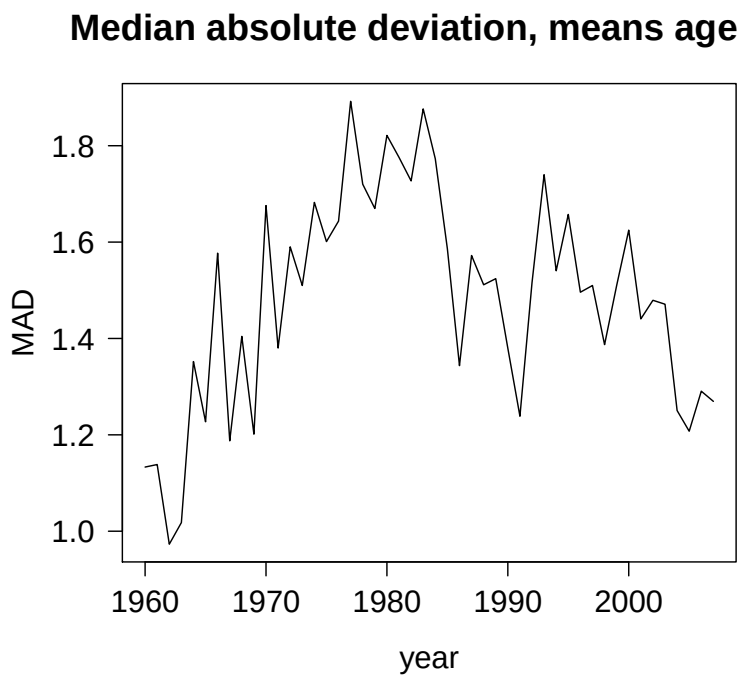
Explaining the trends (Western countries)



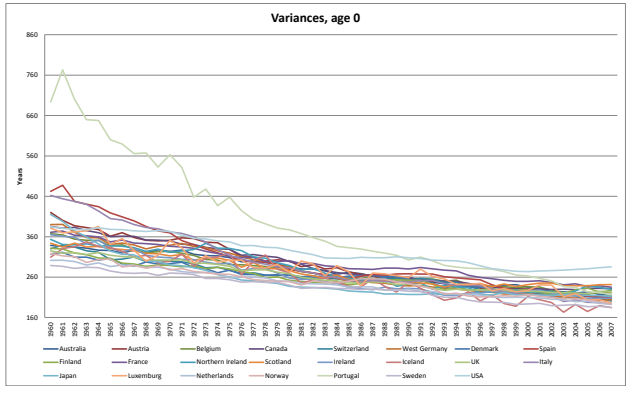


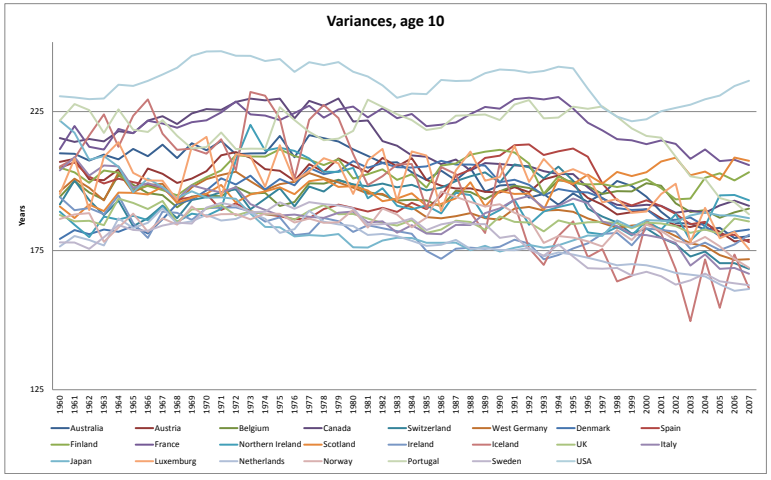
Explaining the trends (Western countries)



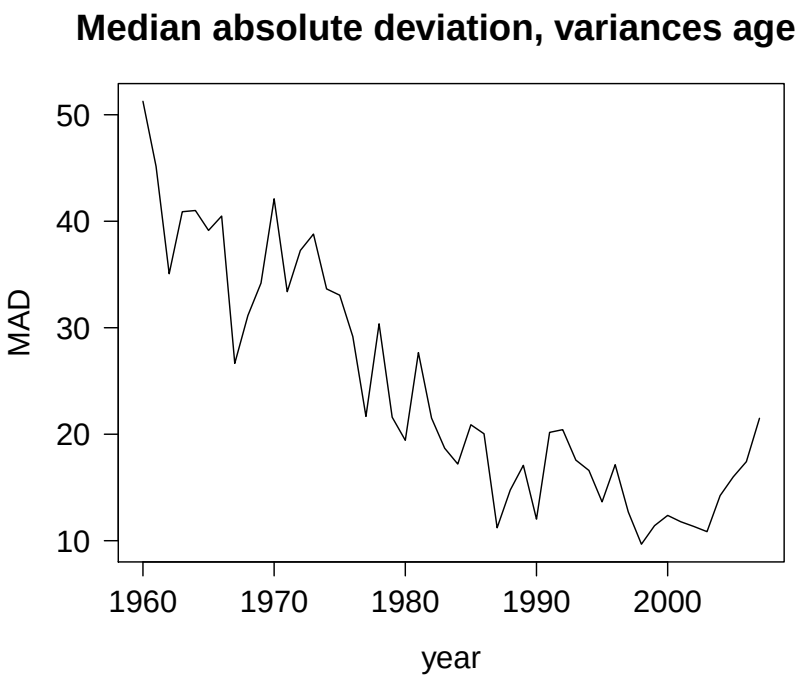


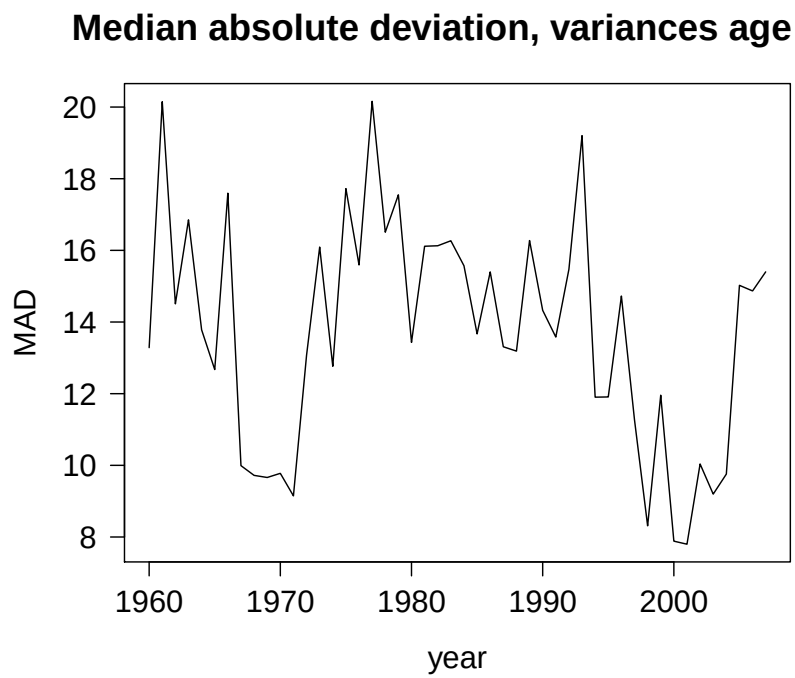
Explaining the trends (Western countries)





Explaining the trends (Western countries)

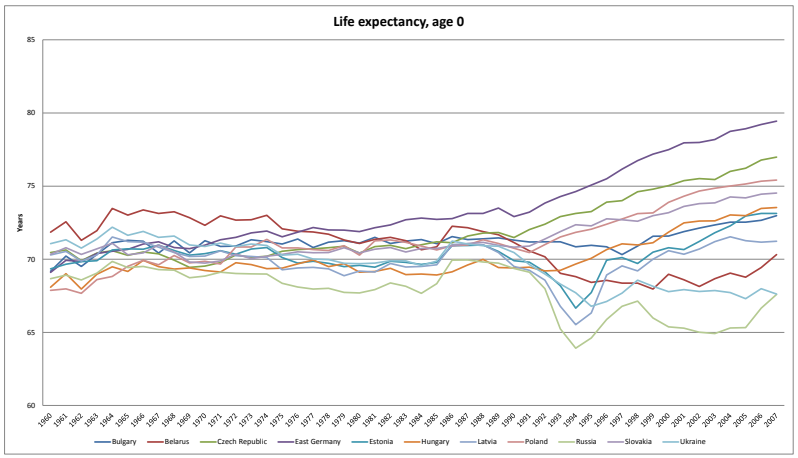


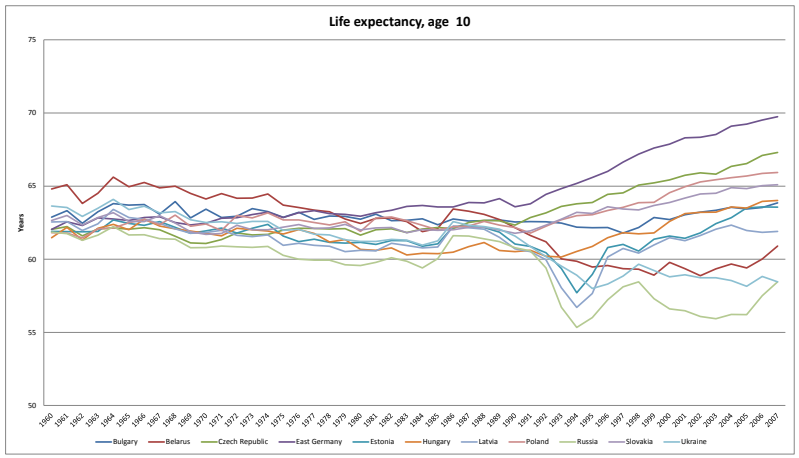


Explaining the trends (Western countries)

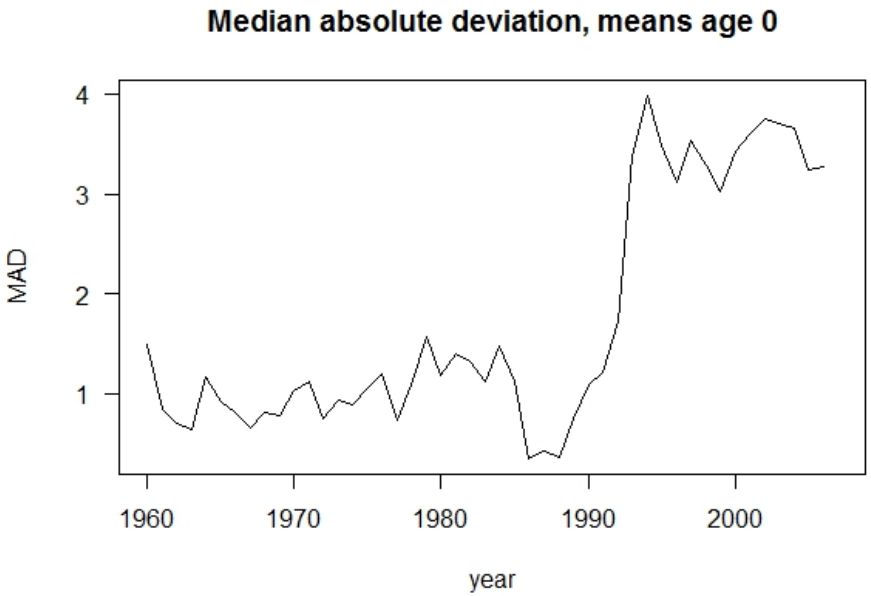
- We compare the values for the KLD holding constant variances.
- At age 0, convergence has been driven mostly by reductions in infant mortality.
  - The dispersion of life expectancies has slightly decreased and there has been a strong convergence in variances.
- At age 10, the variance has greatly contributed to the dissimilarities.
  - There is increased dispersion in life expectancies and the variance has increased slightly too.

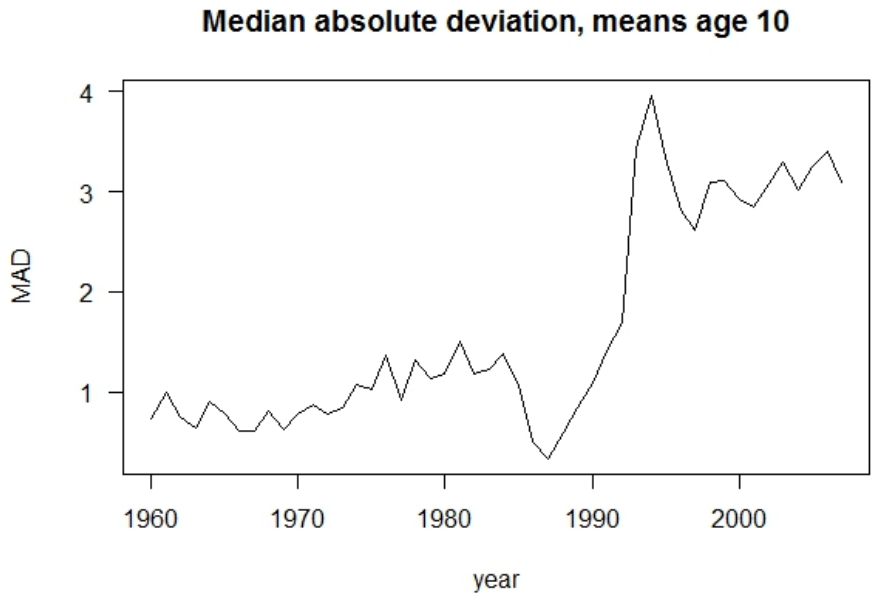
Explaining the trends (Eastern countries)



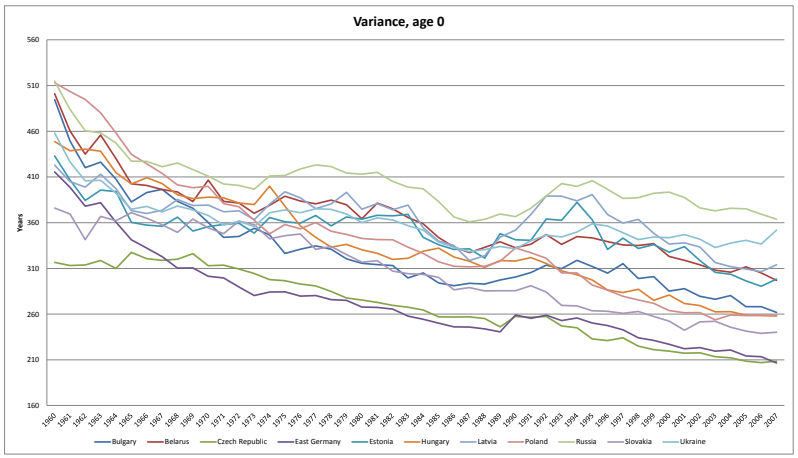


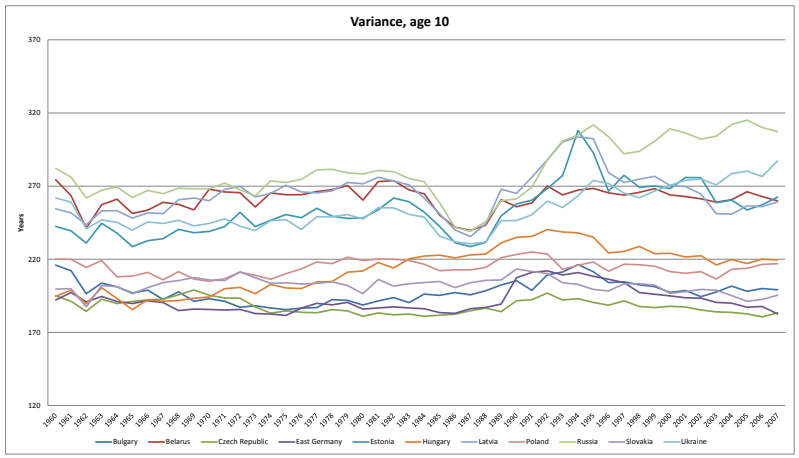
Explaining the trends (Eastern countries)



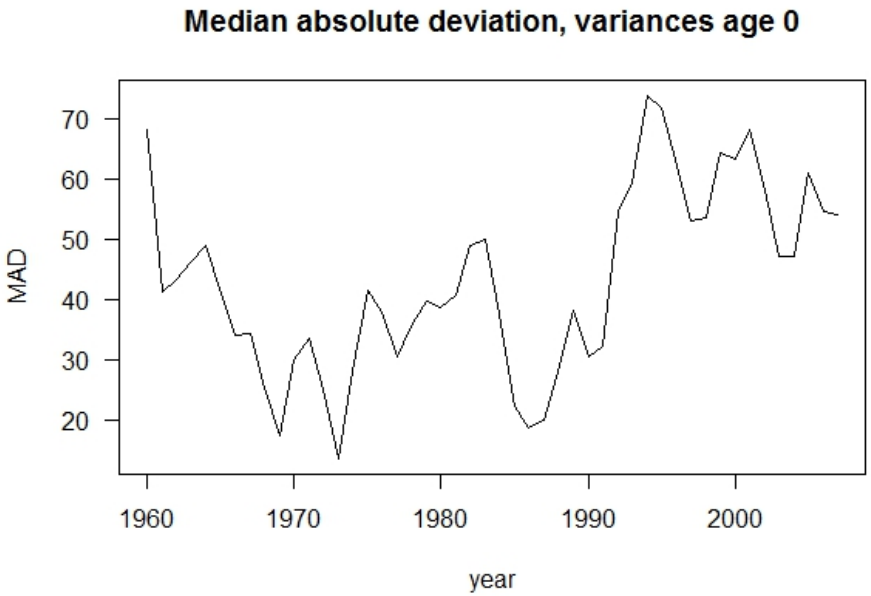


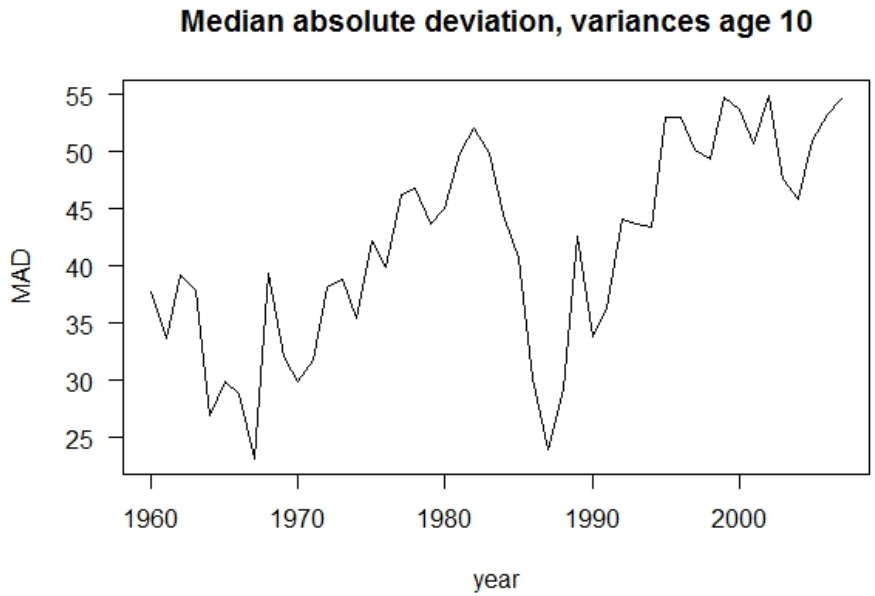
Explaining the trends (Eastern countries)





Explaining the trends (Eastern countries)





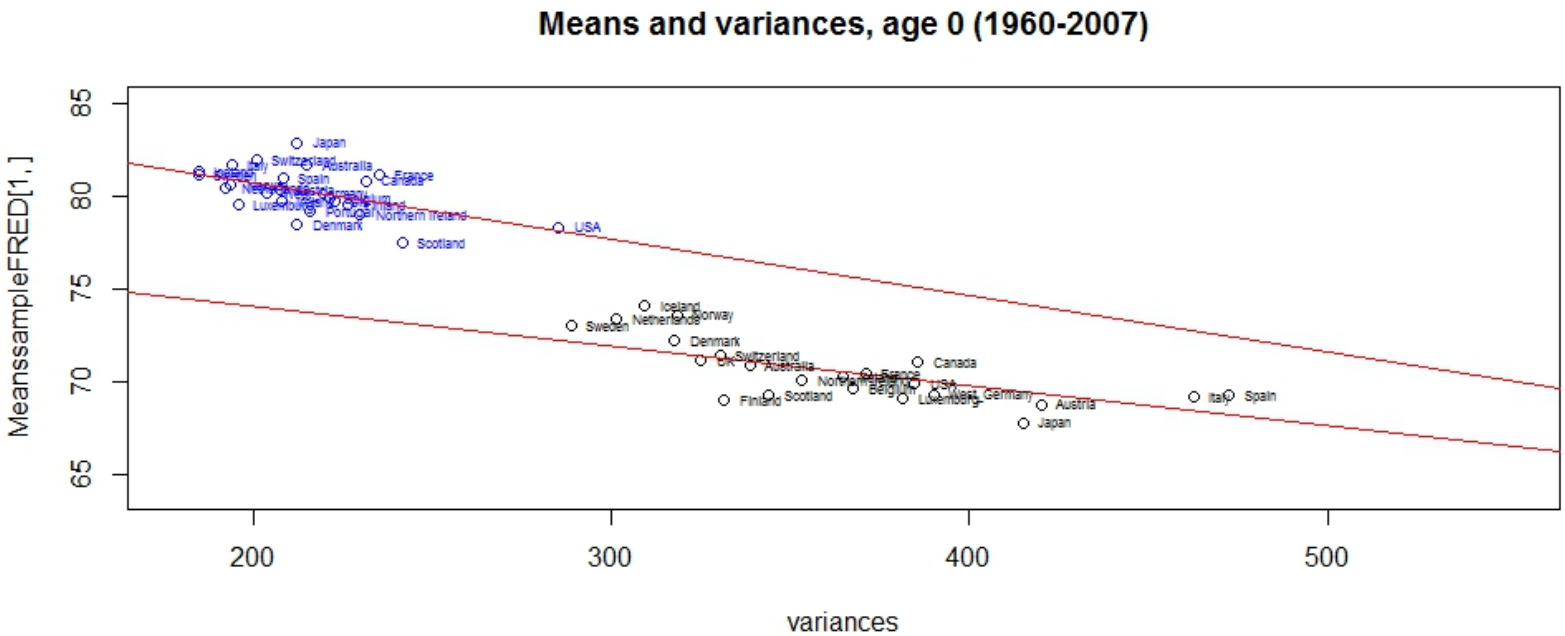
Explaining the trends (Eastern countries)

- At both age 0 and age 10, divergence has been driven increasing disparities in life expectancy
  - Increases in the dispersion of variances have actually contributed negatively to the KLD.

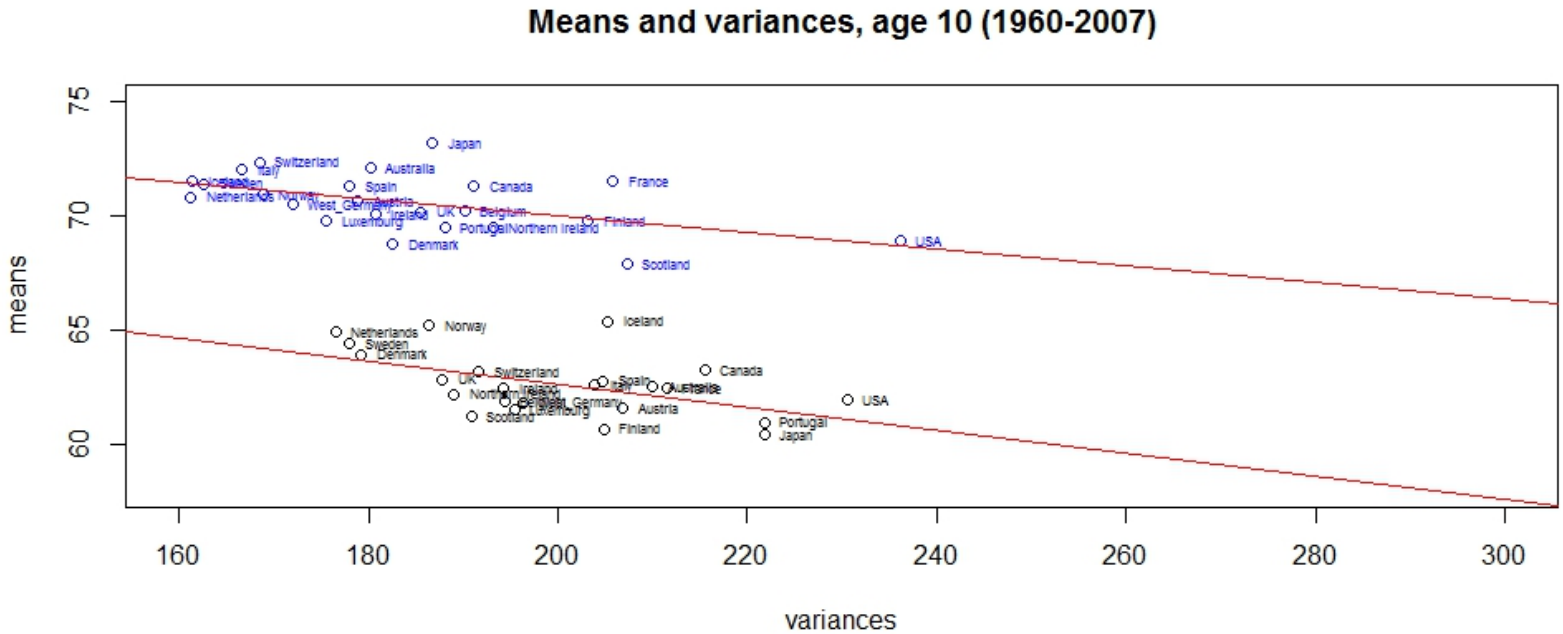
Convergence clubs (Western countries)

- There exist subgroups of countries that converge (e.g. EU vs rest of capitalist countries).
- Are there any clubs of convergence within the sample of western countries?

Convergence clubs (Western countries)



Convergence clubs (Western countries)



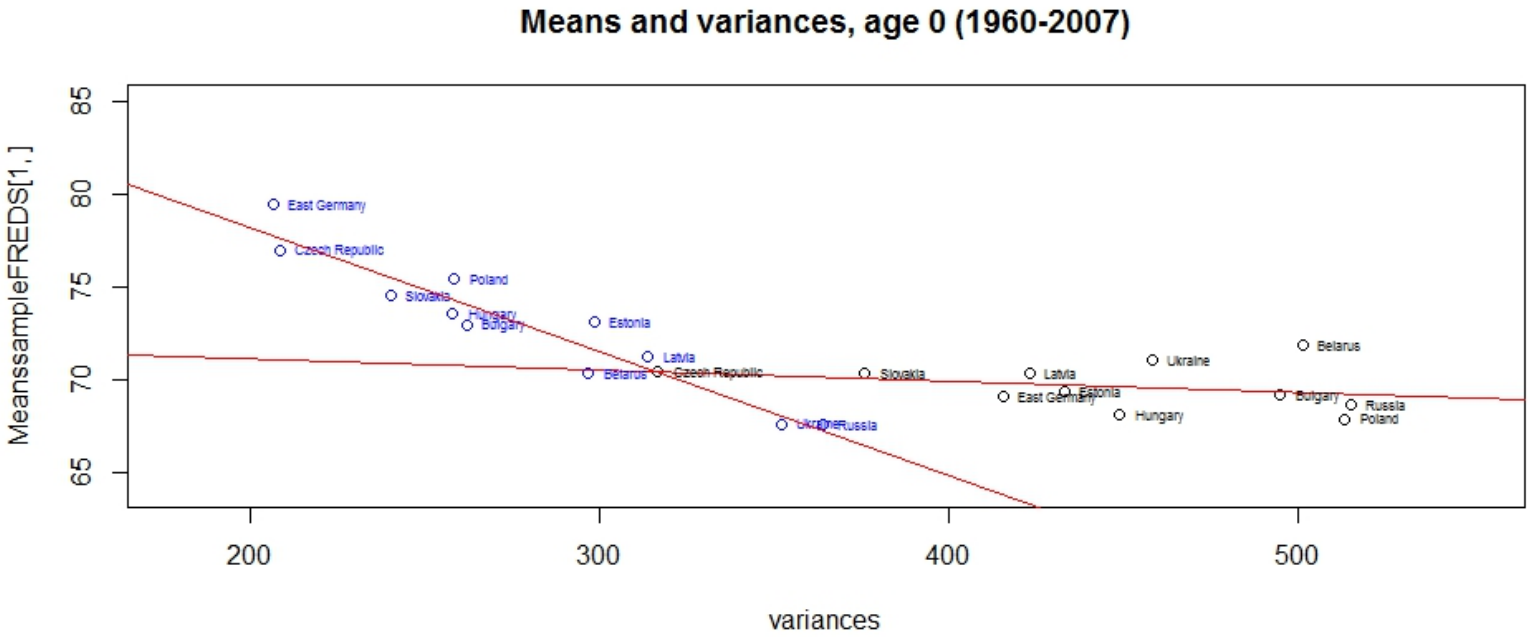
Convergence clubs (Western countries)

- There are several countries that change drastically their mean and variance coordinates (e.g. Japan, Denmark).
- We move from countries being distributed along the axis where we have low variance and high means to increasing disparities.

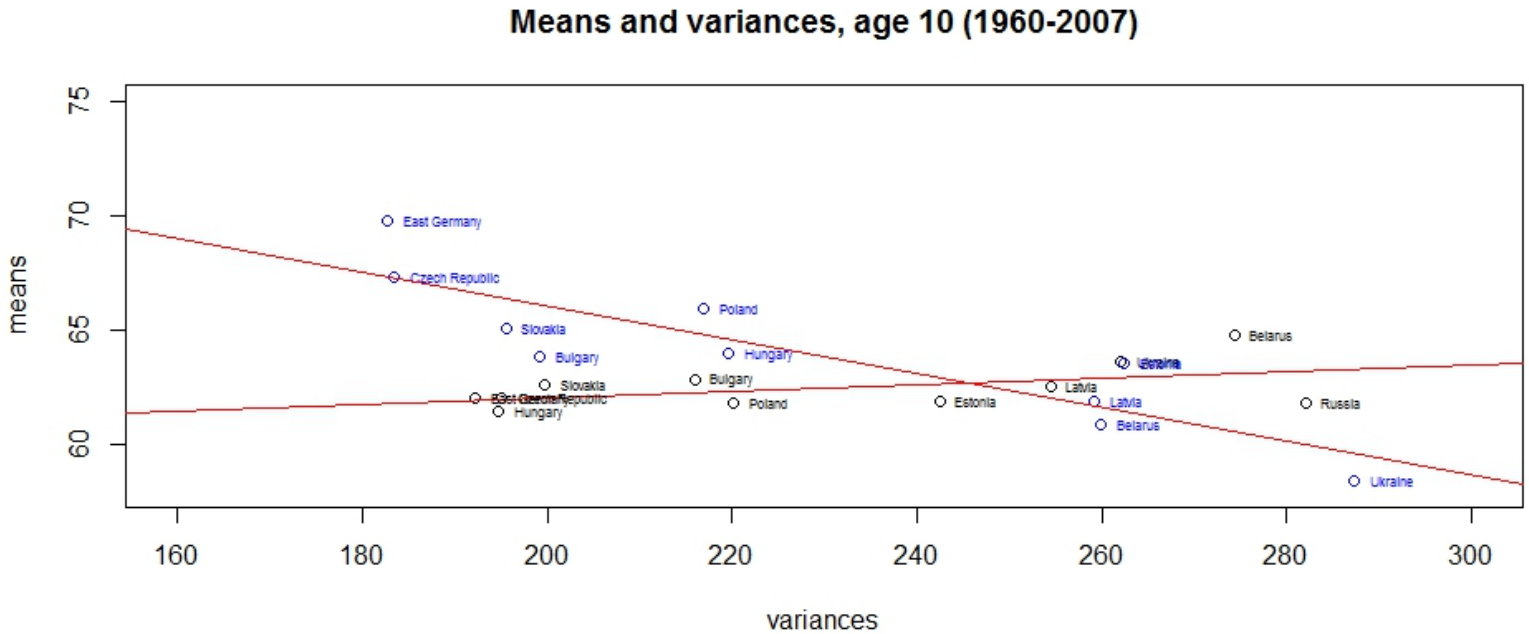
Convergence clubs (Eastern countries)

- How about for Eastern countries?

Convergence clubs (Eastern countries)



Convergence clubs (Easternn countries)



Convergence clubs (Eastern countries)

- In the case of Eastern countries, the pattern is reversed.

Conclusions and Next Steps

- We have reassessed the mortality convergence hypothesis with a different definition of convergence.
- We find that although there isn't convergence for the whole sample, there exist subgroups or convergence clubs (e.g. EU).
- Our resultsnegate the basic hypothesis of previous works: there isn't evidence of a common steady state across countries.
- Next steps include investigating the set of variables that defines a convergence club and the stability over time of the clubs.
- In particular, our preliminary analysis seems to indicate a strong effect of political federations.

- Thanks for coming!