Mortality Improvements

Cross-country correlations

Cord-Roland Rinke, L&H Longevity

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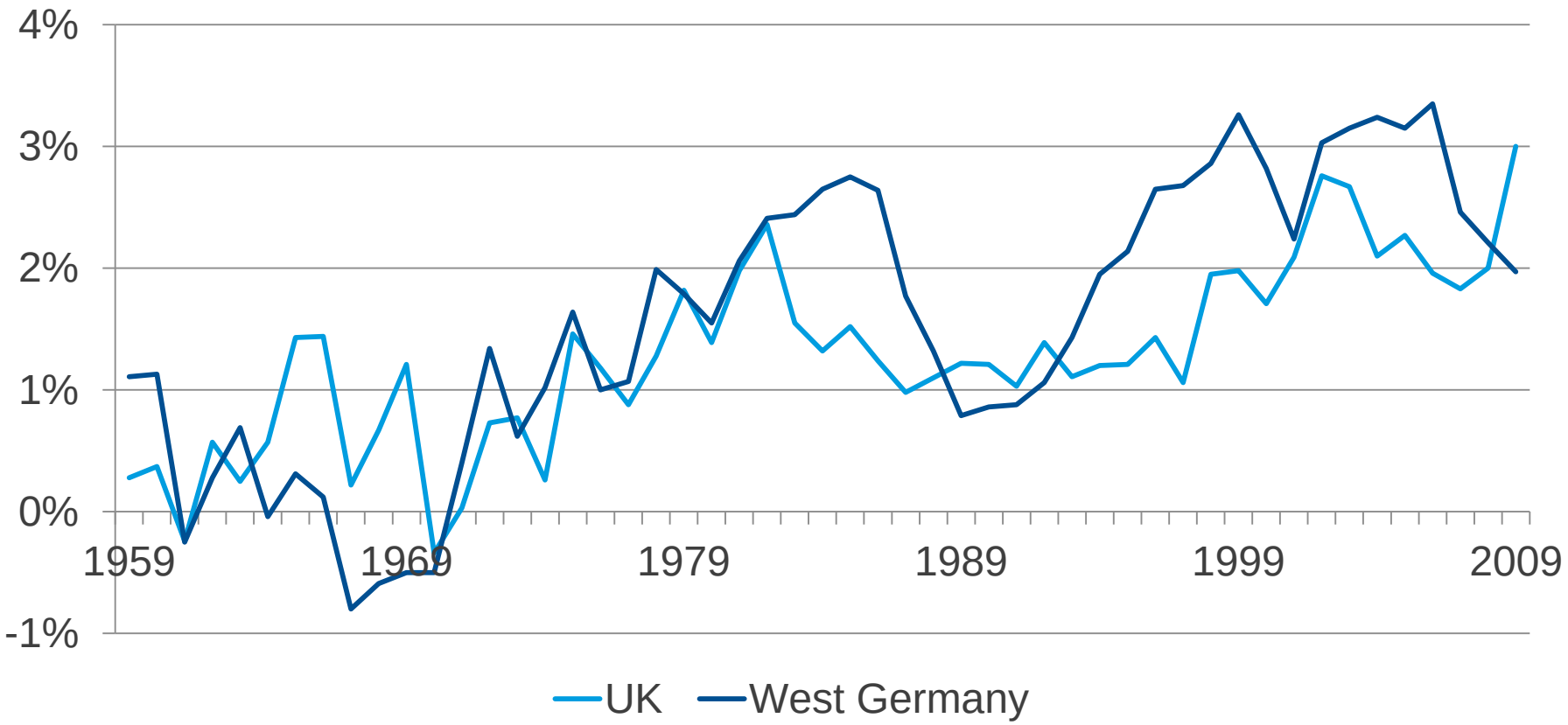
Life Expectancy is increasing almost all over the world

- Mortality in the last decades has dropped significantly in most countries all over the world
- In West Germany the Period Life Expectancy in 1969 was 67.2 years
- 40 years later it is 77.7 years – effectively a new-born has gained more than 6 hours of Life Expectancy every day*
- Other countries in West Europe have similar high improvement rates

*Source: Human Mortality Database (HMD)

Mortality improvements for males
based on HMD data, smoothed

Comparison: UK and West Germany, average over ages 20-90 in %



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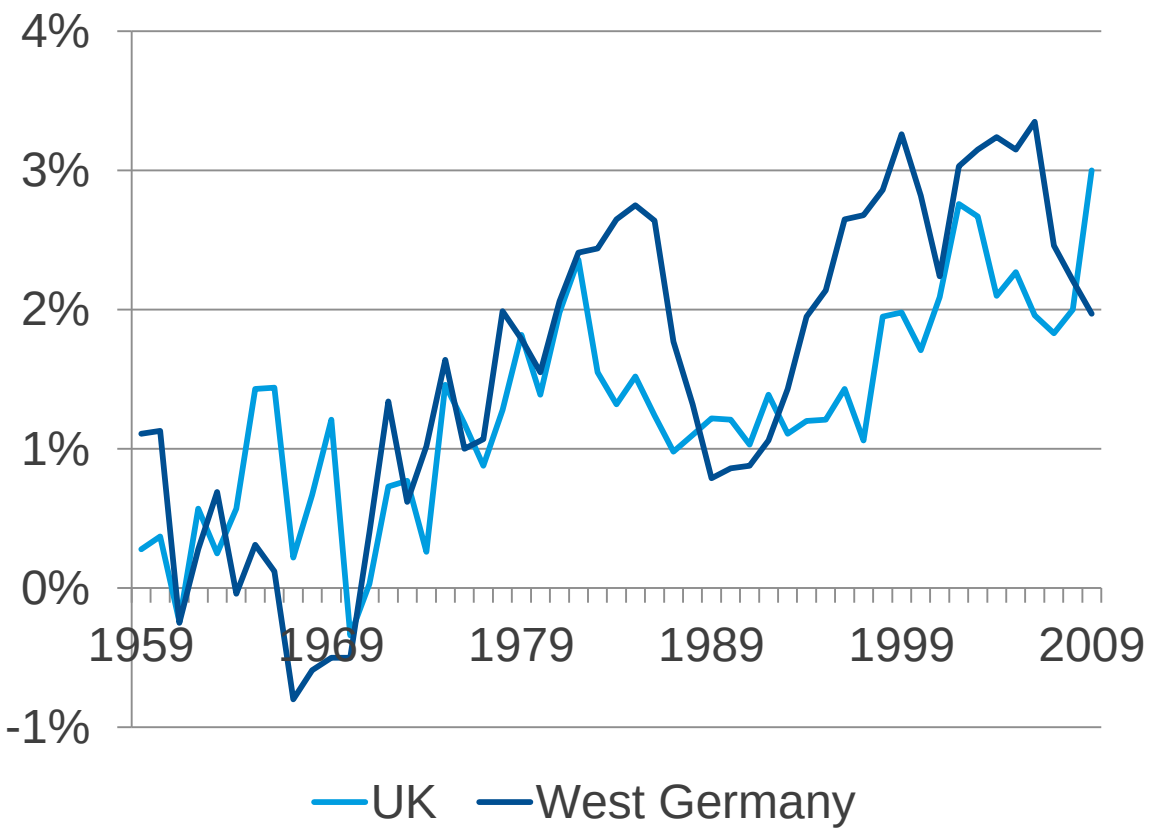
Mortality improvements for males
based on HMD data, smoothed

Comparison: UK and West Germany, ages 20-90 in %



- Similar developments for UK and Germany can be seen in the period from 1970-2002
- Improvement development seems to differ between 1965 and 1970 and from 2003 onwards

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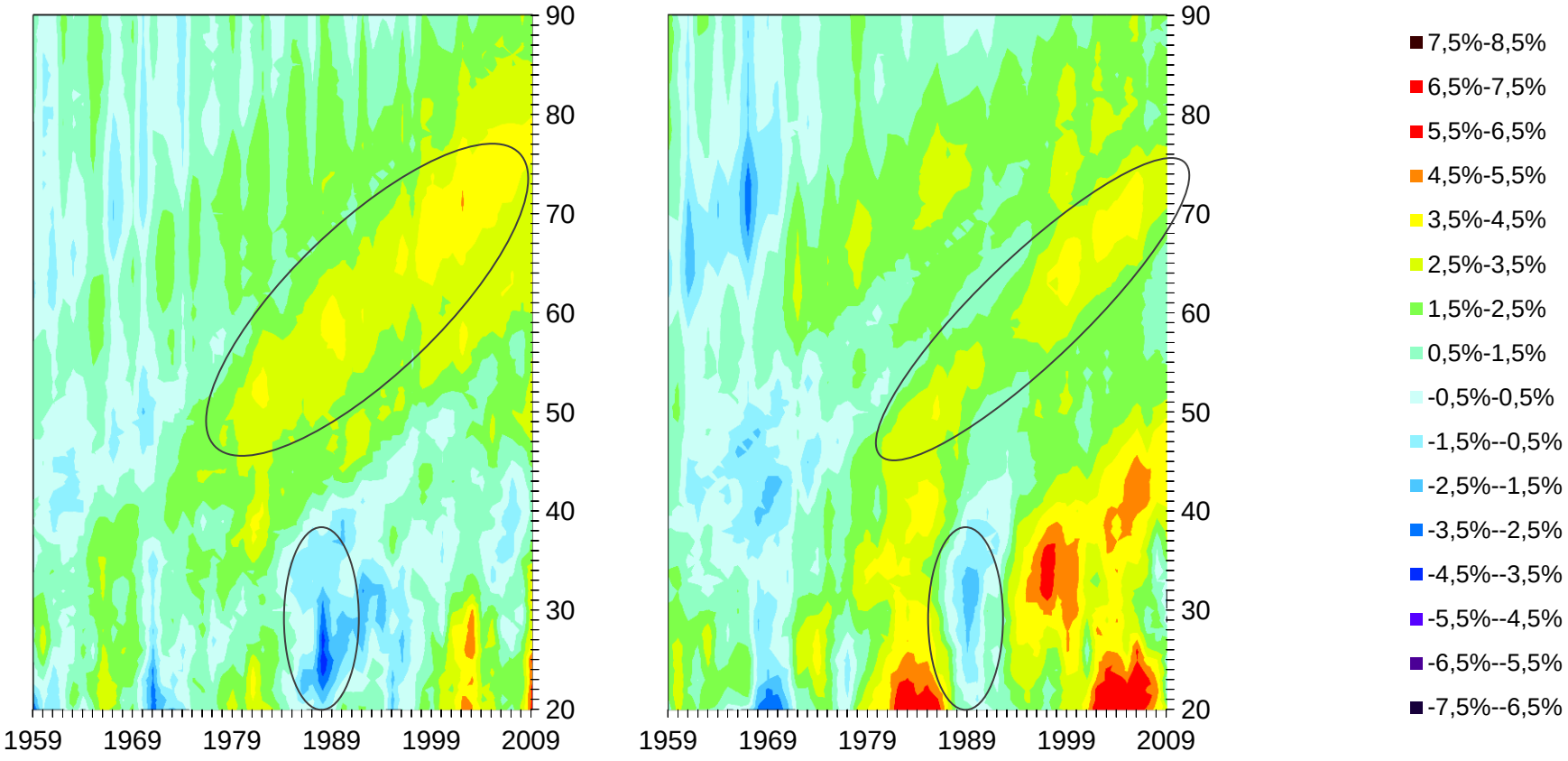
Comparing heat maps of mortality improvement

reveals similarities ...

UK **West Germany** in %



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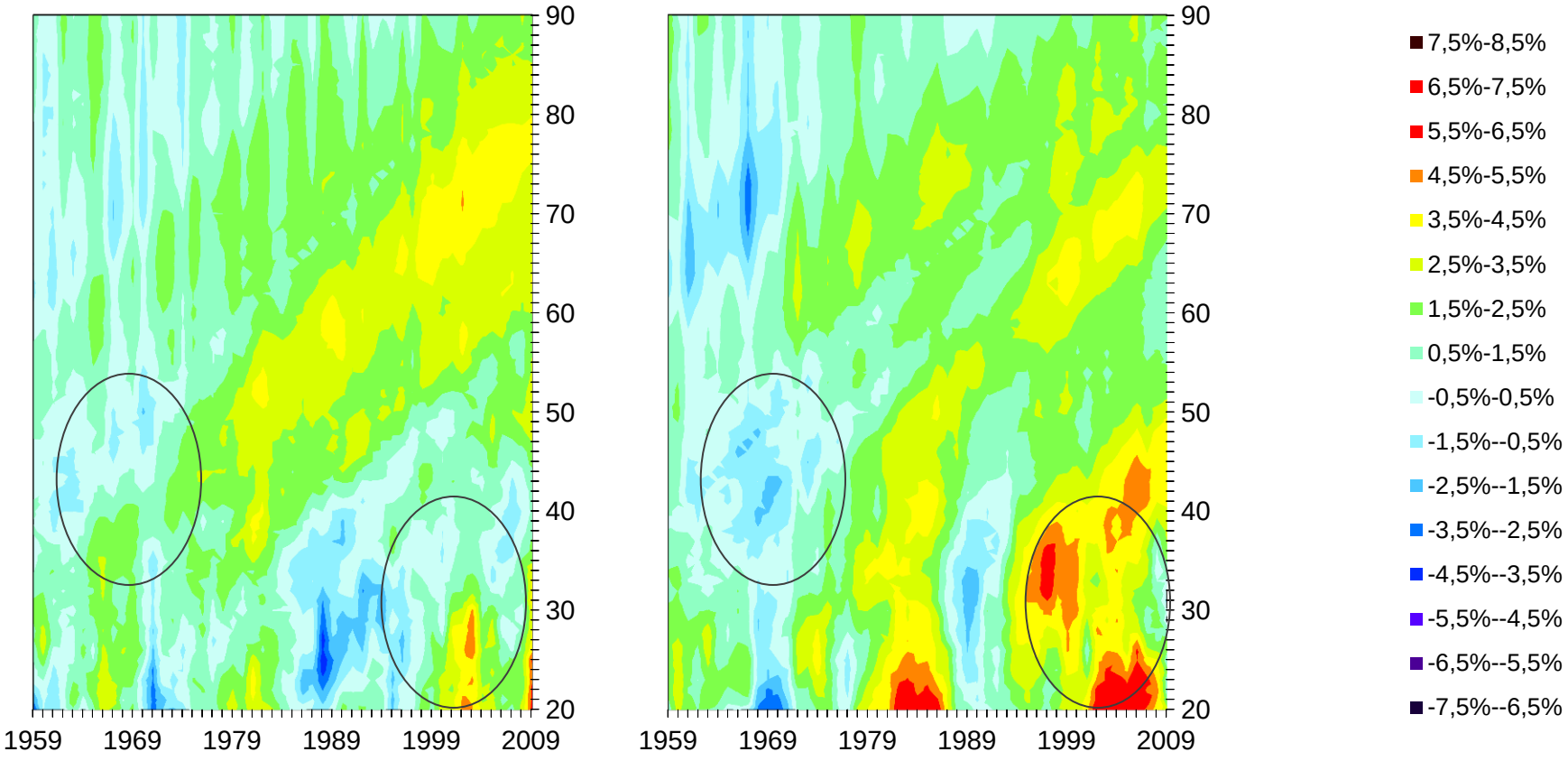
Comparing heat maps of mortality improvement

... and differences

UK **West Germany** in %



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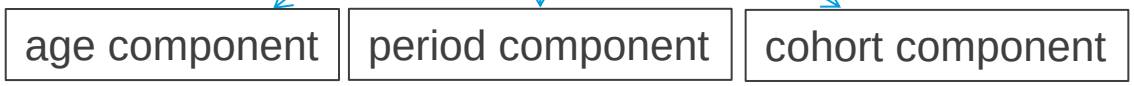
A more detailed approach

- For a detailed analysis, we set up the following model:

$$i(x,t) = a(x) + p(t) + c(t-x),\ x \in \{20,...,90\},\ t \in \{1965,...,2009\}$$

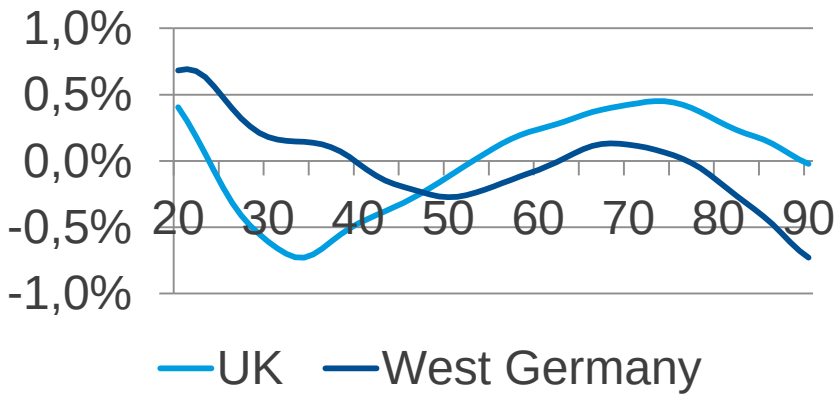


- Idea: fit this model to the past experience by using least-squares estimators and compare the improvements component-by-component
- Problem: depending on the exact range ~200 parameters to estimate
- Possible solution: instead of estimating all parameters, we rather use B-Splines and estimate the knot values
- This leads to less parameters and additional smoothness

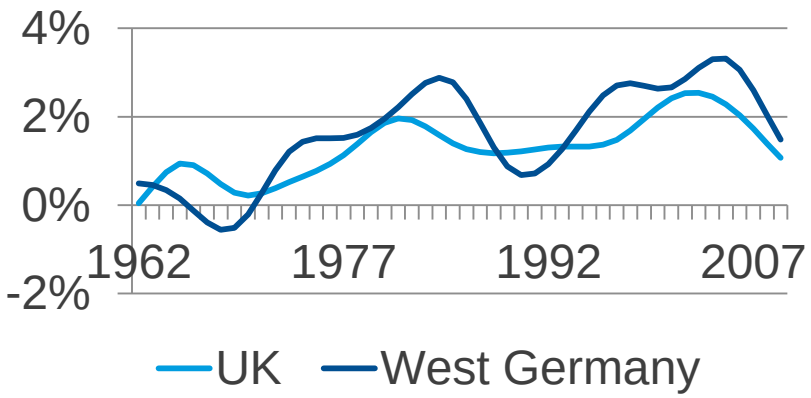
UK and West Germany, males

Age, Period and Cohort Component

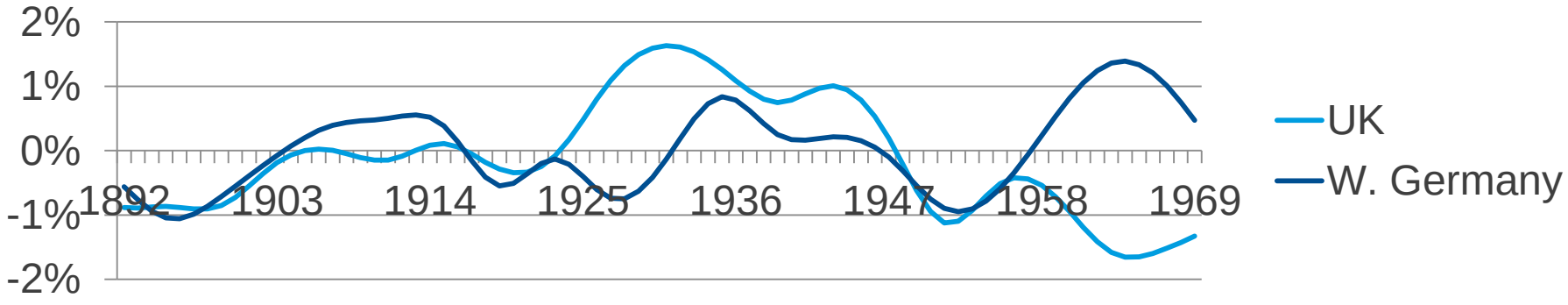
Age component



Period component



Cohort component



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Measuring correlation
The sample Pearson correlation coefficient

- The sample Pearson correlation coefficient is defined by

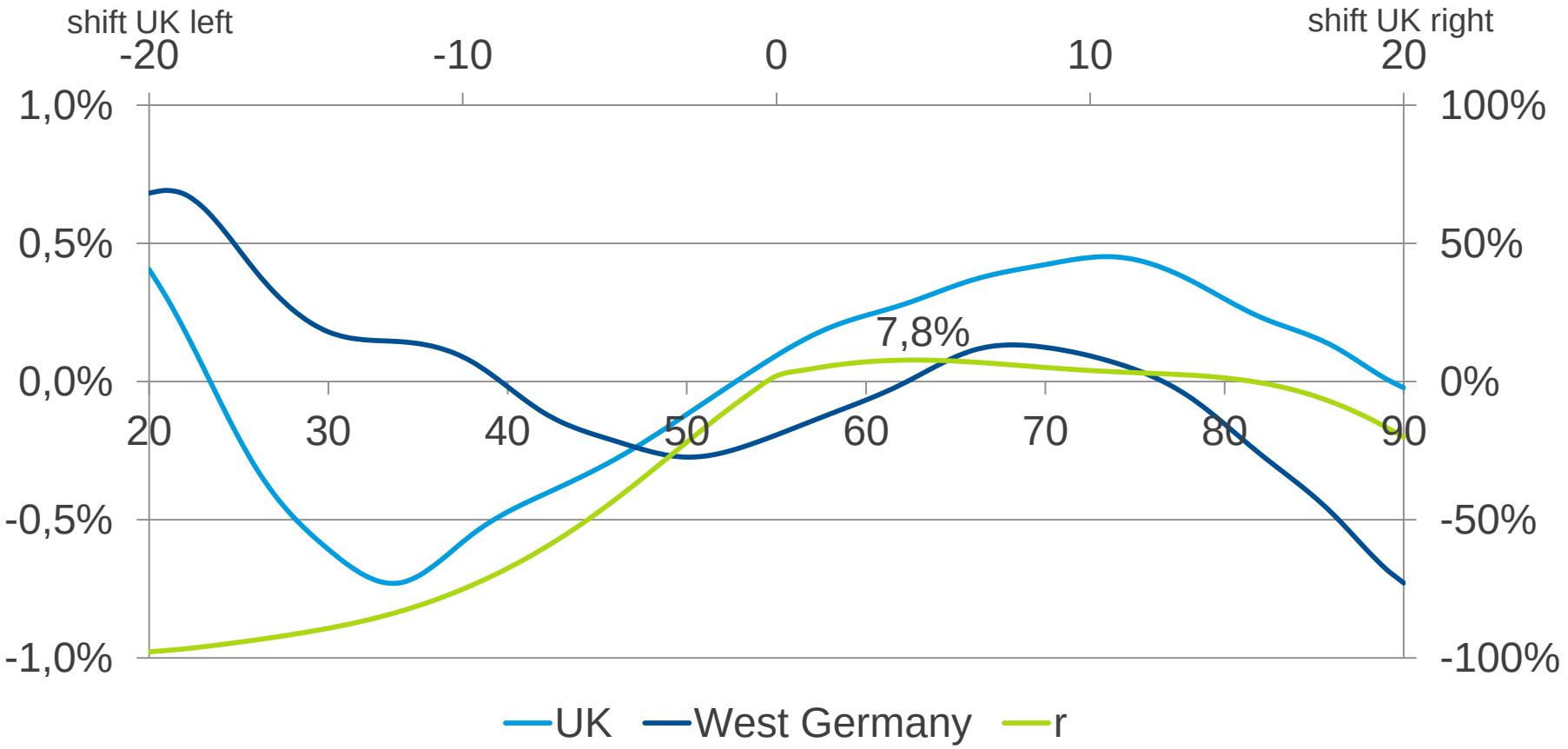
$$r = \frac{\sum_{i=1}^{n}(a_i - \bar{a})\cdot(b_i - \bar{b})}{\sqrt{\sum_{i=1}^{n}(a_i - \bar{a})^2 \cdot \sum_{i=1}^{n}(b_i - \bar{b})^2}}$$

- r measures the correlation between two datasets with $r = 1$ being perfectly positive correlated, $r = -1$ being perfectly negative correlated and $r = 0$ being totally uncorrelated.
- We calculate the r values for different countries for each component separately
- We also calculate r for the shifted datasets as there might be delayed correlations for example within the period component

Age components UK and Germany, males

do not seem correlated - "peak" at +4

Age components (UK and West Germany) and Pearson‘s correlation coefficient



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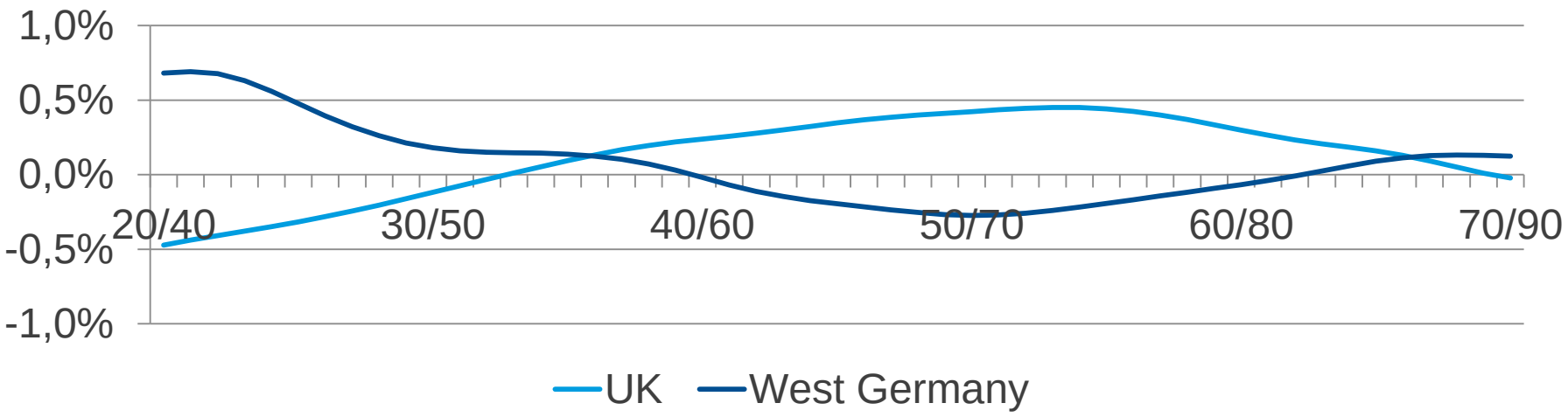
Age components UK and Germany, males
do not seem correlated

Age components: UK shifted by 20 years and West Germany

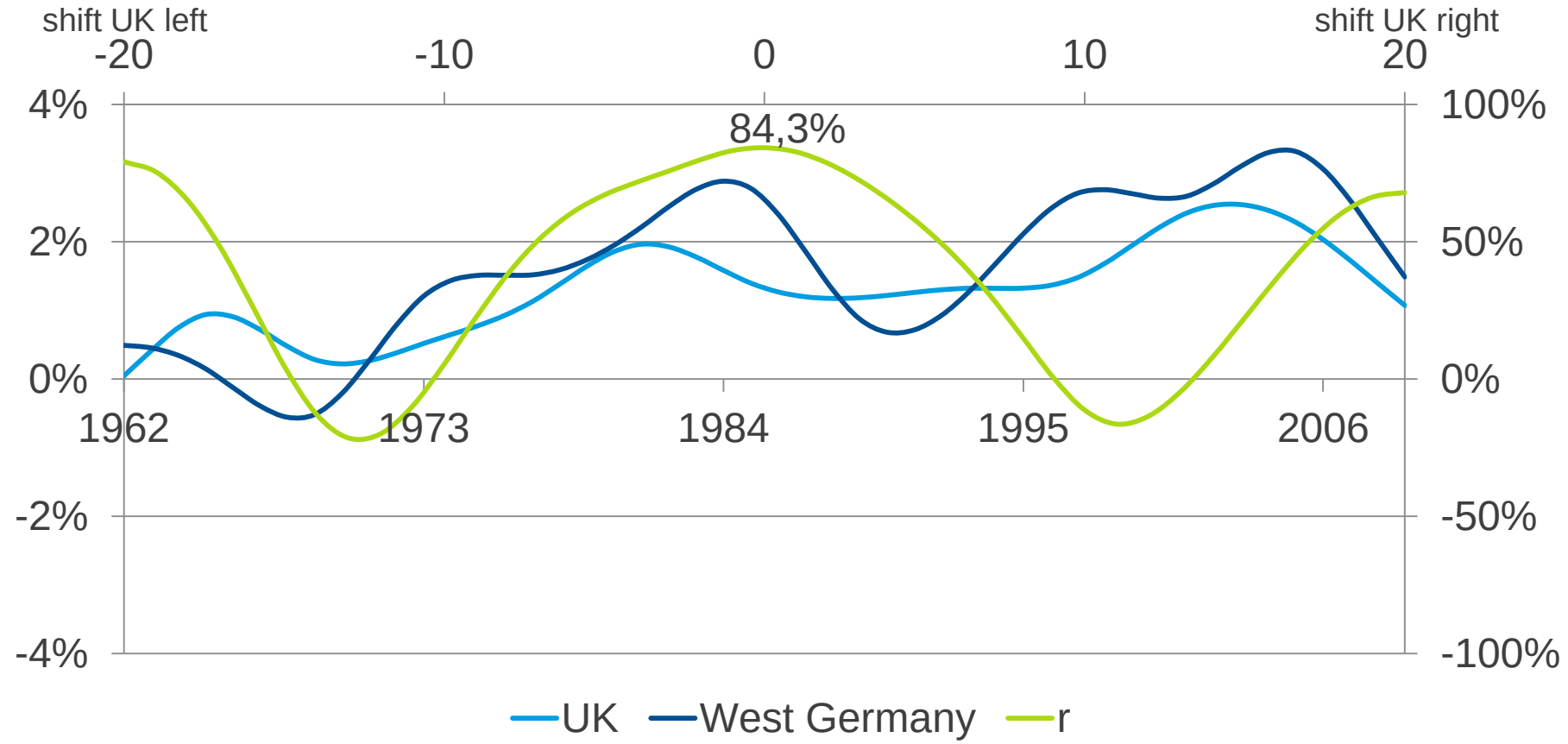


- Remarkably high (negative) correlation at -20: $r = -97.8\%$
- Shifting the chart shows why…

Period components UK and Germany, males

Pearson's r has a peak around 0

Period components (UK and West Germany) and Pearson‘s correlation coefficient



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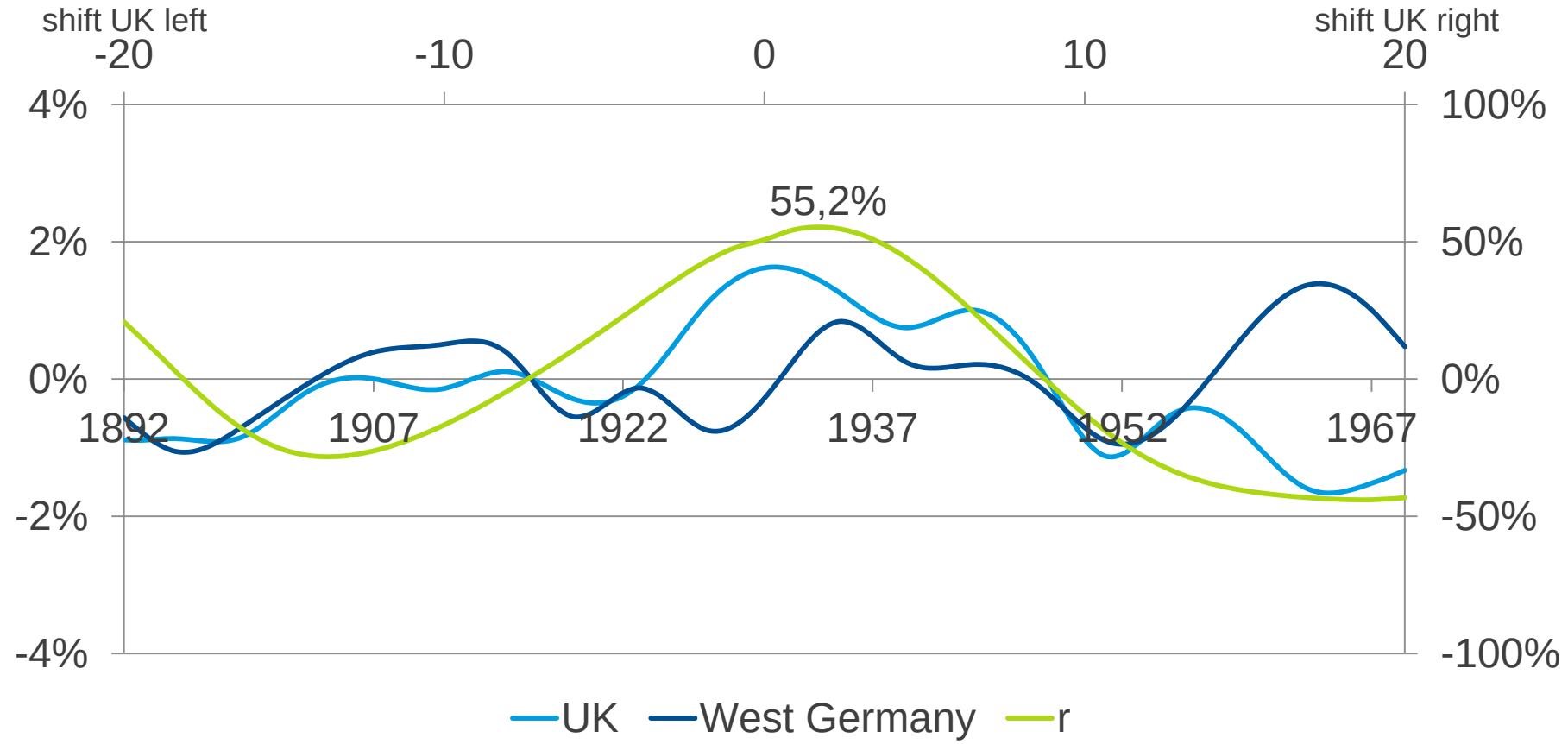
Cohort components UK and Germany, males

Pearson's r has peak at +2

Cohort components (UK and West Germany) and Pearson‘s correlation coefficient



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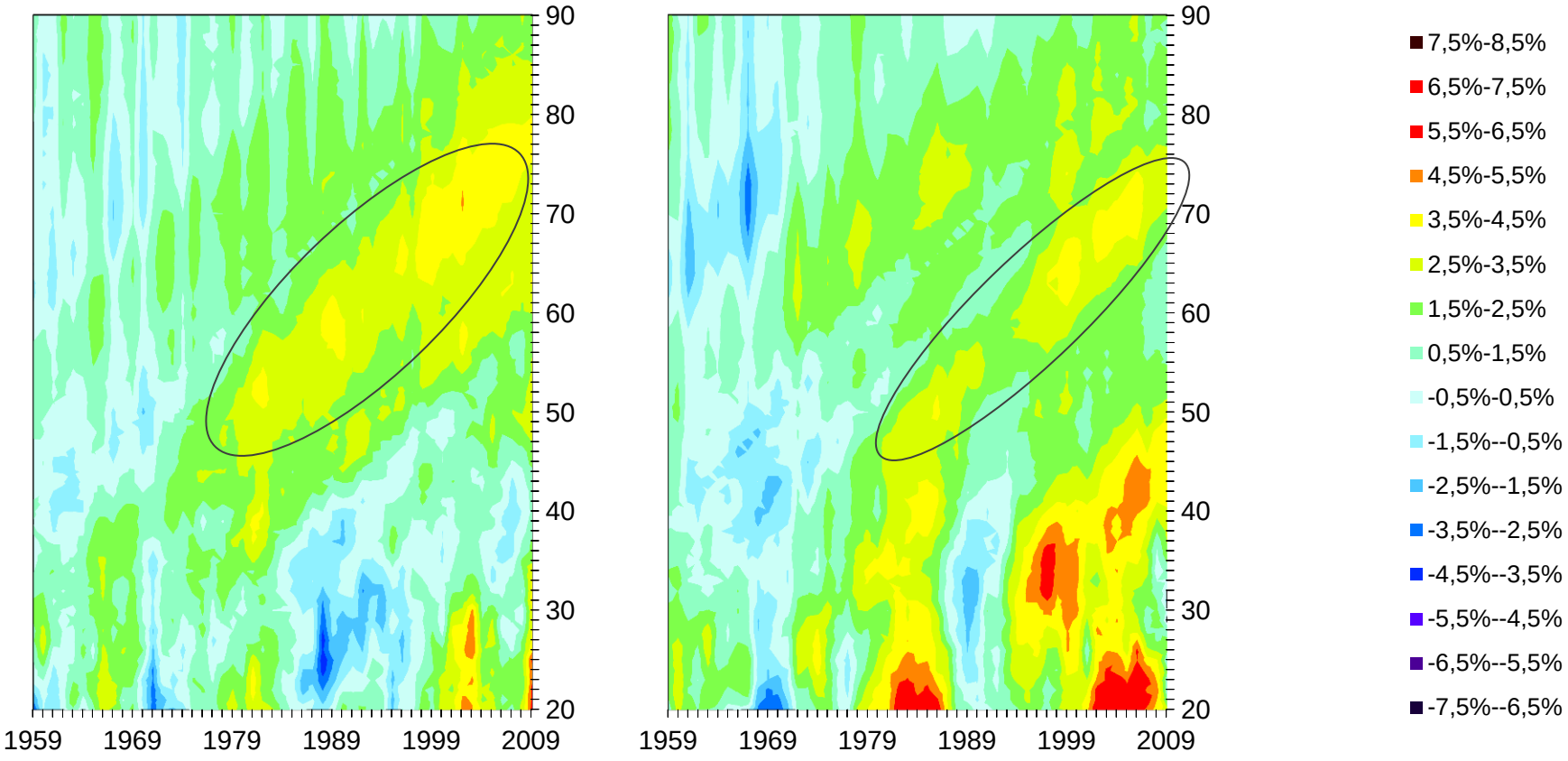
Summary of the comparison

- Highest $r = 55.2\%$ when shifting the cohort-curve by +2 years
- In concrete terms: according to the data the center of the cohort for males in West Germany is born two years later than UK males
- Recalling the heat maps in the beginning proves this
- Moreover: so far we have only looked on the male data set – do we see the same features when looking at the female dataset?

Comparing heat maps again
shows slightly different cohort effects

UK, males **West Germany, males** in %



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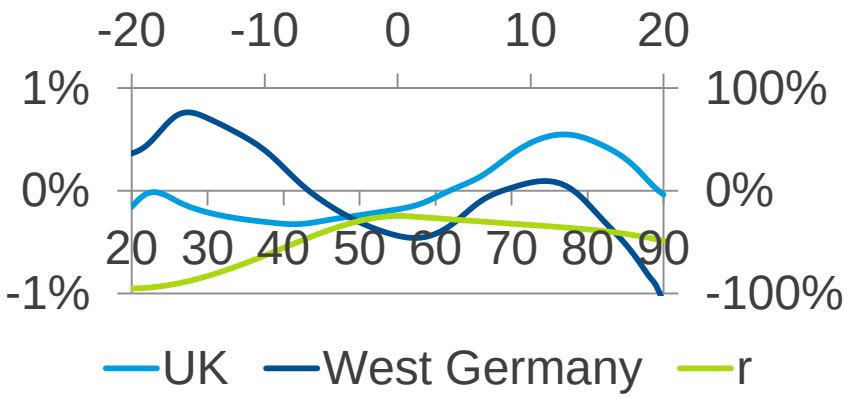
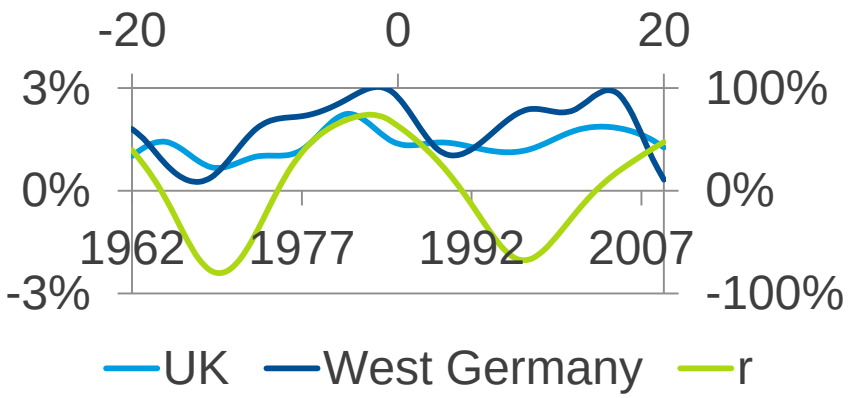
UK and West Germany

Age, Period and Cohort Component for females

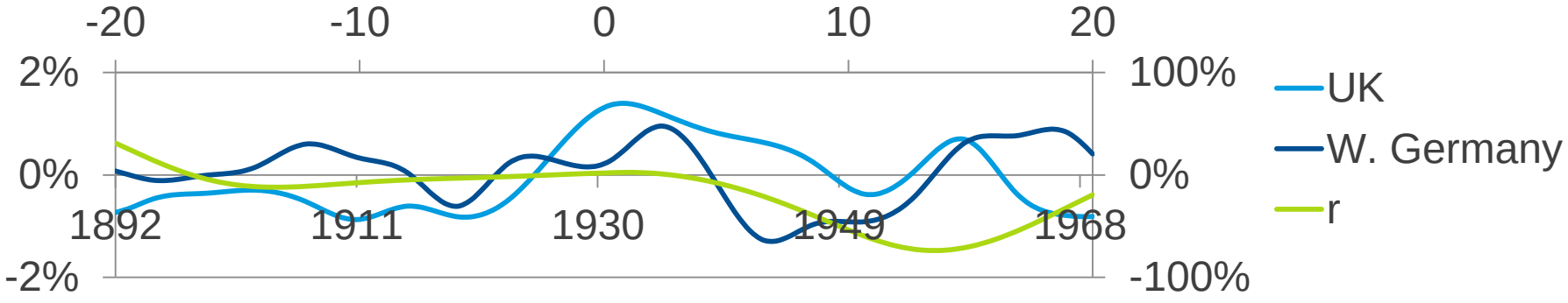
Age component



Period component



Cohort component



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Summary
Improvements UK and West Germany

- While age- and period component look quite similar for males and females, there are some differences within the cohort component
- It is common opinion that one reason for the cohort effect is that the generation born around 1930 is the first being not actively involved into World War II
- It hence makes sense that the female cohort effect differs from the male one
- In total it seems there is a correlation between the UK and the German trend

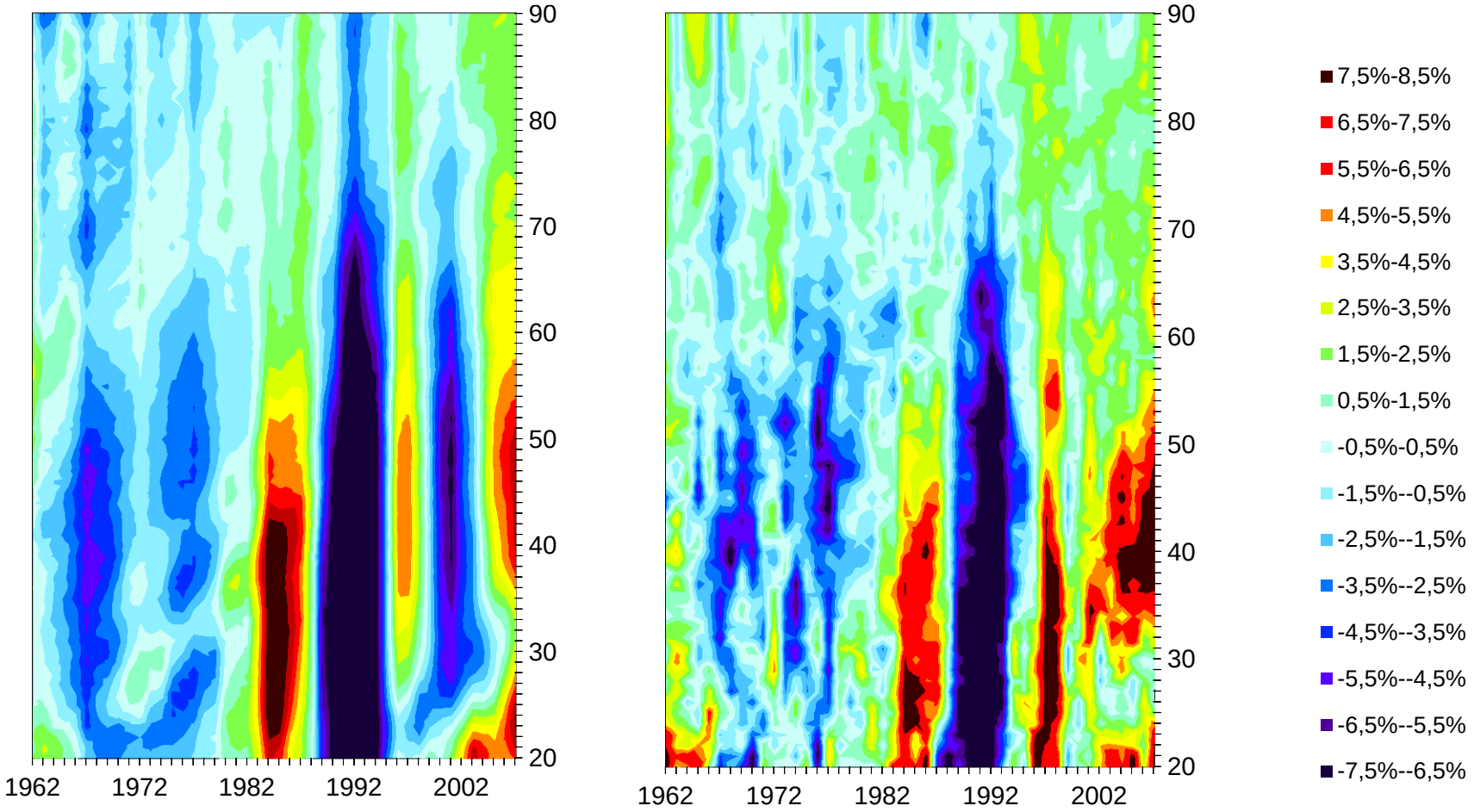
- There are other examples however where correlation is more obvious

Improvements in Russia and Estonia for males

Lots of commonalities

Russia

Estonia



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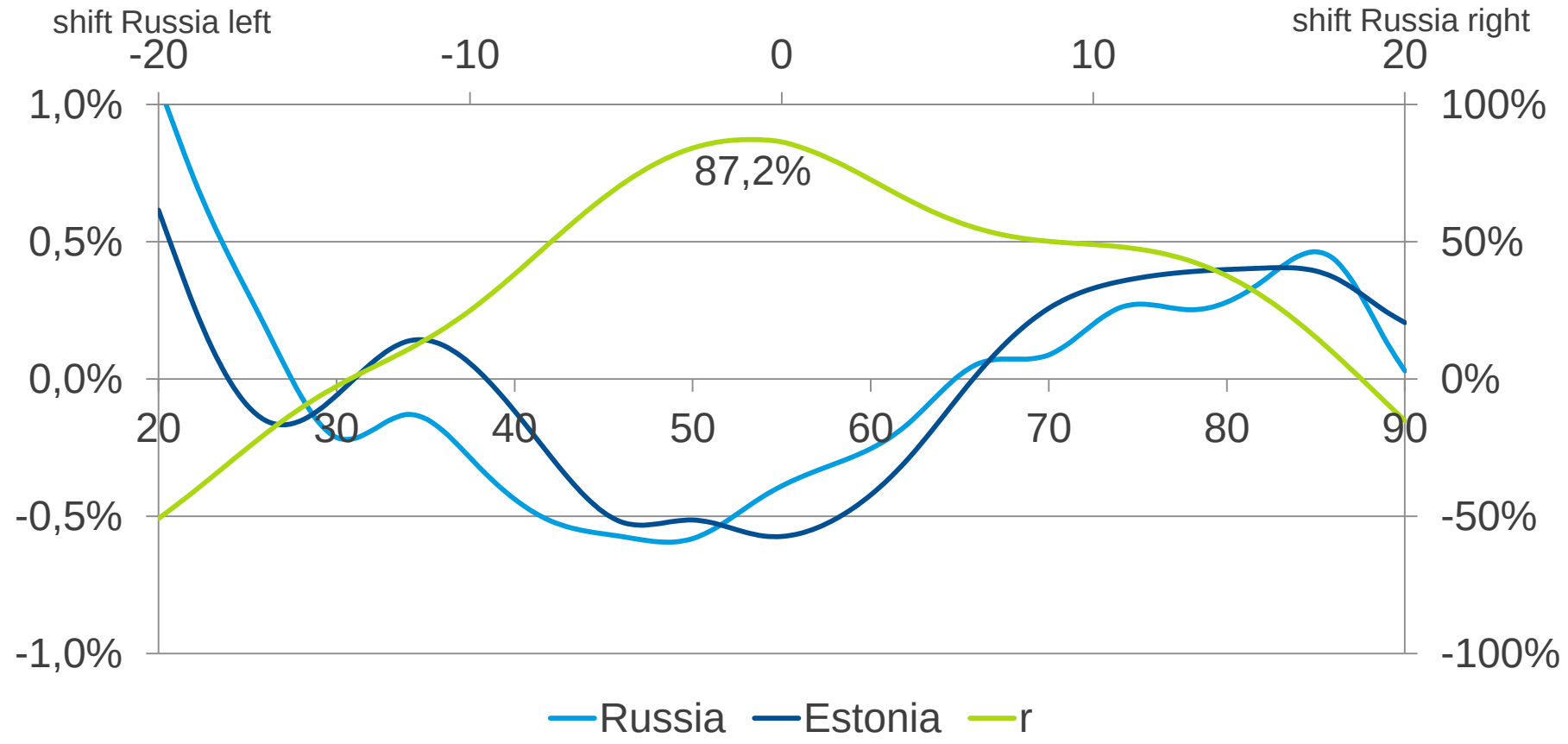
Age components Russia and Estonia, males

seem highly correlated - peak at -1

Age components (Russia and Estonia) and Pearson‘s correlation coefficient



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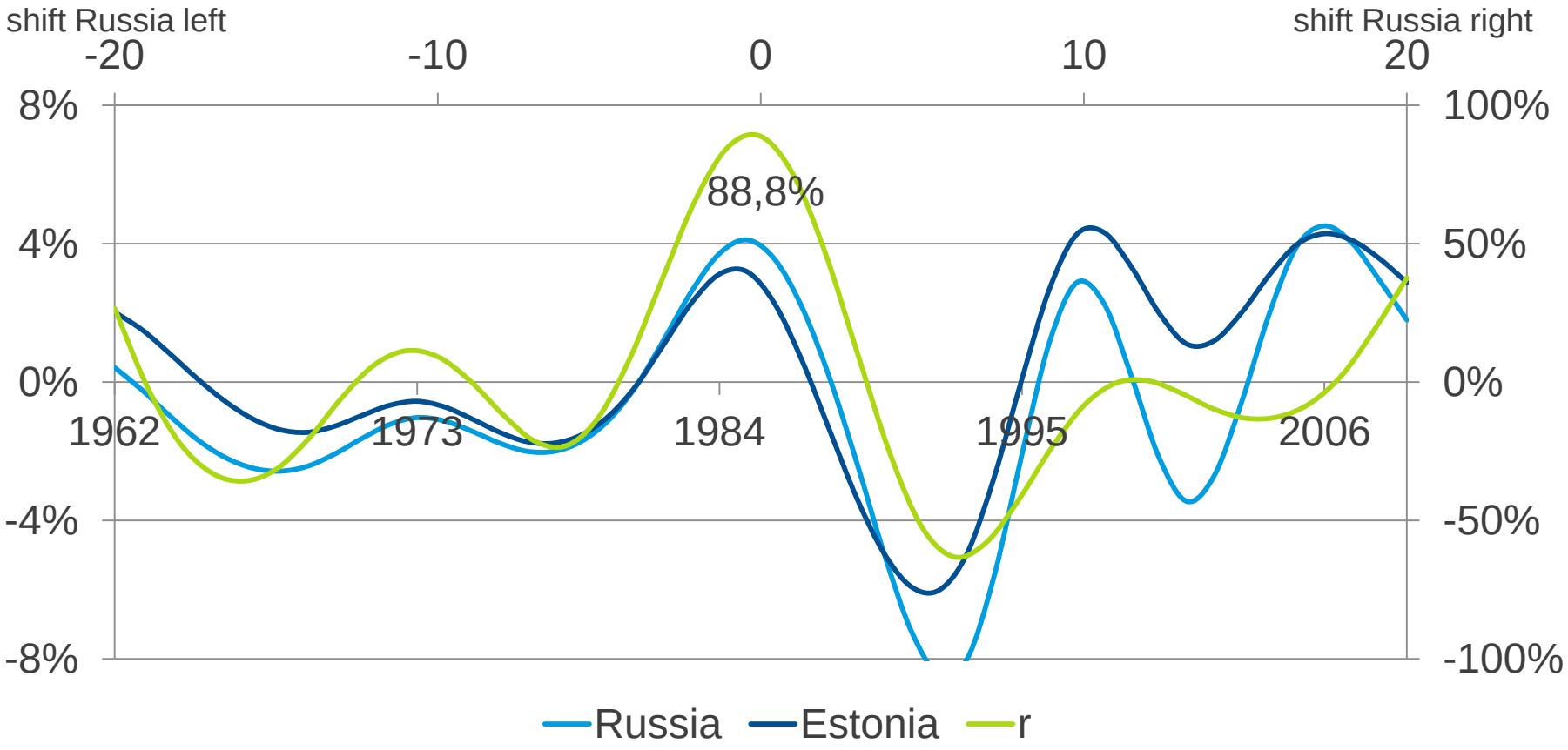
Period components Russia and Estonia, males

seem highly correlated as well - peak at 0

Period components (Russia and Estonia) and Pearson‘s correlation coefficient



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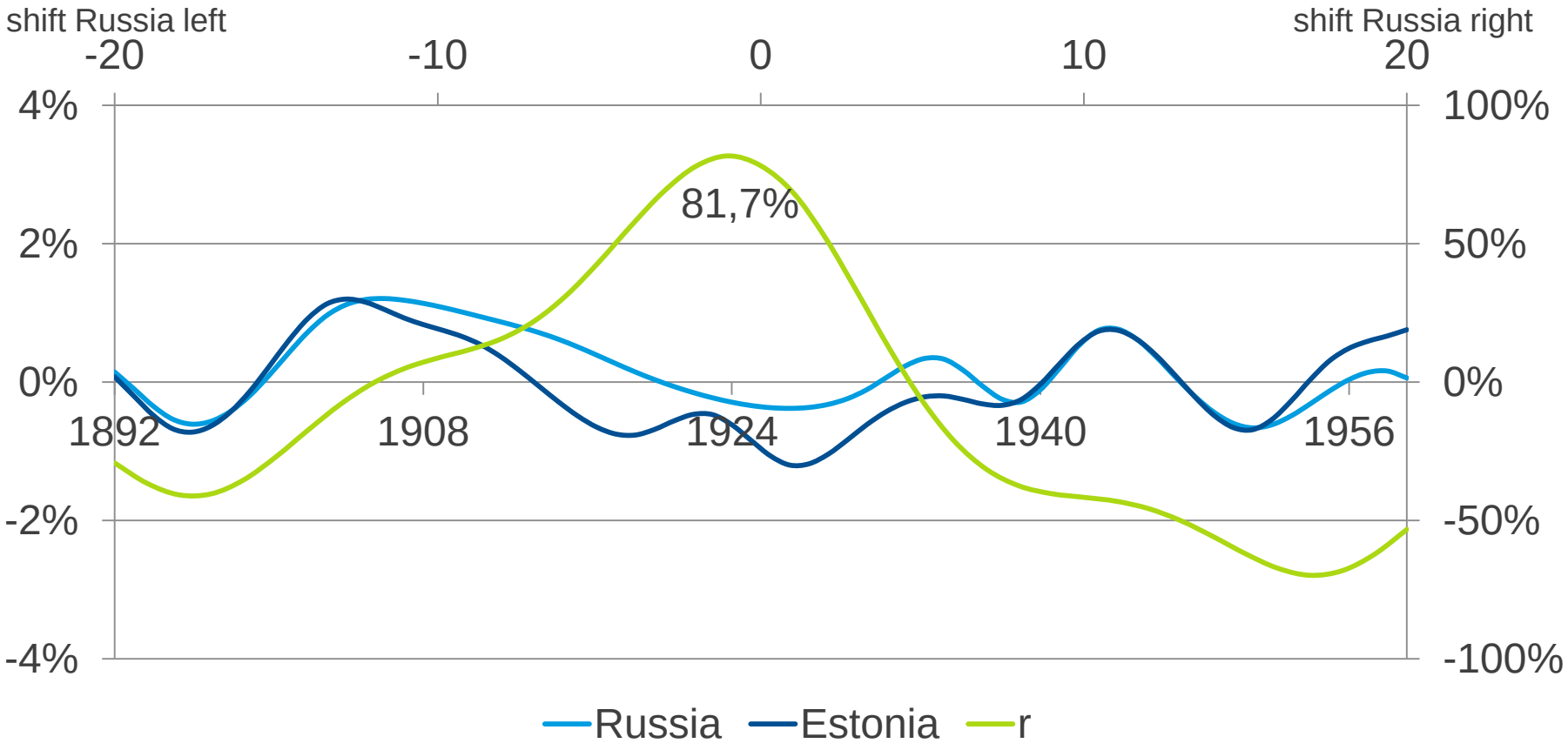

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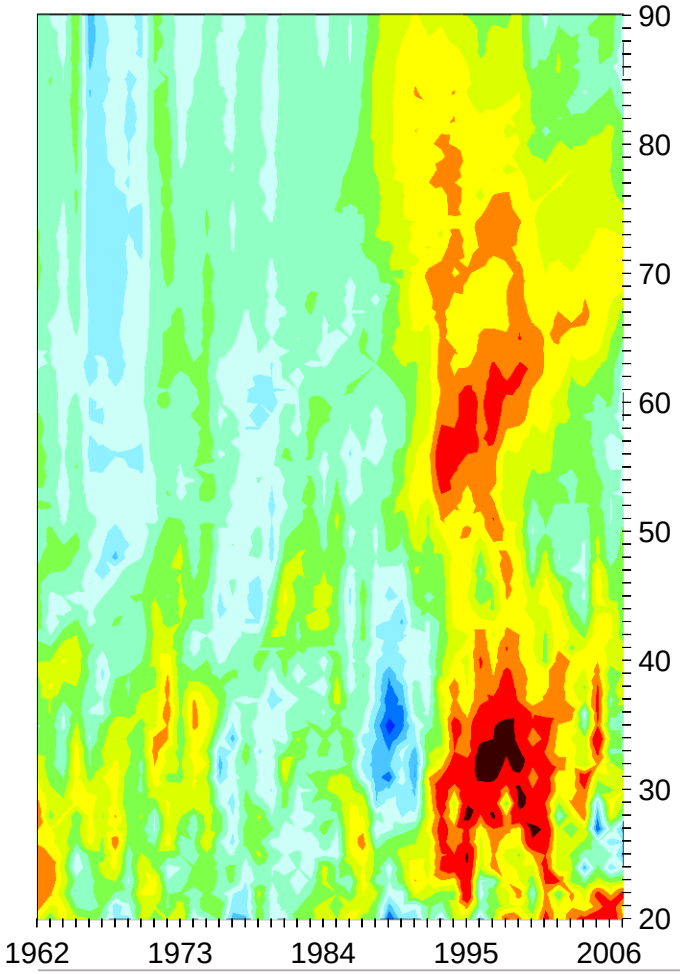
Correlation Russia and Estonia

- All three improvement components seem correlated
- Not too surprising keeping the common history in mind
- However, the correlation of the period improvements from 1990-2009 is 94.2%, which is even higher than the correlation for the whole time span from 1962-2009 (88.8%)

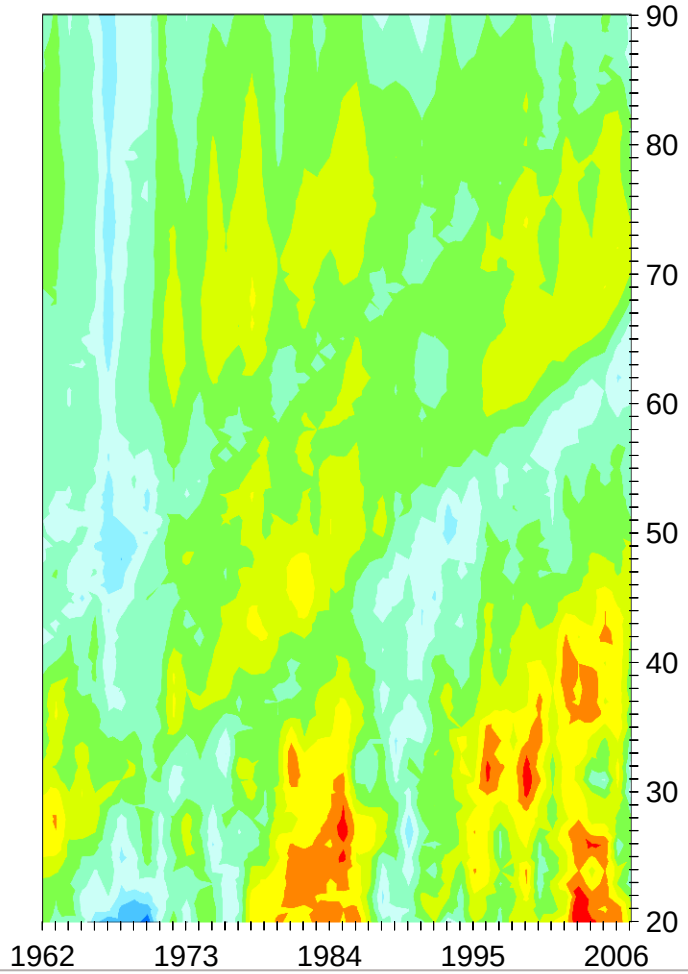
- Let‘s look at other examples in Western Europe

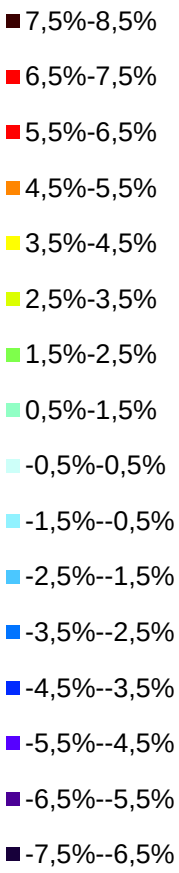
Improvements in East and West Germany for females

East Germany



West Germany





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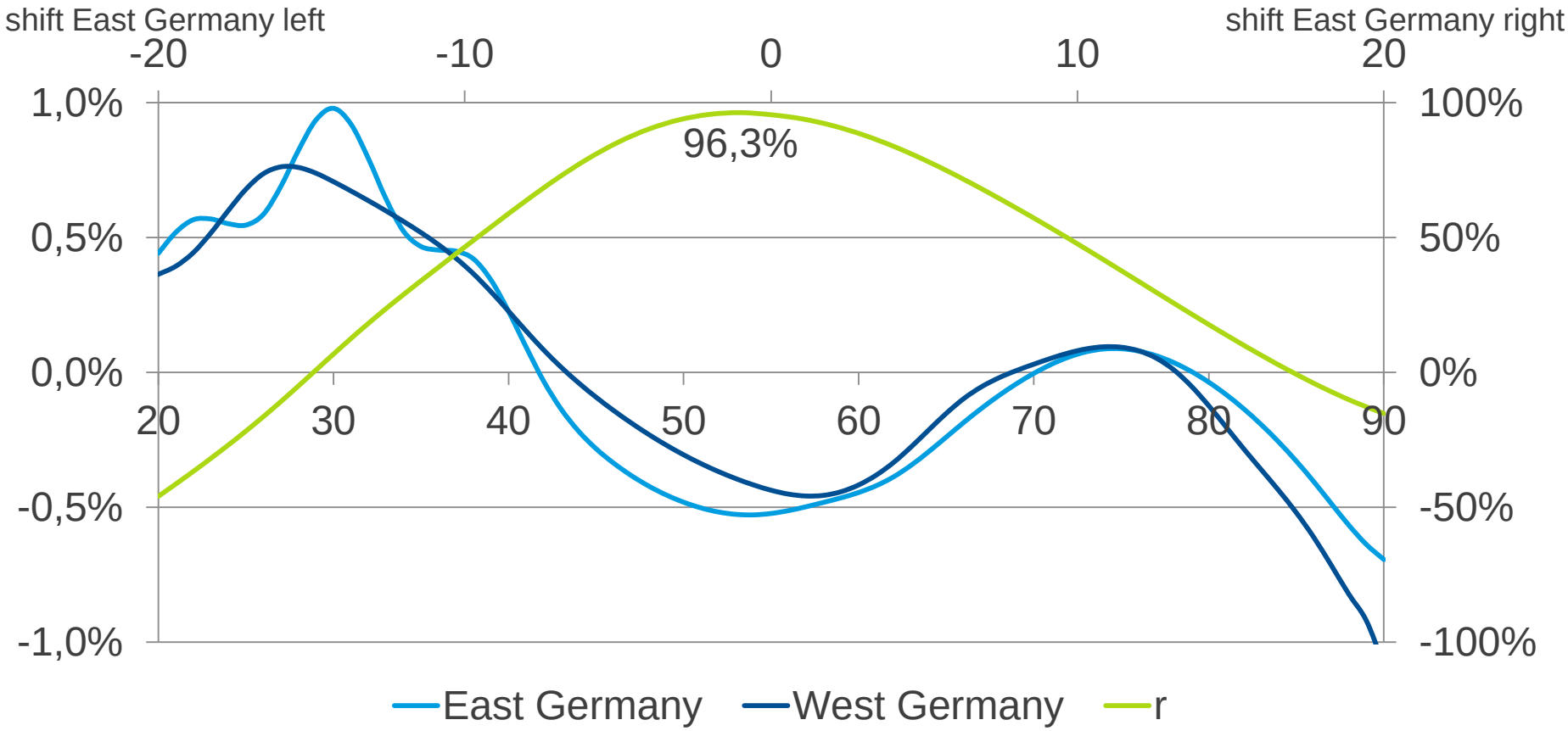
Age components East and West Germany, females

seem highly correlated - peak at -1

Age components (East and West Germany) and Pearson‘s correlation coefficient



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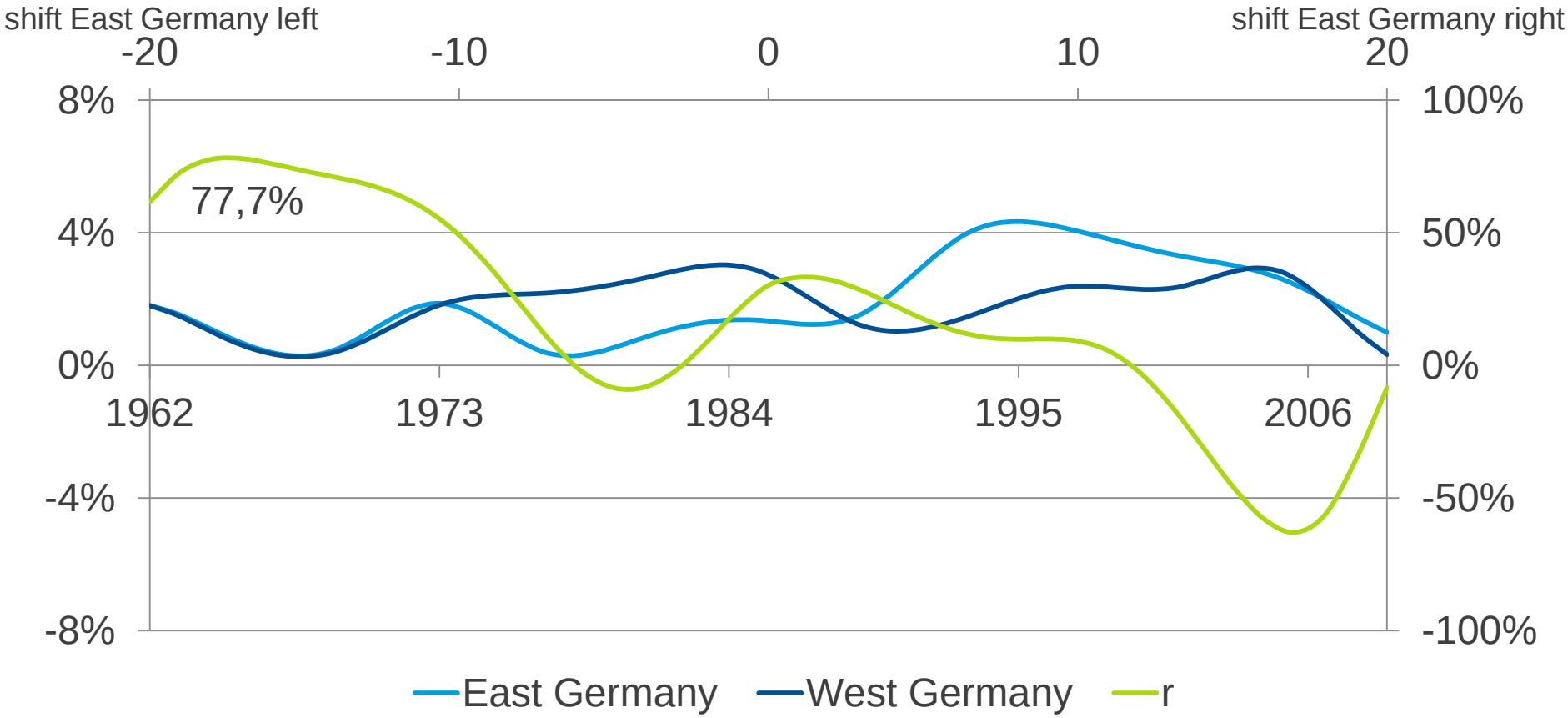
Period components East and West Germany, females

seem not too correlated - peak at -18

Period components (East and West Germany) and Pearson‘s correlation coefficient



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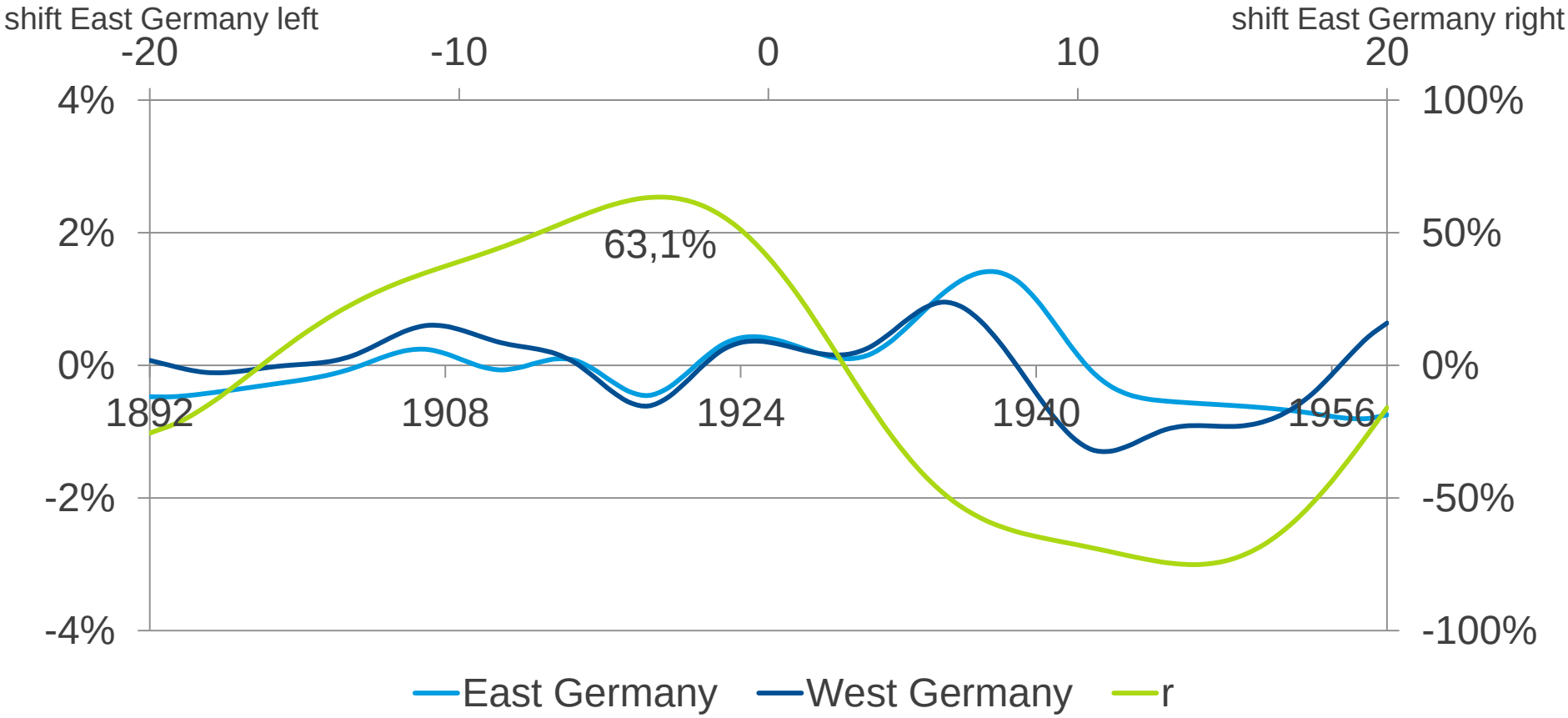
Cohort components East and West Germany, females

seem correlated - peak at -4

Cohort components (East and West Germany) and Pearson‘s correlation coefficient



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Improvement East and West Germany
Summary

- In total age component und cohort component seem correlated in East and West Germany
- The period component does not seem to be correlated
- For the whole time frame from 1962-2009: r=33.2% (at +1shift)
- For the time frame 1990-2009: r=67.8% (at +2 shift)

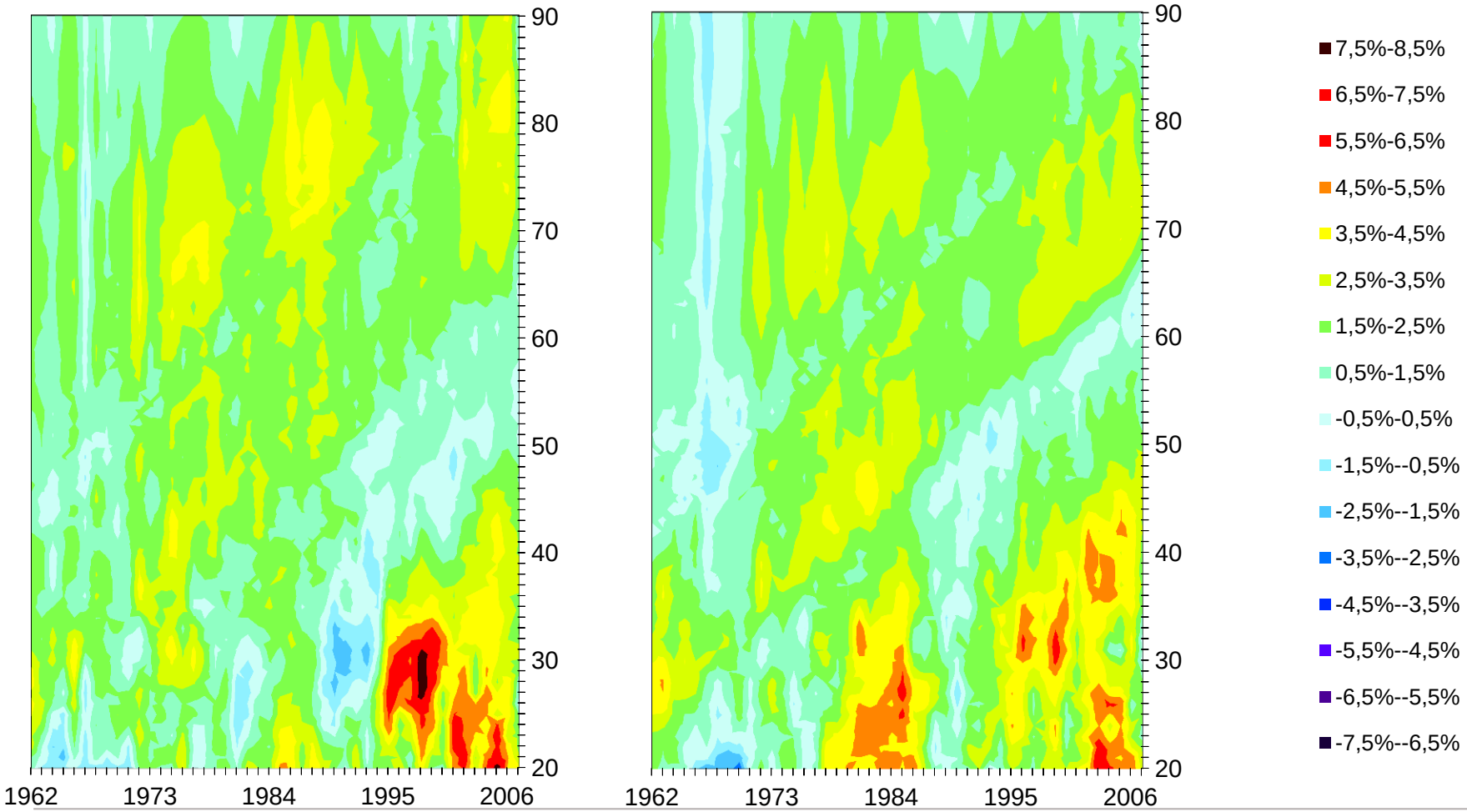
- This result is more or less as expected: Correlation for the whole period is much lower than for the period from 1990-2009

Improvements in France and West Germany for females

Lots of commonalities

France

West Germany



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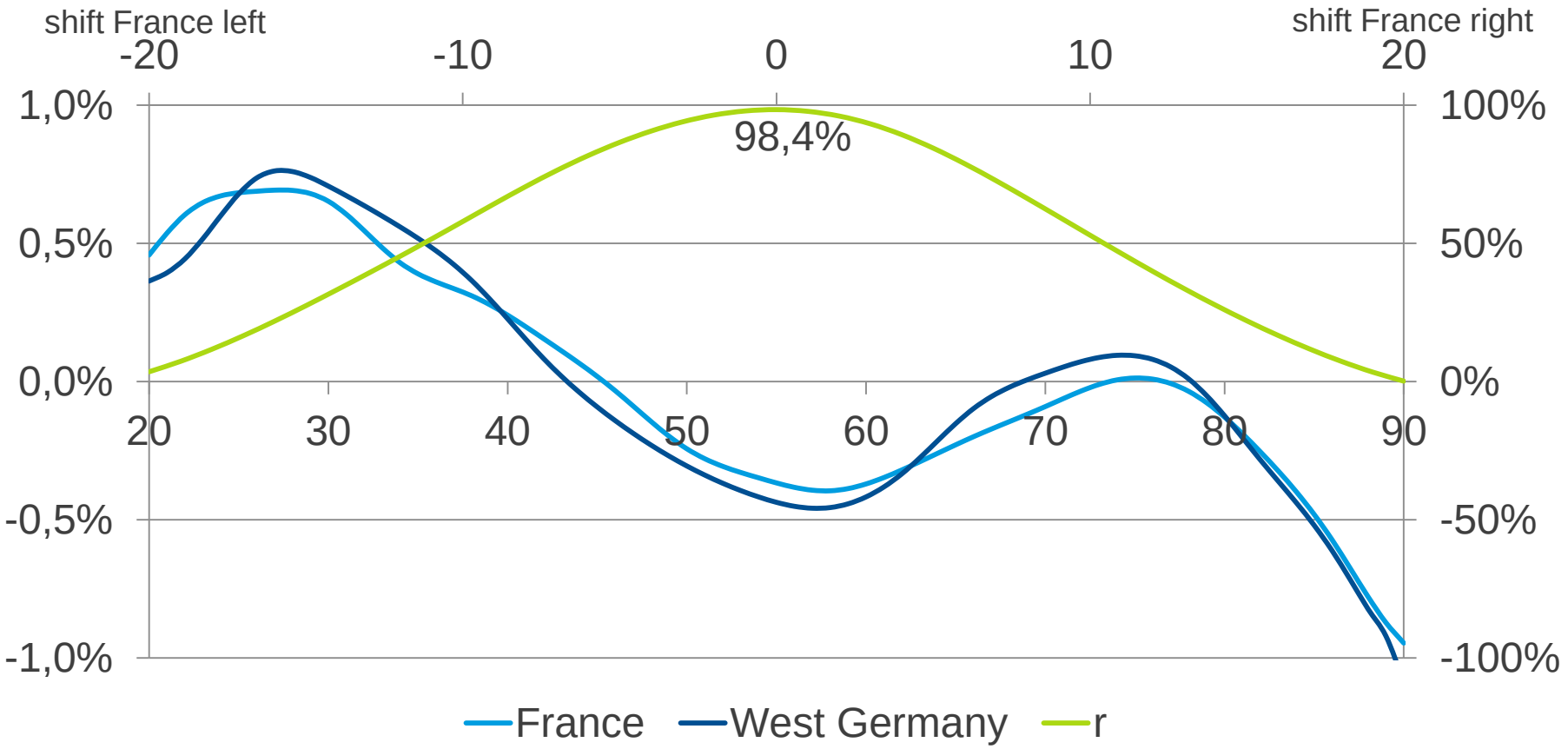
Age components France and West Germany, females

seem highly correlated - peak at 0

Age components (France and West Germany) and Pearson‘s correlation coefficient



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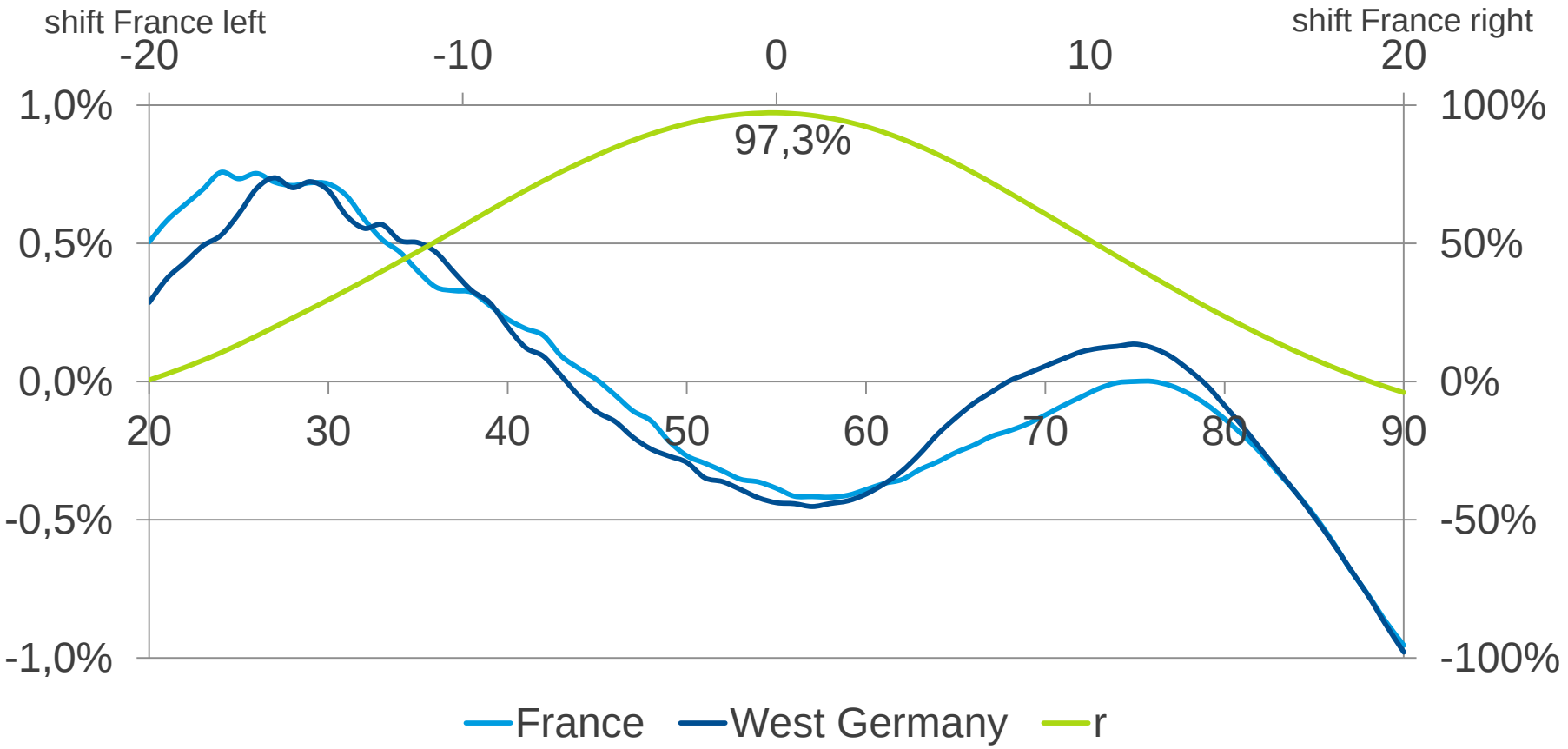

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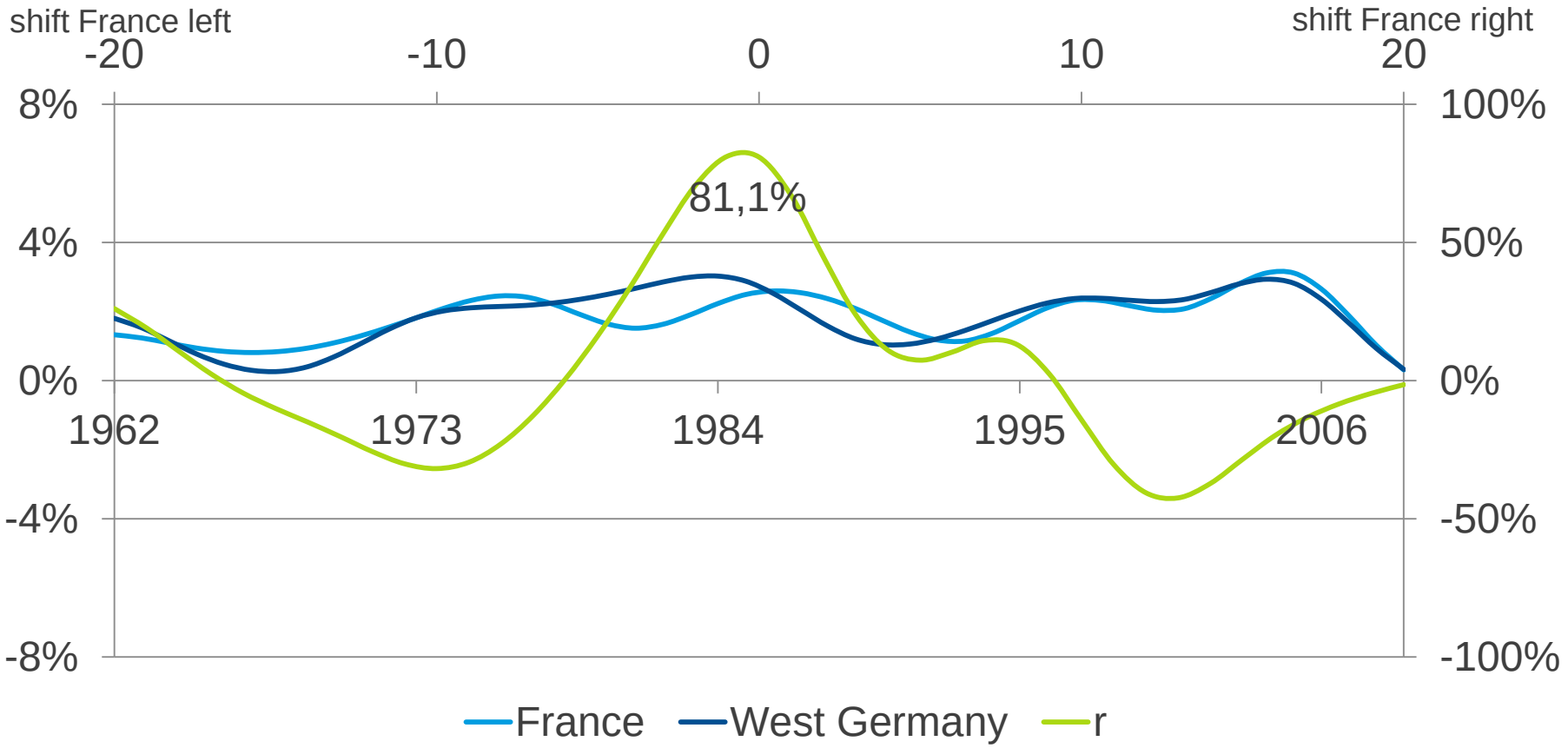
Period components France and West Germany, females

seem highly correlated - peak at -1

Period components (France and West Germany) and Pearson‘s correlation coefficient



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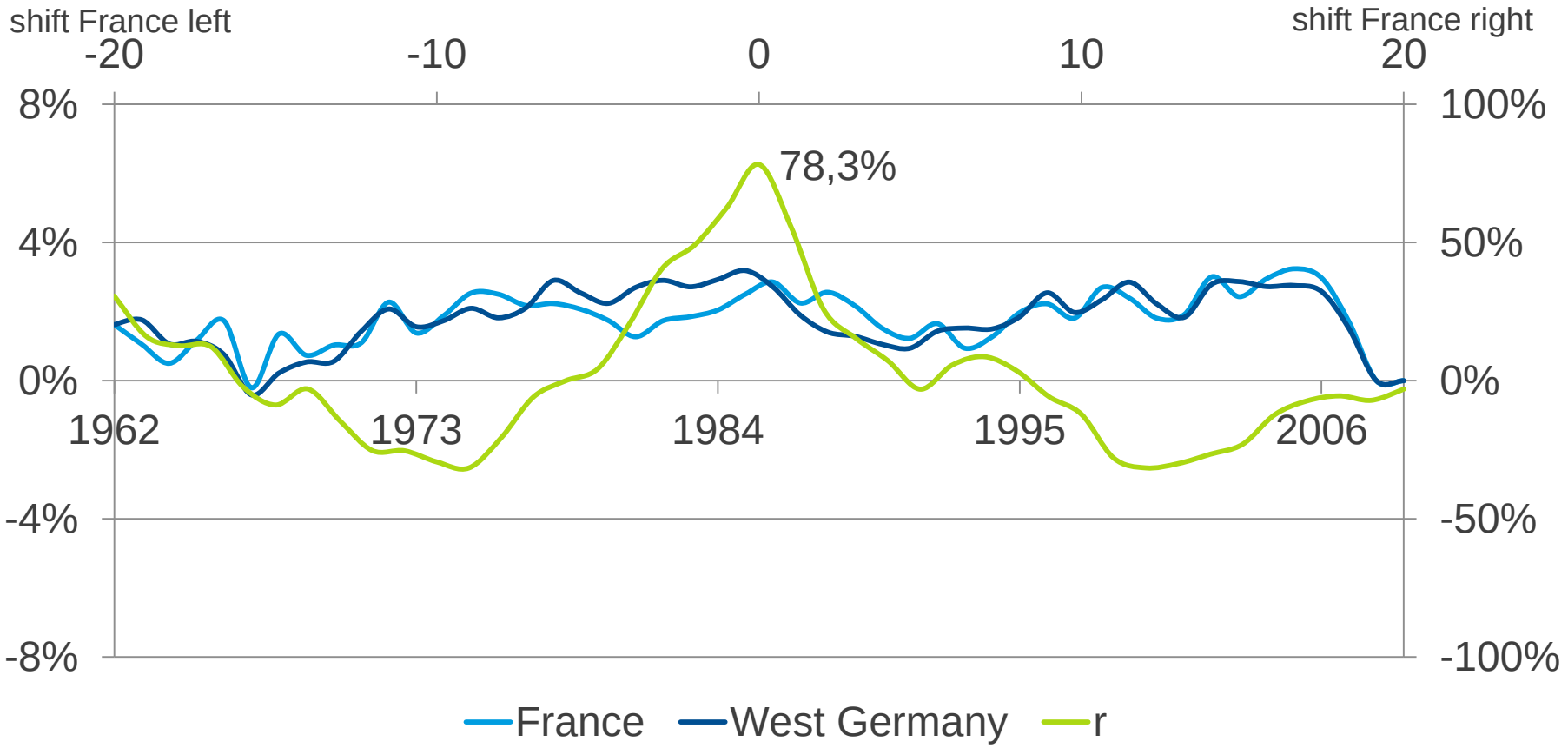

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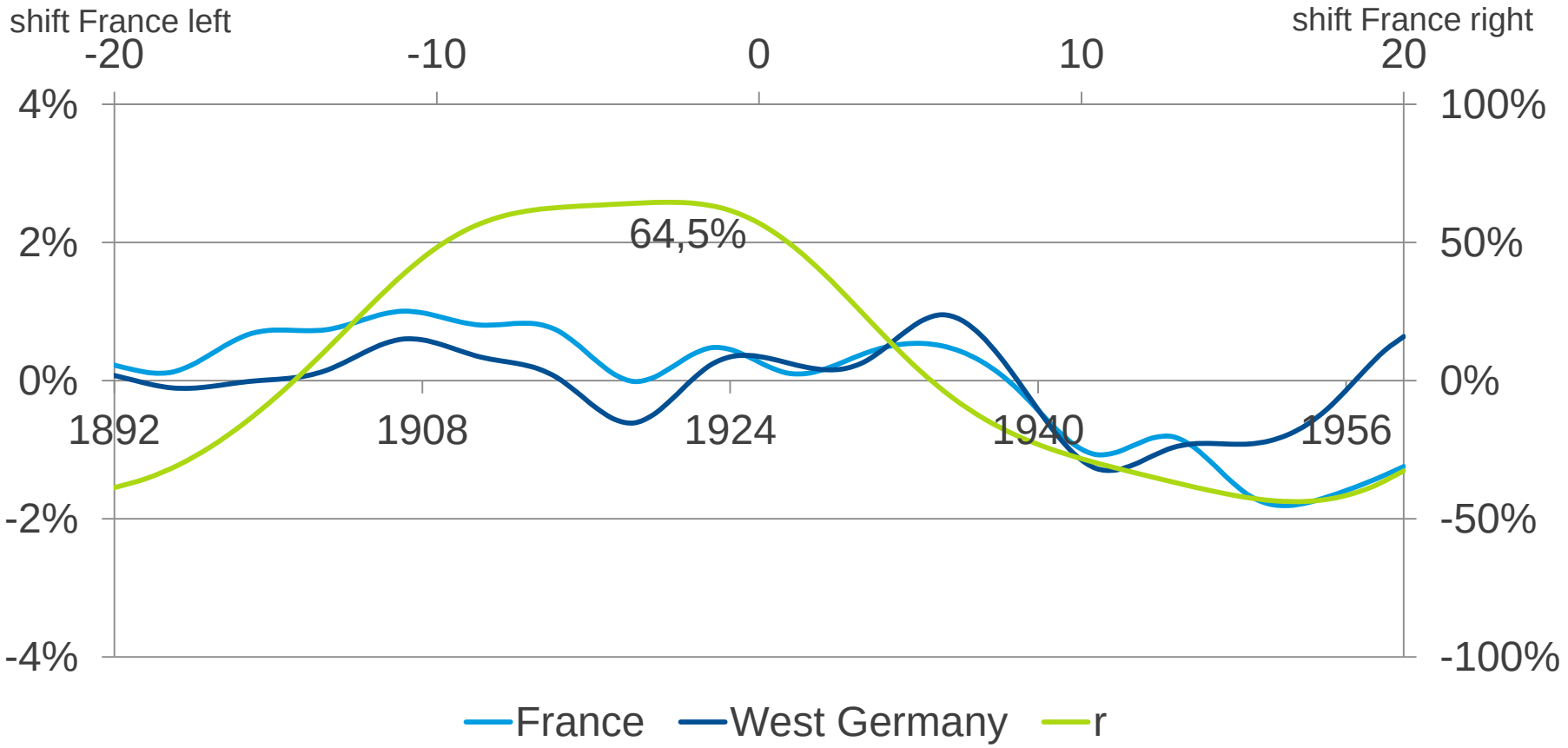
Cohort components France and West Germany, females

seem correlated - peak at -3

Cohort components (France and West Germany) and Pearson‘s correlation coefficient



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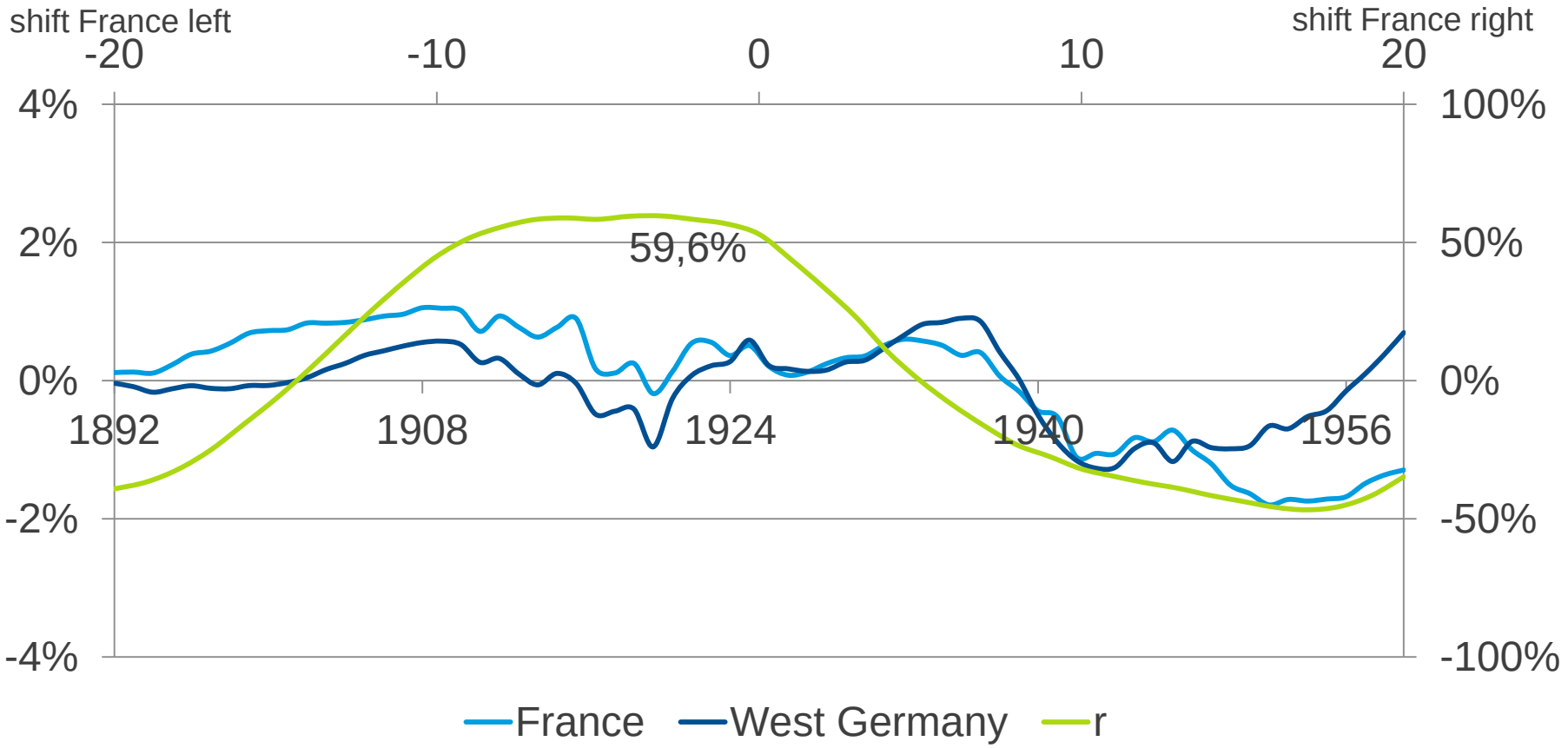
Cohort components France and West Germany, females

seem correlated - peak at -3

Cohort components (France and West Germany) and Pearson‘s correlation coefficient



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Summary

- Russia / Estonia and France / West Germany are two examples of highly correlated mortality improvement patterns in the past
- In fact, Latvia has also a very similar mortality improvement pattern compared to Russia / Estonia
- An additional example of highly correlated mortality improvement patterns is Sweden / Norway

- Why do we benefit from this information?
- Correlations are helpful especially for smaller countries with less (credible) data
- Mortality data for Estonia (population ~1.3m) is very volatile over the years, whereas Russia (population ~144m) has much less volatile data
- But even for two big countries – like France and Germany – it probably makes sense to keep improvement projections in line with each other