

Decomposition - Class 1

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MEDICINE



- Introductions
- Course structure and materials
- Grading
- Class

- Who are you?
- Ever used decomposition methods?
- How comfortable are you with R?

- Serena Vigezzi
- Post-doc at CPop, University of Southern Denmark
- Mostly worked on mortality, now some bridging between mortality and fertility, soon on historical mortality crises

Course structure and materials

- Four classes
- Monday: Kitagawa decomposition and seminar
- Tuesday: Guest Ben Elbers, Kitagawa and Shapley values
- Wednesday: Arriaga decomposition
- Thursday: Horiuchi decomposition (Integral linear decomposition)

Course structure and materials

- Frontal teaching
- Lab
- Group and class discussion
- Slides and code on Github: https://github.com/svigezzi/Decomposition_EDSD_2024_2025
- Quizzes: not graded, in teams, test whether I explained things well

- Class participation
- You don't need to be right, just involved
- Main takeaways: awareness of methods, interpretation of results

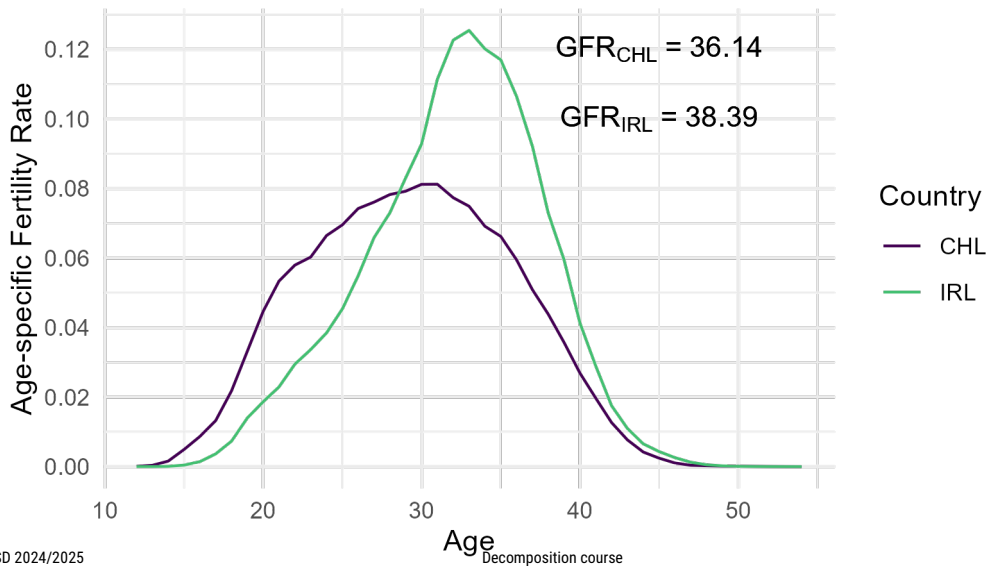
Why decompose?

- We use a lot of aggregate measures (TFR, life expectancy, Crude Rate of Net Migration,...)
- We compare these measures across populations and across time
- We want to explain why differences exist

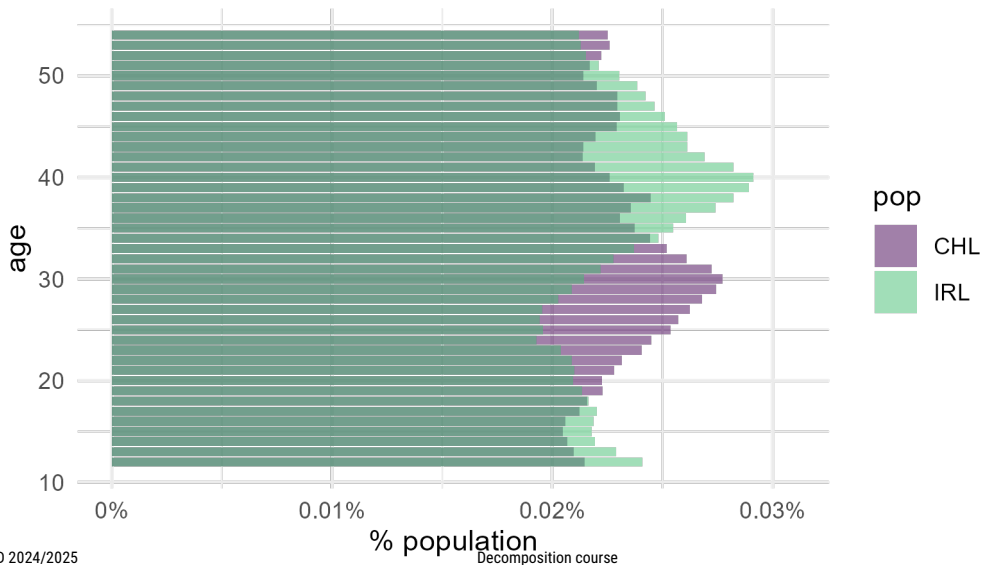
Why decompose?

- We use a lot of aggregate measures (TFR, life expectancy, Crude Migration Rate,...)
- We compare these measures across populations and across time
- We want to explain why differences exist
- BUT... many factors can influence them. How do we know which ones do what?

An example - Chile and Ireland in 2020



An example - Chile and Ireland in 2020



- Eliminate compositional effect and focus on difference in rates or vice versa
- Indirect standardisation (Tetens, 1786)
- Direct standardisation (Neison, 1844)

	Chile	Ireland
GFR	36.14	38.39
DS	32.91	40.48
IS	38.31	35.65

- Eliminate compositional effect and focus on difference in rates or vice versa
- Indirect standardisation (Tetens, 1786)
- Direct standardisation (Neison, 1844)
- BUT...they don't tell us how much each component contributes to overall difference

Here comes decomposition

- Decomposition methods want to improve upon standardisation
→ allocate a quantifiable contribution to each factor
- Oldest methods distinguish compositional vs rate effects
- Newer methods sometimes take a different direction
- Not perfect, but results are informative

- US sociologist and demographer at University of Chicago
- Mostly worked on mortality, some papers on fertility and migration
- Focus on US
- *Components of a Difference Between Two Rates*, 1955



Decomposing a crude rate into

- Difference in rates
- Difference in population composition
 - can be along any categorical dimension
 - age, marital status, gender, education

Let's decompose the change in General Fertility Rate between two years, considering composition by age

Kitagawa decomposition

$$\Delta GFR = \underbrace{\sum_x \left(\frac{ASFR_x(t_2) + ASFR_x(t_1)}{2} \right) \left(\frac{N_x(t_2)}{N(t_2)} - \frac{N_x(t_1)}{N(t_1)} \right)}_{\text{Difference in population composition}} +$$
$$\underbrace{\sum_x \left(\frac{\frac{N_x(t_2)}{N(t_2)} + \frac{N_x(t_1)}{N(t_1)}}{2} \right) (ASFR_x(t_2) - ASFR_x(t_1))}_{\text{Difference in rates}}$$

Where

- t_1 is the first population, t_2 is the second population
- N_x is the mid-year population of age x
- $ASFR_x$ is the fertility rate for age x
- N is the total mid-year population

Kitagawa decomposition

- Composition effect: difference in age-composition, keeping rates at the average of the two populations
→ *how much of the difference in GFR is because the population is older/younger?*
- Rate effect: difference in fertility rates, keeping age-composition at the average of the two populations
→ *how much of the difference in GFR is because the fertility rates are different?*

NB: Effects can be positive (push GFR up) or negative (bring GFR down)

→ The total change in GFR is the sum of the two effects

Let's find out what happens between Chile and Ireland

Another example

Demography (2022) 59(4):1233–1247

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Gender Disparities in Increased Parenting Time During the COVID-19 Pandemic: A Research Note

Jennifer March Augustine and Kate Prickett

Another example

- Between 2019 and 2020, parenting time increased substantially in the USA, due to lockdowns
- Did it increase equally for mothers and fathers?
 - overall
 - for specific kinds of activities
- The pandemic also impacted work status AND parenting time differs by work status
- How much of the increase in parenting time is due to changes in work-status composition? How much to parenting "propensity"?

Another example

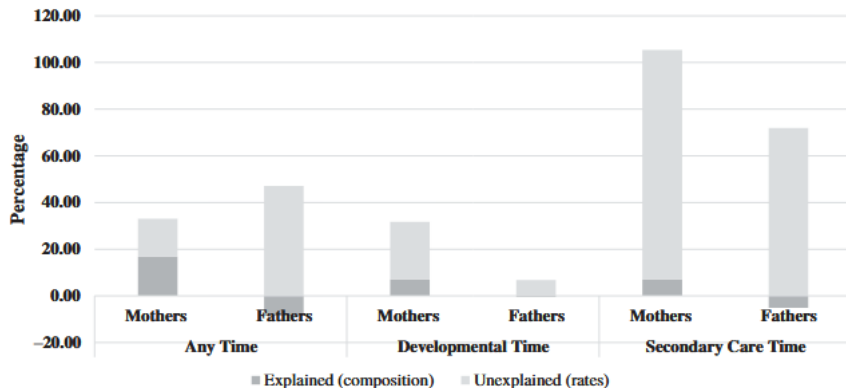


Fig. 2 Percentage of change in parenting time between 2019 and 2020 explained and unexplained by changes in the composition of the sample. Estimates are from results of the Kitagawa–Blinder–Oaxaca decomposition analyses presented in [Table 6](#).

- Did overall parenting time increase more for mothers or fathers?
- Did this change by type of time?
- How much of this was due to changes in work status?
- Could they have decomposed other differences?
- Is this the whole story?

Expansions of Kitagawa decomposition

- Basic method only handles one compositional factor (EITHER age OR marital status OR gender, etc.)
- Expanded to account for multiple compositional factors (age AND marital status AND gender, etc.)
 - more complex math
 - more factors do not necessarily explain differences better
- Similar approach in economics developed in 1970s: Oaxaca-Blinder decomposition
 - it could be considered a generalisation of the Kitagawa method (Oaxaca, 2025)

Can you think of more applications of the Kitagawa method?

More examples

Fertility Preferences and Contraceptive Change in Developing Countries

Bamikale Feyisetan, John B. Casterline

International Family Planning Perspectives, Vol. 26, No. 3 (Sep., 2000), pp. 100-109 (10 pages)

DEMOGRAPHIC RESEARCH

VOLUME 33, ARTICLE 26, PAGES 733–764

PUBLISHED 6 OCTOBER 2015

<http://www.demographic-research.org/Volumes/Vol33/26/>

DOI: 10.4054/DemRes.2015.33.26

Research Article

**Educational differences in timing and quantum
of childbearing in Britain: A study of cohorts
born 1940–1969**

JOURNAL OF ETHNIC AND MIGRATION STUDIES
2023, VOL. 49, NO. 16, 4169–4187
<https://doi.org/10.1080/1369183X.2023.2207339>



 OPEN ACCESS



The impact of immigration and integration policies on immigrant-native labour market hierarchies

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JOURNAL ARTICLE

Sexual Frequency Decline From Midlife to Later Life

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Amelia Karraker , John DeLamater , Christine R. Schwartz

The Journals of Gerontology: Series B, Volume 66B, Issue 4, July 2011, Pages 502–512, <https://doi.org/10.1093/geronb/gbr058>

Published: 01 July 2011 **Article history** ▼

PLOS ONE

RESEARCH ARTICLE

Declining trend of smoking and smokeless tobacco in India: A decomposition analysis

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References

J.N. Tetens (1786). *Einleitung zur Berechnung der Leibrenten und Antwarschaften. Zweyter Theil. Versuche über einige bey Versorgungs-Anstalten erhebliche Punkte, Weidmanns Erben und Reich*: Leipzig.

F.G.P. Neison (1844). "On a method recently proposed for conducting inquiries into the comparative sanatory condition of various districts, with illustrations, derived from numerous places in Great Britain at the period of the last census", *Journal of the Statistical Society of London*, 7(1): 40–68.

R.L. Oaxaca and E. Sierminska (2025). "Oaxaca-Blinder meets Kitagawa: What is the link?", *PloS One*, 20(5): e0321874.