### Variants of decomposition

Tim Riffe MPIDR Laboratory of Population Health

21 Oct 2020

#### Two classes

- bespoke decompositions
- generalized decomposition

▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, . . . )

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, . . . )
- ▶ Partition differences in life expanctancy (Arriaga 1984)

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, . . . )
- Partition differences in life expanctancy (Arriaga 1984)
- CTFR via parity progression (Zeman et al 2018)

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, ...)
- Partition differences in life expanctancy (Arriaga 1984)
- ► CTFR via parity progression (Zeman et al 2018)
- Intrinsic vs extrinsic mortality (Li et al 2013)

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, ...)
- Partition differences in life expanctancy (Arriaga 1984)
- CTFR via parity progression (Zeman et al 2018)
- Intrinsic vs extrinsic mortality (Li et al 2013)
- Survival partitioning (Ebeling et al 2018)

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, . . . )
- Partition differences in life expanctancy (Arriaga 1984)
- CTFR via parity progression (Zeman et al 2018)
- Intrinsic vs extrinsic mortality (Li et al 2013)
- Survival partitioning (Ebeling et al 2018)
- Location-scale (Basellini et al 2016)

- ▶ Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, . . . )
- Partition differences in life expanctancy (Arriaga 1984)
- CTFR via parity progression (Zeman et al 2018)
- Intrinsic vs extrinsic mortality (Li et al 2013)
- Survival partitioning (Ebeling et al 2018)
- ► Location-scale (Basellini et al 2016)
- Name some more

- ► Partition difference between crude rates in two subgroups (Kitagawa 1955)
- ▶ Partition difference between crude rates in N subgroups (Das Gupta 1978, . . . )
- ▶ Partition differences in life expanctancy (Arriaga 1984)
- CTFR via parity progression (Zeman et al 2018)
- Intrinsic vs extrinsic mortality (Li et al 2013)
- Survival partitioning (Ebeling et al 2018)
- Name some more

Partition the difference in a **crude** rate into additive **rate** and **structure** components.

Partition the difference in a **crude** rate into additive **rate** and **structure** components.

The total difference is the difference in rates times the mean structure (rate component) plus the difference in structure times the mean rates (structure component).

Formally, for indices of the form:

$$\mathbb{Z} = \frac{\sum r_{x} P_{x}}{\sum P_{x}}$$

(That is to say, weighted means)

Formally, for indices of the form:

$$\mathbb{Z} = \frac{\sum r_{\mathsf{x}} P_{\mathsf{x}}}{\sum P_{\mathsf{x}}}$$

(That is to say, weighted means)

$$\zeta = \mathbf{r} + \mathbf{s}$$

Formally, for indices of the form:

$$\mathbb{Z} = \frac{\sum r_{\mathsf{x}} P_{\mathsf{x}}}{\sum P_{\mathsf{x}}}$$

(That is to say, weighted means)

$$\zeta = \mathbf{r} + \mathbf{s}$$

where:

- r is how much of the difference is due to rates
- **s** is how much of the difference is due to **structure**

Formally, for indices of the form:

$$\mathbb{Z} = \frac{\sum r_{\mathsf{x}} P_{\mathsf{x}}}{\sum P_{\mathsf{x}}}$$

(That is to say, weighted means)

$$\zeta = \mathbf{r} + \mathbf{s}$$

where:

- r is how much of the difference is due to rates
- **s** is how much of the difference is due to **structure**

$$r = (r^2 - r^1) \frac{s^1 + s^2}{2}$$

Formally, for indices of the form:

$$\mathbb{Z} = \frac{\sum r_{\mathsf{x}} P_{\mathsf{x}}}{\sum P_{\mathsf{x}}}$$

(That is to say, weighted means)

$$\zeta = \mathbf{r} + \mathbf{s}$$

where:

- r is how much of the difference is due to rates
- **s** is how much of the difference is due to **structure**

$$r = (r^{2} - r^{1}) \frac{s^{1} + s^{2}}{2}$$
$$s = (s^{2} - s^{1}) \frac{r^{1} + r^{2}}{2}$$

► Group differences, statistical decomp (Oaxaca-Blinder 1973)

- ► Group differences, statistical decomp (Oaxaca-Blinder 1973)
- Change in mean (Vaupel & Canudas Romo 2002)

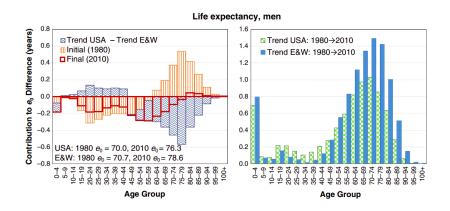
- ► Group differences, statistical decomp (Oaxaca-Blinder 1973)
- ► Change in mean (Vaupel & Canudas Romo 2002)
- ► Between-within decompositions, ANOVA

- Group differences, statistical decomp (Oaxaca-Blinder 1973)
- ► Change in mean (Vaupel & Canudas Romo 2002)
- Between-within decompositions, ANOVA
- SVD (underlies Lee Carter!)

- ► Group differences, statistical decomp (Oaxaca-Blinder 1973)
- ► Change in mean (Vaupel & Canudas Romo 2002)
- Between-within decompositions, ANOVA
- ► SVD (underlies Lee Carter!)
- ► Compare two groups over time (Jdanov et al 2017)

- Group differences, statistical decomp (Oaxaca-Blinder 1973)
- ► Change in mean (Vaupel & Canudas Romo 2002)
- Between-within decompositions, ANOVA
- ► SVD (underlies Lee Carter!)
- Compare two groups over time (Jdanov et al 2017)

# Contour decomposition



▶ Difference-scaled derivatives, LTRE (Caswell 1989)

- ▶ Difference-scaled derivatives, LTRE (Caswell 1989)
- ► Stepwise-replacement algorithm (Andreev et al 2002)

- ▶ Difference-scaled derivatives, LTRE (Caswell 1989)
- ► Stepwise-replacement algorithm (Andreev et al 2002)
- ► Pseudo-continuous (Horiuchi et al 2008)

- Difference-scaled derivatives, LTRE (Caswell 1989)
- ► Stepwise-replacement algorithm (Andreev et al 2002)
- ► Pseudo-continuous (Horiuchi et al 2008)
- Generalized counterfactual approach (Sudharsanan & Bijlsma 2020)

#### Bibliography

Andreev, E. M., Shkolnikov, V. M., & Begun, A. Z. (2002). Algorithm for decomposition of differences between aggregate demographic measures and its application to life expectancies, healthy life expectancies, parity-progression ratios and total fertility rates. Demographic Research, 7, 499-522.

Arriaga, E. E. (1984). Measuring and explaining the change in life expectancies. Demography, 21(1), 83-96.

Basellini, U., Canudas-Romo, V., & Lenart, A. (2016, April). Location-scale models in demography: a generalization of the parametric models of mortality. In 81th Annual Meeting of the Population Association of America Washington.

Caswell, H. (1989). Analysis of life table response experiments I. Decomposition of effects on population growth rate. Ecological Modelling, 46(3-4), 221-237.

Gupta, P. D. (1993). Standardization and decomposition of rates: a user's manual (No. 186). US Department of Commerce, Economics and Statistics Administration, Bureau of the Census. url https://babel.hathitrus.rog/cgi/pt?id=osu.32437011198450&view=1up&seq=3

Horiuchi, S., Wilmoth, J. R., & Pletcher, S. D. (2008). A decomposition method based on a model of continuous change. Demography, 45(4), 785-801.

Kitagawa, E. M. (1955). Components of a difference between two rates. Journal of the american statistical association, 50(272), 1168-1194.

Ebeling, M., Rau, R., & Baudisch, A. (2018). Rectangularization of the survival curve reconsidered: The maximum inner rectangle approach. Population studies, 72(3), 369-379.

Jdanov, D. A., Shkolnikov, V. M., van Raalte, A. A., & Andreev, E. M. (2017). Decomposing current mortality differences into initial differences and differences in trends: the contour decomposition method. Demography, 54(4), 1579-1602.

Li, T., & Anderson, J. J. (2013). Shaping human mortality patterns through intrinsic and extrinsic vitality processes. Demographic Research, 28, 341-372.

Sudharsanan, N., Bijlsma, M. J. (2020) A generalized counterfactual approach to decomposing differences between populations. MPIDR Working Paper WP-2019-004 https://dx.doi.org/10.4054/MPIDR-WP-2019-004