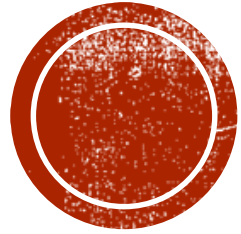


SEMINAR 3 FERTILITY

Chen Luo (l.chen7@uw.edu.pl)

Interdisciplinary Centre for Labour Market and Family Dynamics (LABFAM)
Faculty of Economic Sciences
University of Warsaw

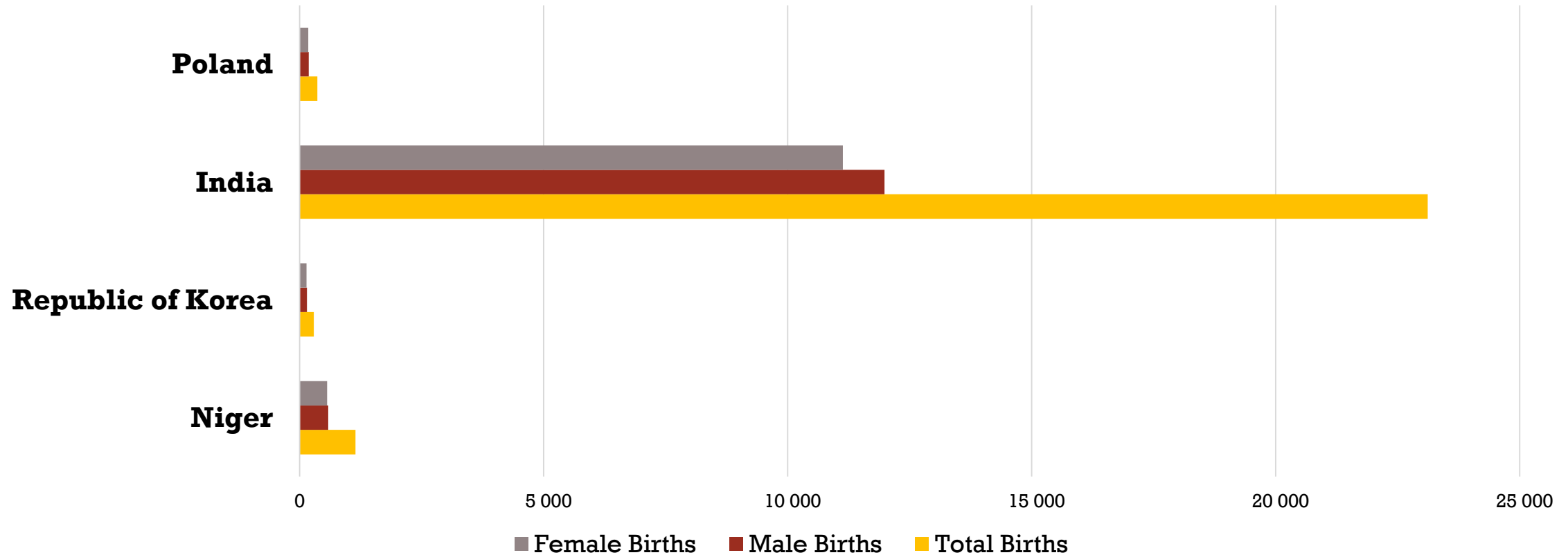




MEASURING FERTILITY: INTERPRETING KEY FERTILITY INDICATORS

BIRTHS

Figure 1. Births (thousands), by country and sex, 2021



Source: UN (2022), *World Population Prospects 2022*



BIRTHS – CRUDE BIRTH RATE

- We need to measure fertility based on the **demographic features** of a country
- We need to take the *population size* into account
 - The Crude Birth Rate (CBR) captures the number of births per 1,000 population

$$\blacksquare CBR = \frac{\text{Number of live births in a year}}{\text{Average population in that year}} * 1000$$



CRUDE BIRTH RATE

Figure 2. Crude Birth Rate by country, 2021

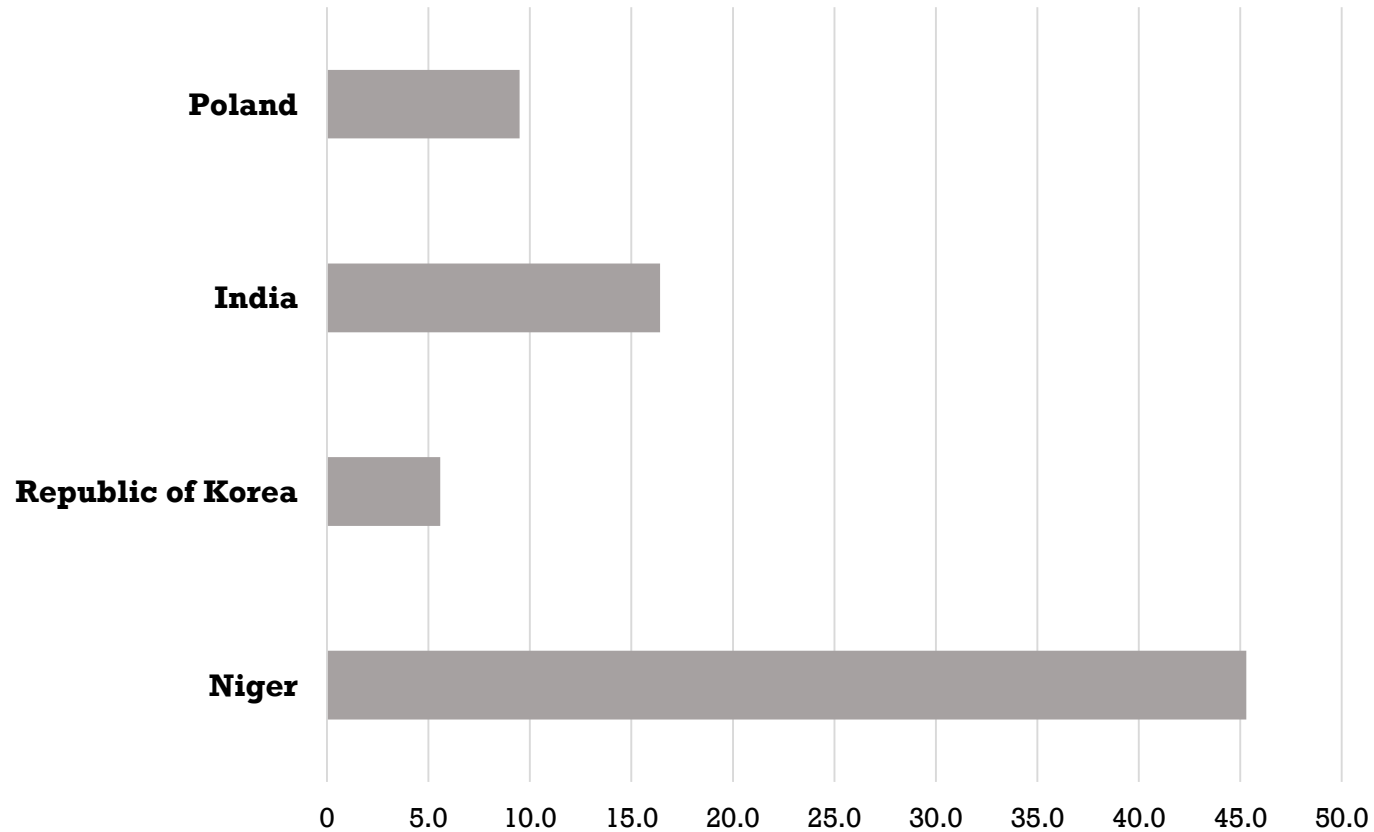
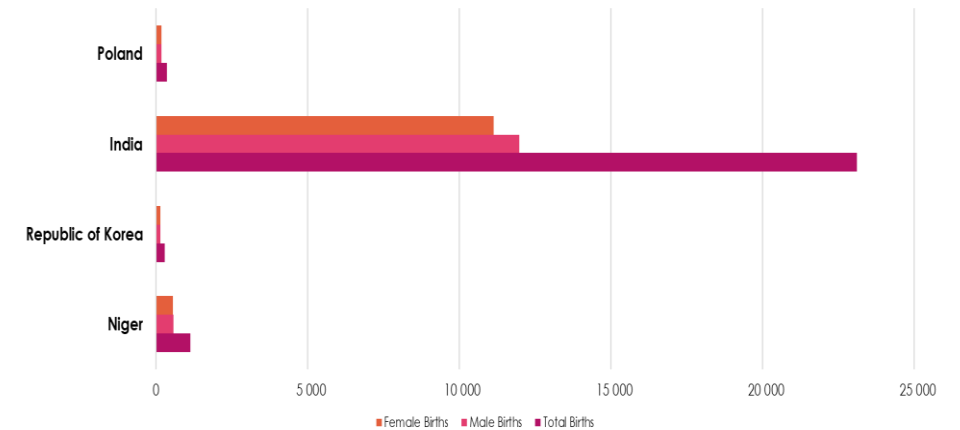


Figure 1. Births (thousands), by country and sex, 2021



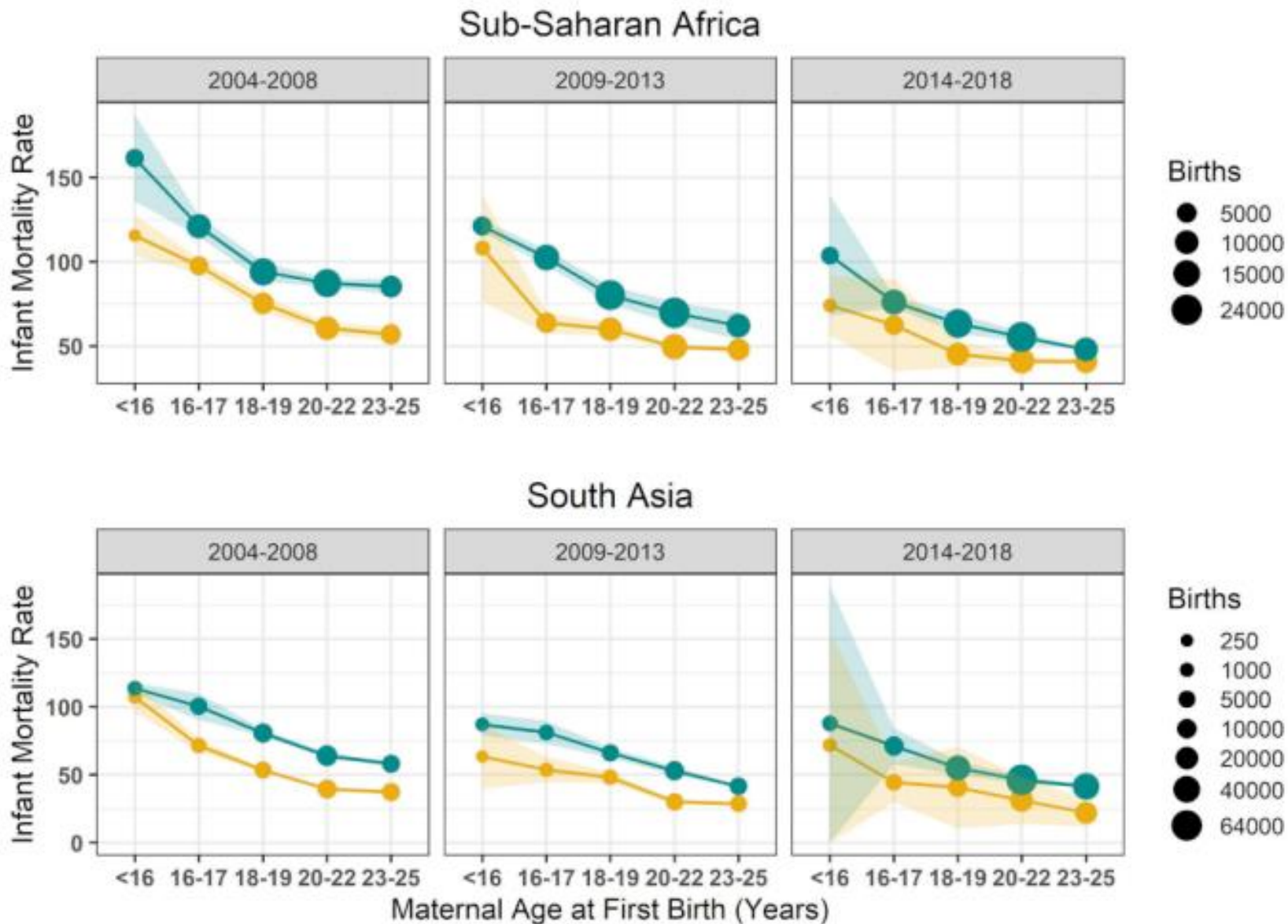
Source: UN (2022), *World Population Prospects 2022*



AGE-SPECIFIC FERTILITY RATE

- Any other factors than population size?
- We also need to consider the *population structure, particularly for mothers*
 - The Age-Specific Fertility Rate (ASFR) and Total Fertility Rate (TFR) capture the number of births per woman, taking into account variations in fertility patterns across different age groups
 - The ASFR measures the **annual number of births to women of a specified age or age group**
- $ASFR_i = \frac{\text{Number of births to women in age group } i \text{ in a given year}}{\text{Number of women in age group } i \text{ in that year}}$





ADOLESCENT PREGNANCY AND CHILD MORTALITY

Figure 3. Infant mortality rate in Sub-Saharan Africa, by period and maternal age at first birth

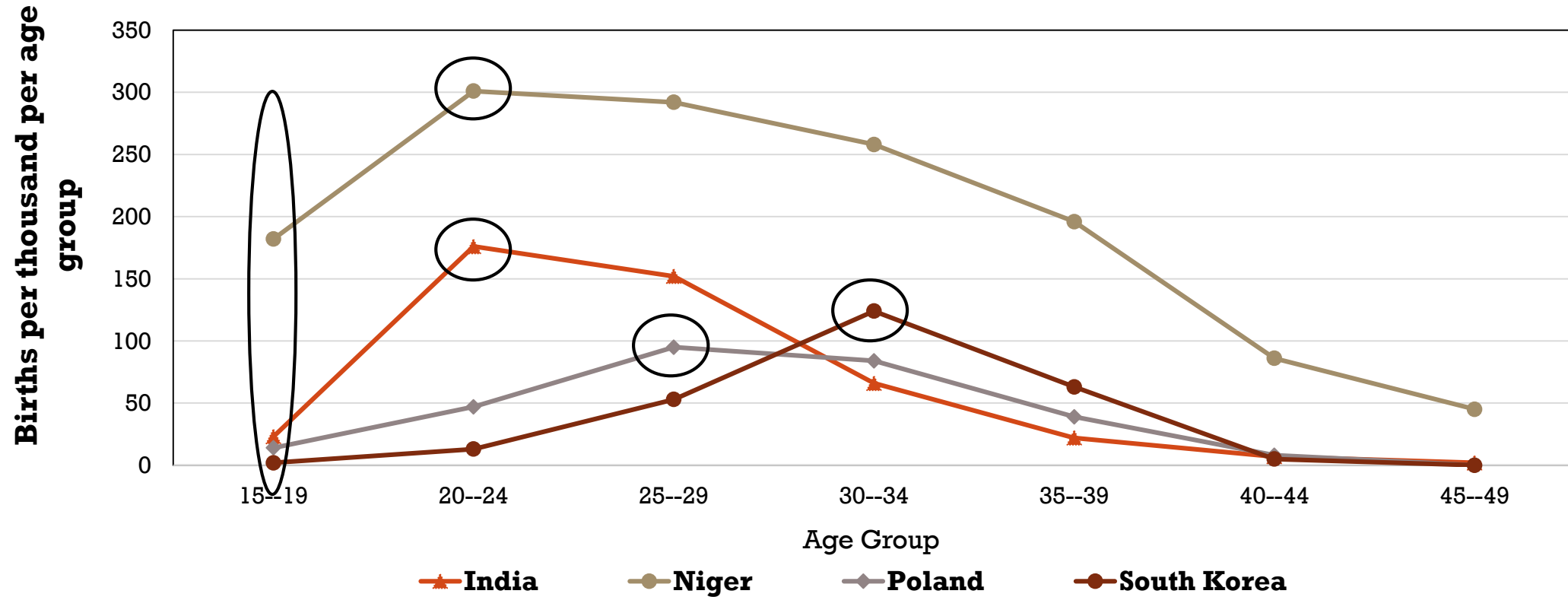
Source: Noori N, et al. BMJ Global Health 2022;7:e007681.
doi:10.1136/bmjgh-2021-007681

Notes: infant mortality: death within the first year of life
Green: rural area; Yellow: urban area



AGE-SPECIFIC FERTILITY RATE

Figure 4. Age-Specific Fertility Rate, by country, 2015-2020

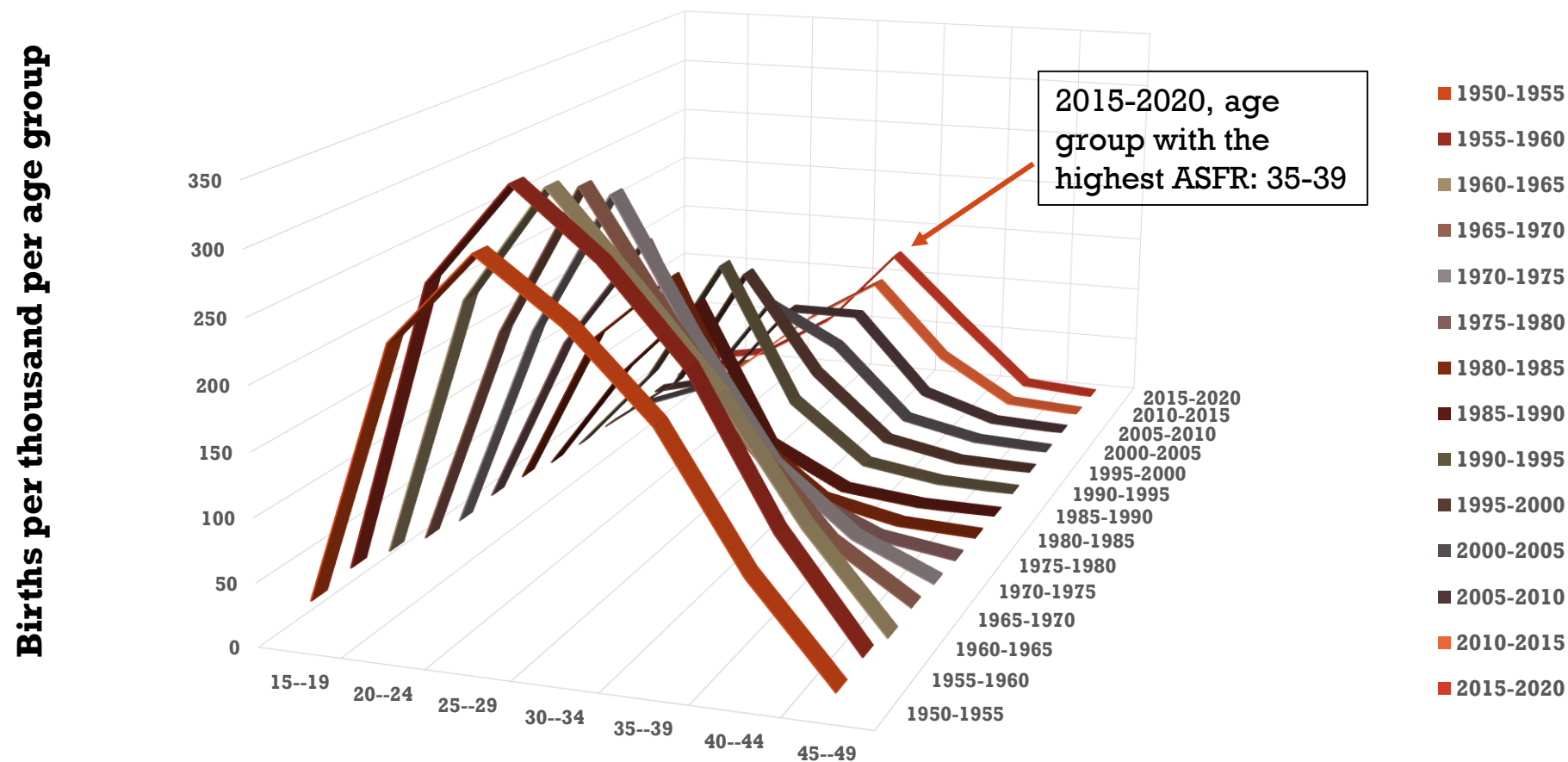


Source: Wittgenstein Centre Human Capital Data Explorer



AGE-SPECIFIC FERTILITY RATE

Figure 5. Age-Specific Fertility Rate in South Korea, by Period



TOTAL FERTILITY RATE

- From Age-Specific Fertility Rate to Total Fertility Rate (TFR):
- TFR: **the average number of live births** a **hypothetical** cohort of women would have at the end of their reproductive period if they were subject during their whole lives to the fertility rates of a given period and if they were not subject to mortality. It is expressed as live births per woman. (UN (2022), *World Population Prospects*)
- Briefly, it captures the number of children a woman would have if she survived the end of her reproductive age and **experienced the ASFRs of the period** in question throughout her reproductive life

$$\text{TFR} = 5 * \sum_{i=1}^n \text{ASFR}_i \quad \text{when ASFR is measured for age group (per 5 year)}$$

$$\text{TFR} = \sum_{i=1}^n \text{ASFR}_i \quad \text{when ASFR is measured per age}$$



TOTAL FERTILITY RATE

Exercise 1. Calculate age-specific fertility rate, TFR, and crude birth rate

Year		Age Group					
		15-19	20-24	25-29	30-34	35-39	40-44
2010	Number of births	50	390	660	720	400	140
	Number of women	5000	5200	5500	6000	6400	7000
	Average population	175500					
	ASFR						
	CBR						
	TFR						

$$CBR = \frac{\text{Number of live births in a year}}{\text{Average population in that year}} \times 1000$$

$$ASFR_i = \frac{\text{Number of births to women in age group } i \text{ in a given year}}{\text{Number of women in age group } i \text{ in that year}}$$

$$TFR = 5 * \sum_{i=1}^n ASFR_i$$



TOTAL FERTILITY RATE

Answer:

Year		Age Group					
		15-19	20-24	25-29	30-34	35-39	40-44
2010	Number of births	50	390	660	720	400	140
	Number of women	5000	5200	5500	6000	6400	7000
	Average population	175500					
	ASFR	0.01	0.075	0.12	0.12	0.0625	0.02
	CBR	13.45					
	TFR	2.0375					

$$CBR = \frac{\text{Number of live births in a year}}{\text{Average population in that year}} \times 1000$$

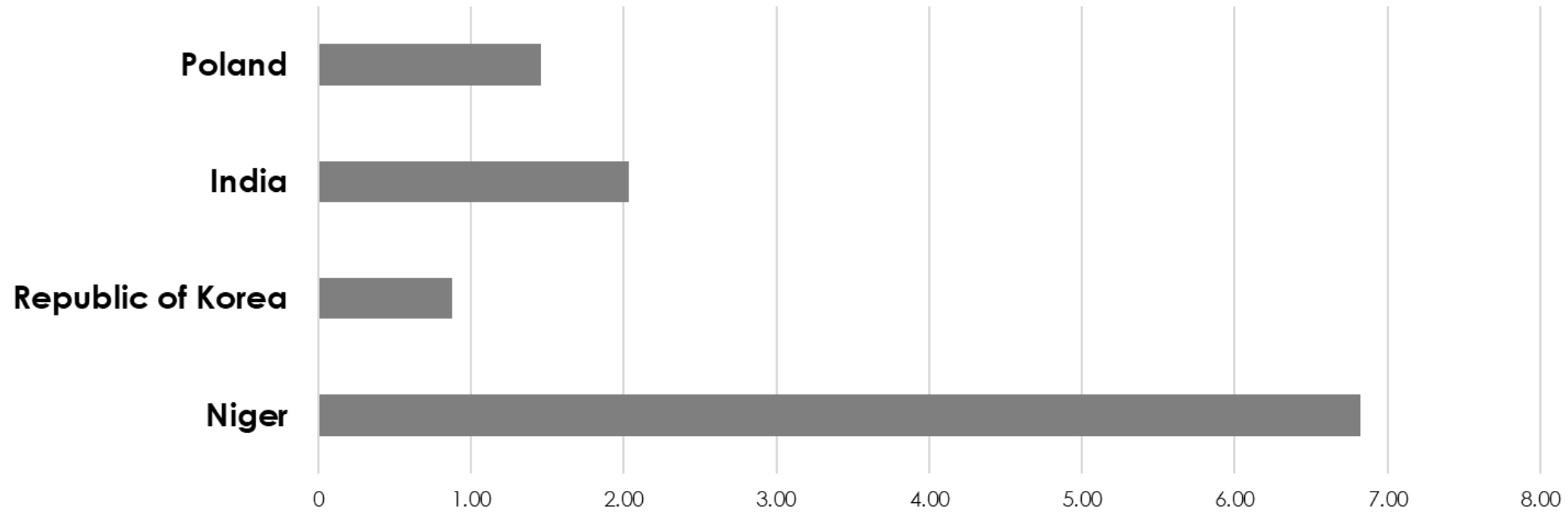
$$ASFR_i = \frac{\text{Number of births to women in age group } i \text{ in a given year}}{\text{Number of women in age group } i \text{ in that year}}$$

$$TFR = 5 * \sum_{i=1}^n ASFR_i$$



TOTAL FERTILITY RATE

Figure 6. Total Fertility Rate, by country, 2021



Source: UN (2022), *World Population Prospects 2022*

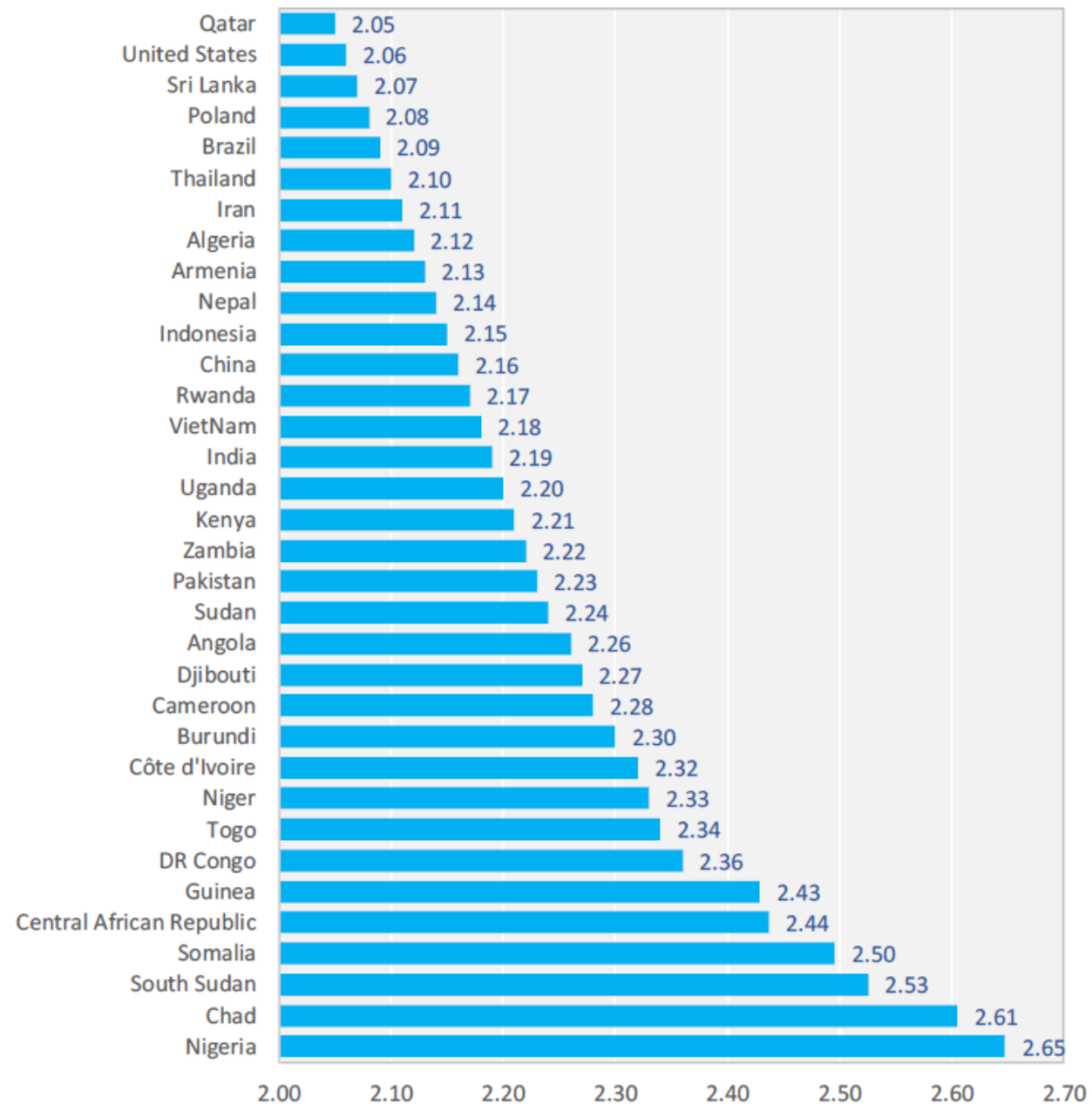


REPLACEMENT LEVEL FERTILITY

- A level of TFR that implies **a generation produces enough children to replace itself (TFR(R))**
- It also depends on the **sex ratio at birth, mortality rate and migration**
- In the absence of mortality
 - Female birth rate (FBR): ratio of female births in the population:
$$\text{FBR} = \text{female births} / (\text{female births} + \text{male births})$$
 - To maintain a constant generation size: $\text{TFR(R)} * \text{FBR} = 1$
 - $\frac{\text{Births}}{\text{Nr.women}} * \frac{\text{Nr.women}}{(\text{Nr.women} + \text{Nr.men})} = 1$ (births = women + men)
 - Therefore, $\text{TFR(R)} = 1/\text{FBR}$
- If the sex ratio is 105:100, then $\text{TFR(R)} = \frac{1}{\text{FBR}} = 1 / (100 / (100 + 105)) = 2.05$
- If the sex ratio is 110:100

$$\text{TFR(R)} = \frac{1}{\text{FBR}} = \frac{1}{100 / (100 + 110)} = 2.10$$





REPLACEMENT LEVEL FERTILITY

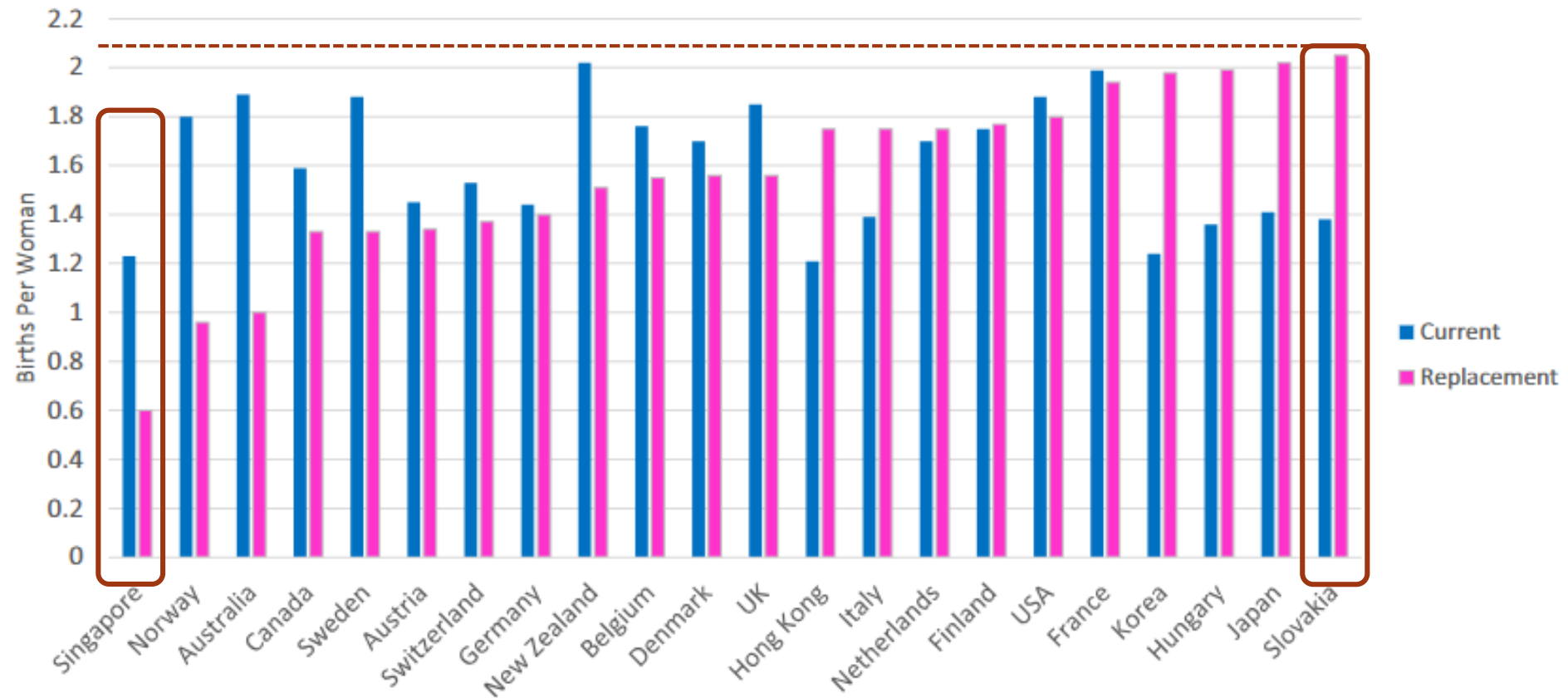
Figure 7. Estimated level of replacement TFR in 2010, accounting for mortality

Source: Sobotka (2023)



REPLACEMENT LEVEL FERTILITY

Figure 8. Estimated level of replacement TFR accounting for migration (2010-2015)



MEASURING FERTILITY

- TFR depicts a quite comprehensive picture of the fertility of a given period, but it can be **misleading**
 - The TFR is a **hypothetical** measure and does not represent real individuals directly.
 - Sometimes people just postpone their fertility plan, instead of giving it up
 - Most countries experienced a decline in TFR during COVID-19, but will we have more babies after COVID-19 to compensate for the short-run fertility decline?
- TFR reflects the interplay of two components: **tempo** (timing) and **quantum** (level) of fertility. The tempo component affects the TFR when the timing of childbearing over the life cycle changes. However, we don't know if the change in TFR is the consequence of tempo and/or quantum effect. We might observe a very high TFR of a given year because women of all age groups decide to have children at the same time.
- $$TFR_t = 5 * \sum \frac{\text{Number of births to women in age group } i \text{ in year } t}{\text{Number of women in age group } i \text{ in year } t}$$



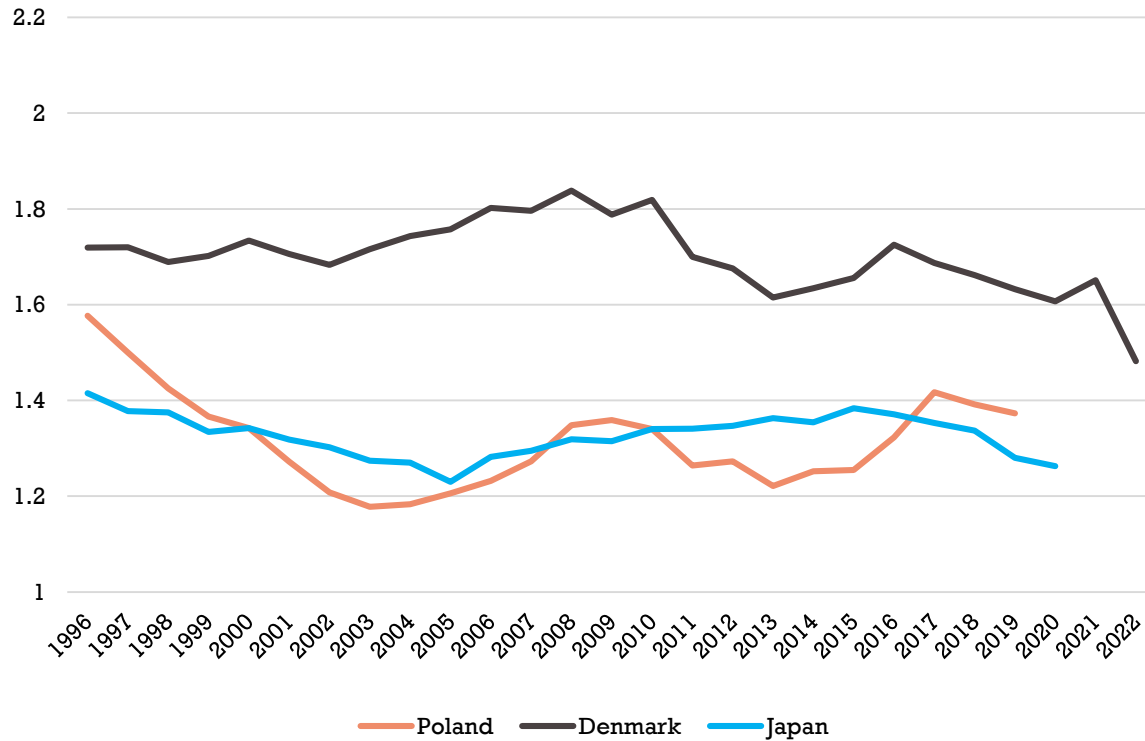
ACCOUNTING FOR TEMPO EFFECTS

- A **cohort** refers to a group of individuals who share a common characteristic within a specific time period.
- **Completed Cohort Fertility (CCF)**: the average number of children born to women belonging to a **certain cohort** over the **whole** of their reproductive lives
 - **Completed Cohort Fertility by birth order** (CCF_i): $CCF = \sum_{i=1}^n CCF_i$



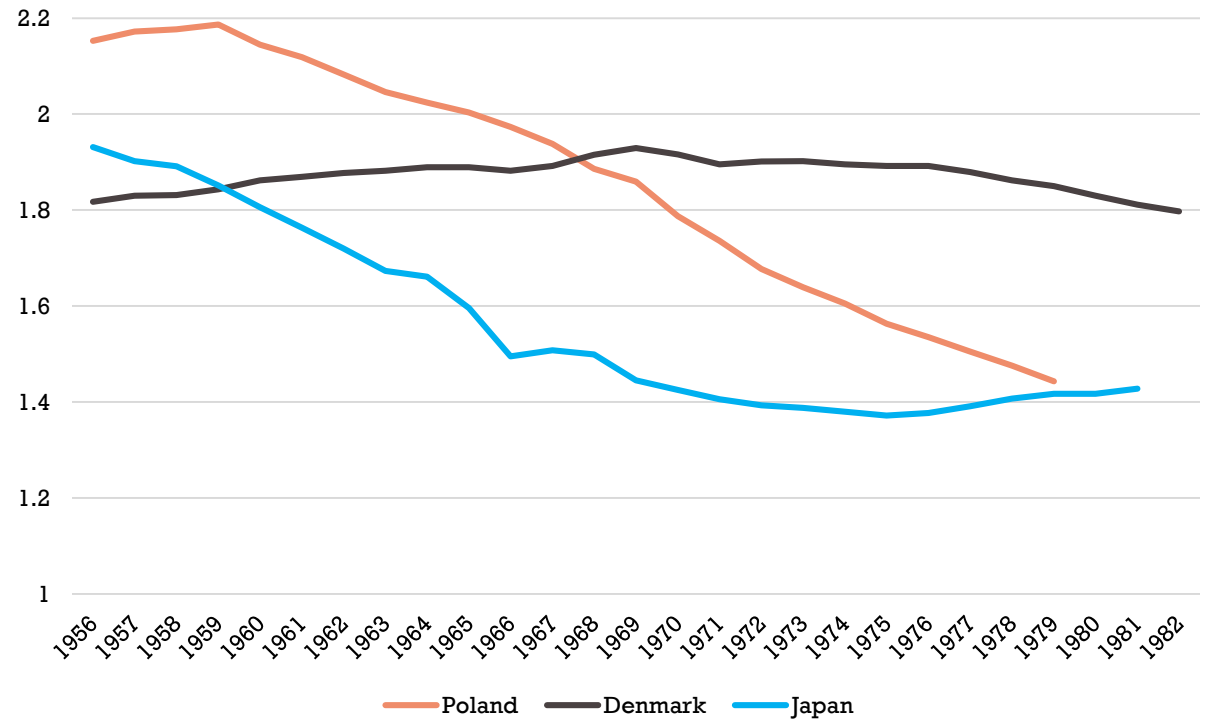
PERIOD VS. COHORT PERSPECTIVES

Figure 9. Total fertility rate by country (by age 40), 1996-2022



Which country, Poland or Japan, experienced a lower level of fertility over this period?

Figure 10. Cohort completed fertility by age 40 by country, women born in 1956-1982



Source: Own calculation based on *Human Fertility Database*



PERIOD VS. COHORT PERSPECTIVES

Figure 9. Total fertility rate by country (by age 40), 1996-2022

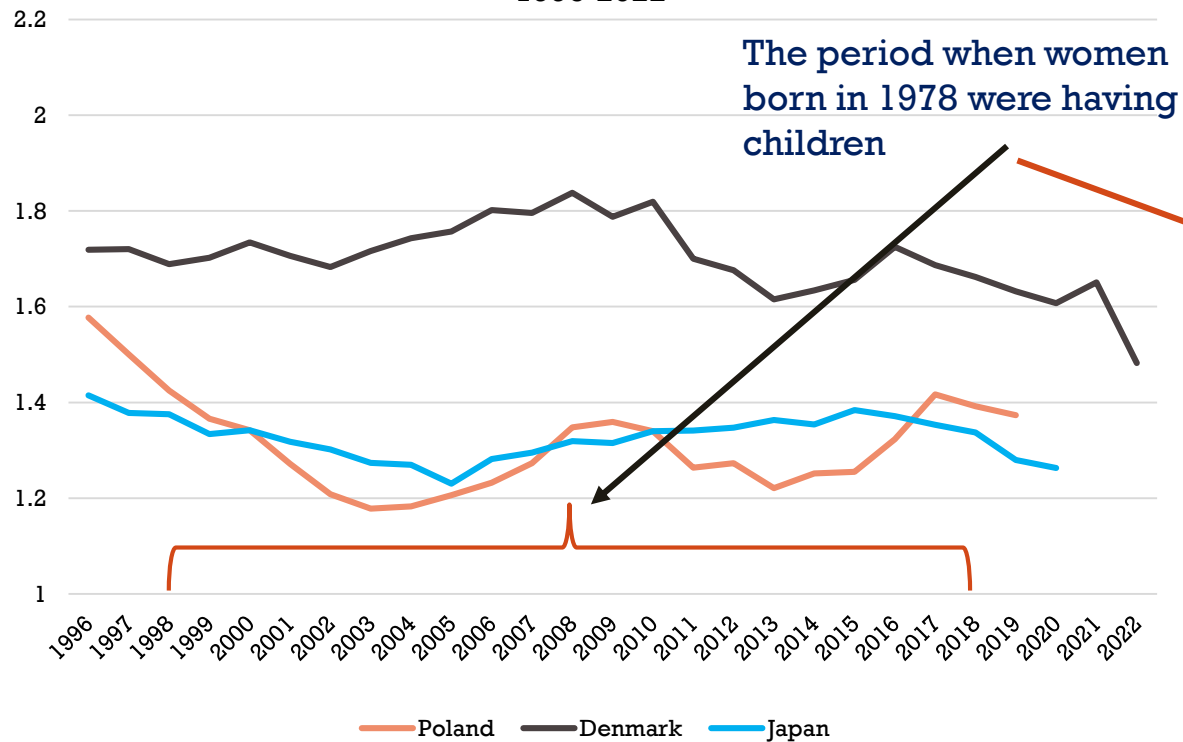
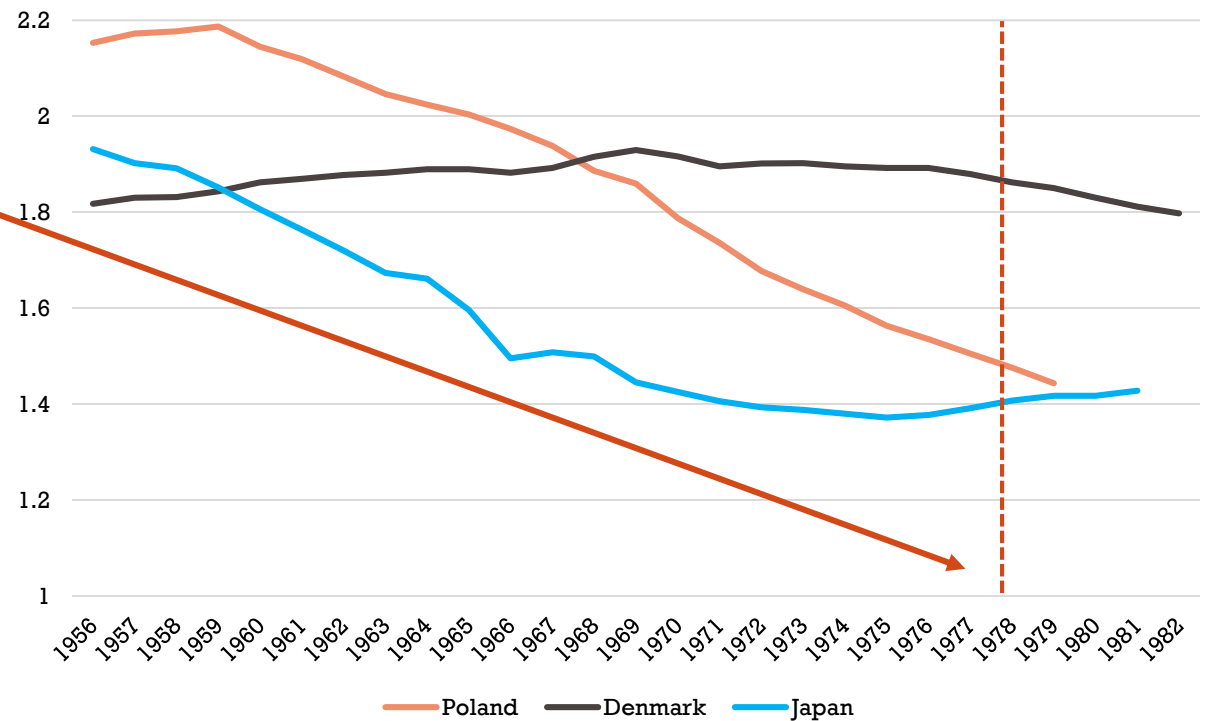
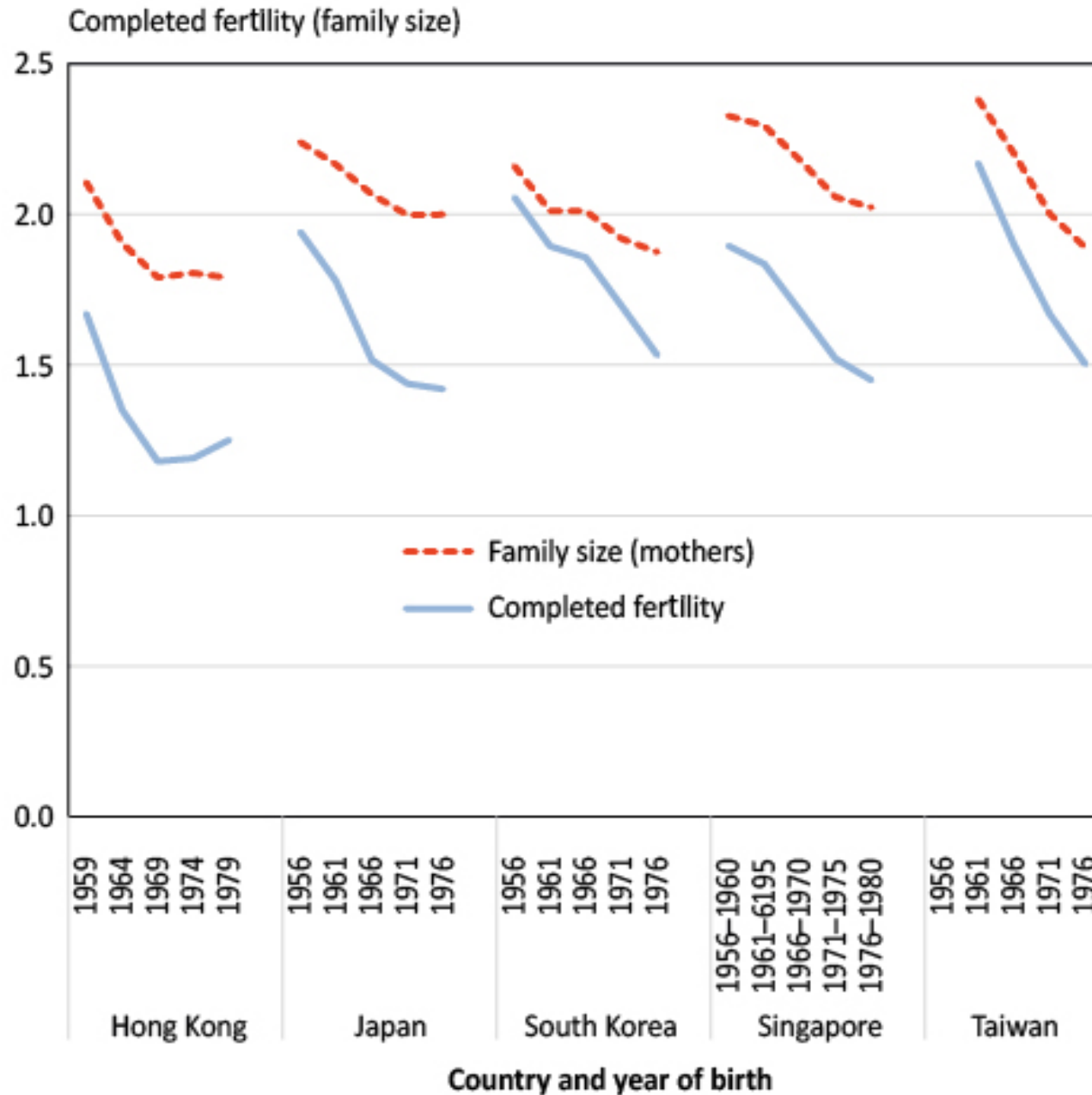


Figure 10. Cohort completed fertility by age 40 by country, women born in 1956-1982



Source: Own calculation based on *Human Fertility Database*



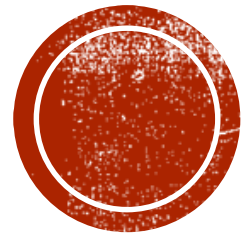


CHILDLESSNESS (CHILDFREE)

Figure 11. Completed cohort fertility among all women and among mothers, by cohort and country

Source: Sobotka, T., 2021. World's highest childlessness levels in East Asia. *Population Societies*, 595(11), pp.1-4.

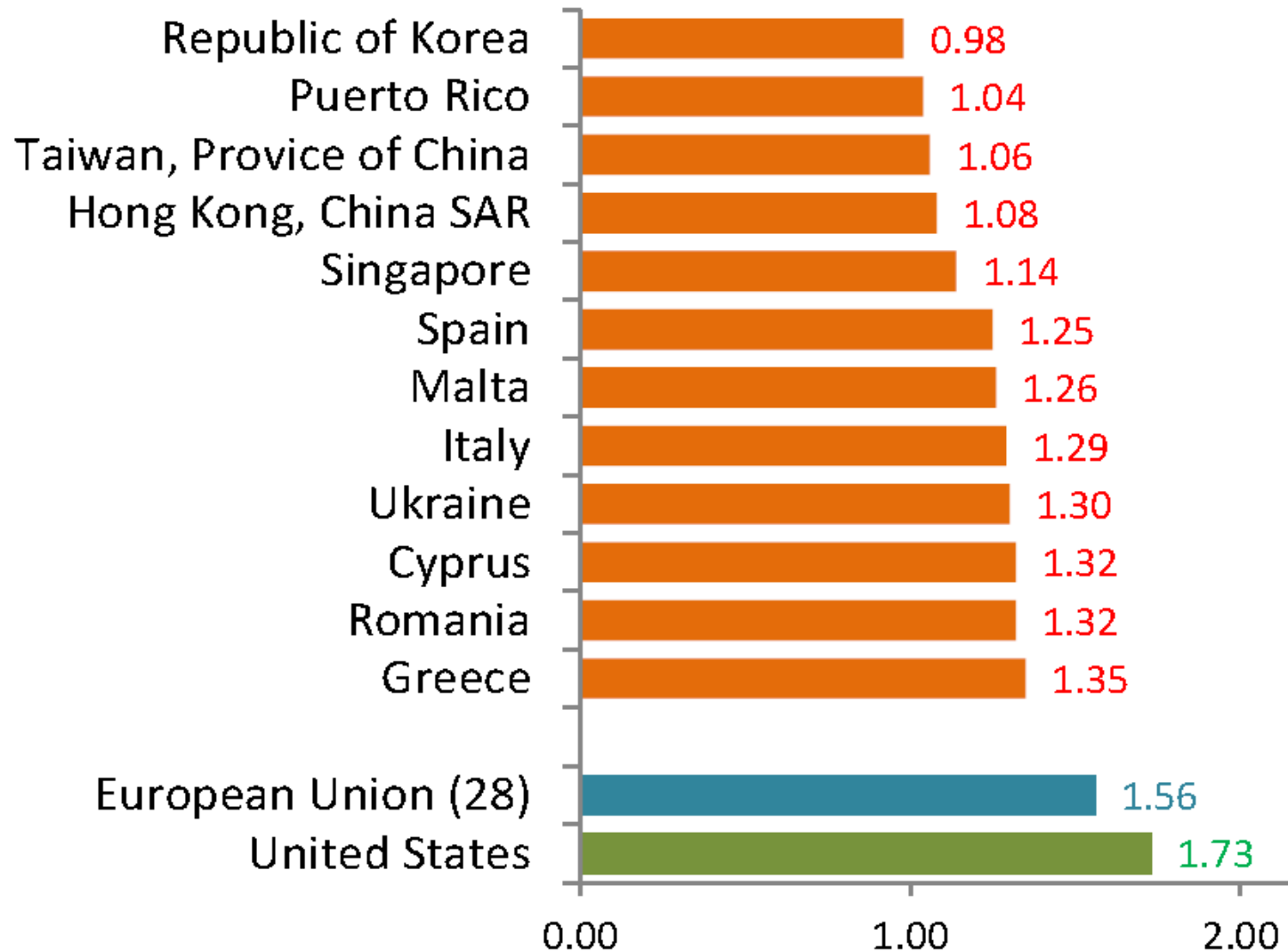




LOW FERTILITY

A problem or not?

Period Total Fertility Rate (2018)



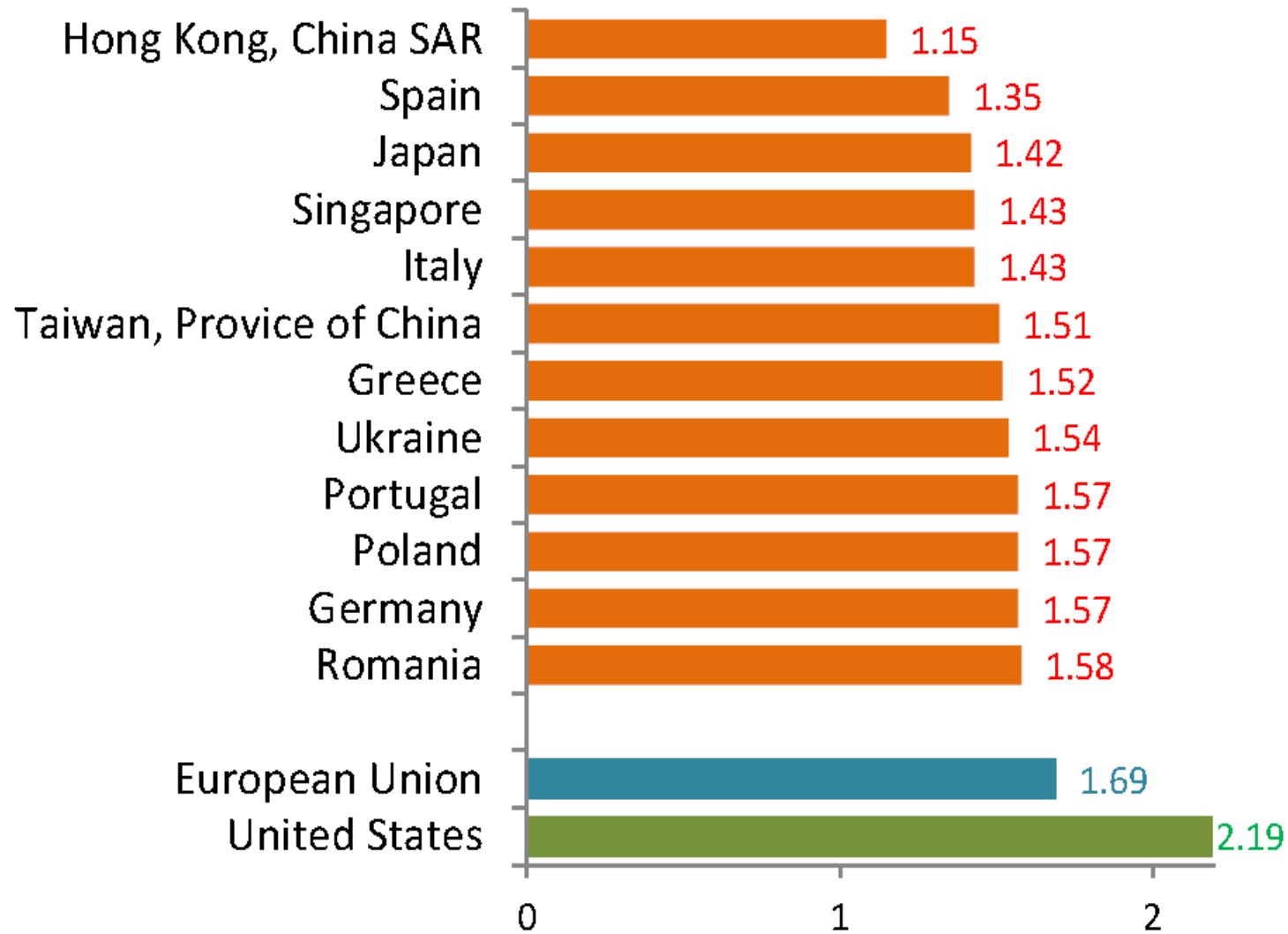
LOW FERTILITY

Figure 12. Period Total Fertility Rate, 2018

Source: Sobotka, T., A. Matysiak, Z. Brzozowska. 2019. "Policy responses to low fertility: How effective are they?" New York: UNFPA, Working Paper No. 1, May 2019 Technical Division Working Paper Series, Population & Development Branch



Completed fertility (children per woman born in 1976)

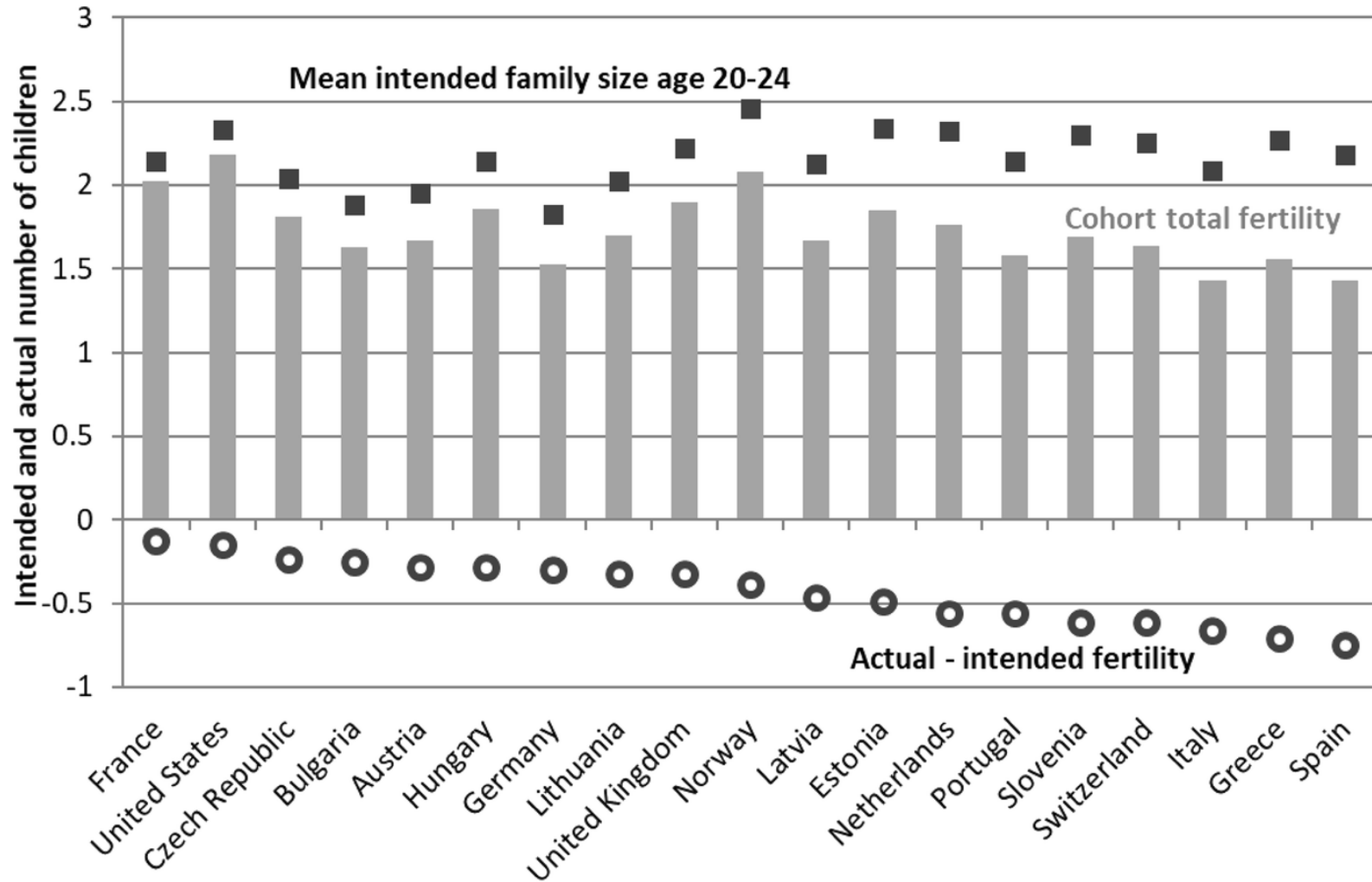


LOW FERTILITY

Figure 13. Completed Fertility for women born in 1976

Source: Sobotka, T., A. Matysiak, Z. Brzozowska. 2019. "Policy responses to low fertility: How effective are they?" New York: UNFPA, Working Paper No. 1, May 2019 Technical Division Working Paper Series, Population & Development Branch



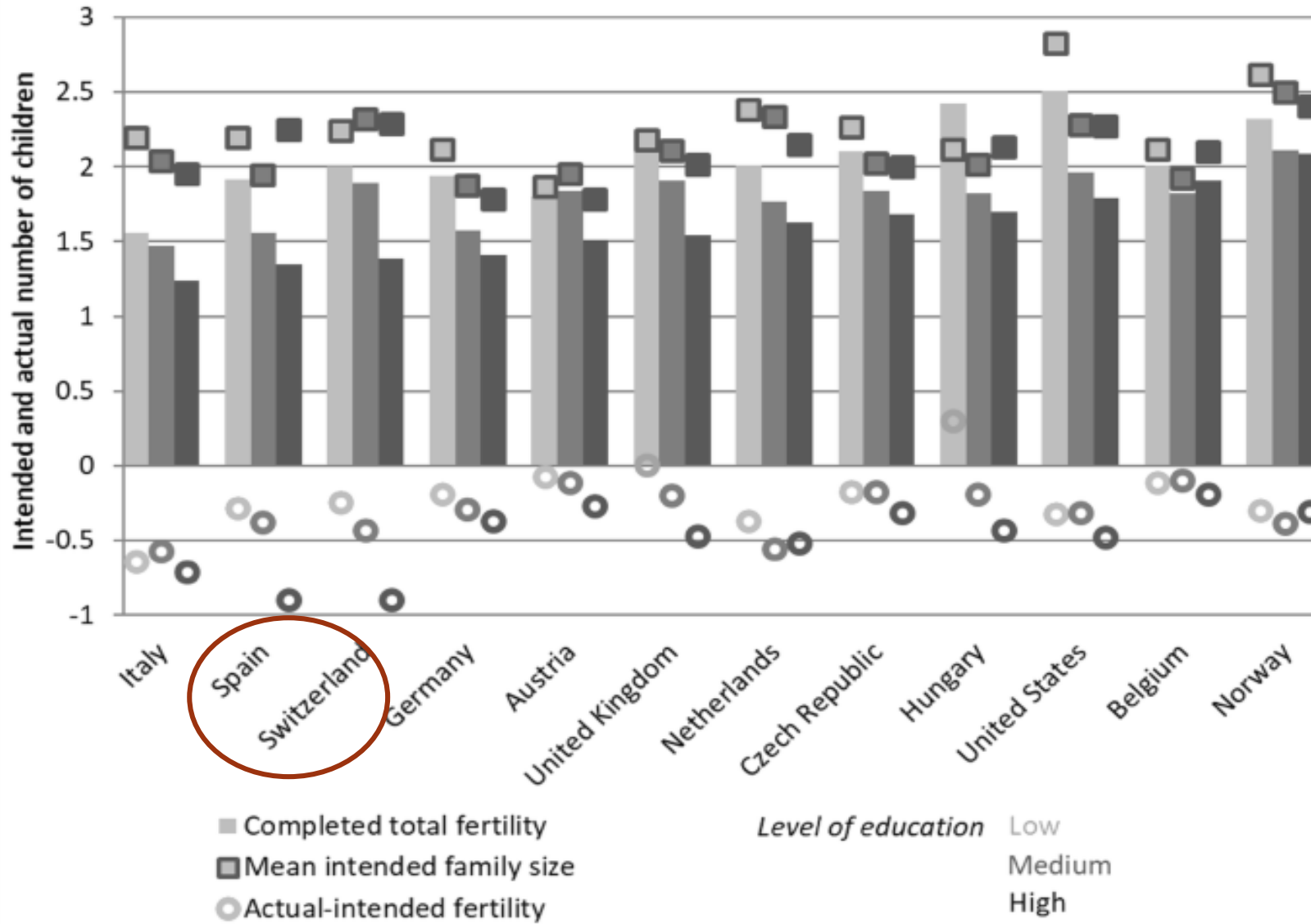


LOW FERTILITY

Figure 14. Intended and realized fertility in Europe

Source: Beaujouan, E., Berghammer, C. (2019) The gap between lifetime fertility intentions in Europe and the United States: a cohort approach, Population Research and Policy Review



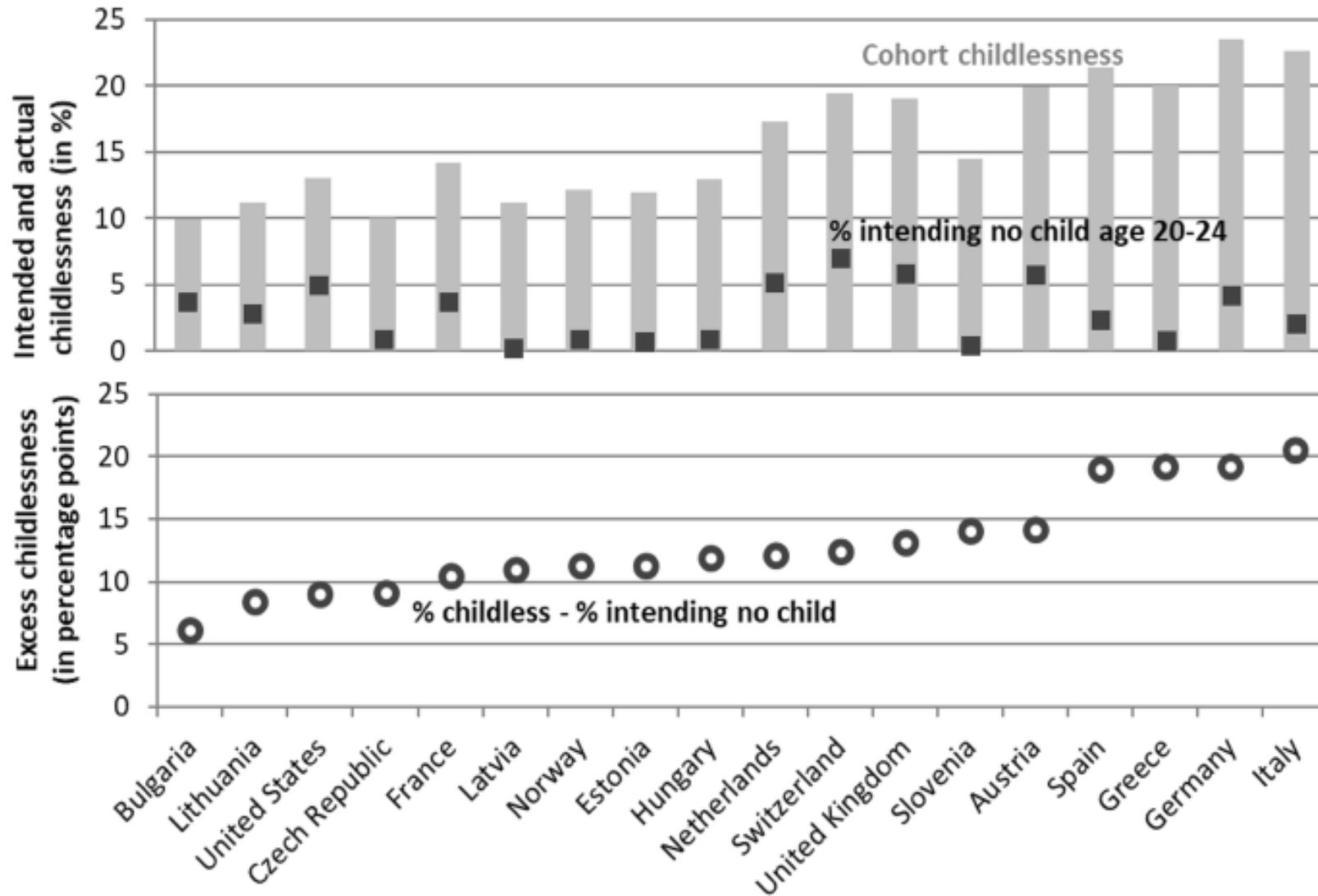


LOW FERTILITY

Figure 15. Intended and realized fertility in Europe by education

Source: Beaujouan, E., Berghammer, C. (2019) The gap between lifetime fertility intentions in Europe and the United States: a cohort approach, Population Research and Policy Review



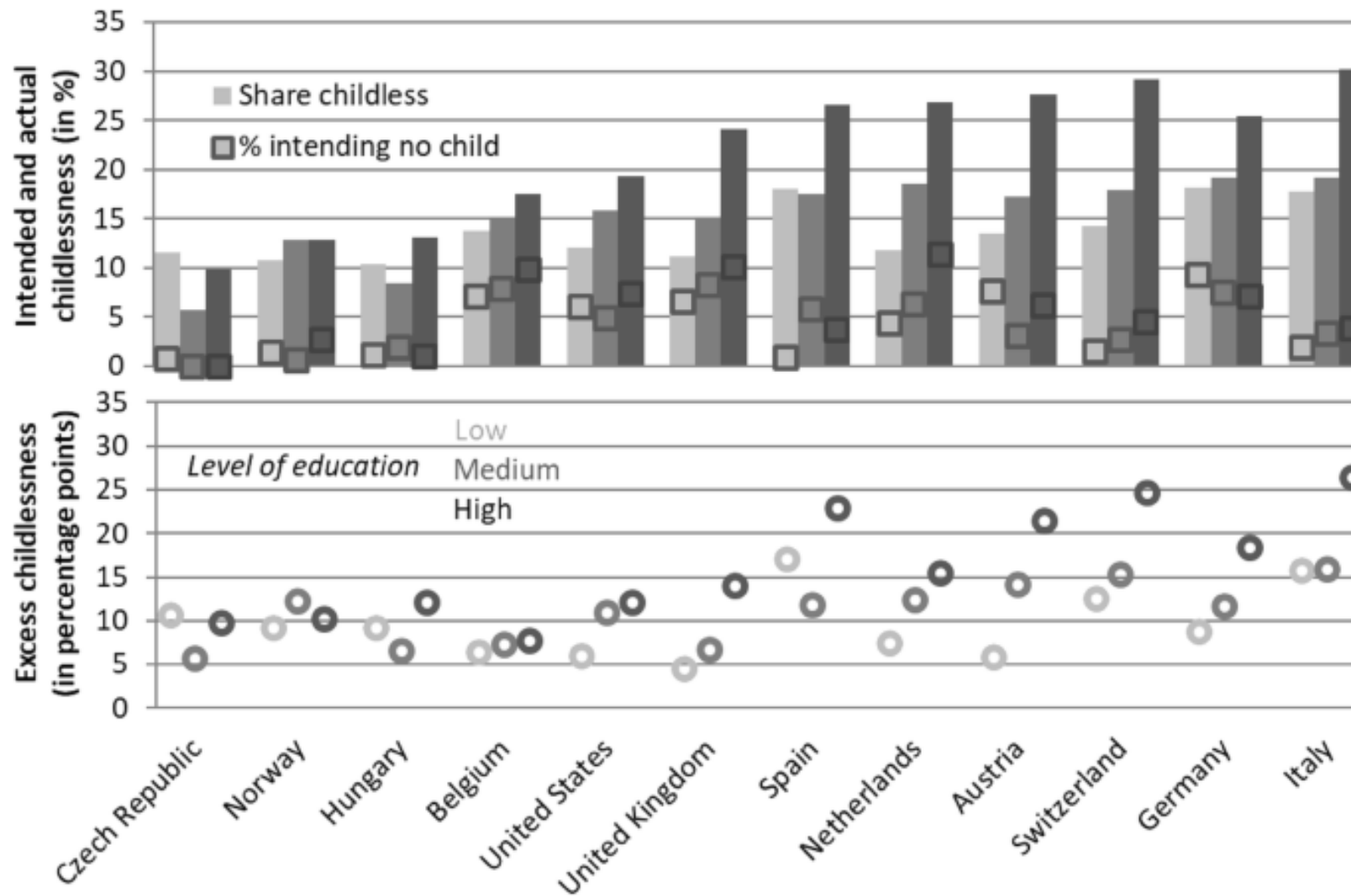


LOW FERTILITY

Figure 16. Intended and actual childlessness in Europe

Source: Beaujouan, E., Berghammer, C. (2019) The gap between lifetime fertility intentions in Europe and the United States: a cohort approach, Population Research and Policy Review





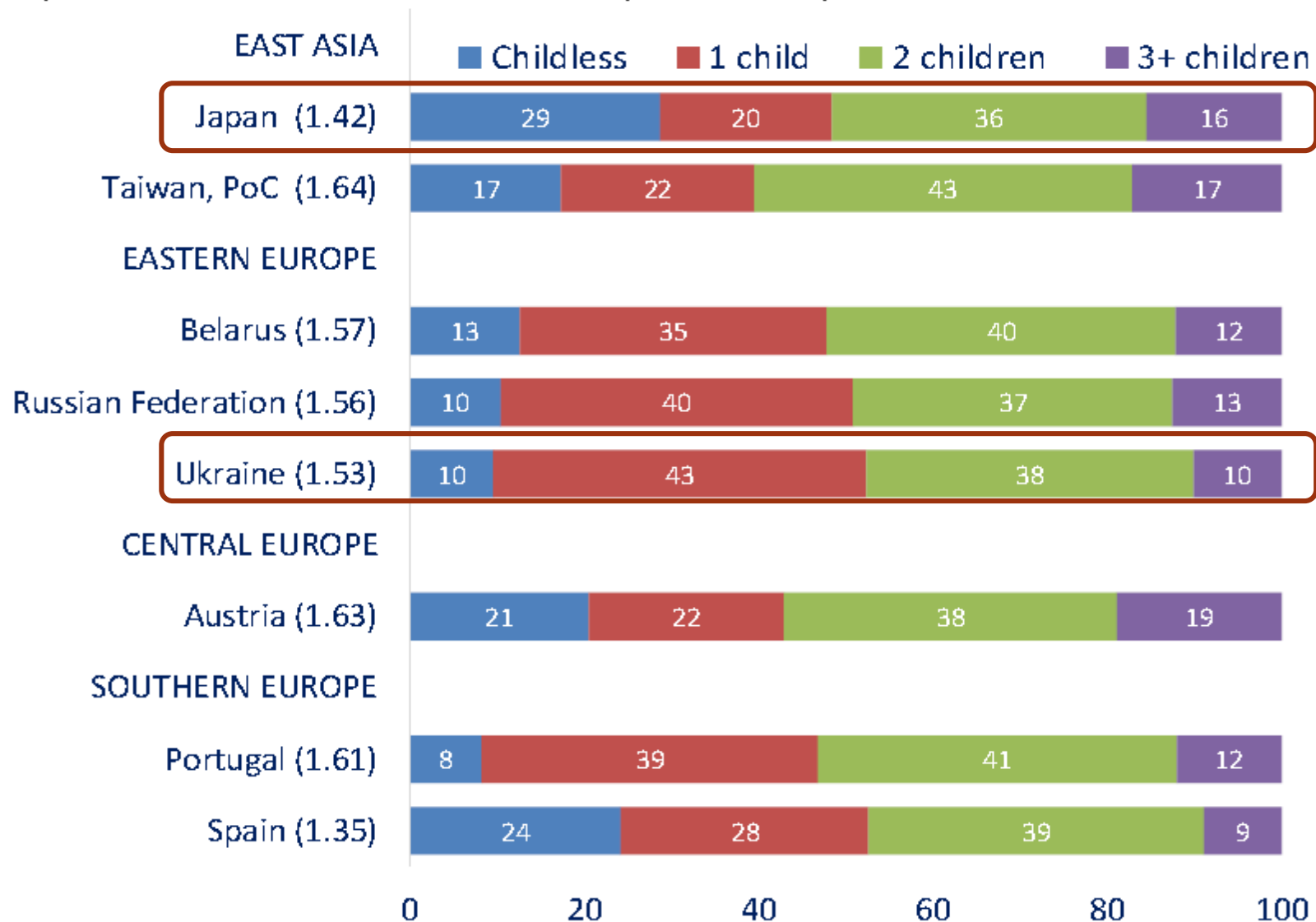
LOW FERTILITY

Figure 17. Intended and actual childlessness in Europe by education

Source: Beaujouan, E., Berghammer, C. (2019) The gap between lifetime fertility intentions in Europe and the United States: a cohort approach, Population Research and Policy Review



a) countries and territories with very low fertility



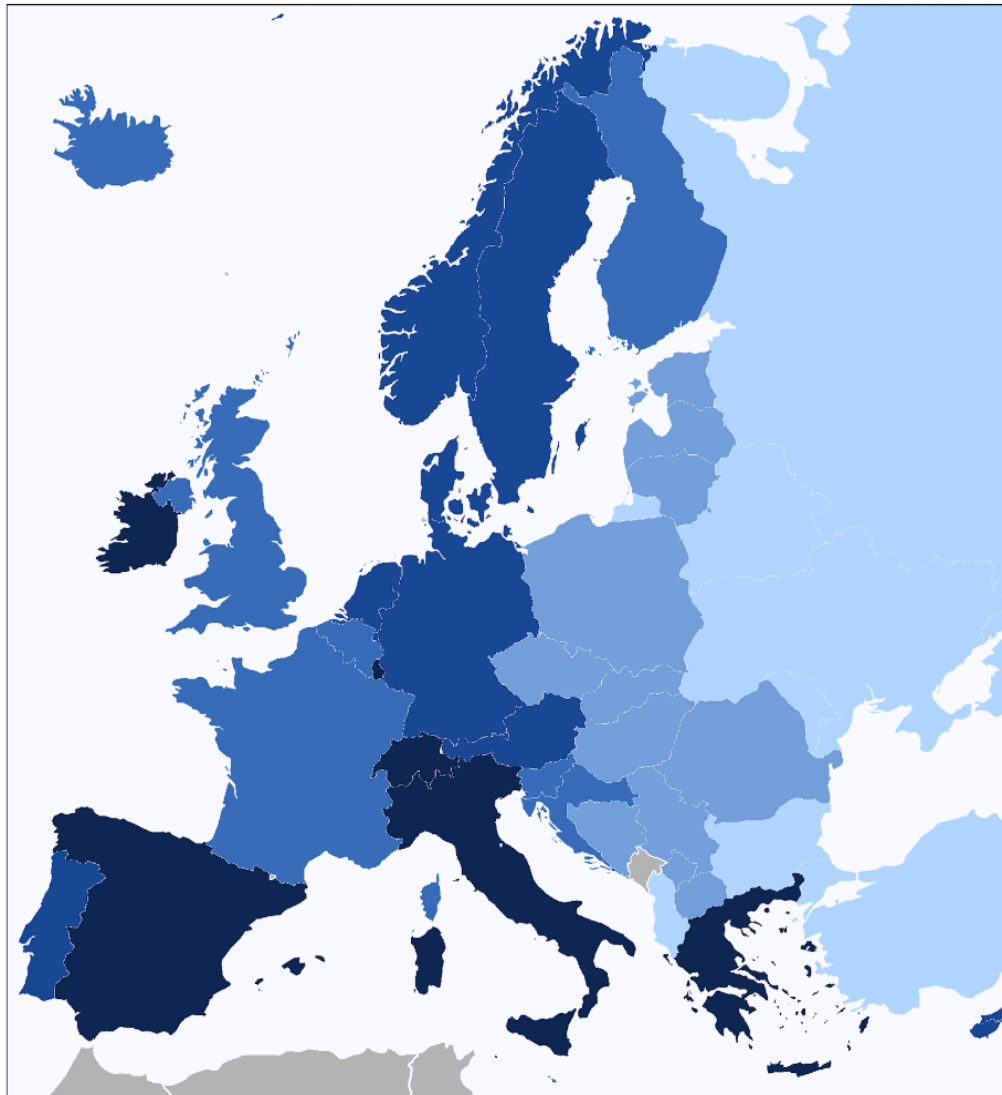
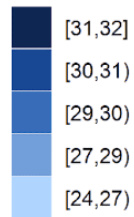
LOW FERTILITY

Figure 18. Women by number of children ever born (%) and completed fertility rate (in brackets), women born in 1971-75

Source: Sobotka, T., A. Matysiak, Z. Brzozowska. 2019. "Policy responses to low fertility: How effective are they?" New York: UNFPA, Working Paper No. 1, May 2019 Technical Division Working Paper Series, Population & Development Branch



Mean age at first birth (years)
2020



European Demographic Datasheet 2022

LOW FERTILITY

Figure 19. Mean age at first birth in Europe, 2020

Source: Vienna Institute of Demography (VID) 2022. European Demographic Datasheet 2022. Wittgenstein Centre (IIASA, VID/OEAW, University of Vienna), Vienna. Available at www.populationeurope.org

