Heritability of fertility

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Main demographic perspectives

Demographic transition model

- Persistent and irreversible low fertility in the modern era
- Around the new replacement level (in the long run)

Detailed explanations for the modern era

- Less-than-replacement is the future
  - "Second demograpic transition"
  - Family economics
- Rebound to (almost) replacement level
  - Gender revolution

Other percpectives

Some perspectives take into account intergenerational effects

- Easterlin hypothesis (Easterlin 1980)
  - Macroeconomic constraints different for successive generations
  - So a negative relationship between generations and fertility
- Low-fertility trap (Lutz, Skirbekk, Testa 2005)
  - One dimension relates to transmission of smaller family preferences in smaller families
  - So a positive relationsip between the fertility of parents and their children
  - Which means a continuing decrease in fertility

Evolutionary understanding

The fall on fertility as the ultimate challenge to evolutionary approaches to human behaviour (Vining 1986)

Attempts of reconciling the fall of fertility and evolutionary approaches (Borgenhoff Mulder 1998)

- Higher quality children will go on to have more descendents themselves
- Non-genetic inheritance of ideas that suggest a better life with fewer or no children
- Low fertility is maladaptive

Fisher's fundamental theorem of natural selection (1930)

Traits that make a big contribution to repreductive fitness genetic variance should decrease to zero in the long run

- No variation, no heritability
- Various biological mechanisms, most importantly mutations, introduce novel variation

Thus, (genetical) heritability of fertility and traits directly related to it should be almost zero

Does Fisher's theorem hold in a post-transitional society?

Udry's postulations 3 ja 4 (Udry 1996)

- The higher the level of social constraints in a society, the less the variance in their behavior is controlled by biological differences
- Conversely, the more choices individuals are permitted, the more the variance in their behavior is controlled by biological forces. Biological forces influence behavior when individual choice is broad

Thus, Fisher's theorem does not longer hold in a post-transitional (individualised, permissive) society

Family studies

Simple correlations of parental-child correlations in (relative) fertility

Correlations ranging from near zero in pre-transitional socities to 0.2-0.3 in post-transitional societies (Murphy 1999)

However, the increase in correlations may be based upon socialisation and not genetic inheritance

Twin studies

Most common design to study genetical heritability of a trait

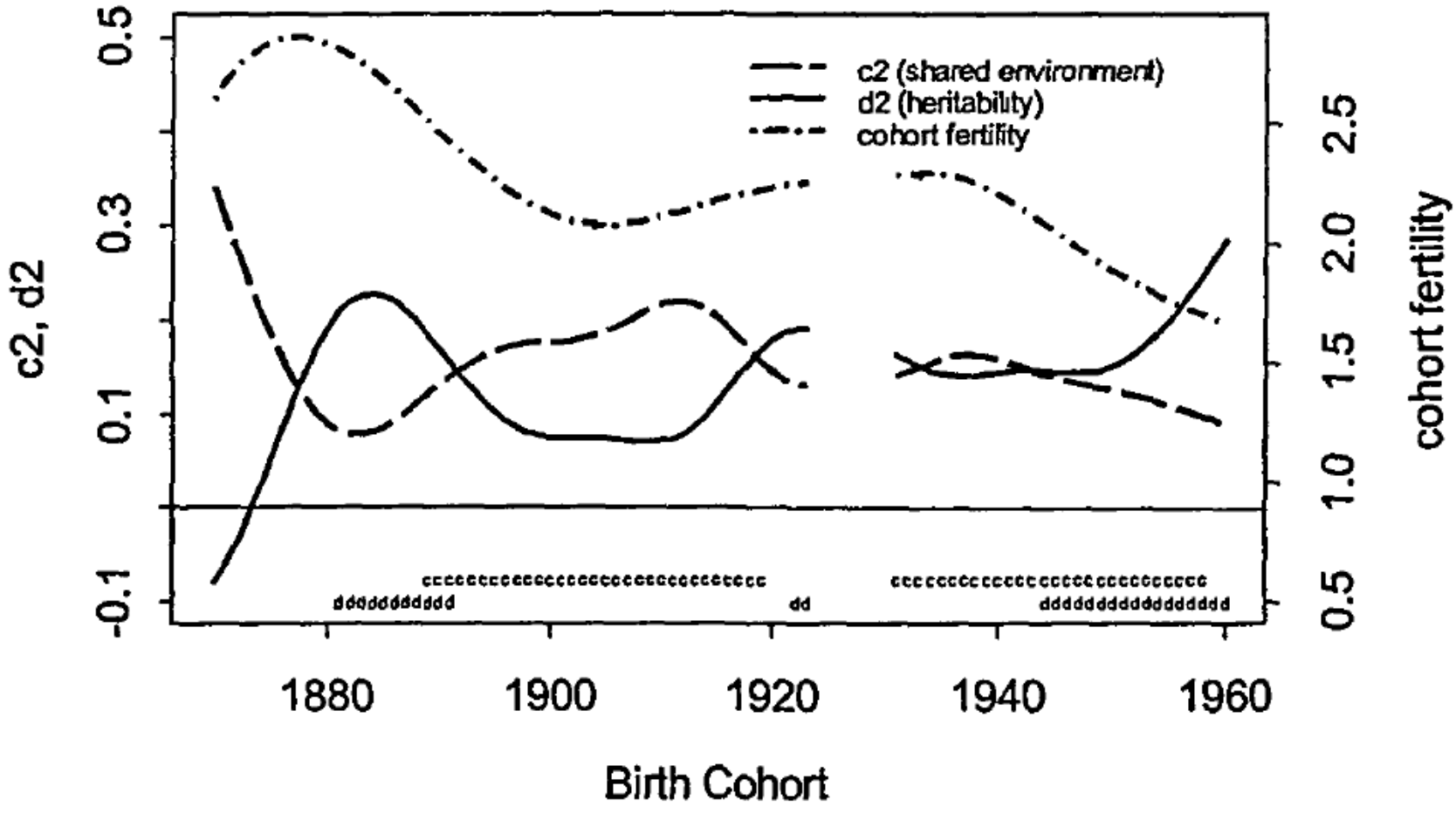
- Both monozygotic (MZ) and dizygotic (DZ) twins share the same environment (at the same age)
- MZ share 100% of their genotype, DZ only 50%
- If MZ twins have higher correlation of a trait, then it suggests a genetical component

At least 13 twin studies on various aspects of fertility have been published

Caveat: Not all share the view that twin studies are good studies (Vetta & Courgeau 2003)

Change in the importance of genetic heritability

Figure 1. Cohort fertility, Danish females 1870–1960 (Kohler et al 2002)



Molecular genetics

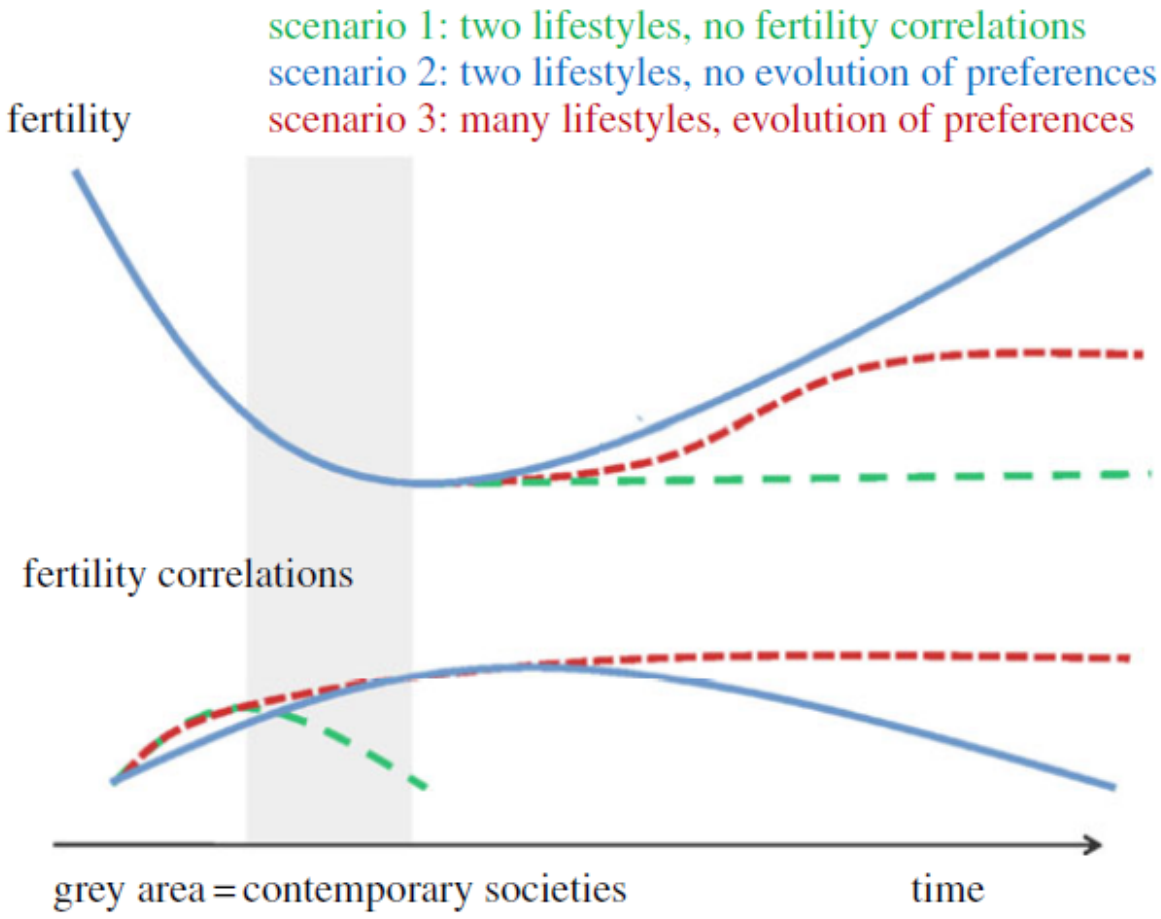
Locating specific genes that relate to a trait

- Candidate-gene studies
- Genome-wide association studies (GWAS)
  - Multiple genes thorugh various pathways influence a trait
  - The validated genes only explain a small fraction of the influence suggested by twin studies

1 GWAS on fertility has been published (Barban et al 2016)

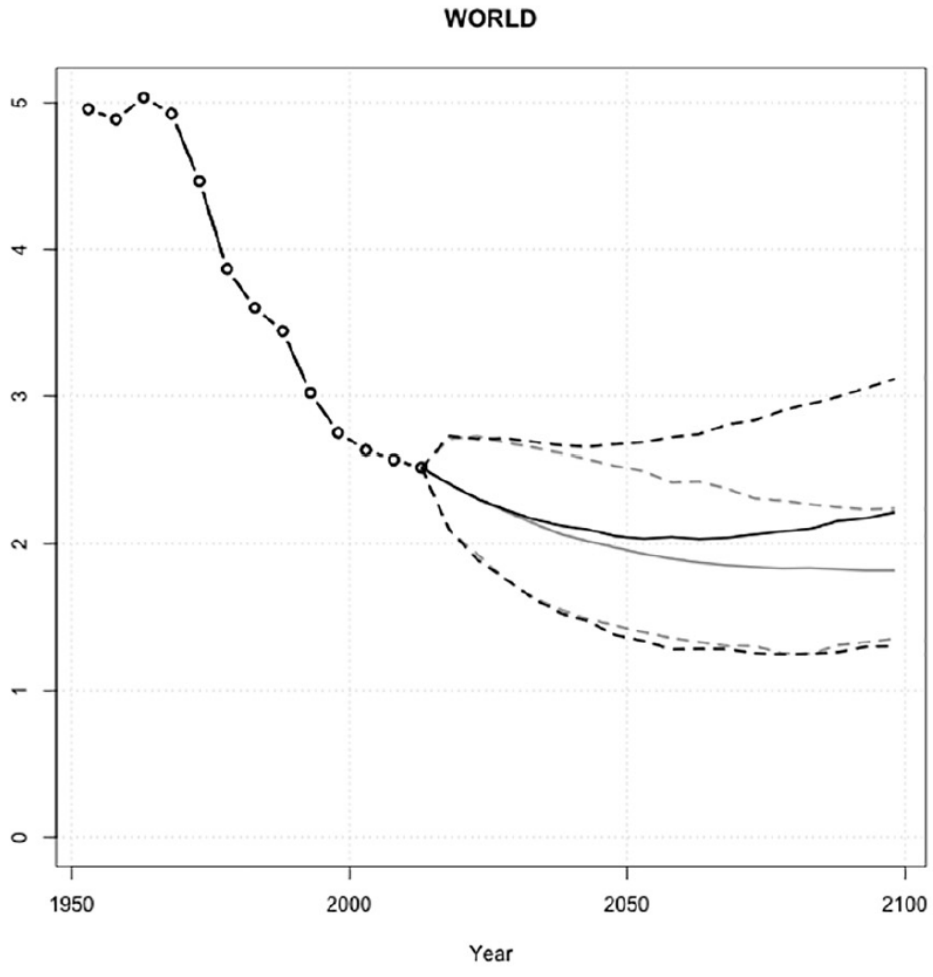
What does this means for the future of fertility?

Figure 2. The importance of inheritance for the future (Kolk et al 2014)



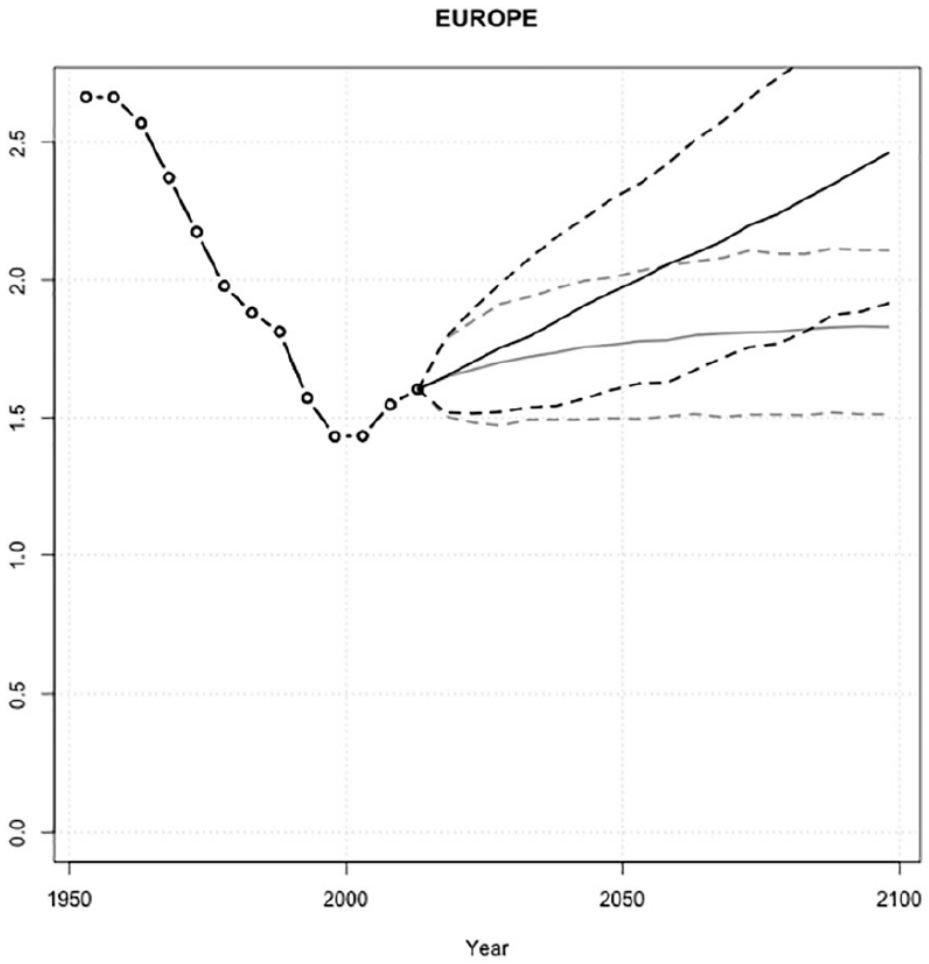
Fertility projection I

Figure 3. UN2017 and projection with inheritance (Collins & Page 2019)



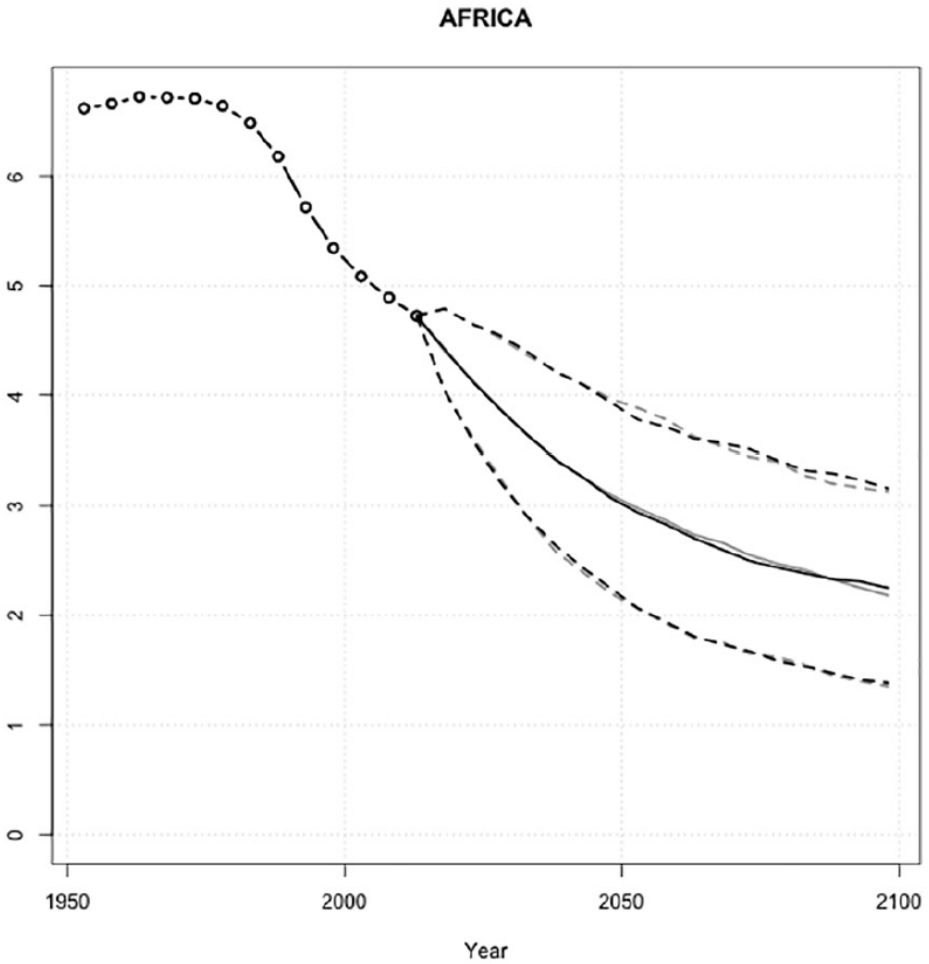
Fertility projection II

Figure 4. UN2017 and projection with inheritance (Collins & Page 2019)



Fertility projection III

Figure 5. UN2017 and projection with inheritance (Collins & Page 2019)



Discussion

- Genetic inheritance is of central importance in determinining fertility nowadays
- Increasing societal permissiveness is increasing this importance
- A dicrease in fertility should be expected in the near future, but an increase in fertility in the more distant future

- Genetic inheritance ought to be discussed in every paper (even without a variable for it)
- What can we contribute in this regard?

Selected literature I

Theory

M. Kolk, D. Cownden & M. Enquist. 2014. Correlations in fertility across generations: can low fertility persist? Proceedings of the Royal Society B: Biological Sciences, 281 (1779).

M. C. Mills & Felix. C. Tropf. 2015. The Biodemography of Fertility: A Review and Future Research Frontiers. Kölner Zeitschrift für Soziologie und Sozialpsychologie, 67(1), 397-424.

R. J. Udry. 1996. Biosocial Models of Low-Fertility Societies. Population and Development Review, 22(S1), 325-336.

A. Vetta & D. Courgeau. 2003. Demographic Behaviour and Behaviour Genetics. Population, 58(4), 401-428.

Empirical studies

N. Barban et al. 2016. Genome-wide analysis identifies 12 loci influencing human reproductive behavior. Nature Genetics, 48(12), 1462-1472.

Selected literature II

D. A. Briley, F. C. Tropf & M. C. Mills. 2017. What Explains the Heritability of Completed Fertility? Evidence from Two Large Twin Studies. Behavior Genetics, 47(1), 36-51.

H.-P, Kohler, J. L. Rodgers & K. Christensen. 2002. Between nurture and nature: The shifting determinants of female fertility in Danish twin cohorts, Biodemography and Social Biology, 49(3-4), 218-248.

W. R. Miller, D. E. Bard, D. J. Pasta & J. L. Rodgers. 2010. Biodemographic Modeling of the Links Between Fertility Motivation and Fertility Outcomes in the NLSY79. Demography, 47(2), 393-410.

J. Nisen, P. Martikainen, J. Kaprio & K. Silventoinen. 2013. Educational Differences in Completed Fertility: A Behavioral Genetic Study of Finnish Male and Female Twins. Demography, 50(4), 1399-1420.

J. L. Rodgers, H.-P. Kohler, K. O. Kyvik & K. Christensen. 2001. Behavior genetic modeling of human fertility: findings from a contemporary danish twin study. Demography, 38(1), 29-42.

Thank you for listening