Maternal Depression and Child Human Capital: A Genetic Instrumental Variables Approach

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1. Motivation

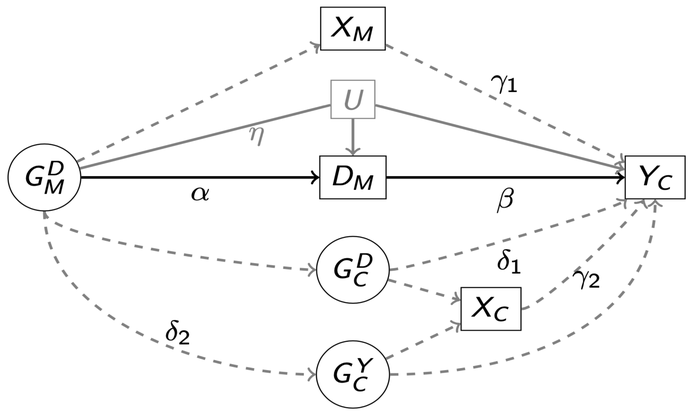
- 20% of the UK population suffers from mental health problems (Stansfeld *et al.*, 2016).
- Depression is one of the most predominant.
- Documented correlation between parental depression and child outcomes, but little causal evidence.

Research question:

How does maternal depression causally affect children's cognitive and non-cognitive skills?

2. An Intergenerational IV setup

- Identification strategy based on **Mendelian Randomisation** (MR)
  - *Law of Segregation (ML1)*: Conditional on the parents' genotype, the child's genotype is the result of a random draw;
  - *Law of Independent Assortment (ML2)*: Traits are transmitted independently of each other (unless in LD).
- **Assumptions:**



- **Relevance**: $\alpha \neq 0$
  - G_M^D: genetic variants based on evidence from large GWAS.
  - For complex traits, single genetic variants tend to be weak instruments: they can be combined in allelic scores (e.g. PGS).
- **Indpendence**: $\eta = 0$
  - Homogeneous white-ancestry population
  - But... grandparents? assortative mating?
- **Exclusion restriction**: the instrumental variable G_M^D affects the outcome Y_C only through the exposure D_M

  Threats:
  - Horizontal pleiotropy: $\gamma_1 \neq 0$
  - Genetic inheritance: the transmitted portion of G_M^D could affect Y_C ($\delta_1, \gamma_2, \delta_2 \neq 0$)

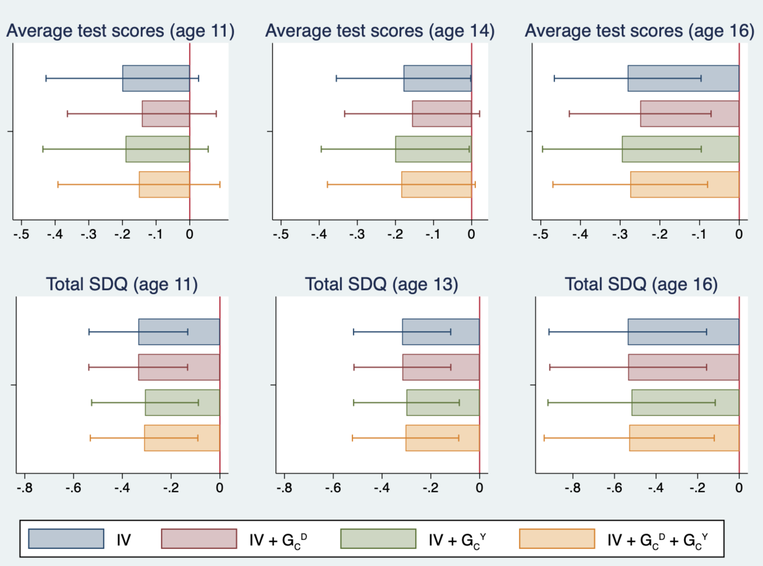
3. Data and Main Variables

- **The Avon Longitudinal Study of Parents and Children (ALSPAC):** about 14,000 pregnant mothers recruited in the early '90s.
  - Wide range of socio-economic and health covariates;
  - DNA genotyping available for a subset of participants.
- **Human capital (Y_C)** measured as:
  - Cognitive skills: test scores at ages 11, 14, and 16 (admin data);
  - Non-cognitive skills: carer reported total score from the Strengths and Difficulties Questionnaire (SDQ).
- **Maternal depression (D_M)**: times mother felt depressed between child birth and age 9 [*scale*: 0 to 7].
- **Polygenic score (G_M^D)**: 125/150 independent genetic variants (p-value<10^{-6}) from meta-analysis on depression (Turley *et al.*, 2018).
- **Estimation samples**: $\approx 2,000$ to $3,000$ observations.

4. Main Results

- **Baseline IV**: one additional episode of maternal depression $\Rightarrow \approx -20\%$ **SD** for cognitive and $\approx -40\%$ **SD** for non-cognitive skills.
- **Genetic inheritance**: baseline IV estimates are robust in smaller samples where we can condition for:
  - G_C^D: the child's PGS for depression;
  - G_C^Y: the child's PGS for cognitive (Demange *et al.*, 2020) or non-cognitive (Middledorp *et al.*, 2016) skills.

Maternal depression ($\widehat{D_M}|G_C^D, G_C^Y$) and child human capital



Notes: bars represent second-stage coefficients for maternal depression. All regressions control for family, child, and mother characteristics. Spikes are for 90% confidence intervals.

5. Sensitivity Analysis

Results are robust to a battery of robustness checks:

Measurement of Y_C and D_M

- *Non-cognitive skills*
  - **Convergent validity** using other measures of socio-emotional development (e.g. SMFQ);
  - **Cross-rater validity**: teacher vs main-carer;
  - Sub-dimensions of non-cognitive: internalising vs externalising.
- *Cognitive skills*
  - Testing separately for Math, English, and Science
- *Maternal depression*
  - Depression as a **binary** indicator: ever depressed, recent depression;
  - Depression before and after the child entering compulsory education;
  - Excluding post-natal depression.

Exclusion restriction

- *Pleiotropy*
  - Test for the **absence of systematic correlation** between PGS and other maternal traits;
  - **Biological annotation**: exclude SNPs linked to (or in LD with) education and/or other traits;
  - Control for the **mother's PGS for cognitive and non-cognitive** skills (GIV-U, DiPrete *et al.*, 2018);
  - Sensitivity to **controlling for** a wide range of **maternal traits**.
- *Genetic inheritance*
  - **Genetic overlap**: exclude SNPs in LD with cognitive (Demange *et al.*, 2020) or non-cognitive (Middledorp *et al.*, 2016) skills;
  - Control for the child's PGS for cog and non-cog (see Main Results section).
- *Plausible exogeneity*: results survive violations of the exclusion restriction up to:
  - 40% of the instrument's reduced form effect (non-cognitive);
  - 10% to 40% of the instrument's reduced form effect (cognitive).

Independence assumption

- Despite the low degree of population stratification in ALSPAC, there might be other threats:
  - U includes **grandparent's depression** (η is genetic inheritance):
    - Results are robust to grandparental controls.
  - U includes **partner's traits** (η is assortative mating): results are robust to controlling for:
    - Partner's education (included in all specifications);
    - Partner's depression.

6. Conclusions

- We here show that **maternal depression negatively affects the cognitive and non-cognitive development of adolescents**. Effects are larger and more precisely estimated for non-cognitive outcomes.
- Combined with studies finding little benefits of treating maternal depression on child outcomes (e.g. Baranov *et al.*, 2020), our results showing a large scarring effect of maternal depression suggest that **prevention, rather than treatment, might have larger societal returns**.