Does Genotype Moderate the Effect of Education on SES?

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Question

Do people with higher genetic predisposition to educational attainment (EA) have higher economic returns to education?

Project Overview

- The effectiveness of educational policies in reducing economic inequality depends on how such policies interact with genetic endowments: policies that disproportionally benefit low-endowment/low-SES populations may reduce inequality.
- We combine a natural experiment that generated variation in secondary education with polygenic scores (PGSs) for 142,000 to investigate how one such policy impacted middle-age SES and whether this effect depended on one's EA PGS.
- The natural experiment, a well-known compulsory schooling age reform in the UK, induced 14% of the students to complete (at least) an additional year of secondary education.

Hypothesis

- The EA PGS captures *among many other things* innate academic ability (Okbay A, et al. 2016); the sign of its interaction with education is a priori unknown.
- We hypothesize that those with lower EA PGSs may be the most affected by the compulsory schooling reform, since they are most likely to drop out from school prior to the policy change.
- The returns to schooling by PGS *among those affected by the reform* are less clear
- On the one hand, individuals with higher EA PGSs may learn more during the extra year of schooling
- On the other hand, individuals with lower EA PGSs may have worse SES to begin with, such that they may benefit most from a given change in schooling
- Moreover, students might react to the change by completing more academic qualifications in order to signal their ability

Data: UK Biobank

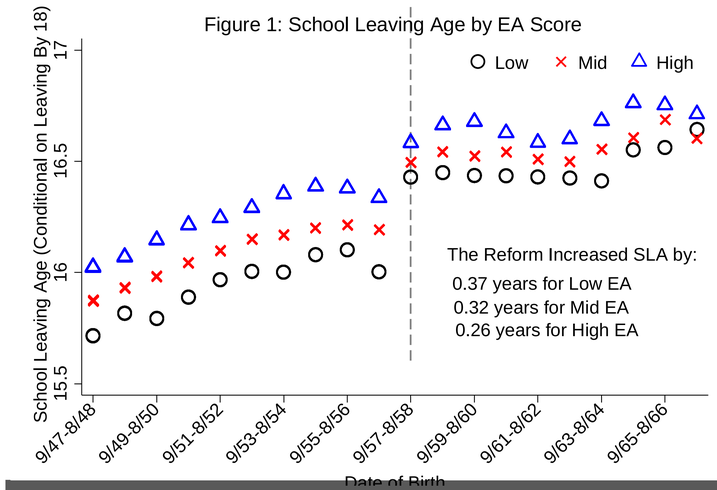
- We use data from the UK Biobank, which genotyped all participants
- Sample restricted to participants of European ancestry born within 10 years of Sep 1, 1957 who left school by age 18 (N = 142,623).
- Main outcomes: academic qualifications, income, occupation SES and Townsend deprivation index (oriented such that higher number corresponds to a better outcome).

Compulsory Schooling Age Reform

- In 1972, England, Scotland, and Wales increased the minimum age at which students could drop out of school from 15 to 16 years.
- The reform affected only students born on or after September 1, 1957, generating a discontinuity in the relationship between education and date of birth (Clark and Royer 2013).

Effects of the Reform on Education

Figure 1: School Leaving Age by EA Score



Method: Regression Discontinuity Design

- The Regression Discontinuity Design (RDD) compares the SES outcomes of individuals born just before and just after September 1, 1957, controlling for cohort trends.
- Intuitively, individuals born on August 31, 1957 and individuals born on September 1, 1957 were comparable (e.g., in terms of their parental background and genetics) before the reform.
- Any later-life SES differences between these two groups can be attributed to the causal effect of the additional schooling.
- Formally, we estimate the following regression:

$$SES_i = \beta_0 + \beta_1(SLA_i \times PGS_i) + \beta_2 SLA_i + \beta_3 PGS_i + \\ + f(DoB_i) + (SLA_i \times \boldsymbol{PC}_i')\boldsymbol{\beta}_4 + \boldsymbol{PC}_i'\boldsymbol{\beta}_5 + \boldsymbol{x}_i'\boldsymbol{\beta}_6 + u_i,$$

- Using the reform to instrument for SLA_i, 2SLS
- The 2SLS estimates the effect of staying in school until age 16 *among those affected by the reform*.
- In other words, our results cannot be explained by the fact that individuals with lower EA PGSs were more likely to have been affected by the reform.

Results

Table 1: Effects of Education on SES

	Qualifications		Occupational	Townsend
	CSE_Olevel	Alevel	SES	Deprivation
SLA * EA PGS	-0.043	0.023	0.125	0.169
	[0.010]***	[0.007]***	[0.037]***	[0.056]***
SLA	0.403	0.032	0.343	0.180
	[0.033]***	[0.022]	[0.125]***	[0.188]
EA PGS	-0.024	0.046	0.149	0.227
	[0.006]***	[0.004]***	[0.022]***	[0.035]***
Observations	141,326	141,326	90,916	142,416
mean (compliers)	0.200	0.0343	3.392	0.0499
	Household Income			
	more_18k	more_31k	more_52k	more_100k
SLA * EA PGS	-0.004	0.017	0.022	0.005
	[0.008]	[0.010]*	[0.009]**	[0.004]
SLA	0.047	0.113	0.020	-0.012
	[0.024]*	[0.032]***	[0.028]	[0.012]
EA PGS	0.019	0.017	0.029	0.009
	[0.005]***	[0.006]***	[0.005]***	[0.002]***
Observations	122,917	122,917	122,917	122,917
mean (compliers)	0.707	0.407	0.139	0.0116

Conclusion

- The reform disproportionally affected those with low EA PGS
- Once those differences in treatment were taken into account (by 2SLS estimates) those with a high PGS had higher returns to a given increase in education.
- Remarkably, those with high EA PGS completed higher qualifications, possibly to signal their ability, which could explain the higher returns.
- While the policy reduced educational inequalities, the corresponding reduction in SES inequalities were not as large as one would have expected in the absence of positive interactions with genetics.
- This is contrast with our previous work on health returns to education, where we found that the extra education reduced differences in obesity by BMI PGS (Barcellos, Carvalho and Turley 2018).

Works Cited

- Barcellos, S.H., L. Carvalho and P. Turley. (2018). "Education can Reduce Health Differences Related to Genetic Risk of Obesity," forthcoming, *Proceedings of the National Academy of Sciences*.
- Clark, D. and H. Royer. (2013). The effect of education on adult mortality and health: Evidence from Britain. *American Economic Review* 103(6):2087–2120.
- Okbay A, et al. (2016) Genome-wide association study identifies 74 loci associated with educational attainment. *Nature* 533(7604):539–542.