The Effect of Non-Cognitive Skills on Academic Performance:Does it Vary by Socio-Economic Status?

Garen Avanesyan, Ksenia Rozhkova

2023-11-11

#### Abstract

The effect of SES on academic achievement is significantly reduced with the implementation of non-cognitive skills into the analysis. The higher return to investment into non-cognitive skills will be observed for the richest. Socio-cultural context matters. Policy discussion.

#### JEL Codes:

#### Keywords:

## Introduction

Education plays a pivotal role in the formation of human capital and remains a key facilitator of social mobility. Being academically successful at school is strongly linked to further educational attainment, and, therefore, may compensate for disadvantaged background. However, academic performance is also the result of unequal educational opportunities. Children, whose parents (especially mother) have higher education, higher cultural capital, and better financial resources study better (Ditton et al., 2019). Since achievements build up on the earlier performance, initial academic disparities increase with the progress of the educational trajectory (Stumm, 2016). Almost one fifth of the variance in education is explained by family socio-economic status (SES) (Erikson, 2016), with the gap in future academic achievements being already formed at kindergarten entry (Reardon, Portilla, 2016). Children from higher SES-families demonstrate a steadier transition to higher education compared to their disadvantaged peers (Jackson, 2013), even when they have similar levels of skills (Gil-Hernánde, 2021).

Research concerning academic performance is usually centered on cognitive abilities. However, ignoring non-cognitive skills biases the estimates of the related returns to education (Heckman, 2000). Non-cognitive skills, also referred to as personality or socio-emotional skills in different fields of social sciences, have recently turned into a prominent instrument of educational research. There are several reasons for that. First, they are known to be linked to a wide array of adult outcomes from wages and employment to health and longevity (Heckman et al., 2006). Second, non-cognitive skills are affected by early social environment, socialization, and family, and, therefore, may serve as a transmission mechanism of inequality. For low-SES students, non-cognitive skills are especially predictive of educational attainment and may help in overcoming their disadvantaged background (Liu, 2020). Third, non-cognitive skills influence the process of human capital accumulation, supporting the development of cognitive abilities from early childhood ("skills beget skills") (Cunha, Heckman, 2007; 2008). Evidence suggests that non-cognitive skills explain as much as 21% in literacy development at early educational stages (Hindman et al., 2010). Finally, non-cognitive skills remain responsive to external influences until late adolescence, despite early initial development (Heckman & Kautz, 2013). Therefore, certain policies, aimed at developing positive non-cognitive skills, may be useful to reduce social inequality.

There are several gaps in contemporary research literature. First, although non-cognitive skills and SES have been separately shown to have strong effects on performance, little evidence combines these characteristics. Second, the existing evidence is mostly centered on high school or university students. For instance, openness and emotional stability are shown to be a stronger predictor of pursuing higher education among adolescents from low-SES background (Lundberg, 2013). Less is known about earlier educational stages. Third, as most of the research on the topic was conducted in psychology and pedagogy, the results are usually based on small samples (see reviews by De Raad, Schouwenberg, 1996; Poropat, 2009) and lack a proper international comparative analysis. The contribution of this paper is twofold. First, it uses a large sample of data collected from the OECD Survey in Socio-economic skills, which was conducted in late 2010s in 6 cities across the world. The dataset allows us to see whether the relationship between non-cognitive skills, SES, and academic performance shows a universal pattern across the world or can only be observed in certain socio-cultural contexts. Second, we shift the research focus from high school and university students to earlier educational stages and differentiate between two cohorts of school children: 10- and 15-year-olds. We hypothesize that non-cognitive skills and SES may be more productive for academic performance for the youngest cohort.

Our results suggest that **… .**

## Literature Review

Non-cognitive skills in educational context

Unlike other socio-economic results, where non-cognitive skills were incorporated only recently (e.g., labour market outcomes), the search for the association between personality and academic performance has a long-standing history (Kline & Gale, 1971). However, little agreement exists on which non-cognitive skills should be in the focus of research and policy. The most convenient and widespread approach is relying on well-developed psychological concepts such as the Big Five (McCrae, John, 1992). In this framework, personality can be described from the perspective of five orthogonal factors: conscientiousness (task performance), openness to experience (open-mindedness), extraversion (engaging with others), neuroticism (emotional regulation), and agreeableness (collaboration). By providing a critical review, De Raad and Schouwenburg (1996) contributed to the Big Five becoming widespread in educational context.

The most influential out of five is conscientiousness (Poropat, 2009; O'Connor, Paunonen, 2007; Bratko et al. 2006). Conscientiousness is positively correlated with student effort, self-regulation, and norm following (Zamarro et al., 2019), resulting in higher attendance rates (Chamorro-Premuzic & Furnham, 2003; Conard, 2006), consistently doing homework, and behaving well in a school setting (West et al.,2015). Conscientiousness is associated with better academic results across the whole educational cycle from elementary school (Rosander & Bäckström, 2014; Richardson et al., 2012) to tertiary education (De Raad, Schouwenburg, 1996). Irrespective of social background, non-cognitive skills measured before university entry are strong predictors of academic achievement, with high levels of conscientiousness compensating for poorer cognitive skills (Edwards et al., 2022; Gil-Hernánde, 2021). In contrast, low levels of conscientiousness are shown to aggravate the negative effect of lower socio-economic background on academic achievement, at least in university students (Edwards et al., 2022).

Neuroticism, or lack of emotional stability, has as well proved to predict performance and to limit academic success (Chamorro-Premuzic, Furnham, 2003). The relationship appears to be nonlinear: while emotionally stable students are more likely to employ effective learning styles (Komarraju et al., 2011), they also spend less time on homework (Lubbers et al., 2010). Therefore, the effect of neuroticism on academic performance may vary, depending not only on the level of education, but rather on the level of manifestation of the trait. Neuroticism is characterized by anxiety, which may lead to worse performance under pressure (e.g., in exam setting). Neuroticism and conscientiousness together predict exam marks above academic variables, accounting for 10 percent of the variance (Chamorro-Premuzic, Furnham, 2003).

Mixed results exist for openness. Openness to experience is positively related to intelligence, stronger than any other personality trait (Borghans et al., 2008), especially at higher stages of education (Poropat, 2014). However, its correlation with achievements is more pronounced for high-ability adolescents (Heaven, Ciarrochi, 2012).  On one hand, openness increases the probability of higher education enrollment for adolescents with disadvantaged backgrounds (Lundberg, 2013) and may be associated with deeper knowledge of subjects. On the other hand, Individuals low in openness may be more practical in choosing their learning strategies, leading to better academic results (Chamorro-Premuzic & Furnham, 2003). The remaining Big Five categories (extraversion and agreeableness) usually show little to no association, except for primary education (Poropat, 2014).

Noncognitive skills remain significantly correlated with grades among elementary and lower-secondary school children, even after including cognitive abilities and SES into the analysis (Boman, 2022). However, limited studies exist for countries other than the US and EU, including Russia. A positive correlation with conscientiousness and openness among high school students (Mishkevich, 2021), however, only 135 respondents were present in the sample. Similarly, on a sample of 176 respondents, introversion, agreeableness, neuroticism, and openness appear to be significant contributors to academic achievement of university students in Russia (Nye et al., 2013).

Different Big Five categories may be linked to different subjects (Rosander et al., 2011). Evidence suggests that personality traits may be more relevant for the explanation of mathematics grades and the overall GPA rather than languages (Vitulić, Zupančič, 2012). Conscientiousness is more important for Math and Science scores (Heaven, Ciarrochi, 2012). Self-efficacy and education aspirations, which are also correlated with conscientiousness, predict academic performance in mathematics, based on data from PISA and TIMSS (Lee, Stankov, 2018). Openness appears to be the only Big Five category, significantly associated with verbal SAT score (Noftle, Robins, 2007).

A problem, arising with the measurement of personality traits in a survey setting, is reference bias which is a tendency to respond to questionnaires in a socially acceptable way. For instance, being more conscientious (hard-working, aim-oriented etc.) and emotionally stable is more socially acceptable. Therefore, item response for some of the Big Five categories, including conscientiousness and neuroticism, may be unlikely to capture extremes (Morris et al., 2021). Self-reports overstate at the bottom and top of the distribution of non-cognitive skills (Edwards et al., 2022). Other-rated traits (e.g., parents, teachers, peers) may show more valid and consistent results (Poropat, 2014, Feng et al., 2022). Another issue is possible reversed causality. For example, schooling intensity decreases emotional stability (Dahmann, Anger, 2018; Korthals et al., 2022) but increases openness for students with lower SES (Dahmann, Anger, 2018). Therefore, methodological approaches should address the issue of causality.

Non-cognitive skills and SES

Differences in non-cognitive skills associated with SES are well documented (Attanasio, Blundell, Conti & Mason, 2020; Elkins & Schurer 2020; Heckman & Mosso 2014) and tend to accumulate over time (Fletcher, Wolfe, 2016). One of the reasons is the difference in children’s upbringing, associated with parental SES (Reardon & Portilla, 2016). Orel and colleagues (2018) showed that the development of both cognitive and non-cognitive skills among Russian first-graders is associated with such family characteristics as mother's education, parental involvement, and number of books at home.

Non-cognitive measures are more predictive of academic achievements for low-SES students (Liu, 2020). Although low-SES individuals demonstrate substantially lower levels of non-cognitive skills measured by the Big Five, they enjoy higher returns to skills (Shanahan et al., 2014). Moreover, socio-economic status is more related to non-cognitive skills, not cognitive abilities (Marks, 2016). In Russia, developing growth mindset, self-efficacy, and grit as measures of non-cognitive skills is positively associated with academic achievement, especially for children coming from low-SES families (Avanesian et al., 2022).

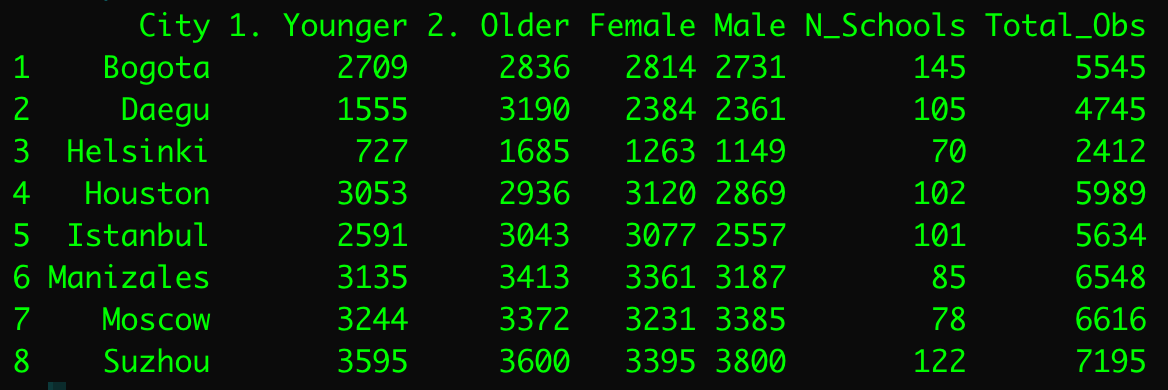
## Methodology

The study uses the data from the OECD Survey on Social and Emotional Skills (SSES) carried out in 10 cities across 9 countries in 2019. The covered cities include Ottawa (Canada), Houston (USA), Bogota and Manizales (both located in Colombia), Helsinki (Finland), Moscow (Russia), Istanbul (Turkey), Daegu (South Korea), Sintra (Portugal), and Suzhou (China). This novel survey program aimed to fill a sizable gap that has been present with regards to the data on non-cognitive skills and factors associated with their acquisition at home, school, and peer environment. Acknowledging that while considerable data are available when it comes to the development of cognitive competences, the survey assessed non-cognitive skills of 10- and 15-year olds by triangulating the information collected from students themselves, as well as their parents and school teachers. As data from Sintra did not reach response rate, and data from Ottawa did not include information on academic performance, they were dropped from the current study (ref).

To reflect a skill-based approach to the well-known Big Five Inventory of personality traits, the survey proposed the following taxonomy to measure non-cognitive skills: open-mindedness, task performance, engagement with others, collaboration, and emotional regulation (ref). These broad skills, in turn, are broken down into 3 facets that represent various sub-dimensions of the revised BFI. The detailed description of the framework, as well as validity and reliability of the items adopted to measure the suggested skills are presented in OECD (2021). Given that the original dataset provides the raw scores for the subdimensions, we aggregated them into five skills by taking arithmetic means of 3 facets that constitute each of them. As our research aimed to produce comparative analysis, we standardized the aggregated scores of non-cognitive skills to the sample average across all 8 cities.

Despite substantial coverage of schools in each participating city and a balanced sample that aimed to recruit approximately equal numbers of students from both age cohorts and by sex, the data suffers from missingness and nonresponse in some key variables of the study. In addition to five non-cognitive skills, these variables referred to academic performance in reading/language and mathematics, index of socio-economic status (a composite indicator produced by the OECD based on education and occupation of both parents, as well as household posessions), and migration background. Sample summary after dropping all missing values are presented in Table 1.

Table 1. Sample summary



Source: Authors’ calculations based on the SSES (2019) data

The primary purpose of the study referred to the estimation of the effect that non-cognitive skills have on academic performance. Grades in reading and language, as well as in mathematics, served as dependent variables of the analysis. Since the grades were fixed on the ordinal scale and grading system differs from country to country, for the plausibility of interpretation we binarized these variables, with 1 referring to the schoolchildren that represent top 25% performers in each subject, and 0 if otherwise. This approach enabled interpretation of the estimated effects of non-cognitive skills on high academic performance on the probability scale, with calculated coefficients representing a probability change of high performance due to the increase of a skill on 1 standard deviation.

As the students were nested within schools, and the data were collected by cities, the verification model needed to account for the hierarchical nature of the data. Furthermore, a number of unobserved city and school factors beyond the scope of this study affect academic performance, which implies that students enrolled in the same schools within respective cities are not independent from each other in terms of their grades, and, as a consequence, variance in the outcome variables is non-random.  In addition to that, we wanted to estimate the degree to which the effect of non-cognitive skills on high academic performance varies across SES quintiles, implying that children from the poorest families could substantially differ in both non-cognitive skills and their chances to demonstrate high academic performance from the richest ones.

To address the outlined challenges, we adopted a three-level multilevel modeling approach. We calculated two regression models, one to estimate the probability of the high performance in reading and language, and another one for mathematics. The fixed part of the regression included such controls as sex, age cohort, a binary categorical variable with the values representing the younger (10-year olds enrolled at primary school) and older (15-year olds enrolled in lower secondary school) groups participated in the survey, SES quintiles, and migration background. To account for the hierarchical nature of the data, the models incorporated a random intercept term with fixed means for the school id within each city. The same term was applied to control for the potential non-independence of the observations due to the age, as the initial survey findings across all participating cities outline the differences in non-cognitive skills between the younger and older cohorts (ref). Finally, as one of the objectives of the study was to highlight the heterogeneous nature of the effect that non-cognitive skills have on academic performance across different levels of socio-economic ladder, we incorporated random slope terms of non-cognitive skills by the SES groups in each of the participating cities. In other words, the slopes of non-cognitive skills varied by the interaction term between the city and SES percentile groups. The adopted framework allows for outlining the policy implications that target the most vulnerable, accounting for the national differences in education systems and macroeconomic contexts. In other words,  the study zooms in on the schoolchildren from economically disadvantaged families, thus also emphasizing an equity-based perspective on human capital acquisition. The econometric analysis was carried out in R, with the help of the lme4 package (ref), an open-source tool for fitting multilevel models.

## Results

### *Socio-Economic Inequality in High Academic Performanc*e

One of the key research questions refers to exploring the distribution of academic performance across various levels of socio-economic ladder. The results of our analysis reveal persistent disparities in high academic achievement between schoolchildren from the different wealth groups. As such, Table 2 presents descriptive findings on the share of students with outstanding grades in reading and language, math, and arts amongst the bottom 40%, middle 50%, and top 10% students by the family SES index score. The last column shows the wealth parity index (hereafter WPI), which is the ratio of the share of outstanding students in the bottom 40% to the share of outstanding students in the top 10%. While  the values closer to 1 indicate equity in high academic achievement, (i.e., equal number of poorest and richest children have excellent grades), the more values lie below 1,the higher is the disadvantage of the poorest in demonstrating outstanding academic performance.

Overall, the table highlights the importance of considering equity and wealth inequality in education, as different cities have varying levels of outstanding students across wealth levels.

Table 2. Socio-economic disparities in high academic performance

Conclusions

1) the schoolchildren from the poorest households systematically lag behind in academic performance at the top and bottom levels of its distribution: they dominate amongst low achievers and fall behind amongst top performers. This can have substantial implications on their human capital gains long term, as well as reproduction of poverty patterns and lack of access to channels of social mobility.

2) incorporation of ncs into educational policy has a potential of reducing economic gap in academic performance. Though the magnitude of the effect varies by macroeconomic context, the study identified that by accounting for the non-cognitive skills in the relationship between SES and academic performance, the effect for the children from the poorest households softens.

3) variance partitioning of the calculated regression models confirms that all in all, variance in the effect (slope) of non-cognitive skills on academic performance across different SES groups accounts for 2.5% of total model variance. This finding emphasizes the importance in the variability in non-cognitive skills by socio-economic context on education and learning. However, most of the model variance can be attributed to the heterogeneity within schools (12% of the model variance is attributed to schools), highlighting the importance of the school-level interventions on academic achievement and accentuating the importance of socio-emotional learning and non-cognitive skill development within the established curricula.

4) Amongst 5 non-cognitive skills, our analysis identified significant fixed effects of task performance and open-mindedness on academic performance, with robust findings both for low achievement (reduction in probability) and high achievement (increase in probability). The effect of engaging with others was not statistically significant. Emotional regulation and collaboration despite showing counterintuitive results (increase low achievement and decrease high achievement) did not obtain high effect sizes.

5) The effect of non-cognitive skills on academic achievement varies depending on SES, as well as by the cities. In XXX it has the highest policy potentials in reducing the gap for the poorest, whereas in XXX almost no effect. It genuinely means that effectiveness of policies aimed at facilitating non-cognitive skill development and their effect on academic performance would yield different results, depending on socio-economic context at the macrolevel.

6) The predicted probabilities derived from the multilevel models allow for concluding however that the returns on non-cognitive skills mostly benefit the students from the wealthiest households.

7) effects of emotional regulation and collaboration are not linear