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Grit and resilient students:
an empirical analysis into the EOp framework

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Grit and resilient students: an empirical analysis into the EOp framework

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Abstract

Education is becoming important in economics and modern societies: it is crucial for medium-long term growth and it is the main social elevator. Ensuring equal educational opportunities has become one of the main tools for policymakers to foster meritocracy, freedom and efficiency. To investigate educational equality of opportunity in this thesis I will focus on resilient students: those who are characterized by a low level of family background and achieve very high school grades. The present thesis analyses how individual and social factors influence students' resilience using a database of 193514 students derived from the OECD PISA database. I found that gritty students have a higher probability of being resilient. Family background and school context are also determinants of students' resilience, but this result is not fully consistent across different model specifications and resilience definitions.

1 Introduction

Education is becoming important in economics and modern societies. While the efficiency-equality trade-off is the main point of contention among economists, education seems to be one of the very few goods for which an increase allows policymakers to pursue both the aforementioned goals. Adopting an efficiency perspective, the human capital accumulation theory states that education is crucial for medium-long term growth. Moreover, adopting an equality approach, it is widely held in the economic literature that education is the main social elevator.

Inequality is one of the main issues that has captured the attention of literature, international institutions, and public opinion in the last few years. About fifty years ago, Amartya Sen stated one of the most important questions about (in)equality: "Equality of what?" (Sen, 1980;

Capriati, 2017). Consequently, many scholars tried to answer this question and a lot of different approaches aimed at dealing with inequality have arisen. The growing importance of equality in economics has led to the assertion in the second fundamental theorem of welfare economics that the playing field must be levelled before the market begins to function.

Since education is a crucial channel to hinder unfair inequalities and promote social mobility, it becomes an important field for research on inequality. Especially in democratic countries, but not only in them, ensuring equal educational opportunities has become one of the main tools for policymakers to foster meritocracy, freedom and also efficiency.

An innovative way to investigate educational equality of opportunity (EOp) is to focus on what is called in literature "resilient student" (OECD, 2013). Resilience is the capacity of individuals to succeed despite adverse circumstances, through their efforts. These types of pupils are described by the OECD as students characterized by a low level of social, economic and cultural family background, who perform very well in terms of school grades. However, this broad definition leads to the use of many different methodologies to identify them without the possibility of obtaining, by now, a unique and cross-country comparable measure of this phenomenon (Agasisti, Avvisati, et al., 2018). Furthermore, even though research on this topic has advanced considerably in recent years, there are no studies, to my knowledge, that attempt to shed light on the determinants of students' resiliency by adopting the circumstances-efforts approach.

The present thesis analyse how individual and social factors influence the likelihood of being a resilient student. To to this I used a database of 193514 students derived from the OECD Programme for International Students Assessment (PISA) database. The role played by circumstances and efforts defined, as defined in the EOp approach (J. Roemer, 2018), was analysed. Particular emphasis was put on non-cognitive traits like grit and motivation. Using a country fixed effect model I found that gritty students have a higher probability of being resilient. Family background and school context are also determinant for students' resilience, but this result is not fully consistent across different model specifications.

The rest of the paper is organised as follows. Chapter 2 is a small review of the existing

literature on inequality, education and grit. In chapter 3 there is a description of the used variables and the identification strategy. Chapter 4 shows the results of the study and chapter 5 is the conclusive one.

2 Literature review

2.1 Inequality and education: the phenomenon of resilient students

The huge increase in all the inequality dimensions began in the eighties (Piketty, 2013; Pianta and Franzini, 2016), led more and more academic scholars to discuss, write and worry about this phenomenon. Economists have always paid close attention to the distributional dimension. Various aspects of economic and social disparities have been addressed both by classics such as Adam Smith, Ricardo and Sraffa, as well as in the current literature through more recent and innovative contributions (Atkinson, 2020; Kurz and Salvadori, 2022).

About fifty years ago Amartya Sen stated one of the most important questions about inequality: "Equality of what?" (Capriati, 2017). This fundamental question transformed how academics thought about inequalities, moving the focus of the research from the provision of primary goods and the equalization of the utilities to the basic capabilities equality defined by the author as: "[...] a person being able to do certain basic things. The ability to move about is the relevant one here, but one can consider others, e.g., the ability to meet one's nutritional requirements, the wherewithal to be clothed and sheltered, the power to participate in the social life of the community." (Sen, 1980). One of the widely used approaches in the literature to analyse this type of inequalities is the Equality of Opportunity (EOp) approach. The EOp principle states that inequalities have two sources: some factors beyond individual control and others deriving from individual autonomy, respectively called circumstances and efforts (J. Roemer, 2018). Following the second fundamental theorem of welfare economics, this school of thought requires that the main objective of an equal-opportunity policy is to level the playing field, such that only the efforts-related inequality is allowed and thus equal chances among individuals are ensured (Peragine and Biagi, 2019).

It is widely believed in our societies that one of the most important "fields to be levelled"

is education (Luongo, 2015; Blanden and Macmillan, 2016), at least for two reasons. From a macroeconomic perspective, the human capital accumulation theory states that education is crucial for growth. However, recent findings in the literature suggest that the presence of unequal opportunities to accumulate human capital harms medium-long term growth (Cingano, 2014; Berg et al., 2018). Moreover, adopting a microeconomic approach, it is widely held in the economic literature that education is positively correlated with future earnings and is associated with a lower average unemployment rate (Wolla and Jessica, 2017; Han et al., 2019). Thus, ensuring EOp in education leads to higher levels of well-being and freedom for individuals. A simple and widely used methodology for analyzing EOp in education is intergenerational mobility (Brunori, Ferreira, and Peragine, 2013; Aiyar and Ebeke, 2019; Arenas and Hindriks, 2021).

Although the research on EOp and intergenerational mobility has advanced considerably in recent years, not enough attention has been paid to a very interesting phenomenon: resilient students. Resilience is the capacity of individuals to succeed despite adverse circumstances. Therefore, this kind of pupil is characterized by a low social, economic and cultural family background and performs very well in terms of school grades (OECD, 2013). Also, it is interesting to introduce this definition into the EOp framework. This could be done by assigning to the academic performance the role of the outcome, to the family background the role of circumstance and computing a synthetic index derived from grit and motivation as a proxy for students' efforts, which is the subject of the next section.

However, the broad definition of a resilient student leads to the use of many different methodologies to identify them, hindering the possibility of obtaining, by now, a unique and cross-country comparable measure of this phenomenon (Agasisti and Longobardi, 2014). What is common in the literature is the use of the PISA index of economic, social and cultural status (ESCS) and to compare it with some measures of academic performance (Agasisti, Avvisati, et al., 2018). To this end, the ordinal approach suggested by Godin and Hindriks (2018) is used in this thesis. They propose to sort by grade and ESCS students and classify as resilient the ones which are both in the last decile in terms of social background and in the first decile in

terms of school performance.

2.2 Grit and resilience

As mentioned earlier, to complete the toolbox of the instruments we need to introduce resilient students into the EOp framework, a proxy for students' efforts must be found. Over the past two decades, research on positive psychology has highlighted the role played by grit in academic performances (Hofmeyr, 2021; Kundu, 2017). Duckworth, Peterson, et al. (2007) defined grit as "the perseverance and passion for long-term goals" and "entails working strenuously toward challenges, maintaining effort and interest over years despite failure, adversity, and plateaus in progress". This definition is completed by decomposing grit into two main factors: perseverance of efforts and consistency of interests. This partition is evident in the Grit Scale (Grit-S), a list of eight questions to obtain self-report measures of grit proposed by Duckworth and Quinn (2009).¹

Based on this definition a part of the psychological and economic literature identifies this personality trait as a highly predictive factor of students' grade and likelihood of graduating (Poropat, 2009; Eskreis-Winkler et al., 2014; Owusu, Larbie, and Bukari, 2020; Pleace and Nicholls, 2022). This trend has led public opinion and education literature, especially in the United States, to foster grit with the aim of raising academic achievement (e.g. The US Department of Education recommend schools to teach grit) (Credé, 2018).

In recent years this relationship was tested under different hypotheses, giving different results. Isolating perseverance and consistency Muenks et al. (2017) found that perseverance and overall grit are significant predictors of academic performance, as opposed to consistency which does not affect grades. In addition, Xu et al. (2021) selected perseverance as the main channel in this relationship, finding that it has a positive effect on school achievements, with different magnitude depending on cultures (Confucian East Asian and Anglo-Saxon countries).

Another part of the literature stresses the effects of different social and scholastic contexts on the grit-score relationship. Classifying 60 South African primary schools according to their low,

¹See A.1 in the appendix.

medium or high functionality, Hofmeyr (2021) finds a stronger positive effect of grit on literacy achievements for higher functionality levels of schools. Moreover, further studies identify some other important factors as personal and social aspects - such as family background, quality of the school, networking opportunities and motivation - that have an indirect effect on educational outcomes through grit (Wilson-Strydom, 2017; Kundu, 2017; Christopoulou et al., 2018).

3 Methodology

3.1 Samples

For this thesis was used the OECD PISA 2018 database.² This is the most recent OECD survey and contains 519334 observations (representing over 31 million 15-year-olds students) from 35 OECD countries and 42 partner countries and economies. In this survey the OECD put greater emphasis on lifelong learning than in previous inquiries, presenting questions on perseverance, motivation and learning strategies. Furthermore, the PISA data contain information about the economic, social and cultural status of the student and her family, crucial for the current thesis.

I limit the analysis to the 35 OECD members in 2018 because of the low shares of missing values in these countries. This selection reduces the sample to 248620 observations. Moreover, because of the presence of missing data³, the sample was further reduced to 193514 observations and by now I will refer to it as the "whole" sample.

Furthermore, to estimate the impact of circumstances on the likelihood of being a resilient student, I used a reduced dataset composed only by the low-ESCS students (i.e., belonging to the last quintile in terms of ESCS). It records 38713 observations and by now I will refer to it as the "reduced" sample.

²<https://www.oecd.org/pisa/data/pisa2018technicalreport>

³See 3.2 in the appendix.

3.2 Measurement

Grades, ESCS and resilient students

Resilient students are the main focus of this analysis. However, to identify them it needs to find proxies for outputs and circumstances, as defined in the EOp framework. Both proxies are taken from the PISA 2018 database and their scales are part of the measurement of the PISA 2018 assessment framework (OECD, 2019a). In this study grades in science and math represent students' outputs, because of their predictive power in terms of future incomes and the greater international comparability of hard science programs (Hanushek and Woessmann, 2015). In addition, using only these achievements is not a source of bias, as the scores in different subjects are strongly correlated in the PISA data (Godin and Hindriks, 2018). This database provides a set of plausible values for each student, representing an estimation of students' proficiency which takes into account measurement errors. I computed a synthetic index of science achievements by doing the arithmetic average of the recorded plausible values.

Table 1 reports the students' mean scores and standard deviations for each of the 35 countries under study. As can be seen from the table, the low-score countries are Mexico (413.20), Turkey (415.80) and Chile (442.20), which are also characterized for the homogeneity in scores. On the opposite, the countries with the highest scores are Japan (532.50), South Korea (523.40) and Estonia (520.80).

For what concerns students' backgrounds, the PISA surveys are rich in information. The most important circumstances highlighted by the EOp literature are the family ones (Bratti, Checchi, and De Blasio, 2008; Peragine and Serlenga, 2008). The socio-economic status of the students' families is usually estimated in PISA data by an index of economic, social and cultural status (ESCS). In the 2018 PISA survey, it is derived from several family background variables grouped into three components: parents' education, parents' occupations and an index summarizing material wealth and cultural capital (i.e., possession of a car, access to the Internet, number of books at home) (OECD, 2019b). As shown in table 2, Turkey is the lowest ESCS country (-1.439), followed by Mexico (-1.138) and Portugal (-0.547). Instead, at the top of the ranking, there are Iceland (0.723), Norway (0.466) and Canada (0.465), which shows also a

mean				mean				mean			
Country	score	s. d.		Country	score	s. d.		Country	score	s. d.	
1 AUS	482.80	87.82	13 FRA	496.60	89.28	25 MEX	413.20	67.23			
2 AUT	498.90	87.81	14 GBR	491.50	81.07	26 NLD	513.90	86.49			
3 BEL	510.30	91.29	15 GRC	461.70	81.39	27 NOR	501.10	78.66			
4 CAN	504.50	78.61	16 HUN	484.70	86.10	28 NZL	495.80	85.77			
5 CHE	519.40	88.50	17 IRL	503.40	74.36	29 POL	505.30	81.08			
6 CHL	442.20	83.53	18 ISL	488.80	85.72	30 PRT	481.00	90.69			
7 CZE	502.60	87.22	19 ISR	471.60	96.40	31 SVK	477.00	88.96			
8 DEU	508.70	83.40	20 ITA	499.80	83.94	32 SVN	494.40	82.23			
9 DNK	497.60	78.53	21 JPN	532.50	82.17	33 SWE	493.60	83.10			
10 ESP	490.50	77.62	22 KOR	523.40	92.69	34 TUR	415.80	73.63			
11 EST	520.80	74.45	23 LUX	486.40	87.97	35 USA	468.70	82.61			
12 FIN	511.90	75.73	24 LVA	484.20	70.36						

Table 1: Students' average score by country and standard deviations.

Source: OECD, PISA 2018 Database (<https://www.oecd.org/pisa/data/2018database/>).

relatively low inequality of social, economical and cultural backgrounds.

It is now possible to identify resilient students using science achievements and ESCS values. Following the ordinal approach proposed by Godin and Hindriks (2018), I sorted the students by score and then by ESCS both in ascending order obtaining for each student her position in the distribution in terms of grade and ESCS.⁴ Then I divided them into different quintiles according to their position in the grade and ESCS ranking. The students who are jointly in the last ESCS quintile and the first score quintile are the resilient ones: those students who despite having the lowest family background, obtained grades that place them at the top of the ranking. It is worth noting that students were grouped by country before computing quintiles (differently from the computation of five centiles). I did it because working with national resilient students instead of international ones avoids the underestimation of resilience in low-grade countries.

Table 3 reports some descriptive statistics on resilient students for all the countries considered

⁴To have an idea of the distribution, I divided the whole population into five centiles groups based on ESCS and math scores and I plot the graph in Figure A.1. We are interested in the bottom-left part of the scatter plot.

mean				mean				mean			
Country		ESCS	s. d.	Country		score	s. d.	Country		score	s. d.
1	AUS	0.19	0.82	13	FRA	-0.11	0.80	25	MEX	-1.14	1.21
2	AUT	0.10	0.85	14	GBR	0.21	0.85	26	NLD	0.16	0.76
3	BEL	0.18	0.90	15	GRC	-0.02	0.95	27	NOR	0.47	0.74
4	CAN	0.46	0.83	16	HUN	-0.17	0.94	28	NZL	0.17	0.78
5	CHE	0.14	0.91	17	IRL	0.15	0.84	29	POL	-0.39	0.82
6	CHL	-0.15	1.19	18	ISL	0.72	0.73	30	PRT	-0.55	1.15
7	CZE	-0.13	0.81	19	ISR	0.17	0.85	31	SVK	-0.09	0.94
8	DEU	0.12	0.94	20	ITA	-0.04	0.92	32	SVN	-0.07	0.81
9	DNK	0.44	0.95	21	JPN	-0.18	0.70	33	SWE	0.33	0.82
10	ESP	-0.45	1.19	22	KOR	-0.20	0.68	34	TUR	-1.44	1.17
11	EST	0.09	0.76	23	LUX	0.08	1.11	35	USA	0.08	1.00
12	FIN	0.26	0.75	24	LVA	-0.42	0.90				

Table 2: Students' ESCS means and standard deviations.

Source: OECD, PISA 2018 Database (<https://www.oecd.org/pisa/data/2018database/>).

in this study and for the OECD as a whole. The percentage of resilient students is computed as the ratio between resilient students and the entire group of disadvantaged students, i.e. those belonging to the last quintile. The average percentage of resilient students in OECD countries is 7.51%. The highest shares are recorded by the Netherlands (11.09%), Greece (10.35%) and Iceland (10.28%). On the contrary, Chile (3.69%), Israel (4.18%) and Luxembourg (4.19%) have the lowest shares of resilient students.

Circumstances: ISCED and ISEI

As already mentioned, the ESCS is a synthetic index computed taking into account parents' education and occupation, among the other family information. Both education and occupation are measured by the OECD and I included them in the analysis as further circumstances which could influence the low-background students' probability of being resilient (i.e., of performing good). In the PISA 2018 database are stored mothers' and fathers' International Standard Classification of Education (ISCED) and the International Socio-Economic Index of occupational status (ISEI).

Country	Interviewed students	Resilient students	Resilient student percentage	Country	Interviewed students	Resilient students	Resilient student percentages
AUS	11632	159	7.16%	ISR	5779	47	4.18%
AUT	5873	88	7.90%	ITA	10309	181	8.98%
BEL	7743	103	7.65%	JPN	6217	83	6.77%
CAN	17654	323	9.38%	KOR	5435	80	7.39%
CHE	4638	66	7.57%	LUX	4320	32	4.19%
CHL	5874	40	3.69%	LVA	4438	61	6.95%
CZE	6127	49	4.34%	MEX	6402	96	8.43%
DEU	3284	41	6.97%	NLD	4796	99	11.09%
DNK	5898	79	7.37%	NOR	4725	82	9.14%
ESP	6010	101	8.66%	NZL	3795	46	6.47%
EST	5167	94	9.23%	POL	4204	71	8.55%
FIN	5275	78	7.60%	PRT	6580	94	7.12%
FRA	5048	60	6.55%	SVK	5268	71	7.65%
GBR	11782	173	7.70%	SVN	5603	88	8.05%
GRC	4905	98	10.35%	SWE	4489	56	6.77%
HUN	4684	39	4.42%	TUR	5285	99	9.74%
IRL	5251	69	6.80%	USA	5131	79	7.85%
ISL	2936	58	10.28%	OECD	212557	3083	7.51%

Table 3: Resilient students descriptive statistics.

Source: OECD, PISA 2018 Database (<https://www.oecd.org/pisa/data/2018database/>).

The former is an index which assigns a measure of the school level between 0 and 9 (from early childhood education to doctorate or equivalent programs) to the parent. The highest and lowest means are recorded respectively by Finland (4.928) and Turkey (2.177) for mothers' education levels (MISCED index) and by Finland (4.560) and Portugal (2.495) for fathers' education levels (FISCED). Moreover, the highest of the two (MISCED and FISCED index) will be called by now HISCED. The latter is an index based on the International Standard Classification of Occupation made by the International Labour Organization (Ganzeboom, 2010). Again, three indices are used for this study: father's (FISEI), mother's (MISEI) and highest (HISCED) occupational status. The recorded range goes from 7.88 (Turkey) to 48.27

(Iceland) for mothers and from 29.858 (Slovakia) to 45.053 (Norway) for fathers.⁵

I also used sex and school features as circumstances. Females and males are equally distributed in the database. The former have lower mean school grades both in mathematics (respectively, 486 and 496) and in science (respectively, 493 and 497). As concerns school related circumstances, I used two indexes related to the escs following the approach of Arenas and Hindriks (2021): the school average ESCS and the school ESCS standard deviation. They are used as proxies of mean level of family background and heterogeneity of family background levels (i.e., non-segregation school level) in a specific school.

Efforts: perseverance and motivation

Now only the last piece of this research is missing: efforts. As said before, to obtain a measure of students' efforts, is used the construct of grit. By the above-given definition, grit results from a mix of perseverance, passion and willingness to achieve long-term goals. These three are the students' characteristics which I was looking for in the PISA 2018 database. In line with the Grit-S questionnaire (Duckworth and Quinn, 2009), for this study I used the answers to 12 questions⁶. All of them asked the interviewees how much they agreed with the sentence, on a 4-point scale ranging from strongly disagree (1) to strongly agree (4). Thus, the questions are interpreted as follows.

Question one (Q1) is a statement on "non-perseverance", by which I mean that students who recorded a 1, are the most perseverant; on the contrary, those who choose a 4 to this question are non-perseverant (i.e., has no grit). With a simple subtraction, it is possible to obtain the measure of perseverance used in this thesis.⁷ Statements two to six (i.e. Q2 to Q6) are treated as proxies of passion for learning (namely, toward science subjects). Students who answer these questions with a 4 are the most interested and passionate. Questions seven to ten (Q7 to Q10) concern the importance of long-term goals. If a student answers these questions with a 4, she is expected to use her best efforts at school to achieve work, life and other future goals.

⁵See table A1 and table A2 in the appendix.

⁶See A.2 in the appendix.

⁷Being 4 the maximum value of the scale it is sufficient to subtract the non-perseverance measure from 4 to obtain the reciprocal value (which express the perseverance level of the student).

The last two questions (Q11 and Q12) concern the student's motivation and ambition: highly motivated students reply with a 4, poorly motivated students with a 1.

I expect all of the effort indexes to be positively correlated with the likelihood of being resilient. This interpretation is based on the belief that to excel and consequently be resilient, disadvantaged students must have grit, persevere in their efforts and be motivated by the achievement of certain long-term goals. In this analysis, grit is proxied alternatively by the values of each index (Q1 to Q12) and synthetic indexes of persistence, passion, long-term goals and motivation, created by grouping replies to the questions as shown above⁸. In addition, it is estimated an index of overall grit, computed as the average of the four above-mentioned constructs⁹. Switzerland (2.82), Austria (2.80) and Japan (2.79) seem to be the countries where students are most gritty, as opposed to Slovakia (2.55), Germany (2.57) and Greece (2.58).

Missing data

The shares of missing values differ among the variables¹⁰. School results have no missing values, whereas there is a small percentage of missing data among ESCS index values (2.12%). For what concern circumstances variables, the ISCED indexes always show no more than 6% of missing values. Moving to the ISEI indexes, the percentages become much higher: for mothers' and fathers' ISEI the percentage of missing values is 22.61% and 17.66% respectively. Since it is not possible to be certain that these percentages do not depend on auto-selective processes, these two indexes were not used and only the highest parent ISEI was used (8.32% missing values). Effort variables also have some missing values. Questions on perseverance and motivation have the lowest share of missing values (always under 4%), while other questions record a higher share (from 7.2% to 9.5%)¹¹. The resulting restricted database has 193514 students.

⁸See table A3 in the appendix for a descriptive analysis of the four proposed indexes of efforts

⁹See table A4 in the appendix.

¹⁰See table A5 in the appendix.

¹¹See table A6 in the appendix.

3.3 Data analysis approach

To estimate the impact of grit on the probability of being a resilient student I estimate the following cross-country fixed effects model, using the logistic (logit) and probit regression methods:

$$resilient_i = \beta_0 + \beta_1 effort_i + \beta_2 circumstance_i + \varepsilon_i \quad (1)$$

Resilient is a dichotomous variable which is equal to one if the i -th student is a resilient one (as defined above). The effort vector has dimension k , i.e. the k -th synthetic indexes of effort: grit, perseverance, passion, long-term goals and motivation. Being the grit index, a construct based on the other effort variables, they are correlated.¹² Thus, to avoid multicollinearity problems, I did not use grit and other variables in the same regression. The whole sample is used when using only effort variables and sex.

A change in the database is necessary to introduce circumstance variables. Resilience is correlated with parental characteristics by the definition I gave to resilient students. Being resilient depends on the ESCS position, which is a synthetic index of parental education and working position, among others. Because of this if I use the whole sample to estimate the effects of parental features on the probability of being resilient, the estimation will be distorted and meaningless. This is the reason why I choose to study the impact of circumstance variables on the probability of being resilient among students who belong to the last ESCS quintile (e.i, low-escs students), instead of all students of the sample. Thus, for these analyses is used a restricted database composed of 38713 observations.

3.4 Hypotheses

Based on the literature reviewed before, I tested the following hypotheses:

H1. grit and other synthetic constructs of perseverance, passion, long-term goals and motivation predict whether the student is resilient or not.

H2. Parents' education and occupation affect the probability of being resilient among poor

¹²See A7 and A8 in the appendix.

family background students.

H3. School mean family background and school segregation level influence the probability of being resilient among poor family background students.

4 Results

4.1 *Effort analysis*

As said before the analyses use two different databases: the whole sample database and the restricted sample database. As can be seen in table 4 (working with the whole sample database), all grit variables are positively correlated with the probability of being resilient. In the first model, perseverance and passion are the constructs which contribute the most in explaining the probability of being resilient, also presenting high levels of significance. In addition, the grit synthetic index is introduced in column 2, having a positive and highly significant coefficient. Although this model explains a lower part of the variance of the dependent variable compared to the previous as shown by the pseudo- R^2 .

The results of these two models confirm Hypothesis 1, which is further tested in all the next regressions. In the third one, I introduced the sex dichotomy variable, which is the only circumstance regressor used with the whole sample. It tells us that males have a higher likelihood of being resilient students. This is surely due to the higher grades that males obtain in math and science, even in the first score quintile. The positive effect of grit remains significant also introducing the sex variable.

4.2 *Circumstance analysis*

When including other circumstance variables, grit continues to have significant positive effects through all the model specifications. The models presented below were estimated using the restricted database and are depicted in Table 5. In the fourth and the fifth models, I introduced the parental characteristics-related variables. A mother's education appears to be strongly correlated with students' resilience; a father's education also is positively correlated but shows a lower significance level due to the lower magnitude. To avoid multicollinearity

Table 4: Country fixed effect estimates of the impact of effort variables on the probability of being resilient student.

	(1)	(2)	(3)
Constant	-4.373 *** (0.082)	-4.270 *** (0.081)	-4.480 *** (0.084)
Perseverance	0.389 *** (0.028)		
Passion	0.472 *** (0.023)		
L.-T. Goals	0.060 ** (0.021)		
Motivation	0.084 *** (0.023)		
Grit		0.460 *** (0.021)	0.460 *** (0.022)
Sex			0.391 *** (0.038)
N	193514	193514	193514
AIC	28913.76	29276.10	29171.75
BIC	29310.51	29642.33	29548.15
Pseudo R ²	0.038	0.024	0.028

Notes: Standard errors in parenthesis (*** p < 0.001; ** p < 0.01; * p < 0.05).

All continuous predictors are mean-centered and scaled by 1 standard deviation.

Source: OECD, PISA 2018 Database

(<https://www.oecd.org/pisa/data/2018database/>)

problems I did not use the mother's and father's education together with the highest education of the two (HISCED)¹³. Because of this, the fifth regression only has the higher level of education and employment status of the parents as circumstance explanatory variables. Again both estimators have the expected signs and are statistically significant. By now, these results

seem to confirm Hypothesis 2.

However, by introducing the average ESCS of the attended school, all family background regressors become non-significant (except MISCED, which is still significant at the .05 level). The fact that the average school ESCS absorbs the predictive power of other circumstance variables is because they are correlated¹⁴. Moreover, the correlation matrices show a strong correlation between family ESCS and school mean ESCS, both in the whole sample (0.65) and restricted sample (0.72). In my opinion, the mean ESCS school is the main channel through which parents' education and working status and, in general, the familiar human capital indirectly affect student's resilience, grades and future human capital, reproducing economic and educational inequalities. Picking the school that the pupil will attend, the family obliquely chooses the extra-familiar context in which he will grow up. In other words, low ESCS families will choose low mean ESCS schools and high ESCS families will choose high mean ESCS schools, which will affect students' academic outcomes, harming intergenerational mobility.

Another relevant school feature for this study is the school segregation level. Asymmetry of information among families plays a crucial role in the school polarization of very high ESCS students and the consequent segregation (Arenas and Hindriks, 2021). As expected, introducing the above mentioned measurement of ESCS school heterogeneity, it appears to be a crucial factor for students' resilience. More heterogeneous schools foster the resilience of the more disadvantaged students, surely through peer effects. Notwithstanding the school-related circumstance variables used are very simple and only two, the results of columns 6 and 7 confirm Hypothesis 3, showing also a certain grade of correlation between family background and school features.

For the sake of completeness, the last model uses the four constructs used in the first regression and the circumstance variables that proved to be significant during the analysis. I did it because the four constructs seem to explain a greater share of the variance of the resilience variable, providing a higher pseudo-R². Sex and the average school ESCS continue to have a positive estimator and high significance. Instead, among the grit constructs, all remain good

¹³Correlation indexes in Table A7 and A7 in the appendix.

¹⁴See A7 in the appendix.

Table 5: Country fixed effect estimates of the impact of effort and circumstance variables on the probability of being resilient student (with standardized continuous variables).

	(4)	(5)	(6)	(7)	(8)
Constant	-2.967 *** (0.088)	-2.986 *** (0.089)	-3.426 *** (0.092)	-2.924 *** (0.088)	-3.592 *** (0.095)
Grit	0.702 *** (0.024)	0.700 *** (0.024)	0.700 *** (0.024)	0.466 *** (0.022)	
Sex	0.500 *** (0.040)	0.502 *** (0.040)	0.542 *** (0.041)	0.506 *** (0.040)	0.509 *** (0.042)
MISCED	0.097 *** (0.028)		0.097 * (0.043)		
FISCED	0.061 * (0.028)		0.051 (0.038)		
HISCED		0.113 *** (0.027)	-0.061 (0.059)		
HISEI		0.058 ** (0.021)	-0.012 (0.022)		
School ESCS			0.033 *** (0.036)		0.967 *** (0.036)
School ESCS sd				0.364 *** (0.023)	
Perseverance					0.622 *** (0.033)
Passion					0.702 *** (0.026)
L.-T. Goals					-0.026 (0.023)

Continue on the next page

Table 5: Country fixed effect estimates of the impact of effort and circumstance variables on the probability of being resilient student (with standardized continuous variables).

	(4)	(5)	(6)	(7)	(8)
Motivation					0.122 *** (0.027)
N	38713	38713	38713	38713	38713
AIC	19188.88	19195.94	18374.23	19213.72	17493.37
BIC	19522.88	19529.94	18733.91	19539.15	17844.49
Pseudo R ²	0.084	0.083	0.133	0.082	0.185

Notes: Standard errors in parenthesis (**p < 0.001; *p < 0.01; * p < 0.05). All continuous predictors are mean-centered and scaled by 1 standard deviation.

Source: OECD, PISA 2018 Database (<https://www.oecd.org/pisa/data/2018database/>)

predictors, but the long-term goals once which is not anymore significant and have a negative sign. This last is the most reliable model because both maximises the pseudo-R² and minimizes AIC and BIC.

4.3 Resilience alternative definition

In this section, I report the results of two different analyses in which I used different definitions of resilient student. In the first case, I used math scores to identify resilient students (instead of science scores as done in the previous section). In the second, I reproduced the main analysis expanding the definition of a resilient students: I used a sort of criterion of mobility instead of resilience, identifying mobile students like those who are below the average in terms of ESCS and above the average in terms of science grades.

The grit-resilience relationship is not influenced by replacing science scores with math ones¹⁵. What changes among effort variables is that long-term goals index loses all the predictive power. This is because long-term questions are more science-related in this PISA database. On the other hand, regarding circumstance variables, MISCED and FISCED coefficients are not any

¹⁵See tables A11 and A12 in the appendix.

more significant and HISCED and HISEI have negative coefficients.

The above-mentioned definition of social mobility is used because ensures higher representativeness, allowing me to work with higher shares of students. When using the mobile students as response variable, regressions results are similar to the analysis presented in the previous section¹⁶. The only exception is the ESCS heterogeneity in school, which now obtains a negative coefficient, meaning that higher school heterogeneity in social backgrounds hampers students' upward mobility.

5 Conclusion

This thesis investigated how efforts and circumstances affect students' resilience, i.e. probability of low social background students achieving high grades. In line with the existing literature, I found that familiar background positively affects the probability of low social background students obtaining a high score. School average social background seems to be also relevant for students' resilience, even absorbing the effect of parents' education and working status. In addition, grit positively affects low background students' upward mobility, both using a synthetic index and the above presented four constructs.

However, I faced a few limitations. The study suffers from omitted variables bias, as can be seen by the low goodness-of-fit indexes. The absence of a precise definition of resilient students does not allow to identify all the crucial individual and social factors. Moreover, there exist in the literature some other family and school circumstances which, affecting students' grades could affect low-ESCS student resilience: quality and quantity of education, lack of school technological devices, and distance to school (Yoon et al., 2007; Reisdorf, Triwibowo, and Yankelevich, 2020). In addition, some of the circumstance variables have a share of missing data near the 10% and it is not possible to be sure that this is due to self-selection.

Results suggest that resilience is influenced by individual grit and familiar and school factors. However, if grit's positive effect remains consistent with different model specifications, family and school coefficients change in sign and significance levels across different definitions of

¹⁶See tables A9 and A10) in the appendix.

resilience. This could also be due to the correlation between parents' education and average school ESCS.

Future developments of this study will integrate the currently used database with other PISA survey data. Especially, could be interesting to use the already unpublished new PISA data collected in the spring 2022 survey. Moreover, I intend to deepen the ex-post and ex-ante EOp methodologies to analyse the resilient student phenomenon. In my opinion, EOp methodologies could shed light on the links between family background and school average ESCS and allow to obtain more robust results about school factors.

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