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Abstract

While students from more advantageous family backgrounds tend to perform better, it is not clear that they exert more effort compared to those from less advantageous family backgrounds. We build a model of students, schools, and employers to study the interaction of family background and effort exerted by the student in the education process. Academic qualifications, which entail an income premium in the labor market, are noisily determined by effort and the student's ability to benefit from education, which in turn depends on her family background and innate talent. In a situation where schools set the optimal passing standard, two factors turn out to be key in determining the relationship between effort and family background: (i) the student's risk aversion and (ii) the degree with which family background alters the student's marginal productivity of effort. We show that when the degree of risk aversion is relatively low (high) compared to the sensitivity of the marginal productivity of the student's effort with respect to her family background, the relation between effort and family background is positive (negative) and students from more advantageous family backgrounds exert more (less) effort. Considering Spanish data and controlling for school fixed effects, we find that an improvement in parental education from not having completed compulsory education to holding a university degree is associated to around 15% more effort by the student (approximately 1 hour and 20 minutes of additional weekly homework). We also find empirical evidence consistent with our assumption that students' marginal productivity of effort varies with family background.

JEL classification: I21, I28, D81.
Keywords: student effort, family background, risk aversion, educational standards.

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1 Introduction

The influence of parental resources on the academic performance of children has received a great deal of attention in the economic literature. For the UK, Ermisch and Francesconi [2001] find that students' performance in school is strongly associated with their parents' educational attainments. According to Haveman and Wolfe [1995], the strong correlation between parental income and student's scholarly achievements is one of the major findings in the literature on the determinants of children's attainments.[1] However, the fact that children of parents with high levels of schooling or income perform better than those from less advantageous family backgrounds does not necessarily imply that the former exert relatively more effort. As effort and talent constitute the centerpieces of a meritocratic society, the question of how effort and family background relate is in our view of great interest.

The current paper attempts to advance in the understanding of the determinants of effort exerted by the student in the education process, and in particular its relation with family background. We build a model of students, schools, and employers where academic qualifications, which entail an income premium in the labor market, are noisily determined by effort and the student's ability to benefit from education. This ability in turn depends on her family background and her innate talent. Our theoretical results show that if schools can set the optimal passing standard, two factors turn out to be key in determining the relationship between effort and family background: (i) the student's risk aversion and (ii) the degree with which family background alters the student's marginal productivity of effort. We show that when the degree of risk aversion is relatively low compared to the sensitivity of the marginal productivity of the student's effort with respect to her family background, the relation between effort and family background is positive and students from more advantageous family backgrounds exert more effort. On the other hand, when the degree of risk aversion is relatively high, students from less advantageous family backgrounds exert more effort than those from more advantageous family backgrounds. Empirically, we find support for the first case. Considering Spanish data for 12-year old students from the Madrid region ("Prueba de Conocimientos y Destrezas Indispensables," CDI) and controlling for school fixed effects, our results show that an improvement in parental education from not having completed compulsory education to holding a university degree is associated to around 15% more effort by the student (approximately 1 hour and 20 minutes of additional weekly homework). We also find empirical evidence consis-

[1] Also, Blanden and Gregg [2004] show that the positive relationship between family income and educational attainment in the UK has been strengthened over time. Feinstein and Symons [1999] establish parental interest, through motivation, discipline, and support, to be one of the major determinants for children's academic achievements.

tent with our theoretical assumption that students' marginal productivity of effort varies with family background. For students whose parents are blue collar workers studying fewer than 8 hours per week is related to a lower test score, while more than 12 hours of study are related to a higher test score. On the contrary, for students whose parents are professional or administrative workers who hold a university degree fewer than 8 hours of homework per week are associated to a higher test score while more than 12 of hours of study are related to a lower test score.

For given levels of ability, student effort is one of the most important input factors for the production of education, and different from other inputs like teacher quality, school autonomy, or class size, student effort is an individual decision variable. However, student effort in the production of education has received only limited attention both on theoretical and empirical grounds. One of the few works in the theoretical literature that takes into account student effort, is an undeservingly little noticed paper by Correa and Gruver [1987] analyzing teacher-student interactions in a game theoretical framework. A more recent paper is De Fraja and Landeras [2006] who show that increasing the power of incentives and the effectiveness of competition in schools may have the counterintuitive effect of lowering student effort. Landeras [2009] compares a standard grading system to a competitive grading system (tournament) in terms of the level of student effort each system is able to motivate, and shows that the system's relative advantage depends crucially on the nature of the noise distorting academic achievement. The model by Lin and Lai [1996] shows that when leisure is a normal good and students are given monetary rewards unrelated to their academic performance they will be less diligent.

Given the difficulty to obtain an independent measure of effort, empirical studies rarely include student effort into estimations of education production functions.[2] Exceptions are however Bonesrønning [2003] and [2004], Cooley [2010], De Fraja et al [2010], and Stinebrickner and Stinebrickner [2008] which are among the few papers that provide measures of effort exerted by students and parents and estimate the effects of effort on schooling attainment.[3] Hence, the current paper advances both on theoretical and empirical grounds. It contributes to the literature by providing a theoretical model of student effort and

[2] An additional constraint faced by researchers is the fact that only few data sets include information about student effort. For the TIMSS (Trends in International Mathematics and Science Study) study for instance, teachers instead of students report information about homework time, turning the variable homework time into an estimate by teachers of the time needed for homework assigned, rather than a measure of study time by students.

[3] The literature on this topic in sociology and education science is less scarce; see Fan and Chen [2001] for a meta-analysis of existing empirical studies that analyze the role of parental effort on scholarly achievement.

achievement that takes into account how student effort interacts with risk aversion and family background. In addition, using Spanish student data that include a measure of effort (homework time per week) we are able to empirically test certain assumptions and results of our theoretical model.

Furthermore, the current paper contributes to raising awareness to the role of students' risk aversion for educational choices. When making educational choices and deciding about the level of effort exerted, students face various types of risks related to labor market returns as well as to the direct costs and the opportunity costs of education. Only few works in the literature have taken into account students' attitudes towards risk and their effects on schooling choices. While theoretical models like De Fraja [2002] address the importance of risk aversion for educational choices, empirical evidence regarding students' risk aversion is still limited and in particular the magnitude of income risk effects on educational choices is highly disputed. For instance, Nielsen and Vissing-Jorgersen [2006] use a structural model of life-time utility maximization and find a parameter estimate of the relative risk aversion coefficient of around 5, while other empirical studies such as Belzil and Leonardi [2007], Brodaty et al [2006], and Belzil and Hansen [2004] all suggest lower degrees of students' relative risk aversion of around 0.5, around 0.75, and 0.93 respectively. Belzil and Hansen [2004] also find that an increase in the degree of risk aversion increases schooling attainments. The same result holds true in our model where risk aversion plays a central role for the student's optimal decision of effort because qualifications that entail an income premium in the labor market are noisily determined by effort and the student's ability to benefit from education.

The remainder of the paper is organized as follows. Section 2 describes our model, the student's choice of the optimal level of effort exerted as well as the school's decision regarding the optimal passing standard that maximizes student effort. In Section 3 we then analyze in greater detail the effect of family background on student effort. Section 4 provides an empirical test of our theoretical model. Section 5 concludes.

2 The model

We consider a model of education with three groups of agents: students, schools, and employers. Our model is an extension of Landeras [2009], taking into account interdependencies between family background and student effort, as well as interdependencies between risk aversion and student effort.[4]

[4] Note that in particular Proposition 2.2 is equivalent to Equation 6 in Landeras [2009].

Students Students differ in terms of their ability to benefit from education $a \in \mathbb{R}$, which in turn depends on a student's family background (family resources such as household income, parental education, etc.) denoted by $b \in \mathbb{R}$, as well as on her innate talent θ. Thus, $a = h(b, \theta)$, satisfying $h_b(\cdot) > 0$ and $h_\theta(\cdot) > 0$. Students from more advantageous family backgrounds and those with more innate talent have a higher ability to benefit from education. In addition we assume decreasing returns to scale in both factors, $h_{bb}(\cdot) < 0$ and $h_{\theta\theta}(\cdot) < 0$. We also assume that given two students from similar family backgrounds but with different innate talent, the student with higher talent benefits more from an increase in her family resources, and hence $h_{b\theta}(\cdot) > 0$.

A student decides about the effort she exerts in school $e \in E \subseteq \mathbb{R}_+$, i.e. the time she spends studying, how diligent she is, how hard she works, etc. Exerting effort implies a utility cost measured by the function $\psi(e)$, increasing and convex, $\psi'(e) > 0$, $\psi''(e) > 0$. Given that effort is not perfectly observable, the school cannot reward effort directly. The student's utility function $U(y, e)$, is additively separable with y being the expected amount of resources enjoyed by the student (the sum of family resources b, and her potential labor market income w).[5] Formally,

$$U(y, e) = u(b + w) - \psi(e), \tag{2.1}$$

assumed to satisfy $u'(\cdot) > 0$, $u''(\cdot) \leq 0$.

Schools Schools issue qualifications $q \in Q \subseteq \mathbb{R}_+$. Formally we define a qualification issued by a school for a student as,

$$q = \xi(h(b, \theta), e) + \epsilon. \tag{2.2}$$

Hence, a student's qualification is the sum of her educational attainment $\xi(\cdot)$ and a random variable ε, which is distributed according to $\Phi[\varepsilon]$, differentiable and symmetric with $\Phi'[\varepsilon] = \phi[\varepsilon]$, and with a positive support in the real line. This implies that qualifications measure academic achievement imperfectly. A student's true attainment $\xi(\cdot)$ depends on her effort e and on her ability to benefit from education a, depending on innate talent θ and family background b.[6] We assume $\xi_{hb}(\cdot) > 0$, $\xi_{h\theta}(\cdot) > 0$, and $\xi_e(\cdot) > 0$, a student

[5] An alternative modeling choice for the individual's cost of education can be found in Nielsen and Vissing-Jorgensen [2006] where instead of an utility cost of effort forgone wages imply a trade-off between further education and working.

[6] Galindo-Rueda and Vignoles [2003] show for the United Kingdom that the role of cognitive ability on educational attainment has actually decreased since the 1970s and 1980s, while the role of parental social class and income in determining educational attainment has increased.

is more productive if she has a higher ability to benefit from education (as a result of a higher innate talent and/or a more advantageous family background) and if she exerts more effort in school. We also assume decreasing returns to scale in all input factors, hence $\xi_{hbb}(\cdot) < 0$, $\xi_{h\theta\theta}(\cdot) < 0$, and $\xi_{ee}(\cdot) < 0$. In addition we assume $\xi_{eh}(\cdot) > 0$, i.e. effort increases attainment more for students with a higher ability to benefit from education.

Furthermore, we denote by $\widehat{q}$ the passing standard, i.e. the level of qualification required for a binary credential. Students who receive a qualification q greater or equal than $\widehat{q}$ obtain a degree, while those with $q < \widehat{q}$ simply receive a certificate of attendance. The probability of passing and obtaining a degree is thus given by

$$Prob\,(q \geq \widehat{q}) = 1 - \Phi\left(\widehat{q} - \xi\left(h\left(b, \theta\right), e\right)\right). \tag{2.3}$$

Employers Before entering the labor market all individuals attend school and an individual's income in the labor market depends on her schooling.[7] Contracts take the form of reward schedules based on the student's qualification, i.e. noisy observations of the student's true attainment. Accordingly, the labor market income or return to education in the labor market w, can be defined by the following scheme:

$$w = \begin{cases} w_S = \overline{w} + x & \text{if} \quad \text{the student obtained a degree} \quad q \geq \widehat{q} \\ w_F = \overline{w} & \text{else} \qquad\qquad\qquad\qquad\qquad\quad q < \widehat{q}, \end{cases} \tag{2.4}$$

where w_S and w_F denote the student's labor market income in case of having obtained a degree and else, respectively. We think of x as the risk premium of the student's educational investment. For simplicity we assume that $\overline{w} = 0$.

2.1 The student's optimal choice of effort

Given her family's socio-economic background b, her innate talent θ, and the school's passing standard $\widehat{q}$, the student chooses her optimal level of effort e, such as to maximize her expected utility

$$EU = \left[1 - \Phi\left(\cdot\right)\right] u\left(b + x\right) + \Phi\left(\cdot\right) u\left(b\right) - \psi\left(e\right). \tag{2.5}$$

First and second order conditions for the maximization of Equation 2.5 with respect to effort e, are given by:

$$EU' = \phi\left(\cdot\right) \xi_e\left(\cdot\right) A - \psi'\left(e\right) = 0, \tag{2.6}$$

[7] There is substantial empirical evidence showing a positive relation between qualification and future earnings in the labor market, see for instance Psacharopoulos and Layard [1979] for the United Kingdom.

$$EU'' = \left(-\phi\prime\left(\cdot\right)\xi_e\left(\cdot\right)^2 + \phi\left(\cdot\right)\xi_{ee}\left(\cdot\right)\right)A - \psi''\left(e\right) < 0, \tag{2.7}$$

where $A = \left[u\left(b+x\right) - u\left(b\right)\right]$ denotes the utility gain from passing the school's standard.[8] The first order condition (2.6) implicitly defines $e^* = e\left(\widehat{q}, x, b, \theta\right)$, i.e. the student's expected effort reaction function to changes in (i) the passing standard $\widehat{q}$, (ii) the labor market risk premium x, and (iii) her family's socio-economic background b given her innate talent θ. We define by $A_x = u'\left(b+x\right)$ the derivative of the utility gain from passing the school's standard with respect to the labor market risk premium, x and state the following lemma.

Lemma 2.1. *An increase in the labor market risk premium x, brings about an increase in the student's effort, e.*

Proof. Totally differentiating Equation 2.6 with respect to the labor market risk premium, x yields

$$\frac{de}{dx} = \frac{\phi\left(\cdot\right)\xi_e\left(\cdot\right)A_x}{-EU''\left(\cdot\right)}. \tag{2.8}$$

Since $-EU''\left(\cdot\right) > 0$, the sign of the above derivative depends on A_x, the marginal utility gain. Given that $A_x > 0$, Equation 2.8 is also positive and hence, as the labor market risk premium increases, the student will exert more effort. This establishes the lemma. □

Lemma 2.1 captures the fact that students, as other economic agents, respond positively to incentives. Employers can affect a student's effort by changing the labor market reward. A higher labor market risk premium increases the marginal utility gain of effort, making it worthwhile for the student to work harder in order to meet the passing standard. Additionally, schools can also affect a student's effort by regulating the level of qualification required to obtain a degree. The next result characterizes the school's optimal decision regarding the passing standard, $\widehat{q}^*$.

Proposition 2.2. *There exists a choice of the school's passing standard $\widehat{q}$, say $\widehat{q}^*$, that maximizes student effort $e^*\left(\widehat{q}, x, b, \theta\right)$. This occurs when $\phi\prime\left(\widehat{q} - \xi\left(h\left(b,\theta\right), e\right)\right) = 0$ which requires $\widehat{q} = \xi\left(\cdot\right)$.*

Proof. Totally differentiating Equation 2.6 with respect to the school's passing standard $\widehat{q}$, we obtain

$$\frac{de}{d\widehat{q}} = \frac{\phi\prime\left(\cdot\right)\xi_e\left(\cdot\right)A}{-EU''\left(\cdot\right)}. \tag{2.9}$$

[8] We assume that $\phi\prime\left(\cdot\right) > 0$ and $\phi\prime\left(\cdot\right) > \frac{\phi(\cdot)\xi_{ee}(\cdot)A - \psi''(e)}{\xi_e(\cdot)^2 A}$ for any e, such that $EU'' < 0$ holds.

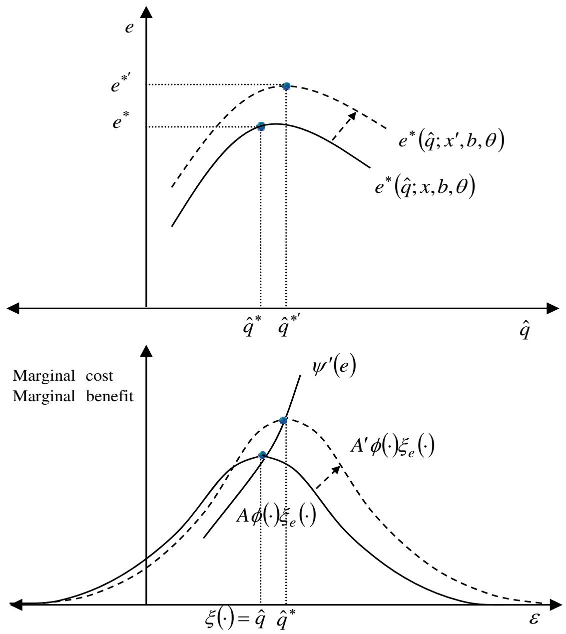
Given that the value of the denominator is positive, the sign of the above derivative depends on the sign of the derivative of the density function $\phi\prime(\cdot)$. For $\phi\prime(\cdot) > 0$, the school's passing standard is lower than the student's true attainment, $\widehat{q} < \xi(\cdot)$. In that case, the probability of passing the standard, $(1 - \Phi(\cdot))$, is relatively high (greater than 0.5 for $\Phi[\varepsilon]$ symmetric), so the student works harder when the passing standard is increased, $\frac{de}{d\widehat{q}} > 0$. However, for $\phi\prime(\cdot) < 0$, the passing standard $\widehat{q}$ is relatively high which implies that the probability of failure is also high. In this case an increase in $\widehat{q}$ reduces the optimal level of effort, $\frac{de}{d\widehat{q}} < 0$. Finally, for $\phi\prime(\cdot) = 0$, which implies $\widehat{q} = \xi(\cdot)$, we can determine the value of $\widehat{q}^*$ that maximizes $e^*(\widehat{q}, x, b, \theta)$. Hence, the optimal passing standard, $\widehat{q}^*$ assures that the level of effort chosen by the student e^*, is the highest level feasible given the student's preferences.[9] □

Figure 2.1 depicts Proposition 2.2. The upper graph represents the student's effort reaction function $e^*(\widehat{q}, x, b, \theta)$. The relationship between student effort and passing standard is non-monotonous. The student's optimal effort level increases first and then decreases as the passing standard is raised. This is due to the fact that when the passing standard is low, students initially tend to work harder as schools raise the passing standard. However, when the passing standard becomes too high, students lose motivation because the marginal cost of effort is too high compared to the expected utility gain from the labor market risk premium associated with obtaining the qualification. The student's reaction function attains a maximum, which corresponds to the optimal passing standard chosen by schools, $\widehat{q}^*$. This passing standard is set such as to induce the highest optimal effort the student is willing to exert, and it is implicitly determined in the lower graph of Figure 2.1. The intersection of the marginal cost of effort $\psi'(e)$, and the marginal benefit of effort $A\phi(\cdot)\xi_e(\cdot)$, pins down the highest optimal effort the student is willing to exert and thus implicitly determines the optimal passing standard. This intersection occurs whenever $\phi\prime(\cdot) = 0$, which ensures that the student's true attainment is equal to the passing standard, $\xi(\cdot) = \widehat{q}$. Hence, the optimal passing standard is such that it eliminates any noise that stands between a student's true attainment and the school's passing standard.

Figure 2.1 also illustrates the effect of an increase in the labor market risk premium on student effort (see Lemma 2.1). A higher labor market risk premium x, leads to an upward shift of the student's effort reaction function (dotted line). This shift implies a new intersection of the marginal cost $\psi'(e)$, and the marginal benefit of effort $A\phi(\cdot)\xi_e(\cdot)$, and hence it also implies a new optimal passing standard. A higher labor market return increases the marginal benefits of student effort, making it worthwhile for the student

[9] The second order differential of effort e, with respect to the passing standard is: $d^2e/d\widehat{q}^2 = [(\phi''(\cdot)\xi_e(\cdot)A)(\psi''(e) - \phi(\cdot)\xi_{ee}(\cdot)A)] / [-EU''(\cdot)]^2$. This ratio is negative if and only if $\phi''(\cdot) < 0$. Note that this condition is satisfied only if $\phi(\cdot)$ is concave near the mode.

Figure 2.1: The Optimal Passing Standard, $\widehat{q}^*$



to work harder in order to meet the new higher passing standard $\widehat{q}^{*\prime}$. Due to this higher passing standard the final increase in student effort goes beyond the initial increase caused by the higher labor market premium.

A student's innate talent also affects her optimal choice of effort exerted. The following lemma captures this.

Lemma 2.3. *When the passing standard is optimal or higher, a more able student exerts more effort, i.e.* $\frac{de}{d\theta} \geq 0$ *when* $\phi\prime(\cdot) \leq 0$.

Proof. Totally differentiating Equation 2.6 with respect to the student's innate talent θ, yields

$$\frac{de}{d\theta} = \frac{\left(-\phi\prime(\cdot)\,\xi_{h\theta}(\cdot)\,\xi_e(\cdot) + \phi(\cdot)\,\xi_{eh\theta}(\cdot)\right)A}{-EU''(\cdot)}. \tag{2.10}$$

Given that the value of the denominator is positive the sign of the above derivative depends on the sign of the derivative of the density function $\phi\prime(\cdot)$. Note that all other terms in the numerator are positive. Thus, when $\phi\prime(\cdot) \leq 0$, Equation 2.10 is positive and hence, a more able student exerts more effort. The opposite does not necessarily hold true. When $\phi\prime(\cdot) > 0$, Equation 2.10 may be positive or negative. This establishes the lemma. □

When the passing standard chosen by schools is high, ($\widehat{q} > \widehat{q}^{*}$) by Proposition 2.2 students lose motivation because the marginal cost of effort is too high compared to the expected utility gain from the labor market return of the academic qualification. According to Lemma 2.3 in such cases, students endowed with higher innate talent, which positively affects student's true attainment, will also exert more effort in order to meet the required passing standard. Hence, innate talent influences achievement positively both directly, $\xi_{h\theta}(\cdot) > 0$, and indirectly via additional effort, $\xi_{eh\theta}(\cdot) > 0$.

3 Student effort and family background

A student's family background influences her potential income directly via better learning efficiency (i.e. more advantageous families enable their children to learn more effectively), or indirectly via greater social capital, better social networks etc. In this section we consider how family background may affect student' s potential income directly by affecting student effort and consequently the student's academic attainment and qualification.

3.1 A benchmark case: $a = h(\theta)$

We first consider as a benchmark case, a situation in which family background does not affect a student's ability to benefit from education. In such a case ($a = h(\theta)$) the student's true attainment is given by $\xi(h(\theta), e)$ and the probability of passing the school's standard and obtaining a degree is given by $Prob(q \geq \widehat{q}) = 1 - \Phi(\widehat{q} - \xi(h(\theta), e))$. We denote by $A_b = [u'(b+x) - u'(b)]$ the derivative of the utility gain from passing the school's standard with respect to a student's family background b, and we state the following lemma.

Lemma 3.1. *If the student exhibits risk aversion, that is if $A_b < 0$, then positive changes in her family background lead to reductions in student effort.*

Proof. Totally differentiating Equation 2.6 with respect to family background, b when $a = h(\theta)$, yields

$$\frac{de}{db} = \frac{\phi(\cdot)\,\xi_e(\cdot)\,A_b}{-EU''(\cdot)} < 0. \tag{3.11}$$

Since $-EU''(\cdot) > 0$, $\phi(\cdot) > 0$ and $\xi_e(\cdot) > 0$, the sign of the above derivative depends on the sign of A_b. As $A_b < 0$ for the case that the student exhibits risk aversion, Equation 3.11 is negative and hence, students from more advantageous family backgrounds (those with higher b) will exert less effort. This establishes the lemma. □

This result is driven by the way a student's family background b, determines how a higher labor market return x, encourages effort. Given our noisy academic context, by Lemma 2.1, an increase in the reward for learning will induce an increase in effort, but as the student becomes better-off, the incentive to work harder is reduced and therefore she exerts less effort. It can also be easily proven that if the student is risk neutral, $(A_b = 0)$, her family background b, has no effect on her optimal choice of effort e. The risk aversion hypothesis is thus key in order for a negative relationship between effort e, and family background b, to arise. However, if different from the benchmark case considered the ability to benefit from education is directly affected by the student's family background this negative relationship might no longer hold.

3.2 The case: $a = h(b, \theta)$

When a student's ability to benefit from education is directly influenced by her family background ($a = h(b, \theta)$), the relationship between effort and family background is altered. In this case, the student's true attainment is given by $\xi(h(b, \theta), e)$, and the probability of passing the school's standard and obtaining a degree is given by $Prob(q \geq \widehat{q}) = 1 - \Phi(\widehat{q} - \xi(h(b, \theta), e))$. In order to analyze the conditions that determine the student's optimal choice of effort for this case we totally differentiate Equation 2.6 with respect to family background b, assuming that $a = h(b, \theta)$

$$\frac{de}{db} = \frac{-\phi\prime(\cdot)\,\xi_{hb}(\cdot)\,\xi_e(\cdot)\,A + \phi(\cdot)\,\xi_{ehb}(\cdot)\,A + \phi(\cdot)\,\xi_e(\cdot)\,A_b}{-EU''(\cdot)}. \tag{3.12}$$

Given three effects in play, a risk aversion effect A_b, a direct productivity effect $\xi_{hb}(\cdot)$, and a cross productivity effect $\xi_{ehb}(\cdot)$, the above derivative can have either sign. Hence, in order to obtain tractable results, we state the following lemma.

Lemma 3.2. *Let $\eta_b(\xi_e) = \frac{\xi_{ehb}(\cdot)b}{\xi_e(\cdot)}$ and $\eta_b(A) = \frac{A_b b}{A}$ be the elasticities of ξ_e and A with respect to b, respectively. In general, for x sufficiently small, $\eta_b(A)$ converges to the coefficient of relative risk aversion $RRA(b) = \frac{-u_{yy}(\cdot)}{u_y(\cdot)}b$.*

Proof. For $y_b = y_x = 1$, $\underset{x\to 0}{Lim}\left(\frac{A_b}{A}\right) = \underset{x\to 0}{Lim}\left(\frac{u_y(b+x)y_b - u_y(b)y_b}{u(b+x)-u(b)}\right) = \underset{x\to 0}{Lim}\left(\frac{u_{yy}(b+x)y_x}{u_y(b+x)y_x}\right) = \frac{u_{yy}(b)}{u_y(b)}$, which proves convergence of $\eta_b(A)$ to $RRA(b)$. In particular, for functional forms of the utility function such as $u(y) = -\exp^{-\beta y}$ (which displays constant absolute risk aversion), $\eta_b(A) = \beta = RRA$, irrespectively of the size of x. This establishes the lemma. □

The elasticity $\eta_b(A)$ relates to the concavity of the utility function and provides a measure for the student's risk aversion, while the elasticity $\eta_b(\xi_e)$ measures the sensitivity of the marginal productivity of student effort with respect to her family background b.[10] Lemma 3.2 allows us to state the next result.

Proposition 3.3. *If the risk aversion effect dominates the cross productivity effect, i.e* $\eta_b(A) > \eta_b(\xi_e)$ *and schools set a passing standard that is lower than the optimal standard* $(\widehat{q} < \widehat{q}^*)$*, then effort is decreasing in family background* $(\frac{de}{db} < 0)$*. On the other hand, if the cross productivity effect dominates the risk aversion effect, i.e* $\eta_b(A) < \eta_b(\xi_e)$ *and schools set a passing standard higher than the optimal standard* $(\widehat{q} > \widehat{q}^*)$*, then student effort and family background relate positively* $(\frac{de}{db} > 0)$*. In particular, when schools set the optimal passing standard* $(\widehat{q} = \widehat{q}^*)$ *and the risk aversion effect is higher (lower) than the cross productivity effect* $(\eta_b(A) \gtreqless \eta_b(\xi_e))$ *then student effort and family background relate negatively (positively)* $(\frac{de^*}{db} \lesseqgtr 0)$*.*

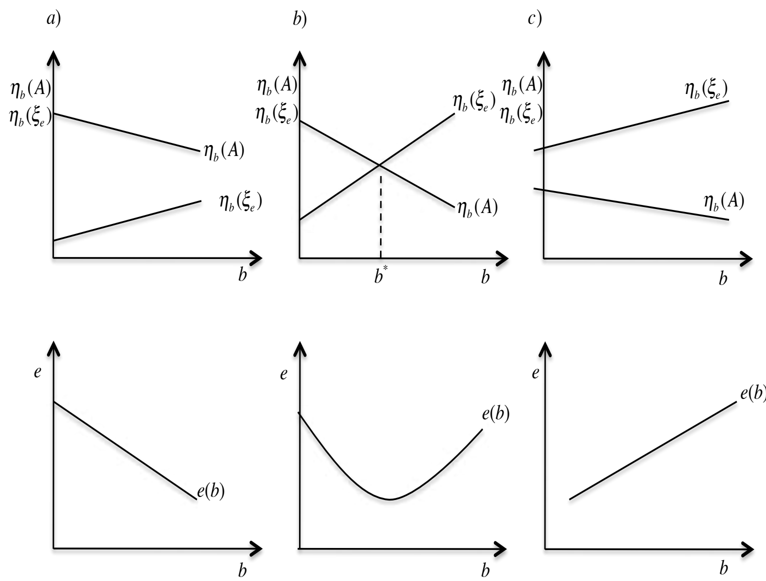
Proof. From Proposition 2.2 we know that when $\widehat{q} < \widehat{q}^*$, the school's passing standard is lower than the student's true attainment, $\widehat{q} < \xi(\cdot)$, which implies $\phi\prime(\cdot) > 0$. In this case, the effect of family background on student effort, captured by Equation 3.12 depends on the sign of $\left(\eta_b(\xi_e) - \eta_b(A) - b\xi_{hb}\frac{\phi\prime(\cdot)}{\phi(\cdot)}\right)$. Given that the last term is positive, the expression in parentheses is strictly negative whenever $\eta_b(\xi_e) < \eta_b(A)$. Therefore students from more advantageous family backgrounds will exert less effort. Note that the opposite does not necessarily hold. When $\widehat{q} < \widehat{q}^*$, and $\eta_b(\xi_e) > \eta_b(A)$, then Equation 3.12 may be of either sign. On the other hand, the ambiguity disappears when $\eta_b(\xi_e) > \eta_b(A)$ and $\widehat{q} > \widehat{q}^*$, which occurs when the passing standard is higher than the student's true attainment, $\widehat{q} < \xi(\cdot)$, which implies $\phi\prime(\cdot) < 0$. In this case, the sign of $\left(\eta_b(\xi_e) - \eta_b(A) - b\xi_{hb}\frac{\phi\prime(\cdot)}{\phi(\cdot)}\right)$ is strictly positive, whenever $\eta_b(\xi_e) > \eta_b(A)$, and therefore students from more advantageous family backgrounds will exert more effort. Note that again the opposite does not necessarily hold. When $\widehat{q} > \widehat{q}^*$, and $\eta_b(\xi_e) < \eta_b(A)$, then Equation 3.12 may be of either sign. For proofing the third statement of Proposition 3.3 consider Proposition 2.2. There exists a passing standard chosen by schools $\widehat{q}$, say $\widehat{q}^*$, that maximizes the student's optimal effort $e^*(\widehat{q}, x, b, \theta)$. This occurs when $\phi\prime(\cdot) = 0$, which requires $\widehat{q} = \xi(\cdot)$. In this case, Equation 3.12 becomes

$$\frac{de^*}{db} = \frac{\phi(\cdot)\,\xi_{ehb}(\cdot)\,A + \phi(\cdot)\,\xi_e(\cdot)\,A_b}{-EU''(\cdot)}, \tag{3.13}$$

with $EU''(\cdot) = \phi(\cdot)\,\xi_{ee}(\cdot)\,A - \psi''(e) < 0$. Since the denominator is positive, the sign of Equation 3.13 is therefore determined by the sign of $(\eta_b(\xi_e) - \eta_b(A))$. The rest follows straight forward. □

[10] $\eta_b(A)$ defines relative risk aversion in the same way as the Arrow-Pratt elasticity, $RRA(b) = \frac{-u_{yy}(\cdot)}{u_y(\cdot)}b$.

Figure 3.2: Effort and Family Background when $\widehat{q} = \widehat{q}^{*}$.



Given Proposition 3.3, and in particular in a situation where the school's passing standard is the optimal one and when students are sufficiently risk averse, students from less advantageous family background who have a lower ability to benefit from education are the ones who exert more effort. This result also holds even if the school chooses a lower passing standard than the optimal one and the student thus does not choose the maximum level of effort. In this case, the more relative risk-averse the student is, the higher the likelihood of responding negatively in terms of effort as she becomes better-off. This case is depicted in Graph a) of Figure 3.2.

On the other hand, given the optimal passing standard, if the degree of risk aversion is relatively low compared to the elasticity related to the marginal productivity of effort, effort and family background are positively related with those from more advantageous family backgrounds exerting more effort (see Graph c) of Figure 3.2). This result also holds even if the school cannot induce exactly the maximum effort the student is able to exert, but establishes a passing standard higher than the optimal one. Hence, the less relative risk-averse the student is, the higher the likelihood of responding positively in terms of effort as she becomes better-off. There also exists the possibility of a non-monotonous relationship between family background and effort. Graph b) of Figure 3.2 shows that if for low levels of family background the degree of risk aversion is higher than the elasticity regarding the student's marginal productivity of effort, effort decreases in family background b. However, as the two functions cross at b^*, the effect of family background on the choice of effort starts to turn positive. As the degree of risk aversion is reduced furthermore and the elasticity related to the marginal productivity of effort increase, students from more advantageous family backgrounds will exert more effort.

4 Empirical Test

Given our theoretical results and the lack of conclusive empirical evidence regarding the relationship between student effort and family background, we consider an empirical test of our theoretical model.[11] We first look at the relationship between family background and student effort. In particular we want to test empirically if students from more advantageous family backgrounds exert more or less effort compared to those from less advantageous family backgrounds. Assuming that schools set the optimal passing standard, in our theoretical model the way student effort and family background relate is determined by the relationship between the degree of the student's risk aversion and the marginal productivity of the student's effort. Hence, in a second step we test if and how this marginal productivity of effort varies with a student's family background.

4.1 Description of the Data

Data base For our empirical test we consider data from a standardized test that 6th grade students (11 -12 years) in all primary schools of the Madrid region have to take each year ('Prueba de Conocimientos y Destrezas Indispensables," CDI).[12] We use the 2009/2010 wave because while the test has been carried out since 2004/2005, only in 2009/2010 were students asked questions about their effort (homework habits). The outcome of the standardized test does not have any implications for students, but is used to provide information to the education authorities. The test consists of two parts, each of 45 minutes length. The first part tests students' reading, language, and general skills, and it also includes a dictation. The second part of the test concerns mathematical skills. In

[11] The only other empirical analysis that considers the relationship between student effort and family background we are aware of is De Fraja et al [2010]. Different from our results, the authors find that children from different backgrounds do not differ significantly in their propensity to exert effort. However, as the authors themselves acknowledge their results are tentative and constrained by the limitations of the data used.

[12] Access to this data set is restricted which is one of the reasons that it has been used little. One exception is Anghel and Cabrales [2010].

addition to the test, each student is asked to fill out a questionnaire regarding individual aspects, family characteristics, and homework habits.

Sample In 2009/2010, a total of 57,080 primary school students were enrolled in 6th grade in the Madrid region. However, we only have test scores for 53,972 students. In addition missing information regarding data from questionnaires further restricts our sample. Excluding students who report less than one hour of homework a week we are thus left with a sample of 46,636 students in 1,222 schools.

Descriptive Statistics Test results differ considerably with some students obtaining scores more than twice the score of others (see Tables A-1 and A-2 of the Appendix A for all summary statistics).[13] About half of all students are girls and most are around 12 years old. Around 13% of students have repeated at least one grade. Disabled and special needs students make up 2% and 5% of our sample respectively. Most 6th grade students in the Madrid region attend public schools (51%) followed by charter schools (38%), and private schools (10%). Over 80% of all students were born in Spain, 9% of students were born in a Spanish speaking country in Latin America while the remaining 8% come from countries with native languages different than Spanish (China, Morocco, Romania or others). A little over half of all students entered school before the age of 3, and almost all students (97%) started school before the age of 6.

Regarding a student's family background, we consider the highest degree of education and the highest occupational category among the two parents. Almost half of all students have at least one parent who holds a university degree and 18% have at least one parent who has completed an apprenticeship. In the case of 12% and 17% of students, at least one parent has finished upper or lower secondary education respectively, and only 5% of students are children of parents who have not completed compulsory education. Using the highest number of years of schooling among parents, on average parents have received approximately 13 years of schooling, where 12.5 years correspond to the length of schooling necessary for obtaining an apprenticeship.[14] We group parents' occupations into: (i)

[13] Given differences in test score scales for the various subjects, original scores have been transformed to represent percentages of maximum points obtainable. We obtain an overall test score by taking the mean of transformed test scores from all five subjects. Then, deviations from the sample mean score have been obtained and they have been divided by the standard deviation of the sample. In a last step, in order to avoid zero scores unsuitable for a logarithmic scale, scores have been adjusted to an IQ scale, multiplying the result by 15 and summing one hundred points (see Table A-3 of the Appendix A for mean scores for each subject). The fact that average scores in Table A-1 are not exactly equal to one hundred points is due to the restrictions imposed on our sample.

[14] We have transform categorical variables on parents' education into numerical variables assuming that

blue collar, (ii) professional, and (iii) administrative occupations.[15] Again considering the highest occupational category among both parents, ranking professionals before administrative workers and before blue collar workers, 34% and 23% of students have at least one parent whose occupation is categorized as professional, and administrative respectively. The majority of students (44%) are children of blue collar workers. Regarding students' household situation, most students (76%) live together with their mother and father, and 13% live in single-parent households. In addition, most students share their home with at least one sibling, 66%. When returning home from school, a little over half of all students are awaited by their mother and 6% of students return home to an empty house. Around 15% of students are awaited by somebody different than their mother or father.

Students spend on average almost 9 hours per week doing homework, with some reporting up to 40 hours. Most students receive some help with their homework while around 27% report to do their homework by themselves. Around 30% of all students receive homework help from their mothers, followed by mothers and fathers, and help from their fathers. Only very few students (5%) receive help with their homework from private teachers. Regarding the extent of homework help, 16 % of students do not receive any help at all from their parents, while most students (63%) receive a little help.

4.2 Effort and Family Background

In order to test empirically if students from more advantageous family backgrounds exert more or less effort compared to those from less advantageous family backgrounds, we estimate the following regression of student effort ($e_{i,j}$) on family background ($b_{i,j}$),

$$e_{i,j} = \beta_o + \beta_1 b_{i,j} + \beta_2 x_{i,j} + a_j, \tag{4.14}$$

controlling for individual characteristics of the student, homework habits, and her household situation ($x_{i,j}$) as well as for school fixed effects (a_j), with i and j being subindexes for the student and the school respectively.[16] To estimate Equation 4.14 we run an OLS

individuals do not repeat courses. Table A-4 of the Appendix A displays the equivalence scale in years of schooling for each educational category.

[15] These groups include the following: (i) blue collar: military, secretary, works in a restaurant or hotel, policeman, fire-fighter, sales-man, shop assistant, cashier, works on construction site, maintenance worker, carpenter, works in a factory, works in somebody' else household, security guard, cleaning service, janitor; (ii) administrative workers: professional or technical worker (for example: professor, scientist, doctor, engineer, lawyer, economist, psychologist, artist); (iii)professional: manages a firm, works in a Ministry, works for the regional government, or works in the town hall.

[16] While there might exist an endogeneity problem regressing homework habits on hours of homework, we consider it of secondary nature given that it only operates through the effect of homework on achievement.

regression with school fixed effects. School fixed effects allow us to control for a possible bias that might arise from the sorting of students according to their family background into schools. If schools with students from more advantageous family backgrounds systematically assign more homework, students from more advantageous family backgrounds will report on average more weekly homework time. In this case, if we were to run an OLS regression without school fixed effects, the coefficient of the variable for parental background would also be picking up a school's policy of assigning more homework. Hence by introducing school fixed effects into the regression we can shut off any effects of different school policies and focus on the direct effects of a student's parental background on effort.

As measures for the student's family background ($b_{i,j}$) we include parents' log years of schooling as well as the highest occupational category among parents'. We approximate a student's innate talent (θ) by using a dummy variable for students who have repeated a grade. As a measure of effort ($e_{i,j}$) we consider log hours of homework per week. Students' individual variables controlled for in our regression are gender, country of birth, age when starting school, situation at home, and help with homework.[17] Table 4.1 presents our estimation results. Our coefficient of interest is β_1, measuring the effect of parental background on effort.

Considering our direct measure of parental background (maximum number of years of education among parents), we find that parental background is clearly positively related to hours of homework by students, i.e. students from more advantageous backgrounds exert more effort. Comparing a student with a parent who graduated from university to a student whose parent has not finished any compulsory education, if the latter dedicates 9 hours (mean value) a week to homework, the former studies around 10.32 hours per week, 14.76% more. Coefficients of dummy variables for parental occupation point in the same direction. Compared to children of blue collar workers, children of professionals and administrative workers spend more hours per week doing homework, +4% and +2.5% respectively.

[17] Our data set does not provide all information needed to estimate our theoretical student's effort best response function ($e^* = e(\widehat{q}, x, b, \theta)$). In particular, we lack information on the labor market risk premium (x), as well as the threshold for passing ($\widehat{q}$), given that test scores have no academic consequence for students.

Table 4.1: Coefficients from School Fixed Effects Regression for Log Hours of Homework

Log Years of Parents' Schooling	0.082***	(0.015)
Occupational Category Parents: Professional	0.040***	(0.010)
Administrative	0.025**	(0.010)
Has repeated grade	-0.148***	(0.014)
With special needs	-0.254***	(0.022)
Disabled	-0.282***	(0.033)
Girl	0.064***	(0.007)
Homework Help from: Mother also	0.027**	(0.010)
Father	-0.026*	(0.014)
Private Teacher	-0.041**	(0.021)
Others	-0.000	(0.018)
Homework help from parents: A little	0.048***	(0.012)
Quite some	0.038**	(0.015)
Much	0.026	(0.023)
All	-0.034	(0.047)
At home when returning from school: Father also	-0.003	(0.008)
Others	-0.014	(0.011)
Nobody	-0.038**	(0.016)
Lives with: Mother only	-0.079***	(0.016)
Mother and siblings	-0.053***	(0.016)
Mother and father only	-0.018*	(0.011)
Mother, father, and more than one sibling	-0.023**	(0.010)
Different living arrangement	-0.017	(0.013)
Started School between 3 and 5	-0.024***	(0.008)
age 6	-0.081***	(0.031)
age 7	-0.159***	(0.044)
Born in Romania	0.170***	(0.027)
Morocco	0.210***	(0.044)
China	0.215***	(0.057)
elsewhere	-0.032	(0.019)
Latin America	-0.084***	(0.017)
Constant	1.707***	(0.037)
Observations	46,636	
Number of Schools	1,222	

Robust standard errors in parentheses: ***p<0.01, **p<0.05, *p<0.1. Reference group: Boy born in Spain who started school before the age of 3 who lives with parents (blue collar workers) and one sibling whose mother is at home when he returns from school and who does not receive any homework help from anybody.

Thus, our empirical findings suggest that among the group of 12 year old Spanish students those from more advantageous backgrounds are the ones exerting more effort.[18] In addition, our estimation also confirm our theoretical result that students of lower innate talent exert less effort (see Lemma 2.3). Having repeated a grade reduces weekly homework by almost 15%. Coefficients of variables of individual characteristics, homework habits and household situation show the expected signs.

4.3 Marginal Productivity of Effort and Family Background

According to Proposition 3.3, if as in our empirical result, students from more advantageous family backgrounds exert more effort ($\frac{de}{db} > 0$) and if schools can set the optimal passing standard ($\widehat{q} = \widehat{q}^*$) a necessary and sufficient condition for this is that $\eta_b(\xi_e) > \eta_b(A)$, i.e. either a student's marginal productivity of effort is very sensitive to her family background and/or her risk aversion is not very high. In order to better evaluate the possible magnitude of the marginal productivity effect, we specify the following functional form for the student's achievement function

$$q_{i,j} = \beta_o + \beta_1 b_{i,j} + \beta_2 e_{i,j} + \beta_{1,2} b_{i,j} e_{i,j} + \beta_3 x_{i,j} + a_j, \tag{4.15}$$

where as before ($e_{i,j}$) denotes student effort, ($b_{i,j}$) are family background variables, ($x_{i,j}$) are variables of individual characteristics, homework habits, and household situation and (a_j) are school fixed effects, with i and j being subindexes for the student and the school respectively. In addition, we also include interaction terms between parental background variables and student effort in order to test our theoretical assumption of a possible distinct impact of student effort on achievement according to family background ($\beta_{1,2} \neq 0$). Specifying $q_{i,j}$ as the log of the student's test score we can estimate Equation 4.15 using an OLS regression with school fixed effects. Sorting of students into schools according to family background, in combination with differences in schools' resources that might affect academic achievement of students differently (number and quality of teachers, finance etc) could lead to a bias in an estimation without fixed effects. Estimation of Equation 4.15 faces a clear endogeneity problem given that the time students spent doing homework not only determines their achievement but that this time is possibly also determined by their past achievement. However, while we thus cannot conclude anything about the causal relationship between family background and student effort on achievement, we are still able

[18] The fact that students born in Rumania, China, and Morocco spend 17% to 22% more hours on homework than students born in Spain could at first point in the opposite direction of our findings (students of less advantageous family backgrounds exerting more effort). However, this does not hold for students from Spanish speaking Latin American countries and hence more hours of homework by students from some immigrant groups is more likely to be due to their limited language skills rather than a less advantageous family background.

to say something about the different relation of effort according to family background.[19]

Table 4.2 shows our estimation results. Our coefficient of interest is $\beta_{1,2}$, indicating possible differences in the relation between effort and achievement for students from different family backgrounds. We find that for students whose parents are professional or administrative workers with university education weekly study of up to eight hours is associated to better test scores, while the relation is negative (however not significantly different from zero) for those whose parents are blue collar workers.[20] The opposite holds true for weekly homework study of more than 12 hours per week, though in this case coefficients are not significantly different from zero. In general and independent of parental background, the relation between effort and scholarly achievement indicated is clearly hump-shaped. Less than eight hours of homework per week seem to be negatively related to achievement while the same holds true for more than 12 hours per week.[21] Students studying around 8 to 12 hours are the ones obtaining better scores. Coefficients of variables of individual characteristics, homework habits, and household situation show the expected signs.

Hence, the results of our empirical test seem to indicate that a student's marginal productivity of effort is quite sensitive to her family background. This suggests that our finding that students from more advantageous family backgrounds exert more effort seems to be largely determined by the fact that these students are somehow better equipped to turn hours of homework (effort) into higher test scores (better achievements) than students from less advantageous family backgrounds. In the theoretical part of our paper a positive relation between effort and family background implied that the cross productivity effect dominated the risk aversion effect.[22] Having estimated an approximation of the cross-productivity effect via our achievement function suggests an empirical confirmation of this theoretical result. However, given that there does not exist any consistent estimation regarding the degree of risk aversion of students, we can only conclude on the qualitative nature of the relation between the risk aversion effect and the cross productivity effect, the later apparently dominating the former.

[19] Again student ability is an omitted variable. However, as before we use the fact that some students have repeated a year as a proxy for ability.

[20] We have grouped parents' educational and professional categories into (i) blue collar workers (ii) professional or administrative workers without university (iii) professional or administrative workers with university.

[21] We have converted homework time into a categorical variable, in order to better interpret results (see Table A-5 of the Appendix A).

[22] It also implied that school were setting the optimal or higher than optimal passing standards, something that given the limitations of our data set we cannot investigate further empirically.

Table 4.2: Coefficients from School-Fixed Effects Regression for Log Test Score

Fewer than 8 Hours of Homework	-0.023***	(0.003)
More than 12 Hours of Homework	-0.006*	(0.003)
Parental Background: Blue Collar Worker	-0.013***	(0.003)
Professional or Administrative with Uni	0.020***	(0.002)
$<$ 8 hours hmwk*Parents Blue Collar	-0.006	(0.004)
$>$ 12 hours hmwk*Parents Blue Collar	0.006	(0.004)
$<$ 8 hours hmwk*Parents Professional/Administr. Uni	0.007**	(0.003)
$>$ 12 hours hmwk*Parents Professional/Administr. Uni	-0.005	(0.004)
Homework Help from: Mother also	-0.014***	(0.002)
Father	-0.014***	(0.002)
Private Teacher	-0.068***	(0.003)
Others	-0.020***	(0.003)
Homework help from parents: A little	-0.016***	(0.002)
Quite some	-0.044***	(0.002)
Much	-0.061***	(0.004)
All	-0.085***	(0.008)
At home when returning from school: Father also	-0.002	(0.001)
Others	0.003**	(0.002)
Nobody	-0.006**	(0.002)
Lives with: Mother only	-0.034***	(0.002)
Mother and siblings	-0.013***	(0.003)
Mother and father only	-0.011***	(0.002)
Mother, father, and more than one sibling	-0.007***	(0.002)
Different living arrangement	-0.013***	(0.002)
Started School between 3 and 5	-0.004***	(0.001)
age 6	-0.030***	(0.005)
age 7	-0.065***	(0.008)
Born in Romania	0.012***	(0.005)
Morocco	-0.050***	(0.009)
in China	-0.053***	(0.012)
elsewhere	-0.004	(0.003)
Latin America	-0.024***	(0.003)
With special needs	-0.185***	(0.005)
Disabled	-0.250***	(0.007)
Girl	-0.004***	(0.001)
Has repeated grade	-0.083***	(0.002)
Constant	4.690***	(0.003)
Observations	46,636	
Number of Schools	1,222	

Robust standard errors in parentheses: ***p<0.01, **p<0.05, *p<0.1 Reference group:Boy born in Spain, who started school before the age of 3 who lives with parents (blue collar workers) and one sibling whose mother is at home when he returns from school and who does not receive any homework help from anybody.

5 Conclusion

In the theoretical model presented in this paper academic attainment which entails an income premium in the labor market is noisily determined by effort and the student's ability to benefit from education which depends in turn on her family background and innate talent. We showed that if schools can set the optimal passing standard the relation between effort and family background is positive (negative) when the degree of risk aversion is smaller (larger) than the elasticity measuring the sensitivity of marginal productivity of the student's effort with respect to her family background. Given that the empirical literature regarding student effort and family background is quite scarce we analyze the question empirically and find that an improvement in parental education from not having completed compulsory education to holding a university degree is associated to around 15% more effort by the student (approximately 1 hour and 20 minutes of additional weekly homework). In addition, we find empirical support for our assumption that students' marginal productivity of effort varies with family background.

Our results come with a caveat. Given the young age of students in our data (12 years), it is not clear that their decision about how much effort to exert is exactly formed in the way suggested by our theoretical model, i.e. fully taking into account labor market consequences of exerting more or less effort. Hence, while we can confirm a positive relationship between effort and family background for young school children the origin of this relation might be somewhat more complex, possibly including parental concerns. This caveat clearly restricts the possibility to generalize the positive relationship between effort and family background found to other groups (university students, postgraduate students). The effort decision of older students might be more similar to our theoretical model and their notion of risk aversion more closely related to that of adults. Thus, it could even be the case that for them, the risk aversion effect could dominate the cross productivity effect, possibly reversing our result regarding the positive relationship between family background and student effort. Findings by the empirical literature on higher education achievement of private school students doing worse conditional on measures of prior achievement may point into this direction. For instance according to Smith and Nylor [2001a], students who attended private secondary school are 4 percentage points less likely to complete their degree compared to students who attended a state school. In a different paper the same authors, Smith and Naylor [2001b] find a similar result for degree achievement, namely that attendance of private secondary schools has a negative effect on degree performance for economics graduates. On the other hand, while our data set has the shortcoming discussed here, considering students at a younger age avoids problems of selection that might occur at higher levels of schooling with those who exert very little effort dropping out of school. If the majority of drop-outs come from less privileged backgrounds, the relationship between family background and effort could possibly change from an initial positive relationship in primary school to a negative one at university.

Given that doubts about the relationship between family background and student effort remain, the paper illustrates the importance of future empirical research to illustrate the degree of income risk effects on educational choices, and particularly on student effort for different age groups. As discussed before, our empirical finding are far from conclusive and are also clearly restraint by the endogeneity that arises when regressing achievement on effort. Finally, one interesting aspect in terms of policy design would be to develop mechanisms that are able to induce students to exert optimal levels of effort.

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A Appendix

Table A-1: Summary Statistics: CDI Cohort 2009/2010

Variable	Mean Value (St.D)
Overall Test Score	101 (14) (Min 51.52 Max 121.40)
Girl	0.49
Age	12.13 (0.36) (Min: 11 Max: 14)
Repeating grades	0.13
Disabled student	0.02
Student with special needs	0.05
Attending:	
Public School	51.32
Private School	10.14
Charter Schools	38.14
Born in:	
Spain	0.83
Rumania	0.02
Morocco	0.009
Spanish speaking Latin America	0.09
China	0.005
elsewhere	0.04
Started school	
before age 3	0.55
age 3-5	0.42
age 6	0.02
age 7	0.01
Highest Education among Parents:	
University	0.48
Apprenticeship	0.18
Upper secondary education	0.12
Lower secondary education	0.17
Without compulsory education	0.05
Years of schooling	12.98 (3.44)(Min 5 Max 16)
Highest Occupation among Parents:	
Professionals	0.34
Administrative workers	0.23
Blue collar worker	0.44
N	46,636

Table A-2: Summary Statistics continued

Variable	Mean Value (St.d)
Lives with:	
Mother	0.07
Mother and one sibling	0.04
Mother and more than one sibling	0.02
Mother and father	0.16
Mother and father and one sibling	0.43
Mother and father and more than one sibling	0.17
Different living arrangement	0.12
When returning from school, awaited by:	
Mother	0.53
Father	0.10
Mother and father	0.17
Others	0.15
Nobody	0.06
Homework Habits:	
Weekly hours of homework	8.93 (5.90)(Min 1 Max 40)
Help from mother	0.29
Help from father	0.10
Help from mother and father	0.22
Help from private teacher	0.05
Help from others	0.06
Help from nobody	0.27
No help form parents	0.16
A little help form parents	0.63
Quite some help form parents	0.15
Much help form parents	0.05
All help from parents	0.008
N	46,636

Table A-3: Detailed Test Statistics for CDI Cohort 2009/2010

Variable	Mean Value (St.D)	Min	Max
Test Scores:			
Dictation	100 (15)	56.53	111.62
Reading	100 (15)	62.31	114.88
Language	100 (15)	50.0	117.4
General Skills	100 (15)	60.17	119.39
Mathematics	100 (15)	70.30	124.94

Table A-4: Equivalence in number of years for educational categories

Variable	Mean Years of Schooling
University	16
Apprenticeship	12.5
Higher secondary education	12
Lower secondary education	8
Compulsory education not completed	5

Table A-5: Homework Time - Categories - Percentage of Students in Sample

Parental Occupation:		Blue Colllar	Administrative /Professional	
Parental Education:		Any	Any excluding University	University
Hours	All			
1-7	0.49	0.54	0.48	0.43
8-12	0.27	0.23	0.27	0.32
> 12	0.24	0.24	0.28	0.25