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Are soft skills conditioned by conflicting factors? A multiobjective programming approach to explore the trade-offs[☆]

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ABSTRACT

Despite the relevance of noncognitive skills (i.e. soft skills) for individual development and for certain forms of employment, they tend to be overlooked in studies centred on educational performance. This study brings an additional contribution to the growing interest on these skills by exploring their main determinants and by providing an additional understanding of how they are influenced by socio-economic and family background. To this end, a multiobjective programming model has been developed, whose coefficients are instantiated by the results of several econometric estimations, in which distinct (and conflicting) aspects of multiple soft skills are considered. Hence, by coupling econometric with multiobjective optimisation modelling approaches we provide an overarching framework for assessing the trade-offs between the different dimensions of noncognitive skills. Data from the most populated region of Spain are used. Overall, our findings highlight the trade-off between different soft skills, which are particularly conditioned by students' gender.

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1. Introduction

Evidence suggests that students' performance at early stages affects the quality of human capital production, being correlated with the national development of human capital accumulation, thus impacting future economic growth (Hanushek and Woessmann, 2015). Like any other development process, nurturing skills involves a dynamic interplay, in which the early years of life set the basis of a successful investment in later-life outcomes (Kautz et al., 2014). Equally important is the role of education as an engine for promoting equity, to the extent that the educational system might reduce the impact of students' socio-economic background on their academic achievements (Roemer, 1998; Palomino et al., 2019).

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Besides, education might contribute to higher levels of social mobility (Corak, 2013; Marcenaro-Gutiérrez et al., 2015) and it provides students with the ability of progressing in their formation, especially for those more disadvantaged who “... are, on average, more than twice as likely as students who are not considered disadvantaged to score in the bottom quarter of the performance distribution” (OECD, 2013, p. 38). Hence, the plethora of empirical studies that have investigated the main factors influencing students’ academic performance is mainly focused on how well students perform in terms of knowledge content and/or competence skills, i.e., on the relationship between a set of “quantitative” inputs and pupil’s outcomes; the latter measured – mainly – by standardised scores (which emphasise “hard” academic skills such as literacy and mathematics)¹. However, school and labour market success should contemplate other factors besides high intellect. In fact, associations between noncognitive skills during childhood, such as concentration, self-reliance and determination, and their future results became a recent concern in the literature (Smithers et al., 2018). Hence, after a rather continued lack of concern, noncognitive skills are beginning to be brought to the education policy agenda (Garcia, 2016). This suggests that other dimensions of students’ skills, also known as “soft” skills² (Heckman and Kautz, 2012; Robles, 2012) should be explicitly addressed in the context of educational policies, since they are crucial for individual development (Levin, 2012) and for economic growth (Balart et al., 2018).

The reluctance of tackling soft skills in education systems can either be related to their underestimation or to the nonexistence of measures to evaluate them in the datasets (Heckman and Kautz, 2012). Furthermore, some authors argue that it is extremely difficult to establish a standard definition for noncognitive skills – see e.g. Cohn and Geske (1990), Zamarro et al. (2018, 2019). However, according to Schulz (2008) and Turner and Böttcher (2012), the inadequate attention that these skills receive in the education system may alter students’ expectations, because students may not be aware of other important capabilities that they possess besides those related to cognitive skills. Also, soft skills are specifically needed according to graduates’ perceptions and companies’ expectations (Itani and Srour, 2016; Dolce et al., 2020). In addition, noncognitive skills aid in the development of cognitive skills throughout early childhood and have a direct impact on labour market outcomes (Carneiro and Heckman, 2003; Heckman et al., 2006; Cunha et al., 2010; Almlund et al., 2011; Durlak et al., 2011; Holmlund and Silva, 2014; Lippman et al., 2015; Agostinelli and Wiswall, 2020; Attanasio et al., 2020). In this vein, Deming (2017) estimated that, between 1980 and 2012, jobs requiring higher levels of social interaction grew by nearly 12 percentage points as a share of the U.S. labour force.³ Likewise, recent longitudinal studies have found strong correlations between a measure of socio-emotional skills in preschool and important young adult outcomes such as employment, earnings, health and criminal activity (Jones et al., 2015). Specifically, Lindqvist and Vestman (2011) stress that “a certain level of noncognitive ability is a prerequisite for avoiding failure in the labour market”; in fact, they found, using data from the Swedish military enlistment, that noncognitive skills were more strongly associated with labour market outcomes than cognitive skills, for those in the top of the earnings distribution.

In spite of having a genetic basis, soft skills are also shaped by the environment, including families, schools and peers (Kautz et al., 2014; Casarico et al., 2015). This means that the promotion of human development is based on “the powerful role of families and general social environments in shaping skills”. Hence, the contextual support to youth development throughout family, educational and community institutions is essential (Martin et al., 2019). In fact, parental investments have been found to be more effective when raising noncognitive skills, because they promote the formation of cognitive skills, whereas causality does not run in the opposite direction (Cunha and Heckman, 2008).

The promotion of certain skills can also be influenced by the direct or indirect adoption of gender roles (Bertrand and Pan, 2013; Rodriguez-Planas and Nollenberger, 2018). This means that skillsets are entrenched in biological assumptions (Hong, 2016): men are assumed to have hard skills, the skills that are more economically valuable, while women lean towards soft skills, those that are thought to be related to care and social interactions. Nonetheless, women can possess hard skills just as men may have soft skills. To delve into these gender differences, Autor et al. (2019) analyse how the contribution of the family environment differentially affects the behaviour and academic progress of boys and girls, separating it from that corresponding to the influence of the school environment and that of their colleagues. But, where do the foundations of these differences between women and men lay? To answer this question, it is essential to go through the first stages of the formation of a person (Chetty et al., 2016).

Overall, from the literature review conducted, and from our stand point, fostering soft skills in the educational system should be regarded as a particularly relevant target in terms of gender and socio-economic equity, because those skills can contribute to promote social mobility, allowing disadvantaged students to overcome the difficulties they face due to their socio-economic background.

Our study is devoted to adolescent students because, during adolescence, noncognitive skills appear to be more malleable than cognitive skills (Carneiro and Heckman, 2003). Hence, in order to help guide efficient educational policy practices, we will evaluate how it is possible to reconcile different targets in terms of soft-skill levels. Towards this end, we propose an overarching methodological framework which combines econometric estimates with multiobjective programming mathematical tools. Hence, our approach provides further insights regarding the potential compromises

¹ Heckman et al. (2014a).

² According to the Collins dictionary, soft skills are “desirable qualities for certain forms of employment that do not depend on acquired knowledge (...)”.

³ Deming (2017) also asserts that math-intensive but less social jobs – including many science, technology, engineering and mathematics occupations – shrank by 3.3 percentage points over the same period for the U.S.

(i.e. trade-offs) attainable for distinct soft-skills – herein viewed as objective functions – that are instantiated by the econometric estimations. Specifically, this study is aimed at attaining compromise efficient solutions,⁴ between seven noncognitive skills indicators, also addressing the impact of gender role and other socio-economic variables on these. Our study employs data from the Spanish region of Andalusia because this is the most populated region in Spain, and its results in external evaluations – such as PISA⁵ – by Andalusian students are relatively poor⁶ in comparison with other Spanish regions (and, in general, with the OECD). Additionally, Andalusia has a very high dropout rate (around a third of boys and a quarter of girls dropped out before finishing compulsory secondary education in 2012; (IECA, 2021a). Therefore, the analysis of the Spanish case might help further understand the relevance and impact of noncognitive skills on the formation of cognitive skills, as the young Andalusian students are essentially failing to progress during their time at school in terms of these hard skills.

The novelties herein introduced are threefold: (a) first, we employ a rich dataset which enables assessing several variables (e.g. soft skills) which are not usually available in educational datasets; (b) we combine econometrics and multiobjective programming approaches to grasp compromises between seven types of soft skills; (c) we perform a robustness evaluation of our results by defining alternative reference points, weights and confidence intervals for the constraints.

The rest of the paper is structured as follows: in the next Section a brief literature review is presented; in Section 3 the dataset and methodology employed are described, followed by the discussion of results in Sections 4 and 5; finally, some conclusions are presented that can help support the design of educational policies in Spain.

2. Literature review

To the best of our knowledge, Cordero et al. (2016) and Suarez-Pandiello et al. (2016) published the only two research works focused on the analysis of the factors affecting soft-skills in Spain. Although these two studies use the same cross-sectional sample of students, in the last year of secondary education in a small Spanish region (Asturias) in the academic year of 2010/11, they have conflicting conclusions. The first employs a Bayesian methodological approach and ascertains that some family characteristics typically related to the level of cognitive abilities, such as the level of formal education of the mother and parents' occupation or family income, are not significantly correlated with noncognitive skills (proxied by factors such as the degree of responsibility of the student, motivation, effort and critical thinking), whereas the latter uses ANOVA to contrast these correlations and does not corroborate the previous findings.

The international literature on this subject is more prolific; see e.g. the meta-analysis given in Smithers et al. (2018), which reviewed 554 eligible publications, and interpreted results from 222 better quality publications.

For assessing the impact of participating in activities involving soft skills (such as sports, academic clubs and fine art occupations) in educational outcomes, Lleras (2008) considered a sample of students of the tenth grade. This study concluded that the participation in these activities predicts educational attainment 10 years later, even after controlling for cognitive ability as measured by achievement tests. In a similar vein, Heckman et al. (2014b) developed and applied methods to use high school grades to measure both cognitive and noncognitive skills. They showed that soft skills promote educational attainment, beneficial labour market outcomes and health.

A growing body of research documenting the positive association between noncognitive skills and labour market returns has also arisen (see, e.g., Heckman and Kautz, 2014, or Borghans et al., 2014). These studies were based on the seminal paper by Heckman (1995), who observed that cognitive ability explains only part of the heterogeneity in earnings and productivity, which means that other skills, such as soft-skills, might be able to contribute to the labour market outcomes of workers.

Regarding gender, there is extended evidence in terms of hard skills. Specifically, empirical results outline that girls usually outperform boys in reading tests, while the reverse is generally true for mathematics and science (Marcenaro-Gutierrez et al., 2018; OECD, 2015)). However, the conclusions in respect to the noncognitive aspects are more limited. In this sense, Card et al. (2008) report in their meta-analysis of almost 150 empirical studies that male students appear to have more discipline problems at school because they are socially more aggressive, both clearly related to socio-emotional skills. Likewise, boys are less inclined to collaborate with their classmates and consider that teachers pay more attention to girls (Kleinfeld, 1998). Autor et al. (2019) conclude that boys born in disadvantaged families have higher rates of disciplinary problems, lower achievement scores and lower high school completion than girls from comparable backgrounds. These differences between boys and girls are, at least, partly conditioned by cultural aspects, gender roles (Alesina et al., 2013), female labour force participation (Alesina and Giuliano, 2010), fertility decisions (Fernández and Fogli, 2009) and risk and trust attitudes (Dohmen et al., 2012). In addition, some researchers, in different countries and educational levels (Cornwell et al., 2013; Carlana, 2019; Lavy and Sand, 2018; Terrier, 2020), link the differential skills of boys and girls to gender stereotypes of teachers; they find that teachers with stronger gender stereotypes have a large negative effect on girls' academic progress and induce them to self-select into less demanding tracks.

⁴ A solution is called Pareto optimal or efficient if there is no other solution which dominates it.

⁵ PISA stands for "Programme for International Student Assessment".

⁶ Specifically, the scores in PISA 2012 for Andalusia were 11 points below the average of Spain as a whole (and 19 points below the OECD average; OECD, 2014).

Furthermore, among the factors affecting cognitive outcomes, the immigrant status of students has been considered relevant, mostly reporting a negative correlation, as immigrants usually have lower cognitive results than native students in most countries (Chiswick and DebBurman, 2004). However, in this field of research, evidence in terms of noncognitive skills is still scarce and not conclusive (Brunello and Schlotter, 2011). For instance, using data from the U.S.,⁷ Hull and Norris (2020) find that children of immigrants have statistically higher noncognitive skills compared to children of natives when finishing elementary school. A related strand of the literature deals with the reasons why immigrants could show different noncognitive skills when contrasted with native students. Specifically, there is certain consensus that migrant people are a selected sample of the population; i.e., the decision to migrate is facilitated by migrants' education level and the social networks available in the country of destination, both of which lower the costs of migration (Bertoli et al., 2016; Naghsh and Schurer, 2019). Additionally, some personality profiles, such as high levels of sociability and extraversion, are also likely to reduce the psychic costs of migration (Bütikofer and Peri, 2017). Thus, it could be expected to find that immigrants, particularly first generation immigrants, are positively selected in terms of their noncognitive skills.⁸

One of the most prominent factors, also held responsible for educational outcomes, is the family socio-economic background (Bornstein and Bradley, 2003; Fuchs and Wözmann, 2007). Better family resources in child's formative years are associated with higher quality of education and better environments that foster cognitive and noncognitive skills (Carneiro and Heckman, 2002). This feature is usually assessed through the number of books at home, parents' highest level of education, parents' occupation, household income, etc. Indeed, the number of books has been found as being highly influential (Evans et al., 2010), while there is scarce evidence of a significant correlation between having a computer – and Internet connection at home – and noncognitive skills (Subrahmanyam et al., 2001). In the case of parents' education, the mother's educational level has been identified as the most influential of these variables (Korupp et al., 2002). Regardless of how family socio-economic background is measured evidence shows, in general, a significant positive association with both cognitive and noncognitive skills (Haveman and Wolfe, 1995). The disposability of computer and Internet connection could also have implications in terms of soft skills. In fact, the study of the implications for educational outcomes of the growing participation in virtual social media has gained increasing importance in recent years, since this is one of children's and adolescents' most common activities nowadays. Nevertheless, although the use of such social instruments can facilitate social relationships, it often has a negative effect on the development of social skills, since there is a risk of addiction or the development of compulsive behaviours (Van Den Eijnden et al., 2018).

Finally, another key issue that influences school outcomes is family structure, since single-parent families, compared to two-parent families, often give less cognitive and emotional stimulation to their children (see, e.g., the evidence in Moon, 2012, 2014) and, as a consequence, their children have diminished cognitive and noncognitive skills. This negative association could also be the consequence of the behaviour of students from single-parent homes, which tend to be more antisocial or inappropriate (Cho et al., 2010).

From the literature review herein conducted it can be established that there is a lack of studies on this subject in Spain. Besides, even in an international context, the approach herein followed has not hitherto been employed. Hence, we will specifically address the optimal compromise between the following soft skills: sports, music and art, relationships, street knowledge, manual skills, being sensitive and being brave. Furthermore, a comprehensive set of variables which are rarely found in international large-scale datasets, such as for the case of those related to soft skills (e.g. gender, first and second generation immigrant status, family structure, level of education of the parents, and the school type, among others), will be used in the model estimations.

3. Data

The data employed in this research is that from the Social Survey 2010: Education and transitions to the Labour Market in Andalusia (IECA, 2021b). This is a panel in which a sample of 1,866 students born in 1994 took the first wave in the academic year 2009/2010, when they were in the 10th grade (age 15–16). The Social Survey 2010 contained student, parent and household questionnaires, together with administrative information about students' academic performance (grades) in each subject and grade retention. These questionnaires are very rich in data, to the extent that they contain many variables which are a rarity in international large-scale assessment tests (like e.g. PISA, etc.) such as, for instance, those related to soft skills.

In particular, this dataset provides us with key information on how the students grade themselves in different soft skills, on a scale from 1 to 10, where 1 is “not good at all” and 10 is “very good”. The soft skills presented were in: sports, music and art in general, relationships, street knowledge, manual skills, being sensitive and being brave. The precise wording of the question was: “Besides the school grades, there may be other things that are important and that you are good at. How do you rate yourself from 1 to 10 in the following areas? Please have into account that 1 is that you are not good at all at it and 10 that you are very good at it”. Students had to grade themselves in the following soft skill options (with this same wording):

⁷ Also analysing the U.S., a subset of the literature has focused on the black–white gap in noncognitive skills (Elder and Zhou, 2021) and on the evolution of minority–white differences, such as students' age (Clotfelter et al., 2009).

⁸ These characteristics could be passed, via intergenerational transmission, to second-generation immigrants (Mendez and Zamarro, 2018). However, Figlio and Özek (2020), using recent data (2003–2012), found a general pattern that successively reduced achievement in the generations following the generation that immigrated to the U.S.

- “Sports”.
- “Music and art in general”.
- “Socialising with people” (relationships).
- “Manage yourself in the street” (street knowledge).
- “Manual skills”.
- “Being sensitive”.
- “Being brave”.

These students’ self-reported gradings of their soft skills are a better approach to their value than parental assessment of their children’s noncognitive skills, because the latter are directly affected by the skills of the parents (Del Bono et al., 2020). Therefore, these self-reported skill levels which might be naturally acquired or developed by the student are used as a proxy of their soft skills. As it can be seen, they are considered as soft skills by the survey administrators (the IECA, i.e. the Statistics and Cartography Institute of Andalusia, *Instituto de Estadística y Cartografía de Andalucía*) because they do not belong to the hard skills’ category (Hendarman and Cantner, 2018), which are normally related to cognitive skills in subjects such as reading, mathematics and science.

The group of skills that can be identified and classified as soft skills has not been precisely delimited in the literature and, depending on the author, this classification can change (Cohn and Geske, 1990; Zamorro et al., 2018, 2019). For instance, John and Srivastava (1999) defined the “Big Five” personality dimensions, a taxonomy in which they summarised five personality domains. According to these authors “These dimensions do not represent a particular theoretical perspective but were derived from analyses of the natural-language terms people use to describe themselves and others. Rather than replacing all previous systems, the Big Five taxonomy serves an integrative function because it can represent the various and diverse systems of personality description in a common framework” (pp. 2–3). These domains are (a) extraversion, (b) agreeableness, (c) conscientiousness, (d) emotional stability and (e) openness to experience. However, these categories and the soft skills considered within them are not definitive and universal. Other authors such as Brent (2013) classified soft skills into attitudes (i.e. variables that reflect the beliefs or thought patterns of a person), intrapersonal behaviour (i.e. behaviours which are characterised by a specific observable behaviour, but which are not primarily related to interactions with other people, like e.g. physical skills) and interpersonal behaviour (i.e. measures of classroom behaviour, social skill and interpersonal style), also including in these groups skills which belong to the “Big Five” personality dimensions. In the particular case of this research study, we follow the labelling that the survey administrators (the IECA) provided for the soft skills’ question (whose seven categories were identified as noncognitive skills) and used them as the soft skills under analysis.

Regarding the soft skills employed in the present research work, some studies have considered “sports” (Pfeifer and Cornelizen, 2010) and “arts” as noncognitive skills (Lleras, 2008) or even “music” (Hille and Schupp, 2015), and “manual skill” (also known as dexterity) has been considered as a noncognitive skill by Stohl et al. (2010); all these soft skills can also be classified as a intrapersonal behaviour, as indicated by authors such as Brent (2013). The other five soft skills considered in this study are more related to personality and can thus be easily identified inside the Big five classification (John and Srivastava, 1999; Lounsbury et al., 2005; Hoeschler et al., 2018; Kassenboehmer et al., 2018): “relationships” could be identified inside extraversion, “street knowledge” in openness to experience, “being sensitive” in agreeableness and “being brave” in emotional stability. To the best of our knowledge, this is the first time that all these soft skills are simultaneously considered in a research study.

Departing from these 1,866 students, we dropped from our sample those who present missing answers to the variables related to soft skills (78 observations), which left us with 1,788 observations. Full descriptive statistics for the sample under scrutiny are provided in Table A.1 (Appendix A), reporting the mean and standard deviation.⁹ Additionally, in Table A.2 (Appendix A) we provide descriptive statistics by soft skills (expressed in logarithms to normalise the distribution). In brief, Table A.2 shows that, on average, women grade themselves significantly over men in terms of soft skills in music and art, relationships and sensitivity, while the opposite applies mainly in sports. This is clearly correlated with the gender stereotypes in society. In respect to the immigrant status, first generation immigrants classify themselves in higher levels of noncognitive skills related to sports, music, manual skills and in being brave; same applies to repeater students. Two additional variables which deserve our special attention are the one indicating whether the child lives only with the father and the characteristics of the school in terms of public funding. On the one hand, children living only with their father report higher skills in sports, but lower skills in street knowledge, being sensitive and being brave. On the other hand, students enrolled in private schools report much higher soft skills in general than those attending public or semi-private schools, but for manual skills. In addition, a one-way ANOVA analysis has been performed in Table A.2 for the categories of each independent variable within the soft skill indicated by the column, finding in most cases significant differences; this may anticipate that these variables will be relevant to explain soft skills. Therefore, a strong degree of conflict can be found for many of the variables included in our model, such as the gender of the student, immigrant status, family structure and type of school that students attend.

Finally, Table A.3 (Appendix) shows the correlations among the seven soft skills under analysis, which present significant and positive correlations between them, with values varying from around 0.05 to 0.51.

⁹ In Table A.1 the labelling of the variables under scrutiny has been stated.

4. Econometric analysis

As aforementioned, we should not consider the success of an education system only by the maximisation of the achievement of students in cognitive skills, but also by the maximisation of the average level of different soft skills, as a way of promoting equity and as a mechanism to directly impact labour market outcomes.

Simple regression models estimated using Ordinary Least Squares (OLS) have been estimated, in which the above mentioned dependent variables are regressed on the set of explanatory variables reported in the Data section. Students' grade in different soft skills are continuous variables expressed in logarithms to normalise the distribution. The coefficients obtained from estimating the regression models are used to build the seven objective functions that we wish to simultaneously optimise, thus having a multiobjective programming problem.¹⁰ In particular, students' level in each of these seven soft skills results from the combination of a set of individual and contextual features, unobservable factors and a random disturbance (ε). The idea behind the OLS estimator is to minimise the latter term in order to get rid of the so-called "statistical noise" as much as possible. If students' order number is indexed as "i", and the seven outputs considered (i.e. noncognitive skills in sports, music and art in general, relationships, street knowledge, manual skills, being sensitive and being brave) are indexed as "j", this model can be represented by the following set of equations:

$$SS_j(i) = \hat{\alpha}^j + \hat{\beta}_1^j X_1(i) + \hat{\beta}_2^j X_2(i) + \dots + \hat{\beta}_{22}^j X_{22}(i) + \varepsilon_j(i) \quad (1)$$

$i = 1, \dots, n$ (number of observations, 1, 788 students);
 $j = 1, 2, 3, 4, 5, 6, 7$ (1 = soft skill in sports; 2 = music&art;
 3 = relationships; 4 = street knowledge; 5 = manual skills; 6 = being sensitive; 7 = being brave).

where $SS_j(i)$ is a measure of the output "j" for student "i", and $X_1(i), X_2(i), \dots, X_{22}(i)$, is a set of explanatory variables; $\varepsilon_j(i)$ is a random disturbance; $\hat{\beta}^j = (\hat{\beta}_1^j, \hat{\beta}_2^j, \dots, \hat{\beta}_{22}^j)^T$ is a vector of slope coefficients and $\hat{\alpha}^j$ is a fixed but unknown population intercept. The size of the sample is represented by the integer value "n". Therefore, we are assuming that each one of the seven outputs is affected by random factors which are inherently unobservable and normally distributed.

Table 1 shows the estimated coefficients of the variables in any of the seven objective functions; it also reports the standard deviations and the significance levels for each coefficient. As robustness check, given the censorship of the dependent variable in the case of the proportion of pupils below the basic performance level, we also estimated a Tobit model; we obtained very similar coefficients to those of OLS and slightly lower standard deviations, what gives further support to the robustness of our estimations. Alternatively, in order to account for the potential correlation among the error terms of the different equations, we estimated a Seemingly Unrelated Regression Equations (SURE) model; again, we obtained parameters of the same size and somewhat smaller standard deviations.¹¹ A set of missing flag variables was introduced with the aim of controlling the students who did not answer the corresponding questions.

Focusing on the results, we find that female students – as compared to male students – have lower skills in sports (20.1%), manual skills (3.3%) and being brave (just 1%). This could be linked to gender stereotypes, both at teacher and family levels (Cornwell et al., 2013; Carlana, 2019; Lavy and Sand, 2018; Terrier, 2020).

Although the proportion of immigrant students is relatively low in Andalusia (5%), those who were not born in Spain (first generation immigrants) grade themselves higher than natives in all soft skills but in relationships (2.5% lower) and sensitivity (5.8%), the main differences being in manual skills and being brave, with around 11.5% higher grades in both cases, which is in line with the results of Hull and Norris (2020). This conditional model also allows to assert that the effect of repeating (at least) one academic year only favours relationships, street knowledge and being brave, i.e. those related with spending more time out of home. The missing flag for this variable shows that most of the students who did not answer this question were repeaters, as the sign of the coefficients are negative (in line with those obtained for repeater students), which means that the coefficients of repeater students are lower bound estimates of the actual effect.

Interestingly enough, having a room for studying stimulates higher grades in all noncognitive skills. In general, previous literature has shown a positive association between family resources and cognitive and noncognitive skills (Carneiro and Heckman, 2002). Similarly, having more books at home is particularly positive in terms of manual skills, although the size of this positive influence is small. This variable is used as a proxy of cultural level, likewise mother and father years of schooling. However, the latter are negatively correlated with manual skills, with one extra year of formal education of any parent reducing 0.2% this soft skill grade.

Household income is reported in relative terms to the home needs, with "totally insufficient" as reference category. Increasing levels of relative income holds a high negative correlation with music and art in general (22.8%), manual skills (23.4%) and being sensitive (15.3%), but it stimulates relationships (1.9%) and being brave (5.5%).

¹⁰ Estimations do not include soft skills as explanatory variables to the extent that they might be endogenous (as they are dependent variables) and, in addition, this would make the multiobjective programming problem very complex (with many relationships between the objective functions) and most likely unsolvable. However, when using the multiobjective programming approach the 7 soft skills are considered simultaneously (as we will see in the following), so the potential relationships and trade-offs between the 7 soft skills are being taken into account in the multiobjective programming phase

¹¹ These tables are available upon request to the authors.

Those students who live only with their mother report lower noncognitive grades in the seven categories considered, and a similar pattern is observed for those who live only with their father, although just 1% of the sample are in that situation. These results support previous evidence by [Cho et al. \(2010\)](#).

The effect of the variables that control for the reading habits shows a heterogeneous behaviour: those students who do not read and their parents do not say to report lower grades in soft skills; however, those who read because they like it report lower skills in sports, relationships and being brave, with a small effect size.

Finally, students enrolled in private funded schools, after controlling for proxies of family socio-economic and cultural status, show higher soft skills than those students attending public funded schools. On the contrary, students enrolled in semi-private funded schools seem to have lower soft-skills in most of the noncognitive skills under scrutiny.

The explanatory power of the estimated model is moderate,¹² in line with those reported in the previous literature on Economics of Education (e.g., [Heckman and Kautz, 2012](#); [Liu et al., 2021](#)); nevertheless, we should bear in mind that the dependent variable is in logarithms.

5. Specification and resolution of a multiobjective programming model

In this section we present the main underpinning concepts, assumptions and notation regarding the solution approach used to solve our multiobjective programming models.

5.1. Concepts and notation in multiobjective programming

Consider, without loss of generality, the following vector optimisation problem:

$$\begin{aligned} \max f(\mathbf{x}) &= (f_1(\mathbf{x}), \dots, f_k(\mathbf{x})) \\ \text{s.t.} &: \mathbf{x} \in X \end{aligned} \tag{2}$$

involving $k \geq 2$ objective functions $f_j: X \rightarrow \mathbb{R}$, which must be maximised simultaneously, and $\mathbf{x} = (x_1, \dots, x_m)^T$ is the vector of decision variables which belongs to the feasible region $X \subset \mathbb{R}^n$. Usually, it is not possible to find a feasible solution that simultaneously optimises all objective functions. Therefore, the solutions to these problems are called efficient or Pareto optimal if none of the objective functions can be improved without deteriorating at least one of the others. Hence, a solution $\mathbf{x}' \in X$ is an efficient or Pareto optimal solution to problem (2) if there does not exist another $\mathbf{x} \in X$ such that $f_j(\mathbf{x}') \leq f_j(\mathbf{x})$ for all $j = 1, \dots, k$, with at least one strict inequality. Whereas, a solution $\mathbf{x}' \in X$ is called weakly efficient or weakly Pareto optimal if there does not exist another $\mathbf{x} \in X$ such as $f_j(\mathbf{x}') < f_j(\mathbf{x})$ for all $j = 1, \dots, k$.

Since all efficient solutions can be considered equivalent, it is necessary to incorporate some preferential information into the model. Preferences about efficient solutions are commonly expressed by the so-called reference point $\mathbf{p} = (p_1, \dots, p_k)^T$, which consists of reference values for the objective functions. Given these values and a vector of weights $\boldsymbol{\mu} = (\mu_1, \dots, \mu_k)^T$, the so-called achievement scalarising function is built and maximised over the feasible set through the following problem ([Wierzbicki, 1980](#)):

$$\begin{aligned} \text{Min } \alpha + \rho \sum_{j=1}^k \mu_j (p_j - f_j(\mathbf{x})) \\ \text{s.t.} &: \mu_j (p_j - f_j(\mathbf{x})) \leq \alpha, j = 1, \dots, k \\ & \mathbf{x} \in X \end{aligned} \tag{3}$$

where the augmentation term $\rho \sum_{j=1}^k \mu_j (p_j - f_j(\mathbf{x}))$ guarantees that the solution obtained is efficient and not just weakly efficient ([Wierzbicki, 1980](#)).

Problem (3) can easily be solved using the optimisation toolbox function for Matlab 2020.¹³

For each efficient solution computed with model (3), the decision maker is asked to provide information regarding his/her preferences, using the achievement rate of the solution obtained with respect to the reference point, which ranges between 0 and 1 if the reference point is set as the ideal solution (i.e. as the individual optimal value of each objective function):

$$tc_j = 1 - \frac{(p_j - f_j(\mathbf{x}))}{(p_j - m_j)}, \quad j = 1, \dots, k \tag{4}$$

where m_j is the worst value attained from the pay-off matrix for objective function j .

5.2. Data characteristics

In our multiobjective model, we consider all the variables described in the econometric analysis as decision variables, although not all of them are controllable by a decision maker, as we will discuss further in the Discussion and conclusions section.

¹² The R-squared is between 2% and 9.1%.

¹³ Specifically, a function developed for Matlab Optimisation Toolbox by Jonathan Currie was used (OPTI Toolbox), designed to solve single objective mixed-integer nonlinear programming problems.

Table 1
Influence of students' characteristics on students' self-assessment of their soft skills.
Source: Authors' own calculations.

Variables	Students' self-assessment of their soft skills						
	In sports	In music, art in general	In relationships	In street knowledge	In manual skills	In being sensitive	In being brave
Female student (Ref.: male student)	-0.201*** (0.003)	0.149*** (0.004)	0.041*** (0.002)	-0.000 (0.002)	-0.033*** (0.003)	0.140*** (0.002)	-0.010*** (0.002)
Immigrant status (Ref.: natives)							
First generation immigrants	0.079*** (0.006)	0.070*** (0.007)	-0.025*** (0.004)	0.057*** (0.004)	0.115*** (0.005)	-0.058*** (0.007)	0.114*** (0.003)
Second generation immigrants	-0.076*** (0.011)	0.058*** (0.008)	0.011* (0.006)	-0.033*** (0.008)	0.075*** (0.006)	-0.002 (0.006)	0.004 (0.005)
Repeater student: yes (Ref.: no)	-0.021*** (0.004)	-0.039*** (0.004)	0.045*** (0.002)	0.006*** (0.002)	-0.007*** (0.003)	-0.020*** (0.003)	0.006*** (0.002)
Repeater student. Missing flag	-0.080*** (0.009)	-0.089*** (0.008)	-0.070*** (0.006)	-0.086*** (0.006)	-0.079*** (0.007)	-0.110*** (0.008)	-0.004 (0.006)
Room for studying: yes (Ref. no)	0.031*** (0.004)	0.054*** (0.005)	0.019*** (0.002)	0.040*** (0.003)	0.041*** (0.004)	0.007** (0.003)	0.016*** (0.002)
Computer and Internet connection: yes (Ref. no)	-0.020*** (0.005)	0.057*** (0.006)	0.007*** (0.003)	-0.002 (0.003)	0.007* (0.004)	0.040*** (0.004)	-0.004 (0.003)
Television: yes (Ref. no)	0.033*** (0.015)	-0.022** (0.011)	-0.022*** (0.005)	-0.125*** (0.005)	-0.241*** (0.006)	-0.131*** (0.009)	-0.050*** (0.005)
Consult books (dictionaries, etc.): yes (Ref. no)	0.084*** (0.008)	-0.102*** (0.007)	-0.015*** (0.003)	-0.007 (0.005)	0.020*** (0.007)	0.114*** (0.007)	0.019*** (0.004)
Number of books at home in tens	-0.000*** (0.000)	0.000*** (0.000)	-0.000*** (0.000)	0.000 (0.000)	0.001*** (0.000)	-0.000* (0.000)	-0.000*** (0.000)
Father years of schooling	-0.004*** (0.001)	-0.001 (0.001)	0.003*** (0.000)	0.007*** (0.000)	-0.002*** (0.000)	0.006*** (0.000)	0.003*** (0.000)
Mother years of schooling	0.008*** (0.001)	0.003*** (0.001)	-0.002*** (0.000)	-0.001*** (0.000)	-0.002*** (0.001)	-0.001** (0.000)	-0.004*** (0.000)
Household income (Ref.: totally insufficient)							
More than necessary, they can save	-0.022*** (0.008)	-0.228*** (0.023)	0.019*** (0.006)	-0.036*** (0.008)	-0.234*** (0.021)	-0.153*** (0.013)	0.055*** (0.006)
Let to live well	-0.075*** (0.006)	-0.044*** (0.007)	-0.004 (0.003)	0.007* (0.004)	-0.023*** (0.005)	-0.073*** (0.004)	-0.026*** (0.003)
Is enough	-0.033*** (0.004)	0.021*** (0.005)	-0.022*** (0.002)	-0.008*** (0.003)	-0.027*** (0.004)	-0.047*** (0.003)	0.002 (0.002)
Is somewhat insufficient	-0.021*** (0.004)	0.023*** (0.005)	-0.013*** (0.002)	0.013*** (0.003)	-0.023*** (0.004)	-0.042*** (0.003)	-0.007*** (0.002)
Household income. Missing flag	-0.115*** (0.009)	0.035** (0.015)	-0.154*** (0.014)	-0.055*** (0.009)	-0.051*** (0.010)	-0.009 (0.006)	-0.000 (0.005)
The student lives (Ref.: with both parents)							
Only with the mother	-0.020*** (0.005)	-0.054*** (0.006)	-0.010*** (0.003)	-0.050*** (0.004)	-0.013*** (0.005)	-0.077*** (0.004)	-0.044*** (0.004)
Only with the father	0.010 (0.007)	-0.056*** (0.015)	-0.004 (0.006)	-0.126*** (0.014)	-0.002 (0.007)	-0.111*** (0.014)	-0.071*** (0.007)
Reading habits (Ref.: do not read although parents say to)							
Do not read and parents do not say to	-0.031*** (0.005)	-0.042*** (0.006)	-0.057*** (0.003)	-0.050*** (0.003)	-0.020*** (0.004)	-0.002 (0.004)	0.000 (0.003)
Read because parents say to	0.066*** (0.004)	0.045*** (0.006)	0.008*** (0.002)	-0.005 (0.003)	-0.003 (0.004)	0.008** (0.003)	-0.014*** (0.003)
Read because the student likes it	-0.028*** (0.004)	0.103*** (0.004)	-0.033*** (0.002)	-0.002 (0.002)	0.007** (0.003)	0.025*** (0.003)	-0.006*** (0.002)
School funding (Ref.: public)							
Semi-private	-0.014*** (0.004)	-0.050*** (0.005)	-0.021*** (0.002)	-0.032*** (0.003)	-0.033*** (0.003)	0.002 (0.003)	-0.022*** (0.002)
Private	0.205*** (0.008)	0.122*** (0.008)	0.088*** (0.006)	0.091*** (0.005)	-0.018* (0.010)	0.123*** (0.007)	0.072*** (0.007)
School funding. Missing flag	-0.250*** (0.024)	-0.216*** (0.029)	-0.340*** (0.031)	-0.278*** (0.032)	0.083*** (0.011)	-0.162*** (0.019)	0.124*** (0.012)
Constant	1.903*** (0.021)	1.665*** (0.016)	2.099*** (0.008)	2.128*** (0.008)	2.162*** (0.010)	1.903*** (0.012)	2.042*** (0.008)
Observations	1,788	1,788	1,788	1,788	1,788	1,788	1,788
R-squared	0.076	0.062	0.055	0.044	0.025	0.091	0.020

Notes: Standard errors in parenthesis. These estimations have been weighted using frequency weights to raise the sample to the population size and standard errors are robust. Estimation method: Ordinary Least Squares. Dependent variable: Ln[Students' self-assessment of their soft skills (scale 1 to 10)]. Coefficient: *** significant at 1%, ** significant at 5%, * significant at 10%.

Table 2
Technical constraints.
Source: Authors' own authors.

$x_2 + x_3 \leq 1$	C(1)
$x_{12} + x_{13} + x_{14} + x_{15} \leq 1$	C(2)
$x_{16} + x_{17} \leq 1$	C(3)
$x_{18} + x_{19} + x_{20} \leq 1$	C(4)
$x_{21} + x_{22} \leq 1$	C(5)

5.3. Constraints

To make our multiobjective model more realistic, we define two different sets of constraints. First, a set of technical constraints which ensures that certain binary variables do not take the value “1” simultaneously; the reference value of each group (which is assumed to be equal to 1 if the rest are equal to 0) is not considered a variable, which is the reason why the constraints reported in Table 2 are inequalities.

We have a mixed-integer linear multiobjective optimisation problem. In addition, other constraints have been established from clear dependencies observed in the regression analysis in Table 3. This means that we have chosen

Table 3
Dependency constraints.
Source: Authors' own authors.

$-11.3511 \cdot x_4 + 18.12455 \leq x_9 \leq -6.675494 \cdot x_4 + 21.71186$	C(6)
$7.661909 \cdot x_5 + 7.049289 \leq x_9 \leq 11.64182 \cdot x_5 + 9.633269$	C(7)
$9.489528 \cdot x_6 + 5.373103 \leq x_9 \leq 12.98098 \cdot x_6 + 7.379643$	C(8)
$2.152141 \cdot x_{11} - 15.18416 \leq x_9 \leq 3.126772 \cdot x_{11} - 6.558611$	C(9)

Table 4
Pay-off matrix.
Source: Authors' own calculations.

	Sol.1	Sol.2	Sol.3	Sol.4	Sol.5	Sol.6	Sol.7
f_1	2.489	2.020	1.857	2.232	2.093	1.974	2.231
f_2	1.937	2.291	1.904	1.871	1.815	2.072	1.620
f_3	2.142	2.193	2.371	2.239	2.051	2.238	2.271
f_4	2.210	2.411	2.301	2.440	2.126	2.363	2.391
f_5	2.064	2.217	1.962	2.266	2.344	2.156	2.055
f_6	2.020	2.206	2.137	2.156	1.942	2.440	2.045
f_7	2.150	2.199	2.187	2.282	2.097	2.149	2.344

Notes: "Sol." stands for "Solutions".

those pairs of variables whose dependencies were stronger according to this analysis and, thus, it is not realistic to give them independent values. One of them is the variable "number of books at home" (x_9); all the dependencies between this variable and the rest included in our model have been checked, from where two-sided constraints have been built, using 99% confidence intervals.

5.4. Objective functions

The objective in this study is to maximise students' noncognitive skills. Therefore, if $\hat{\beta}_m^j$ is the regression coefficient of variable m for soft skill j , and $\hat{\alpha}^j$ is the independent term of performance level j , then we have the following 7 objectives:

$$SS(\mathbf{x}) = (\hat{\beta}^j)^T \cdot \mathbf{x} + \hat{\alpha}^j \quad (5)$$

$$j = 1, 2, 3, 4, 5, 6, 7.$$

where $(\hat{\beta}^j)^T = (\hat{\beta}_1^j, \hat{\beta}_2^j, \dots, \hat{\beta}_{22}^j)$ and $\mathbf{x} = (x_1, x_2, \dots, x_{22})^T$, which measure the expected soft skills in sports, music and art, relationships, street knowledge, manual skills, being sensitive and being brave. The resulting multiobjective problem to be solved in each case is the following:

$$\begin{aligned} & \text{Max } (SS_1(\mathbf{x}), SS_2(\mathbf{x}), SS_3(\mathbf{x}), SS_4(\mathbf{x}), SS_5(\mathbf{x}), SS_6(\mathbf{x}), SS_7(\mathbf{x})) = \\ & = \left((\hat{\beta}^1)^T \cdot \mathbf{x} + \hat{\alpha}^1, (\hat{\beta}^2)^T \cdot \mathbf{x} + \hat{\alpha}^2, (\hat{\beta}^3)^T \cdot \mathbf{x} + \hat{\alpha}^3, (\hat{\beta}^4)^T \cdot \mathbf{x} + \hat{\alpha}^4, (\hat{\beta}^5)^T \cdot \mathbf{x} + \hat{\alpha}^5, (\hat{\beta}^6)^T \cdot \mathbf{x} + \hat{\alpha}^6, (\hat{\beta}^7)^T \cdot \mathbf{x} + \hat{\alpha}^7 \right) \end{aligned}$$

Subject to: (C1)–(C9) (6)

For each case, we have calculated their ideal values ($p^* = 2.303$; equivalent to 10 points in the non-logarithm scale). These are the ideal values for the seven noncognitive skills under scrutiny, which is the maximum grade achieved in our sample for those soft skills.

Table 4 exhibits the pay-off matrix and Table 5 the values of each decision variable for each individual optimum solution, which prove that there is actually some degree of conflict between each pair of functions, thus suggesting that the use of a multiobjective approach is appropriate. The pay-off matrix displays the values of the seven objective functions in each of the individual optimals (for example, row 1 corresponds to the values that objective function 1 takes for the distinct solutions). The worst value of each row (1.857 for f_1 , 1.620 for f_2 , 2.051 for f_3 , 2.126 for f_4 , 1.962 for f_5 , 1.942 for f_6 and 2.097 for f_7) indicates the corresponding anti-ideal value. These values can overestimate their corresponding nadir values and, thus, the ranges of variation of the nondominated objective vectors can be even wider.

5.5. Solutions of the multiobjective models

The multiobjective problem has the aim of detecting the profile of the most balanced student in terms of the seven dimensions of noncognitive skills. To this end, we have used a reference point approach, in which the reference value for each soft skill has been obtained from the actual students who undertook the Andalusian survey described in the Data section.

Table 5

Characteristics of the individual optimal solutions for each soft skill.

Source: Authors' own calculations.

Variables	In sports	In music, art in general	In relationships	In street knowledge	In manual skills	In being sensitive	In being brave
Sex of the student	Male	Female	Female	Male	Male	Female	Male
Immigrant status	First generation immigrants	First generation immigrants	Second generation immigrants	First generation immigrants	First generation immigrants	Native	First generation immigrants
Repeater	No	No	Yes	Yes	No	No	Yes
Study room at home	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Computer and Internet connection at home	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Television at home	Yes	No	No	No	No	No	No
Consult books at home	Yes	No	No	Yes	Yes	Yes	Yes
Number of books at home in tens	19.8	19.4	14.9	14.9	18.5	18.3	15.0
Father years of schooling	5	14	16	16	5	16	16
Mother years of schooling	16	16	7	7	8	8	7
Household income	Totally insufficient	Is somewhat insufficient	More than necessary, they can save	Is somewhat insufficient	Totally insufficient	Totally insufficient	More than necessary, they can save
The student lives	With both parents	With both parents	With both parents	With both parents	Only with the father	With both parents	With both parents
Reading habits	Read because parents say to	Read because the student likes it	Read because parents say to	Do not read although parents say to	Read because the student likes it	Read because the student likes it	Do not read although parents say to
School funding	Private	Private	Private	Private	Public	Private	Private

All the soft skills are equally weighted, meaning that it is implicitly assumed that the achievement of all the reference levels have the same importance for the decision maker. The solutions obtained after solving problem (3) are shown in Table 6. Nevertheless, in Section 5.6, we perform alternative analyses to check the robustness of the results.

The results presented in this table provide a “taxonomy” of the best and more balanced students in terms of their soft skills. After analysing the solutions generated, it is possible to observe that the multiobjective programming approach is able to detect some issues that can hardly be identified only with the econometric analysis. For example, if we only optimise the soft skills “in music, art in general” (which is the second objective function) variable x_{20} (the student reads because he/she likes it) is equal to 1, whereas variable x_{19} (the student reads because parents say to) is 0, because the coefficient of x_{20} (0.103) is higher than the corresponding of x_{19} (0.045) – see Table 1; however, this change in the solution deteriorates the value of the first objective function (skills in sports), since the coefficient of x_{19} for this function (0.066) is higher than the corresponding of x_{20} (−0.028) – see Table 1 – and, as consequence, the optimal value of alpha in Eq. (3) would also deteriorate. However, when a balanced solution is sought through the multiobjective approach, x_{19} is equal to 1 and x_{20} is equal to 0.

In summary, regarding the results presented in Table 6, we can conclude that being brave attains the worst possible achievement rate regarding the target considered, i.e. 30%, while being sensitive, relationships and sports reach values around 50% their targets (47.2%, 52.8% and 49.7%, respectively). Contrarily, music and art and manual skills achieve values above 75% regarding their targets (87.9% and 75.8%, respectively), while skills in street knowledge manage to obtain 66.6% their target. Despite the worst performance of the last soft skill, we can conclude that first generation female immigrants (who have not repeated any grade) manage to obtain an overall good balance in the seven soft skills – what raises some concerns that will be discussed in the Discussion and Conclusions section. Having a room for studying and computer and internet connection also seems to help achieve this optimum, while having a television and consult books seems detrimental. Likewise, 20 books seem to be a balanced level to maximise the whole set of noncognitive skills. Interestingly enough, the upper bound of the mother's years of schooling (i.e. 16 years) appears to clearly contribute to a better level of soft skills, whereas the lower bound of the father's years of schooling (i.e. 5 years) is enough to take students towards that balanced optimum. Similarly, when the student thinks that household income is totally insufficient (lower bound) it has the same effect as it happens when he or she lives with both parents. Finally, being enrolled in a private funded school, and read because parents say to, help to achieve this balanced optimum.

5.6. Robustness of the solutions

In addition to the previous analysis, we have also evaluated the robustness of the solutions by changing the reference points (values), the weights for the different objective functions and the confidence level for the constraint intervals.

In the case of reference points (keeping the same weight for the different objective functions, $\mu = 1/7$), in Table B.1 (Appendix B) we have fixed the reference point at a maximum real level (2.303) for soft skills in music and art, in relationships and being sensitive, i.e. those in which women achieve – on average – higher levels than men, giving the 2.197 value (which corresponds to a level of 9) to the reference points of the remaining soft skills (sports, relationships, street knowledge, manual skills and being brave, i.e. those in which men get higher levels). On the contrary, in Table B.2 (Appendix B), we have fixed the reference point at the maximum for the “dominated” soft skills by men, and relaxed the reference point for the rest of noncognitive skills (music and art, in relationships and being sensitive) to 2.197 (which

Table 6

Possibly efficient solutions with $\mu_k = \frac{1}{7}$ and $q_k = 2.303$ for $k = 1, \dots, 7$.

Source: Authors' own calculations.

Variables	X_5	Values
Female student	x_1	1
Immigrant status	First generation immigrants x_2	1
	Second generation immigrants x_3	0
Repeater student: yes	x_4	0
Room for studying: yes	x_5	1
Computer and Internet connection: yes	x_6	1
Television: yes	x_7	0
Consult books (dictionaries, encyclopaedias, etc.): yes	x_8	0
Number of books at home in tens	x_9	20.2
Father years of schooling	x_{10}	5
Mother years of schooling	x_{11}	16
Household income	More than necessary, they can save x_{12}	0
	Let to live well x_{13}	0
	Is enough x_{14}	0
	Is somewhat insufficient x_{15}	0
The student lives	Only with the mother x_{16}	0
	Only with the father x_{17}	0
	Do not read and parents do not say to x_{18}	0
Reading habits	Read because parents say to x_{19}	1
	Read because the student likes it x_{20}	0
School funding (Ref.: public)	Semi-private x_{21}	0
	Private x_{22}	1
Average soft skills values		
In sports		2.171
In music, art in general		2.210
In relationships		2.220
In street knowledge		2.335
In manual skills		2.252
In being sensitive		2.177
In being brave		2.171

$tc_1 =$	0.497
$tc_2 =$	0.879
$tc_3 =$	0.528
$tc_4 =$	0.666
$tc_5 =$	0.758
$tc_6 =$	0.472
$tc_7 =$	0.300

corresponds to a level of 9). In [Table B.1](#) it is possible to improve the achievement rate of “being brave” (seventh soft skill) to 38.5% (it was 30% in the previous solution) at the expense of decreasing the achievement rates in sports and manual skills to 45.3% (it was 49.7%) and 72.2% (it was 75.6%), respectively. In [Table B.2](#), the relaxation of the reference values of the first, fourth, fifth and seventh soft skills further increases the achievement rate of “being brave” above 50%, but once more at the expense of the reduction of the attainment rates in being sensitive and in relationships to 35.7% and 37.5%, respectively. Curiously, if we contrast the student profiles of both solutions they mainly differ in the fact that in [Table B.2](#) we have male students and a significantly higher average number of books (20.3 against 2.3), suggesting the need of ensuring the access to every student of reading materials in their homes as a way of increasing their self-confidence. These results show prospects for improving the organisation between schools, libraries, and other institutions to increase access to books, thus promoting stronger linkages between resources and families and strengthening students’ reading habits (notice that while in the solution of [Table B.1](#) students only read because parents say to in the solution of [Table B.2](#) students read because they like it). Besides, it is worth mentioning that evidence also shows that students who report having more books in their homes usually perform better academically ([Evans et al., 2010](#)).

An alternative robustness check was implemented by, on the one hand, assigning triple weight to the noncognitive skills dominated by women and holding the weight for the remaining skills ([Table B.3, Appendix B](#)) and, on the other hand, tripling the weights of the soft skills dominated by men (sports, relationships, street knowledge, manual skills and being brave), holding the weights of the rest of soft skills ([Table B.4, Appendix B](#)).

When contrasted with the previous two Tables, [Table B.3](#) further increases the achievement rates of “being brave” to 58.3% and participating in sport activities (that reaches 80.1% of its target – the second highest value followed by the ideal solution). When we contrast this solution with the previous two it is possible to see that besides reading books because their parents say to, these students also have the habit of consulting books, reinforcing the need of increasing reading habits.

Either in [Tables B.3](#) and [B.4](#), we obtain very similar results, with the difference that in the solution depicted in [Table B.4](#) students read because they like to. Curiously, in [Table B.3](#) the achievement rate in sports, street knowledge, manual skills and being brave further increase, but at the cost of reducing the achievement rates in the other soft skills (which are more related to girls); this also happens in [Table B.4](#).

Overall, in all the solutions evaluated it is possible to verify that some features are always present in the students profiles: we always have first generation immigrant students who have computer and internet connection and their mothers, who the students live with, always have a high number of years of schooling. In the case of the confidence intervals for the dependence constraints of the pair of variables, they have been changed to a 95% confidence interval, but the values of the objective functions were not influenced by this variation.¹⁴

Finally, the complete main analysis has been replicated using as dependent variables the soft skills without logarithms, this is, in a 1 to 10 scale.¹⁵ The main tables have been replicated in [Appendix C](#) ([Table C.1](#) replicates [Table 1](#) [Table C.2](#) for [Table 4](#), [Table C.3](#) for [Table 5](#) and [Table C.4](#) for [Table 6](#)). As it can be appreciated, these results are in line with those found in the main results.

6. Discussion and conclusions

The literature on education production functions has mainly been focused on cognitive skills (either test scores or teachers' grades) – achievement tests – to measure individuals' success in school and later in life. However, it has paid little attention to the role of the so called soft (noncognitive) skills in the educational process, especially in countries like Spain, in spite of their relevance for individuals' development, socio-economic growth and as a mechanism for promoting equity. The latter is particularly relevant in a context of increasing inequality, which has been boosted by the pandemic resulting from the expansion of COVID19.

Furthermore, recent evidence from the labour markets of developed countries shows that the demand for those soft skills is increasing at a higher speed than for traditional cognitive skills. Thus, the analysis of soft skills is a very relevant topic. As far as the development of skills can be shaped by environments (including family and school environments) and that it is a dynamic process that appears to be more malleable on the adolescent years, we have focused our analysis on the 15–16 year old students living in the most populated region of Spain (Andalusia). Particularly, this paper is aimed at evaluating the trade-offs between seven indicators linked to distinct soft skills (sports, music and art in general, relationships, street knowledge, manual skills, being sensitive and being brave), thus suggesting ways of attaining balanced efficient levels of soft skills according to the students' profiles computed. Towards this end, we have combined traditional econometric estimates with a multiobjective programming approach. While this latter methodology explicitly allows exploring distinct solutions, contributing to the identification of the profiles of students who reach balanced efficient results in the seven outcomes (i.e. soft skills), the former allows identifying the significant parameters which relate the outcomes to many inputs. Hence, a sound overarching framework has been established providing additional information that can help shape educational policies.

Our results have contributed to the understanding of the role of gender and other socio-economic variables to achieve that optimal solution. All in all, we get that there is a clear division between soft skills by gender; women contribute to the optimal profile in terms of noncognitive skills in music and art, relationships and being sensitive, while men do in sports, street knowledge, manual skills and being brave. This may be the result of an “invisible” sexist prejudice that is embedded in cultural beliefs and practices that often influence the norms and behaviours that men and women adopt in society. As stated by [Folbre \(2010\)](#), women are often taught to be sensitive to the emotions of others as a counterbalance to men, who are tasked to avoid emotional contagion. In other words, gender roles are regarded and valued differently, giving rise to gender inequalities that are reflected in the adolescents' self-perceptions of their level of different soft skills. This construction of gender roles may produce barriers to noncognitive skill acquisition and subsequent employment difficulties, to the extent that these roles may condition the subjects students wish to study, the careers they aspire to, the types of jobs they access and, thus, the perpetuation of occupational segregation and other structural inequalities in the labour market for young women ([Cohen et al., 2018](#)).

Immigrant children (or those born in Spain with two foreign-born parents) outperform natives on noncognitive skills, in line with the results stated by [Hull and Norris \(2020\)](#) for the U.S., who indicate that ability premiums are particularly high for first-generation immigrants.

Moreover, we can conclude that policy makers should be more concerned with the need to promote some cultural habits, concretely promoting reading habits by raising conscience to parents about the importance of reading (and the availability of books at home), e.g. by advertising campaigns. Obviously, schools also have an important role in promoting reading habits among teenagers (and at earlier ages) and interacting with their parents on this issue, to the extent that this contributes, according to our results, to maximise the level of soft skills simultaneously achieved.

¹⁴ For reasons of space the corresponding table is not presented, but it may be supplied upon request to the authors.

¹⁵ Ordered logit/probit might also be used for the present analysis due to the ordinal characteristics of the dependent variables. However, ordered logit/probit estimations are not compatible with multiobjective programming approaches, to the extent that these estimations have 9 different cut points or thresholds, each one representing each category of the soft skill under analysis. Therefore, this may require analysing 9 objective functions per soft skill, reaching a total of 56 objective functions.

Table A.1

Descriptive statistics of soft skills and socio-economic characteristics.

Source: Authors' own calculations.

		Notation	Obs.	Mean	S.D.	Type of variable	Variable bounds
Ln(Soft skills)	In sports	Y_1	1,790	1.90	0.44	Continuous	[0, 2.303]
	In music, art in general	Y_2	1,790	1.77	0.51	Continuous	[0, 2.303]
	In relationships	Y_3	1,790	2.09	0.23	Continuous	[0, 2.303]
	In street knowledge	Y_4	1,790	2.06	0.26	Continuous	[0, 2.303]
	In manual skills	Y_5	1,790	1.90	0.37	Continuous	[0, 2.303]
	In being sensitive	Y_6	1,790	1.99	0.32	Continuous	[0, 2.303]
	In being brave	Y_7	1,790	1.99	0.25	Continuous	[0, 2.303]
Sex of the student	Male	Reference	1,790	0.48	0.50	Binary	[0, 1]
	Female	x_1	1,790	0.52	0.50	Binary	[0, 1]
Immigrant status	Native	Reference	1,788	0.95	0.23	Binary	[0, 1]
	First generation immigrant	x_2	1,788	0.03	0.18	Binary	[0, 1]
Repeater	Second generation immigrant	x_3	1,788	0.02	0.14	Binary	[0, 1]
	No	Reference	1,695	0.59	0.49	Binary	[0, 1]
Study room at home	Yes	x_4	1,695	0.41	0.49	Binary	[0, 1]
	No	Reference	1,790	0.19	0.39	Binary	[0, 1]
Computer and Internet connection at home	Yes	x_5	1,790	0.87	0.33	Binary	[0, 1]
	No	Reference	1,790	0.13	0.33	Binary	[0, 1]
Television at home	Yes	x_7	1,790	0.99	0.11	Binary	[0, 1]
	No	Reference	1,790	0.01	0.11	Binary	[0, 1]
Consult books at home	Yes	x_8	1,790	0.95	0.21	Binary	[0, 1]
	No	Reference	1,790	0.05	0.21	Binary	[0, 1]
Number of books at home in tens		x_9	1,790	15.91	20.55	Continuous	[0, 100]
Father years of schooling		x_{10}	1,790	10.55	3.10	Integer	[5, 16]
Mother years of schooling		x_{11}	1,790	10.24	2.90	Integer	[5, 16]
Household income	Totally insufficient	Reference	1,773	0.20	0.40	Binary	[0, 1]
	Is somewhat insufficient	x_{12}	1,773	0.33	0.47	Binary	[0, 1]
	Is enough	x_{13}	1,773	0.34	0.47	Binary	[0, 1]
	Let to live well	x_{14}	1,773	0.12	0.32	Binary	[0, 1]
	More than necessary, they can save	x_{15}	1,773	0.01	0.11	Binary	[0, 1]
The student lives	With both parents	Reference	1,790	0.88	0.33	Binary	[0, 1]
	Only with the mother	x_{16}	1,790	0.11	0.31	Binary	[0, 1]
	Only with the father	x_{17}	1,790	0.01	0.12	Binary	[0, 1]
Reading habits	Do not read although parents say to	Reference	1,790	0.26	0.44	Binary	[0, 1]
	Do not read and parents do not say to	x_{18}	1,790	0.16	0.37	Binary	[0, 1]
	Read because parents say to	x_{19}	1,790	0.14	0.35	Binary	[0, 1]
	Read because the student likes it	x_{20}	1,790	0.44	0.50	Binary	[0, 1]
School funding	Public	Reference	1,782	0.78	0.41	Binary	[0, 1]
	Semi-private	x_{21}	1,782	0.20	0.40	Binary	[0, 1]
	Private	x_{22}	1,782	0.02	0.13	Binary	[0, 1]

Notes: "Obs." stands for "Observations" and "S.D." stands for "standard deviation". These descriptive statistics have been weighted using frequency weights to raise the sample to the population size.

Similarly, other resources which have a positive influence on the achievement of optimal levels of soft skills are the availability of a study room, computer and internet connection. Consequently, creating a comfortable study environment is another key issue, which also contributes to the development of cognitive skills (Marcenaro-Gutierrez and Lopez-Agudo, 2021).

An important issue is that related to the higher influence of mother years of schooling and who the student lives with, which is linked to the child care literature. In this sense, it has been highlighted the importance of parental time and, especially, maternal time in improving children abilities. Bernal and Keane (2011) conclude that, on average, the substitution of maternal time with other child care sources produces negative effects on children's skills; yet, the sign of the impact depends on the type of child care that substitutes maternal time and on the level of maternal education. In this sense, to the degree that cultural beliefs and practices related to the role of motherhood often influence the norms and behaviours that men and women adopt in society, again this additional result emphasises the relevance of the role of gender to explain the optimal level of soft-skills achievable and the potential for public policy to boost these noncognitive skills. It also raises policy-relevant issues in relation to whether changes in the school system can produce a change in the gender gap in educational achievement.

We can conclude that the intergenerational transmission of skills during childhood and the ways to fight against this mechanism of perpetuating inequity in society must be a priority for governments concerned with the design of optimal public policies aimed at achieving both excellence and equity in students' cognitive and noncognitive achievement. In other words, both family and educational institutions should struggle against sexist thinking, to the extent that gender balanced power relations will yield more equitable noncognitive skills and workforce development.

This research work has some limitations: first, the soft skill values are self-reported by the student. As authors such as Chen et al. (2020) indicated, self-reports on non-cognitive skills are sensitive to survey administration conditions. Second, students' self-assessment of their soft skills depends on students' comprehension of the meaning of each soft skill term from the survey. Third, the data is cross-sectional and corresponds to the academic year 2010/11 which is, unfortunately, the latest wave available. Therefore, the results of this research study have to be taken with caution when making generalisations for other years.

Appendix A

see Tables A.1–A.3.

Table A.2

Descriptive statistics of soft skills by student characteristics.

Source: Authors' own calculations.

Variables		Ln(Soft skills)													
		In sports		In music, art in general		In relationships		In street knowledge		In manual skills		In being sensitive		In being brave	
		Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sex of the student	Male	2.00*	0.38	1.68*	0.56	2.07*	0.24	2.06	0.24	1.92*	0.35	1.91*	0.36	2.00*	0.24
	Female	1.81*	0.47	1.85*	0.44	2.10*	0.21	2.06	0.27	1.89*	0.38	2.06*	0.25	1.99*	0.25
Immigrant status	Native	1.90*	0.44	1.77*	0.51	2.09*	0.23	2.06*	0.26	1.90*	0.37	1.99*	0.32	1.99*	0.25
	First generation immigrant	1.96*	0.35	1.82*	0.41	2.06*	0.19	2.09*	0.15	1.98*	0.28	1.91*	0.39	2.09*	0.16
Repeater	Second generation immigrant	1.84*	0.57	1.80*	0.31	2.06*	0.23	1.99*	0.36	1.96*	0.24	1.97*	0.26	1.98*	0.21
	No	1.91	0.40	1.81*	0.46	2.08*	0.21	2.07*	0.21	1.91	0.33	2.02*	0.28	1.98*	0.22
Study room at home	Yes	1.90	0.48	1.72*	0.56	2.11*	0.22	2.06*	0.28	1.91	0.40	1.96*	0.35	2.00*	0.27
	No	1.91*	0.42	1.78*	0.49	2.09*	0.22	2.07*	0.24	1.91*	0.35	2.00*	0.31	1.99	0.25
Computer and Internet connection at home	Yes	1.87*	0.48	1.71*	0.57	2.08*	0.23	2.03*	0.32	1.87*	0.44	1.95*	0.36	1.99	0.25
	No	1.90	0.43	1.78*	0.49	2.09	0.22	2.06*	0.25	1.91*	0.37	2.00*	0.31	1.99*	0.25
Television at home	Yes	1.90	0.45	1.66*	0.58	2.08	0.24	2.05*	0.28	1.89*	0.38	1.94*	0.38	2.01*	0.23
	No	1.90*	0.44	1.77	0.51	2.09	0.23	2.06*	0.26	1.90*	0.37	1.99*	0.32	1.99*	0.25
Consult books at home	Yes	1.93*	0.51	1.75	0.42	2.12	0.20	2.16*	0.16	2.11*	0.22	2.05*	0.29	2.04*	0.16
	No	1.90*	0.43	1.77*	0.51	2.09*	0.23	2.06*	0.25	1.90*	0.37	2.00*	0.31	1.99*	0.25
Number of books at home in tens	50 or less	1.86*	0.53	1.77*	0.47	2.09*	0.21	2.03*	0.33	1.90*	0.44	1.85*	0.50	1.97*	0.29
	More than 50 to 120	1.88*	0.47	1.77*	0.49	2.09*	0.23	2.05*	0.29	1.89*	0.40	1.96*	0.36	2.00*	0.26
Father years of schooling	More than 10 years	1.92*	0.41	1.73*	0.55	2.07*	0.24	2.06*	0.25	1.90*	0.35	2.00*	0.31	1.99*	0.23
	10 years or less	1.91*	0.43	1.80*	0.48	2.09*	0.21	2.08*	0.22	1.92*	0.36	2.01*	0.27	1.99*	0.24
Mother years of schooling	More than 10 years	1.90	0.44	1.75*	0.52	2.09*	0.22	2.06*	0.28	1.90	0.38	1.98*	0.33	2.00*	0.24
	10 years or less	1.90	0.44	1.79*	0.48	2.08*	0.23	2.07*	0.23	1.90	0.36	2.00*	0.29	1.98*	0.26
Household income	Totally insufficient	1.89*	0.46	1.76*	0.51	2.10*	0.21	2.06*	0.28	1.91*	0.37	1.98*	0.34	2.00*	0.25
	Is somewhat insufficient	1.92*	0.40	1.78*	0.49	2.07*	0.24	2.07*	0.22	1.90*	0.37	2.00*	0.27	1.98*	0.25
The student lives	Is enough	1.91*	0.44	1.73*	0.55	2.10*	0.24	2.05*	0.31	1.91*	0.39	1.99*	0.31	2.00*	0.25
	Let to live well	1.90*	0.44	1.78*	0.52	2.09*	0.22	2.07*	0.25	1.91*	0.36	1.98*	0.33	1.99*	0.24
Reading habits	More than necessary, they can save	1.90*	0.45	1.80*	0.46	2.08*	0.23	2.06*	0.23	1.91*	0.35	2.00*	0.31	2.00*	0.25
	With both parents	1.88*	0.42	1.73*	0.49	2.10*	0.17	2.08*	0.24	1.90*	0.38	1.98*	0.31	1.97*	0.25
The student lives	Only with the mother	1.94*	0.23	1.55*	0.75	2.08*	0.17	2.06*	0.24	1.71*	0.66	1.88*	0.50	2.03*	0.18
	Only with the father	1.90*	0.43	1.77*	0.50	2.09*	0.23	2.07*	0.25	1.91*	0.37	2.00*	0.30	2.00*	0.24
Reading habits	Do not read although parents say to	1.87*	0.49	1.73*	0.55	2.08*	0.22	2.04*	0.29	1.89*	0.41	1.95*	0.41	1.97*	0.31
	Do not read and parents do not say to	1.99*	0.22	1.73*	0.46	2.05*	0.19	1.97*	0.46	1.90*	0.28	1.81*	0.53	1.94*	0.27
School funding	Read because parents say to	1.94*	0.43	1.71*	0.55	2.10*	0.21	2.07*	0.24	1.90*	0.38	1.96*	0.33	1.99*	0.24
	Read because the student likes it	1.88*	0.51	1.67*	0.53	2.06*	0.27	2.02*	0.32	1.88*	0.36	1.94*	0.35	1.99*	0.26
School funding	Public	1.98*	0.33	1.76*	0.47	2.11*	0.18	2.07*	0.26	1.92*	0.31	2.00*	0.26	1.98*	0.24
	Semi-private	1.86*	0.44	1.84*	0.47	2.08*	0.23	2.07*	0.23	1.91*	0.39	2.02*	0.31	2.00*	0.25
School funding	Private	1.90*	0.43	1.77*	0.50	2.09*	0.22	2.06*	0.25	1.91*	0.37	1.99*	0.32	1.99*	0.24
	Private	1.89*	0.46	1.74*	0.52	2.08*	0.23	2.06*	0.25	1.88*	0.38	2.00*	0.30	1.98*	0.26
		2.05*	0.19	1.92*	0.26	2.13*	0.13	2.14*	0.14	1.86*	0.44	2.08*	0.18	2.04*	0.22

Notes: "S.D." stands for "standard deviation". These descriptive statistics have been weighted using frequency weights to raise the sample to the population size. A one-way ANOVA analysis has been performed and the asterisk (*) indicates that there are significant differences (at 5% or lower) between the categories of that particular independent variable within the soft skill indicated by the column.

Table A.3

Correlation matrix between the seven soft skills.

Source: Authors' own calculations.

		Soft skills						
		In sports	In music, art in general	In relationships	In street knowledge	In manual skills	In being sensitive	In being brave
Soft skills	In sports	1						
	In music, art in general	0.1408*	1					
	In relationships	0.2053*	0.1984*	1				
	In street knowledge	0.1254*	0.1550*	0.5131*	1			
	In manual skills	0.1707*	0.2592*	0.2115*	0.2661*	1		
	In being sensitive	0.0449*	0.1830*	0.1343*	0.1114*	0.1450*	1	
	In being brave	0.3108*	0.1386*	0.3063*	0.3018*	0.2820*	0.1919*	1

Notes: The asterisk (*) indicates that correlations are significant at 5% or lower.

Table B.1

Possibly efficient solutions with $\mu_k = \frac{1}{7}$, $q_k = 2.303$ for $k = 2, 3, 6$ and $q_k = 2.197$ for $k = 1, 4, 5, 7$.

Source: Authors' own calculations.

Variables	X_5	Values	
Female student	x_1	1	
Immigrant status	First generation immigrants	x_2	1
	Second generation immigrants	x_3	0
Repeater student: yes	x_4	0	
Room for studying: yes	x_5	1	
Computer and Internet connection: yes	x_6	1	
Television: yes	x_7	0	
Consult books (dictionaries, encyclopaedias, etc.): yes	x_8	0	
Number of books at home in tens	x_9	2.3	
Father years of schooling	x_{10}	12	
Mother years of schooling	x_{11}	16	
Household income	More than necessary, they can save	x_{12}	0
	Let to live well	x_{13}	0
	Is enough	x_{14}	0
	Is somewhat insufficient	x_{15}	0
The student lives	Only with the mother	x_{16}	0
	Only with the father	x_{17}	0
	Do not read and parents do not say to	x_{18}	0
Reading habits	Read because parents say to	x_{19}	1
	Read because the student likes it	x_{20}	0
School funding (Ref.: public)	Semi-private	x_{21}	0
	Private	x_{22}	1
Average soft skills values			
In sports		2.143	
In music, art in general		2.210	
In relationships		2.241	
In street knowledge		2.384	
In manual skills		2.238	
In being sensitive		2.219	
In being brave		2.192	

$tc_1 =$	0.453
$tc_2 =$	0.879
$tc_3 =$	0.594
$tc_4 =$	0.822
$tc_5 =$	0.722
$tc_6 =$	0.556
$tc_7 =$	0.385

Appendix B

see Tables B.1–B.4.

Table B.2

Possibly efficient solutions with $\mu_k = \frac{1}{7}$, $q_k = 2.303$ for $k = 1, 4, 5, 7$ and $q_k = 2.197$ for $k = 2, 3, 6$.
 Source: Authors' own calculations.

Variables	X_5	Values
Female student	x_1	0
Immigrant status	First generation immigrants x_2	1
	Second generation immigrants x_3	0
Repeater student: yes	x_4	0
Room for studying: yes	x_5	1
Computer and Internet connection: yes	x_6	1
Television: yes	x_7	0
Consult books (dictionaries, encyclopaedias, etc.): yes	x_8	0
Number of books at home in tens	x_9	20.3
Father years of schooling	x_{10}	16
Mother years of schooling	x_{11}	16
Household income	More than necessary, they can save x_{12}	0
	Let to live well x_{13}	0
	Is enough x_{14}	0
	Is somewhat insufficient x_{15}	0
The student lives	Only with the mother x_{16}	0
	Only with the father x_{17}	0
	Do not read and parents do not say to x_{18}	0
Reading habits	Read because parents say to x_{19}	0
	Read because the student likes it x_{20}	1
School funding (Ref.: public)	Semi-private x_{21}	0
	Private x_{22}	1
Average soft skills values		
In sports		2.234
In music, art in general		2.119
In relationships		2.171
In street knowledge		2.412
In manual skills		2.270
In being sensitive		2.120
In being brave		2.222

$tc_1 =$	0.597
$tc_2 =$	0.744
$tc_3 =$	0.375
$tc_4 =$	0.911
$tc_5 =$	0.805
$tc_6 =$	0.357
$tc_7 =$	0.506

Table B.3

Possibly efficient solutions with $q_k = 2.303$ for $k = 1, \dots, 7$, $\mu_k = \frac{3}{13}$ for $k = 2, 3, 6$ and $\mu_k = \frac{1}{13}$ for $k = 1, 4, 5, 7$.

Source: Authors' own calculations.

Variables	X_5	Values
Female student	x_1	0
Immigrant status	First generation immigrants x_2	1
	Second generation immigrants x_3	0
Repeater student: yes	x_4	0
Room for studying: yes	x_5	1
Computer and Internet connection: yes	x_6	1
Television: yes	x_7	0
Consult books (dictionaries, encyclopaedias, etc.): yes	x_8	1
Number of books at home in tens	x_9	20.1
Father years of schooling	x_{10}	16

(continued on next page)

Table B.3 (continued).

Variables		X_5	Values
Mother years of schooling		x_{11}	14
	More than necessary, they can save	x_{12}	0
Household income	Let to live well	x_{13}	0
	Is enough	x_{14}	1
	Is somewhat insufficient	x_{15}	0
The student lives	Only with the mother	x_{16}	0
	Only with the father	x_{17}	0
	Do not read and parents do not say to	x_{18}	0
Reading habits	Read because parents say to	x_{19}	1
	Read because the student likes it	x_{20}	0
School funding (Ref.: public)	Semi-private	x_{21}	0
	Private	x_{22}	1
Average soft skills values			
In sports		2.363	
In music, art in general		1.974	
In relationships		2.179	
In street knowledge		2.406	
In manual skills		2.260	
In being sensitive		2.172	
In being brave		2.241	

$tc_1 =$	0.801
$tc_2 =$	0.528
$tc_3 =$	0.400
$tc_4 =$	0.892
$tc_5 =$	0.779
$tc_6 =$	0.462
$tc_7 =$	0.583

Table B.4

Possibly efficient solutions with $q_k = 2.303$ for $k = 1, \dots, 7$, $\mu_k = \frac{3}{15}$ for $k = 1, 4, 5, 7$ and $\mu_k = \frac{1}{15}$ for $k = 2, 3, 6$.

Source: Authors' own calculations.

Variables		X_5	Values
Female student		x_1	0
Immigrant status	First generation immigrants	x_2	1
	Second generation immigrants	x_3	0
Repeater student: yes		x_4	0
Room for studying: yes		x_5	1
Computer and Internet connection: yes		x_6	1
Television: yes		x_7	0
Consult books (dictionaries, encyclopaedias, etc.): yes		x_8	0
Number of books at home in tens		x_9	20.4
Father years of schooling		x_{10}	16
Mother years of schooling		x_{11}	15
	More than necessary, they can save	x_{12}	0
Household income	Let to live well	x_{13}	0
	Is enough	x_{14}	0
	Is somewhat insufficient	x_{15}	0
The student lives	Only with the mother	x_{16}	0
	Only with the father	x_{17}	0
	Do not read and parents do not say to	x_{18}	0
Reading habits	Read because parents say to	x_{19}	0
	Read because the student likes it	x_{20}	1
School funding (Ref.: public)	Semi-private	x_{21}	0
	Private	x_{22}	1

(continued on next page)

Table B.4 (continued).

Variables	X_5	Values
Average soft skills values		
In sports	2.226	
In music, art in general	2.116	
In relationships	2.173	
In street knowledge	2.413	
In manual skills	2.272	
In being sensitive	2.121	
In being brave	2.226	

$tc_1 =$	0.584
$tc_2 =$	0.739
$tc_3 =$	0.381
$tc_4 =$	0.914
$tc_5 =$	0.811
$tc_6 =$	0.359
$tc_7 =$	0.522

Table C.1

Influence of students' characteristics on students' self-assessment of their soft skills, non-logarithmic soft skills.

Source: Authors' own calculations.

Variables	Students' self-assessment of their soft skills						
	In sports	In music, art in general	In relationships	In street knowledge	In manual skills	In being sensitive	In being brave
Female student (Ref.: male student)	-1.183*** (0.014)	0.720*** (0.016)	0.246*** (0.011)	0.032*** (0.012)	-0.202*** (0.014)	0.884*** (0.012)	-0.051*** (0.011)
Immigrant status (Ref.: natives)							
First generation immigrants	0.302*** (0.030)	0.158*** (0.034)	-0.275*** (0.026)	0.237*** (0.025)	0.573*** (0.032)	-0.427*** (0.034)	0.698*** (0.024)
Second generation immigrants	-0.144*** (0.051)	0.007 (0.044)	-0.013 (0.040)	-0.177*** (0.045)	0.329*** (0.041)	-0.136*** (0.039)	-0.042 (0.033)
Repeater student: yes (Ref.: no)	0.008 (0.016)	-0.071*** (0.018)	0.361*** (0.012)	0.108*** (0.013)	0.088*** (0.016)	-0.083*** (0.014)	0.134*** (0.013)
Repeater student. Missing flag	-0.293*** (0.036)	-0.410*** (0.034)	-0.204*** (0.029)	-0.310*** (0.030)	-0.226*** (0.032)	-0.443*** (0.034)	0.123*** (0.028)
Room for studying: yes (Ref. no)	0.105*** (0.018)	0.195*** (0.021)	0.126*** (0.014)	0.206*** (0.015)	0.137*** (0.019)	0.068*** (0.017)	0.112*** (0.014)
Computer and Internet connection: yes (Ref. no)	-0.028 (0.022)	0.276*** (0.025)	0.114*** (0.016)	0.048*** (0.017)	0.089*** (0.021)	0.207*** (0.020)	0.007 (0.017)
Television: yes (Ref. no)	0.005 (0.061)	0.100** (0.051)	-0.146*** (0.042)	-0.805*** (0.034)	-1.573*** (0.044)	-0.723*** (0.053)	-0.227*** (0.035)
Consult books (dictionaries, etc.): yes (Ref. no)	0.282*** (0.034)	-0.420*** (0.033)	-0.067*** (0.024)	-0.028 (0.028)	0.001 (0.033)	0.489*** (0.033)	0.074*** (0.027)
Number of books at home in tens	-0.001* (0.000)	0.003*** (0.000)	-0.001*** (0.000)	0.001*** (0.000)	0.004*** (0.000)	0.000 (0.000)	-0.002*** (0.000)
Father years of schooling	-0.022*** (0.003)	-0.001 (0.003)	0.021*** (0.002)	0.030*** (0.002)	-0.012*** (0.003)	0.029*** (0.003)	0.020*** (0.002)
Mother years of schooling	0.035*** (0.003)	0.010*** (0.003)	-0.018*** (0.002)	-0.014*** (0.002)	-0.010*** (0.003)	-0.015*** (0.003)	-0.025*** (0.002)
Household income (Ref.: totally insufficient)							
More than necessary, they can save	-0.321*** (0.045)	-0.854*** (0.082)	-0.014 (0.041)	-0.235*** (0.056)	-0.829*** (0.081)	-0.853*** (0.060)	0.266*** (0.043)
Let to live well	-0.434*** (0.026)	-0.301*** (0.029)	-0.091*** (0.019)	0.029 (0.021)	-0.092*** (0.026)	-0.423*** (0.023)	-0.202*** (0.021)
Is enough	-0.109*** (0.021)	0.041* (0.022)	-0.142*** (0.015)	-0.121*** (0.017)	-0.148*** (0.020)	-0.242*** (0.018)	0.007 (0.016)
Is somewhat insufficient	-0.111*** (0.019)	0.128*** (0.022)	-0.100*** (0.015)	0.031* (0.016)	-0.144*** (0.019)	-0.206*** (0.017)	-0.077*** (0.015)
Household income. Missing flag	-0.977*** (0.053)	0.040 (0.078)	-0.908*** (0.072)	-0.440*** (0.059)	-0.413*** (0.062)	-0.116*** (0.040)	-0.124*** (0.040)
The student lives (Ref.: with both parents)							
Only with the mother	-0.021 (0.024)	-0.224*** (0.025)	-0.077*** (0.018)	-0.250*** (0.020)	-0.013 (0.023)	-0.345*** (0.022)	-0.201*** (0.020)
Only with the father	-0.170*** (0.046)	-0.351*** (0.062)	-0.203*** (0.038)	-0.620*** (0.059)	-0.049 (0.046)	-0.435*** (0.061)	-0.443*** (0.047)

(continued on next page)

Appendix C

see Tables C.1–C.4.

Table C.1 (continued).

Variables	Students' self-assessment of their soft skills						
	In sports	In music, art in general	In relationships	In street knowledge	In manual skills	In being sensitive	In being brave
Reading habits (Ref.: do not read although parents say to)							
Do not read and parents do not say to	-0.156*** (0.022)	-0.266*** (0.024)	-0.335*** (0.018)	-0.267*** (0.018)	-0.194*** (0.020)	-0.013 (0.020)	0.015 (0.017)
Read because parents say to	0.275*** (0.021)	0.113*** (0.024)	0.058*** (0.016)	0.003 (0.018)	-0.071*** (0.021)	-0.001 (0.019)	-0.095*** (0.018)
Read because the student likes it	-0.241*** (0.018)	0.541*** (0.020)	-0.202*** (0.013)	0.003 (0.014)	0.078*** (0.017)	0.179*** (0.016)	-0.006 (0.014)
School funding (Ref.: public)							
Semi-private	-0.006 (0.018)	-0.209*** (0.020)	-0.132*** (0.014)	-0.160*** (0.015)	-0.178*** (0.018)	0.014 (0.015)	-0.107*** (0.014)
Private	1.043*** (0.043)	0.422*** (0.043)	0.373*** (0.032)	0.487*** (0.034)	-0.141*** (0.045)	0.603*** (0.042)	0.413*** (0.040)
School funding. Missing flag	-1.103*** (0.089)	-0.600*** (0.109)	-1.037*** (0.121)	-0.720*** (0.134)	0.219*** (0.073)	-0.939*** (0.100)	1.017*** (0.083)
Constant	7.580*** (0.085)	5.727*** (0.073)	8.237*** (0.056)	8.608*** (0.051)	8.864*** (0.063)	7.240*** (0.071)	7.696*** (0.052)
Observations	1,788	1,788	1,788	1,788	1,788	1,788	1,788
R-squared	0.106	0.071	0.042	0.027	0.027	0.100	0.023

Notes: Standard errors in parenthesis. These estimations have been weighted using frequency weights to raise the sample to the population size and standard errors are robust. Estimation method: Ordinary Least Squares. Dependent variable: Students' self-assessment of their soft skills (scale 1 to 10). Coefficient: *** significant at 1%, ** significant at 5%, * significant at 10%.

Table C.2
Pay-off matrix, non-logarithmic soft skills.
Source: Authors' own calculations.

	Sol.1	Sol.2	Sol.3	Sol.4	Sol.5	Sol.6	Sol.7
f_1	10.018	7.837	7.698	7.614	7.866	7.496	8.869
f_2	6.789	8.488	7.497	7.670	6.941	7.596	5.548
f_3	8.218	8.254	9.710	9.277	8.325	9.001	9.064
f_4	8.726	8.910	9.886	10.154	9.274	9.767	9.856
f_5	7.735	7.494	8.561	9.062	9.759	8.626	8.578
f_6	7.362	7.846	9.278	8.645	7.224	10.014	7.603
f_7	8.332	8.303	8.324	9.040	8.535	8.327	9.508

Notes: "Sol." stands for "Solutions".

Table C.3
Characteristics of the individual optimal solutions for each soft skill, non-logarithmic soft skills.
Source: Authors' own calculations.

Variables	In sports	In music, art in general	In relationships	In street knowledge	In manual skills	In being sensitive	In being brave
Sex of the student	Male	Female	Female	Female	Male	Female	Male
Immigrant status	First generation immigrants	First generation immigrants	Native	First generation immigrants	First generation immigrants	Native	First generation immigrants
Repeater	No	No	Yes	Yes	Yes	No	Yes
Study room at home	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Computer and Internet connection at home	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Television at home	Yes	Yes	No	No	No	No	No
Consult books at home	Yes	No	No	No	No	Yes	Yes
Number of books at home in tens	19.3	20.4	14.9	15.0	15.0	18.3	14.9
Father years of schooling	5	9	16	16	5	16	16
Mother years of schooling	16	16	7	7	7	8	7
Household income	Totally insufficient	Is somewhat insufficient	Totally insufficient	Is somewhat insufficient	Totally insufficient	Totally insufficient	More than necessary, they can save
The student lives	With both parents	With both parents	With both parents	With both parents	With both parents	With both parents	With both parents
Reading habits	Read because parents say to	Read because the student likes it	Read because parents say to	Do not read although parents say to	Read because the student likes it	Read because the student likes it	Do not read although parents say to
School funding	Private	Private	Private	Private	Public	Private	Private

Table C.4Possibly efficient solutions with $\mu_k = \frac{1}{7}$ and $q_k = 10$ for $k = 1, \dots, 7$, non-logarithmic soft skills.

Source: Authors' own calculations.

Variables	X_5	Values
Female student	x_1	1
Immigrant status	First generation immigrants x_2	1
	Second generation immigrants x_3	0
Repeater student: yes	x_4	0
Room for studying: yes	x_5	1
Computer and Internet connection: yes	x_6	1
Television: yes	x_7	0
Consult books (dictionaries, encyclopaedias, etc.): yes	x_8	0
Number of books at home in tens	x_9	19.3
Father years of schooling	x_{10}	5
Mother years of schooling	x_{11}	16
Household income	More than necessary, they can save x_{12}	0
	Let to live well x_{13}	0
	Is enough x_{14}	0
	Is somewhat insufficient x_{15}	0
	Only with the mother x_{16}	0
The student lives	Only with the father x_{17}	0
	Do not read and parents do not say to x_{18}	0
Reading habits	Read because parents say to x_{19}	0
	Read because the student likes it x_{20}	1
School funding (Ref.: public)	Semi-private x_{21}	0
	Private x_{22}	1
Average soft skills values		
In sports		8.037
In music, art in general		8.257
In relationships		8.417
In street knowledge		9.563
In manual skills		9.255
In being sensitive		8.659
In being brave		8.529

$tc_1 =$	0.215
$tc_2 =$	0.921
$tc_3 =$	0.133
$tc_4 =$	0.586
$tc_5 =$	0.777
$tc_6 =$	0.514
$tc_7 =$	0.188

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