Gender Gaps in Student Achievement in Turkey

Evidence from the Programme for International Student Assessment (PISA) 2015

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EXECUTIVE SUMMARY

1. This work provides a comprehensive analysis of gender gaps in student achievement in Turkey, using data collected by the Programme for International Student Assessment (PISA) in 2015. It starts by estimating education production functions in reading, mathematics and science for boys and girls, and draws conclusions about the current state of academic performance in Turkey. A wide battery of student, family and school characteristics are considered. The obtained gender gaps are decomposed into two components: due to the difference in endowments between boys and girls, and due to the difference in the returns on endowments. As such, the study provides the most up-to-date evidence on education production functions in Turkey, as well as a rare insight into the differentials in academic performance between boys and girls.

2. The study shows that gender gaps in test scores in Turkey are in line with international patterns. Taking into account a large number of student, family and school characteristics, it emerges that girls in Turkey outperform boys in reading by at least 25 points, lag behind boys in mathematics by at least 7 points and perform alike in science.

3. Generally after programme types, school resources and school management are taken into account, ethnicity matters little for student achievement, but ethnic differentials in reading and science are "stickier" than in mathematics. This is the case especially for boys.

4. With regards to student's socio-economic background, father's education is systematically more strongly correlated with student achievement than mother's education. However, the effect of mother's and father's employment status often emerge as important, especially for girls and their mathematics and science scores. These findings point to the importance of productive parental role models for children in general, and girls in particular. Home possessions correlate more persistently with girls' rather than boys' academic achievement. Among three subjects, the effect of wealth is also most persistent in the case of mathematics, both for boys and girls, and in the case of reading and science for girls. This suggests that it is more difficult to mitigate the transmission of inequality in mathematics. Yet, wealth effect is weakened and often disappears after school's disciplinary climate and average socio-economic status is controlled for. This points to the importance of peer effects and the segregation of students into schools along the socio-economic lines in Turkey.

5. Home environment emerges as crucial to student achievement. Parental emotional support correlates with boys' scores in reading. Regularly talking to parents stands out as extremely important, both for boys and girls, in all subjects. Student being engaged in paid employment systematically harms the academic performance of all students, in all subjects. Student's engagement in domestic work is also detrimental to mathematics and science scores, indicating that mathematics and science require more time or undivided attention outside the classroom.

6. The analysis points to the centrality of non-cognitive "facilitators of learning". Achievement motivation comes out as significant for boys, but not for girls, in reading and science. Yet, it is important for both sexes in mathematics. This points to the importance of motivation to girl's success in mathematics. Anxiety is strongly detrimental to girls' academic success in reading, and to both boys' and girls' academic success in mathematics and science. The sense of belonging at school correlates with girls' scores in reading.

7. Rural-urban distinction matters little in all subjects, but regional gender gaps show some heterogeneity. Based on the raw data, three types of regions emerge: (i) performing similar to the reference region of Istanbul both on average and with respect to gender gaps (e.g. West and East Marmara, Aegean, Mediterranean, Central Anatolia and West Black Sea); (ii) performing below Istanbul region on average, but where gender gaps are in line with Istanbul (e.g. Central East or Southeast Anatolia); (iii) performing similar or below Istanbul region on average, but where gender gaps are more pronounced (e.g. West Anatolia, Northeast Anatolia or East Black Sea). The analysis reveals that, after controlling for student,

household and school characteristics, girls in West Anatolia and East Black Sea regions systematically underperform in all subjects *vis-à-vis* local boys and girls elsewhere in Turkey.

8. Students in general selective schools systematically outperform their peers in other types of high schools, in all subjects. However, the effect of programme types usually disappears once school's disciplinary climate and average socio-economic status are accounted for. Disciplinary climate is important – both for boys and girls - and students in less disciplined classrooms systematically score below their peers, in all subjects but especially in mathematics and science. School's average economic, social and cultural status (ESCS) is persistently associated with much higher scores both for boys and girls. These findings are a testimony to learning environment or peer effects being potentially high in Turkish schools.

9. While there is little evidence of the importance of school resources, students – especially girls – in private-managed schools underperform *vis-à-vis* students in public schools. Students in schools with a high fraction of government funding record superior performance. Both findings are consistent with the fact that the best schools in Turkey are public Anadolu and science high schools.

10. In science, the enjoyment of science correlates with higher science scores both for boys and girls, but interest in science and instrumental motivation to learn science translate into higher science scores for boys only. Enquiry-based instruction in science is detrimental to science scores for all students, while adaptive instruction enhances the performance of girls in science.

11. The decomposition of gender gaps suggest that, while there is no evidence of girls being positively selected on observables such as parental education, employment or wealth, girls' overall endowments are higher than boys, potentially pointing to the selection of girls based on non-observables. Girls receive more parental support, talk to parents more often, and are less likely to work for pay. Fifteen-year-old girls on average attend higher grades than their male counterparts, and are enrolled in better schools. They are more likely to attend schools that offer more instruction time and better disciplinary climate. In science, they receive less enquiry-based instruction than boys. Girls are on average more ambitious than boys and develop more sense of belonging to their schools. These are the key characteristics on account of which girls earn at least 20 more points than boys in reading, at least 6 more points in mathematics and at least 11 points in science. Key attribute based on which they lose to boys is higher anxiety. Boys also spend less time studying at home, are more interested in science, and benefit from being in schools where the proportion of girls is high.

12. It is only in reading that girls, on average, obtain higher returns on endowments than boys (5 points), and it is in large part due to the fact that girls get more out of quality teachers in reading. (Girls also benefit from quality teachers in science, but not in mathematics.) Girls also get more out of their time spent studying at home, especially in mathematics and science. Otherwise, in mathematics and science, boys are better in translating endowments into high returns (15 and 8 points, respectively). Boys systematically score higher than girls if they are located in West Anatolia, if they attend more autonomous schools and schools with high socio-economic status. They also capitalise better on their motivation.

13. The study concludes with a list of policy recommendations. It particular, it points to the urgency to (i) address the stratification of the Turkish school system along the socio-economic lines, (ii) alleviate resource constraints in the most disadvantaged households through welfare programs, conditional cash transfers, and employment generation in order to lower the detrimental effects of housework and work for pay, (iii) provide all students with productive parental role models to improve their performance, especially girls in mathematics and science, (iv) sensitise parents about the importance of parental support both for boys and girls, especially of regularly conversing with children, (v) investigate further why girls' ambition and instrumental motivation do not translate into high performance, (vi) sensitise parents, teachers and school principals about the importance of creating environments that are conducive to less stressful learning, especially for girls, and environments that help boys develop a sense of belonging to

their schools, (vii) address the lack of success in mathematics teaching in the case of girls, (viii) engage and interest girls in science by adapting instruction, (ix) promote alternatives to enquiry-based instruction, (x) address the low performance of private schools in Turkey, and (xi) the low performance of girls in West Anatolia and East Black Sea regions.

CONTENTS

1. Introduction

According to the 2016 Global Gender Gap Index of the World Economic Forum,[1] Turkey ranks 130th out of 144 countries in terms of gender equality, just ahead of Iran, Saudi Arabia and Yemen. Turkey's performance is disappointing on account of women's low economic participation and opportunity, political empowerment, as well as educational attainment. Gender school enrolment ratios in Turkey still remain below one at the secondary-school level, and – unlike in many parts of the world where women outnumber men at universities – women in Turkey are still under-represented in tertiary education (WEF (2016))[2]. While Turkey is a member of the OECD, a club of rich countries, its record on account of gender equality in opportunities and outcomes is closer to the MENA region (İlkkaracan (2012)). The inequality carries from education into the labour market, where Turkish women participate at the lowest rate in the OECD (OECD (2017)) and are relegated to less prestigious industries and occupations (İlkkaracan and Selim (2007)). Educational attainment is further related in Turkey to the level of women's wages (Aydemir and Kırdar (forthcoming)), the rate of underage marriage and early childbirth (Kırdar, Dayıoğlu and Koç (2011)), contraceptive use and the uptake of pre-natal care (Dinçer, Kaushal and Grossman (2014)), or bargaining power in the family (Gulesci and Meyersson (2014)).

Enrolment rate being one, another metric of gender gap in education is academic performance. The reported academic performance of enrolled students is usually higher than the hypothetical academic performance of the school-age population due to the positive selection of enrolled students based on observable or unobservable characteristics. This is especially a risk in countries like Turkey where dropout rates remain high, and affect girls more than boys, leading to gender gaps in academic performance being understated. Conditional on being enrolled at school, Turkish girls and young women indeed perform at par with or outperform their male counterparts. This has been observed in the data collected in reading, mathematics and science through international programmes such as the Trends in International Mathematics and Science Study (TIMSS) and the Program for International Student Assessment (PISA). Currently, Turkish girls consistently outperform boys in reading, and on average score at par with boys in mathematics and science. Figure 1 (and Table 1) summarises the evolution of boys', girls' and average scores in reading, mathematics and science in the OECD and Turkey since 2003. While Turkish students persistently score below their OECD peers, gender gaps are very similar across Turkey and OECD. In 2015, Turkish girls performed 28 points above Turkish boys in reading, and their performance in mathematics and science[3] was not statistically different.

This work revisits academic achievement gender gaps in reading, mathematics and science in Turkey, using the most recent wave of data collected by the Programme for International Student Assessment (PISA) in 2015. It starts by estimating education production functions in reading, mathematics and science for boys and girls separately, and follows by decomposing the predicted gender gaps into components due to student, family and school characteristics, and due to the returns on the characteristics. A large battery of student, family and school aspects are taken into account. In particular, this study is interested in understanding how test scores and gender gaps in test scores relate to two groups of variables: (i) parental emotional support and student's engagement with parents, and (ii) the "facilitators" of learning - achievement motivation, test anxiety, and the sense of belonging at school. These variables are important because normally they remain unknown to researcher and are therefore the source of unobserved heterogeneity that leads to the estimates of other coefficients in the regression being biased.

[1] http://reports.weforum.org/global-gender-gap-report-2016/

[2] There are discrepancies in gender enrolment ratios as reported by the Turkish Ministry of National Education (MONE) and survey data (Dinçer (2015), UNICEF (2016)), with MONE statistics suggesting ratios close to one in primary and secondary education. This will be discussed in further detail in section 3.1.
In tertiary education, the enrolment ratio for the young cohorts of women and men has significantly improved over the past 20 years, yet it still remains about 85% (TURKSTAT Education Statistics on www.turkstat.gov.tr)

[3] The composite nature of the science score in PISA does not allow for studying gender gaps by subject, e.g. in physics, chemistry or biology, whereby gender gaps might be more distinct.

More crucially, they are of interest because they are gendered in nature, and thus their contribution to the gender gap in test scores should be investigated formally. No prior study for Turkey looks at their relation to gender gaps in academic performance.

As PISA 2015 focused on science, the present study also explores another, third, group of variables: (iii) student's enjoyment of and interest in science, and instrumental motivation to learn science. Enjoyment, interest and importance given to a subject, normally unknown to the researcher, are also a potential source of unobserved heterogeneity. They are also gendered and their relation to the gender gap in student achievement in science has not been studied in Turkey, except for student motivation in science by Gevrek and Seiberlich (2014) who find a very weak relationship between science motivation and scores, for boys only, in PISA 2006.

Note. Source: OECD.

Figure 1. PISA scores

Although girls outperform boys in reading, and raw data points to similar performance of boys and girls in mathematics and science, a number of studies show that – after controlling for student, family and school characteristics – girls in Turkey still lag behind boys in mathematics, and even in science, which is consistent with the positive selection of female students. These studies establish the evidence of the gender gap in student achievement by the way of a gender dummy in a regression. These are, fore example, in reading – Kasapoğlu (2009), Ferreira and Gignoux (2010), or Bellibaş (2015); in mathematics – Demir and Kılıç (2010), Dinçer and Oral (2013), or Özdemir (2016); in science – Dinçer and Uysal (2010), Ferreira and Gignoux (2010), or Dinçer and Oral (2013). There is only one study for Turkey (Gevrek and Seiberlich (2014)) that decomposes the gender gap in mathematics and science to shed more light on what drives academic achievement differentials between boys and girls in Turkey. It finds that, while girls outperform boys on account of higher endowments – especially favourable family background and the attendance of better schools - it is boys who obtain higher returns on their characteristics. Gevrek and Seiberlich find no gender gap in mathematics and a gender gap in favour of girls in science, based on PISA 2006. There is no more recent study of gender gaps in mathematics and science in Turkey, and no study for Turkey explores the factors behind the gender gap in reading in favour of girls.

This work takes a particular interest in the effect of home environment on academic achievement of boys and girls. OECD's PISA report on student well-being (OECD (2017)) concludes that student achievement, as well as life satisfaction, are strongly influenced by student's interactions with family, especially by regularly talking to parents. This is in line with international literature, whereby it is known that parents systematically convey expectations and values to their children (Hong and Ho (2005), Jeynes (2005, 2007), Hill and Tyson, (2009), Taylor, Clayton and Rowley (2004)). Across the OECD, including in Turkey, there is a significant gender difference in the student-reported engagement with parents. In Turkey, boys are 3% less likely than girls to talk to their parents. Turkey also scores third last among the countries participating in PISA in terms of parental emotional support, defined by parental interest in child's school activities, encouragement, and support in educational efforts and achievements. In Turkey – comparing to girls - boys report receiving less emotional support from their parents. The effect of parental support on student performance, even more so on gender gaps in performance, has rarely been studied in the case of Turkey. Yayan and Berberoğlu (2004), in TIMSS 1999 for Turkey, find that mathematics scores are higher for students whose parents attach more importance to mathematics. Gizir and Aydın (2009), who look at eight-graders in six low-socio-economic-status inner-city schools in Ankara, show that students perform better if they are exposed to high academic expectations at home. Indeed, in PISA 2015, students that interact with their parents also report higher achievement motivation and lower anxiety (OECD (2017)), both of which are consistently related to academic performance (Deci and Ryan (1985), Dweck (1986), Bandura (1997), Green et al. (2004); Hembree (1990), Ashcraft (2002), Beilock et al. (2004)).

OECD (2017) shows that achievement motivation and test anxiety are gendered in nature, across the OECD and in Turkey. Girls are overall more ambitious than boys. However, while girls are more internally motivated - concerned with achieving high performance given own abilities, boys are more likely to be externally and competitively motivated. There are no studies for Turkey that establish the nature of the relationship between ambition or general motivation and test scores, or gender gaps in test scores. Only Dayıoğlu and Türüt-Aşik (2007) suggest that girls' higher scores at a large Turkish university could be attributed to girls' higher motivation levels. School-related anxiety is detrimental to academic achievement, yet it is also more common for countries (and students) that report high achievement motivation (OECD (2017)). Anxiety is also higher in countries where overall scores are low (Kalaycıoğlu (2015)), including Turkey. In PISA 2012 for Turkey, Uysal (2015) uncovers a negative effect of anxiety on mathematics scores. In TIMSS 2011 for Turkey, Topçu, Erbilgin and Arikan (2016) find that lower anxiety correlates with higher mathematics and science scores. Moreover, gender gaps in school-related anxiety are stunning. In the OECD, girls are 17% more likely than boys to report school-related stress; in Turkey the anxiety gender gap is lower at 12% but still highly significant (OECD

(2017)). There are no studies for Turkey that jointly investigate school anxiety and achievement gender gaps.

Apart from family, students are part of school community, and OECD (2017) elaborates on how the sense of belonging at school is important for learning outcomes and student's motivation to learn. The importance of the sense of belonging has been established by education research (Goodenow and Grady (1993), Patterson (2012)). Turkey scores lowest among PISA participants on the account of students' sense of belonging at school, but it is among few countries where girls feel more comfortable at schools than boys. In Turkey, comparing to the OECD, student's sense of belonging at school is particularly strongly (and positively) correlated with school's good disciplinary climate. It correlates with scores even after student family's socio-economic status is controlled for (OECD (2017)). For Turkey, based on PISA 2012, Yilmaz Findik (2016) argues that a higher sense of belonging at school is an important factor in improving student's resilience to disadvantaged circumstances. Also based on PISA 2012, Demir (2016a) finds that the sense of belonging is positively correlated with scientific literacy in Turkey, but Topçu, Erbilgin and Arikan (2016) find the opposite both for science and mathematics scores in TIMSS 2011. Nowhere the relationship between the sense of belonging and the achievement gender gaps is investigated for Turkey.

OECD's report on excellence and equity in education (OECD (2016a)) discusses how students' attitudes to science, their expectations of scientific careers and science achievement are intimately linked. Students' attitudes to science of interest to this study are the enjoyment of science, interest in science and instrumental motivation in science. The enjoyment of science and interest in science reflect student's intrinsic motivation. Instrumental motivation to learn science, on the other hand, arises when learning is perceived as useful, and thus represents extrinsic motivation. In Turkey, Demir and Kılıç (2010) find a significant correlation between the enjoyment of and interest in mathematics and mathematics scores. Enjoyment also comes out as important in Güzeller, Eser and Aksu (2016) for mathematics, in Oral and McGivney (2013) and Topçu, Erbilgin and Arikan (2016) for mathematics and science, and in Sakız (2017) for academic performance in general. Instrumental motivation emerges as significant in many research pieces for Turkey (e.g. Topçu, Erbilgin and Arikan (2016), Yayan and Berberoğlu (2004), Akgül, Cokamay and Demir (2016)).

Attitudes to science remain gendered. According to OECD (2017), boys are slightly more likely to enjoy science than girls, but this is not the case in Turkey where both enjoy science equally. However, the gender gap in interest – in favour of boys – is striking, both in the OCED and Turkey. Boys are systematically more interested than girls in physics and chemistry, while girls show more interest in health. Because interest is built as a result of education and socialisation (Basl (2011), Olsen and Lie (2011)), context or having opportunities to engage with the topic (Drechsel, Carstens and Prenzel (2011)) and one's assessment of own ability in the area (Buccheri, Gruber and Bruhwiler (2011)), interests not in line with social expectations or own self-concept are discarded. This is where gender stereotyping of science (and even more so of math) comes in and is well known to shape – in different directions – boys' and girls' attitudes to subjects and their career expectations (Kjaernsli and Lie (2011)). In spite of lower interest in science among girls, Turkey is one of very few countries where girls are more extrinsically motivated in science than boys, based on PISA 2015. This is a paradox, because Turkey is also the country in the OECD where the expectations of future careers are most gendered, with 50% more boys than girls expecting science careers. Literature usually points to a positive relationship between career expectations, extrinsic motivation and scores, although intrinsic motivation seems to bear more on scores than extrinsic motivation (Eccles (1994), Eccles and Wigfield (1995), Wigfield, Eccles and Rodriguez (1998), Becker, McElvany and Kortenbruck (2010), Vansteenkiste et al. (2008)). No prior study for Turkey explores the relationship between attitudes to science and the gender differences in science scores.

This work sheds light on two aspects of student achievement. First, by estimating education production functions for reading, science and mathematics, it provides general conclusion on the current state of the

academic performance and its determinants in Turkey. In particular, in line with earlier studies for Turkey, it draws attention to the segmented nature of the Turkish school system, where students are streamed into programme types and low- and high-performing schools along the socio-economic lines. It also points to the importance of school's disciplinary climate and school's average socio-economic background, thus speaking to the centrality of school environment, peers and community to fifteen-year-olds' academic performance. Importantly, this study establishes that student's engagement with parents, in particular talking to parents, is a crucial factor driving student performance, both for boys and girls, in all subjects. The study also suggests the importance of motivation for succeeding in mathematics in particular – both for boys and girls. It also shows that anxiety is highly detrimental to both boys' and girls' scores, in all subjects.[4]

Regarding the gender gaps in academic performance, in line with Gevrek and Seiberlich (2014), it emerges that although girls' endowments tend to be higher than boys' in Turkey – especially on account of girls having better child-parent interactions, working less often for pay, attending better schools, being more ambitious and more attached to their schools, boys are better in translating their endowments into returns and scores. This could be related to the fact that in societies where gender-based discrimination is high, and where boys face fewer obstacles to educational and professional development, girls find it harder to capitalise on their investments. A worrying finding is that, systematically, girls more often than boys experience school-related anxiety. Boys overall, on the other hand, spend less time studying at home in all subjects (longer home study is negatively related to scores) and are more interested in science. Yet, girls are more efficient than boys in translating out-of-school study time into scores. Girls also capitalise more than boys on quality teaching, except in mathematics. Why girls do not earn returns on mathematics teaching remains an important concern. Gender gaps are also strongly driven by differential returns on motivation. While girls are more ambitious overall, it is boys who are able to turn their ambition into scores. This is a critical area where further understanding must be gained in order to allow girls to perform to their full potential, especially in mathematics and science. Last but not least, girls persistently underperform across subjects in West Anatolia and East Black Sea, with West Anatolian underperformance contributing in a significant manner to gender gaps in academic achievement in Turkey.

This work ends by suggesting a range of policy implications related to parents, teachers, school principals and the school system overall, in view of not only closing the remaining gender gaps in student achievement, but – foremost - allowing both boys and girls in Turkey to perform to the full of their potential.

2. School system in Turkey

Compulsory education[5] in Turkey was extended from five to eight years in 1997, and further to twelve years in 2012. Pre-primary education exists in Turkey but is not compulsory. Children normally start attending school at the age of six,[6] and go through three four-year education segments at primary, middle and high school, consecutively. Those who proceed to high school, join general, vocational or religious (*imam hatip*) schools.[7] General and vocational schools may be selective or not, conditional on students' past achievement. Students are placed in selective high schools based on their scores at a high-stakes,

[4] The results in this study must be interpreted as conditional correlations, rather than as strictly causal. This will be be discused in more detail in Section 6.
[5] Details can be accessed via Turkey's profile on EURYDICE webpage: https://webgate.ec.europa.eu/fpfis/mwikis/eurydice/
[6] Following 2012 reform, children may enrol at primary school as soon as they reach 55 months of age, and even 50 months upon the presentation of a medical certificate. However, the cohort of students who were fifteen years old at the time of PISA 2015 survey started schooling in the old system, most likely at the age of 6.
[7] In fact, since 2012 students may join religious *imam hatip* middle schools already at the age of 12.

highly competitive and central exam at the eighth grade. Examples of highly competitive high schools are Anatolian high schools (general or vocational), other select general high schools with instruction in a foreign language and science high schools. Four years later, the transition to general tertiary education takes place based on student performance at another high-stakes, highly competitive and central exam. Transition to post-secondary vocational schools is less competitive. What thus emerges is a segmented system that very early starts streaming students based on ability and performance. Further, the system encourages additional personal investments in education, which more are easily achieved in well-resourced households. A by-product of the system is highly developed private tutoring industry that helps prepare students for the central exams already at an early age (e.g. Tansel and Bircan (2006)).

3. Gender gaps in enrolment and academic performance in Turkey

This section discusses the stock of knowledge on gender gaps in schooling in Turkey. It starts by elaborating on school dropout, and potentially the gendered nature of it. Understanding dropout is crucial to the interpretation of the results in this study because – if dropout is gendered, for example – it leads to a sample selection bias in the PISA sample. Next, the section reviews existing evidence on gender gaps in academic performance in Turkey.

3.1. School dropout in Turkey

Although education in Turkey is *de jure* compulsory until the age of 18, this is not *de facto* enforced and students continue to drop out at the time of their transition to high school, and earlier. The official statistics of the Turkish Ministry of National Education (MONE) report the enrolment rates of 96%, 94% and 80% at the primary, lower-secondary and upper-secondary school levels, respectively, and gender ratios close to one throughout all school levels (MONE (2016)). On the other hand, calculations based on the Turkish Demographic and Health Survey (TDHS) 2013 (Table A1 in the appendix) indicate 86% and 79% enrolment rates for fifteen-year-old boys and girls, respectively, and thus a seven per-cent gender enrolment gap, across Turkey. Tables A1a and A1b also show that disparities vary by region and the socio-economic status of the household. Only about 60% of girls are enrolled in Northeast, Central and Southeast Anatolia, while 75-85% boys in the same regions are. Large gender disparities in enrolment are also present in West Anatolia and East Black Sea, approximately of 11-12% order. Enrolment gender gap at fifteen is only 5% in the high-wealth households, but it doubles to 10% in the low-wealth families.

A couple of studies discuss the disparities in enrolment data coming from the national statistics on one hand, and survey data on the other. Dinçer (2015) argues that, because of student absenteeism, enrollment rates do not necessarily reflect actual access to education. Official enrollment data comes from an education management information system - e-School - which is linked to the administrative population database. It automatically assigns each child of compulsory-school age to his or her primary school in the local catchment area. Therefore a child may remain registered in the system even if he or she never attends school. UNICEF (2016), comparing MONE's enrolment statistics with the TDHS 2013, suggests that discrepancies especially at the secondary-school level could also be related to different school-starting ages, drop-out in earlier grades and the timing of the survey. UNICEF confirms that TDHS-reported secondary-school enrolment is higher for boys than girls, with heterogeneity depending on the socio-economic status, region and locality. UNICEF reports severe drop-out after grades 4 and 8, particularly in the lowest socio-economic group, Turkey's East and rural areas.

A number of studies explore gender enrolment gaps in Turkey analytically. Anıl et al. (2016), using e-School data and after accounting for a large number of controls, show that females in Turkey are 9% more likely than males to drop out after completing eighth grade. For early 1990s, Tansel (2002) shows that enrolment is strongly related to household income and parental schooling, and the effects of these are larger for girls. Girls start to drop out of school already around the third grade, and regional differences

exist, with girls faring worst in Turkey's Southeast. Smits and Gündüz-Hoşgör (2006), for Turkey in late 1990s, find higher non-enrolment of girls, especially in rural areas and Turkey's Southeast, as well as document the importance of mother's schooling for girls school attendance. Boys, on the other hand, are more likely to drop out in economically challenged families, potentially indicating the demand for child labour. Kırdar (2009) studies ethnicity and gender enrolment gaps at ages eight-to-fifteen. He finds that, in late 1990s, gender gaps in enrolment were especially prominent for Kurdish and Arabic children, amounting to about 20% difference. Kırdar finds that, while regional and family-level controls can account for the disparities in ethnic enrolment rates for boys, the same is not possible for girls, suggesting a taste for discrimination against girls' in Kurdish and Arabic families. Dayıoğlu, Kırdar, and Tansel (2009), also for Turkey in late 1990s, show that girls' enrolment is adversely affected by the sex composition of older siblings when it is skewed towards boys, especially in poorer households. Akkoyunlu-Wiggley and Wigley (2008), based on a more recent TDHS 2003, report a 6% gender gap in enrolment (in favour of boys) at middle-school level in Turkey, and a substantial regional variation – with gender gap as large as 17% in Northeast Anatolia. A study by Ferreira and Gignoux (2010), also based on TDHS 2003 data, documents that girls from Turkey's East, daughters of less educated mothers, girls in larger and poorer families drop out of school early, or never attend to start with, especially in Turkey's East. When considering enrolment profiles by age, girls start to drop out around the age of twelve, while boys two years later, around the age of fourteen. Last but not least, Hisarcıklılar, McKay and Wright (2010) look at the change in the school enrolment of boys and girls in Turkey between 1988 and 2006. They find that, while enrolment rates increased over time, the gender gap persists. For 2006 they record the gender ratio of 0.94 at the primary and middle school level, and 0.80 at the high school level.

There is a need for a more recent study of dropout and gender in Turkey. TDHS 2013 data in Tables A1 and A2 in the appendix suggests that dropout remains gendered. For the present study this means a potential sample selection in favour of better performing girls in the PISA sample, and possibly achievement gaps being biased in favour of girls.

3.2. Gender gaps in academic performance in Turkey

Most studies for Turkey that inform on gender gaps in test scores do so by comparing the means, or by using a gender dummy in a regression. The only study that decomposes the gender gap in scores is Gevrek and Seiberlich (2014), and it is based on PISA 2006. The general picture that emerges from literature is that girls outperform boys in reading, while the results for mathematics and science are more controversial and depend on the dataset and survey wave. Below, I present a literature review on gender gaps in test scores in Turkey by subject.

Reading

It is a worldwide phenomenon that girls more often than not outperform boys in reading, and Turkey is no exception (OECD (2016a)). Ferreira and Gignoux (2010) – using PISA 2006 – estimate a 33-point (and significant) gender gap in reading in Turkey. Their model controls for student and family background characteristics, such as parental education and occupation, the number of books, durables and cultural possessions at home, as well as school location and region. Kasapoğlu (2009) estimates the probability of students to score above the OECD average in reading in PISA 2009. The study finds that, in Turkey, the odds of female students scoring above the OECD average in reading are at least twice as high as those of their male counterparts. Also for PISA 2009, Dinçer and Oral (2013) confirm that for boys the odds of success in reading are half of those for girls. For the next wave of PISA collected in 2012, Bellibaş (2015) - while focusing on the role of family's socio-economic status – finds a 37-point gender gap in reading.

Math

Gender gaps in mathematics have attracted a lot of global attention (Guiso et al. (2008), Fryer and Levitt (2009)). In Turkey, the results are controversial and there is much disagreement if mathematics gender

gaps actually exist, and the reasons behind them if they do. Erbaş (2005) studies algebra performance of 217 nine-graders from two public academic, one private, and one vocational high school in a middle-class district of a large Turkish city. Coefficient on his gender dummy is not statistically significant; however he employs a limited set of controls. Bulut, Gür and Sriraman (2010) provide a literature overview on gender and mathematics scores in Turkey – based on surveys such as the Trends in International Mathematics and Science Study (TIMSS), as well as national exams (but excluding PISA). They conclude that generally there is little evidence of significant gender gaps in mathematics, but the results nevertheless vary between the surveys and the years of testing.

The majority of studies that explore math scores in Turkey are based on PISA data. In PISA 2003, using Hierarchical Linear Modelling, Demir and Kılıç (2010) find that boys have a significantly higher probability than girls to score above the Turkish average. In PISA 2006, also employing Hierarchical Linear Modelling, Alacacı and Erbaş (2010) report again a significant gender gap in mathematics in favour of boys. Ferreira and Gignoux (2010) – again in PISA 2006 – obtain a 14-point gender gap in mathematics in favour of boys. The study of Gevrek and Seiberlich (2014) – based on PISA 2006 and employing a semi-parametric decomposition of gender gap – finds, to the contrary, that girls do as well as boys in mathematics. They discover that gender differences in observable characteristics (e.g. family background or school type) predict an advantage for girls in mathematics, but boys are better in translating endowments into returns in scores. Authors admit that sample selection remains a problem, and scores in favour of girls might be overstated.

Using the following PISA wave conducted in 2009, Dinçer and Oral (2013) estimate boys' odds of success in mathematics to be more than five times higher than girls'. The study controls for a wide range of family and school characteristics, including school resources. Also in PISA 2009, Kılıç, Çene and Demir (2012) explore learning strategies in mathematics with Hierarchical Linear Modelling. They find that male students are more successful than female students in acquiring math skills (22-point gap in their favour). Studies using PISA 2012 data show, generally, that mathematics gender gap is significant in favour of boys. Bellibaş (2015) obtains a 22-point gender gap in mathematics in favour of male students. Özdemir (2016) shows that girls in Turkey score 23-27 points below boys in mathematics. He investigates if a possible reason for the gender gap in mathematics is that boys in Turkey are allocated to higher-status schools. This does not seem to be the case – in fact, girls are more likely to enrol at selective schools in Turkey. However, the returns to attending selective schools are lower for girls by about 7-8 points *vis-à-vis* boys. Güzeller, Eser and Aksu (2016), unlike other studies on PISA 2012, find that girls have a higher probability of scoring above the average in mathematics. Unfortunately their model uses very few controls. In particular, student's family background and school characteristics are not controlled for.

A number of studies explore gender and mathematics scores in TIMSS data. It must be remembered that TIMSS, unlike PISA, is a curriculum-based exam and hence might be measuring different knowledge and skills. For TIMSS 2007, Badr, Morrisey and Appleton (2012) estimate an education production function in mathematics on eight-graders in the MENA region. Overall, they find very low returns to schooling in MENA, and that student and family characteristics are a more important determinant of scores than school characteristics. For Turkey, they find an 8-point gender gap in favour of boys. For eight-graders in TIMSS 2011, Oral and McGivney (2013) find that on average girls obtain higher scores than boys, especially if their mothers are highly educated. Mullis et al. (2013) - also in TIMSS 2011 in Turkey – find that four- and eight-grade girls perform slightly better than boys in mathematics. Also Sulku and Abdıoğlu (2013) – in TIMSS 2011 for eight-grade students – show that girls in Turkey perform 6-7 points above boys, however this effect disappears after student's attitudes to mathematics and family background are controlled for.

On the whole, the evidence on gender gaps in mathematics is extremely mixed and the results depend on the data source, survey wave and methodology used.

Science

In science, girls perform similar to boys around the world (OECD (2016a)) and evidence on Turkey points to the same conclusion. According to Gevrek and Seiberlich (2014) and their gender gap decomposition in PISA 2006, girls even outperform boys in science in Turkey. It is the gender differences in observable characteristics (e.g. family background or school type) that predict an advantage for girls, but – as in mathematics - boys are better in translating endowments into returns in scores. Dinçer and Uysal (2010) – also for PISA 2006 – find no gender gap in science scores after family background, school types and school's average economic, social and cultural status are controlled for. In Ferreira and Gignoux (2010), still for PISA 2006, gender gap in science is only 2 points and not statistically significant. In PISA 2009, however, Dinçer and Oral (2013) find that the odds of success is science are twice as high for boys, even after school characteristics, resources and climate are controlled for. In PISA 2012, Bellibaş (2015) finds no significant gender gap in science scores. In TIMSS 2011, according to Oral and McGivney (2013), science scores are similar for boys and girls, and girls with educated mothers score above their male counterparts.

GPA and composite scores

A few studies study gender and academic achievement using school GPA scores, university entrance exam scores or own data. Dayıoğlu and Türüt-Aşik (2007) look at university entrance scores, English preparatory school scores, and the university GPA at the Middle-Eastern Technical University (METU). They find that females enter METU with lower scores, and are under-represented in most departments.[8] However – once they are admitted – they excel and outperform their male counterparts (possibly due to better class attendance, study skills and motivation). Saygın (2010) explores 2008 data from the Student Selection Examination in Turkey (OSS) based on which students are allocated to universities. She looks at Turkey as a whole, unlike the above METU study, and finds that - according to their GPA scores - female students outperform males in high schools. They also receive higher test scores at the OSS. However, it is male students who predominate at highly selective and prestigious universities and programs, which leads to their high returns in the labour market. Saygin suggests a positive selection of females enrolled in high schools, better financial support they receive from families, including more private tutoring. Engin-Demir (2009) studies the scores of six-to-eight-graders in city squatter settlements. The composite score used is the weighted score in reading, mathematics and science. She reports a negative and significant coefficient on male dummy, suggesting that girls in disadvantaged neighbourhoods are more resilient than boys.

To summarise, school GPA and university entrance exam scores indicate that girls enrolled at school may be positively selected. Yet, in difficult circumstances, they are more likely to be resilient students, and are capable of outperforming boys even in technical subjects at the university.

4. Data

The OECD Programme for International Student Assessment (PISA) is a triennial survey of fifteen-year olds enrolled at school, in the OECD and partner countries, which measures student achievement in reading, mathematics and science. Rather than focusing on curriculum, PISA aims to measure student knowledge and life skills as deemed required in modern societies. As such, it focuses on literacy in the three domains, as well as on student's ability to extrapolate, in a flexible manner, from the acquired knowledge. Apart form collecting scores in reading, mathematics and science, PISA also conducts comprehensive background questionnaires of students, teachers and schools, and thus collects data on students' socio-economic status, home environment, attitudes to study and learning, among others, as

[8] Entry to university in Turkey is based on central examination scores and student's stated preferences.

well as a large battery of information on class practices and school characteristics, from location, through resources, to management.

The most recent wave of PISA data, used in this study, was gathered in Turkey in Spring 2015. 5,897 students took the tests and answered background questionnaires. The students drew from 187 schools[9]. The majority of the tested fifteen-year-olds attended high schools, from grade 9 up. 123 students drew from middle schools. The principals of all participating schools also filled in school questionnaires. Teacher questionnaires were not conducted. My final sample excludes the middle schools and their students. One reason for this is the relatively few middle-school students in the original PISA dataset, which means that this group cannot be efficiently analysed given the missing data. Another, and a more important reason, is that middle-school students are substantially different from high-school students. Not only they have not taken the central exam based on which students in Turkey are allocated to high schools, but they are also more likely to be low performers and grade repeaters. Restricting attention to high-school students only allows obtaining a more homogenous sample of students for the analysis.

As a large battery of explanatory variables is used in this work, the problem that arises is that of missing data. One high school (38 students) is dropped because its principal does not provide sufficient information about its characteristics. Close to 100 observations are dropped because parental education is missing. Close to 300 observations are dropped because they do not provide information on the time (hours) spent on class and home study. Close to 350 observations are dropped because they do not provide information on engagement with parents, house chores and work for pay. My final sample for reading and mathematics analysis contains 4863 students from 159 high schools, approximately 84% of the original sample of high-school students. About 550 further students are dropped for the purpose of science regressions, because data is missing on the enjoyment of and interest in science, and the science class format. Science regression is, therefore, based on the final sample of 4263 students from 159 schools, approximately 74% of the original sample of high-school students. Robustness checks - regressions with imputed data - are carried out to assess the importance of the dropped observations. When missing values are imputed, the sample becomes 5,724 observations.

5. Education production function and its inputs

Student achievement has traditionally been analysed in the framework of education production function (Coleman et al. (1966), Hanushek and Woessmann (2011), Woessmann (2016)), whereby inputs enter an unobserved technology to produce an educational outcome. In this study, the output of interest is Turkish students' PISA scores in reading, mathematics and science. The scores are standardised, with the mean of 500 and the standard deviation of 100, at the OECD-level. The inputs are student's background characteristics, study time, program types, school resources and management, among others. An added feature of this study is the consideration of student's relationship with parents, as well as a number of non-cognitive attributes and emotions. Student's socioeconomic background, as well as school resources and institutions, have been the focal point of interest in the studies based on education production function since 1960s. This work, in line with more recent developments, incorporates a range of additional inputs that are believed an important determinant of student achievement, and the data on which has started to be collected only more recently. These are, for example, parental emotional support, student's achievement motivation, proclivity for anxiety, or the sense of belonging at school. As PISA 2015 focused on science, it also asked about student's attitudes to science, as well the format of science classes attended, both of which are also explored in this work. The groups of explanatory variables in the present study are described below. The content of indices compiled by PISA is detailed in Table A2 in the appendix.

[9] Students in distance education are not included in the PISA sample.

Student and family background

Sex remains an important determinant of school enrolment in Turkey. Although institutional data for Turkey reports similar enrolment rates for boys and girls (MONE (2016)), survey data points to the persistence of gender enrolment gaps, as explained earlier. In Turkey, sex intersects especially with regions, household wealth and ethnicity in determining school attendance. With regard to scores, across the OECD – including in Turkey - girls tend to outperform boys in reading, slightly lag behind in mathematics and preform similarly in science (OECD (2016a)). I record child's ethnicity based on the primary language spoken at home. Children whose mother tongue is not the same as the test language tend to perform worse than natives (OECD (2016b), Stanat and Christensen (2006)). In Turkey, non-Turkish students score significantly below their Turkish peers – 22 fewer points in reading and 11-12 fewer points in mathematics and science (Bellibaş (2016)). Özdemir (2016) finds no such effect but argues that it may be the result of non-Turkish students being under-represented in the PISA sample. Kasapoğlu (2009) also finds no regular relationship between scores and ethnicity in Turkey. On the other hand, in TIMSS 2007, Badr, Morrisey and Appleton (2012) report native Turkish students scoring 42 points above non-native students. Oral and McGivney (2013) for TIMSS 2011 find that students that speak Turkish at home perform better in mathematics and science.

Mother's and father's educational attainment is divided into three categories: less than high school diploma, high school diploma, or university degree. I also record if mother and father are employed. It is likely that more educated and professionally active parents are more cognisant of the benefits of education and capable of transmitting knowledge in such a way that their children perform better on tests. Household wealth is measured using the home possession index, with mean zero and standard deviation equal to one at the OECD level. The index incorporates household's material wealth, cultural possessions and educational resources, all of which may be conducive to student learning and achievement. In the literature, student's socio-economic background remains a very important determinant of achievement, especially in the developed countries (Sirin (2005), Hanushek and Woessmann (2011), Woessmann (2016)). It does so also in Turkey as reported by a large number of studies (e.g. Bellibaş (2016), Özdemir (2016), World Bank (2013), Kılıç, Çene and Demir (2012), Blanchy and Şaşmaz (2011), Ferreira and Gignoux (2010), Kasapoglu (2009)). Also for Turkey, Gevrek and Seiberlich (2014) show that – although enrolled girls tend to come from higher socio-economic backgrounds than boys – it is boys who achieve higher returns on endowments, including family characteristics, especially in mathematics.

Home environment and upbringing

This group of variables are related to family background, yet they add the sophistication in describing the environment in which child has been growing up. The first variable is attendance in early childhood education for at least a year. Early childhood education is well known to influence learning and life-long outcomes (OECD (2011)). In Turkey, Kasapoğlu (2009) finds that the age of entering school is a significant determinant of reading scores in PISA 2009. Ağırdağ, Yazıcı and Sierens (2015) link early childhood education attendance to higher PISA 2012 scores. However, they find that pupils from wealthy families benefit more from early childhood education than middle-class and poorer pupils, which – given the shortcomings of the study - might reflect the positive selection into school enrolment.

Parental emotional support, normally an unobserved family feature, is recorded in PISA in the form of an index with mean zero and standard deviation equal to one at the OECD level, and is constructed from answers to a number of questions about child's perceived parental guidance. Students are also asked about their activities at home after or before school. In particular, we know if they regularly speak to their parents, if they help with house chores and if they work for pay. Parental emotional support and the time students spend with parents consistently correlates with academic performance and wellbeing, and girls report higher engagement with parents across the OECD (OECD (2017)). In Turkey, Gizir and Aydın (2009) look at students from low socio-economic backgrounds and find that being exposed to high academic expectations at home adds to the academic resilience for these students. Yayan and Berberoğlu

(2004), in TIMSS 1999 for Turkey, also find that mathematics scores are higher for students whose parents attach more importance to mathematics.

Housework and paid work are potentially detrimental to learning, and may also be gendered, as girls are likely to be more involved in house chores and boys in paid jobs. On average across OECD countries, the score-point difference in science performance between students who work in the household and those who do not is 13 points, while the difference is 55 points between students who work for pay and those who do not, after accounting for gender and socio-economic status (OECD (2017)). For Turkey, Engin-Demir (2009) studies teenagers who attend school while also working for pay, and finds that girls are more resilient than boys after controlling for family characteristics and support received at home and at school.

Study time and the "facilitators" of learning

PISA provides information on the number of hours a student spends in class and on home study, in the three domains - reading, mathematics and science. In cross-country studies, time spent in class does not necessarily correlate with scores because the overall school system efficiencies are more important. However, in a specific country context, keeping the system efficiency constant, class study time may improve scores. On the other hand, time spent studying at home tends to be negatively related to student performance. This most likely captures the remedial nature of home study time – struggling students will spend more time at home on homework (OECD (2016b)). For Turkey's urban poor, Engir-Demir (2009) finds that test scores are positively correlated with the total time spent studying during class and at home. Kasapoglu (2009) finds a similar result for Turkey overall, for reading, and Güzeller and Akin (2011) for mathematics.

The indices of student's overall ambition (or achievement motivation), test anxiety and the sense of belonging at school are all standardised at mean zero with standard deviation equal to one at the OECD level, and are constructed from answers to a number of questions about student's attitudes and feelings. Being able to control for student's achievement motivation is important because ambition is usually a hidden personal trait and leads to unobserved heterogeneity in the sample, and biased estimates. In the OECD, while girls are more likely to aspire to top grades and careers, boys more often describe themselves as ambitious and wanting to be the best. Achievement motivation is positively related to performance at school and to life satisfaction, but also comes with higher levels of test anxiety (OECD (2017)). Dayıoğlu and Türüt-Aşik (2007) attribute girls' higher scores at a large Turkish university, among others, to their higher motivation levels.

Test anxiety and the sense of belonging at school are also potentially influential, and gendered. On average, one in two students in the OECD experiences test anxiety; anxiety is more frequent among girls than boys; and it is negatively correlated with achievement and life satisfaction (OECD (2017)). In PISA 2012 for Turkey, Uysal (2015) uncovers the negative effect of anxiety on mathematics scores. For TIMSS 2011 scores in Turkey, Topçu, Erbilgin and Arikan (2016) also find that anxiety correlates negatively with mathematics and science scores. Kalaycıoğlu (2015) shows that anxiety is more common in countries where overall scores are low, including Turkey and Greece. Hence, anxiety and scores are negatively related both within and between countries.

Developing a sense of belonging at school has positive remedial effects. Unfortunately, Turkey scores at the very bottom in PISA sense-of-belonging indicators (OECD (2017)). Disadvantaged students systematically report lower sense of belonging at school than their counterparts from higher socio-economic backgrounds, both at the OECD overall and in Turkey in particular. This could be related to the time spent at school, for example, as well as the quality of schools attended. But unlike in the OECD, Turkish girls experience a higher sense of belonging at school than Turkish boys. For Turkey, Yilmaz Findik (2016) argues that a higher sense of belonging at school is an important factor in improving student's resilience to disadvantaged circumstances. Demir (2016a) finds that the sense of belonging is

good for scientific literacy, but Topçu, Erbilgin and Arikan (2016) find the opposite both for science and mathematics scores in TIMSS 2011.

School and program characteristics

I control for school's location: village (population <15,000), town or city (population 15,000-1,000,000) or big city (population >1,000,000)[10], as well as region at the NUTS-1 level of classification (Istanbul, West Marmara, Aegean, East Marmara, West Anatolia, Mediterranean, Central Anatolia, West Black Sea, East Black Sea, Northeast Anatolia, Central East Anatolia, Southeast Anatolia) as depicted in Figure A1 in the appendix. Programme types recorded in PISA for Turkey are general and vocational. I combine them with school selectivity to construct four programme types: general not selective, general selective, vocational not selective and vocational selective. Selective schools are those that always recruit students based on the scores earned at the centralised exam at the end of the eighth grade. In Turkey, programme types have been shown to be important for student achievement. Dinçer and Uysal (2010) find important correlation between programme types and student scores in science, and Dincer and Oral (2012) with student scores in reading, mathematics and science. A number of other studies also discuss the extent to which programme types remain one of the biggest determinants of score variation, and how school segregation reinforces the effect of family background on academic performance in Turkey (e.g. World Bank (2013) for average scores, or Özdemir (2016) for mathematics).

School resources and management

As is customary, I include in the analysis average class size at the school, and class sized squared, as well as student-teacher ratio and student-teacher ratio squared. There is little evidence in the literature that class size or student-teacher ratios matter, except when the quality of teaching is low (Glewwe (2002), Hanushek (2006), Hanushek and Woessmann (2011), Woessmann (2016)). In Turkey, there is mixed evidence regarding the two. Class size is not statistically significant in some studies (e.g. Dinçer and Uysal (2010) but has a negative effect in others (World Bank (2013)). Reduced class-size seems to benefit students from disadvantaged background (Bellibaş (2016)). Teacher-student ratio remains significant in Dinçer and Uysal (2010) but not in World Bank (2013).

Two indices of resource shortages (educational material and staff) are constructed from school principal's answers, and are standardised with mean zero and standard deviation equal one at the OECD level. The quality of teachers at school is accounted for by the fraction of teachers with at least a bachelor degree. The effect of school resources on test scores is controversial but a consensus is emerging that school resources matter little in the developed countries, while they still come out as important in the developing countries (Glewwe (2002), Hanushek (2006), Hanushek and Woessmann (2011), Woessmann (2016)). Evidence for Turkey points towards the conclusion that material school resources are less important than school environment, disciplinary climate, teaching practices and the level of support that students receive, just to mention a few (e.g. Engin-Demir (2009), Alacacı and Erbaş (2010), Dinçer and Uysal (2010), Dinçer and Oral (2013), World Bank (2013)).

The effect of school management or institutional setting is best studied using a cross-section of countries, as institutions vary little at a country level (Woessmann et al. (2010)). In this study for Turkey only I nevertheless account for private schools, the fraction of school resources provided by the government, student grouping by ability, principal's leadership quality, school's accountability and autonomy in deciding on the allocation of resources and curriculum. The literature has produced mixed results regarding the importance of school management. Privately managed schools tend to produce better students, especially if they are also subsidised by the government. Leadership quality is potentially linked to higher scores, while autonomy tends to have a positive effect on performance if combined with strong accountability mechanisms (Hanushek and Woessmann (2011), Woesmann (2016)). In Turkey, Sulku

[10] School's location is not synonymous with child's residence because an important fraction of students in Turkey attend boarding schools or is bussed to schools in town on daily basis.

and Abdıoğlu (2015) find higher scores in TIMSS 2011 among students attending private schools. However, Alacacı and Erbaş (2010) find a negative correlation between private schools and scores in PISA 2006. The grouping of students by ability emerges as not statistically significant (Alacacı and Erbaş (2010), Dinçer and Uysal (2010)). The effect of school leadership and autonomy are also generally not statistically significant (World Bank (2013), Dinçer and Oral (2013), Alacacı and Erbaş (2010)). Students at schools receiving higher fraction of their funding from the government also do not seem to gain higher scores (Alacacı and Erbaş (2010)).

School's climate and peer effects

This group of variables contains school-level characteristics that capture class, neighbourhood and peer effects. Two relate to the disciplinary climate as reported by school's principal – the indices of (the lack of) student and teacher discipline, respectively, standardised with mean zero and standard deviation equal to one at the OECD level. The lack of discipline is potentially detrimental to student learning. On average across OECD countries, students in advantaged schools enjoy a more positive disciplinary climate than students in disadvantaged schools (OECD (2016b)). In Turkey, the importance of disciplinary climate has been acknowledged in a couple of studies (e.g. World Bank (2013), Dinçer and Oral (2013)). Moreover, I also include school's students' average index of economic, social and cultural status (ESCS) and its square. School's average ESCS might remain important even if school resources and management are controlled for, because students also learn from their peers and the community. Studies for Turkey systematically obtain statistically significant coefficients on school's average ESCS (e.g. World Bank (2013), Dinçer and Uysal (20120), Alacacı and Erbaş (2010)). Finally, the fraction of girls at school is controlled for because evidence exists that both boys and girls perform better in environments dominated by female students (Anıl et al. (2016)).

Student's attitudes to science

PISA 2015 focused on science, and as a result it contained an expanded module related to science in the student background questionnaire. I retain three indices (standardised with mean zero and standard deviation equal to one) of student's enjoyment of science, student's interest in science topics, and his or her instrumental motivation to learn science (as per usefulness for future work and career). All three are potentially important for student's achievement (OECD (2016a, 2017), Ainley and Ainley (2011a, 2011b)). In Turkey, Demir and Kılıç (2010) find a significant effect of enjoyment of and interest in mathematics on mathematics scores. Enjoyment also comes out as important in Güzeller, Eser and Aksu (2016) for mathematics; in Oral and McGivney (2013) and Topçu, Erbilgin and Arikan (2016) for mathematics and science; and in Sakız (2017) for academic performance in general. Instrumental motivation emerges as significant in many research pieces for Turkey (e.g. Topçu, Erbilgin and Arikan (2016), Yayan and Berberoğlu (2004), Akgül, Cokamay and Demir (2016)).

Science class format

Last, but not least, when investigating the determinants of science scores, I control for the science class format that student is exposed to. I retain three indices (standardised with mean zero and standard deviation equal to one) for the use of enquiry-based instruction, teacher-directed instruction and adaptive instruction. The literature shows that enquiry-based instruction tends to be detrimental to learning, while teacher-directed and adaptive instruction – on the contrary – help students score high (OECD (2016b)). Also in Turkey, World Bank (2013) and Yayan and Berberoğlu (2004) find teaching practices important, and particularly beneficial if they are teacher-directed.

6. Methodology

Balanced Repeated Replication and Item Response Theory

Given PISA survey design, the use of its data requires specific methodological attention. PISA's target population are fifteen-year olds currently enrolled at schools. PISA sampling is not random. Rather, it is conducted in two stages. In the first stage, schools are drawn with probabilities proportional to their size. Sampling weights are then assigned to schools in order to render them representative at the country level. In the second stage, students are randomly selected within each school. Because schools were not drawn at random to start with, the selected students cannot be viewed as a random sample. While sampling weights are also assigned to students to render them representative, students within each school form *de facto* clusters likely to share common characteristics, and hence a common error term, which gives rise to heteroscedascity and complicates the estimation of population parameters. The common way to correct for such a variance structure is the method of Balanced Repeated Replication (BRR). BRR uses 80 sub-samples and their sampling weights provided by PISA to estimate each parameter 80-fold and construct a distribution of each parameter, in order to obtain an unbiased and consistent estimator.

Another feature of PISA is the use of Item Response Theory (IRT) to measure test scores. Because during the test each student may answer a different set of questions, IRT imputes each student a score he or she would be likely to obtain had he or she answered all the questions. PISA 2015 provides ten plausible values for each student in the three subjects. This study uses STATA's *repest* module that implements estimations with weighted replicate samples and plausible values. All tests and post-estimation exercises in this study are also obtained with *repest.*[11]

Coverage

The Turkish case requires an additional discussion of the PISA survey coverage. At the time of the survey, Turkish fifteen-year-olds' enrolment rate stood at 83%. Excluding distance education students and after accounting for further school and student exclusions, the final coverage of PISA 2015 in Turkey was 70% of all fifteen-year-olds. PISA coverage being lower than 100% is thus largely due to the less than full enrolment of fifteen-year-olds in Turkey. This poses a risk of sample selection bias in the PISA sample, because low-performing students are more likely to have dropped out before reaching high school and participating in PISA. This is especially likely in the case of girls, as discussed earlier. Hence, the PISA sample in Turkey is likely to be skewed towards high-performing girls, possibly from higher socio-economic backgrounds when compared to boys. It thus follows that gender gaps in scores might be biased in favour of girls. This fact must be remembered when interpreting the results of this study. Some scholars have attempted to correct for this shortcoming in Turkey's PISA by reweighing the PISA sample with weights obtained from a nationally-representative survey, such as the Household Budget Survey (e.g. Ferreira and Gignoux (2010)). With this approach, however, it would be difficult to estimate all the parameters of interest to this work because the calculation of the new weights must take place based on only a limited number of observable characteristics. Moreover, it is likely that individuals excluded from the PISA sample – on account of being low performers - would have scored lower than those in the sample had they actually taken the test. Re-weighing the sample would therefore have to be accompanied by an additional assumption about the level of those scores. In this study, I consequently choose not to re-weight the sample, but remain vigilant when interpreting the results. Finally, there is no alternative way to correct for selection using the participation equation because PISA sample contains only enrolled students.

Missing data

Although in the case of individual variables in PISA 2015 not more than 5% of data is usually missing in the dataset, the list-wise deletion of observations that have any data missing results in the sample reduced in size by about 15% for reading and mathematics, and by about 25% for science. Moreover, there are a couple of variables for which a substantial number of observations have missing data. The most crucial are student's study time at school and at home. For science, at times more than 10% of students also lack

[11] Same regression results are obtained with PV-module of Kevin MacDonald accessible via http://ideas.repec.org.

information on attitudes to science and the format of the science class. Missing data is summarised in Table A3 in the appendix.

I use an add-hoc method and impute values equal to the school's median value for observations and variables with missing data. Using school medians is more realistic than using sample averages because it is less mean preserving, and in PISA 2015 more data is missing at the left tail of the scores distribution. I also add to the regression a set of dummies that take value of one if an observation had a missing data imputed for a given variable. Estimates produced in this way remain biased and inconsistent. Bias usually arises with imputed data when data is missing not at random. Although estimation efficiency is improved because sample size increases, standard errors might eventually become too small as the imputed values are medians and hence lack the dispersion of the actual data. Unfortunately, it is very difficult to impute data properly when data format is such as in PISA: imputation would require the recalculation of plausible values for the test scores. This is beyond the scope of this paper. At the very least, the inclusion of missing-data dummies allows gauging where missing data affects the results most.

Model specifications

Table A4 in the appendix summarizes the models estimated in this paper, whereby groups of variables are included step-wise. The baseline (Model 1) includes the fundamental child and family background variables, such as ethnicity, parental educational background and occupational status, and family wealth. Model 2 adds additional variables that are closely related to student' family – if student attended at least a year of early childhood education, how much emotional support student receives from parents, if he or she regularly talks to parents, and if he or she works in the household or for pay. Time spent learning at school and at home, and the "facilitators" of learning – achievement motivation, test anxiety and the sense of belonging at school are added in Model 3. Model 4 incorporates the basic school and programme characteristics. Model 5 controls for school resources and management, while Model 6 considers a few variables indicative of school's climate and the average socio-economic status. Models 7 and 8 concern the equation estimated for science only. Model 7 adds student's attitudes to science. Model 8 also incorporates the science class format.

Interpretation

Finally, a note on the interpretation of the results is required. The estimation of the education production function as undertaken in this study does not allow interpreting the results as causal. Instead, the results must be seen as conditional correlations. This is the case because of such daunting problems as (i) omitted variable bias and/or unobserved heterogeneity, (ii) measurement error or (iii) reverse causality. While PISA 2015 allows controlling for a large battery of family and student attributes, such as parental emotional support, motivation or interest, there might be other characteristics of families and students that remain unobserved, yet important. One example is prior student achievement or IQ. Measurement error can easily arise in the case of variables measuring attitudes – some groups of students may be prone to systematic understatements or exaggerations. Reverse causality is probably the most pervasive problem. In as much as many variables affect scores, scores may also affect the variables that the study treats as explanatory. For instance, student's enjoyment of science is influenced by the level of student's science knowledge, and vice-versa. Some studies utilise structural equation modelling to discern the relative strength of such relationships. This is beyond the scope of this work.

7. Descriptive statistics

The equity of scores in general, and by gender in particular, being of interest to this study, this section presents descriptive statistics both for low- and high-scoring students, as well as boys and girls. It also calculates within-school and between-school variation of average scores and family economic, social and cultural status (ESCS) to assess the degree of school segregation by performance and family background.

Descriptive statistics by average scores

Students are divided into two halves - scoring below and above the median[12] - and the descriptive statistics for the two groups are presented in Table 2. The average scores in the two groups are more than 100 points apart, which is equivalent to approximately three years of schooling. High-scoring students are slightly more likely to be girls and Turkish, they attend higher grades and have received at least a year of early childhood education. While their mothers are only a little more educated, their fathers are 50% more likely to have at least a high-school diploma and twice as likely to have a university degree. Both their mothers and fathers are more likely to be professionally active. High achievers tend to come from richer households of higher social and cultural status: their indices of home possessions and economic, social and cultural status (ESCS) are close to a half standard deviation above their low-performing peers. They receive more parental emotional support (a third of OECD-level standard deviation), are 10% more likely to talk to parents, close to 10% less likely to work on house chores and less than half as likely to work for pay. Overall, they come from more resourced households and families more supportive of learning.

High performers receive more instruction time at school, in all three subjects. On the other hand, they spend less time on homework after school. As far as the general attitudes to study, and science in particular, are concerned, high performers are about a quarter standard deviation more ambitious, slightly less anxious, and possess a higher sense of belonging at their school. They enjoy and have more interest in science, as well as they are more instrumentally motivated to study science.

High achievers are at schools that offer less enquiry-based, and more teacher-directed and adaptive instruction. They tend to draw from large cities with population above one million, especially Istanbul and Aegean regions. Low achievers are disproportionately concentrated in Central East and Southeast Anatolia. Segregation by school type and selectivity is observed, with students in general selective schools dominant among the high performers, and students in vocational schools (both selective and not selective) dominant among the low performers. Their schools differ little in terms of class size and student-teacher ratios, but high performers attend schools that are significantly more resourced in terms of educational materials and staff. Their schools receive less government funding, are more likely to group students by ability, and score higher on account of leadership and accountability. They also report fewer disciplinary issues on the side of students and teachers, their communities have higher average economic, social and cultural status and their students are more likely to be girls.

Given what looks like the segregation of high performers and low performers into schools along the socio-economic status, I calculate between-school and within-school variation of average scores and ESCS. Table 3 shows that between-school variation (MS column) for both are many-fold larger than within-school variation. This means that students cluster at schools according both to performance and socio-economic status. Therefore the school system is likely to perpetuate the inequality of opportunity that already exists *ex ante*, by adding to the persistence of advantage due to factors beyond students' control such as parental education, wealth or support.

Descriptive statistics by sex

Table 4 provides the descriptive statistics for boys and girls. On average, girls score seven points higher than boys. They outperform boys in reading, and score similarly in mathematics and science. Further differences are more nuanced than those for low- and high-performers. On average, girls are in slightly higher grades. The parental background of boys and girls looks extremely alike, suggesting little selection on observables related to family. However, where the households differ is the level of parental support – like high-scoring students, girls systematically receive more of it than boys. They also converse more with parents, and are substantially less likely to work for pay. Thus, although girls may not be positively selected on family wealth, they nevertheless come from more supportive households where

[12] The average refers to the average score in the three subjects combined.

discrimination in education based on gender might be less likely to arise. The girls of less supportive families, on the other hand, might be more likely to drop out of school earlier.

On average, girls study longer hours than boys at home, and go to schools where they receive more hours of instruction per week. Related to coming from supportive families, girls have higher achievement motivation than boys, however almost half a standard deviation more anxiety about their school performance. They develop more attachment to schools, or are placed at schools that are more caring – overall, they show a quarter standard deviation higher sense of belonging at their institutions.

Girls are less interested in science than boys but are more cognisant of the importance of studying science in order to succeed in their lives and careers. They go to schools that have better teaching practices – less enquiry-based, and more teacher-directed and adaptive instruction. Their schools are more likely to be located in the more developed regions of Turkey – Istanbul, Marmara, Aegean, as well as in the Mediterranean. Girls disproportionately draw from general selective schools. Beyond that, however, there is little difference in the resources and management of the schools they attend, except that girls are less likely to attend private schools and schools that report disciplinary problems. Their schools also have, on average, a higher share of girls.

To summarise, girls perform better than boys on average, draw from more supportive households, are more motivated and placed in higher quality schools in terms of programmes, selectivity, instruction type and discipline. Their schools are less likely to be private, and have a higher share of female students on average.

8. Reading

This section studies boys' and girls' scores in reading. It starts by looking at gender gaps in reading in the raw data. Then, education production function is estimated for boys and girls separately. Based on the estimated model, the reading gender gap is then predicted and explained. In particular, the gender gap is decomposed into the effects due to the endowments and returns on endowments (Oaxaca (1973)). Gender gap may arise because boys and girls have different endowments. For instance, if girls are positively selected, they may come from more educated or affluent families. Or girls may, on average, spend more time in Turkish classes. On the other hand, the gaps may also arise because, for a unit of endowment, girls receive a higher return in terms of scores. Part of the gender gap may also remain unexplained. In this section I also check the robustness of reading results to the inclusion of imputed data, and provide concluding remarks about the reading scores in Turkey.

8.1. Gender gaps in reading

Gender gaps in reading in favour of girls are common around the world. In Turkey girls outperform boys by 28 points in reading (Table 1a). In my sample, excluding middle school students, the gap in favour of girls remains high and significant, at 25 points. Table 5a presents gender gaps in reading for a number of crucial background characteristics of families and schools. The table shows between-category and within-category gender gaps in reading, allowing for the exploration of the intersection of gender and some key features of households and schools, in the raw data.

To start with ethnicity, the score gap in reading between Turkish and non-Turkish (e.g. Kurdish or Arabic) children is very high in Turkey, 49 points, and significant. This gap is similar for boys and girls. The gender gap in reading of Turkish and non-Turkish fifteen-year-olds is also alike, 24-25 points, and significant. This suggests that, although ethnic differentials exist, once at school, ethnic girls do not fare worse than Turkish girls *vis-à-vis* their male counterparts. It also means that gender gaps in reading cannot potentially be responsible for the reading score differential between ethnicities, or vice versa. Similar conclusions can be drawn with respect to household's wealth level (home possessions) and the more

nuanced economic, social and cultural status (ESCS). Between-category reading score gaps in wealth and ESCS are large, 43 points, but gender gaps within each category are stable, between 22-26 points.

Figure 2. Regional gender gaps (boys – girls) in reading – raw data

Note. Statistical significance *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Turning to school's location, differentials between village-based and town-based schools are not significant. They are potentially more important when metropolitan-based schools are compared to village-based schools, in particular for boys. Girls seem to outperform boys in reading especially in rural areas (43 points against 18-26 in towns and cities), although the difference between these gender gaps is at the end non-significant. Comparing Turkey's eleven regions to Istanbul, two types of regions emerge: regions where average reading scores are similar to Istanbul's (from Aegean through Central Anatolia to Northeast Anatolia); and those on the Black Sea and in Turkey's Central East and Southeast where average reading scores are 30-50 points lower. Regional gender gaps are depicted in Figure 2. In the first group of regions, gender gaps in reading tend to persist in favour of girls. An exception is West Anatolia and Northeast Anatolia. In both, girls do not outperform boys in reading. In West Anatolia, moreover, girls actually perform 37 points lower *vis-à-vis* local boys comparing to Istanbul girls. In the second group of regions, gender gaps are in line with Istanbul (e.g. Central East Anatolia), or girls do not outperform boys (e.g. Southeast Anatolia). Also in East Black Sea, girls tend to underperform *vis-à-vis* local boys, comparing to Istanbul girls. Overall, regional gender gaps in reading suggest that regions that are traditionally seen as more challenging in terms of gender equality in Turkey – especially West Anatolia, East Black Sea, Northeast Anatolia and Southeast Anatolia – see a weaker performance of girls in reading, comparing to the reference Istanbul region.

Finally, the inspection of scores across and within the programme types points to the supremacy of general selective schools. Except vocational non-selective schools, where there are no gender gaps in reading scores, the performance of boys and girls within programs is consistently in favour of girls.

8.2. Education production function in reading for boys and girls

Table 5b and 5c present regression results for boys and girls, respectively. Figure 3a summarises the results from the final model, Model 6. Boys in grade 10 and girls in grade 10 and 11 perform significantly better in reading than their peers still in grade 9 at the time of the survey. Turkish students score higher on average, but only until programme types are controlled for (Model 4) in the case of girls, and until school resources and management are controlled for (Model 5) in the case of boys. This suggests that

score gaps in reading between ethnicities are essentially the result of Turkish students attending better schools, but they are more "sticky" for boys. Both for boys and girls, mother's schooling does not affect reading scores, but father's does. Especially for boys, the effect of father having a university degree persists even after school's climate and peer effects are controlled for (Model 6). Mother's employment status is important for boys' reading scores, while father's employment status is important for girls'. On average, the sons of employed mothers score at least 10 points above the sons of non-employed mothers. The daughters of employed fathers on average score at least 9 points above the daughters of non-employed fathers. The effect of home possessions – that is student's material background – remains significant throughout the specifications for girls, but it is much weakened after school's climate and peer effects are incorporated (Model 6). For boys, home possessions are no longer significant once school's climate and peers' status is controlled for. This points to the crucial importance of school environment or peers for students' performance, irrespective of gender. Put otherwise, if a child from a materially disadvantaged household were placed at a privileged school (privileged in terms of the overall economic, social and cultural status), he or she would not perform much worse than a peer from a wealthier family in the very same school. This also means that student's background must not necessarily predetermine his or her reading performance, unless the system segregates students along the socio-economic lines.

As far as home environment and upbringing are concerned, parental emotional support seems more important for boys than girls, at least in reading. It is interesting that even when parental emotional support is controlled for, talking to parents remains highly significant, for both sexes. As expected, paid employment while still at school is detrimental to reading scores. In line with literature, hours spent in class learning are positively correlated, while time spent on homework after or before school is negatively correlated with reading. The latter may reflect the remedial nature of home study time, whereby struggling students may need more time after school to incorporate the material. It is interesting that achievement motivation comes out as significant for boys, but not for girls. On the other hand, test anxiety harms girls, but not boys. The sense of belonging at school is only important for girls. Taken together, these suggest the gender-variegated nature of non-cognitive attributes in relation to reading scores.

As expected, school's location matters little for reading scores, but girls in West Anatolia and East Black Sea perform worse than girls in Istanbul (by 40-50 points) and worse than boys in their own regions (by 20-40 points). Also, as expected, students in general selective schools outperform their peers elsewhere. However, the effect of programme types weakens or disappears once schools' disciplinary climate and average ESCS are controlled for. This suggests that students in Turkey – both boys and girls - sort into programs along the socio-economic lines. As in the literature for developed countries, school resources do not affect the reading performance of students in Turkey. School's management is more important. Girls in private-run school score 56 points below girls in public schools. This finding does not necessarily mean that private schools are bad for girls but, instead, that lower performing girls might be more often than boys placed in private schools. It also emerges that the share of government funding is higher in schools where boys and girls score higher in reading. This is in agreement with the fact that the best high schools in Turkey are public Anadolu high schools. Other institutional features of schools do not emerge as important. Finally, students at schools that record disciplinary problems among students score lower than students in more disciplined environments. One OECD-level standard deviation rise in student disciplinary problems lowers student's scores (both boys and girls) by about 9 points. Finally, one OECD-level standard deviation increase in school's average economic, social and cultural status is associated with additional 45 points for boys and 70 points for girls in reading scores. It thus follows that the effects of school environment or peers in Turkish schools are potentially very high.

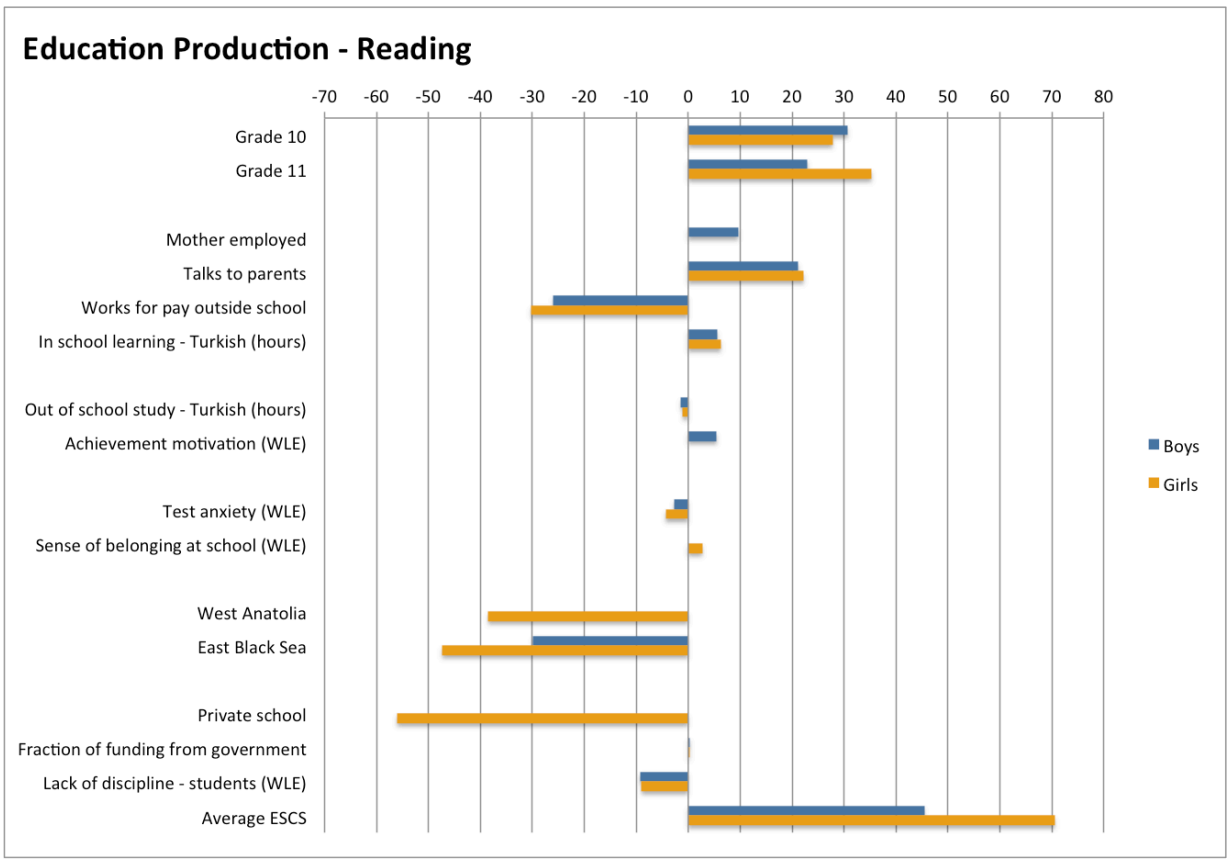

Figure 3a. Education production function in reading

Note. Elements significant at ** $p < 0.05$ or higher. Elements significant at * $p < 0.1$ are exceptionally included if they were significant at ** $p < 0.05$ or higher for the other sex.

8.3. Decomposition of the gender gap in reading

The predicted gender gap, based on the estimated model, is close to 25 points in favour of girls, and significant (Table 5d), as in the raw data. The decomposition of the gender gap shows the importance of both endowments and returns on endowments in driving the reading gap in favour of girls in Turkey. Girls' advantage is 20 points due to girls' higher endowments, and 5 points due to higher returns on endowments. The detailed gender reading gap decomposition is presented in Table 5e, and Figure 3b depicts the elements of endowments and returns that are statistically significant. The endowment column of Table 5e shows that boys lose around 3 points on account of being in lower grades than girls (or put otherwise, girls are more likely than boys to be in grade 10 and 11, as opposed to grade 9). Girls also come from families where they receive more parental emotional support and talk more with parents (one-point gain in total). They are less likely to work for pay (6-point gain *vis-à-vis* boys). They also attend schools where they receive more instruction time in Turkish (1-point gain) but study more than boys at home, while home study time relates negatively to scores. Girls are also significantly more ambitious than boys (half-a-point gain) but more anxious (1.3-point loss in favour of boys). However, on average they are placed at schools where they develop a stronger sense of belonging (0.7-point gain *vis-à-vis* boys). Girls are also more likely to attend schools with better disciplinary climate (2-point gain)[13]. In sum, although girls do not seem to be positively selected on family's socio-economic status *per se* (they

[13] The investigation of the data suggests that schools that report fewer student-related disciplinary issues are general selective schools, schools located in large cities, and better resourced in terms of educational materials and staff. They are more likely to be private, to group students by ability, as well as to report higher educational leadership. Their students have higher average economic, social and cultural status and are more likely to be girls.

do not differ from boys in parental education, employment or household wealth), they do come from more supportive households, talk to parents more often, work for pay less, are more motivated and attend better schools. However, boys are less anxious about their academic performance, and spend more time on study at home.

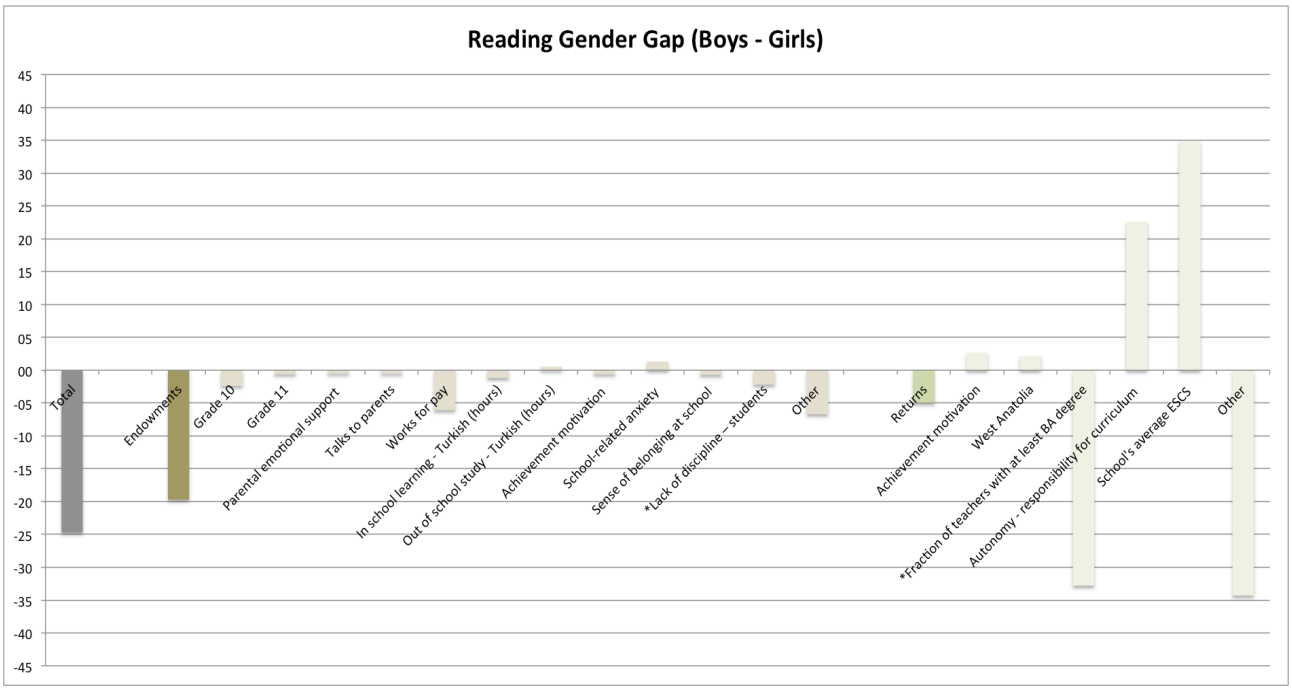

Figure 3b. Decomposition of the gender gap in reading

Note. Elements significant at ** $p < 0.05$ or higher. Elements significant at * $p < 0.1$ are exceptionally included if they were significant at ** $p < 0.05$ or higher in another subject (marked * in the figure).

The scrutiny of the returns on endowments offers a few interesting insights. While girls are more ambitious overall, once they are ambitious, boys score 3 points higher than girls in reading. They also perform 2 point above girls on account of studying in West Anatolia. On the other hand, girls perform 30 points above boys in reading simply on account of getting more out of skilled teachers. Why this is so remains an open question. Boys, on the other hand, do better than girls in schools autonomous with respect to curriculum (23 point gain)[14] and get more out of schools privileged in terms of the average economic, social and cultural status of student families (35 point gain).

8.4. Further explorations of the gender gap in reading

Regressions with imputed data produce results in reading that are very similar to those obtained earlier.[15] The coefficients on the missing data dummies reveal that the missing data affects the estimates on account of observations missing especially at the left tail of the reading scores distribution, both for boys and girls. In particular, boys who did not answer questions regarding their involvement in household chores score approximately 31 points below other boys. This was not the case for girls. Moreover, boys and girls that left unreported the time spent studying Turkish at home, on average, score 31 and 41 points below

[14] In the case of Turkey where school autonomy is generally low, it remains interesting which schools report high autonomy in terms of curriculum. The investigation of the data suggests that more autonomous schools are more likely to be general non-selective, located in big cities, and better resourced in terms of educational materials and staff than non-autonomous schools. They are more likely to be private, with a lower fraction of government funding, reporting good educational leadership, few disciplinary problems but slightly lower average economic, social and cultural status.

[15] In the interest of space, new regression results are not reported here but are available on request. New gender gap decomposition results are presented in the appendix.

their peers, respectively. Girls missing data on achievement motivation are less-performing girls - 51 points below other girls.

Table A5a in the appendix shows the decomposition of the gender gap in reading with imputed data, and table A5b reports the details of the decomposition with imputed data. The results are similar to those obtained with the smaller sample. The gender gap remains highly significant and favours girls, and with imputed data it actually increases from 25 to 27 points. This is not too surprising, given that boys are more likely to be low performers, and low performer are more likely to drop out of the sample due to non-reporting. The inclusion of boys who previously dropped out shows that they weight down on boys' average score because of their lower endowments, rather than lower returns on endowments.

8.5. Summary

Gender gap in reading scores in the PISA sample excluding middle school students stands at 25 points in favour of girls in Turkey. In the raw data, gender intersects most with Turkish regions. In regions that are traditionally seen as more challenging in terms of gender equality – West Anatolia, Northeast Anatolia and Southeast Anatolia - girls no longer outperform boys in reading. Girls also do not outperform boys in reading in vocational non-selective schools.

The decomposition of the gender gap in reading shows that 25-point gender gap is due to girls' higher endowments (20 points), as well as higher returns on endowments (5 points). While there is no evidence of fifteen-year-old girls enrolled in high schools and included in PISA sample being positively selected on observables such as parental education, employment or wealth, girls come from households were they receive more parental support and talk more with parents, comparing to boys. They are also less likely to work for pay. Girls attend higher grades and better schools – in terms instruction time offered and the disciplinary climate. They are more ambitious than boys and develop more sense of belonging to their schools. However, they lose points to boys on account of studying more at home and higher anxiety.

Girls also, on average, obtain higher returns on endowments in terms of reading scores. The key to this is that girls get more out of quality teachers. Otherwise, it is boys who gain more than girls if they study in West Anatolia, if they attend more autonomous schools with regards to curriculum and schools with higher socio-economic status. It is also boys who capitalise more on their motivation in terms of reading achievement.

The results do not change significantly when the sample is augmented with imputed data. However, as boys are more likely to be low achievers, and low achievers are more likely to drop out of the sample due to non-reporting, it is not surprising that the gender gap in reading enlarges to 27 points in favour of girls after the data imputation. This arises essentially because the newly included boys lower boys' average score by further 1-2 points on account of their lower endowments rather than the returns on endowments.

9. Mathematics

This section studies boys' and girls' scores in mathematics. First, gender gaps in mathematics in the raw data are discussed. Then, education production function is estimated for boys and girls separately. The estimated model predicts the gender gap in mathematics scores, which is then analysed further. As for reading, the gender gap is decomposed into the effects due to endowments and returns on endowments. Gender gap may arise because boys and girls have different endowments. For instance, girls may on average have higher levels of test anxiety. On the other hand, the gaps may also arise because for each unit of endowment, girls receive a lower return in terms of scores. For example, a standard deviation increase in achievement motivation may translate into higher points for boys only. Part of the gender gap may also remain unexplained. The section checks the robustness of results to the inclusion of imputed data, and provides concluding remarks about the mathematics scores in Turkey.

9.1. Gender gaps in mathematics

Gender gaps in mathematics in favour of boys are common in the OECD, yet Turkey seems to be one of the exceptions. In Turkey overall, boys outperform girls only by 6 points in mathematics (Table 1b), but this differential is not statistically significant. In my sample, excluding middle school students, the gap in favour of boys enlarges and becomes significant, at 9 points (Table 6a). This is not surprising, given that middle-school students are low performers, low performers in mathematics tend to be boys, and fifteen-year old boys in Turkey are more likely than girls to be in grade 8. Table 6a presents gender gaps in mathematics for a number of crucial background characteristics of families and schools. The table shows between-category and within-category gender gaps in mathematics, allowing for the exploration of the intersection of gender and some key features of households and schools, based on raw data.

As for reading, score gap in mathematics between Turkish and non-Turkish children is very high, 49 points, and significant. This gap is similar for boys and girls. However, the gender gaps in mathematics of Turkish and non-Turkish fifteen-year-olds are slightly different. It is the Turkish boys that outperform Turkish girls in mathematics. This could be the result of a stronger positive selection among ethnic girls, where girls' enrolment rates are lower. Overall, however, the within-ethnicity gender gaps are not statistically different from each other. The conclusions with respect to household's wealth level (home possessions) and the economic, social and cultural status (ESCS) are similar to those obtained for reading scores. Between-category mathematics score gaps are large, 30-40 points, but gender gaps within each category are stable, between 8-11 points in favour of boys. Hence gender gaps are not a likely driver of mathematics differentials between students coming from different wealth strata, and vice versa.

Turning to school's location, differentials between village-based and town-based schools are not significant. However, students score significantly higher in metropolitan-based schools, in particular boys. Boys outperform girls especially in big cities, by some 15 points, although overall the residential gender gaps are not statistically different from each other. Comparing Turkey's eleven regions to Istanbul, again two types of regions emerge: regions where average reading scores are similar to Istanbul's (from Aegean through Central Anatolia to Northeast Anatolia, plus West Black Sea); and those where average mathematics scores are 30-60 points lower than in Istanbul (East Black Sea, Central East Anatolia and Southeast Anatolia). Regional gender gaps are depicted in Figure 4. In the first group of regions, between-region score differentials are similar for boys and girls, and within-region gender gaps are not significant. An exception is West Anatolia, where boys outperform girls in mathematics by 31 points. In the second group of regions, both boys and girls perform worse than their counterparts in Istanbul, and a highly significant gender gap in favour of boys emerges in the East Black Sea region. On the other hand, girls outperform boys in mathematics in Central East Anatolia. Overall, regional data suggests that gender gaps in mathematics in Turkey are driven by two regions – West Anatolia and East Black Sea. Otherwise, mathematics gender gaps are significant neither in Turkey's West nor East.

Figure 4. Regional gender gaps (boys – girls) in mathematics – raw data

Note. Statistical significance *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Finally, the inspection of scores across and within the programme types again points to the supremacy of general selective schools, as in reading. Scores in mathematics in general selective schools are on average about 50 points higher than those in general non-selective schools, 60 points higher than in vocational selective high schools and 70 points higher than those in vocational non-selective institutions. Except vocational selective schools, the performance within programs is consistently in favour of boys.

9.2. Education production function in mathematics for boys and girls

Table 6b and 6c present regression results for boys and girls, respectively. Figure 5a summarises the results from the final model, Model 6. Both boys and girls perform better in mathematics when they are in higher grades, 10 and 11, but the grade premium for boys persists up to grade 12. As with reading, Turkish students – both boys and girls - score higher on average, but this time only until program types are controlled for (Model 4). This means that ethnicity differentials in reading are stickier than in mathematics, and persist regardless of programme types. This is intuitive, given that the native language spoken at home may be a larger obstacle to learning Turkish than mathematics. As with reading, both for boys and girls, mother's schooling does not affect the scores, but father's does. Father's education matters more for girls. Daughters of men with only a high school degree perform 9 points above the daughters of uneducated fathers, even after school resources and management are controlled for (Model 5). The effect of father having a university degree persists for girls even after peer effects are taken into account (Model 6). Parental employment is quite irrelevant for boys' scores in mathematics, but crucial for girls'. In particular, having a professionally active mother adds at least 8 point to girls' scores. The effect of father's employment on mathematics scores dies out, but only late, when school's peer effects are added. These findings are important because they potentially point to the importance of productive parental role models for children learning mathematics. The effect of home possessions – that is student's material background – remains significant throughout the specifications both for boys and girls, although its effect is weak after school's climate and peer effects are incorporated (Model 6). Still, its importance is higher for mathematics scores than reading scores. This means that it is harder to mitigate the transmission of inequality in mathematics than reading. Children from more resourced families would obtain higher mathematics scores than less wealthy peers, even if they all were in prestigious high schools. In other words, mathematics achievement gaps are more elitist in nature.

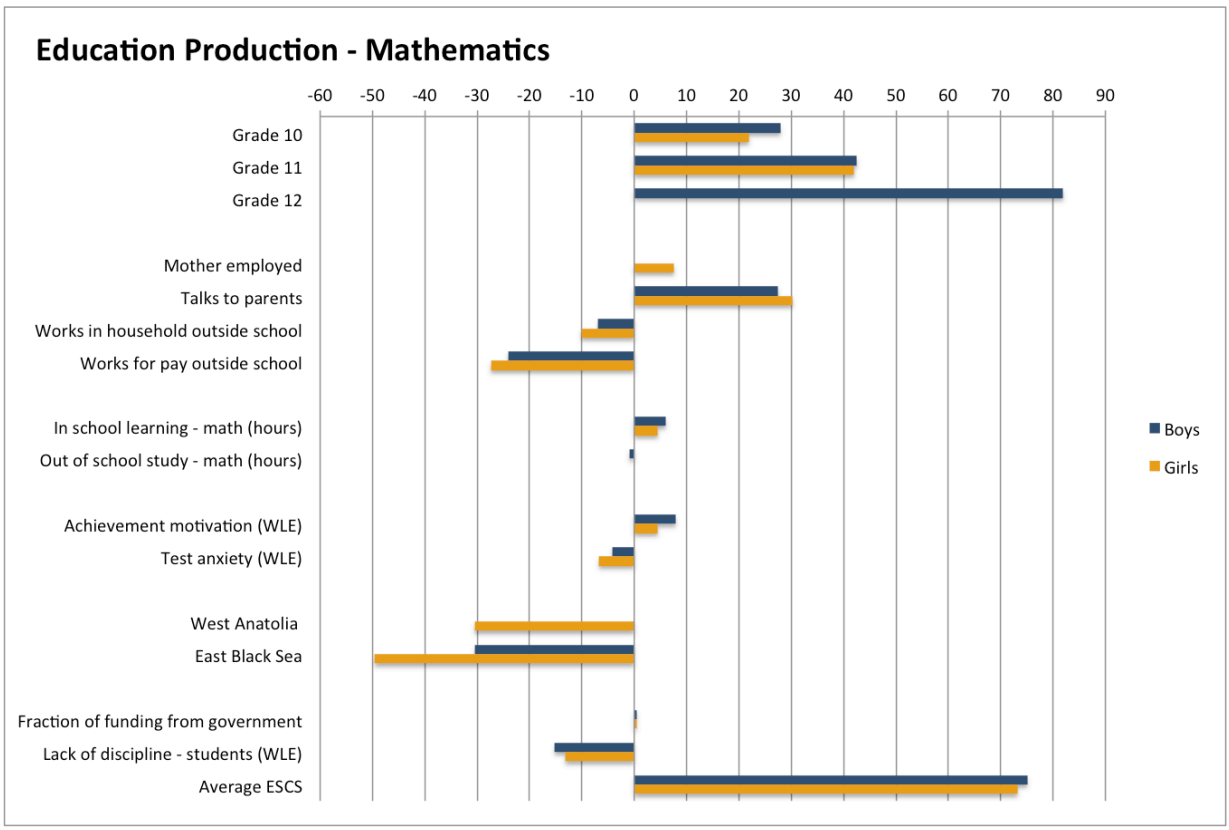

Figure 5a. Decomposition of the gender gap in mathematics

Note. Elements significant at ** $p < 0.05$ or higher. Elements significant at * $p < 0.1$ are exceptionally included if they were significant at ** $p < 0.05$ or higher for the other sex.

Unlike in reading, parental emotional support comes out as not important, neither for boys or girls. This suggests that boys need more nurturing in order to achieve high reading scores, but girls' performance in mathematics is less dependent on parental emotional support. In this way, girls might be more resilient than boys. As with reading, even when parental emotional support is controlled for, talking to parents remains highly significant, for both sexes. Both paid employment and household chores are detrimental to math achievement, both for boys and girls (only paid employment was detrimental in the case of reading). This finding might suggest that achieving high performance in mathematics requires more time and undivided attention devoted to it. This idea is corroborated by the fact that, unlike in the case of reading, the time spent studying mathematics at home is no longer negatively correlated with scores for girls, and becomes negatively correlated for boys only when the quality of school is controlled for (Model 5). Also, unlike in reading, achievement motivation comes out as significant both for boys and girls, not just boys. Hence, highly motivated girls are also able to obtain higher scores in mathematics. Unlike in reading, test anxiety harms both boys and girls, and not only girls. The sense of belonging at school is not important for either sex. Taken together, these suggest that – comparing to reading - the relationship of non-cognitive attributes to mathematics scores is less gendered. Perhaps this helps understand why it is easier for girls to close the gender gap in mathematics than for boys to close the gender gap in reading.

As in reading, school's location matters little for mathematics scores, but (again as in reading) girls in West Anatolia and East Black Sea perform worse than girls in Istanbul (by 40-50 points) and worse than boys in their own regions (by 20-30 points). Also, as expected, students in general selective schools outperform their peers elsewhere. However, again the effect of programme types disappears once schools' disciplinary climate and average ESCS are controlled for. This again confirms that students in Turkey – both boys and girls - sort into programs along the socio-economic lines. As for reading, and in line with other developed countries, school resources do not affect the mathematics performance of students in

Turkey. Girls in private schools are no longer at a disadvantage, comparing to girls in public schools, but boys and girls score higher in mathematics at schools where the share of government funding is higher. As mentioned earlier, this is in agreement with the fact that the best high schools in Turkey are public Anadolu high schools. Other institutional features of schools do not emerge as important. Finally, all students at schools that record disciplinary problems among students score lower than students in more disciplined environments. One OECD-level standard deviation rise in student disciplinary problems lowers student's scores (both boys and girls) by about 13-15 points. Finally, one OECD-level standard deviation increase in school's average economic, social and cultural status is associated with additional 73-75 points for boys and girls in mathematics scores. It thus confirms that school environment or peer effects in Turkish schools are potentially very high.

9.3. Decomposition of the gender gap in mathematics

The predicted gender gap in mathematics, based on the estimated model, is close to 9 points in favour of boys, and significant (Table 6d). In as far as girls enrolled at schools are likely to be positively selected in Turkey, had enrolment been universal, it is plausible that the gender gap in mathematics would widen further.

The decomposition of the gender gap (Table 6d) shows the importance of both endowments and returns on endowments for the mathematics score differential between boys and girls. Indeed, girls have higher endowments than boys. Had they have the same characteristics as boys in the sample, they would have scored 6.5 points lower than they do currently. Boys outperform girls because of high returns on endowments (15-point gain). The detailed gender mathematics scores gap decomposition is presented in Table 6e, and Figure 5b depicts the elements of endowments and returns that are statistically significant. The endowment column in Table 6e shows that boys lose around 3 points in mathematics scores on account of being in lower grades than girls (in grade 9, as opposed to grade 10 and 11). Boys also talk less with their parents (half-a-point loss in scores), and more often than girls work for pay (5-point loss *vis-à-vis* girls). Boys also attend schools where they receive less instruction time in mathematics, and overall are less ambitious than girls (together 1-point loss). However, again and on average, they are less anxious than girls (3-point gain), and study less at home (a third-of-a-point gain). School location, region, programme type, school resources and management do not individually contribute to the gender gap through endowments. Boys lose 3 points to girls because, on average, they are more often placed in schools with lower student discipline, and gain close to 8 points on account of studying in schools where the fraction of girls is high. As in reading, in sum, although girls in the PISA sample do not seem to be positively selected according to family socio-economic status *per se* (they do not differ from boys in parental education, employment or household wealth), what matters for mathematics scores is that they spend more time with parents and less often work for pay. They attend higher grades, receive more instruction time in mathematics, are more motivated, and their schools have better disciplinary climate. On the other hand, boys are less anxious, study more at home and benefit from studying with girls.

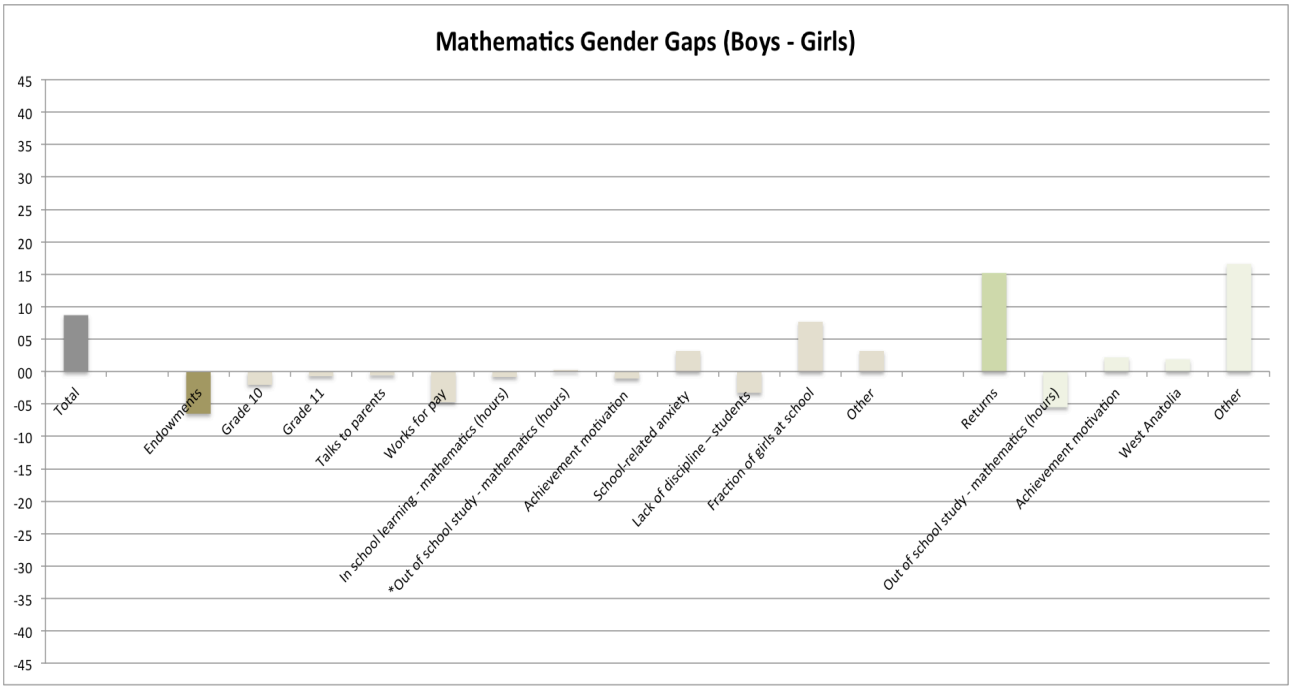

Figure 5b. Decomposition of the gender gap in mathematics

Note. Elements significant at ** $p < 0.05$ or higher. Elements significant at * $p < 0.1$ are exceptionally included if they were significant at ** $p < 0.05$ or higher in another subject (marked * in the figure).

The scrutiny of the returns on endowments offers additional insights, because it is through higher returns on endowments that boys achieve superior performance in mathematics (15-point gain). While girls get more out of additional study time at home, boys score higher than girls if they are motivated and if they are based in West Anatolia. Otherwise, no individual return on endowment is significant, but – jointly – the returns on endowments are significantly higher for boys.

9.4. Further explorations of the gender gap in mathematics

Regressions with imputed data produce results in mathematics that – as in reading - are very similar to those obtained earlier. The missing data affects the estimates on account of observations missing both at the left and right tail of the mathematics scores distribution. At the left tail, the exclusion both of low-performing boys and girls affects the results; at the right tail it is the exclusion of high-performing girls that is observed. Boys and girls that left unreported the time spent studying mathematics at home score on average 31 and 35 points below their counterparts. Girls not reporting on their test anxiety score 60 points above other girls.

Tables A6a and A6b in the appendix report the decomposition of the gender gap in mathematics with imputed data. It is not surprising that the gender gap in favour of boys falls from 9 to 7 points, and it becomes only weakly significant. As in the case of reading, the gender gap shifts in favour of girls because of the lower endowments (rather than higher returns on endowments) of the newly included male students.

9.5. Summary

Gender gap in mathematics scores in the PISA sample excluding middle-school students stands at 9 points in favour of boys in Turkey, and is statistically significant. In the raw data, it is Turkish boys and boys living in big cities that outperform girls in mathematics, although eventually between-ethnicity and between-locality differentials in gender gaps are not statistically significant. Boys also outperform girls in mathematics in general selective schools, but again between-programme differentials in gender gaps are not statistically significant. As in reading, in the raw data gender intersects with Turkish regions. In

the majority of regions there is no gender gap in mathematics scores. Yet, in West Anatolia and North Black Sea boys outperform girls in mathematics.

The decomposition of the gender gap in mathematics shows that 9-point gender gap is essentially due to boys' higher returns on endowments (15-point gain). Girls have higher endowments than boys, which earns them 6 points ahead of boys. While there is no evidence of girls being positively selected on observables such as parental education, employment or wealth, girls talk more with parents, less often work for pay and are more motivated. They attend higher grades and more disciplined schools, and receive more instruction time in mathematics. On the other hand, boys are less anxious and benefit from studying with girls.

Girls obtain lower returns on endowments in terms of mathematics scores. While girls get more out of additional study time at home, boys score higher than girls if they are motivated and if they are based in West Anatolia.

The results do not change significantly when the sample is augmented with imputed data, although the gender gap falls from 9 to 7 points in favour of boys. This is expected, given that high-achieving girls are added to the sample. As a result, the contribution of endowments and returns on endowments to the mathematics score gap are raised in favour of girls.

10. Science

This section studies boys' and girls' scores science. First, gender gaps in science scores in the raw data are investigated. Then, education production function is estimated for boys and girls separately. The estimated model predicts the gender gap in science scores, which is then analysed in more detail. As for other subjects, the gender gap is decomposed into the effects due to endowments and returns on endowments. Gender gap may arise because boys and girls have different endowments. For instance, girls may on average have less interest in science. On the other hand, the gaps may also arise because for each unit of endowment, girls receive a lower return in terms of score. For example, a standard deviation increase in instrumental motivation may translate into higher point for boys. Part of the gender gap may also remain unexplained. The section checks the robustness of results to data imputation, and provides concluding remarks about the science scores in Turkey.

10.1. Gender gaps in science

Around the world, girls increasingly score as well as boys in sciences, and Turkey is no exception. In Turkey overall girls outperform boys by 6 points in science (Table 1c) but the difference is not statistically significant. In my sample, excluding middle-school students, the gap in favour of girls shrinks to 3 points and is again not statistically significant. Table 7a presents gender gaps in science for a number of crucial background characteristics of families and schools. The table shows between-category and within-category gender gaps in science, allowing for the exploration of the intersection of gender and some key features of households and schools, based on raw data.

As for other subjects, score gap in science between Turkish and non-Turkish (e.g. Kurdish or Arabic) children is very high, 49 points, and significant. This gap is similar for boys and girls. There is no gender gap in science for Turkish and non-Turkish fifteen-year-olds. This suggests again that, although ethnic differentials exist, once at school, ethnic girls do not fare worse than Turkish girls *vis-à-vis* their male counterparts. It also means that gender gaps in science cannot potentially be responsible for the science score differential between ethnicities, or vice versa. Similar conclusions can be drawn with respect to household's wealth level (home possessions), as well as the economic, social and cultural status (ESCS). Between-category science score gaps are large, 30-40 points, but there are no gender gaps within each status category.

Turning to school's location, differentials between village-based and town-based schools are not significant. They are potentially more important when metropolitan-based schools are compared to village-based schools, in particular for boys. However, overall, girls seem to perform as well as boys in science in all localities, and gender gap are not statistically significant. Comparing Turkey's eleven regions to Istanbul, two types of regions emerge again: regions where average science scores are similar to Istanbul's (from Aegean through Central Anatolia to Northeast Anatolia); and those on the Black Sea and in Turkey's East where average science scores are 20-40 points lower. Regional gender gaps are depicted in Figure 6. In the first group of regions, score differentials are generally similar for boys and girls, and gender gaps are rare. An exception is again West Anatolia, where boys outperform girls in science, or put otherwise where girls perform 27 points lower *vis-à-vis* boys comparing to Istanbul girls. Another exception is West Marmara, where girls outperform boys in science and the score differential is high – 18 points – and statistically significant. In the second group of regions, boys outperform girls in science only in Turkey's East Black Sea region. Thus, as for mathematics, regional data suggests that gender gaps in science in favour of boys in Turkey are rare, and again driven by two regions – West Anatolia and East Black Sea. Otherwise, science gender gaps are visible in neither Turkey's West nor East, even in the gender-conservative regions.

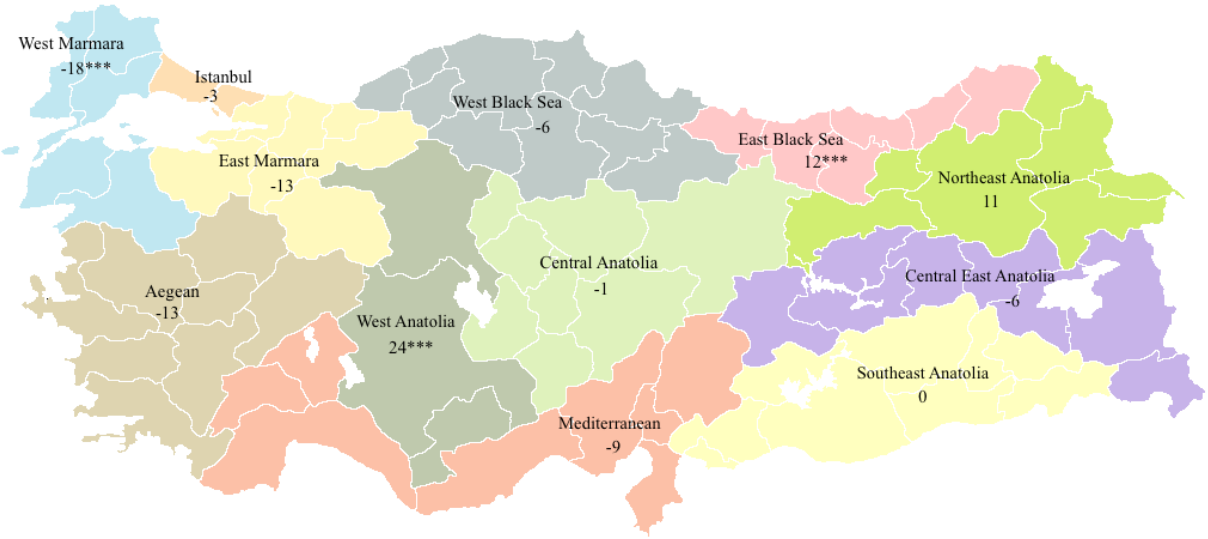

Figure 6. Regional gender gaps (boys – girls) in science – raw data

Note. Statistical significance *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Finally, the inspection of scores across and within the programme types points again to the supremacy of general selective schools. Scores in science in general selective schools are on average 54 points higher than in general non-selective schools. They are about 70 points higher than in vocational selective institutions, and 80 points higher than in vocational non-selective schools. The performance of boys and girls within programmes is consistently similar and no statistically significant gender gaps emerge in the raw data.

10.2. Education production function in science for boys and girls

Table 7b and 7c present regression results for boys and girls, respectively. Figure 7a summarises the results from the final model, Model 8. Results for science are a sort of hybrid of those in reading and mathematics, suggesting that learning science requires different types of literacy. Both boys and girls perform better in science when they are in grade 10 rather than 9, but only girls acquire further scientific literacy in grades 11 and 12. Unlike in reading – where literacy *vis-à-vis* nine-graders improved only for ten-graders, and unlike in mathematics – where girls hit a learning ceiling in grade 11, additional years

of studying science offer girls a chance to significantly expand their scientific knowledge and skills. As with reading and mathematics, Turkish students score higher in science on average, but this time only until programme types are controlled for (Model 4) in the case of girls, and until programme types, school resources and management are controlled for (Model 5) in the case of boys. Ethnicity, as far as learning science is concerned, is thus a less sticky detriment to learning for girls. For example, should a Kurdish girl be placed in general selective school, she would perform as well as her Turkish female peer. This would not be the case for a Kurdish boy. It still should be remembered that ethnic girls enrolled at schools are more likely to be positively selected than Turkish girls.

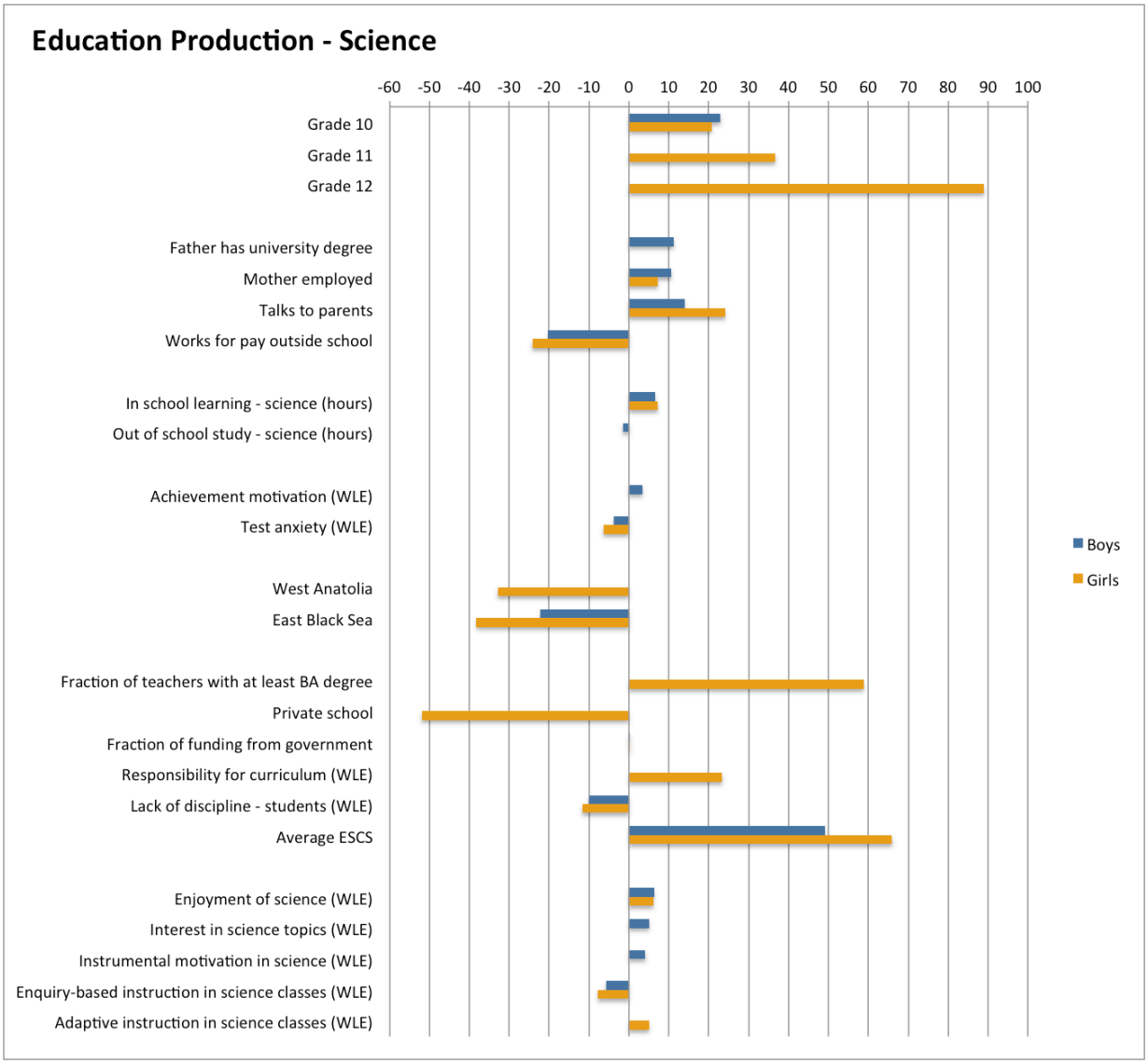

Figure 7a. Decomposition of the gender gap in science

Note. Elements significant at ** $p < 0.05$ or higher. Elements significant at * $p < 0.1$ are exceptionally included if they were significant at ** $p < 0.05$ or higher for the other sex.

Maternal education has a somehow puzzling effect on scores in science, while it did not correlate with scores in the case of reading and mathematics. After school's average socio-economic status is included in the regressions (Model 6), the coefficients on mother's education acquire a negative (yet significant) sign both for boys and girls. This negative effect is larger and stronger for highly educated mothers. Given the methodology, the presented result cannot be understood as causal. Yet, it requires a commentary. Negative sign on mother's education means that, should a child whose mother has less than high school diploma be placed in a high-status school, he or she would perform better in science than peers whose

mothers have university degrees. It is difficult to justify why it should be the case. The most likely reason for a negative sign on mother's education is that mother's education is positively correlated with a number of other variables in the regression, especially mother's employment status, father's education and household wealth. As the analysis is not causal, other variables are jointly determined with mother's education and are picking up some of its effect, pushing the coefficient on mother's education below zero. It is interesting to note that the negative effect of mother's education can be cancelled out by the positive effect of mother being employed. Hence, an educated mother should also be employed in order for her advanced education to translate into higher scores. Table A7a and A7b in the appendix show the results of the regression when mother's education and employment status are interacted, for boys and girls. It emerges that mother having a university degree is only good for scores if mother also works (the sum of the coefficients on mother having a university degree and working is in all cases positive). This may suggest the importance of parental role models in learning science, both for boys and girls. At the very least perhaps, mother's advanced education – even if not detrimental to child's science achievement – could translate into child's positive scores if mother herself actually capitalises on her education through employment.

In science, father's schooling is positively correlated with science scores, but more so for boys than girls (as in reading but unlike in the case of mathematics). Father's employment has little relationship with science scores for both sexes, but especially for boys. The effect of home possessions – that is student's material background – remains significant (though just weakly) only for girls after school's climate and peer effects are incorporated (Model 6). This means that it is harder for girls to mitigate the transmission of inequality in science achievement.

As with mathematics, parental emotional support does not matter, neither for boys nor girls. As with other subjects, even when parental emotional support is controlled for, talking to parents remains highly significant, for both sexes. As with mathematics, both paid employment and household chores are detrimental to science achievement, both for boys and girls, although girls placed in high-status schools can overcome the detrimental effect of household chores. Still, this finding suggest that achieving high performance in science, as in mathematics, requires time and attention to be devoted to it. This idea is corroborated by the fact that, unlike in the case of reading, and as in the case of mathematics, the time spent studying science at home is no longer negatively correlated with scores for girls, yet remains negatively correlated with science scores for boys. As in reading, achievement motivation effect is significant for boys, but not girls. As in mathematics, test anxiety harms both boys and girls, and not only girls. The sense of belonging at school is not important for either sex. Taken together, these suggest that the relationship of non-cognitive attributes to science scores is less gendered than reading but more gendered than mathematics. Hence, it is less surprising that – in science – girls perform similar to boys, but do not overtake them as in reading, or lag behind them as in mathematics.

As earlier, school's location matters little for science scores, but (again as in reading and mathematics) girls in West Anatolia and East Black Sea perform worse than girls in Istanbul (by 30-40 points) and worse than boys in their own regions (by 20-30 points). Only boys consistently outperform their male peers if placed in general selective, as opposed to general non-selective, schools. This effect survives the inclusion of school's average socio-economic status, suggesting that especially girls in Turkey sort into programs along the socio-economic lines.

As earlier, school resources do not seem to affect the science performance of students in Turkey. However, both boys and girls in private schools perform below students in public schools, at least until the science class format is controlled for (Model 8). As in reading and mathematics, again it also emerges that the share of government funding is higher in schools where boys and girls score higher in science. As mentioned earlier, this is in agreement with the fact that the best high schools in Turkey are public Anadolu and science high schools. Other institutional features of schools do not emerge as important. As earlier, students at schools that record disciplinary problems among students score lower than students in

more disciplined environments. One OECD-level standard deviation rise in student disciplinary problems lowers student's scores (both boys and girls) by about 10-12 points. Finally, one OECD-level standard deviation increase in school's average socio-economic status is associated with additional 50 points for boys and 65 points for girls. It thus confirms again that the effects of school environment or peers in Turkish schools are potentially very high.

Because PISA 2015 focused on science, it also quantified students' attitudes to science, as well as the format of their science class. Model 7 indicates that the enjoyment of science is important both for boys and girls, but that interest in science and instrumental motivation to learn science translate into higher scores for boys only. This is unfortunate, because on average girls in Turkey have higher levels of instrumental motivation than boys. Finally, in line with international evidence, enquiry-based instruction harms science scores for both sexes in Turkey, and adaptive instruction benefits them – at least in the case of girls.

10.3. Decomposition of the gender gap in science

The predicted gender gap in science, based on the estimated model, is close to 3 points in favour of boys, but it is not statistically significant (Table 7d). However, in as far as girls enrolled at schools are positively selected in Turkey, had enrolment been universal, it is plausible that the gender gap in science would widen further in favour of boys.

The decomposition of the gender gap (Table 7d) shows the importance of both endowments and returns on endowments for science score gender differentials (or rather the lack of them). As in the case of reading and mathematics, girls' higher endowments mean that - had they have the same characteristics as boys in the sample - they would have scored 11 points lower than they do currently. As in mathematics, boys outperform girls because of high returns on endowments (8 point gain). The detailed gender science gap decomposition is presented in Table 7e, and Figure 7b depicts the elements of endowments and returns that are statistically significant. The endowment column of Table 7e shows that boys lose around 2.5 points in science scores on account of being in lower grades than girls (in grade 9, as opposed to grade 10 and 11). Boys also spend less time with their parents (0.4 point loss in science scores), and more often than girls work for pay (4.5 point loss *vis-à-vis* girls). Boys also attend schools where they receive less instruction time in science (1 point loss in score), and overall are less ambitious than girls (half a point loss). However, again and on average, they are less anxious than girls (3-point gain), and study less at home (half-a-point gain). School location, region, program type, school resources and management do not contribute to the gender gap though endowments. Boys lose 2.5 points to girls in science because, on average, they are more often placed in schools with lower student discipline, with more enquiry-based instruction in science, and gain close to 4 points on account of being placed in schools where the fraction of girls is high. They gain half a point on account of being more interested in science than girls. As in the other two subjects, in sum, although girls do not seem to be positively selected on family's socio-economic status *per se* (they do not differ from boys in parental education, employment or household wealth), what matters for science scores is that they spend more time with parents, less often work for pay, are more motivated, attend higher grades and better schools – schools with more hours of instruction in science, less enquiry-based instruction in science class, as well as schools that have fewer disciplinary problems. They are, however, more anxious than boys, study less at home and are less interested in science. Boys also benefit from schools that have a high fraction of girl students.

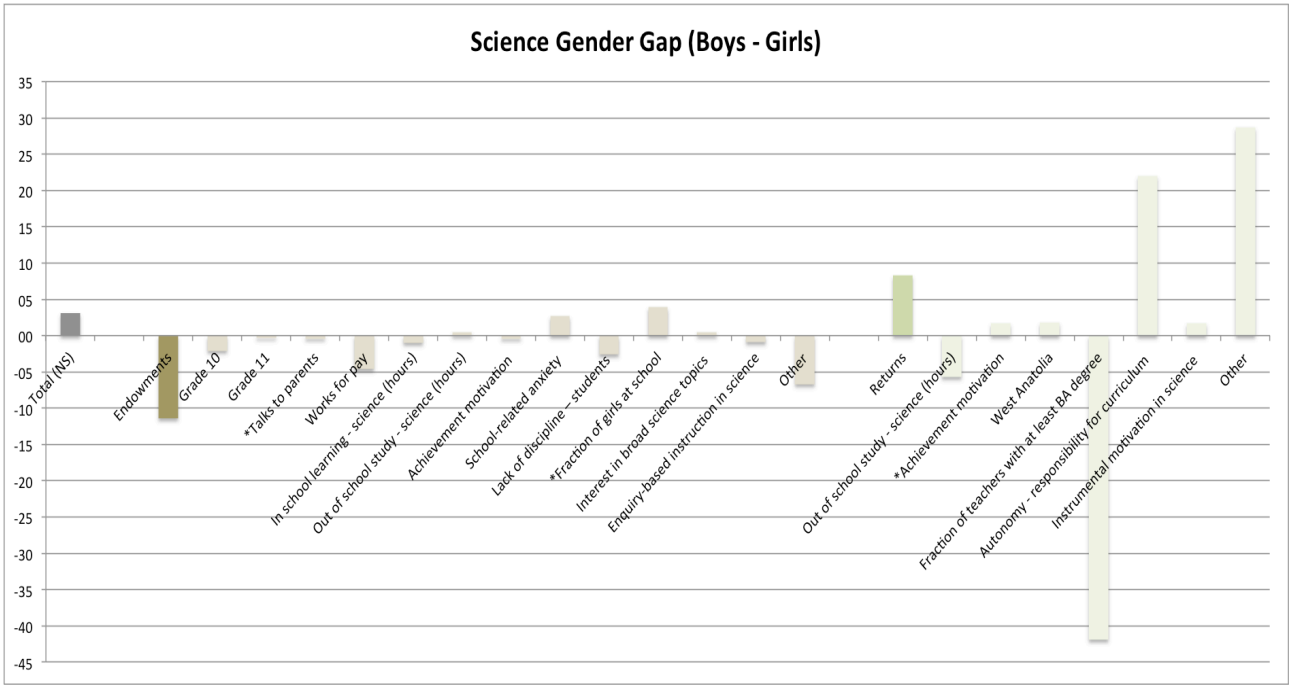

Figure 7b. Decomposition of the gender gap in science

Note. Elements significant at ** $p < 0.05$ or higher. Elements significant at * $p < 0.1$ are exceptionally included if they were significant at ** $p < 0.05$ or higher in another subject (marked * in the figure). NS – non significant.

The scrutiny of the returns on endowments offers additional insights because it is through higher returns on endowments that boys match girls in their performance in science (8-point gain). As in mathematics, while girls get more out of additional study time at home, boys score higher than girls in science if they are motivated and if they are based in West Anatolia. As in reading, girls do a lot better than boys if placed in schools with educated teachers (42 point gain), but boys fare better than girls in autonomous schools (23 point gain). Boys also get more than girls out of instrumental motivation in science. Overall, given the stock of enrolled students, gender gap in science is negligible. However, it would likely re-emerge in favour of boys were there no the selection bias in enrolment.

10.4. Further explorations of the gender gap in science

Regressions with imputed data produce results in science that are very similar to those obtained earlier, and the gender gap remains non-significant (Table A7c). The missing data affects the estimates on account of observations missing both at the left and right tail of the reading scores distribution. Regressions with missing data are affected by the exclusion of some low-performing boys and girls, as well as high-performing girls. As was the case for reading and mathematics, boys and girls that left unreported the time spent studying science at home score on average 26 and 32 points below their counterparts, respectively. As in reading, girls not reporting on achievement motivation score 39 points below other girls. However, girls not reporting on the sense of belonging at school score 67 points above other girls. Boys not reporting on their interest in science score 16 points below other boys, while girls not reporting on their enjoyment of science score 22 points above other girls.

Table A7d in the appendix reports the detailed decomposition of the gender gap in science with imputed data, which is similar to the decomposition of the gender gap obtained from regressions based on the smaller sample. The gender gap in favour of boys remains statistically non-significant. The gender gap shifts slightly in favour of girls because of the lower endowments, as well as lower returns on endowments, of the newly included male students.

10.5. Summary

Gender gap in science scores in the PISA sample excluding middle-school students stands at 3 points in favour of boys in Turkey, but it is not statistically significant. In the raw data, there are no gender gaps in science within ethnicities, localities or programme types. As for reading and mathematics, in the raw data, gender intersects with Turkish regions also for science. In the majority of regions there is no gender gap in science scores. Yet, in West Anatolia and North Black Sea boys outperform girls in science. In West Marmara, on the other hand, girls outperform boys in science.

The decomposition of the gender gap in science shows that girls have higher endowments than boys, but obtain lower returns on endowments in terms of science scores. These two effects offset each other and the gender gap in scores is not statistically significant. As earlier, while there is no evidence of girls in the PISA sample being positively selected on observables such as parental education, employment or wealth, girls spend more time with parents, less often work for pay, are more motivated, attend higher grades, receive more instruction time in science, less enquiry-based instruction, and their schools score higher in terms of disciplinary climate. They are, however, more anxious than boys, and less interested in science. Boys also benefit from being at schools where the fraction of girls is high.

Regarding the returns on endowments, girls get more out of additional study time at home, and if placed in schools with educated teachers. Boys benefit more from achievement and instrumental motivation, from studying in West Anatolia, and from being in more autonomous schools.

The results do not change significantly when the sample is augmented with imputed data, and the gender gap remains statistically non-significant, although it slightly improves in favour of girls. This is expected, given that high-achieving girls are added to the sample. As a result, the contribution of endowments and returns on endowments to the science gender gap are raised in favour of girls.

11. Summary and policy implications

This work started by looking at gender gaps in student achievement in Turkey, based on PISA 2015. It showed that gender gaps in test scores in Turkey are in line with international patterns. In the raw data, after middle school students are excluded, Turkish girls outperform Turkish boys in reading, lag behind in mathematics and do as well in science.

Education production function

Next, education production functions for reading, mathematics and science were estimated for boys and girls separately. The estimation of the education production functions leads to the following conclusions for Turkey:

(i) Students acquire higher reading, mathematics and science knowledge and skills as they progress through grades.

(ii) Ethnicity is positively correlated with scores only until school resources and management are controlled for in reading and science, but only until programme types are controlled for in mathematics. This suggests that (i) achievement gaps between ethnicities in Turkey are the result of Turkish students attending better schools and programmes, and also that (ii) ethnic differentials in reading and science are "stickier" than in mathematics. This is the case especially for boys. Given that the language spoken at home may be a larger obstacle to excelling in reading than in mathematics, the result is not surprising.

(iii) Father's education is systematically more strongly correlated with student achievement than mother's education. The effect of both mother's and father's employment status often emerge as important especially for girls, and their mathematics and science scores. Father's employment is consistently more important for girls than boys. These findings point to the importance of productive parental role models

for all children, but especially for girls to excel in mathematics and science. Home possessions correlate more persistently with girls' academic achievement. The effect of wealth is also most persistent in the case of mathematics for both sexes, and in the case of science for girls, meaning that it is most difficult to mitigate the transmission of inequality in mathematics and science. Yet, wealth effect is weakened and often disappears after school's climate and average socio-economic status are controlled for. It means that student's background must not necessarily predetermine his or her school performance unless the school system segregates students along strict socio-economic lines.

(iv) Parental emotional support is important for boys' reading performance. On the other hand, regularly talking to parents stands out as instrumental both for boys and girls, in all subjects. Child's involvement in paid employment systematically harms the academic performance of all children. Child's involvement in domestic work is also detrimental to mathematics and science scores, indicating that those subjects might require more time and undivided attention outside the classroom. This conclusion is corroborated by the fact that – for girls, unlike for boys - time devoted to mathematics and science at home is not negatively correlated with scores.

(v) Overall achievement motivation comes out as significant for boys, but not for girls, in reading and science. Yet, it is important for both sexes in mathematics. This finding is crucial because it points to the centrality of motivation to girl's success in mathematics. On the other hand, anxiety is strongly detrimental to girls' academic success in reading, yet to both boys' and girls' academic success in mathematics and science. The sense of belonging is important for girls in reading. This suggests the nature of non-cognitive attributes is least gender-variegated in mathematics, followed by science. It is most gendered in reading.

(vi) Rural-urban distinction matters little for scores in all subjects, but girls in West Anatolia and East Black Sea regions systematically underperform in all subjects *vis-à-vis* local boys and girls elsewhere in Turkey.

(vii) Students in general selective schools systematically outperform their peers in other types of highs schools, in all subjects. However, the effect of programme types usually disappears once school's average economic, social and cultural status are accounted for. This suggests that students in Turkey – both boys and girls – sort into programme types along the socio-economic lines.

(viii) While there is little evidence of the importance of school resources, students – especially girls – in private-managed schools underperform *vis-à-vis* girls in public schools. Students in schools receiving a high fraction of funding from the government record superior performance. Both findings are consistent with the fact that the best schools in Turkey are public Anadolu and science high schools. Disciplinary climate is important – both for boys and girls - and students in less disciplined classrooms systematically score below their peers, in all subjects. School's average economic, social and cultural status is persistently associated with much higher scores both for boys and girls. These point to the effects of school environment or peers being potentially very high in Turkish schools.

(ix) Enjoyment of science correlates with higher science scores both for boys and girls, but interest in science and instrumental motivation to learn science translate into higher science scores for boys only. Finally, enquiry-based instruction is detrimental to science scores for all, while adaptive instruction enhances them in the case of girls.

Gender gaps in student achievement

Taking into account a large number of student, family and school characteristics, it emerged that girls in Turkey outperform boys in reading by at least 25 points, lag behind boys in mathematics by at least 7 points and perform alike in science. Gender gaps in reading, mathematics and science scores were then

decomposed into two components - due to endowments and returns on endowments. The study of gender gaps in academic achievement lends itself to two main conclusions:

(i) While there is no evidence of girls being positively selected on observables such as parental education, employment or wealth, girls' endowments are higher than boys. Girls receive more parental support, talk to parents more often, and are less likely to work for pay. Fifteen-year-old girls on average attend higher grades than their male counterparts, and are enrolled in better schools. They are more likely to attend schools that offer more instruction time and better disciplinary climate. In science, they receive less enquiry-based instruction than boys. Girls are on average more ambitious than boys and develop more sense of belonging to their schools. These are the key characteristics on account of which girls earn at least 20 more points than boys in reading, at least 6 more points in mathematics and at least 11 points in science. Key attribute based on which they lose to boys is higher anxiety. Boys also spend less time studying at home, are more interested in science, and benefit from being in schools with a high fraction of girl students.

(ii) It is only in reading that girls, on average, obtain higher returns on endowments than boys (5 points), and it is due especially to the fact that girls get more out of quality teachers. It is only in mathematics that girls do not capitalise on quality teachers. Girls also get more out of their time spent studying at home, especially in mathematics and science. Yet overall, in mathematics and science, boys are better in translating endowments into high returns (15 and 8 points, respectively). Boys systematically score higher than girls if they are located in West Anatolia, if they attend more autonomous schools and schools with high socio-economic status. They also capitalise better on their motivation in general, and instrumental motivation in science in particular.

Policy implications

This research sheds light on a number of policy measures in view of allowing both boys and girls perform to their full potential. Policy recommendations originating from this work complement prior research on academic achievement in Turkey, but add new insights, especially on the gendered nature of parent-child relationships and non-cognitive attributes such as motivation, anxiety and the sense of belonging, and their importance for the academic achievement of boys and girls.

- *School system*

(i) First observation – in line with prior research - is that Turkish school system remains segregated into high- and low-performing schools and programmes along the socio-economic lines. This affects the academic performance of boys and girls coming from lower economic, social and cultural backgrounds, especially in mathematics and science. Most often, student's socio-economic background correlates with academic achievement only until school's climate and average socio-economic status are accounted for. This points to the importance of learning environment or peers for student performance. It also suggests that student's background would be less likely to correlate with scores, had the school system not perpetuated the existing inequality of opportunity. The correlation of programme types with scores also weakens once school climate is controlled for. In the case of Turkey, the segregation is the artefact of the system that streams students by ability very early (currently already in 5th grade following "4+4+4" education reform of 2012) and allocates students to high schools based on a highly competitive central examination.

- *Family background and home environment*

(ii) Although they do not seem to contribute to gender gaps, productive parental role models emerge as important, especially for girls in mathematics and science. When parental employment cannot fulfil this

function, role models must be absorbed from outside home. This could be achieved, for example, through mathematics and science teachers, or being exposed to role models through school activities or engagement with civil society.

(iii) Home environment appears to be instrumental for academic achievement. In particular, receiving parental emotional support correlates with boys' scores in reading. Regularly talking with parents emerges as a critical factor in improving scores, in all subjects, both for boys and girls. Yet boys receive less parenting than girls in the sample, both in terms of emotional support and talking to parents, which contributes in a significant way to them losing points *vis-à-vis* girls in all subjects. Sensitising parents about the importance of parent-child engagement could play a role in improving both boys' and girls' academic performance.

(iv) Time devoted to house chores and paid labour is systematically detrimental to academic performance of both boys and girls. It emerges from this study that boys, more often than girls, are involved in paid labour, which harms their performance *vis-à-vis* girls in all subjects. As children's involvement in chores and paid work prevails in households facing resource constraints, single-parent households and families with many siblings, the role of the government should be to help alleviate resource constraints in the most disadvantaged households through welfare programs, conditional cash transfers, and employment generation.

- *Study time and the "facilitators" of learning*

(v) High performance in the three subjects is related to the learning time at school, both for boys and girls. Girls in the PISA sample systematically attend schools where they receive more instruction time, and this earns them extra scores in the three subjects *vis-à-vis* boys. On the other hand, boys devote less time to study after school, which contributes to the gender gaps in their favour because home study time correlates negatively with scores. However, both of those effects are rather small. On the other hand, girls are much more efficient than boys in translating their mathematics and study time outside school into scores.

(vi) A discouraging finding is that girls report higher achievement motivated than boys, yet they are not able to translate this motivation into higher scores, except in mathematics. Boys systematically capitalise more on motivation in the three subjects. It remains an open question why this is so. There is scope to learn from education research literature on how to ameliorate this shortcoming.

(vii) Girls much more than boys suffer from performance anxiety, with detrimental result for their scores in all subjects. There is a role to play for parents, teachers, school principals and peers in creating environments that are conducive to less stressful learning.

(viii) Girls seem to develop more sense of belonging to their schools, comparing to boys, and this adds to their scoring higher than boys in reading. This might be, to a certain extent, the artefact of boys and girls – on average - attending different schools in Turkey. Girls in PISA sample are somewhat more likely to study in selective general schools, while boys are more likely to be in vocational schools. Also, the sense of belonging might be generated in schools where the disciplinary climate is better and the fraction of girls is higher. Yet, the sense of belonging remains important after programme types, school resources, management and climate are accounted for. Although this study cannot inform on the direction of causal relationships, learning environments that foster a good sense of belonging for the students are certainly a plausible "facilitator" of learning.

- *School resources, school management and school climate*

(ix) Out of school resources, what matters for girls' achievement is the quality of teaching. Girls get more than boys in reading and science out of teachers with at least a bachelor degree. The question remains

why girls do not capitalise on quality teachers in the case of mathematics. Adapting mathematics teaching strategies to better match the needs of girls might be a piece of the puzzle that could help close the remaining gender gap in mathematics.

(x) In Turkey, students in private schools – both boys and girls, but especially girls - systematically underperform comparing to their peers in public schools. In the raw data this might be the artefact of education segregation in Turkey, where the best high schools are publicly run Anadolu and science high schools. A model with many student-, family- and school-level controls, however, points to a residual (negative) correlation between private schooling and academic achievement. As the number of students attending private schools in Turkey is on a rise, education quality control in private establishments should remain on the policy agenda.

(xi) What seems to add to boys' performance in reading and science relative to girls is attending schools that have higher autonomy in terms of their responsibility for curriculum. Further insights from education research are needed to understand this phenomenon.

(xii) School's climate persistently emerges as important for academic achievement, both for boys and girls. The lack of student discipline in class is detrimental to both boys' and girls' performance in all subjects. The fact that, on average, girls in Turkey attend schools with better disciplinary climates adds to their higher scores relative to boys in all subjects. School's average economic, social and cultural status (ESCS) is very strongly correlated with scores for all children, in all subjects, but in particular benefits boys in reading. On the other hand, in mathematics and science, boys benefit from attending schools with a high fraction of girls. All of the above suggest the importance of learning environments or peers in fostering good learning outcomes.

- *Student's attitudes to science and science class format*

(xiii) Teaching methodologies that foster the enjoyment of science could potentially benefit both boys and girls. Girls are on average less interested in science than boys, and this contributes to the gender gap in science scores in favour of boys. Being aware of this fact should lead to developing teaching strategies that could stimulate girls' interest in science, bearing in mind that girls and boys are interested in different science topics. Also, as with general motivation, instrumental motivation in science translates into high returns in terms of scores for boys only. Again, there is scope to learn from education research literature on how to approach this phenomenon.

(xiv) Consistent with international evidence, enquiry-based instruction is detrimental to student performance is science, while adaptive instruction correlates with higher scores in science. Girls comparing to boys, on average, receive less enquiry-based instruction, which adds to their scores in science. This finding should be considered when new curricula are being developed. In particular, moving towards alternatives to enquiry-based teaching should be considered.

- *Regional academic performance and gender gaps*

(xv) There are only two regions in Turkey – West Anatolia and East Black Sea – where girls systematically underperform in reading, mathematics and science, and local specificities should be analysed in further detail with aim of addressing the persistent gender gap in student achievement in those two regions.

Results relevant to Science, Technology, Engineering and Mathematics (STEM) education

As Turkey attributes increasing attention to STEM education, a number of finding from this study emerge as relevant.

(i) In mathematics and science, girls underperform *vis-à-vis* boys in West Anatolia and East Black Sea, while no striking gender gaps are recorded in other regions. This being said, the academic performance

of both boys and girls in mathematics and science is lower in the regions of the Black Sea, and Central East and Southeast Anatolia.

(ii) Productive parental role models are important for STEM, both for boys and girls, but especially for girls. The study also shows that the transmission of household inequality is stronger in STEM than in other subjects. Talking to parents emerges as important for student mathematics and science achievement, while boys in Turkey - comparing to girls - systematically report less daily engagement with parents. Both paid employment and household chores are detrimental to science and math performance, and they seem to affect boys more than girls because boys are more likely to work for pay.

(iii) The amount of time devoted to mathematics and science in the classroom stands out as important, and girls attend schools where they receive more classroom instruction time. Home study also matters, and it is girls who are more efficient in translating home study time into scores. The enjoyment of science benefits all students. Interest in science topics is also important. Girls are overall less interested in science topics, and this harms their performance in science. Also, girls – unlike boys - are not able to translate their higher levels of ambition and instrumental motivation into better academic achievement. While performance anxiety is highly detrimental to mathematics and science performance of both boys and girls, girls are also systematically more anxious than boys.

(iv) Enquiry-based instruction emerges as detrimental to science scores for all students, and boys are more likely to attend schools that offer this type of teaching. Adaptive instruction in science is likely to be beneficial, especially for girls. On the other hand, it is puzzling why girls are not able to capitalise on qualified mathematics teachers, while they get a lot out of qualified science teachers.

(v) Classroom discipline comes out as vital for student performance in mathematics and science, and girls benefit from it in particular because, on average, they attend schools with better disciplinary climates. Boys tend to benefit if they attend schools with a high fraction of female students, as well as schools that report high autonomy in setting their curriculum.

(vi) Overall, it appears that fostering better STEM performance requires attention to be paid to different facets of education – from parents, through teachers and teaching, to school climate and peers.

12. Conclusions

Based on the data collected by the Programme for International Student Assessment in Turkey in 2015, this work finds that gender gaps in student achievement in Turkey are consistent with international patterns – Turkish girls outperform Turkish boys in reading, lag behind in mathematics and do as well in science. The estimations of education production functions for reading, mathematics and science, for boys and girls, are carried out using a large battery of student, family and school characteristics. Gender gaps predicted by the model are decomposed into the effects due to student, family and school characteristics, and due to the returns on them. This work takes a particular interest in three groups of variables: (i) child-parent relationship, (ii) non-cognitive "facilitators" of learning such as motivation, the lack of anxiety and the sense of belonging at school, and (iii) student's attitudes to science – the enjoyment of, interest in and motivation to learn science. While studies for Turkey occasionally accounted for these variables in the estimations of education production functions, the contribution of them to gender gaps has hardly been studied. As such, this work provides not only the most up to date insight into education production in Turkey, but also into the differentials in academic performance between boys and girls.

First, based on the estimation of education production functions and in line with earlier studies for Turkey, this works once again draws attention to the segmented nature of the Turkish school system. Turkish students are streamed into programme types and low- and high-performing schools along the socio-economic lines. This propagates further the inequalities that arise due to differences in ethnicity, parental

background and household wealth. While school resources and management rarely emerge as significant contributors to academic achievement, the persistent importance of school's disciplinary climate and school's average socio-economic background speak to the centrality of school environment, peers and community to fifteen-year-olds' academic performance. Additionally, for science, this work corroborates international evidence that enquiry-based instruction is detrimental to scores, while adaptive instruction tends to improve student performance.

Second, based on the estimation of education production functions but with regards to the three groups of variables of particular interest to this study, student's engagement with parents, especially talking to parents, emerges as a crucial factor driving student performance, both for boys and girls, in all subjects. This confirms that parents are an important source of motivation and values for children, and that daily space must be devoted to child-parent engagement in order to produce citizenry equipped in advanced knowledge and skills. The study also establishes the pertinence of devoting undivided attention to the study of science and mathematics, as well as the importance of motivation for succeeding in mathematics in particular – both for boys and girls. Another clear-cut conclusion concerns school-related anxiety. Anxiety is highly detrimental to both boys' and girls' scores, especially in science and mathematics. Overall, this suggests that science and mathematics, and especially mathematics, require high investments, irrespective of gender, as well as more attention to be paid to alleviating children's study-related stress. However, the enjoyment of, interest in and motivation for science are more gendered - while the enjoyment of science benefits both boys and girls, interest in and instrumental motivation for science more readily translate into science scores for boys only. The sense of belonging at school is also gendered, translating most into girls' reading performance.

Third, regarding the gender gaps in academic performance, it emerges that although girls' endowments tend to be higher than boys' in Turkey – especially on account of girls having better child-parent relationships, attending better schools, being more ambitious and more attached to their schools - boys are better in translating their endowments into returns and scores. This could be related to the fact that in societies where gender-based discrimination is high, and where boys face fewer obstacles to educational and professional development, girls find it harder to capitalise on their investments. A worrying finding is that, systematically, girls more often than boys experience school-related anxiety. This is a finding that persists across the subjects and certainly requires the attention of parents, teachers and school principals. On the other hand, boys spend less time studying at home (in all subjects) and are more interested in science. Possibly more effort should be put on developing girls' interest in science through adjustments to curriculum or teaching methods. Currently, girls are more efficient than boys in translating out-of-school study time into scores. Girls also capitalise more than boys on quality teaching, except in mathematics. Why girls do not earn returns on mathematics teaching remains an important concern. The higher returns they get on own-study time are not sufficient to compensate for this deficiency. Finally, gender gaps are driven by differential returns on motivation. While girls are more ambitious overall, and more instrumentally motivated in science in particular, it is boys who are able to turn their ambition and motivation into scores. This is a critical area where further understanding must be gained from education research in order to allow girls to perform to their full potential in mathematics and science. Last but not least, girls persistently underperform across subjects in West Anatolia and East Black Sea, with West Anatolian underperformance contributing in a significant way to academic differentials between boys and girls in Turkey.

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TABLES

Table 1a. *Scores in reading*

		2003	2006	2009	2012	2015	2015-2012
OECD	Average	494	492	494	497	493	-4
	Boys	477	473	474	478	479	2
	Girls	511	511	514	516	506	-9
	Boys-Girls	**–34**	**-38**	**-39**	**-38**	**-27**	**11**
Turkey	Average	441	447	464	475	428	**-47**
	Boys	426	427	443	453	414	**-38**
	Girls	459	471	486	499	442	**-56**
	Boys-Girls	**–33**	**-44**	**-43**	**-46**	**-28**	**18**

Note. In bold if significant at least at 0.05 level. Source: OECD.

Table 1b. *Scores in mathematics*

		2003	2006	2009	2012	2015	2015-2012
OECD	Average	500	498	495	494	490	-4
	Boys	506	503	501	499	494	-5
	Girls	494	492	490	489	486	-2
	Boys-Girls	**11**	**11**	**12**	**10**	**8**	**-3**
Turkey	Average	423	424	445	448	420	**-28**
	Boys	430	427	451	452	423	**-29**
	Girls	415	421	440	444	418	**-26**
	Boys-Girls	**15**	6	**11**	8	6	-2

Note. In bold if significant at least at 0.05 level. Source: OECD.

Table 1c. *Scores in science*

		2003	2006	2009	2012	2015	2015-2012
OECD	Average	499	498	501	501	493	**-8**
	Boys	503	499	501	502	495	-7
	Girls	497	497	501	501	491	**-9**
	Boys-Girls	**6**	**2**	0	1	**4**	**3**
Turkey	Average	434	424	454	463	425	**-38**
	Boys	434	418	448	458	422	**-36**
	Girls	434	430	460	469	429	**-40**
	Boys-Girls	0	**-12**	**-12**	**-10**	-6	4

Note. In bold if significant at least at 0.05 level. Source: OECD.

Table 2. *Descriptive statistics by average scores*

	Below median		Above median	
	Mean	SD	Mean	SD
Scores				
Average	**367.73**	33.80	**483.08**	45.92
Reading	**373.60**	43.87	**487.03**	48.00
Math	**362.53**	38.46	**477.44**	51.80
Science	**367.06**	34.64	**484.76**	49.44
Student				
Female	**0.50**	0.50	**0.53**	0.50
Ethnicity -Turkish	**0.90**	0.30	**0.97**	0.18
Grade	**9.72**	0.53	**9.92**	0.37
Had at least 1 year ECE	**0.39**	0.49	**0.48**	0.50
Parents				
Mother at least high school	**0.30**	0.46	**0.35**	0.48
Mother at least university degree	**0.07**	0.25	**0.09**	0.29
Father at least high school	**0.31**	0.46	**0.48**	0.50
Father at least university degree	**0.08**	0.28	**0.17**	0.38
Mother working	**0.15**	0.36	**0.24**	0.43
Father working	**0.84**	0.37	**0.91**	0.29
Home				
Home possessions (WLE)	**-1.73**	1.10	**-1.09**	0.99
ESCS (WLE)	**-1.71**	1.05	**-1.15**	1.17
Parental emotional support (WLE)	**-0.40**	1.12	**-0.07**	0.99
Talks to parents	**0.83**	0.37	**0.94**	0.24
Works in household	**0.85**	0.36	**0.78**	0.41
Works for pay	**0.49**	0.50	**0.21**	0.41
Study time				
Home study – Turkish (hr)	**5.77**	5.17	**4.41**	3.77
Home study – Math (hr)	**6.54**	5.21	**6.28**	4.83
Home study – Science (hr)	**5.55**	4.77	**5.15**	4.14
Class study – Turkish (hr)	**2.68**	1.27	**3.06**	1.04
Class study – Math (hr)	**3.60**	1.45	**3.91**	1.05
Class study – Science (hr)	**2.92**	1.78	**3.85**	1.61
General attitudes				
Ambition/Achievement motivation (WLE)	**0.52**	1.11	**0.78**	0.89
Performance anxiety (WLE)	**0.39**	1.11	**0.27**	1.00
Sense of belonging at school (WLE)	**-0.51**	1.09	**-0.32**	1.17
Attitudes to science				
Science – enjoyment of (WLE)	**-0.05**	1.13	**0.31**	1.16
Science – interest in (WLE)	**-0.12**	1.08	**0.02**	0.96
Science – instrumental motivation (WLE)	**0.35**	0.91	**0.43**	0.92
Science class format				
Enquiry-based instruction (WLE)	**0.48**	1.24	**0.19**	1.07
Teacher-directed instruction (WLE)	**-0.11**	0.97	**0.04**	0.96
Adaptive instruction (WLE)	**0.05**	0.95	**0.20**	0.97
School's location				
Village: Pop <15,000	**0.09**	0.29	**0.05**	0.22
Town/City: 15,000<Pop<1,000,000	**0.56**	0.50	**0.50**	0.50
Large city: Pop>1,000,000	**0.35**	0.48	**0.45**	0.50
School's region				
Istanbul	**0.14**	0.34	**0.19**	0.39
West Marmara	**0.03**	0.18	**0.04**	0.21
Aegean	**0.09**	0.29	**0.14**	0.34
East Marmara	**0.08**	0.26	**0.10**	0.30
West Anatolia	**0.08**	0.27	**0.11**	0.32
Mediterranean	**0.16**	0.37	**0.15**	0.36
Central Anatolia	**0.06**	0.24	**0.06**	0.24
West Black Sea	**0.06**	0.24	**0.06**	0.24
East Black Sea	**0.05**	0.22	**0.03**	0.16
Northeast Anatolia	**0.03**	0.17	**0.03**	0.17
Central East Anatolia	**0.06**	0.23	**0.02**	0.14
Southeast Anatolia	**0.16**	0.37	**0.07**	0.25

Program and selectivity				
General not selective	**0.08**	0.27	**0.06**	0.23
General selective	**0.29**	0.45	**0.71**	0.46
Vocational not selective	**0.24**	0.43	**0.06**	0.24
Vocational selective	**0.39**	0.49	**0.17**	0.38
School's resources				
Class size	**48.06**	9.18	**47.16**	10.66
Student-teacher ratio	**14.66**	4.90	**15.34**	4.36
Shortage – educational resources (WLE)	**0.40**	1.36	**-0.15**	1.08
Shortage – staff (WLE)	**0.78**	1.08	**0.25**	1.07
Fraction of teachers with at least BA degree	**0.89**	0.15	**0.92**	0.12
School's institutional setting				
Private school	**0.06**	0.23	**0.04**	0.20
Fraction of funding from government	**78.87**	25.89	**73.52**	26.94
Students grouped by ability	**0.41**	0.49	**0.56**	0.50
Leadership – overall (WLE)	**0.58**	0.96	**0.65**	1.02
Accountability (0-1)	**0.78**	0.22	**0.82**	0.22
School autonomy – resources (WLE)	**-0.69**	0.23	**-0.70**	0.23
School autonomy – curriculum (WLE)	**-1.12**	0.37	**-1.15**	0.27
School's climate				
Discipline issues – students (WLE)	**0.44**	0.81	**-0.10**	0.93
Discipline issues – teachers (WLE)	**0.18**	0.80	**0.01**	0.88
Average ESCS	**-1.68**	0.50	**-1.16**	0.58
Fraction of girls	**0.49**	0.30	**0.54**	0.21
Observations	**2,239**		**2,624**	

Table 3a. *Within- and between-school variation in average scores*

Source	SS	df	MS	F
Between school	14,891,023	158	**94,247**	48.13***
Within school	9,210,741	4,704	**1,958**	
Total	24,101,764	4,862	**4,957**	

Note. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 3b. *Within- and between-school variation in ESCS*

Source	SS	df	MS	F
Between school	1,800	158	**11.39**	11.48 ***
Within school	4,667	4,704	**0.99**	
Total	6,467	4,862	**1.33**	

Note. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 4. *Descriptive statistics by sex*

	Boys		Girls	
	Mean	SD	Mean	SD
Scores				
Fraction with average score above median	**0.55**	0.50	**0.58**	0.49
Average	**429.82**	70.56	**436.27**	70.14
Reading	**425.12**	72.17	**449.84**	71.34
Math	**432.30**	73.71	**423.47**	73.09
Science	**432.04**	73.12	**435.48**	72.57
Student				
Ethnicity -Turkish	**0.93**	0.25	**0.94**	0.23
Grade	**9.77**	0.48	**9.89**	0.43
At least 1 year ECE	**0.45**	0.50	**0.44**	0.50
Parents				
Mother at least high school	**0.34**	0.47	**0.32**	0.47
Mother at least university degree	**0.09**	0.28	**0.07**	0.26
Father at least high school	**0.42**	0.49	**0.39**	0.49
Father at least university degree	**0.14**	0.35	**0.13**	0.34
Mother working	**0.20**	0.40	**0.21**	0.41
Father working	**0.88**	0.33	**0.88**	0.33
Home				
Home possessions (WLE)	**-1.39**	1.09	**-1.35**	1.08
ESCS (WLE)	**-1.38**	1.15	**-1.40**	1.15
Parental emotional support (WLE)	**-0.30**	1.06	**-0.14**	1.05
Talks to parents	**0.88**	0.32	**0.91**	0.29
Works in household	**0.80**	0.40	**0.82**	0.38
Works for pay	**0.44**	0.50	**0.23**	0.42
Study time				
Home study – Turkish (hr)	**4.78**	4.24	**5.20**	4.68
Home study – Math (hr)	**6.17**	4.79	**6.60**	5.17
Home study – Science (hr)	**5.11**	4.20	**5.52**	4.62
Class study – Turkish (hr)	**2.79**	1.19	**2.99**	1.13
Class study – Math (hr)	**3.69**	1.21	**3.86**	1.29
Class study – Science (hr)	**3.30**	1.71	**3.59**	1.77
General attitudes				
Ambition/Achievement motivation (WLE)	**0.58**	1.04	**0.74**	0.95
Performance anxiety (WLE)	**0.09**	1.03	**0.54**	1.02
Sense of belonging at school (WLE)	**-0.53**	1.11	**-0.29**	1.16
Attitudes to science				
Science – enjoyment of (WLE)	**0.17**	1.16	**0.15**	1.17
Science – interest in (WLE)	**0.05**	1.07	**-0.12**	0.95
Science – instrumental motivation (WLE)	**0.32**	0.92	**0.46**	0.91
Science class format				
Enquiry-based instruction (WLE)	**0.37**	1.24	**0.25**	1.06
Teacher-directed instruction (WLE)	**-0.03**	1.01	**-0.02**	0.93
Adaptive instruction (WLE)	**0.09**	0.98	**0.18**	0.95
School's location				
Village: Pop <15,000	**0.08**	0.28	**0.05**	0.22
Town/City: 15,000<Pop<1,000,000	**0.51**	0.50	**0.54**	0.50
Large city: Pop>1,000,000	**0.41**	0.49	**0.40**	0.49
School's region				
Istanbul	**0.15**	0.36	**0.18**	0.38
West Marmara	**0.03**	0.18	**0.05**	0.21
Aegean	**0.11**	0.32	**0.12**	0.33
East Marmara	**0.09**	0.29	**0.09**	0.29
West Anatolia	**0.11**	0.31	**0.09**	0.29
Mediterranean	**0.17**	0.38	**0.14**	0.35
Central Anatolia	**0.06**	0.24	**0.06**	0.23
West Black Sea	**0.06**	0.24	**0.06**	0.24
East Black Sea	**0.04**	0.20	**0.03**	0.18
Northeast Anatolia	**0.03**	0.16	**0.04**	0.19
Central East Anatolia	**0.03**	0.18	**0.04**	0.19
Southeast Anatolia	**0.11**	0.32	**0.10**	0.30

Program and selectivity				
General not selective	**0.07**	0.26	**0.06**	0.24
General selective	**0.48**	0.50	**0.58**	0.49
Vocational not selective	**0.17**	0.38	**0.11**	0.32
Vocational selective	**0.28**	0.45	**0.25**	0.43
School's resources				
Class size	**47.45**	10.19	**47.64**	9.92
Student-teacher ratio	**15.14**	4.80	**14.95**	4.44
Shortage – educational resources (WLE)	**0.09**	1.27	**0.08**	1.21
Shortage – staff (WLE)	**0.49**	1.18	**0.48**	1.04
Fraction of teachers with at least BA degree	**0.90**	0.15	**0.92**	0.12
School's institutional setting				
Private school	**0.07**	0.25	**0.03**	0.18
Fraction of funding from government	**76.79**	27.42	**74.95**	25.84
Students grouped by ability	**0.49**	0.50	**0.50**	0.50
Leadership – overall (WLE)	**0.65**	1.00	**0.60**	0.99
Accountability (0-1)	**0.79**	0.23	**0.82**	0.22
School autonomy – resources (WLE)	**-0.68**	0.26	**-0.71**	0.20
School autonomy – curriculum (WLE)	**-1.13**	0.35	**-1.15**	0.28
School's climate				
Discipline issues – students (WLE)	**0.25**	0.90	**0.03**	0.91
Discipline issues – teachers (WLE)	**0.10**	0.83	**0.07**	0.87
Average ESCS	**-1.40**	0.60	**-1.37**	0.61
Fraction of girls	**0.38**	0.21	**0.64**	0.23
Observations	**2,332**		**2,531**	

Table 5a. *Key score gaps – reading*

	Average	Boys	Girls	Boys-Girls
	438	425	449	-25***
Ethnicity				
Non-Turkish	392	380	405	-25*
Turkish	441	428	453	-24***
Gap	-49***	-49***	-48***	1
Home possessions (WLE)				
Low	416	404	427	-22***
High	459	446	471	-25***
Gap	-43***	-41***	-45***	4
ESCS (WLE)				
Low	416	407	433	-26***
High	459	441	466	-25***
Gap	-43***	-34***	-33***	-1
Location				
Village: Population <15,000 (Ref.)	406	389	431	-43*
Town/City: Population 15,000-1,000,000	436	422	448	-26***
Gap	-30	-33*	-17	-17
Big city: Population >1,000,000	445	437	455	-18**
Gap	-40*	-48**	-23	-25
Region				
Istanbul (Ref.)	453	436	466	-31***
West Marmara	463	439	479	-46***
Gap	-11	-4	-13	9
Aegean	456	441	469	-29***
Gap	-3	-5	-3	-2
East Marmara	446	428	463	-36**
Gap	7	8	3	5
West Anatolia	443	446	440	6
Gap	10	-11	26	-37**
Mediterranean	442	431	455	-24***
Gap	10	5	11	-6
Central Anatolia	433	418	447	-28**
Gap	20	17	20	-3
West Black Sea	424	404	440	-35***
Gap	29**	31**	26	5
East Black Sea	407	401	414	-13***
Gap	45***	34**	52***	-18*
Northeast Anatolia	434	431	436	-5
Gap	19	5	30	-25
Central East Anatolia	396	380	407	-27***
Gap	57***	55***	59***	-4
Southeast Anatolia	406	396	416	-19
Gap	47***	39***	51***	-11
Program type				
General not selective (Ref.)	410	400	422	-22***
General selective	471	462	478	-16***
Gap	-61***	-62***	-56***	-6
Vocational not selective	388	384	393	-10
Gap	23***	16*	29***	-12
Vocational selective	405	394	416	-23**
Gap	5	6	5	1

Note. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 5b. *Reading – boys*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Grade (Ref. Grade 9)						
Grade 10	51.13***	44.99***	42.04***	36.53***	34.66***	30.65***
	(5.03)	(4.72)	(4.71)	(4.34)	(4.18)	(4.03)
Grade 11	30.61*	17.58	17.75	22.18*	19.20	22.99*
	(16.66)	(15.03)	(13.72)	(12.11)	(12.59)	(12.02)
Grade 12	32.38	47.15	54.97	57.53*	52.70	43.28
	(43.49)	(35.06)	(38.06)	(34.92)	(35.62)	(33.79)
Turkish	27.55**	22.74*	22.90*	17.64*	13.13	9.80
	(13.27)	(13.00)	(13.08)	(9.08)	(9.09)	(9.07)
Mother's education (Ref.: Less than high school)						
High school	-6.13	-4.47	-4.38	-3.41	-2.25	-5.49
	(5.09)	(4.68)	(4.74)	(4.44)	(4.47)	(4.29)
University degree	-14.70*	-7.65	-5.53	-7.66	-6.26	-12.07*
	(8.61)	(8.39)	(8.54)	(7.38)	(7.33)	(6.83)
Father's education (Ref.: Less than high school)						
High school	11.93***	9.39**	8.16**	5.14	4.75	2.71
	(4.37)	(3.99)	(3.93)	(3.40)	(3.51)	(3.33)
University degree	26.85***	21.34***	19.91***	16.11***	14.30***	9.34*
	(6.40)	(6.29)	(6.02)	(5.35)	(5.32)	(5.17)
Parental employment status						
Mother employed	15.04***	13.42***	13.22***	12.93***	12.05***	9.63**
	(5.10)	(4.80)	(4.82)	(3.99)	(3.92)	(3.79)
Father employed	12.66**	9.36*	7.24	4.41	4.84	5.81
	(5.48)	(5.33)	(5.18)	(4.94)	(5.11)	(4.95)
Home possessions (WLE)	15.10***	9.25***	8.82***	5.21**	5.17***	2.41
	(2.44)	(2.28)	(2.24)	(2.12)	(1.95)	(1.96)
ECE - at least 1 year		3.39	3.02	-0.44	-0.13	-0.67
		(4.50)	(4.52)	(4.10)	(4.08)	(4.03)
Parental emotional support (WLE)		6.59***	4.35**	3.94**	3.49**	3.02*
		(1.88)	(1.81)	(1.74)	(1.71)	(1.69)
Talks to parents		33.91***	32.87***	25.22***	23.98***	21.16***
		(6.00)	(5.99)	(5.62)	(5.27)	(5.03)
Works in household		-3.60	-5.21	-3.65	-2.90	0.43
		(4.44)	(4.57)	(4.03)	(4.01)	(4.01)
Works for pay		-42.67***	-38.08***	-29.29***	-28.08***	-25.97***
		(4.32)	(4.23)	(3.93)	(3.74)	(3.53)
In school learning - Turkish (hours)			8.35***	6.21***	6.17***	5.59***
			(1.52)	(1.35)	(1.32)	(1.31)
Out of school study - Turkish (hours)			-2.14***	-1.71***	-1.67***	-1.40***
			(0.40)	(0.40)	(0.39)	(0.38)
Achievement motivation (WLE)			5.74***	5.63***	5.67***	5.46***
			(2.03)	(1.98)	(1.94)	(1.80)
Test anxiety (WLE)			-2.61	-2.82*	-2.65	-2.73*
			(1.96)	(1.63)	(1.62)	(1.59)
Sense of belonging at school (WLE)			3.28**	2.20	2.23	2.14
			(1.53)	(1.43)	(1.47)	(1.37)
School's location (Ref.: Village – Pop. < 15,000)						
Town or city (15,000 < Pop. < 1,000,000)				15.55	6.17	1.63
				(11.68)	(13.84)	(11.08)
Large city (Pop. > 1,000,000)				21.48	10.87	6.23
				(13.34)	(14.79)	(12.46)
Region (Ref.: Istanbul)						
West Marmara				-6.69	-2.40	-4.39
				(12.40)	(15.78)	(15.22)
Aegean				-0.50	-1.46	-3.78
				(12.19)	(12.37)	(11.44)
East Marmara				-0.42	-4.71	-2.59
				(10.78)	(11.22)	(10.36)
West Anatolia				-6.09	-15.39	-17.12
				(9.45)	(10.27)	(10.74)
Mediterranean				-0.71	-5.13	-5.27
				(9.54)	(9.35)	(10.38)
Central Anatolia				-11.80	-15.93	-8.68
				(15.42)	(16.73)	(15.94)

West Black Sea				-16.72	-29.17**	-21.82*
				(12.81)	(13.97)	(12.87)
East Black Sea				-27.46*	-15.26	-29.84**
				(15.39)	(16.06)	(12.23)
Northeast Anatolia				-22.60	-34.30	-15.41
				(26.01)	(29.15)	(18.55)
Central East Anatolia				0.12	-8.05	12.21
				(16.19)	(14.21)	(14.39)
Southeast Anatolia				-20.73**	-22.60*	-19.18
				(9.63)	(11.63)	(13.41)
Program selectivity (Ref.: General not selective)						
General selective				40.28***	23.94**	20.28*
				(10.81)	(10.96)	(12.20)
Vocational not selective				-13.61	-24.06**	-7.79
				(12.55)	(11.29)	(11.70)
Vocational selective				-8.32	-21.19*	-4.48
				(11.88)	(11.55)	(10.85)
School resources						
Class size					-1.63	-1.80
					(2.57)	(2.05)
Class size squared					0.02	0.02
					(0.03)	(0.03)
Student-teacher ratio					-0.47	0.57
					(2.63)	(2.28)
Student-teacher ratio squared					0.02	0.01
					(0.07)	(0.06)
Shortage of educational material (WLE)					-6.91**	-3.16
					(3.06)	(3.30)
Shortage of educational staff (WLE)					-1.51	-0.49
					(3.46)	(3.28)
Fraction of teachers with at least BA degree					-7.62	2.06
					(25.18)	(26.27)
Private school					-4.40	-20.69
					(19.06)	(20.88)
Share of funding from government					0.10	0.38***
					(0.13)	(0.12)
Students grouped by ability					12.45*	9.17
					(6.60)	(6.42)
Educational leadership (WLE)					2.85	-0.70
					(3.63)	(3.13)
Accountability (0-1)					5.83	4.64
					(14.29)	(13.78)
School autonomy						
Responsibility for resources (WLE)					-2.81	-2.07
					(16.33)	(15.33)
Responsibility for curriculum (WLE)					-14.42	-3.60
					(10.10)	(9.95)
Discipline						
Lack of discipline – students (WLE)						-9.28**
						(3.98)
Lack of discipline – teachers (WLE)						2.41
						(3.94)
Other school characteristics						
Average ESCS						45.43***
						(15.84)
Average ESCS squared						3.06
						(5.11)
Fraction of girls						4.88
						(12.80)
R-squared	.21	.30	.34	.44	.46	.49
Observations	4863	4863	4863	4863	4863	4863

Note. Standard errors in parentheses
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 5c. *Reading – girls*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Grade (Ref. Grade 9)						
Grade 10	44.31***	38.11***	36.22***	31.05***	28.65***	27.78***
	(5.66)	(4.99)	(5.04)	(4.48)	(4.28)	(3.84)
Grade 11	42.04***	33.92***	31.56***	34.39***	32.26***	35.30***
	(9.42)	(9.28)	(9.29)	(8.28)	(8.31)	(7.92)
Grade 12	37.57	31.20	46.29	53.92	47.67	24.28
	(62.61)	(59.97)	(56.87)	(45.03)	(45.45)	(40.95)
Turkish	19.45**	14.63*	15.53*	2.74	1.11	-2.69
	(9.24)	(8.75)	(8.78)	(9.59)	(9.26)	(8.85)
Mother's education (Ref.: Less than high school)						
High school	-7.73*	-6.22	-4.91	-4.11	-4.66	-7.66**
	(4.62)	(4.39)	(4.10)	(4.09)	(3.82)	(3.75)
University degree	-10.78	-6.40	-4.08	-6.48	-6.26	-10.52*
	(6.57)	(6.37)	(6.17)	(5.89)	(5.90)	(5.54)
Father's education (Ref.: Less than high school)						
High school	12.84***	10.86***	9.42**	7.39**	7.28**	2.99
	(4.40)	(4.11)	(3.98)	(3.64)	(3.70)	(3.47)
University degree	25.97***	20.92***	20.03***	15.01**	14.84**	7.61
	(8.20)	(7.78)	(7.72)	(7.13)	(7.16)	(6.46)
Parental employment status						
Mother employed	11.36**	10.35**	10.28**	7.02	7.15	6.32
	(5.12)	(4.74)	(4.72)	(4.91)	(4.43)	(4.22)
Father employed	19.25***	16.38***	13.43***	9.06**	9.48**	8.43*
	(5.26)	(4.97)	(4.93)	(4.57)	(4.45)	(4.30)
Home possessions (WLE)	17.79***	13.43***	12.04***	7.82***	7.40***	3.18*
	(2.65)	(2.61)	(2.47)	(1.99)	(2.14)	(1.75)
ECE - at least 1 year		3.68	3.75	0.60	0.12	-1.37
		(4.63)	(4.66)	(4.27)	(4.06)	(3.97)
Parental emotional support (WLE)		5.19***	4.32**	2.79	2.75	2.20
		(2.01)	(2.06)	(1.89)	(1.85)	(1.90)
Talks to parents		37.12***	34.28***	26.04***	25.47***	22.21***
		(5.90)	(5.58)	(5.03)	(4.98)	(4.68)
Works in household		-6.22	-6.00	-2.99	-1.59	2.13
		(5.19)	(5.11)	(4.30)	(4.05)	(3.92)
Works for pay		-45.62***	-43.94***	-35.13***	-33.20***	-30.21***
		(4.71)	(4.59)	(4.16)	(4.17)	(3.68)
In school learning - Turkish (hours)			7.25***	6.76***	6.80***	6.24***
			(1.50)	(1.60)	(1.56)	(1.48)
Out of school study - Turkish (hours)			-1.55***	-1.34***	-1.24***	-1.04***
			(0.37)	(0.36)	(0.34)	(0.32)
Achievement motivation (WLE)			0.98	1.84	1.83	1.45
			(1.99)	(1.79)	(1.74)	(1.67)
Test anxiety (WLE)			-4.43**	-4.85***	-4.83***	-4.33***
			(1.87)	(1.65)	(1.62)	(1.55)
Sense of belonging at school (WLE)			3.72***	3.30**	2.79**	2.70**
			(1.40)	(1.41)	(1.36)	(1.26)
School's location (Ref.: Village – Pop. < 15,000)						
Town or city (15,000 < Pop. < 1,000,000)				9.14	-0.51	2.24
				(19.69)	(20.43)	(16.30)
Large city (Pop. > 1,000,000)				17.19	5.69	5.66
				(18.90)	(19.34)	(15.57)
Region (Ref.: Istanbul)						
West Marmara				7.68	8.23	-9.63
				(16.22)	(17.89)	(15.45)
Aegean				-0.53	-6.26	-11.34
				(14.92)	(14.53)	(13.34)
East Marmara				-12.61	-15.64	-12.19
				(15.45)	(15.44)	(14.48)
West Anatolia				-36.17**	-39.28**	-38.49***
				(14.52)	(15.56)	(14.26)
Mediterranean				-11.36	-15.89	-14.26
				(11.68)	(11.23)	(12.97)
Central Anatolia				-17.82	-14.86	-7.38
				(19.23)	(23.85)	(23.04)

West Black Sea				-27.42*	-35.82**	-15.60
				(14.71)	(14.64)	(12.54)
East Black Sea				-35.66***	-26.78**	-47.35***
				(12.17)	(13.28)	(14.09)
Northeast Anatolia				-32.05	-43.92	-23.69
				(28.12)	(30.52)	(22.49)
Central East Anatolia				-21.86	-30.69*	-13.88
				(13.69)	(16.89)	(16.39)
Southeast Anatolia				-31.74**	-29.31**	-26.66*
				(14.90)	(14.70)	(14.36)
Program selectivity (Ref.: General not selective)						
General selective				32.23***	22.89**	16.04
				(10.49)	(11.35)	(10.95)
Vocational not selective				-29.05**	-28.60**	-14.20
				(11.57)	(12.64)	(12.13)
Vocational selective				-17.89	-23.75*	-6.97
				(12.55)	(13.49)	(12.40)
School resources						
Class size					-2.77	-1.77
					(3.00)	(2.21)
Class size squared					0.04	0.02
					(0.04)	(0.03)
Student-teacher ratio					-1.56	0.67
					(2.66)	(2.48)
Student-teacher ratio squared					0.05	-0.00
					(0.08)	(0.07)
Shortage of educational material (WLE)					-3.77	-0.07
					(3.40)	(3.11)
Shortage of educational staff (WLE)					-4.73	-1.29
					(3.78)	(3.59)
Fraction of teachers with at least BA degree					25.79	38.05
					(29.10)	(27.05)
Private school					-17.75	-56.05***
					(23.63)	(21.48)
Share of funding from government					0.06	0.29**
					(0.17)	(0.13)
Students grouped by ability					15.63*	4.19
					(8.14)	(7.46)
Educational leadership (WLE)					2.89	-3.48
					(4.21)	(3.45)
Accountability (0-1)					12.40	8.75
					(18.94)	(13.86)
School autonomy						
Responsibility for resources (WLE)					-11.78	-5.90
					(20.26)	(17.42)
Responsibility for curriculum (WLE)					0.52	16.24
					(14.58)	(12.11)
Discipline						
Lack of discipline – students (WLE)						-8.98*
						(4.63)
Lack of discipline – teachers (WLE)						-0.76
						(4.19)
Other school characteristics						
Average ESCS						70.53***
						(15.55)
Average ESCS squared						9.66*
						(5.73)
Fraction of girls						-8.55
						(14.75)
R-squared	.18	.27	.30	.42	.44	.49
Observations	4863	4863	4863	4863	4863	4863

Note. Standard errors in parentheses
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 5d. *Decomposition of the gender gap in reading*

	Reading
Predicted reading - boys	425.17***
	(4.26)
Predicted reading - girls	449.84***
	(4.51)
Predicted gender gap	**-24.67*** **
	(4.03)
Endowments	-19.68***
	(3.82)
Coefficients	-4.99***
	(1.31)
Observations	4,863

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5e. *Detailed decomposition of the gender gap in reading*

	Reading	Endowments	Coefficients
Predicted reading - boys	425.17***		
	(4.26)		
Predicted reading - girls	449.84***		
	(4.51)		
Predicted gender gap	**-24.67*** **		
	(4.03)		
Grade 10		-2.37***	2.21
		(0.48)	(2.76)
Grade 11		-0.57***	-0.34
		(0.19)	(0.26)
Grade 12		-0.01	0.03
		(0.03)	(0.05)
Turkish		-0.04	11.70
		(0.14)	(10.23)
Mother - High school		-0.03	0.54
		(0.10)	(1.01)
Mother - University degree		-0.18	-0.11
		(0.11)	(0.48)
Father - High school		0.05	-0.07
		(0.04)	(0.89)
Father - University degree		0.09	0.23
		(0.10)	(0.68)
Mother employed		-0.12	0.68
		(0.12)	(0.73)
Father employed		0.01	-2.30
		(0.07)	(3.77)
Home possessions (WLE)		-0.10	1.05
		(0.12)	(2.48)
ECE - at least 1 year		-0.02	0.32
		(0.04)	(1.56)
Parental emotional support (WLE)		-0.46**	-0.14
		(0.18)	(0.34)
Talks to parents		-0.50**	-0.92
		(0.22)	(3.72)
Works in household		-0.03	-1.37
		(0.05)	(2.74)
Works for pay		-6.13***	1.63
		(0.69)	(1.16)
In school learning - Turkish (hours)		-1.19***	-1.88
		(0.31)	(3.75)
Out of school study - Turkish (hours)		0.49**	-1.81
		(0.21)	(1.66)
Achievement motivation (WLE)		-0.57***	2.65**
		(0.20)	(1.03)
Test anxiety (WLE)		1.30***	0.79
		(0.32)	(0.55)
Sense of belonging at school (WLE)		-0.67***	0.30
		(0.20)	(0.53)
Town or city (15,000 < Pop. < 1,000,000)		-0.11	-0.28
		(0.38)	(7.32)
Large city (Pop. > 1,000,000)		0.03	0.23
		(0.24)	(5.88)
West Marmara		0.06	0.25
		(0.15)	(0.49)
Aegean		0.06	0.89
		(0.14)	(1.07)
East Marmara		-0.01	0.86
		(0.24)	(1.15)
West Anatolia		-0.33	2.10**
		(0.43)	(1.07)
Mediterranean		-0.27	1.36
		(0.42)	(1.52)
Central Anatolia		-0.03	-0.08
		(0.23)	(0.88)
West Black Sea		0.09	-0.38
		(0.44)	(0.69)
East Black Sea		-0.29*	0.66
		(0.17)	(0.48)
Northeast Anatolia		0.17	0.27
		(0.25)	(0.72)
Central East Anatolia		0.03	0.90*
		(0.10)	(0.52)
Southeast Anatolia		-0.29	0.81
		(0.64)	(0.98)

General selective		-1.71*	2.12
		(0.96)	(5.23)
Vocational not selective		-0.61	0.89
		(0.60)	(1.70)
Vocational selective		-0.21	0.69
		(0.49)	(2.88)
Class size		0.29	-1.30
		(1.38)	(81.86)
Class size squared		-0.20	-4.09
		(1.27)	(53.01)
Student-teacher ratio		0.14	-1.52
		(0.43)	(34.16)
Student-teacher ratio squared		0.07	3.89
		(0.50)	(15.31)
Shortage of educational material (WLE)		-0.02	-0.26
		(0.22)	(0.45)
Shortage of educational staff (WLE)		-0.01	0.39
		(0.15)	(1.37)
Fraction of teachers with at least BA degree		-0.31	-32.80*
		(0.54)	(17.01)
Private school		-1.07	1.55
		(0.74)	(1.06)
Share of funding from government		0.65	6.70
		(0.60)	(8.36)
Students grouped by ability		-0.04	2.46
		(0.28)	(2.69)
Educational leadership (WLE)		-0.10	1.74
		(0.19)	(1.61)
Accountability (0-1)		-0.19	-3.34
		(0.36)	(10.10)
Responsibility for resources (WLE)		-0.09	-2.67
		(0.37)	(7.88)
Responsibility for curriculum (WLE)		0.07	22.59**
		(0.17)	(10.73)
Lack of discipline – students (WLE)		-2.16*	0.04
		(1.11)	(0.73)
Lack of discipline – teachers (WLE)		0.02	0.27
		(0.14)	(0.40)
Average ESCS		-1.55	34.79**
		(2.19)	(16.73)
Average ESCS squared		0.37	-15.09
		(0.76)	(10.56)
Fraction of girls		-1.07	8.39
		(2.53)	(7.87)
Constant			-51.21
			(38.31)
Total		**-19.68*** **	**-4.99*** **
		(3.82)	**(1.31)**
Observations	4,863		

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6a. *Key score gaps – mathematics*

	Average	Boys	Girls	Boys-Girls
	428	432	423	9**
Ethnicity				
Non-Turkish	382	386	377	9
Turkish	431	436	426	9**
Gap	-49***	-50***	-50***	0
Home possessions (WLE)				
Low	405	411	400	11**
High	449	453	445	7*
Gap	-43***	-42***	-45***	4
ESCS (WLE)				
Low	410	414	406	8*
High	444	448	441	8*
Gap	-34***	-34***	-34***	0
Location				
Village: Population <15,000 (Ref.)	402	397	410	-13
Town/City: Population 15,000-1,000,000	426	430	422	8
Gap	-24	-33*	-11	-22
Big city: Population >1,000,000	435	442	428	15**
Gap	-33**	-46**	-17	-29
Region				
Istanbul (Ref.)	437	440	436	4
West Marmara	432	428	435	-7
Gap	5	12	0	11
Aegean	448	448	449	0
Gap	-11	-8	-13	4
East Marmara	440	440	440	0
Gap	-2	0	-4	4
West Anatolia	434	449	418	31***
Gap	4	-9	18	-27**
Mediterranean	433	436	430	6
Gap	4	3	6	-2
Central Anatolia	426	436	415	21
Gap	12	3	21	-17
West Black Sea	416	416	416	0
Gap	21	23	20	4
East Black Sea	402	412	389	23***
Gap	36**	28**	46***	-19**
Northeast Anatolia	431	446	421	25
Gap	6	-6	-15	-21
Central East Anatolia	379	376	382	-6***
Gap	58***	64***	54***	10
Southeast Anatolia	397	407	386	21*
Gap	41***	33***	49***	-17
Program type				
General not selective (Ref.)	406	408	403	5
General selective	459	469	451	17***
Gap	-53***	-60***	-48***	-13
Vocational not selective	387	396	374	22***
Gap	19***	13*	30***	-17*
Vocational selective	393	399	387	12
Gap	13*	9	16	-7

Note. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 6b. *Mathematics – boys*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Grade (Ref. Grade 9)						
Grade 10	48.71***	42.81***	41.61***	35.36***	33.17***	27.90***
	(5.73)	(5.43)	(5.52)	(5.12)	(4.92)	(4.64)
Grade 11	41.04***	27.67**	38.43***	40.04***	36.72***	42.52***
	(15.36)	(14.02)	(13.58)	(12.34)	(12.38)	(12.15)
Grade 12	65.22	79.44**	87.30**	100.35**	97.74**	81.91**
	(43.91)	(32.87)	(35.34)	(39.15)	(38.65)	(35.89)
Turkish	29.11***	23.49**	22.82**	16.53	14.20	11.76
	(10.48)	(10.25)	(10.44)	(10.18)	(10.58)	(10.00)
Mother's education (Ref.: Less than high school)						
High school	-7.63	-6.01	-5.40	-4.54	-3.47	-7.91
	(6.30)	(5.77)	(5.73)	(5.40)	(5.19)	(5.00)
University degree	-11.10	-4.31	-2.30	-3.50	-1.82	-10.06
	(9.13)	(8.81)	(8.78)	(7.56)	(7.41)	(6.91)
Father's education (Ref.: Less than high school)						
High school	12.46***	9.86**	9.33**	5.57	5.25	3.12
	(4.62)	(4.27)	(4.19)	(3.55)	(3.50)	(3.26)
University degree	27.63***	22.02**	21.30**	16.12**	14.24*	7.07
	(8.78)	(8.57)	(8.83)	(8.04)	(7.97)	(7.29)
Parental employment status						
Mother employed	10.55*	8.93	8.50	9.10**	8.56*	5.20
	(5.78)	(5.47)	(5.63)	(4.50)	(4.39)	(4.10)
Father employed	4.24	0.90	0.69	-2.12	-1.52	-0.07
	(6.15)	(5.88)	(5.75)	(5.33)	(5.36)	(5.20)
Home possessions (WLE)	16.01***	10.99***	10.52***	7.72***	7.50***	4.28*
	(2.52)	(2.45)	(2.39)	(2.35)	(2.31)	(2.29)
ECE - at least 1 year		2.75	2.12	-1.53	-1.79	-2.91
		(3.72)	(3.63)	(3.25)	(3.05)	(3.06)
Parental emotional support (WLE)		3.04*	0.07	-0.51	-0.80	-1.45
		(1.81)	(1.94)	(1.71)	(1.66)	(1.55)
Talks to parents		37.87***	38.65***	31.86***	30.94***	27.50***
		(5.89)	(5.80)	(5.64)	(5.51)	(5.39)
Works in household		-11.99**	-12.73***	-11.62***	-11.24***	-6.86*
		(4.71)	(4.84)	(4.41)	(4.24)	(4.16)
Works for pay		-40.72***	-38.21***	-28.96***	-27.47***	-24.06***
		(4.54)	(4.50)	(3.96)	(3.68)	(3.47)
In school learning - Mathematics (hours)			7.37***	6.23***	5.99***	6.00***
			(1.73)	(1.48)	(1.39)	(1.39)
Out of school study - Mathematics (hours)			-0.76	-0.83*	-0.87**	-0.88**
			(0.47)	(0.44)	(0.43)	(0.41)
Achievement motivation (WLE)			8.55***	8.07***	8.30***	7.92***
			(1.87)	(1.78)	(1.74)	(1.63)
Test anxiety (WLE)			-4.46**	-4.58***	-4.33***	-4.19***
			(1.87)	(1.56)	(1.55)	(1.54)
Sense of belonging at school (WLE)			1.17	0.08	0.15	0.21
			(2.04)	(1.90)	(1.92)	(1.76)
School's location (Ref.: Village – Pop. < 15,000)						
Town or city (15,000 < Pop. < 1,000,000)				17.63	5.90	2.26
				(14.54)	(16.81)	(13.17)
Large city (Pop. > 1,000,000)				22.21	7.81	5.26
				(15.50)	(17.59)	(14.78)
Region (Ref.: Istanbul)						
West Marmara				-18.56	-18.36	-21.02
				(14.72)	(17.36)	(17.07)
Aegean				2.98	2.65	0.01
				(13.04)	(14.26)	(11.60)
East Marmara				9.39	5.25	11.10
				(13.30)	(13.30)	(12.29)
West Anatolia				-4.25	-12.52	-12.61
				(12.47)	(13.56)	(13.06)
Mediterranean				2.35	-2.61	-3.36
				(8.48)	(10.47)	(10.65)
Central Anatolia				4.65	-2.22	8.84
				(18.56)	(19.13)	(17.98)

West Black Sea				-8.83	-22.08	-10.15
				(15.34)	(16.38)	(14.44)
East Black Sea				-19.46	-9.61	-30.39**
				(13.71)	(16.72)	(13.11)
Northeast Anatolia				-7.73	-19.97	9.77
				(34.72)	(37.51)	(21.67)
Central East Anatolia				-10.44	-19.11	2.96
				(17.03)	(16.61)	(18.44)
Southeast Anatolia				-11.40	-14.64	-11.29
				(12.61)	(13.47)	(15.06)
Program selectivity (Ref.: General not selective)						
General selective				37.70***	23.49**	15.51
				(9.84)	(11.73)	(12.68)
Vocational not selective				-11.98	-21.16*	-0.38
				(10.57)	(11.57)	(11.93)
Vocational selective				-13.75	-26.15**	-4.98
				(10.56)	(12.09)	(11.89)
School resources						
Class size					-2.11	-1.47
					(2.78)	(2.11)
Class size squared					-2.23	-2.30
					(2.81)	(2.12)
Student-teacher ratio					0.03	0.03
					(0.04)	(0.03)
Student-teacher ratio squared					1.25	2.52
					(2.96)	(2.58)
Shortage of educational material (WLE)					-0.03	-0.03
					(0.08)	(0.06)
Shortage of educational staff (WLE)					-5.37	0.74
					(3.66)	(3.52)
Fraction of teachers with at least BA degree					-0.86	1.53
					(4.03)	(3.85)
Private school					-4.82	-27.63
					(18.14)	(17.98)
Share of funding from government					0.08	0.46***
					(0.18)	(0.11)
Students grouped by ability					12.43*	5.84
					(7.48)	(6.70)
Educational leadership (WLE)					4.66	-2.16
					(3.76)	(3.04)
Accountability (0-1)					-0.90	-3.67
					(15.22)	(15.05)
School autonomy						
Responsibility for resources (WLE)					0.46	1.40
					(19.38)	(16.28)
Responsibility for curriculum (WLE)					-13.58	0.76
					(12.33)	(9.80)
Discipline						
Lack of discipline – students (WLE)						-15.16***
						(4.23)
Lack of discipline – teachers (WLE)						-0.67
						(3.22)
Other school characteristics						
Average ESCS						75.08***
						(15.05)
Average ESCS squared						9.60*
						(5.47)
Fraction of girls						1.49
						(14.51)
R-squared	.19	.27	.30	.39	.41	.47
Observations	4863	4863	4863	4863	4863	4863

Note. Standard errors in parentheses
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 6c. *Mathematics – girls*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Grade (Ref. Grade 9)						
Grade 10	38.76***	32.44***	31.42***	26.58***	23.01***	21.89***
	(6.64)	(5.90)	(5.96)	(5.40)	(5.28)	(4.79)
Grade 11	42.70***	34.64***	40.08***	43.05***	39.75***	42.01***
	(12.50)	(12.40)	(12.31)	(11.47)	(11.49)	(11.43)
Grade 12	63.75	62.37	66.95	78.32*	73.73*	48.24
	(60.15)	(55.65)	(53.31)	(42.90)	(43.29)	(37.30)
Turkish	22.21**	16.75*	18.32**	4.12	4.17	-1.16
	(9.48)	(9.10)	(8.44)	(12.37)	(11.01)	(10.00)
Mother's education (Ref.: Less than high school)						
High school	-8.23	-7.39	-6.95	-5.48	-5.87	-9.11**
	(5.40)	(5.10)	(5.11)	(4.95)	(4.63)	(4.59)
University degree	-7.05	-3.34	-3.43	-6.32	-6.10	-10.60
	(9.40)	(9.12)	(8.95)	(8.15)	(7.85)	(7.51)
Father's education (Ref.: Less than high school)						
High school	12.71***	11.59***	10.97**	8.99**	8.94**	4.02
	(4.55)	(4.45)	(4.35)	(3.87)	(3.91)	(3.69)
University degree	28.20***	24.11***	23.58***	18.33**	18.06**	10.35*
	(8.57)	(8.21)	(8.09)	(7.30)	(7.04)	(6.12)
Parental employment status						
Mother employed	9.85*	8.83*	10.08**	8.18*	8.54**	7.57**
	(5.15)	(4.91)	(4.90)	(4.43)	(4.16)	(3.79)
Father employed	16.29***	13.36***	12.54***	7.94*	8.29*	6.58
	(4.66)	(4.43)	(4.50)	(4.45)	(4.45)	(4.34)
Home possessions (WLE)	18.79***	14.70***	13.87***	9.72***	8.91***	4.26*
	(2.82)	(2.63)	(2.59)	(2.29)	(2.34)	(2.24)
ECE - at least 1 year		2.37	2.12	-0.69	-1.42	-3.15
		(3.99)	(4.01)	(3.78)	(3.62)	(3.47)
Parental emotional support (WLE)		3.65*	2.05	0.75	0.69	-0.01
		(1.89)	(1.89)	(1.68)	(1.57)	(1.58)
Talks to parents		43.55***	43.51***	35.49***	34.47***	30.23***
		(5.84)	(5.86)	(5.63)	(5.49)	(4.94)
Works in household		-18.70***	-18.98***	-16.14***	-14.34***	-10.11**
		(5.49)	(5.29)	(4.57)	(4.33)	(4.17)
Works for pay		-40.86***	-41.00***	-32.12***	-30.75***	-27.36***
		(5.48)	(5.44)	(4.57)	(4.65)	(4.43)
In school learning - Mathematics (hours)			4.33**	4.90***	5.36***	4.52***
			(1.83)	(1.36)	(1.28)	(1.28)
Out of school study - Mathematics (hours)			0.60	0.25	0.17	0.01
			(0.40)	(0.35)	(0.33)	(0.32)
Achievement motivation (WLE)			3.72*	4.59***	4.79***	4.47***
			(2.01)	(1.67)	(1.60)	(1.53)
Test anxiety (WLE)			-6.74***	-7.25***	-7.17***	-6.71***
			(2.28)	(2.01)	(1.97)	(1.85)
Sense of belonging at school (WLE)			1.86	1.63	1.12	1.06
			(1.47)	(1.47)	(1.42)	(1.34)
School's location (Ref.: Village – Pop. < 15,000)						
Town or city (15,000 < Pop. < 1,000,000)				3.71	-6.93	-1.65
				(21.70)	(22.01)	(16.68)
Large city (Pop. > 1,000,000)				9.08	0.12	2.53
				(20.36)	(20.13)	(15.44)
Region (Ref.: Istanbul)						
West Marmara				-1.62	-5.12	-23.17
				(17.04)	(19.31)	(17.41)
Aegean				9.40	1.92	-1.67
				(18.07)	(17.61)	(16.39)
East Marmara				-4.17	-6.73	-3.37
				(17.84)	(15.88)	(16.32)
West Anatolia				-23.33*	-32.27**	-30.45**
				(13.36)	(14.90)	(14.48)
Mediterranean				-7.01	-15.38	-15.04
				(11.59)	(12.03)	(12.70)
Central Anatolia				-16.65	-13.06	-3.99
				(19.35)	(23.27)	(23.08)

West Black Sea				-19.28	-29.15*	-5.30
				(17.67)	(17.10)	(19.12)
East Black Sea				-34.88***	-26.43*	-49.56***
				(12.02)	(13.92)	(15.00)
Northeast Anatolia				-16.87	-28.84	-5.80
				(33.22)	(38.27)	(26.19)
Central East Anatolia				-23.27*	-33.62**	-13.50
				(13.76)	(16.50)	(16.73)
Southeast Anatolia				-32.52*	-29.20	-25.47
				(19.28)	(17.81)	(19.30)
Program selectivity (Ref.: General not selective)						
General selective				21.01**	12.61	5.54
				(9.84)	(14.47)	(13.13)
Vocational not selective				-30.74***	-28.60**	-10.37
				(9.95)	(12.57)	(12.34)
Vocational selective				-30.16***	-35.31**	-15.14
				(11.44)	(14.66)	(14.45)
School resources						
Class size					-5.29*	-3.93
					(2.89)	(2.57)
Class size squared					0.07*	0.05
					(0.04)	(0.03)
Student-teacher ratio					-1.01	1.26
					(3.01)	(3.06)
Student-teacher ratio squared					0.04	-0.01
					(0.09)	(0.09)
Shortage of educational material (WLE)					-3.34	0.51
					(3.74)	(3.53)
Shortage of educational staff (WLE)					-5.70	-1.59
					(4.49)	(4.35)
Fraction of teachers with at least BA degree					29.56	41.87
					(34.93)	(33.65)
Private school					-0.23	-39.43
					(28.16)	(25.71)
Share of funding from government					0.16	0.41**
					(0.22)	(0.16)
Students grouped by ability					14.31*	0.41
					(8.25)	(7.09)
Educational leadership (WLE)					3.94	-2.77
					(3.91)	(3.22)
Accountability (0-1)					21.23	16.45
					(21.03)	(16.65)
School autonomy						
Responsibility for resources (WLE)					-16.43	-10.37
					(25.99)	(23.62)
Responsibility for curriculum (WLE)					-0.54	15.25
					(16.09)	(13.02)
Discipline						
Lack of discipline – students (WLE)						-13.14***
						(4.67)
Lack of discipline – teachers (WLE)						1.24
						(4.15)
Other school characteristics						
Average ESCS						73.22***
						(17.64)
Average ESCS squared						9.19
						(6.49)
Fraction of girls						-17.83
						(13.60)
R-squared	.17	.25	.27	.37	.40	.46
Observations	4863	4863	4863	4863	4863	4863

Note. Standard errors in parentheses
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 6d. *Decomposition of the gender gap in mathematics*

	Mathematics
Predicted mathematics - boys	432.26***
	(4.48)
Predicted mathematics - girls	423.57***
	(4.69)
Predicted gender gap	**8.69****
	(3.62)
Endowments	-6.47**
	(3.27)
Coefficients	15.17***
	(1.31)
Observations	4,863

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 6e. *Detailed decomposition of the gender gap in mathematics*

	Mathematics	Endowments	Coefficients
Predicted mathematics - boys	432.26***		
	(4.48)		
Predicted mathematics - girls	423.57***		
	(4.69)		
Predicted gender gap	**8.69****		
	(3.62)		
Grade 10		-1.99***	4.44
		(0.40)	(2.92)
Grade 11		-0.68***	-0.06
		(0.19)	(0.24)
Grade 12		-0.01	0.05
		(0.06)	(0.06)
Turkish		-0.05	9.78
		(0.14)	(10.60)
Mother - High school		-0.04	0.41
		(0.13)	(1.02)
Mother - University degree		-0.14*	0.01
		(0.09)	(0.50)
Father - High school		0.07	-0.03
		(0.07)	(1.00)
Father - University degree		0.10	-0.49
		(0.12)	(0.64)
Mother employed		-0.10	-0.75
		(0.09)	(0.87)
Father employed		0.01	-4.60
		(0.03)	(4.16)
Home possessions (WLE)		-0.20	-1.05
		(0.19)	(2.60)
ECE - at least 1 year		-0.03	0.08
		(0.04)	(1.18)
Parental emotional support (WLE)		0.21	0.22
		(0.13)	(0.30)
Talks to parents		-0.59**	-1.50
		(0.26)	(4.13)
Works in household		0.17	2.80
		(0.14)	(2.76)
Works for pay		-4.71***	0.34
		(0.58)	(1.29)
In school learning - mathematics (hours)		-0.84***	4.73
		(0.23)	(4.56)
Out of school study - mathematics (hours)		0.27*	-5.49**
		(0.15)	(2.33)
Achievement motivation (WLE)		-1.15***	2.17**
		(0.28)	(0.93)
Test anxiety (WLE)		3.23***	0.00
		(0.39)	(0.57)
Sense of belonging at school (WLE)		-0.05	0.30
		(0.16)	(0.55)
Town or city (15,000 < Pop. < 1,000,000)		-0.00	2.24
		(0.43)	(7.00)
Large city (Pop. > 1,000,000)		0.02	0.64
		(0.17)	(5.75)
West Marmara		0.32*	0.11
		(0.19)	(0.53)
Aegean		-0.00	0.09
		(0.15)	(1.28)
East Marmara		0.00	1.32
		(0.16)	(1.20)
West Anatolia		-0.25	1.94**
		(0.35)	(0.97)
Mediterranean		-0.26	1.79
		(0.39)	(1.39)
Central Anatolia		0.01	0.69
		(0.16)	(0.97)
West Black Sea		0.04	-0.34
		(0.25)	(0.74)
East Black Sea		-0.21*	0.68
		(0.12)	(0.47)
Northeast Anatolia		-0.02	0.50
		(0.20)	(0.64)
Central East Anatolia		0.06	0.50
		(0.11)	(0.58)
Southeast Anatolia		-0.26	1.59
		(0.60)	(1.28)

General selective		-0.96	4.75
		(0.93)	(4.42)
Vocational not selective		-0.38	1.55
		(0.54)	(1.72)
Vocational selective		-0.42	2.70
		(0.68)	(2.96)
Class size		0.78	91.80
		(2.24)	(93.00)
Class size squared		-0.65	-67.96
		(2.21)	(57.93)
Student-teacher ratio		0.44	17.11
		(0.75)	(37.99)
Student-teacher ratio squared		-0.22	-3.45
		(0.66)	(17.16)
Shortage of educational material (WLE)		0.00	-0.04
		(0.16)	(0.36)
Shortage of educational staff (WLE)		-0.01	1.48
		(0.14)	(1.42)
Fraction of teachers with at least BA degree		-0.45	-29.11
		(0.59)	(20.54)
Private school		-0.93	0.41
		(0.88)	(0.85)
Share of funding from government		0.83	2.77
		(0.73)	(9.71)
Students grouped by ability		-0.02	2.40
		(0.17)	(2.61)
Educational leadership (WLE)		-0.10	0.52
		(0.16)	(1.70)
Accountability (0-1)		-0.23	-16.63
		(0.44)	(11.02)
Responsibility for resources (WLE)		-0.09	-9.61
		(0.42)	(9.30)
Responsibility for curriculum (WLE)		0.10	18.16
		(0.22)	(11.57)
Lack of discipline – students (WLE)		-3.29**	-0.15
		(1.32)	(0.67)
Lack of discipline – teachers (WLE)		0.03	-0.19
		(0.13)	(0.36)
Average ESCS		-2.18	1.78
		(2.60)	(19.13)
Average ESCS squared		0.60	-0.97
		(0.96)	(10.49)
Fraction of girls		7.75***	3.75
		(2.47)	(8.96)
Constant			-29.01
			(46.75)
Total		**-6.47****	**15.17*****
		(3.27)	**(1.31)**
Observations	4,863		

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7a. *Key score gaps – science*

	Average	Boys	Girls	Boys-Girls
	434	432	435	-3
Ethnicity				
Non-Turkish	388	382	393	-10
Turkish	437	436	438	-2
Gap	-49***	-53***	-45***	-8
Home possessions (WLE)				
Low	413	413	413	0
High	454	451	456	-5
Gap	-41***	-39***	-44***	5
ESCS (WLE)				
Low	417	415	419	-4
High	450	447	452	-5
Gap	-32***	-32***	-33***	0
Location				
Village: Population <15,000 (Ref.)	408	399	421	-23
Town/City: Population 15,000-1,000,000	432	430	435	-5
Gap	-25	-31*	-13	-18
Big city: Population >1,000,000	440	442	439	3
Gap	-32	-43**	-17	-26
Region				
Istanbul (Ref.)	444	443	445	-3
West Marmara	450	439	457	-18***
Gap	-6	-3	-11	15
Aegean	452	445	457	-13
Gap	-7	-2	-12	10
East Marmara	446	440	452	-13
Gap	-2	3	-7	10
West Anatolia	439	451	426	24***
Gap	5	-8	19	-27**
Mediterranean	439	435	444	-9
Gap	5	8	1	7
Central Anatolia	423	423	424	-1
Gap	21	20	22	-2
West Black Sea	423	420	425	-6
Gap	21*	23*	20	3
East Black Sea	415	420	408	12***
Gap	30***	23*	38***	-14
Northeast Anatolia	441	448	437	11
Gap	3	-5	9	-14
Central East Anatolia	391	388	394	-6
Gap	53***	55***	52***	3
Southeast Anatolia	401	401	401	0
Gap	44***	42***	45**	-3
Program type				
General not selective (Ref.)	412	411	413	-2
General selective	467	470	465	5
Gap	-54***	-58***	-51***	-7
Vocational not selective	387	390	383	8
Gap	25***	21**	31***	-10
Vocational selective	398	399	398	1
Gap	14**	12*	16	-3

Note. *** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 7b. *Science – boys*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Grade (Ref. Grade 9)								
Grade 10	46.82***	40.47***	38.23***	30.53***	28.51***	22.66***	23.59***	22.95***
	(5.41)	(5.12)	(4.83)	(4.62)	(4.40)	(4.37)	(4.23)	(4.22)
Grade 11	50.00**	36.23*	28.90	29.69	30.97	23.46	28.22	26.91
	(22.00)	(21.30)	(21.20)	(21.46)	(21.62)	(22.80)	(26.32)	(26.18)
Grade 12	41.74	63.44	51.59	52.42	45.95	44.82	26.67	21.05
	(52.06)	(46.60)	(45.77)	(47.65)	(47.61)	(49.50)	(45.35)	(43.39)
Turkish	33.26***	28.43**	25.76**	20.77**	14.82	10.90	8.94	14.43
	(11.87)	(11.55)	(12.04)	(9.72)	(10.48)	(10.28)	(9.75)	(10.44)
Mother's education (Ref.: Less than high school)								
High school	-7.80	-6.28	-5.43	-4.71	-4.32	-8.37**	-7.40*	-7.83*
	(5.25)	(4.82)	(4.91)	(4.52)	(4.50)	(4.27)	(4.31)	(4.34)
University degree	-15.99*	-9.51	-9.76	-9.54	-8.54	-14.99**	-15.38**	-17.18***
	(8.37)	(8.09)	(8.07)	(7.16)	(7.15)	(6.71)	(6.60)	(6.50)
Father's education (Ref.: Less than high school)								
High school	12.34***	9.89**	10.63**	5.84	5.90*	3.18	2.58	3.66
	(4.52)	(4.32)	(4.33)	(3.70)	(3.58)	(3.33)	(3.30)	(3.52)
University degree	26.50***	21.20***	21.12***	15.61***	15.39***	9.20*	10.74**	11.21**
	(6.27)	(6.14)	(5.98)	(5.45)	(5.47)	(5.24)	(5.38)	(5.43)
Parental employment status								
Mother employed	14.87***	13.36***	12.13**	12.30***	11.68***	9.27**	10.10***	10.58***
	(5.37)	(5.00)	(5.01)	(3.94)	(3.81)	(3.72)	(3.58)	(3.68)
Father employed	10.97**	8.03	6.92	3.63	3.47	4.40	3.94	5.02
	(5.38)	(5.25)	(4.99)	(4.53)	(4.60)	(4.42)	(4.63)	(4.56)
Home possessions (WLE)	13.99***	9.16***	7.83***	4.95***	4.85***	1.54	2.09	2.38
	(2.13)	(2.10)	(1.89)	(1.86)	(1.72)	(1.44)	(1.54)	(1.64)
ECE - at least 1 year		2.79	3.52	0.19	0.34	-0.53	-0.94	-1.16
		(3.54)	(3.43)	(3.11)	(3.09)	(3.03)	(3.10)	(3.17)
Parental emotional support (WLE)		3.70**	1.22	0.80	0.44	-0.05	-0.90	-0.59
		(1.68)	(1.65)	(1.56)	(1.56)	(1.54)	(1.63)	(1.45)
Talks to parents		31.21***	29.58***	22.48***	21.87***	18.50***	16.61***	13.89***
		(5.83)	(5.79)	(5.47)	(5.29)	(5.11)	(4.89)	(4.95)
Works in household		-9.73**	-12.62**	-11.17**	-10.65**	-6.60	-8.28*	-7.91*
		(4.94)	(5.05)	(4.65)	(4.67)	(4.43)	(4.47)	(4.65)
Works for pay		-39.91***	-33.94***	-24.98***	-23.87***	-21.31***	-21.49***	-20.27***
		(4.39)	(4.38)	(3.97)	(3.83)	(3.56)	(3.57)	(3.56)
In school learning - Science (hours)			9.69***	8.16***	8.23***	7.33***	6.36***	6.52***
			(1.27)	(1.13)	(1.12)	(1.09)	(1.08)	(1.08)
Out of school study - Science (hours)			-1.18***	-1.26***	-1.28***	-1.28***	-1.45***	-1.51***
			(0.44)	(0.42)	(0.41)	(0.40)	(0.40)	(0.41)
Achievement motivation (WLE)			6.12***	5.94***	5.75***	5.41***	3.89***	3.37**
			(1.73)	(1.57)	(1.48)	(1.35)	(1.37)	(1.58)
Test anxiety (WLE)			-3.14	-3.42**	-3.34**	-3.45**	-2.75*	-3.81**
			(1.96)	(1.57)	(1.59)	(1.52)	(1.53)	(1.49)
Sense of belonging at school (WLE)			0.76	-0.25	-0.11	-0.32	-1.13	-1.88
			(1.44)	(1.32)	(1.38)	(1.20)	(1.32)	(1.36)
School's location (Ref.: Village – Pop. < 15,000)								
Town or city (15,000 < Pop. < 1,000,000)				10.41	4.75	-0.53	-4.02	-2.43
				(13.22)	(14.95)	(12.07)	(11.62)	(12.45)
Large city (Pop. > 1,000,000)				16.35	7.32	1.39	-0.18	0.85
				(14.62)	(15.10)	(12.39)	(11.81)	(12.65)
Region (Ref.: Istanbul)								
West Marmara				-11.92	-6.83	-9.53	-6.38	-5.35
				(13.41)	(15.56)	(14.40)	(14.93)	(14.61)
Aegean				-4.76	-5.42	-8.42	-10.96	-10.05
				(9.88)	(10.05)	(9.74)	(9.30)	(9.33)
East Marmara				6.75	2.61	5.14	5.08	4.17
				(10.45)	(11.38)	(10.73)	(11.33)	(11.40)
West Anatolia				-7.06	-12.81	-14.83	-16.19	-15.75
				(8.98)	(10.25)	(11.25)	(10.62)	(10.86)
Mediterranean				-7.81	-9.96	-8.48	-10.71	-7.92
				(7.91)	(8.51)	(10.13)	(9.73)	(9.67)
Central Anatolia				-18.16	-21.93	-11.38	-10.11	-5.80
				(15.59)	(16.88)	(16.56)	(16.66)	(17.35)
West Black Sea				-7.94	-15.81	-6.82	-4.68	-5.79
				(11.05)	(13.05)	(12.49)	(12.56)	(12.36)
East Black Sea				-16.32	-7.95	-26.14**	-22.58*	-22.24*
				(12.48)	(16.73)	(12.09)	(11.77)	(11.37)
Northeast Anatolia				-10.03	-20.09	3.86	3.20	5.93
				(40.75)	(42.30)	(24.34)	(23.02)	(22.92)
Central East Anatolia				-0.90	-8.36	17.41	17.94	17.38
				(16.97)	(13.79)	(15.74)	(14.99)	(15.07)
Southeast Anatolia				-22.23*	-22.85*	-17.54	-17.47	-11.00
				(11.43)	(12.98)	(14.69)	(14.89)	(15.21)

Program selectivity (Ref.: General not selective)								
General selective				39.60***	27.83***	22.42**	20.47*	19.13*
				(8.99)	(9.91)	(9.94)	(10.80)	(10.39)
Vocational not selective				-16.55	-21.87*	-4.48	-5.74	-6.17
				(10.86)	(11.19)	(9.84)	(10.48)	(9.96)
Vocational selective				-11.76	-21.31**	-3.17	-5.54	-3.74
				(10.22)	(10.41)	(9.57)	(10.31)	(10.03)
School resources								
Class size					0.16	0.04	-0.15	-0.45
					(2.72)	(1.97)	(1.85)	(1.80)
Class size squared					-0.00	-0.00	-0.00	0.00
					(0.03)	(0.02)	(0.02)	(0.02)
Student-teacher ratio					1.56	2.61	2.15	1.82
					(2.58)	(2.06)	(2.06)	(2.05)
Student-teacher ratio squared					-0.05	-0.05	-0.03	-0.03
					(0.07)	(0.05)	(0.05)	(0.05)
Shortage of educational material (WLE)					-6.92**	-2.12	-2.26	-2.20
					(3.39)	(3.38)	(3.31)	(3.30)
Shortage of educational staff (WLE)					-0.74	0.67	0.88	1.13
					(3.56)	(3.44)	(3.36)	(3.38)
Fraction of teachers with at least BA degree					0.45	12.50	9.13	8.36
					(21.48)	(19.57)	(18.99)	(18.28)
Private school					-16.73	-36.18**	-28.46*	-26.01
					(17.52)	(17.28)	(17.09)	(17.70)
Share of funding from government					0.04	0.37***	0.34***	0.32***
					(0.15)	(0.12)	(0.11)	(0.11)
Students grouped by ability					4.16	0.49	1.10	1.44
					(6.71)	(6.29)	(6.30)	(6.45)
Educational leadership (WLE)					3.37	-1.64	-1.57	-1.17
					(3.35)	(2.95)	(2.84)	(2.78)
Accountability (0-1)					-1.82	-3.10	0.42	1.50
					(14.52)	(13.42)	(13.13)	(13.11)
School autonomy								
Responsibility for resources (WLE)					5.98	7.38	-1.99	-4.29
					(16.22)	(14.45)	(16.15)	(16.34)
Responsibility for curriculum (WLE)					-13.18	0.12	0.50	0.67
					(10.29)	(8.32)	(8.20)	(8.04)
Discipline								
Lack of discipline – students (WLE)						-10.21***	-9.47***	-10.00***
						(3.33)	(3.30)	(3.33)
Lack of discipline – teachers (WLE)						0.70	0.28	0.44
						(3.06)	(3.01)	(3.01)
Other school characteristics								
Average ESCS						54.92***	51.72***	49.05***
						(14.79)	(13.81)	(14.20)
Average ESCS squared						3.03	2.40	1.26
						(4.91)	(4.60)	(4.63)
Fraction of girls						2.95	5.25	6.61
						(12.92)	(12.27)	(12.68)
Student's attitudes to science								
Enjoyment of science (WLE)							6.60***	6.31***
							(1.39)	(1.55)
Interest in broad science topics (WLE)							5.20***	5.04***
							(1.55)	(1.58)
Instrumental motivation in science (WLE)							2.96**	4.14***
							(1.49)	(1.60)
Science class format								
Enquiry-based instruction in science (WLE)								-5.77***
								(1.48)
Teacher-directed instruction in science (WLE)								2.30
								(1.58)
Adaptive instruction in science (WLE)								1.50
								(1.72)
R-squared	.19	.28	.33	.43	.45	.50	.52	.53
Observations	4263	4263	4263	4263	4263	4263	4263	4263

Note. Standard errors in parentheses
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 7c. *Science – girls*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Grade (Ref. Grade 9)								
Grade 10	42.26***	36.43***	32.17***	26.70***	22.95***	21.99***	22.01***	20.67***
	(6.67)	(5.75)	(5.40)	(4.62)	(4.52)	(3.83)	(3.82)	(3.91)
Grade 11	77.49***	68.19***	51.68***	46.55***	42.69***	40.35***	39.62***	36.67***
	(18.94)	(18.18)	(16.62)	(14.08)	(14.24)	(13.88)	(13.96)	(13.44)
Grade 12	194.06***	174.14***	174.78***	148.21***	149.41***	104.68***	99.60***	89.00**
	(32.50)	(32.73)	(33.80)	(33.80)	(37.86)	(36.72)	(36.84)	(36.85)
Turkish	17.96**	12.99*	15.32**	1.83	0.01	-6.38	-4.59	-3.30
	(7.68)	(7.25)	(6.90)	(8.64)	(7.58)	(7.31)	(7.45)	(7.62)
Mother's education (Ref.: Less than high school)								
High school	-6.64	-5.88	-5.15	-3.61	-4.10	-7.30**	-7.68**	-7.28**
	(4.55)	(4.34)	(4.09)	(3.92)	(3.59)	(3.57)	(3.48)	(3.45)
University degree	-12.54*	-9.17	-5.43	-8.95	-9.02*	-13.45***	-12.44**	-12.00**
	(6.71)	(6.46)	(6.28)	(5.57)	(5.11)	(4.68)	(4.92)	(4.90)
Father's education (Ref.: Less than high school)								
High school	10.73***	9.09**	8.73**	6.86**	6.96**	2.08	1.96	0.31
	(4.06)	(3.91)	(3.84)	(3.38)	(3.42)	(3.21)	(3.47)	(3.70)
University degree	27.40***	22.70***	20.62***	15.43**	15.43**	8.13	8.64	7.63
	(7.78)	(7.37)	(7.10)	(6.55)	(6.26)	(5.48)	(5.61)	(5.86)
Parental employment status								
Mother employed	10.33**	9.15*	9.58**	7.69*	8.40**	7.58**	8.16**	7.17*
	(5.12)	(4.87)	(4.89)	(4.31)	(3.98)	(3.58)	(3.69)	(3.82)
Father employed	16.92***	14.15***	10.85**	7.21	7.41*	5.97	5.68	5.70
	(4.80)	(4.59)	(4.59)	(4.40)	(4.37)	(4.04)	(3.92)	(3.89)
Home possessions (WLE)	17.81***	13.74***	11.32***	7.58***	7.19***	2.58*	2.69*	2.51
	(2.36)	(2.31)	(2.14)	(1.76)	(1.84)	(1.55)	(1.53)	(1.67)
ECE - at least 1 year		5.37	6.20*	2.94	2.36	0.58	0.67	0.58
		(3.34)	(3.35)	(3.02)	(2.81)	(2.55)	(2.48)	(2.48)
Parental emotional support (WLE)		3.45*	1.98	0.53	0.50	-0.04	-0.84	-1.27
		(1.81)	(1.69)	(1.47)	(1.45)	(1.46)	(1.45)	(1.50)
Talks to parents		38.01***	33.76***	27.00***	26.39***	22.83***	23.04***	24.08***
		(6.73)	(6.39)	(5.65)	(5.60)	(5.25)	(5.21)	(5.30)
Works in household		-13.98***	-12.65***	-9.72**	-7.85**	-3.85	-3.35	-4.22
		(5.05)	(4.75)	(3.84)	(3.76)	(3.58)	(3.58)	(3.37)
Works for pay		-41.38***	-40.34***	-30.73***	-28.94***	-26.07***	-26.64***	-24.20***
		(4.19)	(4.11)	(3.71)	(3.50)	(3.05)	(3.02)	(2.96)
In school learning - Science (hours)			9.83***	8.43***	8.44***	7.37***	7.20***	7.21***
			(1.26)	(1.08)	(1.04)	(1.00)	(1.06)	(1.12)
Out of school study - Science (hours)			-0.21	-0.50	-0.50	-0.46	-0.56*	-0.41
			(0.36)	(0.33)	(0.31)	(0.29)	(0.30)	(0.33)
Achievement motivation (WLE)			1.82	2.65*	2.80*	2.31*	1.40	1.35
			(1.83)	(1.52)	(1.47)	(1.35)	(1.41)	(1.40)
Test anxiety (WLE)			-6.93***	-7.29***	-7.30***	-6.91***	-6.17***	-6.40***
			(1.76)	(1.49)	(1.46)	(1.36)	(1.38)	(1.39)
Sense of belonging at school (WLE)			1.54	1.24	0.76	0.73	0.86	0.49
			(1.35)	(1.29)	(1.25)	(1.17)	(1.28)	(1.35)
School's location (Ref.: Village – Pop. < 15,000)								
Town or city (15,000 < Pop. < 1,000,000)				3.70	-5.52	-1.11	-0.98	-1.64
				(20.21)	(19.86)	(15.30)	(15.35)	(15.26)
Large city (Pop. > 1,000,000)				9.01	-1.25	-0.15	1.25	1.22
				(19.00)	(18.09)	(14.83)	(14.85)	(14.52)
Region (Ref.: Istanbul)								
West Marmara				6.61	3.68	-15.17	-15.06	-14.23
				(13.37)	(15.61)	(12.80)	(12.66)	(12.16)
Aegean				4.92	-2.12	-6.88	-6.86	-5.71
				(12.80)	(12.00)	(12.15)	(12.05)	(11.84)
East Marmara				-2.09	-4.15	-1.78	-2.73	-1.10
				(14.77)	(13.58)	(14.20)	(14.45)	(13.81)
West Anatolia				-27.04**	-32.87***	-32.65***	-32.95***	-32.87***
				(11.02)	(12.53)	(12.28)	(12.48)	(12.13)
Mediterranean				-7.09	-13.20	-11.81	-13.64	-11.33
				(9.70)	(9.71)	(12.01)	(11.90)	(11.70)
Central Anatolia				-25.40*	-22.49	-14.78	-14.50	-11.15
				(14.50)	(19.08)	(18.89)	(18.93)	(19.35)
West Black Sea				-19.19	-27.29**	-5.57	-6.38	-5.40
				(13.45)	(12.59)	(11.77)	(11.68)	(11.49)
East Black Sea				-26.65***	-19.92*	-43.54***	-44.01***	-38.22***
				(9.41)	(11.57)	(13.38)	(13.09)	(12.48)
Northeast Anatolia				-9.18	-21.80	-0.56	0.15	1.05
				(33.87)	(36.30)	(23.27)	(22.38)	(22.52)
Central East Anatolia				-19.24*	-27.35**	-8.73	-9.04	-7.42
				(10.91)	(13.19)	(13.88)	(14.07)	(13.42)
Southeast Anatolia				-30.53**	-28.46**	-24.46	-25.30*	-23.99
				(15.51)	(14.18)	(15.27)	(15.34)	(15.08)

Program selectivity (Ref.: General not selective)								
General selective				25.90***	19.45*	12.33	10.02	12.68
				(7.45)	(10.69)	(9.39)	(9.96)	(9.50)
Vocational not selective				-29.76***	-28.14***	-13.04	-15.30	-12.06
				(7.60)	(10.16)	(9.39)	(10.11)	(9.51)
Vocational selective				-26.20***	-29.06**	-11.07	-13.84	-8.85
				(9.85)	(11.86)	(12.00)	(12.34)	(11.88)
School resources								
Class size					-3.24	-1.88	-2.04	-2.81
					(2.67)	(1.83)	(1.80)	(1.77)
Class size squared					0.04	0.02	0.02	0.03
					(0.03)	(0.02)	(0.02)	(0.02)
Student-teacher ratio					-0.07	2.10	1.67	1.80
					(2.46)	(2.38)	(2.36)	(2.21)
Student-teacher ratio squared					-0.00	-0.05	-0.04	-0.04
					(0.07)	(0.07)	(0.07)	(0.07)
Shortage of educational material (WLE)					-3.92	-0.04	0.08	-0.09
					(3.31)	(3.05)	(3.06)	(2.90)
Shortage of educational staff (WLE)					-4.11	-0.72	-0.42	0.77
					(3.43)	(3.10)	(3.07)	(3.07)
Fraction of teachers with at least BA degree					40.71	51.09*	48.38*	58.81**
					(29.89)	(26.54)	(26.33)	(25.85)
Private school					-17.05	-53.47**	-50.42**	-51.93**
					(25.94)	(22.79)	(23.18)	(21.79)
Share of funding from government					0.07	0.32**	0.30**	0.30**
					(0.18)	(0.13)	(0.13)	(0.12)
Students grouped by ability					12.99*	0.66	0.65	0.49
					(6.92)	(5.79)	(5.76)	(5.60)
Educational leadership (WLE)					1.32	-5.18*	-5.13*	-4.19
					(3.86)	(2.99)	(2.96)	(2.91)
Accountability (0-1)					15.81	11.94	11.70	15.49
					(18.06)	(13.80)	(13.81)	(13.86)
School autonomy								
Responsibility for resources (WLE)					-4.50	1.28	-2.55	-4.87
					(20.20)	(17.47)	(17.40)	(16.64)
Responsibility for curriculum (WLE)					2.35	17.18*	16.82	23.37**
					(13.15)	(10.31)	(10.72)	(10.52)
Discipline								
Lack of discipline – students (WLE)						-10.34***	-10.84***	-11.70***
						(3.72)	(3.80)	(3.66)
Lack of discipline – teachers (WLE)						0.45	0.38	0.71
						(3.16)	(3.16)	(2.98)
Other school characteristics								
Average ESCS						66.20***	62.64***	65.95***
						(15.92)	(16.45)	(15.85)
Average ESCS squared						6.74	5.87	8.11
						(5.98)	(6.21)	(6.04)
Fraction of girls						-14.98	-15.81	-18.02
						(12.53)	(12.63)	(12.48)
Student's attitudes to science								
Enjoyment of science (WLE)							6.59***	6.14***
							(1.23)	(1.33)
Interest in broad science topics (WLE)							-1.15	-1.24
							(1.35)	(1.33)
Instrumental motivation in science (WLE)							-1.27	-0.60
							(1.45)	(1.52)
Science class format								
Enquiry-based instruction in science (WLE)								-7.74***
								(1.40)
Teacher-directed instruction in science (WLE)								1.59
								(1.44)
Adaptive instruction in science (WLE)								5.00***
								(1.71)
R-squared	.17	.25	.31	.42	.44	.50	.51	.52
Observations	4263	4263	4263	4263	4263	4263	4263	4263

Note. Standard errors in parentheses
*** $p < 0.01$. ** $p < 0.05$. * $p < 0.1$

Table 7d. *Decomposition of the gender gap in science*

	Science
Predicted science - boys	436.82***
	(4.72)
Predicted science - girls	439.93***
	(4.39)
Predicted gender gap	**-3.11**
	(3.79)
Endowments	-11.38***
	(3.41)
Coefficients	8.27***
	(1.42)
Observations	4,263

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7e. *Detailed decomposition of the gender gap in science*

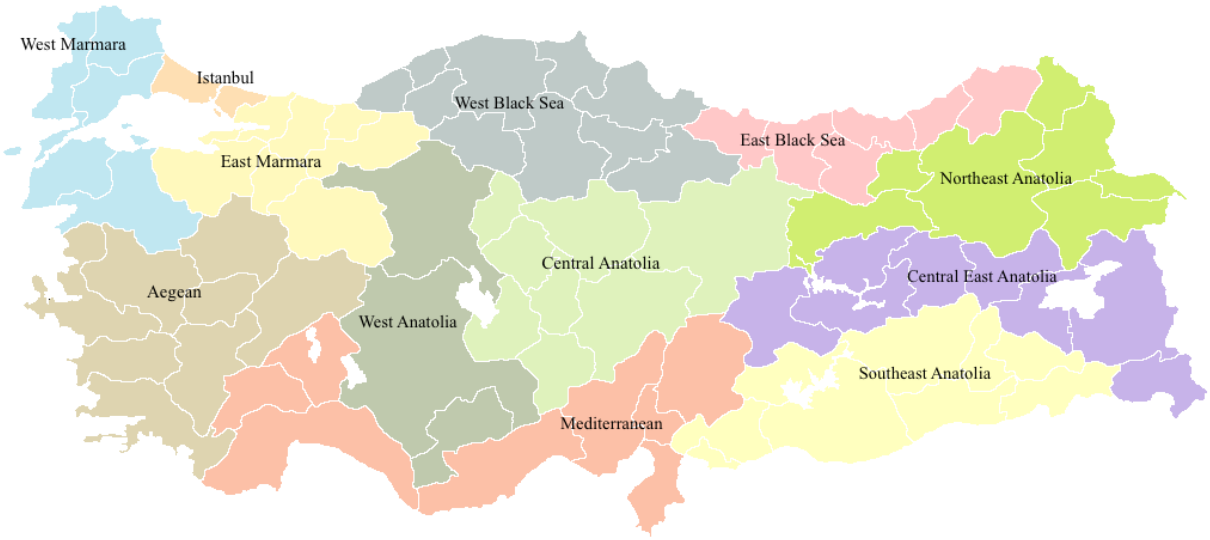
	Science	Endowments	Coefficients
Predicted science - boys	436.82***		
	(4.72)		
Predicted science - girls	439.93***		
	(4.39)		
Predicted gender gap	**-3.11**		
	(3.79)		
Grade 10		-2.07***	0.22
		(0.42)	(2.81)
Grade 11		-0.31**	-0.23
		(0.13)	(0.23)
Grade 12		0.03	-0.04
		(0.05)	(0.03)
Turkish		-0.04	18.11
		(0.13)	(11.59)
Mother - High school		-0.04	0.02
		(0.12)	(0.99)
Mother - University degree		-0.20	-0.18
		(0.13)	(0.52)
Father - High school		0.04	0.90
		(0.06)	(1.13)
Father - University degree		0.03	0.17
		(0.11)	(0.75)
Mother employed		-0.19	0.64
		(0.13)	(0.88)
Father employed		0.02	-0.81
		(0.08)	(3.35)
Home possessions (WLE)		-0.18	-0.50
		(0.12)	(2.55)
ECE - at least 1 year		-0.00	-0.98
		(0.01)	(1.34)
Parental emotional support (WLE)		0.20	0.04
		(0.16)	(0.33)
Talks to parents		-0.37*	-8.39*
		(0.19)	(4.43)
Works in household		0.05	-0.88
		(0.09)	(3.16)
Works for pay		-4.57***	0.34
		(0.57)	(1.21)
In school learning - science (hours)		-0.97***	2.24
		(0.29)	(5.28)
Out of school study - science (hours)		0.48**	-5.67**
		(0.19)	(2.45)
Achievement motivation (WLE)		-0.45**	1.72*
		(0.19)	(0.96)
Test anxiety (WLE)		2.72***	0.37
		(0.36)	(0.57)
Sense of belonging at school (WLE)		0.20	0.85
		(0.19)	(0.58)
Town or city (15,000 < Pop. < 1,000,000)		0.08	-2.57
		(0.48)	(6.77)
Large city (Pop. > 1,000,000)		-0.01	-2.08
		(0.26)	(5.12)
West Marmara		0.14	0.35
		(0.17)	(0.62)
Aegean		0.03	-0.74
		(0.15)	(1.07)
East Marmara		0.00	0.87
		(0.15)	(1.04)
West Anatolia		-0.38	1.79**
		(0.42)	(0.86)
Mediterranean		-0.16	0.71
		(0.39)	(1.34)
Central Anatolia		-0.01	0.24
		(0.20)	(0.85)
West Black Sea		0.06	-0.00
		(0.23)	(0.65)
East Black Sea		-0.08	0.73
		(0.09)	(0.48)
Northeast Anatolia		-0.04	0.29
		(0.23)	(0.52)
Central East Anatolia		0.01	0.72
		(0.08)	(0.54)
Southeast Anatolia		-0.26	1.58
		(0.57)	(1.05)

General selective		-1.40	3.43
		(0.91)	(3.52)
Vocational not selective		-0.80	1.28
		(0.67)	(1.55)
Vocational selective		-0.32	2.16
		(0.59)	(2.52)
Class size		0.09	79.51
		(1.32)	(98.70)
Class size squared		-0.07	-51.41
		(1.28)	(60.83)
Student-teacher ratio		0.45	9.47
		(0.72)	(35.17)
Student-teacher ratio squared		-0.34	-0.15
		(0.61)	(15.45)
Shortage of educational material (WLE)		0.01	-0.19
		(0.11)	(0.39)
Shortage of educational staff (WLE)		-0.00	0.29
		(0.11)	(1.10)
Fraction of teachers with at least BA degree		-0.57	-41.94**
		(0.52)	(19.33)
Private school		-1.05	0.59
		(0.94)	(0.91)
Share of funding from government		0.61	0.42
		(0.54)	(7.70)
Students grouped by ability		-0.01	0.63
		(0.12)	(2.39)
Educational leadership (WLE)		-0.11	1.94
		(0.18)	(1.47)
Accountability (0-1)		-0.21	-9.39
		(0.39)	(9.97)
Responsibility for resources (WLE)		-0.07	-6.89
		(0.33)	(10.11)
Responsibility for curriculum (WLE)		0.22	22.99**
		(0.26)	(10.70)
Lack of discipline – students (WLE)		-2.58**	0.41
		(1.16)	(0.54)
Lack of discipline – teachers (WLE)		0.03	0.04
		(0.11)	(0.26)
Average ESCS		-2.33	18.32
		(2.12)	(17.34)
Average ESCS squared		0.38	-11.84
		(0.60)	(10.67)
Fraction of girls		3.95*	9.31
		(2.02)	(7.87)
Enjoyment of science (WLE)		-0.02	-0.02
		(0.23)	(0.24)
Interest in broad science topics (WLE)		0.48***	-0.19
		(0.18)	(0.12)
Instrumental motivation in science (WLE)		-0.21	1.68**
		(0.13)	(0.75)
Enquiry-based instruction in science (WLE)		-0.86***	0.74
		(0.30)	(0.47)
Teacher-directed instruction in science (WLE)		-0.05	-0.01
		(0.06)	(0.08)
Adaptive instruction in science (WLE)		-0.34*	-0.40*
		(0.18)	(0.23)
Constant			-32.34
			(46.96)
Total		**-11.38*** **	**8.27*** **
		(3.41)	**(1.42)**
Observations	4,863		

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

APPENDIX

Figure A1. *Regional division (NUTS-1)*



01 Istanbul – İstanbul
02 West Marmara – Balıkesir, Çanakkale, Edirne, Kırklareli, Tekirdağ
03 Aegean – Afyon, Aydın, Denizli, İzmir, Kütahya, Manisa, Muğla, Uşak
04 East Marmara – Bilecik, Bolu, Bursa, Eskişehir, Kocaeli, Sakarya, Yalova, Düzce
05 West Anatolia – Ankara, Konya, Karaman
06 Mediterranean – Adana, Antalya, Burdur, Hatay, Isparta, Mersin, Kahramanmaraş, Osmaniye
07 Central Anatolia – Kayseri, Kırşehir, Nevşehir, Niğde, Sivas, Yozgat, Aksaray, Kırıkkale
08 West Black Sea – Amasya, Çankırı, Çorum, Kastamonu, Samsun, Sinop, Tokat, Zonguldak, Bartın, Karabük
09 East Black Sea – Artvin, Giresun, Gümüşhane, Ordu, Rize, Trabzon
10 Northeast Anatolia – Ağrı, Erzincan, Erzurum, Kars, Bayburt, Ardahan, Iğdır
11 Central East Anatolia – Bingöl, Bitlis, Elâzığ, Hakkâri, Malatya, Muş, Tunceli, Van
12 Southeast Anatolia – Adıyaman, Diyarbakır, Gaziantep, Mardin, Siirt, Şanlıurfa, Batman, Şırnak, Kilis

Table A1a. *School attendance at age 15 by region and sex*

Region	Boys	Girls
All	**.86**	**.79**
Istanbul	.90	.80
West Marmara	.92	1
Aegean	.75	.87
East Marmara	.86	1
West Anatolia	.97	.85
Mediterranean	.88	.89
Central Anatolia	.90	.92
West Black Sea	.96	.96
East Black Sea	.97	.86
Northeast Anatolia	.85	.58
Central East Anatolia	.74	.58
Southeast Anatolia	.76	.61

Note. Own calculations based on the Turkish Demographic Health Survey 2013.

Table A1b. *School attendance at age 15 by wealth and sex*

Wealth	Boys	Girls
Below median	.76	.66
Above median	.96	.91

Note. Own calculations based on the Turkish Demographic Health Survey 2013.

Table A2. *Indices compiled by the Programme for International Student Assessment*

Index	Components
Household	
Home possessions	Material possessions (e.g. TV, cars, computers) Educational possessions (e.g. desk to study, computer for school work) Cultural possessions (e.g. classical literature, books of poetry, books on art)
Economic, social and cultural status (ESCS)	Home possessions index (as above) Highest parental education level Highest parental occupational level
Parental emotional support	My parents are interested in my school activities. My parents support my educational efforts and achievements. My parents support me when I am facing difficulties at school. My parents encourage me to be confident.
Student	
Ambition/Achievement motivation	I want top grades in most or all of my courses. I want to be able to select from the best opportunities when I graduate. I want to be the best, whatever I do. I see myself as an ambitious person. I want to be one of the best students in my class.
Performance anxiety	I often worry that it will be difficult for me taking a test. I worry that I will get poor grades at school. Even if I am well prepared for a test I feel anxious. I get very tense when I study for a test. I get nervous when I don't know how to solve a task at school.
Sense of belonging at school	I feel like an outsider at school. I make friends easily at school. I feel like I belong at school. I feel awkward and out of place in my school. Other students seem to like me. I feel lonely at school.
Science - enjoyment	I generally have fun when I am learning science topics. I like reading about science topics. I am happy working on science topics. I enjoy acquiring new knowledge in science. I am interested in learning about science.
Science – interest in topics	Biosphere (e.g. ecosystems and sustainability) Motion and forces (e.g. velocity, friction, magnetic and gravitational forces) Energy and its transformation (e.g. conservation) The universe and its history How science can help us prevent disease
Science – instrumental motivation	Making an effort in my science subjects is worth because this will help me in the work I want to do later on. What I learn in my science subjects is important for me because I need this for what I want to do later on. Studying my science subjects is worthwhile for me because what I learn will improve my career prospects. Many things I learn in my science subjects will help me get a job.
Science class format	
Enquiry-based instruction	Students are given opportunities to explain their ideas. Students spend time in the laboratory doing practical experiments. Students are required to argue about science questions. Students are asked to draw conclusions from an experiment they have conducted. Students are allowed to design their own experiments.

	There is a class debate about investigations. Students are asked to do an investigation to test ideas.
Teacher-directed instruction	The teacher explains scientific ideas. A whole class discussion takes place with the teacher. The teacher discusses our questions. The teacher demonstrates an idea.
Adaptive instruction	The teacher adapts the lesson to my class's needs and knowledge. The teacher provides individual help when a student has difficulties understanding a topic or task. The teacher changes the structure of the lesson on a topic that most students find difficult to understand.
School	
Shortage of educational resources	Lack of educational material Inadequate or poor quality educational material Lack of physical infrastructure Inadequate or poor quality physical infrastructure
Shortage of staff	Lack of teaching staff Inadequate or poorly qualified teaching staff A lack of assisting staff Inadequate or poorly qualified assisting staff
Leadership - overall	Curriculum development Institutional leadership Teacher professional development Teacher participation in school leadership
Accountability	Achievement data are posted publicly. Achievement data are tracked over time by an administrative authority. Achievement data are provided directly to parents.
Autonomy – resources	Hiring and firing teachers Establishing salaries and salary increases Formulating budget Deciding on budget allocations
Autonomy - curriculum	Choosing textbooks Determining course content Choosing which courses are offered
Discipline issues - students	Student truancy Students skipping classes Students lacking respect for teachers Student use of alcohol and illegal drugs Students intimidating or bullying other students
Discipline issues - teachers	Teachers not meeting individual students' needs Teacher absenteeism Staff resisting change Teachers being too strict with students Teachers not being well prepared for classes

Table A3. *Missing data in the final sample*

VARIABLES	Non-missing	Missing (1)	Missing (2)
Reading	5,774	0	0
Math	5,774	0	0
Science	5,774	0	0
Female	5,774	0	0
Ethnicity -Turkish	5,735	39	36
Grade	5,774	0	0
Had at least 1 year ECE	5,774	0	0
Mother at least high school	5,708	66	63
Mother at least university degree	5,708	66	63
Father at least high school	5,713	61	57
Father at least university degree	5,713	61	57
Mother working	5,774	0	0
Father working	5,774	0	0
Home possessions (WLE)	5,739	35	31
ESCS (WLE)	5,739	35	31
Parental emotional support (WLE)	5,717	57	54
Talks to parents	5,498	276	265
Works in household	5,475	299	288
Works for pay	5,388	386	375
Home study – Turkish (hr)	5,284	490	475
Home study – Math (hr)	5,385	389	381
Home study – Science (hr)	5,226	548	531
Class study – Turkish (hr)	5,529	245	236
Class study – Math (hr)	5,553	221	213
Class study – Science (hr)	5,516	258	249
Ambition/Achievement motivation (WLE)	5,695	79	74
Performance anxiety (WLE)	5,706	68	64
Sense of belonging at school (WLE)	5,692	82	78
Science – enjoyment of (WLE)	5,524	250	241
Science – interest in (WLE)	5,289	485	474
Science – instrumental motivation (WLE)	5,484	290	279
Enquiry-based instruction (WLE)	5,177	597	580
Teacher-directed instruction (WLE)	5,167	607	593
Adaptive instruction (WLE)	5,097	677	665
Village: Pop <15,000	5,736	38	0
Town/City: 15,000<Pop<1,000,000	5,736	38	0
Large city: Pop>1,000,000	5,736	38	0
Istanbul	5,774	0	0
West Marmara	5,774	0	0
Aegean	5,774	0	0
East Marmara	5,774	0	0
West Anatolia	5,774	0	0
Mediterranean	5,774	0	0
Central Anatolia	5,774	0	0
West Black Sea	5,774	0	0
East Black Sea	5,774	0	0
Northeast Anatolia	5,774	0	0
Central East Anatolia	5,774	0	0
Southeast Anatolia	5,774	0	0
General not selective	5,736	38	0
General selective	5,736	38	0
Vocational not selective	5,736	38	0
Vocational selective	5,736	38	0
Class size	5,736	38	0
Student-teacher ratio	5,736	38	0
Shortage – educational resources (WLE)	5,774	0	0
Shortage – staff (WLE)	5,774	0	0
Fraction of teachers with at least BA degree	5,774	0	0
Private school	5,736	38	0
Fraction of funding from government	5,736	38	0
Students grouped by ability	5,774	0	0
Leadership – overall (WLE)	5,736	38	0
Accountability (0-1)	5,774	0	0
School autonomy – resources (WLE)	5,774	0	0
School autonomy – curriculum (WLE)	5,774	0	0
Discipline issues – students (WLE)	5,774	0	0
Discipline issues – teachers (WLE)	5,774	0	0
Average ESCS	5,774	0	0
Fraction of girls	5,774	0	0

Note. Missing (1) – missing data after excluding middle schools (123 students);
Missing (2) – missing data after excluding middle school (123 students) and problematic high schools (38 students)

Table A4. *Model specifications*

		Details
Model 1	Baseline	Grade, ethnicity, parental education, parental occupation, home possessions
Model 2	Model 1 + Home environment	Early childhood education, parental emotional support, if talks to parents, if helps with house chores, if works for pay
Model 3	Model 2 + Study time and the modality of learning	Hours of study at school, hours of study at home, achievement motivation, test anxiety, sense of belonging at school
Model 4	Model 3 + School and program	School's location and region, program type and selectivity
Model 5	Model 4 + School resources and management	Class size, student-teacher ratio, shortage of materials, shortage of staff, fraction of teachers with BA degree, private school, fraction of funding from government, students grouped by ability, leadership, accountability, autonomy
Model 6	Model 5 + School's climate	Lack of student discipline, lack of teacher discipline, average ESCS, fraction of girls
Model 7	Model 6 + Attitudes to science	Enjoyment of science, interest in science, instrumental motivation to learn science
Model 8	Model 7 + Science class format	Enquiry-based instruction, teacher-directed instruction, adaptive instruction

Table A5a. *Decomposition of the gender gap in reading with imputed data*

	Reading
Predicted reading - boys	418.45***
	(4.37)
Predicted reading - girls	445.06***
	(4.56)
Predicted gender gap	**-26.62*** **
	(4.48)
Endowments	-21.26***
	(4.23)
Coefficients	-5.36***
	(1.28)
Observations	5,724

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A5b. *Detailed decomposition of the gender gap in reading with imputed data*

	Reading	Endowments	Coefficients
Predicted reading - boys	418.45***		
	(4.37)		
Predicted reading - girls	445.06***		
	(4.56)		
Predicted gender gap	**-26.62*** **		
	(4.48)		
Grade 10		-2.47***	3.59
		(0.45)	(2.38)
Grade 11		-0.45**	-0.38
		(0.19)	(0.26)
Grade 12		-0.01	0.02
		(0.03)	(0.05)
Turkish		-0.08	9.95
		(0.16)	(8.66)
Mother - High school		-0.04	1.26
		(0.09)	(0.95)
Mother - University degree		-0.21*	-0.05
		(0.11)	(0.47)
Father - High school		0.06	0.10
		(0.05)	(0.86)
Father - University degree		0.09	0.43
		(0.09)	(0.60)
Mother employed		-0.07	0.41
		(0.11)	(0.65)
Father employed		-0.04	-1.24
		(0.06)	(3.58)
Home possessions (WLE)		-0.08	2.01
		(0.10)	(2.48)
ECE - at least 1 year		-0.01	-0.20
		(0.02)	(1.45)
Parental emotional support (WLE)		-0.51***	0.25
		(0.16)	(0.36)
Talks to parents		-0.34*	0.14
		(0.20)	(3.37)
Works in household		-0.02	-1.39
		(0.03)	(3.06)
Works for pay		-5.56***	0.79
		(0.73)	(1.32)
In school learning - Turkish (hours)		-1.44***	-3.32
		(0.32)	(3.46)
Out of school study - Turkish (hours)		0.41**	-0.35
		(0.19)	(1.64)
Achievement motivation (WLE)		-0.78***	2.19**
		(0.22)	(0.90)
Test anxiety (WLE)		1.44***	0.48
		(0.28)	(0.54)
Sense of belonging at school (WLE)		-0.64***	0.19
		(0.19)	(0.51)
Town or city (15,000 < Pop. < 1,000,000)		-0.24	-0.90
		(0.42)	(7.26)
Large city (Pop. > 1,000,000)		-0.00	-0.03
		(0.29)	(5.54)
West Marmara		0.07	0.19
		(0.09)	(0.44)
Aegean		0.07	1.18
		(0.18)	(1.07)
East Marmara		-0.04	1.33
		(0.22)	(0.98)
West Anatolia		-0.29	2.59**
		(0.36)	(1.03)
Mediterranean		-0.25	1.55
		(0.37)	(1.45)
Central Anatolia		-0.00	0.28
		(0.19)	(0.81)
West Black Sea		0.03	-0.06
		(0.49)	(0.63)
East Black Sea		-0.21	0.62*
		(0.13)	(0.38)
Northeast Anatolia		0.18	0.51
		(0.51)	(0.76)
Central East Anatolia		0.01	0.75
		(0.06)	(0.67)
Southeast Anatolia		-0.16	1.22
		(0.56)	(0.91)

General selective		-2.09*	-1.25
		(1.08)	(5.04)
Vocational not selective		-0.45	0.31
		(0.52)	(1.72)
Vocational selective		-0.28	0.38
		(0.56)	(3.25)
Class size		0.66	-8.26
		(1.74)	(70.83)
Class size squared		-0.50	-1.12
		(1.59)	(46.80)
Student-teacher ratio		0.14	-5.31
		(0.62)	(33.56)
Student-teacher ratio squared		-0.12	4.95
		(0.42)	(14.67)
Shortage of educational material (WLE)		-0.10	-0.37
		(0.27)	(0.52)
Shortage of educational staff (WLE)		-0.04	1.35
		(0.18)	(1.37)
Fraction of teachers with at least BA degree		-0.46	-35.43**
		(0.55)	(16.97)
Private school		-0.87	1.40
		(0.61)	(0.99)
Share of funding from government		0.78	2.62
		(0.61)	(8.17)
Students grouped by ability		-0.02	2.19
		(0.24)	(2.51)
Educational leadership (WLE)		-0.13	0.55
		(0.22)	(1.60)
Accountability (0-1)		-0.40	2.86
		(0.44)	(9.71)
Responsibility for resources (WLE)		-0.14	-8.50
		(0.30)	(7.73)
Responsibility for curriculum (WLE)		0.05	24.87**
		(0.21)	(11.07)
Lack of discipline – students (WLE)		-2.23**	-0.03
		(1.10)	(0.85)
Lack of discipline – teachers (WLE)		0.02	0.17
		(0.12)	(0.35)
Average ESCS		-1.72	24.89
		(2.30)	(16.21)
Average ESCS squared		0.43	-8.92
		(0.82)	(10.13)
Fraction of girls		-1.17	3.59
		(2.54)	(7.95)
Constant			-30.80
			(33.74)
Total		**-21.26*** **	**-5.36*** **
		(4.23)	**(1.28)**
Observations	5,724		

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6a. *Decomposition of the gender gap in mathematics with imputed data*

	Mathematics
Predicted mathematics - boys	426.74***
	(4.40)
Predicted mathematics - girls	419.72***
	(4.70)
Predicted gender gap	**7.03***
	(4.01)
Endowments	-7.66**
	(3.64)
Coefficients	14.68***
	(1.24)
Observations	5,724

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A6b. *Detailed decomposition of the gender gap in mathematics with imputed data*

	Mathematics	Endowments	Coefficients
Predicted mathematics - boys	426.74***		
	(4.40)		
Predicted mathematics - girls	419.72***		
	(4.70)		
Predicted gender gap	**7.03***		
	(4.01)		
Grade 10		-2.05***	4.80*
		(0.39)	(2.74)
Grade 11		-0.57***	-0.12
		(0.19)	(0.25)
Grade 12		-0.02	0.04
		(0.05)	(0.05)
Turkish		-0.08	7.81
		(0.16)	(9.55)
Mother - High school		-0.05	0.66
		(0.12)	(0.94)
Mother - University degree		-0.17**	0.01
		(0.09)	(0.48)
Father - High school		0.07	-0.06
		(0.06)	(0.96)
Father - University degree		0.10	-0.23
		(0.10)	(0.58)
Mother employed		-0.05	-0.26
		(0.09)	(0.80)
Father employed		-0.02	-4.91
		(0.04)	(4.31)
Home possessions (WLE)		-0.14	0.82
		(0.19)	(2.55)
ECE - at least 1 year		-0.03	-0.18
		(0.04)	(1.20)
Parental emotional support (WLE)		0.10	0.43
		(0.11)	(0.33)
Talks to parents		-0.43*	-2.95
		(0.24)	(3.94)
Works in household		0.13	0.69
		(0.14)	(2.78)
Works for pay		-4.27***	0.28
		(0.62)	(1.31)
In school learning - mathematics (hours)		-0.87***	5.72
		(0.25)	(4.20)
Out of school study - mathematics (hours)		0.27**	-4.97**
		(0.14)	(2.16)
Achievement motivation (WLE)		-1.27***	1.51*
		(0.27)	(0.88)
Test anxiety (WLE)		3.12***	-0.19
		(0.39)	(0.52)
Sense of belonging at school (WLE)		-0.09	0.35
		(0.15)	(0.53)
Town or city (15,000 < Pop. < 1,000,000)		-0.09	0.52
		(0.41)	(7.06)
Large city (Pop. > 1,000,000)		-0.00	0.00
		(0.19)	(5.45)
West Marmara		0.18	0.15
		(0.12)	(0.52)
Aegean		-0.01	0.42
		(0.16)	(1.31)
East Marmara		0.02	1.76
		(0.18)	(1.13)
West Anatolia		-0.22	2.18**
		(0.31)	(0.88)
Mediterranean		-0.22	1.46
		(0.35)	(1.31)
Central Anatolia		0.00	0.74
		(0.16)	(0.92)
West Black Sea		0.01	-0.05
		(0.26)	(0.72)
East Black Sea		-0.20	0.58
		(0.12)	(0.40)
Northeast Anatolia		0.04	0.57
		(0.22)	(0.68)
Central East Anatolia		0.03	0.31
		(0.08)	(0.68)
Southeast Anatolia		-0.13	1.91
		(0.51)	(1.27)

General selective		-1.03	0.90
		(1.03)	(4.30)
Vocational not selective		-0.28	0.45
		(0.53)	(1.65)
Vocational selective		-0.64	1.02
		(0.83)	(3.15)
Class size		0.97	60.20
		(2.27)	(85.07)
Class size squared		-0.82	-49.91
		(2.20)	(53.38)
Student-teacher ratio		0.27	14.19
		(1.11)	(36.56)
Student-teacher ratio squared		-0.39	-3.21
		(0.79)	(16.09)
Shortage of educational material (WLE)		-0.01	-0.04
		(0.19)	(0.41)
Shortage of educational staff (WLE)		-0.01	1.78
		(0.16)	(1.45)
Fraction of teachers with at least BA degree		-0.48	-32.60
		(0.58)	(21.18)
Private school		-0.76	0.35
		(0.71)	(0.77)
Share of funding from government		0.95	1.71
		(0.71)	(9.10)
Students grouped by ability		-0.01	2.59
		(0.13)	(2.39)
Educational leadership (WLE)		-0.14	-0.24
		(0.20)	(1.60)
Accountability (0-1)		-0.44	-11.48
		(0.52)	(11.07)
Responsibility for resources (WLE)		-0.11	-11.99
		(0.32)	(8.87)
Responsibility for curriculum (WLE)		0.04	17.62
		(0.19)	(10.78)
Lack of discipline – students (WLE)		-3.65***	-0.05
		(1.33)	(0.73)
Lack of discipline – teachers (WLE)		0.03	-0.27
		(0.14)	(0.38)
Average ESCS		-2.18	-4.31
		(2.82)	(18.02)
Average ESCS squared		0.65	3.63
		(1.11)	(9.91)
Fraction of girls		7.94***	0.40
		(2.49)	(8.66)
Constant			3.99
			(42.90)
Total		-7.66**	14.68***
		(3.64)	(1.24)
Observations	5,724		

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7a. *Science – boys: Mother's education and occupation interactions*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Mother - High school	-9.03	-7.41	-6.12	-4.69	-3.97	-8.06	-7.50	-8.61*
	(5.86)	(5.40)	(5.61)	(5.32)	(5.33)	(5.09)	(4.94)	(4.99)
Mother - University degree	-44.41***	-36.36***	-35.63***	-32.27***	-30.75***	-32.97***	-33.52***	-33.19***
	(9.73)	(9.26)	(9.13)	(8.33)	(7.92)	(7.49)	(7.32)	(7.47)
Mother employed	1.14	2.11	2.10	4.48	4.05	2.62	3.68	2.72
	(8.20)	(7.73)	(7.49)	(6.05)	(5.67)	(5.59)	(5.52)	(5.52)
Mother - High school * Employed	11.04	8.64	7.32	5.61	4.19	5.50	4.63	7.76
	(13.27)	(12.09)	(12.04)	(10.65)	(10.35)	(10.01)	(9.82)	(9.63)
Mother - University degree * Employed	70.99***	64.35***	60.63***	50.23***	49.63***	40.01***	39.44***	39.35***

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7b. *Science – girls: Mother's education and occupation interactions*

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
Mother - High school	-8.52*	-7.58	-5.61	-3.60	-3.81	-6.64	-6.66	-6.26
	(4.81)	(4.64)	(4.39)	(4.30)	(4.03)	(4.14)	(4.06)	(4.05)
Mother - University degree	-46.53***	-37.60***	-29.95***	-32.08***	-29.02***	-31.99***	-32.88***	-32.45***
	(7.42)	(6.75)	(6.07)	(6.33)	(6.43)	(6.33)	(6.34)	(6.26)
Mother employed	-1.98	-2.25	-0.10	0.65	2.39	2.81	2.92	3.16
	(6.69)	(6.48)	(6.41)	(5.96)	(5.55)	(5.31)	(5.22)	(5.12)
Mother - High school * Employed	12.00	10.95	8.01	3.07	1.66	0.47	-0.27	-0.54
	(10.64)	(10.23)	(9.98)	(8.90)	(8.49)	(8.18)	(8.05)	(7.92)
Mother - University degree * Employed	72.08***	61.86***	53.67***	49.47***	43.73***	39.70***	41.41***	38.13***

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7c. *Decomposition of the gender gap in science with imputed data*

	Science
Predicted science - boys	426.32***
	(4.45)
Predicted science - girls	431.21***
	(4.35)
Predicted gender gap	**-4.90**
	(3.99)
Endowments	-12.20***
	(3.63)
Coefficients	7.31***
	(1.25)
Observations	5,724

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A7d. *Detailed decomposition of the gender gap in science with imputed data*

	Science	Endowments	Coefficients
Predicted science - boys	426.32***		
	(4.45)		
Predicted science - girls	431.21***		
	(4.35)		
Predicted gender gap	**-4.90**		
	(3.99)		
Grade 10		-1.94***	5.55**
		(0.39)	(2.53)
Grade 11		-0.71***	-0.25
		(0.25)	(0.27)
Grade 12		-0.01	-0.02
		(0.04)	(0.04)
Turkish		-0.06	15.07
		(0.15)	(9.25)
Mother - High school		-0.05	0.23
		(0.11)	(0.91)
Mother - University degree		-0.22**	-0.12
		(0.11)	(0.47)
Father - High school		0.06	0.18
		(0.06)	(0.99)
Father - University degree		0.09	0.43
		(0.09)	(0.62)
Mother employed		-0.07	0.65
		(0.10)	(0.73)
Father employed		-0.03	-3.43
		(0.04)	(3.12)
Home possessions (WLE)		-0.08	0.63
		(0.10)	(2.26)
ECE - at least 1 year		0.00	-0.71
		(0.02)	(1.06)
Parental emotional support (WLE)		0.11	0.23
		(0.13)	(0.35)
Talks to parents		-0.29*	-5.02
		(0.17)	(3.65)
Works in household		0.08	-4.61
		(0.08)	(2.90)
Works for pay		-3.84***	1.38
		(0.52)	(1.22)
In school learning - science (hours)		-2.19***	-1.44
		(0.52)	(3.29)
Out of school study - science (hours)		0.35**	-4.05**
		(0.15)	(1.77)
Achievement motivation (WLE)		-0.55***	0.94
		(0.19)	(0.77)
Test anxiety (WLE)		2.64***	0.31
		(0.36)	(0.51)
Sense of belonging at school (WLE)		0.16	0.77
		(0.15)	(0.48)
Town or city (15,000 < Pop. < 1,000,000)		-0.10	-1.42
		(0.38)	(6.14)
Large city (Pop. > 1,000,000)		-0.00	-0.34
		(0.16)	(4.52)
West Marmara		0.10	0.13
		(0.09)	(0.55)
Aegean		0.06	-0.37
		(0.16)	(1.09)
East Marmara		-0.00	0.92
		(0.13)	(0.91)
West Anatolia		-0.24	2.04**
		(0.32)	(0.81)
Mediterranean		-0.24	0.23
		(0.34)	(1.36)
Central Anatolia		-0.01	0.14
		(0.21)	(0.71)
West Black Sea		0.01	0.00
		(0.26)	(0.71)
East Black Sea		-0.17	0.51
		(0.10)	(0.39)
Northeast Anatolia		0.02	0.32
		(0.20)	(0.55)
Central East Anatolia		0.01	0.84
		(0.06)	(0.57)
Southeast Anatolia		-0.16	1.04
		(0.57)	(0.90)

General selective		-1.46	2.45
		(0.90)	(3.27)
Vocational not selective		-0.52	0.73
		(0.53)	(1.45)
Vocational selective		-0.54	1.89
		(0.69)	(2.74)
Class size		0.46	66.38
		(1.32)	(80.52)
Class size squared		-0.33	-46.31
		(1.18)	(50.50)
Student-teacher ratio		0.24	-9.18
		(1.00)	(33.09)
Student-teacher ratio squared		-0.42	6.59
		(0.79)	(14.38)
Shortage of educational material (WLE)		-0.07	-0.27
		(0.23)	(0.45)
Shortage of educational staff (WLE)		-0.01	1.05
		(0.14)	(1.06)
Fraction of teachers with at least BA degree		-0.59	-34.81**
		(0.52)	(17.23)
Private school		-1.03	0.55
		(0.90)	(0.84)
Share of funding from government		0.74	0.77
		(0.54)	(7.75)
Students grouped by ability		0.00	0.29
		(0.10)	(2.22)
Educational leadership (WLE)		-0.19	0.62
		(0.26)	(1.38)
Accountability (0-1)		-0.26	-6.69
		(0.45)	(8.77)
Responsibility for resources (WLE)		-0.03	-11.30
		(0.24)	(8.99)
Responsibility for curriculum (WLE)		0.05	22.24**
		(0.20)	(9.57)
Lack of discipline – students (WLE)		-2.63**	0.16
		(1.08)	(0.66)
Lack of discipline – teachers (WLE)		0.02	0.04
		(0.13)	(0.26)
Average ESCS		-1.77	15.19
		(2.30)	(15.40)
Average ESCS squared		0.36	-7.63
		(0.68)	(9.33)
Fraction of girls		4.73**	1.99
		(2.01)	(6.96)
Enjoyment of science (WLE)		-0.04	-0.05
		(0.17)	(0.19)
Interest in broad science topics (WLE)		0.37***	-0.36***
		(0.13)	(0.12)
Instrumental motivation in science (WLE)		-0.17*	1.73***
		(0.10)	(0.60)
Enquiry-based instruction in science (WLE)		-0.53**	0.53
		(0.24)	(0.44)
Teacher-directed instruction in science (WLE)		-0.07	-0.02
		(0.06)	(0.08)
Adaptive instruction in science (WLE)		-0.32**	-0.20
		(0.16)	(0.20)
Constant			-10.14
			(39.27)
Total		**-12.20*** **	**7.31*** **
		(3.63)	**(1.25)**
Observations	5,724		

Note. Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1