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Abstract

This paper argues that the socialist episode in East Germany, which constituted a radical experiment in gender equality in the labor market and other instances, has left persistent tracks on gender norms. We focus on one of the most resilient and pervasive gender gaps in modern societies: mathematics. In spite of the great push of girls into education since the 1980s, mathematics remains a predominantly male field in most developed countries. But the underperformance of girls in math is sharply reduced in the regions of the former GDR, in contrast with those of the former FRG. We show that this East-West difference is due to girls' attitudes, confidence and competitiveness in math, and not to other confounding factors, such as the difference in economic conditions or teaching styles across the former political border. We also provide illustrative evidence that the gender gap in math is smaller in European countries that used to be part of the Soviet bloc, as opposed to the rest of Europe. The lesson is twofold: (1) a large part of the pervasive gender gap in math is due to social stereotypes; (2) institutions can durably modify these stereotypes.

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1 Introduction

Since the 1980's, girls have started to reverse their initial disadvantage in educational investment (Goldin et al. 2006, Goldin 2014, Kane and Mertz 2012, Autor and Wasserman 2013, Blau and Kahn 2015, Fortin et al. 2015), and they now account for a disproportionate share of "the worldwide boom in higher education" (Becker et al. 2010). However, they still accumulate a specific mix of human capital, neglecting mathematics-intensive fields (Ceci, et al. 2014, Blau and Kahn 2015). The broad picture is that girls have closed the gap and conquered most of the avenues to professional success, such as business, medicine, law and biology, not talking about their traditional and intact advantage in reading and literature (Fryer and Levitt, 2009), but they stagger at the door of math-based curricula and occupations, especially at top levels.

Beyond being intriguing, this resilient male advantage in math bears important implications, as mathematics are generally associated with higher earnings (Altonji and Blank 1999, Altonji et al. 2012) and more prestigious occupations (Blau and Kahn, 2015). This could simply be because math training enhances cognitive and non-cognitive skills, such as clarity in expressions, logical reasoning and inference (Joensen and Nielsen 2006, 2014, Arcidiacono, 2004). It could also be due to the increasing value of math skills in a period of rapid math-intensive technological change. As a consequence, the number of math-skilled people in the labor force is a positive ingredient for growth, as illustrated by Hanushek and Kimko (2000). Hence, both equity and efficiency motives plead for understanding and reducing the gender gap in math.

A large literature has examined whether girls' lower appetence and performance in math is the outcome of natural brain-based skills or of social stereotypes (on behalf of pupils, parents and teachers). This paper argues that a large part of the gap is indeed due to social norms and stereotype threat, which can be undone by institutions. We use the German division and reunification as a natural experiment that offers the possibility to study the lasting effect of highly gender-equal institutions. In view of its ambitious growth objectives (and maybe its egalitarian ideology), the former GDR, as alike other socialist countries, made employment a universal right, but also a duty, for women as well as men, and adopted a host of accompanying measures ensuring the compatibility between fertility and employment. These gender-equal policies reflected on the work values of women, and, more generally, modified the conception of gender roles (Campa and Serafinelli, 2016, Lippmann et al. 2016). We argue that the gender gap in math is one of the domains that were affected by these changes. We document the persisting "gap in gap" in math scores and attitudes to math, i.e. the smaller gender gap in math in East Germany, as compared to West Germany.

The idea that gender differences in mathematics are innate and based on a brain, hormones and genetic basis is widespread. Halpern (2007) provides an exhaustive review of the large scientific literature dedicated to this idea, but finds it to be inconclusive, as experience can alter brain structure and functioning. One particular nature-based explanation of the preponderant presence of boys at high achievement levels in math is the so-called ”male greater variability hypothesis”. This hypothesis has been tested many times but no consensus has been reached: some studies found it consistent with data on American students (Benbow and Stanley, 1980), while other found it implausible, based on PISA and TIMSS (Kane and Mertz 2012) or IMO data (Hyde and Mertz 2009).

In a totally different spirit, the gender gap in math can be explained as a rational response to the unequal opportunities offered to boys and girls. In countries where women are bound to spend shorter years on the labor market, with interruptions due to pregnancy and childcare, leading to lower-profile careers, they naturally opt for less ambitious, less competitive, and thus less rewarding, education tracks. They also chose fields that are related to the type of activities that they expect to be exerting in the future, i.e. relational, caregiving or educational, hence their taste for language, psychology, healthcare, etc. Conversely, the more open the prospects for labor market achievement and opportunities in general, the greater the incentives for girls to invest in education, including the more demanding and competitive math tracks. As suggested by the economics of identity and culture, rational expectations can also be reinforced by social roles, which become sources of utility in themselves (Akerlof and Kranton 2002, 2010). Cultural norms may be self-sustained as they create expectations that influence educational choices, which, in turn, contribute to the dynamic persistence of stereotypes (se Altonji et al. 2012 for instance). Cultural economics have shown how such beliefs and attitudes could persist over time and across generations (Fernandez 2006, 2007, 2009, Blau et al. 2013, Bisin and Verdier 2001, 2010). Other behavioral motives such as self-confidence, biased priors about their chances of success and girls' lower appetence for competition, in general or against boys (Gneezy et al. 2003, Niederle and Vesterlund 2010), lie somewhere between the expectations and the cultural hypotheses.

This paper belongs in the second line of interpretation that posits that the gender gap in math is sustained by stereotypes. It argues that institutions can durably shape expectations, social norms and gender roles, that eventually reflect on the gender gap in math.

The economic literature has provided a lot of empirical evidence for this conjecture. Various measures of economic and social gender inequality have been shown to correlate with the size of the gender gap in math and science, as measured by PISA scores (Fortin et al. 2015, Guiso et al. 2008, Nollenberger et al. 2015), TIMSS scores (Baker and Jones (1993), IMO data (Hyde and Mertz 2009), or all of these measures (Kane and Mertz 2012, Ellison and Swanson 2010), as well as American data (Pope and Snydor 2010). Some studies have also documented the association between stereotypes about gender roles and the degree of the gender gap in math across American states (Pope and Snydor 2010, Else-Quest et al. 2010) or across Spanish regions (González de San Román and de la Rica Goiricelaya 2012). Concerning former socialist countries, Schnepf (2007), using PISA and TIMSS data, noted the lower gender gap in education that prevails in Central and Eastern European countries, as opposed to other OECD countries. Amini and Commander (2011) also reported that the gender gap in math and the ratio of male to female top performers in mathematics, calculated using PISA data, is smaller in Russia than it is in average in the OECD and in other emerging economies, such as Brazil and Mexico.

We generalize the conjecture of these papers, and provide causal evidence thereof, based on the German experience. Indeed, the lower gender gap in math in former socialist countries, and in more gender equal countries in general, could be due to a host of confounding factors. In the case of Germany however, it is possible to infer the direction of causality, using the historical sequence of unity, division and reunification of the country. We thus concentrate on the history of Germany and show that, starting from the same initial point, the egalitarian socialist episode has reduced the gender gap in math in East Germany. We document this, using the PISA data as well as the German Socio-Economic Panel. The legacy of the socialist experience persists until now, concerning objective math scores, self-declared math grades, as well as a host of subjective attitudes concerning math. Girls do seem to "shy away from competition", but much less so in East Germany. This higher performance of girls in math does not come at the price of a lower performance of girls in reading (their traditional advantage). We checked that there is no difference in teaching methods in math in Eastern versus Western schools. We also checked that the smaller gender gap in math in East Germany is not due to some other structural differences, such as poorer economic conditions in the Eastern region, which could make it necessary for women to work and influence their education choices.

This paper is far from being the first attempt to use the German division as a "natural experiment". Before us, some articles have illustrated the smaller gender gap in East Germany, as compared with West Germany, in terms of household behavior (Kunzler, et al., 2001, Cooke 2004, 2007), self-reported work preferences and beliefs about gender role (Breen and Cooke 2005, Bauernschuster and Rainer 2012, Beblo and Georges 2015, Campa and Serafinelli 2016). In a companion paper, Lippmann et al. (2016) showed that gender norms concerning household behavior have been radically modified in East Germany, as opposed to West Germany. Other papers have documented the lasting (and sometimes progressively withering) effect of East German institutions on mentalities (Alesina and Fuchs-Scündeln 2007, Rainer and Siedler 2009). This paper adds to this literature, by focusing on the gender gap in mathematics.

2 The socialist episode in East Germany

The identification of the influence of the socialist period in East Germany rests on the assumption that Eastern and Western regions were identical before the division. It is now well established that the output and employment structure, as well as the rate of female labor market participation were similar in the regions of East and West Germany before the division (Alesina and Fuchs-Shündeln 2007, Bauernschuster and Rainer 2012, Schenk 2003, Lippmann et al. 2016). The geographical divide was delimited by purely military power balance, across regions that nothing predisposed to diverge. Once separated (in 1949), the economic and political regimes of the two countries rapidly departed.

The GDR immediately settled institutions in favor of gender equality in education and occupations. This was not only for ideological reasons, but also, and perhaps mostly, in view of the industrialization objective, in particular, in the East German context of wartime destruction, postwar labor shortage and mass exodus from the country. The policy enacted by the socialist party explicitly aimed at three objectives: (1) the realization of legal equality between men and women, (2) the promotion of women's work, and (3) special protection of mothers and children (Kranz, 2013). The 1965 Family code stated that *"relationships between spouses must be organized in a way that allows the wife to conciliate maternity with her professional and social activities"* (Richter, 2014). Work-family compatible policies were put in place, included kindergartens and other childcare facilities (often within firms), generous maternity leaves, paid days-off for doing housework, exclusion from dangerous or strenuous jobs, and promotion of women?s enrollment in factories and other productive units (Kranz 2013, Cooke 2006). In the 1970s and 1980s, the "mothers' policy" (*Mutti-Politik*) made women's work hours more flexible, gave them more day-offs, holidays and paid leaves, preserved some jobs and some places for them in universities, and introduced the free "desired child pill" (*Wunschkindpill*) in order to allow them to plan the time of childbirth.

In the meantime, the FRG strengthened the traditional male-breadwinner model. Irregular school schedules and scarce childcare facilities inhibited female employment (Cooke, 2007). The tax system favored single earner families as unemployed spouses and children could get public health insurance at no extra cost. Until 1977, the Marriage and Family law stated that: "*The wife is responsible for running the household. She has the right to be employed as far as this is compatible with her marriage and family duties*" (Rheinstein and Glendon, 1978). Subsequent policies then alternated more or less conservative incentives for female participation in the labor market.

The FRG and GDR also radically diverged as concerns the representations of the ideal womanly models, as illustrated by newspapers, movies, television programs, posters and advertisements (Richter, 2014). In the GDR, Clara Zetkine, whose portrait was represented on 10 DDM (Ostmark) bills, incarnated the ideal model of a feminist, politically engaged and influent woman. Female stereotypes represented in the *Neue Berliner Illustrierte* between 1949 and 1989 were professionally active and "emancipated" women, working as journalists, professors, brigadiers or factory workers, participating in the construction of socialism. By contrast, in West Germany, the female stereotype was a perfect and modern housewife and mother, inspired by the American standard of the 1950s (Richter 2014).

As a result of these very different ideologies and policies, the rate of female labor market participation rapidly diverged. At the end of the division episode, in 1990, women's labor market participation rate in East Germany was about 89% compared to 92% for men, whereas in West Germany, only 56% of women were in the labor force, as compared to 83% of men (German Statistical yearbooks 1933-1991, Rosenfeld et al., 2004, Kranz 2013). Ten years later (in 2000), the labor force participation was still approximately the same across gender in the former GDR (around 80%), whereas the gap remained wide in West Germany, with 65% of women in the labor force against 81% of men (Schenk, 2003). These objective differences are matched by opinions regarding gender roles (Bauernschuster and Rainer 2012, Campa and Serafinelli 2016).

Our main argument is that equality on the labor market has changed East German women's expectations, hence their educational attitudes, but we do not exclude the possibility that some differences in the school systems of East versus West Germany also played a role in shaping persistent gender attitudes towards math and science curricula. Traditionally, the German education system was managed at the Länder level. Several unification policies took place under the Prussian empire, the Weimar republic, and the third Reich. During the division, Western Länder recovered their autonomy over schools' curricula, whereas, in the GDR, education was standardized over the entire territory (Schnepf, 2007). A unique education track was compulsory until Grade 10, without any formal differentiation between boys and girls (Campa and Serafinelli, 2016). By contrast, in West Germany, boys and girls followed different curricula until the 1970s. Even after this was abolished, the allocation of pupils into different types of schools (*Hauptschule, Realschule, Gymnasium*) after grade 4 allowed for more differentiation between boys and girls. In terms of contents, Fuchs-Schündeln and Masella (2015, p 8) indicate that "*the teaching of mathematics was of similar importance in East and West, even though GDR schools devoted significantly more time to natural sciences, while FRG schools devoted more time to teaching of "softer" subjects like foreign languages, sports, arts and music, and religious education*".

After the German reunification, the Western system spread to the Eastern part. About 20 percent of teachers of the GDR were dismissed. Curricula became more flexible (Fuchs-Schündeln and Masella, 2015). Regional differentiation may have appeared, given the greater autonomy given by the Federal system. In spite of these changes, we cannot exclude a priori that the socialist episode has left some persisting legacy on the gender gap in math. However, as we will show, the information collected by PISA about current school' s teaching styles, in particular in math, reveals no statistically significant difference between Eastern and Western schools for that matter.

The next sections discuss successively the socialist episode in East Germany, the data and empirical strategy, the results and robustness exercises, some extensions and the conclusions.

3 Data and Empirical Strategy

We use the PISA international evaluation scores of high school pupils, the German Socio-Economic Panel, as well as information about the International Mathematical Olympiads, and Chess tournaments.

3.1 PISA

The OECD Program for International Student Assessment, PISA [1], was launched in 2000, in order to measure (and monitor) the outcomes of OECD countries? education systems in terms of student achievement, within a common international framework. It assesses the Scientific, Reading and Mathematical Literacy of 15 years old students (more precisely from 15 years 3 months to 16 years 2 months). The survey takes place every three years.

Paper-and-pencil tests are used, with assessments lasting a total of two hours for each student. Test items are a mixture of multiple-choice items and questions requiring students to construct their own responses. A total of about 390 minutes of test items is covered, with different students taking different combinations of test items. Students answer a background questionnaire, which takes 30 minutes to complete, providing information about themselves and their homes. School principals are given a 20-minute questionnaire about their school.

The international survey is typically administered to between 4 500 and 10 000 students in each country. On top of the international survey, countries have the possibility to run PISA on a larger national sample (PISA-E). Because we need information about the localization of students, we need to use the national German PISA-E survey. Each of PISA cycles looks in depth at a major domain, to which two-thirds of the testing time is devoted. Major domains were: *reading literacy* in 2000, *mathematical literacy* in 2003 and *scientific literacy* in 2006. We thus focus on PISA-E 2003 Germany, which is dedicated to math.

The mathematics section of PISA includes four content domains in addition to a Math composite: Quantity (which assesses the understanding of numeric phenomena, quantitative relationships, and patterns), Space/Shape (spatial and geometric phenomena and relationships), Change/Relationships (mathematical manifestations of change, functional relationships, and dependency among variables), and Uncertainty (probabilities and statistics).

Simple descriptive statistics (Table A1 in the Appendix) show that the scores are generally lower for girls than for boys, but higher in East Germany than in West Germany, and that the gender gap is smaller in East Germany.

In addition to objective tests of performance, PISA includes a student questionnaire and a school questionnaire. The student questionnaire elicits a host of attitudes to math, spanning motivation, self-confidence, stress, pleasure, as well as competitiveness in math (see Appendix 9.3). It also asks pupils about the time spent on math in their class, as well as the last grade

[1] https://www.oecd.org/pisa/

they obtained in mathematics in their last school report. Finally, the school questionnaire asks the director a series of questions concerning teaching styles in mathematics.

We use all of this information in order to assess the objective and subjective performance of German boys and girls across the former political border.

3.2 GSOEP

We also use self-stated math scores contained in the German Socio-Economic Panel, a longitudinal survey run by the German Institute for Economic Research (DIW, Berlin). This survey was started in 1984 in West Germany and was extended to East Germany in 1990. We use 22 waves, from 1991 to 2012. A question about their last grade in math is asked to adults upon their entry in the panel, and to 17 years old teenagers: *Can you remember your last report card? What grade did you have in mathematics?* (1-6 scale with 1 being the highest grade)?. For adults, we restrict the sample to individuals who were born before 1971, hence completed their education before 1990; we define a dummy East that code 1 for individuals who, in 1991, declared that they used to leave in East Germany before 1990 (and 0 otherwise). For teenagers, East is a dummy that codes 1 for individuals of German nationality who reside on the territory of the former GDR at the time they are surveyed. We drop people who were born outside Germany. We drop Berlin from the sample, as the data does not allow distinguishing East Berlin from West Berlin.

3.3 Estimation Strategy

We are interested in the gender gap in math scores (or math attitudes) and in the influence of the socialist episode on this gap. Hence, all of our estimates regress the considered math score of individuals (indexed by subscript i) on gender, a dummy for East Germany (as opposed to West), and the interaction of the two later terms, controlling for the socio-demographic variables and the relevant contextual magnitudes. The typical form of our estimate is described by equation (1):

$$MathScore_i = \gamma_1 Female_i + \gamma_2 Female_i * East_i + \gamma_3 East_i + \beta X_{it} + \epsilon_{it} \quad (1)$$

We expect the coefficient γ_1 to be negative, reflecting the usual disadvantage of girls in math; we have no prior on the coefficient γ_3 and our test is about the sign of γ_2, i.e. the specific gender gap in math in East Germany.

Using PISA, we regress math scores of pupils (i) on a dummy for living in East Germany (versus West Germany, dropping Berlin from the sample). The controls X_{it} include a quadratic in age, the pupil?s class level, a quadratic in wealth, education, employment status of both parents, size of the location area (1: village, hamlet or rural area (fewer than 3 000 people) ; 2: small town (3 000 to 15 000 people) ; 3: town (15 000 to 100 000 people) ; 4:

city (100 000 to 1 000 000 people) ; 5: large city (over 1 000 000 people), share of girls in the school and Lander fixed-effects.

Using GSOEP, the controls include age, household income and Lander fixed-effects. We run probit estimates of declaring a good grade, i.e. strictly below 3 on a 1-6 scale (where 1 is the best grade and 6 the worst). We cluster the standard errors at the household level. We restrict the sample to individuals who were born before 1971, hence have completed their education before 1990.

4 Results

4.1 Self-Declared Math Grades

We start with self-declared math grades collected by the GSOEP. We begin with adults, who used to live in the former GDR before 1990. Table 1 shows that, as expected, women score lower in terms of remembered grades, i.e. they are 7% less likely to report good grades in math. Eastern people report slightly higher grades. But, notwithstanding memory-biases, East German women totally close the subjective gender gap in math.

Table 1: Self-declared Math Grades by German Adults - GSOEP

Dependent Variable: Self-Declared Last Math Grade (0-1 scale)	
	(1)
Female	-0.07***
	(0.01)
East	0.05**
	(0.02)
East*Female	0.05***
	(0.02)
Observations	19709

* p < 0.1, ** p < 0.05, *** p < 0.01. Probit marginal effects. The data comes from the German Socio-Economic Panel. Standard errors clustered at the household level are given in parentheses. Sample restricted to individuals born before 1971. East=1 if the household head lived in the GDR before 1990. Controls: Age, Household Income and Lander FE. Question: Can you remember your last report card ? What grade did you have in mathematics (1-6 scale with 1 being the highest grade)? Answer originally on a 1-6 scale recoded on a 0-1 scale, 1 corresponding to a grade of 1 or 2.

Concerning teenagers, the picture is similar. The upper panel of Table 2 reveals a gender gap in math grades of the same magnitude, no statistically significant difference between East and West Germany, and again, the absence of gender gap in math in East Germany. The lower panel of Table 2 is based on the German PISA-E survey of 2003. As PISA also asks pupils about their objective grades in math (*In your last school report, what was your mark in Mathematics?*), we can use this information to double-check the findings based on GSOEP. The gender gap in self-declared math grades, collected by PISA, is of approximately the same order of magnitude as that found using GSOEP (9%). PISA data confirm that the gender gap in math grades obtained in schools is entirely closed in East Germany. Hence, from ten to twenty years after the reunification, subjective perceptions of one's performance in math are similar for men and women in Eastern Lander, whereas they are lower for women living in Western Lander.

Table 2: Self-declared Math Grades by Teenagers (0-1 Scale)

Panel A: GSOEP - 17 years old	
Female	-0.05***
	(0.02)
East	-0.04
	(0.05)
Female*East	0.09**
	(0.04)
Observations	3446
Panel B: PISA-E - 15 years old	
Female	-0.09***
	(0.01)
East	-0.01
	(0.02)
Female*East	0.08***
	(0.01)
Observations	23513

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. Probit marginal effects. *Panel A*: the data comes from the German Socio-Economic Panel. The sample is restricted to individuals who were born in Germany. Standard errors clustered at the household level are given in parentheses. East=1 if Lander is part of the former GDR. Controls: Age, Household Income and Lander FE. Question : What Grade did you get in your last report card in mathematics ? Answer originally on a 1-6 scale recoded on a 0-1 scale, 1 corresponding to a grade of 1 or 2. *Panel B*: the data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors are calculated with a bootstrap method. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area and share of girls in the school and Lander Fixed Effects.

4.2 PISA-E Germany 2003. Objective Math Scores

We now calculate the average score obtained by each student in each of the four categories of math skills (Space and Shape, Relationship and Change, Uncertainty, and Quantity), as well as in an additional category: Problem Solving, assessed by PISA-E 2003.

The estimates displayed in Table 3 show that, in average, the scores of Eastern Lander pupils do not differ from those of Western Lander. Girls' scores are lower than boys', by 18 points (Problem Solving) to 39 points (Uncertainty), where the average score is about 500. However, the interaction term show that this gap is reduced for girls from East Germany, by 5 points (Quantity) to 11 points (Uncertainty). In average, the gender gap in the global score amounts to 31 points, and is reduced by 4 points in East Germany, i.e. about one eighth. In general, the gender gap is math is thus reduced in East Germany, as compared to West Germany, by about one tenth to one third, depending on the subjects.

Table 3: Maths Scores - PISA 2003-E Germany

	Dependent Variable: Math Score					
	(1) Global	(2) Space and Shape	(3) Relationships and Change	(4) Uncertainty	(5) Quantity	(6) Problem Solving
Female	-31.36***	-34.70***	-32.32***	-39.06***	-23.78***	-17.86***
	(1.31)	(1.59)	(1.61)	(1.47)	(1.51)	(1.40)
East	2.70	5.69	6.80	-5.15	-3.75	-11.62
	(7.60)	(8.43)	(8.97)	(7.69)	(7.54)	(7.94)
Female*East	4.35*	-2.72	6.06**	10.90***	4.86**	6.71***
	(2.26)	(2.91)	(2.58)	(2.36)	(2.35)	(2.35)
Observations	23619	23619	23619	23619	23619	23619

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors clustered at the school level are given in parentheses. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area and share of girls in the school and Lander Fixed Effects. OLS estimation.

One could wonder whether the better performance of East German girls in mathematics comes at the price of lesser efforts in other domains, such as Reading. Table 4 shows that this is not the case. There is not average difference between East and West Germany in terms of Reading scores. As is generally the rule, girls outperform boys in Reading, in average, and this is even more so in East Germany. This is consistent with the findings by Guiso et al. (2008), who report that in more gender-equal countries, the gender gap in math is smaller, but girls outperform boys in reading.

Table 4: Reading Score - PISA 2003-E Germany

Dependent Variable: Reading Score	
	(1)
Female	17.60***
	(1.48)
East	-6.04
	(7.50)
Female*East	6.56***
	(2.50)
Observations	23619

* p < 0.1, ** p < 0.05, *** p < 0.01. The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors clustered at the school level are given in parentheses. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area, share of girls in the school. OLS estimation.

4.2.1 The Case of the Space and Shape Content Domain

It is remarkable that the only type of exercise for which the gender gap in math is not reduced in East Germany is the Space and Shape category. This goes back to the discussion about the brain foundation of the gender gap in math. Else-Quest et al. (2010) already noticed that the largest gender difference in math achievement concerns the Space and Shape content domain of PISA. A possible evolutionist explanation is that hunting has formatted males' brain, making them more apt to orientation in space. However, the authors notice that spatial skill instruction is often neglected in schools, and that small amounts of instruction can produce large increases in spatial skills. They also mention research showing that playing videogames can improve mental rotation skills and in some cases eliminate gender differences in mental rotation. Without further research, we can only acknowledge the particularly resilient gender gap in visuo-spatial skills.

4.2.2 Quantile Regressions of Objective Math Scores

Because the gender gap in math is often found at higher levels of achievement, we run quantile regressions of the previous estimates. Table 5 distinguishes math scores from the 10th to the 90th decile, with an increment of 20 points. The gender gap increases at higher levels of performance for Relationship and Change and Uncertainty (by one third), in Problem Solving (where it doubles) and in Quantity (slightly), but not in Space and Shape. Again, this gap is attenuated in East Germany, sometimes particularly so at the top level of performance, i.e. for Relationship and Change and Uncertainty, but this is not systematic.

Table 5: Maths Scores by Quantiles - PISA 2003-E Germany

	(1)	(2)	(3)	(4)	(5)
Quantile	10	30	50	70	90
Dependent Variable: Space and Shape Score					
Female	-31.52***	-34.56***	-34.11***	-35.03***	-34.81***
	(2.76)	(1.76)	(1.23)	(1.80)	(2.26)
East	1.79	5.49	-0.39	2.04	-1.74
	(6.00)	(5.19)	(4.51)	(5.04)	(6.20)
Female*East	-6.73	-3.32	-4.09	-1.19	1.12
	(4.91)	(2.55)	(2.64)	(2.84)	(3.88)
Dependent Variable: Relationships and Change Score					
Female	-24.45***	-30.57***	-31.79***	-33.68***	-38.43***
	(2.51)	(1.59)	(1.43)	(2.04)	(2.35)
East	15.96**	8.39*	9.56***	4.60	-13.08**
	(7.58)	(4.46)	(3.40)	(4.10)	(6.27)
Female*East	-2.77	6.43**	6.17**	2.53	7.28**
	(5.53)	(2.85)	(3.01)	(4.35)	(3.00)
Dependent Variable: Uncertainty Score					
Female	-33.19***	-38.27***	-41.82***	-41.82***	-43.48***
	(2.24)	(1.73)	(1.59)	(1.41)	(2.43)
East	-2.99	-4.39	-6.90*	-9.74**	-22.32***
	(4.95)	(4.78)	(4.00)	(4.08)	(5.99)
Female*East	7.99**	10.19***	13.10***	11.83***	14.61***
	(3.43)	(3.03)	(1.94)	(2.97)	(4.24)
Dependent Variable: Quantity Score					
Female	-23.78***	-23.83***	-24.22***	-24.57***	-26.48***
	(1.99)	(1.81)	(1.49)	(1.89)	(1.54)
East	-3.05	-5.29	-3.13	-5.56	-11.46*
	(6.41)	(6.17)	(5.59)	(4.77)	(5.87)
Female*East	5.33*	4.15*	5.65	4.29	2.54
	(2.75)	(2.43)	(3.56)	(3.37)	(3.46)
Dependent Variable: Problem Solving Score					
Female	-12.92***	-14.67***	-20.58***	-21.51***	-23.27***
	(2.89)	(1.88)	(1.59)	(1.87)	(1.97)
East	-9.46	-6.94**	-14.71***	-16.46***	-16.85***
	(6.31)	(2.91)	(3.48)	(3.95)	(6.05)
Female*East	7.02	3.82	9.04***	9.49***	7.10**
	(4.78)	(2.73)	(2.82)	(3.16)	(3.39)

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors are calculated with a bootstrap method. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area and share of girls in the school and Laender Fixed Effects.

4.3 PISA-E Germany 2003. Subjective Attitudes to Math

If the gender gap in math is at least partly, a social construct, it should reflect on students' perceptions of their skills. Bharadwaj et al. (2012) showed that boys and girls differ significantly in perceptions about their own ability in math: conditional on math test scores, girls are much more likely to state that they dislike math, or find math difficult. Else-Quest et al. (2010) also found that boys felt more confident and less anxious in their math abilities and were more extrinsically and intrinsically motivated to do well in math than were girls. Boys also scored higher than girls on math self-concept and self-efficacy.

We use PISA 2003-E questions about students' subjective attitudes towards math. (The questionnaire is presented in the Appendix, Section 9.3). Table 6 shows that girls generally express a lower appetence for math, lower self-confidence, more stress and less pleasure in the practice of math. Their score is about 0.4 point lower than that of boys, on a 6 points scale, for these measures. Living in East Germany does not significantly influence these attitudes. But being a girl in East Germany reduces the subjective gender gap. The magnitude of this effect varies from about one tenth to one third. This is quite impressing, as this effect is measured at least ten years after the dissolution of the GDR. The last column of the table shows that this East-West difference is not due to the learning methods practiced by students.

Table 6: Subjective Attitudes to Math - PISA 2003-E Germany

Dependent Variable: Aggregate Subjective Variables					
	(1) Attitude	(2) Confidence	(3) Stress	(4) Pleasure	(5) Methods
Female	-0.37***	-0.32***	0.35***	-0.48***	0.01
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
East	0.01	-0.03	0.02	-0.01	-0.01
	(0.03)	(0.03)	(0.04)	(0.04)	(0.02)
Female*East	0.11***	0.04***	-0.04**	0.07***	0.02
	(0.02)	(0.01)	(0.02)	(0.02)	(0.01)
Observations	23598	23561	23553	23536	23550

* p < 0.1, ** p < 0.05, *** p < 0.01. The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors clustered at the school level are given in parentheses. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area, share of girls in the school. OLS estimation. Full labelling of the questions in Appendix 9.3.

4.4 Stereotype Threat. Are East German Girls More Competitive?

In line with our interpretation, we expect the stereotype threat concerning math that weights on girls to be smaller in East Germany than in the West. In particular, one of the main channels through which gender stereotypes are thought to influence girl's attitude to math is that they "shy away from competition" (Niederle and Vesterlund, 2010), especially when competitors are boys. Part of the student questionnaire targets exactly this notion of competition, namely: Thinking about your mathematics classes: To what extent do you agree with the following statements?

- I would like to be the best in my class in mathematics.
- I try very hard in mathematics because I want to do better on the exams than the others.
- I make a real effort in mathematics because I want to be one of the best.
- In mathematics I always try to do better than the other students in my class.
- I do my best work in mathematics when I try to do better than others.

Table 7 shows that girls do express much less competitive attitudes than boys (a difference of 20 percentage points). There is generally no difference in competitive attitudes of East versus West pupils (except for one question). But Eastern girls express much more competitive attitudes than Western ones.

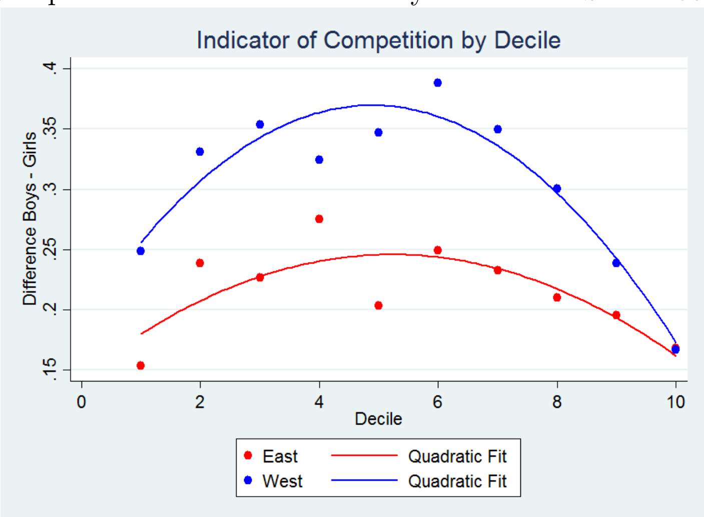
Figure 1 plots a quadratic fit of the gender gap in competitive attitudes (based on the average score on the five questions mentioned above) in East (red line) and West (blue line) Germany, depending on the actual PISA average math score of pupils (by deciles, computed for the distribution of scores for East and West Germany separately). The gender gap in competitive spirit is generally greater in West Germany. But the difference between East and West Germany is particularly important at intermediate levels of performance. It grows from the first to the fifth decile, and then declines. This exactly corresponds to the predictions of a model à la Altonji et al. (2012): the greater the uncertainty about their skills, the more girls underestimate themselves and shy out from competition. At very low levels of math skills, it is likely that boys and girls have a precise notion of their (low) performance, and we do not expect any gender gap in competitiveness. The same reasoning goes for very high levels of performance. It is in-between the two extremes that there is room for under/over-confidence, and this is where the gender gap takes place. This finding is thus in line with an interpretation in terms of persisting cultural attitudes inherited from the time of the division.

Table 7: Competitive Attitudes in Math - PISA-E 2003 Germany

	Subjective Variable: Competitiveness in Mathematics				
	(1) Be the Best	(2) Try hard	(3) Effort	(4) Outperform	(5) Challenge
Female	-0.20***	-0.22***	-0.27***	-0.39***	-0.32***
	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)
East	-0.16***	0.03	-0.02	-0.06	0.03
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Female*East	0.08***	0.07***	0.10***	0.09***	0.04*
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
Observations	23474	23393	23370	23362	23340

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors clustered at the school level are given in parentheses. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area, share of girls in the school. The explained variables are, for each column: Column 1 : I would like to be the best in my class in mathematics; Column 2 : I try very hard in mathematics because I want to do better in the exams than the others; Column 3 : I make a real effort in mathematics because I want to be one of the best; Column 4 : In mathematics I always try to do better than the other students in my class; Column 5 : I do my best work in Mathematics when I try to do better than others. Answers are given on a 1-4 scale, estimation by OLS.

Figure 1: Competitive Attitudes in Math by Deciles - PISA-E 2003 Germany



Notes: The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. The red line shows the quadratic fit of the indicator of competitive attitudes in mathematics by deciles for East Germany (computed on the basis of PISA global mathematics scores in East or West Germany). The blue line represents West Germany.

5 Robustness

Could the difference across the former Berlin wall be due to other structural differences? Two main confounding factors are obvious: different teaching practices, and structural economic differences across the former political border between the FRG and the GDR.

5.1 Are Eastern and Western Schools Different?

As discussed in Section 2, it could be possible that mathematics are taught in a different way, that could happen to be more favorable to girls, in Eastern Lander. Testing this idea thoroughly would be the object of a separate study. However, we can make use of PISA's student and school questionnaires to enquire.

To start with, PISA student questionnaire contains a question about the time allotted to math in their class. We aggregate the answers at the school level and look at the difference between East and West schools for this matter. If Eastern schools devoted more time to math training, say, than Western schools, this could have an impact on the gender gap in math. It could, for instance, reduce the gender gap in math because of increasing returns, or on the contrary, discourage girls even more, if they are initially little attracted to this field. It turns out (Table 8) that the time allotted to math does not differ in East versus West German schools.

Table 8: Total Math Time in Class per Week - PISA 2003-E Germany

Dependent Variable: Minutes of Mathematics per Week - School level	
	(1)
East	-10.93
	(7.33)
Constant	251.57***
	(8.99)
Observations	1199

* p < 0.1, ** p < 0.05, *** p < 0.01. The data comes from the German National Evaluation of Pisa. School controls: Size of location area, share of girls in the school and Lander fixed-effect.

In addition, we analyze the school questionnaire, which interviews each school's director, and covers a lot of teaching aspects.

The upper panel of Table 9 displays an aggregate score of answers to a series of questions about the organization of classes, in particular the allocation of students into ability groups. The second panel displays the average score of questions pertaining to the degree of innovative teaching methods for mathematics adopted by teachers. The third panel uses questions related to the optimal level of difficulty to target. Finally, the bottom panel presents questions related to the relative weight of cognitive (math) versus non cognitive skills, i.e. whether mathematics teachers grant more importance to the social and emotional development of students or to their acquisition of Mathematical skills and knowledge in Mathematics classes. Again, the result of our analysis shows that there is little statistical difference between East German versus West German school. To be sure, this does not rule out definitively the idea that schools may differ, but with the available data, we are unable to reject the hypothesis that they are similar.

Table 9: Teaching Methods per School - PISA-E 2003 Germany

	(1)	(2)	(3)	(4)
Panel A: Organization of Classes and Abilities				
East	0.13	-0.05	0.16	-0.05
	(0.14)	(0.12)	(0.12)	(0.15)
Observations	1175	1164	1171	1155
Panel B: Teachers and Innovation				
East	0.13	-0.12	0.05	
	(0.11)	(0.11)	(0.12)	
Observations	1191	1191	1191	
Panel C: Level of Difficulty				
East	0.30**	-0.09	0.03	
	(0.12)	(0.12)	(0.10)	
Observations	1187	1188	1188	
Panel D: Cognitive vs Non-Cognitive Skills				
East	0.13	-0.37***	0.18*	
	(0.11)	(0.12)	(0.11)	
Observations	1194	1189	1190	

* p < 0.1, ** p < 0.05, *** p < 0.01. The data comes from the German National Evaluation of Pisa. School level regressions. School controls: Size of location area and share of girls in the school and Lander Fixed Effects.
Panel A: Which of the following options describe what your school does for 15-year-old students in Mathematics classes? 1-3 scale. Column 1: Mathematics classes study similar content, but at different levels of difficulty; Column 2: Different classes study different content or sets of Mathematics topics that have different levels of difficulty; Column 3: Students are grouped by ability within their Mathematics classes; Column 4: In mathematics classes, teachers use a pedagogy suitable for students with heterogeneous abilities (i.e. students are not grouped by ability). *Panel B*: How much do you agree with these statements about innovation in your school? 1-4 scale. Column 1: Mathematics teachers are interested in trying new methods and teaching practices; Column 2: There is a preference among Mathematics teachers to stay with well-known methods and practices; Column 3: There are frequent disagreements between innovative and traditional Mathematics teachers. *Panel C*: How much do you agree with these statements about teachers expectations in your school? 1-4 scale. Column 1: There is a consensus among Mathematics teachers that academic achievement must be kept as high as possible; Column 2: There is a consensus among Mathematics teachers that it is best to adapt academic

standards to the students' level and needs; Column 3: There are frequent disagreements between Mathematics teachers who consider each other to be too demanding or too lax. *Panel D*: How much do you agree with these statements about teaching goals in your school? 1-4 scale. Column 1: There is consensus among Mathematics teachers that the social and emotional development of the student is as important as their acquisition of Mathematical skills and knowledge in Mathematics classes;Column 2: There is consensus among Mathematics teachers that the development of Mathematical skills and knowledge in students is the most important objective in Mathematics classes; Column 3: There are frequent disagreements between Mathematics teachers who consider each other as too focused on skill acquisition or too focused on the affective development of the student.

5.2 Are the Results Driven by Different Economic Conditions?

The difference in girls' math scores across the Berlin wall could also be due to different economic conditions prevailing in East versus West Germany, instead of persisting gender norms. For instance, it could be the case that a higher rate of regional unemployment in the East increases the necessity for women to work, hence the motivation for girls to invest in math and other human capital skills.

To rule out this alternative explanation, we need to look at the possible relationship between economic conditions and the gender gap in math. The difficulty is that, because PISA does reveal the actual denomination of Länder, for confidentiality reasons, we cannot match PISA scores to regional and macroeconomic statistics. PISA has "anonymized" the Länder, so that we know which schools belong to the same Länder, and whether the latter was part of the former FRG or GDR, but we cannot precisely identify it. In order to go around this problem, we construct our own measures of economics conditions on the basis of the information available in PISA data.

We focus on West Germany, and, using the answers given by students about their parent's labor market status; we calculate the ratio of parents who are declared to be unemployed by their children to the total number of parents. These ratios based on PISA are of 6% in West Germany and 13% in the East. They do not match the official figures for the rate of unemployment in 2003 (8.4% in the West and 18.2% in the East), because the concepts are different, but the difference is of similar magnitude.

Concerning wealth, we use the household wealth indicator constructed by the OECD on the basis of the answers given by students about the size and equipment of their house, and the number of books that their parents possess. We use this variable and aggregate it at the Lander level. We obtained a score of wealth varying from -6.17 to 3.15, with a higher score indicating a plausibly higher family wealth.

The upper panel of Table 10 shows that a higher unemployment rate is associated with a lower general score in math, but that there is no association with the gender gap in math. The lower panel shows that, identically, math scores are higher in wealthier families, but not particularly for girls or boys. Extrapolating these results to the East-West difference, we conclude that the poorest economic conditions that prevail in East Germany, as opposed to West Germany, cannot explain the smaller gender gap in math in the Eastern part of the country.

Table 10: Economic Conditions and the Gender Gap in Mathematics - PISA-E 2003. Within West Germany

	(1) Global	(2) Space and Shape	(3) Relationships and Change	(4) Uncertainty	(5) Quantity	(6) Problem Solving
	Indicator of economic conditions : Rate of unemployment					
Female	-31.09***	-33.03***	-33.25***	-40.29***	-22.07***	-19.92***
	(1.85)	(2.33)	(2.37)	(2.14)	(2.15)	(2.13)
Unemployment Rate	-3.98***	-3.67***	-4.65***	-4.11***	-3.88***	-4.10***
	(0.36)	(0.38)	(0.42)	(0.38)	(0.38)	(0.38)
Unemployment Rate*Female	0.04	-0.11	0.29	0.34	-0.16	0.50
	(0.26)	(0.32)	(0.32)	(0.29)	(0.31)	(0.32)
Observations	15886	15886	15886	15886	15886	15886
	Indicator of economic conditions : Wealth					
Female	-30.73***	-33.07***	-31.75***	-38.20***	-23.04***	-16.07***
	(1.29)	(1.64)	(1.65)	(1.52)	(1.56)	(1.44)
Wealth Lander	99.18	111.90	157.67*	109.01	62.33	79.68
	(67.02)	(69.82)	(82.00)	(69.70)	(66.60)	(67.68)
Wealth Lander*Female	-2.01	6.08	-8.86	-2.44	-6.55	12.65
	(8.39)	(10.73)	(9.67)	(9.55)	(9.34)	(11.24)
Observations	15886	15886	15886	15886	15886	15886

* p < 0.1, ** p < 0.05, *** p < 0.01. The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany. Standard errors are calculated with a bootstrap method. Individual controls: a quadratic in age, class, a quadratic in wealth, education and employment status of both parents. School controls: Size of location area and share of girls in the school and Lander Fixed Effects.The rate of unemployment is computed from the answers given by the students on their parent's job status and aggregated at the Lander level. The variable wealth is developed by the OECD based on the answers given by the students on the size of their house, the equipment of their house, the number of books that their parents have. We use this variable and aggregate the answers given by the students at the Lander level. This variable is scaled from -6.17 to 3.15, a higher score meaning a higher plausible family wealth.

6 Extensions

The case of the German division is particularly adapted to the demonstration of the causal influence of institutions. Nonetheless, for illustration, we now extend the analysis to all of the European countries, and contrast former socialist "Eastern" countries to capitalist "Western" countries. We uncover a similar picture: the gender gap in math is much smaller, and even sometimes inexistent, in Eastern countries. This is also true for other math-related domains such as Chess competition ratings.

6.1 Empirical Evidence from PISA Europe

We first look at the sample of European countries participating in PISA international assessments from 2000 until 2012. Controlling for country and year fixed-effects, as well as the same socio-demographic controls as before, we uncover a gender gap in math of 16 points, where the sample's average score is of 500. Students from former socialist countries do not score differently, in average, than the rest of the sample. However, girls from these countries score 9 points above their western counterpart, i.e. they close more than half of the gender gap (conditional on coming from a former socialist country). Table 11 displays there results.

Table 11: Math Scores - PISA Europe 2000 to 2012

Dependent Variable: Global Math Score	
	(1)
Female	-16.38***
	(0.38)
Former Socialist	-5.73
	(4.19)
Female*Former Socialist	9.23***
	(0.63)
Observations	724784

* p < 0.1, ** p < 0.05, *** p < 0.01. The data comes from the 2000,2003,2006,2009 and 2012 waves of PISA. Controls: quadratic in age, class, quadratic in household wealth, education of both parents and country and year fixed effects. Sample restricted to national born individuals.

6.2 IMO

In order to explore the gender gap in high achievers in math, we now focus on students who are sent to the International Mathematical Olympiad (IMO), an annual world championship mathematics competition for high school students under 20 years old[2]. The IMO involves an extremely difficult, proof-based, essay-style examination in mathematical problem solving (Kane and Mertz 2012).

The first IMO was first held in 1959 in Romania, with 7 countries participating. Over the past 50 years it has grown from a small contest among Soviet-bloc nations to a true worldwide contest among 100 countries. The number of high school students that each country may send was progressively reduced to six students. These students are often winners of the

[2] https://www.imo-official.org/?language=en

country's national Olympiad, but the manner in which teams are selected varies. The top scorers on the IMO have exceptional skills in mathematics, that is, at the 1-in-a-million level (Ellison and Swanson 2010, Andreescu et al. 2008). Several contestants have become famous mathematician, some have won the Fields Medal.

We use the IMO data spanning from 1959 until 2015. The skewness of the composition of IMO teams has already been documented paper by Andreescu et al. (2008). Here, the proportion of girls in each team is 8.5% in Eastern countries against 6.4% in Western countries, i.e. one third higher. The difference is significant at the 1% level. Western countries typically send 0.34 girls to the IMO, whereas Eastern countries send 0.48.

Is this smaller eviction of girls in Eastern country a legacy of the socialist period? When we reduce the sample to the years 1959-1991 (the USSR then counts for one country), the proportion of girls is lower but the pattern remains the same: the share of girls in national teams falls to 4.5% in former Socialist countries against 3% in the West, i.e. 50% higher (the difference is statistically significant at the 5% level). To put it differently, between 1959 and 1991, socialist countries typically used to send 0.32 girls, and capitalist countries 0.16 girls. Since 1991, socialist countries typically send 0.69 girls, and capitalist countries 0.46 girls.

We checked in a regression including country and year fixed-effects, that the probability that the national team includes at least one woman is 20% higher in former socialist countries.

6.3 Chess

Chess championships are another type of top level competition for math-minded people. The FIDE, French acronym for the World Chess Competition (Federation Internationale des Echecs) publishes ratings for the very top of the distribution of chess players, i.e. the top 100 and top 50 players by sex, each year, for standard, rapid and blitz competitions. It also ranks the top 100 junior boys and girls players (separately) along the same categories. The ranking of participants is based on their Elo rating. The data indicates the origin country of each player, men and women, in the sample. We use data from the FIDE chess ratings[3].

We simply compare the proportion of men coming from former socialist/capitalist countries to the same ratio for women. Among men, top level players coming from a former socialist country account for 72.9%. This proportion is 81% for women. The difference between the two ratios is statistically significant at the 1% level. When we reduce the sample to one observation per player (there is on average 5.26 observations per player), we obtain similar results: the ratio of top men players coming from the former Soviet bloc is 73% and 83.8% for women. These proportions are statistically different at the 5% level. It thus seems that the socialist episode has exerted long lasting effects on girls' performance in math, as measured by international standardized PISA scores, as well as by the International Mathematical

[3]https://ratings.fide.com/

Olympiads, and Chess competitions. [4]

7 Conclusions

The claim of this paper is that the socialist episode has exerted long lasting multi-directional effects on women expectations, self-confidence and choices. Previous studies have shown that women's attachment to paid work was greater in East Germany. In a companion paper, we provided evidence that household behavior had been durably modified in East Germany, in contrast with West Germany. This paper extends the same conjecture to girls' appetence for mathematics and achievement therein. It is a general stylized fact that girls underperform in math; this constitutes one of the most resistant gender gaps of modern societies. We show that this specific handicap has been sharply attenuated in East Germany. Even in recent years, girls' performance in math, as measured by international standardized PISA scores, is closer to that of boys in the regions of the former GDR, as opposed to the former FRG. Evidence from the international standardized PISA scores, the International Mathematical Olympiads and International Chess competitions, suggest that the gender gap in math and math-minded competitions is generally smaller in countries of the former Soviet bloc, as opposed to other European countries.

We interpret this stylized fact as a legacy of socialist institutions and policies that enacted, in a particularly compelling way, the objective of female full-employment. Policies that facilitated labor market participation and maternity for women were accompanied by official propaganda sustaining stereotypes of professionally active women, whose work was praised as a political engagement in the construction of socialism. Overall, this normative pressure changed the conception of gender roles and identity in many dimensions, including girls' school curricula and performance.

The claim of this paper is not that the socialist ideology in general was favorable to women. Nor do we discuss whether the gender policy that was implemented in socialist countries was dictated by equality motives or rather by the imperious rapid growth objective that commanded the 5-year plans. On the normative side, needless to say that we do not advocate for the implementation of similarly authoritarian gender policy, nor, of course, for the host of other measures that came with it. Some of the aspects of the gender policy (child care, maternity leaves, etc.) have already been successfully replicated in other contexts, in particular in Nordic countries such as Sweden and Denmark, without the same degree of

[4] Formally we test whether :
$Prop^{com}_{men} = Prop^{com}_{women}$
where $Prop^{com}_{men}$ corresponds to the proportion of men from former socialist countries among the top 100 players
and $Prop^{com}_{women}$ corresponds to the proportion of women from former socialist countries among the top 50 women.

authoritarianism. A minima, this paper wishes to show that, to a large extent, gender gaps, even in domains that seem to be grounded in nature, can actually be dissolved by institutions.

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9 Appendix

9.1 Descriptive statistics. PISA 2003-E Germany

Table 12: Descriptive statistics. PISA 2003-E Germany

	West Germany		*East Germany*	
	Mean	S.D.	Mean	S.D.
Male Score Global	524.33	94.92	531.34	86.65
Female Score Global	505.43	91.49	515.00	83.33
Grade 8	0.14	0.35	0.09	0.29
Grade 9	0.61	0.49	0.61	0.49
Grade 10	0.25	0.44	0.30	0.46
Female	0.50	0.50	0.49	0.50
Wealth	0.17	0.95	-0.06	0.86
Age	15.69	0.28	15.71	0.28
Mother Educ.	3.41	1.59	4.03	1.24
Father Educ.	3.82	1.67	4.07	1.29
Father's professionnal situation				
Working Full-Time	0.24	0.43	0.63	0.48
Working Part-Time	0.46	0.50	0.18	0.38
Looking for Work	0.04	0.19	0.11	0.32
Other	0.26	0.44	0.07	0.26
Mother's professionnal situation				
Working Full-Time	0.84	0.37	0.81	0.40
Working Part-Time	0.07	0.26	0.06	0.24
Looking for Work	0.04	0.19	0.09	0.29
Other	0.06	0.23	0.04	0.19
Share of Female in School	0.51	0.09	0.50	0.07
Size of the community				
Less than 3000 people	0.15	0.35	0.01	0.09
Between 3000 and 15000	0.02	0.14	0.14	0.35
Between 15000 and 100000	0.25	0.44	0.34	0.48
Between 100000 and 1000000	0.36	0.48	0.37	0.48
More than 1000000	0.22	0.41	0.14	0.35
Observations	16401		7922	

Notes: The data comes from the German National Evaluation of Pisa. The sample is restricted to individuals who were born in Germany.

9.2 Descriptive statistics. GSOEP

Table 13: Descriptive statistics. GSOEP

	West Germany		*East Germany*	
	Mean	S.D.	Mean	S.D.
		Panel A : Adults		
Dummy Mathematics Male(1=Very Good or Good)	0.49	0.50	0.55	0.50
Dummy Mathematics Female(1=Very Good or Good)	0.42	0.49	0.53	0.50
Age	49.57	16.66	48.59	17.03
Female	0.52	0.50	0.52	0.50
Household Income (EUR)	3080.08	2575.18	2223.61	1322.18
Observations	14906		4799	
		Panel B : Teenagers		
Dummy Mathematics Male(1=Very Good or Good)	0.34	0.47	0.35	0.48
Dummy Mathematics Female(1=Very Good or Good)	0.30	0.46	0.39	0.49
Age	17.10	0.39	17.11	0.41
Female	0.50	0.50	0.47	0.50
Household Income (EUR)	3238.77	1946.33	2479.61	1346.98
Observations	2618		827	

Notes: The data comes from the German Socio-Economic Panel. The sample is restricted to individuals who were born in Germany.

9.3 PISA-E 2003 Germany. Student Questionnaire

- Thinking about your views on Mathematics: to what extent do you agree with the following statements:
  - I enjoy reading about Mathematics
  - Making an effort in mathematics is worth it because it will help me in the work I want to do later.
  - I look forward to Mathematics lessons.
  - I do Mathematics because I enjoy it.
  - Learning Mathematics is worthwhile for me because it improves my career prospects, chances.
  - I am interested in the things is learn in Mathematics.
  - Mathematics is an important subject for me because I need it for what I want to study later on.

- I will learn many things in Mathematics that will help me get a job.

- How confident do you feel about having to do the following Mathematics tasks?
  - Using a train timetable to work out how long it would take to get from one place to another.
  - Calculating how much cheaper a TV would be after a 30% discount.
  - Calculating how many square feet of tile you need to cover a floor.
  - Understanding graphs presented in newspapers.
  - Solving an equation like 3x+5= 17.
  - Finding the actual distance between two places on a map with a 1:100 scale.
  - Solving an equation like 2(x+3)=(x + 3)(x - 3).
  - Calculating the gas mileage of a car.

- Thinking about studying mathematics: To what extent do you agree with the following statements?
  - I often worry that it will be difficult for me in Mathematics classes.
  - I am just not good at Mathematics.
  - I get very tense when I have to do Mathematics homework.
  - I get good grades in Mathematics.
  - I get very nervous doing Mathematics problems.
  - I learn Mathematics quickly.
  - I have always believed that Mathematics is one of my best subjects.
  - I feel helpless when doing a Mathematics problem.
  - In my Mathematics class, I understand even the most difficult work.
  - I worry that I will get poor grades in Mathematics.

- Thinking about your Mathematics classes: To what extent do you agree with the following statements?
  - I would like to be the best in my class in Mathematics.
  - In Mathematics I enjoy working with other students in groups.
  - I try very hard in Mathematics because I want to do better on the exams than the others.
  - When we work on a project in Mathematics, I think that it is a good idea to combine the ideas of all the students in a group.

- I make a real effort in Mathematics because I want to be one of the best.
- I do my best work in Mathematics when I work with other students.
- In Mathematics I always try to do better than the other students in my class.
- In Mathematics, I enjoy helping others to work well in a group.
- In Mathematics I learn most when I work with other students in my class.
- I do my best work in Mathematics when I try to do better than others

- There are different ways of studying Mathematics.To what extent do you agree with the following statements?
  - When I study for a Mathematics test, I try to work out what are the most important parts to learn
  - When I am solving Mathematics problems, I often think of new ways to get the answer.
  - When I study Mathematics, I make myself check to see if I remember the work I have already one.
  - When I study Mathematics, I try to figure out which concepts I still have not understood properly.
  - I think about how the Mathematics I have learnt can be used in everyday life.
  - I go over some problems in Mathematics so often that I feel I could solve them in my sleep.
  - When I study for Mathematics, I learn as much as I can by heart.
  - I try to understand new concepts in Mathematics by relating them to things I already know.
  - In order to remember the method for solving a Mathematics problem, I go through examples again and again.
  - When I cannot understand something in Mathematics, I always search for more information to clarify the problem.
  - When I am solving a Mathematics problem, I often think about how the solution might be applied to other interesting questions.
  - When I study Mathematics, I start by working out exactly what I need to learn.
  - To learn Mathematics, I try to remember every step in a procedure.
  - When learning Mathematics, I try to relate the work to things I have learnt in other subjects.

Respondents have to tick one answer on a 4 points scale, labeled as: 1 'strongly agree', 2 'agree', 3 'disagree' and 4 'strongly disagree'. We recoded the variables in ascending order of positive attitude.

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