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Math, girls and socialism☆

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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. Using the German division as a natural experiment, we show that 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.

1. Introduction

Since the 1980s, 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; 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, 2017). 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, 2010), but they stall at the door of math-based curricula and occupations.

Beyond being intriguing, this resilient male advantage in math bears important implications in terms of well-being and quality of life, as mathematics are generally associated with higher earnings (Altonji, 1995; Altonji et al., 2012) and more prestigious occupations (Blau and Kahn, 2017). 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, 2009; 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 Kimko and Hanushek (2000). Hence, both equity and efficiency motives plead for understanding and reducing the gender gap in math.

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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 stereotypes, 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 first show that the gender gap in mathematics is smaller in East Germany as compared to West Germany. This is true both in self-declared math grades but also in standardized tests. Then, we establish that this smaller gap is accompanied by different attitudes towards mathematics. In particular, girls in the East feel less anxious and more confident about their aptitude in math than their counterparts from West Germany. They also are more competitive, especially at intermediate levels of performance. Importantly, this higher performance of girls in math does not come at the price of a lower performance of girls in reading (their traditional advantage). Finally, we generalize our results to all European countries by contrasting 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.

Most of our findings are based on the PISA, the OECD Program for International Student Assessment. To assess the robustness of our results, we also use the German Socio-Economic Panel. We also provide substantive evidence that the reduction in the gender gap is not due to differences in teaching methods, organization of classes or math workloads in Eastern versus Western schools. Finally, we check that other structural differences, such as poorer economic conditions in the Eastern regions, do not affect the gender gap.

Our paper is related to a large literature, which has tried to determine whether gender differences in mathematics are innate, e.g. brain-based, or acquired. Halpern et al. (2007) provide an exhaustive review of the large scientific literature dedicated to the brain-based conjecture, 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 they expect to be exerting in the future, i.e. relational, caregiving or educational, hence their taste for language, psychology, healthcare, etc. As suggested by the economics of identity and culture, rational expectations can also be reinforced by social roles, which become sources of utility per se (Akerlof and Kranton, 2000; 2013). Norms may be self-sustained as they create expectations that influence educational choices, which, in turn, contribute to the dynamic persistence of stereotypes (see Altonji et al., 2012 for instance). Cultural economics have shown how such beliefs and attitudes could persist over time and across generations (Fernandez and Fogli, 2009; Fernandez, 2010; Blau et al., 2013; Bisin and Verdier, 2001; 2010). Other behavioral motives such as girls' self-confidence, biased priors about their chances of success and 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.

Beyond consequences on educational choices, such stereotypes have important implications in terms of well-being as they provide strong ground for statistical discrimination against women. Employer's beliefs about women's mathematical abilities are likely to hinder female careers (Reuben et al., 2014; Moss-Racusin et al., 2012) and directly impact their mental and physical health (Pascoe and Richman, 2009; Schmitt et al., 2014).

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 result in a gender gap in math. We directly contribute to the the empirical evidence supporting 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., 2016), TIMSS scores (Baker and Jones, 1993), IMO data (Hyde and Mertz, 2009), or all of these measures together (Kane and Mertz, 2012; Ellison and Swanson, 2010), as well as American data (Pope and Sydnor, 2010). Some studies have also documented the association between stereotypes about gender roles and the width of the gender gap in math across American states (Pope and Sydnor, 2010; Else-Quest et al., 2010) or across Spanish regions (Gonzalez de San Roman and de la Rica, 2012). Our paper is closer to that of Schnepf (2007) and Amini and Commander (2012) who noted the smaller gender gap in education that prevails in Central and Eastern European countries. We add to this literature by providing evidence of the causal influence of socialism. We also analyze the gender gap in some types of competitions that have not been explored before.

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 (Kuenzler et al., 2001; Cooke, 2004; 2007), self-reported work preferences and beliefs about gender role (Breen and Cooke, 2005; Bauernschuster and Rainer, 2012; Gorges and Beblo, 2015; Campa and Serafinelli, 2016; Lippmann et al., 2016). Other papers have documented the lasting (and sometimes progressively withering) effect of East German institutions on mentalities (Alesina and Fuchs-Schündeln, 2007; Rainer and Siedler, 2009). This paper adds to this literature, by focusing on the gender gap in mathematics.