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Do the maths: An analysis of the gender gap in mathematics in Africa

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ABSTRACT

This paper uses microdata for 19 African countries to examine the gender difference in maths test scores amongst primary school children. There is a significant difference in maths test scores in favour of boys, similar to that previously observed in developed countries. This difference cannot be explained by gender differences in school quality, home environment, or within-school gender discrimination in access to schooling inputs. However, the gender gap varies widely with characteristics of the regions in which the pupils live, and these regional characteristics are more predictive of the gender gap than parental education and school characteristics, including teacher gender. At the cross-country level, differences in fertility rates account for nearly half the variation in the gender gap, and this relationship is not due to the correlation between fertility and GDP.

1. Introduction

There is widespread evidence of the existence of a female disadvantage in performance in mathematics tests in high- and middle-income countries (e.g., Fryer & Levitt, 2010; Guiso, Monte, Sapienza, & Zingales, 2008; Hedges & Nowell, 1995). The causes underlying these differences remain the subject of much debate. In the literature focussing on developing countries, an increasingly important theme has been the study of female discrimination in human capital accumulation. However, few studies have investigated gender differences in test scores, and instead the focus has been on school enrolment and, to a lesser extent, grade completion. Skills acquired matter more for individual labour market outcomes and growth than mere attendance (Hanushek & Woessman, 2008), and so evidence on the former is needed. Estimates of the impact of cognitive skills on earnings are scarce outside developed countries. However, returns to cognitive skills are generally estimated to be large, and where maths and reading skills are considered separately, maths skills appear to matter more for income (Glewwe, 1996; Jolliffe, 1998 for Ghana; Moll, 1998 for South Africa), thus justifying our focus here on maths scores.

Two main types of arguments have been suggested to explain the gender gap in mathematics test scores documented in developed countries. A first potential explanation is the biological one that boys are genetically more able mathematically. In a recent critical review in which she refutes each claim in turn, Spelke (2005) summarises the three most prominent genetic arguments: (i) male infants' inherent larger interest in objects *versus* people; (ii) gender-specific profiles in spatial and numerical abilities leading to a greater aptitude for mathematics; and (iii) higher dispersion of male than female performance in quantitative and spatial ability,

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so that larger numbers of men have unusually high scores. For example, Machin and Pekkarinen (2008) clearly show that maths tests scores at age 15 are more dispersed among males than females in most OECD countries. Similarly, Ellison and Swanson (2010) document the universal over-representation of males in International Mathematical Olympiads, in which participants are under 20 years old. However, neither finding necessarily implies higher dispersion in intrinsic ability since societal factors can influence these outcomes.

Lack of suitable data prevents us from casting direct light on the importance of genetic factors. One way in which our findings speak to the biological argument, however, is that we find that the size of the gender gap varies widely across individuals with different characteristics, both within and between countries, and indeed becomes insignificant in some strata of the population. Thus, any explanation based on biology would have to be able to account for these differences i.e., by invoking an interaction of nature and nurture rather than nature alone.

Instead, we focus on the second group of explanations which have been suggested, namely cultural or societal explanations for the gender gap. Here we test for two possibilities. First, it could be that observable factors that influence mathematics tests scores vary systematically across the genders, with boys having observable characteristics that lead to higher test scores. It could, for instance, be the case that parents send their sons to better schools than their daughters, or that teachers discriminate against girls in the allocation of schooling inputs. If girls indeed face poorer observable schooling experiences than boys, then after controlling for such characteristics, the gender gap should disappear. The second possibility is that, although girls do not have observable characteristics that are less conducive to performing well in maths tests than boys, family, school and societal influences affect boys and girls differently in ways that we do not directly observe. For instance, some of these influences could result in genuine or perceived gender-specific returns to maths skills or in stereotype threats (i.e. "situation[s] where one faces judgement on societal stereotypes about one's group" (Spencer et al., 1999, p.5)), that are not captured by our individual regressors. We investigate this second possibility by studying the interaction between female gender and various indicators of societal influences measured at the household-, school-, and (sub-national) region level, to determine whether the size of the gender gap varies with such influences.

We use data from two surveys of primary school pupils in Africa, namely the 'Southern and Eastern African Consortium for Monitoring Educational Quality' (SACMEQ) and the 'Program for the Analysis of Education Systems' (PASEC), which together cover 19 countries and nearly 50,000 pupils in Sub-Saharan Africa. We merge these data with relevant characteristics of 139 sub-national regions in which the pupils live based on microdata taken from available Demographic and Health Surveys (DHS).

We contribute to the maths gender gap literature in several ways. First, we are the first to document the ubiquity of a gender gap in mathematics in Sub-Saharan African countries. We find that the size of the gap (0.1 standard deviations (sd) or 4–5% of the male mean grade towards the end of primary school) is of the same order of magnitude as that observed in developed countries.[1] Second, we are able to rule out a number of potential explanations for the existence of this gap, including gender differences in school quality, within-school discrimination in access to schooling inputs and lower parental investments in female schooling conditional on enrolment. Third, we show that girls only perform substantially less well than boys in maths in some societal environments, and that characteristics of the societies children grow up in are more predictive of the gender gap than parental education and school characteristics, including teacher gender. Fourth, we show that, in Sub-Saharan Africa, differences in fertility rates account for nearly half the cross-country variation in the gender gap, and this relationship is not due to the correlation between fertility and GDP per capita or between fertility and gender (in)equality in the labour market and political sphere. Our findings therefore suggest that a gender gap in maths performance is observed in Africa too, but that it is not due simply to inherent, genetic differences between genders *per se*; specific environmental factors are required in order for any genetic difference to translate into substantially lower average female performance in maths.

Given the non-experimental nature of the data, we do not give a causal interpretation to the estimated effect of the variables entering the standardised maths score production function. Instead, we aim to shed light on the broad nature of the gender gap by answering the following questions: Can the gap be accounted for by differences in school quality, within-school discrimination in access to schooling inputs, differences in parental socio-economic status, or differential investments in schooling, such as help with maths school work and child labour? Under what circumstances does the gap arise? To what extent can biology account for the observed gap(s)? Are the same societal explanations valid uniformly across developed and developing countries?

Given the lower enrolment rates of girls compared to boys in developing countries, and especially so in Sub-Saharan Africa, we expect the girls we observe in our in-school samples to be more positively selected than the boys (Glick, 2008). We are not aware of a survey of African children that applied an internationally comparable test to all, irrespective of school enrolment status. By controlling for a wide range of observable characteristics, we expect to reduce much of the differential selection into enrolment between boys and girls. The remaining selection bias should work against finding a female disadvantage and so our estimates should be seen as lower bounds of the true gender gap in maths in Sub-Saharan Africa. Similarly, any selection bias should work against finding a lower gender gap in the circumstances under which we observe a lower gender gap.

The remainder of the paper is structured as follows. The next section summarises the most relevant literature. Section 3 describes the data sources employed. Section 4 documents the gender gap in the raw data and motivates the regression analysis, Section 5 presents the regression results and discussion, and, finally, Section 6 concludes.

[1] For example, 2% of the male mean in PISA countries at age 15 (Guiso et al., 2008), and 0.2 sd in the US in fifth grade (Fryer and Levitt, 2010).