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Age at School Entry and Human Capital Development: Evidence from Lesotho†

By Jan-Walter De Neve, Ramaele Moshoeshoe, and Jacob Bor*

Evidence on school-entry age impacts in lower-income countries is limited. We assess how school starting age affects human capital development in Lesotho, exploiting an enrollment age threshold. Children who start primary school at older ages overcome initial skill deficits as they progress. They are more likely to remain in school, spend less time on economic and household activities, and obtain substantially higher total years of schooling. In adulthood they are more likely to have professional occupations and less likely to be married or have children as teenagers, become HIV infected (men), and experience the death of a child (women). (*JEL* I12, I21, I25, I26, J13, J24, O15)

The age at which a child enters primary school matters for human capital development and later life outcomes (Bedard and Dhuey 2006; Dhuey and Lipscomb 2008; Black, Devereux, and Salvanes 2011; McCrary and Royer 2011; Bai et al. 2019). Evidence from high- and middle-income countries points to countervailing "quantity" and "quality" effects.

On the one hand, children who enter primary school younger have more years of education before reaching compulsory schooling age and before labor market opportunities encourage dropout (Angrist and Krueger 1991). Upon school completion, they have more years in the workforce and higher lifetime earnings (Deming and Dynarski 2008).

On the other hand, children who start school younger are less developmentally mature and may appear to have less innate ability than their older peers. Students who are young for their grade have lower test scores (Bedard and Dhuey 2006; McEwan and

* De Neve: San Diego State University and University of Heidelberg (email: jdeneve@sdsu.edu). Moshoeshoe: National University of Lesotho and Global Education Analytics Institute (email: rmoshoeshoe@gmail.com). Bor: Boston University (email: jbor@bu.edu). Christopher Walters was coeditor for this article. We thank two anonymous reviewers for extremely useful comments and suggestions. Thank you to Diogo Amaro, Moussa Blimpo, Timotej Cejka, Trevor Croft, Jon Denton-Schneider, David Figlio, Guy Harling, Janny Liao, Suguru Mizunoya, Simon ter Meulen, Paola Villar, and seminar participants at the 100 Years of Economic Development Conference at Cornell University, CREST, HE2RO, AIDS 2022, ESPE 2022, CSAE 2023, ASHEcon 2023, 2023 Africa Meeting of the Econometric Society, Global Health Economics Working Group, Boston University, Clark University, National University of Lesotho, University of Cape Town, University of Heidelberg, and University of Sydney for feedback on this project. We also extend our gratitude to the survey field, data management staff, and respondents who generously contributed their time to this research. We also acknowledge the statistical offices that provided the underlying census and Community Survey data, which made this research possible, including the Bureau of Statistics in Lesotho and Statistics South Africa, South Africa.

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Shapiro 2008; Dhuey et al. 2019) and are more likely to be diagnosed with attention deficit hyperactivity disorder (ADHD) (Layton et al. 2018). Perceived differences in skill may be reified if teachers, students, households, and school systems invest more in children who are more mature, leading to differences in education "quality" and human capital development. Children who are young for their grade are less likely to hold leadership positions in secondary schools (Dhuey and Lipscomb 2008). They have lower expectations and aspirations (Peña 2020), lower self-esteem and confidence (Thompson, Barnsley, and Battle 2004; Bai et al. 2019), and lower life satisfaction (Fumarco and Baert 2019). They also have higher rates of teenage pregnancy and alcohol poisoning (Black, Devereux, and Salvanes 2011; Johansen 2021), crime in early adolescence (Cook and Kang 2016), and are more likely to smoke and have poor physical health in adulthood (Bahrs and Schumann 2020). To avoid these negative consequences, some caregivers delay enrolling their children in primary school, a phenomenon known as "redshirting" (Deming and Dynarski 2008).

Due to these countervailing forces, the effects of age at school entry on educational attainment and later life outcomes are theoretically ambiguous (Peña 2017). Average effect estimates vary widely in the literature, which to date has been almost exclusively from upper- and middle-income countries. Some studies find higher educational attainment (Angrist and Krueger 1992; Dobkin and Ferreira 2010; Cook and Kang 2016; Arnold and Depew 2018) and earnings (Angrist and Krueger 1991; Black, Devereux, and Salvanes 2011) among children who start school at younger ages. In other studies, children who started younger had *lower* educational attainment and worse labor market outcomes (Fredriksson and Öckert 2014; Bai et al. 2019; Guo, Wang, and Meng 2023; Valdés and Requena 2024). Still others find zero or minimal impact on educational attainment (Oosterbeek, ter Meulen, and van Der Klaauw 2021), adult wages, employment, homeownership, fertility, partner selection, and infant health (McCrary and Royer 2011; Tan 2017; Arnold and Depew 2018). Variation in estimates may reflect contextual factors related to the education system (e.g., extent and timing of tracking), labor market, and specific policies studied (Fredriksson and Öckert 2014; Peña 2020).

Average effects also conceal individual-level heterogeneity. Whereas some children may be ready to start primary school at younger ages, others who are less developmentally mature may benefit from starting school later (Molnár 2025). Caregivers may have private information on their children's school-readiness (Ricks 2024). Countries have sought to encourage earlier school entry through compulsory enrollment policies. However, these policies may have adverse consequences for children who enter before they are ready.

In this paper, we evaluate the impact of age at school entry on human capital development in Lesotho, a lower-income African country. We employ a regression discontinuity design (RDD), leveraging an enrollment age threshold for primary school. Children who were 5.5 years or older at the start of the school year (born on or before June 30) were required to enroll; however, children who were under 5.5 years (born after June 30) had the option of deferring enrollment for an additional year. The policy induced a 40 percentage point difference in primary school enrollment and a 0.5-year gap in average age at entry among children born just before versus after the enrollment threshold.

Using multiple nationally representative datasets for Lesotho, we assess the impacts of starting primary school a year older (being born after the June 30 threshold) on educational attainment in adulthood and a myriad of longer-run outcomes, including economic (employment, occupation, wealth), demographic (childbearing, marriage, partner quality), health (HIV infection), and intergenerational outcomes (child survival). Despite an initial disadvantage, children born after the cutoff go on to complete 0.41 years more total years of schooling by adulthood. While they have fewer years of schooling at each age from 6 to 10 years, they are less likely to drop out of school or repeat grades, leading to a reversal of fortunes during adolescence. When they grow up, children who start school at an older age have higher wealth, are more likely to have professional occupations, are less likely to have children or get married before age 20, are less likely to be HIV positive (in the case of men), and are less likely to experience the death of a child. These results are robust to potential selective migration, sample and model specifications, different surveys, different bandwidths around the cutoff point, and alternative empirical approaches.

This paper contributes to the literature on age at school entry in several ways. First, this paper is among the first to assess the effects of school entry age on educational attainment in a lower-income country in sub-Saharan Africa. A growing literature documents the effects in upper-middle-income countries.[1] However, little is known about the impacts of age at school entry in lower-income and African countries (Dhuey and Koebel 2022; Liao et al. 2023). Conditions in lower-income countries may shift the balance of the countervailing "quantity" and "quality" effects discussed above. Large class sizes, student heterogeneity, and poor training may constrain teachers' ability to teach across the full distribution of skill levels. Limited seats in secondary and tertiary education create bottlenecks and may reduce incentives for teachers, students, and their households to invest in the lowest-performing students. Laws requiring students to stay in school up to specific ages may not be enforced. Additionally, the opportunity costs of schooling may be greater where children can work on family farms, herd livestock, provide child and elder care, perform other home production activities, or enter the labor force. Each of these factors suggests that enrolling children in primary school before they are ready may carry a greater educational penalty in lower-income countries than in middle- and upper-income countries. Resulting differences in educational attainment may in turn have large downstream impacts on wages (Psacharopoulos 1994; Peet, Fink, and Fawzi 2015), health, and other outcomes (De Neve et al. 2015; Ozier 2018).

Second, we estimate the impact of age at school entry on outcomes across the life course. We observe impacts on employment, wealth, marriage, partner selection, and childbearing. We document the health effects of starting school a year older on HIV infection using objective measured biomarkers. (Prior literature on health impacts has used only self-reported or quasi-objective health outcomes (Black, Devereux, and Salvanes 2011; Bahrs and Schumann 2020)). Whereas prior literature has shown that formal schooling reduces HIV risk behaviors and HIV

[1] See Ryu, Helfand, and Moreira (2020) and Levasseur (2022) in Brazil Chen, and Park (2021); Li, Lou, and Zhang (2022); and Guo, Wang, and Meng (2023) in China, Peña (2017); Caudillo (2019); and Peña (2020) in Mexico, and Morales (2020) in Peru.

acquisition (De Walque 2007; Alsan and Cutler 2013; De Neve et al. 2015), this paper is the first to link school-starting age to HIV acquisition directly. Finally, our paper is the first to show the positive intergenerational consequences of starting school at an older age on child survival. Prior work finds zero effect (McCrary and Royer 2011) or negative effect (Borra, González, and Patiño 2024) of older age at school entry on infant health despite the evidence that education lowers child mortality in the next generation (Andriano and Monden 2019); however, this evidence was from the United States and Spain where age at school entry has a negative (McCrary and Royer 2011) or a zero effect (Borra, González ,and Patiño 2024) on educational attainment. Further, unlike in Borra, González, and Patiño (2024), we find that child health (mortality) effects of age at school entry are transmitted through education.

Third, we assess mechanisms that may explain the large effects of starting school a year older in Lesotho. We first show that children who start school a year older have more preprimary education and may enter school with greater skills, in addition to being biologically older. We then show that despite having equivalent innate ability, children who start school at an older age have faster year-on-year growth in cognitive skills, leading to differences in literacy even in adulthood. We find that households invest more in children born after the cutoff, as seen in differences in reading at home and in participation in home production. In detailed time-use data, we show that boys who started school at an older age are less likely to drop out of school and in later childhood spend less time herding animals. Effects are limited to households with livestock, illustrating how perceived returns to schooling interact with opportunity costs in lower-income settings.

Our investigation of mechanisms suggests a simple model for the impact of school entry age on human capital development in low-income settings. Despite no differences in innate ability, older children start school with greater cognitive and socioemotional skills than younger children due to their biological age and an extra year of exposure to pre-school or home environments. During primary school, perceived differences in innate ability lead to differential investment of scarce resources by teachers and households (Peña 2020). Older students get more out of each year of schooling than younger students, leading to different rates of skill acquisition. Finally, as opportunity costs rise in adolescence, older students have higher perceived returns to further schooling. Despite facing higher opportunity costs, older students are less likely to drop out of school than younger students, leading to a large advantage in human capital accumulation.

Our paper proceeds as follows. Section I describes the education policy context in Lesotho. Section II describes the data sources used and the econometric approach. Section III presents the main results of the paper, showing effects on educational attainment, long-run effects on other outcomes, and potential mechanisms. Section IV concludes.

I. The Context

A. *Socioeconomic Background*

Lesotho is a small, landlocked country in southern Africa. It is among the poorest of World Bank-designated lower-middle-income countries, with 34.7 percent of the population below the international poverty line of US$2.15/person/day (World Bank 2019). Twenty-eight percent of the labor force is unemployed, and among those working, 44 percent are in subsistence agriculture (Choi, Dutz, and Usman 2020). Fertility declined from 5.8 births per woman in 1975 to 3.1 births in 2019; however, it remains above the desired fertility level of 2.3 births. Lesotho has the world's second-highest HIV prevalence, with 25 percent of adults infected, and despite the availability of treatment, HIV remains a leading cause of death nationally (Abbafati et al. 2020). In 2020, Lesotho ranked 185 out of 193 countries globally in child survival, with an under-five mortality rate of 89.5 deaths per 1,000 live births (World Bank 2023).

B. *Lesotho's Education System*

Lesotho's first formal schools were established in the 1830s by missionaries and focused on religious education, vocational skills, and basic literacy. Today, Lesotho's primary education system includes community schools (3 percent), government schools (11 percent), and mission (church-owned) schools (85 percent), as well as a small number of private schools (1 percent). Despite differences in ownership and administration, all schools are governed by policies set forth by the Ministry of Education and Training (MOET), and all except private schools follow the same national curriculum. Lesotho's education spending is 13.8 percent of the government budget and 6.9 percent of GDP, making it the highest among all government sectors. However, education's budget share falls below the 15-20 percent specified in the Sustainable Development Goals (UNICEF Lesotho 2019; UNESCO 2021).

The education system in Lesotho is divided into primary school (grades 1–7), junior secondary school (grades 8–10), senior secondary school (grades 11–12), and postsecondary education. The first years of primary school are taught primarily in Sesotho, which is most children's first language. Higher primary school grades and secondary school are taught mainly in English. Primary school education has been free since 2000, and attendance is high, particularly for girls. In 2017, the gross enrollment ratio for primary school was 121 per 100 children of primary school age (UNICEF Lesotho 2019), reflecting that many older Basotho children remain in primary school beyond the traditional primary school age. Fees are assessed to attend secondary school. Despite the high transition rate from primary to secondary school (88 percent), many children do not complete secondary school, due in part to cost. Boys are more likely to be kept out of school to herd livestock and are more likely to leave school early in search of work. Still, very high youth unemployment rates, estimated at 43 percent (Choi, Dutz, and Usman 2020), keep many people in school into late adolescence.

Despite high enrollment rates, the quality of education is low. During the 10 years of primary and lower-secondary education, Lesotho students learn an average of 6.3 years worth of content. At graduation from lower-secondary school, most children remain challenged by foundational literacy and numeracy tasks (World Bank 2021).

C. *Enrollment Age*

Lesotho's school year starts in January. Per the Education Act of 2010, "a parent shall enrol a learner in a primary school at the age of six years or in the year in which he or she will be six years of age by the 30 of June of that calendar year" (Supplemental Appendix A1). This policy sets up a threshold rule for enrollment: Children who are 5.5 years or older (i.e., will turn six by June 30) are required to start grade 1 by January of that year, whereas children who are less than 5.5 years (i.e., will turn six on July 1 or later) have the option to defer enrollment to January of the following year. The Act stipulates that age shall be determined by birth certificate, infant medical record, baptismal certificate or declaration by the parent or guardian.[2] The Act also makes education compulsory for all children ages 6–13. Parents and guardians may be legally prosecuted, with a penalty of community service, fine, or imprisonment if a child does not attend school, although such prosecutions are rare.

Figure 1, panel A shows the probability of attending grade 1 or higher by month and year of birth using the Lesotho Multiple Indicator Cluster Survey (MICS) 2018 data.[3] There is a discontinuity in attendance between children who will turn six in June versus July. The June discontinuity reflects an increase in the probability of currently attending grade 1 of about 40 percentage points. The difference is less than 100 percentage points because some children enter primary school late despite the legal requirement, and some children born July–December start primary school when they are five years old. There is a smaller jump in enrollment between children who will be five years old at the start of the school year in January and those who are still four years, indicating that some caregivers may anchor on five years as the appropriate school enrollment age. (Because of enrollment discontinuities at December/January, we show that our results are robust to limiting the data to the months around June 30th.)

These enrollment patterns result in a natural experiment: whereas children born on or before June 30 are supposed to enroll when they are five years old, children who are born on or after July 1 may enroll when they are five years old or have the option to defer enrollment until they are six years old. While we focus on intention-to-treat effects, we note that the local variation in age at school entry induced by this enrollment policy comes from comparisons of children who deferred entry into primary school and children who entered primary school but would have deferred if they had been eligible to do so.

Figure 1, panel B shows the impact of this cutoff rule on the key exposure variable: age-at-entry into grade 1 (in January) by month of birth. Data are from the Lesotho 2018 Lesotho Multiple Indicator Cluster Survey (MICS) and exclude children repeating grade 1. June-born children are, on average, 5.3 years old; July-born children are, on average, 5.8 years old, a difference in average age-at-entry of

[2] Birth registration with the government is mandatory and is done country-wide across district offices.

[3] Figure B.1 in the Supplemental Appendix shows the probability that a child born in 2000 ever attended primary school using data from the Lesotho 2006 census. The results are consistent with Figure 1.

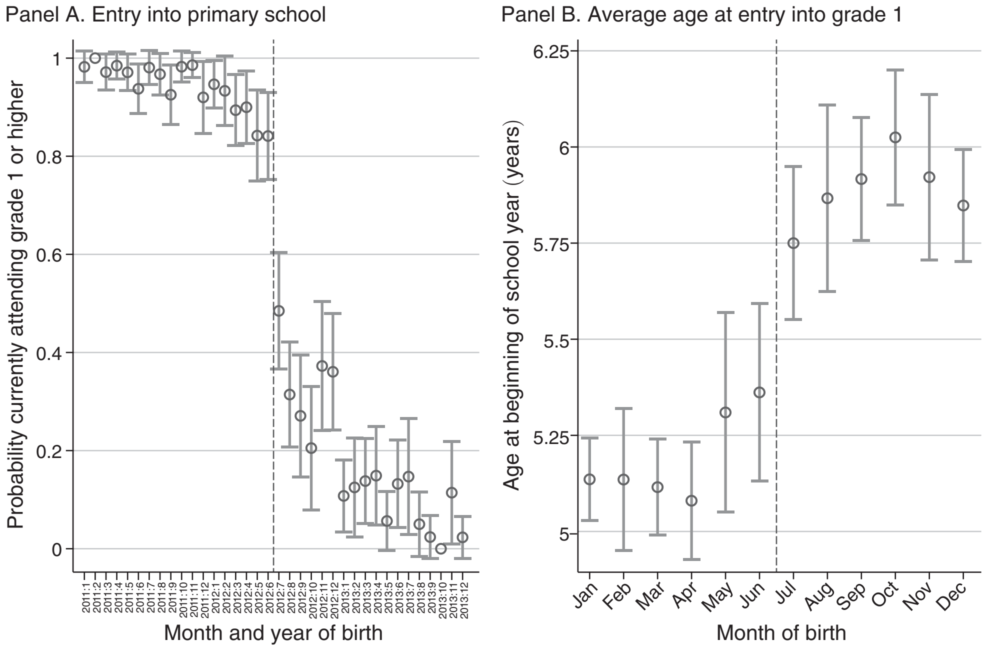

Figure 1. Month of Birth and Entry into Primary School

Notes: Panel A shows the probability of attending grade 1 or higher among children born between January 2011 and December 2013 in the MICS survey (ages 4–7 years at the time of the survey). $N = 2,341$. Panel B shows the average age at the beginning of the school year by month of birth. Age at entry is the age in January, at the start of the school year, for students currently attending grade 1 and who are not repeating a grade. $N = 561$.

Source: Own calculations using the Lesotho 2018 MICS.

0.5 years. Henceforth, we refer to children as "treated" if they were born after the June 30 cutoff and had the option to start school at an older age.

The 2010 policy appears to have codified a long-standing practice. Although detailed historical enrollment data by month of birth is scarce, anecdotal evidence suggests the June cutoff was in place in the late 1980s and 1990s. Using data from the Lesotho 2006 census and Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) 2000 and 2007 Surveys—which were implemented before the 2010 Education Act—we find similar discontinuities in age at school enrollment between June and July as in the 2018 MICS survey (see Supplemental Appendix Figure B.1 and Supplemental Appendix Figure B.2).

The first documented age-of-entry policy was in the 1960 Annual Report of the Director of Education of Basutoland, a British Crown colony from 1884 to 1966 in present-day Lesotho. The report states that children could enter primary school at age five, provided they would turn six in the same academic year. Although no specific date-of-birth cutoff was specified (Basutoland 1960), education data published a few years later in the 1965 Annual Report suggest a mid-year cutoff. The report presents data "as at June 1965" showing the distribution of student ages at each grade level. Supplemental Appendix Figure B.3 shows that, in June 1965, just 2 percent of grade 1 students were under 6 years old; 23 percent were age 6; and 24 percent were

Table 1—Data Sources and Sample Sizes

Survey	Sample description	Observations
Lesotho MICS 2018 household questionnaire	All ages	33,997
Lesotho MICS 2018 child questionnaire	Ages 5–17	4,992
Lesotho census 2006, 10% sample	All ages	180,208
Lesotho DHS 2004–05 women's questionnaire	Ages 15–49	7,095
Lesotho DHS 2009–10 women's questionnaire	Ages 15–49	7,624
Lesotho DHS 2014 women's questionnaire	Ages 15–49	6,621
Lesotho DHS 2004–05 men's questionnaire	Ages 15–59	2,797
Lesotho DHS 2009–10 men's questionnaire	Ages 15–59	3,317
Lesotho DHS 2014 men's questionnaire	Ages 15–59	2,931
Lesotho DHS 2004–05/2009–10/2014 HIV biomarkers	Ages 15–59	18,291
Lesotho SACMEQ 2000 student survey	Grade 6 (ages 10–22)	3,155
Lesotho SACMEQ 2007 student survey	Grade 6 (ages 10–27)	4,240
South Africa census 2001, 10% sample	All ages	3,601,799
South Africa census 2011, 8.5% sample	All ages	4,258,681
South Africa Community Survey 2016, 5.8% sample	All ages	3,193,774

Notes: *N* includes respondents with data on month of birth (unweighted). All surveys are national, population-representative household surveys, except SACMEQ, a nationally representative school-based survey of sixth graders.

age 7, with the remainder ages 8 and older. These data are consistent with a June 30 date-of-birth cutoff, with nearly all students—by June—having already reached their sixth birthday. Over time, the primary school entry threshold appears to have shifted from establishing eligibility for school to mandating enrollment. We assume all Lesotho birth cohorts were exposed to a policy that led children born after June 30 to start school at older ages on average than persons born on or before June 30.

II. Data and Methods

A. *Data*

To determine the effects of school starting age, we leverage data from multiple nationally representative household surveys (Table 1). We use the 2018 Lesotho Multiple Indicator Cluster Survey (MICS 2018) (Bureau of Statistics 2019); all three rounds of the Lesotho Demographic and Health Surveys (DHS 2004–05, DHS 2009–10, and DHS 2014) (ICF 2017); the 10 percent random sample of the Lesotho census 2006 obtained from the Integrated Public Use Microdata Series (IPUMS) (Minnesota Population Center 2019); two rounds of the Southern and Eastern Africa Consortium for Monitoring Educational Quality (SACMEQ) surveys for Lesotho (SACMEQ 2000–2002, 2007); the 10 percent and 8.5 percent random samples of the South African census for 2001 and 2011 obtained from IPUMS; and the 5.8 percent random sample of the South African Community Survey of 2016, also from IPUMS (Minnesota Population Center 2019).

These surveys span different years, cover different age groups, and collect data on different outcomes. All are representative of the Lesotho civilian population, except for the SACMEQ surveys, which only include children attending school, and the South African censuses. By combining these different datasets, we can assess short- and long-run economic, demographic, health, and intergenerational outcomes by month of birth. For all long-run analyses, we limit the sample to ages 18 years or over when most respondents would have had the opportunity to complete their formal schooling. Below, we briefly describe each of these surveys and provide further details on sample sizes and eligibility for all surveys in Table 1. Supplemental Appendix A2 presents detailed descriptions of the data sources.

The MICS 2018 is the largest of the detailed surveys and includes data on schooling, labor market outcomes, marriage, fertility, and child mortality. Further, the MICS collected measurements of foundational mathematics and reading skills for a sample of children ages 5–17 years, randomly selected from each household (Amaro and Mizunoya 2020). MICS also collected information on out-of-school time use (such as herding animals and domestic work) and hazardous working conditions (Khan and Hancioglu 2019). The Lesotho Population and Housing Census of 2006 (10 percent sample) provides information on month of birth, age, school attendance, and years of schooling completed, as well as demographic, economic, and fertility outcomes for adults. DHS 2004–05, DHS 2009–10, and DHS 2014 (Corsi et al. 2012) collect demographic and health indicators, with a focus on sexual and reproductive health. The DHS samples include information on all women aged 15–49 in sampled households and, in half of the households, all men aged 15–59 years who were either permanent residents or visitors. Blood specimens were collected for laboratory testing of HIV, enabling population-representative biomarker-based inferences on HIV infection rates (Asiedu, Asiedu, and Owusu 2012; Sia et al. 2014). The SACMEQ 2000 and 2007 Surveys are national school-based surveys of sixth graders conducted in their penultimate year of primary school (Jopo, Maema, and Ramokoena 2011). The SACMEQ surveys for Lesotho provide data on demographic indicators, time spent at nursery or preschool (years), grade progression, and standardized literacy and numeracy scores among students. The SACMEQ surveys do not include out-of-school youth and include sixth graders regardless of whether they have been held back or skipped a grade.

Each of the surveys described above contains information on the month of birth for all household members (MICS, census) or respondents aged 15–49 years (DHS, women) or 15–59 years (DHS, men). In the census, month 6 (June) was imputed if the month of birth was unknown, so we exclude people born in June in all analyses. The SACMEQ surveys collected data on the exact date of birth for all respondents (i.e., day of birth). Additionally, the MICS and DHS collected information on the exact date of birth of all children of eligible mothers as part of a woman's full birth history, which covers all births, regardless of children's survival status or co-residence with the mother at the time of the survey. Because eligible women in the DHS and MICS are ages 15–49 years, data on exact dates of birth were available for the next generation ages 0–39 years. Data on social and emotional skills were limited across data sources. Other national household surveys were not included because they either did not contain data on the month of birth (e.g., Lesotho census 1996) or were not available to the authors at the time of writing (e.g., Lesotho MICS 1996, Lesotho census 2016, Lesotho DHS 2023–24).

Because of significant out-migration from Lesotho to neighboring South Africa, we additionally utilized data from the 2001 and 2011 South African census, as well as the 2016 South African Community Survey to assess outcomes among the Lesotho-born population residing within South Africa (Minnesota Population Center 2019). The 2001 census was conducted by Statistics South Africa and covered all persons who were present in the country on the night of 9–10 October 2001. People living in households across the country, as well as those in hostels, hotels, hospitals and other types of communal living quarters, including the homeless, were visited (de facto). The 2011 census covered all persons present in the country on the night of 9–10 October 2011. The 2016 South African Community Survey was conducted from March 7 to April 22, 2016, and covered the population residing in private dwellings (de facto). Data on the month of birth and years of schooling completed was available for over 99 percent of eligible respondents, yielding 11,054,254 individuals in the 2001, 2011, and 2016 surveys.

B. *Empirical Strategy*

Base Specification.—We employ a regression discontinuity design (RDD) to assess discontinuities in outcomes between children born just before versus just after the June 30 enrollment cutoff. Our base specification is the standard linear regression discontinuity model shown in equation (1), where we fit separate linear terms to the six-month periods on either side of the cutoff and estimate the difference at the threshold (β_2) (Hahn, Todd, and Van der Klaauw 2001).

$$(1) \qquad E\left[Y_i | MOB_i\right] = \beta_0 + \beta_1\left(MOB_i\right) + \beta_2 \times 1 \cdot \left[MOB_i \geq July\right] + \beta_3\left(MOB_i\right) \times 1 \cdot \left[MOB_i \geq July\right].$$

In equation (1), Y_i is the outcome of interest and MOB_i is month of birth centered as $MOB_i - 6.5$ (Hahn, Todd, and Van der Klaauw 2001; Calonico et al. 2017).

Most of our data do not contain exact dates of birth; hence we use month of birth as the assignment variable. The discrete nature of the assignment variable and limited support (+/− six months) on either side of the cutoff in our analyses of birth month renders moot any computation of optimal bandwidth. However, we explore generalizability to different bandwidths.

Support for Identifying Assumptions.—Causal inferences on an exposure assigned at age five based on the month of birth could be undermined by selection based on parental characteristics, manipulation of birth dates, and/or early-life exposures. For example, prior evidence suggests that different types of parents have children at different times of the year, and these parental characteristics may shape child development (Buckles and Hungerman 2013). Sophisticated parents may even plan the timing of conception or birth based on school enrollment cutoffs (Shigeoka 2015). Although births are recorded in a national registry, it is also conceivable that parents

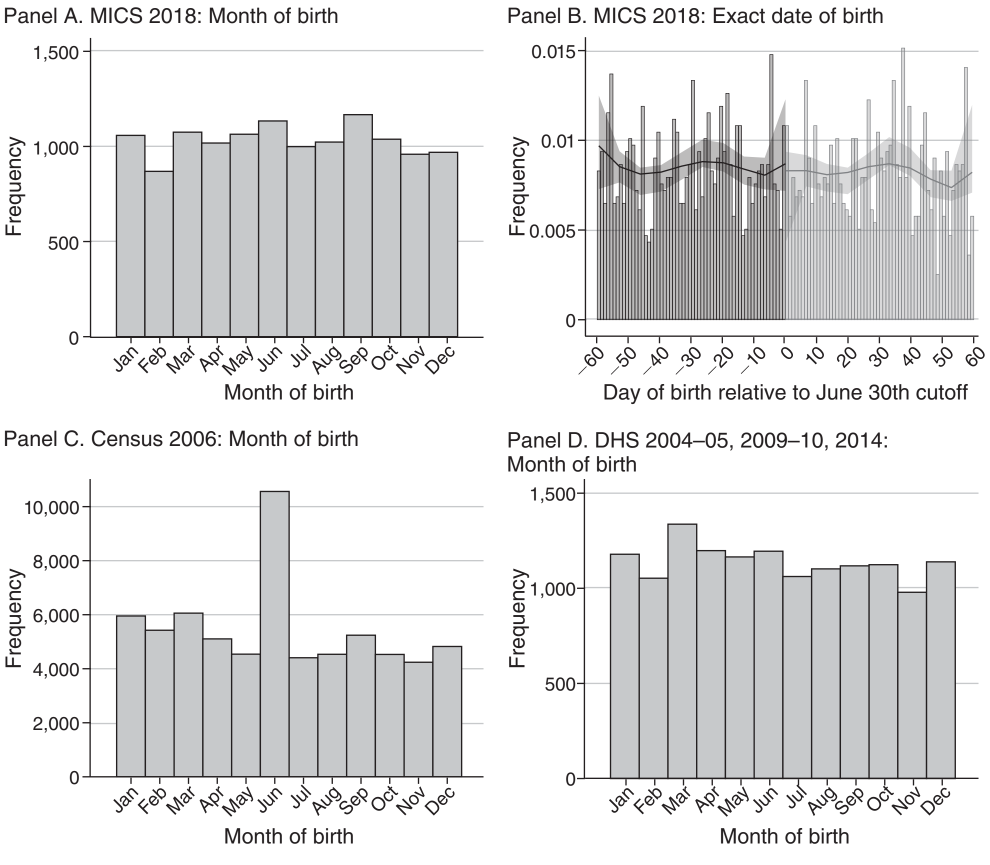

Figure 2. Date-of-Birth Distribution in Different Surveys

Notes: Distributions of (panel A) month of birth among MICS 2018 household respondents age 15 years or less; (panel B) exact day of birth among children of eligible mothers in the MICS 2018 (60 days +/− relative to the June 30 cutoff) and density test; (panel C) month of birth among respondents ages 15 years or less in the 2006 census; and (panel D) month of birth among eligible respondents ages 15–35 years in the DHS 2004–05, 2009–10, and 2014. In the census there is substantial excess mass at June due to mid-year imputation when the month of birth is not known. Based on these findings, we exclude people born in June from all analyses of census data.

Source: Own representation using Lesotho MICS, DHS, and census datasets.

could manipulate or misreport birth dates. Early exposure to seasonal shocks may also play a role. For example, seasonal variation in nutrient availability due to harvest times or seasonal infectious diseases can affect fetal development (Almond and Currie 2011).

To rule out selection and manipulation of birth dates, we plot histograms of the month of birth for each dataset and assess continuity in the density of birth dates across the threshold (McCrary 2008). Figure 2 shows histograms of month-of-birth for the different surveys and the McCrary test for exact date-of-birth in the MICS 2018 full birth history. We observe no evidence of bunching at the threshold in the DHS and MICS. In the census data, there is substantial excess mass in June due to mid-year imputation when the month of birth is not known. Mid-year imputation increases with age in the census data.

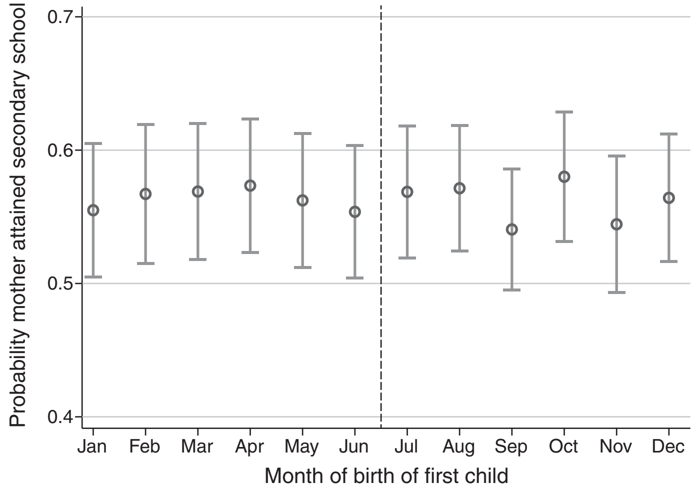

Figure 3. Continuity in Pre-treatment Characteristics: Maternal Education

Notes: The figure shows the probability of maternal secondary school attainment ($1 = yes$; $0 = otherwise$) by month of birth of the mother's first-born child. The sample includes all first-born children of eligible mothers in the MICS. $N = 4,489$.

Source: Own representation using Lesotho MICS 2018 data.

To rule out selection in the timing of conception, we assess for balance at the threshold in parental characteristics. To rule out confounding by early life exposures, we assess for balance in health outcomes for children under five years and household characteristics among children born in different months. Supplemental Appendix Tables B.1 and B.2 report regression results for these placebo tests. We find no differences in children's birth order, birth weight, measured anemia, reported cough, measured stunting (low height-for-age), and measured underweight (low weight-for-height). We additionally find no differences in mother's education, wealth of the child's household, or place of birth for respondents born on either side of the threshold. Finally, we find no differences in measured adult height. Nongenetic variation in height is highly influenced by early childhood nutrition and illness; but these effects are largely determined by age 2 (Perkins et al. 2016). Figure 3 shows the binned scatter plot for maternal education by children's month of birth. Supplemental Appendix Figures B.4 and B.5 show binned scatter plots for children's health outcomes and measured adult height.

These findings support the validity of our identification strategy. Children born in June versus July have similar parents, grew up in similar households, and have similar early childhood health and anthropometric measurements. In fact, they look quite similar on all assessed measures—until they start primary school.

Interpretation of Causal Estimands.—For all analyses, we report reduced form (intention-to-treat) effects of starting school at an older age due to being born after versus before the school entry cutoff. As described above, the date-of-birth cutoff increased the age at school entry by about 0.5 years for children born in July (versus

June). Under additional assumptions of monotonicity and excludability, the reader can multiply our reduced form estimates by two to get the local average treatment effect of starting school at an older age. Monotonicity would imply that no child born in June who did not enroll (despite eligibility) in school would have enrolled in school if born in July (and not eligible). Excludability implies that being born in July (versus June) only affects later outcomes through the option to defer entry into primary school by one year (and downstream effects thereof). Unfortunately, we cannot directly estimate the first stage (i.e., age at entry) for all birth cohorts due to data limitations. Nonetheless, the first stage in 2006 (Supplemental Appendix Figure B.1) is similar to that in 2018 (Figure 1).

We note that the variation in school starting age induced by the enrollment threshold is "local" to a particular population: children whose caregivers would choose to defer primary school enrollment if they were not compelled to enroll. This population is likely to have larger expected benefits of starting school at an older age and to be lower in the distribution of school readiness (conditional on age). Features such as early life cognitive and socioemotional development, while unobserved in available data, may be partially observable to caregivers, and caregivers may act on this information. Thus, the effects estimated in this study may be larger than the effects of starting school at an older age for children whose caregivers would choose to enroll them early (Ricks 2024). We caution against generalizing beyond the population whose enrollment decisions were affected by the policy threshold.

The persistence of Lesotho's school eligibility cutoff implies that we can estimate the impacts of being born just after (in July) versus just before (in June) the cutoff on outcomes for children, adolescents, adults, and the next generation. Under additional assumptions, we can interpret our findings for short and long-term outcomes as reflecting human capital trajectories in a synthetic cohort. This interpretation relies on the assumption that the experiences of a person at older ages in the survey are similar to what can be expected of a person at younger ages when they reach that age. This assumption, analogous to that of period life expectancy calculations, is strong but enables a compelling view of life trajectories. We provide support for a synthetic cohort interpretation by replicating our main findings for educational attainment in an actual (i.e., not synthetic) population birth cohort born 1995–1999, which we observe longitudinally from ages 7 to 24 years via repeated cross-sections in the 2006 census, 2014 DHS, and 2018 MICS.

III. Results

Our findings are organized as follows. Section IIIA presents evidence on the effects of age at school entry on progression through school and total years of schooling completed. We show a reversal of fortunes: Children born just after the enrollment cutoff have an initial disadvantage in educational attainment. However, this disadvantage disappears and reverses as they progress through schooling. Section IIIB presents the long-run impacts of age at school entry on economic, demographic, health, and intergenerational outcomes. Section IIIC presents the heterogeneous effects of age at school entry by gender and birth cohort. Section IIID

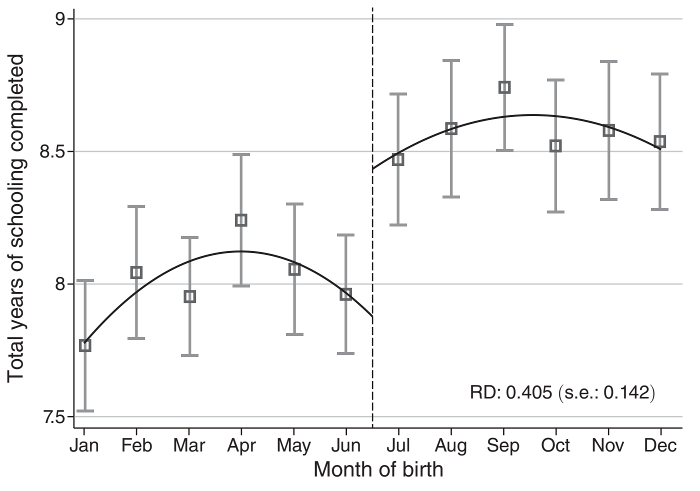

Figure 4. Total Years of Schooling Completed by Month of Birth

Notes: Figure shows total years of schooling completed by month of birth. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age and gender to reduce residual variance. Additional information on specifications used in RD models and regression output is shown in Supplemental Appendix Table B.3. The sample includes all ages 18–35 years from the MICS 2018. $N = 10{,}073$.

Source: Own representation using the Lesotho MICS 2018.

presents evidence on potential mechanisms, including measured literacy and numeracy skills and opportunity costs to schooling.

A. *Educational Attainment*

Thus far, we have shown that people born in July (versus June) are more likely to enter primary school at an older age. The difference in age at school entry results from the June 30 enrollment cutoff and is not associated with parental, household, and early-childhood characteristics. What is the impact of school starting age on schooling outcomes?

Figure 4 shows a binned scatter plot of total years of schooling completed by month of birth. People born in July complete greater total years of schooling than people born in June. The difference in total years of schooling at the threshold is about 0.5 years, consistent with the regression results shown in Supplemental Appendix Table B.3. Being born in July (versus June) increases educational attainment by 0.41 years in our preferred specification, controlling for gender and age indicators.[4] This effect size is a 5 percent increase in average years of schooling (8.1 years). Our estimate of the positive effect of starting school at an older age on educational attainment in Lesotho is much larger than most prior estimates, including studies in the United States (Angrist

[4] Supplemental Appendix Table B.3 shows regression results from specifications adding different controls. In all cases, the point estimate is between 0.41 and 0.56 years and is highly statistically significant.

and Krueger 1992; Dobkin and Ferreira 2010; McCrary and Royer 2011; Arnold and Depew 2018), where estimated effects were negative. In Supplemental Appendix Figure B.6, we plot effect sizes for total years of schooling in several studies against log-GDP per capita of the country or state where the study took place. We find an inverse relationship between income levels and reported effect size although variation around this curve suggests that policies can attenuate this effect.

We conducted extensive sensitivity analyses to assess the robustness of our results. Supplemental Appendix Table B.4 confirms that these results are robust to (i) smaller bandwidths around the threshold (see also Supplemental Appendix Table B.5), (ii) excluding months of June and July (i.e., one-month donut RDD), and (iii) clustering standard errors by month of birth. Supplemental Appendix Table B.6 further confirms that our results are also robust to adding household fixed effects to our base specification, eliminating any potential between-household confounders. Supplemental Appendix Figure B.7 displays the RDD plots based on continuous day of birth (as opposed to month of birth) for the MICS birth history subsample. These results are qualitatively similar to those in Figure 1 and Figure 4, further supporting our interpretation of our month-of-birth estimates as causal. We also show estimates of the impact of being born after the June 30 cutoff on various measures related to migration between Lesotho and South Africa. We find no significant effect on any of the migration indicators. These results suggest that it is unlikely that migration patterns between Lesotho and South Africa materially bias our other results (Supplemental Appendix Table B.7).

People born in July (versus June) complete more total years of schooling despite starting school later and having fewer potential years of education before the end of compulsory schooling (age 13). Figure 5 shows the "reversal" of an early disadvantage for children born after the June 30 cutoff. At ages 5–11 years, children born in July have attained fewer years of schooling than children born in June. However, this pattern flips for older children, with an advantage in total years of schooling apparent by age 16 and above. Supplemental Appendix Figure B.9 confirms that this result is not due to cohort differences, as the reversal of fortunes is observed even when we follow a specific birth cohort over time.

When do July-born children (who entered school at an older age) catch up with children who were born in June and compelled to start school at a younger age? Supplemental Appendix Figure B.8, panel A shows the share of students leaving school after each grade. Children born January–June are about twice as likely to leave school after grades 2–5 than children born July–December, but the absolute differences are small. Most early school leaving—regardless of the month of birth—occurs after completion of primary school and during secondary school. The largest difference in dropout between January–June and July–December-born children occurs after grade 10 when students transition from junior to senior secondary school. Relative to junior secondary schools, there are fewer senior secondary schools, with fewer total seats, and greater costs to attend.

Supplemental Appendix Figure B.8, panel B shows the share of students who leave school or repeat a grade by age. Children born July–December are just as likely as those born January–June to be in their age-appropriate grade up to age 12; however, starting at age 13, they are about 8 percentage points less likely to be

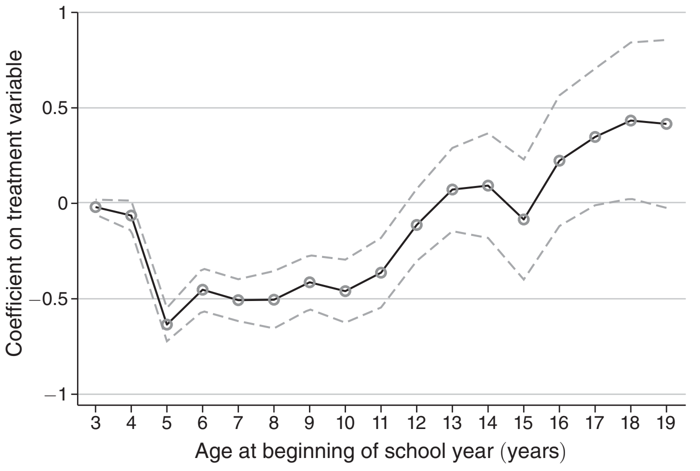

Figure 5. Reversal of Early Disadvantage for Cohorts Born July–December

Notes: The figure shows the difference in highest year of schooling and the 95 percent CI attended for people born July–December versus January–June. Differences are estimated separately at each age. The early advantage in years of schooling for people born January–June due to their earlier eligibility disappears by ages 12–15 and is reversed by ages 16–19. The sample includes all children aged 3–19 years, regardless of whether they are in school or not at the time of the survey. Age at the beginning of the school year does not imply that children are in school. $N = 13,173$.

Source: Own representation using Lesotho MICS 2018.

held back a grade or leave school early. These differentials open up before grade 10 (when children would be expected to be 15–16 years old), suggesting that children born January–June are first being held back in junior secondary school before they finally leave school.

In Figure 6, we show the distributional effects of age at school entry on total years of schooling completed. Increases in educational attainment among children who started school a year older occur at all levels (years) of schooling, consistent with the monotonicity assumption. The largest absolute effects are observed on the middle of the education distribution leading to a large increase in the probability of having completed at least 7, 8, 9, or 10 years of schooling. Differences in the probability of completing fewer than five years or more than 12 years were smaller. These distributional effects are consistent with observed patterns of grade repetition and dropout, which accumulate during early adolescence. They are also consistent with our hypothesis that the enrollment policy may have little effect for children who are high in the skill distribution and who would be enrolled at age five regardless of their date of birth.

Starting primary school a year older results not just in additional years of schooling, but also in skill advantages in adulthood. Figure 7 presents the effects of age at school entry on literacy in Sesotho or English, as well as information, communications, and technology skills using multiple surveys. Adults born just after the school entry cutoff (who started school at an older age) are 1.7 to 3.9 percentage points more likely to be able to read a sentence in Sesotho or English or read newspapers and magazines than those born just before the cutoff. Moreover, adults born

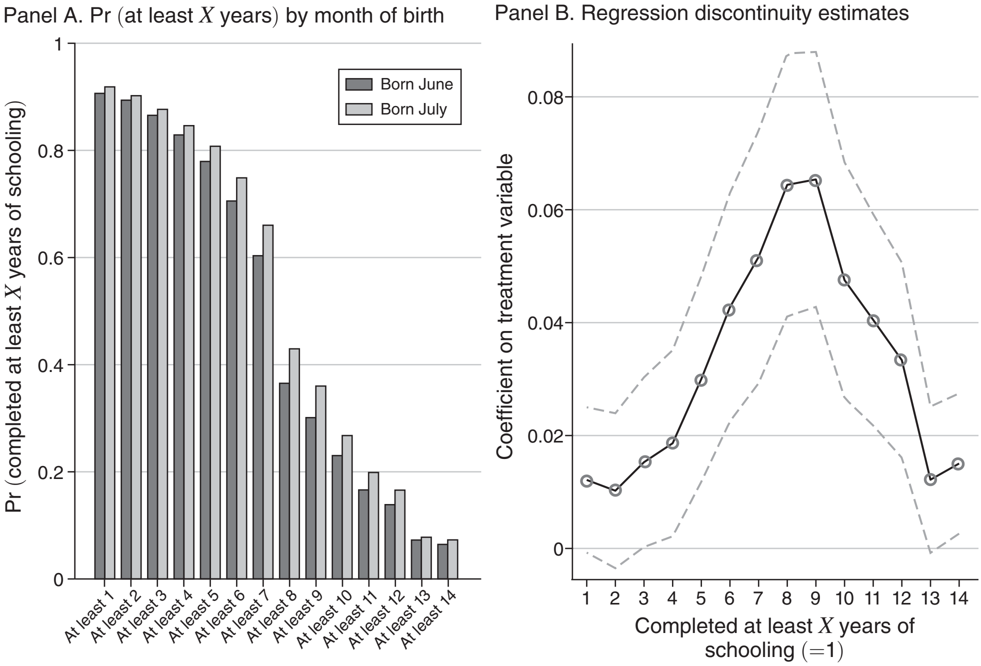

Figure 6. Effect of School-Entry Age on Having Completed at Least X Years of Schooling

Notes: Panel A shows descriptive means for having completed at least X years of schooling, separately for respondents who are born either in June or July. Panel B shows coefficients and 95 percent CIs from regression discontinuity models for the effect of school-entry age (being born July–December) on an indicator for having completed at least X years of schooling, estimated separately for having completed at least 1, 2, … , or 14 years of schooling. All models control for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, indicators for age, an indicator for gender, and an indicator for survey year. Sample included all respondents ages 25–49 years. This sample is restricted to ages 25 years or more so that they have the opportunity to complete higher education. Schooling is defined as total number of years completed. $N = 26{,}337$.

Source: Own representation using pooled data from the Lesotho MICS 2018 and DHS 2004–05, 2009–10, and 2014.

just after the cutoff are 2.3 percentage points more likely to report using computers. Schooling advantages associated with starting school at an older age lead to measurable differences in human capital acquisition, which likely shape economic productivity and long-run outcomes.

B. *Long-Run and Intergenerational Outcomes*

Lesotho's enrollment threshold induced an exogenous shock to education-related human capital acquisition through its effect on age at school entry. Children born after the June 30 cutoff enter primary school at an older age. Despite an initial education disadvantage, students who entered relatively older go on to complete more years of schooling and manifest higher literacy and computing skills. What are the long-run effects of school starting age on economic, demographic, and health outcomes in this context? We first present evidence on the long-term effects of age

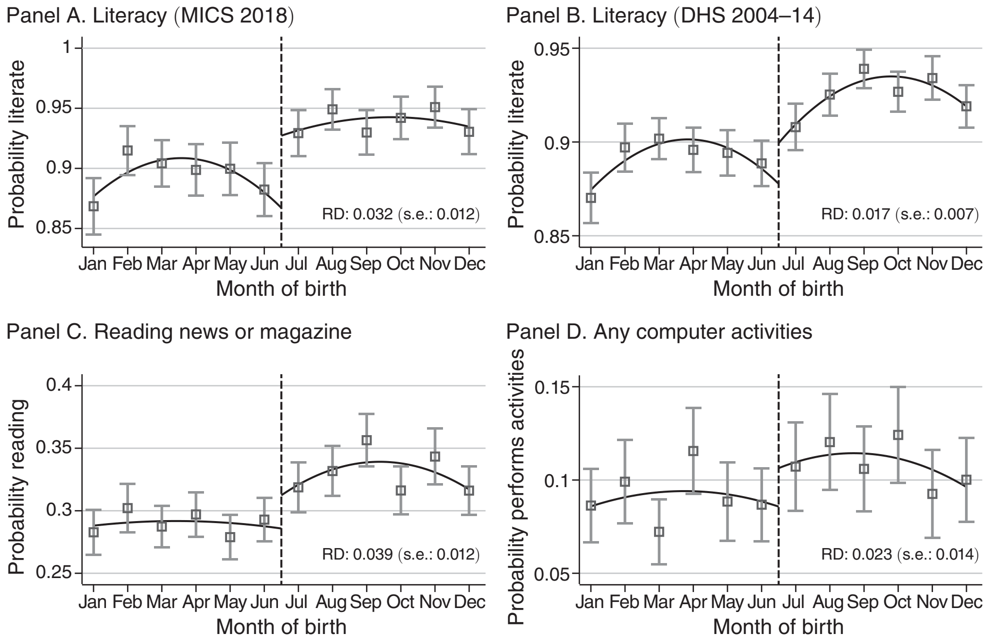

FIGURE 7. LITERACY AND ICT SKILLS IN ADULTHOOD BY MONTH OF BIRTH

Notes: Figure shows adult skills by month of birth. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age and gender to reduce residual variance. Additionally, we add indicators for survey year when using DHS data (panels B and C). Additional information on specifications used in RD models and regression output is shown in Table B.8 in the Supplemental Appendix. Sample includes all respondents ages 18–49 years old in the Lesotho MICS 2018 (panels A and D) or DHS 2004–05, 2009–10, and 2014 (panels B and C).

Source: Own representation using the Lesotho MICS 2018 and DHS 2004–05, 2009–10, and 2014 data.

at school entry on labor market outcomes and household wealth. We then present the long-term effects on family formation (fertility and marital status) and HIV infection. Last, we show the intergenerational effects on child survival. The results presented below are robust to smaller bandwidths (see Supplemental Appendix Table B.5) and migration (see Supplemental Appendix Table B.7).

Labor Market Outcomes and Household Wealth.—Figure 8 shows the effect of being born just after the June 30 cutoff on labor market outcomes among adults—i.e., being employed in the past 12 months, being in agricultural or manual labor, being in a "high-class" occupation—and on household wealth in the DHS data. We do not find any significant effects on labor force participation. Being born just after the cutoff has a positive but statistically insignificant effect on the chances of being employed in the past 12 months (panel A) and a negative but statistically insignificant effect on being an agricultural or manual laborer (panel B). However, we find a larger and statistically significant 1.8 percentage point increase in employment in

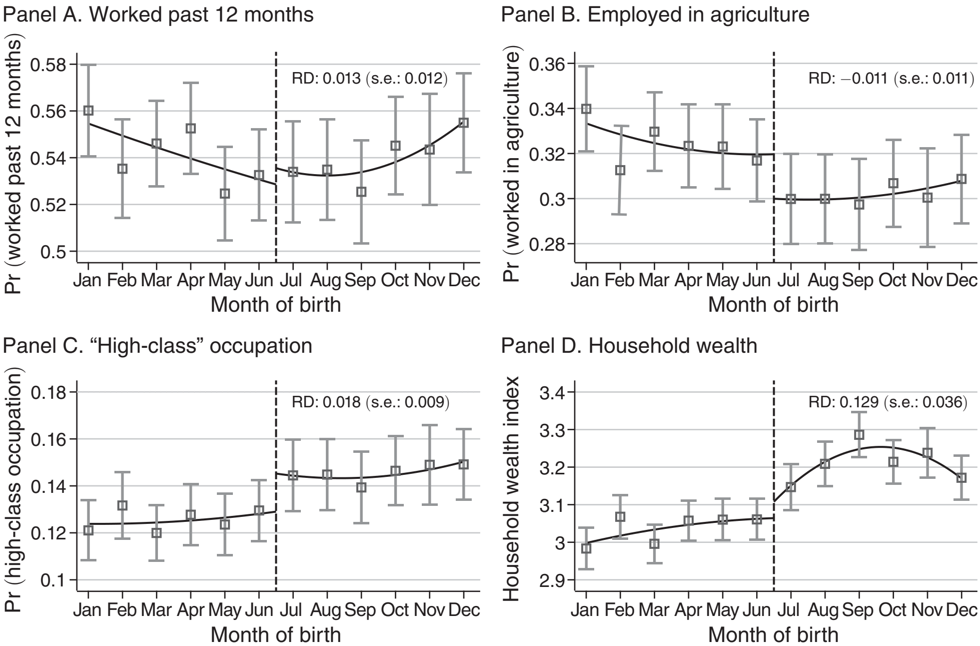

Figure 8. Labor Market Outcomes and Household Wealth by Month of Birth

Notes: Figure shows adult labor market outcomes and household wealth by month of birth. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age, gender, and survey year to reduce residual variance. Additional information on specifications used in RD models and regression output is shown in Tables B.9 and B.10 in the Supplemental Appendix. In the DHS, "high-class" occupations are legislators, managers, professional/technical/managerial, clerical, and salespersons. The DHS-provided wealth index is a composite measure of a household's cumulative living standard, categorizing households into quintiles ($1 = \textit{poorest}, 5 = \textit{richest}$). The index is calculated using data on a household's ownership of assets, such as televisions, bicycles, and cars; dwelling characteristics, such as flooring material; type of drinking water source; and toilet and sanitation facilities. The sample includes all respondents ages 18–59 years. $N = 25{,}840$.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, and 2014 data.

a "high-class" primary occupation, such as professional or managerial occupations (panel C). Relative to a baseline of just 12.7 percent, this reflects a 14.2 percent increase in the likelihood of being in such an occupation. Supplemental Appendix Table B.9 shows results using the census data.

Figure 8, panel D shows the effect of being born after the cutoff on household wealth. Being born just after the cutoff is associated with a statistically significant 0.13 units increase in the DHS-provided household wealth index quintile. "Higher-class" occupations attract higher earnings, which enable those born after the cutoff point to accumulate more wealth. Taken together, the labor and asset findings illustrate that being born just after (versus just before) the threshold is associated with higher probabilities of having a high-paying job and the modern trappings it enables. These results are consistent with previous evidence that age at school entry increases earnings in Mexico (Peña 2017) and among Swedish residents

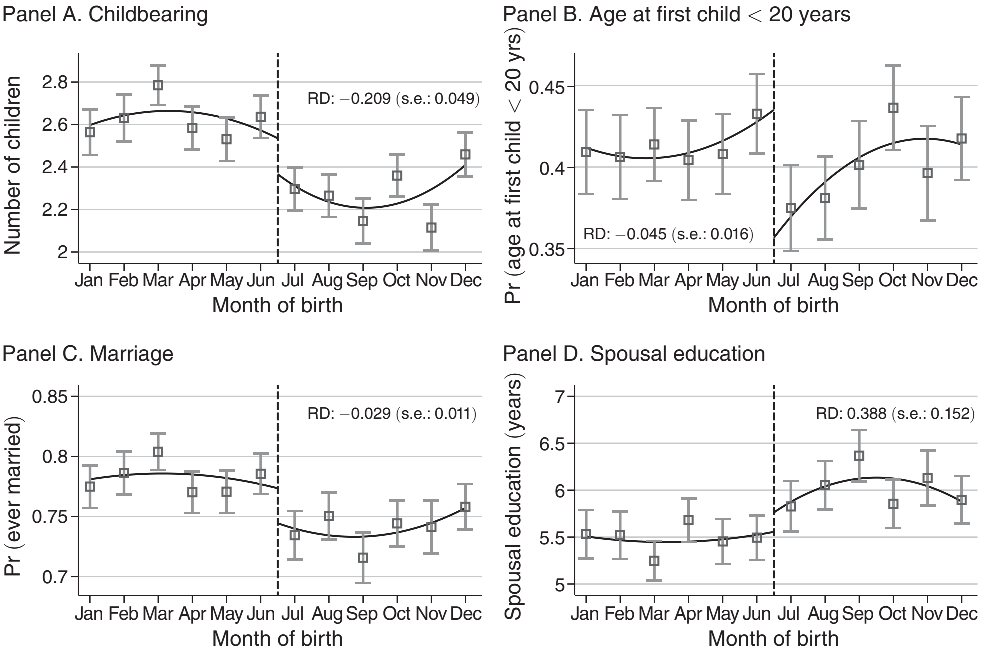

Figure 9. Fertility, Marriage, and Spousal Education by Month of Birth

Notes: Figure shows adult childbearing, marriage, and spousal educational attainment by month of birth. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age, gender, and survey year to reduce residual variance. Additional information on specifications used in RD models and regression output is shown in Tables B.11 and B.12 in the Supplemental Appendix. Panels A, B, and D include all women ages 20–49 years, and panel C includes all respondents ages 20–49 years (both genders). $N = 22{,}027$.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, and 2014 data.

with low-educated parents (Fredriksson and Öckert 2014), but run counter to other studies (e.g., Dobkin and Ferreira 2010; Black, Devereux, and Salvanes 2011; and Oosterbeek, ter Meulen, and van Der Klaauw 2021) that find negative or zero effects in higher-income populations.

Fertility and Marital Outcomes.—Education has implications for family formation. Figure 9, panels A–C show the results for age at school entry on fertility, teen childbearing, and marital status. Panel A shows that being born after the cutoff is associated with a 0.21 (or 8 percent) reduction in the total number of children ever born, off the baseline of 2.6. Being born after the cutoff is also associated with a 4.5 percentage points (or 11 percent) reduction in teen childbearing, off a baseline of 42.1 percent (panel B). Further, panel C of the figure shows that people born after the June 30 cutoff are 2.9 percentage points (or 3.7 percent) less likely to have ever been married in the DHS, off a baseline of 77.7 percent. This shift is due entirely to a reduction in early marriage, with a 3.3 percentage point (or 14 percent) reduction in marriage before age 18 years, from a baseline of 23.1 percent (see Supplemental Appendix Table B.12). These findings are consistent with some prior evidence that older age at school entry delays marriage and childbearing (Black, Devereux, and Salvanes 2011; Caudillo 2019; Johansen 2021; Borra, González, and Patiño 2024).

We also show in Figure 9, panel D and Supplemental Appendix Table B.12 that not only do respondents born after the cutoff have higher educational attainment, but they are also more likely to marry spouses with higher education levels, consistent with assortative mating (Schwartz 2013). The benefits of increased spousal education and income likely contribute to the large increases in modern household assets reported above.

HIV Infection.—Education is an established determinant of health and health behaviors, including risk factors for HIV infection (Alsan and Cutler 2013; De Neve et al. 2015). While available national datasets contain a limited set of adult health indicators, the DHS surveys do collect biomarkers for HIV, a leading cause of morbidity and mortality in Lesotho.

Supplemental Appendix Table B.13 reports the effect of age at school entry on HIV status for both genders. Because only a very small number of people in the samples would have acquired HIV due to perinatal exposure, we can interpret differences in HIV prevalence in adulthood as differences in cumulative incidence occurring after the exposure of interest, i.e., age at entry into primary school. Overall, we find that school-starting age does not affect the acquisition of HIV. Later on, we present results disaggregated by gender.

Intergenerational Effects on Child Survival.—Education has cross-generational effects. Parental education may improve child health and survival (Andriano and Monden 2019) through its effect on parental health behaviors (e.g., hand washing, nutrition, vaccination, health services utilization), early childhood anthropometric measurements, and exposure to environmental stressors (Grépin and Bharadwaj 2015). Therefore, in addition to its direct effect on parental education, we can expect age at school entry to have a knock-on effect on the health and survival of their children (Meng 2023). In this subsection, we examine the intergenerational effects of mothers' age at school entry on child survival. We focus on maternal education because we lack complete birth histories for fathers.

Figure 10 shows results for the effect of maternal age at school entry on the survival (panels A and D) or mortality (panels B and C) of her children. The probability of child survival increases by between 1.1 percentage points (or 1.2 percent off the baseline of 89.6 percent) in the DHS and 2.3 percentage points (or 2.5 percent off the baseline of 90.1 percent) in the MICS for mothers born after the June 30 cutoff (panels A and D). Mothers born after the cutoff experience 0.045 fewer deaths among their children (panel B) and are 3.9 percentage points less likely to experience the death of any child (panel C). Given the baseline child mortality prevalence of 19.2 percent, this represents a 20 percent decline in the probability of experiencing the death of a child. The impacts on lifetime prevalence of offspring mortality among mothers could be a result of several factors. First, mothers who started school at an older age have a lower risk of adolescent pregnancy. Teenage

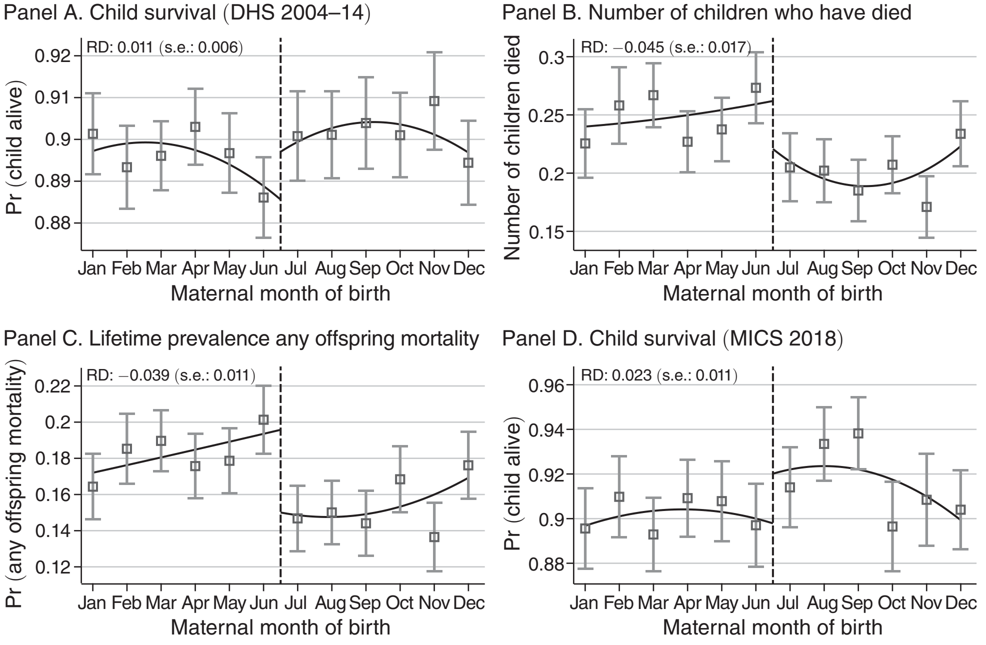

FIGURE 10. INTERGENERATIONAL EFFECTS ON CHILD SURVIVAL BY MATERNAL MONTH OF BIRTH

Notes: Figure shows child survival, number of children who have died, and maternal lifetime prevalence of any offspring mortality by month of birth. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show point regression estimates and standard errors (s.e.) from linear RD models when controlling for maternal month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, indicators for children's age (panels A and D) and maternal age (panels B and C), children's gender (panels A and D), and indicators for survey year (panels A, B, and C) to reduce residual variance. Additional information on specifications used in RD models and regression output is shown in Supplemental Appendix Table B.15. Panels A and D include all children ages 0–39 years born to eligible mothers using the mother's full birth history in the DHS 2004–05, 2009–10, 2014, and MICS 2018. Panels B and C include all women aged 18–49 years in the DHS 2004–05, 2009–10, 2014.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, 2014, and MICS 2018 data.

motherhood is associated with higher likelihood of eclampsia, systemic infections, anemia, and adverse birth outcomes (younger mother at birth). Second, mothers who started school at an older age have, on average, fewer kids (lower total number of children). Third, children born to mothers who started school at an older age have higher survival, which may reflect differences in health investments or exposures.

These effects are large. Previous work by McCrary and Royer (2011) finds zero effects of a mother's age at school entry on child health in the United States, while Meng (2023) reports that, in China, a mother's age at school entry improves birth weight and reduces the number of times the child is sick. On the contrary, Borra, González, and Patiño (2024) report that mothers' school-starting age in Spain reduces infants' birth weight.

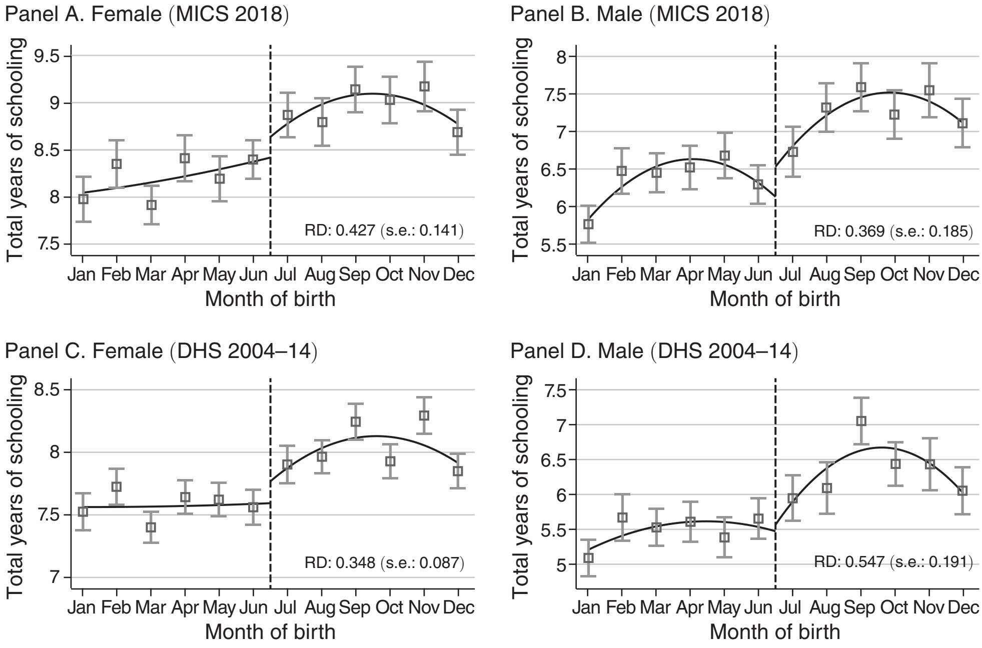

Figure 11. Total Years of Schooling Completed by Month of Birth and Gender

Notes: Figure shows total years of schooling completed by month of birth, separately by gender and data source. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age to reduce residual variance. Additionally, we add indicators for survey year when using DHS data (panels C–D). Panels A and B include all respondents ages 18–59 years old from the Lesotho MICS 2018, whereas panels C and D include all respondents ages 18–59 years in the Lesotho DHS 2004–05, 2009–10, and 2014.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, 2014 and MICS 2018 data.

C. *Heterogeneity*

Looking at the entire sample may mask important differences among children from different groups. For example, age at school entry might affect girls more than boys or vice versa, which might call for different policy responses. In this section, we examine the effect of age at school entry on short- and long-run outcomes by gender and cohort (i.e., young versus old cohort). Some prior studies find that age-at-entry effects vary by gender (Black, Devereux, and Salvanes 2011; Fredriksson and Öckert 2014).

Differences by Gender.—Figure 11 presents the effect of age at school entry on total years of schooling when stratifying the sample by gender. Being born after the June 30 cutoff is consistently associated with more total schooling in adulthood across all sub-populations. The school-entry age policy affects both genders. In the latest survey, the 2018 MICS, the effects of age at school entry are similar for females (0.43 additional years of schooling) and males (0.37 years). We also

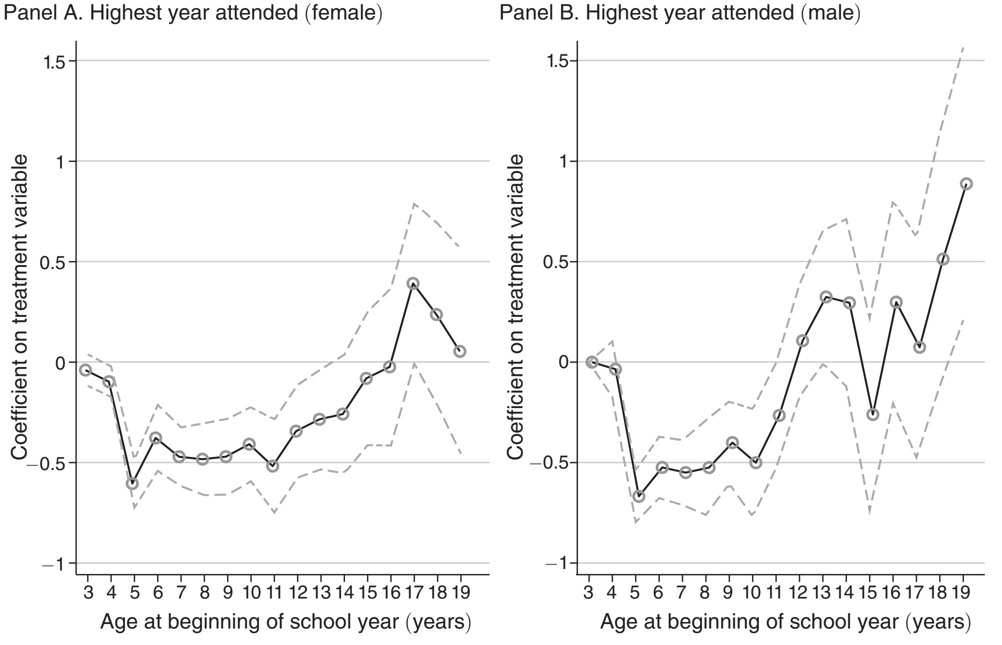

Figure 12. Reversal of Early Disadvantage for Cohorts Born July–December by Gender

Notes: The figure shows the difference in the highest year of schooling attended and the 95 percent CI for people born July–December versus January–June. Differences are estimated separately at each age and gender. The early disadvantage in highest year of schooling attended for people born in July–December due to their later eligibility disappears by ages 12–15 and reverses by ages 16–19, particularly among young men. The sample includes all children aged 3–19 years, regardless of whether they are in school or not at the time of the survey. Age at the beginning of the school year does not imply that children are in school. $N = 13{,}173$.

Source: Own representation using Lesotho MICS 2018.

investigate whether the reversal of the early disadvantage for children who started school at an older age differs by gender. Figure 12 shows that the catch-up and reversal of fortunes happen more slowly for females (by age 16, panel A), while it happens earlier for males (by age 12, panel B). Boys may face greater opportunity costs at younger ages, for example, which we discuss in more detail below. The dip in males' educational advantage observed at age 15 likely reflects the fact that, in Lesotho, most boys at this age attend "initiation schools"—a cultural rite of passage into manhood—at the expense of their formal education (Gebre et al. 2023).

Figure 13 presents the effect of age at school entry on labor market outcomes and household wealth position, separately by gender. There are few discernible gender differences in the probability of having worked in the past 12 months and that of being employed in agriculture (panels A–D). Some prior studies find significant differences in labor force participation effects by gender (Guo, Wang, and Meng 2023). Age-at-school-entry effects on occupation and household wealth appear more pronounced and statistically significant among the female subsample (panels E–H). For example, being born in July–December increases the probability of being in "high-class" occupations by 2 percentage points and increases the wealth index by

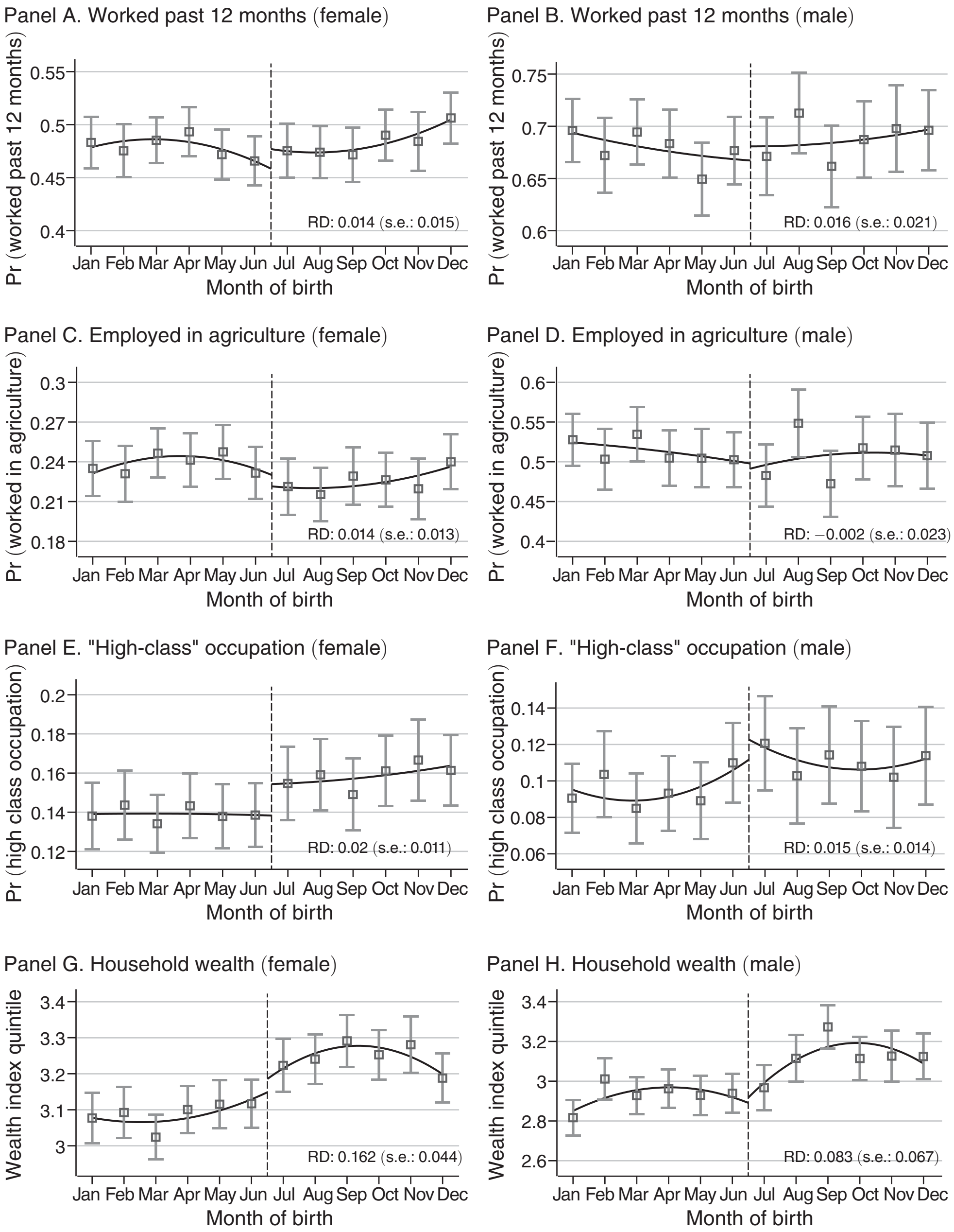

FIGURE 13. LABOR MARKET OUTCOMES AND HOUSEHOLD WEALTH BY MONTH OF BIRTH AND GENDER

Notes: "High-class" occupations are legislators, managers, professional/technical/managerial, clerical, and salespersons. The DHS-provided wealth index is a composite measure of a household's cumulative living standard, categorizing households into quintiles ($1 = poorest$, $5 = richest$). We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models, controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age to reduce residual variance. Sample includes all respondents aged 18–59 years. $N = 25,840$.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, and 2014 data.

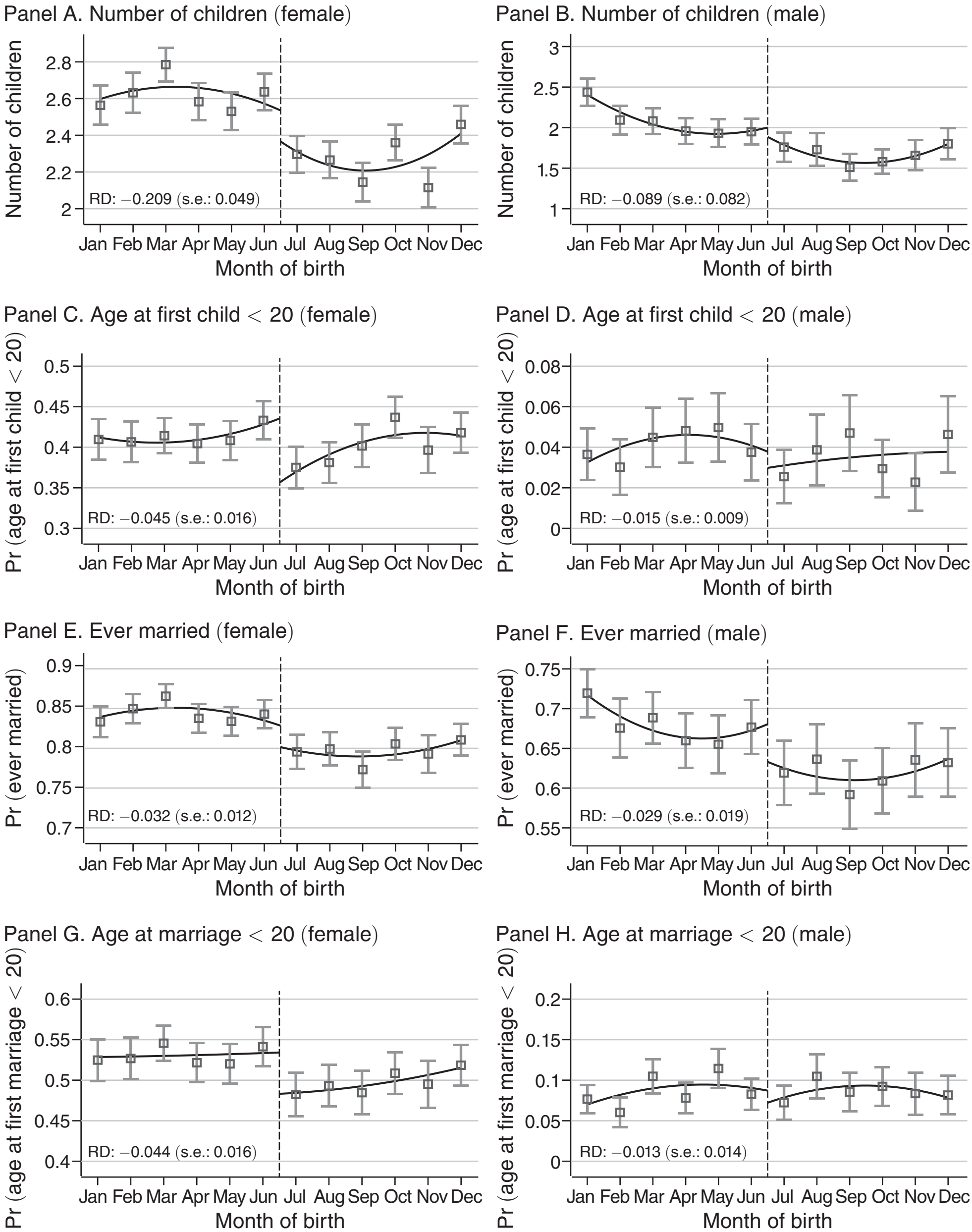

Figure 14. Fertility and Marriage by Month of Birth and Gender

Notes: Panels A and B show the total number of children. Panels C and D show the probability of having a child before age 20. Panels E and F show the probability of ever having married. Panels G and H show the probability of having married before age 20. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models, controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age to reduce residual variance. Sample includes all respondents aged 20–59 years. $N = 30,383$.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, and 2014 data.

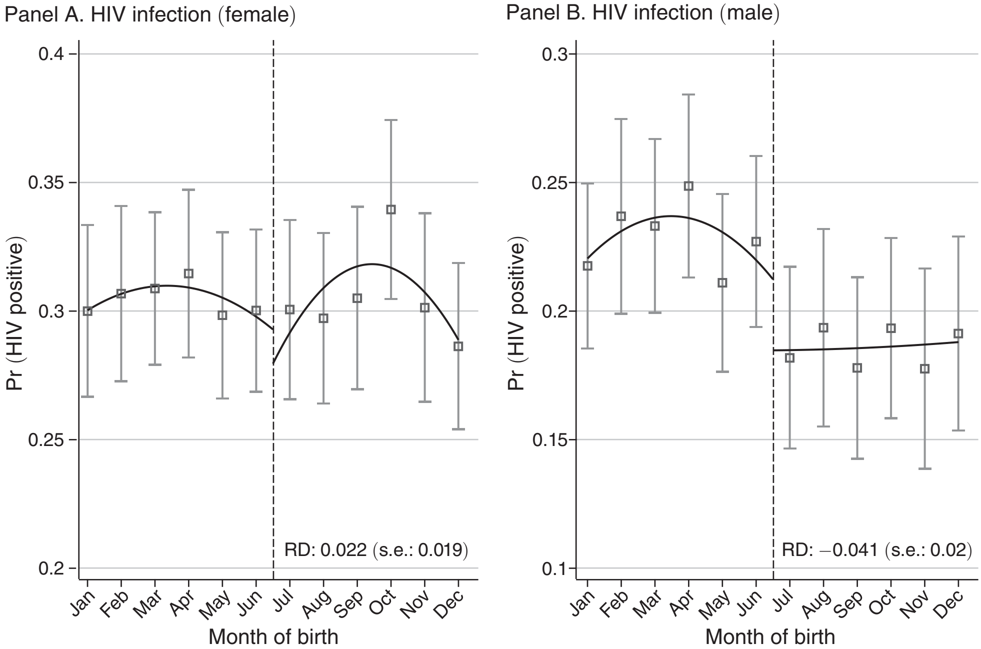

Figure 15. HIV Infection by Month of Birth and Gender

Notes: Panels A and B show the probability of testing HIV positive, separately for women and men, respectively. Sample includes respondents aged 18–49 years. We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models, controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age and survey year to reduce residual variance. Additional information on specifications used in RD models and regression output is shown in Supplemental Appendix Table B.13. $N = 14{,}596$.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, and 2014 data.

0.16 units among women. While the association in both cases is also positive in the male subsample, it is not statistically significant.

Figure 14 shows the effect of age at school entry on family formation, separately by gender. Being born just after the school entry cutoff leads to 0.21 fewer children among women, while the effect is not statistically significant among men (panels A and B). Further, age at school entry reduces the probability of teenage motherhood by 4.5 percentage points, three times larger than the effect on teenage fatherhood, which is rare (panels C and D). Similar results are observed for early marriage. Being born just after the school entry cutoff reduces the chances of marriage by 3.2 and 2.9 percentage points for females and males, respectively (panels E and F).

Disaggregating by gender, we find that school-starting age has no statistically significant effect on HIV infection among women (panel A in Figure 15), but it has a large and statistically significant protective effect among men. Being born after the school entry threshold reduces HIV prevalence among men by 4.1 percentage points, representing a 17 percent decline from a baseline prevalence of 23.8 percent (panel B in Figure 15). Our HIV results are consistent with prior work showing the protective effects of schooling on HIV infection risk due to primary education policy reforms in Malawi and Uganda (Behrman 2015) and a secondary education policy reform in Botswana (De Neve et al. 2015). However, this is the first paper to link age at school entry directly to later HIV infection risk. There are several possible reasons for the lack of protective effects of age at school entry on HIV infection for women. While education may reduce the onset of girls' fertility, it may not reduce sexually transmitted infections (including HIV) (Duflo, Dupas, and Kremer 2015). Similarly, by delaying marriage, education can increase the time period at which women are most at risk for HIV infection (Case and Paxson 2013).

Differences by Age Cohort.—In Figure 9, we show that starting school at an older age reduces the probability of early childbearing and marriage. But does this reflect a true decrease in completed fertility and the probability of marriage? To answer this question, we present the difference in family formation between early-borns and late-borns by age cohort in Figure 16. Panel A suggests that the effect of age at school entry on fertility accumulates across the full span of reproductive years. In comparison, the effect on marital status is primarily driven by the younger cohort (those below 30 years), and the effect is largest between ages 19 and 23, where it ranges between a 5 and 11 percentage point decline when women are most likely pursuing their tertiary education. The mean age at first marriage among women aged 25–49 years was 20.1 years in the DHS 2014 data. These results imply that those born just after the school entry cutoff postpone age at first marriage and permanently reduce fertility, consistent with evidence from Uganda and China (Keats 2018; Chen and Guo 2022). Supplemental Appendix Table B.14 shows regression results when disaggregating the sample into a younger cohort (18–29 years old) and older cohort (30–49 years old).

D. *Mechanisms*

Children who start school at an older age complete more years of schooling than children who enter school earlier. We now provide suggestive evidence on the mechanisms for these age-at-school-entry effects on educational attainment. It is well established that within grade levels, older children have higher cognitive skills, socioemotional maturity, and academic performance, simply due to biological age (Bai et al. 2019; Peña 2020). These differences should equalize as children grow older unless additional mechanisms are in play. We highlight three mechanisms likely to be present in Lesotho and other lower-income country settings: differences in preprimary education; differential skill acquisition during primary and early secondary school; and differential incentives for dropout. We then investigate whether educational attainment is plausibly the main pathway for the long-term effects on economic, family formation, and health outcomes.

Time Spent in Preprimary Education.—Children who start primary school at an older age are not just aging in a vacuum; they are doing something else with their time. It is possible that differences in time spent in nursery, in preschool, or interacting with others at home may lead to differences in skills at entry into primary school

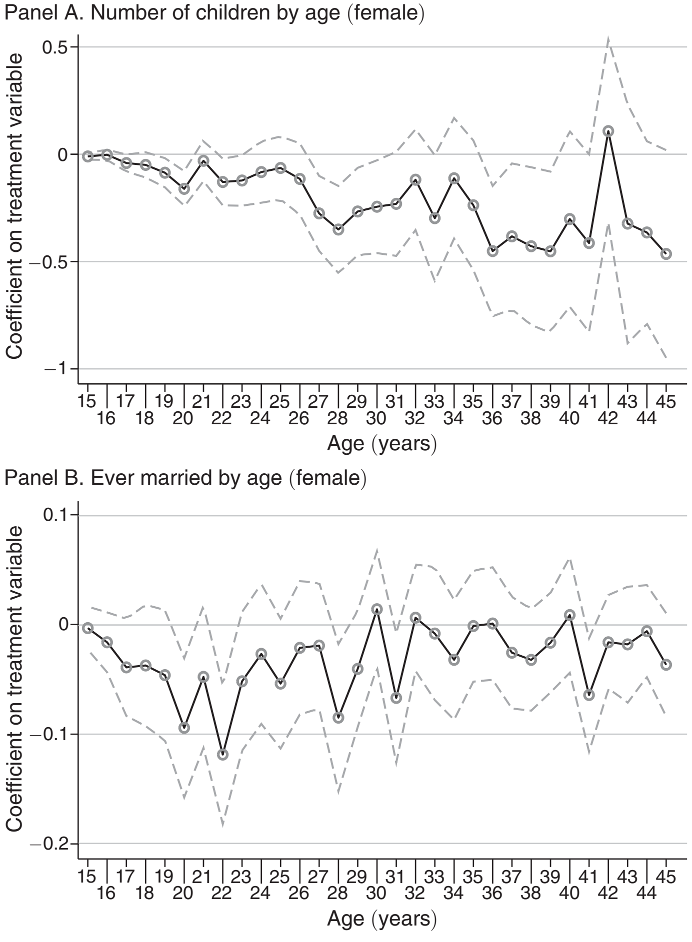

Figure 16. Family Formation by Age among Women

Notes: Panel A shows the difference in the number of children for women born July–December versus January–June. Panel B shows the difference in the probability of ever being married for women born July–December versus January–June. Differences are estimated separately at each age. The decrease in childbearing continues and increases with age (shown in panel A), whereas the differences in marriage tend to fade out over time (panel B). By age 40 there is still a qualitative difference in childbearing, whereas the difference in marriage gradually fades out. Results from regression discontinuity models where we split the sample into a young cohort and old cohort are shown in Supplemental Appendix Table B.14. $N = 21,340$.

Source: Own representation using the Lesotho DHS 2004–05, 2009–10, and 2014 data.

that go beyond the effects of biological age. Figure 17 shows time spent in nursery or preschool (in years) among sixth graders, using data from the SACMEQ III (2007), who were likely in grade 1 in 2000. Starting school a year older is associated with significantly more years in preprimary education. Time spent in preschool or at home could increase socioemotional skills (e.g., confidence, paying attention, following instructions, and so on) of children who start school at an older age, increasing their ability to learn once they reach primary school (Bai et al. 2019).

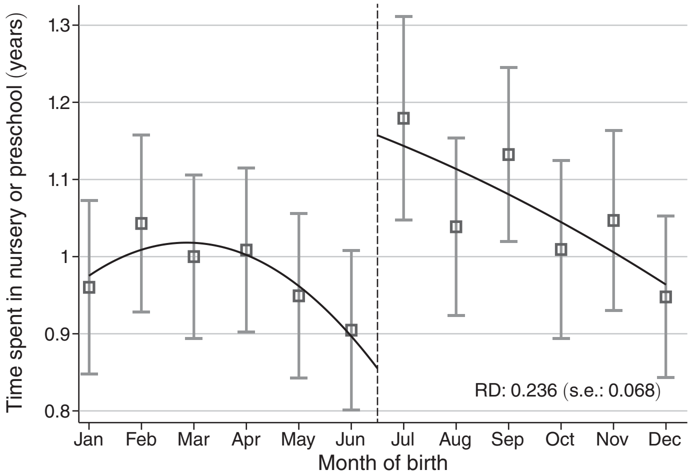

Figure 17. Time Spent in Nursery or Preschool by Month of Birth

Notes: SACMEQ defined the outcome as "time spent attending a preschool, kindergarten, nursery, reception, or similar prior to entering grade 1" (in years). We show means and confidence intervals for each month of birth, superimposed with quadratic regression discontinuity (RD) estimation using the *rdplot* command in Stata (Calonico et al. 2017). We also show regression point estimates and standard errors (s.e.) from linear RD models, controlling for month of birth, an indicator for being born between July and December, the interaction of month of birth and the July–December indicator, and indicators for age, gender, and survey year to reduce residual variance. Sample includes all children currently attending grade 6. Data on time in preprimary education was not available in the SACMEQ II (2000), MICS, DHS or census data. $N = 4,240$.

Source: Own representation using Lesotho SACMEQ III (2007) data.

Divergence in Skill Acquisition at School.—Children who are older at entry into primary school may develop skills faster during their schooling. Faster growth in skills may occur due to dynamic complementarities in skill formation (Cunha and Heckman 2007) or because of greater investment from teachers, caregivers, and students themselves. These channels may operate in concert, with differential investments compounding divergence in skill in a positive feedback loop—or remedial investments offsetting initial differences (Peña 2020; Chen and Park 2021; Cáceres-Delpiano and Giolito 2024).

We assess trajectories in skill development by month of birth once children reach primary schooling age. We use the 2018 MICS data on foundational learning skills (literacy and numeracy) and home reading habits for children 5–17 years. Foundational reading skills include word recognition, literal questions, and inferential questions. Literacy was assessed for both Sesotho and English. Foundational numeracy skills include number reading, number discrimination, addition, and pattern recognition (see Supplemental Appendix A3 and A4 for assessment tools). These measures are calibrated to measure learning outcomes “expected for grades 2 and 3” in numeracy and reading (Amaro and Mizunoya 2020).

Figure 18, panels A and B show foundational reading skills in Sesotho and English, respectively, by age and month of birth. Children who start school at a younger age have an advantage at younger ages, consistent with their earlier entry into school and

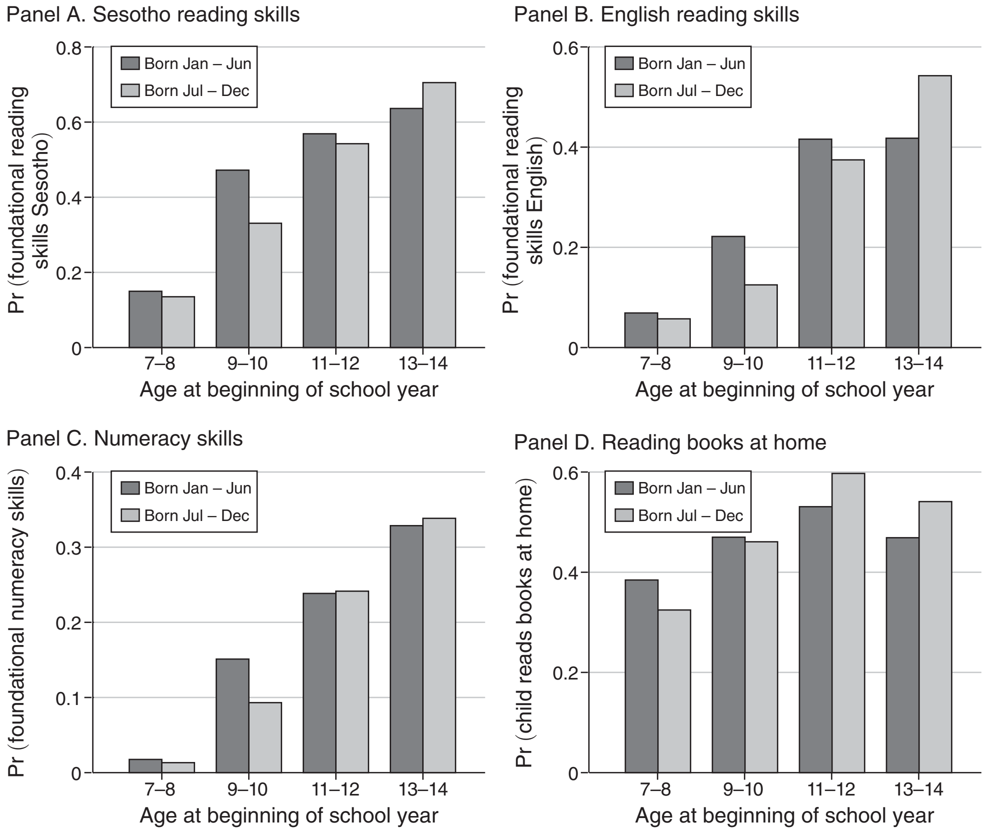

Figure 18. Proportion of Children with Measured Foundational Reading and Numeracy Skills, and the Proportion of Children Who Reported Reading Books at Home by Age and Month of Birth

Notes: In the MICS foundational learning skills modules, children are considered to have foundational literacy skills if they can (i) read 90 percent of words in a story accurately, (ii) interpret information, and (iii) answer inferential questions. Children have foundational numeracy skills if they can (i) read numbers aloud, (ii) determine which number is larger, (iii) calculate simple addition questions, and (iv) recognize patterns of numbers in a sequence provided by the MICS team. Sample includes children aged 7–14 years at the beginning of the school year, regardless of whether they are in school or not at the time of the survey. Age at the beginning of the school year does not imply that children are in school. Sample weights used. $N = 3,118$.

Source: Own representation using the Lesotho MICS 2018 data.

higher grade level at each age. However, this difference narrows at higher ages. By ages 13–14—during which total years of schooling have largely equalized—children who start school at an older age are over 10 percentage points more likely to demonstrate fundamental English reading skills than those who start school at a younger age. We observe a similar attenuation of the initial disadvantage of starting school at an older age for numeracy but do not observe a reversal (Figure 18, panel C).[5]

[5] These results are consistent with using alternative skills measurements—standardised reading scores of sixth graders from SACMEQ II (2000) and III (2007) data (see Supplemental Appendix Figure B.10). In the subsample of children who never repeated a grade (Supplemental Appendix Figure B.10, panel A), children who start school at an older age (i.e., the July–December borns) have higher standardised reading scores than children who start school at a younger age (i.e., the January–June borns).

Reading skills may be developed both at school and through parental encouragement at home. We therefore assess whether starting school at an older age affects the probability of a child receiving more stimulation (reading books) at home (Cáceres-Delpiano and Giolito 2024). Figure 18, panel D shows the share of children of each age who read books at home. Those who start school at a younger age have an early advantage during ages 7–10 years and are more likely to read books at home than those who start school at an older age. However, by ages 11–14, the pattern has reversed, with children who start school at an older age more likely to read at home. Taken together, these results are consistent with a mechanism in which children who are relatively old for their grade experience faster skill development in reading, due in part to greater investments at home and at school. Faster skill growth during school enables older children to catch up with and surpass children who are younger for their grade, leading to large, statistically significant differences in literacy in adulthood, as reported above.

Opportunity Costs and School Dropout.—The third mechanism relates to the perceived returns to staying in school (versus dropping out) for younger versus older students. In lower-income settings such as Lesotho, children face rising opportunity costs in the labor market or home production as they age into adolescence. Old-for-grade children may face higher opportunity costs due to, for example, physical strength and developmental maturity. Children who started school at an older age are also first to complete compulsory schooling, which ends at age 13 in Lesotho. However, as shown above, older children also have faster skill development during school and may have higher perceived returns to further education. [6]

If the effect of starting school at an older age on human capital acquisition is small or negative, then we would expect relatively older students to have higher rates of dropout than younger students due to the higher opportunity costs they face. Conversely, if age-at-entry has a large positive effect on human capital, then old-for-grade students should be less likely to drop out *despite* the higher opportunity costs they face. Patterns of school dropout and participation in other economic activities thus offer a revealed preference measure of the perceived returns to schooling for younger versus older students. We expect to see greater effects of age at school entry on educational attainment where the opportunity costs to schooling are higher. To test this hypothesis, we exploit a local economic and cultural practice. In rural Lesotho, livestock ownership is common, and animal farming is a major source of income. Basotho boys are often expected to herd animals as a cultural way of training boys into becoming responsible men (Gebre et al. 2023).

We first assess the effect of starting school at an older age on out-of-school activities, using detailed time-use data. The 2018 MICS survey includes information for school-aged youth on time spent herding animals, doing domestic activities such as collecting water and firewood, cleaning, cooking, and caregiving, and other economic

[6] The types of labor market or home production opportunities generally available to younger adolescents involve manual labor or caregiving, for which upper secondary schooling may have limited perceived benefit. Thus, we interpret the decision to stay in school as an investment in a person's future employability in other sectors or jobs, rather than increased productivity in the same activities that represent the opportunity costs to schooling.

Table 2—Effect of Age at School Entry on Children's Time Use by Gender

Dependent variable (DV):	Herding animals (hours)		Domestic activities (hours)		Economic activities (hours)		Hazardous labor (= 1)	
Subsample	Female (1)	Male (2)	Female (3)	Male (4)	Female (5)	Male (6)	Female (7)	Male (8)
Born July to December (= 1)	0.020	−5.306	−2.083	0.783	−0.191	−1.412	0.022	−0.059
	(0.201)	(2.369)	(2.010)	(1.908)	(0.720)	(1.419)	(0.034)	(0.053)
Controls								
(Born July to December) × MOB	✓	✓	✓	✓	✓	✓	✓	✓
MOB	✓	✓	✓	✓	✓	✓	✓	✓
School age indicators	✓	✓	✓	✓	✓	✓	✓	✓
Mean DV, lower limit	0.2	17.0	13.7	7.5	1.4	5.6	0.054	0.258
Observations	940	970	940	970	940	970	940	970
R^2	0.004	0.013	0.027	0.006	0.002	0.025	0.008	0.021

Notes: Born-July-to-December ($MOB_i \geq July$) equals 1 if the month of birth (MOB) is between July and December. Columns 1 to 6 show the number of hours worked during the past week. The category for domestic activities includes collecting firewood or water, shopping, cooking, washing, childcare, caring for siblings or older adults, and other household tasks. Columns 7 and 8 show the probability of conducting hazardous work the past week. Hazardous working conditions were defined by MICS as exposure to dust, fumes, gas; extreme cold, heat, or humidity; loud noise or vibration; work at heights; work with chemicals, such as pesticides, glues and similar, or explosives; work at night; and other things, processes, or conditions that were bad for health or safety. Sample includes all children ages 10–14 years at the beginning of the school year. School age was defined as age at the beginning of the school year and does not imply that children are in school. Robust unclustered standard errors in parentheses.

Source: Own computations using the Lesotho MICS 2018 data.

activities such as working on a family business or farm.[7] Table 2 presents the results disaggregated by gender. We observe a large, economically and statistically significant effect on time spent herding animals by males, an activity traditionally reserved for boys. Being born just after the cutoff reduces the time spent herding animals by 5.3 hours or 31 percent (Table 2, column 2). Effects on domestic activities, economic activities, and hazardous labor are qualitatively consistent with our expectations, but imprecisely estimated.

How do opportunity costs shape the impacts of starting school at an older age on educational attainment? We stratify our primary analysis by child's gender and household ownership of livestock. Supplemental Appendix Table B.16 presents the results. Panel A shows results for children aged 5–10 years at the beginning of the school year (mostly in grades 1–5). As expected, starting primary school at an older age initially leads to lower educational attainment. This observation holds in households with and without livestock and for both boys and girls aged 5–10 years. Panel B of Supplemental Appendix Table B.16 shows results for older children aged 11–18 years. In households without livestock, the initial disadvantage of starting school at an older age disappears and children who start school at an older age

[7] All time-use activities are self-reported and refer to the past week preceding the survey (data collection took place between April and September 2018).

have similar educational attainment as children who start school at a younger age (columns 1–3). In households with livestock, we see divergent impacts by gender. For girls, years of schooling equalize for those born before and after the cutoff. However, among boys ages 11–18 in households with livestock, those born after the cutoff (old-for-grade) have 0.60 more years of schooling than those born before the cutoff (columns 4–6). In households with livestock, boys who are young for their grade are much more likely (than boys who are old for their grade) to drop out of school and herd animals as they age into adolescence. Greater labor supply for boys who are young for their grade is consistent with lower "reservation wages" and lower perceived returns to schooling. We do not know how perceptions relate to real differences in skill, nor do we directly observe motivations. However, revealed preference suggests that these young-for-grade boys and their caregivers receive a strong signal that the returns to staying in school are low.

Our investigation of mechanisms identifies factors that may explain the very large effects of age at school entry on educational attainment in Lesotho, factors which may be present in other low-income or lower middle-income countries. Children who are born after the cutoff and enter primary school at an older age start primary school with greater baseline skills and maturity. Despite an initial deficit in years of schooling, these old-for-grade children catch up and leapfrog their younger peers in real (measured) skills, due in part to increased household investment. As they age, despite facing higher opportunity costs, old-for-grade children are much less likely to drop out of school than their younger peers, consistent with much higher perceived returns to schooling. Opportunity costs play an important role in school drop out in low-income settings and may contribute to long-term divergence in human capital by school entry.

Education and Its Long Term Impacts.—Having explored the mechanisms through which age at school entry increases total years of schooling, we next examine whether years of schooling is the main channel through which age at school entry affects our long-term outcomes. To do this, we do the following decomposition exercise.[8] We first determine the cross-sectional relationship between total years of schooling and several long-term outcomes (literacy, childbearing, marriage, occupation, household wealth, and spousal educational attainment) using data on respondents ages 18 years or older from the Lesotho DHS 2004–05, 2009–10, and 2014 in six separate OLS regressions. In all six OLS regressions, we control for month of birth (continuously), indicators for age and gender, as well as indicators for survey year (panel A of Supplemental Appendix Table B.17). Second, for each long-term outcome, we then multiply the observed OLS relationship by the "first-stage" effect of being born after the June 30 cutoff on total years of schooling (i.e., 0.422 additional years of schooling in the DHS data, shown in column 4 of Supplemental Appendix Table B.3). Third, to assess how close these estimates get to our ITT estimates of being born after the cutoff on our long-term outcomes, we divide the estimates above by our ITT estimate as follows: $(\text{First stage} * \text{OLS})/\text{ITT}$.

[8] We thank the editor for this suggestion.

Panel B of Appendix Table B.17 presents the decomposition results. We find that the ITT estimates for total years of schooling explain most of the effects for cognitive skills, occupation, wealth, and spousal quality (100 percent for literacy, 75 percent for primary occupation, 73 percent for household wealth, and 78 percent for spousal education). These results suggest that a sizable proportion of the age-at-school-entry effect on long-term socioeconomic outcomes goes through educational attainment. The childbearing and marriage results are only partially explained by total years of schooling (22 percent and 25 percent, respectively) and could be explained by other factors (such as differences in expectations, aspirations, and peer networks conditional on educational attainment).

IV. Conclusion

In this paper we assess the impact of age at school entry on educational attainment and a wide range of long-term economic, demographic, health, and intergenerational outcomes in Lesotho. We use multiple national household surveys and exploit the discontinuity created by the date of birth cutoff for primary school enrollment. We find that, in Lesotho, the positive "quality effect" of starting primary school at an older age swamps the negative "quantity effect" of having fewer potential years of schooling. Age at school entry increases total educational attainment and adult literacy, even though older school entrants experience a schooling disadvantage in the early years.

We further show that age at school entry delays marriage; reduces early childbearing, fertility, and HIV infection (among men); increases household wealth, education level of marital partners, and the probability of being in high-earning occupations; and reduces child mortality in the next generation. Our results are consistent across multiple national household surveys and robust to different specifications. To our knowledge, this is among the first papers on age at school entry in a lower-income country and the first in Africa. In contrast to evidence from higher-income countries, where age-at-school-entry effects are mostly zero or negative, we find a consistent, strong signal that starting primary school at an older age positively affects human capital development in Lesotho.

We provide suggestive evidence on mechanisms: Older entrants spent more time in preschool, develop cognitive skills more quickly during primary school, receive more home stimulation, spend less time herding animals, and are less likely to drop out. We show that the divergence in foundational (reading and numeracy) skills between those born just after and those born just before the cutoff occurs during middle childhood, a critical period for cognitive skills development. We also find that age-at-school-entry effects are more pronounced when the opportunity costs are higher, highlighting the importance of perceived returns to schooling in school drop out decisions.

This paper is not without limitations. First, like most papers in the literature, we cannot separate the effect of relative age from the absolute age ("pure" age or "age-at-test") effect. Empirically, disentangling relative and absolute age effects is challenging because of the high degree of collinearity between the two variables. To reduce potential differences because of absolute age, we focus on individuals who are born near the school entry cutoff (who differ in absolute age by only one month) and stratify our results by single-year age groups. We also find consistent results when using continuous day of birth. With better data, future studies can attempt to identify the separate effects of age at school entry. Second, we do not have longitudinal data, and we rely on multiple national surveys and the synthetic cohort assumption to examine long-term outcomes. Nonetheless, we show that the synthetic cohort assumption is largely plausible by showing confirmatory data from birth cohorts observed longitudinally, thus aiding the interpretability of our long-term results. Third, other context-specific factors may contribute to the very large age-at-school-entry effects observed in Lesotho, including wide age heterogeneity within grades, large class sizes, and limited seats for secondary and tertiary education. We do not examine the influence of these systems-level factors on age-at-school-entry effects. Further work is required to tease out these pathways.

Dozens of studies reveal that in high-income countries the long run "quality" and "quantity" effects of starting school at an older age are basically a wash (Oosterbeek, ter Meulen, and van Der Klaauw 2021; Dhuey and Koebel 2022). As we show here, the same is not necessarily true in lower-income countries, where school entry age may be a key factor in human capital growth trajectories and long-term health and well-being.

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