Educational and Geographic Spillovers of Higher Education in the Developing World: *Case Studies in Sub-Saharan Africa*

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Under the Direction of

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A Thesis

Presented to the Faculty of Mount Holyoke College

in partial fulfillment of the requirements for the degree of

Bachelor of Arts with Honors

Department of Economics

Mount Holyoke College

South Hadley, Massachusetts 01075

May 2020

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May 8, 2020

Abstract

Education is often a means to intergenerational mobility, but it still remains inaccessible to many people in much of the developing world. Higher education institutions directly affect the higher education level of the communities they are established in, but they may also have spillovers on lower levels of schooling. In this paper, I use an event study framework to estimate the spillovers universities in developing countries have on the local community's educational attainment. I find more consistent spillovers on primary school enrollment than on secondary school enrollment. I estimate the establishment of a college increases the likelihood of the enrollment of primary school age children by up to 3.8 percentage points in Uganda, up to 5.1 percentage points in Kenya, and up to 9.2 percentage points in Ghana. I also find spillovers on school enrollment are strongest for children from low and lower-middle income families. My research adds to the literature on the spillovers of higher education in developing countries by providing some of the first estimates of educational spillovers in Uganda, Kenya, and Ghana. This cross-country comparison will allow me to assess the external validity of my findings and study the factors that might be driving the differences in spillovers in various countries.

ACKNOWLEDGEMENTS

I am indebted to my thesis advisor, Professor Sarah Adelman for her guidance, encouragement, and optimism. Professor Adelman's genuine excitement about research, theses, and my thesis in particular set an example for me to follow and kept me motivated during the frustrating parts of the research process. I am deeply appreciative of the time and energy Professor Adelman has invested in me over the last two years, especially in regards to my thesis.

I am forever grateful for Professor Sarah Adelman and Professor Margaret Lay for their mentorship and for inspiring my love of economics and research. They taught me how to conduct economic research, from developing a research question to submitting a paper for publication, through my thesis and other research projects with them. I whole-heartedly appreciate the countless hours Professor Adelman and Professor Lay spent with me, beginning my junior year, helping me formulate my research question and sending me numerous papers, while exhibiting extreme patience throughout the process. Both Professor Adelman and Professor Lay provided me with invaluable feedback that shaped my thesis. They also showed me that I have something to contribute to economic research. They, along with Professor James Hartley, inspired me to continue to pursue economics and research beyond my undergraduate studies.

I wish to show my deepest gratitude to Professor James Hartley, who has been my academic advisor since orientation and has indulged my numerous questions and engaged in many thoughtful conversations that have sharpened my way of thinking. Professor Hartley changed the way I see the world to now view everything through an economic and mathematical lens. I am also appreciative of his input and assistance on the conceptual piece of my thesis.

I would like to thank Professor Johannes Norling for meeting with me to discuss the DHS data; providing me with feedback; serving on my thesis committee; and organizing the economics department thesis process. I am also grateful to Professor Dylan Shepardson for serving on my thesis committee and considering how I might incorporate a differential equations model into my research. I would also like to thank Professor Theodore Gilliland for providing feedback on my research.

Thank you to my friends–including Mendi Mwangi, Angela Nayiga, Abena Sekyere, and Lukachi Okonji–who shared their experiences and knowledge about their community's, state's, and country's educational systems with me, that inspired my research. I am grateful for the encouragement, support, and prayers of my friends and peers including Aryaa Rajouria, Daphne Schneewind, Yidan Xu, Savita Diggs, Susan Khan, Zeyu (Tina) Lu, Savana Wang, Elisa Malvicini, Abby Tuckett, Amelia Morrissey, Melanie Krumrey, Meghan Berry, Lyuba Popadic, Nista Shrestha, Anamika Khanal, Marihah Idroos, and Sabah Lotia.

Most of all, I am grateful to God for His sustaining grace through this project, college, and my life. *"Whatever you do, work at it with all your heart, as working for the Lord." –Colossians 3:23*

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1 INTRODUCTION

How does the establishment of a college in a developing country affect the local community's educational attainment at the primary and secondary school level? To study the geographic spillovers of colleges, I compiled geocoded higher education datasets for Uganda, Kenya, and Ghana. Using this and survey and geospatial data from USAID's Demographic and Health Surveys, I estimate the spillovers colleges have on the surrounding community's educational enrollment at the primary and secondary school level.

Positive spillovers (or externalities) on lower levels of schooling occur through a college increasing the returns to schooling, decreasing the costs of lower levels of schooling, or easing binding constraints that impede educational investment. I consider the mechanisms through which higher education may influence educational attainment at lower levels of schooling in my conceptual framework.

Through an event study framework, I find evidence there may be positive spillovers on the enrollment of primary school age children in Uganda and primary and secondary school age children in Kenya. My results in Ghana provide some support for positive spillovers, but are ultimately inconclusive. At the secondary school level, there are positive spillovers in Kenya, no spillovers in Uganda, and inconclusive results in Ghana.

My paper also estimates the spillovers separately for children from different family wealth levels and I find spillovers vary by family wealth in some contexts. In Uganda, I find lower-middle income families experience the highest spillovers from a nearby college on primary school age children's school enrollment. In Kenya, the primary school enrollment spillovers of a local college concentrate to children from the lowest and lower-middle income families. Similarly, in Ghana, I find the strongest and most consistent coefficients in terms of magnitude for primary school children from the lowest income families, but these results are not as statistically significant.

Human capital investment is a critical component of economic development and socioeconomic mobility. Education is one of the focal points of policies and interventions aimed at increasing social welfare (World Bank 2018). When education is not prioritized, development policy may be more focused on meeting a population's immediate needs at the expense of being forward-looking. In accordance with endogenous growth theory, for a country's development status to progress, investments in the future, including human capital investment, should be prioritized (Barro 2001; Barro and Sala-i-Martin 2004; Hanushek and Woessmann 2007; Karpov 2017; Ray 1998; Romer 2006; World Bank 2000). In addition, human capital investment and access to education have equity implications for the population (Darvas et al. 2017; Hanushek and Woessmann 2007). Increased access to education increases the possibilities for intergenerational mobility, which may help lift some families out of poverty and positively influence development and economic growth on the aggregate level (Abbott and Gallipoli 2017; Chetty et al. 2018; Chetty and Hendren 2018; Darvas et al. 2017; Kotera and Seshadri 2018).

Consistent with the concept of diminishing marginal returns, the highest social (or public) returns to education are achieved through investment in the lower levels of education (Taylor and Lybbert 2015; Pritchett 2001; Birdsall 1996; Psacharopoulos 1982; Psacharopoulos and Patrinos 2004; World Bank 2000). On the contrary, *private* returns are estimated to remain fairly consistent across each level of schooling (Card 2001; Gruber 2012). Governments and other external agents generally intervene in a market when there is a market failure. In this case, when the social returns to schooling exceed the private returns to schooling, a government may subsidize education through a Pigouvian intervention to raise the level of schooling to the optimal social level (Gruber 2012; Jenkins 2014; Orazem and King 2008). All levels of education are usually subsidized to some degree by the government. There is disagreement over the degree to which each level of schooling should be subsidized. Many believe tertiary education is overly subsidized in developing countries. Subsidizing tertiary education may perpetuate, and even exacerbate, inequality if the people who directly benefit from these subsidies tend to be primarily from high income families (Chiswick 1974; Darvas et al. 2017).

However, social returns to higher education may be underestimated if they do not account for spillovers that are more difficult to estimate and attribute directly to tertiary education expansion. Colleges can have spillovers on lower levels of schooling, the community, and the local labor market (Abel and Deitz 2011; Baumann and Solomon 2005; Jagnani and Khanna 2018; Lange and Topel 2006; Lavy 1996; Moretti 2002; Sallee and Tierney 2007).

To my knowledge, there is only one other paper studying the spillovers of colleges on lower levels of schooling in developing countries. Jagnani and Khanna (2018) estimate spillovers of elite public universities in India through a similar event study design. My study considers a very similar research question and utilizes the same specification across three Sub-Saharan African countries, allowing me to test the external validity of Jagnani and Khanna's findings. I expand on their work by extending my research to study spillovers on secondary school. Additionally, my analysis considers whether spillovers differ by family wealth level. By including case studies of several Sub-Saharan African countries in this work, I can make a preliminary assessment of the external validity of my findings and consider why results might diverge between countries. My research also adds to the literature by providing estimates for different countries using the same methodology and considering the driving forces behind different observed effects. Further, my work adds to the literature on higher education in developing countries by providing new geocoded higher education datasets for Uganda, Kenya, and Ghana.

The paper proceeds as follows. Section 2 provides background on education in Uganda, Kenya, and Ghana. Section 3 outlines a conceptual framework that explains the household's educational investment decision. Section 4 lays out a conceptual framework exploring the mechanisms through which the entrance of a college in a community changes the market for primary and secondary schooling. Section 5 describes the data, while Section 6 presents descriptive statistics. Section 7 explains the event study design and briefly reviews literature on the use of an event study. I explain my empirical approach in Section 8 and present results in Section 9. Robustness checks are outlined in Section 10. In Section 11, I discuss the potential significance, applications, and shortfalls of my research. Section 12 concludes with some suggestions for future research.

2 COUNTRY-SPECIFIC EDUCATION BACKGROUND

2.1 *Uganda*

2.1.1 *Primary and Secondary Schooling in Uganda*

Uganda's Universal Primary Education (UPE) went into effect at the beginning of 1997. The policy first allowed up to four children per family to attend primary school without school fees but was later expanded to remove primary school fees for all children. Even with UPE, it should be noted there are still other direct and indirect costs of school attendance including uniforms, school supplies, and the opportunity cost of the child's potential labor supply. The diminishing costs of primary education led to a dramatic increase in enrollment. UPE increased equity in Uganda's education system by decreasing costs and barriers to entry to school for children from low income families, as well as prioritizing the enrollment of girls and children with disabilities through specific policy stipulations. Uganda does not have compulsory schooling laws, and instead focuses on incentivizing human capital investment (Bategeka and Okurut 2006).

Though UPE significantly increased enrollment, educational quality decreased with the passage of UPE. Primary school class sizes spiked immediately after UPE's passage, reaching an average student-teacher ratio of approximately 60:1 (UNESCO 2019). Class sizes have since declined to an average of 43 students in 2017 (UNESCO 2019). High teacher absenteeism and poor infrastructure and sanitation pose challenges to children's educational attainment and achievement (UNICEF 2020). There are still high dropout rates in primary school and even those who do complete primary school have not all developed the skills to succeed in further education or in medium to high-skilled jobs (UNICEF 2020; Bategeka and Okurut 2006).

Despite Uganda being the first sub-Saharan African country to pass Universal Secondary Education (USE), enrollment in secondary school has remained around 25 percent (Ministry of Education and Sports 2019; O'Donoghue et al. 2018; UNICEF 2020).

2.1.2 *Higher Education in Uganda*

The Ugandan higher education system began solely as a public university system, diversifying to a system with both public and private universities in 1998 (Nannyonjo, Mulindwa, and Usher 2009). Since this liberalization of higher education policy, there has been a dramatic increase in the number of universities in Uganda, reaching 51 registered and accredited universities in 2016 (Omona 2012; The National Council for Higher Education 2018). Other types of higher education institutions in Uganda include national teachers' colleges, community colleges, and colleges of commerce and technology (Obwona and Ssewanyana 2007). In 2016, there were 179,067 people enrolled in Ugandan universities, equating to less than one half of one percent of the population. In 2017, there were 399 people per 100,000 inhabitants enrolled in higher education, which is comparable to the enrollment in Kenya (Darvas et al. 2017; National Council for Higher Education 2018; World Bank 2019).

Uganda has a dual-track admissions policy for higher education, where the government sponsors 4,000 students' university education at public universities each year. The sponsorship covers all fees associated with attending the university. The remaining students pay tuition set by their faculty, where tuition varies by discipline (Darvas et al. 2017). Fees are also dependent on student enrollment, and decline when enrollment in a program rises (National Council for Higher Education 2019).

One major concern with public investment in higher education in developing countries is that the benefits primarily accrue to the wealthiest members of the population. Uganda's dual-track admissions policy aims to address this concern by making university education free for some students, awarding these scholarships based on merit (Darvas et al. 2019). The concern is not alleviated through dual-track admissions though because the students who do well enough to earn the scholarship are often the students who attended the best primary and secondary schools and had greater levels of family inputs into their education. These students disproportionately come from the wealthiest portion of the population (Darvas et al. 2017). It is likely these students would have pursued a university education in the absence of the scholarship since many of them come from families who may have the resources to finance their children's education (Darvas et al. 2017. If this is the case, government sponsorship is inefficient and further propagates inequity in higher education. Higher education remains inaccessible to the majority of the Ugandan population, particularly those who are from low- to middle-income families. If higher education is not accessible to most of the population, it may have limited levels of spillovers on lower levels of education.

Table 1: State of Higher Education in Uganda, 2016

Total University Enrollment	179,067
Total Tertiary Enrollment	254,043
Female Enrollment in Universities	44%
University Students in Sciences	34%
University Students in Arts and Humanities	66%
Graduation Rate	94%
International Student University Enrollment	8.9%
Faculty-Student Ratio	19
Students Formally Employed after Graduation	64.7%
Students Self-Employed after Graduation	18.2%
Students Unemployed after Graduation	17.1%

Note: Data are from The National Council for Higher Education's (2019) report "The State of Higher Education and Training in Uganda 2015/2016." All statistics apart from total university enrollment, total tertiary enrollment, and gross enrollment ratio are conditional on university enrollment.

2.2 *Kenya*

2.2.1 *Primary and Secondary Schooling in Kenya*

Primary or "basic" education is eight years in Kenya, beginning at the age of six for most children. Kenya passed UPE and simultaneously made primary school compulsory in 2003, which led to an increase in the demand and the supply of primary schooling. By 2010, Kenya's gross enrollment ratio in primary school stood at 114 percent, meaning there were more children enrolled in primary school than the number of children who were of primary school age (Darvas et al. 2017). As in other developing countries, families face additional costs of schooling (e.g. uniforms) that remain a barrier to entry for many children (Glennerster et al. 2011). Over time, wealthier families increasingly send their children to higher quality private schools that give these students a competitive advantage over their peers with lower levels of learning at lower quality schools. These differences in education quality at the primary school level have lasting effects on educational attainment and achievement, leading to educational disparities between those of different socioeconomic backgrounds (Clark 2015; Glennerster et al. 2011).

Upon the completion of primary school, students take the national Kenya Certificate of Primary Education examination. This national exam ranks students educational achievement relative to their peers across Kenya. Performance on this exam determines students' eligibility to attend national secondary schools, which provide higher quality education than provincial schools. Following primary school, students can attend youth polytechnics (that provide technical or vocational education) rather than secondary school, but this limits children's access to tertiary education (Clark 2015; Darvas et al. 2017).

Kenya passed USE in 2008, removing school fees for secondary education but not making it compulsory. Kenya's secondary enrollment has increased significantly since the passage of USE, also making higher education attainable for more people. By 2010, Kenya's secondary school gross enrollment ratio reached 67 percent, which is relatively high for Sub-Saharan Africa (Darvas et al. 2017). USE was particularly had pronounced benefits for specific subsets of the population, including girls and lower income children who were less likely than their peers to attend secondary school prior to the passage of USE. USE has not equalized enrollment among subsets of the population, but it has reduced the level of disparities in enrollment (Clark 2015; Glennerster et al. 2011)

In addition to public and private secondary schools, Kenya has harambee schools that are primarily managed by local communities. Harambee schools receive some federal funding, but are not fully sustained by federal funding and require greater support from the local community to continue operations. Harambee schools usually provide lower quality education than their private and public counterparts. These schools also have a high concentration of low income students, whose families have less ability to invest in their children's education (Clark 2015).

Upon completion of secondary school, students take the Kenya Certificate of Secondary Education (KCSE). Performance on this exam determines students' eligibility for higher education. Students from private schools tend to perform the best on the KCSE (followed by those from public schools), thus increasing their access to higher education (Amburo 2011; Darvas et al. 2017; Mulongo 2013).

2.2.2 *Higher Education in Kenya*

Kenya is among the countries in Sub-Saharan Africa to experience rapid expansion of higher education in the 2000s through 2010s. The number of public universities has increased more than fourfold between 2005 and 2020. Simultaneously, there has been a rapid increase in the number of private universities. Likewise, enrollment in higher education has increased in Kenya, but is still low. In 2017, higher education enrollment reached 422 people per 100,000 inhabitants which is comparable with tertiary education enrollment in Uganda (Clark 2015; Commission for University Education 2017; Darvas et al. 2017).

Higher education enrollment is higher for males than females in Kenya, but differs by the type of institution. Private universities have a greater proportion of females than public universities, in part since admission to private universities is not as dependent on performance on the KCSE and boys tend to score higher than girls on the KCSE. Additionally, boys are more likely to attend secondary school than girls, thus making it more likely that boys continue their education beyond secondary school (Amburo 2011; Darvas et al. 2017; Mulongo 2013).

Like some other Sub-Saharan African countries, Kenya has a dual-track admissions policy in higher education. Under Kenya's dual-track admissions system, the federal government heavily subsidizes higher education for some students, on the basis of merit, measured by achievement on the KCSE. The remainder of students who are admitted to universities may earn degrees, but at their own expense (Amburo 2017; Darvas et al. 2017; Ngome 2003).

Despite its intentions to increase equity in higher education, this policy still has the highest benefits for the students who would have attended higher education in the absence of dual-track admissions. The system makes it possible for some new students to access higher education, but students who had access to the best primary and secondary schools (who are disproportionately from higher income families) are primarily the students who receive scholarships (Amburo 2017; Darvas et al. 2017; Mulongo 2013).

Reforms to address equity concerns with the current system, including a quota system similar to affirmative action policies, are under consideration. One attempt to decrease the disparities between students of different socioeconomic status, occurred through the introduction of the Higher Education Loans Board (HELB). The HELB was created to ease credit constraints that prohibit students from attending college by offering means-tested loans for higher education. The HELB addresses some concerns about equity in higher education, but access to credit hinders educational attainment even earlier in many students' academic journeys than the tertiary level. Additionally, loans from the HELB lessen the immediate costs of attending universities, but they often are not large enough to cover the full cost of university fees (Darvas et al. 2017; Mulongo 2013; Mwiria and Ng'ethe 2002).

2.3 *Ghana*

2.3.1 *Primary and Secondary Schooling in Ghana*

Ghana's education system has roots in Christian missionary schools and British colonial government schools. The system was established earlier than many other systems in Sub-Saharan Africa. The system expanded when Ghana gained sovereignty as an independent nation in 1957. In 1961, Ghana became one of the first countries in Sub-Saharan Africa to offer free primary education and to make it compulsory. This focus on educational investment led to rapid increases in enrollment and literacy (Kamran et al. 2019).

True to its British roots, the Ghanian education system had a 6-4-2-3 (six years of primary, four years of secondary, two years of college preparatory, and three years of tertiary schooling) system prior to 1974. Since then, the system has evolved to a 6-3-3-4 system, where schooling is compulsory through ninth grade (Kamran et al. 2019).

In the last 10 years, gross primary enrollment ratios have been above 100 percent in Ghana and net enrollment ratios have ranged between 79 and 89 percent (UNESCO 2020). There are no differences in primary school enrollment by sex (UNESCO 2020). Though there is no tuition for primary or junior secondary school, costs (such as uniforms and school supplies) remain prohibitive for some families, hindering the educational attainment of children from lower income families. Private schools are often similar in cost to public schools, which has increased the number of private schools. Some areas lack government-funded schools so transportation costs (the time it takes a child to travel to school) are also prohibitive for students from some areas (Adamba et al. 2017; Kamran et al. 2019).

Secondary school enrollment is lower than primary school enrollment, but still fairly high for the region. Secondary school enrollment has been increasing over time. In 2017, gross secondary enrollment reached 70 percent while net secondary enrollment reached 58 percent. Historically, boys have attended secondary school at higher rates than girls, but this gap has been closed in the last 10 years (UNESCO 2020).

At the end of junior secondary education (ninth grade), students take the

Basic Education Certificate Exam (BECE), which determines their admission to senior secondary schools. Scores on the Basic Education Certificate are a weighted average of the exam score (70 percent) and performance throughout school (30 percent). Students are accepted to senior secondary schools based on their BECE scores and a computerized school selection placement system. Only the highest achieving students get to choose which secondary school to attend. In 2017, eight percent of students did not receive high enough scores on the BECE to continue their education beyond ninth grade (Adamba et al. 2017; Kamran et al. 2019).

Upon completion of senior secondary school, students take a standardized exam that determines their eligibility for higher education. Beginning in 2007, this admissions exam became the West African Senior School Certificate Examination (WASSCE). Prior to then, Ghana had a national senior secondary school certificate examination. Ghana's National Accreditation Board sets basic admissions standards for higher education. Individual universities can set more stringent admissions requirements. Public universities tend to be the most competitive and desirable higher education institutions in Ghana (Kamran et al. 2019; National Accreditation Board Ghana 2020).

2.3.2 *Higher Education in Ghana*

Ghana is among the countries in Sub-Saharan Africa with the highest per-capita enrollment levels in higher education. In 2017, there were 1,370 people per 100,000 inhabitants enrolled in higher education. This is more than triple the per-capita enrollment of Uganda and Kenya. Ghana managed to achieve relatively high tertiary enrollment with relatively low spending on higher education in comparison to its counterparts in Sub-Saharan Africa. The ratio of per-tertiary student spending to per-primary student spending is more than three times lower than that in Uganda and Kenya, and the lowest of the 10

Sub-Saharan African countries studied by Darvas et al. (2017).

Under the Akosombo Accord, Ghana has a cost sharing higher education system, where public universities are primarily funded by the federal government, but nearly a third of their funding must come from internally generated revenue, including tuition and donations to the university. This portion of funding is primarily obtained through tuition, in large part paid by lower achieving students who obtain admission to the university primarily so the university can generate enough internal revenue (Darvas et al. 2017; Marcucci 2007).

As is the case in other countries in the region, enrollment in tertiary education is highest for those from higher income families; however, the disparity is less dramatic in Ghana than in other countries in Sub-Saharan Africa. This disparity occurs partially due to the prohibitive costs of higher education and partially due to the achievement gap on Ghana's college admissions exam: the Computerized School Selection and Placement System. Similar to other standardized exams, students from the best primary and secondary schools (who are disproportionately from higher income families) perform the best on the exam (Darvas et al. 2017).

In an effort to address equity concerns stemming from the cost of tertiary education, Ghana created the Student Loan Trust Fund (STLF) to offer means-tested loans for higher education. These loans ease credit constraints on low-income families, increasing their access to higher education. The STLF often delays the distribution of its loans, putting the burden of the immediate cost of tuition on students at least temporarily, thus countering the intended effect of the loans. As is the case in other developing countries, credit constraints often become binding before the tertiary education level so intervention may be required at lower levels of schooling, for the STLF to maximize its equity-enhancing effects (Darvas et al. 2017).

Additionally, Ghana has introduced quota systems to lessen the disparities. Some of these quotas are aimed at increasing the enrollment of rural students, who attend higher education at lower rates than urban students. Ghana also established the Less-Endowed Schools Initiative to address enrollment disparities caused by the differing access to high quality secondary education. Because this reform addresses this difference in secondary school quality, it may have a greater equity-enhancing effect than higher education admissions policies in other Sub-Saharan African countries; yet students from Less-Endowed Schools may face greater challenges once they are at a higher education institution if they are not as well prepared as their peers who received higher quality primary and secondary education. Tertiary enrollment is still considerably higher for males than females, so the admissions requirements for girls have been lowered slightly in an effort to decrease the gender disparity in higher education (Anyan 2011; Darvas et al. 2017; Morley et al. 2007; UNESCO 2020).

3 HOUSEHOLD EDUCATIONAL INVESTMENT DECISION

The educational investment decision is made by households based on time-discounted returns to schooling (Becker 1963; Mincer 1974; Heckman, Lochner, and Todd 2003; Soares et al. 2012). Households must weigh returns to education that will accrue in the future against the costs of education they face in the present. Because they face the cost first, their decision will be constrained by income and access to credit, potentially making it more difficult for children from poorer families to go to school. This is important to note, but for now, we will assume constraints are not binding.

Jacob Mincer's (1974) Accounting-Identity Model frames this decision in terms of potential lifecycle earnings, which vary with years of schooling, the returns to schooling, years spent working, and a discount rate. Households choose the years of education that maximizes lifetime earnings, given direct and opportunity costs of education, labor market returns, returns to education, and the household's preferences for current versus future consumption (captured by the discount rate). Understanding the inputs and dynamics of lifecycle earnings is a critical piece to understanding the educational investment decision households face. I adapt this model to fit the context of my research question.

In Mincer's (1974) model, future potential earnings (E_{t+1}) are a function of earnings in the current time period (E_t), time invested in human capital (C_t), and the rate of return on human capital investments (ρ_t) :

$$E_{t+1} = E_t + C_t\rho_t.$$

Time invested in human capital can also be written in terms of E_t to express that some earnings in the current period must be given up to invest time into human capital acquisition (Equation 2). This fraction of potential earnings invested in human capital is denoted by k_t. We can write time invested in human capital as:

$$C_t = k_t E_t.$$

Substituting C_t into the previous future potential earnings equation yields:

$$E_{t+1} = E_t(1 + k_t\rho_t)$$

(1).

From this equation, we can derive a generalized potential earnings function by iterating the equation forward and making substitutions:

$$E_t = E_0 \prod_{j=0}^{t-1}(1 + k_j\rho_j).$$

I separate human capital investments into formal schooling and post-school investments in the following potential earnings function:

$$E_t = E_0 \prod_{s=1}^{s=s}(1 + k_s\rho_s) \prod_{j=0}^{t-1}(1 + k_a\rho_a).$$

Mincer's (1974) model assumes there is a constant rate of return on formal schooling (ρ_s) across each year of school (s), when all of the individual's time is invested in school $(k_t = 1)$. For the purposes of this paper, I assume returns on post-school human capital investment equal zero ($\rho_a = 0$), so we can rewrite the potential earnings function as:

$$E_t = E_0(1 + \rho_s)^s$$

(2). The resulting potential earnings function (Equation 2) is only dependent on base-level earnings (E_0), years of schooling (s), and returns to schooling (ρ_s). Base earnings (E_0) are determined by a vector of individual and family characteristics (i.e. ability, family income, and parents' education level). We assume this is the income an individual would earn if he did not go to school (when $s = 0$, $E_t = E_0$). Returns to schooling (ρ_s) are taken exogenously and directly influence the household decision of the optimal number of years of schooling (s) for its children.

Because I focus on the educational attainment of minors, I focus on the parents' (represented by the household) decision regarding their children's schooling. I assume it is a unified household decision made by benevolent parents with the ideal of maximizing the net present value (NPV) of their child's lifetime earnings potential (E_i), represented by Equation 3:

$$E_i = \Sigma_{t=1+s}^{t=T} \frac{E_0(1 + \rho_s)^s}{(1 + r)^{t-1}}$$

(3) In the intertemporal earnings function above (Equation 3), future earnings are discounted at the interest rate (r). An individual begins accruing lifetime earnings in the year following her exit from schooling ($t = 1 + s$) and continues accruing lifetime earnings through the end of her working life ($t = T$).

Since earnings potential is directly affected by returns to schooling (ρ_s), the optimal years of schooling is also inextricably linked to returns to schooling. Returns to schooling are the amount earnings potential increases by for an additional year of schooling. This is affected by the quality of education offered and the access to obtaining education. It is also affected by the benefits of receiving an education. Labor market opportunities are one of the biggest determinants of returns to schooling. Labor market opportunities are determined by the industries, types of jobs available, level of business investment, employment levels, and state of the economy, among other things. Despite differences in these conditions, most empirical literature has estimated returns to schooling to be around seven to twelve percent (Gruber 2012; Card 1994; Hausman and Taylor 1981).

4 SPILLOVER EFFECTS OF A COLLEGE ON THE MARKET FOR PRIMARY AND SECONDARY SCHOOLING

Higher education institutions directly influence a community's educational attainment since the primary good they provide is educational training, but they also may have indirect effects on lower levels of schooling (Jagnani and Khanna 2018; Lavy 1996). Universities may potentially affect the supply and demand for lower levels of schooling through various mechanisms considered below. In particular, my research focuses on whether there is an increase in primary and secondary schooling following the establishment of a college in a community. Each mechanism I consider affects the educational investment decision through changing returns to education, costs of education, or wealth constraints.

Excluding migrants to the community who move after the college opens, I expect average educational attainment of the surrounding community to increase after the college opens due to a change in the returns to primary and secondary schooling. If the college impacts the labor market, returns to schooling will be affected. In this section, I expand on Jagnani and Khanna's (2018) model of how universities affect the market for lower levels of schooling. Their research focuses more on the supply-side effects, while my framework focuses more on the demand-side effects.

4.1 *Demand for Schooling*

Universities have the potential to increase the demand for primary and secondary schooling through increasing the returns to schooling, decreasing the costs of lower levels of schooling, or easing household resource constraints. For instance, a college may directly and indirectly increase the quality of schooling through student teaching programs, resource sharing, partnerships, and attracting a new demographic of people to a community; however, it is also possible that a university will negatively affect the quality of primary and secondary schooling public investment in higher education draws funds away from lower levels of schooling. Additionally, if a college changes the structure of the local economy, it will shape the labor market, increasing the returns to education which will increase the demand for schooling. I explore these and other mechanisms that may affect the demand for primary and secondary schooling in the subsections below.

4.1.1 *Population*

When a college is established, there is an influx of migrants into the community. These migrants include the college's faculty, staff, and their families, as well as students attending the college (Jagnani and Khanna 2018). There is some evidence that the entire family does not migrate, but rather only the employed family member migrates and instead sends remittances home (Katz and Stark 1986; Lucas and Stark 1985; Paulson 1993; Rosenzweig 1988; Rosenzweig and Stark 1989). Even in this case, there is still an increase in migration, but not to the extent that there would be if the entire family migrated together. If the entire family does not migrate, this migration will have no direct effect on the demand for primary and secondary schooling; however, it is likely that at least some people will migrate with their families, particularly those who are permanently relocating to the area (i.e. faculty and staff of the college).

There may be an additional wave of migration after the college enters the local community, stemming from new businesses entering the newly expanded market (Agesa 2001; Carrington et al. 1996). If there are greater employment opportunities or higher wages available in the community around the college, these higher labor market returns attract migrants (Agesa 2001; Bardhan and Udry 1999; Boustan 2017; Harris and Todaro 1970; Marshall 1890; Moretti 2019; Sanso-Navarro et al. 2017). Carrington et al. (1996) also find that as more people migrate, moving costs for future migrants decrease, incentivizing more migration.

With a larger population, demand for goods increases, so new businesses will open in the community to meet these needs. These businesses may be started by more migrants or they may be a new source of revenue for the native population. This expanded population leads to an increase in the aggregate demand for all levels of schooling.

The population effects on an individual native household's demand for schooling are more ambiguous. The influx of migrants leads to an increase in housing demand before the market has time to adjust its supply of housing, which leads to an increase in housing prices (Roback 1982; Roback 1988; Moretti 2004; Reynolds and Rohlin 2015). This often leads to neighborhood gentrification, pushing native residents out of the community (Reynolds and Rohlin 2015). If natives move out of the communities surrounding a college, a change in the aggregate demand for primary and secondary schooling may not reflect an improvement in educational outcomes for the native population. Instead, it may reflect a change in the composition of the population. If many of the migrants are migrating for the purpose of education, it is likely they value education more highly than the average resident, which may make them more likely to invest in their children's schooling. If this is the case and natives are being pushed out of their communities, though school enrollment may increase, estimates of enrollment spillovers will be upward biased and not reflect an actual increase in enrollment for the native population.

Inmigration may instead have a positive effect on the native population's demand for schooling. If the expansion of the population leads to job creation or greater diversity in economic opportunity, this raises household income for natives (Glaeser 1999; Lucas 1988; Moretti 2004). An increase in household income shifts the household budget constraint outward, increasing the household's choice set. According to the decision framework outlined in the previous section, this easing of household constraints will lead to an increase in the native population's demand for schooling.

4.1.2 *Innovation*

Universities increase research output, which leads to positive technology shocks in the community (Abel and Deitz 2011; Audretsch and Feldman 2019; Feldman 1994a; Glaeser 1999; Krugman 1991a; Lucas 1988). This leads to an increase in productivity in the local and aggregate economy, which should lead to an increase in wages (Abramovsky and Simpson 2011; Bell et al. 2018; Hadzimustafa 2011; Hausman 2012; Toivanen and Vaananen 2016; Valero and Van Reenen 2016). In either instance, innovation increases the benefits of schooling, which also increases the returns to schooling. This leads to higher demand for schooling.

4.1.3 *Complementary Industries*

The effects a college has on the local community's development may be underestimated if knowledge and innovation flows are complementary and there are increasing marginal returns to human capital investment as theories of matching suggest (Autant-Bernard 2001; Ciccone and Peri 2006; Easterly 2002; Feldman 1994b; Glaeser 1999; Krugman 1991b; Marshall 1890; Moretti 2004; Niehaus 2012; Palacios 2005; Paytas et al. 2004; Roback 1982; Roback 1988). The population not only increases in size with the establishment of a college, but also becomes diversified in terms of skills (Moretti 2004; Roback 1982; Roback 1988). If a college did not exist in the area prior to this new institution, it is likely that many of the new migrants who are employed by the college or attending the college have higher education levels than the native population. Since there is now an increase in the college-educated population, investors are more likely to develop highly skilled industries in this community (Abel and Deitz 2011; Castro 2014; Fischer et al. 2009; Glaeser 1999; Moretti 2004; Paytas et al. 2004; Roback 1982; Roback 1988; Sena and Higon 2014).

In accordance with theories of economic geography and agglomeration, as these advanced industries develop, complementary advanced industries will also develop (Bresnahan et al. 2001; Carlino and Kerr 2015; Duranton and Kerr 2015; Duranton and Puga 2019; Glaeser 1999; Hausman 2012; Palacios 2005; Rosenthal and Strange 2008; Marshall 1890; Thisse 2018). This may lead to the development of an industrial cluster like in the case of the development of the software industry in Bangalore, Karnataka, India following the establishment of the Indian Institute of Science, the technological cluster in Guadalajara, Mexico, and Kenya's "Silicon Savannah" (Easterly 2002; Palacios 2005; Rosen 2015; Mallonee 2018; Dahir 2017). The development of these industries also increases labor demand. The increase in higher paying jobs and in the level of employment should spur the development and growth of the economy, which should increase social welfare.

Further, the newly diversified labor market increases the returns to schooling through increasing the potential wage for people who obtain an education (Bell et al. 2018; Chetty and Hendren 2018; Chetty et al. 2018; Easterly 2002;

Glaeser 1999). Since the returns to schooling are an input into the household's human capital investment decision, an increase in returns leads to an increase in the demand for schooling (Card 1994; Card 2001; Mincer 1974).

4.1.4 *Income*

An increase in the college-educated population increases wages throughout the labor market, for both skilled and unskilled workers (Moretti 2002; Rosenthal and Strange 2008; Schumacher et al. 2014). Similarly, this increased proportion of college-educated people in the population often correlates with an increase in firm productivity, even for low skilled industries (Roback 1982; Roback 1988; Moretti 2004).

The productivity to wage spillover occurs not only through agglomeration effects, but also through human capital externalities (Glaeser 1999; Marshall 1890; Moretti 2004; Rauch 1993). Human capital externalities arise through learning spillovers and knowledge diffusion (Lucas 1988; Marshall 1890; Moretti 2004; Easterly 2002). Learning spillovers and knowledge diffusion can occur through various mechanisms, including individuals sharing new techniques and ideas with their coworkers and employers to increase productivity (Easterly 2002; Glaeser 1999; Lucas 1988; Marshall 1890). These human capital externalities also occur through the creation of social networks that lend to the interaction of individuals in the local population (Glaeser 1999; Marshall 1890).

Human capital externalities lead to increased output which leads to higher wages (Abramovsky and Simpson 2011; Bell et al. 2018; Glaeser 1999; Hadzimustafa 2011; Hausman 2012; Moretti 2004; Rauch 1993; Toivanen and Vaananen 2016; Valero and Van Reenen 2016). If education is a normal good, this increase in income will ease household income constraints and will lead to an increase in the demand for schooling (Basu and Van 1998; Cameron and Taber 2004; Goodman 2010; Soares et al. 2012).

4.1.5 *Quality of Education*

Population expansion often leads to an increase in the number of schools, which may affect the overall quality of education (Jagnani and Khanna 2018; Muralidharan and Sundararaman 2015).[1] While the quality of education may not increase in every school, the average quality of education may increase. Hanushek, Lacy, and Hitomi (2006) find that lower quality schools in Egypt are correlated with lower levels of educational attainment. Dobbie and Fryer (2012) find a strongly significant effect of high-quality schools on human capital accumulation. With a higher number of schools, class sizes and student-teacher ratios may decrease, which increases returns to schooling, which should increase the demand for schooling (Angrist and Lavy 2003; Fredriksson et al. 2013; Fryer and Katz 2013; Gilraine et al. 2018; Krueger 2003).

Colleges may also have resource spillovers on local primary and secondary schools that increase the quality of schooling, in turn increasing the benefits and returns to schooling (Brumbauch and Ridenour 2003; Callahan and Martin 2007; Castleman et al. 2016; Clark 1999; Sallee and Tierney 2007). This again leads to an increase in average educational attainment. Opper (2016) finds higher quality education, particularly from good teachers, has a lasting effect on students' educational longevity and achievement. Further, he finds there are spillovers on the students' future peers that also increase these students' educational attainment and achievement.

4.1.6 *Role Models*

The larger share of the college-educated population serves as a source of role models for children in the population. Role models have a positive effect on educational attainment and achievement (Bell et al. 2018; Fruehwirth 2017;

[1] Even if the number of public schools does not change, the number of private schools will increase (Jagnani and Khanna 2018; Muralidharan and Sundararaman 2015).

Nguyen 2008). Children stay in school longer when there are people around them who encourage them to do so (Muralidharan and Sheth 2016). This effect is particularly pronounced for girls when they have female role models (Muralidharan and Sheth 2016). Role models can also help children perceive higher returns to education since they can tangibly see the returns to schooling for people they know (Bell et al. 2018; Chetty and Hendren 2018; Nguyen 2008). Additionally, this increases information flows to parents, who are often the decision makers for their children's school enrollment. If parents perceive a higher return to education, they awill keep their children enrolled in school longer, thus increasing aggregate educational attainment (Jensen 2010; Manski 1993; Nguyen 2008).

4.2 *Supply of Schooling*

The entrance of a university in a community affect primary and secondary levels of schooling indirectly by changing other characteristics of a community that may be at least partially deterministic of the supply of primary and secondary schools. In this section, I explore how population and infrastructure effects change the supply of lower levels of schooling.

4.2.1 *Population*

A newly established college attracts migrants to a community, increasing the local population. With an expanded potential student population, more primary and secondary schools are likely to enter the market until the schooling market returns to an equilibrium. This increase in schools may not come from an increase in public schools, but there will likely be an increase in the amount of private schools (Duflo 2001; Kremer and Muralidharan 2008; Pal 2010; Jagnani and Khanna 2018). In some places, these private schools are actually more cost effective than public schools so they are not necessarily inaccessible to the local population (Alderman et al. 2003; Muralidharan and Sundararaman 2015). An increase in the number of primary and secondary schools decreases transportation costs for students because they do not have to travel as far since there are now schools closer to home (Carneiro and Reis 2016; Carneiro, Das, and Reis 2015). This decreases the time required to travel to and from school, thus decreasing the cost of attending school, which in turn increases the returns to schooling (Jagnani and Khanna 2018). An increase in the returns to schooling leads to an increase in the average educational attainment of the population.

4.2.2 *Infrastructure*

The college itself and the businesses it attracts to the local community lead to an increase in the level of infrastructure. Increases in infrastructure lead to increases in productivity, which can crowd in other types of investment (Munnell 1989). This increased investment leads to an increase in the number of jobs available in the community. Jagnani and Khanna (2018) found that elite public colleges in India *crowded in* public infrastructure and public goods including roads, electricity, and water. They also found that this was correlated with an increase in the number of private schools near these new colleges. Again, an increase in the number of schools decreases the costs of schooling, which increases aggregate educational attainment.

5 DATA

The Demographic and Health Surveys (DHS) program is a data collection effort funded by the United States Agency for International Development. The DHS yield nationally representative household survey data from over 90 countries. Surveys are conducted in waves approximately five years apart, generating repeated cross-sectional data for each country (Ghana Statistical Service et al. 2015; ICF 2004-2017; Kenya National Bureau of Statistics et al. 2015; Uganda Bureau of Statistics and ICF 2018).

Data are collected with a two-stage stratified sampling strategy consistent with the framework of the most recent census in each country. In the first stage, census enumeration areas (also referred to as clusters or communities) are selected at random to be included in the survey. On average, each of these clusters (customarily defined by population size) encompasses approximately 130 households. In the second stage of the sampling design, 25 to 30 households from each enumeration area are randomly selected to be surveyed (Ghana Statistical Service et al. 2015; ICF 2004-2017; Kenya National Bureau of Statistics et al. 2015; Uganda Bureau of Statistics and ICF 2018).

My research utilizes the Household Member DHS datasets, which include information on each member of the household as reported by the female head of the household. This person level dataset contains information about educational attainment, assets, demographics, and family background. I append all available waves within each country to create a repeated cross-sectional dataset. To compile these datasets, I use four waves of data for Uganda (2000-2001, 2006, 2011, 2016), three waves for Kenya (2003, 2008, 2014), and five waves for Ghana (1993, 1998, 2003, 2008, 2014; Ghana Statistical Service et al. 2015; ICF 2004-2017; Kenya National Bureau of Statistics et al. 2015; Uganda Bureau of Statistics and ICF 2018).

Since I am interested in geographic spillovers, I link each wave of the DHS survey datasets with its respective geographic shape file. These geocoded data contain geographic coordinates at the household cluster-level for each specific country and wave of data collection. Geographic coordinates are assigned based on the center of the household cluster. To maintain confidentiality of survey respondents, there is noise inserted into the geographic data, limiting the precision of my estimates. Communities are randomly displaced, with urban communities displaced up to two kilometers and rural communities displaced up to five kilometers. One percent of rural communities are displaced up to 10 kilometers. There are several clusters within each wave of data for each country whose geographic coordinates are not reported. Because geographic coordinates are essential for my analysis, I drop individuals residing in these communities from my sample (ICF 2004-2017).

Because there are no available datasets of higher education institutions and their geographic locations in each country, I assemble these datasets myself. First, I compile lists of accredited universities in each country from the Uganda National Council for Higher Education (2018), Kenya's Commission for University Education (2017), and Ghana's National Accreditation Board (2020). While other higher education institutions (e.g. vocational schools) may have spillovers, I focus on bachelors-granting institutions in this paper. For Ghana, determining whether an institution offered bachelors degrees required further research into the degree offerings of every higher education institution accredited by Ghana's National Accreditation Board (totaling 229 institutions). Some colleges are highly specialized and offer as few as one to two majors or programs, so I include all colleges with at least one bachelors degree offering. My higher education datasets include 52 bachelors degree awarding colleges in Uganda, 60 in Kenya, and 80 in Ghana. For each college, I record the type of institution (public or private), the year it was established or received its charter, and the city or town it is located in.[2] To obtain the precise location of each college, I locate each institution on Google Maps and record its latitude and longitude coordinates (Commission for University Education 2017; National Accreditation Board Ghana 2020; National Council for Higher Education 2018).[3]

Finally, I merge the college datasets I created with the collated DHS datasets to measure the connectivity of each household to higher education. With this dataset, I locate the nearest college to each community and its respective distance from the community. I also record the number of colleges located within a 25 kilometer radius of the community since these institutions may be relevant to the likelihood of other colleges opening in the same area and may decrease the marginal benefit of an additional college opening within close proximity (if there are diminishing marginal returns to colleges within the same geographic area).

For my analysis of spillovers on primary school, I restrict my samples to primary school age children (ages six through 13) who live in treated communities. Treated communities are those located within 25 kilometers of a college established in the time period of interest, which I define in my empirical approach section. This yields a sample size of 17,756 children in Uganda, 21,050 children in Kenya, and 8,505 children in Ghana.

Likewise, to study the spillovers on secondary school, I restrict the samples

[2]I list the establishment year for each college, unless the college was granted a charter post-establishment, in which case I include the year the college was chartered. This distinction only occurs for colleges in Kenya.

[3]Some universities have multiple campuses. To maintain consistency with the lists of accredited institutions, I only include the main campus of these universities in my higher education datasets.

to secondary school age children, those between ages 14 and 18, who live in treated communities. My sample size of secondary school age children is 8,130 in Uganda, 10,699 in Kenya, and 4,437 in Ghana.

Note that my sample sizes for Ghana are considerably smaller than those for Kenya and Uganda. Moreover, the Ghana sample is spread across more rounds of data collection, meaning there are fewer individuals within each wave in Ghana. Ghana's more limited sample size will lead to less precise estimates (and larger standard errors) of spillovers.

Wealth index quintile is the best measure of a family's socioeconomic status available in the DHS data since individuals do not report income, wages, or total value of assets.[4] I control for wealth index quintile in my main specifications because it approximates the resource constraints families face and these constraints are central to the educational investment decision, particularly in the contexts of the developing countries I study. The index is constructed from a series of questions about household assets (e.g. water source, electricity, refrigerator, telephone, bicycle). The variable measures household wealth relative to other households in the country. Wealth index quintile is a categorical variable, where one represents belonging to the lowest wealth bracket and five represents belonging to the highest wealth bracket (ICF 2004-2017).

The DHS data collection for Ghana begins earlier than it does in Uganda or Kenya. In the first two rounds of Ghana data, wealth index quintile is not recorded, so I also run the same regressions for Ghana excluding wealth index quintile to extend my analysis over a greater period of time. This expands Ghana's primary school sample to 11,807 children and Ghana's secondary school sample to 6,053 children.

[4] I attempted to find a data source with more specific measures of income, wages, or assets, but did not find an alternative data source with this information *and* specific geographic locations.

6 DESCRIPTIVE STATISTICS

6.1 *Uganda*

Educational attainment in Uganda has generally been linearly increasing over time, as seen in Figure 1. Educational attainment reaches a peak of just under eight years of education for the 1990-1994 birth cohort. The 1990-1994 birth cohort has the highest educational attainment, but the dip in the 1995-1999 cohort may occur because there is this is the youngest cohort included. Only a portion of the 1995-1999 birth cohort is old enough to be included in these calculations. The older side of this cohort is 18 years old or just over 18 years old when sampled, so if individuals are still in school between 18 and 21 years of age (which may be the case if they are in higher education, have repeated grades, or have delayed their primary or secondary education), then we expect educational attainment to be lower for this cohort (Figure 1).

To study the educational attainment trends for younger cohorts, I consider average school enrollment status for each age group (Figure 2; Table 2). I plot enrollment over time and by age for primary school aged children. It appears there are generally similar trends of increased enrollment over time for nearly all age groups, implying there is likely a continuation of the observed trend of a positive correlation between birth cohort and educational attainment (Figure 2).

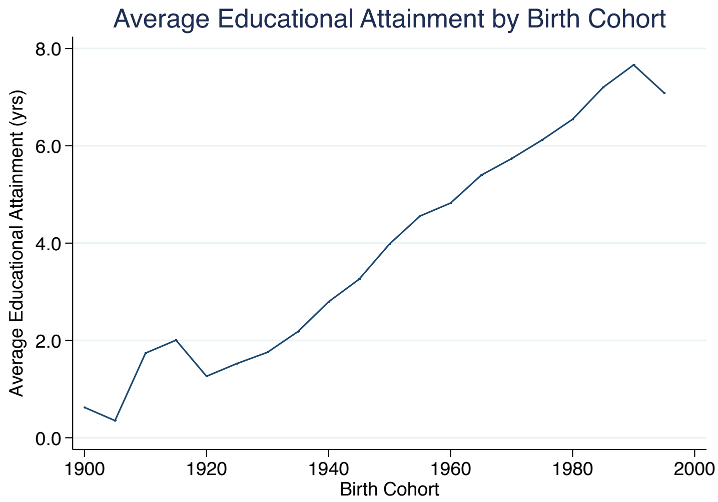
School enrollment is the most variable for six year olds. Since primary school begins at age six in Uganda, it is expected that some six year olds would not yet have begun primary school, dropping the average enrollment of six year olds below that of older school aged children. Enrollment gradually increases each year until reaching a peak at 11 years old, when 93 percent of 11 year olds are enrolled in school. In my sample, enrollment is above 90 percent for nine to 13 year olds and average enrollment for the entire primary school age group (ages 6 to 13) is at 86 percent (Figure 2; Table 2).

School enrollment is at its lowest for all age groups in 2006. Between 2006 and 2011, there is over a 10 percentage point increase in the enrollment of six year olds, implying the low enrollment in 2006 is not entirely due to the alignment of birth dates and the academic calendar.

In the absence of any control variables, primary school enrollment in Uganda appears to have a weak correlation with the timing of a nearby college opening, but secondary school enrollment appears to have a positive correlation with the establishment of a college. Secondary school enrollment trends fluctuate with each individual year, but remain generally stagnant prior to the establishment of a nearby college. In the years after the college opens, local secondary school age children appear to be enrolled in school at higher rates (Figure 3).

I calculate other summary statistics in Table 3 to examine other characteristics of children in my sample that may be important to consider in my work. Only 17 percent of my sample lives in urban communities. Educational attainment is often lower in rural areas than in cities so its possible that rural children's educational attainment may be more greatly influenced by the establishment of a college nearby since their school enrollment has greater potential to increase than urban children's enrollment. Since there are often fewer schools in rural areas, children have to travel farther to get to school, raising transportation costs and decreasing the likelihood of a child attending schools. Households in my sample have limited access to private transportation so these transportation costs may be outside of many families' constraints, thus limiting

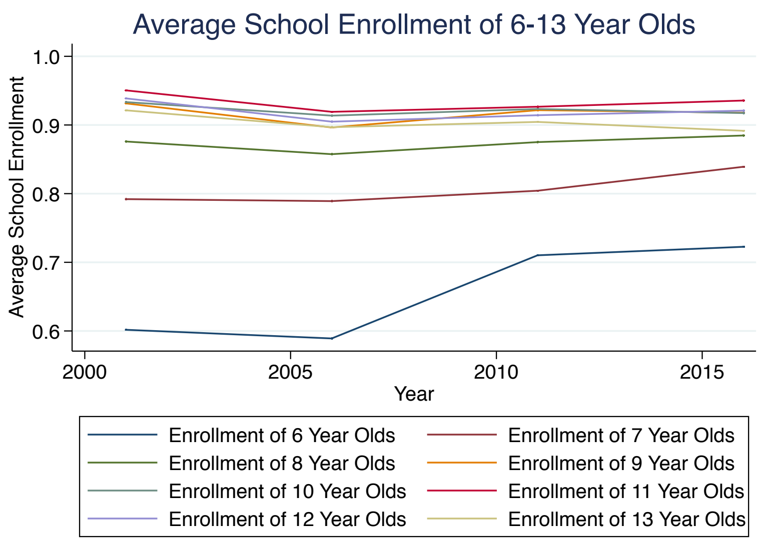
Figure 1



Note: Sample is restricted to people ages 18 or older for this graph since these individuals are no longer of primary or secondary school age. Most of the population in Uganda would likely have reached or nearly reached their lifetime educational attainment by this age. Enrollment data are from the 2001-2016 waves of the Demographic and Health Survey for Uganda. Educational attainment is topcoded at 26 years since this would be primary, secondary, tertiary, and some graduate school if no grades were repeated. Individuals with higher educational attainment have misreported values or are outliers.

their choice sets and likely leading to lower educational attainment in the long run (Muralidharan and Prakash 2013).

Figure 2



Note: Sample is restricted to primary school aged children (6 to 13 years old). Enrollment data are from the 2001-2016 waves of the Demographic and Health Survey for Uganda.

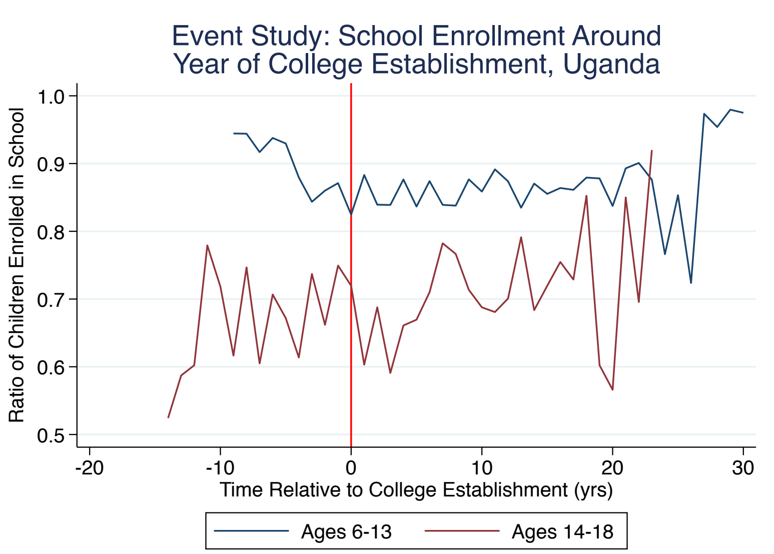
Table 2

Average School Enrollment by Age, Uganda

	Mean	SD	N
Enrollment of 6 Year Olds	0.67	0.06	7,829
Enrollment of 7 Year Olds	0.81	0.02	7,152
Enrollment of 8 Year Olds	0.88	0.01	7,165
Enrollment of 9 Year Olds	0.92	0.01	6,136
Enrollment of 10 Year Olds	0.92	0.01	7,266
Enrollment of 11 Year Olds	0.93	0.01	5,109
Enrollment of 12 Year Olds	0.92	0.01	6,714
Enrollment of 13 Year Olds	0.90	0.01	5,983
Enrollment of 14 Year Olds	0.87	0.01	5,310
Enrollment of 15 Year Olds	0.81	0.01	4,435
Enrollment of 16 Year Olds	0.72	0.03	4,538
Enrollment of 17 Year Olds	0.58	0.05	3,598
Enrollment of 18 Year Olds	0.42	0.03	4,333
Average Enrollment of 6-13 Year Olds	0.86	0.01	53,354
Average Enrollment of 6-10 Year Olds	0.83	0.02	35,548
Average Enrollment of 9-13 Year Olds	0.92	0.01	31,208

Notes: Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID.

Figure 3



Note: Sample is restricted to children ages 6 to 18. Enrollment data are from the 2001-2016 waves of the Demographic and Health Survey for Uganda.

Table 3

Descriptive Statistics, Children ages 6-13, Uganda

	Mean	SD	N
Enrolled in School	0.86	0.34	53,354
Attended School Last Year	0.73	0.44	19,244
Current Grade Level	2.78	1.58	43,296
Educational Attainment in Years	2.28	1.86	53,354
Distance to Nearest College (km) Established 1996-2015	43.08	32.46	52,067
Number of Colleges within 25 km of Community	1.14	3.99	53,354
Current Age	9.31	2.31	53,354
Age in Year when College was Established	8.11	7.57	53,354
Attended Primary School	0.78	0.42	53,354
Urban	0.17	0.37	53,354
Male	0.50	0.50	53,354
De Jure Household Members	7.02	2.68	53,354
Number of Kids in Household Age 5 or Under	1.33	1.10	53,354
Bicycle	0.43	0.51	53,343
Motorcycle or Scooter	0.08	0.32	53,334
Car or Truck	0.03	0.23	53,334
Time to Get to Water Source (min)	45.83	43.80	52,805
Bednet	0.59	0.49	53,353
Electricity	0.15	0.40	53,331
Refrigerator	0.04	0.31	53,337
Telephone	0.02	0.15	53,347
Radio	0.58	0.51	53,347

Notes: This sample is restricted to school age children between 6 and 13 years old. Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

6.2 *Kenya*

In line with global trends, school enrollment has generally linearly increased over time and reaches a peak of about 8.5 to nine years of education for the 1990-1994 birth cohort, as evidenced in Figure 3 depicting educational attainment by birth cohort of individuals 18 and older. Similarly to the corresponding figure for Uganda (Figure 1), average educational attainment is lower for the youngest birth cohort (1995-1999) than the preceding birth cohort (1990-1994). Only those born in 1995 or 1996 were included in the measure for the youngest cohort, and those included would still only be 18 or 19 years old by this time of data collection. If a significant enough portion of this population is in school at 18 or older, this could be causing the dip observed in Figure 4.

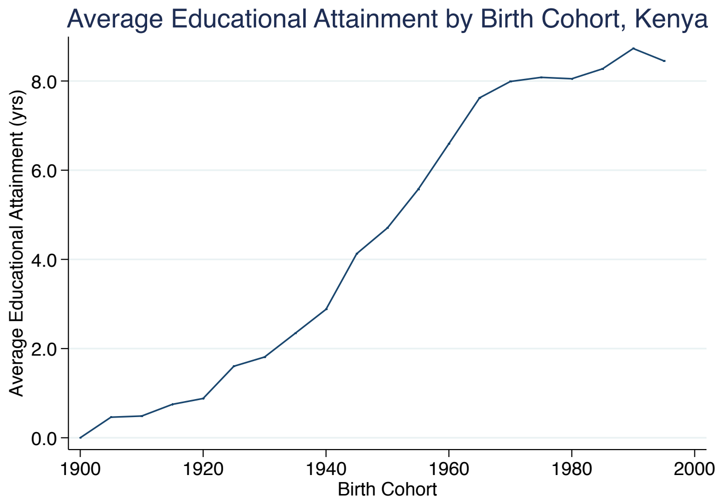
To study the continuing trends in educational attainment in the younger generation, I again study the school enrollment of children under 18 years old. Overall, it appears there is an increase in average school enrollment over time for every age between six and 13 years old. As in Uganda, six year olds are the least likely to be enrolled in school, but they also experience the most dramatic increase in enrollment over time (Figure 5). Again, enrollment is highest for 11 year olds, with 94 percent of children age 11 in school. Enrollment is above 90 percent for nine through 14 year olds. Average enrollment of school aged children (ages six to 13) in my study is 90 percent (Table 4).

School enrollment of primary and secondary school age children in Kenya increases after a college opens. However, the increase appears to be a continuation of the trend in enrollment increases for six to 13 year olds and although there is an increase in enrollment for 14 to 18 year olds, enrollment actually increases at a decreasing rate, meaning gains in enrollment are slower after the college opens. This may point to the existence of underlying linear trends that may simultaneously lead to both a college opening and an increase in primary and school enrollment. This likely indicates that college placement is endogenously determined based on characteristics of the community and potentially the macroeconomy (Figure 6).

I calculate other summary statistics in Table 5 to examine characteristics of children in my sample that may be important to consider in my work. Only 17 percent of my sample lives in urban communities. Educational attainment is often lower in rural areas than in cities so its possible that rural children's educational attainment may be more greatly influenced by the establishment of a college nearby since their school enrollment has greater potential to increase than urban children's enrollment. Since there are often fewer schools in rural areas, children have to travel farther to get to school, raising transportation costs and decreasing the likelihood of a child attending schools. Households in my sample have limited access to private transportation so these transportation costs may be outside of many families' constraints, thus limiting their choice sets and likely leading to lower educational attainment in the long run (Muralidharan and Prakash 2013).

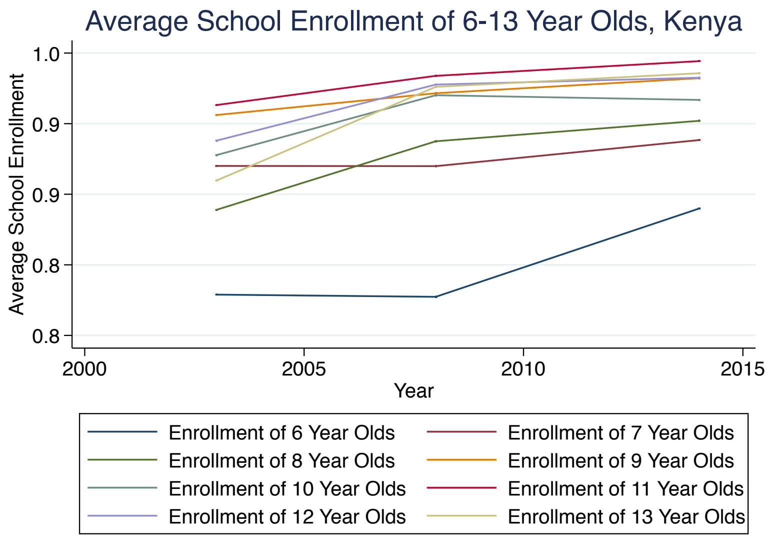
Just over a quarter of school age children in my sample live in urban communities. This is nine percentage points higher than my corresponding sample in Uganda. Again, access to private transportation–as measured by the child's family owning a bicycle, motorcycle, scooter, car, or truck–is very limited. As discussed in the preceding section, this may mean transportation costs of schooling are too high for many families to send their children to school if there is not a school nearby (Muralidharan and Prakash 2013). In this case, the quantity, as well as the geographic placement, of primary and secondary schools is likely a crucial factor in educational attainment. If a college increases the supply of primary and secondary schools, then it likely also increases average school enrollment, and consequently increases educational attainment (Table 5).

Figure 4



Note: Sample is restricted to people ages 18 or older for this graph since these individuals are no longer of primary or secondary school age. Most of the population in Kenya would likely have reached or nearly reached their lifetime educational attainment by this age. Enrollment data are from the 2003-2014 waves of the Demographic and Health Survey for Kenya. Educational attainment is topcoded at 26 years since this would be primary, secondary, tertiary, and some graduate school if no grades were repeated. Individuals with higher educational attainment have misreported values or are outliers.

Figure 5



Note: Sample is restricted to primary school aged children (6 to 13 years old). Enrollment data are from the 2003-2014 waves of the Demographic and Health Survey for Kenya.

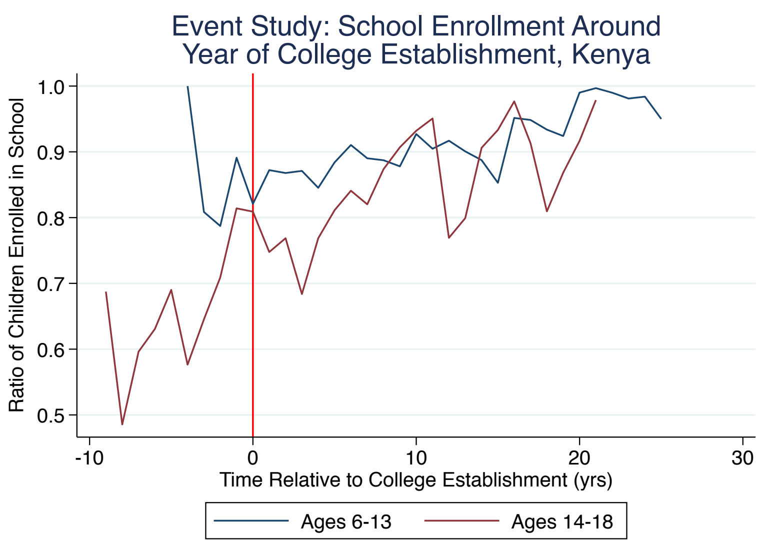
Table 4

Average School Enrollment by Age, Kenya

	Mean	SD	N
Enrollment of 6 Year Olds	0.82	0.03	7,753
Enrollment of 7 Year Olds	0.88	0.01	7,005
Enrollment of 8 Year Olds	0.89	0.02	7,433
Enrollment of 9 Year Olds	0.93	0.01	6,403
Enrollment of 10 Year Olds	0.91	0.01	7,437
Enrollment of 11 Year Olds	0.94	0.01	5,701
Enrollment of 12 Year Olds	0.93	0.02	7,045
Enrollment of 13 Year Olds	0.92	0.03	6,180
Enrollment of 14 Year Olds	0.92	0.04	6,323
Enrollment of 15 Year Olds	0.88	0.04	4,965
Enrollment of 16 Year Olds	0.83	0.06	5,064
Enrollment of 17 Year Olds	0.76	0.07	4,418
Enrollment of 18 Year Olds	0.58	0.09	4,960
Average Enrollment of 6-13 Year Olds	0.90	0.02	54,957
Average Enrollment of 6-10 Year Olds	0.88	0.02	36,031
Average Enrollment of 9-13 Year Olds	0.92	0.02	32,766

Notes: Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID.

Figure 6



Note: Sample is restricted to children ages 6 to 18. Enrollment data are from the 2003-2014 waves of the Demographic and Health Survey for Kenya.

6.3 *Ghana*

Consistent with global trends, average educational attainment increases over time. Educational attainment peaks at eight years of schooling for individuals born in the 1990s (Figure 7).

School enrollment for primary school age children (ages six to 13) increases rapidly between the late 1990s and mid-2000s. Enrollment is consistently lowest for six year olds, but by 2008, over 75 percent of six year olds are enrolled in school. By 2008, enrollment for all other primary school age groups is above 80 percent. Over time, average enrollment is highest for 11 year olds with 84 percent enrolled in school. Over 80 percent of each age group between nine and 14 years old is enrolled in school between 2003 and 2014 (Figure 8; Table 6).

In Figure 9, it appears that educational enrollment in Ghana increases after the establishment of a college for both primary and secondary school age children; however, there is a more rapid increase in enrollment prior to the establishment of the college. This figure has unusually low baseline enrollment at

Table 5

Descriptive Statistics, Children ages 6-13, Kenya

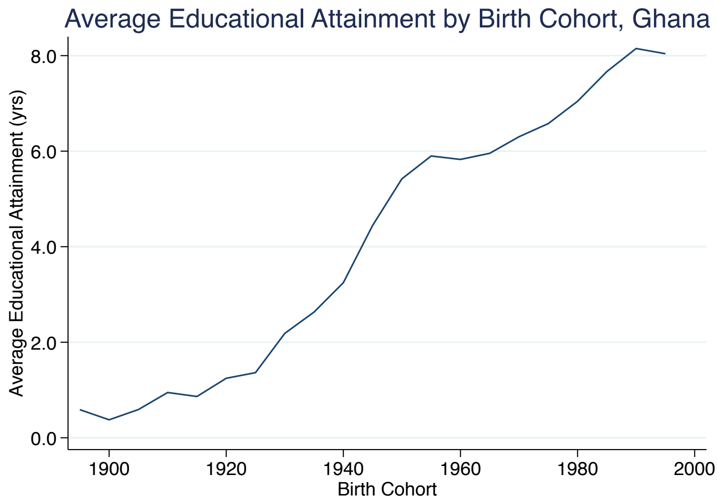
	Mean	SD	N
Enrolled in School	0.90	0.30	54,957
Attended School Last Year	0.86	0.35	54,890
Current Grade Level	3.38	1.92	44,509
Educational Attainment in Years	2.71	2.25	54,957
Distance to Nearest College (km) Established 1996-2015	36.21	30.48	47,538
Number of Colleges within 25 km of Community	0.94	2.63	54,957
Current Age	9.36	2.30	54,957
Age in Year when College was Established	6.68	5.38	54,957
Attended Primary School	0.74	0.44	54,957
Urban	0.26	0.44	54,957
Male	0.51	0.50	54,957
De Jure Household Members	6.38	2.39	54,957
Number of Kids in Household Age 5 or Under	1.02	1.01	54,957
Bicycle	0.25	0.45	54,936
Motorcycle or Scooter	0.06	0.29	54,933
Car or Truck	0.04	0.25	54,930
Time to Get to Water Source (min)	31.25	39.50	52,637
Bednet	0.59	0.50	54,953
Electricity	0.15	0.38	54,941
Refrigerator	0.04	0.25	54,930
Telephone	0.03	0.23	54,909
Radio	0.62	0.50	54,947

Notes: This sample is restricted to school age children between 6 and 13 years old. Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Kenya's Commission for University Education. Geographic data of colleges are obtained from Google Maps.

least in part because there are very few people in the sample who live in a community where the nearest college has not yet been established. I will expand on this later in the paper.

Other summary statistics that provide insight into asset levels, access to education, geographic spread of colleges, and demographic characteristics of my sample are displayed in Table 7. Approximately one third of primary school age children in Ghana live in urban areas that often have greater access to education and resources. Average household size, as measured by de jure household members (or the number of people who usually reside in the household) is similar to that in Kenya and Uganda, at about six to seven people per household. This is important to consider since family size may have an effect on the likelihood of school enrollment (Becker 1963). Families in Ghana have lim-

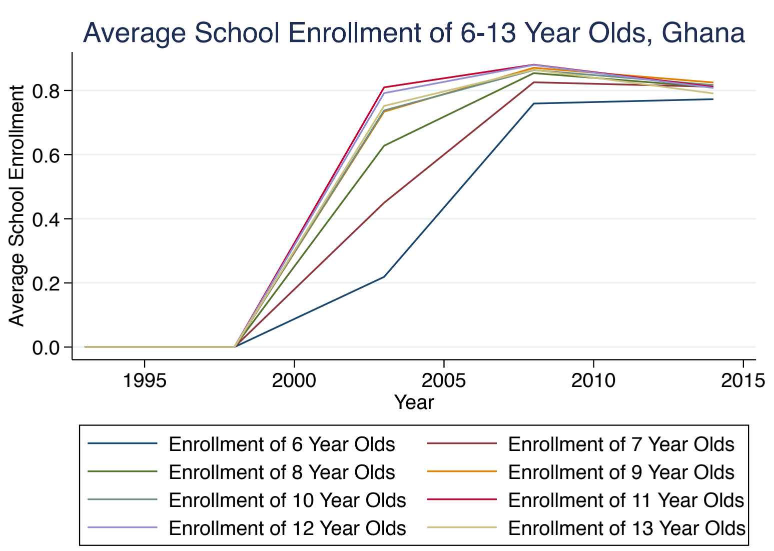
Figure 7



Note: Sample is restricted to people ages 18 or older for this graph since these individuals are no longer of primary or secondary school age. Most of the population in Ghana would likely have reached or nearly reached their lifetime educational attainment by this age. Enrollment data are from the 1993-2014 waves of the Demographic and Health Survey for Ghana. Educational attainment is topcoded at 26 years since this would be primary, secondary, tertiary, and some graduate school if no grades were repeated. Individuals with higher educational attainment have misreported values or are outliers.

ited access to private means of transportation, making transportation costs for schooling more prohibitive than they would otherwise be (Muralidharan and Prakash 2013).

Figure 8



Note: Sample is restricted to primary school aged children (6 to 13 years old). Enrollment data are from the 1993-2014 waves of the Demographic and Health Survey for Ghana.

Table 6

Average School Enrollment by Age, Ghana

	Mean	SD	N
Enrollment of 6 Year Olds	0.64	0.23	3,570
Enrollment of 7 Year Olds	0.73	0.16	3,438
Enrollment of 8 Year Olds	0.79	0.09	3,463
Enrollment of 9 Year Olds	0.82	0.05	3,099
Enrollment of 10 Year Olds	0.82	0.05	3,327
Enrollment of 11 Year Olds	0.84	0.03	2,598
Enrollment of 12 Year Olds	0.83	0.04	3,238
Enrollment of 13 Year Olds	0.81	0.05	3,320
Enrollment of 14 Year Olds	0.80	0.03	2,958
Enrollment of 15 Year Olds	0.74	0.03	2,454
Enrollment of 16 Year Olds	0.67	0.06	2,241
Enrollment of 17 Year Olds	0.56	0.01	1,994
Enrollment of 18 Year Olds	0.43	0.03	2,534
Average Enrollment of 6-13 Year Olds	0.78	0.09	26,053
Average Enrollment of 6-10 Year Olds	0.76	0.12	16,897
Average Enrollment of 9-13 Year Olds	0.82	0.04	15,582

Notes: Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID.

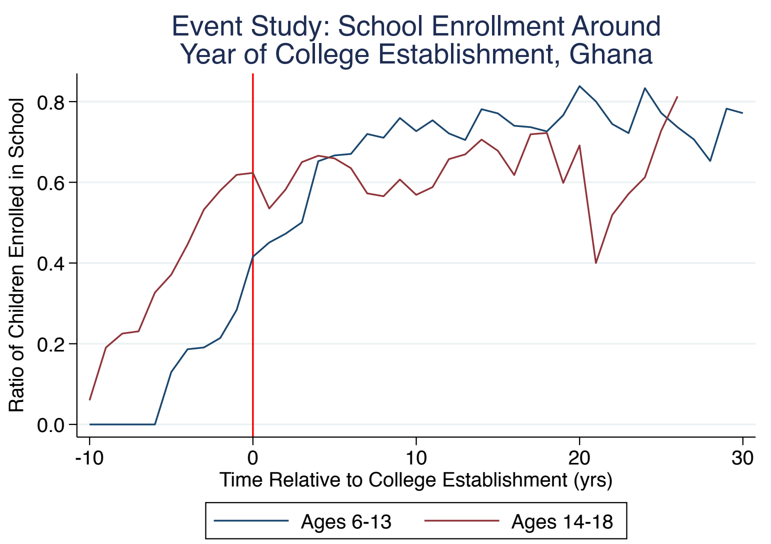
Table 7

Descriptive Statistics, Children ages 6-13, Ghana

	Mean	SD	N
Enrolled in School	0.55	0.50	36,868
Attended School Last Year	0.74	0.44	16,548
Current Grade Level	2.91	1.59	19,389
Educational Attainment in Years	3.58	2.88	36,868
Distance to Nearest College (km) Established 1996-2015	46.29	38.01	33,053
Number of Colleges within 25 km of Community	1.90	5.21	36,868
Current Age	9.38	2.32	36,868
Age in Year when College was Established	8.60	8.02	36,868
Attended Primary School	0.72	0.45	36,868
Urban	0.34	0.47	36,868
Male	0.52	0.50	36,868
De Jure Household Members	6.48	2.93	36,868
Number of Kids in Household Age 5 or Under	1.03	1.06	36,868
Bicycle	0.37	0.49	36,867
Motorcycle or Scooter	0.08	0.28	36,868
Car or Truck	0.06	0.26	36,868
Time to Get to Water Source (min)	19.21	21.07	34,160
Bednet	0.56	0.50	26,053
Electricity	0.43	0.52	36,860
Refrigerator	0.18	0.43	36,860
Telephone	0.03	0.29	31,465
Radio	0.64	0.51	36,863

Notes: This sample is restricted to primary school age children between 6 and 13 years old. Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

Figure 9



Note: Sample is restricted to children ages 6 to 18. Enrollment data are from the 1993-2014 waves of the Demographic and Health Survey for Ghana.

7 EVENT STUDY

An event study is a statistical method that allows researchers to consider the relationship between variables of interest and the timing of an event. An event can be anything of interest including international migrations, the opening of a school, and the passage of a policy. Event studies classify observations in relation to their timing of the event and allow the flexibility of studying a window of time before and after the event. This methodology does not force a trend on the pre-treatment data, but rather considers what the trends are both before and after the occurrence of the event. Event study frameworks can be used to study short and long term effects, but currently are most commonly used to estimate trends. Moreover, event studies are nonparametric in nature, because coefficients are estimated separately for each time interval (e.g. five years before an event, the year the event occurs, five years after the event, 10 years after the event). This gives the event study even greater flexibility and makes it appealing for studying patterns and underlying data structures (Kondylis and Loeser 2019).

At times, event studies can be used in place of a regression discontinuity or difference-in-differences approach, which are more common in the economics literature. All three methodologies study natural experiments over time, but they differ in terms of their identification assumptions and primary goals (Kondylis and Loeser 2019).

With a regression discontinuity design, the researcher usually assumes there is a discontinuity at a specific time or point. For instance, there is a jump in social security receipt at age 60 because individuals become eligible for the pension at age 60. A regression discontinuity requires a control group that is assumed to be the same as the treated group, except the control group is just barely ineligible. In the previous example, individuals age 55 to 59 can serve as the control group and individuals age 60 to 64 can be the treated group (Angrist and Pischke 2014).

In a difference-in-differences approach, the researcher must pair a treated group with another group that seems similar but did not receive the treatment. For example, if a health treatment is prescribed to one group of patients and a placebo is given to another group of patients with the same symptoms and diagnosis, the effect of the treatment can be studied through a difference-in-differences framework. This approach requires establishing the parallel trends assumption, meaning both the treatment and control groups exhibit similar patterns prior to receipt of treatment. If the researcher can can make a convincing case, then we assume the difference-in-difference is due to the treatment itself (Angrist and Pischke 2014).

An event study offers an alternative to these approaches that does not require the same identifying assumptions. Some event studies can be done with stricter assumptions, but they offer the flexibility to be done without these strict assumptions. Unlike the regression discontinuity and difference-in-differences frameworks, an event study does not require an exogenous change. This makes an event study an appropriate choice for many cases where there is no exogenous variation, but there remain questions to study. If there is sufficient variation in the timing of data collection and the number of events, then there is sufficient variation to counter the absence of an exogenous change. When event studies are conducted in the absence of an exogenous change, their explanatory power is limited in terms of providing evidence of causal effects. Even in these cases, they can still provide some convincing evidence and demonstrate patterns in trends that may tell an interesting story (Angrist and Pischke 2014; Kondylis and Loeser 2019; Jagnani and Khanna 2018; Sandler and Sandler 2013; Todd 2008).

7.1 *Review of Event Study Literature*

The event study methodology is more common in the finance literature but has risen in popularity in the public finance and labor economics literature in recent years (Khotari and Warner 2006; Jacobson, LaLonde, and Sullivan 1993; Campbell et al. 2009; DellaVigna 2010; Sandler and Sandler 2013; Borusyak and Jaravel 2017). Within the labor and public economics literature, event studies are more commonly employed parallel to other identification strategies to investigate assumptions or assess exposure effects of a policy (Hoynes et al. 2012; Hoynes et al. 2015). Sometimes event studies are used in place of a difference-in-difference or regression continuity design because event studies offer more flexibility and provide a framework through which to study varying impacts in the short-run and long-run (Kondylis and Loeser 2019).

Event studies can be done with a control group–similar to a difference-in-difference approach–or without a control group, instead comparing the pre-treatment period to the post-treatment period. If there is variation in the timing of the event across the data, it is unnecessary, and potentially redundant, to include a control group (Sandler and Sandler 2013). Excluding a control group circumvents endogeneity concerns by avoiding comparing two dissimilar populations since treated areas might be fundamentally different from untreated areas (Jagnani and Khanna 2018; Todd 2008). When an event study is limited to only treated individuals, the "control group" becomes individuals in the pre-treatment period (Jagnani and Khanna 2018; Sandler and Sandler 2013; Todd 2008).

7.2 *Event Study Specification*

Though the event study design is flexible, lending itself to modification, most event study specifications in the public finance literature take a form similar to the following equation:

$$y_{ijt} = \Sigma_{\tau=-p}^{-1} \beta_\tau 1(t - T_j^* = \tau) + \Sigma_{\tau=0}^{m} \beta_\tau 1(t - T_j^* = \tau) + \chi + \epsilon_{ijt}$$

(Bailey and Goodman-Bacon 2015; Jagnani and Khanna 2018; Sandler and Sandler 2013). In this specification, y_{ijt} represents the outcome variable of interest for person i in community j at time t. y_{ijt} equals one when the binary outcome variable equals one, or is true, for individual i in community j at time t. Here χ is a vector of controls and ϵ_{ijt} is the stochastically distributed error term.

Event study specifications must define an event window to study. T_j^* is the year the event occurred in community j (i.e. the year a college or health clinic was established). τ is the time relative to the occurrence of the event, so in year T_j^*, $\tau = 0$. In the pre-treatment years, $\tau < 0$, while in the post-treatment years, $\tau \geq 0$. To avoid the dummy variable trap, one wave must be omitted from the regression (Sandler and Sandler 2013). The omitted wave is typically the wave prior to the event ($\tau = -1$). This wave serves as a baseline, meaning all coefficients are reported in relation to the wave $\tau = -1$. The number of waves before and after the event included in the analysis need not be equivalent. Here p and m are both measures of the number of waves away from the occurrence of the event an individual is at time t. The same variable can be used if there is an equivalent number of waves pre- and post-treatment included in the study. Here p represents the number of waves pre-treatment and m represents the number of waves post-treatment.[5]

The first term in the specification above represents the pre-treatment waves, while the second term captures the post-treatment years. In an event study, the coefficients of interest are those on the event year dummy variables (β_t).

[5] Accordingly, p is negative.

8 EMPIRICAL APPROACH

Because I do not study the effects of a specific exogenous policy change, selecting an identification strategy and empirical methodology to test for a causal impact poses a greater challenge. To overcome this challenge, I use an event study framework where I compare outcomes in treated communities pre- and post-treatment. Through an event study specification, I study the differential impacts at various time intervals before and after the nearest college was established (Kondylis and Loeser 2019).

8.1 *Identification Concerns and Study Design*

Since college placement is likely endogenously determined based on geographic and demographic characteristics, comparing communities with a college and those without a college is problematic (Orazem and King 2008; Jagnani and Khanna 2018; Todd 2008). Additionally, the timing of college establishment is likely correlated with other determinants of educational attainment. For instance, if a community's per capita income is rising, there may be a rise in educational attainment of children and a college may be more likely to open since education is a normal good and people will send their children to school when their budget constraint is not binding. At the same time, a college is more likely to open when aggregate income rises, since there may be a change in the local economy leading to a rise in the returns to higher education. Further, it is more likely for colleges to open in communities that have greater potential for an impact to be made. To address this identification concern, I compare treated communities in the years *before* and *after* treatment, rather than comparing treated communities to untreated communities. To do this, I restrict my analysis to communities that are located within 25 kilometers of a college established within my event window.[6]

Because I study colleges that have been established at different times, my sample includes variation in timing. This variation avoids picking up effects of aggregate shocks that may be correlated with increased educational attainment. I also include birth cohort fixed effects to control for differences in educational attainment between birth cohorts. This may control for historical events that may be correlated with educational attainment, such as a famine.

Since school enrollment is more variable for secondary school, I separate my analysis into spillovers on primary school and spillovers on secondary school. I define primary school age children as six to 13 year olds and secondary school age children as 14 to 18 year olds, in accordance with other education economics literature (Duflo 2001). Accordingly, my specification studies the effects of a college opening on the school enrollment of six to 13 year olds and 14 to 18 year olds in the local community.

8.2 *Empirical Specification*

My empirical strategy exploits variation in the timing of college establishment to study the educational attainment of communities with a newly established college within 25 kilometers through an event study framework given by the following equation:

$$y_{ijt} = \Sigma_{\tau=-p}^{\tau=-1} \beta_\tau 1(t - T_j^* = \tau) + \Sigma_{\tau=0}^{\tau=m} \beta_\tau 1(t - T_j^* = \tau) + \eta_i + \gamma_j + \chi_t + \epsilon_{ijt},$$

[6]The event window varies slightly by country. It is defined based on the available waves of DHS data.

where y_{ijt} is the outcome variable of interest: a binary variable equal to one if child i in community j is enrolled in school at time t. Here η_i is a vector of controls specific to individual i, γ_j is a vector of controls specific to community j, χ_t is representative of birth year fixed effects, and ϵ_{ijt} is the stochastically distributed error term. In this specification, u represents the number of untreated waves (before the establishment of the nearest college) and p represents the number of treated waves.

At the individual level (η_i), I control for a child's sex and the family's wealth index quintile, since these characteristics have been found to affect educational attainment. A child's gender often has a strong impact on her educational attainment, but this effect varies greatly between countries (Muralidharan and Sheth 2016). I use the wealth index quintile of the child's family as a proxy for family income. I control for this since income affects the constraint in the educational investment decision (Darvas et al. 2017; Orazem and King 2008).

At the community level (γ_j), I control for urbanicity and the number of colleges within 25 kilometers. Educational attainment is often significantly higher in urban communities than in rural communities, so I control for this potentially confounding variable (Darvas et al. 2017; Orazem and King 2008). I assume there are diminishing marginal returns to colleges in each community, meaning if there are many colleges in a community, the marginal benefit of an additional college opening will be smaller than if there are none or very few colleges. To control for this effect, I control for the number of colleges within 25 kilometers.

I apply birth year fixed effects to control for events that differentially affect people of different ages (χ_t).[7] For instance, if there is an exposure effect for Universal Primary Education (UPE) where awareness of the policy grows over time which leads to incrementally higher enrollment with each year after UPE

[7]Birth year fixed effects allow the regression to vary nonparametrically by estimating the spillovers separately for children with different birth years.

is implemented, this will be captured in the birth year fixed effects. Even if the exposure effect is logarithmically or quadratically related to enrollment, for example if enrollment dramatically increases in the years directly following passage of UPE and then tapers off, this effect will still be captured by the birth year fixed effects. Further, if there are other macroeconomic shocks that may affect the likelihood of educational attainment, such as a famine, recession, or the passage of a mandate requiring school enrollment, these will also be controlled for through birth year fixed effects.

8.2.1 *Event Window and Wave Classification*

My event window is defined based on the number of rounds of DHS data available. Consequently, the event window varies by country. T_j^* denotes the time the nearest college was established in community j, or the entry wave. τ is the time relative to the occurrence of the event, so in entry wave T_j^*, $\tau = 0$. In the pre-treatment waves, $\tau < 0$, while in the post-treatment waves, $\tau \geq 0$.

The omitted wave in my regressions is the wave prior to the establishment of the college $(\tau = -1)$. This wave serves as a baseline, meaning all coefficients are reported in relation to the wave prior to college establishment $(\tau = -1)$.

Here p is a measure of the number of waves, or periods, pre-college establishment and m is the number of waves post-college establishment for community j at time t. The first term in the specification above represents the pre-treatment waves, before the college was established; while the second term captures the post-treatment waves, after the college opened. The coefficients of interest are those on the event wave dummy variables, β_t in the specification given above.

I classify the timing of college establishment in waves that correspond to the available survey waves of the Demographic and Health Surveys (DHS). Each wave is approximately five years.

Recall, τ is the number of waves to the event, in this case the establishment of the nearest college. τ is calculated by taking the difference between the survey wave and the entry wave ($t - T_j^* = \tau$).[8] The college is established in wave 0 ($\tau = 0$).[9] For people who live in a community where the nearest college was established prior to the year they were surveyed, $\tau \geq 0$. Treated waves are those where $\tau \geq 0$.

8.2.2 *Wave Classification for Uganda*

Since I have four rounds of data in Uganda (2001, 2006, 2011, and 2016), each wave in my specification for Uganda is exactly five years. Entry wave (T_j) is assigned in five year time intervals of college establishment, where a college established between 1996 and 2000 would be in entry wave one ($T_j^* = 1$).[10]

In my specification, time t denotes survey wave. For Uganda, observations in the 2001 survey are classified as being in survey wave one ($t = 1$). Those in the 2006, 2011, and 2016 surveys are in survey waves two, three, and four, respectively.

It follows that there are seven waves τ that will be included in Uganda's event study: three untreated waves ($-3 \leq \tau \leq -1$) and four treated waves ($0 \leq \tau \leq 3$).

8.2.3 *Wave Classification for Kenya*

There are three available rounds of DHS data for Kenya: 2003, 2008, and 2014. Waves are five to six years since the surveys are spaced five to six years apart. Here, colleges established between 1997 and 2002 are assigned an entry wave

[8]The assignment of survey waves (t) and entry waves (T_j^*) is discussed in the following country-specific wave classification sections.

[9]Here, $\tau = 0$ if the nearest college was established in the survey year or the four years *preceding* the survey year.

[10]Similarly, $T_j^* = 2$ for colleges established in 2001-2005; $T_j^* = 3$ for colleges established in 2006-2010; and $T_j^* = 4$ for colleges established in 2011-2015.

of one ($T_j = 1$); those established between 2003 and 2007 receive an entry wave of two ($T_j = 2$); and those established between 2008 and 2013 are assigned an entry wave of three ($T_j = 3$). Survey wave is assigned in the same way it is assigned for Uganda, so $t = 1$ for people surveyed in 2003. Because there are only three rounds of DHS data available for Kenya, there are only five waves τ in Kenya's event study, so $(-2 \leq \tau \leq 2)$.

8.2.4 *Wave Classification for Ghana*

I work with five rounds of DHS data from Ghana: 1993, 1998, 2003, 2008, and 2014. Data were collected every five years between 1993 and 2008. The most recent wave (2014) was collected six years after the preceding wave. Colleges established between 1988 and 1992 have an entry wave of one $(T_j = 1)$, 1993 and 1997 have an entry wave of two $(T_j = 2)$, 1998 and 2002 have an entry wave of three $(T_j = 3)$, 2003 and 2007 have an entry wave of four $(T_j = 4)$, and 2008 and 2013 have an entry wave of five $(T_j = 5)$. Survey wave is assigned analogously to its assignment for Uganda and Kenya, where $t = 1$ for individuals surveyed in 1993. Since there are five rounds of data, there should theoretically be a larger event window in Ghana than that of Uganda and Kenya, where $-4 \leq \tau \leq 4$. Because the event window is based on the timing of when the nearest college was established, it is more limited in my data, including only two pre-treatment waves and five treated waves $(-2 \leq \tau \leq 4)$.

9 RESULTS

9.1 *Spillovers to Primary School*

Through my event study specification, I find statistically and economically significant spillovers of a college on lower levels of schooling in the local community. Nearly all of the coefficients on the event wave dummy variables are significant at the one percent level. The coefficients on most the treated waves are positive and the coefficients generally increase in magnitude with each consecutive wave.[11] This outcome is consistent with positive enrollment spillovers that increase with the amount of time the college is established.

In Uganda, in the college establishment wave ($\tau = 0$), the probability a child will attend school is 2.3 percentage points higher than the wave preceding the establishment of the college ($\tau = -1$). This effect increases to 2.9 percentage points in the next treated wave ($\tau = 1$), and increases even further to 3.8 percentage points in the following wave ($\tau = 2$; Table 8).

In Kenya, the observed effects on school enrollment are even stronger. When the college is first established ($\tau = 0$), there is a 2.8 percentage point increase in the likelihood of primary school age children attending school in comparison to the wave prior to college establishment ($\tau = -1$). This grows to a 4.2 percentage point increase in the likelihood of attending school in the next wave, and a 5.1 percentage point increase in the following wave (Table 8).

[11] Note coefficients are reported in reference to the baseline wave, which is the wave directly before the establishment of the college ($\tau = -1$).

In Ghana, the spillovers on school enrollment of primary school aged children are not as clear. At the time a college opens, there is a 4.4 percentage point increase in the likelihood of school enrollment of six to 13 year olds. Approximately five years after the college opens, I find no significant change in school enrollment for primary school children. When the college has been established for approximately ten years, I observe a 9.2 percentage point increase in the enrollment of primary school age children. Five years later, there is again no significant effect of the college on enrollment. After a college has been open for approximately 20 years, I observe a negative effect on enrollment, where primary school age children are 14.2 percentage points less likely to be enrolled in school. This final coefficient estimate conflicts with my other estimates and is not of a negligible magnitude. We must consider the possibility that there is a negative spillover on primary school enrollment in the long run, but upon further investigation, it appears this result may be due to a small sample size. Ghana has the smallest sample size of the countries I study and there are very few people for whom the nearest college was established 20 years prior. This may only be true for one or two communities, which may lead to biased estimation results. I will revisit this possibility later in my paper.

The primary specification for Ghana included in Table 8 is analogous to the specification run for Uganda and Kenya; however, since data collection began earlier in Ghana, not all variables are available in the earlier rounds of data. Wealth index quintile is not reported before 2003 so Columns 1 and 2 in Table 9 (and Column 3 in Table 8) omit data from 1993 and 1998. In the remaining regressions reported in Table 9, I exclude wealth index quintile from my specification in order to expand the sample to include the earlier waves of data. Columns 3 and 4 in Table 9 omit wealth index quintile, but are limited to the sample used for the regressions reported in Columns 1 and 2. I include Columns 3 and 4 to consider the how the results change as a result of removing wealth index quintile from the controls before also expanding the sample. Then we can also see how the extension of the sample influences the results, by comparing Columns 3 and 4 to Columns 5 and 6, respectively.

When I control for wealth index quintile–as I do for Kenya and Uganda–there are generally positive enrollment spillovers for primary school age children. When the college is established ($\tau = 0$), there is a 4.4 percentage point increase in the likelihood of enrollment in comparison to the wave prior to college establishment. Approximately 10 years after college establishment ($\tau = 2$), there is a 9.2 percentage point increase in the likelihood of school enrollment. These are fairly high increases in the likelihood of enrollment. Not all coefficients on treated waves are statistically significant. This could be because enrollment spillovers are inconsistent over time, the positive spillovers I estimated are anomalous occurrences, or my sample size is not large enough (particularly the portion of the sample that falls into specific treatment waves).

With Ghana's expanded sample, most coefficients on treatment waves are statistically significant and positive (Table 9, Columns 5 and 6). When I include birth year fixed effects, the likelihood of school enrollment increases by two percentage points in the treatment wave and rises to 4.4 percentage points in the second post-treatment wave. There is no change in school enrollment in the first post-treatment wave. In the fourth post-treatment wave (approximately 20 years after the college was established), there is a 17.7 percentage point decrease in school enrollment (Column 5). This particular result is anomalous when considering the results obtained in Kenya and Uganda. Kenya and Uganda did not have enough rounds of data collection to obtain estimates of school enrollment four waves post-treatment, so it may be that colleges have a negative impact on enrollment of primary school aged children in the longer run. It is also possible that the observed effect is specific to the context of Ghana. The sample of people who live in an area where the nearest college was established 20 years prior is considerably smaller than the sample of households whose nearest college was established more recently. This result may be obtained from a single or only a few neighborhoods' school enrollment. If these neighborhoods are not representative of the rest of the country, the estimated coefficient may not accurately reflect the change in the likelihood of school enrollment 20 years after the nearest college was established.

As expected, family socioeconomic status (as measured by wealth index quintile) is positively correlated with school attendance and is statistically significant in Kenya, Uganda, and Ghana. The effect is largest in Ghana, where there is a 2.8 percentage point increase in the likelihood of school attendance with each increase in wealth index quintile (Table 8).

In Uganda, Kenya, and Ghana, I find a primary school age child's gender does not influence her school enrollment. Urban-rural status does not change the likelihood of enrollment in Uganda. Contrary to what is expected, I find children who live in urban areas in Kenya are 3.5 percentage points less likely to be enrolled in school than those living in rural Kenya. In Uganda, residing in an urban or rural area has no correlation to enrollment of primary school aged children. In Ghana, the correlation between urbanicity and school enrollment is unclear and dependent on the specification. In the specification analogous to that of Uganda and Kenya, I observe there is no correlation between urban-rural status and school enrollment in Ghana (Table 8).

Table 8

Event Study Analysis, Enrollment of Primary School Age Children

Dependent Variable: School Enrollment	(1)	(2)	(3)
Sample:	Uganda	Kenya	Ghana
3 Waves Pre-Treatment	-0.027		
	(0.009)**		
2 Waves Pre-Treatment	-0.002	-0.022	-0.094
	(0.008)	(0.006)**	(0.017)**
Treatment Wave	0.023	0.028	0.044
	(0.007)**	(0.005)**	(0.011)**
1 Wave Post-Treatment	0.029	0.042	0.008
	(0.008)**	(0.005)**	(0.013)
2 Waves Post-Treatment	0.038	0.051	0.092
	(0.009)**	(0.007)**	(0.017)**
3 Waves Post-Treatment	0.036		0.015
	(0.019)		(0.024)
4 Waves Post-Treatment			-0.142
			(0.025)**
Number of Colleges within 25 km	0.001	0.000	-0.001
	(0.000)	(0.000)	(0.001)*
Male	-0.007	0.001	0.014
	(0.004)	(0.002)	(0.008)
Wealth Index Quintile	0.021	0.013	0.028
	(0.002)**	(0.001)**	(0.004)**
Urban	-0.001	-0.035	-0.021
	(0.005)	(0.003)**	(0.011)
Constant	0.834	0.912	0.740
	(0.007)**	(0.005)**	(0.013)**
R_2	0.02	0.02	0.03
Birth Year FE	yes	yes	yes
N	17,756	21,050	8,505

* p<0.05; ** p<0.01

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened in the defined event window. For Uganda, the event window is 1996 through 2015. For Kenya, the event window is 1997 through 2013. For Ghana, the event window is 1998 through 2013. Time to college establishment is measured by 5 to 6 year waves. Regressions include birth year fixed effects to control for aggregate shocks that differentially affect individuals of different birth years. Columns 1, 2, and 3 display results for Uganda, Kenya, and Ghana respectively. All wave coefficients are reported in relation to the baseline wave $\tau = -1$, the wave before the college was established.

Data are from Uganda's 2001-2016 waves, Kenya's 2003-2014 waves, and Ghana's 2003-2018 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education, Kenya's Commission for University Education, and Ghana's National Accreditation Board. Geographic coordinates of colleges are obtained from Google Maps.

Table 9

Event Study Analysis, Enrollment of 6-13 Year Olds, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)	(6)
2 Waves Pre-Treatment	-0.094	-0.076	-0.099	-0.070	-0.029	-0.180
	(0.017)**	(0.019)**	(0.017)**	(0.019)**	(0.011)**	(0.016)**
Treatment Wave	0.044	0.034	0.047	0.033	0.020	0.202
	(0.011)**	(0.011)**	(0.011)**	(0.011)**	(0.009)*	(0.012)**
1 Wave Post-Treatment	0.008	-0.003	0.017	-0.003	-0.003	0.261
	(0.013)	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)**
2 Waves Post-Treatment	0.092	0.072	0.100	0.073	0.044	0.223
	(0.017)**	(0.014)**	(0.017)**	(0.014)**	(0.013)**	(0.016)**
3 Waves Post-Treatment	0.015	-0.002	0.021	-0.002	-0.003	0.320
	(0.024)	(0.024)	(0.024)	(0.025)	(0.022)	(0.025)**
4 Waves Post-Treatment	-0.142	-0.127	-0.150	-0.159	-0.177	0.182
	(0.025)**	(0.033)**	(0.025)**	(0.032)**	(0.024)**	(0.032)**
Number of Colleges within 25 km	-0.001	-0.002	-0.000	-0.001	-0.000	0.003
	(0.001)*	(0.001)**	(0.001)	(0.001)*	(0.000)	(0.001)**
Male	0.014	0.013	0.014	0.012	0.011	0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.006)	(0.009)
Wealth Index Quintile	0.028	0.043				
	(0.004)**	(0.004)**				
Urban	-0.021	-0.043	0.023	0.020	0.034	-0.016
	(0.011)	(0.011)**	(0.009)**	(0.009)*	(0.007)**	(0.010)
Constant	0.740	0.726	0.801	0.833	0.576	0.505
	(0.013)**	(0.015)**	(0.010)**	(0.010)**	(0.008)**	(0.011)**
R^2	0.03	0.03	0.02	0.01	0.01	0.11
Birth Year FE	yes	no	yes	no	yes	no
N	8,505	8,505	8,505	8,505	11,807	11,807

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1988 and 2013. Time to college establishment is measured by 5 to 6 year waves. Columns 1, 3, and 5 include birth year fixed effects, while Columns 2, 4, and 6 do not include fixed effects but do include sampling weights.

In Columns 3, 4, 5, and 6, I exclude wealth index quintile from the controls because it is not available in the 1993 or 1998 waves of the DHS. Excluding wealth index quintile, expands the sample size as seen in Columns 5 and 6. Columns 3 and 4 exclude wealth index quintile from the regression, but run the regressions on the same sample used for the regressions whose results are displayed in Columns 1 and 2.

Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

9.2 *Spillovers to Secondary School*

Spillovers of colleges on the enrollment of secondary school age children are more varied than spillovers on primary school enrollment. I obtain similar estimates of spillovers of college establishment on the enrollment of primary and secondary school age children in Kenya. There is no change in the likelihood of school enrollment of 14 to 18 year olds in Uganda with college establishment. In Ghana, the significance of all coefficients is diminished and the estimates of spillovers on enrollment of secondary school aged children are mixed.

In Uganda, I observe there is not a significant effect of college establishment on school enrollment of secondary school aged children. None of the coefficients on the treated waves are statistically significant (Table 10).

In Kenya, there are significant, positive correlations between college establishment and school enrollment of secondary school aged children (14 to 18 years old). The coefficients on each treated wave are positive and statistically significant, starting with a 3.1 percentage point increase in the likelihood of enrollment in the treatment wave. The effect on the likelihood of school enrollment gradually increases to a 5.3 percentage point increase two waves post-treatment, or about 10 years after the college is established.

In Ghana, the significance of the coefficients on most waves decreases. Note that the sample size is considerably smaller for secondary school age children than primary school age children in Ghana. It is also smaller than the sample of 14 to 18 year olds in Kenya and Uganda. With this smaller sample size, it is expected that the statistical significance of the coefficients on each wave will decrease. The coefficient on the first post-treatment wave (approximately five years after the college has been established) changes directionally. There is a

3.6 percentage point decrease in the likelihood of school enrollment of 14 to 18 year olds five years after the nearest college was established. The estimated effect of a college 10 years (two waves) post-establishment on the likelihood of school enrollment of 14 to 18 year olds is a 4.6 percentage point increase, which is consistent with the estimate for 6-13 year olds between the enrollment of primary and secondary school aged children (Tables 8, 9, 10, and 11).

There are similar patterns in the other regressors observed between the primary and secondary school regression results across countries. Though boys ages six to 13 are no more likely to attend school than their female counterparts, boys ages 14 to 18 are more likely to attend school than girls of the same age. Boys in Uganda aged 14 to 18 are 7.8 percentage points more likely to be in school than girls of the same age. In Kenya, boys are 4.9 percentage points more likely to be enrolled in school. In Ghana, secondary school aged boys are 5.9 percentage points more likely to be in school than secondary school aged girls. In Uganda and Kenya, we observe a negative correlation of urban residence and school enrollment, as with younger children. There is no effect of urban-rural status on secondary school enrollment in Ghana.

In Uganda, family wealth index quintile is positively correlated with school enrollment of both primary and secondary school aged children. In both Kenya and Ghana, I find there is no effect of a family's wealth index quintile on the likelihood of their secondary school aged children's school enrollment, despite it having a positive correlation with primary school aged children's school enrollment (Tables 8 and 10).

Table 10

Event Study Analysis, Enrollment of Secondary School Age Children

Dependent Variable: School Enrollment	(1)	(2)	(3)
Sample:	Uganda	Kenya	Ghana
3 Waves Pre-Treatment	0.050		
	(0.022)*		
2 Waves Pre-Treatment	0.042	0.049	-0.009
	(0.020)*	(0.015)**	(0.031)
Treatment Wave	0.001	0.031	-0.005
	(0.017)	(0.013)*	(0.020)
1 Wave Post-Treatment	0.015	0.044	-0.039
	(0.019)	(0.015)**	(0.023)
2 Waves Post-Treatment	-0.005	0.053	0.062
	(0.022)	(0.019)**	(0.029)*
3 Waves Post-Treatment	-0.058		-0.018
	(0.045)		(0.041)
4 Waves Post-Treatment			-0.117
			(0.045)**
Number of Colleges within 25 km	-0.004	-0.003	-0.003
	(0.001)**	(0.001)**	(0.001)**
Male	0.078	0.049	0.059
	(0.009)**	(0.007)**	(0.013)**
Wealth Index Quintile	0.015	0.004	0.013
	(0.004)**	(0.003)	(0.007)
Urban	-0.034	-0.081	-0.013
	(0.012)**	(0.008)**	(0.019)
Constant	0.641	0.786	0.611
	(0.018)**	(0.014)**	(0.024)**
R_2	0.02	0.02	0.01
Birth Year FE	yes	yes	yes
N	8,130	10,699	4,437

* p<0.05; ** p<0.01

Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened in the defined event window. For Uganda, the event window is 1996 through 2015. For Kenya, the event window is 1997 through 2013. For Ghana, the event window is 1998 through 2013. Time to college establishment is measured by 5 to 6 year waves. Regressions include birth year fixed effects to control for aggregate shocks that differentially affect individuals of different birth years. Columns 1, 2, and 3 display results for Uganda, Kenya, and Ghana respectively. All wave coefficients are reported in relation to the baseline wave $\tau = -1$, or the wave before the college was established.

Data are from Uganda's 2001-2016 waves, Kenya's 2003-2014 waves, and Ghana's 2003-2018 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education, Kenya's Commission for University Education, and Ghana's National Accreditation Board. Geographic coordinates of colleges are obtained from Google Maps.

Table 11

Event Study Analysis, Enrollment of 14-18 Year Olds, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)	(6)
2 Waves Pre-Treatment	-0.009	-0.046	-0.012	-0.045	-0.006	-0.143
	(0.031)	(0.033)	(0.031)	(0.033)	(0.017)	(0.021)**
Treatment Wave	-0.005	-0.026	-0.003	-0.028	-0.004	0.122
	(0.020)	(0.021)	(0.020)	(0.021)	(0.014)	(0.018)**
1 Wave Post-Treatment	-0.039	-0.057	-0.034	-0.061	-0.036	0.160
	(0.023)	(0.024)*	(0.023)	(0.024)**	(0.018)*	(0.022)**
2 Waves Post-Treatment	0.062	0.038	0.066	0.034	0.046	0.163
	(0.029)*	(0.030)	(0.029)*	(0.030)	(0.021)*	(0.027)**
3 Waves Post-Treatment	-0.018	-0.053	-0.014	-0.055	-0.016	0.209
	(0.041)	(0.045)	(0.041)	(0.045)	(0.034)	(0.044)**
4 Waves Post-Treatment	-0.117	-0.134	-0.120	-0.166	-0.122	0.106
	(0.045)**	(0.052)**	(0.045)**	(0.052)**	(0.037)**	(0.051)*
Number of Colleges within 25 km	-0.003	-0.004	-0.002	-0.003	-0.002	-0.001
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)
Male	0.059	0.059	0.059	0.057	0.043	0.037
	(0.013)**	(0.016)**	(0.013)**	(0.016)**	(0.010)**	(0.014)**
Wealth Index Quintile	0.013	0.031				
	(0.007)	(0.008)**				
Urban	-0.013	-0.046	0.007	0.002	0.007	-0.010
	(0.019)	(0.022)*	(0.016)	(0.018)	(0.012)	(0.016)
Constant	0.611	0.594	0.641	0.676	0.471	0.416
	(0.024)**	(0.029)**	(0.018)**	(0.020)**	(0.013)**	(0.017)**
R^2	0.01	0.02	0.01	0.01	0.01	0.04
Birth Year FE	yes	no	yes	no	yes	no
N	4,437	4,437	4,437	4,437	6,053	6,053

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1988 and 2013. Time to college establishment is measured by 5 to 6 year waves. Columns 1, 3, and 5 include birth year fixed effects, while Columns 2, 4, and 6 do not include fixed effects but do include sampling weights.

In Columns 3, 4, 5, and 6, I exclude wealth index quintile from the controls because it is not available in the 1993 or 1998 waves of the DHS. Excluding wealth index quintile, expands the sample size as seen in Columns 5 and 6. Columns 3 and 4 exclude wealth index quintile from the regression, but run the regressions on the same sample used for the regressions whose results are displayed in Columns 1 and 2.

Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

9.3 *Spillovers by Socioeconomic Status*

Colleges have higher levels of educational spillovers on primary school age children from lower income families than those from higher income families. At the secondary school level, the vast majority of my coefficients on the post-treatment waves are not statistically significant when I estimate the regressions by wealth index quintile.[12] Note that this decreases the sample size for each regression considerably, thus decreasing the likelihood of attaining statistically significant results (Table 12 through 17).

In Uganda, I find colleges have the largest impact on the enrollment decisions of primary school age children in the lower-middle (second) wealth quintile. Coefficients on nearly all treated waves are statistically significant at the one percent level and positive. Children from this quintile are 9.9 percentage points more likely to be enrolled in school when the college is established, 9.0 percentage points more likely to be in school 5 years after the college is established, and 11.1 percentage points more likely to be enrolled in school 10 years post-establishment. Additionally, girls ages six to 13 are 3.0 percentage points more likely to be enrolled in school than boys (Table 12).

Uganda's middle income quintile accrues the next highest level of benefits in terms of school enrollment of six to 13 year olds. When a college has been established, it raises the likelihood of school enrollment by between 5.2 and 5.8 percentage points for primary school aged children from the middle income quintile.

Note that school enrollment is lowest for primary school age children from

[12] I measure socioeconomic status by wealth index quintile, where one represents the lowest income quintile and five represents the highest income quintile.

the lowest income quintile, where 83.1 percent of six to 13 year olds are enrolled in school. Enrollment increases incrementally with each wealth index quintile, reaching its peak at 96.1 percent for those from the wealthiest families. Because baseline enrollment is already high for children from wealthier families, they have less to gain (in terms of the likelihood of their school enrollment) from a change in the environment, such as the establishment of a college. These results present evidence that there are diminishing marginal returns to college establishment on school enrollment based on wealth index quintile. Those from the lowest wealth index quintile may not benefit as much from a change in the environment even if it changes their choice set of education options, if their constraint is still binding. For instance, if a family needs the income from their child working to cover household expenditures, a college opening may not have a large enough impact on this family's constraints to change their educational investment decision.

In Kenya, primary school aged children of the lowest wealth index quintile benefit the most in terms of their school enrollment after a college opens in the community. All treated waves have significant and positive coefficients, increasing in magnitude with each consecutive wave. When the college opens, children are 4.9 percentage points more likely to attend school. Five years after the college opens, six to 13 year olds are 8.0 percentage points more likely to be enrolled in school. Ten years post-establishment, children are 9.3 percentage points more likely to attend school (Table 13).

Kenyan primary school aged children of the lower-middle wealth index quintile see the next highest increases in enrollment, ranging between 4.4 and 5.3 percentage points in the years following the establishment of the nearest college.

Note that the baseline enrollment of six to 13 year olds in the lower-middle income quintile in Uganda is 85.4 percent, which is closest to the baseline enrollment of the lowest wealth index quintile in Kenya, where 85 percent of children are enrolled in school. These two groups also both experience the highest level of benefits compared to the other wealth index quintiles from their respective country. This may support the hypothesis of diminishing marginal returns with wealth index quintile of a college opening on the school enrollment of primary school age children.

Again, results are not as consistent in Ghana, where the sample size for each quintile is also smaller. The highest wealth index quintile has the most statistically significant coefficients on treated waves, ranging in impact on school enrollment from 4.2 to 11.8 percentage points. As with the main findings, the coefficient on the 4 waves post-treatment (approximately 20 years post-establishment) is -49.6 percentage points, which seems inconsistent with the other results. Again, this may be due to the subsample of individuals who live in a community where the nearest college was established 20 years prior being very small (Table 14).

Baseline enrollment for six to 13 year olds from the highest wealth index quintile in Ghana is at 89.9 percent, which is most comparable to baseline enrollment of the middle income quintile in Uganda and between the baseline enrollment of the lowest and low-middle wealth quintiles in Kenya. These groups are also all among the groups who benefited the most the most in terms of school enrollment in the years following the establishment of a college. This supports the idea of diminishing marginal returns to changes in school enrollment, where an external factor such as a college opening can influence school enrollment decisions for six to 13 year olds.

Table 12

Event Study Analysis, Enrollment of 6-13 Year Olds by Wealth Index Quintile, Uganda

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)
3 Waves Pre-Treatment	-0.135	0.076	-0.130	-0.097	-0.050
	(0.034)**	(0.024)**	(0.034)**	(0.024)**	(0.016)**
2 Waves Pre-Treatment	-0.061	0.023	-0.033	-0.018	-0.004
	(0.036)	(0.021)	(0.018)	(0.019)	(0.012)
Treatment Wave	0.045	0.099	0.055	0.022	-0.024
	(0.031)	(0.019)**	(0.017)**	(0.017)	(0.009)**
1 Wave Post-Treatment	-0.003	0.090	0.058	0.031	0.005
	(0.037)	(0.023)**	(0.019)**	(0.018)	(0.011)
2 Waves Post-Treatment	0.076	0.111	0.052	0.039	-0.001
	(0.034)*	(0.024)**	(0.021)*	(0.020)	(0.012)
3 Waves Post-Treatment	0.339	0.044	0.082	-0.018	-0.010
	(0.244)	(0.124)	(0.055)	(0.041)	(0.019)
Number of Colleges within 25 km	0.034	-0.009	0.002	0.002	-0.000
	(0.020)	(0.004)*	(0.003)	(0.001)	(0.000)
Male	0.002	-0.030	-0.012	-0.006	0.006
	(0.013)	(0.010)**	(0.010)	(0.008)	(0.006)
Urban	0.037	0.007	-0.020	-0.037	-0.004
	(0.020)	(0.017)	(0.016)	(0.010)**	(0.007)
Constant	0.831	0.854	0.900	0.942	0.961
	(0.022)**	(0.013)**	(0.014)**	(0.014)**	(0.009)**
R^2	0.02	0.01	0.01	0.01	0.00
Birth Year FE	yes	yes	yes	yes	yes
N	2,733	3,433	3,036	3,381	5,173

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1996 and 2015. Time to college establishment is measured by 5 year waves. All columns include birth year fixed effects. Each column represents the results of the respective wealth index quintile, where one represents the lowest quintile and five represents the highest quintile.

Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Uganda's National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

Table 14

Event Study Analysis, Enrollment of 6-13 Year Olds by Wealth Index Quintile, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)
2 Waves Pre-Treatment	-0.145	-0.009	-0.082	-0.114	-0.058
	(0.047)**	(0.055)	(0.041)*	(0.034)**	(0.027)*
Treatment Wave	0.087	-0.045	0.048	0.044	0.070
	(0.042)*	(0.038)	(0.030)	(0.023)	(0.017)**
1 Wave Post-Treatment	0.124	0.057	0.018	-0.010	0.042
	(0.057)*	(0.042)	(0.035)	(0.025)	(0.020)*
2 Waves Post-Treatment	0.119	0.152	0.105	0.100	0.078
	(0.085)	(0.058)**	(0.046)*	(0.028)**	(0.024)**
3 Waves Post-Treatment	0.261	-0.339	-0.090	0.116	0.118
	(0.197)	(0.085)**	(0.055)	(0.039)**	(0.039)**
4 Waves Post-Treatment	-0.008	-0.108	0.040	-0.320	-0.496
	(0.066)	(0.069)	(0.057)	(0.056)**	(0.055)**
Number of Colleges within 25 km	-0.033	-0.010	0.000	-0.003	-0.000
	(0.015)*	(0.004)**	(0.002)	(0.001)**	(0.001)
Male	-0.024	-0.019	0.029	0.020	0.031
	(0.023)	(0.026)	(0.020)	(0.015)	(0.012)**
Urban	0.007	0.040	0.003	-0.070	-0.063
	(0.047)	(0.035)	(0.021)	(0.019)**	(0.023)**
Constant	0.835	0.794	0.769	0.904	0.899
	(0.025)**	(0.031)**	(0.025)**	(0.023)**	(0.025)**
R_2	0.02	0.05	0.01	0.05	0.06
Birth Year FE	yes	yes	yes	yes	yes
N	1,094	1,049	1,575	2,155	2,632

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1998 and 2013. Time to college establishment is measured by 5 to 6 year waves. All columns include birth year fixed effects. Each column represents the results of the respective wealth index quintile, where one represents the lowest quintile and five represents the highest quintile.

Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

Table 15

Event Study Analysis, Enrollment of 14-18 Year Olds by Wealth Index Quintile, Uganda

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)
3 Waves Pre-Treatment	-0.158	0.056	-0.030	0.020	0.153
	(0.078)*	(0.047)	(0.085)	(0.081)	(0.046)**
2 Waves Pre-Treatment	-0.041	0.088	0.052	0.032	0.050
	(0.077)	(0.055)	(0.052)	(0.058)	(0.034)
Treatment Wave	-0.060	-0.002	0.013	-0.011	0.023
	(0.070)	(0.047)	(0.049)	(0.048)	(0.027)
1 Wave Post-Treatment	-0.097	0.017	-0.008	0.054	0.018
	(0.077)	(0.053)	(0.045)	(0.047)	(0.031)
2 Waves Post-Treatment	-0.000	0.009	-0.127	0.016	0.050
	(0.078)	(0.057)	(0.056)*	(0.057)	(0.035)
Number of Colleges within 25 km	0.038	-0.013	-0.007	-0.000	-0.005
	(0.041)	(0.011)	(0.008)	(0.002)	(0.001)**
Male	0.153	0.045	0.022	-0.013	0.140
	(0.026)**	(0.021)*	(0.023)	(0.022)	(0.017)**
Urban	-0.016	0.020	0.026	-0.109	-0.047
	(0.035)	(0.035)	(0.037)	(0.026)**	(0.020)*
3 Waves Post-Treatment		0.118	0.009	-0.180	-0.014
		(0.418)	(0.130)	(0.095)	(0.060)
Constant	0.686	0.701	0.740	0.755	0.662
	(0.049)**	(0.029)**	(0.038)**	(0.042)**	(0.025)**
R_2	0.04	0.01	0.02	0.02	0.04
Birth Year FE	yes	yes	yes	yes	yes
N	1,058	1,530	1,299	1,485	2,758

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1996 and 2015. Time to college establishment is measured by 5 year waves. All columns include birth year fixed effects. Each column represents the results of the respective wealth index quintile, where one represents the lowest quintile and five represents the highest quintile.

Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Uganda's National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

Table 16

Event Study Analysis, Enrollment of 14-18 Year Olds by Wealth Index Quintile, Kenya

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)
2 Waves Pre-Treatment	-0.093	-0.011	-0.008	0.073	0.062
	(0.052)	(0.036)	(0.030)	(0.031)*	(0.039)
Treatment Wave	0.057	-0.004	0.016	0.025	0.039
	(0.050)	(0.031)	(0.028)	(0.028)	(0.027)
1 Wave Post-Treatment	0.127	0.001	0.023	0.018	0.055
	(0.053)*	(0.034)	(0.032)	(0.032)	(0.034)
2 Waves Post-Treatment	0.027	0.019	0.041	0.047	0.068
	(0.072)	(0.043)	(0.038)	(0.038)	(0.045)
Number of Colleges within 25 km	0.017	-0.008	-0.005	-0.004	-0.000
	(0.020)	(0.009)	(0.004)	(0.002)	(0.001)
Male	0.027	0.010	0.006	0.038	0.137
	(0.022)	(0.014)	(0.013)	(0.014)**	(0.015)**
Urban	-0.054	-0.018	-0.061	-0.115	-0.036
	(0.027)*	(0.019)	(0.018)**	(0.015)**	(0.021)
Constant	0.747	0.868	0.864	0.828	0.670
	(0.041)**	(0.027)**	(0.024)**	(0.024)**	(0.028)**
R_2	0.02	0.00	0.01	0.03	0.04
Birth Year FE	yes	yes	yes	yes	yes
N	1,179	2,181	2,430	2,456	2,453

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1997 and 2013. Time to college establishment is measured by 5 to 6 year waves. All columns include birth year fixed effects. Each column represents the results of the respective wealth index quintile, where one represents the lowest quintile and five represents the highest quintile.
Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Kenya's Commission for University Education. Geographic data of colleges are obtained from Google Maps.

10 ROBUSTNESS CHECKS

10.1 *More Restrictive Treatment*

Geographic spillovers are likely concentrated in the area directly surrounding a college and dissipate as distance from the college increases (Chetty and Hen-

Table 17

Event Study Analysis, Enrollment of 14-18 Year Olds by Wealth Index Quintile, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)
2 Waves Pre-Treatment	-0.039	0.175	0.103	0.032	-0.041
	(0.131)	(0.113)	(0.076)	(0.062)	(0.049)
Treatment Wave	-0.025	0.114	-0.063	-0.032	-0.001
	(0.086)	(0.067)	(0.051)	(0.041)	(0.031)
1 Wave Post-Treatment	-0.075	0.038	0.008	-0.027	-0.010
	(0.095)	(0.078)	(0.061)	(0.045)	(0.037)
2 Waves Post-Treatment	-0.011	0.203	0.137	0.055	0.066
	(0.158)	(0.105)	(0.076)	(0.054)	(0.045)
3 Waves Post-Treatment	0.124	-0.134	-0.199	-0.006	0.176
	(0.442)	(0.133)	(0.089)*	(0.071)	(0.070)*
4 Waves Post-Treatment	-0.236	0.042	0.020	-0.255	-0.127
	(0.117)*	(0.111)	(0.096)	(0.102)*	(0.132)
Number of Colleges within 25 km	-0.020	-0.005	-0.007	-0.004	-0.001
	(0.026)	(0.007)	(0.003)*	(0.002)*	(0.001)
Male	0.032	0.042	0.064	0.056	0.061
	(0.040)	(0.044)	(0.034)	(0.027)*	(0.022)**
Urban	0.044	-0.001	-0.034	0.018	-0.054
	(0.074)	(0.054)	(0.036)	(0.036)	(0.043)
Constant	0.739	0.511	0.616	0.650	0.700
	(0.051)**	(0.059)**	(0.044)**	(0.043)**	(0.047)**
R^2	0.02	0.03	0.04	0.02	0.01
Birth Year FE	yes	yes	yes	yes	yes
N	498	439	737	1,124	1,639

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1998 and 2013. Time to college establishment is measured by 5 to 6 year waves. All columns include birth year fixed effects. Each column represents the results of the respective wealth index quintile, where one represents the lowest quintile and five represents the highest quintile.

Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

dren 2018; Chetty et al. 2018; Glaeser 1999; Marshall 1890; Moretti 2004). If spillovers are very concentrated, it would be best to define people as treated if they live within a very small radius of a college, possibly as small as a one mile radius. If I redefine treated individuals as those living within closer proximity to the college, this will decrease my sample size. Inconveniently, my household geographic data is only available at the household cluster, or neighborhood, level. These neighborhoods vary in geographic width, limiting the accuracy of each individual household's geographic location. Further, there is noise inserted into the household geographic data. Restricting my treatment area comes with the trade-off that the limited accuracy of my household geographic data may become more problematic. For this reason, I define the treatment as living within 25 kilometers of the college in my main specifications.

As a robustness check, I redefine treated communities as those located within 15 kilometers of a college established within the event window. As expected, this diminishes my sample size, limiting the accuracy of my results. This is particularly problematic for specific waves where fewer people live within 15 kilometers of a college established in that specific wave.

When I limit my treatment area to a 15 kilometer radius, I find similar results. In Uganda, there is a slight increase in the magnitude of the coefficients on some of the later treatment wave variables (Table 18). For Kenya, coefficients are slightly smaller in magnitude under the more restrictive treatment (Table 19). In Ghana, I observe that the enrollment spillovers of a college within 15 kilometers are generally significant and positive for both primary and secondary school age children (Table 20). The estimated spillovers are fairly similar to those estimated under the 25 kilometer treatment, but are slightly stronger in magnitude and significance for the enrollment of secondary school age children.

10.2 *Event Study with a Control Group*

As a robustness check, I run the event study for each country with a control group. I modify my specification to accommodate the inclusion of a control group. The original specification is given by the following equation:

$$y_{ijt} = \Sigma_{\tau=-p}^{\tau=-1}\beta_\tau 1(t - T_j^* = \tau) + \Sigma_{\tau=0}^{\tau=m}\beta_\tau 1(t - T_j^* = \tau) + \eta_i + \gamma_j + \chi_t + \epsilon_{ijt},$$

where y_{ijt} is the outcome variable of interest: school enrollment of child i in community j at time t. When including a control group, I add a binary variable (α) indicating whether a community was ever treated. Additionally, I include interaction terms between the binary wave variables and the binary treatment variable. The specification for my event study with a control group is given by the following equation:

$$y_{ijt} = \alpha + \Sigma_{\tau=-p}^{\tau=-1}\beta_\tau(1+\alpha)(t - T_j^* = \tau) + \Sigma_{\tau=0}^{\tau=m}\beta_\tau(1+\alpha)(t - T_j^* = \tau) + \eta_i + \gamma_j + \chi_t + \epsilon_{ijt}.$$

The coefficients of interest in this specification are those on the interaction terms of the treated variable and the treated waves. These coefficients represent the causal effect of living within 25 kilometers of a college on the likelihood of school enrollment. The results of the event studies with a control group are varied.

In Uganda, there are no significant coefficients on the interaction terms for treated waves, but there are significant and positive coefficients on the treated wave dummy variables. In fact, there are also negative coefficients on the untreated wave dummy variables. This may provide evidence that the observed effect of an increase in the likelihood of school enrollment is not actually due to spillovers from a local college. Instead, it may be that the observed increase in the likelihood of enrollment is due to underlying linear trends. To further inves-

Table 18

Event Study Analysis, School Enrollment, 15 km Treatment, Uganda

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)
3 Waves Pre-Treatment	-0.012	0.006	0.054	0.025
	(0.012)	(0.014)	(0.028)	(0.028)
2 Waves Pre-Treatment	0.001	0.003	0.060	0.033
	(0.011)	(0.012)	(0.026)*	(0.026)
Treatment Wave	0.020	0.006	0.016	-0.020
	(0.009)*	(0.009)	(0.022)	(0.022)
1 Wave Post-Treatment	0.025	0.017	0.023	0.028
	(0.010)*	(0.010)	(0.025)	(0.027)
2 Waves Post-Treatment	0.040	0.015	0.006	-0.007
	(0.011)**	(0.010)	(0.027)	(0.027)
3 Waves Post-Treatment	0.035	0.027	-0.043	-0.088
	(0.021)	(0.016)	(0.052)	(0.058)
Number of Colleges within 25 km	0.001	0.001	-0.003	-0.005
	(0.000)*	(0.000)	(0.001)**	(0.001)**
Male	-0.008	-0.010	0.094	0.074
	(0.005)	(0.006)	(0.012)**	(0.015)**
Wealth Index Quintile	0.019	0.019	0.014	0.013
	(0.002)**	(0.003)**	(0.005)**	(0.006)*
Urban	0.009	0.013	-0.042	-0.069
	(0.006)	(0.006)*	(0.014)**	(0.017)**
Constant	0.829	0.838	0.617	0.668
	(0.010)**	(0.013)**	(0.023)**	(0.027)**
R_2	0.02	0.02	0.02	0.03
Birth Year FE	yes	no	yes	no
Sample Age Group	6-13	6-13	14-18	14-18
N	10,587	10,587	5,040	5,040

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to treated communities, where treated communities are DHS household clusters that are within 15 km of a college that opened between 1996 and 2015. Time to college establishment is measured by 5 year waves. Columns 1 and 2 are restricted to 6-13 year olds, while Columns 3 and 4 are restricted to 14-18 year olds. Column 1 and 3 include birth year fixed effects, while Column 2 and 4 do not include fixed effects but do include sampling weights.

Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

Table 19

Event Study Analysis, School Enrollment, 15 km Treatment, Kenya

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)
2 Waves Pre-Treatment	-0.031	-0.003	0.044	0.005
	(0.008)**	(0.008)	(0.021)*	(0.025)
Treatment Wave	0.023	0.012	0.029	0.128
	(0.007)**	(0.005)*	(0.019)	(0.017)**
1 Wave Post-Treatment	0.045	0.025	0.044	0.162
	(0.008)**	(0.005)**	(0.022)*	(0.018)**
2 Waves Post-Treatment	0.045	0.028	0.031	0.152
	(0.009)**	(0.005)**	(0.027)	(0.028)**
Number of Colleges within 25 km	0.001	0.001	-0.003	-0.004
	(0.000)**	(0.000)**	(0.001)*	(0.002)*
Male	0.000	-0.003	0.070	0.067
	(0.003)	(0.003)	(0.009)**	(0.012)**
Wealth Index Quintile	0.014	0.011	0.009	-0.002
	(0.002)**	(0.002)**	(0.004)*	(0.006)
Urban	-0.053	-0.036	-0.100	-0.088
	(0.004)**	(0.004)**	(0.011)**	(0.015)**
Constant	0.915	0.938	0.764	0.744
	(0.007)**	(0.008)**	(0.020)**	(0.022)**
R_2	0.02	0.01	0.03	0.05
Birth Year FE	yes	no	yes	no
Sample Age Group	6-13	6-13	14-18	14-18
N	11,629	11,629	6,062	6,062

* p<0.05; ** p<0.01

Note: This sample is restricted to treated communities, where treated communities are DHS household clusters that are within 15 km of a college that opened between 1997 and 2013. Time to college establishment is measured by 5 to 6 year waves. Columns 1 and 2 are restricted to 6-13 year olds, while Columns 3 and 4 are restricted to 14-18 year olds. Column 1 and 3 include birth year fixed effects, while Column 2 and 4 do not include fixed effects but do include sampling weights.

Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Kenya's Commission for University Education. Geographic data of colleges are obtained from Google Maps.

Table 20

Event Study Analysis, School Enrollment, 15 km Treatment, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)
2 Waves Pre-Treatment	-0.027	-0.147	-0.006	-0.119
	(0.012)*	(0.019)**	(0.020)	(0.024)**
Treatment Wave	0.037	0.239	0.013	0.147
	(0.010)**	(0.014)**	(0.016)	(0.021)**
1 Wave Post-Treatment	-0.030	0.271	-0.042	0.169
	(0.013)*	(0.015)**	(0.020)*	(0.025)**
2 Waves Post-Treatment	0.034	0.208	0.047	0.161
	(0.015)*	(0.020)**	(0.024)*	(0.032)**
3 Waves Post-Treatment	0.037	0.403	0.042	0.283
	(0.026)	(0.023)**	(0.039)	(0.048)**
4 Waves Post-Treatment	-0.190	0.155	-0.076	0.150
	(0.028)**	(0.039)**	(0.044)	(0.057)**
Number of Colleges within 25 km	-0.000	0.004	-0.002	-0.001
	(0.000)	(0.001)**	(0.001)*	(0.001)
Male	0.012	0.005	0.041	0.035
	(0.007)	(0.010)	(0.011)**	(0.016)*
Urban	0.050	-0.031	0.007	-0.027
	(0.009)**	(0.012)**	(0.014)	(0.019)
Constant	0.561	0.487	0.463	0.408
	(0.010)**	(0.014)**	(0.015)**	(0.021)**
R_2	0.02	0.12	0.01	0.04
Birth Year FE	yes	no	yes	no
Sample Age Group	6-13	6-13	14-18	14-18
N	8,844	8,844	4,753	4,753

* p<0.05; ** p<0.01

Note: This sample is restricted to treated communities, where treated communities are DHS household clusters that are within 15 km of a college that opened between 1988 and 2013. Time to college establishment is measured by 5 to 6 year waves. Columns 1 and 2 are restricted to 6-13 year olds, while Columns 3 and 4 are restricted to 14-18 year olds. Columns 1 and 3 include birth year fixed effects, while Columns 2 and 4 do not include fixed effects but do include sampling weights.

Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

tigate this possibility, I linearly control for birth year and estimate similar coefficients. Future research should consider controlling for other linear trends in the event study specification as Bailey and Goodman-Bacon (2015) suggest. The coefficient on the treatment dummy variable is positive and significant for both the primary and secondary school age samples, indicating children in treated communities (those located within 25 kilometers of a college) are more likely to be enrolled in school than those in untreated communities, but as mentioned prior, that does not point to a causal effect of a nearby college increasing the likelihood of school enrollment (Table 21).

In Kenya, there are negative effects of a college on the enrollment of primary school age children and no effect of a college on the enrollment of secondary school age children. As with Uganda, there is a positive correlation between wave and school enrollment. This may support the idea that the spillovers estimated in my main specification are capturing the linear trends of enrollment increasing over time. Again, there is a positive correlation between school enrollment and residing in a treated community, which is indicative of treating communities potentially being fundamentally different than untreated communities (Table 22).

In contrast, there are significant and sometimes positive spillovers of a college on the enrollment of primary school age children in Ghana. I observe positive spillovers 10 and 15 years after the college was established. There is only one significant coefficient, pointing to a causal effect of a college on the enrollment of secondary school age children, which is approximately 10 years after the college has opened. As with Uganda and Kenya, children residing within 25 kilometers of a college are more likely to be enrolled in school (Table 23).

Event studies can be done with or without a control group. Including a control group in my event study is redundant because there is variation in the timing of college establishment across my data for each country (Sandler and

Sandler 2013). Including a control group requires making the assumption that treated communities are no different from untreated communities. Because I do *not* study college expansion that occurred as a result of an exogenous change (similar to the Indonesian school expansion that Duflo (2001) studies), the assumption that treated communities are *not* fundamentally different from untreated communities is difficult to accept (Jagnani and Khanna 2018). It is likely that colleges were opened in communities with more potential to make the college more successful. For instance, a college might be more likely to open in an area where there is a greater proportion of young people, an area that is easily accessible and well connected to roads, or an area with a more developed labor market. These qualities of a community may also affect school enrollment, in which case there would be endogeneity concerns that would be unaddressed (Jagnani and Khanna 2018).

Table 21

Event Study Analysis with Control Group, School Enrollment, Uganda

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)
Treated	0.055	0.040	0.036	0.024
	(0.007)**	(0.007)**	(0.014)**	(0.016)
3 Waves Pre-Treatment	-0.052	-0.049	0.108	0.031
	(0.009)**	(0.010)**	(0.019)**	(0.017)
2 Waves Pre-Treatment	-0.026	-0.033	0.012	-0.049
	(0.006)**	(0.007)**	(0.014)	(0.015)**
Treatment Wave	0.049	0.022	-0.012	-0.052
	(0.005)**	(0.005)**	(0.012)	(0.012)**
1 Wave Post-Treatment	0.050	0.027	0.018	-0.019
	(0.007)**	(0.007)**	(0.014)	(0.016)
2 Waves Post-Treatment	0.067	0.028	0.023	-0.025
	(0.007)**	(0.007)**	(0.016)	(0.017)
3 Waves Post-Treatment	0.116	0.062	-0.085	-0.151
	(0.017)**	(0.012)**	(0.032)**	(0.039)**
Treated*3 Waves Pre-Treatment	0.028	0.042	-0.029	-0.026
	(0.013)*	(0.014)**	(0.024)	(0.027)
Treated*2 Waves Pre-Treatment	0.011	0.015	0.024	0.032
	(0.011)	(0.011)	(0.021)	(0.024)
Treated*Treatment Wave	-0.013	-0.021	0.032	0.021
	(0.009)	(0.009)*	(0.017)	(0.020)
Treated*1 Wave Post-Treatment	-0.014	-0.017	0.007	0.042
	(0.011)	(0.010)	(0.022)	(0.026)
Treated*2 Waves Post-Treatment	-0.011	-0.019	-0.002	0.011
	(0.011)	(0.011)	(0.023)	(0.027)
Treated*3 Waves Post-Treatment	-0.073	-0.051	0.057	0.062
	(0.027)**	(0.019)**	(0.052)	(0.065)
Number of Colleges within 25 km	-0.002	-0.001	-0.007	-0.007
	(0.000)**	(0.000)**	(0.001)**	(0.001)**
Male	0.006	0.001	0.083	0.071
	(0.003)*	(0.003)	(0.006)**	(0.007)**
Wealth Index Quintile	0.051	0.039	0.034	0.023
	(0.001)**	(0.001)**	(0.002)**	(0.003)**
Urban	-0.005	0.001	-0.013	-0.032
	(0.004)	(0.004)	(0.008)	(0.010)**
Constant	0.676	0.752	0.533	0.628
	(0.005)**	(0.006)**	(0.011)**	(0.013)**
R_2	0.06	0.04	0.03	0.02
Birth Year FE	yes	no	yes	no
Sample Age Group	6-13	6-13	14-18	14-18
N	53,354	53,354	22,214	22,214

* p<0.05; ** p<0.01

Note: Treated communities are DHS household clusters that are within 25 km of a college that opened between 1996 and 2015. This sample includes both treated and untreated communities. Time to college establishment is measured by 5 year waves. The regressions in Columns 1 and 2 are restricted to primary school age children (ages 6 to 13), while the regressions reported in Columns 3 and 4 are restricted to secondary school age children (ages 14 to 18). Columns 1 and 3 include birth year fixed effects, while Columns 2 and 4 do not include fixed effects but include sampling weights.
Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

Table 22

Event Study Analysis with Control Group, School Enrollment, Kenya

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)
Treated	0.094	0.066	0.033	-0.029
	(0.007)**	(0.007)**	(0.013)**	(0.016)
2 Waves Pre-Treatment	-0.067	-0.030	0.012	-0.100
	(0.007)**	(0.009)**	(0.016)	(0.017)**
Treatment Wave	0.099	0.052	0.016	0.045
	(0.006)**	(0.006)**	(0.012)	(0.012)**
1 Wave Post-Treatment	0.146	0.069	0.038	0.055
	(0.007)**	(0.007)**	(0.014)**	(0.014)**
2 Waves Post-Treatment	0.195	0.101	0.073	0.045
	(0.011)**	(0.007)**	(0.021)**	(0.025)
Treated*2 Waves Pre-Treatment	0.047	0.019	0.057	0.086
	(0.011)**	(0.011)	(0.020)**	(0.025)**
Treated*Treatment Wave	-0.027	-0.031	0.022	0.059
	(0.007)**	(0.007)**	(0.014)	(0.017)**
Treated*1 Wave Post-Treatment	-0.054	-0.042	0.014	0.077
	(0.009)**	(0.008)**	(0.016)	(0.020)**
Treated*2 Waves Post-Treatment	-0.089	-0.068	-0.009	0.091
	(0.014)**	(0.009)**	(0.025)	(0.032)**
Number of Colleges within 25 km	-0.005	-0.002	-0.007	-0.006
	(0.001)**	(0.000)**	(0.001)**	(0.001)**
Male	0.007	0.003	0.059	0.045
	(0.002)**	(0.002)	(0.005)**	(0.006)**
Wealth Index Quintile	0.051	0.037	0.032	0.017
	(0.001)**	(0.001)**	(0.002)**	(0.002)**
Urban	-0.042	-0.039	-0.076	-0.081
	(0.003)**	(0.002)**	(0.006)**	(0.008)**
Constant	0.672	0.789	0.672	0.744
	(0.005)**	(0.007)**	(0.011)**	(0.013)**
R_2	0.09	0.06	0.03	0.03
Birth Year FE	yes	no	yes	no
Sample Age Group	6-13	6-13	14-18	14-18
N	54,957	54,957	25,730	25,730

* $p<0.05$; ** $p<0.01$

Note: Treated communities are DHS household clusters that are within 25 km of a college that opened between 1997 and 2013. This sample includes both treated and untreated communities. Time to college establishment is measured by 5 to 6 year waves. The regressions in Columns 1 and 2 are restricted to primary school age children (ages 6 to 13), while the regressions reported in Columns 3 and 4 are restricted to secondary school age children (ages 14 to 18). Columns 1 and 3 include birth year fixed effects, while Columns 2 and 4 do not include fixed effects but include sampling weights.

Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Kenya's Commission for University Education. Geographic data of colleges are obtained from Google Maps.

Table 23

Event Study Analysis with Control Group, School Enrollment, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)
Treated	0.039	-0.010	0.018	-0.052
	(0.008)**	(0.012)	(0.012)	(0.017)**
2 Waves Pre-Treatment	-0.051	-0.254	-0.007	-0.203
	(0.007)**	(0.009)**	(0.012)	(0.014)**
Treatment Wave	0.023	0.181	-0.009	0.090
	(0.007)**	(0.009)**	(0.011)	(0.014)**
1 Wave Post-Treatment	0.015	0.288	-0.043	0.132
	(0.009)	(0.011)**	(0.015)**	(0.020)**
2 Waves Post-Treatment	-0.082	-0.076	-0.049	-0.070
	(0.011)**	(0.015)**	(0.019)**	(0.025)**
3 Waves Post-Treatment	-0.113	0.159	-0.125	0.028
	(0.013)**	(0.020)**	(0.022)**	(0.031)
4 Waves Post-Treatment	0.010	0.320	0.060	0.226
	(0.016)	(0.018)**	(0.025)*	(0.030)**
Treated*2 Waves Pre-Treatment	0.015	0.083	0.003	0.064
	(0.013)	(0.018)**	(0.020)	(0.026)*
Treated*Treatment Wave	-0.012	0.019	-0.012	0.031
	(0.011)	(0.015)	(0.017)	(0.023)
Treated*1 Wave Post-Treatment	-0.036	-0.024	-0.020	0.031
	(0.014)**	(0.017)	(0.021)	(0.030)
Treated*2 Waves Post-Treatment	0.105	0.289	0.072	0.227
	(0.017)**	(0.022)**	(0.028)**	(0.037)**
Treated*3 Waves Post-Treatment	0.089	0.155	0.078	0.174
	(0.027)**	(0.031)**	(0.040)	(0.054)**
Treated*4 Waves Post-Treatment	-0.235	-0.135	-0.237	-0.116
	(0.028)**	(0.038)**	(0.042)**	(0.060)
Number of Colleges within 25 km	-0.001	0.001	-0.003	-0.002
	(0.000)*	(0.001)*	(0.001)**	(0.001)*
Male	0.003	0.005	0.043	0.040
	(0.004)	(0.005)	(0.006)**	(0.008)**
Urban	0.063	0.063	0.023	0.053
	(0.005)**	(0.006)**	(0.007)**	(0.010)**
Constant	0.530	0.478	0.462	0.432
	(0.005)**	(0.007)**	(0.009)**	(0.011)**
R_2	0.02	0.15	0.01	0.06
Birth Year FE	yes	no	yes	no
Sample Age Group	6-13	6-13	14-18	14-18
N	36,868	36,868	16,525	16,525

* $p<0.05$; ** $p<0.01$

Note: Treated communities are DHS household clusters that are within 25 km of a college that opened between 1988 and 2015. This sample includes both treated and untreated communities. Time to college establishment is measured by 5 to 6 year waves. The regressions in Columns 1 and 2 are restricted to primary school age children (ages 6 to 13), while the regressions reported in Columns 3 and 4 are restricted to secondary school age children (ages 14 to 18). Columns 1 and 3 include birth year fixed effects, while Columns 2 and 4 do not include fixed effects but include sampling weights.

Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

11 DISCUSSION

My findings support the conclusion that colleges have positive spillovers on primary school enrollment across the contexts of different countries, and that there may be positive spillovers on secondary school enrollment in certain contexts. My case studies are of lower income countries in Sub-Saharan Africa. The extent to which the income level of a country or a region affects the presence or size of spillovers remains a question. Future research on education spillovers should investigate whether GDP or regional economic activity is causal in creating an environment in which a spillover can occur or whether it affects the size of a spillover. It may be a more important factor for spillovers to secondary school because primary school enrollment has been prioritized over secondary school enrollment. Because secondary school enrollment is initially lower than primary school enrollment, secondary school enrollment has greater potential for a marginal change in enrollment. If constraints are binding, families cannot send their children to school; so as income rises, constraints are eased so families are more likely to send their children to school. It is likely also important to consider the level of inequality in relation to aggregate income since a more even distribution of income is more likely to impact school enrollment. Future research could also consider how changes in different measures of poverty levels are related to changes in school enrollment and the strength or potential for spillovers.

While my findings support the hypothesis that colleges have spillovers on lower levels of schooling, my research does not prove there is a causal effect of a college leading to higher school enrollment. In earlier pre-treatment waves ($\tau \leq -2$), my coefficients of interest are negative in comparison to the pre-treatment wave closest to the establishment of the college ($\tau = -1$), signifying the likelihood of school enrollment increases as time progresses toward the college establishment year. Because the coefficients on the pre-treatment waves are negative and significant, it is possible there is omitted variable bias that is not captured in my specification. This may point to the existence of an underlying trend that may lead to an upward bias in my estimated spillovers if enrollment is already linearly increasing over time. In other specifications, I ran regressions where I linearly controlled for birth year and found similar results. In some cases, the magnitude of my estimated coefficients increased marginally when linearly controlling for birth year. Future research on educational spillovers should consider studying the cause of linear trends.

The spillovers I estimate are often highest for low and low-middle income families. This group may have been most affected by a college opening because their initial enrollment level is lower than other groups so their enrollment numbers have the greatest potential to change. It could also be the case that children from high income families will go to school regardless of whether a college opens, but a college opening may be what changes the decisions of lower income families who are on the margin. This could occur through a college influencing an easing of household constraints or an increase in the perceived returns to schooling. Though I find this particular externality may have a progressive effect on enrollment, this is likely outweighed by the regressive nature of the direct benefits of tertiary education investment (Birdsall 1996; Darvas et al. 2017; Prakasam 2015; Psacharopoulos 1982; Psacharopoulos and Patrinos 2004).

Due to data constraints, my research only estimates spillovers on school enrollment, but colleges likely have many other spillovers on the local community. Spillovers on the local labor market may provide a better understanding of the social welfare implications a college may have. Researchers should seek to estimate the size and distributional impact of other types of externalities to give policymakers a more complete picture of colleges' geographic spillovers and social welfare impacts.

In the following subsections, I consider the potential significance, applications, and limitations of my research. These sections discuss gaps in the literature, the contributions of my research, and directions for future research.

11.1 *Labor Market*

When average school enrollment increases, the local labor market experiences an immediate decrease in labor supply, which leads to a new higher equilibrium wage for the remaining laborers in the local economy, which likely includes the child's parents (Basu and Van 1998; Soares et al. 2012). It is possible an increase in education will not benefit the children who go to school or the local economy if they do not actually learn while in school or if the labor market does not develop in tandem with the evolving workforce (Pritchett 2001). The possibility of no returns to schooling or of returns to schooling being lowered by forces such as government corruption, low education quality, or a lack of economic development should be considered, but in this paper, I assume there are positive returns to schooling (Mincer 1974; Card 1994; Duflo 2001; Gruber 2011). When there are positive returns to schooling, future wages for children who are in school will be higher (Mincer 1974; Card 1994; Duflo 2001).

Additionally, human capital investment has benefits for the local economy and potentially the aggregate economy as well. When school enrollment increases, the local workforce becomes more educated, which increases its ability to attract new businesses and diversify in terms of industries and job opportunities (Hadzimustafa 2011; Palacios 2005; Paytas et al. 2004; Feser et al. 2008; Otsuba and

Sonobe 2018; Porzio and Santangelo 2019). With a more diversified economy, workers across industries may benefit from a raise in wages since there will be a lower supply of workers in each given industry. An influx of firms may lead to urban growth and development, which can lead to the development of an industrial cluster that attracts even more people, particularly those with a skill set that is complementary to the dominant industry in the cluster (Easterly 2002; Rosenthal and Strange 2008; Hanlon and Miscio 2017; Duranton and Kerr 2015; Narayana 2011; Porzio and Santangelo 2019; Moretti 2004; Moretti 2019; Faggio et al. 2019; Sanso-Navarro et al. 2017). This urban and economic development may catalyze regional development, which may increase aggregate income and improve quality of life (Sanso-Navarro et al. 2017; Hadzimustafa 2011).

11.2 *Quality of Higher Education*

Quality of education is a critical piece of my question that is not captured in my work due to the uncertainty and inconsistency around measures of quality. Future work should consider how to measure and control for quality of higher education. Higher quality tertiary education institutions not only deliver a higher quality education to the students who attend the college, but it would be expected that these institutions would also have higher spillovers on primary and secondary schooling. Lower quality institutions likely are likely more inward-focused, focusing on improving the quality of their own institution before considering how they might influence the surrounding community. My estimated spillovers are likely downward biased since I do not control for quality of education. If measures of education quality were included, I expect the spillovers of high quality institutions to be greater than the spillovers I estimate.

11.3 *Type of Higher Education Institution*

It is likely that different types of institutions affect the community differently. Many higher education institutions in the countries I study are fairly specialized and only offer training in a few areas. These specialized institutions likely influence the community in ways that are related to the type of training they offer. For instance, the area around an agricultural college may benefit from greater access to agricultural technologies and people trained in the most innovative techniques, which may lead to a boom in the agricultural industry (Rosenzweig 1995). It is also likely an area with a thriving agricultural industry would attract an agricultural college; but even in this case, the college would be a complementary industry and would likely boost the local agricultural industry through theories of matching (Easterly 2002).

Under this assumption, National Teaching Colleges, Education Colleges, or colleges whose programs focus on teaching may have stronger spillovers on primary and secondary schooling than other types of higher education institutions. Because these institutions focus on educating teachers, they are more likely to have knowledge of the most recent innovations in education, which will likely be disseminated into the local community through formal and informal mechanisms. Since the institution's students are part of the community, they may interact with people in the neighborhood who they may share their ideas and knowledge with. The level of integration between the institution and the local community may vary, but is likely higher for teaching colleges since they are more likely to also have formal mechanisms, such as student teaching programs, through which students will engage with the local community. These formal programs make informal mechanisms of knowledge dissemination more likely as well through broadening the students' social network (Hadzimustafa 2011; Easterly 2002). In addition, an education college produces teachers and other education professionals, which leads to an increased supply of trained education professionals. This may lead to an increase in the number of schools in the local area since there are more people able to teach in these schools. It could also lead to higher quality education in the community because there is greater competition for teaching positions in the local community since the supply of teachers is increasing, while the demand for teachers may not be increasing at a commensurate rate.

11.4 *Quality of Primary and Secondary Education*

Much of the education economics literature focuses on educational attainment, rather than achievement because like education quality, achievement is difficult and controversial to measure. My paper also focuses on educational attainment, rather than achievement due to data limitations. The outcome variable I study is school enrollment, which can be a problematic measure. Quite a bit of literature documents that enrollment does not equate to school attendance (Barr and Zeitlin 2010; Posso and Feeny 2016). Many children who are enrolled in school do not regularly attend school (Posso and Feeny 2016). Even if the children come to school regularly, their teachers may not which also leads to lower true educational attainment, but this is not captured in my data (Barr and Zeitlin 2010; Duflo et al. 2012; Muralidharan et al. 2017). Despite these shortcomings of studying school enrollment, it has still been linked to economic growth and it is the best measure of educational attainment available in my data (Seebens and Wobst 2005). Future research should study the educational spillovers of colleges on educational quality at the primary and secondary level. I expect these effects would be sensitive to the quality of the college itself as well.

11.5 *Access to Higher Education*

Higher education remains inaccessible to the majority of the population in many developing countries, including Uganda and Kenya (Darvas et al. 2017). The social welfare implications of public investment in higher education are lower when access to higher education is not available to much of the population. While there are not formal regulations prohibiting the admission of students from lower income families, often times students from these backgrounds face prohibitive costs at lower levels of education that halt their progression in school. The costs of higher education may still be too high for the students who complete primary and secondary school, particularly if access to credit is limited, which is often the case, especially in developing countries (Darvas et al. 2017). Credit constraints are particularly binding for individuals from low income families (Darvas et al. 2017).

If higher education is more accessible to a larger proportion of the population, I would expect the spillovers to lower levels of education to be higher. There would likely be increases in enrollment at lower levels of schooling that occur through several different mechanisms. If children from similar backgrounds attend college, younger children will see that they also might be able to attend college. Further, if these college graduates have improved labor market opportunities, this may encourage families with younger children to continue investing in schooling because it raises their perception of the returns to schooling (Aaronson et al. 2017; Bell et al. 2018); Jagnani and Khanna 2018.

Additionally, if a college has resource spillovers on lower levels of schooling, this may also increase school enrollment and simultaneously increase the perception of the accessibility to higher education. For instance, a college may partner with primary and secondary schools to offer dual-enrollment courses, collaborate on curriculum formation, form a student teaching program, host a summer enrichment program, offer access to the university library, or donate technology to the primary and secondary schools. These avenues may increase the spillovers to primary and secondary schooling. Further, these partnerships increase the interaction between families and the college while their children are still young. The increased familiarity with the institution may help college not seem like a distant and unattainable goal. If families know the college is actively investing in the community, this may also increase their perception of the college's interest in their child, which may incentivize households to invest in human capital. Moreover, parents may be more likely to believe their child may be able to receive financial aid to support her education in the future if the college has already been financially supporting their child's educational attainment through partnerships with primary and secondary schools or through programs aimed at primary and secondary school age children.

When higher education is more accessible to children from lower income families, college students may be more conscious of the potential for spillovers to these communities and may be more active in seeking out ways to invest in, mentor, and support lower income children in the local communities.

11.6 *Equity Implications*

The equity implications of public investment in higher education are dependent on the source of the expenditures. My research shows colleges may have indirect benefits for low-income and lower-middle income children, by increasing the likelihood of their school enrollment.

Even with these positive spillovers on enrollment, public investment in higher education still is often of greater benefit to those of higher income families, since it is more often higher income children who have access to higher education (Darvas et al. 2017). If financing higher education is a substitute for financing primary or secondary education, then there are likely regressive effects of investment in higher education since lower income children benefit more from lower levels of education, while higher income children benefit more from higher levels of education (Birdsall 1996; Darvas et al. 2017; Prakasam 2015; Psacharopoulos 1982; Psacharopoulos and Patrinos 2004; Arias Ciro and Torres Garcia 2018; World Bank 1995; World Bank 2000). If this is the case, public investment in higher education may perpetuate and exacerbate disparities between socioeconomic classes (Chiswick 1974; Darvas et al. 2017; Psacharopoulos 1982; Psacharopoulos and Patrinos 2004).

11.7 *Scalability*

It remains a question whether an expansion of higher education institutions would change the size of spillovers on lower levels of education. If there are diminishing marginal returns to the number of colleges in a country or in a community, then spillovers will decrease. However, if the expansion of tertiary education leads to greater competition between the institutions and improves the quality of higher education, it may increase the size of spillovers. Additionally, if there are more colleges, higher education may become more accessible since the increase in supply will likely lead to a decrease in the cost of higher education. If there are more colleges and if this leads to more people attending college, there may be an even greater spillover on educational attainment through the mechanism of increasing the number of role models for children. This also makes higher education seem more attainable and raises the perceived returns to education, which leads to higher educational attainment.

12 CONCLUSION

In this paper, I study the effects a college in a developing country has on the surrounding community's educational attainment. I measure educational attainment by the school enrollment of primary and secondary school age children and estimate these spillovers using an event study framework. Traditional econometric methodologies, such as a regression discontinuity or difference-in-differences approach are not appropriate for answering my question because I do not study higher education expansion that occurred as a result of an exogenous change. To overcome this identification concern, I use an event study design that exploits variation in the timing of college establishment across my data. My methodology allows me to assess the short- and long-run impacts of a college on the local community's educational attainment, since it allows me to estimate coefficients separately for each five year period.

I find there are generally positive spillovers of a college on the local community's educational attainment, as measured by the school enrollment of primary and secondary school age children. At the primary school level, these spillovers are fairly consistent across countries and usually increase with the amount of time the college has been established. For secondary school age children, I find some evidence of positive spillovers on school enrollment in Kenya.

The enrollment spillovers are highest for low and lower-middle income children, which suggests there may be some redistributive features of college investment. However, much literature has documented the primary beneficiaries of tertiary education investment in developing countries tend to be high income households, so my findings do not provide enough justification for continued public investment in higher education (Birdsall 1996; Darvas et al. 2017; Prakasam 2015; Psacharopoulos 1982; Psacharopoulos and Patrinos 2004; Arias Ciro and Torres Garcia 2018; World Bank 1995; World Bank 2000). My research considers the existence of social benefits of higher education investment and attempts to measure one of these benefits. My findings should be considered in conjunction with the body of literature documenting the equity and efficiency implications of educational investment, at each level of schooling.

At the macroeconomic level, human capital investment is a driver of economic growth and development (Barro 2001; Barro and Sala-i-Martin 2004; Karpov 2017; Ray 1998; Romer 2006; World Bank 2000; World Bank 2018). Human capital investment increases labor productivity and may also lead to positive technology shocks (Autor et al. 2020; Barro 2001; Barro and Sala-i-Martin 2004; Porzio and Santangelo 2019; Romer 2006; World Bank 2018).

At the microeconomic level, human capital investment leads to a future increase in wages and access to a greater variety of labor market opportunities (Card 1994; Card 2001; Duflo 2001; Gruber 2012). Education equips students with new skills and knowledge and broadens their worldview and social networks. Some of these new networks give children the opportunity to interact with children of different family income levels, which may have positive social implications since it increases interaction between socioeconomic classes, which may lead to lesser disparities in the future. Educators have the potential to widen students' perspectives by sharing with them that opportunities exist outside of what they know from their family and friends. Knowledge of these opportunities, access to different social networks, and acquisition of knowledge and skills make education a conduit for increasing socioeconomic and intergenerational mobility (Chetty et al. 2018; Chetty and Hendren 2018; Fryer and Katz 2013).

Educational investment is crucial for both microeconomic and macroeconomic reasons. Education does not only provide private returns, but there are also social benefits to education. Social benefits provide the justification for public investment in education. When making policy recommendations, it is important to consider that the benefits of different levels of schooling concentrate to different subsets of the population. My research provides some evidence of spillovers to low and lower-middle income portions of the population, but my paper does not provide enough evidence to conclude this is the socially optimal public investment in education expenditure. Before making education finance decisions, policymakers should assess the social benefits of primary schools and secondary schools, as well as considering the other social benefits of colleges. Each level of schooling should be funded to some extent, so governments should consider the allocation of funding to each level. To optimize social benefits and increase equity through educational investment, governments should also consider how the funding is distributed within that level of schooling, as well as the structure of their education systems and policies.

Further research is needed before it can definitively be determined that there are positive spillovers of colleges in developing countries. My paper supports this hypothesis and is consistent with the findings of Jagnani and Khanna (2018) in India, but further research is needed to assess the external validity of these findings. These findings would be strengthened if there were a clear exogenous change that led to the expansion of higher education. Future research should focus on finding an exogenous expansion of higher education, allowing the use of other econometric approaches. Within the event study framework, it would also be wise to study what is driving underlying linear time trends to strengthen the internal validity of the study.

In my continuing research, I will consider the external validity of my estimated spillovers by estimating spillovers in other countries. I have assembled a geocoded higher education dataset for Nigeria. Nigeria has 170 bachelors degree-granting institutions, approximately double to triple the number of colleges in the countries I study in this paper. Nigeria's colleges are more geographically dispersed than the colleges in Uganda, Kenya, and Ghana, thus leading to more geographic variation in treated communities. Because Nigeria also has a larger population and larger sample sizes within the DHS, it has rich sources of data that make a good choice for my research question. Further, Nigeria has education finance and admissions policies that increase access to higher education for lower income students. I am interested to see if these characteristics will affect the strength of the enrollment spillovers and plan to investigate this in continuing research. It is also likely that the quality and type of institutions affects the spillovers the college will have on the local community, so I would like to compare the spillovers different tiers of colleges or specific types of colleges have on their local communities.

APPENDIX

Table 24

Event Study Analysis, Enrollment of 6-13 Year Olds, Uganda

Dependent Variable: School Enrollment	(1)	(2)
3 Waves Pre-Treatment	-0.027	-0.015
	(0.009)**	(0.011)
2 Waves Pre-Treatment	-0.002	-0.009
	(0.008)	(0.009)
Treatment Wave	0.023	0.001
	(0.007)**	(0.007)
1 Wave Post-Treatment	0.029	0.013
	(0.008)**	(0.008)
2 Waves Post-Treatment	0.038	0.007
	(0.009)**	(0.008)
3 Waves Post-Treatment	0.036	0.019
	(0.019)	(0.014)
Number of Colleges within 25 km	0.001	0.000
	(0.000)	(0.000)
Male	-0.007	-0.009
	(0.004)	(0.005)
Wealth Index Quintile	0.021	0.021
	(0.002)**	(0.002)**
Urban	-0.001	0.006
	(0.005)	(0.005)
Constant	0.834	0.848
	(0.007)**	(0.009)**
R^2	0.02	0.02
Birth Year FE	yes	no
N	17,756	17,756

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1996 and 2015. Time to college establishment is measured by 5 year waves. Column 1 includes birth year fixed effects, while Column 2 does not include fixed effects. Column 2 includes sampling weights.

Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

Table 25

Event Study Analysis, Enrollment of 6-13 Year Olds, Kenya

Dependent Variable: School Enrollment	(1)	(2)
2 Waves Pre-Treatment	-0.022	-0.013
	(0.006)**	(0.007)*
Treatment Wave	0.028	0.017
	(0.005)**	(0.005)**
1 Wave Post-Treatment	0.042	0.023
	(0.005)**	(0.005)**
2 Waves Post-Treatment	0.051	0.033
	(0.007)**	(0.005)**
Number of Colleges within 25 km	0.000	0.001
	(0.000)	(0.000)
Male	0.001	0.001
	(0.002)	(0.003)
Wealth Index Quintile	0.013	0.012
	(0.001)**	(0.001)**
Urban	-0.035	-0.026
	(0.003)**	(0.003)**
Constant	0.912	0.926
	(0.005)**	(0.006)**
R_2	0.02	0.01
Birth Year FE	yes	no
N	21,050	21,050

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1997 and 2013. Time to college establishment is measured by 5 to 6 year waves. Column 1 includes birth year fixed effects, while Column 2 does not include fixed effects but does include sampling weights. Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Kenya's Commission for University Education. Geographic data of colleges are obtained from Google Maps.

Table 26

Event Study Analysis, Enrollment of 6-13 Year Olds, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)	(6)
2 Waves Pre-Treatment	-0.094	-0.076	-0.099	-0.070	-0.029	-0.180
	(0.017)**	(0.019)**	(0.017)**	(0.019)**	(0.011)**	(0.016)**
Treatment Wave	0.044	0.034	0.047	0.033	0.020	0.202
	(0.011)**	(0.011)**	(0.011)**	(0.011)**	(0.009)*	(0.012)**
1 Wave Post-Treatment	0.008	-0.003	0.017	-0.003	-0.003	0.261
	(0.013)	(0.012)	(0.013)	(0.013)	(0.011)	(0.013)**
2 Waves Post-Treatment	0.092	0.072	0.100	0.073	0.044	0.223
	(0.017)**	(0.014)**	(0.017)**	(0.014)**	(0.013)**	(0.016)**
3 Waves Post-Treatment	0.015	-0.002	0.021	-0.002	-0.003	0.320
	(0.024)	(0.024)	(0.024)	(0.025)	(0.022)	(0.025)**
4 Waves Post-Treatment	-0.142	-0.127	-0.150	-0.159	-0.177	0.182
	(0.025)**	(0.033)**	(0.025)**	(0.032)**	(0.024)**	(0.032)**
Number of Colleges within 25 km	-0.001	-0.002	-0.000	-0.001	-0.000	0.003
	(0.001)*	(0.001)**	(0.001)	(0.001)*	(0.000)	(0.001)**
Male	0.014	0.013	0.014	0.012	0.011	0.006
	(0.008)	(0.008)	(0.008)	(0.008)	(0.006)	(0.009)
Wealth Index Quintile	0.028	0.043				
	(0.004)**	(0.004)**				
Urban	-0.021	-0.043	0.023	0.020	0.034	-0.016
	(0.011)	(0.011)**	(0.009)**	(0.009)*	(0.007)**	(0.010)
Constant	0.740	0.726	0.801	0.833	0.576	0.505
	(0.013)**	(0.015)**	(0.010)**	(0.010)**	(0.008)**	(0.011)**
R^2	0.03	0.03	0.02	0.01	0.01	0.11
Birth Year FE	yes	no	yes	no	yes	no
N	8,505	8,505	8,505	8,505	11,807	11,807

* p<0.05; ** p<0.01

Note: This sample is restricted to 6-13 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1988 and 2013. Time to college establishment is measured by 5 to 6 year waves. Columns 1, 3, and 5 include birth year fixed effects, while Columns 2, 4, and 6 do not include fixed effects but do include sampling weights.

In Columns 3, 4, 5, and 6, I exclude wealth index quintile from the controls because it is not available in the 1993 or 1998 waves of the DHS. Excluding wealth index quintile, expands the sample size as seen in Columns 5 and 6. Columns 3 and 4 exclude wealth index quintile from the regression, but run the regressions on the same sample used for the regressions whose results are displayed in Columns 1 and 2.

Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

Table 27

Event Study Analysis, Enrollment of 14-18 Year Olds, Uganda

Dependent Variable: School Enrollment	(1)	(2)
3 Waves Pre-Treatment	0.050	0.002
	(0.022)*	(0.021)
2 Waves Pre-Treatment	0.042	-0.011
	(0.020)*	(0.020)
Treatment Wave	0.001	-0.031
	(0.017)	(0.016)
1 Wave Post-Treatment	0.015	0.024
	(0.019)	(0.020)
2 Waves Post-Treatment	-0.005	-0.015
	(0.022)	(0.021)
3 Waves Post-Treatment	-0.058	-0.089
	(0.045)	(0.051)
Number of Colleges within 25 km	-0.004	-0.005
	(0.001)**	(0.001)**
Male	0.078	0.069
	(0.009)**	(0.011)**
Wealth Index Quintile	0.015	0.011
	(0.004)**	(0.004)**
Urban	-0.034	-0.051
	(0.012)**	(0.014)**
Constant	0.641	0.691
	(0.018)**	(0.020)**
R_2	0.02	0.02
Birth Year FE	yes	no
N	8,130	8,130

* p<0.05; ** p<0.01

Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1996 and 2015. Time to college establishment is measured by 5 year waves. Column 1 includes birth year fixed effects, while Column 2 does not include fixed effects but does include sampling weights. Data are from the 2001-2016 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from the Uganda National Council of Higher Education. Geographic data of colleges are obtained from Google Maps.

Table 28

Event Study Analysis, Enrollment of 14-18 Year Olds, Kenya

Dependent Variable: School Enrollment	(1)	(2)
2 Waves Pre-Treatment	0.049	-0.017
	(0.015)**	(0.018)
Treatment Wave	0.031	0.099
	(0.013)*	(0.013)**
1 Wave Post-Treatment	0.044	0.128
	(0.015)**	(0.014)**
2 Waves Post-Treatment	0.053	0.135
	(0.019)**	(0.020)**
Number of Colleges within 25 km	-0.003	-0.004
	(0.001)**	(0.001)*
Male	0.049	0.048
	(0.007)**	(0.009)**
Wealth Index Quintile	0.004	-0.004
	(0.003)	(0.004)
Urban	-0.081	-0.081
	(0.008)**	(0.011)**
Constant	0.786	0.776
	(0.014)**	(0.016)**
R^2	0.02	0.04
Birth Year FE	yes	no
N	10,699	10,699

* $p<0.05$; ** $p<0.01$
Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1997 and 2013. Time to college establishment is measured by 5 to 6 year waves. Column 1 includes birth year fixed effects, while Column 2 does not include fixed effects but does include sampling weights.
Data are from the 2003-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Kenya's Commission for University Education. Geographic data of colleges are obtained from Google Maps.

Table 29

Event Study Analysis, Enrollment of 14-18 Year Olds, Ghana

Dependent Variable: School Enrollment	(1)	(2)	(3)	(4)	(5)	(6)
2 Waves Pre-Treatment	-0.009	-0.046	-0.012	-0.045	-0.006	-0.143
	(0.031)	(0.033)	(0.031)	(0.033)	(0.017)	(0.021)**
Treatment Wave	-0.005	-0.026	-0.003	-0.028	-0.004	0.122
	(0.020)	(0.021)	(0.020)	(0.021)	(0.014)	(0.018)**
1 Wave Post-Treatment	-0.039	-0.057	-0.034	-0.061	-0.036	0.160
	(0.023)	(0.024)*	(0.023)	(0.024)**	(0.018)*	(0.022)**
2 Waves Post-Treatment	0.062	0.038	0.066	0.034	0.046	0.163
	(0.029)*	(0.030)	(0.029)*	(0.030)	(0.021)*	(0.027)**
3 Waves Post-Treatment	-0.018	-0.053	-0.014	-0.055	-0.016	0.209
	(0.041)	(0.045)	(0.041)	(0.045)	(0.034)	(0.044)**
4 Waves Post-Treatment	-0.117	-0.134	-0.120	-0.166	-0.122	0.106
	(0.045)**	(0.052)**	(0.045)**	(0.052)**	(0.037)**	(0.051)*
Number of Colleges within 25 km	-0.003	-0.004	-0.002	-0.003	-0.002	-0.001
	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)**	(0.001)
Male	0.059	0.059	0.059	0.057	0.043	0.037
	(0.013)**	(0.016)**	(0.013)**	(0.016)**	(0.010)**	(0.014)**
Wealth Index Quintile	0.013	0.031				
	(0.007)	(0.008)**				
Urban	-0.013	-0.046	0.007	0.002	0.007	-0.010
	(0.019)	(0.022)*	(0.016)	(0.018)	(0.012)	(0.016)
Constant	0.611	0.594	0.641	0.676	0.471	0.416
	(0.024)**	(0.029)**	(0.018)**	(0.020)**	(0.013)**	(0.017)**
R_2	0.01	0.02	0.01	0.01	0.01	0.04
Birth Year FE	yes	no	yes	no	yes	no
N	4,437	4,437	4,437	4,437	6,053	6,053

* $p<0.05$; ** $p<0.01$

Note: This sample is restricted to 14-18 year olds in treated communities, where treated communities are DHS household clusters that are within 25 km of a college that opened between 1988 and 2013. Time to college establishment is measured by 5 to 6 year waves. Columns 1, 3, and 5 include birth year fixed effects, while Columns 2, 4, and 6 do not include fixed effects but do include sampling weights.

In Columns 3, 4, 5, and 6, I exclude wealth index quintile from the controls because it is not available in the 1993 or 1998 waves of the DHS. Excluding wealth index quintile, expands the sample size as seen in Columns 5 and 6. Columns 3 and 4 exclude wealth index quintile from the regression, but run the regressions on the same sample used for the regressions whose results are displayed in Columns 1 and 2.

Data are from the 1993-2014 waves of the Demographic and Health Survey (DHS) conducted by USAID. College data are obtained from Ghana's National Accreditation Board. Geographic data of colleges are obtained from Google Maps.

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