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Education, health, and labor force supply: Broadening human capital for national development in Malawi

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Abstract: Education and health are both capital investments in national development, often viewed as independent factors on a country's labor force supply and productivity. This study uses the 2010–2011 Third Integrated Household Survey in Malawi to propose an Education-enhanced Health Human Capital (EHHC) model where education influences labor force supply directly as well as indirectly through improvements in adult health. Relative to the Health Human Capital (HHC) model, the EHHC model better fits the available data, capturing the multiple effects of education. A national economic simulation of the 2013 age 13 cohort in Malawi confirms the importance of education as a tool for national development. Specifically, if the mean education of the age 13 cohort increased from the present national mean to the completion of secondary school, the total effects of education would lead to a predicted increase in annual tax revenue of 580 million Malawian Kwacha.

Subjects: Development Economics; Education & Development; Health & Development

Keywords: Africa; Malawi; human capital; health; labor force supply; tax revenue; education

ABOUT THE AUTHORS

William C. Smith's research focuses on the role of education in social and economic development. Especially interested in the complex relationship between education and health, he works closely with an international, inter-disciplinary team of researchers, led by David P. Baker at the Pennsylvania State University. In addition to this work, capturing the cognitive benefits of education and indirect benefits of education through health, William C. Smith and David P. Baker have led the development of the Population Education Transition (PET) curve which explores how socio-demographic and cultural contexts mediate the relationship between education and health. Although their work on education and health is global and comparable in nature, the foundation of their understanding comes from earlier work on Sub-Saharan Africa.

PUBLIC INTEREST STATEMENT

Education and health are both important factors in a country's labor force supply and productivity. Education increases labor force productivity through increased knowledge, while those in better health have more healthy time, enabling them to take full advantage of their advanced skills. Using a 2010–2011 survey in Malawi, this study finds that, in addition to both education and health being positively related to labor force participation, education has a bonus positive benefit through improved adult health. Central for national development, increasing average education in the country from its present position (less than primary) to secondary education for a single age group in Malawi could result in an increase in national tax revenue of approximately 580 million Malawian Kwacha per year. Education, clearly, has a role to play in national development and it is important to understand its holistic impact on multiple parts of society.

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1. Introduction

Greater education and strong health play a crucial role in a prospering economy, not only at the individual level, but also at the national level (Barro, 2001; Bartel & Taubman, 1979; Bloom, 2006; Psacharopoulos, 1994; Strauss & Thomas, 1998). Education can provide both theoretical knowledge and practical skills to raise productivity, which will lead to higher income (Barro, 2001; Hall, 2002; Mincer, 1974; Psacharopoulos, 1994; Rouse, 2005). A healthy mind and body can help an individual gain and apply the knowledge and skills necessary for a fulfilling life (Bleakley, 2010; Cowell, 2006). At both macro- and micro-levels, policy-makers and legislatures have been targeting education and health in order to construct policies aimed at economic prosperity. As shown below, much research has been done to understand how those three factors relate to each other; however, due to their intertwined contexts, previous research might not properly capture the full extent of influence among education, health, and human capital production for labor force supply and national development.

Past research supports the conclusion that early childhood health leads to greater education attainment, the latter of which then influences labor force supply and productivity (Barro, 2001; Hall, 2002; Mincer, 1974; Psacharopoulos, 1994; Rouse, 2005). However, a positive education–health gradient for both children and adults suggests that education is also a precursor to post-school health, the latter of which influences labor force supply and productivity (Chirikos & Nestel, 1985; Schultz & Tansel, 1993; Strauss & Thomas, 1998; Thomas et al., 2006). Extensive epidemiological and demographical literatures indicate that *ceteris paribus* education is directly associated with better health, lower health risky behavior, and increased longevity (Arendt, 2005; Cutler, Lleras-Muney, & Vogl, 2008; Groot & Maassen van den Brink, 2007; Muennig, 2007; Silles, 2009; Smith, Anderson, Salinas, Horvatek, & Baker, 2015; Smith, Salinas, & Baker, 2012). The emerging conclusion from this research suggests an additional avenue by which education can influence human capital and labor force productivity that holds equally important development policy implications, namely: that education influences adult's physical, mental, and emotional health which in turn influences labor force supply, productivity, and innovation. This particular ordering of the causal impact of education on economic productivity is less considered in development policy because it has not been scientifically tested.

We hypothesize that the traditional human capital model of education and productivity fails to fully capture education's ability to indirectly affect the labor force through education's positive influence on adult health. Following a review of research on health education and labor force productivity, a new conceptual model of education, adult health, and labor force supply is developed and tested using the Malawian 2010–2011 Third Integrated Household Survey. Following results, the policy implications of the Malawian survey for investing in education as a vehicle for national economic development are considered.

2. Health and the human capital model

In the traditional conception of human capital, health is generally viewed as exogenous to education. When it is considered, it is usually limited to the idea that childhood health impacts the amount of education attained which determines an individual's skills and their activity in the labor force. Children in poor health are unable to attend school regularly and may have difficulty providing the effort needed to get the most out of their education when present. This in turn impacts the individual's skill set as well as their ability to contribute productively in the labor force. Bleakley (2010) expands on the *Envelope Theorem* (see Fudenberg & Tirole, 1991; Mas-Colell, Whinston, & Green, 1995; Simon & Blume, 1994) that explains this relationship as one where health impacts the labor force indirectly through schooling by allowing healthy children to "learn faster and grow up stronger" (p. 285). Healthier children are able to more efficiently produce greater educational outcomes (Cowell, 2006; Hanushek & Kim, 1995; Schultz, 1999) because "individuals with better health may have a tendency to continue learning for longer" (Hammond, 2002, p. 552). These results have been supported by twin studies conducted in the USA and Norway that indicate that children in poorer health complete less years of schooling (Behrman & Rosenzweig, 2004; Black, Devereux, & Salvanes, 2007). Causal ordering, when identified in this model, runs from childhood health to education.

Figure 1. Health Human Captial (HHC) model.
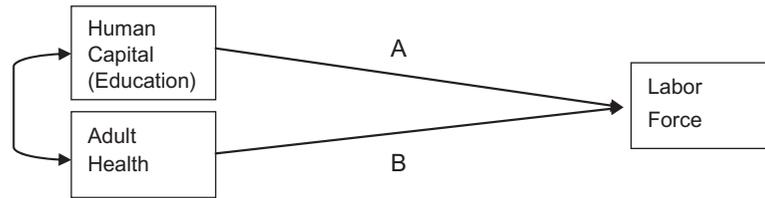
Expanding on this narrower view of childhood health and productivity, the Health Human Capital (HHC) model (Grossman, 1972), as shown in Figure 1, considers health over the life course as a capital good, so that "a person's stock of knowledge affects his market and nonmarket productivity, while his stock of health determines the total amount of time he can spend producing money and earning commodities" (p. 224). Essentially, health capital impacts healthy time and subsequently labor force supply, while knowledge capital (education) impacts labor productivity. The idea of health human capital segments health stock—an individual's initial health lot—from their investment in health (Shea, Miles, & Hayward, 1996). From this perspective, higher levels of education lead independently to an increase in wages. As a result, more educated individuals invest more to ensure a surplus of healthy time and capture the corresponding future financial returns (Grossman, 1972). The most obvious benefits to health, then, are "fewer working days lost to illness, increased productivity, greater opportunities to obtain better-paying jobs, and longer working lives" (Rivera & Currais, 2004, p. 872).

The HHC model conceptualizes health and education as partially correlated, but independent causal factors for labor force supply and productivity, and there is evidence for both paths of the model. The causal effect of education on labor force supply and economic benefits is well established (path A) (Barro, 2001; Hall, 2002; Mincer, 1974; Psacharopoulos, 1994; Rouse, 2005). At the same time, numerous studies have found significant effects of health on individual labor force supply and productivity and national-level economic development (path B). Healthier workers are more productive workers. They are less likely to miss work and are more effective when they are working. Additionally, a higher proportion of the population is engaged in the workforce in healthier countries (Strauss & Thomas, 1998). In a pseudo-experiment in which one group of iron-deficient individuals was randomly assigned to a treatment group, healthier individuals were more likely to be working, lost less time working due to illness, and had more energy (Thomas et al., 2006). Additionally, the level of individual health stock has been connected to labor force productivity in Cote d'Ivoire and Ghana (Schultz & Tansel, 1993) and poor health has been found to reduce the number of hours worked in the USA (Chirikos & Nestel, 1985).

Cross-nationally, health is related to economic growth. In a series of studies, Barro (Barro, 1991; Barro & Lee, 1994), using life expectancy as a proxy for health stock, found that health stock is positively and significantly related to a country's economic well-being. Gyimah-Brempong and Wilson (2004) attributed 30% of the economic growth in their sample of OECD countries to the nations' aggregated health stock and health investments. The positive relationship between health and economic outcomes, however, is not limited to the developed world. Drawing on data from Africa, results indicate that a 1% increase in HIV prevalence rate is related to an average marginal decrease in per capita income of .59% (McDonald & Roberts, 2006). Overall, the HIV/AIDS pandemic has reduced per capita growth by .7 percentage points on the African continent (Bonnel, 2000) and in Sub-Saharan Africa, general health decisions are accountable for 22% of the economic growth (Gyimah-Brempong & Wilson, 2004).

2.1. Education-enhanced Health Human Capital Model
While the original HHC highlights some important interrelated aspects of health and education, the extended Education-enhanced Health Human Capital model (EHHC), proposed here, incorporates the assumption that education influences labor force supply in two ways. One, directly through skill enhancement and the other indirectly through educations' continued impact on adult health, as

Figure 2. Education-enhanced Health Human Captial (EHHC) model.
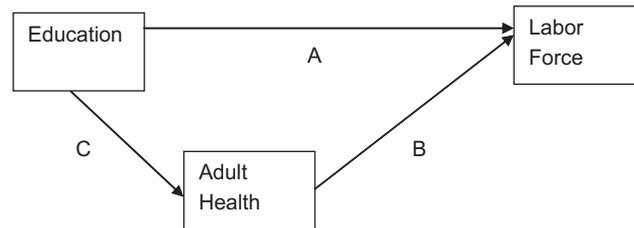
shown in Figure 2 paths C and B. Previous research has identified education as a causal precursor to health, whereby more educated individuals are able to better understand health information, make healthier decisions, and increase their health productivity (Arendt, 2005; Groot & Maassen van den Brink, 2007; Grossman, 2006; Kenkel, 1991; Smith, Salinas, & Baker, 2012). Substantial research shows more educated individuals tend to lead longer and healthier lives (Cutler et al., 2008; Groot & Maassen van den Brink, 2007; Muennig, 2007; Silles, 2009). For example, high school graduates in the USA live about six to nine years longer than high school dropouts (Muennig, 2007). Silles (2009) identifies a causal relation between education and health status, arguing that "one more year of education increases the probability of being in good health between 4.5 and 5.5 percentage points" (p. 127). Groot and Maassen van den Brink (2007) focus on gender differences and found that the effect of education on health is larger for men than for women. Lleras-Muney (2005) identifies that a one-year increase in compulsory schooling is associated with an approximately 3% decrease on mortality after age 35. She argues, "the benefits of education are large enough that we need to consider education policies more seriously as a means to increase health, especially in the light of the fact that other factors, such as expenditures on health, have not been proven to be very effective" (p. 215). In a similar vein, Arendt (2005) found that individuals with more years of education tend to report better health.

Recently, there is a growing body of research focusing on more holistic aspects of the effects of education to better health. For example, Mirowsky and Ross (2003) argue that education enhances our self-recognition and helps us shape our lives for better health. Through the analysis of a structural equation model, Peters, Baker, Dieckmann, and Collins (2010) emphasize cognitive effects of education on health. Other than learning direct knowledge (e.g. specific strategies to prevent HIV/AIDS), they argue that it is the holistic experience of schooling—fostering cognitive abilities, numeracy, and decision-making abilities, to name a few—that can nurture cognitive development and thus can trigger multiple effects of education to protect one's health. The importance of cognition in increasing information processing and leading to better health decisions is also supported by Cutler and Lleras-Muney (2010).

In order to fully understand how education impacts economic growth, we need to have a more complete understanding of its effects on a country's economy; yet, the HHC model omits the indirect relationship of the cognitive effects from education to labor force supply through health. We hypothesize that the new EHHC model provides a stronger policy argument for education by capturing both education's direct effect on the labor force and indirect effects on the labor force through its impact on health.

3. Country selection

To examine the relationship between education, health, and labor force supply, we selected a country that is resource-restricted with low levels of education and national health, thus providing the greatest potential benefit of effective resource allocation. Malawi, a country at the east part of Sub-Saharan Africa, fits these requirements as it ranks below average in Sub-Saharan Africa (SSA) in GNI per capita (750 USD in 2013; SSA average = 3,348), secondary school gross enrollment rate (37% in 2013, SSA average = 40%), and above average in HIV prevalence (10% in 2013, SSA average = 4%) (World Bank, 2015). Additionally, Malawi faces a demographic shift with an increasing proportion of school age population as well as issues of poor school quality. The population in Malawi was 15.38

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million in 2011, and the estimate of Malawi's population growth rate will decrease little by little (World Bank, 2010, 2015). However, the estimated population of the 6–13-year-old children in Malawi will increase by 20% by 2018 (World Bank, 2010). The nation's education system suffers from inefficiency and has a student–teacher ratio (In 2013, primary = 69:1, secondary = 42:1) well above the Sub-Saharan Africa average (In 2013, primary = 42:1, secondary = 24:1) (World Bank, 2015). When we consider these factors in unison, it becomes clear that education in Malawi has the potential to be a sound investment in the nation's societal development (World Bank, 2010).

4. Data and methods

This study uses the 2010–2011 Third Integrated Household Survey (IHS3), the third iteration of a survey which provides a cross-sectional picture of Malawian households. Implemented by the National Statistics Office of the Government of Malawi with technical support from the World Bank, the IHS3 obtained a representative national sample of 12,271 households that contained a total of 56,409 individuals through 2 stage-stratified sampling. Although four questionnaire instruments (household, agriculture, fisheries, and community) were used for the IHS3, this study focuses solely on the household questionnaire which contains 24 modules including modules C (Education), D (Health), and E (Time Use and Labor). The survey was administered to the head of the household or their spouse and all individuals that normally live and eat at that establishment were recorded in the household roster. The household head answered questions as a proxy for members of the household under the age of 12. Those above the age of 12 provided their own responses to personal questions if they were present. To ensure that only those that qualify for the labor force are included in our analysis, the sample is limited to those at least 15 years old, for a sample of 30,137 individuals.

4.1. Variables

4.1.1. Independent variables

To fully measure the indirect effects of education through adult health on labor force supply, thus testing the EHHC model, educational attainment and adult health status are included. Educational attainment is an ordinal variable derived from the question "what is the highest educational qualification you have acquired?" Responses range from 0 (none) to 6 (postgraduate degree). Sixty-four percent of respondents had not completed a primary school education certification, while only 10% completed a full course of secondary education or higher.

The adult health variable is a composite health measure, capturing multiple self-reported general health measures with self-reported diagnosed chronic illness[1]. It was created using principal component analysis with varimax rotation; all factors loaded at .6 or higher. Self-reported health is commonly used when medical records are unavailable and has been shown to be a valid measure of personal health in Sub-Saharan Africa (Kuhn, Rahman, & Menken, 2006). A composite capturing both official diagnoses and self-reported health is appropriate in Malawi, given the wide dispersion of treatment-seeking behavior (24–70%) reported by individuals (Mota, Lara, Kunkwenzu, & Lalloo, 2009; Salaniponi et al., 2000). As the use of traditional care is often the first course of action of sick individuals in Malawi (Hatchett et al., 2004), the reliance on "official" numbers would largely underestimate the severity of health issues in the country. Additionally, asking individuals to report specific illnesses may be difficult due to a lack of diagnosis or a belief that their everyday pains are natural or inevitable (Kaler, 2004). To address these issues, the self-reported health measure used in this study incorporates the individuals' reported difficulties in completing common but essential activities: seeing, hearing, walking, remembering/concentrating, self-care (such as washing, feeding, or toileting), and communicating. These difficulties may signify an underlying, untreated, or chronic condition. The adult health variable is a standardized measure with a mean of zero and standard deviation of one with positive numbers indicating better health.

4.1.2. Control variables

To condition the association of education and health on labor force supply on other factors, we control for influence of individual demographics and family background including: socioeconomic

status, age, sex, marital status, father's education, and mother's education. The relationship between age and labor force supply resembles an inverted U with participation in the labor force increasing until some peak age and then decreasing. To account for these differences, age is controlled in this analysis. Age is captured in ordinal age groups, starting at age 15 and continuing at 10-year intervals to the 55 and over age group. As the dependent variable is focused solely on occupations in the formal labor force and men in Malawi make up a disproportionate (77%) amount of these positions in the sample, it is essential that sex is controlled. Additionally, it is important to control for marital status as individuals that are married may be less likely to participate in the formal labor force because the income of their spouse may be sufficient to support the family.

A standardized socioeconomic status (SES) index is created by combining the ownership of durable goods (i.e. radio, TV, bicycle, car, and computer) with agricultural resources (i.e. agricultural tools and buildings such as pig stys and livestock kraals) and presence of utilities (i.e. electricity and flushing toilet). Parent's education was measured using the same attainment scale as respondents: 0 representing no educational attainment to 6 representing a postgraduate degree. Father's education has a strong influence on labor force supply (Hout & Rosen, 2000) and mother's education has a significant impact on childhood and early adult health (Schultz, 1993). Since labor force supply and adult health are key variables in this analysis, the inclusion of both father's and mother's education is important in our model design.

4.1.3. Dependent variable

The dependent variable is labor force supply, measured as number of hours worked in the participant's primary occupation per year. Labor force supply is the product of questions asking: how many months over the past 12 months the participant worked at that occupation, how many weeks per month were spent in this occupation, and how many hours per week were spent in this occupation. The mean number of hours worked per year of those that report a primary occupation in the formal labor force is 1,563.33 (SD = 1,037.31). To test the HHC and EHHC models, the sample is limited to those that participate in the formal labor force, allowing us to capture the potential tax benefits of increasing the population participating in the labor force. Table 1 compares the characteristics of those in the formal labor force with the overall sample. Nearly 25% of participants in the formal labor force have completed a secondary education certificate compared to approximately 5% in the overall sample. In addition, participants in the formal labor force come from more educated families and are disproportionately male. Given these characteristics, when the sample is limited to those that already participate in the labor force, results under-represent the actual education effect size.

Table 1. Sample characteristics (means)		
	Formal labor force	**Overall sample**
Sample size	3,428	30,137
Education	2.80 (1.60)	.71 (1.13)
Adult health	−.08 (.81)	.00 (1.00)
Female	22.7%	51.7%
Age	36.18 (11.97)	33.82 (16.34)
Father's education	1.77 (1.34)	.36 (.93)
Mother's education	1.35 (.93)	.13 (0.56)

Note: Standard deviations in parentheses.

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4.2. Data analysis

Simultaneous regression is used to compare hypothesized relationships between our two causal models (Lleras, 2005). First, we estimated the HHC model, calculating the effects of Path A (p_{le} E) and Path B (p_{lh} H).

$$\text{HHC Model: Labor – force Supply} = p_{le}E + p_{lh}H + p_{lc}C + e_l$$

Then, we estimated the EHHC model by adding Path C (p_{he} E) to capture the indirect effect of education on labor force supply through adult health.

$$\text{EHHC Model: Labor – force Supply} = p_{le}E + (p_{lh}E \times p_{lh}H) + p_{lc}C + e_l \tag{2}$$

where p equals the path coefficient, l is labor force supply, h is adult health, e is education, and c is control variables. Upper case letters represent the corresponding individual responses to each variable (L = labor force supply, H = adult health, E = education, and C = control variables). Path coefficients between variables are standardized and the significance level is set at $p < .05$. Un-standardized effect sizes are used to capture the total effects of education on labor force supply. Household sampling weights are applied to all inferential analyses to ensure accurate representativeness.

The HHC and EHHC models are then compared for their ability to predict annual hours worked. Akaike information criteria (AIC) and Bayesian information criteria (BIC) are used for model fit. AIC and BIC measure the overall model fit for both nested and non-nested models, identifying how likely the model is to generate the original data, given the specified parameters. For AIC, smaller numbers indicate desirable model fit; for BIC, the larger negative number indicates the preferred model (Long & Freese, 2001). As the purpose of this analysis is to capture how education as a component of human capital can impact national economic growth, the appropriateness of the model is indicated by both the total effects of education and the relative size of goodness of fit indices. Finally, a simulation was run using the EHHC model to demonstrate the potential broad influence of education on labor force supply in Malawi.

5. Results[2]

The HHC model (Figure 3) correlates health with education in an attempt to parse out adult health effects on labor force supply from those of education. Conditioning on wealth, sex, age, marital status, and parent's education, adult health and education are positively correlated and both education and health directly contribute to labor force supply, confirming prior research.

In comparison, the estimation of the EHHC model captures a broader effect of education on labor force supply.[3] As shown in Figure 4, childhood education both influences supply directly and indirectly through an independent influence on adult health. This health effect does not reduce the positive, direct effect of education on labor force supply which remains robust. The total effect of education is found by adding the direct effect (path A) with the indirect effect (path C × path B); our total standardized effect of education on labor force supply is .095.

Table 2 compares the fit of the HHC model to the EHHC model, providing the un-standardized total effects of education, AIC and BIC. The table shows that the EHHC model accounts for the total effect of education by capturing the indirect effect of education through health (un-standardized coefficient = .02, $p < .01$). Considering these total effects and the goodness of fit indices, it is clear that the EHHC model is the preferred substantive description of the associations within these data.

The absolute impact of education in the context of Malawi illustrates how education can make a significant impact on the national economy. Provided that the average level of education completed by individuals in this sample is less than primary school, if the average individual was to complete secondary education (an increase of approximately 2.3 units), it would be associated within a direct increase of 141.9 h worked in the formal labor force per year. Given the mean number of hours worked for those without a primary school certification is just over 1,398, this direct effect of

Figure 3. Health Human Capital simultaneous regression estimate of educational attainment and adult health on labor force supply.
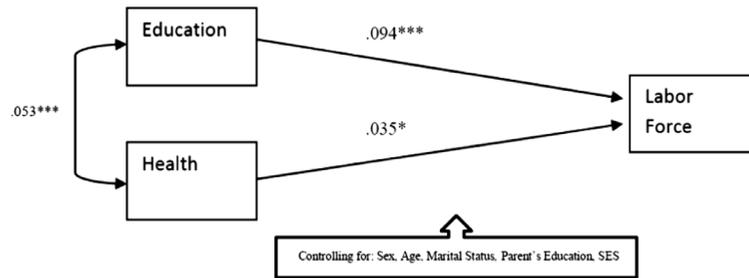
*$p < .05$, ***$p < .001$.

Figure 4. Education-enhanced Health Capital path analysis estimate on the total effect of educational attainment on labor force supply.
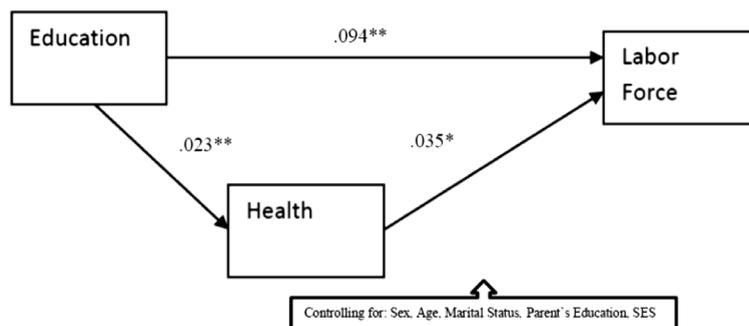
*$p < .05$, **$p < .01$, ***$p < .001$.

Table 2. Model comparison		
	HHC model	**EHHC model**
Total effect of education	61.68	62.59
AIC	16.68	2.35
BIC	26,212.80	−17,079.84

education on labor force supply would account for a 10.2% increase. Additionally, this average male Malawian would be positively impacted by the indirect effect of education on labor force supply through adult health, associated with an additional 2.1 h worked per year. Wage differential is also affected by education; those with more education make higher wages. Individuals with no educational credentials earn significantly less over the year (85,272 Malawian Kwacha, hereafter MK) than those that have completed secondary education (226,260 MK: *t*-score = 20.04, $p < .001$). This is not surprising, given that those with no educational credential also work 278 h less per year (*t*-score = 5.64, $p < .001$). Taking this into account, the difference in hourly wage rate is approximately 6 MK. If the average Malawian was able to increase his educational attainment from the mean attainment to the completion of secondary education, the 144.0 h worked in addition to the hourly wage premium for individuals that have completed secondary school would result in an increase of 118,272 MK or over 136% of the individual's prior annual wage.

6. Policy implications

Education has significant direct and indirect effects on labor force supply. The EHHC Model demonstrates how increases in education can improve individual health. Those in better health have more healthy time to work in the formal labor force and this healthy time is complemented by gains from educational attainment. The difference in total effects of education and the better model fit statistics support the expanding research regarding the importance of an education–adult health link. Education improves cognitive processing, enhancing decision-making skills and increasing the likelihood of making healthy behavioral choices (Cutler & Lleras-Muney, 2010; Peters et al., 2010). The resulting increase in hours worked in the formal labor force, when compounded by an hourly wage

premium, speaks to the potential individual financial benefits of education. However, an investment in education is also a national investment. In regions where resources are sparse, governments must make difficult decisions, supporting some public goods over others. This analysis suggests that investments in education are essential to national development as they positively impact both the health of the country and its economic output. Nations that fail to recognize the education–adult health link will not take into account the total effects of education, and thus under-invest in education as a public good.

In a first attempt to explore the role of education as a public good, we expand our individual-level analysis into the national context of Malawi, making it apparent how an investment in education can benefit the country's economy. While this initial analysis should be interpreted with some caution, as it assumes that occupational opportunities are present and costs associated with providing the education are minimal, it is to some extent also an underestimate as it maintains the 11% participation rate in the formal labor force, a rate that is likely to increase with greater average levels of education.

Our results indicate that the mean educational attainment in the country is less than a primary school education certificate. Malawi uses an 8–2–2 education structure. At the age of 13, after 8 years in primary school, students should be ready to continue to lower secondary. Using this age cohort in our national-level simulation, the U.S. Census Bureau predicts that in 2013, there are nearly 423,000 13-year olds in Malawi. The 13-year-old cohort is appropriate for the following simulation, given that over half of the population has not completed primary school and the cohort has yet to enter the formal labor force (as described in our sample). If we assume, similar to our sample, that 11% of this population will work in the formal labor force, our simulation sample is reduced to 46,530. If each of these 13-year olds persisted to complete a secondary school certificate, they would receive a wage premium based on both the direct and indirect effect of education of 118,272 MK per year, bringing their yearly salary to 203,544 MK. In terms of national tax revenue, this is a substantial and important increase. The individual tax structure in Malawi dictates that the first 144,000 MK in annual income is tax free, indicating that the average Malawian worker pays no taxes. After the 144,000 threshold is reached, the next 36,000 MK is taxed at a 15% rate and all income over 180,000 MK is taxed at a 30% rate (Malawi Revenue Authority. Domestic Tax Division, n.d.). The annual tax revenue generated from each of the 46,530 individuals in this simulation, therefore, has shifted from 0 to 12,463. This represents an increase in tax revenue of nearly 580 million MK from this single-year cohort. As taxes are used in Malawi to support schools, health care facilities, and provide provisions for other social services (Malawi Revenue Authority. Domestic Tax Division, n.d.), an investment in education can lead to a virtuous cycle where increases in tax revenue generated by education can be re-invested to increase access to and quality in education. Furthermore, the above simulation provides a lower bound estimate as it does not take into account the effect of education on being employed in the formal labor force. Adjustments in the percentage working in the formal labor force from the present 11% would significantly add to the tax revenue estimate presented here.

To increase the number of individuals participating in the formal labor force, Malawi must work to improve their governance and ensure that citizens feel they are receiving their fair share of the public goods. Theories outlining potential tax avoidance behavior can help explain who chooses to participate in the formal labor market. Since the estimate on tax revenue is based on the 11% that participate in the formal labor market, the estimate is subject to citizens' sense of perceived trust in governance in Malawi. However, given the low starting point and positive, albeit fragmented, strengthening of government capacity (O'Neil et al., 2014), we believe that a decrease in participation is unlikely. Research suggests that tax avoidance is motivated by mistrust in the way taxes are being spent (Cummings, Martinez-Vazquez, McKee, & Torgler, 2008; Gerxhani, 1999), a feeling that public goods are unfairly distributed (Cummings et al., 2008; Pommerehne, Hart, & Frey, 1994), and low penalties for avoidance or likelihood of being caught (Baldry, 1987; Gerxhani, 1999). Although

Public Choice theory suggests that rational actors act in their own self-interest and, therefore, those at the lower threshold of a tax bracket may choose to decrease their labor supply to avoid paying increased taxes, past research shows that these estimates are much lower than expected as a sense of moral obligation often leads rational actors to comply with tax laws at a greater than expected rate (Cummings et al., 2008; Gerxhani, 1999). Furthermore, research from South Africa, North Africa, and the Middle East regions demonstrates that the return to education is greater in the formal sector, enticing individuals to seek formal sector employment when possible (Angel-Urdinola & Tanabe, 2012; Walsh, Badaoui, & Strobl, 2008). This suggests that the combination of increased educational attainment and improved governance can amplify the estimated tax returns and move participation in the formal labor market beyond the current 11%.

A review of the education, health, and labor force outcome literature in Sub-Saharan Africa suggests that the simulation results for Malawi are not an isolated case. Increases in the number of years of education completed by an individual improve their health outcomes (Arendt, 2005; Baker, Leon, & Collins, 2011; Groot & Maassen van den Brink, 2007; Grossman, 2006; Kenkel, 1991) with those in better health more likely to be productive members of the labor force (Chirikos & Nestel, 1985; Schultz & Tansel, 1993; Strauss & Thomas, 1998; Thomas et al., 2006). For example, Peters et al. (2010) found that individuals in Ghana with more years of education were more likely to exhibit protective behaviors, while Schultz (2002), see also Schultz & Tansel, 1997), examining the health to labor force outcome path in Ghana, finds that a one-centimeter increase in adult height (as a proxy for health) is associated with an increase in personal income of 1.5–8%. Modeling the more comprehensive effects of education through adult health is, therefore, advantageous in many countries as governments search for efficient and effective investments in national development.

The benefits of education are not limited to economic or labor market returns. Education, as a public good, can also aid national development through a multitude of other avenues, including decreasing the community crime rate and increasing civic participation (Dee, 2004; Lochner & Moretti, 2004; Machin, Marie, & Vujic, 2010; Milligan, Moretti, & Oreopoulos, 2004; Moretti, 2007; Sondheimer & Green, 2010). This is in addition to the private returns on education such as increased cognitive processing, increased labor force productivity, and improved health outcomes, as laid out in this study (Cutler & Lleras-Muney, 2010; Peters et al., 2010). Future research should incorporate these non-labor outcomes to capture a more holistic return on education investment for national development. An additional limitation of our research is the restriction of our inferential analysis to individuals employed in the formal labor force. As one of our primary interests was to capture the economic development gains of investments in education, and individuals working outside of the formal labor force are not formally taxed, this restriction was appropriate. However, this fails to take into account the potential benefits education can bring to these non-formal occupations and the resulting improvements in national development. Of particular interest for future research should be the effect of education on the Ganyu system present in Malawi. Ganyu is "off-hand informal labor" (Dimowa, Michaelowa, & Weber, 2010, p. 2) that usually takes place on another individual's farm and is short term in nature. It is a prominent practice in rural Malawi, providing necessary food between harvest cycles while potentially locking poor Malawians in a "vicious cycle of food insecurity" (Whiteside, 1999, p. 3). What is education's role in this system? Can education mitigate the social reproduction present in the Ganyu system? These and additional questions should be the aim of future research. Finally, due to data restrictions, we are unable to incorporate measures of childhood health into our model. As mentioned in our description of the traditional human capital model, we assume that childhood health affects both educational attainment and adult health. Future models that specify childhood health as the exogenous variable can add to the discussion surrounding education, health, and national development.

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Notes
1. Chronic illnesses that are predominately genetic (i.e. diabetes, asthma, and mental illness) were not included in this variable.
2. See Appendix A for complete correlation matrix.
3. For complete analysis, see Appendix B.

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Appendix A

Pearson correlations of included variables

	Educational attainment	Adult health	Labor force participation	Female	Age	Father's education	Mother's education	Married	SES
Educational attainment	1.0000								
Adult health	.0695 (.000)	1.0000							
Labor force supply	.1332 (.000)	.0517 (.003)	1.0000						
Female	−.1228 (.000)	−.0788 (.000)	−.0428 (.012)	1.0000					
Age	−.0278 (.000)	−.3540 (.000)	.1215 (.000)	.0085 (.141)	1.0000				
Father's Education	.4458 (.000)	.0426 (.000)	.0483 (.005)	−.0136 (.028)	−.1682 (.000)	1.0000			
Mother's Education	.3830 (.000)	.0434 (.000)	.0386 (.028)	−.0092 (.153)	−.1231 (.000)	.5908 (.000)	1.0000		
Married	−.0332 (.000)	.0244 (.000)	.0876 (.000)	−.0306 (.000)	.2436 (.000)	−.1138 (.000)	−.0884 (.000)	1.0000	
SES	.4887 (.000)	.0641 (.000)	.1372 (.000)	−.0144 (.013)	−.0597 (.000)	.3703 (.000)	.3287 (.000)	−.0848 (.000)	1.0000

Notes: *p* values in parentheses.

Appendix B

Path analysis for education enhanced health capital model

Relationship A: Labor force supply as dependent variable

	Coefficient	Standard error	*t*-score	P > |t|	Beta
Educational attainment	50.83	14.63	3.48	.001	.079
Female	−140.54	49.14	−2.86	.004	−.056
Age	6.51	1.66	3.92	.000	.073
Father's education	5.18	18.84	.28	.783	.007
Mother's education	−9.19	25.69	−.36	.721	−.009
Married	71.54	48.12	1.49	.137	.028
SES	71.51	14.80	4.83	.000	.108
Constant	1276.35	109.19	11.69	.000	

Notes: $N = 3024$, $R^2 = .0377$.

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Relationship B: Labor force supply as dependent variable

	Coefficient	Standard error	t-value	P > |t|	Beta
Adult health	82.87	23.39	3.55	.000	.065
Female	−131.16	49.31	−2.66	.008	−.052
Age	7.28	1.68	4.33	.000	.082
Father's education	22.45	18.48	1.22	.223	.030
Mother's education	−1.38	25.56	−.05	.957	−.001
Married	74.78	48.05	1.56	.120	.030
SES	90.72	13.30	6.82	.000	.137
Constant	1,315.71	106.84	12.31	.000	

Notes: $N = 3{,}024$, $R^2 = .0379$.

Relationship C: Adult health as dependent variable

	Coefficient	Standard error	t-value	P > |t|	Beta
Educational attainment	.03	.01	2.37	.018	.053
Female	−.19	.04	−4.87	.000	−.096
Age	−.01	.001	−9.28	.000	−.172
Father's education	−.05	.1	−3.07	.002	−.077
Mother's education	.01	.02	.60	.546	.014
Married	.10	.04	2.73	.006	.052
SES	.03	.01	2.76	.006	.062
Constant	.63	.08	7.41	.000	

Notes: $N = 3{,}024$, $R^2 = .0420$.

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