International Journal of Development and Sustainability
ISSN: 2186-8662 – www.isdsnet.com/ijds
Volume 6 Number 9 (2017): Pages 1200-1217
ISDS Article ID: IJDS17082401

The financial rates of return to health investments in Kenya: Evidence from micro and macro data

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Abstract

The paper estimates financial rates of return to health investments in Kenya using micro and macro data. We develop a simple method for computing a financial rate of return using information from the expenditure and income sides of an investment activity. The expenditure side provides evidence on the contribution of an investment outlay to better health while the income side shows the contribution of better health to income. The two contributions are econometrically estimated, and are the basis for the new method for computing financial rates of return to health investments. The application of the approach to Kenyan data yields large returns to health investments. The conservative return from the control function estimates based on survey data is about 100%. This rate increases significantly and varies widely when specific health investments are considered, and when estimations are performed with different methods and data sets. The general conclusion from the study is that health investments in Kenya improve both health and income, and that the financial rate of return associated with the investments is substantially larger than the mean interest rate at which the banks in the country lend money.

Keywords: Total Health Expenditure; Rates Of Return; Health Investments; Interest Rate; HIV/AIDS; Kenya

Cite this article as: Mwabu, G., Mwai, D. and Muchiri, S. (2017), "The financial rates of return to health investments in Kenya: Evidence from micro and macro data", *International Journal of Development and Sustainability*, Vol. 6 No. 9, pp. 1200-1217.

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1. Introduction

The Kenyan health sector faces major challenges in delivering quality and accessible health services to the population. Finding ways to increase the budget allocated to the health sector is the most pressing policy issue at the moment. This problem is due to a number of factors, one of which is the perception by policy makers that health and health care are consumer goods (Republic of Kenya, 1996). Perhaps, a more important and related factor is the failure of individuals and agencies that advocate for higher levels of investment expenditure in the health sector to demonstrate the rate of return associated with such investments. This is as a result of lack of empirical evidence on the magnitude of returns associated with health investment in Kenya and the region. The inability to make a convincing case for investing in health, has led, over time, to insufficient increases in health finance. The current level of health finance in Kenya is not adequate to meet the population's needs for quality and accessible health services.

The amount of resources (financial, physical and technological), that society allocates to the health sector determines the level of health expenditure, and the volume of health services available to the population. Thus total health expenditure is an important determinant of health. There is a large literature causally linking health expenditure to better health (Commons, 2009). The causal link from health expenditure to better health arises from the fact that some of the inputs into health must be purchased from the market by households and governments. Thus, the higher the health expenditures, the greater the quantity of the inputs available to produce health. In the absence of publicly subsidized health care, low-income households would have lower levels of health inputs (and hence health) relative to high-income households. Thus governments have a major role in ensuring equity in health outcomes across population groups. Nixon and Ulman (2006) and Mackenbach et al. (2007) show that the poor have lower life expectancy than the non-poor, a finding that demonstrates the need for government interventions in health. The finding is also consistent with Grossman's (1972) model that demonstrates that that individuals can determine their own life spans through investments in heath so that poor would, ceteris paribus, have lower levels of health.

The complexity of the relationship between health and health expenditure has also been noted in recent studies. The evidence from the work of Kuen and Shannon (2013) suggests that to reduce incidences of reporting biased results, there is need to disaggregate health effects of government health expenditure by gender and age. In the same vein, Muthaka (2013) shows that government health expenditure has no effect on neonatal mortality, and points out that, it is the improvement in mother's environment that strongly pulls down neonatal mortality. He further demonstrates that when government and private sector (including households) spend together on healthcare, the expenditure effect on health is stronger. Thus, there is strong evidence that health spending improves health.

The causal threads that link health expenditure to health and then health to income – help determine the financial rate of return to health investments. The evidence on financial rates of return to health investment in Africa, Kenya included, is limited, and the methods previously used to compute the rates in other parts of the world are unsatisfactory. The most comprehensive treatment of this issue for the United States is by Luce et al. (2006). Using three approaches (with little attention to endogeneity), Luce and his collaborators find that the financial rate of return to overall health in the United States over the period 1980-2000 varied from

155% to 194%. That is, every dollar invested in general health had a monetary yield of $ 1.55 to $ 1.94, with investments in specific dimensions of health commanding much higher rates of return. However, the production value assigned to health, and the cost of producing that health are based on parameters borrowed from the literature, which may have little validity in the African context, where factor and product markets function very differently.

A salient aspect of this study is that if the case for enhanced investment in the health sector is accepted, the rights to good health enshrined in the Constitution would be easier to protect. The Kenya Constitution 2010 (Republic of Kenya, 2010) gives every Kenyan the right to obtain the best health care possible in the event of sickness. This Constitutional right cannot be realized if health resources are insufficient to implement interventions that make quality health care available to the whole population. The resources available for health and the level of care that the Constitution mandates for the population are closely linked. The health rights mandated by the Constitution cannot be enjoyed unless the resources to finance the extension of the rights to individuals and households are available. Information on financial rates of return to health investments will facilitate mobilization of the resources required to safeguard these rights.

This study estimates the economic and financial rates of return to overall health investments, and compares them with returns to investment outlays that control HIV/AIDS.

2. Methodology and data

2.1. Conceptual framework

A health production function solves conceptually the twin problems of poor health status and of low income in the population. The concept suggests that, holding other things constant, accumulation of health inputs improves health, which in turn enhances income – because health is a factor of production. Thus, the critical step in solving the low-income problem is to improve health, ceteris paribus. Population health (H) can be improved by solving the following health production problem:

Maximize $H = H(R1, R2; T)$ (1a)

Subject to: $B = R1*p1 + R2*p2$ (1b)

where,

R1 = a row vector of purchased health inputs, such as medical care and bed-nets, all proxied by total health expenditure; p1 is the corresponding column vector of market prices.

R2 = a row vector of non-purchased health inputs, such as own time and health-enhancing behaviours; p2 is a column vector of non-market prices.

B = the quantity of resources allocated to health production by a decision-making unit (an individual, a household, an economy).

T = Health technology parameter, summarizing the existing state of medical knowledge and innovations.

Solving the above problem, one obtains optimal vectors of R1 and R2 as functions of B, p1, and p2. The dual problem of minimizing the cost of realizing a given level of health (H) yields the same solution, as long as the inputs used to produce that level of health are constrained to exhaust the budget, B. The vector of interest in either case is R1, which we approximate with the total health expenditure (THE). Moreover, if prices and the resource budget, B, are exogenously given, the amount of health produced by THE and the associated income, follow in succession, i.e., recursively.

The solution to the optimization problem sketched in (1a) and (1b) provides several theoretical and policy insights into the production of health and the associated income. (i)Since only a single vector of health inputs maximizes health, total health spending (THE) in the economy can be too little or too much; (ii) THE may increase, remain the same or decrease with a rise in p1. Since R1 represents a vector of demands for health inputs, there is temptation to believe that the associated total health expenditure (THE) also falls when p1 increases. However, an increase in p1 reduces the amount of health inputs that can be purchased with a given level of THE, necessitating the need to increase taxes to finance higher levels of THE to maintain the existing level of service provision. If the government then implements higher taxes, THE rises with p1 provided that the taxpayers' response is positive, but falls if the response is negative and remains the same if it is neutral. Thus, higher taxes can reduce THE and harm health[1]; (iii) there is a limit to improving health – even with additional THE, given the existing technology; (iv) good health (H) should be positively correlated with THE if there is scarcity of health inputs in the health system, a testable prediction; (v) The concept of a health production function is useful in measuring the returns to health investments. The concept helps stakeholders in the health sector to see that health inputs have an opportunity cost because the resources to finance the inputs must be reallocated from other sectors of the economy, and should thus be used efficiently to avoid loss of welfare. The idea that health inputs have an opportunity cost implies that the inputs must have positive returns. These returns are worth computing so that the contribution of health to income can be compared with the contributions made by other factors of production.

The above framework is a partial model of the benefits from health because it only highlights the production value of health, neglecting its consumption value. Thus, the size of the return it suggests is the lower bound of the total return to health investment. The pioneering work of Rosenzweing and Schultz (1983) contains the general framework for such analysis, but that model is unnecessary here because the scope of the analysis at present is on income effects of health. Briefly, the partial framework formulated above serves several purposes. First, it points to economic relationships that should be estimated to measure returns to health, thus facilitating the interpretation of returns. Second, it suggests the variables on which data should be collected to carry out the needed calculations. Third, the framework points to health

[1]This is a political economy issue that should be carefully considered in designing health care financing mechanisms.

determinants, thus aiding the design of policies to improve health. Finally it suggests the channels through which health affects income, providing important clues to improving productivity of a healthy work force.

2.2. Measurement framework

The contribution of health investment to national and household incomes can be measured using a production function of the form:

$$Y = f(X (Z), W) \qquad (2)$$

where

Y = Income measured at national or household level;

X = A measure of health;

Z = Inputs into the production of health, proxied by health expenditure;

W= Control variables (exogenous factors that affect Y in addition to X).

We measure X (health) using life expectancy, mortality, mortality and sickness prevalence. These health indicators are alternatives to other measures of health, such as quality adjusted life years (QALYs), and disability adjusted life years (DALYs), with the former being a positive health metric and the latter a negative one.

The above formulation of the income equation is restrictive because it posits a recursive relationship from Z to X, and finally from X to Y. Nonetheless, this is an important formulation to which we return shortly. A more general relationship that elucidates the mechanisms through which total health expenditure influences health, and through which health in turn, affects income, is shown in equations (3a and 3b).

First Stage Equation:

$$X = H (W) + v1 \qquad (3a)$$

Second Stage Equation:

$$Y = F (X, W1) + v2 \qquad (3b)$$

where, W is a vector of exogenous determinants of X, including Z, and W1 is a subset of W without the instruments for X.

The main equation in the above set up is (3b), which causally relates income (Y) to health (X). However, finding the causal effect of health on income is problematic because health is endogenous to income. Specifically, the covariance between X and v2 is non-zero. Thus, the effect of health on income is difficult to identify because of the confounding factors in v2, which include errors in measuring health, omitted determinants of health, and unobservable factors that simultaneously determine health and income. We use several methods to estimate the effect of health on income. We use the control function approach (Wooldridge, 2002) to obtain this estimate from cross-sectional data, and further employ the OLS to estimate in a dynamic version of the same equation using time series data after checking for desirable properties of the data (stationary and cointegration). In the control function approach we use total government expenditure as the instrument for health.

We also exploit the recursive nature of our cross sectional data to estimate the contribution of Z to X (the health returns associated with health expenditures) and thereafter, the contribution of X to Y (the income return associated with better health) without having to worry about the interdependence among Y, X and Z. In other words, we regress X on Z. with W as the controls after which we predict X, and then regress Y on the predicted value of X to obtain the contribution of X to Y. This simple approach permits computation of economic and the financial rates of return to health investments that are partially free from endogeneity biases.

It is important to emphasize that there is no way to compute the financial rate of return on health without linking health to its source, namely, a set of health inputs that we proxy with health expenditures – and without at the same time, linking better health to higher incomes. In measuring the contribution of expenditure to health we rely on the assumption that health expenditure (the bundle of health inputs available to households) is exogenous. In particular, it is assumed that a household cannot influence government's health expenditure. Thus, the regression coefficient on government expenditure in a health production function can be interpreted as the contribution of expenditure to health. A further assumption is that apart from the improvement in health arising from changes in government expenditure, the health of all households is affected by the same set of factors. Accordingly, households that have access to government-financed health services have better health than households that do not have such access. In the micro data estimations the exogeneity assumption is nearly met because our household survey data is linked to total government health expenditure at the district level. Thus, all households in a district face the same government health care expenditure that no single household can influence. To concretize the exogeneity assumption, we make the subsidiary assumption that each household is doing its best to improve its health by using other health inputs. That is, everything else that the household does to improve health is uncorrelated with changes in government expenditure. Thus, it is the differential access to health inputs coming from the government that is responsible for the differences observed in household health levels. To the extent that the above scenario holds, household health can be causally linked to government health spending.

Since government health expenditure is exogenous, the contribution of health to household income is assumed to be recursive – in the sense that household health is first improved through government expenditure, and then that health is used to perform activities that increase income. That is, the two household activities (health improvement and income generation) do not occur at the same time but are sequenced by exogenous government spending.

The fact that government health expenditure is measured at the district level helps overcome, to a large extent, the endogeneity problem that would otherwise arise in associating improvement in health to an increase in expenditure. Similarly, the sequencing or separation of activities that improve health from those that enhance income helps overcome the same problem.

The identification of the contribution of health to income is accomplished by regressing household income only on that part of health predicted by government expenditure. The fact that government expenditure might also affect household income is not a problem, because household characteristics (such as education and location) that influence income, and which might also be correlated with health expenditures are included in the income equation. Once the estimation results for the health production function (i.e., the health-expenditure equation) and the output production function (the income-health equation) are available, the computation of the financial rate of return to health is straightforward.

It is also possible to use the time series nature of the macro data to identify the contribution of total health expenditure to health. Although in time series data, health expenditures for a given time period, e.g., a year, are measured at the same time as health outcomes, the expenditures actually precede health outcomes. Since health infrastructure (the health system) is available at the beginning of each year, population health in a particular year is determined by taxation and public budgetary processes of previous periods. Thus, the contribution of aggregate government expenditure to population health can be found by regressing current year health indicators on previous year expenditures. That is, lagged values of expenditures can be used to mitigate the endogeneity problem. A similar procedure can be used to identify the contribution of aggregate health to aggregate income. However, since in time-series data, all variables tend to trend together, the attribution problem cannot merely be solved by resorting to lag structures of variables. We use appropriate macro econometric methods to avoid estimating spurious regressions and to ensure that contributions of interest can be identified once existence of meaningful relationships has been ascertained (Greene, 1990).

The contribution of health expenditure to health (i.e., the coefficient on expenditure in a health production function), is the economic return to health investment. The 'investment' in this case is the additional capacity that is built to improve health, expressed in money terms. The economic return to this investment is measured in terms of health units, e.g., QALYs, DALYs, number of healthy days, or percentage reductions in mortality or morbidity per unit of expenditure.

Similarly, the coefficient on health in an output production function is the return on investment in health. The term 'investment' here means the improvement in health that is associated with a Shilling invested in the capacity to improve health. This improvement is precisely the coefficient on health expenditure in a health production function. The economic return to 'health investment' is expressed in terms of money income per unit of health, e.g., a QALY, a DALY, a day of good health or a percentage reduction in mortality or disease prevalence. This return is the coefficient on health in an output production function, with output being valued at market prices, or analogously, the coefficient on health in an income equation.

2.3. The financial rate of return

An investment is an asset that yields a stream of benefits over time. In the present case, we have two kinds of assets: 'health investment expenditure' – the additional capacity created for the purpose of improving health – and 'health investment' (Grossman, 1972) – the improvement in health associated with this capacity. Thus, the overall health investment is accumulated through health spending on interventions that improve health. The return to this investment is better health, which in turn increases labor productivity and hence income.

Our goal is to find the financial rate of return to the overall health investment expenditure, and to one of its dimensions – the expenditure on interventions to control HIV/AIDS. From a business or accounting perspective (see also Luce et al., 2006), the return on overall health investment can be computed using the expression:

$$FROR = dY/THE \quad (4)$$

where,

FROR = Financial rate of return;

dY = The increase in money income associated with better health arising from THE;

THE = Total health expenditure, an approximate measure of the amount of health inputs available to the population.

From expression (4), it is evident that a financial rate of return (FROR) is the Shilling yield of an investment per Shilling invested. This simple equation combines the income and expenditure sides of any investment -- an asset with a time-bound stream of benefits. The literature on economic returns to health investment in Africa and elsewhere (see Schultz and Strauss, 2008), has for a long time concentrated on the income side of this investment, i.e., on the contribution of health to income, as measured using the equation:

$$y = a_0 + a_1H + a_2W + e \quad (5a)$$

where, y is typically wage income or profits, but can also be national income; H is health – the stock of health (Grossman, 1972), and W is a vector of controls; a_1 is the contribution of health to income, and e is the unobserved part of y, which is due to factors we cannot measure, or to temporary irrationality of people; a_0 and a_2 are the other parameters to be estimated.

Similarly, the literature (Schultz and Strauss, 2008) on the expenditure side of health investment has been restricted to measuring the contribution of that investment (THE) to the enhancement of health without regard to equation (5a). This contribution (b_1) is typically measured using the equation:

$$H = b_0 + b_1THE + b_2W + u \quad (5b)$$

where, H is health – which in practice is imperfectly measured using mortality, morbidity, disease prevalence, and probability of illness, QALYs, DALYs, among others. The coefficient on THE, b_1, is the increase in health stock associated with a shilling invested in the capacity to improve health.

We compute the financial rate of return to health investment using information from the economic returns estimated from equations (5a) and (5b). It is helpful at this point to clarify what is meant by the term 'economic return'. The assumption made in estimating a_1 and b_2 is that households as optimizers face constraints. In equation (5a), the constraint on wage income is poor health. Thus, if health is improved marginally, wage income rises by a_1. An important implication of this is that the opportunity cost of the resources spent to improve health is a_1. Thus, the resources must be used efficiently when allocated to the health sector to avoid loss in welfare – because welfare depends on health and non-health goods. Similarly, in equation (5b) the constraint to improving health is insufficient government expenditure. The epithet 'economic' is attached to a_1 and b_1 in equations (5a and 5b) because relaxation of the health constraint in (5a) and of the expenditure constraint in (5b) is assumed to improve income and health, respectively.

In using equation (4) to compute FROR, it is recognized that people may have good health but still have low incomes because they lack jobs. Thus, realization of the financial rate of return computed using equations (5a) and (5b) is dependent on other things happening in the economy, e.g., implementation of employment creation policies and existence of incentives and information systems that facilitate utilization of health services by the population. We abstract from this complexity and assume that a conducive environment for deployment of health exists,

It now remains to show how we compute the financial rate of return using information on a_1 and b_2 in equations (5a) and (5b), respectively. The economic return to health, a_1, is the increase in wage income due to a unit increase in health, and that increase is approximately equal to dY in equation (4). Thus from equation (5a) we can compute the increase in income, dY, associated with a unit of better health.

To find the cost of a unit of health associated with dY, we have to use the coefficient on THE in equation (5b), i.e., b_1. This coefficient represents the number of units by which health improves for every Shilling invested to upgrade the health production capacity (e.g., clinics, drugs, bed-nets, ARVs, health personnel, medical equipment, research, training, and sanitation, nutrition, and health information). This view of what constitutes an overall health investment is consistent with that of Luce et al. (2006). Since b_1 is the number of health units produced by one unit of THE (a Shilling), the cost of a unit of b_1 is simply $1/b_1$. Thus, the formula for computing the financial rate of return shown in equation (4) can be restated as follows:

$$FROR = a_1/\ (1/b_1) = a_1{*}b_1 \qquad (6)$$

Where, $a_1{*}b_1$ is the monetary value of the improvement in health associated with a Shilling invested in interventions that promote health. This interpretation is intuitive because b_1 represents the units of health produced by a unit of THE (a Shilling), and a_1 is the monetary worth of each unit of b_1. Thus, the total value of b_1 is $a_1{*}b_1$, which is the financial return to each Shilling invested in health – precisely as indicated in equation (4).

Equation (6) is a simple but a powerful way of combining information from the income and the expenditure sides of an investment activity to estimate the financial rate of return associated with that activity. Since the number yielded by equation (6) is a ratio, its multiplication by 100 converts it to a percentage, which can be used to compare benefits from investment activities across sectors, industries or countries regardless of the monetary units in which the benefits and costs are measured.

In the above illustrative examples, the two equations of an investment activity are expressed in linear form, a specification that greatly simplifies the computation of the financial rates of return. In more realistic specifications, such as the ones we use, several manipulations of the coefficients of interest (a_1 and b_1) are needed before equation (6) can be used to compute financial rates of returns. For example, if in equation (5a) the dependent variable (y) is in logarithmic form, $a_1{*}b_1$ would require exponentiation to convert it into money. Needless to say, other equivalent manipulations can be performed. It is worth noting that equation (6) computes the marginal financial rate of return, whereas (4) calculates the average return.

In the special case when both the income and health functions (equations (3a) and (3b)) are in linear form, the two rates coincide because the formula for the average is:

FROR_av = (b_1*THE_sm*a_1)/THE_sm = a_1*b_1.

The two rates are the same because THE_sm is the sample mean for THE, and 'b_1*THE_sm' is the total amount of health produced by THE_sm – the sample mean for THE (since b_1 is the number of health units yielded by one Shilling). From this it is clear that '(b_1*THE_sm*a_1)' is the monetary value of the total health produced -- because a_1 is the monetary value of one unit of health, e.g., an extra year of life expectancy, or a percentage reduction in mortality or disease prevalence. The greatest challenge in applying equation (6) – the new method of computing the financial rates of return to health investments – is in estimating unbiased values for a_1 and b_1. The old methods are in Luce et al. (2006).

2.4. Data

The study used cross-sectional and time series data sets. The cross-sectional data sets were derived from two household surveys: the Kenya Integrated Household Budget Survey collected by the Ministry of Planning in 2005/6 (Republic of Kenya, 2007), and the Kenya Household Expenditure and Health Service Utilization Survey collected by the Ministry of Health in 2007 (Republic of Kenya, 2007). The surveys are nationally representative, with response rates of over 95%. A unique feature of the analytic sample from the Ministry of Planning (the Kenya Integrated Household Budget Survey) data is that it is merged with total government health expenditure at the district level, making health expenditure exogenous to households. The time series data was obtained from the national income statistics documents available at the Kenya National Bureau of Statistics (Republic of Kenya, 2014). The series cover a short period (2002-2014) over which the relevant data are available.

3. Results and discussion

3.1. Financial rates of return, macro evidence

Table 1 summarizes the health and income returns from the total health investment expenditure. The first row in the table contains information on the expenditure side of health investment. It shows improvements in various dimensions of health following a percentage point increase in total health expenditure. As already noted, the expenditure elasticity of life expectancy is .093, suggesting that life expectancy improves sluggishly as the expenditure rises. The income side of the investment is shown in row 2, where a percent improvement in life expectancy is associated with a .023 percent increase in national income. The financial rate of return to investments in interventions that improve life expectancy can easily be computed from equation (6).

The financial rates of return are computed from rows (1) and (2) using Equation (6). The financial rates of return to various investments are 341% for investments that increase life expectancy, 138%, 159%, and

778% for investments that reduce infant mortality rate, child mortality rate and HIV/AIDS prevalence respectively. The estimates of these financial benefits are consistent with previous findings reported globally and in the region; for instance MedTap International (2004), Luce et al. (2006), Murphy and Topel (2006), Cutler et al. (2007) and Mwabu (2015).

Table 1. Summary of Health Returns (row 1) and Income Returns (row 2) from Health Investments (*t*-statistics in parentheses)

Expenditure Side Equation: (Independent Variables)	Log Life Expectancy, Years	Infant Mortality per 1000	Child (Under-five) Mortality per 1000	HIV/AIDS Prevalence, percent	Mean
(1) Log Total Government Expenditure	0.093 (5.06)	-11.19 (8.85)	-10.84 (2.05)	-1.10 (2.09)	25.51
Lagged Health Variables included as Controls?	Yes	Yes	Yes	Yes	
Mean	4.01	53.73	85.38	6.1	
R-Squared	.99	.99	.96	.95	
N	10	10	11	11	
Income Side Equation: Variables (Dep Var is Log GDP)	Log (Life Expect.)	IMR	CMR	HIV/AIDS	
(2) Log Gross Domestic Product	0.023 (1.71)	-.007 (1.05)	-.009 (1.94)	-.403 (.59)	28.38
Lags of GDP Included as Controls?	Yes	Yes	Yes	Yes	
R-Squared	.99	.99	.99	.99	
Control for Lags? Yes					
N	11	11	11	11	

3.2. Financial Rates of Return, Micro Evidence

Table 2 shows economic returns to investments in interventions that reduce child mortality. The coefficient on total government expenditure shows the reduction in child mortality associated with a percentage increase in government spending on health care.

Columns (1)-(3) show the response of household income to a reduction in child mortality estimated using different methods. The total government expenditure is the exclusion restriction in the income equation. The coefficient on the reduced form residual shows that child mortality is endogenous to household income while the Wu-Durbin-Hausman *t*-test rejects the exogeneity of child mortality in the income model. The exclusion restriction (column 4) is exogenous (by construction), and is strong and relevant (i.e., the coefficient on expenditure is large and statistically significant). The coefficients on health *inputs* (e.g., total health expenditure) is the economic return to health care expenditure. It shows the magnitude by which health improves when health expenditure increases. The coefficient on *health* is the economic return to good health. It shows the amount by which income increases when health improves. Financial rate of return obtained from the control function model is 223%; while the rate from the recursive model is 111% and that from the OLS model is 102%.

Table 2. Parameter Estimates for the Income Side (columns 1-3) and the Expenditure Side (column 4) of Investments that Reduce Child Mortality (*t*-statistics in parentheses)

Variables	Control Function Estimates (**Dep Var is Log Income**) (1)	OLS, Recursive Estimates (**Dep Var is Log Income**) (2)	OLS Estimates, Baseline Regression (**Dep Var is Log Income**) (3)	First Stage Regression, Reduced-form Estimates (**Dep Var is Child Mortality**) (4)
Log Total Government Health Expenditure				-.196 (2.29)
Child Mortality, Percent	**-4.071** (3.11)	-.534 (24.3)	-.099 (1.46)	
Reduced Form Residual for Child Mortality	.255 (5.61)			--
Reduced-Form Residual Squared	4.47 (3.32)			--
Child Mortality interacted with its Residual	8.79 (3.27)			--
Location (Rural =1)	-.477 (16.5)	-.114 (4.45)	-.596 (37.7)	.0072 (3.05)
Age of Household Head	.066 (4.15)	-.216 (17.8)	.032 (4.76)	-.0097 (5.2)
Mother's Education, Years	.201 (28.8)	.354 (22.4)	.359 (22.3)	-.0013 (2.15)
Constant	10.7 (83.6)	13.9 (164.8)	2.12 (297.0)	.1036 (3.56)
R-Squared	.23	.19		.004
F-Statistics [*p*-value]	353 [.000]	657 [.000]		10.37 [.000]
Sample size	11206	11206	11206	11206

Table 3 shows returns to investments that reduce sickness prevalence. Column (1) depicts the association between probability of illness and log of household expenditure on outpatient care and transportation to health facilities. This expenditure is arguably (weakly) endogenous to illness, because treatment and transport costs are fixed in travel and health care markets and households cannot change them. Although households make visit decisions they cannot influence unit costs of visits. Thus the log of expenditure on outpatient care and transportation are taken as the exclusion restrictions in the income equation. The financial rates of return from the OLS estimates (column 2) and the control function estimates are 100% and 114%, respectively. It is worth noting that the estimated returns are statistically significant are based on a large, representative sample.

Table 3. Returns to Health Investments that Reduce Sickness Prevalence (*t*-statistics in parentheses)

Variables	Control Function Estimates (Income Side: Dependent Variable is Log Household Income) (3)	OLS Estimates, Baseline Regression (Income Side: Dependent Variable is Log Household Income)(2)	First Stage OLS Regression (Expenditure Side: Dep Var is Probability of Illness) (1)
Log Household Expenditure on Transport to Health Facilities and Outpatient care			**-.4088** (2.33)
Sickness (1=ill)	**-.3099** (24.5)	**-.1267** (6.08)	
Reduced-form Sickness Residual	.302 (23.9)		
Sickness interacted with its Residual	.989 (4.83)		
Log Age	-9.29 (23.8)	.0806 (2.39)	-.3071 (23.3)
Log Age Squared	2.09 (23.9)	-.0112 (1.61)	.0689 (26.1)
Gender of Head (Feale =1)	-1.584 (22.9)	.0293 (1.69)	-.0529 (8.78)
Location (Urban =1)	1.917 (48.3)	1.158 (53.9)	.0283 (3.95)
Constant	26.36 (40.1)	10.57 (256.4)	.539 (29.5)
R-Squared	.179	.152	.048
F-Statistic (*p*-value)	494 (.000)	588 (.000)	168 (.000)
Sample Size	19366	19366	19366

Table 4 is the basis for computing returns to investment expenditures to combat HIV/AIDS and non-non communicable diseases. The purpose of the estimates in column (1) is to introduce some exogeneity into household health expenditure in the AIDS/NCD equation (column 2). It should be stressed that distance is not an exclusion restriction in the estimation of the AIDS/NCD model. The role of the distance variable is to introduce some recursive structure in the relationship between household income, AIDS/NCD illness and health expenditure. The introduction of distance into the analysis allows us to assume that equation (1) leads to (2) and (2) to (4). The financial rate of return for the baseline model (equation 3) is 100% and that for the hypothesized recursive model (equation 4) is 120%.

Table 4. Returns to Investments that Reduce Prevalence of HIV/NCD Diseases (*t*-statistics in parentheses)

Variables	OLS Regression, Income Side: (Dep Var is Log Household Income Under Recursive Assumption) (4)	OLS Regression, Income Side: (Dep Var is Log Household Income, *without* Recursive Assumption) (3)	OLS Regression, Expenditure Side: (Dep Var is Probability of Reporting AIDS/NCD Case Under Recursive Assumption) (2)	OLS Regression Expenditure Side: (Dep Var Total Health Expenditure) (1)
Log Distance to Health Facilities				*-.0746* (10.48)
Log Distance Squared				*.0180* (8.44)
AIDS/NCD Dummy (10^2)	**-.337** (1.55)	**-.00291** (1.211)		
Log Age of Head (10^{-3})	.096 (2.51)	.116 (3.21)	.2323 (.36)	.147 (5.09)
Log Age Squared (10^{-3})	-.0119 (1.04)	-.025 (3.4)	.2777 (1.64)	-.023 (3.84)
Location (Urban =1)	.908 (17.6)	.879 (17.8)	.00175 (1.80)	
Predicted AIDS/NCD interacted with Urban Dummy	96.88 (5.96)			
Gender of Head (Male =1)	.0207 (.93)	.039 (2.07)	.00053 (.78)	.007 (.45)
Log Total Household Health Expenditure, predicted (10^{-3})			**.53442** (1.93)	
Constant	10.56 (240.3)	10.56 (240.3)	.046 (1.93)	8.617 (253.6)
Squared	.152	.152	.002	.010
F-Statistic (*p*-value)	412 (.000)	409 (.000)	5.19 (.000)	30.9 (.000)
Sample size	16417	16417	16417	16417

Table 5 pulls together the macro and micro evidence on financial rates of return to health investments. The notable feature of the returns is that a Shilling invested in health yields an income of at least one Shilling. Investment interventions that reduce child mortality, increase life expectancy and reduce HIV prevalence have the highest financial rates of return. It is evident from Table 5 that the returns are not independent of the estimation methods and data sources. The estimates of the returns obtained with the control function approach (120% and 223%) have the smallest error margins (row 3). Taken together, the findings presented in table 5 indicate that health investments in Kenya have large financial benefits.

The policy value of the financial rates of return shown in Table 5 emerges clearly when the results are examined in relation to bank interest rates in Kenya. One important function of banks and other financial institutions is to mobilize funds from savers and channel them to investors. The interest rate is the device that financial institutions use both to mobilize money from savers and to transfer it to investors. The interest rate paid to savers must at least cover the opportunity cost of deposits. The interest rate on deposits encourages agents to shift resources from consumption and other alternative uses to savings accounts at financial institutions. Further, the interest premium at which investors borrow from financial institutions incentivizes them to lend.

Table 5. Summary of Financial Rates of Return

Investments in health interventions that are associated with:	Financial Rates of Return	Source of Evidence	Estimation Method
1. Lower AIDS/ NCD[2] Prevalence	100-120%	Survey data, 2007	Control Function Approach, OLS
2. Less General Sickness	100-114%	Survey data, 2007	OLS, OLS with Recursive Assumption
3. Lower Child Mortality	102-223%	Survey data, 2006	OLS, Control Function Approach
4. Higher Life Expectancy	341%	Macro data, 2002-2013	OLS, applied to stationary and cointegrated series
5. Lower Infant Mortality	138%	Macro data	Same as above
6. Lower Under-Five Mortality	159%	Macro data	Same
7. Lower HIV Prevalence	778%	Macro data	Same

A comparison of the financial rate of return to health investments in Kenya with the interest rate that potential investors in the health sector stand to pay indicates that there is a large economic surplus from expenditures that improve health. Since in equilibrium, the financial rate of return and the interest rate must be equal, our findings (Table 5) show that investors are currently paying interest rates that are far below the rates that they are willing to pay. That is, investments in the sector yield a large economic surplus. In particular, the conservative financial rate of return to overall health in Kenya is about 100%. In contrast, the average lending rate in Kenya between 1971 and 2015 ranged from 9% to 32.3%. In other words, the cost of each shilling borrowed for the health sector (in terms of interest payments) varied from 9-32 cents, whereas the return on that shilling exceeded one shilling (in terms of its monetary value addition). This observation

[2] There is a difference between (1) and (7) in the table for HIV resulting from the measurement issues, the survey data (1) uses variable aids/ncds (aids is treated as a chronic illness). Since the data is captured at household level its relative external effect are excluded. On the other hand population level data (8) captures the fully and pure effects from an aids episode. Third Age difference , non-aids/ncds tend to be concentrated among older people whose productivity is not as high as prime aged workers who are greater risk of AIDs this explain the variation in the magnitude of the returns.

raises the question as to why private investments are in short supply in Kenya (and elsewhere) given their high rates of return. The answer is that many of the activities that improve health cannot be initiated or managed on commercial basis. For example, 'clean drinking water' or 'health information' cannot be provided at full market prices, i.e., at costs which reflect their productivity benefits to society.

The implied economic surplus from health investments in Kenya is particularly striking because the associated financial rates far exceed the banking lending interest rates even when these rates incorporate non-interest costs borne by borrowers. The non-interest changes include: commitment or facility fees, processing fees, early repayment fees, negotiation fees, valuation fee, insurance premiums, appraisal fees, and legal fees.

In 2014-2015, the lending interest rates at the main banks in Kenya, excluding non-interest charges were as follows: Consolidated Bank of Kenya, 15.50%; Barclays Bank of Kenya, 16.0%; K-RepBank, 16.50%; Standard Chartered Bank, 18.0%; Equity Bank, 18.0%; Kenya Commercial Bank, 18.11%; Commercial Bank of Africa, 19.0%; Co-operative Bank of Kenya, 19.0%; Consolidated Bank of Kenya, 15.5%; and NIC Bank, 17.0%.

It is interesting to note that even if the above interest rates were to increase ten-fold, health investments would still generate a large economic surplus because in many cases the overall rate of financial return is in excess of 200%. Furthermore, whereas the financial rate of return to health investments is specific to the health sector, the lending interest rate ideally reflects the average return on investment in the whole economy so that in equilibrium, the interest rate is equal to the rate of return. Thus, the interest rate is roughly a measure of the loss that an economy as a whole would suffer if a resource were invested in the health sector rather than in another sector. The results we report show that the financial benefits from investments in the health sector are overwhelmingly larger than the associated financial opportunity costs. The case for increased funding to the health sector is strongly supported by the findings in Table 5.

4. Conclusion and policy implications

This paper estimates the economic and financial returns to health investments in Kenya derived from macro and micro data. To compute the two rates, three estimation procedures were carried out. First, the contribution of health expenditure to health was computed. In the second procedure, the contribution of health to income was found. The final step entailed computing the financial rate of return from the two steps. The financial rate of return is the monetary value of a shilling invested in interventions that improve health.

We are able to conclude that investing in health brings large financial benefits to the Kenyan households and to the country as a whole. The financial rate of return to investments that improve general health varies from 100% to over 200%, while the return on investments that reduce HIV prevalence is over 700%. Specifically, the specific investments and their associated financial rates of return are as follows: health investments that increase life expectancy – 341%; investments that reduce infant mortality rate – 138%; investments that reduce child mortality rate – 159%; investments that reduce HIV/AIDS prevalence – 778% (macro evidence).

The micro evidence shows that lowering AIDS and NCD prevalence results in financial rates of return of between 100-120%; reducing general sickness brings returns ranging from 100-114%; lowering child mortality is associated with returns that range from 102% to 223%; and lowering infant mortality yields a return of 138%. The preferred (conservative) rate is about 100% estimated with the control function approach. The evidence from the macro data show that increasing life expectancy boosts national income by 341%, i.e., for every shilling invested in interventions that improve life expectancy, the gross domestic product increases by Ksh 3.41. The results presented in this analysis are consistent with other recent studies (Cutler et al., 2007; Luce et al., 2006; Murphy and Topel, 2006). The implication of these findings is that additional resources should be earmarked for health improvements at national and household levels. The results showcase that there are returns that merit both the private and public sector to tap into. There is also a case for supporting health-improving investments in non-health sectors, such as education, agriculture, environment and sanitation, further analysis should be carried out to consider the real value of the products and service (e.g. clean drinking water) instead of their full market price.

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