The impact of poverty on health and well-being in rural Malawi[1]

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Abstract: This paper isolates the causal link of poverty on health status and subjective well-being of the rural population in Malawi using three waves of household panel data spanning the period 2004-2008 from the Malawi Diffusion and Ideational Change Project (MDICP) and the Malawi Longitudinal Study of Families and Health (MLSFH). Several suitable instruments for economic resources, e.g. rainfall and the price of salt, are employed in both instrumental variables and fixed effects strategies to consistently address endogeneity of the wealth to health relationship. This link is examined in the context of Malawi, a low-income country with high background morbidity and mortality, as well as an AIDS epidemic, high fertility, and poor reproductive health. The analyses show that a doubling of income improves general health status by 23.6% and well-being by 20.4% of rural Malawians. Economic hardship has health and well-being implications to individuals and families in rural Malawi that are also likely found in other regions and countries in sub-Saharan Africa facing a novel set of critical development challenges.

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1. Introduction

Strong causal links may run in both directions between income and health, and also through mediating factors. Health and wealth can be considered two of the most important components of wellbeing; especially at low levels of wealth when there are higher returns to health. At the individual level, measurement and ranking of wellbeing based on the estimated association with income or health differ depending on how income and health are related, among other complementary non-monetary relationships such as social comparisons and adaptation which reduce income's impact on wellbeing.

Pritchett and Summers (1996) first phrased the hypothesis "wealthier is healthier" when they found that economic growth in developing countries led directly to reductions in infant mortality rates and improvements in life expectancy, as they saw improved health as a by-product of higher income levels. They calculated that in 1990 alone, more than half a million child deaths in the developing world could be attributed to poor economic performance in the 1980s.

The relationship between health and income have mostly centered on cross-country comparisons. In a classic work on this topic, Preston (1975, 1980) described the association of increasing standards of living as measured by per capita income to increases in life expectancy in three different decades during the twentieth century. The relationship is strongest in developing countries, and weaker in developed countries, though life expectancy increased over time at all income levels. Preston proposed that the gains could be attributed to improvements in nutrition, access to clean water and sanitation, and medical treatment. The "Preston hypothesis" has been revisited and framed as an apt starting point in the context global inequalities in health poverty and income poverty (Deaton 2006).

The idea that income, only through better nutrition, clothing, and housing, was the primary determinant of health in the history of now rich countries was argued by McKeown (1976). Detailed data on adult height have been used to support this theory by investigating causes of the historical decline in mortality (Fogel 1997, Fogel 2004, Steckel 1995). However, historical views have been convincingly challenged, most notably by Szreter (1988), Guha (1994), Preston (1996), and Easterlin (2004).

On the happiness front, Easterlin (1974) first introduces "Easterlin paradox" where within a country richer people on average report higher subjective well-being (SWB) than poorer people in the same country, whereas a comparison between countries reveals only a minor relation between income levels and SWB. Moreover, this relationship holds up over time (Easterlin 1995). The paradox was reassessed by Hagerty and Veenhoven (2003) and Stevenson and Wolfers (2008), showing that income is clearly linked to increased self-reported happiness, for both individual people and whole countries over time.

Several issues with the wealth to health argument is that most of the health gains we have experienced have been due to improvements in health at each level of income, is likely to be due to technological progress, i.e., using resources more effectively, and not necessarily as a proximal result of wealth. Bloom and Canning (2001) suggest that before 1870 health in rich and poor countries was very similar, but after 1870 health improved in rich countries whereas improvements in poor countries only began after 1930 consistent with the view that technological advances are employed first in rich countries before eventually diffusing to poorer societies. The demographic dividend as first proposed by Bloom and Canning (2000) where a rise in the rate of economic growth due to a rising share of working age people in a population could possibly explain this reverse relationship. There is also a long literature that attempts to control for the endogeneity of health and nutritional status in estimating the impact of that status on income (Strauss 1986, Deolalikar 1988, Behrman and Deolalikar 1991, Sahn and Alderman 1988, Hoddinott et al. 2008).

Acemoglu and Johnson (2006) found no evidence that the increase in life expectancy led to faster growth of income per capita. This evidence sheds considerable doubt on the view that health has a first-order impact on economic growth. Using life-expectancy and cause-specific mortality data prior to the international epidemiological transition and examining the wave of international health innovations and improvements that began in the 1940s, they found that increases in life expectancy (and the associated increases in population) appear to have reduced income per capita at first, with this negative effect slowly wearing off over the next 40 years.

The argument that economic growth is by default good for health remains widely accepted, particularly among those arguing for the benefits of globalization and development aid (Filmer and Pritchett 1999, Dollar 2001, World Bank 2002). Until now, there have only been few studies that have persuasively established the causal link between economic resources and health across countries (Pritchett and Summers 1996, Filmer and Pritchett 1999). Given the importance of development and the enormous amount of global economic and health aid committed to developing countries today, there has not been a systematic analysis of the downstream effect of the wealth-health causal link at the individual recipient level in for example, HIV-afflicted sub-Saharan Africa (SSA). However, even if the "wealthier is healthier" hypothesis is *not* true, economic growth should still be supplemented by appropriate public and private action to directly improve population health, independent of whether better health promotes better economic levels of living (Case and Deaton 2006).

Malawi is a good setting for the proposed study because it, unfortunately, has a mature epidemic with a rural HIV prevalence of 10.8% (Malawi DHS 2004). There has been enormous effort as part of national as well as international development strategic focus on HIV. While the Malawian per capita income is below the sub-Saharan average, Malawi is similar to other SSA countries and countries in the World Bank low income group in terms of life expectancy, infant mortality, child malnutrition, access to clean water, literacy, and educational enrollment (World Bank 2006).

Much of the academic literature, while analyzing levels, trends, and determinants of health outcomes and behavior in SSA, has a focus in the context of HIV, yet similarly ignores the potential of individual's and family's coping mechanisms of the HIV epidemic. Moreover, a preponderance of these analyses are based on case studies or cross-sectional surveys that do not permit important distinctions between immediate impacts and longer-term consequences, or lacks controls for endowments, unobserved characteristics, behavioral determinants of individual's and family's health status, endogenous decision processes, and selective participation in risk prevention efforts. Amidst gripping poverty, the assessments and expectations of own and family members' health, well-being, and HIV status may influence investments in human and social capital in ways that have not been analyzed before.

This study contributes to the understanding of the wealth to health endogenous relationship in a country with vast development challenges, while controlling for the complex linkages between these variables by using time-varying micro-level factors such as salt price and rainfall as instruments in an instrumental variable-fixed effects approach applied to three waves of panel data in contrast to the usual reduced-form model.

2. Empirical Models

The longitudinal nature of the MDICP/MLSFH data will allow control for unobserved fixed effects. In addition, the data is comprehensive enough to facilitate causal analyses with instrumental variables and address problems of endogeneity and omitted variable bias in regression analyses as similarly performed by Kohler et al. (2007) that examines whether social interactions have causal effect on HIV/AIDS risk perceptions.

The models employed herein are defined as follows; starting from the full form second-stage least squares model,

(1) $$Y_{ijt} = \beta \cdot W_{ijt} + \delta \cdot X_{ijt} + \alpha \cdot Z_{jt} + f_i + e_{ijt}$$

where Y_{ijt} is a health outcome with W_{ijt} income for individual i living in region j in year t; X_{ijt} is a vector of individual characteristics (e.g., age, marital status, number of children ever born); Z_{jt} are some time-varying unobservables that affect both income W and health outcome Y; f_i represents unobserved fixed factors (unobserved community characteristics) that affects health outcome Y; and e_{ijt} is an i.i.d. disturbance term that affects health outcome Y.

To get at the direct effect of income on health, it is necessary to eliminate the unobserved time-invariant, individual-specific fixed effects f_i, so the IV fixed-effect (IV-FE) estimation of Equation (1) is used where they drop out as defined below

(2) $$\Delta Y_{ijt} = \beta \Delta W_{ijt} + \delta \Delta X_{ijt} + \alpha \Delta Z_{jt} + \Delta e_{ijt} .$$ [3,4]

[3] See Schaffer (2007) `xtivreg2`: Stata module to perform extended IV/2SLS, GMM and AC/HAC, LIML and k-class regression for panel data models. http://ideas.repec.org/c/boc/bocode/s456501.html

[4] Additionally, Generalized Methods of Moments (GMM) IV fixed-effect estimation and GMM system dynamic model approach could be explored in the future which utilizes more efficient weighting of the

The first-stage least squares estimation model is defined as follows:

(3) $$W_{ijt} = \alpha \cdot Z_{jt} + g \cdot X_{ijt} + k \cdot f_i + u_{ijt}$$

where W_{ijt} is a measure of income status, Z_{jt} is a vector of instrumental variable(s) that affects income W but not the second-stage health outcome Y in Equation (1), X_{ijt} is a vector of individual characteristics, f_i represents the unobserved time-invariant fixed factors that affect an individual's level of income (expectations regarding future prices and productivity, interfamilial and community resources), and u_{ijt} are unobserved factors that are uncorrelated with X_{ijt} and the second-stage error term e_{ijt} in Equation (1).

The least squares estimation within or fixed effects model is applied to Equation (3) to control for the unobserved fixed factors f_i that may provide differential comparative advantage in income as described above.

(4) $$\Delta W_{ijt} = a\Delta Z_{jt} + g\Delta X_{ijt} + \Delta u_{ijt}$$

For dichotomous health outcomes (HIV status and HIV risk perception), a linear probability model is employed which allows the use of the IV-FE strategy that is used also for the other outcome measures.

The samples are restricted to non-missing, non-singleton (non-one-observation groups) observations for each of the various specifications (by total, men, and women). Robust standard errors are calculated, allowing for clustering at the individual level for all models.

3. Data

3.1 Malawi Diffusion and Ideational Change Project (MDICP)/Malawi Longitudinal Study of Families and Health (MLSFH)

The data come from three waves (2004, 2006 and 2008) of MDICP/MLSFH longitudinal household survey conducted in Malawi by an on-going collaborative project between the University of Pennsylvania and the University of Malawi College of Medicine. The survey is conducted in three distinctive districts of Malawi: Rumphi (Northern region), Mchinji (Central), and Balaka (Southern). The sampling strategy was not designed to be representative of the national population of rural Malawi, although the sample characteristics closely match those of the rural population of the Malawi Demographic and Health Survey.[5] The first wave sampled in 1998 consisted of ever-married women

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moment conditions in the presence of possible arbitrary serial correlation especially with panels where the cross-section dimension is large and the time-series dimension is small (Hayashi 2000, Baum et al. 2003, Baum et al. 2007, Blundell et al. 2000, Bond 2002).

[5] Detailed descriptions of the MDICP/MLSFH sample selection, data collection and data quality are provided on the project website at http://www.malawi.pop.upenn.edu and in a Special Collection of the online journal *Demographic Research* that is devoted to the MDICP (Watkins et al. 2003).

age 15-49, and their husbands. These respondents were re-interviewed in 2001, and all new spouses of men and women who remarried between 1998 and 2001 were added to the sample. In 2004, in addition to the original sample and their new spouses, MDICP added a sample of approximately 1,500 adolescents, aged 15-25. These adolescents were both ever- and never-married. In 2006, all respondents from previous waves in 1998, 2001 and 2004 were included in the sample, along with all spouses of 2004 adolescents, and any new spouses to respondents in the original sample. In 2008, as with previous waves, all previous respondents and new spouses were included in the study. Also, a new sample of approximately 800 living biological parents of MLSFH/MDICP respondents from 2006 who resided in the same village as the respondent were included. Between 2004 and 2008, approximately 10,500 adults and 3,500 adolescents were included.

3.2 Central variables for the analysis

3.2.1 *Dependent variables – general health status, subjective well-being, HIV status, HIV risk perception, and SF-12 scores*

The first dependent variable is self-reported general health status, "In general, would you say your health is: Excellent, Very Good, Good, Fair, or Poor?" (1 = excellent, 2 = very good, 3 = good, 4 = fair, and 5 = poor), which has been used widely in surveys and has been shown to be well correlated with clinical measures of health (Case and Paxson 2005, Case and Wilson 2000).[6] Figure 1 shows the distribution of general health status by total, men and women across the three waves. The measures are reported for the same set of persons, and thus differences are due to changes in reported health rather than group composition. The highest category "excellent" health has been decreasing dramatically while "very good" health increases for both men and women. "Good" health remains constant while "fair" health decreases. Very few respondents (~1%) report themselves to be in "poor" health. Table 1 shows that men on average report better health than women, and mean health status increases from 3.69 to 3.86 between 2004 and 2006, then decreases to 3.74 in 2008.

[FIGURE 1 – ABOUT HERE]
[TABLE 1 – ABOUT HERE]

The second dependent variable is life satisfaction or subjective well-being (SWB), a one-question measure derived from Fordyce (1988) phrased, "I am interested in your general level of well-being or satisfaction with life. How satisfied are you with your life, all things considered?" (1 = very satisfied, 2 = somewhat satisfied, 3 = satisfied, 4 = somewhat unsatisfied, and 5 = very unsatisfied).[5] Self-reported SWB consists of an affective part that is a hedonic evaluation guided by emotions and feelings, and a cognitive part that is an information-based appraisal of one's life for which respondents judge the extent to which their life so far measures up to their expectations and resembles their envisioned "ideal" life (Diener 1994).

[6] The variable has been recoded in reverse to enable ease of interpretation, i.e., better health or SWB is equal to being in a higher value category.

Figure 2 shows the distribution of SWB by total, men and women. In both groups, the "somewhat satisfied" category drops dramatically from 2006 to 2008, which results in an increase of men reporting being "very satisfied" with life (from 40.9% in 2006 to 46.8% in 2008) while women increase reporting "somewhat satisfied" with life (from 32.0% in 2006 to 38.5% in 2008) with only slight gains in the "very satisfied" category. Table 2 shows that the mean SWB increases from 3.97 to 4.07 between 2006 and 2008.

[FIGURE 2 – ABOUT HERE]
[TABLE 2 – ABOUT HERE]

The third health outcome is HIV status which is equal to 1 if positive and 0 if negative. The HIV tests were performed for all respondents from the 2004 wave onward according to the protocol by Bignami-Van Assche et al. (2004). Over 90% of respondents in each round accepted the HIV test, despite variations in testing protocols (Obare et al. 2009). The sample examined in this study is a restricted sample conditional on surviving and constant sample composition, Table 3 shows that HIV prevalence increases 1.3 percentage points for women from 3.7 in 2004 to 5.0 in 2008, and increases 0.6 percentage points for men from 2.6 in 2004 to 3.2 in 2008.

[TABLE 3 – ABOUT HERE]

The fourth variable is subjective HIV risk perception, "In your opinion, what is the likelihood (chance) that you are infected with HIV/AIDS now?" (0 = no likelihood, 1 = low, 2 = medium, 3 = high). This variable is dichotomized to equal 0 if there is no likelihood, and 1 if there is some likelihood (categories 1 through 3). Table 4 shows that HIV risk perception has greatly increased from lower levels of around 25-30% in 2004 and 2006 to over 50% stating some likelihood of HIV risk. Men overall state less risk than women.

[TABLE 4 – ABOUT HERE]

In addition, the fifth and sixth health outcomes come from the health status instrument SF-12 (Ware et al. 1996, 2001), a twelve question constructed indicator, derived from its predecessor the SF-36, for each of physical (PCS-12) and mental (MCS-12) health that has been validated globally (including in SSA), and is less affected by measurement error than are alternative subjective health measures (Dow et al. 1997, Strauss and Thomas 1998).[7,8] Appendix Figure 3 is a histogram that shows MCS-12 level is higher than PCS-12 for both men and women. Appendix Figures 4 and 5 show that men have higher levels of both MCS-12 and PCS-12 than women, although both levels for men and women decrease between 2006 and 2008. Appendix Tables 2 and 3 show that mean PCS-12 decreases from 52.45 to 52.38 between 2006 and 2008, and similarly for MCS-12 55.49 to 54.34.[9]

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[7] See Appendix Figure 1 for more information on the SF-12 summary health measures.

[8] For subjective well-being, PCS-12 and MCS-12, data are only available for the 2006 and 2008 waves.

[9] SF-12 was used in 2006 and SF-12v2 in 2008. The two sets of questions are pretty much consistent, except for a few questions that improved on the binary answer choices with categorical ones. SF-12

3.2.2 *Key independent variable – Income*

In general, it is difficult to obtain a composite measure of wealth that captures income from all sources (wage, non-wage, savings, transitory income, and permanent income). There also lies great deal of measurement error in incomes reported. Similar to papers in the existing development economics literature, this study uses the natural logarithm of per capita household consumption expenditures as a measure of income (Thomas et. al 1990, Thomas and Strauss 1992).[10] They are constructed from the sum of personal expenditures (Malawian Kwacha) in the past three months on clothes and medicine; children's clothes, school and medicine; and funeral costs; adjusted for regular members of the household size N with household size elasticity parameter θ=0.6, which accounts for the size economies of consumption and the effect of change in household composition between adults and children (Lanjouw and Ravillion 1995).[11]

Household dissolution by migration, divorce or mortality of a household member should not affect the results since the income and health variables used are at the individual level and not linked to their spouses (i.e., not analyzed at the household level). Therefore, in the case when there is a household dissolution, its effects are already captured in individual-level responses related to health and income. A thorough examination of household dissolution would indeed be pertinent if these individuals were linked or analyzed at the household level.

3.2.3 *Individual characteristics*

The controls used include age, the squared term of age (at the time of the interview) divided by ten, which accounts for any non-linear relationship of age and health; marital status; the number of children ever born; and year dummies.

3.2.4 *Instruments*

The excluded instruments have been identified from regional market data on the price of salt and regional rainfall data. Commodity prices as instruments have been successfully employed in several other studies (Thomas and Strauss 1997, Brückner and Ciccone 2007). Regional market data for salt was identified because salt is a widely-used daily

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administration in 2006 and 2008 did not differ much, except that in 2006 it was done by regular interviewers and in 2008 by voluntary, counseling and testing (VCT) people. Even after using a conversion formula (SF-12 to SF-12v2), the shape of the distributions do not change.

[10] The literature uses real per capita consumption expenditures; however in this case, nominal values are used since regional deflators were not available.

[11] First considered was total acres of land owned by the household; however, there is likely large measurement error in reporting and also in converting football pitches into acres (not all pitches are the same size). The second was the total amount in kilograms of crops harvested by the household in the previous growing season. The issue here is that each region specializes in a particular cash crop; e.g. Balaka produces cotton, Mchinji tobacco and wheat, and Rumphi tobacco and rice, and per unit weight of each cash crop is not comparable. If prices by cash crop were available it might be possible to convert to amounts produced into monetary units. The third was a constructed wealth index based on dwelling characteristics and ownership of household durable assets. The creation of this index was achieved by using principal component analysis (Filmer and Pritchett 2001, Vyas and Kumaranayake 2006).

staple and its price has a strong association with income. There is no issue with salt price being correlated with health outcomes since Malawi imports virtually all its salt from Mozambique and South Africa. Salt prices are from the month of June for all three waves to ensure temporal proximity to reported health outcomes in survey conducted in June through August.[12] The variable for salt price has been rescaled by dividing by 1,000, which results in the salt price in Malawian Tambalas per gram.

Accumulated monthly rainfall data for each of the three regions were obtained by NASA's Tropical Rainfall Measuring Mission (Huffman et al. 2007). Weather variation can be plausible instruments for economic growth in economies that largely rely on rain-fed agriculture, i.e., neither have extensive irrigation systems nor are heavily industrialized (Wolpin 1982, Paxson 1992, Miguel et al. 2004). In this empirical framework, variability in rainfall is captured by lagged rainfall growth (ΔR_{t-1}), defined as the difference of the average annual rainfall between the previous two years and the prior year.[13] The rainfall variable has been rescaled by dividing by 1,000, which results in a unit of annual rainfall in meters. Presumably, the lagged variability in rainfall proxies for the presence or absence of an economic shock based on the levels of water that influenced the previous year's agricultural productivity.

A variety of other instrumental variables were experimented with and deemed unsuitable, including current and further lags of rainfall growth, current and lagged rainfall levels, current and lagged rainfall levels in the lowest 10th and 25th percentiles, current and lagged levels of longer-run income from an index constructed using principal component analysis on household characteristics and ownership of durable assets as argued for child schooling rather than health in Vietnam in Behrman and Knowles (1999), number of "economically productive" male and female children (ages 10-49), their mortality and sex ratios by household.

4. Results

The estimations have been carried out using the two-stage, least squares within estimator. Appendix Tables 4-9 show the results for the first-stage logged expenditure estimates for six health outcomes: general health status, subjective well-being, HIV status, HIV risk perception, PCS-12, and MCS-12. Tables 5-10 show the results for the second-stage regressions.

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[12] The unit measurement for each item or commodity is in Malawian Tambalas per kilogram. Every month surveyors buy three samples for each of 25 commodities from different vendors in the main market of each region. The three samples are combined and weighed on a digital scale. The unit total cost of three samples purchased divided by the total weight of the three samples to get the commodity prices. See Appendix Table 1 for the list of Balaka Market prices in 2006. Prices are not adjusted for inflation since the published consumer price indices for Malawi are not at the region level.

[13] Annual rainfall is set at June through May to encompass the whole distribution of the rainy season (October through April) and to ensure that it is most proximal to reported health outcomes in surveys conducted in June-August; e.g. lagged rainfall (ΔR_{t-1}) for year 2006 would be the difference in annual rainfall amounts from June 2003 through May 2004 and June 2004 through May 2005. See Appendix Figure 2 for a sample of rainfall data and its trends from 2001-2009.

4.1 First-stage regressions

Appendix Table 4 shows for general health status, the F-test statistic of the excluded instruments in the first-stage regression of the IVs with all the other exogenous variables. Although the F-statistic of 5.798 for the model with joint IVs is less than 10, the result is significantly relevant (p<0.01).[14] The models for men do not show any significant F-test statistics; however, the test of joint IVs for women is significant and close enough to ten to account for the statistical significance found in the total sample. As expected, the coefficient for salt price is negative and significant (-0.138); as the price of salt, a common household staple, increases, the individual and household available income decreases. Likewise, the coefficient for lagged rainfall growth is positive and significant (0.793); more rainfall is associated with higher agricultural output (income).

Appendix Tables 5-9 show for the other health outcomes F-tests of excluded instruments are both individually and jointly significant. The results for SWB in Table 6 show that the coefficient for rainfall is surprisingly large and negative (-20.71) and salt price is positive (0.509), which is puzzling and could be due to a smaller sample size since there are only two years of analysis (2006 and 2008) whereas for general health status there are three (2004, 2006 and 2008). If models for general health status are restricted to the two years of analyses, the first-stage results correspond to that of SWB, PCS-12 and MCS-12 (results not shown).

4.2 Second-stage regressions

Table 5 shows the second-stage estimates of general health status. There is a strong and highly-significant causal relationship between logged expenditure and general health status. For the model with both prices and rainfall instruments, the coefficient is 0.945 and significant.[15] For robustness checks, the Kleibergen-Paap Lagrange Multiplier test for underidentification is satisfied at 11.49 and significant; however, the Kleibergen-Paap Wald F statistic for weak identification is 5.798 which falls above the 25% maximal IV size of Stock-Yogo critical values.[16] Lastly, Sargan-Hansen's J statistic of overidentification p-value is 0.921 and fails to reject the null hypothesis that the overidentifying restrictions are valid.[17]

The interpretation of this model is: for a 10% increase in consumption expenditure there is a corresponding 0.0945 increase in a categorical unit of health status. Alternatively, a doubling of income (100% increase) affords individuals 0.945 units of improved health

[14] Staiger and Stock (1997) formalized the definition of weak instruments. Many researchers conclude from their work that if the first-stage F statistic exceeds 10, their instruments are sufficiently strong. Still, this criterion does not necessarily establish the absence of a weak instruments problem.

[15] Henceforth, coefficients reported are for the model with both the price of salt and rainfall as IVs unless otherwise noted.

[16] Refer to Stock and Yogo (2005) for discussion on critical values based on Cragg-Donald statistic by Cragg and Donald (1993). Weak instruments means having bias in the IV results >20% of the bias in first-stage results.

[17] The overidentifying restriction means that the model is well-specified and the instruments are valid, i.e., do not belong in the second-stage equation.

or a 23.6% increase in health status. Women have a 0.858 significant coefficient whereas men have a 1.167 coefficient, though insignificant. This indicates that the income to health relationship may be stronger for men, possibly because men are responsible for more household consumption expenditures whereas women have less influence on income therefore their results are weaker. When comparing the OLS and IV-FE income estimates, the IV-FE estimates are vastly different (0.0313 and 0.945, respectively), which indicates that the rationale holds for using IV-FE.

[TABLE 5 – ABOUT HERE]

For the model on subjective well-being with both instruments in Table 6, the coefficient for income is 0.817, slightly less than for the general health model. The model implies that for a 10% increase in consumption expenditure there is a corresponding 0.0817 increase in a categorical unit of SWB. Alternatively, a doubling of income increases SWB by 20.4%. It is possible to compare this result with general health since both measures have five category responses, in which case income is considered about as influential (and positive) on subjective well-being as on general health status. Still, income's causal effect on health is larger despite health status being a sub-domain of which SWB is comprised. The SWB scale does not assess satisfaction with specific life domains such as health or finances, but allows respondents to integrate and weight these domains in whichever way they choose (Diener and Seligman 2004, Diener and Suh 1997, Pavot and Diener 1993).

Overall the mean SWB is quite high (3.97 to 4.07 between 2006 and 2008 on a 5 point scale). Life satisfaction is high for both men and women, and the income to SWB relationship is 0.792 for men and 0.644 for women.

[TABLE 6 – ABOUT HERE]

Table 7 shows the second stage results for HIV status where income has a 0.00436 insignificant coefficient in the model with both IVs; meaning a 10% increase in income is associated with a 0.0436% higher probability of being tested HIV positive. Likewise, a 10% increase in income is associated with 0.176% higher probability of being HIV positive for men and a 0.0306% lower probability for women.

[TABLE 7 – ABOUT HERE]

Table 8 shows the estimates for HIV risk perception where income has a -0.0778 insignificant coefficient, meaning a 10% increase in income is associated with a 0.778% lower probability of perceiving oneself to be infected with HIV. The result implies that wealthier individuals perceive themselves to be less likely to have HIV, though the data show that HIV positives have higher median household expenditure than HIV negatives (1,042 compared to 979). The cross-tabs show that over time, HIV positives report greater risk perception most likely due to finding out their HIV status and subsequently modifying their risk perception. For HIV status, the income coefficient is positive for men and negative for women; however, for subjective HIV risk perception, the income coefficient for both sexes is negative (-0.0927 for men and -0.100 for women). Over time, the coefficient for year controls are positive and increasing (0.0283 in 2006 and 0.357 in 2008), which means HIV risk perception increases over time.

[TABLE 8 – ABOUT HERE]

For SF-12 estimates in Tables 9-10, income does not have a significant result on health. Three significant results are noteworthy. First, the physical health (PCS-12) of married women decreases by 2.789 units compared to unmarried women. This result is not surprising because it may be the case that once married, the women take on more physically intensive labor from household chores to agricultural activities. Second, women's physical health improves 0.425 units with each additional child, lending support to a physio-protective effect of having and rearing children. Third, the mental health (MCS-12) is improved by 2.911 units for married individuals. The result for married men is even more striking; 8.352 units higher compared to unmarried men. Studies have shown that the presence of a spouse lowers cumulative biological dysregulation or allostatic load more for men than women (Seeman et al. 2004).

[TABLES 9 & 10 – ABOUT HERE]

However, the result for women is also positive but smaller (1.996) and insignificant. Previous literature has shown that married people compared with single people are happier and healthier, by ruling out selection as the explanation for the mental-health advantage of married people, but it does so through different mechanisms for men and women (Horwitz et al. 1996, Marks and Lambert 1998, Waite and Gallagher 2000). In the developed world setting, health benefits of marriage follow women from economic advantages since women become more economically independent, and they work outside the home so they have less time to focus on their husbands and therefore health advantage for married men may fall (Waite et al. 2000). In developing world setting like Malawi, the pattern may be that women work even more when married and have husbands (and children) to take care of thereby increasing the health of married men at the expense of women's health.

There is some reason to believe that the relationship between income and health is stronger at different starting points of income and health. Appendix Figure 6 shows transition matrices for general health status and income, and the probabilities of individuals changing from one category to another over years *t* and *t+1*.

One major observation from the general health status transition matrix is that individuals whose health is "Poor" are more likely to skip the "Fair" state (5.56%) into the higher health states (38.89% for Good, 33.33% for Very Good, and 22.22% for Excellent) over time. Likewise, the same higher probabilities of reporting higher health status over time applies to individuals in "Fair" and "Good" health states. The "Very Good" generally stay in this state (47.93%), and there is a strong tendency to fall into this state from "Excellent" health (46.02%) while the probability of gains is lower (24.80%).

In the income transition matrix, there is a fairly evenly spread set of steady probabilities. Individuals in the poorest income quintile generally remain in the same state (30.82%) as do the richest income quintile (37.16%). There is less mobility into higher, where probabilities remain around and below 20%. Overall, there is slightly more mobility from the higher quintiles into lower quintiles as demonstrated by transitions around 20% below the highlighted diagonal.

5. Conclusions

One important assumption about this study is that neither salt price nor rainfall growth determines an individual or population's health—market institutions mediate the relationship between income and health in a significant way. Presumably, as lagged rainfall growth is large and positive it drives up agricultural productivity, and this in turn affords families and individuals more income for health care and services, and also drives down prices of market goods. Similarly, salt price alone does not determine health—it is mediated through transnational market forces that are exogenous to the income to health relationship.

All the analyses are condition on survival. It would be safe to conclude that poorer individuals have less resources and access to health services and treatment in rural Malawi and are subject to higher mortality risk. If death is considered a poor health outcome and income shocks affect mortality risks, overall, this would attenuate the income-health relationship for the models examined since the sample consists of the "healthier" population. The greatest attenuating effect of the income-health relationship can be found in HIV status as the disease has huge mortality consequences in Malawi and SSA, so results are to be interpreted with caution.

Although rainfall may contribute to growth of mosquito-born malaria, the problem of malaria is confined to other geographic regions near the lake shore (~450 meters above sea level) and the Shire River valley (outflow from Lake Malawi), where transmission is perennial with a peak in the January-April rainy season. Since the regions surveyed are reasonably far from bodies of water there is not so much concern for malaria influencing results. Balaka is approximately 30 km from the Shire River, and Rumphi and Mchinji are situated in the plateau (~1,000 meters above sea level) where transmission is seasonal from December-April/May. Moreover, the groups at highest risk are children (of which the sample is small) and pregnant women (CDC 2004). Moreover, most adults have developed immunity to malaria illness.

6. Discussion

The systematic analysis of this rich data has permitted an advance in understanding how and to what magnitude economic hardship affects the health and well-being of individuals and families adjusting to and coping with AIDS-related health shocks and changing risk environments in rural Malawi. Using data on the price of salt, a commonly consumed commodity, and lagged rainfall growth, it is possible to ascertain that a doubling of income raises the general health status of rural Malawians by 23.6% and well-being by 20.4%, for both men and women. For HIV outcomes, income increases the probability of HIV infection for men while the opposite is true for women; and income decreases the probability of perceiving oneself to be HIV positive for both men and women. Married women have lower physical health status but having children affords some physio-protective effect, and married men have higher mental health status.

Current development programs of conditional cash transfers, income redistribution, resource allocation, income generation, agricultural subsidies, etc. may help in improving overall health in this population. Further studies can examine the relationship in controlled studies where these programs are currently in place. The implication of a sizeable causal effect of income on health status does not preclude that the command over many of the goods and services that promote health, such as better nutrition and access to safe water, sanitation, and good quality health services that are severely lacking in Malawi are any less important. It may also be the case, however, that consumption expenditures are less applicable a measure of wealth than permanent income or asset-based measures. If overall well-being and life-satisfaction of the population is the sole interest, then the data shows a slightly weaker causal pathway. An enormous potential for further studies of this causal relationship involves possibly a better measure of wealth and other instruments such as geographic access to markets and services, the work of all which could have enormous implications on addressing challenges of poverty on health in rural Malawi and other contexts in SSA.

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Figure 1. General health status

Table 1. General health status – means and standard deviations

	Total			Men			Women		
	2004	2006	2008	2004	2006	2008	2004	2006	2008
N	1,092	1,092	1,092	415	415	415	677	677	677
General health status	3.69	3.86	3.74	3.79	4.02	3.86	3.64	3.76	3.67
	(1.07)	(0.91)	(0.77)	(1.07)	(0.85)	(0.76)	(1.07)	(0.93)	(0.77)
Total expenditure	1,450	1,877	5,262	2,206	2,099	6,626	987	1,741	4,426
	(4,716)	(5,370)	(14,214)	(7,020)	(3,260)	(15,061)	(2,268)	(6,324)	(13,613)
Age	36.9	39.4	41.3	42.2	44.6	46.5	33.7	36.2	38.1
	(11.9)	(11.8)	(11.7)	(12.1)	(12.0)	(11.5)	(10.5)	(10.5)	(10.7)
(Age/10) squared	15.0	16.9	18.4	19.3	21.3	23.0	12.4	14.2	15.7
	(9.6)	(10.1)	(10.4)	(10.8)	(11.4)	(11.1)	(7.7)	(8.1)	(8.8)
Married	0.94	0.93	0.91	0.97	0.99	0.98	0.92	0.90	0.87
	(0.24)	(0.25)	(0.29)	(0.16)	(0.12)	(0.15)	(0.27)	(0.30)	(0.34)
Children ever born	5.61	5.92	6.43	6.51	6.67	7.42	5.06	5.46	5.82
	(3.35)	(3.19)	(3.17)	(3.74)	(3.67)	(3.61)	(2.96)	(2.76)	(2.69)

Notes: Standard deviations in parentheses.

Figure 2. Subjective well-being

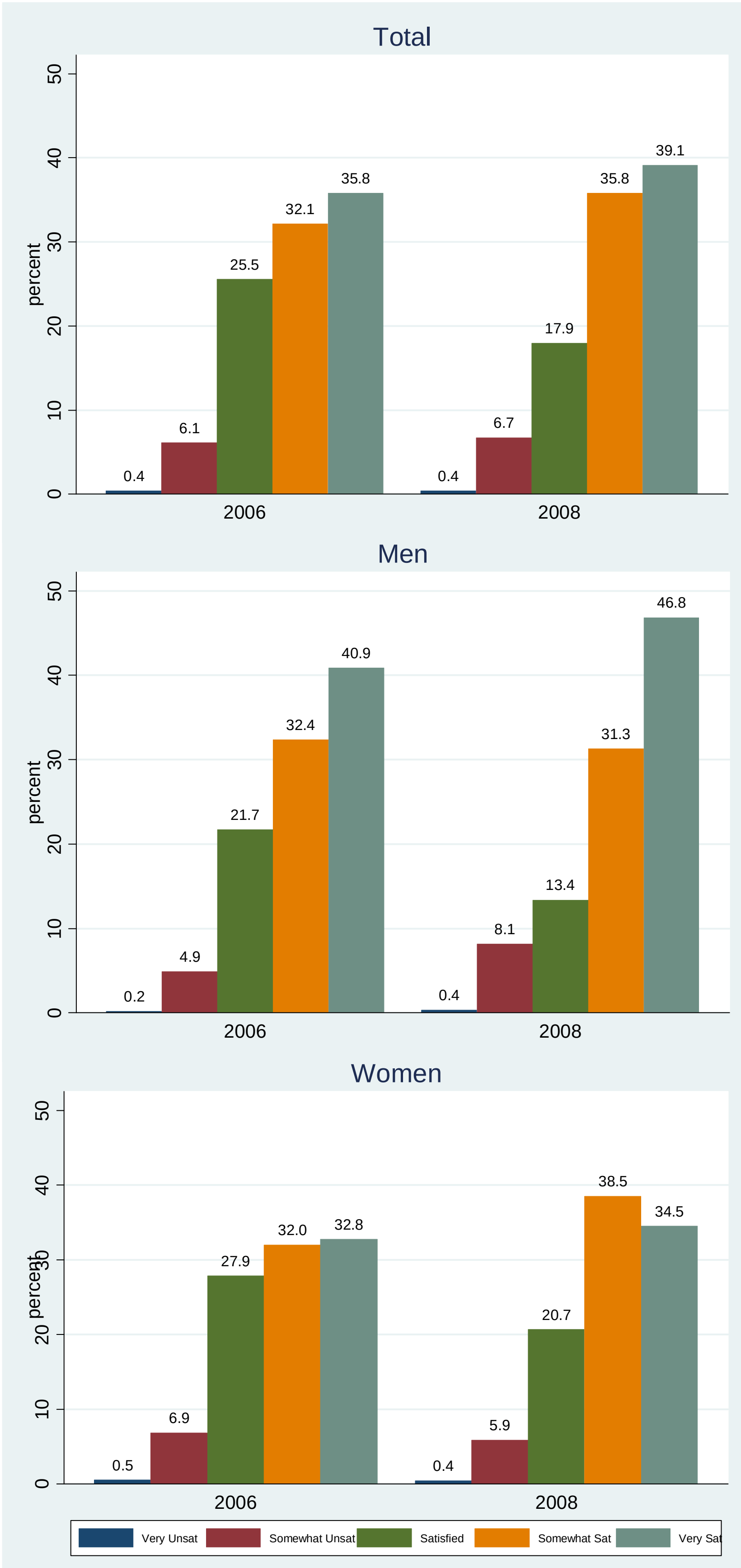

Table 2. Subjective well-being – means and standard deviations

	Total		Men		Women	
	2006	2008	2006	2008	2006	2008
N	1,472	1,472	553	553	919	919
Subjective well-being	3.97	4.07	4.09	4.16	3.90	4.01
	(0.95)	(0.93)	(0.91)	(0.97)	(0.96)	(0.91)
Total expenditure	1,809	5,353	2,185	6,937	1,584	4,399
	(4,781)	(17,356)	(3,138)	(14,624)	(5,529)	(18,752)
Age	39.2	41.1	43.1	45.0	36.9	38.7
	(11.9)	(12.1)	(12.6)	(12.2)	(10.9)	(11.5)
(Age/10) squared	16.8	18.3	20.2	21.8	14.8	16.3
	(10.3)	(11.1)	(11.7)	(11.5)	(8.7)	(10.3)
Married	0.92	0.90	0.98	0.97	0.89	0.86
	(0.27)	(0.30)	(0.15)	(0.17)	(0.32)	(0.35)
Children ever born	5.78	6.35	6.15	7.01	5.56	5.95
	(3.24)	(3.26)	(3.78)	(3.84)	(2.85)	(2.79)

Notes: Standard deviations in parentheses.

Table 3. HIV status – means and standard deviations

	Total			Men			Women		
	2004	2006	2008	2004	2006	2008	2004	2006	2008
N	884	884	884	342	342	342	542	542	542
HIV status	0.033	0.038	0.043	0.026	0.029	0.032	0.037	0.044	0.050
	(0.18)	(0.19)	(0.20)	(0.16)	(0.17)	(0.18)	(0.19)	(0.21)	(0.22)
Total expenditure	1,479	1,971	5,545	2,272	2,146	6,705	979	1,860	4,813
	(5,047)	(5,907)	(15,248)	(7,591)	(3,483)	(15,641)	(2,144)	(7,019)	(14,964)
Age	37.2	39.7	41.5	42.0	44.4	46.2	34.2	36.7	38.6
	(11.7)	(11.5)	(11.5)	(12.0)	(11.8)	(11.5)	(10.5)	(10.3)	(10.6)
(Age/10) squared	15.2	17.1	18.6	19.1	21.1	22.6	12.8	14.5	16.0
	(9.6)	(9.9)	(10.2)	(10.7)	(11.2)	(11.0)	(7.9)	(8.0)	(8.8)
Married	0.95	0.94	0.91	0.97	0.98	0.98	0.93	0.92	0.87
	(0.22)	(0.23)	(0.28)	(0.16)	(0.13)	(0.15)	(0.25)	(0.27)	(0.33)
Children ever born	5.66	5.92	6.42	6.52	6.54	7.32	5.13	5.53	5.85
	(3.30)	(3.12)	(3.10)	(3.73)	(3.56)	(3.53)	(2.87)	(2.74)	(2.65)

Notes: Standard deviations in parentheses.

Table 4. HIV risk perception – means and standard deviations

	Total			Men			Women		
	2004	2006	2008	2004	2006	2008	2004	2006	2008
N	975	975	975	392	392	392	583	583	583
HIV risk perception	0.30	0.25	0.51	0.21	0.18	0.44	0.36	0.31	0.55
	(0.46)	(0.44)	(0.50)	(0.41)	(0.38)	(0.50)	(0.48)	(0.46)	(0.50)
Total expenditure	1,470	1,895	5,436	2,227	1,967	6,477	961	1,847	4,737
	(4,921)	(5,592)	(14,930)	(7,207)	(3,104)	(15,402)	(2,231)	(6,772)	(14,577)
Age	36.9	39.4	41.2	41.4	44.0	45.9	33.9	36.3	38.1
	(12.1)	(11.9)	(11.8)	(12.1)	(12.2)	(11.6)	(11.1)	(10.7)	(10.8)
(Age/10) squared	15.1	17.0	18.4	18.6	20.9	22.4	12.7	14.3	15.7
	(10.0)	(10.4)	(10.4)	(10.7)	(11.5)	(11.1)	(8.7)	(8.6)	(8.9)
Married	0.94	0.94	0.91	0.98	0.99	0.98	0.92	0.90	0.87
	(0.23)	(0.25)	(0.28)	(0.15)	(0.10)	(0.15)	(0.27)	(0.30)	(0.33)
Children ever born	5.54	5.86	6.39	6.43	6.59	7.33	4.94	5.37	5.75
	(3.42)	(3.20)	(3.18)	(3.86)	(3.65)	(3.58)	(2.94)	(2.76)	(2.71)

Notes: Standard deviations in parentheses.

Table 5. Second-stage estimates of general health status

Total	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.0313**	0.0323**	0.0317**	0.0388**	0.975*	0.916*	0.945**
	(0.008)	(0.008)	(0.009)	(0.012)	(0.443)	(0.417)	(0.308)
Age		-0.00371	-0.00507				
		(0.010)	(0.010)				
(Age/10) squared		-0.00446	-0.00324	-0.00200	-0.0151	-0.0143	-0.0147
		(0.011)	(0.011)	(0.006)	(0.014)	(0.013)	(0.013)
Married		0.0772	0.0727	-0.0653	0.415	0.385	0.400
		(0.057)	(0.057)	(0.082)	(0.311)	(0.307)	(0.269)
Children ever born		0.00479	0.00584	0.00768	0.0265	0.0253	0.0259
		(0.007)	(0.007)	(0.014)	(0.036)	(0.034)	(0.035)
Year 2006			0.154**	0.132**	-0.669+	-0.618+	-0.643*
			(0.041)	(0.042)	(0.382)	(0.370)	(0.276)
Year 2008			0.0158	-0.0298	-1.751*	-1.642*	-1.695**
			(0.042)	(0.049)	(0.818)	(0.775)	(0.575)
Constant	3.568**	3.682**	3.659**	3.535**			
	(0.053)	(0.198)	(0.197)	(0.158)			
Adj R^2	0.0048	0.0117	0.0167	0.0145			
N	3276	3276	3276	3276	3276	3276	3276
KP LM Underid					5.575*	6.057*	11.49**
KP Wald F-test					5.586	6.085	5.798
Sargan *p*							0.921

Men	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.0332**	0.0298*	0.0275*	0.0207	1.063	1.343	1.171
	(0.012)	(0.013)	(0.014)	(0.022)	(0.957)	(1.466)	(0.860)
Age		0.0119	0.00998				
		(0.017)	(0.016)				
(Age/10) squared		-0.0218	-0.0204	0.00581	-0.00952	-0.0136	-0.0111
		(0.018)	(0.018)	(0.008)	(0.023)	(0.030)	(0.023)
Married		0.0755	0.0505	0.0657	0.581	0.719	0.634
		(0.205)	(0.203)	(0.221)	(0.875)	(1.091)	(0.881)
Children ever born		0.00366	0.00564	-0.0103	0.0626	0.0821	0.0701
		(0.009)	(0.009)	(0.017)	(0.087)	(0.122)	(0.085)
Year 2006			0.224**	0.202**	-0.594	-0.807	-0.676
			(0.065)	(0.065)	(0.743)	(1.169)	(0.691)
Year 2008			0.0464	0.0193	-1.809	-2.300	-1.998
			(0.068)	(0.079)	(1.688)	(2.630)	(1.545)
Constant	3.672**	3.526**	3.520**	3.563**			
	(0.086)	(0.404)	(0.396)	(0.324)			
Adj R^2	0.0052	0.0139	0.0236	0.0166			
N	1245	1245	1245	1245	1245	1245	1245
KP LM Underid					1.475	0.930	2.208
KP Wald F-test					1.469	0.927	1.102
Sargan *p*							0.858

Women	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.0231*	0.0254*	0.0228*	0.0487**	0.967+	0.774*	0.856**
	(0.010)	(0.010)	(0.011)	(0.014)	(0.521)	(0.383)	(0.309)
Age		-0.00342	-0.00546				
		(0.014)	(0.014)				
(Age/10) squared		-0.0141	-0.0120	-0.0110	-0.0236	-0.0210	-0.0221
		(0.017)	(0.017)	(0.007)	(0.018)	(0.015)	(0.016)
Married		-0.0536	-0.0543	-0.109	0.359	0.260	0.302
		(0.061)	(0.062)	(0.088)	(0.326)	(0.283)	(0.257)
Children ever born		0.00600	0.00671	0.0339	-0.0108	-0.00139	-0.00541
		(0.012)	(0.012)	(0.023)	(0.055)	(0.046)	(0.047)
Year 2006			0.136*	0.0838	-0.731	-0.560	-0.633*
			(0.054)	(0.056)	(0.464)	(0.349)	(0.283)
Year 2008			0.0413	-0.0610	-1.773+	-1.413*	-1.567**
			(0.052)	(0.061)	(0.975)	(0.712)	(0.577)
Constant	3.547**	3.870**	3.868**	3.451**			
	(0.065)	(0.259)	(0.259)	(0.183)			
Adj R^2	0.0022	0.0231	0.0258	0.0165			
N	2031	2031	2031	2031	2031	2031	2031
KP LM Underid					3.835+	5.521*	9.554**
KP Wald F-test					3.840	5.559	4.839
Sargan *p*							0.759

Notes: Robust standard errors in parentheses.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Table 6. Second-stage estimates of subjective well-being

	Total							Men							Women						
	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.0441**	0.0406**	0.0349**	0.0233	0.999*	0.915**	0.817**	0.0344*	0.0233	0.0182	-0.0177	0.735+	0.816+	0.792+	0.0410**	0.0387**	0.0311*	0.0421*	1.367	1.015*	0.644**
	(0.010)	(0.010)	(0.010)	(0.015)	(0.406)	(0.286)	(0.222)	(0.015)	(0.016)	(0.016)	(0.022)	(0.421)	(0.419)	(0.416)	(0.012)	(0.012)	(0.013)	(0.019)	(0.863)	(0.408)	(0.204)
Age		-0.0174*	-0.0174*						-0.0106	-0.0114						-0.0317**	-0.0313**				
		(0.009)	(0.009)						(0.015)	(0.016)						(0.011)	(0.011)				
(Age/10) squared		0.00882	0.00860	0.00416	0.0175	0.0163	0.0150		-0.00262	-0.00200	0.0201	0.00366	0.00188	0.00240		0.0230*	0.0220+	-0.00106	0.0362	0.0263	0.0158
		(0.010)	(0.009)	(0.007)	(0.020)	(0.018)	(0.017)		(0.016)	(0.016)	(0.014)	(0.019)	(0.020)	(0.020)		(0.012)	(0.012)	(0.008)	(0.040)	(0.027)	(0.018)
Married		0.200**	0.206**	-0.0222	0.283	0.257	0.226		0.0190	0.0258	-0.00265	0.703	0.780	0.757		0.149*	0.155*	-0.0316	0.234	0.163	0.0888
		(0.058)	(0.058)	(0.126)	(0.325)	(0.292)	(0.264)		(0.173)	(0.173)	(0.276)	(0.970)	(1.043)	(1.020)		(0.064)	(0.064)	(0.140)	(0.403)	(0.295)	(0.209)
Children ever born		0.0139+	0.0132+	0.0272	0.0380	0.0371	0.0360		0.0144	0.0138	0.0241	0.0619	0.0660	0.0648		0.0231*	0.0225*	0.0383	-0.0532	-0.0289	-0.00326
		(0.007)	(0.007)	(0.018)	(0.040)	(0.037)	(0.034)		(0.010)	(0.010)	(0.026)	(0.046)	(0.048)	(0.047)		(0.010)	(0.010)	(0.025)	(0.104)	(0.071)	(0.047)
Year 2008			0.0789*	0.0521	-0.918*	-0.835**	-0.737**			0.0685	0.0363	-0.678	-0.756+	-0.733+			0.101*	0.0561	-1.266	-0.915*	-0.544*
			(0.035)	(0.040)	(0.420)	(0.299)	(0.229)			(0.057)	(0.069)	(0.415)	(0.411)	(0.409)			(0.044)	(0.049)	(0.892)	(0.431)	(0.214)
Constant	3.721**	4.021**	4.021**	3.617**				3.883**	4.370**	4.390**	3.654**				3.685**	4.279**	4.273**	3.474**			
	(0.067)	(0.189)	(0.189)	(0.230)				(0.113)	(0.366)	(0.367)	(0.487)				(0.082)	(0.225)	(0.225)	(0.255)			
Adj R^2	0.0072	0.0207	0.0220	0.0077				0.0035	0.0199	0.0203	0.0060				0.0059	0.0241	0.0262	0.0131			
N	2944	2944	2944	2944	2944	2944	2944	1106	1106	1106	1106	1106	1106	1106	1838	1838	1838	1838	1838	1838	1838
KP LM Underid					7.856**	13.80**	19.07**					5.080*	6.010*	6.097*					2.808+	7.521**	15.30**
KP Wald F-test					7.898	13.98	9.724					5.110	6.092	3.091					2.811	7.590	7.830
Sargan *p*							0.516							0.532							0.135

Notes: Robust standard errors in parentheses.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Table 7. Second-stage estimates of HIV status

	Total							Men							Women						
	LPM	LPM 2	LPM 3	FE	IV-FE salt	IV-FE rain	IV-FE both	LPM	LPM 2	LPM 3	FE	IV-FE salt	IV-FE rain	IV-FE both	LPM	LPM 2	LPM 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.00398*	0.00368*	0.00361+	-0.000451	0.0174	-0.00943	0.00436	0.00173	0.00150	0.00123	-0.00132	0.0189	0.00553	0.0176	0.00593*	0.00535*	0.00572*	0.0000186	0.0175	-0.0115	-0.00306
	(0.002)	(0.002)	(0.002)	(0.001)	(0.017)	(0.010)	(0.010)	(0.002)	(0.002)	(0.003)	(0.001)	(0.022)	(0.011)	(0.020)	(0.002)	(0.002)	(0.003)	(0.001)	(0.027)	(0.012)	(0.012)
Age		0.00501*	0.00498*						0.00318	0.00310						0.0108**	0.0109**				
		(0.002)	(0.002)						(0.004)	(0.004)						(0.004)	(0.004)				
(Age/10) squared		-0.00626**	-0.00624**	0.0000033	-0.000304	0.000158	-0.0000797		-0.00401	-0.00395	-0.000131	-0.000334	-0.000200	-0.000321		-0.0134**	-0.0135**	0.000130	-0.000262	0.000388	0.000199
		(0.002)	(0.002)	(0.000)	(0.000)	(0.000)	(0.000)		(0.004)	(0.004)	(0.000)	(0.000)	(0.000)	(0.000)		(0.005)	(0.005)	(0.001)	(0.001)	(0.001)	(0.001)
Married		-0.0663+	-0.0663+	-0.0137+	-0.00473	-0.0183	-0.0113		0.0271**	0.0270**		0.00903	0.00276	0.00842		-0.0822*	-0.0825*	-0.0166+	-0.00802	-0.0222	-0.0181
		(0.034)	(0.034)	(0.007)	(0.013)	(0.013)	(0.012)		(0.009)	(0.009)		(0.017)	(0.007)	(0.016)		(0.039)	(0.039)	(0.009)	(0.017)	(0.016)	(0.015)
Children ever born		-0.00105	-0.00104	0.000564	0.000833	0.000429	0.000637		0.000985	0.000999	0.000597	0.00179	0.00100	0.00172		-0.00505	-0.00506	0.000425	-0.000440	0.000994	0.000577
		(0.002)	(0.002)	(0.001)	(0.001)	(0.001)	(0.001)		(0.003)	(0.004)	(0.001)	(0.002)	(0.001)	(0.002)		(0.004)	(0.004)	(0.002)	(0.002)	(0.001)	(0.001)
Year 2006			0.00166	0.00584*	-0.00947	0.0135	0.00171			0.00229	0.00425	-0.0118	-0.00120	-0.0108			-0.00112	0.00675	-0.00852	0.0168	0.00944
			(0.004)	(0.003)	(0.014)	(0.010)	(0.009)			(0.005)	(0.004)	(0.015)	(0.009)	(0.013)			(0.005)	(0.004)	(0.022)	(0.013)	(0.012)
Year 2008			0.00101	0.0101**	-0.0234	0.0270	0.00108			0.00392	0.00819+	-0.0280	-0.00407	-0.0256			-0.00482	0.0112*	-0.0224	0.0332	0.0171
			(0.006)	(0.004)	(0.031)	(0.020)	(0.019)			(0.009)	(0.004)	(0.037)	(0.019)	(0.033)			(0.009)	(0.005)	(0.050)	(0.025)	(0.024)
Constant	0.0132	-0.00816	-0.00805	0.0450**				0.0180	-0.0703	-0.0684	0.0324*				0.00736	-0.0884	-0.0902	0.0484**			
	(0.010)	(0.052)	(0.052)	(0.013)				(0.017)	(0.102)	(0.105)	(0.014)				(0.013)	(0.070)	(0.071)	(0.017)			
N	2652	2652	2652	2652	2652	2652	2652	1026	1026	1026	1026	1026	1026	1026	1626	1626	1626	1626	1626	1626	1626
KP LM Underid					5.065*	5.216*	9.642**					2.894+	0.366	3.074					2.206	5.682*	7.578*
KP Wald F-test					5.070	5.231	4.860					2.895	0.363	1.537					2.199	5.728	3.832
Sargan *p*							0.065							0.705							0.165

Notes: Linear probability model (LPM). Robust standard errors in parentheses.
+ p<0.1, * p<0.05, ** p<0.01

Table 8. Second-stage estimates of HIV risk perception

	Total							Men							Women						
	LPM	LPM 2	LPM 3	FE	IV-FE salt	IV-FE rain	IV-FE both	LPM	LPM 2	LPM 3	FE	IV-FE salt	IV-FE rain	IV-FE both	LPM	LPM 2	LPM 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.0133**	0.0129**	-0.00206	-0.00666	-0.129	-0.0317	-0.0778	0.0144*	0.0136*	-0.00282	-0.00990	-0.237	0.227	-0.0927	0.0171**	0.0163**	0.00361	-0.00406	-0.0496	-0.127	-0.100
	(0.004)	(0.004)	(0.004)	(0.006)	(0.091)	(0.076)	(0.054)	(0.007)	(0.007)	(0.007)	(0.008)	(0.160)	(0.234)	(0.094)	(0.005)	(0.005)	(0.006)	(0.008)	(0.116)	(0.095)	(0.068)
Age		0.00983*	0.00799+						0.00835	0.00499						0.0186*	0.0168*				
		(0.004)	(0.005)						(0.006)	(0.006)						(0.008)	(0.008)				
(Age/10) squared		-0.0135**	-0.0122*	0.000301	0.000495	0.000341	0.000413		-0.0107+	-0.00827	-0.00379	-0.00348	-0.00412	-0.00368		-0.0213*	-0.0198*	0.00251	0.00266	0.00291	0.00282
		(0.005)	(0.005)	(0.003)	(0.003)	(0.003)	(0.003)		(0.006)	(0.007)	(0.004)	(0.006)	(0.005)	(0.004)		(0.010)	(0.010)	(0.004)	(0.004)	(0.004)	(0.004)
Married		-0.103**	-0.0831*	-0.00439	-0.0609	-0.0159	-0.0371		-0.00576	0.0174	0.0811	-0.0619	0.230	0.0290		-0.0628+	-0.0500	-0.0257	-0.0443	-0.0758	-0.0649
		(0.035)	(0.034)	(0.051)	(0.067)	(0.066)	(0.059)		(0.101)	(0.101)	(0.116)	(0.216)	(0.295)	(0.154)		(0.038)	(0.037)	(0.058)	(0.072)	(0.072)	(0.064)
Children ever born		-0.000228	-0.00136	-0.00470	-0.00749	-0.00527	-0.00632		0.00452	0.00337	-0.00667	-0.0197	0.00684	-0.0114		-0.00783	-0.00842	-0.00219	-0.00101	0.000999	0.000300
		(0.004)	(0.004)	(0.008)	(0.009)	(0.008)	(0.008)		(0.005)	(0.005)	(0.010)	(0.019)	(0.020)	(0.012)		(0.006)	(0.006)	(0.013)	(0.013)	(0.014)	(0.013)
Year 2006			-0.0416*	-0.0390+	0.0772	-0.0153	0.0283			-0.0235	-0.0141	0.170	-0.206	0.0530			-0.0665*	-0.0561+	-0.00965	0.0693	0.0418
			(0.020)	(0.022)	(0.087)	(0.074)	(0.053)			(0.028)	(0.032)	(0.134)	(0.202)	(0.081)			(0.027)	(0.029)	(0.120)	(0.099)	(0.072)
Year 2008			0.213**	0.221**	0.457**	0.269+	0.357**			0.241**	0.267**	0.677*	-0.159	0.416*			0.174**	0.190**	0.280	0.434*	0.380**
			(0.023)	(0.025)	(0.176)	(0.146)	(0.105)			(0.035)	(0.038)	(0.294)	(0.433)	(0.172)			(0.031)	(0.034)	(0.232)	(0.188)	(0.137)
Constant	0.270**	0.212*	0.286**	0.361**				0.182**	0.0174	0.134	0.299+				0.301**	0.0365	0.114	0.385**			
	(0.028)	(0.094)	(0.095)	(0.084)				(0.044)	(0.171)	(0.171)	(0.161)				(0.035)	(0.143)	(0.144)	(0.103)			
N	2925	2925	2925	2925	2925	2925	2925	1176	1176	1176	1176	1176	1176	1176	1749	1749	1749	1749	1749	1749	1749
KP LM Underid					8.358**	9.745**	17.54**					3.914*	1.879	5.339+					4.253*	8.261**	12.51**
KP Wald F-test					8.414	9.860	8.932					3.950	1.878	2.696					4.260	8.410	6.407
Sargan *p*							0.425							0.0411							0.634

Notes: Linear probability model (LPM). Robust standard errors in parentheses.
+ p<0.1, * p<0.05, ** p<0.01

Table 9. Second-stage estimates of PCS-12

	Total							Men							Women						
	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.157*	0.120+	0.123+	-0.00178	-1.255	-0.907	-0.505	0.197*	0.0757	0.115	0.169	1.320	1.381	1.362	0.0503	0.0329	0.00291	-0.104	-3.920	-2.456	-0.878
	(0.067)	(0.068)	(0.072)	(0.101)	(1.472)	(1.099)	(0.920)	(0.090)	(0.084)	(0.090)	(0.154)	(1.652)	(1.616)	(1.611)	(0.094)	(0.094)	(0.099)	(0.136)	(3.374)	(1.735)	(1.000)
Age		0.0472	0.0472						0.363**	0.369**						-0.255**	-0.254**				
		(0.083)	(0.083)						(0.127)	(0.126)						(0.093)	(0.093)				
(Age/10) squared		-0.158+	-0.158+	-0.00503	-0.00753	-0.00683	-0.00603		-0.534**	-0.539**	0.0263	0.00101	-0.000313	0.000105		0.161	0.159	-0.0263	-0.0743	-0.0559	-0.0360
		(0.095)	(0.095)	(0.041)	(0.041)	(0.040)	(0.040)		(0.140)	(0.139)	(0.096)	(0.105)	(0.104)	(0.104)		(0.104)	(0.104)	(0.042)	(0.089)	(0.058)	(0.042)
Married		0.354	0.351	-1.962+	-2.342*	-2.237*	-2.115*		1.114	1.061	1.513	2.595	2.652	2.634		-0.608	-0.588	-2.646*	-3.351*	-3.080*	-2.789*
		(0.516)	(0.519)	(1.021)	(1.135)	(1.088)	(1.073)		(1.823)	(1.840)	(2.438)	(3.216)	(3.231)	(3.219)		(0.562)	(0.564)	(1.108)	(1.654)	(1.345)	(1.172)
Children ever born		0.0129	0.0132	0.000842	-0.00803	-0.00557	-0.00272		0.0127	0.0174	-0.160	-0.102	-0.0984	-0.0994		0.123	0.121	0.366*	0.657+	0.545*	0.425*
		(0.061)	(0.061)	(0.134)	(0.146)	(0.141)	(0.137)		(0.080)	(0.081)	(0.188)	(0.221)	(0.223)	(0.222)		(0.091)	(0.091)	(0.179)	(0.360)	(0.244)	(0.194)
Year 2008			-0.0384	-0.0988	1.127	0.786	0.393			-0.538	-0.628	-1.718	-1.775	-1.757			0.394	0.165	3.906	2.470	0.923
			(0.235)	(0.279)	(1.514)	(1.150)	(0.962)			(0.348)	(0.496)	(1.728)	(1.704)	(1.697)			(0.311)	(0.339)	(3.425)	(1.792)	(1.020)
Constant	51.36**	52.08**	52.08**	54.34**				51.95**	46.85**	46.69**	51.50**				51.52**	58.58**	58.57**	53.06**			
	(0.477)	(1.733)	(1.733)	(1.592)				(0.688)	(3.360)	(3.352)	(3.782)				(0.640)	(1.906)	(1.899)	(1.754)			
N	2922	2922	2922	2922	2922	2922	2922	1100	1100	1100	1100	1100	1100	1100	1822	1822	1822	1822	1822	1822	1822
KP LM Underid					7.664**	13.28**	18.12**					4.891*	5.762*	5.837+					2.783+	7.218**	14.29**
KP Wald F-test					7.705	13.45	9.230					4.917	5.837	2.957					2.786	7.283	7.308
Sargan *p*							0.487							0.904							0.196

Notes: Robust standard errors in parentheses.
+ p<0.1, * p<0.05, ** p<0.01

Table 10. Second-stage estimates of MCS-12

	Total							Men							Women						
	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both	OLS	OLS 2	OLS 3	FE	IV-FE salt	IV-FE rain	IV-FE both
ln expenditure	0.00744	-0.0213	0.0566	-0.0697	-0.966	-0.736	-0.472	-0.0493	-0.104	-0.0767	-0.203	1.024	0.394	0.593	-0.0848	-0.105	-0.00368	-0.0111	-3.632	-1.813	0.166
	(0.083)	(0.084)	(0.087)	(0.127)	(1.979)	(1.546)	(1.288)	(0.121)	(0.123)	(0.128)	(0.205)	(2.195)	(2.085)	(2.096)	(0.111)	(0.113)	(0.116)	(0.162)	(4.002)	(2.297)	(1.379)
Age		-0.0123	-0.0108						0.0856	0.0898						-0.147	-0.150				
		(0.084)	(0.084)						(0.146)	(0.145)						(0.098)	(0.099)				
(Age/10) squared		-0.0211	-0.0201	-0.0190	-0.0208	-0.0203	-0.0198		-0.160	-0.163	-0.00168	-0.0286	-0.0148	-0.0191		0.101	0.109	-0.0378	-0.0833	-0.0605	-0.0356
		(0.094)	(0.095)	(0.045)	(0.049)	(0.047)	(0.046)		(0.162)	(0.161)	(0.102)	(0.105)	(0.107)	(0.106)		(0.108)	(0.109)	(0.049)	(0.102)	(0.066)	(0.053)
Married		3.645**	3.568**	3.042*	2.750+	2.825+	2.911*		3.083	3.047	7.605**	8.757**	8.166**	8.352**		2.853**	2.790**	1.959	1.195	1.579	1.996
		(0.651)	(0.654)	(1.360)	(1.550)	(1.482)	(1.445)		(2.129)	(2.125)	(2.089)	(2.949)	(2.829)	(2.838)		(0.716)	(0.719)	(1.558)	(2.038)	(1.710)	(1.602)
Children ever born		-0.0470	-0.0387	-0.0615	-0.0672	-0.0657	-0.0640		-0.0252	-0.0220	-0.372+	-0.310	-0.342	-0.332		0.0125	0.0192	0.367	0.650	0.508	0.353
		(0.071)	(0.071)	(0.160)	(0.159)	(0.158)	(0.159)		(0.087)	(0.088)	(0.197)	(0.256)	(0.242)	(0.246)		(0.112)	(0.112)	(0.267)	(0.446)	(0.331)	(0.290)
Year 2008			-1.070**	-0.965**	-0.0873	-0.313	-0.572			-0.370	-0.00533	-1.167	-0.571	-0.759			-1.327**	-1.530**	2.024	0.239	-1.703
			(0.314)	(0.365)	(1.952)	(1.527)	(1.271)			(0.451)	(0.600)	(2.201)	(2.077)	(2.095)			(0.422)	(0.458)	(3.947)	(2.249)	(1.352)
Constant	54.87**	52.88**	52.84**	53.80**				56.60**	53.73**	53.62**	52.76**				54.66**	56.23**	56.23**	51.71**			
	(0.579)	(1.806)	(1.813)	(1.952)				(0.901)	(3.694)	(3.675)	(3.615)				(0.746)	(2.102)	(2.121)	(2.408)			
N	2920	2920	2920	2920	2920	2920	2920	1100	1100	1100	1100	1100	1100	1100	1820	1820	1820	1820	1820	1820	1820
KP LM Underid					7.887**	13.60**	18.44**					4.891*	5.762*	5.837+					2.952+	7.513**	14.58**
KP Wald F-test					7.932	13.78	9.399					4.917	5.837	2.957					2.957	7.585	7.459
Sargan *p*							0.715							0.292							0.209

Notes: Robust standard errors in parentheses.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Appendix Figure 1. SF-12 score for a hypothetical subject [18]

Note that at the top of each item response choice box is the physical weight used to score the PCS-12 scale and the mental weight used to score the MCS-12 scale is at the bottom of each item response choice box. A physical and mental weight of 0 is assigned for the item response choice indicative of the most favorable health state. In essence, the physical weights at the top of the response choice box should be considered as the item response choice value for scoring the PCS-12 scale. Similarly, the mental weight at the bottom of the response choice box should be considered as the response choice value for scoring the MCS-12 scale. Using the responses selected for the hypothetical respondent in Figure 1, scores for PCS-12 and MCS-12 would be computed in the following way: 1) summate the physical weights corresponding to the item response choice selected to score PCS-12 and summate the mental weights corresponding to the item response choices selected to score MCS-12; 2) standardize the PCS-12 score by adding the constant (56.57706) to the sum of the physical weights (-9.51592) and standardize the MCS-12 score by adding the constant (60.75781) to the sum of the mental weights (-3.7207). The final PCS-12 and MCS-12 scores for the hypothetical respondent are 47.06 and 57.04, respectively.

SF-12 HEALTH SURVEY

INSTRUCTIONS: This survey asks for views about your health. This information will help keep track of how you feel and how well you are able to do your usual activities. Please answer every question by marking one box. If you are unsure about how to answer, please give the best answer you can.

1. In general, would you say your health is:

	Excellent	Very good	Good	Fair	Poor
(Physical)	0	-1.31872	-3.02396	-5.56461	-8.37399
	☐	☐	☒	☐	☐
(Mental)	0	-0.06064	0.03482	-0.16891	-1.71175

The following items are about activities you might do during a typical day. Does your health now limit you in these activities? If so, how much?

2. Moderate activities,such as moving a table, pushing a vacuum cleaner, bowling, or playing golf

	Yes, Limited A Lot	Yes, Limited A Little	No, Not Limited At All
(Physical)	-7.23216	-3.45555	0
	☐	☒	☐
(Mental)	3.93115	1.86840	0

3. Climbing several flights of stairs

(Physical)	-6.24397	-2.73557	0
	☐	☐	☒
(Mental)	2.68282	1.43103	0

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activities as a result of your physical health?

4. Accomplished less than you would like

	YES	NO
(Physical)	-4.61617	0
	☒	☐
(Mental)	1.44060	0

5. Were limited in the kind of work or other activities

(Physical)	-5.51747	0
	☐	☒
(Mental)	1.66968	0

During the past 4 weeks, have you had any of the following problems with your work or other regular daily activitie as a result of any emotional problems (such as feeling depressed or anxious)?

6. Accomplished less than you would like

	YES	NO
(Physical)	3.04365	0
	☐	☒
(Mental)	-6.82672	0

7. Didn't do work or other activities as carefully as usual

(Physical)	2.32091	0
	☐	☒
(Mental)	-5.69921	0

8. During the past 4 weeks, how much did pain interfere with your normal work (including both work outside the home and housework)?

	Not at all	A little bit	Moderately	Quite a bit	Extremely
(Physical)	0	-3.80130	-6.50522	-8.38063	-11.25544
	☐	☒	☐	☐	☐
(Mental)	0	0.90384	1.49384	1.76691	1.48619

These questions are about how you feel and how things have been with you during the past 4 weeks. For each question, please give the one answer that comes closest to the way you have been feeling. How much of the time during the past 4 weeks -

9. Have you felt calm and peaceful?

	All of the Time	Most of the Time	A Good Bit of the Time	Some of the Time	A Little of the Time	None of the Time
(Physical)	0	0.66514	1.36689	2.37241	2.90426	3.46638
	☐	☒	☐	☐	☐	☐
(Mental)	0	-1.94949	-4.09842	-6.31121	-7.92717	-10.19085

10. Did you have a lot of energy?

(Physical)	0	-0.42251	-1.14387	-1.61850	-2.02168	-2.44706
	☐	☒	☐	☐	☐	☐
(Mental)	0	-0.92057	-1.65178	-3.29805	-4.88962	-6.02409

11. Have you felt downhearted and blue?

(Physical)	4.61446	3.41593	2.34247	1.28044	0.41188	0
	☐	☐	☐	☐	☒	☐
(Mental)	-16.15395	-10.77911	-8.09914	-4.59055	-1.95934	0

12. During the past 4 weeks, how much of the time has your physical health or emotional problems interfered with your social activities (like visiting with friends, relatives, etc.)?

	All of the Time	Most of the Time	Some of the Time	A Little of the Time	None of the Time
(Physical)	-0.33682	-0.94342	-0.18043	0.11038	0
	☐	☐	☐	☒	☐
(Mental)	-6.29724	-8.26066	-5.63286	-3.13896	0

PCS Score = (-3.02396)+(-3.45555)+(0)+(-4.61617)+(0)+(0)+(0)+(-3.8013)+(0.66514)+(-0.42251)+(0.41188)+(0.11038) = -9.51592

Norm-Based Standardized PCS = -9.51592 + 56.57706 = **47.06**

MCS Score = (0.03482)+(1.8684)+(0)+(1.4406)+(0)+(0)+(0)+(0.90384)+(-1.94949)+(-0.92057)+(-1.95934)+(-3.13896) = -3.7207

Norm-Based Standardized MCS = -3.7207 + 60.75781 = **57.04**

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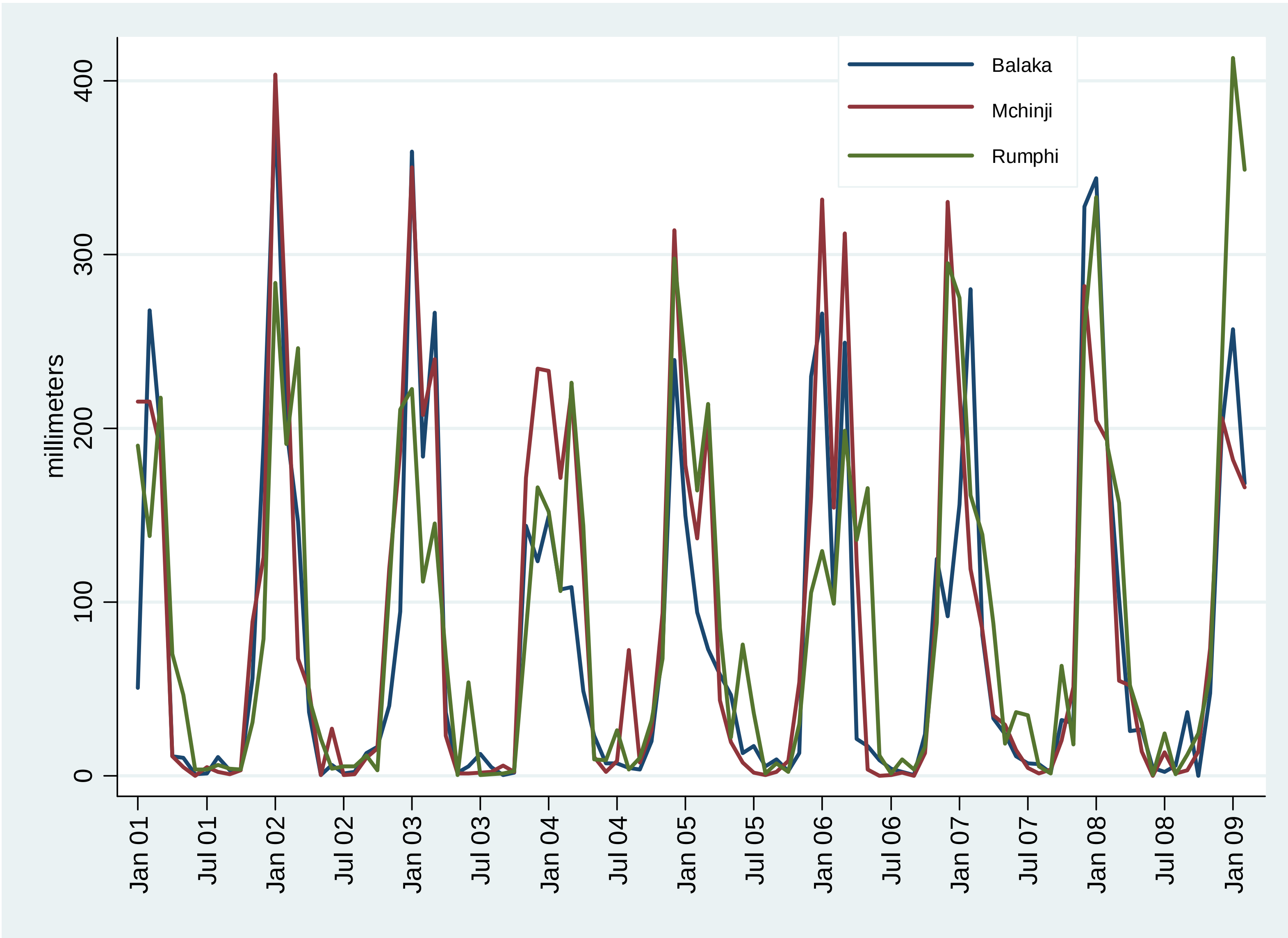
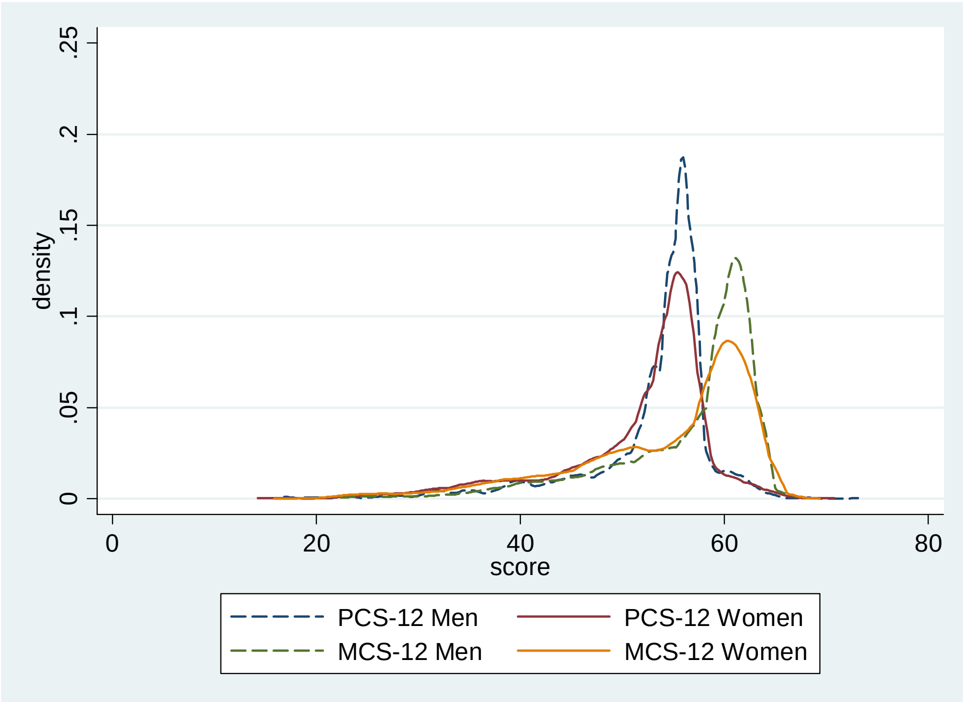
[18] This example is derived from Kosinski, M. (1997). Scoring the SF-12 Physical and Mental Health Summary Measures. *Medical Outcomes Trust Bulletin* 5(5): 3. Revised by Li-Wei Chao.

Appendix Figure 2. Monthly accumulated rainfall

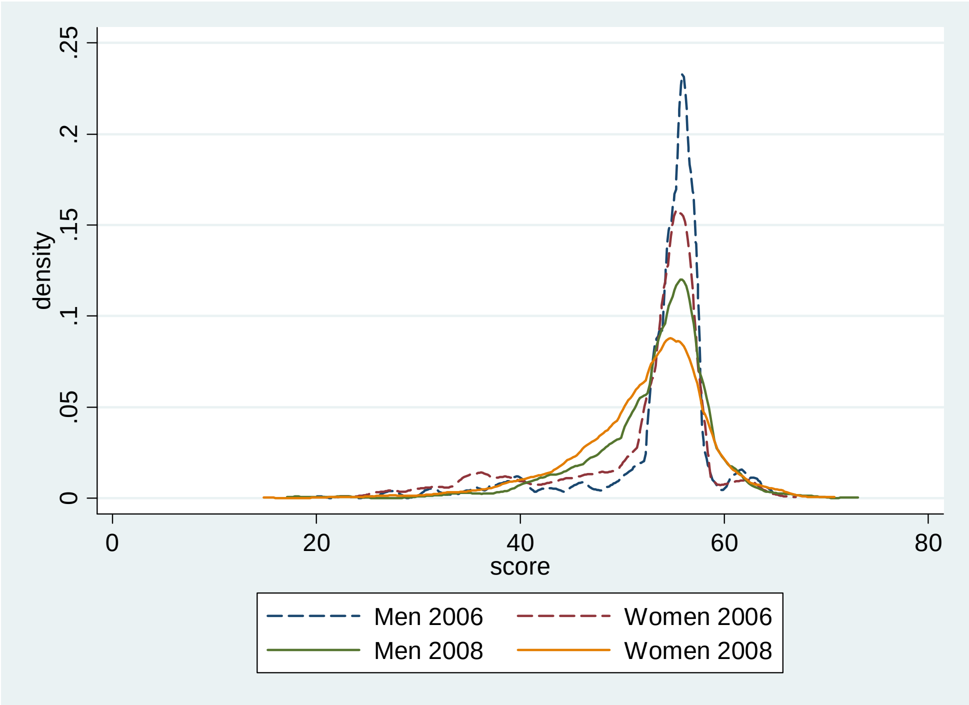


Appendix Figure 3. PCS-12 and MCS-12



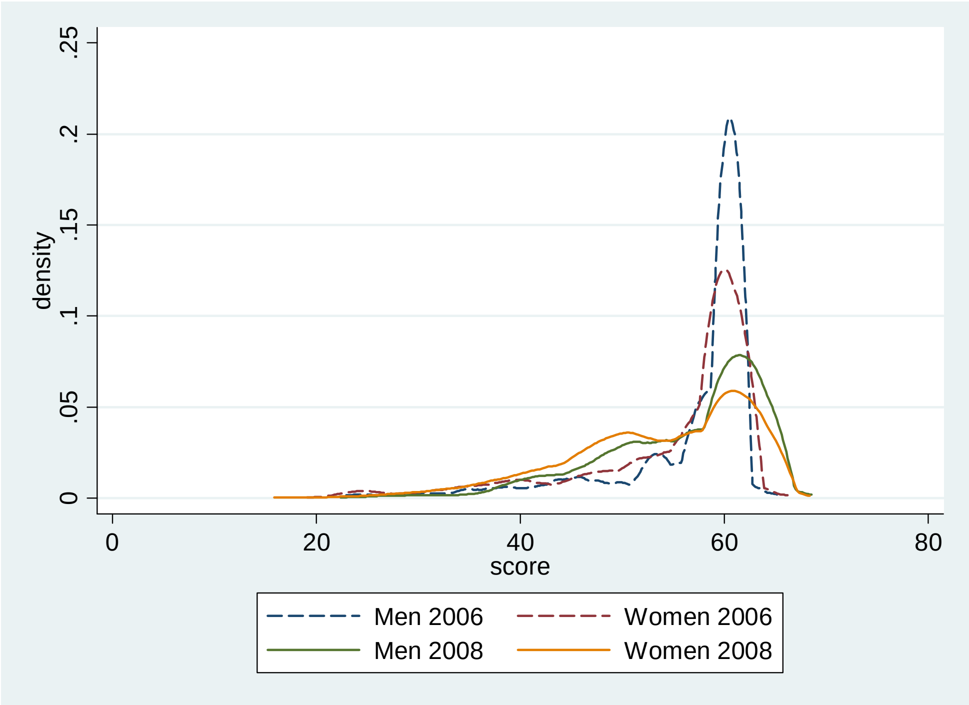
Notes: Epanechnikov kernel density estimates.

Appendix Figure 4. PCS-12 in 2006 and 2008



Notes: Epanechnikov kernel density estimates.

Appendix Figure 5. MCS-12 in 2006 and 2008



Notes: Epanechnikov kernel density estimates.

Appendix Figure 6. Transition matrices

General health status (t)	General health status (t+1)					Total
	1	2	3	4	5	
1	0.00	5.56	38.89	33.33	22.22	100
2	1.99	11.94	35.82	33.33	16.92	100
3	0.45	4.75	34.03	41.90	18.87	100
4	0.61	4.30	26.57	47.93	20.58	100
5	0.47	3.12	25.59	46.02	24.80	100
Total	0.64	4.81	29.53	44.05	20.97	100

Note: General health status: 1=Poor, 2=Fair, 3=Good, 4=Very Good, 5=Excellent.

Income quintile (t)	Income quintile (t+1)					Total
	1	2	3	4	5	
1	30.82	19.86	21.69	16.67	10.96	100
2	24.94	23.11	18.54	20.14	13.27	100
3	19.68	22.88	21.51	18.76	17.16	100
4	15.37	20.87	21.56	20.87	21.33	100
5	9.40	13.07	16.97	23.39	37.16	100
Total	20.05	19.96	20.05	19.96	19.96	100

Note: Income quintile: 1=lowest, 5=highest.

Appendix Table 1. Balaka Market prices in 2006

	January	February	March	April	May	June	July	August	September	October	November	December
Maize Grain	9615.38	2491.69	2348.93	2206.17	1792.11	1764.71	1718.21	2942.44	4166.67	2225.52	2215.66	2340.09
Maize Flour	14778.33	8865.25	8971.08	9076.90	7267.44	6590.51	6443.30	9668.64	12893.98	13392.86	13111.89	9911.89
Rice other	14285.71	9740.26	9587.11	9433.96	9615.38	9803.92	9803.92	10146.72	10489.51	12500.00	12048.19	10563.38
Irish/ Potatoes		3218.88	3298.63	3378.38	2652.52	2688.17	2604.17	2965.06	3325.94	3472.22	3311.26	3198.29
Sweet Potatoes		1859.89	1820.42	1780.94	3231.02	1588.98	1705.03	1753.96	1802.88	3821.66	3627.57	3171.25
Cassava						2568.49	2415.46	2449.45	2483.44	3886.01	4143.65	6060.61
Beans white	16666.67	11627.91	11766.34	11904.76	9146.34	9677.42	11235.96	11816.33	12396.69	13274.34	13888.89	12711.86
Beans Brown	14084.51	11450.38	11450.38		9174.31	10416.67	10869.57	11434.79	12000.00	12500.00	14285.71	13274.34
G/Nuts	18867.92	14563.11	14563.11		16129.03	13636.36	14285.71	16883.12	19480.52	21126.72	19736.84	19480.52
Onions	11764.71	12765.96	12876.49	12987.01	15384.62	13043.48	8130.08	6743.61	5357.14	12711.86	10273.97	8241.76
Tomatoes	8064.52	4385.96	4335.84	4285.71	3012.05	2862.60	2645.50	2428.95	2212.39	6578.95	6276.15	6000.00
Cabbage	1976.89	1329.00	1149.00	968.99	2237.14	2577.32	2042.01	1563.70	1085.38	1103.75	1336.90	2238.81
Tanapusi	4950.50	2533.78	2728.88	2923.98	2347.42	2049.18	2100.84	1831.67	1562.50	3112.03	3012.05	6355.93
Nkhwani	1250.00	3750.00	3523.35	3296.70	2906.98	2027.03	5555.56	6725.15	7894.74	7075.47	7042.25	4545.45
Okra	6535.95	6198.35	6432.51	6666.67	5263.16	4573.17	4347.83	8639.43	12931.03	10273.97	11627.91	9615.38
Bananas		3623.19	3579.27	3535.35	3571.43	3378.38	2976.19	2245.67	1515.15	5681.82	6198.35	2293.58
Mangoes(Maboloma)	1886.79							2311.25	2311.25	3554.50	3125.00	1470.59
Chicken	20161.29	31413.61	30835.04	30256.47		29752.07						
Chambo fresh			45638.98	45638.98	33333.33	31746.03						20202.02
Chambo dry		75000.00	71944.45	68888.89	62500.00	68965.52		72580.65	72580.65	38461.54	90909.09	73529.41
Utaka-sun dry	32258.06	56250.00	56971.16	57692.31		57692.31		42857.14	42857.14	50847.46	62500.00	60000.00
Usipa-sun dry	32786.89	40178.57	40359.56	40540.54	53571.43	48387.10	66666.67	52083.34	37500.00	29411.76	26548.67	50561.80
Salt	35714.29	3631.96	3717.12	3802.28	4901.96	4615.38	4545.45	4545.45		2964.43	2808.99	4143.65
Charcoal	1728.11	2292.26	2272.26	2252.25	2125.40	1888.57	1885.01	2010.88	2136.75	2506.26	2469.14	1322.75
Firewood	469.85	735.84	711.09	686.34	778.82	699.30	577.37	581.43	585.48	596.66	626.57	1111.11

Notes: Gaps represent that there was not enough to buy or that there were no products available at the market at the time of the market survey.

Appendix Table 2. Physical health summary measure (PCS-12) – means and standard deviations

	Total		Men		Women	
	2006	2008	2006	2008	2006	2008
N	1,461	1,461	550	550	911	911
PCS-12	52.45	52.38	53.62	53.05	51.74	51.97
	(7.32)	(6.55)	(6.41)	(6.19)	(7.74)	(6.74)
Total expenditure	1,816	5,374	2,189	6,957	1,591	4,418
	(4,798)	(17,417)	(3,145)	(14,661)	(5,552)	(18,831)
Age	39.2	41.1	43.1	45.0	36.8	38.6
	(11.9)	(12.1)	(12.6)	(12.2)	(10.9)	(11.4)
(Age/10) squared	16.8	18.3	20.2	21.8	14.7	16.2
	(10.3)	(11.0)	(11.8)	(11.5)	(8.7)	(10.1)
Married	0.92	0.90	0.98	0.97	0.89	0.86
	(0.27)	(0.30)	(0.15)	(0.17)	(0.32)	(0.35)
Children ever born	5.78	6.34	6.16	7.01	5.55	5.94
	(3.25)	(3.27)	(3.79)	(3.85)	(2.85)	(2.79)

Notes: Standard deviations in parentheses.

Appendix Table 3. Mental health summary measure (MCS-12) – means and standard deviations

	Total		Men		Women	
	2006	2008	2006	2008	2006	2008
N	1,460	1,460	550	550	910	910
MCS-12	55.49	54.34	56.54	55.97	54.86	53.36
	(8.47)	(8.72)	(7.56)	(7.86)	(8.92)	(9.07)
Total expenditure	1,816	5,377	2,189	6,957	1,591	4,422
	(4,799)	(17,423)	(3,145)	(14,661)	(5,555)	(18,841)
Age	39.2	41.1	43.1	45.0	36.8	38.7
	(11.9)	(12.1)	(12.6)	(12.2)	(10.9)	(11.4)
(Age/10) squared	16.8	18.3	20.2	21.8	14.8	16.2
	(10.3)	(11.0)	(11.8)	(11.5)	(8.7)	(10.1)
Married	0.92	0.90	0.98	0.97	0.89	0.86
	(0.27)	(0.30)	(0.15)	(0.17)	(0.32)	(0.35)
Children ever born	5.78	6.34	6.16	7.01	5.55	5.94
	(3.25)	(3.27)	(3.79)	(3.85)	(2.85)	(2.79)

Notes: Standard deviations in parentheses.

Appendix Table 4. First-stage estimates of ln expenditure – general health status

	Total			Men			Women		
	salt	rain	both	salt	rain	both	salt	rain	both
(Age/10) squared	0.0128	0.0143	0.0130	0.0140	0.0146	0.0138	0.0120	0.0149	0.0131
	(0.011)	(0.011)	(0.011)	(0.015)	(0.014)	(0.014)	(0.017)	(0.017)	(0.017)
Married	-0.503*	-0.501*	-0.490*	-0.479	-0.475	-0.459	-0.501*	-0.498*	-0.489*
	(0.225)	(0.226)	(0.225)	(0.580)	(0.584)	(0.584)	(0.244)	(0.244)	(0.242)
Children ever born	-0.0171	-0.0249	-0.0220	-0.0661	-0.0727	-0.0689	0.0492	0.0420	0.0424
	(0.031)	(0.031)	(0.031)	(0.045)	(0.045)	(0.045)	(0.041)	(0.041)	(0.041)
Year 2006	1.162**	0.890**	1.207**	1.005**	0.783**	1.031**	1.223**	0.933**	1.280**
	(0.162)	(0.082)	(0.163)	(0.239)	(0.122)	(0.241)	(0.217)	(0.109)	(0.218)
Year 2008	2.259**	1.771**	2.202**	2.084**	1.713**	2.049**	2.326**	1.780**	2.253**
	(0.204)	(0.094)	(0.205)	(0.310)	(0.159)	(0.311)	(0.272)	(0.118)	(0.272)
Salt price	-0.134*		-0.138*	-0.106		-0.108	-0.147+		-0.151*
	(0.057)		(0.057)	(0.087)		(0.087)	(0.075)		(0.075)
Rain		0.771*	0.793*		0.464	0.484		0.969*	0.990*
		(0.313)	(0.313)		(0.482)	(0.485)		(0.411)	(0.411)
Constant	6.249**	5.777**	6.307**	6.738**	6.377**	6.771**	5.767**	5.234**	5.833**
	(0.392)	(0.314)	(0.392)	(0.704)	(0.686)	(0.707)	(0.500)	(0.360)	(0.499)
Adj R^2	0.230	0.230	0.232	0.211	0.211	0.212	0.243	0.244	0.246
N	3276	3276	3276	1245	1245	1245	2031	2031	2031
F-statistic	5.586*	6.085*	5.798**	1.469	0.927	1.102	3.835+	5.521*	9.554**

Notes: Least squares within estimates using all non-missing, non-singleton observations for each specification.
Robust standard errors in parentheses. F-statistic of excluded instruments.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Appendix Table 5. First-stage estimates of ln expenditure – subjective well-being

	Total			Men			Women		
	salt	rain	both	salt	rain	both	salt	rain	both
(Age/10) squared	-0.0149	-0.0146	-0.0132	0.0204	0.0218	0.0214	-0.0289	-0.0291	-0.0279
	(0.019)	(0.019)	(0.019)	(0.022)	(0.022)	(0.022)	(0.024)	(0.024)	(0.023)
Married	-0.303	-0.295	-0.284	-0.889	-0.900	-0.896	-0.196	-0.185	-0.155
	(0.274)	(0.273)	(0.272)	(0.986)	(0.980)	(0.984)	(0.264)	(0.264)	(0.263)
Children ever born	-0.00301	-0.000245	-0.000168	-0.0338	-0.0346	-0.0341	0.0713	0.0748	0.0824
	(0.036)	(0.036)	(0.036)	(0.047)	(0.047)	(0.047)	(0.057)	(0.058)	(0.058)
Year 2008	1.178**	1.973**	3.384**	1.175**	1.957**	1.737	1.142**	1.938**	4.536**
	(0.085)	(0.262)	(0.751)	(0.130)	(0.408)	(1.150)	(0.108)	(0.339)	(1.003)
Salt price	-0.198**		0.509*	-0.266*		-0.0811	-0.148+		0.927**
	(0.070)		(0.259)	(0.118)		(0.419)	(0.088)		(0.336)
Rain		-7.084**	-20.71**		-7.413*	-5.291		-6.742**	-31.84**
		(1.895)	(7.006)		(3.005)	(10.758)		(2.448)	(9.366)
Constant	7.948**	6.220**	2.148	8.841**	6.670**	7.319*	7.093**	5.701**	-1.706
	(0.651)	(0.503)	(2.073)	(1.143)	(1.202)	(3.373)	(0.807)	(0.571)	(2.669)
Adj R^2	0.166	0.169	0.171	0.185	0.185	0.185	0.164	0.168	0.176
N	2944	2944	2944	1106	1106	1106	1838	1838	1838
F-statistic	7.898**	13.98**	9.724**	5.110*	6.092*	3.091*	2.811+	7.590**	7.830**

Notes: Least squares within estimates using all non-missing, non-singleton observations for each specification.
Robust standard errors in parentheses. F-statistic of excluded instruments.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Appendix Table 6. First-stage estimates of ln expenditure – HIV status

	Total			Men			Women		
	salt	rain	both	salt	rain	both	salt	rain	both
(Age/10) squared	0.0161	0.0173	0.0162	0.00880	0.00998	0.00871	0.0215	0.0231	0.0221
	(0.011)	(0.011)	(0.011)	(0.016)	(0.015)	(0.015)	(0.017)	(0.017)	(0.017)
Married	-0.499+	-0.483+	-0.478+	-0.431	-0.458	-0.420	-0.490+	-0.459	-0.461
	(0.264)	(0.266)	(0.264)	(0.673)	(0.677)	(0.677)	(0.286)	(0.286)	(0.284)
Children ever born	-0.0120	-0.0184	-0.0154	-0.0537	-0.0603	-0.0547	0.0497	0.0429	0.0432
	(0.031)	(0.031)	(0.032)	(0.043)	(0.043)	(0.043)	(0.046)	(0.046)	(0.046)
Year 2006	1.187**	0.905**	1.232**	1.176**	0.811**	1.193**	1.162**	0.942**	1.226**
	(0.179)	(0.089)	(0.180)	(0.273)	(0.132)	(0.274)	(0.239)	(0.119)	(0.241)
Year 2008	2.325**	1.823**	2.265**	2.304**	1.763**	2.280**	2.304**	1.839**	2.222**
	(0.222)	(0.099)	(0.223)	(0.349)	(0.168)	(0.351)	(0.291)	(0.124)	(0.292)
Salt price	-0.142*		-0.142*	-0.167+		-0.167+	-0.124		-0.122
	(0.063)		(0.063)	(0.098)		(0.098)	(0.084)		(0.084)
Rain		0.799*	0.795*		0.315	0.320		1.113*	1.106*
		(0.350)	(0.349)		(0.523)	(0.523)		(0.465)	(0.465)
Constant	6.174**	5.649**	6.197**	6.893**	6.301**	6.903**	5.533**	5.073**	5.561**
	(0.436)	(0.346)	(0.436)	(0.800)	(0.786)	(0.803)	(0.560)	(0.393)	(0.558)
Adj R^2	0.244	0.244	0.247	0.221	0.217	0.221	0.261	0.263	0.265
N	2652	2652	2652	1026	1026	1026	1626	1626	1626
F-statistic	5.070*	5.231*	4.860**	2.895+	0.363	1.537	2.199	5.728*	3.832*

Notes: Linear probability model estimates using all non-missing, non-singleton observations for each specification.
Robust standard errors in parentheses. F-statistic of excluded instruments.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Appendix Table 7. First-stage estimates of ln expenditure – HIV risk perception

	Total			Men			Women		
	salt	rain	both	salt	rain	both	salt	rain	both
(Age/10) squared	-0.000317	0.00156	-0.000411	-0.00168	0.00183	-0.00127	0.00204	0.00267	0.00140
	(0.011)	(0.011)	(0.011)	(0.022)	(0.021)	(0.021)	(0.012)	(0.012)	(0.012)
Married	-0.456+	-0.439+	-0.433+	-0.621	-0.615	-0.605	-0.403	-0.381	-0.375
	(0.245)	(0.246)	(0.244)	(0.706)	(0.717)	(0.711)	(0.256)	(0.256)	(0.253)
Children ever born	-0.0185	-0.0306	-0.0264	-0.0495	-0.0620	-0.0545	0.0259	0.0158	0.0154
	(0.037)	(0.037)	(0.038)	(0.055)	(0.055)	(0.055)	(0.044)	(0.043)	(0.043)
Year 2006	1.334**	0.992**	1.396**	1.225**	0.840**	1.262**	1.382**	1.078**	1.464**
	(0.164)	(0.086)	(0.166)	(0.251)	(0.127)	(0.253)	(0.215)	(0.112)	(0.217)
Year 2008	2.459**	1.828**	2.384**	2.374**	1.738**	2.318**	2.485**	1.869**	2.400**
	(0.210)	(0.100)	(0.211)	(0.329)	(0.174)	(0.331)	(0.273)	(0.121)	(0.273)
Salt price	-0.173**		-0.179**	-0.183*		-0.186*	-0.161*		-0.171*
	(0.060)		(0.060)	(0.092)		(0.092)	(0.078)		(0.078)
Rain		1.054**	1.089**		0.699	0.726		1.288**	1.327**
		(0.336)	(0.337)		(0.510)	(0.512)		(0.444)	(0.445)
Constant	6.517**	5.911**	6.610**	7.299**	6.625**	7.350**	5.936**	5.384**	6.060**
	(0.440)	(0.368)	(0.442)	(0.929)	(0.938)	(0.934)	(0.495)	(0.333)	(0.497)
Adj R^2	0.231	0.232	0.236	0.199	0.197	0.201	0.255	0.258	0.262
N	2925	2925	2925	1176	1176	1176	1749	1749	1749
F-statistic	8.414**	9.860**	8.932**	3.950*	1.878	2.696+	4.260*	8.410**	6.407**

Notes: Linear probability model estimates using all non-missing, non-singleton observations for each specification.
Robust standard errors in parentheses. F-statistic of excluded instruments.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Appendix Table 8. First-stage estimates of ln expenditure – PCS-12

	Total			Men			Women		
	salt	rain	both	salt	rain	both	salt	rain	both
(Age/10) squared	-0.00328	-0.00307	-0.00193	0.0205	0.0219	0.0214	-0.0135	-0.0139	-0.0131
	(0.017)	(0.017)	(0.017)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.021)
Married	-0.293	-0.284	-0.275	-0.890	-0.901	-0.897	-0.179	-0.168	-0.142
	(0.276)	(0.275)	(0.274)	(0.986)	(0.980)	(0.984)	(0.267)	(0.266)	(0.265)
Children ever born	0.000736	0.00336	0.00351	-0.0347	-0.0355	-0.0350	0.0782	0.0815	0.0886
	(0.036)	(0.036)	(0.036)	(0.047)	(0.047)	(0.048)	(0.057)	(0.057)	(0.057)
Year 2008	1.160**	1.940**	3.276**	1.168**	1.936**	1.703	1.124**	1.902**	4.367**
	(0.084)	(0.262)	(0.751)	(0.130)	(0.409)	(1.156)	(0.108)	(0.338)	(1.002)
Salt price	-0.196**		0.482+	-0.262*		-0.0860	-0.148+		0.879**
	(0.071)		(0.260)	(0.118)		(0.421)	(0.089)		(0.337)
Rain		-6.965**	-19.86**		-7.284*	-5.033		-6.615**	-30.42**
		(1.899)	(7.019)		(3.016)	(10.817)		(2.452)	(9.368)
Constant	7.713**	6.005**	2.152	8.822**	6.685**	7.374*	6.813**	5.434**	-1.589
	(0.626)	(0.478)	(2.083)	(1.146)	(1.204)	(3.394)	(0.775)	(0.536)	(2.679)
Adj R^2	0.167	0.170	0.172	0.183	0.184	0.184	0.166	0.169	0.176
N	2922	2922	2922	1100	1100	1100	1822	1822	1822
F-statistic	7.705**	13.45**	9.230**	4.917*	5.837*	2.957+	2.786+	7.283**	7.308**

Notes: Least squares within estimates using all non-missing, non-singleton observations for each specification.
Robust standard errors in parentheses. F-statistic of excluded instruments.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$

Appendix Table 9. First-stage estimates of ln expenditure – MCS-12

	Total			Men			Women		
	salt	rain	both	salt	rain	both	salt	rain	both
(Age/10) squared	-0.00327	-0.00306	-0.00191	0.0205	0.0219	0.0214	-0.0135	-0.0139	-0.0131
	(0.017)	(0.017)	(0.017)	(0.022)	(0.022)	(0.022)	(0.022)	(0.022)	(0.021)
Married	-0.316	-0.308	-0.299	-0.890	-0.901	-0.897	-0.207	-0.197	-0.171
	(0.277)	(0.277)	(0.276)	(0.986)	(0.980)	(0.984)	(0.268)	(0.267)	(0.266)
Children ever born	0.00160	0.00426	0.00440	-0.0347	-0.0355	-0.0350	0.0804	0.0839	0.0909
	(0.036)	(0.036)	(0.036)	(0.047)	(0.047)	(0.048)	(0.057)	(0.057)	(0.057)
Year 2008	1.163**	1.953**	3.286**	1.168**	1.936**	1.703	1.130**	1.923**	4.384**
	(0.084)	(0.261)	(0.751)	(0.130)	(0.409)	(1.156)	(0.108)	(0.338)	(1.001)
Salt price	-0.199**		0.481+	-0.262*		-0.0860	-0.153+		0.878**
	(0.071)		(0.260)	(0.118)		(0.421)	(0.089)		(0.337)
Rain		-7.049**	-19.92**		-7.284*	-5.033		-6.752**	-30.53**
		(1.899)	(7.019)		(3.016)	(10.817)		(2.452)	(9.367)
Constant	7.746**	6.016**	2.170	8.822**	6.685**	7.374*	6.851**	5.437**	-1.573
	(0.627)	(0.478)	(2.083)	(1.146)	(1.204)	(3.394)	(0.775)	(0.536)	(2.677)
Adj R^2	0.168	0.171	0.173	0.183	0.184	0.184	0.167	0.170	0.177
N	2920	2920	2920	1100	1100	1100	1820	1820	1820
F-statistic	7.932**	13.78**	9.399**	4.917*	5.837*	2.957+	2.957+	7.585**	7.459**

Notes: Least squares within estimates using all non-missing, non-singleton observations for each specification.
Robust standard errors in parentheses. F-statistic of excluded instruments.
+ $p<0.1$, * $p<0.05$, ** $p<0.01$