Food Crisis, Household Welfare and HIV/AIDS Treatment: Evidence from Mozambique

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Abstract

Using panel data from Mozambique collected in 2007 and 2008, the authors explore the impact of the food crisis on the welfare of households living with HIV/AIDS. The analysis finds that there has been a real deterioration of welfare in terms of income, food consumption, and nutritional status in Mozambique between 2007 and 2008, among both HIV and comparison households. However, HIV households have not suffered more from the crisis than others. Results on the evolution of labor-force participation suggest that initiation of treatment and better services in health facilities have counterbalanced the effect of the crisis by improving the health of patients and their labor-force participation. In addition, the authors look at the effect of the change in welfare on the frequency of visits to health facilities and on treatment outcomes. Both variables can proxy for adherence to treatment. This is a particularly crucial issue as it affects both the health of the patient and public health because sub-optimal adherence leads to the development of resistant forms of the virus. The authors find no effect of the change in welfare on the frequency of visits, but they do find that people who experienced a negative income shock also experienced a reduction or a slower progression in treatment outcomes.

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1. Introduction

HIV/AIDS is the leading cause of adult mortality in Africa. In Mozambique, 12.5% of adults were HIV positive in 2008 (UNAIDS/WHO, 2008). The proportion of HIV positive patients with an advanced infection receiving HAART (Highly Active Antiretroviral Treatment) in Mozambique was 24% in 2007 (UNAIDS/WHO, 2008). Adherence to treatment is a key determinant of treatment success and is crucial in avoiding the development of resistances. Antiretroviral therapies need to be taken at least once a day and need to be taken after a meal to avoid side effects. Good nutrition is therefore an essential element in ensuring adherence and treatment success among HIV/AIDS patients. The food crisis that culminated in 2008 constitutes a major risk by reducing access to food for HIV/AIDS patients who generally are already among the most vulnerable groups in the communities. In addition, even if the antiretroviral medicines are generally subsidized, access to treatment is costly in terms of travel to the health facility and opportunity costs for patients and their households.

The aim of this paper is twofold. First, we try to evaluate the impact of the food crisis on households living with HIV/AIDS. In particular, our estimates will give an indication of whether these households are more vulnerable than others in times of economic crisis. Second, we assess whether the change in welfare of households, potentially caused by the crisis, affects their health status and adherence. We use data from a longitudinal survey carried out in Mozambique in 2007 and 2008, which was designed to include households with HIV positive individuals as well as comparison households with no identified HIV positive members.

At the global level, food grain prices have risen by 150% between January 2006 and June 2008, with about 40% of that rise that occurred in just the first half of 2008 (World Bank, 2008). Ivanic and Martin (2008) have estimated that, as a consequence of higher global food prices, worldwide, the 2.3 billion people living with less then 2$ a day will become poorer, while 100 million will fall into poverty. There are multiple channels by which a food (and fuel) crisis can negatively

impact human development, such as reducing the utilization of education and health services, depleting the productive assets of the poor and, in particular, worsening nutrition, as food prices are higher (World Bank, 2008).

The welfare impact of a rise in food prices depends on the distribution of net sellers and net buyers of food in an economy, and can be represented by the concept of Net Benefit Ratio (NBR) of a food price shock, introduced by Deaton (1989). The NBR is the difference between the ratio of food sales over total income and the ratio of food purchases over total expenditures for a household. If the NBR of a household is positive, a rise in food prices will increase the NBR and thus have a positive impact on its welfare. On the contrary, a net consumer (NBR < 0) will suffer from such a shock.

In urban areas, where most households are net consumers, a rise in food prices is likely to have a negative impact on welfare, whereas it is more contrasted in rural areas. Poor rural households are often unable to produce a marketable surplus that exceeds their food expenditures, and if such is the case their welfare will worsen as a result of the food crisis.[2]

Arndt et al. (2008) assess the impact of higher fuel and food prices in Mozambique at the households and macroeconomic level. As this country is a net importer of food and imports all its fuel, the crisis is a negative terms-of-trade shock. Rice and maize prices increased by 68.8% and 57.3% in Maputo respectively, which is slower than international prices, but wheat prices increased faster (107.6%). While rural Mozambican households are fairly well insulated from a variation in market prices because of the large part of food consumption that is home produced, poor households living in Maputo city will suffer the most, because consumption of own-produced food is non-existent. Arndt et al. (2008) predict that the poorest households in Maputo lose the most while middle-income groups in the rural north and center gain the most.

While a rural/urban HIV prevalence breakdown is unavailable for Mozambique, data from other African countries show that most people living with HIV/AIDS in Africa live in urban areas

[2] The NBR does not allow for behavioral changes on the part of producers or consumers and measures only first order impacts. As households and firms modify the structure of their consumption and production, second order adjustments should dampen any negative first-order impacts.

(Measure DHS, 2008). Moreover, the province breakdown shows that the southern (where Maputo city is situated) and central provinces have the highest rates of prevalence of HIV/AIDS in Mozambique (Republic of Mozambique National AIDS Council, 2008). People living with HIV/AIDS are already a vulnerable group because of the negative impact of the illness on labor force participation or the cost and difficulty of accessing treatment. A negative impact of the crisis on their welfare and nutritional status could thus be expected.

Medical research has established that a minimum level of adherence to ARV treatment of 95% is necessary to achieve significantly better health outcomes as assessed by the viral load, immune system and occurrence of opportunistic infections (Paterson et al., 2000). Non adherence predicts disease progressions and survival rates, and increases the risk of transmission of drug resistant viruses (Bangsberg et al., 2001, De Olalla et al., 2002, Falagas et al., 2008). Failure to achieve proper adherence to treatment is thus both an individual and collective risk.

Determinants of adherence depends on several factors such as the treatment regimen (which can be quite complex and include food restrictions, specific schedules, etc.), disease characteristics, the quality of the patient-provider relationship, or the clinical setting. Socio-demographic factors do not consistently predict adherence behavior (Ickovics & Meade, 2002). The meta-analysis by Falagas et al. (2008) on socioeconomic status as a determinant of adherence finds that while the relationship is unclear, there is a positive trend of association between income, education or employment status and adherence. It is worth noting that adherence is not found to be consistently lower in developing countries, and largely depends on access to treatment and financial barriers (Orrel et al., 2003b). When therapy is fully subsidized in developing countries, it can be at least as good as in developed countries (Orrel et al., 2003a).

Even when treatment *per se* is free, transportation costs to the health facility to get a prescription refilled are found to be a powerful barrier to adherence. Moreover, patients have to make "impossible choices" between competing claims: transport costs and good nutrition of the patients compete with schooling fees or medical costs for children, food for the rest of the family, etc. (Ware et

al., 2009). As already mentioned, malnutrition can be an obstacle to adherence (Weiser, 2003). A negative shock on income or food access that may occur in the event of a food crisis, and more generally, of a global economic crisis, could therefore act a strong determinant of non-adherence to treatment.

We use household level panel data from Mozambique collected in 2007 and 2008, to evaluate the extent to which the effects of the food crisis differed between households with identified HIV-positive patients and households with no identified HIV-positive person. The baseline of the survey was fielded shortly before the peak of the food crisis while the follow-up survey was fielded when the food crisis was already winding down. Moreover, we purposely sampled households with and without an identified HIV-positive member. Overall, the timing of the survey and the sampling strategy make our data uniquely fitted for contrasting the effects of large economic shocks on HIV-patients' households and other households.

The paper makes two main contributions to the literature on the interactions between economic conditions on the one hand, and access to treatment and adherence to treatment regimen on the other hand. First, we show that access to treatment help shield HIV households from the effects of the food crisis in Mozambique. Our analysis uncovered that welfare, measured in terms of income, food consumption and anthropometric outcomes, has deteriorated for both HIV and comparison households between 2007 and 2008. The welfare loss was, however, less severe for HIV households than for comparison households. We find evidence supporting the hypothesis that initiation of treatment and better services in the health facilities have counter-balanced the effect of the crisis by improving the health of patients and their labor force participation.

Second, we find that change in welfare has no significant effect on the frequency of visits to the health facility of patients and on their treatment outcomes, measured by the change in the CD4 count. We find, however, that people who experienced a negative income shock also experienced a reduction or a slower progression in their CD4 counts. This would be suggestive evidence that welfare loss has a negative effect on treatment outcomes, but that negative effect, however, may be working

through physical weakening due to inadequate nutrition for example rather than through non-adherence.

The paper is organized as follows. In the next section, we present the dataset. In section 3, we look at the impact of the food crisis on the welfare of households in the sample, differentiating by their HIV status. Changes in adherence to treatment between 2007 and 2008 will be studied in section 4. We then assess the impact of welfare changes on the frequency of visits to the health facility of HIV/AIDS patients in section 5 and on the evolution of their treatment outcomes in sections 6.

2. The data

We use data collected in 2007 and 2008 in 4 provinces of Mozambique (Maputo City, Maputo Province, Sofala, Manica).The survey was designed to collect data in order to assess the impact of the Treatment Acceleration Project (TAP). The TAP is a World Bank project carried out in three countries of Africa: Mozambique, Burkina Faso and Ghana, which scaled-up access to HAART. The project began in 2004 and had a 4-year duration.

The HIV/AIDS patients of the survey were identified at the health facility where they received treatment and were interviewed at home along with the rest of the household. The questionnaire includes information on consumption, time use, labor force participation and earnings of not only the patient, but of all members of the household. It also included questions on adherence to treatment, health of adults and children, anthropometric measurements, and quality of life. We will refer to these households in which there is one HIV/AIDS patient identified as “HIV households” in the rest of the paper.

A group of comparison households was included in the sample, in which there was no identified HIV/AIDS patients, to control for general trends in socio-economic circumstances. The comparison households were randomly selected in the neighborhood of the HIV households of the sample.

The first wave of the survey, conducted between August and December of 2007, included 658 HIV households and 341 comparison households. In the second wave, one year later, HIV households that could not be found and interviewed were not replaced, but comparison households were. The panel consists of 896 households interviewed in both waves: 616 HIV households and 280 comparison households. At the individual level, there are 616 identified HIV positive patients, 2579 individuals living in HIV households but not identified as HIV positive, and 1431 individuals belonging to comparison households.

In addition to the living standards and health questionnaire, we collect biomedical records for HIV positive individuals at the health facility, allowing an objective measure of the health and treatment status of patients. These biomedical records include the date of treatment initiation as well as the dates, weights and CD4 counts at the last visits (up to 7) by the patient at the health facility. There are 498 observations in this biomedical record dataset, out of the 616 potential patients identified in the living standards and health survey.

3. Is there an impact of the food crisis on the welfare of households in Mozambique?

The first step of our analysis is to assess whether the food crisis had an impact on the welfare of households in Mozambique, and, in particular, on their nutritional status. Indeed, if the crisis lowers the income of households, then access to food could be restricted which will have a negative impact on adherence to treatment or health outcomes.

As mentioned in the introduction, a food crisis, namely, the drastic increase in the price of food products, affects different types of households differently. An urban household is mainly a net consumer of food and is therefore affected negatively by a price increase, whereas a rural household can be affected positively if he is a net seller of food. In the data, health facilities in which HIV patients are found for the survey are identified as rural or urban. Using this definition of urban or rural, we find that only 5% of the sample is rural, which is consistent with the fact that most HIV positive

adults live in urban areas, where, in addition, access to antiretroviral treatment is easier. We can thus assume that their food consumption and nutritional status will be affected negatively by the food crisis. Although there is no way, with our data, to measure the direct impact of the food crisis on the overall welfare of households, we can use the change in income, consumption, food consumption and nutritional status of children between 2007 and 2008 as proxies for that impact. The food crisis indeed reached its peak between January and June 2008 and can be considered a systemic shock.

Income, consumption and food consumption are measured on a monthly per adult equivalent basis, in meticais[3]. Income is the sum, over all members of the household, of labor income (wage, household business or farm), non labor income (insurance, pension, etc.), private and institutional transfers, and home produced food. Consumption is the sum of food consumption (purchased and home produced), non food items purchased, education, housing (water, electricity, etc.), health, ceremony and special events expenditures. Real income and consumption are obtained using the Mozambique Consumer Price Index (INE, 2009). As the data in 2007 and 2008 were collected across several months, the monthly values of the CPI were used to match the date of interview of each household, to ensure the inflation index used is as close as possible to what the household actually experienced. Unfortunately we were not able to use a regional CPI which, to our knowledge, does not exist in Mozambique, and thus the national index was used. The food-and-drink CPI was used to deflate the food consumption variable.

The anthropometric measures used to proxy for households' nutritional status are the weight-for-age z-scores for children aged 1 to 10 years old, the body-mass-index and the height-for-age z-scores for children aged 5 to 19 years. These were computed using the WHO growth standard (De Onis et al., 2007).

Figure 1 shows the change in some of these measures for all households and children of the sample between 2007 and 2008. All measures of welfare show a worsening of economic conditions, except for the height-for-age measures. Mean values of the welfare and nutritional measures in 2007

[3] 100 mts = $4.32 (November 2008)

and 2008 and the p-value of the mean comparison Student tests are shown in Table 1. It confirms that there has been a statistically significant worsening of welfare between 2007 and 2008. The weight-for-age and BMI-for-age z-score too have worsened between 2007 and 2008, while the height-for-age, a longer-term measure of nutritional status, does not change.

We use a difference-in-differences specification to assess whether there was a specific impact of the crisis on HIV households. The equation estimated is:

$$y_{it} = \alpha_0 + \beta_1 X_{it} + \beta_2 HIV_i + \beta_3 d2008 + \delta HIV_i * d2008 + \varepsilon_{it},$$

where y_{it} is a measure of welfare, X_{it} is a set of controls that include characteristics of the head of household (age, age squared, education, sex), the number of children aged 0 to 14 in the household and province dummies (Maputo city province is the reference), HIV_i is a dummy that equals 1 if household *i* is HIV, 0 otherwise, $d2008$ is a dummy that equals 1 if year *t* is 2008, 0 otherwise. This model is first estimated at the household level, where the dependent variable is income, consumption and food consumption. The second specification has anthropometric measures as the dependant variable, and is estimated at the child level. It controls for the age and sex of the child.

In this equation, coefficient β_2 indicates whether HIV households are worse off or better off in general, whatever the year and β_3, capturing the trend, signals whether the economic situation of all households improved or worsened between 2007 and 2008. Coefficient δ is the difference-in-differences estimator: it shows whether, once initial characteristics and the trend are controlled for, HIV households did better or worse than comparison households between the two waves.

Endogeneity of the explanatory variable HIV_i is likely in this setting as there could be some unobservable heterogeneity between households that would explain both the level of income (or other welfare measures) and the HIV status. For example, HIV-positive individuals are often better off than average in developing countries. To control for this source of bias, we use a second specification with household fixed effects:

$$y_{it} = \beta d2008 + \delta HIV_i * d2008 + \mu_i + \varepsilon_{it},$$

where μ_i is the household fixed effect. This model makes the identification of the permanent effect of being an HIV household impossible.[4] The child level specification also has a child fixed effect estimation. Table 2 and Table 3 show results of the regressions for both specifications. HIV households are generally worse off in terms of consumption and income (Table 2). There is a general worsening of economic conditions between 2007 and 2008. The interaction term $HIV_i * d2008$ has a positive and significant coefficient in the consumption and food consumption equation and is not significant in all other cases. This shows that, even if HIV households suffer from the crisis between 2007 and 2008, they do not suffer more than the comparison households of the sample. In Table 3, we see clearly a deterioration of the nutritional status of the children between 2007 and 2008. Children belonging to all households have a worsened body mass index-for-age z-score between 2007 and 2008, which is consistent with a negative impact of the food crisis. The coefficient for 2008 in the height-for-age regressions is not significant, which is consistent with the fact that height-for-age is a measure of long-term nutrition while weight-for-age and BMI-for-age measure short-term nutritional status (WHO, 1995). The interaction variable of the HIV status with the 2008 dummy are significant in none of the regressions which confirms the findings from the previous table: children belonging to households in which there is an HIV positive adult do not seem to become more undernourished or malnourished between 2007 and 2008 than other children.

One possible explanation for this is that there could be two opposite shocks on the welfare of HIV households simultaneously. The first one is of course the negative shock of the food crisis between 2007 that 2008. The second, positive shock could possibly be the initiation and the continuation of antiretroviral therapy. As ARVs become more available over time, patients who were too ill to work started a treatment and could work again and increase their income. To test this

[4] Potentially time-varying controls that were included in the previous model are excluded from the regression, because most of these are essentially time-invariant, and when they do vary, it is often because of a change in the head of the household or data collection errors.

hypothesis, we estimate an analogous model, with labor force participation of the individual as the dependent variable. We add to the model the explanatory variable $Patient_i$, which indicates whether individual i is the identified HIV-positive patient in the HIV household, and an interaction of $Patient_i$ and the year dummy. Results are shown in Table 4. HIV-positive individuals have significantly lower labor force participation than other members of their households'. However, as shown by the significantly positive coefficient of the patient*year variable, HIV-positive individuals do seem to increase their propensity to work between 2007 and 2008 in larger proportions than other HIV household members. Using the number of hours worked in the last month as a dependent variable does not change the results. This suggests that an HIV-positive individual-specific effect is driving the results of the previous regressions: access to antiretroviral therapy is helping patients work again and thus improving not only their health but also their monetary welfare as well as their households'.

Endogeneity issues are a limitation of this analysis. For example the negative coefficients on being HIV positive in either year (β_2) could be driven by some unobservable heterogeneity among households which explains both the level of welfare and the probability of being HIV positive. One must be cautious when interpreting the coefficient on HIV status in Table 2. The effect is not necessarily causal because there could be some reverse causality that biases (probably overestimates) the coefficient.

As mentioned in the previous section, there are 896 households in the panel, among which 616 have at least one identified HIV positive adult. As the household follow-up was not based on the patient himself but rather on the whole household, there are a certain number of cases in which the patient does not reside in the household anymore in 2008, while the household was still interviewed in the second wave. The two main reasons for that were that the patient had left the household (for marriage for example) or that he had died. 43 HIV households are in this situation, among which 29 experienced the death of the patient. This could introduce noise in the estimates by including in the treated (HIV) units households that are no longer "HIV households", because the identified patient is

gone. The departure or death of the ill member individual could actually represent a positive shock by eliminating health-related expenditures and reducing the dependency ratio of the household if the patient was unable to work. To eliminate this potential source of bias, we run the regressions in which we add an indicator variable of departure or death of the patient from the household (Table 5). Table 5 shows that this "attrition" issue does not seem to cause a significant bias in the coefficient as the coefficient on the interacted variables is not significantly different from zero.

4. Is there an impact of the food crisis on adherence to treatment of HIV patients?

Results in the previous section show that HIV households, like comparison households, have suffered a deterioration of their income, food consumption and nutritional status. As explained earlier, nutrition can be a determinant of adherence of treatment, as well as income (because of transportation costs for example). In this section we try to assess whether the evolution of adherence is linked to the change in welfare, and therefore if it has worsened.

Measuring adherence to a treatment is difficult. In our sample, adherence is not observed, as in other studies where pill counts and other methods allow for an objective measure[5]. We have to rely on the report of the patient himself or of the female head of households. Indeed, the questionnaire has two "health services and utilization" sections. The first is answered by the female responsible for the health of the members of the household. She gives information for every member of household. In the second section, the respondents are the individuals themselves. They answer the section if they declare that they were ill in the last 6 months (all illnesses, not only HIV/AIDS). An individual will be declared non-adherent to his treatment if any of the following conditions is satisfied: he forgot to take his medication at least once in the last 4 weeks, he did not take all the medication exactly as prescribed at least once in the last 7 days or he did not take his medication appropriately at any time. In most cases

[5] See Liu et al. (2001) for a comparison of the difference measurement methods.

we only have the female head's report or the self-report. When we have both, an individual is considered non-adherent if he did not adhere by at least one of the two reports. A binary measure of adherence is thus obtained, equal to 0 if non adherent. This measure is defined for all individuals, whatever the type of treatment, but can be restricted only to HIV patients, and thus represent a measure of adherence to ARVs.

There is an alternative measure of adherence that is available from the specific HIV/AIDS section of the questionnaire. From this section, we define a patient as non-adherent if he has initiated anti-retroviral treatment and has stopped or interrupted it at any time or is not currently taking it. This measure is self-reported and defined for HIV patients only. A shortfall of this measure is that if the patient is non-adherent in 2007, he is theoretically, non-adherent once and for all, because he has interrupted treatment at some point. It is thus not possible to "become adherent" between the 2 waves of survey.

Both measures of adherence have the drawback of being binary. This means that there can be no distinction between a patient who forgets his pill once and one that never takes his treatment appropriately. Medical research has defined a threshold of adherence of 95% to insure efficacy of HAART, and our measures are therefore a little too strict, medically speaking (Paterson, 2000). Unfortunately, the data on hand do not allow us to define a continuous measure of adherence.

Table 6 shows rates of adherence and non adherence in 2007 and 2008 for all individuals, HIV patients only and the alternative measure. HIV patients are less adherent to treatment than the average in 2007, with rate of non adherence of 18.4% against 13.5% for the whole sample (all sick individuals who took some treatment in the past 6 months). In 2008 adherence among HIV patients improves while total adherence worsens. The alternative measure of non adherence is much lower, namely, 7.2% in 2007 and 5% in 2008. One possible reason for that is that this measure is only self-reported, whereas the other measure is partly reported by the female head of household. Self-report has a high probability of underestimating non adherence because of memory and disclosure issues.

If adherence seems to improve among HIV patients between 2007 and 2008, this can be misleading because the statistics are only cross-sectional, which means that it is not necessarily the same sub-sample in the two cross-sections. Stigma and secrecy associated with being infected with HIV can lead to under-declaration of being infected or taking ARV treatment. Moreover, the survey design does not force disclosure of the HIV/AIDS status in the health module of the questionnaire. Individuals are asked about illness in the past 6 months, but a HIV-positive individual under ARV therapy can feel perfectly healthy and thus not declare any recent illness[6]. In that case, he is not asked about any kind of treatment nor adherence to it. For the HIV patients-only measure of adherence, this leads to a number of 67 observations for which adherence is observed both years, out of a potential 616 patients. Besides, only 17 of these observations are changes in adherence between the two waves. Unfortunately, such a small number of observations and minimal variability in the dependant variable do not allow us to analyze the evolution of adherence in a multivariate, panel setting and we are limited to bivariate analyses.

Table 7 shows the change in the 3 measures of adherence (whole sample, HIV patients only, alternative measure of adherence) between 2007 and 2008. The second column shows that 71% of HIV patients stayed adherent, while 18% were not adherent in 2007 and became so in 2008. A limited number of patients were adherent previously and became non adherent in the second wave. Although sample sizes are too small to definitely conclude, there has been no visible deterioration of adherence to treatment between the two waves of the survey.

The descriptive analysis of the change in adherence suggests that there is no effect of the food crisis on adherence: the vast majority of individuals stayed adherent between 2007 and 2008. Besides, there are more individuals who became adherent between 2007 and 2008 than individuals who became non-adherent. However, scaling-up of treatment and HIV related services in health facilities could have triggered a general trend towards better adherence. In addition, as patients become familiar with their treatment regimen, which can be very complex, and as treatment shows its efficacy by improving

[6] For ethical reasons, the survey was conducted so that the interviewer did not know whether the patient was HIV positive.

their health, there could be a tendency for them to become more adherent. Therefore, we cannot conclude definitely as to the impact of the crisis on adherence between these two years, as we do not have a good counterfactual, that is, we do not know how adherence would have evolved without the crisis.

5. Is there an impact of the food crisis on the frequency of visits to the health facility?

As mentioned in the introduction, cost of transportation to get a prescription refill at a health facility is a strong barrier to adherence. Essential expenditures such as food, schooling and health are competing inside the household budget. An economic crisis, by reducing income and increasing food prices can shift the equilibrium in the household allocation of resources and reduce expenditures devoted to health. In addition to the food crisis, a sharp increase in fuel prices potentially increased even more the cost of transportation for patients. In this context, another way to look at the impact of a food crisis on adherence to treatment and on the livelihoods of people living with HIV/AIDS is to consider the change in the frequency of visits to the health facility. The frequency of visits can also be understood as a proxy for good adherence to treatment.

The biomedical data, which collected health related information on 498 HIV positive patients of the survey, allows us to calculate the number of weeks between two visits, with one to six observations for each patient (data on the last seven visits). For the analysis we keep only those observations that are in the proper timeframe, that is, between the two waves of the survey. The time between two visits in itself is not a sufficient indicator of regularity because the visit protocol varies across health facilities. Therefore, the outcome studied is the standardized deviation from the mean frequency of visits in the health facility of the considered observation. A positive number means that the patient visited the facility less often than average. We merged the biomedical records with the living standards survey to regress the frequency of visits on welfare and nutritional status measures. The equation estimated using OLS is:

$$Freq_{ij} = \alpha + \beta X_i + \delta \Delta y_{it,t-1} + \varepsilon_i ,$$

$Freq_{ij}$ is the outcome of patient *i*. Subscript *j* indicates that there can be more than one observation per patient if there are more than two visits between the two rounds of survey[7].

$\Delta y_{it,t-1}$ is the change in the welfare measure between 2007 and 2008. X_i is a vector of controls including the initial level of welfare in 2007, the time since treatment was initiated, age, gender, marital status, education, household characteristics (age, education and marital status of household head, size of household) and health facility dummies.

The welfare measures used are those defined in section III: income, consumption, food consumption and weight-for-age z-score. We include both the initial level and the change in the welfare measure because we need to control for the initial situation of the household, since variations in income might be differently felt depending on whether it was initially poor or rich. The weight-for-age z-score is averaged over all the children in the household to obtain a household level variable.

None of the coefficients estimated in Table 8 are significantly different from zero. This suggests that a decrease of income, consumption or food consumption of a household does not interfere with the regularity of the visits to the health facility by the HIV positive individual of that household.

6. Is there an impact of the food crisis on antiretroviral treatment outcomes?

The next issue we consider is whether the food crisis had an impact of the health outcomes of patients taking antiretroviral therapy. Health outcomes, measured by the CD4 count, can also proxy for adherence to treatment and will thus complete the analysis from the previous section (Paterson et al., 2000). Furthermore, health outcomes are a subject of interest by themselves: has the crisis, by lowering the access to food, decreased the effectiveness of the treatment?

[7] Standard errors are clustered at the individual level.

We use OLS regressions where the dependent variable is the variation of the CD4 count, measured as the difference between the most recent CD4 count and the lowest CD4 count. CD4 are cells that are part of the immune system and their count is a measure of the severity of the HIV/AIDS infection. A healthy adult has a CD4 count between 500 and 1500 cells per cubic millimeter of blood, while ARV treatment is initiated when they fall below 200 (350 in high resource settings).

We estimate a model similar to the one shown in the previous section: using OLS, the change in the CD4 count is regressed on the change in and baseline level of welfare and a set of controls:

$$\Delta CD4_i = \alpha + \beta_1 X_i + \beta_2 B_i + \delta \Delta y_{it,t-1} + \varepsilon_i ,$$

where X_i includes individual characteristics in 2007 (age, gender, marital status, education, health facility dummies, province dummies, welfare or nutritional status in 2007),

B_i represents biological controls, which we detail in the next paragraph,

$\Delta y_{it,t-1}$ is the change in the welfare or nutritional status measure between 2007 and 2008.

To control for heterogeneity in each patient's illness and treatment, we include the number of months between the two CD4 counts (lowest and most recent) and the level of the lowest CD4 count. The former is expected to have a positive coefficient because a longer period of time allows for a more important improvement in health status, while the latter should be negative: the lower the initial CD4 count, the larger scope there is for an improvement through treatment. We also include the duration of treatment at the time of the most recent CD4 count and a dummy indicating whether the patient is under antiretroviral therapy at all: there are indeed patients in the sample who are monitored at a health facility but not treated with antiretrovirals because they have not yet reached the threshold at which treatment is initiated. Health facility dummies should control for differences in the quality of treatment, monitoring and care. For example a health facility that has better counseling on adherence to treatment will help a patient take his treatment properly and make it more efficient.

The results are presented in Table 9. Column (1) shows that using the income measure, those who are initially wealthier have better treatment outcomes. Meanwhile, the coefficient on the change

in income is positive and significant at the 5% level. In the context of the crisis, this means that those whose income has been affected negatively by the food crisis have seen their health outcome deteriorate more or progress slower than others. However, in Table 9, we do not find similar results when looking at consumption and nutritional status measures. As income typically has a large transitory component, while consumption and nutritional status are measures of permanent income, these findings suggest that transitory, as opposed to permanent, welfare shocks have a negative impact on treatment outcome.

7. Conclusion

People living with HIV/AIDS in Africa are among the most vulnerable because of the debilitating effect of the illness, which prevents them from having an income-generating activity. As highly active anti-retroviral treatments are developed, and access to this therapy scaled-up, they are able to improve their health to a point of living a normal life. The treatment, however, must be taken in certain conditions, such as after a nutritious meal, and can by costly in terms of travel to the health facility, even if it is entirely subsidized. In this context, the impact of a food crisis on welfare, and in particular, on food consumption, can have a very negative impact on adherence to treatment and health outcomes. This is a particularly crucial issue, as it affects both the health of the patient and public health, by the development of resistant forms of the virus that occur when adherence is sub-optimal.

Our analyses have found that, as a likely effect of the food crisis, there has been a real deterioration of welfare in terms of income, food consumption and nutritional status in Mozambique between 2007 and 2008, among both HIV and comparison households. However, HIV households have not suffered more from the crisis than others. Initiation of treatment and better services in the health facilities could have counter-balanced the effect of the crisis by improving the health of patients and their labor force participation.

Keeping in mind that sample sizes are very small and adherence is only reported and not observed, the data shows that adherence to antiretroviral treatment has not significantly decreased, as the vast majority of those for which it is measured stayed adherent between the two waves of the survey. This result tends to confirm other (medical) studies of adherence, which find no consistent link between it and the socio-economic status, in particular income. However, those whose income was negatively affected by the crisis have seen a less rapid progression or a deterioration of their CD4 count, compared to those whose income did not change.

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Figure 1: Change in welfare indicators between 2007 and 2008

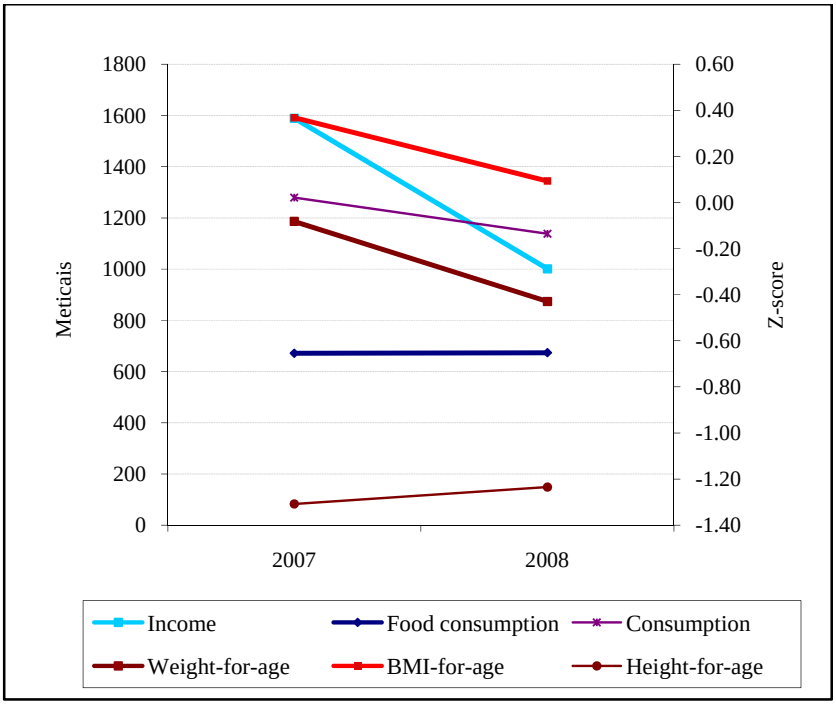

Table 1: Change in household welfare indicators between 2007 and 2008 in Mozambique. Sample means.

	2007	N	2008	N	Difference	p-value
Income	1588,96	896	1001,07	896	-587,89	**0,02**
Consumption	1278,96	861	1137,67	872	-141,29	**0,05**
Food consumption	670,90	861	673,24	872	2,34	0,96
Weight-for-age z-score	-0,08	3314	-0,43	3807	-0,35	**0,00**
Height-for-age z-score	-1,31	3962	-1,24	4446	0,07	**0,03**
Body Mass Index-for-age z-score	0,37	3930	0,09	4411	-0,27	**0,00**
Lowest weight-for-age z-score	-0,46	494	-0,85	546	-0,39	**0,00**
Lowest height-for-age z-score	-1,96	604	-1,85	662	0,12	0,22
Lowest BMI-for-age z-score	-0,15	601	-0,51	656	-0,36	**0,00**

Notes: Income, consumption and food consumption are monthly, per adult equivalent measures, in meticais (100mt = $3.7). The weight-for-age z-score is calculated for children aged 1-10 years. The height-for-age and body mass index-for-age are calculated for children aged 5-19 years. Lowest z-scores are the lowest z-score in each household. One observation per household (resp. child) in lines 1-3 and 7-19 (resp. 4-6).

Table 2: HIV status, the 2008 food crisis and household welfare indicators in Mozambique. OLS Regressions with and without household fixed effects.

VARIABLES	Consumption	Consumption	Income	Income	Food consumption	Food consumption
HIV household	-0.338***		-0.392***		-0.327***	
	(0.0596)		(0.113)		(0.0650)	
Year 2008	-0.159**	-0.197***	-0.459***	-0.380***	0.00741	-0.0529
	(0.0695)	(0.0585)	(0.128)	(0.123)	(0.0759)	(0.0697)
HIV household*year 2008	0.204**	0.215***	0.0507	-0.0329	0.189**	0.227***
	(0.0836)	(0.0704)	(0.155)	(0.151)	(0.0913)	(0.0838)
Constant	7.665***	6.677***	6.830***	6.465***	7.059***	5.993***
	(0.160)	(0.0229)	(0.322)	(0.0500)	(0.175)	(0.0273)
Household fixed effects	**no**	**yes**	**no**	**yes**	**no**	**yes**
Observations	1733	1733	1480	1480	1733	1733
R-squared	0.266	0.014	0.204	0.048	0.172	0.017

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0. Controls not shown but included in the regressions without fixed effects are characteristics of the household head (age, age squared, education, sex), the number of children aged 0 to 14 in the household and province dummies.

Table 3: HIV status, the 2008 food crisis and child nutritional status indicators. OLS regressions with household/child fixed effects

	Household fixed effects			Child fixed effects		
VARIABLES	**Weight-for-age**	**Height-for-age**	**BMI-for-age**	**Weight-for-age**	**Height-for-age**	**BMI-for-age**
Year 2008	-0.243*	-0.0667	-0.253**	-0.280*	-0.0784	-0.283**
	(0.134)	(0.109)	(0.101)	(0.149)	(0.122)	(0.123)
HIV household*year 2008	-0.150	0.145	-0.118	-0.0876	0.233	-0.113
	(0.164)	(0.131)	(0.121)	(0.183)	(0.146)	(0.147)
Constant	-0.142	-0.685***	1.039***	-0.154***	-1.320***	0.353***
	(0.118)	(0.117)	(0.110)	(0.0581)	(0.0451)	(0.0449)
Observations	1897	3015	2967	1897	3017	2969
R-squared	0.017	0.015	0.038	0.024	0.004	0.029

Notes: Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1. Controls not shown include age and sex of child. The weight-for-age z-score is calculated for children aged 1-10 years. The weight-for-age z-score is calculated for children aged 1-10 years. The height-for-age and body mass index-for-age are calculated for children aged 5-19 years.

Table 4: Labor force participation of HIV-positive patients. Probit and OLS regressions.

	Labor force participation	Hours worked
HIV household	-0.136*	0.172
	(0.0801)	(1.506)
Year 2008	0.0864	4.959***
	(0.0664)	(1.557)
HIV*year 2008	0.0569	-1.437
	(0.0867)	(1.839)
HIV patient in household	-0.347***	-5.323***
	(0.0786)	(1.578)
HIV patient*year 2008	0.171**	3.708*
	(0.0874)	(1.899)
Constant	-3.394***	-27.18***
	(0.295)	(4.871)
N	4782	4761

Notes: Standard errors in parentheses.*** p<0.01, ** p<0.05, * p<0.1. Controls included but not shown: age, education, sex, marital status of the individual and the household head, status in the household of the individual, size of household, province dummies. Probit regression used for the labor force participation specification, OLS for the hours worked.

Table 5: HIV status, household welfare indicators and attrition. OLS regressions with household fixed effects adding an interaction variable for attrition of the HIV patient.

VARIABLES	Consumption	Income	Food consumption
Year 2008	-0.197***	-0.380***	-0.0529
	(0.0585)	(0.123)	(0.0697)
HIV household*year 2008	0.212***	-0.0620	0.233***
	(0.0713)	(0.153)	(0.0848)
HIV household*year 2008*patient left household/died	0.0466	0.465	-0.0834
	(0.155)	(0.363)	(0.184)
Constant	6.707***	6.478***	6.017***
	(0.0223)	(0.0485)	(0.0265)
Observations	1889	1615	1889
R-squared	0.014	0.051	0.017

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.

Table 6: Adherence to treatment in 2007 and 2008

	All	Only HIV+	Alternative	All	Only HIV+	Alternative
	2007			2008		
Non adherent	46	23	41	81	61	32
%	*13,5*	*18,4*	*7,2*	*16,4*	*16,3*	*5*
Adherent	294	102	528	413	314	609
%	*86,5*	*81,6*	*92,8*	*83,6*	*83,7*	*95*
Total	340	125	569	494	375	641
%	*100*	*100*	*100*	*100*	*100*	*100*

Table 7: Evolution of adherence between 2007 and 2008

	All	HIV+ only	Alternative measure
Became adherent	14	12	26
%	*17.1*	*17.9*	*5.6*
Became non adherent	7	5	10
%	*8.5*	*7.5*	*2.2*
Stayed adherent	59	48	418
%	*72*	*71.6*	*90.7*
Stayed non adherent	2	2	7
%	*2.4*	*3*	*1.5*
Total	82	67	461
%	*100*	*100*	*100*

Table 8: Impact of household welfare indicators and their variation during the 2008 food crisis on the frequency of visits to the health facility. OLS Regressions.

VARIABLES	Weeks between two visits	Weeks between two visits	Weeks between two visits	Weeks between two visits
Income variation	-0.00170			
	(0.00188)			
Income level in 2007	-0.00164			
	(0.00288)			
Consumption variation		-0.00262		
		(0.00472)		
Consumption level in 2007		-0.00389		
		(0.00613)		
Food consumption variation			-0.00625	
			(0.0107)	
Food consumption level in 2007			-0.000468	
			(0.0122)	
Weight-for-age z-score variation				6.200
				(7.930)
Weight-for-age z-score in 2007				4.794
				(8.406)
Constant	0.967	0.611	0.604	0.829
	(0.714)	(0.780)	(0.774)	(0.883)
Observations	475	428	428	196
R-squared	0.207	0.227	0.229	0.286

Notes: Standard errors clustered at the individual level to allow more than one observation per patient. *** p<0.01, ** p<0.05, * p<0.1. All coefficients are *100 to make table more readable. Controls not shown in the table but included in the regression: individual characteristics (age, sex, marital status, education), household characteristics (size, age, education and marital status of head), duration of treatment at second wave of survey, health facility indicators. The dependent variable is the standardized deviation from the health facility mean of the number of weeks between 2 visits.

Table 9: Impact of household welfare indicators and their variation during the 2008 food crisis on the evolution of the CD4 counts of HIV/AIDS patients in Mozambique. OLS Regressions.

VARIABLES	Variation of cd4	Variation of cd4	Variation of cd4	Variation of cd4
Income variation	0.0140**			
	(0.00688)			
Income level in 2007	0.0257**			
	(0.0116)			
Consumption variation		-0.00773		
		(0.0140)		
Consumption level in 2007		0.0151		
		(0.0200)		
Food consumption variation			-0.0533	
			(0.0354)	
Food consumption level in 2007			-0.000264	
			(0.0380)	
Weight-for-age z-score variation				6.022
				(22.24)
Weight-for-age z-score in 2007				10.81
				(27.37)
Constant	-363.0	-334.8	-419.2	446.7
	(368.1)	(356.1)	(348.9)	(484.6)
Observations	186	172	172	75
R-squared	0.302	0.276	0.306	0.416

Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1. Controls not shown but included in the regression: individual characteristics (age, sex, marital status, education), biological variables (months between the two CD4 counts, value of the lowest CD4 count, on-treatment indicator, time since initiated treatment), health facility and province indicators.