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# ADULT HEALTH IN THE TIME OF DROUGHT

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# ABSTRACT

This paper examines the impact of rainfall shocks on a measure of adult health, body mass, drawing on a unique panel data set of households residing in rural Zimbabwe. Controlling for individual, household, and community factors, and individual fixed, unobservable effects, we find women, but not men, are adversely affected by drought. However, these effects are not borne equally by all women. Women residing in poor households and daughters more generally appear to bear the brunt of this shock. Our results suggest that an ex ante private coping strategy, the accumulation of livestock, protects women against the adverse consequences of this shock. By contrast, we find that ex post public responses are not effective, though for several reasons we treat this finding with caution.

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# ACKNOWLEDGMENTS

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# 1. INTRODUCTION

It is well known that households in developing countries experience shocks that affect incomes. A large and growing literature explores the efficacy of ex ante and ex post responses to these events. One strand addresses the mechanisms by which households respond to these events. Three studies that exemplify work in this area are Udry (1990), on credit as insurance, Fafchamps, Udry, and Czukas (1998), on the role of livestock as a means of smoothing consumption, and Kochnar (1999), who examines the role of labor market activity as an ex post response to income shocks. A second strand looks at the effectiveness of these strategies in reducing fluctuations in consumption. The principal result that emerges, as summarized in Morduch (1995, 1999) and Townsend (1995), is that some, but not all, households can smooth consumption. In particular, households facing liquidity constraints have limited smoothing ability. For these households, therefore, income fluctuations will generate a welfare loss.

This study contributes to this literature by examining the impact of rainfall shocks at the individual level. Only a handful of studies do so (Foster 1995; Hoddinott and Kinsey 1998; Jacoby and Skoufias 1997; Rose 1999). These studies all focus on children. By contrast, this paper examines a different measure of well-being, the body mass of adults. We do so for three reasons. First, body mass index (BMI) is a good proxy for underlying adult health, a valid welfare outcome in its own right (North 1999). Second, there is an increasing body of evidence linking adult BMI to agricultural productivity (Dasgupta 1993; Dercon and Krishnan 1997; Strauss and Thomas 1995; Pitt,

Rosenzweig, and Hassan 1990). Third, low BMI is correlated with a large number of health-related indicators, including early onset of chronic conditions and increased risk of premature mortality (North 1999; Waaler 1984 cited in Higgins and Alderman 1997).

The paper examines this issue by drawing on a unique panel data set of households residing in rural Zimbabwe. Adult anthropometric data, together with other relevant individual, household, and community covariates, were collected annually between 1994 and 1997. This period includes three years of reasonably good rainfall and one drought. We find that, controlling for individual, household, and community factors, and individual fixed, unobservable characteristics, women, but not men, are adversely affected by the drought. However, these effects are not borne equally by all women. Women residing in poor households and daughters more generally appear to bear the brunt of this shock. Our results suggest that an ex ante private coping strategy, the accumulation of livestock, protects women against the adverse consequences of this shock. By contrast, we find that ex post public responses are not effective, though, for several reasons, we treat this finding with caution.

The paper begins with a brief conceptual model. We describe our somewhat unique data set in detail before setting out the model we will estimate. We provide basic results, followed by a number of extensions.

## 2. CONCEPTUAL FRAMEWORK

Households ($h$) are assumed to maximize utility over some time horizon subject to a budget constraint and those constraints imposed by the technology through which

inputs such as food and care generate health.[1]  This intertemporal utility function can be written as

$$U_h = v(U_1, U_2, \ldots, U_T) \qquad \text{for time periods 1 to } T. \qquad (1)$$

Utility in each period is a function of consumption of goods ($x_{ih}$), leisure ($\ell_{ih}$) and health status ($h_{ih}$) of all individuals ($i = 1, \ldots I$) in the household.  This utility may also be affected by household characteristics ($A_{ht}$) such as its life cycle position, preferences for health, and the education of household members.  The utility function for time period $t$ is

$$U_{ht} = u_t(x_{iht}, \ell_{iht}, h_{iht}; A_{ht}) \qquad i = 1, \ldots I \qquad (2)$$

As Deaton (1992) notes, the preferences implied by equation (1) are extremely general, allowing unlimited complementarities and substitutions across periods.  Here, preferences are assumed to be intertemporally additive and individual sub-utility functions are increasing and quasi-concave in their arguments. It is also assumed that there exists a household utility function.  Although this is questionable on both theoretical and empirical grounds (Alderman et al. 1995), the data available here will not permit implementation of a collective model of the household.  Following the principle of Occam's razor, therefore, the simpler—though unrealistic—assumption of a unitary household is used instead.

The next step is to specify a health production function.  Adult health in the current period depends on past health history ($h_{iht-1}$), recent disease incidence ($d_{iht}$), nutrient intake ($N_{iht}$), and energy expenditure ($E_{iht}$).  Individual characteristics ($z_{iht}$) such as age and sex

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[1] The presentation of this conceptual framework draws heavily on Higgins and Alderman (1997) and Thomas, Lavy, and Strauss (1996).

will affect health outcomes through their impact on intrahousehold allocation, as in Pitt, Rosenzweig, and Hassan (1990) as well as a direct effect. (For example, basal metabolic rates slow with age.) Household characteristics ($z_{ht}$) such as location and community characteristics ($z_{ct}$) such as availability of health care are also inputs in the health production function. Finally, $\mathbf{S}_{iht}$ captures characteristics of the adult such as inherent healthiness that are unobserved by the social scientist but that may, or may not, be known to the household.

$$h_{iht} = h(h_{iht-1} , d_{iht} , N_{iht} , E_{iht} , z_{iht} , z_{ht} , A_{ht} , z_{ct} , \mathbf{S}_{iht}). \tag{3}$$

In the context of rural households, farm production ($Y_h$) will depend on characteristics of individual members, individual health status (whereby better health leads to improved labor productivity), capital stock and land endowments ($K_{ht}$), other intermediate inputs ($OI_{ht}$), and locality characteristics ($z_{ct}$).

$$Y_{ht} = y(z_{iht} , h_{iht} , K_{ht} , OI_{ht} , z_{ct} ) \ i = 1, ... , I \tag{4}$$

Finally, note that individuals may contribute to household income via providing labor time, remittances, or other transfers. These contributions are a function of wages, which will vary by sex (given labor market discrimination), education and age, health (via the links between health/child quality and productivity reviewed in Strauss and Thomas [1995]), and community or cultural factors ($\theta_{ct}$). For example, when daughters of the household head are married in Zimbabwe, the groom and his family pledge resources in the form of cattle and money to compensate the bride's family for the cost of her upbringing and the loss of her labor. These contributions can be expressed as

$$R_{iht} = r(z_{iht}, h_{iht}, \theta_{ct}) \qquad i = 1, \dots, I. \tag{5}$$

Maximizing (1) subject to (3), (4), and (5) generates a set of first order conditions that can be solved out to yield a set of reduced form commodity and health demand functions. Under the assumption of intertemporal separability, a standard result is that the discounted expected value of additional income is constant, implying as Alderman et al. (1994) and Foster (1995) point out, that households will seek to smooth fluctuations in health. Accordingly, the reduced form health demand function takes the form.

$$h_{iht} = f_t(z_{iht}, S_{iht}, A_{ht}, K_{ht}, z_{ht}, z_{ct}, \theta_{ct}). \tag{6}$$

## 3. DATA AND MODEL SPECIFICATION

BACKGROUND

The individuals in this sample reside in resettlement areas of rural Zimbabwe. As their history is somewhat unusual, we begin with an extended introduction to their background.

Access to land has long been an issue of major economic and political importance in Zimbabwe. Anger at the gross disparities in landownership between blacks and whites was a major factor motivating armed rebellion against white minority rule. Upon gaining independence, the Government of Zimbabwe announced a wide ranging program of land reform, designed to redress these severe inequalities. A component of the land reform program was the resettlement of households on farms previously occupied by white commercial farmers. Initially, the supply of land for resettlement was determined by the

availability of areas that had been abandoned during the liberation war and also the general insecurity of European farmers in peripheral areas who were willing to sell. In most cases, these were the commercial farms contiguous to or generally bordering communal areas.

Criteria for selection into these schemes included being a refugee or other persons displaced by war, including extraterritorial refugees, urban refugees and former inhabitants of protected villages; being unemployed; being landless residents in a communal area or having insufficient land to maintain themselves and their families (Kinsey 1982). At the time of settlement, the household heads were also supposed to be married or widowed, aged 25 to 50, and not in formal employment. Families selected for resettlement were assigned to these schemes, and the consolidated villages within them, largely on a random basis. Generally, these criteria seem to have been followed. In this sample, some 90 percent of households settled in the early 1980s had been adversely affected by the war for independence in some form or another. Before being resettled, most (66 percent) had been peasant farmers with the remainder being landless laborers on commercial farms, refugees, and workers in the rural and urban informal sectors.

Families settled on these schemes were required to renounce any claim to land elsewhere in Zimbabwe. They were not given ownership of the land on which they were settled but instead were given permits covering residential and farm plots. Each household was allocated 5 hectares of arable land for cultivation, with the remaining area in each resettlement site being devoted to communal grazing land. In return for this allocation of land, the Zimbabwean government expected male heads of households to

rely exclusively on farming for their livelihoods.  Until 1992, male household heads were not permitted to work elsewhere, nor could they migrate to cities, leaving their wives to work these plots.  Although this restriction has been relaxed, with male heads being allowed to work off farm (provided that household farm production is judged satisfactory by local government officials), in this sample agriculture continues to account for at least 80 percent of household income in nondrought years.

The nature of the settlement pattern in these households deserves further comment.  Unlike the homestead pattern of settlement found throughout much of rural Zimbabwe, households in these resettlement schemes live in small (12-60 household) villages.  Cultivated fields surround these villages.  The small size of each village, together with their physical isolation, has precluded the development of small markets in these localities.  Indeed, a striking visual feature of these places is the absence of shops or trading areas.  Instead, each resettlement scheme has what is called a "rural service center."  This is a central location within each scheme in which government offices, a health clinic, and shops are located.  Periodic cattle sales are also held here.

THE SAMPLE

Over the period 1982-84, an initial survey of approximately 400 resettled households was undertaken.  The initial sampling frame was all resettlement schemes established in the first two years of the program in Zimbabwe's three agriculturally most important agroclimatic zones.  These are Natural Regions (NR) II, III, and IV and correspond to areas of moderately high, moderate, and restricted agricultural potential.

One scheme was selected randomly from each zone: Mupfurudzi in Mashonaland Central

Province (which lies to the north of Harare in NR II), Sengezi in Mashonaland East

Province (which lies southeast of Harare in NR III), and Mutanda in Manicaland

Province (which lies southeast of Harare, but farther away than Sengezi and in NR IV).

Random sampling was then used to select villages within schemes, and in each selected

village, an attempt was made to cover all selected households.

These households were first interviewed over the period July-September 1983 to

January-March 1984.  They are located in 20 different villages (two additional villages

were added to the sample in 1993).  Just over half (57 percent) are found in Mupfurudzi

with 18 percent located in Mutanda and 25 percent found in Sengezi.   They were

reinterviewed in the first quarter of 1987 and annually, during January to April, from

1992 to 1998.  There is remarkably little sample attrition.  Approximately 90 percent of

households interviewed in 1983/84 were reinterviewed in 1997.  There is no systematic

pattern to the few households that drop out.  Some were inadvertently dropped during the

resurveys, a few disintegrated (such as those where all adults died), and a small number

were evicted by government officials responsible for overseeing these schemes.

These particular characteristics of the sample provide it with properties that are

desirable from the point of view of examining the determinants of adult health.  First,

there is no requirement to address biases brought about by *household* sample attrition.

Second, as Rosenzweig and Wolpin (1988) have argued, examination of the impact of

any locality level characteristic, such as quality of health care, access to drought relief,

and so on, is hampered by considerations of selective migration.  There are strong a priori

grounds for believing that this will not affect these results. Relocation of these households preceded, by a significant period of time, the droughts that occurred in the 1990s and which, as discussed below, is the principal focus of the study. Third, the availability of repeated observations makes it possible to control for any correlation between explanatory variables and fixed, unobserved characteristics. Fourth, as the survey is conducted at the same time each year, the impact of seasonality considerations is minimized. Fifth, the random allocation of households to plots of land, together with prohibitions on transfers, means that certain land characteristics, such as distance to plots, number of plots, soil types, and land slope, can be treated as fixed and exogenous. Sixth, the prohibitions on nonagricultural activities, together with the fact that each household received an identical quantity of land, implies that data on agricultural capital stock and livestock will provide a good proxy for household wealth and permanent income.[2] Seventh, each survey round records deaths that have occurred in the previous 12 months and enumerators are instructed to probe carefully for all deaths. There are relatively few adult deaths in any given year, suggesting that these results are unlikely to be affected by selective mortality. Finally, it was not until after the 1991-92 drought that adult male heads were permitted to out-migrate. Rural-urban migration by males, together with temporary visits to rural areas, are an important mechanism by which HIV is passed from urban areas—where the disease is widespread—to rural areas. The presence of this prohibition, which appears to have been strictly enforced, provides an a priori reason for

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[2] Owens and Hoddinott (1998) find that every additional dollar of agricultural capital stock raises annual household income by about 30 cents.

believing that HIV infection will play a much smaller part in explaining trends in adult

health than might be the case in other parts of Zimbabwe or Sub-Saharan Africa.

Although we do not have direct evidence on HIV rates, we also note that there have been

relatively few adult deaths from diseases such as tuberculosis, which are often HIV

related, which is also suggestive of relatively low HIV prevalence in these areas.[3]

*Trends in Adult Body Mass Indices, 1994-97*

The measure of adult health used here is body mass index, also called the Quetelet

index, defined as weight divided by the square of height.  These data were first collected

in 1994; thus we have four rounds of data from this ongoing panel, 1994 to 1997

inclusive.  It is important to note that not every adult in the household is measured. The

sample used here is restricted to adults who had children aged 6 months to 6 years (1994,

1995, and 1996 rounds) and 6 months to 7 years (1997 round), were household heads,

spouses of the head or sons, daughters or daughters-in-law of the head, and were

measured at least twice.[4] As the sample is not random, there are selectivity issues that

need to be addressed. These are discussed below.

The first two agricultural seasons in this panel are reasonably good years in terms

of rainfall. The third year was a major drought year, which was followed by an especially

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[3] Further indirect evidence underlying this claim comes from the 1997 survey round.  Households were asked if they knew of anyone whom they believed had died from AIDS and if they knew of anyone who was living with HIV/AIDS.  Affirmative answers to these questions were followed with the questions, "How many people altogether?" and "How many from this area?"  Mean values to these questions were 3.22, deaths altogether; 0.92, deaths locally; 0.58, people living with HIV/AIDS; and 0.21, living locally.

[4] Women who were pregnant, or had given birth in the month preceding measurement, are also excluded.

good year in terms of rainfall and crop production. These patterns are shown in Table 1, which records mean rainfall levels by agricultural year and resettlement scheme in terms of their departure from long-term levels. In examining these data, it is important to place them within the context of the seasonal cycles of these households. The Zimbabwean agricultural year runs from October to September. Planting typically occurs in October/November, with harvesting occurring in May and June. Marketing occurs over the period June to September. The household survey takes place in February and March. The timing was deliberately chosen so as to interview households at the height of the hungry season. It does, however, mean that dating events can be somewhat confusing. Drought in the 1994/95 agricultural year implies that households potentially face severe food shortages in the year that *follows*, as it is a full 12 months before the next harvest is ready. It should also be noted that the 1994/95 drought was somewhat unusual in that rainfall in the early part of the season was consistent with long-term averages. The drought only began to manifest itself in February 1995 when mid- and end-season rains failed. Consequently, when examining the impact of this drought on adult health, the "drought observation" will be 1996. Mindful of this, Table 1 indicates that there is relatively little variation in male BMIs over this period. By contrast, women's mean BMI falls by about 3 percent in the aftermath of the 1994/95 drought. However, these descriptive data, while suggestive, do not control for other factors that may change over this period.

*Model Specification*

Recall that we seek to estimate the following relationship:

$$h_{iht} = f_t(z_{iht}, \mathbf{S}_{iht}, A_{ht}, K_{ht}, z_{ht}, z_{ct}, \theta_{ct}). \tag{6}$$

We write an estimable version of (6) as

$$\mathrm{BMI}_{iht} = \boldsymbol{\beta_i}' \cdot \mathbf{X}_{iht} + \boldsymbol{\beta_H}' \cdot \mathbf{X}_{ht} + \boldsymbol{\beta_C}' \cdot \mathbf{X}_{Ct} + \varepsilon_i + \varepsilon_h + \varepsilon_C + \varepsilon_{iht}. \tag{7}$$

Health is represented as the log of adult body mass index of person *i* residing in household *h* at time *t*. Individual characteristics affecting BMI are placed in the vector, $\mathbf{X}_{iht}$. Similarly, $\mathbf{X}_{ht}$ is a vector of household characteristics at period *t* and $\mathbf{X}_{Ct}$ is a vector of locality characteristics. $\boldsymbol{\beta_i}'$, $\boldsymbol{\beta_H}'$, and $\boldsymbol{\beta_C}'$ are vectors of parameters to be estimated. $\varepsilon_i$, $\varepsilon_h$, and $\varepsilon_C$ are unobserved characteristics of the adult, household, and locality that are assumed to be time invariant and $\varepsilon_{iht}$ is a white noise disturbance term. In moving from (6) to (7), explicit acknowledgment is made that certain relevant individual, household, and community characteristics are not observed in these data but will affect adult health outcomes. As we have repeated observations on these adults, we use individual-level fixed-effects estimation to sweep out the impact of these fixed, unobservable characteristics on BMI. By doing so, fixed personal characteristics such as height, relationship to head, and years of completed schooling do not appear in the results reported below.[5]

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[5] Strictly speaking, one individual characteristic does change over time in a nonlinear fashion, namely log age. As individuals age, their basal metabolic rates gradually slow, with the result that holding all other factors constant, we would expect to observe an increase in BMI. All regressions reported here were run with log age included as a regressor. This variable has a small, positive effect on BMI, but one that is not statistically significant. This is not surprising, given the relatively short period of time being considered here. The inclusion of this variable has no substantive effect on the results reported below.

Table 2 provides the mean values of the time varying regressors that appear in equation (7). Although most household characteristics are fixed, such as landholdings and location, two do change over time: the real values of the log of agricultural capital stock and livestock.[6] In the results reported below, lagged values of these variables are used to avoid simultaneity concerns.[7] It might seem surprising that livestock holdings do not fall in the aftermath of the 1994/95 drought. In fact, the real value of livestock holdings continues to grow, albeit at a much slower rate. Given the magnitude of the rainfall shock, one might question whether livestock is being used as a means of smoothing consumption. Three points should be noted. First, respondents themselves state that livestock were the principal means of coping with this drought, with more than 60 percent reporting a sale. Income from these sales comprised 37 percent of the self-reported "sources of cash used to buy food."[8] Second, frequency tabulations of these data indicate that approximately 40 percent of households experienced either a decline or no change in their holdings. Third, a small number of households made significant acquisitions of cattle. Excluding the 10 percent of households who had the largest

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[6] Agricultural capital stock is defined as those tools and equipment used in crop production. It includes the real value of the number of functioning ox-ploughs, scotch carts, cultivators/harrows, ox-planters, water carts, cotton sprayers, wheelbarrows, tractors and tractor equipment, hoes, axes, spades, machetes, slashers, and trained oxen. Owens and Hoddinott (1998) provide further details on the construction of this variable.

[7] So, for example, log livestock in 1993 is considered a determinant of BMI in 1994.

[8] Another 43 percent was raised from ex post actions such as taking temporary jobs and engaging in petty crafts or trading. Less than 2 percent of these funds came from borrowing. See Kinsey, Burger, and Gunning (1998) for a detailed discussion of the role of livestock and other strategies used to cope with rainfall shocks.

increases in the real value of their livestock holdings, mean values for the rest of the

sample fell in the aftermath of the 1994/95 drought.

Recall that these households live in small isolated settlements. Partly for this

reason, and partly as a consequence of data limitations, our time varying locality

characteristics are aggregated to the level of the resettlement scheme, of which there are

three. At this level of aggregation, there are data on rainfall, health facilities, and food

prices. Rainfall shocks are expressed as a percentage of a long-term average. These data

are from the nearest rainfall station. In Mupfurudzi, this is located in the service center.

In Mutanda and Sengezi, they are located about five kilometers away from the center of

the resettlement scheme. Unfortunately, these data are only available on a consistent

basis for a period of eight years, from 1989 to 1997. The second set of data are mean

prices: daily wages paid to unskilled farm workers, the cost of purchasing one kilogram

of beef and one litre of cooking oil. Prices are based on data collected in the household

questionnaire, averaged by resettlement scheme. Information on local health facilities is

derived from a short questionnaire that is administered annually to clinic staff. This

covers a number of topics including whether the facility had experienced either staff or

drug shortages in the previous 12 months. These variables are also included in the

multivariate analysis.[9]

A final feature of this sample is the relationship of these adults to the household

head. As the bottom part of Table 2 demonstrates, only about half the women in the

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[9] These data were cross-checked against comparable information available at the Ministry of Health in Harare and found to be reliable.

sample are spouses of the head. Recall that at the time of settlement, male heads were aged between 25 and 50. As the sample literally ages, so, too, do the spouses of these heads. As they do so, they become less and less likely to have children aged six months to six years. Concurrently, there are an increasing number of women in these households who are daughters-in-law of the head. They, and their spouses, find themselves in these households—rather than splitting off and forming a separate household unit—for two reasons. First, deteriorating economic prospects in urban areas are reducing the incentive to migrate. Second, the absence of a clear policy regarding land succession rights in these resettlement areas means that there is no land for these sons to operate that is separate from the land operated by their fathers. Daughters of the household are either young women who have had children out of wedlock, or increasingly women who have either separated or divorced their husbands and have returned to their natal homes. We will return to this feature of the data below.

## 4. RESULTS

BASIC FINDINGS

Table 3 reports the results of estimating equation (7) separately for women and men. F tests easily reject the null hypothesis that these individual unobservables have no effect, as does a (not reported) Lagrange multiplier test in the case of random effects estimation. We note that we are unaware of previous studies that examine the

determinants of adult body mass controlling for fixed individual-level unobservable characteristics.

The first set of results for men and women define rainfall shocks using a dummy variable that equals one if the individual was measured in 1996 (the aftermath of the 1994/95 drought), zero otherwise. This confirms the impressionistic finding noted in Table 1, namely that this drought is associated with a reduction in the body mass of women but not men. However, this is not an entirely satisfactory way of measuring the impact of rainfall shocks. It does not differentiate the intensity of the shock experienced across these three resettlement areas. Further, it treats all nondrought years as a single group, despite significant variations in rainfall across these years. Consequently, a second measure is also reported. This is the impact of positive and negative shocks, or deviations, from long-term averages, an approach first used by Fafchamps, Udry, and Czukas (1998). The core result is that, controlling for time varying household and locality characteristics, and individual fixed effects, negative rainfall shocks reduce women's BMI. The coefficient on these negative shocks is –0.115, indicating that female BMI falls by 1.15 percent for every 10 percent negative deviation in rainfall from long-term average. Male BMIs are unaffected by changes in rainfall.[10]

Table 3 also produces a number of other results of note. Changes in agricultural capital stock do not affect adult body mass. Increases in the value of lagged livestock holdings increase women's body mass, but not men's. The price variables have the

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[10] These models were also estimated using log weight, rather than BMI, as the dependent variable. This produces similar results to those reported here.

correct signs, but do not tend to be statistically significant.  Drug shortages in local

clinics are associated with reductions in adult body mass. This result is more robust for

women than for men.  Staff shortages in these clinics do not appear to lead to reductions

in this measure of adult health.

The impact of lagged livestock holdings on women's body mass deserves further

comment. It is especially interesting in light of the findings of Fafchamps, Udry, and

Czukas (1998) that in the very different environment of semi-arid West Africa, livestock

transactions do not appear to play a major role in household consumption smoothing. We

hypothesize that livestock holdings are working through two channels. First, they are a

relatively liquid store of wealth whose real value has been maintained in the Zimbabwean

context of persistent inflation. Second, livestock—especially oxen—can substitute for a

wide variety of labor tasks. Although ox-plowing rather than manual hoeing comes most

readily to mind, oxen can also be used to pull carts carrying firewood and water. These

activities are regarded as women's responsibilities in this survey area. Not only does

animal haulage reduce human energy expenditures, they also allow greater quantities of

wood and water to be collected during a single trip.

The next step is to consider some objections to these results.  First, only three

prices (labor, beef, and cooking oil) are included in these regressions. One might wonder

whether these results are robust to the inclusion of other prices.  In results not reported

here, we experimented with a larger price set, adding in the prices of sugar, salt, and

producer prices for maize.  Sugar, salt, and cooking oil are the three items most

commonly purchased by these households in the shops located in each resettlement

scheme's service center. All are produced in urban areas and transported to these localities for sale. Their prices are highly collinear, with Pearsonian correlation coefficients ranging from 0.62 to 0.93. It is therefore not surprising that the inclusion of these additional prices has no effect on the results reported here.

In principle, there is a strong case for including the price of maize, since maize meal is the staple food of these households. Doing so, however, is not unproblematic. In the three nondrought crop years, the households in this sample are self-provisioning in maize. In the aftermath of the drought, there are generalized maize shortages with the result that maize meal is not available in local shops.[11] Consequently, it is not possible to construct a "consumer maize price" (and in nondrought years, it is not clear that this is a meaningful concept). It is possible to construct a producer price for maize, based on the quantities and value of reported sales to the Government of Zimbabwe's Grain Marketing Board, to private traders, and (occasionally) to neighbors. This variable is highly correlated with rainfall, with a Pearsonian correlation coefficient of –0.76. Including this price in the model generated, perhaps not surprisingly, a standard multicollinearity result, namely that the regression $R^2$ and F statistic remained unchanged but no regressors were statistically significant. We also note that replacing these rainfall shocks with the producer price of maize leaves other coefficients basically unchanged. The coefficient on the price of maize is negative and significant for women, and negative and not significant for men.

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[11] Our own field observations also confirm this. One virtually never sees maize meal being sold in these shops.

A second concern is potential selectivity biases. Recall that only certain adults (male household heads and spouses, sons, daughters, and daughters-in-law of the head) with young children are included in this sample. Note that this selection process by itself does not cause concern. Selection by virtue of having a resident child is selection on the basis of a fixed, individual-level characteristic. The impact of this is swept away in the fixed-effects estimation. A second selectivity effect is of greater concern. Some sons, daughters, and daughters-in-law may have returned to these areas as a consequence of events that occurred elsewhere. Consider a daughter who had married and left her natal home. Suppose she experiences some adverse shock and elects to return to her parents' household. For such women, there is an individual *time varying unobserved* characteristic that might be correlated with the regressors reported here. For example, these women might only return in cases where parents are wealthy, leading to a correlation between the error term and the livestock covariate. This effect is not swept out by the fixed-effects estimation.

In addressing this concern, note that in order to estimate the individual-level, fixed-effects regressions, adults must be measured at least twice. Suppose we restrict the sample to those women measured in three of the four survey years, or who are measured in every survey year. By doing so, we eliminate from the sample individuals who migrate in, or migrate out, over these four years. Table 4 reports the results of imposing these sample restrictions on the coefficients for the measures of the rainfall shock and livestock

where the dependent variable is women's BMI.[12]  The impact of rainfall shocks in the

base sample is reported for comparison.  The fundamental result is that the parameter

estimates are largely unchanged.  In other words, our core findings do not appear to be

affected by this selectivity concern.


*Extensions: Disaggregating Results by Relationship to Head*

The core results presented in Table 3 are disaggregated by sex.  We make no

presumption that the impact of this rainfall shock will be the same for men and women.

However, individuals within these groupings are related in various ways to the household

head.  For example, women in this sample include daughters and daughters-in-law of the

head, as well as spouses.  Is it correct to assume that the 1994/95 drought has an equal

effect across all women?

Table 5 examines this proposition by disaggregating the sample into five groups,

based on relationship to household head.  There are two noteworthy findings.  First, the

impact of a negative rainfall shock is not uniform across all women.  The BMIs of

daughters-in-law of the household head are unaffected by drought.  Both wives and

daughters are adversely affected, with a 10 percent reduction in rainfall corresponding to

a 2.2 and 3.9 percent reduction in BMIs, respectively.  Second, household holdings of

livestock are associated with higher BMIs for wives of the household head, but not for

any other group.  These findings suggest that the vulnerability of wives of the household

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[12] Full results are available on request.  These regressions were also run for the male subsample, but no impact of rainfall shocks or livestock on men's BMI was found.

head is a function of the level of household assets that can be used as a buffer when negative income shocks arise. Daughters-in-law may have access to resources outside the household. For example, regulations severely limiting off-farm work apply only to household heads, not their children. Consequently, these women may have access to remittance income that offsets the impact of the drought.

By contrast, daughters of the household head seem especially vulnerable. Recall that changes in body mass reflect changes in the balance between energy intake and energy expenditures. We hypothesize that during drought, there is relatively little change in the energy needs of these women. In particular, we suspect that they may have continued responsibilities for household reproductive activities such as the carriage of water and fuel. To the extent to which these resources become scarce during drought, or if these women are forced to seek employment outside the household, energy expenditures might actually increase. At the same time, the position of these women in the household is somewhat ambiguous. Women who have returned to the household following failed marriages are sometimes stigmatized (Armstrong 1997). There may be an expectation that the woman will subsequently return to her husband. In such circumstances, household heads may limit the amount of resources made available to such daughters. This is consistent with the conceptual model's suggestion that body mass will be affected by factors influencing future contributions to the household. Alternatively, these women will have little bargaining power within the household.

Unmarried daughters who have had children out of wedlock may face similar constraints within their households.[13]

*Extensions: Assessing the Impact of Private Responses to Drought*

We have noted that livestock holdings are associated with higher BMIs for women, most notably wives of the household head. We also noted that households report that livestock are an important mechanism for coping with drought. Here, we test these ideas more formally, using a method suggested by Townsend (1995) and Morduch (1999). We stratify our sample by livestock holdings measured in 1995. Recall that these were measured just prior to the realization that 1994/95 would be a drought year for these households. Further, the results presented above suggest that livestock holdings are associated with increased body mass for women.

Table 6 presents the results of dividing the sample of women into three groups: women residing in households in the bottom quartile of pre-drought livestock holdings; women in the middle quartiles; and women in the top quartile. (Replicating these results for men produced no statistically significant results. Using the drought year dummy instead of these rainfall shocks produces results comparable to those reported here.) This produces a clear pattern in the parameters on the negative rainfall shocks. As we move

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[13] In a companion paper, we investigate the impact of the 1994-95 drought on the growth (in stature) velocities of children aged 12-24 months (Hoddinott and Kinsey 1998). This produces remarkably comparable findings. Specifically, the drought lowers annual growth rates for these children by somewhere between 1.5 and 2 centimeters. This adverse effect is most pronounced among children whose mothers are themselves daughters of the head.

from richer to poorer households, the impact of the shock becomes larger and more precisely estimated. This is consistent with the argument that livestock holdings built up prior to drought provide a means of smoothing consumption, measured here by adult body mass.

*Extensions: Assessing the Impact of Public Responses to Drought*

The 1994/95 drought did not go unremarked in Zimbabwe. A national disaster was declared in the middle of 1995—after our survey round for that year had been completed—and a variety of interventions put into place (Kinsey, Burger, and Gunning 1998). One of these was a grain loan program.[14] Rather than provide households with outright transfers of maize, the intention was that these would be loans, repayable after the next (1995/96) harvest. Households were required to apply for these loans, with these applications vetted by local government officials. The intention was to target resources to those households in greatest need by a mix of self-selection and administrative review. In practice, the scheme appears to have been largely untargeted. In these survey areas, 87 percent of all households received loans. Conditional on applying for a loan, there was virtually no variation in the amount of grain allocated across households regardless of income or wealth levels. On average, households received about half of what they applied for.

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[14] Other interventions included supplementary feeding for preschoolers, school feeding programs, and waivers on school fees.

Assessing the impact of the grain loans scheme on adult BMI is challenging for several reasons. Drought relief is measured at the household level, and is only measured once. Such a fixed household characteristic is differenced out in individual-level, fixed-effects estimation. Receiving large amounts of drought relief might be indicative of the fact that the household had been particularly badly affected by this drought. This would confound any attempt to use this variable directly. Finally, about 10 percent of households in the sample did not apply for a grain loan. On average, these households tended to be considerably wealthier, in terms of livestock holdings, than those households that applied for a loan.

In light of these considerations, we adopt the following approach. First, we restrict the sample to those women living in households where pre-drought livestock holdings were below the 75th centile. Just over 96 percent of households in this group applied for a grain loan. Thus, by stratifying, using this variable, which we can plausibly regard as predetermined (because it is a *pre*-drought measure), we largely eliminate the problem of self-selection into the program. Next, we calculate what proportion of its request each household receives. We assume that the amount requested is a true measure of need. Some households may have inflated their requirements, but we have no direct means of verifying the validity of their requests. Having made this strong assumption, we stratify the sample by the proportion of request that the household receives. By doing so, we can see whether individuals living in households that receive a greater proportion of their request are better protected against the impact of the drought than individuals in households that receive only a small fraction of their request.

Table 7 reports three results. The first column shows the impact of the negative rainfall shock on all women residing in households where pre-drought livestock holdings were below the 75th centile. The coefficient on the negative rainfall shock is –0.163. Not surprisingly, this is slightly higher than that reported in Table 3, as the pre-drought wealthiest households have been dropped from the sample. The next two columns are based on stratifying the sample into women living in households receiving less or more than 50 percent of their request. The important feature to note across these three results is that the parameter estimate for the negative rainfall shock is virtually identical across these three specifications. Using different cutoffs, for example, dividing the sample into terciles or quartiles, does not change this result. We also note that running these regressions for men produces no statistically significant rainfall coefficients.

These findings suggest that the grain loans scheme had no significant impact on adult body mass. However, we regard these results with some caution. First, our means of identifying the impact of the grain loans scheme is far from ideal. If households were overstating their needs when applying for these loans, a measure of what proportion of these requests they actually received is not a good measure of the extent to which shortfalls were met by this intervention. Second, suppose that government officials allocating these loans did so on the basis of a fixed, household characteristic. For example, suppose that a larger percentage of a request was granted if a household lived in a particular village. If this is the case, the sample is stratified on a variable whose impact is swept out by the fixed-effects estimation. But suppose, instead, that these officials have knowledge of the circumstances of each household and that these circumstances affect

what percentage of their request a household receives. Although we do not believe that this is the case, it implies that the sample is stratified on the basis of a time-varying unobservable that, being correlated with our regressors, produces biased coefficients. Finally, this measure of impact relates to body mass. It may be the case that these grain loans allowed individuals to increase their levels of physical activity. If this was the case, then increased access to food would be offset by greater energy expenditure, leaving BMI unchanged.

## 5. CONCLUSIONS

This paper has examined the impact of the 1994-95 drought on the health of adults, drawing on a unique panel data set of households residing in rural Zimbabwe. We find that, controlling for community, household- and individual-level covariates and fixed, unobservable effects, women, but not men, are adversely affected by this drought. However, these effects are not borne equally by all women. Women in poor households, and daughters generally appear to bear the brunt of this shock. Our results suggest that an ex ante private coping strategy, the accumulation of livestock, protects women against the adverse consequences of this shock. By contrast, we find that ex post public responses are not effective, though for several reasons we treat this finding with caution.

**TABLES**

**Table 1  Trends of adult body mass, by agricultural year and resettlement scheme**

|  | Year of observation | | | |
|---|---|---|---|---|
|  | 1994 | 1995 | 1996 | 1997 |
| Mean body mass index, men | 21.7 | 21.3 | 21.3 | 21.7 |
| Mean body mass index, women | 22.2 | 22.1 | 21.5 | 22.0 |
| Percent change from previous year, men |  | -1.84 | 0 | 1.88 |
| Percent change from previous year, women |  | -0.45 | -2.71 | 2.32 |
| Relevant agricultural year | 1992/93 | 1993/94 | 1994/95 | 1995/96 |
| Percent of long-term mean rainfall in relevant agricultural year |  |  |  |  |
| Mupfurudzi | 107 | 116 | 74 | 131 |
| Mutanda | 106 | 104 | 68 | 156 |
| Sengezi | 142 | 104 | 80 | 111 |

Notes:  Rainfall stations used are Mupfurudzi resettlement (Mupfurudzi); Bita (Sengezi) ; and Stonedale farm (Mutanda).

**Table 2   Descriptive statistics**

| | Survey year | | | | |
|---|---|---|---|---|---|
| | 1993 | 1994 | 1995 | 1996 | 1997 |
| Value of agricultural capital stock | 2,420 | 2,576 | 2,724 | 2,826 | 2,994 |
| Percent change in agricultural capital stock | | 6.4 | 5.7 | 3.7 | 5.9 |
| Value of livestock | 2,516 | 3,316 | 4,927 | 5,609 | 6,246 |
| Percent change in livestock | | 31.8 | 48.6 | 13.8 | 11.4 |
| | | | | | |
| Unskilled agricultural wage | | 11.0 | 13.5 | 16.1 | 16.2 |
| Price of beef, 1 kilogram | | 7.5 | 8.9 | 7.9 | 8.6 |
| Price of cooking oil, 1 litre | | 7.8 | 6.1 | 5.7 | 5.6 |
| | | | | | |
| Percent individuals residing in areas where health clinics have drug shortages | | 0 | 72.2 | 75.4 | 70.8 |
| Percent individuals residing in areas where health clinics have staff shortages | | 0 | 0 | 75.4 | 70.8 |
| | | | | | |
| Percent of men who are household heads | | 71.7 | 76.6 | 63.3 | 59.6 |
| Percent of men who are sons of head | | 28.3 | 23.4 | 36.7 | 40.4 |
| Percent of women who are spouses of head | | 56.3 | 56.7 | 54.2 | 49.6 |
| Percent of women who are daughters of head | | 18.8 | 14.6 | 11.3 | 12.1 |
| Percent of women who are daughters-in-law of head | | 24.9 | 28.7 | 34.5 | 38.3 |

Notes:   1   All monetary values are expressed in 1993 Zimbabwe dollars, using the CPI as a deflator.
2.   Agricultural capital stock and livestock means are based on household level data.  All other means are individual based.

**Table 3   Determinants of log body mass index, individual level fixed effects estimates**

|  | Women | | Men | |
|---|---|---|---|---|
| Rainfall shocks | | | | |
| Post-drought year dummy (year of observation is 1996) | -0.028 (4.144)** | - | -0.005 (0.558) | - |
| Positive rainfall shock | - | -0.006 (0.126) | - | -0.082 (1.189) |
| Negative rainfall shock | - | -0.115 (2.193)** | - | -0.094 (1.348) |
| | | | | |
| Time varying household characteristics | | | | |
| Log of lagged agricultural stock | 0.004 (0.222) | 0.006 (0.270) | 0.001 (0.022) | 0.004 (0.148) |
| Log of lagged value of livestock | 0.004 (1.954)* | 0.004 (1.956)* | -0.001 (0.436) | -0.001 (0.360) |
| | | | | |
| Time varying locality characteristics | | | | |
| Agricultural wage rate | 0.003 (1.566) | 0.002 (0.944) | 0.002 (0.885) | -0.0001 (0.039) |
| Price of beef | -0.010 (1.454) | -0.009 (0.788) | -0.002 (0.191) | 0.013 (0.861) |
| Price of cooking oil | -0.027 (2.426)** | -0.025 (1.303) | -0.017 (1.179) | 0.007 (0.298) |
| Clinic experiences drug shortages | -0.062 (2.516)** | -0.054 (1.371) | -0.070 (2.054)** | -0.021 (0.390) |
| Clinic experiences staff shortages | -0.013 (0.602) | -0.007 (0.187) | -0.015 (0.543) | 0.034 (0.690) |
| | | | | |
| F statistic on regressors | 4.12** | 3.70** | 0.87 | 0.94 |
| F statistic on individual fixed effects | 8.66** | 8.64** | 5.41** | 5.43** |

Notes:   1.   Dependent variable is log of body mass index.
2.   Sample are adults (household heads and wives, daughters, daughters-in-law, and sons of head) with a child aged 6 to 72 months currently residing in the household, observed twice, three, or four times.
3.   Absolute value of t statistics in parentheses. * = significant at the 10 percent level; ** = significant at the 5 percent level.
4.   Sample size for women is 926, with an average of 2.7 observations per woman.  Sample size for men is 560, with an average of 2.6 observations per man.

**Table 4   Determinants of women s log body mass index under different sample restrictions, individual fixed-effects regressions**

| | Sample restriction | | |
|---|---|---|---|
| | Between 1994 and 1997, women were measured: | | |
| | Twice, three or four times | Three or four times | Four times |
| Positive rainfall shock | -0.006 | -0.003 | -0.141 |
| | (0.126) | (0.551) | (1.617) |
| Negative rainfall shock | -0.115 | -0.154 | -0.255 |
| | (2.193)** | (2.499)** | (2.849)** |
| Log of lagged value of livestock | 0.004 | 0.005 | 0.005 |
| | (1.956)* | (2.330)** | (1.857)* |
| Number of women | 347 | 214 | 90 |

Notes:  1.   Dependent variable is log of body mass index.
2.   Sample is adult women (wives, daughters, daughters-in-law of head) with a child aged 6 to 72 months currently residing in the household.
3.   Other regressors included but not reported are log of lagged agricultural capital stock; wage rate; price of beef and cooking oil; clinics experiencing drug or staff shortages.
4.   Absolute value of t statistics in parentheses. * = significant at the 10 percent level; ** = significant at the 5 percent level.

**Table 5   Determinants of log body mass index, by relationship to household head, individual fixed-effects regressions**

| | Relationship to household head | | | | |
|---|---|---|---|---|---|
| | Wife | Daughter | Daughter-in-law | Head | Son |
| Positive rainfall shock | -0.102 | -0.222 | 0.105 | -0.060 | -0.136 |
| | (1.518) | (1.238) | (1.106) | (0.750) | (0.969) |
| Negative rainfall shock | -0.217 | -0.386 | 0.023 | -0.066 | -0.203 |
| | (3.203)** | (2.027)** | (0.233) | (0.820) | (1.409) |
| Log of lagged value of livestock | 0.006 | -0.002 | 0.001 | -0.001 | -0.001 |
| | (2.473)** | (0.363) | (0.269) | (0.306) | (0.140) |
| Number of individuals | 192 | 42 | 115 | 149 | 65 |

Notes:  1.   Dependent variable is log of body mass index.
2.   Sample is adults (household heads and wives, daughters, daughters-in-law and sons of head) with a child aged 6 to 72 months currently residing in the household.
3.   Other regressors included but not reported are log of lagged agricultural capital stock; wage rate; price of beef and cooking oil; clinics experience drug or staff shortages.
4.   Absolute value of t statistics in parentheses. * = significant at the 10 percent level; ** = significant at the 5 percent level.

**Table 6   Determinants of women s log body mass index, by pre-drought livestock holdings, individual fixed-effects estimates**

|  | Woman resides in household whose pre-drought livestock holdings are in the: | | |
|---|---|---|---|
|  | Bottom quartile | Middle quartiles | Top quartile |
| Positive rainfall shock | -0.157 | -0.027 | 0.107 |
|  | (1.257) | (0.335) | (1.242) |
| Negative rainfall shock | -0.226 | -0.141 | -0.008 |
|  | (1.787)* | (1.670)* | (0.088) |
| Number of women | 82 | 166 | 99 |

Notes:  1.  Dependent variable is log of body mass index.
2.  Sample is women (wives, daughters, and daughters-in-law of head) with a child aged 6 to 72 months currently residing in the household.
3.  Other regressors included but not reported are log of lagged agricultural capital stock; wage rate; price of beef and cooking oil; clinics experiencing drug or staff shortages.
4.  Absolute value of t statistics in parentheses. * = significant at the 10 percent level; ** = significant at the 5 percent level.

**Table 7   Determinants of women s log body mass index, by percentage of drought relief application that is filled, individual fixed-effects estimates**

|  | Woman residing in households whose pre-drought livestock holdings are below the 75th percentile: | | |
|---|---|---|---|
|  | All women | Women in households receiving less than 50.1 percent of requested drought relief | Women in households receiving more than 50.1 percent of requested drought relief |
| Positive rainfall shock | -0.060 | -0.049 | -0.076 |
|  | (0.901) | (0.330) | (0.972) |
| Negative rainfall shock | -0.163 | -0.168 | -0.171 |
|  | (2.385)** | (0.996) | (2.241)** |
| Number of women | 248 | 113 | 135 |

Notes:  1.  Dependent variable is log of body mass index.
2.  Sample is women (wives, daughters, and daughters-in-law of head) with a child aged 6 to 72 months currently residing in a household whose livestock holdings were less than the 75th centile prior to the drought.
3.  Other regressors included but not reported are log of lagged agricultural capital stock; wage rate; price of beef and cooking oil; clinics experiencing drug or staff shortages.
4.  Absolute value of t statistics in parentheses. * = significant at the 10 percent level; ** = significant at the 5 percent level.

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