Changes in Consumption and Saving Behavior before and after Economic Shocks: Evidence from Zimbabwe

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Changes in Consumption and Saving Behavior before and after Economic Shocks: Evidence from Zimbabwe*

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I. Introduction

Individuals face numerous natural, market, and institutional risks in generating livelihoods. In recent years, a number of studies have explored the strategies by which individuals in developing countries adapt to this uncertainty. Such studies show that households generally have smoother consumption than income and, further, that they have smoother income than what a risk-neutral agent would achieve.[1]

People insulate their consumption from income fluctuations in different ways. These range from informal community risk sharing to participating in insurance and credit markets when such opportunities exist.[2] They also use saving and spending arrangements.[3] Keeping cattle as an insurance substitute has long-standing importance in the economic literature on Africa.[4] N. Jodha and M. Rosenzweig and K. Wolpin provide evidence that livestock sales and purchases are used as part of farm households' consumption-smoothing strategies.[5] Households may also use income diversification and remittances to manage risk.[6] Individuals and communities participate in a variety of institutions (such as sharecropping) that sacrifice static allocative efficiency in order to manage risk over time. Transfers and remittances also provide implicit insurance networks among families and friends.[7]

Consumption smoothing can involve important costs to households that could lead to a differentiated ability to smooth among different segments of the population. J. Jalan and M. Ravallion bring empirical evidence from rural

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China showing that holding liquid wealth as a precaution against risk differed significantly across income groups.[8] They find that precautionary response to income risks led to a higher share of liquid wealth holding among the middle-income groups, while high-income groups did not need to hold unproductive precautionary wealth and the poor could not afford to do so. This evidence is consistent with a theoretical model offered by F. Zimmerman and M. R. Carter and is supported by their findings reinforced by empirical evidence from Burkina Faso.[9] Zimmerman and Carter find that the poor pursue asset accumulation strategies that lead to smoother income but less smooth consumption than is the case for the wealthy.

In general, access to credit markets is limited, and borrowing constraints are pervasive in developing countries, particularly in sub-Saharan Africa. Even if credit markets exist, many of the poor in developing countries do not have access to the low interest rates afforded by formal credit institutions, and they depend on higher-interest loans from informal creditors such as local moneylenders.[10] In areas of developing countries where insurance and credit markets may not function well or do not exist, it is of interest to investigate the extent to which households smooth consumption and to examine how savings and transfers options respond to covariate economic shocks. This investigation will help determine appropriate risk management policies when governments and international institutions assist people at risk.

This study examines the effects of drought and macroeconomic changes on household consumption and savings behavior in Zimbabwe, using two nationally representative cross-sectional data sets that straddle a period of economic volatility. Specifically, the article (1) analyzes changes in consumption and saving behavior before and after economic shocks and (2) investigates the effectiveness of savings as a means of cushioning the impacts of covariate shocks.

Section II discusses a modified consumption and saving model to reflect the peculiarities of a typical developing country household. Section III develops the empirical model for analyzing the problem. Section IV briefly presents background about Zimbabwe in the 1990s and describes the data source. Results and discussion are in Section V. Section VI presents our conclusions.

II. Household Saving and Consumption Behavior: Theory

A. Basic Household Choice Model

Define $U_t(C_t)$ as a continuously differentiable instantaneous utility function for a representative household, where C_t is per capita household consumption of goods and services at time period t. Since the choice is concerned with resource allocation over time, consider a household maximizing the expected lifetime utility as of time zero

$$E\left[\sum_{t=0}^{T-1}(1+\Theta)^{-t}U_t(C_t)\mid I_0\right], \tag{1}$$

where T is the life span of the household, $E(. \mid I_t)$ is an expectation conditional on information at time t (I_t), and Θ is the rate of time preference.[11] The household is assumed to maximize the present discounted value of expected utility, conditional on information at time zero. The evolution of household assets governs the budget constraint within which intertemporal utility is maximized:

$$A_{t+1} = (A_t + Y_t - C_t)(1 + r_t), \tag{2}$$

where A_t is household's wealth per capita, Y_t is labor income at time t, and r_t is the real interest rate. Earnings (Y_t) and the real interest rate are treated as stochastic. Households use their savings in various investment options with return r_t. Or, if $(A_t + Y_t - C_t)$ is negative, they borrow from credit markets or other households with positive savings.

The above basic model of intertemporal choice ignores a number of important dimensions of livelihood strategies of typical developing country households. First, there may not be clear-cut separability between capital income from asset accumulation (A_t) and labor income (Y_t). Second, we assume that households can borrow and lend freely at the same discount rate. In practice, credit markets are not readily available in developing areas, and their accessibility differs between the wealthy and the poor. The implications of these stylized facts are discussed below.

Dynamic optimization can be used to solve the problem implied by (1) and (2). Optimization leads to standard Euler equations. Assume that r_t is constant and that the instantaneous utility function $U_t(C_t) = U(C_t)$ for all t. Define $\Omega(C)$ to be the derivative of $U(C)$; then the solution to the problem becomes

$$\left(\frac{1 + r}{1 + \Theta}\right) E_t[\Omega(C_{t+1})] = \Omega(C_t). \tag{3}$$

Equation (3) implies that the marginal rate of substitution between consumption in two periods should equal the expected marginal rate of transformation. The parameters r and Θ control the rate at which expected marginal utility tomorrow is discounted relative to marginal utility today.

B. Permanent Income and Life Cycle Models

Both the permanent income model and the life cycle model are special cases of the above model.[12] Suppose that the rate of time preference (Θ) is the same as the interest rate (r) and the instantaneous utility functions are quadratic so that the marginal utility functions are linear; then (3) becomes

$$C_t = E_t(C_{t+1}). \tag{4}$$

Equation (4) says that consumption is a martingale, a stochastic process whose expected value is its current value. The optimal path of consumption is such that consumption is expected to be constant over the remainder of the decision

horizon. This condition, along with the budget constraint, implies that, for a quadratic utility function, consumption is a linear function of expected lifetime wealth. In life cycle models, where the focus is more on age profile than uncertainty, the martingale property of consumption and saving becomes the constant consumption property of the simplest of such models. The permanent income hypothesis essentially has the same interpretation, saying that consumption is equal to permanent income, defined as the annuity value of the sum of current assets and the discounted present value of expected future earnings.

However, when people invest and save in different ways, such as through mutual reciprocity agreements or investments in human capital, there is less need for saving and dissaving schemes in the way that both models portray.[13] Including household characteristics such as age and composition in the model as factors affecting the marginal utility of consumption, in addition to consumption itself, may help address the shortcoming of the life cycle models. Let $\boldsymbol{Z}_t$ be a set of household characteristics. A version of (3) with such properties can be defined as

$$\Omega(C_t, \boldsymbol{Z}_t) = \left(\frac{1+r}{1+\Theta}\right)\Omega(C_{t+1}, \boldsymbol{Z}_{t+1}). \tag{3'}$$

Thus the age profile of consumption is determined by household characteristics and the relationship between r and Θ. In the following sections, we present peculiarities of developing country conditions that further challenge the assumptions of the basic model above.

C. Modifications to the Basic Household Choice Model

The permanent income and life cycle models, where consumption depends on lifetime resources or permanent income, make an explicit assumption that households are able to borrow at interest rate r. In fact, interest rates vary according to assets and to access to credit markets. Thus, the poor are unlikely to fully smooth consumption by either borrowing from formal creditors or engaging in informal risk-sharing mechanisms, leaving agents to undertake consumption smoothing by relying on their own portfolio of assets. In fact, this environment characterizes the realities of most people in developing countries, particularly in sub-Saharan Africa. In the absence of credit markets, developing country households are forced to undertake their own insurance mechanism by storing their wealth and surpluses from good times for down times that they know will inevitably come.

What happens if one year's shocks are not independent of next year's? This may be typically the case for developing country households whose livelihood and employment depend on mainly rain-fed agriculture in which weather-related shocks could make harvests serially correlated across years.[14] Alternatively, political or macroeconomic shocks could presage long periods of unstable conditions. Under such scenarios, consumption-smoothing pre-

scriptions derivable from permanent income models would not hold. As information sets are updated, expectations change, and agents who foresee worse times ahead may rationally destabilize ("unsmooth") consumption and maintain their wealth base. An optimal response thus takes into account expectations about whether next year will be worse or better or about whether the household will be able to borrow next year.[15] These considerations exacerbate current inability to borrow to facilitate the trade-off between consumption now and in the future.

The permanent income and life cycle models also do not address cases with uncertainty and when household marginal utility is not linear. Clearly, households face substantial uncertainty in most developing countries. Moreover, A. Deaton argues that marginal utility may well be convex for households in developing countries.[16] This convexity has important behavioral implications. Assume that the interest rate is constant at the subjective discount rate so that equation (3′) becomes

$$\Omega(C_t, \boldsymbol{Z}_t) = E_t[\Omega(C_{t+1}, \boldsymbol{Z}_{t+1})]. \tag{5}$$

Equation (5) implies that, if a household is risk averse, an increase in the variance of consumption decreases expected utility. But the effect on consumer behavior (i.e., on the Euler equation) depends on whether it affects the consumer's marginal utility. Since marginal utility is linear for quadratic utility, an increase in variance of consumption has no effect on expected marginal utility, and thus no effect on behavior. As argued above, a convex marginal utility function is plausible for a typical developing country household, and an increase in uncertainty will raise expected marginal utility. To maintain the identity in (5), expected future consumption must increase as compared to current consumption. Uncertainty thus leads consumers to defer consumption, to be more cautious. More income uncertainty and higher risk aversion lead to lower consumption and more prudent behavior.[17]

III. The Empirical Approach

Assume that consumption and savings are linear functions of permanent income (Y_{it}^P), transitory income (Y_{it}^T), income variability (VY_{it}), and a set of variables that measure the life cycle stage of a household ($\mathbf{LC}_{it}$):

$$\boldsymbol{H}_{it} = \Phi_0 + \Phi_1 Y_{it}^P + \Phi_2 Y_{it}^T + \Phi_3 \mathrm{VY}_u + \Phi_4 \mathbf{LC}_{it} + \varepsilon_{it}, \tag{6}$$

where $\boldsymbol{H}_{it} \equiv \{\mathrm{CONS}_{it}, \mathrm{SAV}_{it}\}$ is a vector of real per capita consumption and per capita saving instruments for household i in time period t ($t = 1990/91$ or $1995/96$), and ε_{it} is an error term. Real per capita consumption (CONS_{it}) includes consumption expenditures on food, health care, schooling, and other items. Real savings (SAV_{it}) includes monetary savings, the net of loans taken and loans paid, purchase and sale of financial stocks, bank deposits and withdrawals, and physical asset savings (i.e., net of purchases and sales of physical assets such as land, livestock, buildings, household durables, etc.).

From the theory of permanent income, we expect the coefficient on

permanent income in the $CONS_{it}$ equation (the propensity to consume out of permanent income) to be significantly higher than the coefficient on transitory income (the propensity to consume out of transitory income). For a constant absolute risk aversion (CARA) form utility function, we expect the coefficient on VY_{jt} (i.e., the impact of variability of income on consumption) to be negative for consumption and positive in the savings equations, due to precautionary savings by households. For a quadratic utility function, the coefficient on VY_{jt} will be zero for all equations.

The explanatory variables are either directly obtained from the Zimbabwe Income, Consumption, and Expenditure Surveys (ICES) of 1990/91 and 1995/96 (discussed further below) or derived from them with the exception of the instrumental variables employed as a proxy for income variability. Estimating income variability (VY_{jt}) requires panel data, which do not exist in our case. Instead, VY_{it} is instrumented by a set of variables measuring the variability of regional rainfall on the grounds that more variable rainfall leads to more variable income for both rural and urban households, particularly in the predominantly agricultural economy of Zimbabwe. Standard deviations of regional and seasonal rainfall (planting, weeding, and harvesting periods) over 8 years are used as instruments.

The life cycle measures ($\mathbf{LC_{it}}$) are variables for the number of household members in different age categories. We include the number of household members in five different age categories (<6 years, 6–11 years, 12–17 years, 18–64 years, >64 years). Households with many young children and old members may save less since their present income is less than the annuity value of their wealth. According to the old age hypothesis, households may opt to spend on children as a substitute to saving with the view that children will take care of the parents at old age.[18]

A. Permanent and Transitory Incomes

While this study addresses issues more general than those in the permanent income hypothesis, we begin with a decomposition of income into permanent and transitory components—using a methodology formulated by C. H. Paxson and later adapted by H. Alderman.[19] Paxson, in her study of the savings behavior of Thai farm households, used time-series information on regional rainfall in conjunction with cross-sectional data on farm household income to obtain estimates of components of household income attributed to rainfall shocks.[20] She assumed that rainfall variation produces shocks to income but has no direct effect on consumption so that part of each household's income explained by shocks to regional rainfall serves as an explicit measure of transitory income. The part of household income explained by households' permanent variables (such as household members in different age, sex, and education categories) serves as an explicit measure of permanent income. Finally, residual income is that part of household income unexplained by either transitory or permanent variables.

We follow this approach in instrumenting income variability. However, while Paxson's sample was entirely rural, our sample includes urban households as well. The extension of rainfall variability as an instrument of income variation in urban areas is based on the assumption that there are strong urban-rural linkages in developing countries such as Zimbabwe through food markets and other factors.[21] In order to make the rainfall variables better instruments, we employ national average rainfall information for the capital city Harare. For all other urban areas, we use rainfall information for the region in which the urban area is located.[22]

Total household income is usually estimated as a sum of household earnings from sources such as wages, farming, business, interest, and rent from physical capital assets. However total income can also be derived from the outlays where it may be spent, such as consumption and savings. In the current study, since the Zimbabwe ICES does not lend itself to the first approach, household income is derived from different consumption and saving types.

More specifically, let Y_{it} be a derived income for household i at survey period t. Income can be derived using the following identity:

$$Y_{it} \equiv \text{CONS}_{it} + \text{SAV}_{it}. \tag{7}$$

Total household income at any given period is also made up of permanent income (denoted by Y_{it}^{P}) and a random transitory income component (denoted by Y_{it}^{T}), which can be positive, negative, or zero. The variable Y_{it}^{T} represents current deviations from permanent income. Therefore, households' derived income, Y_{it}, can be decomposed into permanent and transitory components:

$$Y_{it} = Y_{it}^{P} + Y_{it}^{T}. \tag{8}$$

Define $\boldsymbol{X_{it}}$ to be the set of all variables important in determining income for household i at time t. The variables in $\boldsymbol{X_{it}}$ may be divided into two categories—those that affect the permanent component of total income (denoted by $\boldsymbol{X_{it}^{P}}$) and those that affect its transitory component and income variability (denoted by $\boldsymbol{X_{it}^{T}}$). The variables in $\boldsymbol{X_{it}^{P}}$ and $\boldsymbol{X_{it}^{T}}$ are made mutually exclusive in order to facilitate the decomposition of income into permanent and transitory components, although strictly speaking this is not necessary. Assume that a household's permanent income (Y_{it}^{P}) is a linear function of variables in $\boldsymbol{X_{it}^{P}}$:

$$Y_{it}^{P} = \alpha_{t}^{P} + \alpha_{0r} + \boldsymbol{\alpha_{P}} \boldsymbol{X_{it}^{P}} + \eta_{it}^{P}, \tag{9}$$

where η_{it}^{P} are error terms. The parameter α_{t}^{P} represents a year effect common to all households, α_{0r} is a regional fixed effect that captures the influence of region-specific variables (such as location, prevailing weather conditions, sectoral differences, etc.) on income generation of households living in region r, and $\boldsymbol{\alpha_{P}}$ is a parameter vector associated with $\boldsymbol{X_{it}^{P}}$. Variables in $\boldsymbol{X_{it}^{P}}$ include family composition variables measuring the number of household members in different age, sex, and education categories, and an asset index variable.

In similar fashion, transitory income is defined as a linear function of $\boldsymbol{X_{it}^T}$, a vector of variables that mainly influence the transitory component of observed income:

$$Y_{it}^T = \alpha_t^T + \boldsymbol{\alpha_T X_{it}^T} + \eta_{it}^T, \tag{10}$$

where η_{it}^T represents the error term associated with the estimation of transitory income; α_t^T is a year effect, common to all households; and $\boldsymbol{\alpha_T}$ is a parameter vector associated with $\boldsymbol{X_{it}^T}$. The variables used in $\boldsymbol{X_{it}^T}$ to estimate the transitory component of income are regional rainfall deviations from long-range normal precipitation. These were obtained from 10 major weather stations and catchments.

Equations (9) and (10) can be substituted into (6) for Y_{it}^P, and Y_{it}^T, respectively, to estimate the structural consumption and savings equations. Also, we can combine equations (9) and (10) and use the identity in equation (8) to estimate total income:

$$Y_{it} = \alpha_t + \boldsymbol{\alpha_P X_{it}^P} + \boldsymbol{\alpha_T X_{it}^T} + \eta_{it}, \tag{11}$$

$$H_{it} = \Phi_{0t} + \Phi_1\left(\alpha_{0r} + \boldsymbol{\alpha_P X_{it}^P}\right) + \Phi_2\left(\boldsymbol{\alpha_T X_{it}^T}\right) + \Phi_3 \mathrm{VY}_{it} + \Phi_4 \mathbf{LC_{it}} + \varepsilon_{it}, \tag{12}$$

where $\alpha_t = \alpha_t^P + \alpha_t^T$, and $\Phi_{0t} = \Phi_0 + \alpha_t^P\Phi_1 + \alpha_t^T\Phi_2$. The reduced form for consumption and savings is expressed as

$$H_{it} = \lambda_t + \lambda_{0r} + \boldsymbol{\lambda_P X_{it}^P} + \boldsymbol{\lambda_T X_{it}^T} + \nu_{it}, \tag{13}$$

where ν_{it} is a vector of error terms. The parameter λ_t measures the year effect. Note that the reduced-form equations do not explicitly contain either VY_{it} or $\mathbf{LC_{it}}$ since both are part of the determinants of household's permanent income. The variable VY_{it} does not vary across households within the same region, and its effects are subsumed in the regional fixed effects λ_{0r}. Similarly, the variables in $\mathbf{LC_{it}}$ are sums of the age/sex/education variables in $\boldsymbol{X_{it}^P}$. As a result, the elements of $\boldsymbol{\lambda_P}$ that correspond to age/sex/education variables reflect the impact of these variables on consumption and savings through their effects on permanent income as well as through life cycle effects. The parameter vector $\boldsymbol{\lambda_T}$ measures the impact of regional rainfall ($\boldsymbol{X_{it}^T}$) on consumption/savings through its effect on the transitory income. Equations (11) and (13) consist of three equations (income, consumption, savings), of which only two are independent since equation (7) has to hold. The estimates of these equations can be used to test a number of hypotheses of interest in this study.

While equation (13) gives reduced-form estimates of the parameters in equation (6), we can estimate them directly using a two-stage estimation. First, using ordinary least squares, we estimate equations (11). The resulting parameters can be used to decompose the total income into its estimated per-

manent (Y_{it}^P) and transitory (Y_{it}^T) incomes. The remainder residual income is obtained as follows:

$$\hat{Y}_{it}^R = Y_{it} - \hat{Y}_{it}^P - \hat{Y}_{it}^T. \tag{14}$$

Conceptually, income has three components (permanent, transitory, and residual). The residual component is excluded from the structural equation below since it will necessarily be correlated with the error terms.[23] Such exclusion, however, will not lead to an omitted variable problem, since by design the residual component is orthogonal to the other two. We estimate the structural equation (6) as

$$H_{it} = \beta_0 + \beta_1 \hat{Y}_{it}^P + \beta_2 \hat{Y}_{it}^T + \beta_3 \mathrm{VY}_{it} + \boldsymbol{\beta}_4 \mathbf{LC}_{it} + \zeta_{it}, \tag{15}$$

where ζ_{it} is a vector of error terms. Using (15), we can directly test the implications of the permanent income hypothesis and examine changes in consumption and saving behavior using parameter estimates on permanent and transitory incomes and income variability. The coefficient on the proxy for income variability (VY_{it}) is used to see if households are risk averse and employ precautionary behavior to safeguard their consumption from income shocks. We compare all corresponding coefficients across time to investigate changes in consumption and saving behavior. Finally, we estimate multiple regression regimes by dividing the sample by relative wealth levels to examine if the degree of consumption smoothing differs by household wealth.

Several econometric issues need to be addressed in order to achieve consistent estimation and testing using equation (15). The first is the issue of measurement error typical of income and saving data in developing countries. As mentioned, the income variable was derived from consumption and savings. Moreover, instead of equating saving as a residual between income and consumption, the saving variable was directly derived from the ICES. This construction avoids the spurious correlation between saving and income in the structural estimates that would result if saving were derived from the difference between income and consumption. Since income is instrumented, we avoid introducing a new correlation of error terms otherwise attributed to the manner of constructing income using saving and consumption.

Finally, in order to obtain consistent estimates of the consumption and savings equations (15), we assume that the estimates of permanent and transitory incomes are consistent and are uncorrelated with ζ_{it}. However, this procedure does not produce the correct estimates of the covariance matrix for the parameters since Y_{it}^P and Y_{it}^T are predicted values. Therefore, for the purpose of hypothesis testing, test statistics using estimates of the asymptotic covariance matrix were employed.[24]

B. Tests on Saving Behavior and Parameter Stability

The estimates from equations (11) and (13), together with the estimates of equation (15), can be used to test the implications of the permanent income

hypothesis (PIH) and to analyze changes in saving behavior across survey years. From the PIH standpoint, we expect the propensity to consume out of permanent income to be close to unity. In the case of equations (11) and (13), this means that the impact of variables in $\boldsymbol{X}_{it}^{P}$ on CONS_{it} and Y_{it} should be similar (i.e., $\boldsymbol{\lambda_P} = \boldsymbol{\alpha_P}$). We also test if the joint impact of $\boldsymbol{X}_{it}^{T}$ on consumption is significant. The propensity to save out of transitory income is expected to be close to unity, which, in our model, implies that $\boldsymbol{\lambda_T}$ in the savings equation should be close to $\boldsymbol{\alpha_T}$. Put differently, the impact of rainfall variability on income should be identical to its impact on saving. The acceptance of this last test means that households do in fact use saving and dissaving to smooth consumption.

The coefficients in the structural equation (15) can be used to directly conduct the above tests. For the PIH, we can test hypotheses H_0: $\beta_1 = 1$, H_0: $\beta_2 = 0$, and H_0: $\beta_1 > \beta_2$ for the per capita real consumption equation. Failure to reject these hypotheses indicates that household consumption follows the PIH and that households use savings to reduce consumption fluctuations. Similarly, on the savings side, the reverse hypotheses are tested on total savings; that is, H_0: $\beta_1 = 0$, H_0: $\beta_2 = 1$, and H_0: $\beta_1 < \beta_2$. Finally, we can test if the coefficients on rainfall variability (a proxy for income variation) $\boldsymbol{\beta}_3$ are negative for consumption and positive for saving. Failure to reject this hypothesis indicates that households are risk averse and use precautionary savings to smooth consumption.

The second group of tests investigates whether or not there are any significant structural changes in consumption and saving behavior. The Chow test is the most common one used for structural change. The assumption of the same variance for error terms in both periods is crucial for the validity of the Chow test. Such an assumption fails for the ICES, and, as a result, we revert to the Wald test statistic, which is distributed χ^2 (k) and which takes the form $W = (\mathbf{b}_{1990} - \mathbf{b}_{1996})'Q^{-1}(\mathbf{b}_{1990} - \mathbf{b}_{1996})$. Here $\mathbf{b}_{1990}$ and $\mathbf{b}_{1996}$ are estimated parameter vectors for 1990 and 1996, respectively; k is the number of parameters being tested; and Q is the variance-covariance matrix of $(\mathbf{b}_{1990} - \mathbf{b}_{1996})$. We test the equivalency of the complete parameter vectors as well as subsets for important categories (such as education, asset ownership index, gender, and urban-rural variables) before and after economic shocks. We expect changes in household consumption and savings behavior across survey years because of the economic shocks that occurred during the time between the two surveys.

IV. Country Background and Data

Widespread public debate has emerged about the direction and impact of economic changes in Zimbabwe during the 1990s. These changes include economic liberalization associated with the Economic Structural Adjustment Programme (ESAP), changes in governance such as decentralization, and recurring droughts, among others. The ESAP was launched in December 1991 and was intended to last 5 years. This program was unique among adjustments in African countries in that it was not a response to a crisis per se but represented recognition that

the controlled economy of postindependent Zimbabwe was essentially unsustainable. The objectives of the program were to deregulate the domestic economy, privatize many government-owned parastatals, deregulate prices and wages, and reduce public spending and the central government's budget deficit.

Many of the ESAP reforms were not implemented as planned due to the 1992 drought, which necessitated increased public spending and the relocation of budget money to drought relief. Eventually, trade and exchange rate policies were reformed, food subsidies were removed, and market liberalization was introduced in stages. Maize market reforms began in 1991, but these were subsequently put on hold as a result of the drought. Price controls and marketing restrictions remained in place through 1994. By 1995, however, restrictions on the private movement and sale of grain were removed. The 1991/92 drought was one of the most severe in recent memory and affected all of Southern Africa.[25] The entire economy of Zimbabwe was affected; real GDP per capita shrunk by almost 12% in that year.[26] This decline was associated with a dramatic decrease in agricultural production; maize yields on all farms fell to about one-third of "normal" levels, and agriculture's share of total production fell from about 14% to below 7%. The drought of 1994/95 was less severe, but, coming on the heels of the earlier drought, it may have led to significant increases in poverty, especially among the most vulnerable. For a variety of macroeconomic and political reasons that go beyond the subject of this article, Zimbabwe's economy has been in decline since the 1995 drought.

A. Data

This article uses cross-sectional data from the National Income Consumption and Expenditure Survey (ICES) of 1990/91 and 1995/96 from Zimbabwe. The surveys were undertaken by the Central Statistical Office (CSO) and contain data on sociodemographic characteristics, incomes, receipts from households including agriculture, consumption, and other expenditures on a weekly basis, and for some durable and semidurable items, on a monthly or yearly basis. The surveys were based on representative samples from the urban and rural sectors.

Income is notoriously difficult to measure in a developing country context. Moreover, while the Zimbabwe ICES survey covered an entire year, each recall period spanned only 1 month. Thus, the survey is not optimal to capture seasonal variation in income generation from agricultural and other enterprises. This factor motivates the use of a measure of income based on observed consumption expenditures and saving.

B. Consumption and Savings Measures

The household per capita consumption expenditure variable was created from an extensive list of food and nonfood items from the surveys. The consumption expenditure measure includes market and nonmarket consumption, and consumption flows from ownership of assets. The ICES has detailed information

on expenditures (market, own consumption, gifts, transfers, and payments in kind) for some 250 food items. Since expenditures on durable goods are lumpy, we spread the value of expenditures on them over the estimated lifetime of the good in question. Expenditures on nondurable good items, such as clothing and household furnishings, were recorded for the month of the interview and were directly included. Total consumption was computed as the sum of consumption of food, nondurable goods, and durable goods.

As stated above, we create the per capita savings variable from the survey data instead of defining savings as a residual between observed expenditures and observed income. Total savings (SAV) is the net sum of loans taken and loans paid, purchase and sale of financial stocks, bank deposits and withdrawals, and net purchases and sales of physical assets such as land, livestock, buildings, household durable items, and vehicles. The variable SAV may be underestimated in the case of rural households whose under-the-mattress deposits are not recorded. Descriptive statistics in table 1 show that welfare measures (real income, real consumption, and real savings) and their cross-sectional variability decreased after the economic shocks.

C. Accounting for Human and Capital Assets

Ownership or access to durable and income-generating assets by households may have an important role in determining consumption and saving behavior. A physical asset index variable was created using the relative prices of all assets owned by households as weights. This variable is assumed to capture the role of physical assets ownership on income generation, consumption, and the savings decision.

Another category of household asset is human capital. Several variables were created with different age/sex/education categories to address the importance of human capital assets in molding consumption and saving behavior. Descriptive statistics show that most age/sex/education variables for an average household remained about the same before and after economic shocks, as expected (table 1).

D. The Rainfall Data

Rainfall data were collected from all 10 major catchment areas covering the entire country. Monthly rainfall figures for 7 months (October–April) from 1989 to 1996 and for normal monthly precipitation were obtained from Central Statistical Office (CSO) of Zimbabwe. October and November constitute the planting season. December and January are weeding months, while February, March, and April are the main harvest months in Zimbabwe. Three weather variables representing region-specific rainfall in the three periods (planting, weeding, and harvest) of the cropping season were created. The percent deviations in periodic regional rainfall ($RPDEV_t$, $RWDEV_t$, $RHDEV_t$) from normal regional precipitation are used to estimate the transitory income component of household income.

V. Results

Tables 2–7 contain the parameter estimates for income regressions and the consumption and saving equations for 1990/91 and 1995/96. Income was estimated mainly to decompose observed income into permanent and transitory components. These income regression estimates (table 2) show that most explanatory (including rainfall) variables have highly significant effects on income and that returns to human capital and other assets considerably declined in the 1990s. The coefficients and hypothesis test on urban and rainfall interactions indicate that rainfall has a significant impact on livelihood and income generation in urban areas.[27] We next briefly discuss the results of the reduced-form consumption equation (eq. [13]). These results offer a consistency check on our main results from the structural consumption and saving equation estimates, which are shown in tables 5–7.

A. Consumption and Savings before and after Economic Shocks

Regarding reduced form estimates, the reduced-form consumption equations (table 3) for 1990/91 and 1995/96 households show that most explanatory variables have highly significant effects on consumption. The urban-rural dummy variable shows significantly higher consumption in urban areas, conditional on assets; however, the urban sector advantage diminished after the economic shocks. The asset index variable had a significant effect on consumption in both years. As anticipated, consumption increases with greater asset ownership. But, like other determinants of consumption, for a given level of assets, consumption was sharply lower after the economic changes, indicating a worsened economic environment in postdrought and postmacroeconomic adjustment era. The asset ownership index variable was significant in both years, but its effect on consumption was higher before the economic shocks than after—in fact, its impact reduced fivefold from 1990/91 to 1995/96. Households with higher asset holdings also saved more in both years.

The age/sex/education variables have the expected signs and significance. For male household members whose age is between 18 and 64 (the most productive age category), consumption is significantly lower for households with members with primary or lower education level. Members with secondary or higher education have positive impacts on consumption. The rate that consumption increases with additional education fell considerably for all age/sex groups after the macroeconomic changes and the droughts of 1992 and 1994. This reflects the decline in overall productivity due to macroeconomic instability evidenced in the 1990s.

The sign and significance on the household head sex variable indicate that, even after accounting for differences in assets, education, and household labor availability, male-headed households are better off than female-headed ones. The relative impact of this gender variable remained about the same across survey periods. Households with many young members have lower consumption expenditures per capita, as do those with many elderly members.

TABLE 1

VARIABLES USED

VARIABLE	DEFINITION	1990/91		1995/96	
		Mean	SD	Mean	SD
RINC	Real per capita income	104.082	13,728.1	67.682	12,021.2
RCONS	Real per capita consumption	93.562	4,375.8	68.153	3,431.6
RSAV	Real total per capita savings	10.520	12,874.4	−.471	11,634.3
RREMITR	Real per capita remittances received	10.540	738.1	6.733	1,233.1
RPENSION	Real per capita pension income	1.044	450.4	.981	447.2
HEAD	Household head (male, female)	.680	11.7	.681	11.5
AGE0_5	Household members age ≤ 5 years	1.280	30.2	1.104	25.8
MAL6_11	Males between 6 and 11 years	.738	22.0	.611	19.5
MAL12_17	Males between 12 and 17 years	.611	20.2	.573	19.2
M18_64PE	Males between 18 and 64 with ≤ primary education	.623	17.5	.595	17.9
M18_64SE	Males between 18 and 64 with secondary education	.549	20.1	.527	19.5
M18_64HE	Males between 18 and 64 with postsecondary education	.012	3.0	.083	7.4
FEM6_11	Females between 6 and 11 years	.738	22.2	.624	20.0
FEM12_17	Females between 12 and 17 years	.606	20.1	.592	19.2
F18_64PE	Females between 18 and 64 with ≤primary education	1.028	20.1	.943	19.8
F18_64SE	Females between 18 and 64 with secondary education	.448	18.2	.478	17.5
F18_64HE	Females between 18 and 64 with postsecondary education	.004	1.7	.059	6.5
MAL65_	Elderly males (age ≥ 65 years)	.092	7.3	.089	7.1
FEM65_	Elderly females (age ≥ 65 years)	.082	7.0	.085	7.0

NATYPE	Index of asset types owned	1.819	53.3	1.854	49.0
CATTLE	Number of cattle owned	3.605	206.9	2.961	195.6
TV	Ownership of a television (yes, no)	.114	8.0	.194	9.7
RADIO	Ownership of radio (yes, no)	.414	12.4	.513	12.3
UR	Urban-rural dummy (1 = urban, 0 = rural)	.308	11.6	.325	11.6
CA	Communal area dummy	.554	12.5	.533	12.3
SSCF	Small scale commercial farm dummy	.009	2.4	.024	3.8
LSCF	Large scale commercial farm dummy	.099	7.5	.094	7.2
RA	Resettlement area dummy	.029	4.2	.024	3.8
RPDEV	Planting period rainfall deviations	11.237	567.7	−18.217	241.4
RWDEV	Weeding period rainfall deviations	8.872	394.4	−8.528	406.3
RHDEV	Harvesting period rainfall deviations	−33.238	335.0	−58.008	323.6

SOURCES.—Authors' calculations are from the National Income Consumption and Expenditure Survey (ICES) of 1990/91 and 1995/96 from Zimbabwe. The time-series data on rainfall were reported from 10 weather stations.

NOTE.—For 1990/91, $N = 14{,}116$; for 1995/96, $N = 17{,}527$. Monetary variables are adjusted by the 1990 Harare CPI (consumer price index) to get real values from the nominal figures derived from the survey. Cattle ownership is reported only for rural households.

TABLE 2

INCOME REGRESSIONS FOR 1990/91 AND 1995/96

VARIABLE	1990/91		1995/96	
	Estimate	*t* Value	Estimate	*t* Value
Constant	38.534	1.07	22.091	6.47
Urban (urban = 1, rural = 0)	49.673	6.55	24.677	7.76
Index of assets owned	35.291	4.15	17.486	28.14
Household head sex (male = 1, female = 0)	26.784	3.23	22.616	5.11
Household members age ≤ 5 years	−21.310	−6.66	−25.809	−8.47
Males between 6 and 11 years	−23.511	−6.17	−16.341	−9.38
Males between 12 and 17 years	−21.073	−5.64	−20.384	−6.56
Males between 18 and 64 with ≤ primary education	−30.574	−5.99	−17.333	−6.97
Males between 18 and 64 with secondary education	17.149	4.96	14.164	8.44
Males between 18 and 64 with postsecondary education	93.658	4.45	45.492	10.25
Females between 6 and 11 years	−22.069	−5.4	−18.234	−9.08
Females between 12 and 17 years	−18.930	−4.22	−22.882	−10.39
Females between 18 and 64 with ≤ primary education	−32.828	−6.48	−14.946	−8.41
Females between 18 and 64 with secondary education	33.053	7.34	23.594	2.87
Females between 18 and 64 with postsecondary education	47.622	4.36	28.767	2.83
Elderly males (age ≥ 65 years)	−34.440	−3.06	−33.953	−7.11
Elderly females (age ≥ 65 years)	−6.714	−.86	−26.184	−5.42
Planting period rainfall deviations	−.391	−1.92	−2.634	−2.54
Weeding period rainfall deviations	.367	1.33	−1.512	−4.5
Harvesting period rainfall deviations	−5.409	−2.66	3.091	2.85
Planting period rainfall deviations squared	−.003	−.73	−.051	−3.85
Weeding period rainfall deviations squared	.002	.16	.001	.57
Harvesting period rainfall deviations squared	−.074	−2.85	.004	2.41
Urban × planting period rainfall deviations	.026	1.72	−.03	−2.02
Urban × weeding period rainfall deviations	−.003	−.27	.002	1.52
Urban × harvesting period rainfall deviations	−.041	−2.81	−.001	−1.27
Number of observations	14,116		17,527	
R^2	.263		.319	
Hypothesis test:*				
Test 1	9.35		2.57	
	(.000)		(.0059)	
Test 2	6.38		2.18	
	(.000)		(.088)	

NOTE.—The dependent variable is capital real income.

* Hypotheses tests report χ^2 (Wald test) statistics; *P* values are in parentheses. Test 1: joint test that the coefficients on rainfall variables are zero; test 2: joint test that the coefficients on rainfall variables are zero in urban areas.

TABLE 3

REDUCED-FORM REAL CONSUMPTION ESTIMATES FOR 1990/91 AND 1995/96

VARIABLE	1990/91		19/96	
	Estimate	*t* Value	Estimate	*t* Value
Constant	31.32	4.94	21.30	7.61
Urban (urban = 1, rural = 0)	50.87	4.08	27.84	5.84
Index of assets owned	30.21	5.28	10.39	3.84
Household head sex (male = 1, female = 0)	13.21	3.53	13.84	6.21
Household members age ≤ 5 years	−17.82	−12.45	−20.58	−2.38
Males between 6 and 11 years	−21.86	−11.82	−15.64	−2.75
Males between 12 and 17 years	−20.02	−10.06	−17.62	−4.01
Males between 18 and 64 with ≤ primary education	−28.93	−11.2	−13.79	−8.78
Males between 18 and 64 with secondary education	17.10	8.34	16.44	2.9
Males between 18 and 64 with postsecondary education	66.59	5.77	31.20	9.78
Females between 6 and 11 years	−20.65	−11.28	−14.44	−5.9
Females between 12 and 17 years	−18.60	−9.27	−16.51	−3.18
Females between 18 and 64 with ≤ primary education	−26.78	−11.81	−13.39	−4.78
Females age between 18 and 64 with secondary education	21.12	9.09	16.34	2.61
Females age between 18 and 64 with postsecondary education	36.79	1.96	28.66	3.97
Elderly males (age ≥ 65 years)	−35.07	−6.5	−28.60	−8.56
Elderly females (age ≥ 65 years)	−18.28	−3.54	−17.69	−5.71
Planting period rainfall deviations	−.18	−2.06	−3.09	−4.06
Weeding period rainfall deviations	−.21	−1.05	−1.55	−7.08
Harvesting period rainfall deviations	−3.02	−2.69	3.41	3.47
Planting period rainfall deviations squared	−.04	−5.43	−.11	−4.45
Weeding period rainfall deviations squared	.02	2.7	−.05	−5.59
Harvesting period rainfall deviations squared	−.04	−2.6	.03	2.94
Number of observations	14,116		17,527	
R^2	.367		.287	
Hypothesis test:*				
Test 1	6.78		9.48	
	(.009)		(.002)	
Test 2	1.98		16.92	
	(.1692)		(.000)	

NOTE.—The dependent variable is per capita real consumption.

* Hypotheses tests report χ^2 (Wald test) statistics; *P* values are in parentheses. Test 1: joint test that the coefficients on rainfall variables on consumption are zero; test 2: test that the permanent income variable, the index of asset types owned, has same effect on consumption as on income.

Having many elderly and younger household members also means significantly negative savings. The family composition variables thus follow notions of life cycle models for both survey years.

Turning to the primary focus on saving and consumption smoothing, we note that most transitory rainfall variables are jointly (and often individually) significant; see hypothesis test 1 in table 3. Rainfall deviations from long-

term normal precipitation have significant unfavorable impacts on consumption expenditures.

While positive savings accompanied rainfall variability (standard deviations using 8-year time-series data on regional rainfall) in 1990/91, such deviations had no significant effect in 1995/96 (table 4). Since rainfall variability is employed as a proxy for income variability, this result implies that household saving behavior in 1990/91 was more precautionary than it was in 1995/96. Lack of precautionary response to rainfall variability following the drought and structural changes may be explained by the urgency of current needs and the lack of economic resources to save for future use.

B. Two-Stage Estimates

Consumption out of permanent and transitory incomes. The two-stage structural estimates provide us with a clear look at household saving and consumption behavior (eq. [15]) since we explicitly have permanent and transitory incomes as regressors (see tables 5 and 6). The predrought and macroeconomic adjustment results support the implication that households consume the majority of their permanent income (about 89%). In 1990/91, households consumed 47% of their transitory income. The consumption out of transitory income is certainly larger than standard permanent income hypothesis models would predict. However, it is significantly smaller than the consumption out of permanent income, thus lending some support to the nonpolar case of permanent income hypothesis. On the other hand, the 1995/96 data reveal that households consumed nearly all of their transitory income (97%) and about 83% of their permanent income. Thus, both the reduced-form and two-stage estimations show that Zimbabwe households' consumption behavior has changed in the 1990s. The postdrought and macroeconomic trend has been to use all sources of incomes for current consumption. Looked at from a different viewpoint, this information shows that, after the shocks, consumption closely tracked incomes; when transitory shocks are negative, households reduce consumption in response. Dissavings strategies were not common means of smoothing after the shocks, while predrought households used savings and dissavings to smooth consumption.

The empirical results show that household per capita consumption decreases with additional young and elderly members in both survey years (table 5). This finding is not contrary to the old age security hypothesis that people depend on their children for provision when they are old. It is interesting to note that, although household consumption and saving behavior changed over the 1990s, the family composition effect and its dependency structure remained intact even in the face of growing economic shocks.

Since rainfall variability is used as a proxy for income variability, we expect that, if households have precautionary saving, it will have negative effect on consumption. This measure of income variability does not vary across households in the same region; caution should be taken in interpreting the results. Controlling for the amount of transitory income, households with

TABLE 4

REDUCED-FORM ESTIMATES: TOTAL SAVINGS

VARIABLE	1990/91		1995/96	
	Estimate	*t* Value	Estimate	*t* Value
Constant	7.348	1.29	−10.329	−1.99
Urban (urban = 1, rural = 0)	13.444	4.57	3.969	2.35
Index of assets owned	2.187	4.44	.744	1.52
Household head sex (male = 1, female = 0)	2.626	2.77	.628	1.36
Household members age ≤5 years	−1.085	−3.01	−.655	−3.44
Males between 6 and 11 years	.073	.16	−.566	−2.23
Males between 12 and 17 years	−.390	−.78	−.652	−2.51
Males between 18 and 64 with ≤ primary education	−3.605	−5.54	−.569	−1.75
Males between 18 and 64 with secondary education	−1.022	−1.98	−.771	−2.93
Males between 18 and 64 with postsecondary education	29.183	10.04	7.347	11.12
Females between 6 and 11 years	−.107	−.23	−.042	−.17
Females between 12 and 17 years	.974	1.93	−.177	−.68
Females between 18 and 64 with ≤ primary education	−2.785	−4.88	−.784	−2.77
Females between 18 and 64 with secondary education	.620	1.06	−.653	−.5
Femalesbetween 18 and 64 with postsecondary education	35.796	7.58	8.370	5.61
Elderly males (age ≥ 65 years)	−7.371	−5.42	−1.966	−2.84
Elderly females (age ≥ 65 years)	−2.702	−2.08	−1.327	−2.07
Planting period rainfall deviations	.048	2.11	.104	.66
Weeding period rainfall deviations	.009	.17	−.013	−.28
Harvesting period rainfall deviations	.176	.62	.224	1.1
Planting period rainfall deviations squared	.004	2.08	.002	.46
Weeding period rainfall deviations squared	.003	1.29	.001	.29
Harvesting period rainfall deviations squared	.003	.88	.001	.62
Number of observations	14,116		17,527	
R^2	.20		.26	
Hypothesis test:*				
Test 1	9.23		3.16	
	(.002)		(.075)	
Test 2	4.44		10.52	
	(.035)		(.001)	
Test 3	2.32		7.40	
	(.1197)		(.006)	

NOTE.—The dependent variable is per capita real total savings.

* Hypotheses tests report χ^2 (Wald test) statistics; *P* values are in parentheses. Test 1: joint test that the coefficients on rainfall variables on savings are zero; test 2: test that the asset index variable has insignificant effect on savings; test 3: test that the transitory rainfall variables have the same effect on savings as on income.

TABLE 5

TWO-STEP ESTIMATION: CONSUMPTION

VARIABLE	1990/91		1995/96	
	Estimate	*t* Value	Estimate	*t* Value
Constant	43.433	8.34	40.672	5.69
Estimated permanent income	.885	5.45	.830	8.93
Estimated transitory income	.467	4.24	.967	6.06
Household members ages ≤ 5 years	−2.625	−1.31	−.225	−.21
Household members ages between 6 and 11 years	−4.163	−2.21	.970	1.00
Household members ages between 12 and 17 years	−3.504	−1.76	1.649	1.67
Household members ages between 18 and 64 years	.926	1.56	1.187	2.39
Household members age ≥ 65 years	−3.048	−.67	.226	1.49
Planting period rainfall deviations	−1.461	−5.08	−.005	−.32
Weeding period rainfall deviations	.501	1.38	.037	.08
Harvesting period rainfall deviations	−.305	−1.12	−.117	−1.73
Number of observations	14,116		17,527	
R^2	.609		.7330	
Hypothesis test:*				
Test 1	15.82		31.89	
	(.000)		(.0000)	
Test 2	71.60		2.95	
	(.000)		(.0856)	
Test 3	12.43		1.61	
	(.0000)		(.1923)	

NOTE.—Results are obtained by a two-step procedure: first, obtaining the measures of income types (permanent and transitory incomes) and, finally, estimating a system consisting of consumption and savings. Asymptotic variance estimates are used in testing hypotheses.

* Hypotheses tests report χ^2 (Wald test) statistics; *P* values are in parentheses. Test 1: propensity to consume out of permanent income is unity (i.e., $\beta_1 = 1$); test 2: propensity to consume out of permanent income is not greater than that out of transitory income (i.e., $\beta_1 = \beta_2$); test 3: joint effect of transitory rainfall variability is insignificant (i.e., $\beta_3 = 0$).

greater rainfall variability had significantly less consumption in 1990/91, but rainfall's effect was not significant in 1995/96. This implies precautionary behavior for 1990/91, while such prudent behavior is not observed in post-drought and structural adjustment consumption behavior. Investment strategies do not depend on the degree of rainfall variability in the latter period.

Savings out of permanent and transitory incomes. The savings estimates in table 6 (eq. [15]) show that households in both years saved small but significant fractions of their transitory income. The fraction saved in 1990/91 is considerably higher than that in 1995/96. Household saving increased with rainfall variability before the drought and structural changes. Conversely, rainfall variability does not seem to have much effect on savings of the 1995/96 households except that harvest-period rainfall variability showed a positive

TABLE 6

TWO-STEP ESTIMATION: TOTAL SAVINGS

VARIABLE	1990/91		1995/96	
	Estimate	*t* Value	Estimate	*t* Value
Constant	10.003	5.65	−7.61	−1.88
Estimated permanent income	.065	3.77	.120	2.64
Estimated transitory income	.375	3.37	.076	2.87
Household members age ≤ 5 years	2.249	1.00	−.304	−.29
Household members ages between 6 and 11 years	3.077	2.83	1.037	5.57
Household members ages between 12 and 17 years	1.332	.6	1.048	5.36
Household members ages between 18 and 64 years	−1.124	−1.25	.750	5.05
Household members age ≥ 65 years	5.594	2.45	.47	.89
Planting period rainfall deviations	1.607	7.08	−.04	−.75
Weeding period rainfall deviations	.053	.42	.024	1.45
Harvesting period rainfall deviations	.116	1.20	−.06	−2.14
Number of observations	14,116		17,527	
R^2	.5839		.400	
Hypothesis test:*				
Test 1	10.88		23.34	
	(.001)		(.000)	
Test 2	77.42		1.77	
	(.000)		(.1834)	
Test 3	21.54		2.19	
	(.000)		(.1389)	

NOTE.—Results are obtained by two-step procedure: first, obtaining the measures of income types (permanent and transitory incomes) and, finally, estimating a system consisting of consumption and savings. Asymptotic variance estimates are used for testing hypotheses.

* Hypotheses tests report χ^2 (Wald test) statistics; *P* values are in parentheses. Test 1: propensity to save out of transitory income is unity (i.e., $\beta_2 = 1$); test 2: propensity to save out of transitory income is not greater than that out of permanent income (i.e., $\beta_1 = \beta_2$); test 3: joint effect on savings of transitory rainfall variability is insignificant (i.e., $\beta_3 = 0$).

effect on saving. This result shows that household precautionary savings could not be maintained as a result of severe constraints emanating from the unfavorable changes in the 1990s.

These results, along with the results from the consumption equations, indicate that households in the postdrought and structural adjustment period did not save as much as they did before the changes. There is increased dependence on transitory income as a source of consumption. To phrase this differently, in the face of negative shocks, households allowed consumption to decline more in the latter period. Although we do not have evidence for a polar case of PIH, results indicate that predrought households used savings and dissavings to mitigate income fluctuations, while such behavior was limited afterward. Furthermore, the results show that postdrought and structural

adjustment households do not manifest substantial precautionary saving behavior, while households in the earlier period saved significantly more when their income fluctuation was higher.

C. Evidence against the Permanent Income Hypothesis

The implications of the permanent income hypothesis (PIH) on household consumption and saving behavior and the results of its tests using two-step estimates are statistically equivalent to the ones employing the reduced-form estimates of tables 3 and 4. Thus, to save space, although the test results are reported for both estimates on their respective tables, we discuss only those involving the two-stage estimates. Hypothesis test 1 in table 5 shows that the propensity to consume out of permanent income is lower than unity for both years. Hypothesis test 2 indicates that propensities to consume out of permanent and transitory incomes are about the same in 1995/96, while there is evidence that the former was higher in 1990/91. The test for household precautionary saving behavior (hypothesis 3 in table 5) supports the notion that predrought and structural adjustment household consumption responded negatively to rainfall variability (a proxy for income variability). The latter period households did not respond in statistically significant fashion to income fluctuations (P value $= 0.1923$). Similar hypothesis tests for the savings equations are reported in table 6. Hypothesis 1 (i.e., the propensity to save out of transitory income is unity) is rejected for both years. Hypothesis 2 (the propensity to save out of transitory income is the same as that out of permanent income) shows some support for the PIH in 1990/91 and strong evidence against it for 1995/96. We do not reject the hypothesis (hypothesis 3, table 6) that rainfall variability had no influence on saving in 1995/96—the coefficients are jointly insignificant with a P value of 0.1389. However, they are significant in the regression for 1990/91 (P value < 0.0001).

These tests indicate that changes occurred in household consumption and saving behavior after the weather and economic shocks. In 1990/91, households consumed the majority of their permanent income and less than half of their transitory income. The fact that propensities to consume out of permanent income is statistically less than one and that savings out of it are generally greater than zero indicates that a polar version of the permanent income hypothesis cannot be accepted. The postdrought and structural adjustment households, however, consumed the majority of both permanent and transitory incomes. The lower marginal propensity to save out of transitory income by households in this period relative to the previous implies that they were less likely to draw down assets in the face of negative income shocks. They might be trying to maintain their asset base as a precaution against worse conditions in the future. Saving behavior appears to have been adversely affected by recurring droughts and unfavorable economic changes. Similarly, precautionary savings differ between periods. Higher income variability is associated with reduced consumption indicating prudent behavior on the part of predrought and prestructural adjustment households. Conversely, household con-

sumption and savings did not respond well to income variability following the droughts and structural changes.

D. Differentiated Propensity to Smooth Consumption

Table 7 presents two-stage consumption estimates for the stratified sample of households based on wealth level.[28] We observe important differences in propensities to smooth consumption between the relatively poor and the wealthy. Although polar cases of the permanent income hypothesis are rejected by both groups of households in both survey years, the poor tend to save more of their transitory income than the wealthy do. While this is the case before the economic shocks, consumption out of transitory income significantly increased for both the rich and the poor following the shocks. Both groups of households moved away from consumption smoothing and toward asset-defending behavior. Moreover, precautionary saving behavior is practiced more among the poor, who usually tend to be more credit constrained and more at risk for consumption uncertainty.

These results are in agreement with empirical evidence from other parts of the developing world, such as that reported by Jalan and Ravallion from rural China.[29] The differentiated propensity to save among the poor and the wealthy, as well as the general lack of support to permanent income hypothesis among the Zimbabwean households, may imply that smoothing consumption entails an important cost and the perceived cost level differs by relative wealth level. It might also highlight the difference in credit accessibility among the poor and the rich, and the former pursue a more costly precautionary behavior that could perpetuate poverty.[30] It thus strengthens the incentives and makes it all worthwhile for governmental and nongovernmental efforts to promote credit institutions for financial intermediations for developing countries in general and in poorer communities in particular.

E. Parameter Stability Tests

Table 8 presents the results of a parameter stability test using the Wald statistic. As mentioned, the Wald test statistic is preferred over the Chow test primarily because of the lack of support for equal variances for the two periods, a critical assumption for validity of Chow tests. Parameter stability is rejected both over all parameters and for the subsets of parameters. The test statistic values are extremely high and the *P* values are virtually zero for most tests, rendering strong evidence that returns to education and productive assets have changed significantly after drought and macroeconomic adjustments. This also reinforces our findings in the previous sections that household consumption and saving behavior has changed negatively after the economic shocks.

VI. Summary and Policy Implications

This article analyzed changes in per capita consumption and saving behavior in Zimbabwe before and after a range of economic and weather-related shocks using comparable national income, consumption, and expenditure surveys of

TABLE 7

TWO-STEP ESTIMATION: CONSUMPTION STRATIFIED BY WEALTH LEVEL

VARIABLE	BOTTOM WEALTH GROUP		TOP WEALTH GROUP	
	Estimate	*t* Value	Estimate	*t* Value
1990/91:				
Constant	34.646	.95	72.604	3.48
Estimated permanent income	.648	9.43	.922	6.07
Estimated transitory income	.237	7.86	.681	4.65
Planting period rainfall deviations	.123	4.03	−.619	−1.58
Weeding period rainfall deviations	−.127	−5.37	1.402	3.80
Harvest period rainfall deviations	−.148	−3.09	1.925	2.39
Number of observations	4,699		4,699	
R^2	.7726		.5811	
Hypothesis test:*				
Test 1	2.5815 (.0091)			
Test 2	5.481 (.000)			
1995/96:				
Constant	22.797	17.87	80.684	5.08
Estimated permanent income	.593	5.22	.912	8.96
Estimated transitory income	.708	8.53	.984	3.92
Planting period rainfall deviations	−.018	−.61	−1.004	−2.87
Weeding period rainfall deviations	−.034	−3.34	.013	2.39
Harvest period rainfall deviations	.140	7.01	.509	1.64
Number of observations	5,832		5,832	
R^2	.6144		.5475	
Hypothesis test:*				
Test 1	2.6833 (.003)			
Test 2	3.8910 (.000)			

NOTE.—Results are obtained by two-step procedure: first, obtaining the measures of income types (permanent and transitory incomes) and, finally, estimating a system consisting of consumption and savings. Asymptotic variance estimates are used for testing hypotheses.

* Hypotheses tests report *t*-test statistics; *P* values are in parentheses. Test 1: propensity to consume out of permanent income is the same among the poorest and the richest; test 2: propensity to consume out of transitory income is the same among the poorest and the richest.

1990/91 and 1995/96. We estimated the propensities to consume and save out of permanent and transitory incomes and tested the notions of permanent income hypothesis and precautionary saving motives. We examined structural changes in parameters and found significant changes in returns to education and assets as well as in saving and consumption behavior following the shocks. Among other things, this finding has implications on the empirical validity of poverty mappings that are currently being employed to allocate transfers

TABLE 8

RESULTS OF PARAMETER STABILITY TESTS: WALD TEST STATISTICS

VARIABLE	DISTRIBUTION OF TEST STATISTIC*	INCOME		CONSUMPTION		SAVINGS	
		Wald Statistic	*P* Value	Wald Statistic	*P* Value	Wald Statistic	*P* Value
Overall test	$\chi 2$ (23)	8.84e + 4	.00	5.82e + 3	.00	2.71e + 4	.00
Asset index	$\chi 2$ (1)	2.12e + 3	.00	2.13e + 3	.00	3.88e + 2	.00
Education	$\chi 2$ (4)	1.14e + 3	.00	9.04e + 2	.00	3.58e + 2	.00
Rainfall	$\chi 2$ (6)	2.59e + 3	.00	3.34e + 4	.00	1.57e + 4	.00
Urban dummy	$\chi 2$ (1)	2.29	.139	1.29e + 2	.00	9.60e + 1	.00
Gender dummy	$\chi 2$ (1)	1.15	.2835	4.70e − 2	.83	1.44e − 1	.70
Variance equivalence†	F (14,993, 17,504)	2.08	.00	1.86	.00	2.58	.00

* Degrees of freedom are in parentheses.

† The test statistic used here is $F = s_{90}^2/s_{96}^2 \sim F(N_{90} - k - 1, N_{96} - k - 1)$, where N_{90} and N_{96} are number of observations for 1990/91 and 1995/96 ICES, respectively; k is the number of regressors in both; and (s_{90}^2, s_{96}^2) are the variances of error terms in the 1990/91 and 1995/96 regressions, respectively.

and inform policy design in many developing countries, including Zimbabwe.[31] Our parameter stability tests for the two periods cast serious doubt on the assumption of parameter stability, at least during periods of significant economic adjustment and natural disaster.

In addition, we find that changes in an overall economic situation translate into changes in propensities to save. To our knowledge, this is the first study of its kind in Africa. Our results show that, before droughts and economic adjustment, Zimbabweans consumed the majority of their permanent income and less than half of their transitory income. The higher marginal propensity to save out of transitory income before the shocks implies that Zimbabweans used savings to smooth consumption. Following the droughts and adjustments, however, the majority of both permanent and transitory incomes were consumed. Reduced propensity to smooth consumption may reflect a "stocking out," in which a household's ability to cushion economic shocks changes as it draws down its liquidity.[32] Households facing repeated setbacks may no longer have the cash in hand or the cattle in field to offset income shortfalls. In such situations, consumption more closely tracks income than when there has been sufficient time between shocks for households to replenish liquid assets. Alternatively, changes in expectations following revisions to subjective probabilities may explain the lack of consumption smoothing in the latter period. Zimbabwean households may have begun a strategy of defending their asset bases against the perceived likelihood of worse times in the future.

Following the drought and structural changes, Zimbabweans appear to exhibit low risk management and precautionary motives and heavy dependence on transitory income for consumption. However, there were differentiated propensities to smooth consumption between the rich and the poor, with the latter group exhibiting stronger precautionary motives and more propensities to save from their transitory income both before and after the shocks. Higher income variability is associated with reduced consumption, indicating precautionary behavior on the part of predrought and prestructural change households. Household consumption and saving in the latter period did not significantly respond to income variability; however, households in the lower income bracket showed a more pronounced precautionary behavior in that they cut consumption and increased savings when rainfall variability was higher.

Notes

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1. A. Deaton, "Saving and Liquidity Constraints," *Econometrica* 59, no. 5 (1991): 1221–48; C. H. Paxson, "Using Weather Variability to Estimate the Response of Savings to Transitory Income in Thailand," *American Economic Review* 82, no. 1 (1992): 15–33; C. Udry, "Risk and Insurance in a Rural Credit Market: An Empirical

Investigation in Northern Nigeria," *Review of Economic Studies* 61, no. 3 (1994): 495–526, and "Risk and Saving in Northern Nigeria," *American Economic Review* 85, no. 5 (1995): 1287–1300; S. Lund, "Informed Credit and Risk-Sharing Networks: Empirical Evidence from the Philippines" (Stanford University, Department of Economics, 1996, unpublished manuscript).

2. D. W. Bromley and J. P. Chavas, "On Risk, Transactions, and Economic Development in the Semi-arid Tropics," *Economic Development and Cultural Change* 37, no. 4 (1989): 719–36; M. Fafchamps, "Solidarity Networks in Rural Africa: Rational Peasants with a Moral Economy," *Economic Development and Cultural Change* 41 (1992): 147–75; S. Coate and M. Ravallion, "Reciprocity without Commitment: Characterization and Performance of Informal Insurance Arrangements," *Journal of Development Economics* 40 (1993): 1–24; C. Udry, "Credit Markets in Northern Nigeria: Credit as Insurance in a Rural Economy," *World Bank Economic Review* 49, no. 30 (1990): 251–69, and "Risk and Insurance in a Rural Credit Market"; R. M. Townsend, "Consumption Insurance: An Evaluation of Risk-Bearing Systems in Low-Income Economies," *Journal of Economic Perspectives* 9, no. 3 (1995): 85–102; M. Carter, "Environment, Technology, and the Social Articulation of Risk in West African Agriculture," *Economic Development and Cultural Change* 45, no. 3 (1997): 557–90.

3. Paxson; Udry, "Risk and Saving in Northern Nigeria."

4. H. Binswanger and J. McIntire, "Behavioral and Material Determinants of Production Relations in Land-Abundant Tropical Agriculture," *Economic Development and Culture Change* 36, no. 1 (1987): 73–99; M. Fafchamps, C. Udry, and K. Czukas, "Drought and Saving in West Africa: Are Livestock a Buffer Stock?" *Journal of Development Economics* 55, no. 2 (1998): 273–305.

5. N. Jodha, "Effectiveness of Farmers' Adjustment to Risk," *Economic Politics Weekly* 18 (1978): 38–48. M. Rosenzweig and K. Wolpin, "Credit Market Constraints, Consumption Smoothing, and the Accumulation of Durable Production Assets in Low-Income Countries: Investments in Bullocks in India," *Journal of Political Economy* 101 (1993): 223–45.

6. M. Rosenzweig and H. Binswanger, "Wealth, Weather Risk, and the Composition and Profitability of Agricultural Investment," *Economic Journal* 103 (1993): 56–78; T. P. Reardon, P. Matlon, and C. Delgado, "Coping with Household-Level Food Insecurity in Drought-Affected Areas of Burkina Faso," *World Development* 16, no. 9 (1992): 1065–74.

7. R. E. B. Lucas and O. Stark, "Motivations to Remit: Evidence from Botswana," *Journal of Political Economy* 93, no. 5 (1985): 901–18; M. Rosenzweig, "Risk, Private Information, and the Family," *American Economic Review* 78, no. 2 (1988): 245–50.

8. J. Jalan and M. Ravallion, "Are the Poor Less Well Insured? Evidence on Vulnerability to Income Risk in Rural China," *Journal of Development Economics* 58, no. 1 (1999): 61–81, and "Behavioral Responses to Risk in Rural China," *Journal of Development Economics* 66, no. 1 (2001): 23–49.

9. F. Zimmerman and M. R. Carter, "Dynamic Portfolio Management under Risk and Subsistence Constraints in Developing Countries," Agricultural and Applied Economics Staff Paper Series (University of Wisconsin—Madison, 1996).

10. A. Deaton, *The Analysis of Household Surveys: A Microeconomic Approach to Development Policy* (Baltimore: Johns Hopkins University Press, 1997).

11. Note that T can be assumed to be infinity (∞), as there are strong ties among generations in most developing countries.

12. M. Friedman, *A Theory of the Consumption Function* (Princeton, N.J.: Princeton University Press, 1957); F. Modigliani and R. Blumberg, "Utility Analysis and the Consumption Function: An Interpretation of Cross-Sectional Data," in *Post Keynesian Economics*, ed. Kenneth K. Kurihara (New Brunswick, N.J: Rutgers University Press, 1954), pp. 388–436.

13. Deaton, *The Analysis of Household Surveys*.

14. In Africa, where most of the poor reside in rural areas and rely, at least partially, on agricultural activities for their livelihoods, climatic conditions can have a major impact on economic well-being and production decisions. Although the contribution of agriculture to Zimbabwe's GNP is relatively low as compared with that of other sub-Saharan countries, this sector provides employment and livelihood for approximately 70% of the population and provides raw materials for the majority of the country's manufactured goods and exports. We believe that these aspects of agriculture are quite relevant for our study. Even in urban areas, many households rely on food from nearby gardens and goods remitted from rural households; these informal contributions of agriculture go largely unaccounted for in national accounts and help support our use of rainfall as an instrument for transitory income. See J. Alwang and B. Mills, "Why Has Poverty Increased in Zimbabwe? A Nonparametric and Parametric Analysis of the Causes," working paper (Virginia Tech, Department of Agricultural and Applied Economics, Blacksburg, Va., 2000); Central Statistical Office, *Poverty in Zimbabwe* (Harare: Government Printing Office, 1997).

15. A. Deaton, *Understanding Consumption* (Oxford: Clarendon, 1992).

16. Deaton, *The Analysis of Household Surveys.*

17. M. S. Kimball and N. G. Mankiw, "Precautionary Saving and the Timing of Taxes," *Journal of Political Economy* 97, no. 4 (1989): 863–79; R. J. Caballero, "Consumption Puzzles and Precautionary Savings," *Journal of Monetary Economics* 25, no. 1 (1990): 113–36.

18. M. Nerlove, A. Razin, and E. Sadka, "The Old Age Hypothesis Reconsidered," *Journal of Development Economics* 18 (1985): 243–52; Paxson (n. 1 above).

19. Paxson; H. Alderman, "Saving and Economic Shocks in Rural Pakistan," *Journal of Development Economics* 51 (1996): 343–65.

20. Paxson.

21. For instance, on India, see M. Ravallion and G. Datt, "How Important to India's Poor Is the Sectoral Composition of Economic Growth?" *World Bank Economic Review* 10, no. 1 (1996): 1–25.

22. Our empirical results, discussed in Sec. V, indicate that rainfall variability significantly affects income in urban areas of Zimbabwe.

23. In order to see this, assume that the observed savings (H) is the sum of "true savings" (S) and measurement error (M). Our income measure would then differ from "true" income by M, and the residual income measure would be M plus a prediction error. Both residual income and the dependent variables (i.e., H) contain M, thus introducing a correlation between errors. Note that we do not face any such problems with the predicted permanent and transitory incomes since these are fully instrumented.

24. W. K. Newey, "A Method of Moments Interpretation of Sequential Estimators," *Economic Letters* 14, no. 2 (1984): 201–6; A. Pagan, "Econometric Issues in the Analysis of Regressions with Generated Regressors," *International Economic Review* 25 (1984): 221–47.

25. I. Scoones et al., *Hazards and Opportunities: Farming Livelihoods in Dryland Africa: Lessons from Zimbabwe* (London: Zed, 1996).

26. J. Alwang, L. Ersado, and N. Taruvinga, "Changes in Poverty in Zimbabwe between 1990 and 1996: Worsening Outcomes under Adverse Conditions," *Development Southern Africa* 18, no. 5 (2001): 553–79; Central Statistical Office, *Poverty in Zimbabwe* (Harare: Government Printing Office, 1998).

27. This is not surprising given that urban and rural households are linked through formal and informal market transactions of agricultural products. Many urban households rely on goods remitted from rural households; some depend on urban agriculture for food (e.g., see L. Ersado, "Livelihood Strategies in Urban and Rural Areas: Activity and Income Diversification in Zimbabwe," working paper [International Food Policy Research Institute, Washington, D.C., 2002]). As in most developing countries, most of these agricultural activities are highly dependent on rainfall.

28. Only the consumption equation is reported as the saving estimates tell virtually the same story about household behavior. To save space, only the coefficients of explanatory variables of interest are reported.

29. Jalan and Ravallion, "Behavioral Responses to Risk in Rural China" (n. 8 above).

30. V. R. Bencivenga and B. D. Smith, "Financial Intermediation and Endogenous Growth," *Review of Economic Studies* 58 (1991): 195–209; Jalan and Ravallion, "Are the Poor Less Well Insured?" (n. 9 above).

31. J. Hentschel, J. O. Lanjouw, P. Lanjouw, and J. Poggi, "Combining Census and Survey Data to Trace the Spatial Dimensions of Poverty: A Case Study of Ecuador," *World Bank Economic Review* 4, no. 1 (2000): 147–65.

32. Deaton, "Saving and Liquidity Constraints" (n. 1 above); Alderman (n. 19 above).