Testing for Poverty Traps: Asset Smoothing versus Consumption Smoothing in Burkina Faso

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April 2009

Abstract
The permanent income hypothesis posits that rational agents smooth consumption as transitory income fluctuates. Empirical evidence of this behavior among the poor has been mixed, but often suggests very limited consumption smoothing tendencies. We contend that much of this evidence pools agents that pursue different smoothing strategies and consequently produce muddled tests of consumption smoothing. In this paper, we use dynamic asset smoothing as a theoretical structure to justify wealth-differentiated smoothing tendencies. We test this theory by allowing the smoothing target to shift from assets and consumption as livestock wealth increases. We find evidence for the existence of a threshold that divides asset and consumption smoothers and document behavioral differences between these groups that are consistent with asset smoothing as a response to the presence of a dynamic asset threshold. These results suggest that failing to carefully distinguish between asset and consumption smoothers may be responsible for the muddled consumption smoothing evidence common in previous analyses.
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The permanent income hypothesis posits that rational agents smooth consumption as transitory income fluctuates. Economists have looked for evidence of consumption smoothing behavior in a variety of development contexts. Since the poor typically have limited access to financial markets in which to save and invest or withdraw and borrow, consumption smoothing in these contexts would presumably involve building up asset stocks in good times and drawing them down in bad times. Empirical evidence of this behavior among the poor has been mixed, but often suggests very limited consumption smoothing tendencies. For example, Fafchamps et al. (1998) test whether livestock holdings are used to buffer transitory income shocks due to drought in Burkina Faso. Ironically, they find that of those households that sell livestock, most do so in response to shocks. Ironically, when they then test whether shocks can explain livestock sales (using of course data on all households), they find almost no evidence of the sort of systematic dis-saving that would be needed to smooth consumption. At best, only 15%-30% of consumption shocks are buffered by livestock sales. Our contention in this paper is that pooling the Burkina herders in this sample together produces a muddled test since the sample may include asset and consumption smoothing as distinct behavioral regimes. A pooled sample produces a data-weighted average of these different regimes.

Recent research on asset and poverty dynamics offers some promising insights into empirical tests of consumption smoothing. In the presence of a dynamic asset threshold the poor may rationally destabilize consumption in order to protect productive assets from irreversible withdrawals. For the poor who appreciate the dynamic forces shaping their future, smoothing assets may be better than smoothing consumption. In this case, testing for consumption smoothing using a pooled sample that includes both asset and consumption smoothers may well yield confused or even misleading results. This pooled sample problem muddles the distinction between asset and consumption smoothers. This muddling problem has policy implications: it would likely prevent the implementation of innovative safety net polices designed to protect the poor from falling below critical asset thresholds (e.g., Barrett, et al. 2008).
Kazianga and Udry (2006) use the same data as Fafchamps et al. (1998) and test for differences in consumption smoothing tendencies between the rich and poor. While they find evidence that the rich smooth consumption more than the poor, which is consistent with the dynamic asset smoothing hypothesis, their criterion for distinguishing the rich from the poor is ad hoc and their motivation for testing for differences between them is atheoretic. In this paper, we use dynamic asset smoothing as a theoretical structure to justify wealth-differentiated smoothing tendencies. We test this theory by allowing the smoothing target to shift from assets and consumption as wealth increases. In particular, we use threshold estimation techniques to estimate (i) whether a consumption smoothing threshold marking a shift from asset to consumption smoothing exists and (ii) the location of such a threshold conditional upon its existence. This approach allows us to test the presence and location of a dynamic asset threshold in asset wealth space as perceived by those in our sample.

We find evidence for the existence of a threshold that divides asset and consumption smoothers and document behavioral differences between these groups that are consistent with asset smoothing as a response to the presence of a dynamic asset threshold. These results suggest that failing to carefully distinguish between asset and consumption smoothers may be responsible for the muddled consumption smoothing evidence common in previous analyses. Furthermore, these results highlight the potential value of threshold estimation techniques in empirical microeconomics of development, especially where promising policy options presuppose an ability to discern between different behavioral regimes among the poor.

Section 1: Theoretical Insights on Consumption versus Asset Smoothing
Risk has long been a central preoccupation of especially agricultural development economics. The obvious absence of insurance and other financial markets in low income areas, coupled with the equally obvious riskiness of agricultural production underwrote the suspicion that risk could result in major welfare losses and stand as a major
impediment to economic development as individuals might understandably shy away from mean income-increasing but riskier technological and market opportunities.\footnote{Among other things, these observations have led agronomic researchers to search for ‘pro-poor’ seeds and technologies that reduce income fluctuation while still increasing the mean.}

In addition to an outpouring of work on the effectiveness of informal risk-sharing mechanisms (cite …), these observations led to efforts to understand the capacity of financial market-constrained households to autarchically manage risk through intertemporal arbitrage with themselves (i.e., with savings). Deaton (1991) puts forward a canonical model of this intertemporal choice problem that has the following form:

\[
\max_{\{c, L, M, \theta\}} E_0 \left\{ \sum_{t=0}^{\infty} \delta^t u(c_t) \right\} \\
\text{subject to:} \\
c_{it} \leq F(\theta_t) - (L_{it} + 1 - L_{it}) \forall t \\
L_{it} \geq 0 \forall t
\]

where \(c_{it}\) is the consumption of household \(i\) in time period \(t\), \(F\) is the production or income generation function of the household that depends on a random variable \(\theta_t\), \(L_{it}\) is the households stock of assets, and the non-negativity restriction on assets captures the borrowing constraint implicit in missing financial markets. Deaton shows that the optimal solution to this inter-temporal maximization problem implies consumption smoothing and behavior that mimics that permanent income hypothesis first (?) See Bruce Gardner on ?? articulated by Milton Friedman (i.e., individuals will save/dis-save substantial pieces of transitory income shocks in order to smooth consumption). Using numerical simulation, Deaton shows that a modest asset stock is sufficient to autarchically manage (modest) degrees of risk (the 7% solution to the 10% problem!). The force of this analysis would seem to be that uninsured risk may be less of a problem than economists may have suspected.

While often undertaken without any particular alternative theoretical model in mind, a number of studies have tried to test for consumption smoothing behavior. Two questions drive the structure of these tests: (1) How much of a positive income shock is consumed rather than saved? and (2) How much of a negative income shock is offset by liquidation of savings or assets?
Paxson (1992) decomposes income into permanent, transitory and unexplained income in Thailand using weather variability, then uses these income components to estimate savings and consumption equations. Tests of consumption smoothing require a similar, initial income decomposition and many use Paxson’s original consumption function specification in these tests. In developing contexts, the results of these tests suggest little or no consumption smoothing. The poor seem to smooth income, but not to the full temporal extent – as implied by the permanent income hypothesis – or to the full spatial extent – as implied by a Pareto efficient allocation of risk. None of this work recognizes the possibility that different smoothing regimes exist and that a pooled analysis yields muddled results at best since asset smoothing and consumption smoothing have different objectives.

Two consumption smoothing analyses in this literature use the same Burkina Faso data as we do and reach conclusions that are consistent with this general consensus (Fafchamps, et al. 1998, Kazianga and Udry 2006). Although Kazianga and Udry (2006) test for consumption smoothing separately for relatively rich and poor herders in their data, they split their sample arbitrarily using the possession of animal traction as an indicator of relatively rich herders. This wealth indicator follows the design of the survey which stratified households according to cultivation by animal traction versus hand tools. In this paper, we conduct similar consumption smoothing tests, but focus our attention on splitting the sample based on fundamental differences in smoothing tendencies in accordance with an asset smoothing framework.

While interesting and provocative, these empirical studies suffer from the absence of a well-specified theoretical alternative to the canonical consumption smoothing model. Fortunately, more recent work on poverty traps and asset dynamics has begun to articulate an alternative formulation. Asset smoothing becomes a compelling intertemporal strategy when asset wealth dynamics are characterized by non-convexities (e.g., Lybbert, et al. 2004). In such cases, agents may rationally destabilize consumption in order to protect their asset stocks from irreversible losses or liquidation (Zimmerman and Carter 2003), which entail dynamic opportunity costs. A key feature that emerges in these models is what Zimmerman and Carter and others have labeled the Micawber Threshold, meaning an asset level around which dynamic behavior bifurcates.
Individuals in the vicinity of the Micawber Threshold will tend to find it dynamically optimal to asset smooth (and destabilize consumption). The costliness of following below the threshold are substantial, and the costs of avoiding that fall are also possibly quite substantial. While not yet formally modeled by the literature discussed above, individuals in the neighborhood of this threshold might be expected to pursue severe income smoothing to avoid shocks. In addition, when those shocks do occur and families asset smooth by decreasing consumption severely, the costs may also be quite high in terms of irreversible human capital losses for young children (Hoddinott, 2006). A recent theoretical paper by Carter, Barrett and Ikegami (2008) indicates that returns to insurance may be especially high for those in the vicinity of the Micawber Threshold.

Empirical evidence of asset smoothing is starting to trickle in. Barrett et al. (2006) find descriptive evidence that is consistent with asset smoothing: among the very poor in northern Kenya the coefficient of variation of income is less than the coefficient of variation of expenditure, but for the rest of their sample income is more variable than expenditure. Taking a different approach, Lybbert and McPeak (2007) estimate relative risk aversion and the elasticity of intertemporal substitution directly using an Epstein and Zin (1991) recursive utility function and find that the poor (also in northern Kenya) are simultaneously more risk averse and more willing to destabilize consumption than the relatively rich. Adato, Carter and May (2006) also find some direct evidence of non-linear asset dynamics in South Africa.

In this paper, we want to use the basic theoretical insight of the Micawber Threshold to revisit the empirical consumption smoothing literature of the sort pioneered by Paxson (1991). The econometric crux of our analysis is the threshold estimation technique developed by Hansen (2000). Carter has successfully used this estimation approach with data from Ethiopia and Honduras to infer the location of asset thresholds (Carter, et al. 2007). In this paper, we demonstrate the potential of this technique to discern different smoothing regimes and thereby improve our understanding of asset and consumption smoothing behavior.
Section 2: The ICRISAT VLS Data from Burkina Faso

To estimate the consumption and livestock sales equations specified above and the associated smoothing threshold, we use data from rural Burkina Faso collected from 1981 to 1985 by the International Crop Research Institute for the Semi-Arid Tropics (ICRISAT). This panel dataset was constructed using household surveys across three distinct agro-climatic zones (Sahelian, Sudanian, Guinean), which vary in rainfall patterns, soil types and population densities. In each of these zones, two villages were included in the sampling frame, each with roughly 25 households selected into the survey. This panel dataset spans the drought of 1984, which makes it an excellent dataset for studying risk.

Carter (199x) extensively studies the extent of production risk in this system, but does not explore the degree to which individuals are able to buffer such shocks with asset management strategies. Subsequent studies explicitly study the extent which households use assets to smooth consumption in response to stochastic shocks (e.g., Fafchamps, et al. 1998, Kazianga and Udry 2006). For a detailed description of the survey, sample, and data, we refer interested readers to Malton (1988) and Malton and Fafchamps (1989).

Section 3: Decomposing Income into Permanent and Transitory Components

We begin our analysis by decomposing observed household income into permanent, transitory and unexplained income components. Building on Paxson (1992) and following the approach of Kazianga and Udry (2006), we decompose income using farm profit model specified as follows:

\[
\pi_{ivt} = \alpha_i z_{ivt} + \alpha_2 F_{vt} X_{ivt} + \alpha_i F_{vt} + \gamma_i + \epsilon_{ivt}
\]

where \( \pi_{ivt} \) is farm profit for household \( i \) in village \( v \) in year \( t \), \( z_{ivt} \) is a vector of household demographic variables, \( X_{ivt} \) is a vector of variables indicating the amount of land cultivated by household \( i \) by slope and soil type, \( F_{vt} \) is a rainfall variable measured as the deviation of rainfall from its long-run village average, \( \gamma_i \) is a household fixed effect, and \( \epsilon_{ivt} \) is the error term. After estimating the coefficients in this farm profit model, we can decompose income as follows:
\[
\begin{align*}
\text{Permanent Income}_{ivt} &= y^p_{ivt} = \alpha_1' z_{ivt} + \gamma_i \\
\text{Transitory Income}_{ivt} &= y^T_{ivt} = \alpha_2' F_v X_{ivt} + \alpha_v F_v \\
\text{Unexplained Income}_{ivt} &= y^U_{ivt} = \varepsilon_{ivt}
\end{align*}
\]

(2)

Table 1

Fixed Effect Regression to Identify Income Components

<table>
<thead>
<tr>
<th>Variables</th>
<th>Estimated Coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rainfall Deviation from Long-term Mean</td>
<td></td>
</tr>
<tr>
<td>Rainfall Deviation Squared</td>
<td></td>
</tr>
<tr>
<td>Rainfall Deviation Cubed</td>
<td></td>
</tr>
<tr>
<td>Rainfall deviation interacted with</td>
<td></td>
</tr>
<tr>
<td>Seno soil area</td>
<td></td>
</tr>
<tr>
<td>Zinka soil area</td>
<td></td>
</tr>
<tr>
<td>Bissiga soil area</td>
<td></td>
</tr>
<tr>
<td>Raspuiga soil area</td>
<td></td>
</tr>
<tr>
<td>Ziniare soil area</td>
<td></td>
</tr>
<tr>
<td>Other soil area</td>
<td></td>
</tr>
<tr>
<td>Low land area</td>
<td></td>
</tr>
<tr>
<td>Near low land area</td>
<td></td>
</tr>
<tr>
<td>Midslope area</td>
<td></td>
</tr>
<tr>
<td>Near upland area</td>
<td></td>
</tr>
<tr>
<td>Near home area</td>
<td></td>
</tr>
<tr>
<td>Distance to home</td>
<td></td>
</tr>
<tr>
<td>Household Fixed Effects</td>
<td>Included</td>
</tr>
<tr>
<td>Observations</td>
<td>464</td>
</tr>
<tr>
<td>Number of hh</td>
<td>126</td>
</tr>
</tbody>
</table>

*Other included variables include demographic variables (age and age-squared of household head, and adult equivalent-weighted numbers of adult males, adult females, boy children and girl children and overall household size.*
A graphical depiction of our farm profit decomposition (see equation (2)) is shown in figure 1. Transitory income has a large variance relative to the other income components and plays an important role among the households in our sample.

**Figure 1**
Kernel density distributions of observed, permanent, transitory, and unexplained farm profit

**Decomposition of Crop Income**

Section 4: Asset versus Consumption Smoothing

With these income components we estimate a consumption function following the specification of Paxson (1992) and a net livestock sales function following Kazianga and Udry (2006) and Fafchamps et al. (1998). Specifically, these two functions are specified as follows:

\[
c_{it} = \beta_1 y_{it}^p + \beta_2 y_{it}^T + \beta_3 y_{it}^U + \beta_4 z_{it} + \gamma_i + \epsilon_{it}
\]

**(3)**

\[
Net \, Livestock \, Sales_{it} = \beta_1 y_{it}^p + \beta_2 y_{it}^T + \beta_3 y_{it}^U + \beta_4 z_{it} + \gamma_i + \epsilon_{it}
\]
Tests of consumption smoothing hinge on the estimated coefficients on transitory income. For example, a negative and significant $\beta_3$ is evidence that households use livestock as a buffer stock to smooth consumption during transitorily bad production years.

We use Hansen’s (2000) threshold estimation technique to estimate the equations specified in (3). In the case of the livestock sales equation, this approach allows us (1) to test for the presence of a threshold that splits our sample into two meaningfully different livestock sales regimes and (2) to estimate the location of such a threshold. We search the presence and location of such a threshold in livestock wealth space. Conditional on finding a threshold and estimating its location in livestock wealth space as $\hat{T}$, we are then able to estimate a more flexible version of (3):

$$
\text{Net Livestock Sales}_{it} = \begin{cases} 
\beta_1 y_{it}^p + \beta_2 y_{it}^T + \beta_3 y_{it}^{ui} + \beta_4 z_{it}' + \gamma_i + \epsilon_{it} \quad \text{if } T_i \geq \hat{T} \\
\beta_1 y_{it}^p + \beta_2 y_{it}^T + \beta_3 y_{it}^{ui} + \beta_4 z_{it}' + \gamma_i + \epsilon_{it} \quad \text{if } T_i < \hat{T}
\end{cases}
$$

where + and – superscripts denote coefficients for the subset of households above and below the estimated threshold, respectively. In this specification, $\hat{T}$ may represent a dynamic asset threshold – as perceived by households – if these estimated coefficients suggest asset smoothing below the threshold such that $\beta_2^- = 0$ and consumption smoothing above the threshold such that $\beta_2^+ < 0$.

Table 2 contains the estimation results from the consumption and net livestock sales functions. Consider for a moment the coefficient on transitory income in the net livestock sales equation. If livestock are used as a buffer to consumption shocks, this coefficient should be negative and significant. Complete buffering of consumption shocks via livestock sales would imply an estimated coefficient of -1. When we pool all households in our sample, this coefficient tells the same story as in Fafchamps et al. (1998) and Kazianga and Udry (2006): livestock appear to be used as a buffer stock, but a relatively weak one with about 75% of the volatility in consumption left unsmoothed by livestock sales.

Next, we apply Hansen’s threshold estimator to the net livestock sales function. We use the value of the household herd – a primary wealth indicator – averaged over the
years of the panel as the threshold variable. At the 95% level, we find evidence of a threshold at 596,000 CFA.

Table 1
Estimated transitory income coefficient and relative consumption volatility on either side of the estimated threshold

<table>
<thead>
<tr>
<th></th>
<th>Pooled OLS</th>
<th>Lower Regime (L&lt;596)</th>
<th>Upper Regime (L&gt;596)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Key Variables</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Transitory Income, $y^T$</td>
<td>-0.012*</td>
<td>-0.005*</td>
<td>-0.027*</td>
</tr>
<tr>
<td>Permanent Income, $y^P$</td>
<td>0.018</td>
<td>-0.007</td>
<td>-0.10</td>
</tr>
<tr>
<td>Unexplained Income, $y^U$</td>
<td>-0.007</td>
<td>-0.002</td>
<td>-0.07*</td>
</tr>
<tr>
<td>NOBS</td>
<td>361</td>
<td>316</td>
<td>45</td>
</tr>
<tr>
<td>$R^2$ (within)</td>
<td>23%</td>
<td>15%</td>
<td>73%</td>
</tr>
<tr>
<td><strong>Coefficients of Variation</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food Consumption</td>
<td>25%</td>
<td>25%</td>
<td>37%</td>
</tr>
<tr>
<td>Crop Income</td>
<td>34%</td>
<td>31%</td>
<td>62%</td>
</tr>
<tr>
<td>$CV_{Cons}/CV_{Inc}$</td>
<td>73%</td>
<td>81%</td>
<td>60%</td>
</tr>
</tbody>
</table>

*Other control variables include household fixed effects and demographic variables (age and age-squared of household head, and adult equivalent-weighted numbers of adult males, adult females, boy children and girl children and overall household size.

Table 2 contains results that serve to characterize the two regimes on either side of our estimated threshold. Figure 2 shows that the estimated threshold of 600,000 CFA of livestock is statistically significant and sharply estimated. Note that only those values of the asset threshold for which the likelihood ratio test statistic fall below the 5% critical value are significant. Figure 2 also displays a kernel estimate of the probability function that describes the distribution of livestock amongst sample households.

Two observations from this table are particularly relevant. First, net livestock sales among households below the threshold are statistically unresponsive to transitory income shocks. Among households above the threshold, on the other hand, livestock sales appear to buffer consumption from such shocks. Moreover, the coefficient on transitory income is twice in regime 2 as it is for the pooled sample. Second, consumption is more volatile relative to income in regime 1 than it is for households in regime 2. Both of these observations are consistent with regime 1 consisting of asset smoothers and regime 2 consisting of (imperfect) consumption smoothers.
Figure 2
Results of threshold estimation in average household herd value space with estimated threshold at 596 thousand CFA of livestock

Figure 3 illustrates the estimated regressions from Table 2, illustrating the expected livestock sales in response to transitory income shocks, holding other variables at their mean values for the relevant population sub-group. As expected, households in the low asset regime barely respond to negative transitory income shocks with asset sales, whereas the households in the wealthier cohort do.

Finally, following up on an observation of Zimmerman and Carter (2003), we undertake a simple test of the asset smoothing hypothesis by comparing coefficients of variation for consumption and income for the low and high asset groups. As Table 2 reports, households in the low asset regime have smoother income (with a coefficient of variation of 31% for low asset households versus twice that level of high asset households). In addition, the lower asset households more pass more of that income volatility onto consumption (the coefficient of variation of consumption relative to the coefficient of variation of income).
variation of income is 81% for the low asset group versus 60% for the high asset group).

Figure 3
Fitted Threshold Estimates

Section 5: Conclusions
In this paper, we use Hansen’s threshold estimation technique (Hansen 2000) to test whether both asset smoothers and consumption smoothers are present in VLS data from Burkina Faso that have been used in well-known consumption smoothing analyses (Fafchamps, et al. 1998, Kazianga and Udry 2006). This threshold estimation approach suggests that two different smoothing regimes indeed exist in this data. Furthermore, our results are consistent with asset smoothing in the face of dynamic asset thresholds. Households below our estimated threshold choose to endure greater relative consumption volatility in order to preserve their livestock holdings, while those above the threshold actively buffer consumption shocks with livestock sales.
Threshold estimation as an empirical technique appears to be a promising way of discerning between behavioral regimes. For economists and policy makers alike, this ability to discern regimes is especially important in contexts that are subject to important non-convex wealth or asset dynamics. In such contexts, thresholds can drive substantial disparities in behaviors and in welfare outcomes. Being able to characterize these thresholds – as well as attendant behavioral and outcome differences – is a valuable input into the pro-poor policy process.

Finally, it is worth reiterating an observation from Hoddinott (2006). We have sought in this paper to distinguish between asset and consumption smoothing as distinct behavioral regimes. In reality, smoothing decisions often involve more than these two dimensions.

…consumption smoothing implies an attempt to preserve assets, but consumption is an input into the formation and maintenance of human capital. [Thus] the distinction between consumption and asset smoothing, while useful as a descriptive tool, may be somewhat misleading. Rather, household responses to adverse shocks are effectively changes in their asset portfolio, with a critical issue being the extent to which the draw down of a given asset has permanent consequences. (Hoddinott 2006)

Future research into asset and poverty dynamics and intertemporal smoothing tendencies should take this multidimensional view of smoothing into account. In the context of threshold estimation techniques, this suggests the potential for multiple thresholds or, possibly, thresholds that cut across multiple asset dimensions (e.g., productive assets and innate ability (Lybbert and Barrett forthcoming)).
References


