# Saving and Income Smoothing in Côte d'Ivoire[1]

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*This paper is concerned with the extent to which farmers and other households in Côte d'Ivoire save and dis-save in order to make their consumption smoother than their incomes. I attempt to test a strict form of inter-temporal smoothing, that consumption follows the permanent income hypothesis, by which consumption is equal to the annuity value of the sum of assets and the present discounted value of current and expected future labour income. The extent to which households in LDCs can and do smooth their incomes is still a matter of debate. Especially in rural areas, formal credit markets are imperfect or absent, and it has sometimes been argued that poor and ill-educated people find it inherently difficult to make good inter-temporal choices. Yet many important policy issues hang on the issue.*

## 1. Introduction

Much of the uncertainty in individual incomes depends on price and output variability in agriculture, and the value of government stabilization of commodity prices depends crucially on the extent to which rural households can stabilize their own consumption in the face of variable farm incomes, see Newbery and Stiglitz (1981) and Mirrlees (1988). Similarly, the extent to which public action is required to alleviate distress during periods of low incomes is determined by how well individuals themselves can provide for bad times. In much of Africa, and including Côte d'Ivoire for most of its history, commodity prices paid to farmers have been held below world prices, and have not varied as much as world prices. Although such policies are perhaps necessary to supply the public purse in economies where there are limited other sources of revenue, they have also been justified on the grounds that governments

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are better able than producers to smooth income fluctuations. In practice, the swings in government revenues engendered by fluctuations in world commodity prices have rarely been adequately sterilized by African governments, but have rather been the source of much macroeconomic instability, so that it is important to find out whether private producers might not do better if left to themselves.

There has been a good deal of previous work on the permanent income hypothesis in LDCs, reviewed, for example in Gersovitz (1988) and Deaton (1990). But it is clear from Bhalla's work on India (1979), (1980), Musgrove's work on Latin America (1979), and most convincingly of all, from Paxson's work on Thailand (1990), (1992), that smoothing takes place, and that consumption is not equal to income, even among very poor households. The main object of this paper is to add evidence for another country, Côte d'Ivoire, in a continent where there has been relatively little previous research on these issues. But I also test an implication of the permanent income hypothesis that has not been previously examined in a developing country. If agents look to the future when they are deciding how much to consume, they will save more when they have reason to expect that their incomes will fall. In particular, if agents have private information about their future incomes, we should be able to use their current saving to predict their future income changes more accurately than would be possible using public information alone. Côte d'Ivoire is a good country in which to test this proposition. A substantial fraction of agricultural income derives from tree-crops, mainly cocoa and coffee, but also palm trees and bananas. If weather damages flowers, or if the farmer does not provide adequate weeding, the crop will suffer, and the farmer will know that his income is going to be low many months before he actually receives payment and income is realized. For many tree crops, yields are negatively correlated from one year to the next, so that a bumper harvest in one year is a token that income is unlikely to be so high a year later. Ivorian farmers are therefore likely to have a great deal of advance information about their incomes, and if they succeed in smoothing their consumption, we should be able to detect this advance information in their saving behaviour.

My methodology is based on that pioneered by Campbell (1987), who used aggregate time-series data for the United States, and which here is adapted to the short panel data that are available for Côte d'Ivoire. This methodology offers a number of advantages. As in the standard "excess sensitivity" literature, that traces back to Hall (1978) and Flavin (1981), it tests whether or not changes in consumption are orthogonal to previous information, and particularly whether consumption is sensitive to previously predictable changes in income. Moreover, the tests are carried out in such a way that if the null hypothesis is accepted, then the change in consumption will be exactly the amount that is warranted by the change in permanent income calculated from a simultaneously estimated equation for income. Such a methodology reconciles "excess sensitivity" tests with tests for "excess smoothness" that check whether the volatility of consumption changes is consistent with the volatility of permanent income changes calculated from fitted equations for income. (See Deaton (1987) for the original statement of the excess smoothness puzzle, and Campbell and Deaton (1989) and Deaton (1992, Chapter 4) for an explanation of the relationship between the smoothness and sensitivity issues.) There are real attractions to applying Campbell's tests to microeconomic behaviour rather than to the macroeconomic aggregates of the original paper. It is easy to think of macroeconomic feedbacks that could generate a negative relationship between saving and future income growth, but these feedbacks are less likely to be an issue at the level of the individual farmer.

The main difficulty in the work lies in the nature of the data. The Côte d'Ivoire Living Standards Survey collected information from around 1600 households in the country for the years 1985, 1986, and 1987. Half of the households interviewed in 1985 were re-interviewed again in 1986, while the new sample households in 1986 were carried through to a second interview in 1987. This rolling panel design means that for two *distinct* sets of 800 households, we have data on two consecutive years. For no household is there more than this; the data do not track households over a period of years, as is the case, for example, in the Panel Study of Income Dynamics in the United States. Data such as these cannot be used to test hypotheses about inter-temporal behaviour without very strong supplementary assumptions. Permanent income theory delivers propositions about time averages of individual behaviour, propositions that cannot be tested directly without time series data on individuals. Absent long panels, either we can make aggregation assumptions that allow the theory to be tested on aggregate time-series data, or we can make assumptions that allow us to identify time-series properties from cross-section data. The latter is the route followed here, and it must be admitted from the outset that the assumptions are strong. In the empirical application, I shall require that each agent's income process be stationary, and that once individual means have been subtracted out, each agent's time series process is identical, at least within geographical regions. Each farmer or worker receives his or her own income innovation, but even here, I need to assume that all incomes are affected equally by common regional *macroeconomic* shocks, shocks that are likely to be of the greatest importance in an agricultural economy like that of Côte d'Ivoire. I shall discuss these assumptions in more detail when I require them, and defend them as best I am able.

Section 1 of the paper develops the basic theory, following the general principles of Campbell's work, but adapting the model to the special requirements of Côte d'Ivoire. The section lays the groundwork for interpreting the parameters that are estimated in the final section. I try to develop a link between the nature of agricultural income, particularly the different time series properties that might be associated with different crops, and the joint stochastic behaviour of saving and income. The formulas that are developed can in principle relate agro-climatic conditions to the bivariate time-series process describing saving and income. Section 2 lays the econometric groundwork, makes the compromises that are required to use the Ivorian data, and explains how they affect the interpretation of the results. Section 3 presents the estimates. The restrictions implied by the permanent income theory are not supported by the data, although the nature of the failure does not suggest that consumption responds to predictable income changes, as has often been found in studies for the United States. However, I consistently find that saving predicts falls in income in the cross-section data, so that farmers who are saving in one year are those who are most likely to have a fall in income in the next. Although the interpretation of these findings is complicated by econometric and data problems, they provide further support for the notion that farmers plan ahead, even if they do not do so according to the strict permanent income calculus for consumption.

## 2. Saving, Income and Information

The hypothesis under consideration is that consumption is the annuity value of assets and expected future labour income. Following Flavin (1981), I write this as

$$(1)\quad c_t = \frac{r}{1+r}A_t + \left(\frac{r}{1+r}\right)\sum_{i=0}^{\infty}(1+r)^{-i}E(y_{t+i}|\Omega_t).$$

where $c_t$ is real consumption, $y_t$ is real *labour* income, $A_t$ is the real value of financial assets, $r$ is the constant, known real rate of interest, and $\Omega_t$ is the information set available to the agent at time $t$ and upon which expectations are based. The use of an infinite horizon model allows me to abstract from life-cycle considerations, but perhaps the best literal interpretation is in terms of a household that is a timeless dynasty or extended family, that will live for ever, and that is large enough so that its demographic structure does not vary very much over time. In the analysis that follows, I shall require that the real interest rate $r$ be strictly positive. However, it is possible to recast the model with a finite horizon and with $r \leq 0$ with only a slight increase in the complexity of the algebra.

For my purposes, it is more convenient to write the PIH in a different but equivalent form, originally derived by Campbell. Define saving, $s_t$ as the difference between *total* income and consumption, i.e.

$$(2)\quad s_t = \frac{r}{1+r}A_t + y_t - c_t.$$

Then substitution of (2) in (1) and rearrangement yields Campbell's "saving for a rainy day" equation, *viz.*

$$(3)\quad s_t = -\sum_{i=1}^{\infty}(1+r)^{-i}E(\Delta y_{t+i}|\Omega_t).$$

where $\Delta$ denotes a backward first difference. Saving at $t$ is the discounted present value of all future expected *falls* in income. Turning this equation into a testable proposition on the Ivorian data is the main purpose of this section.

Start from the problem of observing expectations. The information set $\Omega_t$ is the information set available to the agent, not the econometrician, and we should expect the agent to have all sorts of advance notice of income changes that would be extremely difficult to detect in the data. As argued in the introduction, this is particularly likely to be the case for farmers of tree crops, or for any farmer whose income is realized some time after the first information becomes available about the likely size of the harvest. Again we adopt a device first applied in this context by Campbell (1987).

Suppose that the information available to the econometrician at time $t$ is $H_t$ where $H_t \subseteq \Omega_t$ so that everything known to the econometrician is known to the farmer, but not *vice versa*. Suppose also that $H_t$ contains (at the very least) both saving $s_t$ and income $y_t$ Then we can "project" (3) on to $H_t$ i.e. we take expectations of both sides conditional on $H_t$ Since $s_t$ belongs to $H_t$ the projection of $s_t$ on to $H_t$ is just $s_t$, while, for the right hand side, the law of iterated expectations simply results in the agent's information set $\Omega_t$ being replaced by the econometrician's information set $H_t$ Hence, (3) becomes

(4) $$s_t = -\sum_{i=1}^{\infty}(1+r)^{-i}E(\Delta y_{t+i}|H_t).$$

Equation (4), unlike (1) or (3), contains only observable quantities. Even so, the similarity between (3) and (4) is perhaps deceptive, and it might easily be supposed that the argument above serves only to provide a formal basis for what would have to be done in any case, which is the substitution of observable for unobservable information. Note however that the argument requires that saving be in the econometrician's information set, so that (4) will not hold unless expectations about future income are conditioned on current saving. If income is modelled as a univariate time series process, which is then used to generate forecasts, current saving will not satisfy equation (4) if the agent has private information. Under the permanent income hypothesis, saving acts as a sufficient statistic for the agent's future income expectations, so that using it to help predict income is necessary if we are to control for private information.

To go further, we need to specify a model for forecasting income, based on the econometrician's observation set, $H_t$, which can be used, together with (4), to generate testable restrictions on the behaviour of saving. Campbell, in his work on savings in the United States, makes the assumption that the *change* in labour income is stationary, and shows that, in such circumstances, the PIH is consistent with a model in which saving and the *change* in labour income are jointly stationary. For the Côte d'Ivoire, I assume, in contrast, that incomes are stationary in *levels*. Over the last 15 years, there has been little growth in real living standards in Côte d'Ivoire; real per capita consumption in 1985 was the same as in 1970, and for the two years of the survey, 1985–86, average household income changed by less than a third of one per cent. This apparent lack of change disguises the fact that, at the national level, there was considerable growth in the first part of the period, followed by a marked decline later, as national income followed fluctuations in cocoa and coffee prices. However, since procurement prices for these crops were held more or less constant in real terms, this national pattern was not passed through to the farmers who are our main concern, and whose income can perhaps therefore be treated as stationary. If so, the permanent income hypothesis implies that savings have a mean of zero, see equation (4). Assets are built up in advance of expected declines in income, and are run down when current income is lower than its expected future level.

What variables should be used to predict incomes? In principle, any information in the survey could be used, but, for the moment, I work with a minimal representation, using only past incomes and saving. Note that it is *not* required to match the income process as seen by the agents themselves; all that is required is a model of the process as seen by the econometrician, using the information in $H_t$. Since this consists of lagged values of saving and income, and since the Ivorian data contain only one lagged value for each household, the obvious starting point is to write income as

$$(5) \quad (y_t-\mu) = a_{11}(y_t-\mu)+a_{12}s_{t-1}+\varepsilon_{1t}$$

where $\mu$ is the mean of labour income, $\varepsilon_{1t}$ is the income innovation, and $a_{11}$ and $a_{12}$ are parameters. Note that saving $t_{t-1}$ does not require its mean removed, since, by the stationarity assumption, its mean is zero. Note also that (5) is supposed to hold for the income of a single household; in practice, it will need to be modified to allow for differences between households, an issue that is addressed in the next section. Equation (5) is "obvious" only from the point of view of the information set $H_{t-1} = \{y_{t-1}, s_{t-1}\}$, and it is not clear how it relates, for example, to the sort of advance information about crops that Ivorian farmers might actually possess. I shall return to this issue below, when I am in a better position to discuss it.

The income process (5) and the "rainy day" equation (4) have immediate implications for saving, implications that could be derived by applying (4) to (5). A more straightforward, but equivalent route, is to propose a companion equation to (5) that relates current saving to lagged income and lagged saving, and then use (4) to derive restrictions. Combining (5) with the corresponding saving equation, and writing $z_t$ for $y_t - \mu$ we have a VAR of the form

$$(6) \quad \begin{pmatrix} z_t \\ s_t \end{pmatrix} = \begin{pmatrix} a_{11} & a_{12} \\ a_{21} & a_{22} \end{pmatrix} \begin{pmatrix} z_{t-1} \\ s_{t-1} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \end{pmatrix}$$

or, writing $x_t = (z_t, s_t)'$,

$$(7) \quad x_t = Ax_{t-1} + \varepsilon_t$$

The VAR form (7) is a particularly convenient form in which to impose (4). Note that, given (7), $E_t(x_{t+i}|H_t = A^i x_t$, so that, defining $e_1=(1\ 0)'$ $e_2 = (0\ 1)'$and $\rho = (1+r)^{-1}$ equation (4) can be written

$$(8) \quad -s_t = -e_2'x_t = e_1'\sum_{i=1}^{\infty}\rho^i(A^i - A^{i-1})x_t.$$

so that, provided income and savings are not exactly linearly dependent,

$$(9)\quad -e_2' = e_1'\sum_{i=1}^{\infty}\rho^i(A-I)A^{i-1} = e_1'\rho(A-I)(I-\rho A)^{-1}$$

or, on re-arrangement,

$$(10)\quad (e_1'-e_2')A = e_1'-\rho^{-1}e_2'.$$

Given an estimate of the matrix $A$, the permanent income hypothesis can be tested by examining the validity of (10).

This test is essentially equivalent to the standard procedure of checking the orthogonality between consumption change and lagged variables. To see this, lag equation (2) one period to get

$$(11)\quad (1+r)s_{t-1} = rA_{t-1} + (1+r)(y_{t-1}-c_{t-1})$$

and compare this with the period to period budget constraint

$$(12)\quad A_t - (1+r)A_{t-1} = (1+r)(y_{t-1}-c_{t-1}).$$

Subtraction gives $(1+r)s_{t-1} = \Delta A_t$, which can be substituted into the first-difference of (2) to give an expression for the change in consumption

$$(13)\quad \Delta c_t = \Delta y_t + (1+r)s_{t-1} - s_t = (e_1'-e_2')x_t - (e_1'-\rho^{-1}e_2')x_{t-1}.$$

The identity (13) is given behavioural content by substituting for $x_t$ from (7), so that, if the restrictions (10) hold, we have at once that

$$(14)\quad \Delta c_t = (e_1'-e_2')u_t$$

so that the change in consumption is an innovation, and in particular is orthogonal to both lagged saving and lagged income. The condition (10) is satisfied if and only if these orthogonality conditions hold. The restriction that lagged saving not predictable consumption changes is perhaps of particular interest. It is less familiar than the standard tests, which tend to focus on income. Furthermore, as I shall show by an example below, it is possible for the permanent income hypothesis to be false, but for saving still to indicate future income expectations. In such circumstances, tests of the orthogonality of consumption changes to lagged saving are tests that even agents' own private expectations about future income changes cannot help predict changes in consumption.

It is worth attempting to provide a somewhat closer link between the restrictions and the underlying income and savings processes, since it is here that the bivariate methodology can provide us with more information than can the usual tests of consumption orthogonality. In particular, if we use the VAR to solve out for the univariate representation of the income process, we can link the parameters of $A$ to what we know about income and agriculture in

Côte d'Ivoire. This provides an explicit link between the time-series process for income, as determined for example by the farmer's crop mix, and the joint stochastic behaviour of saving and income.

Given (10) two parameters of the $A$ matrix may be chosen freely. Write $A$ in the form

$$(15)\quad A = \begin{pmatrix} \alpha & \beta \\ \alpha - 1 & \beta + \rho^{-1} \end{pmatrix}$$

and I shall try to interpret the parameters $\alpha$ and $\beta$. The VAR (6) or (7) implies that the univariate process for income $\{z_t\} = \{y_t - \mu\}$ is an ARMA(2,1); use the second row of the VAR to substitute for $s_{t-1}$ in the first row, and for $s_{t-2}$ in the result, and so on. Write this

$$(16)\quad z_t = \phi_1 z_{t-1} + \phi_2 z_{t-2} + u_t + \theta u_{t-1}.$$

Matching coefficients, $\alpha$ and $\beta$ can be solved in terms of the auto-regressive parameters $\phi_1$ and $\phi_2$, to give

$$(17)\quad \alpha = \frac{1-\rho(\phi_1+\phi_2)}{(1-\rho)} \qquad \beta = -\frac{\{1-\rho(\phi_1+\rho\phi_2)\}}{\rho(1-\rho)}$$

for the first row of the $A$ matrix, and

$$(18)\quad \alpha - 1 = \frac{\rho(1-\phi_1-\phi_2)}{1-\rho} \qquad \beta + \rho^{-1} = -\frac{\rho(1-\phi_1-\rho\phi_2)}{1-\rho}$$

for the second. The parameter $\theta$ plays no part in $\alpha$ and $\beta$, but affects the relative variances of the innovations.

Note first that $\beta$ is negative; as emphasized by Campbell, past savings is a predictor that income will fall next period. If the agent had no more information than the econometrician, and if income were predictable by either the agent or the economist *only* by previous income, this effect would not exist. However, it is plausible that the agent knows more than the economist, so that we would expect falls in income to be anticipated by positive saving, and if such an effect actually appears in the data, it would seem very good evidence in favour of the proposition that some smoothing is going on. Indeed, it is quite difficult to think of alternative explanations for such a correlation. Note too the role played in this effect by the auto-regressive parameters. If the univariate income process displays positive auto-correlation, private information about an expected fall in income in the next period will imply expected falls in the further future, so that, for any given one period ahead fall in income, saving will be larger the larger the degree of positive auto-correlation. In consequence, any given amount of current saving will reveal less of an expected fall the larger the degree of positive auto-correlation. Consider the opposite case, for example that of a coffee farmer who observes damage to blossoms early in the year. He revises downward his estimate of next period's income but knows that, in the period after that, he will recoup some of the loss, because, after a period of "rest:, the trees are likely to be abnormally productive. His additional saving will therefore be relatively modest, and small levels of saving will indicate relatively large income falls in the subsequent period.

The first term in the $A$ matrix also requires some interpretation; the coefficient of last period's income deviation in the prediction of this period's income deviation is positive and greater than unity, but is *smaller* the *larger* the degree of auto-correlation in the univariate process. Again, it is important to realize that these effects are conditional on the amount of last period's saving. Lagged saving tells us what the agent expects future income changes to be. Conditional on this expectation, a higher value of lagged income implies a higher value for current income, and the derivative is greater than unity unless the income process has a unit root. If lagged income had been one unit higher, and there were no implications for current or future incomes, lagged consumption would have been higher by $r/(1+r)$. However, since lagged saving is being held constant, lagged consumption must have been a full unit higher, and for this to make sense, there must have been private information that current income or future incomes would be high enough to justify the rest. If there is no auto-correlation in the income process, the correct amount is $(1+r)/r$, and this would be the value of $a_{11}$, but will be lower (or higher) if there is positive (or negative) auto-correlation.

The bottom row of the $A$ matrix is easily interpreted in terms of the first row. Once we know what the implications of lagged saving and income for current income, the implications for current saving are a direct consequence.

Before moving on to econometric issues, I give some consideration to possible alternatives to the PIH and to the question of how to interpret possible failures of the restrictions (10). In this I follow a recent paper by Flavin (1990) who has shown how her 1981 "excess sensitivity" hypothesis fits into the framework used in this paper. Flavin proposes that consumption be written

$$(19)\quad c_t = y_t^p + \chi(y_t + rA_t - y_t^p),$$

where $y_t^p$ is permanent income, i.e. the right hand side of equation (1), and $\chi$ is an "excess sensitivity" parameter, representing the extent to which consumption responds to current income over and above the amount that is warranted by the PIH. The obvious interpretation of a finding that $\chi > 0$ runs in terms of the presence of liquidity constraints, since households whose borrowing is limited can only increase their consumption when the income is directly to hand. Since at least some households in Côte d'Ivoire are likely to be restricted in their borrowing power, this alternative hypothesis is worth examination. Even so, the formulation should be seen as providing a specification test for liquidity constraints, rather than as a fully worked out model of behaviour when borrowing is limited. For example, consumers with assets can consume by selling them, and do not have to wait until the asset income is actually paid. Nor is it the case that people who cannot borrow at all will simply spend their incomes; nothing stops them from saving, and from accumulating and decumulating their own assets; see Deaton (1991) for further discussion.

Even so, the excess sensitivity model (19) is very useful in the current context. Flavin shows that (19) implies that the rainy day equation (3) is modified to

$$(20)\quad s_t = -(1-\chi)\sum_{i=1}^{\infty}(1+r)^{-i}E(\Delta y_{t-i}|\Omega_t),$$

so that current saving while no longer equal to the discounted present value of expected falls in labour income, is proportional to it. In consequence, the switch of information sets, from $\Omega_t$ to $H_t$ works exactly as it did before, and once again, there is a VAR representation in terms of income and saving. If the algebra is carried through as before, the restriction (10) takes the new form

$$(21)\quad [(1-\chi)e_1' - e_2']A = (1-\chi)e_1' - \rho^{-1}e_2'$$

which, on elimination of $\chi$, gives the single non-linear restriction

$$(22)\quad (a_{22}-\rho^{-1})(a_{11}-1) = a_{12}a_{21}.$$

A failure of (10) when (22) is satisfied would suggest that the excess sensitivity model is a fair representation of the data, and Flavin's own work (1990) suggests that this is the case for the aggregate data in the United States. Note finally that, as was the case with the permanent income hypothesis, the restrictions of the excess sensitivity model have implications for the form of the consumption change equation. Follow the same procedure as before, and substitute from (7) for $x_t$ in the general consumption change equation (13), but now apply the excess sensitivity restriction (21). This gives

$$(23)\quad \Delta c_t = \chi e_1'(A-I)x_{t-1} + (e_1'-e_2')u_t = \chi E_{t-1}\Delta y_t + (e_1'-e_2')u_t$$

so that, as is standard in the excess sensitivity literature, $\chi$ measures the response of consumption change to anticipated changes in income.

## 3. Econometric Implementation

The theory developed in the previous section could be implemented without modification if there were extensive time-series data for each household, so that a VAR could be estimated and the restrictions tested for each individually. Instead, we have a large number of households but only two consecutive observations for each. What is possible, and it is essentially all that is possible, is to run cross-section regressions of income and saving on last period's income and saving, using the cross-sectional variances and covariances to estimate the parameters. However, these parameters cannot be regarded as estimates of the $A$ matrix, except under very implausible assumptions. This section examines the problems, and shows how the data can still be used to test the theoretical restrictions.

The version of (5) that I shall work with is written

$$(24)\quad y_{it}-\mu_i = a_{11}(y_{it-1}-\mu_i) + a_{12}s_{it-1} + \psi_{1t} + \varepsilon_{1it}$$

with a corresponding saving equation

$$(25)\quad s_{it} = a_{21}(y_{it-1}-\mu_i) + a_{22}s_{it-1} + \psi_{2t} + \varepsilon_{2it}.$$

According to these equations, and apart from the fixed effects $\mu_i$ and the idiosyncratic shocks $\varepsilon_{i1t}$ and $\varepsilon_{i2t}$ the bivariate process describing income and saving is identical for all households, at least within a region or agro-climatic zone. The innovations in the original model are now decomposed into macroeconomic shocks, $\Psi_{1t}$ and $\Psi_{2t}$ and idiosyncratic shocks, the former entering additively and affecting all households equally. Equations (24) and (25) are perhaps the simplest generalization of the original VAR that it is sensible to attempt to apply. Clearly, individual incomes must have different means, and just as clearly, there have to be macroeconomic shocks, so that the aggregates of income and saving are not constant over time. However, there are many ways of incorporating these features, and the one I have chosen is very special, and is guided as much by data availability as by realism. The assumption that income is stationary has already been discussed, as well as its implication that saving has mean zero for all the observations in the sample. Without this, the methods discussed below would not work. The assumption that the macroeconomic shocks are additive is also required to obtain the results. As written, the two macroeconomic terms in (24) and (25) can be dealt with by including year dummies in the regression. However, if the macroeconomic shocks operated in some other way, so that for example the effect on each household's income was different, then the cross-section estimates would not identify the parameters that I need. The fundamental underlying problem here is that of using short panel data to estimate time series parameters, something that cannot be done without strong maintained assumptions on the nature of common shocks; for a review of this issue in the consumption context and a guide to some of the original literature, see Deaton (1992, Chapter 5).

It will also be useful to have the consumption change equation that corresponds to (24) and (25). If we apply equation (13) to (23) and (24), we reach

$$(26)\quad \Delta c_{it} = b_1(y_{it-1}-\mu_i) + b_2 s_{it-1} + (\psi_{1t}-\psi_{2t}) + (\varepsilon_{1it}-\varepsilon_{2it})$$

where, the coefficients are given by

$$(27)\quad b_1 = a_{11} - a_{21} - 1 \qquad b_2 = a_{12} - a_{22} - (1+r)$$

so that, if the permanent income hypothesis is true, $b_1 = b_2 = 0$. Clearly, it is a matter of indifference which two of the three equations (24), (25), and (26) is estimated. However, my main interest is first, the effect of lagged saving on income, and second, the orthogonality of consumption change to the lagged variables, so I shall work with the income and consumption equations (24) and (26).

Since the panel data for Côte d'Ivoire never have more than two years of data for each household, it is not possible to estimate any of the three equations with appropriate allowance for the fixed effects. My procedure is to run the simplest regressions, ignoring the fixed effects, and to examine the nature of the biases in the estimated coefficients. In general, it is clear that consistent estimates of the matrix $A$ cannot be obtained by using two years of the cross-section to regress income and saving on lagged income and lagged saving. However, given the structure of the model, it is nevertheless the case that the estimates of the $A$ matrix so obtained, although inconsistent, will still satisfy the theoretical restrictions (10) if the permanent income hypothesis is true. I shall justify this statement formally below, but the simplest way to see what is going on is to examine, not the income and saving equations (24) and (25), but the consumption change equation (26). Suppose that the consumption change is regressed on lagged income and lagged saving, ignoring the fixed effects. This regression can be written

$$(29) \quad \Delta c_{it} = b_0 + b_1 y_{it-1} + b_2 s_{it-1} + \xi_{it}$$

where the constant absorbs the macroeconomic shocks and the compound error term is given by

$$(30) \quad \xi_{it} = -b_1 \mu_i + \varepsilon_{1it} - \varepsilon_{2it}.$$

In general, ordinary least squares will not yield consistent estimates of (29), since the error term contains the fixed effect which is correlated with the lagged income variable. However, if the permanent income hypothesis is true, $b_I$ is zero, the fixed effect vanishes from the error term, and there is no bias. Hence, the PIH can be validly tested even if the fixed effects are ignored. Another way of putting the same point is to note that non-zero estimates of the parameters cannot be attributed to the fixed effects, since they act as would measurement error, biasing the estimates towards zero. The same argument goes through for any instrumental variable estimator where the instruments are correlated with the omitted fixed effects. Once again, non-zero estimates cannot be explained by omitted fixed effects if the permanent income hypothesis is true.

To see how the argument works for the VAR of saving and income, define the vector $v_{it}$ by

$$(31) \quad v_{it}' = (y_{it} \;\; s_{it})',$$

so that the income and saving VAR can be written

$$(32) \quad v_{it} = b_t + A v_{it-1} + f_i + \zeta_{it},$$

where

$$(33)\quad b_t = \begin{pmatrix} (1-a_{11})\mu+\psi_{1t} \\ \psi_{2t}-a_{21}\mu \end{pmatrix} \quad f_i = \begin{pmatrix} (1-a_{11})(\mu_i-\mu) \\ -a_{21}(\mu_i-\mu) \end{pmatrix} \quad \zeta_{it} = \begin{pmatrix} \zeta_{1it} \\ \zeta_{2it} \end{pmatrix}$$

and $\mu$ is the grand mean of the fixed effects. Although the $b_t$ vector contains quantities that vary with $t$, there is only a single $t$ in the analysis, 1987 or 1986 depending on which panel we are using, and a single $t$-1, 1986 or 1985, so that $b_t$ is a constant in the cross-section regression.

Define the cross-sectional variance and covariance matrices

$$(34)\quad C = cov(v_{it}, v'_{it-1}) \qquad M = var(v_{it-1}, v'_{it-1}) \qquad F = cov(f_i, v'_{it-1})$$

which, from (32), satisfy

$$(35)\quad C = AM + F.$$

The ordinary least squares estimate of $A$ from the cross-section has the probability limit $CM^{-1}$ so that we can write

$$(36)\quad \operatorname*{plim}_{n\to\infty} \hat{A} = CM^{-1} = A + FM^{-1}$$

which shows how the fixed effects render the OLS estimates inconsistent. However, suppose that the PIH is correct, and that the $A$ matrix satisfies the restrictions in (10) and so can be written in the form (11). Hence, the truth of the PIH implies that the fixed effect vector $f_i$ in (33) has the form:

$$(37)\quad f_i = (1-\alpha)(\mu_i-\mu)\begin{pmatrix} 1 \\ 1 \end{pmatrix}$$

Hence, from (34) $(e_1' - e_2')F = 0$, so that from (36) and (10),

$$(38)\quad (e_1' - e_2')CM^{-1} = (e_1' - e_2')A = e_1' - \rho^{-1}e_2'.$$

Under the null hypothesis of the PIH, we have the result that the probability limit of the OLS estimates satisfy exactly the same restrictions as does the matrix $A$, even though they do not provide consistent estimates of it. For the purpose of testing the restrictions, it is unnecessary to make any correction for differences between households in mean incomes.

It is also possible to use (36) to discover more about the properties of the OLS estimates, or at least of their probability limit $CM^{-1}$ Again, under the null hypothesis of the PIH, (11) can be used to evaluate (36) element by element. For the first row, which gives the parameters predicting income,

$$(39)\quad \text{plim}\,\hat{\alpha} = (CM^{-1})_{11} = \alpha + \sigma_\mu^2(1-\alpha)(M^{-1})_{11}$$

$$\text{plim}\,\hat{\beta} = (CM^{-1})_{12} = \beta + \sigma_\mu^2(1-\alpha)(M^{-1})_{12}.$$

The stationarity of income implies that $\alpha$ is greater than unity, see (17), and $(M^{-1})_{11}>0$, because $M$ is positive definite, while $(M^{-1})_{12}<0$ if saving and income are positively correlated in the cross section, as they are. Hence, if the permanent income hypothesis is true, the coefficient of lagged income on income is biased downwards, and that of lagged saving on income biased up. Therefore if, conditional on previous values of income, saving does in fact predict income falls, the result is consistent with the hypothesis, provided the value of $\alpha$ is sufficiently close to one. By contrast, if consumers are not looking ahead in planning their consumption, it is quite hard to think of explanations of why, conditional on lagged income, lagged saving should help predict future income. In particular, there does not appear to be any mechanical reason why we would expect the estimate of $\beta(a_{12})$ to be negative. Consider, for example, a simple mechanical model in which each farmer's income is a first-order auto-regressive process around its own individual mean, but in which there is no effect of lagged saving on income. This model is (26) with $a_{12}$ equal to zero, and with $|a_{11}| \le 1$ and probably small in absolute value given the nature of agricultural income. To match the data, suppose also that for some reason unconnected with the theory, saving is positively correlated with the fixed effect in income (richer farmers always save more), and thus with income itself, while remaining orthogonal to the innovations in income. A standard mis-specification analysis can then be used to derive the probability limit of the coefficient on lagged saving in a cross-sectional regression in which income is regressed on lagged income and lagged saving and no allowance is made for fixed effects. As is easily shown, this limit is *positive*, so that such a model can yield no explanation for a finding that farmers who save more will be those with the largest falls of income in the subsequent period.

If the permanent income hypothesis is false, but the data conform to Flavin's excess sensitivity model, the foregoing analysis can be modified in an appropriate way. It is still possible to start from the same VAR, and since the expected value of saving is still zero, the representation (32) still holds, and the OLS estimates will still converge to the right hand side of (36), although the $A$ matrix will be different. If (21) holds instead of (10), the $A$ matrix takes the form

$$(40)\quad A = \begin{pmatrix} \alpha & \beta \\ (1-\chi)(\alpha-1) & (1-\chi)\beta+\rho^{-1} \end{pmatrix}.$$

Given (40), the fixed effects $f_i$ in (33) can be written

(41) $f_i = (1-\alpha)(\mu_i-\mu)\begin{pmatrix} 1 \\ 1-\chi \end{pmatrix}.$

In consequence, $[(1-\chi)e_1' - e_2']F = 0,$ so that, corresponding to (38), the excess sensitivity hypothesis implies that

(42) $[(1-\chi)e_1' - e_2']CM^{-1} = [(1-\chi)e_1' - e_2']A = (1-\chi)e_1' - \rho^{-1}e_2'.$

As is the case for the pure permanent income hypothesis, when evaluating the test, we can treat the OLS estimates as if they were estimates of $A$.

My statistical procedures can now be readily presented. The first stage is to estimate the VAR by ordinary least squares in the form

(43) $\Delta y_{it} = a_0 + (\alpha-1)y_{it-1} + \beta s_{it-1} + \xi_{1it}$

$\Delta c_{it} = b_0 + b_1 y_{it-1} + b_2 s_{it-1} + \xi_{2it}$

where $b_1$ and $b_2$ are given by (27). The estimates of $\alpha$ and $\beta$ are expected to be inconsistent, but, as argued above, a negative estimate for $\alpha$ can still be regarded as evidence that agents are looking forward and saving in anticipation of bad times. If the full PIH is correct, $b_1$ and $b_2$ should be zero, and this is straightforwardly tested using an $F$-test. The excess sensitivity hypothesis can be tested, for example, by applying a Wald test to the parameters of the VAR. However, the simplest way to obtain an estimate of the excess sensitivity parameter and to test the hypothesis is to estimate (23) from the regression

(44) $\Delta c_{it} = \gamma + \chi \Delta y_{it} + \xi_{3it}$

using $y_{it-1}$ and $s_{it-1}$ as instruments. The first-stage of the appropriate two stage least squares procedure is simply the first of the two regressions in (43). The specification can be tested using the over-identification test that comes from comparing the fit of (44) with the unrestricted model, which is the second regression in (43). I shall again present this as an $F$-statistic in order to facilitate comparison with the $F$-test for the unpredictability of consumption changes.

## 4. Results from Côte d'Ivoire

I use data from the first three years, 1985, 1986, and 1987 of the Ivorian survey. Together, these give me two separate panels, which I shall work with separately. Although it would be possible to pool the two data sets, three years' data are insufficient to average out any macroeconomic shocks, and pooling will only blur any differences between the two panels that will result if the assumptions about the macroeconomic shocks are wildly incorrect. The sample design called for 800 households to be interviewed using essentially identical questionnaires in the three years, and a wide range of topics were covered, see Ainsworth and Muñoz (1986) for a description. For current purposes I need data on income, with labour income separate from capital income, and on saving, or equivalently, on consumption. The measurement of consumption is relatively straightforward. Households are asked to record purchases of a fairly detailed list of foods and other goods, and separate sections of the questionnaire deal with home produced food, and with regular charges, such as rent, water, and electricity for those few urban households who record such expenditures. The total of these amounts defines consumption. I have done relatively little editing of the consumption data. Each of the hundred or so components were examined for gross outliers, and a few replacements were made, usually by the mean (sometimes median) expenditure on that item in the village or sample cluster of the household. There were less than 100 such replacements in each year, out of a total of 80,000 recorded expenditures.

The definition and measurement of income is a good deal more complex. It is clear that it is useless to ask self-employed agricultural households in LDCs (and probably anywhere else), "What was your income last year?" and the Living Standards Surveys make no attempt to do so. Instead, a measure of income is computed *ex post*, using the answers to several hundred different questions. The most important of these cover wage employment in primary and other jobs (significant only in urban areas), business income of various sorts, and agricultural income, which is itself computed by adding up sales of crops and deducting costs, an important element of which is in kind payment of crops to "share-croppers" who help with the coffee and cocoa harvests in return for a fraction of the crop. The code that generates the income figures is many hundreds of lines long, and embodies many difficult decisions, both about conceptual matters, and about likely measurement errors. An example of the former provides an illustration of the sort of problems that have to be faced. Ideally, some allowance should be made when computing farmers' incomes for depreciation to buildings and implements, as well as for appreciation to various stocks of commodities and livestock. The survey collects information on the value of capital and of stocks, including livestock, but essentially arbitrary conventions have to be employed, particularly to estimate depreciation. Such corrections can very easily generate income figures that look very low relative to measured consumption, and the estimates of savings may well be negative when, in fact, on a cash flow basis, the household's incomings are in excess of its outgoings. There is nothing conceptually wrong with such a situation, but questions arise as to whether the measured savings figures have much relationship to the concepts that the farmer actually thinks about. It is also far from clear that we can interpret a large number of negative values for saving as an indication that income is typically under-reported. Another problem that is specific to the Ivorian data is the treatment of payments to share-croppers. The questionnaire was less than perfectly designed to deal with the institution of *mettayage* as it exists in Côte d'Ivoire and Ghana, and while in kind payments to *mettayeurs* are theoretically recorded separately, the relevant questions are open to misinterpretation. In addition, some farmers clearly reported these payments as payments to farm labour. Fairly elaborate precautions were taken to try to unscramble these problems, and many of the figures are undoubtedly correct. However, the possibility remains both for double counting of costs, and for zero counting of costs.

A problem that is more specific to this paper is the separation of asset from labour income. This has always been a problem for empirical work on the permanent income hypothesis, particularly in the United States where the two magnitudes are reported separately neither on individual tax returns nor in the national income and product accounts. For farmers in LDCs, the problem is a different one; if a farm family works land using tools, equipment, orchards, livestock, and buildings, and from that earns an income, how do we divide that income between a return to capital and a return to labour? For Côte d'Ivoire, it is possible to finesse this problem, at least to some extent. In spite of increasing scarcity in recent years, land is still relatively plentiful, so that it is possible to think of a family moving on to vacant land, on which they can earn a return to their labour by growing crops, and it seems reasonable to think of this return as labour income. Furthermore, many farmers have little in the way of equipment, so that ignoring it altogether may not be too serious. Even so, cocoa and coffee farmers have substantial capital in the form of stands of trees, and farmers in the northern savannah typically have herds of cattle. However, in a stationary environment there will be little or no *net* investment in these assets, and most are not suitable as vehicles for short-term income smoothing, which is the topic of this paper. Imagine therefore that there is a fixed capital stock of all sorts, including land and trees, and that the application to these fixed assets of labour generates labour income. This labour income is variable, because of weather fluctuations, pests, and particularly in Côte d'Ivoire, bush fires, and households use assets such as money to smooth consumption, with net saving averaging zero over long enough time periods. The LSS data report show very little capital income, at least in the form of returns on liquid financial assets. This is presumably because a good deal of smoothing is done using currency, but possibly also because there are a large number of loans between households, only a fraction of which are actually reported. This paper therefore uses total income as if it were labour income; any "corrections" would be small enough to be well within the (large) margin of error in the income estimates themselves.

Table 1 shows the means and standard deviations of income and saving for 1985, 1986, and 1987 from the two panels for five separate regions of the country. Since the two panels overlap in 1986, there are two independent estimates for that year. Abidjan is the principal city, and along with Other Urban comprise the areas where wage employment is common. East Forest and West Forest are in the south of the country, are rural areas, and much of income in both regions comes from the cultivation of coffee and cocoa. The Savannah region is in the north, where agriculture is largely livestock and rain-fed crops, such as yams, maize, rice, and cotton. Note that the years are "survey years", rather than either calendar or crop years for any of the many crops grown in Côte d'Ivoire. Different households are interviewed at different times during the year and are asked about their income and consumption during the previous twelve months. In consequence, most individuals will be interviewed at a point midway through their crop year, at which time they can be expected to have a good deal of private information about next year's income. There are 718 households out of the original 800 for which it is possible to calculate estimates of income in both years, and the distribution of these over the five regions is shown in the table.

*Table 1: Saving and Income 1985, 1986, and 1987 (thousands of CFA)*

| | Abidjan | | Other Urban | | West Forest | | East Forest | | Savannah | |
|---|---|---|---|---|---|---|---|---|---|---|
| $n_1$ | 137 | | 123 | | 152 | | 183 | | 123 | |
| $n_2$ | 154 | | 139 | | 77 | | 165 | | 154 | |
| | mean | s.d. | mean | s.d. | mean | s.d. | mean | s.d. | mean | s.d. |
| $y_{85}$ | 2591 | 3292 | 1829 | 1479 | 1162 | 1408 | 1040 | 1697 | 630 | 695 |
| $y_{86,1}$ | 2891 | 4031 | 1746 | 1396 | 806 | 796 | 1081 | 1228 | 788 | 738 |
| $y_{86,2}$ | 3301 | 6966 | 2236 | 2104 | 1225 | 2010 | 1282 | 1187 | 742 | 994 |
| $y_{87}$ | 3724 | 7232 | 2256 | 2208 | 1151 | 1353 | 1220 | 1400 | 716 | 629 |
| $s_{85}$ | -405 | 1790 | -126 | 1221 | -70 | 1285 | 21 | 1434 | -41 | 611 |
| $s_{86,1}$ | 264 | 2601 | 89 | 1021 | -103 | 612 | 33 | 923 | -40 | 605 |
| $s_{86,2}$ | 579 | 5990 | 240 | 1642 | 199 | 1263 | 136 | 904 | -28 | 876 |
| $s_{87}$ | 1167 | 6061 | 355 | 1494 | 258 | 947 | 172 | 993 | 57 | 432 |

Note: 86,1 and 86,2 refer to the means of the first and second panels respectively; the two rolling panels overlap in 1986. Similarly $n_1$ and $n_2$ are the numbers of households in each of the two panels.

Perhaps the most striking feature of the Table 1 is in the West Forest, where there was a 31% drop in estimated income between 1985 and 1986 for the households in the first panel. However, note that here, as elsewhere in the table, the standard deviations are large, as are the implicit standard errors given the sample sizes in the first two rows. Indeed, the West Forest households in the second panel reported a very much higher figure for their income in 1986. Furthermore, local agricultural experts in Côte d'Ivoire claim that there was no major disaster in the area in 1986, and although there were bush fires, these were no worse than in normal years, see SEDES (1990). These anomalies should, at the least, alert us to the very large uncertainties surrounding these figures.

Estimates of the parameters of the VARs for the two sets of panel data are listed in Table 2. These are simply the OLS equation by equation estimates obtained by regressing income change and consumption change on the previous year's values of income and saving using the individual household data. If the coefficient $\alpha$ were being consistently estimated, we would expect the coefficients on lagged income to be positive, but some downward bias is to be expected, and the estimated coefficients are negative more often than not. More interesting is the coefficient on lagged saving in the income equation, which is negative in all ten cases, and significantly so with one exception, the West Forest in the second panel. The size of the effect varies somewhat from region to region, but is consistently strongest between the two panels in the East Forest, which is the major cocoa growing area. Conditional on the previous year's income, 1000 CFA of additional saving predicts that income in the next year will be lower by between a third and two-thirds of that amount. This is exactly what the theory predicts, and unless some alternative explanation can be found, seems good evidence that these households save when they expect their incomes to fall.

Of course, that consumers look ahead when deciding how much to save does not imply that they save exactly the amount that would be required by the permanent income hypothesis. The tests for this are much more negative, and the consumption change regressions show that consumption changes are negatively related to lagged values of income and positively related to lagged values of saving. Note that, to a first approximation, the income and saving coefficients are equal and opposite, so that the consumption regressions in Table 2 suggest that, in the cross-section, households with higher consumption in one year have a smaller consumption change from that year to the next. These violations of the permanent income hypothesis are sometimes quite large, particularly in the West Forest, and are statistically significant, again with a single exception, the Savannah using the 1985–86 panel. The $F$-statistics for the hypothesis that lagged income and saving cannot predict consumption change are given in the last row of Table 3, and with the one exception, strongly reject the hypothesis.

Somewhat surprisingly, the excess sensitivity model is not able to account for these results. While the formal tests are again in Table 3, the source of the problem can be seen in Table 2. Saving predicts declines in income, which, if there is excess sensitivity, should predict declines in consumption, but the opposite is true in the data. Conditional on lagged income, lagged saving predicts consumption positively and (in all cases but one) significantly. As a result, the excess sensitivity parameters listed in Table 3 are either negative (Abidjan and Other Urban), or essentially zero. In only one case, the West Forest in the second panel, is there a sensible estimate for $\chi$, and even here, the over-identification test in the first row rejects the restrictions implied by the model. Indeed, most of these $F$-tests reject the excess smoothness model. Note further that the additional variance explained by the addition of the excess sensitivity parameter can be assessed by comparing the $F$-statistics in the first two rows with twice the $F$-statistics in the last two rows. This comparison shows that, not only is the excess smoothness model rejected, but it typically shows very little improvement over the strict permanent income hypothesis. When this is not the case, as in the second panel for Abidjan and Other Urban (marginally), the estimates of $\chi$ are not sensible, or, as in the Savannah in the first panel, hold for a value of $\chi$ of zero, because the PIH itself cannot be rejected. These results seem to provide a strong rejection of the permanent income hypothesis, with no support for a weakening in the direction implied by the excess sensitivity formulation.

*Table 2: VAR Estimates for Income and Consumption Changes (absolute t-values in parentheses)*

| | Constant | | $y_{t-1}$ | | $s_{t-1}$ | | $R^2$ |
|---|---|---|---|---|---|---|---|
| Abidjan | | | | | | | |
| $\Delta y_t$ | 165.4 | (0.4) | -0.0143 | (0.2) | -0.4241 | (2.5) | 0.072 |
| | -14.7 | (0.1) | 0.1697 | (2.1) | -0.2104 | (2.2) | 0.032 |
| $\Delta c_t$ | 331.2 | (1.6) | -0.2069 | (4.2) | 0.4054 | (4.4) | 0.150 |
| | 421.2 | (2.8) | -0.2237 | (5.0) | 0.2634 | (5.0) | 0.145 |
| Other Urban | | | | | | | |
| $\Delta y_t$ | 286.0 | (1.5) | -0.2328 | (2.8) | -0.4500 | (4.4) | 0.336 |
| | -227.7 | (1.2) | 0.1803 | (2.3) | -0.6513 | (6.3) | 0.301 |
| $\Delta c_t$ | 490.9 | (3.9) | -0.3933 | (7.0) | 0.5522 | (8.1) | 0.375 |
| | 57.4 | (0.6) | -0.0835 | (2.2) | 0.1392 | (2.8) | 0.055 |
| West Forest | | | | | | | |
| $\Delta y_t$ | 115.1 | (1.4) | -0.4249 | (7.8) | -0.3280 | (5.5) | 0.735 |
| | 443.4 | (2.5) | -0.3905 | (2.5) | -0.1965 | (0.8) | 0.555 |
| $\Delta c_t$ | 460.0 | (6.8) | -0.6314 | (14.1) | 0.6900 | (14.0) | 0.587 |
| | 595.7 | (4.7) | -0.7286 | (6.7) | 0.8226 | (4.7) | 0.466 |
| East Forest | | | | | | | |
| $\Delta y_t$ | 258.1 | (2.4) | -0.1952 | (2.5) | -0.6741 | (7.4) | 0.632 |
| | 154.7 | (1.1) | -0.0976 | (1.1) | -0.6836 | (5.7) | 0.282 |
| $\Delta c_t$ | 453.8 | (6.8) | -0.4172 | (8.7) | 0.4394 | (7.6) | 0.293 |
| | 212.4 | (3.5) | -0.2682 | (6.6) | 0.2400 | (4.5) | 0.215 |
| Savannah | | | | | | | |
| $\Delta y_t$ | 278.9 | (2.6) | -0.2193 | (1.7) | -0.4317 | (2.9) | 0.278 |
| | 352.3 | (4.6) | -0.5209 | (6.4) | -0.3015 | (3.3) | 0.647 |
| $\Delta c_t$ | 215.8 | (2.0) | -0.0852 | (0.7) | 0.1181 | (0.9) | 0.006 |
| | 312.2 | (5.8) | -0.5464 | (9.7) | 0.6432 | (10.0) | 0.414 |

Notes: there are two sets of estimates for each equation. In each case, the first row comes form the first panel 1985-1986, the second row from the panel 1986-1987.

While these results are disappointing, there are a number of possible explanations that are worth considering. Firstly, it is clear that measurement error is likely to be prevalent in the data used here. However, measurement error is not a very plausible candidate to explain the results. The PIH requires that the regression of consumption on its lag generate a unit coefficient, whereas the data (and Table 2) suggest that the coefficient is considerably less than one. Conceivably, such an effect could be produced by the classic attenuation bias of measurement error. This is fairly readily checked, since the survey data contain a large number of potential instruments for consumption. These are instruments that either "cause" income or consumption, or are components of income that play no part in the measurement of consumption. In particular, I have experimented with net agricultural income, earnings, land under cocoa, land under coffee, personal assets, business assets, agricultural assets, as well as various indicators of rainfall. However, regressions of consumption on lagged consumption using these instruments still do not produce coefficients that are close to one or even insignificantly different from it.

*Table 3: Tests for Excess Smoothness and the PIH: OLS Estimates*

| Abidjan | | Other Urban | | West Forest | | East Forest | | Savannah | |
|---|---|---|---|---|---|---|---|---|---|
| Over-identification $F$-test for excess smoothness model | | | | | | | | | |
| 18.41 | | 67.23 | | 220.13 | | 75.49 | | 0.16 | |
| 0.76 | | 2.57 | | 27.48 | | 44.36 | | 106.54 | |
| Excess sensitivity parameter ($t$-value) | | | | | | | | | |
| -0.39 | (2.2) | -0.17 | (1.8) | 0.04 | (0.6) | 0.02 | (0.4) | -0.04 | (0.3) |
| -1.24 | (5.0) | -0.15 | (2.3) | 0.45 | (5.2) | 0.01 | (0.2) | 0.02 | (0.3) |
| Orthogonality $F$-test for full PIH | | | | | | | | | |
| 11.82 | | 36.02 | | 110.50 | | 37.84 | | 0.36 | |
| 12.78 | | 3.99 | | 32.30 | | 22.21 | | 53.35 | |

Note: in each case, the first row refers to the first panel, 1985-1986, and the second row to the second panel, 1986-1987.

The second issue concerns the tests for excess sensitivity. Negative values for $\chi$, as occur for Abidjan and the Other Urban areas, seem extremely implausible, since they imply a negative effect of anticipated income change on consumption. Note too that, at least for Abidjan, the income change equation fits very badly, so the poor performance of the excess sensitivity tests may simply reflect the fact that the instruments provide inadequate predictions at the first stage. To test this, I re-estimated the income change equation and the excess sensitivity equation using, in addition to lagged income and saving, the assets and land variables listed above. Table 4 gives the results. In the first panel are selected results from the first stage regression, the coefficient of lagged saving, β, its absolute $t$-value, and the $R^2$ statistic for the regression. As can be seen, the new variables add a good deal to the prediction of income change, although the savings variable typically retains its predictive power. However, the improved instrumentation does little to help the excess sensitivity model. The middle panel of the table shows that, although there are no longer any significant negative estimates of χ, there are only two cases where there is a significant positive value. As before, the over-identification tests yield no support for the model, and the $F$-tests for the permanent income hypothesis itself show once again that consumption changes also fail to be orthogonal to the extended list of instruments.

*Table 4: The Effects of Additional Predictors*

| | ß | *t* | $R^2$ | χ | *t* | *OID* | *F* |
|---|---|---|---|---|---|---|---|
| Abidjan | -0.42 | (2.4) | 0.100 | -0.27 | (1.7) | 4.24 | 4.13 |
| | -0.34 | (3.4) | 0.210 | 0.28 | (2.7) | 11.91 | 11.64 |
| Other Urban | -0.39 | (3.8) | 0.453 | -0.09 | (1.0) | 13.16 | 11.52 |
| | -0.49 | (4.2) | 0.380 | -0.09 | (1.6) | 3.31 | 3.25 |
| West Forest | -0.20 | (3.4) | 0.781 | 0.04 | (0.7) | 37.49 | 32.29 |
| | -0.16 | (0.7) | 0.693 | 0.48 | (6.7) | 12.92 | 24.28 |
| East Forest | -0.38 | (3.2) | 0.667 | 0.05 | (1.1) | 22.26 | 19.39 |
| | -0.52 | (4.8) | 0.545 | 0.08 | (1.8) | 10.89 | 9.97 |
| Savannah | -0.17 | (1.1) | 0.418 | 0.08 | (0.7) | 1.33 | 1.21 |
| | -0.06 | (0.5) | 0.671 | 0.02 | (0.4) | 17.69 | 15.21 |

Note: β is the coefficient of lagged saving in the regression of income change on the instruments, and $R_2$ relates to the same regression. χ is the excess sensitivity parameter using the same instruments. OID is the (over-identification) $F$ -test comparing the fit of the IV regression with that of the unrestricted regression of consumption change on the instruments, and $F$ is the $F$-test for the hypothesis that consumption change is orthogonal to the instruments. The instruments are income, saving, hectares under cocoa, hectares under coffee, agricultural assets, business assets, and personal assets, all from period $t$-1. In each case, the top row is from the first 1985-6 panel, and the second row from the second 1986-7 panel.

While it is hard to be absolutely sure that the results of this paper are not the consequence of measurement error, there seem to be several consistent patterns that are hard to explain by mechanical properties of poorly collected or noisily reported data. Looking across both cross-sections, we have the robust result that households who save in one year are, conditional on income, more likely to experience an income decline in the next year. Such a finding is predicted by models in which farmers and other agents have private information about the future, and use that information to put money aside when they anticipate that their income is going to fall. Beyond that, the amount that people save is not well predicted by the permanent income theory, nor, perhaps more surprisingly, by the supposition that consumption changes at least partly reflect anticipated income changes. Exactly what motivates the amount of saving must remain a topic for future research, as must the possibility that the problems have more to do with data problems than with reality.

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