Using Weather Variability To Estimate the Response of Savings to Transitory Income in Thailand

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This paper measures the extent to which farmers are able to use savings and dissavings to smooth consumption in response to unexpected shocks to income. Time-series information on regional rainfall is used to construct estimates of transitory income due to rainfall shocks. The relationship between these measures of transitory income and savings indicates that farm households save a significantly higher fraction of transitory income than nontransitory income. (*JEL* D91, O16)

The incomes of farm households in developing countries are notorious for being both low and uncertain. Policies that increase the incomes of farmers may well be different from those that decrease income variability, and in some cases, there may be a trade-off between these two goals. However, fluctuations in farm incomes will lead to changes in the consumption of farmers only if the savings behavior of farm households does not offset income fluctuations. If farmers are able to save and dissave in response to fluctuations in income, then income fluctuations may have no serious consequences for the well-being of farmers, and there need be no concern about policies that increase farm-income variability.

The purpose of this paper is to examine how the savings behavior of Thai farm households is related to transitory income. The study uses three cross sections of income and expenditure data on Thai rice farmers drawn from the 1975/76, 1981, and 1986 Thai Socio-Economic Surveys (SES). The major objective of the paper is to estimate marginal propensities to save out of transitory income: a finding that these marginal propensities are high would indicate that farmers do use savings to smooth consumption.

The challenge of the paper lies in decomposing income into transitory and nontransitory (i.e., permanent) components. Most studies using household income and expenditure data have focused on the measurement of permanent income, treating transitory income as a residual (e.g., Philip Musgrove, 1979; Surjit Bhalla, 1980; Kenneth Wolpin, 1982). A different approach, taken in this study, is to focus on the explicit measurement of transitory income. Specifically, I use time-series information on regional rainfall in conjunction with cross-sectional data on farm household income to obtain estimates of that component of household income due to shocks in regional rainfall. The basic idea underlying the estimation is that shocks to rainfall will produce shocks to income but will have no direct effect on consumption. Therefore, the part of each household's income that is explained by shocks to regional rainfall serves as an explicit measure of transitory income. After obtaining estimates of transitory income due to rainfall shocks, I estimate the marginal propensity to save out of these estimates of transitory income.

A second contribution of this paper concerns the measurement of savings. In many

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household surveys from LDC's, income appears to be severely underreported relative to expenditure, resulting in absurdly low savings figures. Many income and expenditure surveys yield estimates of aggregate household savings levels that are far below those indicated by national-accounts estimates (see Pravin Visaria, 1980). Estimates of models of savings behavior based on such apparently questionable data are themselves likely to be suspect.

The Thai data used in this paper are similar to other survey data in that savings figures appear to be much too low. However, I show that a portion of the apparent downward bias in the savings measures is due to inflation over the survey period and can be easily corrected. Specifically, the Thai income and expenditure survey, like many such surveys, asked respondents about income earned in the year before the survey and expenditure on many items in the week or month before the survey. This method of data collection makes income appear low relative to consumption, since consumption is measured at more recent (and higher) prices. Simple adjustments for inflation can be done after the survey is completed, yielding savings figures that are much closer to (although still lower than) national-accounts measures of household savings.

The paper is organized in the following way. Section I develops an empirical model of savings in the presence of transitory income fluctuations and discusses some estimation issues. Section II discusses the construction of the savings measures used in the analysis and shows how inflation adjustment affects estimates of household savings rates for the whole Thai economy. Section III presents estimation results.

I. A Permanent-Income Model of Savings

As a starting point, I assume that the savings of household i in region r at time t is a linear function of permanent income (Y_{irt}^{P}), transitory income (Y_{irt}^{T}), and the variability of the household's income (VAR_{ir}). Permanent income is defined over a short time horizon, as expected income for year t conditional on the resources (and information) of the household at the beginning of the period. Transitory income is the difference between realized and expected income.[1] Because longer-term life-cycle factors may also be important determinants of savings, a set of variables $\mathbf{W}_{irt}$ that measure the life-cycle stage of the household is also included in the savings equation.

$$(1)\quad S_{irt} = \alpha_0 + Y_{irt}^{\mathrm{P}}\alpha_1 + Y_{irt}^{\mathrm{T}}\alpha_2 + \mathrm{VAR}_{ir}\alpha_3 + \mathbf{W}_{irt}\boldsymbol{\alpha}_4 + \mathrm{error}_{irt}.$$

A savings equation that is linear in permanent income, transitory income, and the variance of income can be obtained by maximizing a lifetime utility function that is additively separable over time and has either a quadratic or a constant-absolute-risk-aversion (CARA) form, given that the household's income stream is normally distributed. Such a model suggests that the parameter α_1, the propensity to save out of permanent income, should be close to 0 and that α_2, the propensity to save out of transitory income, should be close to 1.[2]

The sign of α_3 is theoretically ambiguous. A CARA utility function implies a positive value for α_3, whereas a quadratic utility function implies that α_3 should equal 0. Other utility functions imply that the change in savings with respect to the variance of income is negative (see Mark Gersovitz, 1987). Although theoretically ambiguous, it is of empirical interest to find out whether those with riskier income streams save more,

[1] In this paper, I am most concerned with whether households smooth consumption in response to short-term shocks to income, and so I use a short-term horizon when defining permanent income. The concept of "permanent income" used in this paper should not be confused with that used in life-cycle models, in which permanent income is defined as the annuity value of lifetime wealth.

[2] If (i) the utility function has a CARA or quadratic form, (ii) the interest rate equals r, (iii) the discount rate equals $1/(1+r)$, and (iv) income is independently and identically distributed normal, then α_2 approaches $1/(1+r)$ as the length of the household's lifetime goes to infinity. If there is serial correlation in income such that $Y_t = \mu + \rho Y_{t-1} + \varepsilon$, then α_2 approaches $(1-\rho)/(1+r-\rho)$.

on average, than those with more stable incomes. However, without panel data on households, measures of income variability are hard to come by. The approach taken in this paper is to proxy VAR_{ir} with a set of variables that measure the variability of regional rainfall, on the assumption that more variable rainfall results in more variable income. This implies that VAR_{ir} does not vary across households within the same region or across survey years.

The life-cycle factors in $\mathbf{W}_{irt}$ consist of variables that measure the number of household members in each of five age categories. Life-cycle models suggest that households with greater numbers of young children and older members can be expected to save less, since the current labor income of these household members is less than the annuity value of their lifetime wealth. Furthermore, if parents rely on children for support in old age, then expenditure on children may serve as a substitute for savings, implying that households with more children will save even less (see e.g., Mark Nerlove, 1985).

Estimation of the savings equation (1) requires information on permanent and transitory income. The basic problem of estimating the model is that these are unobserved. The typical method of estimating savings equations similar to (1) using cross-sectional data has been to find a set of variables that are assumed, a priori, to be related to permanent income but not to consumption, use these variables as instruments in an income equation, and then estimate the propensity to save out of permanent income.[3] In these studies, transitory income is either measured as a residual (i.e., income minus estimated permanent income) or is left unmeasured and is omitted from the savings (or consumption) equation. This estimation method is useful only if suitable instruments for permanent income can be found. When the available data comprise only one or a few cross sections, it may be that the chosen determinants of permanent income are actually related to transitory income in the survey year.

Because of the difficulties associated with measuring permanent income, I focus on the explicit measurement of transitory income produced by rainfall shocks. I use time-series information on regional rainfall to construct measures of a component of transitory income for Thai rice farmers and estimate the propensity to save out of transitory income. An estimable version of the model is as follows. First, assume that the permanent income Y_{irt}^{P} of the household may be expressed as

$$(2) \qquad Y_{irt}^{\mathrm{P}} = \beta_t^{\mathrm{P}} + \beta_{0r} + \mathbf{X}_{irt}^{P}\boldsymbol{\beta}_1 + \varepsilon_{irt}^{P}.$$

$\mathbf{X}_{irt}^{\mathrm{P}}$ represents a vector of household-specific variables that are determinants of permanent income. These include six dummy variables indicating the amount of land owned by the household and a set of variables measuring the number of household members in 13 age/sex/education categories.[4] β_{0r} is a regional fixed effect that captures the influence of region-specific

[3]For example, Musgrove (1979) estimates savings models with cross sections of South American households using variables such as the age, education, and occupation as determinants of permanent income. Wolpin (1982) instruments income using information on historical (not current) regional rainfall for rural Indian households, on the assumption that regions with typically good weather will have higher permanent incomes. Bhalla (1980) uses three-year panel data on Indian households to calculate two measures of permanent income, one based on estimates of an earnings equation and another based on a weighted average of past income. See also Bhalla (1978, 1979) for other strategies for estimating permanent-income models with panel data.

[4]The use of the number of household members as a determinant of permanent income could be problematic if the number of household members were to change during the course of the year. For example, one could imagine that poor weather conditions might result in temporary migration to other regions of the country. In this case, the number of household members would be a "transitory" variable that is determined jointly with income and savings. Fortunately, this is not likely to be a large problem, given the definition of household membership used by the SES. The SES included in the survey all "usual" members of the household, even if they were absent at the time of the survey, provided that they were not expected to be away for more than three months.

variables (such as typical weather conditions, locational advantages, etc.) on the permanent incomes of households living in region r. β_t^{P} is a year effect common to all households, and $\varepsilon_{irt}^{\mathrm{P}}$ is a random error with zero expectation.

Transitory income is expressed as:

$$(3) \qquad Y_{irt}^{\mathrm{T}} = \beta_t^{\mathrm{T}} + \mathbf{X}_{rt}^{T}\boldsymbol{\beta}_2 + \varepsilon_{irt}^{\mathrm{T}}$$

where $\mathbf{X}_{rt}^{\mathrm{T}}$ is a set of region-specific variables that affect transitory income. In this study, $\mathbf{X}_{rt}^{\mathrm{T}}$ consists of deviations from average values of regional rainfall in each of four seasons (plus deviations from averages squared). Ideally, equation (3) would also contain a set of household-specific variables that affect transitory income, such as temporary changes in the health status of household members. However, no information of this type is available, and the effects of household-specific variables on transitory income are included in the error term. β_t^{T} is a year effect common to all households, and $\varepsilon_{irt}^{\mathrm{T}}$ is a random error term.

Equations (2) and (3) can be used to form an equation for total income and can also be substituted into the structural savings equation (1):

$$(4) \quad Y_{irt} = \beta_t + \beta_{0r} + \mathbf{X}_{irt}^{\mathrm{P}}\boldsymbol{\beta}_1 + \mathbf{X}_{rt}^{\mathrm{T}}\boldsymbol{\beta}_2 + \varepsilon_{irt}$$

$$(5) \quad S_{irt} = \alpha_{0t} + \left[\beta_{0r} + \mathbf{X}_{irt}^{\mathrm{P}}\boldsymbol{\beta}_1\right]\alpha_1 + \left[\mathbf{X}_{rt}^{\mathrm{T}}\boldsymbol{\beta}_2\right]\alpha_2 + \mathrm{VAR}_{ir}\alpha_3 + \mathbf{W}_{irt}\boldsymbol{\alpha}_4 + u_{irt}$$

where $\beta_t = \beta_t^{\mathrm{P}} + \beta_t^{\mathrm{T}}$, and $\alpha_{0t} = \alpha_0 + \beta_t^{\mathrm{P}}\alpha_1 + \beta_t^{\mathrm{T}}\alpha_2$. The unrestricted reduced form for the savings equation is expressed as

$$(6) \quad S_{irt} = \gamma_t + \gamma_{0r} + \mathbf{X}_{irt}^{\mathrm{P}}\boldsymbol{\gamma}_1 + \mathbf{X}_{rt}^{\mathrm{T}}\boldsymbol{\gamma}_2 + v_{irt}.$$

Note that the reduced-form savings equation does not explicitly contain either VAR_{ir} or $\mathbf{W}_{irt}$. This is because both are colinear with determinants of permanent income. VAR_{ir}, as measured, does not vary across individuals within the same region, so its effects on savings are subsumed in the region-specific fixed-effects γ_{0r}. Likewise, the age variables in $\mathbf{W}_{irt}$ represent sums of the age/sex/education variables in $\mathbf{X}_{irt}^{\mathrm{P}}$. The elements of $\boldsymbol{\gamma}_1$ that correspond to the age/sex/education variables reflect the effect of additional household members on savings through effects on permanent income, as well as through life-cycle effects.

The first set of results presented in Section III consists of estimates of reduced-form income and savings equations. These estimates are used to test several hypotheses implied by the permanent-income hypothesis. Specifically, the hypothesis that α_2 (the propensity to save out of transitory income) equals 1 implies that the effects of the elements of $\mathbf{X}_{rt}^{\mathrm{T}}$ on savings should be identical to their effects on income ($\boldsymbol{\gamma}_2 = \boldsymbol{\beta}_2$). In other words, transitory rainfall should affect income and savings in an identical manner and should have no effect on consumption. Likewise, the hypothesis that α_1, the propensity to save out of permanent income, is 0 implies that the effects of all variables in $\mathbf{X}_{irt}^{\mathrm{P}}$ (that are not colinear with elements of $\mathbf{W}_{irt}$) should have no effects on savings. This hypothesis can be tested by checking whether the elements of $\boldsymbol{\gamma}_1$ that correspond to the landownership variables equal 0.

The second set of results in Section III consists of estimates of the structural savings equation (5). Two estimation strategies are used. The first, which is computationally simple although not efficient, is a two-step procedure (see Adrian Pagan, 1984). First, the income equation (4) is estimated using ordinary least squares.[5] The resulting pa-

[5]Assuming that the error term in the income equation is not correlated with the explanatory variables, ordinary least squares will produce consistent estimates. It is likely, however, that households have unmeasured characteristics that affect permanent income and are correlated with measured determinants of permanent income, leading to biased parameter estimates. Bhalla (1980) finds that including household-specific fixed effects in Indian earnings functions significantly alters coefficients on land, capital, and labor assets. Since panel data on Thai households are not available, household-specific heterogeneity cannot be adequately handled here. However, it is unlikely that omitted

rameter estimates are used to form estimates of permanent and transitory income (denoted $\hat{Y}^{P}_{irt}$ and $\hat{Y}^{T}_{irt}$). I then regress savings on $\hat{Y}^{P}_{irt}$, $\hat{Y}^{T}_{irt}$, and the variables in VAR_{ir} and $\mathbf{W}_{irt}$. I also include, as an additional regressor, the residual from the income equation (called "unexplained income"):

$$\hat{\varepsilon}_{irt} = Y_{irt} - \hat{Y}^{P}_{irt} - \hat{Y}^{T}_{irt}.$$

Unexplained income has been interpreted in many savings studies as a measure of transitory income. However, since ε_{irt} is the sum of the error terms from both the permanent- and transitory-income equations, estimates of ε_{irt} are likely to contain both permanent and transitory components. Within the context of a permanent-income framework, this implies that the propensity to save out of unexplained income will exceed the propensity to save out of measured permanent income but will be less than the propensity to save out of measured transitory income.

Several econometric issues should be addressed. First, it should be noted that estimation of the income equation requires more than one cross section of data, in order to distinguish the effects of the region-specific transitory rainfall variables from the regional fixed effects. Second, if the estimates of permanent and transitory income are consistent and are uncorrelated with u_{irt}, the parameter estimates from the savings equation will be consistent. However, since permanent and transitory income are estimated, ordinary least squares will not produce correct estimates of the variance-covariance matrix for the parameter estimates. I present, instead, test statistics based on estimates of the asymptotic variance-covariance matrix (see Whitney Newey, 1984; Pagan, 1984).[6]

The third issue of importance is measurement error. As with all household income and expenditure surveys, it is likely that income is measured with a great deal of error. Measurement error in income is likely to be especially prevalent for farm households, since some income is received in kind rather than in cash. Because two (out of three) of the savings measures used are calculated as the difference between income and expenditure, measurement error in these savings measures will be positively correlated with measurement error in income.

When savings are measured as the difference between income and expenditure, measurement error will have the effect of biasing estimates of the propensity to save out of unexplained income ($\hat{\varepsilon}_{irt}$) upward toward 1.[7] This potential bias points to the danger of interpreting unexplained income as a measure of transitory income; the upward bias may lead to an incorrect acceptance of a permanent-income model. How-

household-specific characteristics are correlated with the determinants of regional transitory income, so the estimate of β_2 should be unbiased.

[6]In general, the correction to the standard errors made little difference. The asymptotic standard errors tend to be approximately 3-percent larger than those produced by ordinary least squares.

[7]To show this, one can assume that the error term in income is composed of two independent components: the first reflects unexplained deviations in income from its permanent level, and the second reflects measurement error. If savings are computed as the difference between income and expenditure, then it might be reasonable to assume that the error term for the savings equation also consists of two independent terms: that due to measurement error in expenditure and that due to measurement error in income. Let α_ε denote the propensity to save out of unexplained income. Since the residual from the income equation is orthogonal to the other variables in the savings equation, then only α_ε will be inconsistent, and

$$\text{plim}\,\hat{\alpha}_\varepsilon = \alpha_\varepsilon + \frac{\sigma^2_{\text{m}}(1-\alpha_\varepsilon)}{(\sigma^2_{\text{m}} + \sigma^2_{1})}$$

where σ^2_{m} is the variance of the measurement-error term for income, and σ^2_1 is the variance of the error term for income that is due to true unexplained deviations in income from its permanent level. It is not difficult to work out the bias factor for more general cases. Note that if, as a permanent-income model suggests, α_ε is very close to 1, then the extent of the bias on α_ε will be small. If, on the other hand, α_ε is less than 1, the estimate of α_ε will be biased toward 1, increasing the chance that a permanent-income model is (incorrectly) accepted.

ever, measurement error should not affect estimates of the parameters α_1 and α_2.

The second strategy for estimating the model is to estimate the income and savings equations (4) and (5) simultaneously using a maximum-likelihood procedure. The maximum-likelihood estimator is simply the estimator of the reduced-form savings and income equations subject to the nonlinear restrictions on the parameters embedded in equation (5). The maximum-likelihood estimates (together with reduced-form estimates) are used to test the overidentifying restrictions in the model. For example, the model implies that the effects of each of the transitory rainfall variables on savings should be proportional to their effects on income, with the factor of proportionality equal to α_2, the propensity to save out of transitory income. Similar restrictions on the effects of determinants of permanent income are also tested.

II. Data

A. *Alternative Savings Measures*

The 1975/76, 1981, and 1986 Socio-Economic Surveys (SES) (National Statistical Office, 1976, 1981, 1986) collected detailed information on income by source and on expenditure by commodity type for samples of Thai households. Also included in the surveys were questions about purchases and sales of financial assets and liabilities and a limited set of questions on purchases and sales of real assets.

There are (at least) three ways to measure savings with these data. The first measure, which will be called SAVE1, is defined as the difference between income and expenditure on all goods and services. SAVE1 is a traditional measure of savings and corresponds closely to the concept of savings used in the national accounts. However, SAVE1 may understate savings, because expenditure on consumer durables has a savings component: many consumer durables (such as vehicles, consumer electronics, and even clothing and shoes) are not consumed upon purchase, but instead yield a flow of consumption services over the lifetime of the good.

The second measure, SAVE2, is defined as the difference between income and expenditure on all goods and services *except* consumer durables. Consumer durables are broadly defined to include vehicles, household and recreational equipment, furniture, clothing, footwear, and educational expenses. Unlike SAVE1, SAVE2 accounts for the fact that purchases of consumer durables may actually represent savings. However, SAVE2 overestimates "true" savings (given that income and expenditure are reported accurately), since it includes purchases of durables as savings but does not exclude the consumption flow from durables already owned or purchased in the survey year.[8]

The third savings measure, SAVE3, is defined as purchases minus sales of real and financial assets in the month before the survey. The financial assets (and liabilities) include cash holdings, checking and savings accounts, stocks, bonds, business investments, and liabilities to various sources. The real assets include land, real estate, gold, jewelry, and "other valuables." Because consumer durables are not treated as assets, this measure is conceptually the same as SAVE1. However, SAVE3 may have serious measurement problems, since purchases and sales of such things as farm animals and equipment are not explicitly measured (although respondents may have treated these items as "other valuables").

B. *Correcting Saving Figures for Inflation Bias*

Income and expenditure data from less-developed countries often yield the result that reported expenditure exceeds reported income for a large fraction of households. For example, Visaria (1980) examines household survey data from Malaysia, Sri

[8]The SES does provide information on the rental value of housing owned by survey respondents, and this rental value is included in expenditure for both SAVE1 and SAVE2.

Lanka, and Taiwan and finds that income appears to be underreported relative to expenditure. The Thai data used in this paper appear to have similar problems. For example, the estimate of national household savings (using SAVE1) based on the 1981 SES is −6,780 million baht. The national-accounts figure for household savings in 1981 is 88,283 million baht. Although the national-accounts figures may also be subject to a great deal of error, it appears that the survey-based measure of savings is far too low.

While much of the apparent downward bias in savings measures from household surveys may be due to reporting error, part of it may be due to the structure of the surveys themselves. Many surveys of income and expenditure use different time frames to obtain information on income and expenditure. Often, households are asked about expenditure during a short time period (i.e., a week or month) before the survey, and income received during a longer time period (i.e., a month or year) before the survey. This is true of surveys from Malaysia and Sri Lanka discussed in Visaria (1980). It is also true of the Thai SES, which asked households about income and expenditure on infrequently purchased goods in the year before the survey, expenditure on all other goods except food in the month before the survey, and expenditure on food in the week before the survey.[9] If there is inflation over the survey year, savings measures will be biased downward, since expenditure is measured at more current (and therefore higher) prices.[10]

To adjust for inflation bias in SAVE1 and SAVE2, I deflated all "monthly" expenditure items using a monthly consumer price index obtained from the International Financial Statistics data tape and then recalculated the savings measures using deflated expenditure.[11] Specifically, let E_{M} be expenditure on all monthly (and weekly) items in the month before the survey and let E_{A} be average monthly expenditure on annual items. Further, let S equal savings measured as $Y - E_{\mathrm{M}} - E_{\mathrm{A}}$ and let P_t be a price index for time t. Adjusted monthly expenditure, $E_{\mathrm{M}}^{\mathrm{a}}$, is defined as

$$E_{\mathrm{M}}^{\mathrm{a}} = E_{\mathrm{M}}\left(\tfrac{1}{12}\right) \sum_{j=0}^{11} \left[P_{t-j}/P_t \right] = E_{\mathrm{M}} B$$

and adjusted savings S^{a} is defined as

$$S^{\mathrm{a}} = S + E_{\mathrm{M}}(1 - B).$$

If inflation is positive, the bias factor B must be between 0 and 1. For example, an annual inflation rate of 16 percent would result in a value of B of 0.93, implying that measured expenditure overstates actual expenditure by 7 percent. Since $B < 1$, adjusted savings will be greater than unadjusted savings, with the extent of the bias determined by the inflation rate and the amount spent on monthly and weekly items. If poorer households spend a larger fraction of their incomes on those goods included in E_{M} (food and clothing, as opposed to durable goods), then unadjusted measures of the fraction of income saved will be biased down more for poorer households than for richer households.

SAVE3 is not based on the difference between income and expenditure, so it will

[9]In 1981 and 1986, farm households were asked about farm revenues and costs for the past "agriculture year." Households were also asked to assess the value of home-produced goods that were consumed. These items are included in expenditure. All figures were then converted to monthly amounts by dividing the annual figures by 12 and multiplying the weekly figures by 4.3.

[10]Paul Glewwe (1986, 1988) finds that measured expenditure from the Sri Lankan socioeconomic surveys exceeded measured income by 8 percent in the 1969–1970 survey and by 36 percent in the 1980–1981 survey. His explanation is that income was severely underreported in the 1980–1981 survey. However, the Sri Lankan surveys have a structure quite similar to that of the Thai SES, and numbers presented by Glewwe indicate that inflation rates were quite high in 1980–1981 relative to the earlier period. Inflation-adjustment might have yielded more sensible savings figures in 1980–1981.

[11]Commodity-specific price indexes were not available.

TABLE 1—AVERAGE SAVINGS AND INCOME MEASURES

Community type	Observations	SAVE1 Unadjusted	SAVE1 Adjusted	SAVE2 Unadjusted	SAVE2 Adjusted	SAVE3 Unadjusted	SAVE3 Adjusted	Income
A. *1975/76, Average Adjustment Factor (B) = 0.98:*								
Municipal areas	2,133	666.9	709.1	1,135.9	1,173.2	686.8	679.0	3,377.1
		(6,721)	(6,728)	(6,856)	(6,862)	(16,960)	(16,892)	(7,479)
Sanitary districts	1,744	151.0	184.3	510.2	539.4	135.9	133.7	2,194.3
		(1,712)	(1,711)	(1,855)	(1,856)	(3,064)	(3,005)	(2,241)
Villages	5,175	−7.0	18.1	241.7	263.2	47.2	46.2	1,464.0
		(1,505)	(1,488)	(1,527)	(1,512)	(1,646)	(1,614)	(1,296)
Bangkok[a]	2,303	461.8	512.0	890.0	935.1	278.4	279.5	3,468.6
		(2,371)	(2,366)	(2,380)	(2,477)	(5,338)	(6,588)	(3,078)
Whole kingdom[a]	11,355	112.4	142.6	409.7	436.0	127.7	126.4	1,916.3
		(2,367)	(2,360)	(2,427)	(2,421)	(3,271)	(5,208)	(2,570)
B. *1981, Average Adjustment Factor (B) = 0.95:*								
Municipal areas	2,181	577.8	792.2	1,301.6	1,499.5	393.4	374.5	5,736.8
		(13,143)	(13,153)	(13,597)	(13,608)	(6,064)	(5,745)	(14,237)
Sanitary districts	1,663	−231.3	−80.5	309.3	446.2	99.8	94.8	3,340.1
		(2,472)	(2,398)	(2,533)	(2,477)	(4,595)	(4,361)	(2,971)
Villages	5,019	−126.7	−2.3	274.2	386.0	114.7	109.6	2,651.0
		(2,399)	(2,346)	(2,224)	(2,187)	(3,829)	(3,637)	(2,486)
Bangkok[a]	3,031	70.9	340.2	731.2	981.9	158.4	153.5	6,141.5
		(4,225)	(4,212)	(4,312)	(4,320)	(11,277)	(10,621)	(5,810)
Whole kingdom[a]	11,894	−62.7	89.4	406.8	545.1	137.8	131.7	3,385
		(4,304)	(4,280)	(4,345)	(4,333)	(5,634)	(5,326)	(4,815)
C. *1986, Average Adjustment Factor (B) = 0.99:*								
Municipal areas	1,927	488.3	527.3	1,211.3	1,247.9	814.2	808.9	6,703.7
		(7,358)	(7,358)	(7,273)	(7,275)	(10,196)	(10,086)	(8,972)
Sanitary districts	2,159	−240.4	−214.6	261.9	285.8	368.9	366.2	3,724.3
		(4,262)	(4,255)	(4,187)	(4,182)	(5,570)	(5,527)	(4,596)
Villages	4,355	−399.8	−379.5	−1.7	16.9	278.2	275.9	2,659.2
		(2,691)	(2,687)	(2,585)	(2,582)	(4,141)	(4,109)	(2,912)
Bangkok[b]	2,057	237.2	280.1	911.1	951.7	189.4	185.7	6,827.9
		(4,867)	(4,865)	(4,793)	(4,796)	(17,548)	(17,438)	(7,056)

Notes: Standard deviations are given in parentheses. Values are expressed in (nominal) baht. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

[a]Means and standard deviations are weighted means and variances of households in different community types using weights provided in the SES documentation.

[b]I had no weights for 1986, so means for the whole kingdom are not reported, and the figures for Bangkok are computed over all Bangkok households, regardless of their community types within Bangkok.

TABLE 2—SAVINGS RATES BY INCOME QUARTILE, USING UNADJUSTED AND ADJUSTED SAVINGS MEASURES, 1981

	SAVE1/income			SAVE2/income		
Quartile	Unadjusted	Adjusted	Difference	Unadjusted	Adjusted	Difference
Income less than 1,658 baht	−0.69	−0.61	0.07	−0.51	−0.44	0.07
Income between 1,658 and 2,850 baht	−0.24	−0.18	0.06	−0.09	−0.04	0.05
Income between 2,850 and 4,915 baht	−0.10	−0.05	0.05	0.04	0.09	0.05
Income greater than 4,915 baht	0.08	0.12	0.04	0.21	0.24	0.03

Notes: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods.

not be biased by inflation. However, because SAVE3 is measured as changes in assets in the *month* before the survey, inflation during the survey period will attenuate the observed relationship between the fraction of income saved and income. For this reason, SAVE3 is also adjusted for inflation.

Table 1 presents comparisons of unadjusted and inflation-adjusted savings measures. Averages are presented for the different community types represented in the survey and for the whole kingdom.[12] Annual inflation of consumer prices in Thailand averaged approximately 16 percent over 1980 and 1981, under 5 percent over the time period covered by the 1975/76 survey, and less than 2 percent during the 1986 survey period. Therefore, inflation adjustment has a much larger effect on savings in 1981 than in the other two years. As shown by the results for 1986 in Table 1, however, even low levels of inflation can produce nontrivial biases in savings measures.

Inflation-adjustment also alters the relationship between savings rates and income levels. Table 2 shows average household savings rates in 1981 for households classified into four income groups. For the poorest households in the survey, inflation adjustment increases savings rates by almost twice as much as for the richest households in the survey. This result underscores the importance of performing simple adjustments for inflation on all data derived from surveys that use different time frames for the measurement of income and expenditure items.[13]

C. *Data and Sample Selection*

The model presented in Section I was estimated using data from two sources. First, a sample of rice farmers from the central, northern, and northeastern sections of Thailand was selected from the SES. The South was excluded because it has little rice farming, and the weather patterns are very different from the rest of the country. Second, information on regional rainfall during 1951–1985 was matched up with the household information.

[12]The community types are municipal areas (towns and cities), sanitary districts (semiurban areas), and villages. Households are categorized by community type in many publications of the National Statistical Office of Thailand, so I continue to use this classification for comparability.

[13]Although inflation-adjustment brings the savings figures up substantially, it should be noted that the aggregate savings rates implied by the SES figures are still below national-accounts estimates of private savings rates. According to the national accounts, the fraction of total household disposable income that was saved was approximately 15.5 percent in 1975 and 1976, 16.5 percent in 1980, and 14.5 percent in 1981. If one uses the SES to construct estimates of total national household disposable income and total household savings (using inflation-adjusted SAVE1), one arrives at estimates of savings rates of 7.9 percent in 1975/76 and 4.9 percent in 1981. Even accounting for biases due to inflation, it still appears that households tend to underreport income relative to consumption. However, simple inflation-adjustments do at least partially reconcile discrepancies between the two data sources.

The region-specific information used to construct $\mathbf{X}_{rt}^{\mathrm{T}}$ consisted of information on regional rainfall from 21 weather stations in Thailand, collected by the Meteorological Department in the Ministry of Communications.[14] Monthly rainfall data from 1951 through 1985 were available for most of these stations; a handful had shorter time-series of data. The rainfall measures were used to construct four basic weather variables representing different crop seasons. R_1 measures total rainfall (in millimeters) during January–March. This is the agricultural off-season, although some farmers do grow crops in this season. R_2 measures rainfall during April–June and covers the planting season. R_3 measures rainfall during July–September and runs through the growing season. Finally, R_4 measures rainfall during October–December and covers the harvest.[15]

In order to construct the transitory rainfall variables in $\mathbf{X}_{rt}^{\mathrm{T}}$, one needs to know how current rainfall deviates from its expected value. If rainfall were serially correlated across years, one would have to forecast the expected value of rainfall for each region in each survey year. However, rainfall does not appear to be serially correlated: for each region, I was unable to reject the hypothesis that rainfall follows a white-noise process. $\mathbf{X}_{rt}^{\mathrm{T}}$ can therefore be measured as the difference between actual rainfall in region r at time t and mean rainfall in region r.[16] Deviations of rainfall from mean values were computed for each region in each of the four seasons, denoted as $(R_j - \overline{R}_j)$ for each of the four seasons $(j = 1,2,3,4)$. The variables $(R_j - \overline{R}_j)^2$ were also included in $\mathbf{X}_{rt}^{\mathrm{T}}$.[17] The standard deviations of each rainfall measure around its mean value, denoted STD.DEV(R_j), were used as the measures of rainfall variability in VAR_{ir}.

III. Results

Estimates of reduced-form income and savings equations are presented in Table 3. The results for the income equation in the first column indicate that the transitory rainfall variables are jointly significant. Furthermore, rainfall has large effects on income, especially in the planting season (R_2). For example, the average of STD.DEV(R_2) over all households is 127.93 (see Appendix). The income equation indicates that if R_2 turned out to be 127.93 millimeters above its average level, monthly income would increase by 175 baht. This effect is fairly large, given that average monthly income is 1,355 baht. Similar calculations for the other seasons show that a one-standard-deviation in-

[14]There are 61 weather stations in Thailand that collect monthly rainfall data. Households were matched up to weather stations by choosing the weather station closest to the amphoe (county) in which the household resided. Some regions of the country have more weather stations than others, so the distance between the household and the nearest station varied considerably across locations. Also, the fact that the households surveyed are not evenly scattered across the country meant that the information from some weather stations was not used. After matching up households with weather stations, households in weather regions not represented in each of the survey years were eliminated.

[15]These "seasons" are approximate: sowing can actually take place as late as July, and harvesting can run to as late as February. Information on seasons was obtained from crop calendars published by the Food and Agriculture Organization.

[16]I actually computed the regional means over all years *except* the current year, to eliminate biases in the measure of the deviation from the mean for those regions with shorter time-series.

[17]In each of the surveys, households were interviewed in different months. Therefore, not all of the households in the same weather regions were assigned identical values for all of the transitory rainfall measures. Rainfall measures were selected for each household according to the month in which they were interviewed. Households interviewed in the first half of the year were assigned weather variables from the calendar year before the survey year. Households interviewed in the second half of the survey year were assigned weather variables from the last half of the calendar year before the survey and the first half of the survey year. For example, a household interviewed in February 1981 was assigned rainfall during April–June 1980 for R_2; a household that lived in the same weather region but was interviewed in November was assigned rainfall during April–June 1981 for R_2. Because the weather information was only available up to the end of 1985, households interviewed in the second half of 1986 had to be excluded from the sample.

TABLE 3—REDUCED-FORM INCOME AND SAVINGS EQUATIONS

	Income		SAVE1		SAVE2		SAVE3	
Variable	Estimate	t	Estimate	t	Estimate	t	Estimate	t
Intercept	2,455.6	(16.30)	767.30	(2.88)	1,062.0	(4.03)	358.38	(1.06)
Year = 1981	301.68	(6.39)	44.774	(0.54)	37.450	(0.45)	121.57	(1.15)
Year = 1986	−402.26	(4.85)	−616.08	(4.20)	−725.18	(5.00)	−229.02	(1.23)
Rainfall variables:								
$(R_1 - \bar{R}_1)$	1.9093	(2.52)	3.2338	(2.42)	2.9861	(2.26)	2.6737	(1.58)
$(R_1 - \bar{R}_1)^2$	−0.0450	(3.99)	−0.0654	(3.28)	−0.0493	(2.50)	−0.0388	(1.54)
$(R_2 - \bar{R}_2)$	1.2502	(5.55)	1.2077	(3.03)	1.2888	(3.27)	1.2698	(2.52)
$(R_2 - \bar{R}_2)^2$	0.0009	(0.66)	−0.0009	(0.40)	−0.0002	(0.09)	−0.0007	(0.23)
$(R_3 - \bar{R}_3)$	0.2282	(1.00)	−0.7973	(1.98)	−0.6963	(1.75)	0.6231	(1.23)
$(R_3 - \bar{R}_3)^2$	0.0004	(0.62)	0.0008	(0.63)	0.0009	(0.72)	0.0011	(0.66)
$(R_4 - \bar{R}_4)$	1.6097	(2.57)	0.5466	(0.49)	0.6314	(0.58)	2.7626	(1.97)
$(R_4 - \bar{R}_4)^2$	−0.0095	(2.85)	−0.0090	(1.53)	−0.0087	(1.50)	−0.0170	(2.29)
Sex/age/education variables:								
Number of people aged 0–5	37.693	(1.73)	−43.168	(1.12)	−56.465	(1.48)	26.942	(0.55)
Number of males aged 6–11	59.730	(2.29)	13.313	(0.29)	37.334	(0.82)	20.976	(0.36)
Number of females aged 6–11	79.547	(3.16)	9.2344	(0.21)	20.577	(0.47)	−74.5333	(1.32)
Number of males aged 12–17	220.57	(8.11)	−32.445	(0.68)	38.508	(0.81)	32.678	(0.54)
Number of females aged 12–17	192.98	(7.08)	−19.965	(0.41)	40.598	(0.85)	60.605	(1.00)
Number of males aged 18–64:								
Primary school or less	349.38	(13.14)	41.919	(0.89)	95.070	(2.04)	30.400	(0.51)
Secondary school	765.72	(8.20)	−131.55	(0.80)	76.724	(0.47)	−318.86	(1.53)
Postsecondary school	1042.9	(7.69)	23.487	(0.10)	302.51	(1.27)	−182.55	(0.60)
Number of females aged 18–64:								
Primary school or less	62.306	(1.62)	31.259	(0.46)	43.890	(0.65)	292.07	(3.39)
Secondary school	345.63	(2.59)	−257.59	(1.09)	−43.456	(0.19)	210.00	(0.70)
Postsecondary school	676.93	(3.32)	186.11	(0.52)	277.22	(0.78)	−429.96	(0.94)
Number of males aged 65 or more	135.52	(1.99)	−5.1721	(0.04)	−32.04	(0.27)	−48.097	(0.32)
Number of females aged 65 or more	159.68	(2.60)	−91.856	(0.85)	−53.10	(0.50)	27.394	(0.20)
Landownership dummies (omitted category is owns 40 rai or more):								
Renter	−1,338.8	(18.93)	−742.32	(5.93)	−938.24	(7.58)	−297.15	(1.88)
Owns less than 2 rai	−1,699.6	(5.46)	−281.72	(0.51)	−588.17	(1.08)	−24.900	(0.04)
Owns 2–4 rai	−1,769.4	(16.32)	−707.31	(3.69)	−924.65	(4.87)	−479.16	(1.98)
Owns 5–9 rai	−1,583.2	(20.97)	−641.01	(4.80)	−850.34	(6.44)	−440.61	(2.61)
Owns 10–19 rai	−1,368.3	(21.11)	−695.45	(6.07)	−841.95	(7.42)	−382.71	(2.64)
Owns 20–39 rai	−1,008.3	(15.99)	−559.39	(5.01)	−685.25	(6.21)	−367.25	(2.60)
R^2:	0.34		0.03		0.04		0.02	
F tests:[a]								
Test 1	0.0001		0.0008		0.0016		0.0090	
Test 2			0.4044		0.6180		0.9049	
Test 3			0.0001		0.0001		0.1432	

Notes: The numbers in parentheses are t statistics. The table shows ordinary least-squares estimates of income and savings equations. The number of observations is 4,855. In addition to the variables listed, the regressions included dummy variables for 20 regions and two years. Means and standard deviations for all variables are given in the Appendix. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

[a]Table entries for F tests are P values. Test 1: rainfall variables jointly insignificant. Test 2: effect of rain on income equals effect of rain on savings. Test 3: landownership variables jointly insignificant.

crease in rainfall would result, on average, in an increase in income of 44 baht for R_3 and 68 baht for R_4. The estimates indicate that changes in off-season rainfall (R_1) have very little effect on income levels.[18]

The rainfall variables are jointly significant in the reduced-form savings equations as well as in the income equation. Furthermore, the hypothesis that the effect of transitory rainfall on savings is identical to the effect of transitory rainfall on income cannot be rejected for any of the three savings measures. The results for rainfall in the planting season are particularly striking and indicate almost identical effects of transitory rainfall on income and savings. The implication of these results is that all extra income due to transitory rainfall is saved rather than consumed, providing support for a strong version of a permanent-income hypothesis.

Although the results support the idea that all transitory income is saved, they do not support the hypothesis that all permanent income is consumed. A strong version of the permanent-income model implies that savings should be unrelated to permanent income ($\alpha_1 = 0$.) This hypothesis implies that the landownership variables should be insignificant in the reduced-form savings equations. This is not the case for all savings measures; the landownership variables are jointly significant in the equations for SAVE1 and SAVE2. It should be noted, however, that the coefficients on the landownership variables in the savings equations are smaller (in absolute value) than their corresponding coefficients in the income equation. Simple calculations of the ratios of these coefficients imply a marginal propensity to save out of permanent income of around 0.3–0.5, although these ratios vary across savings measures and variables.

The two-step and maximum-likelihood estimates of the fully restricted savings equation (5) are in Table 4. The two-step and maximum-likelihood estimates are quite similar. The results of these estimates are summarized as follows.

1. *Propensities to Save Out of Permanent and Transitory Income.*—The results for all savings measures are supportive of the idea that farmers save a high fraction of transitory income. The estimated propensities to save out of transitory income (α_2) range from 0.73 to 0.83. The hypotheses that each of these coefficients equals 1 cannot be rejected.[19] For all savings measures, the savings propensities out of transitory income are significantly different from the lower propensities to save out of permanent income. As expected, the propensity to save out of permanent income is higher for SAVE2 than for SAVE1: given that SAVE2 treats expenditure on all durable goods (including clothing and footwear) as savings, the part of expenditure on these items that actually represents current consumption should respond positively to increases in permanent income. SAVE3 is associated with the lowest propensity to save out of

[18]It should be noted that the estimated effects of rainfall changes on income implicitly incorporate the effects of rainfall on output levels, output quality, and prices. If regional differences in rice prices exist, then changes in regional rainfall may affect the value as well as the quantity of output: increased rain could increase output, leading to lower prices, which dampen the effects of rainfall on income. Although rice prices do appear to vary across regions of Thailand, it is difficult to determine whether these differences are driven by local supply conditions or by spatial differences in the quality of rice grown (which may also be affected by rainfall). The general consensus in the literature on rice pricing in Thailand has been that local prices are driven largely by world prices and the Thai government's export policies (see Randolph Barker and Robert W. Herdt, 1985; Amar Siamwalla and Suthad Setboonsarng, 1989). For the purposes of this paper, however, the mechanism by which rainfall affects income need not be specified; all that matters is that rainfall does affect income in a systematic way. The income equations that are estimated are best thought of as reduced-form equations that incorporate price, quality, and quantity effects of regional rainfall variation.

[19]As noted in Section I, permanent-income models imply that the propensity to save out of transitory income should equal something less than 1. Given that the estimated saving propensities are less than 1, the fact that a null value of 1 cannot be rejected indicates that all null values between the estimated values and 1 also cannot be rejected.

TABLE 4—TWO-STEP AND MAXIMUM-LIKELIHOOD ESTIMATES OF SAVINGS EQUATIONS

	Two-step			Maximum likelihood		
Variable	SAVE1	SAVE2	SAVE3	SAVE1	SAVE2	SAVE3
$\hat{Y}^{\mathrm{P}}$ (α_1)	0.2773	0.4400	0.1824	0.2514	0.4210	0.1649
	(5.40)	(8.94)	(2.73)	(4.86)	(8.51)	(2.45)
$\hat{Y}^{\mathrm{T}}$ (α_2)	0.7362	0.8039	0.7340	0.7546	0.8015	0.8294
	(4.28)	(4.87)	(3.21)	(4.32)	(4.84)	(3.50)
$\hat{\varepsilon}$	0.6015	0.6925	0.3801			
	(24.89)	(29.71)	(11.91)			
Number of people aged 0–5	−33.627	−52.854	29.147	−32.634	−52.186	29.439
	(0.92)	(1.51)	(0.61)	(0.89)	(1.49)	(0.62)
Number of people aged 6–11	3.3521	7.8316	−43.575	5.2934	9.2304	−41.756
	(0.11)	(0.26)	(1.07)	(0.17)	(0.31)	(1.03)
Number of people aged 12–17	−83.585	−49.733	1.1948	−76.071	−44.321	5.7906
	(2.34)	(1.45)	(0.03)	(2.11)	(1.29)	(0.12)
Number of people aged 18–64	−42.556	−38.812	55.067	−32.092	−31.225	62.543
	(1.08)	(1.03)	(1.08)	(0.81)	(0.82)	(1.22)
Number of people aged 65 or more	−104.31	122.77	−56.013	−96.869	−117.38	−49.628
	(1.54)	(1.89)	(0.64)	(1.43)	(1.80)	(0.56)
STD.DEV(R_1)	2.3958	1.7377	−3.6314	3.0425	2.1041	−3.1111
	(0.76)	(0.58)	(0.89)	(0.96)	(0.70)	(0.76)
STD.DEV(R_2)	−3.4154	−3.0750	−0.7963	−3.4043	−3.0948	−1.1993
	(1.99)	(1.88)	(0.36)	(1.97)	(1.89)	(0.53)
STD.DEV(R_3)	4.1747	4.0070	−2.1694	4.2644	4.0898	−1.7891
	(1.80)	(1.81)	(0.72)	(1.83)	(1.84)	(0.59)
STD.DEV(R_4)	3.7522	3.4730	−1.9300	4.1689	3.7832	−1.4476
	(1.73)	(1.67)	(0.68)	(1.91)	(1.82)	(0.51)
t test, $\alpha_2 = \alpha_1$:	2.50	2.06	2.26	2.69	2.14	2.64
t test, $\alpha_2 = 1$:	1.53	1.19	1.16	1.40	1.20	0.72
Overidentification test, $X^2_{[36]}$				97.59	87.39	70.88
[significance level]:				[0.0001]	[0.0001]	[0.0001]

Notes: The number of observations is 4,855. The numbers in parentheses are t statistics. $\hat{Y}^{\mathrm{P}}$, $\hat{Y}^{\mathrm{T}}$, and $\hat{\varepsilon}$ for the two-step estimates are based on estimates of the income equation shown in Table 3. The savings equations contained, in addition to the variables shown, a time-varying intercept. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

permanent income (0.16 for the maximum-likelihood estimates).

As discussed in Section I, it is difficult to interpret the estimates of the marginal propensity to save out of unexplained income ($\hat{\varepsilon}$). Since estimates of ε contain both permanent and transitory components, the estimated propensity to save out of $\hat{\varepsilon}$ is likely to be a mixture of the propensities to save out of permanent and transitory income. Furthermore, measurement error in income will bias up the estimated propensity to save out of unexplained income when using SAVE1 or SAVE2 as the dependent variable. The extent that measurement error affects estimates of the propensity to save out of $\hat{\varepsilon}$ can be seen by comparing estimates using SAVE1 and SAVE2 with those using SAVE3: the estimates using SAVE3 are almost half of those based on SAVE1 and SAVE2, indicating that measurement error significantly biases these coefficients. This result underscores the importance of using explicit measures of transitory income to test permanent-income models. If one were to (mistakenly) interpret unexplained income as transitory income, one would tend to accept a permanent-income model based on the biased estimates of savings propensities out of unexplained income.

2. *The Effect of Rainfall Variability on Savings.*—The results provide contradictory evidence on the relationship between savings and rainfall variability. For SAVE1 and SAVE2, STD.DEV(R_2) is negatively related to savings. Since rainfall in the second period has a large and positive effect on income, this result appears to indicate that those with more variable incomes save less. However, R_3 and R_4 were also found to be positively related to income, and for these rainfall measures, variability in rainfall is positively related to savings. The results for SAVE3 indicate no relationship between rainfall variability and savings. Finally, none of these coefficients is precisely estimated. Insofar as rainfall variability is a good indicator of income variability for farm households, the results indicate no relationship between income variability and savings. It should be kept in mind that these measures of variability do not vary across households within a region or over time. There may be other region-specific factors that affect savings; this possibility is discussed in more detail below. If these region-specific factors are correlated with rainfall variability, the estimates could be biased.

3. *The Effect of Family Composition on Savings.*—The results do not show a strong, consistent pattern between savings and the age structure of the household members. Although additional people over the age of 65 depress savings more than extra people in any other age category, the coefficients are imprecisely estimated. These results are generally consistent with those in Angus Deaton and Christina Paxson (1992), which suggest that old-age support in Thailand is derived primarily from transfers among generations rather than from a running down of assets accumulated over the life cycle.[20]

4. *Tests of Overidentifying Restrictions.*—The maximum-likelihood estimates were used to test the overidentifying restrictions of the model. There are 36 such restrictions, which can be categorized into several groups. First, the coefficients on the rainfall variables in the savings equation must be proportional to the coefficients on these variables in the income equation, with the factor of proportionality equal to α_2. Second, the coefficients on the landownership variables must also be proportional across the savings and income equations, with the factor of proportionality equal to α_1. There are additional sets of restrictions on the parameters of the age/sex/education variables and on the regional fixed effects. These are not straightforward proportionality restrictions, since age variables and region-specific measures of rainfall variability appear in the structural savings equation.

The test statistics presented at the bottom of Table 4 indicate that the full set of restrictions can be rejected. One possible reason for this outcome is that there may be unmeasured region-specific factors that affect savings independently of income. For example, regional rainfall variability may be only one of several region-specific variables that affect income variability. To explore this possibility, I estimated a model that included regional effects in the savings equations, the results of which are shown in the top portion of Table 5. The tests of overidentifying restrictions for this model pass at conventional levels of significance, although there is some evidence against the

[20]See also Deaton (1990) for a discussion of the applicability of standard life-cycle models to LDC's. Other articles are discussed in Gersovitz (1987).

TABLE 5—ESTIMATES OF PARTIALLY RESTRICTED SAVINGS EQUATIONS

Variables	SAVE1	SAVE2	SAVE3
A. *No restrictions imposed on regional effects*:			
Y^{P} (α_1)	0.356	0.508	0.084
	(5.77)	(8.56)	(1.03)
Y^{T} (α_2)	0.903	0.884	1.074
	(4.58)	(4.69)	(3.98)
Number of people aged 0–5	−56.870	−76.505	23.905
	(1.56)	(2.18)	(0.49)
Number of people aged 6–11	−11.447	−5.295	−36.140
	(0.37)	(0.18)	(0.88)
Number of people aged 12–17	−102.560	−68.238	35.1139
	(2.80)	(1.94)	(0.73)
Number of people aged 18–64	−67.878	−61.539	80.917
	(1.66)	(1.57)	(1.50)
Number of people aged 65 or older	−95.317	−110.030	−8.558
	(1.42)	(1.70)	(0.10)
Overidentification test, $X^2_{[20]}$:	32.20	25.04	25.37
[significance level]:	[0.0412]	[0.1999]	[0.1875]
t test, $\alpha_1 = \alpha_2$:	2.65	1.91	3.73
B. *Restrictions on rainfall variables only*:			
Y^{T} (α_2)	0.881	0.883	1.090
	(4.48)	(4.46)	(4.04)
Overidentification test $X^2_{[7]}$:	11.65	9.22	3.88
[significance level]:	[0.1126]	[0.2369]	[0.7930]

Notes: The numbers in parentheses are t statistics. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

restrictions for SAVE1. The parameter estimates are not greatly changed. Estimates of α_1 increase for SAVE1 and SAVE2, and estimates of α_2 rise for all savings measures (actually exceeding 1 for SAVE3). The effects of the age composition of the household are largely the same.

The lower portion of Table 5 shows estimates for a model that imposes only the restriction that the rainfall variables have effects in the savings equation that are proportional to their effects in the income equation. No restrictions are placed on the coefficients for variables in $\mathbf{X}^{\mathrm{P}}_{irt}$ or on the regional fixed effects. The test for the validity of this restriction easily passes. This is not surprising, given that the stronger hypothesis of equal coefficients across the reduced-form savings and income equations could not be rejected. This model indicates propensities to save out of transitory income that are similar to those from the more restricted models discussed above.

5. *Month Effects and Savings.*—All of the savings measures are based, in part, on questions that refer to expenditure or savings in the month before the survey. Because Thai agriculture is seasonal, measured savings may display month effects. If expenditure on monthly items (largely food and clothing) varies seasonally, then SAVE1 and SAVE2 should contain seasonal com-

TABLE 6—SAVINGS EQUATION WITH MONTH EFFECTS

Variable	SAVE1	SAVE2	SAVE3
January	−258.188	−140.520	877.925
	(1.76)	(0.99)	(4.52)
February	−253.081	−127.270	360.246
	(1.74)	(0.91)	(1.88)
March	−319.319	−193.977	−0.595
	(2.24)	(1.41)	(0.00)
April	30.927	99.501	−145.615
	(0.21)	(0.71)	(0.76)
May	−55.443	10.636	5.812
	(0.38)	(0.08)	(0.03)
June	−22.631	−10.218	−183.078
	(0.16)	(0.07)	(0.98)
July	−349.907	−374.327	−16.275
	(2.37)	(2.62)	(0.08)
August	−4.862	−17.138	−201.556
	(0.03)	(0.12)	(1.00)
September	67.398	17.920	−141.409
	(0.44)	(0.12)	(0.71)
October	53.792	33.287	−11.399
	(0.36)	(0.23)	(0.06)
November	105.616	51.331	−150.443
	(0.68)	(0.34)	(0.73)
Y^P (α_1)	0.362	0.510	0.084
	(5.93)	(8.66)	(1.05)
Y^T (α_2)	0.865	0.886	1.016
	(4.45)	(4.72)	(3.96)
$\hat{\varepsilon}$	0.606	0.695	0.372
	(25.19)	(29.90)	(11.70)
Number of people aged 0–5	−58.520	−79.036	21.960
	(1.62)	(2.27)	(0.46)
Number of aged 6–11	−8.816	−3.997	−39.244
	(0.29)	(0.13)	(0.96)
Number of people aged 12–17	−107.033	−71.015	35.294
	(2.96)	(2.03)	(0.74)
Number of people aged 18–64	−68.757	−61.588	85.733
	(1.70)	(1.58)	(1.61)
Number of people aged 65 and more	−98.374	−111.508	−7.756
	(1.48)	(1.74)	(0.09)
R^2:	0.15	0.20	0.05
F test:[a]	0.0057	0.0622	0.0001

Notes: These are two-step estimates. Also included in the savings equations were an intercept, two year dummy variables, and 20 regional dummy variables. Ordinary-least-squares t statistics are given in parentheses. Definitions of variables: SAVE1 is income minus expenditure on all goods; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

[a]Table entries for F tests are P values from testing the null hypothesis that month effects are insignificant.

ponents, with low savings for those households interviewed in months with high expenditure. If expenditure is smoothed across seasons through savings and dissavings over the course of the year, then SAVE3 should display seasonal components, with high savings in months for which realized income is high.

Table 6 shows a set of savings equations that contain interview-month effects. The model corresponds to that presented in the top portion of Table 5 (i.e., regional effects were included in the savings equations). Two-step estimates are presented, due to the large number of parameters. The results indicate the presence of month effects for SAVE1 and SAVE3, with weak evidence in favor of month effects for SAVE2. The results for SAVE1 and SAVE2 show high expenditure in the first three months of the year and high July expenditure. The estimates using SAVE3 indicate that savings are high in January and February. These results are sensible, given that the rice harvest is typically completed in December and that farmers are engaged in selling their output in the early part of the year. The fact that expenditure is high in the postharvest period relative to other months need not imply that households are unable to smooth consumption over the course of the year. The results in Paxson (1991) indicate that similar seasonal expenditure patterns exist for Thai households that do not engage in farming (whereas seasonal savings patterns are quite different for farm and nonfarm households). The addition of month effects to the savings equations does not alter the results for other variables in the model.

IV. Conclusion

This study has yielded some specific results about the savings behavior of Thai farm households. Propensities to save out of transitory income due to rainfall shocks are quite high. This result is important because it indicates that transitory income fluctuations do not have serious welfare consequences for farm households: savings are used to buffer consumption from income shocks. The results provide indirect evidence on how the savings of farm households may respond to shocks to income caused by factors other than rainfall. For example, it may be that reductions in farm income due to transitory declines in world rice prices will result in large decreases in savings of the farm sector, whereas a tax on rice exports that permanently lowers the farm-gate rice price will have a much smaller effect on farm savings. One should be cautious, however, about applying the results of this paper to all types of transitory income fluctuations. Economy-wide declines in income may strain the limits of credit institutions. Likewise, individual households may face borrowing constraints if income declines are very large. The fact that estimated propensities to save out of permanent income are generally above zero indicates that a strong version of the permanent-income model cannot be accepted.[21]

The techniques used in this study may be usefully applied to studies of savings in other countries. First, the income and expenditure surveys in many countries use data-collection methods similar to those used for the Thai SES. This study has demonstrated the importance of adjusting savings figures for inflation when different time frames are used to collect income and expenditure data. Second, the technique of using regional time-series data in conjunction with cross-sectional household data to derive explicit measures of transitory income may be applied to many countries and occupation groups within countries. To identify a component of transitory income, all one needs are regional time-series on economic or agroclimatic variables that (i) affect income but do not directly affect consumption, and

[21]See Mark Rosenzweig and Wolpin (1989) and Jonathan Morduch (1990) for Indian evidence on the importance of borrowing constraints. The model in Deaton (1990) contains the assumption that households face a positive net wealth constraint. The simulation results of this model indicate significant amounts of consumption smoothing in most years, with sharp downward spikes in consumption when assets are drawn down to zero. This model implies propensities to save out of permanent income above zero consistent with the results of this paper.

(ii) can be merged with household-level data. Time-series on regional wages, input prices, or output prices, in addition to time-series on weather variables, could potentially be used to identify the transitory income of households. Although cross-sectional data sources are, by themselves, of limited use in the estimation of dynamic savings models, the results of this study indicate that cross-sectional data augmented with appropriate time-series data can be used to estimate dynamic savings models.

Appendix: Descriptive Statistics

Household Variables (Number of Households = 4,855)

Variable	Mean	SD
Income	2,055.30	1,525.0
SAVE1	−106.03	2,230.1
SAVE2	209.5	2,223.7
SAVE3	45.96	2,793.8
Year = 1981	0.45	
Year = 1986	0.13	
$(R_1 - \bar{R}_1)$	2.43	39.0
$(R_1 - \bar{R}_1)^2$	1,528.10	2,695.4
$(R_2 - \bar{R}_2)$	24.72	114.9
$(R_2 - \bar{R}_2)^2$	13,810.5	19,246.6
$(R_3 - \bar{R}_3)$	16.77	127.1
$(R_3 - \bar{R}_3)^2$	16,430.2	40,379.5
$(R_4 - \bar{R}_4)$	37.54	67.8
$(R_4 - \bar{R}_4)^2$	6,004.0	11,715.6
STD.DEV(R_1)	42.64	11.41
STD.DEV(R_2)	127.93	30.87
STD.DEV(R_3)	152.47	29.85
STD.DEV(R_4)	89.56	25.10
Renter	0.159	
Owns less than 2 rai	0.004	
Owns 2–4 rai	0.043	
Owns 5–9 rai	0.140	
Owns 10–19 rai	0.272	
Owns 20–39 rai	0.255	
Number of people aged 0–5	0.800	
Number of males aged 6–11	0.490	
Number of females aged 6–11	0.498	
Number of males aged 12–17	0.423	
Number of females aged 12–17	0.432	
Number of males aged 18–64:		
Primary school or less	1.196	
Secondary school	0.036	
Postsecondary school	0.017	
Number of females aged 18–64:		
Primary school or less	0.355	
Secondary school	0.017	
Postsecondary school	0.007	
Number of males aged 65 or older	0.085	
Number of females aged 65 or older	0.105	

Rainfall Across Weather Stations
(Number of Stations = 21)

Variable	Mean	SD	Minimum	Maximum
$\bar{R}_1$	121.07	48.12	38.00	221.50
$\bar{R}_2$	693.09	231.75	301.10	1,349.30
$\bar{R}_3$	484.92	126.63	277.60	863.20
$\bar{R}_4$	75.79	65.45	7.60	261.80
STD.DEV(R_1)	66.89	11.03	48.90	85.71
STD.DEV(R_2)	146.88	48.22	93.28	277.30
STD.DEV(R_3)	152.29	35.24	104.44	238.90
STD.DEV(R_4)	37.26	15.60	18.09	67.07

Note: All money values are in real 1980 baht and are expressed as amounts per month. All rainfall measures are in millimeters. Definitions of variables: "income" is after-tax income; SAVE1 is income minus all expenditures; SAVE2 is income minus expenditure on nondurable goods; SAVE3 is the change in assets.

REFERENCES

Barker, Randolph and Herdt, Robert W., *The Rice Economy of Asia*, Washington, DC: Resources for the Future, 1985.

Bhalla, Surjit S., "The Role of Sources of Income and Investment Opportunities in Rural Savings," *Journal of Development Economics*, August 1978, *5*, 259–81.

______, "Measurement Errors and the Permanent Income Hypothesis: Evidence From Rural India," *American Economic Review*, June 1979, *63*, 295–307.

______, "The Measurement of Permanent Income and its Application to Savings Behavior," *Journal of Political Economy*, June 1980, *88*, 722–43.

Deaton, Angus, "Saving in Developing Countries: Theory and Review," in *Proceedings of the World Bank Annual Conference on Development Economics, 1989*, supplement to *The World Bank Economic Review* and *The World Bank Research Observer*, Washington, DC: World Bank, 1990, pp. 61–96.

______ **and Paxson, Christina H.,** "Patterns of Aging in Thailand and Côte d'Ivoire" in David Wise, ed., *Issues in the Economics of Aging*, Chicago: University of Chicago Press, 1992 (forthcoming).

Gersovitz, Mark, "Saving and Development," in Hollis B. Chenery and T. N. Srinivasan, eds., *Handbook of Develop-*

ment Economics, Vol. 1, Amsterdam: North-Holland, 1987, pp. 382–424.

Glewwe, Paul, "Income Distribution in Sri Lanka," *Journal of Development Economics*, December 1986, *24*, 255–74.

______, "Economic Liberalization and Income Inequality: Further Evidence on the Sri Lankan Experience," *Journal of Development Economics*, March 1988, *28*, 233–46.

Morduch, Jonathan, "Risk, Production, and Saving: Theory and Evidence from Indian Households," mimeo, Harvard University, 1990.

Musgrove, Philip, "Permanent Income and Consumption in Urban South America," *American Economic Review*, June 1979, *69*, 355–68.

Nerlove, Mark, Razin, Assaf, and Sadka, Efraim, "The 'Old Age Security Hypothesis' Reconsidered," *Journal of Development Economics*, August 1985, *18*, 243–52.

Newey, Whitney K., "A Method of Moments Interpretation of Sequential Estimators," *Economics Letters*, 1984, *14* (2–3), 201–6.

Pagan, Adrian, "Econometric Issues in the Analysis of Regressions With Generated Regressors," *International Economic Review*, February 1984, *25*, 221–47.

Paxson, Christina H., "Consumption and Income Seasonality in Thailand," Research Program In Development Studies Discussion Paper No. 150, Princeton University, April 1991.

Rosenzweig, Mark and Wolpin, Kenneth, "Credit Market Constraints, Consumption Smoothing and the Accumulation of Durable Production Assets in Low-Income Countries: Investments in Bullocks in India," mimeo, University of Minnesota, 1989.

Siamwalla, Amar and Setboonsarng, Suthad, *Trade, Exchange Rate and Agriculture Pricing Policies in Thailand*, Washington, DC: World Bank, 1989.

Visaria, Pravin, "Poverty and Living Standards in Asia: An Overview of the Main Results and Lessons of Selected Household Surveys," Living Standards Measurement Study Working Paper No. 2. Washington, DC: World Bank, 1980.

Wolpin, Kenneth I., "A New Test of the Permanent Income Hypothesis: The Impact of Weather on the Income and Consumption of Farm Households in India," *International Economic Review*, October 1982, *23*, 583–94.

Meteorological Department, "Monthly Rainfall in Millimeters by Weather Station," unpublished printout, Ministry of Communications, Bangkok, 1951–1985.

National Statistical Office, *1975–76 Socio-Economic Survey Data Tape*, Bangkok: Office of the Prime Minister, 1976.

______, *1981 Socio-Economic Survey Data Tape*, Bangkok: Office of the Prime Minister, 1981.

______, *1986 Socio-Economic Survey Data Tape*, Bangkok: Office of the Prime Minister, 1986.