Title
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Publication Date
1989-10-01

514

DEPARTMENT OF AGRICULTURAL AND RESOURCE ECONOMICS
DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA, Berkeley.

WORKING PAPER NO. 514

A MODERN VIEW OF JOSEPH'S POLICY: FOOD STOCKS AS FINANCIAL ASSETS

by

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October 1989

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1. Introduction

Food consumption at levels below the FAO normal values is an all too common occurence in the less developed world. Stabilization policy, whether of prices or quantities, aims to reduce that part of malnutrition caused by the transitory or cyclic elements in the food system, such as weather, or international prices. Buffer stocks, Joseph's policy, are an implementable stabilization policy. Indeed, there is a very long literature analyzing stocks as a stabilization policy and comparing them to other possible stabilization instruments. FAO advice to LDCs[1] as to the advisability of stabilization policies is based on this literature. Our view of buffer stocks is that they are financial assets and must compete with other assets for scarce investment resources.

The literature on stabilization and storage policy began with simple abstractions for both the measure of benefits and the definition of policies. In the earliest literature [Waugh (1944) and Oi (1961)], benefits were simple consumer and producer surplus measures, and policies were the (usually infeasible) stabilization of stochastic prices at their mean. The definition of benefits from stabilization was brought into conformance with modern economic theory by Turnovsky, Shalit, and Schmitz (1980), who used the expected utility of consumption to measure benefits. A different branch of the food security literature makes a more controversial choice of benefit measure. In Bigman's (1985) view, the correct indicator function depends upon food consumption (and for that matter, calorie deficit) only and not on total consumption. In this paper we will make the more common choice of maximizating the utility of consumption rather than of food consumption.

The examination of feasible policies, at least in the sense that producers and consumers must face the same prices, seems to begin with Massell (1969) and

Samuelson (1972). Newberry and Stiglitz (1979) show that buffer stock policies produce large transfers from producers to consumers while producing small net benefits to the economy as a whole. Wright and Williams (1988) show that accumulating stocks accentuates production instability while Sarris and Freebairn (1983) show that agricultural policy (particularly the common agricultural policy) exacerbates instability in prices. Explicit comparison of buffer stock policy to another policy (trade) is in Bigman and Reutlinger (1979), and in Bigman (1985). The latter work presents a dynamic simulation model of the food side of an economy which is sufficiently rich to carry out policy experiments. Adelman and Berck (forthcoming) embed the buffer stock choices in a (stochastic) computable general equilibrium model, a richer formulation of the underlying economy than Bigman's (1985), accounting for variation in incomes as well as variation in production or prices. Taken together, these models give a good idea of how to construct feasible buffer stock policies and compare them to other feasible policies.

In this paper, we propose a much simpler and theoretically better justified exercise—the evaluation of a buffer stock as a financial asset. Financial assets are valuable because holding them increases expected utility of consumption. They do this by increasing the expected value of consumption more than, in some appropriate sense, they increase risk. Buffer stocks are an asset designed to reduce risk. The question we pursue is whether they provide a risk and return combination that is more attractive than other assets.

Developing countries suffer from a great deal more instability in personal consumption and are more dependent upon agriculture than are the countries in the developed world. Since food is an important component of consumption in these countries, food storage is a plausible way for these countries to smooth their consumption streams. Another plausible way to smooth consumption streams is to adjust the amount of borrowing the less developed country (LDC) undertakes. This is the financial point of view: A food stockpile and a little less sovereign debt are simply two investment opportunities competing for scarce funds.

The method we use to compare assets is based upon the consumption beta version of the capital asset pricing model. The risk properties of assets are measured by their covariance with the marginal utility of consumption. In the standard stabilization literature, risk properties are measured as the ability to reduce price variance or consumption variance or to increase producer and consumer surplus. In the earlier finance literature, risk is measured as the covariance of asset returns with the "market portfolio." The consumption beta view of risk coincides exactly with a dynamic stochastic expected utility model, where the other views of risk in general do not.

In equilibrium, all assets held in an agents' portfolio are equally atttractive investments to that agent. Thus, one only needs to compare a potential asset, the buffer stock, to one of the currently held assets. Since nearly all developing countries have dollar denominated foreign debt, we explicitly compare a grain stockpile to that debt.

Comparing debt and buffer stocks requires that we construct a measure of the expected return and required risk premium for a buffer stock. In both the United States and the developing world, the measure of risk is based upon the variance of the return of the buffer stocks with the marginal utility of observed consumption. Since the United States is a major holder of grain, we use the consumpton beta asset pricing model for the United States to find the expected return to holding a buffer stock. Using these expectations, an estimate of the risk to the LDC of buffer stock holding, and the fact that both the United States and LDCs hold (opposite sides of) dollar denominated debt instruments, we determine whether it will be welfare improving for an LDC to hold a grain stockpile. The second section of this paper provides the details of this consumption beta asset pricing theory.

The theory requires only observable information—real consumption, exchange rates, and grain prices—for estimation. In section 3 we use a sample of 18 less developed countries to estimate the risk premia required for grain storage in a sample of 18 LDCs. In Section 4 we make use of the theory of section 2 to calculate the relative advantages of holding grain in the U.S. or in any of the 18 LDCs. Section 5 provides the conclusions.

2. The Model

The government wishes to maximize an expected welfare function that depends upon per capita consumption, C_t,, for $\tau > 0$,

(1) $E_t \; \Sigma_\tau \; U(C_{t+\tau})(1 + \delta)^{-(t+\tau)}$

where E_t is the expectation at time t and δ is the social rate of time preference. That part of national income not attributable to asset holdings is Y_t, and asset holdings are the vector Z_t held at prices Π_t, also a vector. Thus, the budget constraint in real domestic currency is

(2) $C_{t+1} + \Pi_{t+1} Z_{t+1} = \Pi_{t+1} Z_t + Y_{t+1}$.

From the perspective of time t, $\Pi_{t+\tau}$ and $Y_{t+\tau}$ for $\tau > 0$ are both random variables. Since consumption, $C_{t+\tau}$, is chosen dependent upon $\Pi_{t+\tau}$ and $Y_{t+\tau}$, it too is a random variable. Let e_t be the real exchange rate and P_t be the dollar asset prices, so the real domestic currency price of assets is

(3) $\Pi_t = e_t \; P_t$.

The first-order conditions for maximizing the expected welfare function are well known. Heuristically, along an optimal path, saving one additional dollar costs

(4) $U'(C_t)\, e_t\, (1+\delta)^{-t}$

in discounted utility. The term, $U'(C_t)\, e_t$, is the current utility cost of a dollar saved, and we call it the dollar marginal utility. It buys $1/P_{it}$ in the *i*th asset Z_i, which yields P_{it+1}/P_{it} in dollars. In real domestic currency this enables a consumption increase of $e_{t+1}P_{it+1}/P_{it}$ for an expected utility gain of

(5) $E_t[U'(C_{t+1})\, e_{t+1}\, (P_{it+1}/P_{it})]\, (1+\delta)^{-(t+1)}$.

Along an optimal path, this expected utility gain and cost must be the same, so

(6) $E_t[U'(C_{t+1})e_{t+1}P_{it+1}/P_{it}] = (1+\delta)\, U'(C_t)e_t$.

The right hand side of (6) is not stochastic because at time t all the variables relevant to time t are known. Expanding the product of the two random variables in (6) gives

(7) $E_t[U'(C_{t+1})e_{t+1}\, P_{it+1}/P_{it}] = E_t[U'(C_{t+1})e_{t+1}]\, E_t[P_{it+1}/P_{it}]$

$+ \operatorname{cov}(U'(C_{t+1})e_{t+1}, P_{it+1}/P_{it})$.

The symbol, cov, is the covariance at time t. If x and y are two random variables then $\operatorname{cov}(x,y) = E_t[(x - E_t x)(y - E_t y)]$. When x can be estimated by a regression, $E_t x$ is the predicted value from the regression and $x - E_t x$ is the residual. Thus one representation of the covariance term is the covariance of regression residuals, one residual from predicting $U'(C_{t+1})e_{t+1}$ using all information available at time t and another residual from predicting P_{it+1}/P_{it}.

From (6) and (7),

(8) $E_t\frac{P_{it+1}}{P_{it}}\, E_t[U'(C_{t+1})\, e_{t+1}] + \operatorname{cov}(U'(C_{t+1})e_{t+1}, P_{it+1}/P_{it}) = (1+\delta).\ U'(C_t)e_t$.

Among the assets the country holds are dollar denominated sovereign debt obligations at a fixed interest rate r. By convention, this asset is the first element of Z_t, Z_{1t}. Letting P_{1t} be the dollar price of this asset,

$$(9) \qquad P_{1t+1} / P_{1t} = 1+r,$$

where r is the rate of interest. In domestic currency the return to this instrument varies with the exchange rate, which is stochastic. For the fixed dollar return asset the covariance term in (8) is zero so,

$$(10) \qquad E_t[U'(C_{t+1})e_{t+1}] = (1+\delta)/(1+r) \; U'(C_t)e_t.$$

Rearranging equation (8) and using equation (10) gives

$$(11) \qquad E_t \frac{P_{it+1}}{P_{it}} = (1+r) - \frac{(1+r)}{(1+\delta)} \frac{\operatorname{cov}(U'(C_{t+1})e_{t+1}, P_{it+1}/P_{it})}{U'(C_t)e_t}.$$

Equation (11) is a version of the "consumption beta" pricing equation for an asset.[2] It says that assets whose payoff has high covariance with the dollar marginal utility ($U'(C_t)e_t$) of consumption (which is likely to have a negative covariance with consumption itself) need a lower rate of return than other assets to be included in an optimal portfolio. Agents prefer assets that pay off when their consumption is low which is also when their marginal utility of consumption is high.

Equation (11) is attractive because it uses real consumption measured by standard national accounts and available for most countries. The theoretical basis for this equation is attributable to Breeden (1979), who worked in a continuous time framework where the asset pricing equations depend upon the "consumption betas," covariance of asset return, and percent change in consumption, normalized by the variance in percent change in consumption. Hall (1978) tested an implication of equation (6) for the United States and found it to be reasonable. Hansen and Singleton (1983) tried equation (7), again on U. S. data with results not as satisfactory as Hall's (1978). In terms of a developing world context, the model requires that governments have an interest in real consumption and borrow with that in mind. The model would be a particularly poor approximation in a country in which borrowing was synonymous with the enrichment of government officials.

For compactness of notation, let subscript D denote a developed grain storing country whose currency is dollars and L denote the less developed country that trades in grain and is a potential storer. Let,

$$(12) \quad \alpha_D = \frac{(1+r)}{(1+\delta_D)} \quad \text{and} \quad \alpha_L = \frac{(1+r)}{(1+\delta_L)}.$$

Let the *k*th asset be the food stockpile and define

$$(13) \quad s_L = -\frac{\operatorname{cov}(U'(C_{t+1})e_{t+1}, P_{kt+1}/P_{kt})}{U'(C_t)e_t}.$$

Since prices are in the currency of the developed country (DC), there are no exchange rate terms for that country and

$$(14) \quad s_D = -\frac{\operatorname{cov}(U'(C_{t+1}), P_{kt+1}/P_{kt})}{U'(C_t)}.$$

The term $s_L\alpha_L$ is the price of risk in terms of sure consumption in t+1. It includes exchange rate risk, consumption risk, and world price risk.

Equation (11) implies a stockpile asset should be added to the portfolio of an LDC if and only if (*iff*)

$$(15) \quad E_t\frac{P_{kt+1}}{P_{kt}} - (1+r) \geq \alpha_L s_L.$$

Let us now consider the meaning of P_k for the case of a grain stockpile. We consider only grain held for a fixed period, bought at t, sold at t + 1 (possibly to be bought again at t + 1 and held to t + 2, etc.). Physical holding costs are the nonstochastic V and measured in units comparable to P_k. The cost of a stockpile is the value of the grain, CIF the LDC, plus the storage costs, V. Let B_t be the basis, the marginal cost of delivery from a port in which the price is W_t, the world price, then

(16) $P_{kt} = W_t + B_t + V_t.$

The value of this asset in the succeeding period is

(17) $P_{kt+1} = W_{t+1} + B_{t+1}.$

Assuming that at world prices ($B \equiv 0$) developed-world-merchants voluntarily hold stocks,

(18) $E\frac{W_{t+1}}{W_t+V} - (1+r) = \alpha_D s_D.$

Solving for $E_t W_{t+1}$ and using equations (6) and (7) and substituting into equation (5) gives: Hold a stockpile in an LDC *iff*

(19) $\{EB_{t+1} - (1+r)B_t - B_t\alpha_L s_L\} - [(W_t + V)\alpha_L s_L] \geq -[(W_t+V)\alpha_D s_D].$

Given our assumption that physical holding costs are the same in both types of countries, the expected return to holding the stockpile at world prices is the same for both types of countries. Thus, $EW_{t+1} - W_t$ does not appear in (19). To interpret (19), first consider the term in braces. It is the net expected basis payoff, the value of a synthetic security consisting of the difference between LDC and world price less the risk cost. The two terms in brackets are the risk costs to LDC and to the DC of holding a stockpile. Summing up: An LDC should hold a stockpile *iff* the value of the net expected basis payoff less the LDCs risk costs to holding a stockpile exceed the risk costs of the DCs.

For extreme assumptions on s_D, s_L, etc., there are a number of theoretical consequences of this model:

1. When the prices are uncorrelated with consumption in both countries (s_L and s_D are zero), then it is optimal to hold stockpiles only when

(20) $EB_{t+1} - B_t(1 + r) > 0.$

Under these circumstances, it is only the basis that determines where food should be stored. Developed grain importing countries and newly industrialized countries are likely to be in this category.

2. If the countries are substantially the same, that is $\alpha_L s_L = \alpha_D s_D$ —two countries have same risk and time preference attributes—then stocks are held in the LDC when

(21) $EB_{t+1} - (1 + r) B_t - B_t s_L \alpha_L > 0.$

The richest of the LDCs with small agricultural sectors are likely to be in this position. The oil exporting countries should fit here.

3. The DC differs greatly from the LDC in the importance of food in aggregate income and consumption. Since only a small percentage of the developed world work force has income dependent upon farming and the whole population is affected by agricultural prices, it is plausible that the cov(Ce,W) is negative and small in the developed world. In that case, cov(U'e,W) would be positive and $s_D < 0$, but weakly so. For the LDC, farm income could be more important than farm prices in determining consumption. This condition is likely to hold for the less developed LDCs, in which a large percentage of the population derives its income from farming. In these countries, consumption is likely to be high in those years when agricultural prices are high, so $s_L > 0$. Consider an "average" year for which there is no expected change in the basis, $EB_{t+1} = B_t$. From (19) the condition to hold stocks in the LDCs is

(22) $-[(W_t + V + B_t) \alpha_L s_L] \geq -[(W_t+V) \alpha_D s_D].$

This inequality, however, cannot hold because the left-hand side is less than zero while the right-hand side is greater than zero. In this case the LDC should not hold stocks—a proposition most likely to hold for poorer LDCs with reasonable infrastructure.

4. This is the case of a country very dependent upon agriculture with very limited infrastructure, so that it has a potentially low import capacity. Most Sub-Saharan countries and Bangladesh during its initial years are in this situation. In these countries when C is low, food imports are high; and the marginal cost of importing food, B, is very high. For instance, a crop failure (or civil war) reduces consumption and there are insufficient port facilities to bring in food, so B becomes very large. Using the definition of P_{kt+1},

$$(23) \quad \mathrm{cov}(U'(C_{t+1})e_{t+1}, P_{kt+1})$$

$$= \mathrm{cov}(U'(C_{t+1})e_{t+1}, B_{t+1}) + \mathrm{cov}(U'(C_{t+1})e_{t+1}, W_{t+1}).$$

Since for this case, $\mathrm{cov}(C_{t+1}\, e_{t+1}, B_t)$ is very large and negative, $\mathrm{cov}(U'(C_{t+1})e_{t+1}, P_{kt+1})$ should be large and positive and s_L should again be large and negative. Since s_L is large and negative, the left-hand side of (19) is positive and large, and the inequality should hold. Under those circumstances, stocks should be held locally because they are necessary to avert disaster.

5. The final case is where the basis is not expected to change from year to year, and where the rate of time preference, δ, is higher in the developing country than in the developed country, so $\alpha_D > \alpha_L$. Moreover, in the developed country we expect δ_D to be approximately r, so α_D is approximately 1 and $\alpha_L < 1$. Then the stockpile should be held *iff*

$$(24) \quad \frac{B_t \alpha_L s_L}{(W_t + V)} \leq \alpha_D s_D - \alpha_L s_L < s_D - s_L.$$

Any advantage in absorbing price risk that developing countries may have could be offset by the risk in the basis. Of course if s_D is negligible, then the expression for stockholding is even simpler,

(25) $s_L [1 + B_t\alpha_L /(W_t + V)] < 0$,

quite independent of the arguments about the rate of time preference.

3. Implementation

A good deal can be learned about who should hold stock by calculating the statistics s_D and s_L for a sample of developing and developed countries. To calculate these statistics requires estimates of $E(P_{t+1}|P_t)$ and $E(U'_{t+1}e_{t+1}|\ U'_te_t)$. These estimates are made by regressing the variables on themselves once lagged and on a constant term. The covariance of the residuals of these two regressions is the estimate of the denominator of (13), while the realized value of U'_te_t is the numerator. This section proceeds by discussing the utility function, the data, the regressions, and then the estimation of s_D and s_L.

These calculations are made with $U = (1-A)^{-1}C^{1-A}$ for varying values of A. This is a constant, relative, risk aversion, utility function and is the same form used by Hall (1978) and Hansen and Singleton (1983), among many others. Using very different methods and cross section data on the United States, Friend and Blume (1975) also concluded that this function was a reasonable approximation, especially for $A > 1$ and possibly higher than 2.

The data for the world price of cereals come from the United Nations "International Trade Statistics Yearbook" (various years) and was computed as the average dollar price per metric ton of cereals and cereal preparations imported by each country in each year. Data on real consumption expenditures came primarily from United Nations "National Accounts Statistics: Main Aggregates and Detailed Tables" (various years) Table 1.2 and consisted of private final consumption expenditures in constant prices. For some countries and years, missing data were filled in from the World Bank "World Tables 1987," (1988) using the series for private consumption in current prices and the gross domestic product (GDP) deflator. The data for the real exchange rate were computed from the World Bank "World Tables 1987" (1988) by deflating the nominal exchange rate (labeled as "Conversion Factor" and consisting of the number of units of domestic currency per US $) by the GDP deflator. The years in our sample included as many years from 1972 to 1986 for which we were able to collect data. The minimum number of observations for any country was 11.

Table 1 presents the results of regressions of the dollar marginal utility consumption on its lagged values. In 3 of the 19 countries, the constant term was significant in the regression, but in no country was its magnitude as great as .0005. Lagged consumption was significant in all countries studied. Two countries had R-squares in the range of one-half, while all the rest had much larger values. One of those two countries suffered a major drought while the other had an abrupt devaluation. The theory [Hall 1978)] implies that past marginal utility contains all the information needed to predict current marginal utility, so no other variables ought to matter in these regressions. In particular, only the first lag of consumption should be significant, and this was true for 18 of the 19 countries listed.

When the regression coefficient is below one, this means that real consumption in dollars is rising. Despite the fact that the period in our sample is one of falling growth rates and, after 1981, rapid devaluations for most countries, the dollar marginal utility of consumption declines, on the average, by about 18% per year in our sample. The primary exception to the growth in consumption was Sudan, where, on the average, the dollar marginal utility of consumption rose by 50%. During this period Sudan experienced a major drought as well as an influx of refugees from Ethiopia.

Table 2 summarizes the results of regressions of the dollar prices of cereal and cereal preparations on its lagged value. The values of R-square for this regression are much smaller than for real consumption. Twelve out of 19 countries had a price drift which was not statistically significant. Averaging over the statistically significant regressions, the dollar price of cereals and cereal preparations was .63 of its lagged value. To find the range of prices for which price is expected to rise, we find the stable point of the difference equation, $P_t = P_{t-1}\gamma + \beta$. The stable point is $P^* = \beta/(1-\gamma)$. In our sample the average value of P* is $240/ton, well above most of the prices in the sample. Thus, cereal prices are generally expected to rise. Other possible ways of making these predictions for prices include use of U. S. futures market information or lagged prices from DCs, but we have not pursued these avenues.

For each of the 19 countries, the covariance of the residuals of the price and dollar marginal utility autoregressions was calculated. The covariances were divided by C_{t-1}^{-A} to provide yearly estimates of s_L or s_D. The average of the yearly estimates was taken as our estimate of s_L or s_D. Table 3 presents these estimates for A = 2. It also presents the jackknifed estimate of their standard deviation and an asymptotic t-statistic. Many of the s's are significantly different from zero (and each other), but we defer the discussion of the meaning of these coefficients to the next section.

4. Results

In the previous section we developed estimates of s which is an important element needed to evaluate the stock holding condition, Equations (24) or (25). This section presents those estimates and discusses them in general terms. It then uses those estimates and some estimates of B to make judgements as to whether stocks should be held in developed or developing countries.

Table 4 presents these calculated grain stockpile risk premia, s, by country for different relative risk aversion coefficients. The premia are in percent of price, directly comparable to a percentage expected gain on price or basis. Equation (18) is an example of such a comparison. The first thing to note about the estimated grain stockpile premia is that they are all fairly small. The highest risk premia are for the Sudan at 10.9% and Kenya at 8.9% (both for a relative risk aversion coefficient of 4); the lowest is -5.1% (Chile, for a relative risk aversion coefficient of 4). All of these numbers are less than the return to manufacturing in the United States, not to mention the expected return on a private project in an LDC. Thus, without expected price changes, holding additional stockpiles can only be a marginal economic activity, at best. Not surprisingly, the higher the relative risk aversion coefficient the higher the absolute value of the grain stockpile risk premium for a given country.

The extreme values of the grain stockpile risk premia include both very poor and very rich countries, and both highly agricultural and newly industrializing countries (Table 4). The R square of the grain stockpile risk premium with GNP and with the share of agricultural value added in GDP, both singly and together, is near zero. The highest correlation we found is the rank correlation of the grain stockpile premium with GDP (.25); it, too, is statistically insignificant. We also computed the correlation of the grain stockpile risk premium with the coefficient of variation of grain prices in domestic currency and with the coefficient of variation of real consumption. (Table 6 gives the coefficient of variation). These correlations also turned out to be near zero. The grain stockpile risk premia thus seem to be uncorrelated with any of the obvious economic considerations.

If we use Hansen and Singleton's (1983) estimate of the relative risk aversion coefficient for the United States (1.25) s_D becomes -.05%.[3] This is very near zero, so equation (25), s, can be used to evaluate whether stockholding would increase welfare. Since B/(V+W) is positive in theory and in practice, on average, for those countries we have been able to check, s must be negative for stockholding to improve welfare. Six countries, Chile, Ethiopia, Indonesia, Korea, Liberia, and Panama, have values of s (for A = 2) that are statistically significantly negative. At A = 2, the minimum value of s was -2%. Looking at equation (15)—that is the same as saying that the interest rate, risk adjusted for a grain storage facility would be 2% below the sure rate. With the extreme risk aversion of A = 4, this is 5% for Chile and 3.6% for Liberia, but all other countries are below 3%.[4]

As the presumed degree of risk aversion and s_D in the United States rises (Table 4), equation (24) shows that the desirability of holding stocks in the LDCs also increases. With A = 4 for the United States, there are no plausible stock holders. Values of A as large as 4 are well beyond the range of values estimated in Hansen and Singleton (1983), so this result is very unlikely.

On the other side of the coin, equation (24) shows that countries with high levels of s_L are very unlikely to find stock holding to be welfare improving. A very crude estimate of the first term of (24) would be that B/(W + V) is about 10%[5], perhaps $\alpha_L = .9$, so the term amounts to 9% of s_L. Thus, inequality (24) is approximately $s_D \geq 1.09\ s_L$. When the United States is taken to have an A = 1.25, and the LDCs an A = 4, admittedly an extreme case, 5 of the LDCs are disadvantaged in stock holding by over 4 percentage points.

Finally, there is the middle ground—countries that have no marked advantage or disadvantage over the developed world in holding food stocks. Taking 2% as the cutoff for a marked disadvantage, at A = 3, 12 of the 18 countries have no marked disadvantage.

5. Conclusions

This paper presented a new method for determining whether inventories should be held in developing countries or in their developed world trading partners. The model, put most simply, is one of marginal portfolio choice. Only two assets are considered: a dollar denominated debt instrument with a fixed interest rate and a food stockpile held for an entire year. The first asset is held by both LDCs and the United States. The second asset is held by the United States. Since the United States holds stockpiles, we used a consumption beta version of the capital asset pricing equation to find the implied rate of return to holding that asset. It is then a simple matter to use the consumption beta version of the capital asset pricing model, along with the implied return to stockholding, to discover whether an LDC should also hold stocks. The question is an empirical one because the LDC and United States have different realized consumptions and therefore different consumption betas.

We applied our model to a sample of 18 developing countries. We found very little empirical regularity in our measure of the stock holding risk premia, s, among these countries. Neither GDP, nor the percent of GDP that is agriculture, nor both of these factors together offer much in the way of a clue as to which countries will have high and which low risk premia. We did find that exchange rates are useful in categorization: Those countries whose exchange rate is fixed against the dollar were among those with the highest value of s.

Turning to the central question of whether the developing countries should hold the stocks, we found no strong reason for most developing countries to hold stockpiles of food. This result must be tempered with our fourth theoretical case, a country for whom the basis rises rapidly as import volume rises. Our data on prices do not include the costs of the land-side operations of food importing, thus nothing in our data gives a clue as to how difficult it is to move food from a boat to the more distant population centers in Ethiopia. As such it is a model of normal, trading countries, not of Sub-Saharan Africa in the throws of famine and civil war. For the bulk of the more normal LDCs, though, the lesson is simple: Reduce sovereign debt, don't increase stockpiles.

Footnotes

[1]Presentation by Barbara Huddleston to conference on Inventory Policies in Less Developed Countries. Lake Balaton, Hungary, September 1989.

[2]To make this look more like equation (17) of Breeden's model, approximate U' in the numerator of (10) by U'(EC) + (C - EC)U".

[3]Hansen and Singleton (1983) estimated a number of monthly models. The ones with 6 lags fit best and had A values of 1.25 and 1.5. The quarterly data gave estimates of A between 2 and 3.

[4]Of the countries that are candidates for local storage, three (Panama, Liberia, and Korea) have no exchange rate risk since their currencies are pegged to the dollar. Chile is a significant food exporter, and Indonesia became an exporter during this period. Ethiopia was a large recipient of international relief.

[5]We were able to compute this value for Ecuador, Pakistan, and Sudan, and 10% is an average across the countries and the years of our samples.

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Table 1

Regression of Dollar Marginal Utility of Consumption
On its Lagged Value (UCEL) and a Constant

	Coefficient	Standard error	T-statistic	R-squared
Bolivia				
UCEL	0.858	0.054	15.798	0.95
CONSTANT	0.000	0.000	-0.384	
Chile				
UCEL	0.720	0.199	3.622	0.5
CONSTANT	0.000	0.000	1.081	
Columbia				
UCEL	0.780	0.153	5.091	0.74
CONSTANT	0.000	0.000	0.571	
Ecuador				
UCEL	0.577	0.029	19.716	0.97
CONSTANT	0.000	0.000	4.150	
Egypt				
UCEL	0.918	0.047	19.665	0.98
CONSTANT	0.000	0.000	-1.057	
Ethiopia				
UCEL	0.827	0.051	16.149	0.96
CONSTANT	0.000	0.000	1.505	
Hong Kong				
UCEL	0.688	0.049	14.159	0.96
CONSTANT	0.000	0.000	1.191	
Indonesia				
UCEL	0.791	0.034	23.589	0.98
CONSTANT	0.000	0.000	0.176	
Kenya				
UCEL	0.642	0.248	2.585	0.4
CONSTANT	0.000	0.000	1.305	
Korea				
UCEL	0.654	0.030	21.532	0.98
CONSTANT	0.000	0.000	3.612	
Liberia				
UCEL	0.644	0.193	3.335	0.55
CONSTANT	0.000	0.000	1.627	

(Continued on next page.)

Table 1— continued.

	Coefficient	Standard error	T-statistic	R-squared
Pakistan				
UCEL	0.735	0.018	40.843	0.99
CONSTANT	0.000	0.000	3.676	
Panama				
UCEL	0.925	0.060	15.460	0.96
CONSTANT	0.000	0.000	-0.788	
Paraguay				
UCEL	0.795	0.068	11.668	0.94
CONSTANT	0.000	0.000	0.564	
Philippines				
UCEL	0.792	0.054	14.609	0.96
CONSTANT	0.000	0.000	1.253	
Senegal				
UCEL	0.729	0.079	9.230	0.9
CONSTANT	0.000	0.000	1.919	
Sri Lanka				
UCEL	0.994	0.111	8.987	0.91
CONSTANT	0.000	0.000	-0.813	
Sudan				
UCEL	1.493	0.320	4.662	0.73
CONSTANT	0.000	0.000	-0.616	
United States				
UCEL	0.842	0.064	13.120	0.95
CONSTANT	0.000	0.000	0.882	

Table 2

Regression of Cereal and Cereal Preparation Price ($/ton)
On a Lagged Price and a Constant

	Coefficient	Standard error	T-statistic	R-squared
Bolivia				
PL	0.625	0.205	3.051	0.437
CONSTANT	0.076	0.040	1.880	
Chile				
PL	0.597	0.157	3.810	0.528
CONSTANT	0.071	0.027	2.666	
Columbia				
PL	0.576	0.264	2.180	0.346
CONSTANT	0.075	0.050	1.508	
Ecuador				
PL	0.258	0.311	0.830	0.071
CONSTANT	0.153	0.064	2.373	
Egypt				
PL	0.465	0.294	1.580	0.217
CONSTANT	0.101	0.057	1.772	
Ethiopia				
PL	-0.078	0.295	-0.265	0.007
CONSTANT	0.333	0.096	3.491	
Hong Kong				
PL	0.742	0.214	3.460	0.571
CONSTANT	0.148	0.116	1.284	
Indonesia				
PL	0.336	0.317	1.061	0.111
CONSTANT	0.158	0.078	2.028	
Kenya				
PL	0.598	0.256	2.335	0.353
CONSTANT	0.074	0.050	1.482	
Korea				
PL	0.395	0.328	1.205	0.139
CONSTANT	0.090	0.061	1.479	
Liberia				
PL	0.283	0.241	1.174	0.133
CONSTANT	0.321	0.103	3.125	

(Continued on next page.)

Table 2—continued.

	Coefficient	Standard error	T-statistic	R-squared
Pakistan				
PL	0.453	0.278	1.632	0.210
CONSTANT	0.093	0.048	1.941	
Panama				
PL	0.669	0.245	2.731	0.453
CONSTANT	0.093	0.067	1.382	
Paraguay				
PL	0.306	0.495	0.619	0.046
CONSTANT	0.125	0.097	1.290	
Philippines				
PL	0.135	0.244	0.554	0.033
CONSTANT	0.176	0.048	3.644	
Senegal				
PL	0.048	0.323	0.148	0.002
CONSTANT	0.215	0.074	2.919	
Sri Lanka				
PL	0.493	0.216	2.285	0.395
CONSTANT	0.109	0.053	2.075	
Sudan				
PL	0.332	0.238	1.393	0.195
CONSTANT	0.126	0.043	2.890	
United States				
PL	0.591	0.299	1.981	0.304
CONSTANT	0.057	0.044	1.293	

Table 3

Grain Stockpile Risk Premia by Country: S
Jackknifed Estimates of Standard Errors and T-Ratios

Country	S	Standard error	T-Statistic
Bolivia	2.465%	0.01380	1.78616
Chile	-1.916%	0.00497	3.85671
Colombia	2.162%	0.00630	3.43440
Ecuador	2.861%	0.00539	5.31050
Egypt	-0.103%	0.00162	0.63720
Ethiopia	-1.204%	0.00415	2.90400
Hong Kong	-0.266%	0.00205	1.29547
Indonesia	-0.777%	0.00213	3.65386
Kenya	3.819%	0.00852	4.48146
Korea	-1.239%	0.00274	4.52668
Liberia	-1.322%	0.00188	7.03245
Pakistan	-0.095%	0.00082	1.15298
Panama	-0.226%	0.00058	3.93038
Paraguay	-0.026%	0.00365	0.07139
Plilippines	-0.583%	0.00299	1.95248
Senegal	-0.627%	0.00327	1.91850
Sri Lanka	0.369%	0.00296	1.24910
Sudan	-0.016%	0.02766	0.00587
United States	0.004%	0.00080	0.05413

Note: Coefficient of relative risk aversion is 2.

Table 4

Grain Stockpile Risk Premia by Country: S

Relative risk aversion coefficient	2	3	4
Country			
Bolivia	2.465%	3.106%	4.175%
Chile	-1.916%	-3.306%	-5.133%
Colombia	2.162%	3.712%	5.897%
Ecuador	2.861%	3.580%	4.588%
Egypt	-0.103%	-0.019%	0.099%
Ethiopia	-1.204%	-1.697%	-2.193%
Hong Kong	-0.266%	-0.507%	-1.184%
Indonesia	-0.777%	-1.090%	-1.809%
Kenya	3.819%	6.058%	8.863%
Korea	-1.239%	-1.863%	-2.534%
Liberia	-1.322%	-2.298%	-3.606%
Pakistan	-0.095%	-0.520%	-1.261%
Panama	-0.226%	-0.451%	-0.775%
Paraguay	-0.026%	-0.348%	-0.895%
Plilippines	-0.583%	-1.032%	-1.618%
Senegal	-0.627%	-0.781%	-0.978%
Sri Lanka	0.369%	-0.112%	-1.186%
Sudan	-0.016%	2.278%	10.862%
United States	0.004%	-0.053%	-11.420%

Table 5

Risk Premia, GDP, and Percent Agriculture by Country

Country	Risk premia	GDP/Capita 1980 dollars	Agriculture as percent of GDP
Bolivia	2.46%	480	20.57%
Chile	-1.92%	2,100	8.22%
Colombia	2.16%	1,220	21.46%
Ecuador	2.86%	1,260	13.38%
Egypt	-0.10%	490	20.09%
Ethiopia	-1.20%	120	50.81%
Hong Kong	-0.27%	5,210	0.00%
Indonesia	-0.78%	480	24.80%
Kenya	3.82%	410	32.36%
Korea	-1.24%	1,620	16.55%
Liberia	-1.32%	590	35.86%
Pakistan	-0.09%	290	29.38%
Panama	-0.23%	1,680	8.99%
Paraguay	-0.03%	1,290	31.37%
Philippines	-0.58%	700	25.94%
Senegal	-0.63%	490	25.52%
Sri Lanka	0.37%	260	27.42%
Sudan	-0.02%	430	33.94%
United States	-0.05%	12,010	2.82%

Table 6

Coefficient of Variation of Imported Food Prices and of Consumption
Real Domestic Currency

Country	Prices	Consumption
Bolivia	53.51%	16.43%
Chile	34.37%	14.09%
Colombia	37.05%	19.09%
Ecuador	40.22%	19.72%
Egypt	22.48%	20.09%
Ethiopia	53.52%	10.34%
Hong Kong	28.12%	30.89%
Indonesia	35.23%	30.18%
Kenya	21.98%	12.17%
Korea	56.80%	20.26%
Liberia	15.82%	17.03%
Pakistan	23.19%	22.49%
Panama	15.90%	18.30%
Paraguay	29.24%	22.23%
Philippines	19.82%	13.80%
Senegal	25.03%	11.38%
Sri Lanka	23.67%	23.42%
Sudan	26.94%	33.30%
United States *	13.30%	9.94%

*Note: Prices are export prices