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FINANCIAL CONSIDERATIONS OF PUBLIC INVENTORY HOLDINGS IN DEVELOPING COUNTRIES

by

Irma Adelman and Peter Berck

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1. Introduction

Food-security enhancing buffer stocks are usually analyzed as projects, to be compared to other feasible projects, but they are also assets like stocks and bonds and can be compared to other feasible assets. The theory of finance permits the comparison of an asset to all other assets, while projects can only be compared to specified alternatives, including of course, the no action alternative. The theory of finance accounts for risk in a very general setting, while projects are typically evaluated for risk on the basis of stochastic simulations. Thus the assets market view of food stocks provides a powerful new tool of food-security analysis.

Current approaches to food-security analysis are based on the comparison of a food stockpile to other possible government actions, whether projects or policies. Explicit comparison of buffer stocks to food 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 compare feasible buffer stock policies 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 the expected utility of consumption. They do this by increasing the expected value of consumption more than, in some appropriate sense, they increase its 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 any other asset.

In the programming models of Bigman, Bigman and Reutlinger, and Adelman and Berck, the structure of the economy needed to be explicitly laid out. Each alternative to stock holding needed to be carefully specified. In the finance based model, consumption is assumed to be chosen based upon a knowledge of the true model (see Breeden, 1979). Observed consumption is smoothed in whatever way the economy could manage, not just in ways specified by the investigator. Thus observation of consumption substitutes for specification of the equations for the whole economy and for the need to specify any further alternatives to stock holding.

The paper is organized as follows. The theory is presented in section 2 and its implementation is discussed in section 3. Risk premia for a sample of 18 less developed countries are presented and discussed in section 4, while section 5 contains the conclusions.

2. The Model

Stored grain is a risky asset, just like shares in firms, junk bonds, small farms, and water projects. Since individuals are risk averse, risky assets must have higher returns than safe assets. The extra return on a risky asset, above and beyond the return on a safe asset, such as a U. S. government bond, is called the risk premium. This section presents the theoretical formulation of the risk premium for a food-security stockpile.

When agents, both individuals and countries, are willing to hold many assets, it must be that each of those assets provides an acceptable trade-off between risk and return. A standard way to express this trade-off is to draw a diagram, figure 1, with risk, however defined, on the horizontal axis and expected return on the vertical axis. Each asset can then be represented as a point in this risk-return plane. One can also
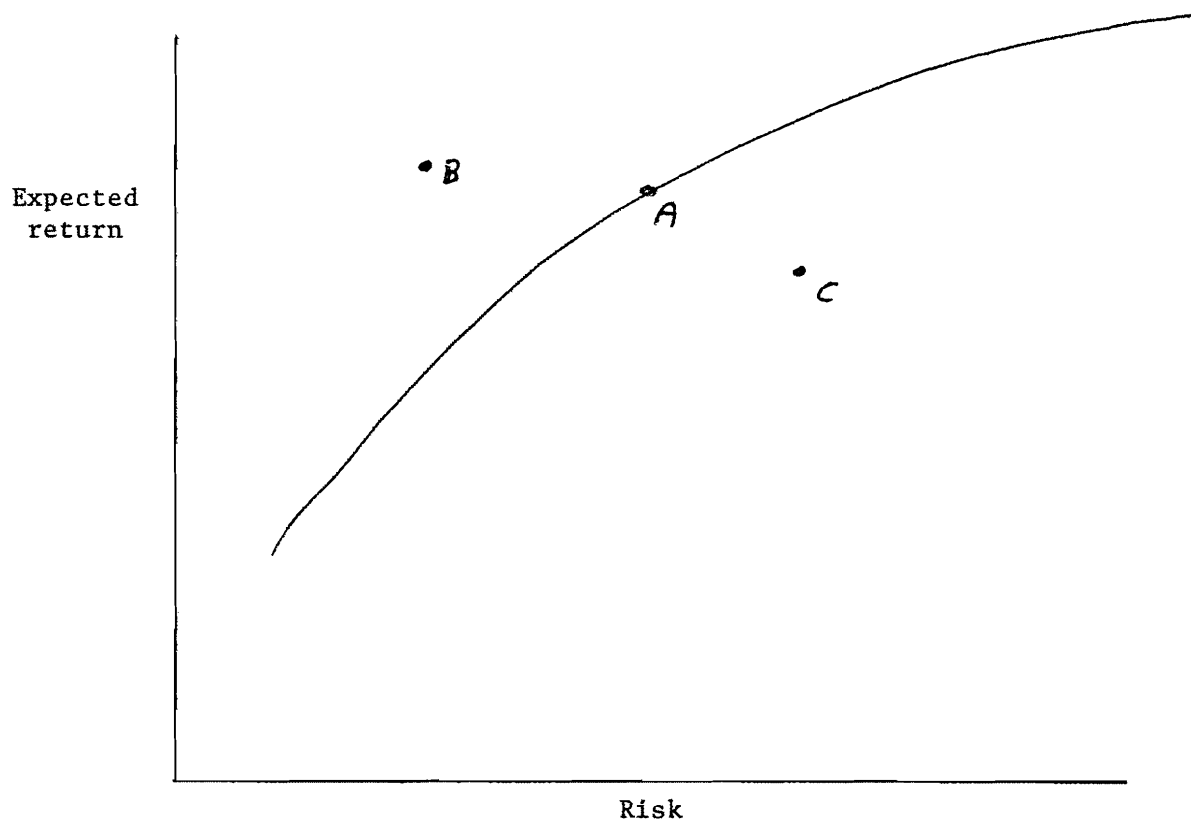
Figure 1. Risk-Return Frontier

draw a curve that connects the points representing those assets that have maximal

return for given risk. This curve is known as the risk-return frontier. Let the risk-

return frontier in figure 1 represent all assets other than a food-security stockpile.

Points A, B and C on the diagram represent three different risk-return possibilities for

the food-security stockpile. Consider an asset below the frontier like that represented

by point C. This point represents an asset that has too much risk for given return. An

asset lying directly above it, on the frontier, will have the same risk and more return.

No one who is risk averse would voluntarily hold an asset like C. An asset like A has

no better and no less risk for given return than other assets and could be voluntarily

held by a risk averse agent. A point like B represents a "bargain" in terms of risk and

return. In a perfect capital market, competition among buyers of B would drive its

price up to the point where it, too, lies on the risk-return frontier. Therefore, in a

country with perfect capital markets, all assets that are voluntarily held should be on

the risk-return frontier. In developing nations, with less than perfect capital

markets—access to foreign currency is rationed, capital is often centrally allocated,

etc.—there is no reason why opportunities like B cannot persist and no reason why

investments like C cannot be made. The purpose of a financial analysis is to provide a

ready method to discriminate bargains like B from wastes of resources like C.

For the same state of nature, risk varies across agents. This is so because

agents have different endowments of assets and different tastes, including the taste

for risk. In this paper, we develop a methodology for finding out whether a particular

country should hold buffer stocks of grain by establishing whether a food-security

stockpile is on, above, or below the risk-return frontier for that country.

The first step in locating the risk-return frontier for a food stockpile is to

choose a definition of risk. The literature offers many such definitions, each with its

advantages and drawbacks. The measure of risk we use should summarize the

expected welfare consequences to the agent resulting from fluctuations in the market-

return of the risky asset. There are three obvious candidates for assessing these expected welfare consequences: the expected utility from the agent's wealth, the expected utility from the agent's income, or the expected utility from the agent's consumption.

The use of wealth to measure risk is well ingrained in the capital asset pricing model of finance. The Standard and Poor 500 index is taken as a measure of wealth and called the market. An asset's risk depends upon the covariance of its return with the market-return. The method is imminently practical for the United States where the stock market is representative of a substantial fraction of wealth. It would be of no use in an LDC lacking well established financial markets.

Whole farm programming models with risk tend to concentrate upon defining risk in terms of farm-income. This is natural because data on farm-income is readily available while data on farm-wealth and consumption are not. There are serious theoretical difficulties with income, however. Agents are believed to maximize some function of consumption not income. So long as agents use savings to protect themselves against bad financial fortune, changes in income will overstate the consumption risk faced by the agents. Put another way, savings are a method of coping with bad financial fortune that are ignored by an income-based risk model. Another way to see the inadequacy of income-based measures is to recall that measured income is transitory income while consumption, which is what matters, is based on permanent income.

Risk based on measured consumption is the best theoretically justified measure. There is a direct link between consumption and welfare. Consumption also offers the most practical measure for comparing risk across nations since data on real domestic consumption are published in international statistics, while data on permanent income or wealth are not. Aggregate private consumption does have its shortfalls, however. Its aggregation masks questions of income distribution to an

extreme degree. For theoretical purposes one could just as well consider consumption by income group, but these data are not generally available. It is common when dealing with food inventory to take the view that food consumption is what matters. Indeed, as an ethical precept consumption of necessities such as food may well take precedence over consumption of other goods. Food consumption may also produce a measure that weights the needs of the poor more heavily than does aggregate consumption. In countries with a reasonable degree of market penetration, the breakup of consumption into consumption of food and other goods is a matter of personal choice. As such, the broader concept of aggregate consumption should give a better view of the individual's well-being than the narrower concept of aggregate food consumption. In economies where the choice amongst goods to consume is not made by consumers themselves or where the public storage entity takes serious account of income distribution, aggregate total consumption would be a very poor measure. For an average LDC, however, aggregate consumption is the most reasonable choice for measuring risk. It is the measure we adopt in this analysis.

In economics, agents are believed to be risk averse. That is to say, that agents would rather have a constant amount of consumption year after year than double consumption in one year and no consumption at all in the next. Another way of putting this is that the extra pleasure or utility from an additional unit of consumption decreases as the number of units of consumption increase. Assets that pay off when consumption would otherwise be low are obviously preferred to those that pay off when consumption would be high. As a concrete example, consider crop insurance. Crop insurance is desirable precisely because it sends the farmer a check when the farmer has no crop. The technical way of saying this is that preferred assets pay off most when the marginal utility of consumption is highest. An equivalent way of stating this condition, which is the result of the diminishing marginal utility postulate,

is that preferred assets are positively correlated with the marginal utility of consumption.

The technical question to be answered is, Would another dollar invested in a food-security stockpile be a good or bad investment for an LDC? The words, "another dollar" mean that only marginal changes are considered. Consider buying one dollar's worth of food and holding it for a year. Let the value of this food, net of costs of the stockpile, at the end of the holding period be P dollars. It is the rate of return on the stockpiled asset. For a trading nation, P would be the then current world price less the costs of storage. Since the world price of food varies from year to year, P is a random variable.

There are many factors other than food prices that affect a nation's consumption of goods and services. High oil prices, low prices for its exports, and bad weather are all events that lead to low consumption. Low consumption means low welfare and high marginal utility of consumption. Thus (real private) consumption, C and marginal utility of C, MU, are also random variables.

The value of an asset is measured by how much it increases an expected utility of consumption function, EU. The symbol E is the mathematical expectation operator, the average across good and bad outcomes for oil prices, export prices and the like.

A very simple example is a world with two equally probable states of nature, good, G, and bad B. In the good state, oil prices are low, weather is good and export prices are high. Consumption is then high, and the marginal utility of consumption is low. We use subscripts to denote the outcomes in the two state of nature, e.g., C_G is consumption in the good state of nature.

Not considering the one dollar additional investment to the stockpile, welfare is EU_0. The welfare value of the stockpile in the good state of nature is $MU_G P_G$. The stockpile is worth P_G dollars and each dollar contributes MU_G units to welfare. In the bad state of nature it is worth $MU_B P_B$. Adding the two outcomes together and

dividing by two gives the increase to expected welfare, so welfare, including the uncertain payoff to the stockpile, EU_1 is given by

(1) $EU_1 = EU_0 + 1/2\ MU_B P_B + 1/2\ MU_G P_G.$

Since the last two terms of equation (1) are E [MU P] a more general expression for the value of a stockpile is

(2) $EU_1 = EU_0 + E[MU\ P]$.

Now consider a second asset, a dollar denominated bond. We consider this bond to be a risk-free asset. For a dollar invested it has a yield of (1+r) dollars, regardless of prices, weather and the like. Expected welfare including the payoff to this bond is

(3) $EU_1 = EU_0 + (1+r)\ E[MU]$.

The interest rate term is not stochastic, so it can be written outside the expected value operator.

Subtracting equation (2) from (3) and rearranging gives

(4) $(1+r)\ E\ MU = E\ [MU\ P]$.

The last term of (4) is the expected value of the product of two random variables. This term can also be expressed in terms of the covariance (cov) of the variables.

(5) $E\ [MU\ P] = E\ MU\ E\ P + cov(MU,P)$.

Using (5) for the right-hand side of (4) and rearranging gives

(6) $E\ P = (1+r) - \dfrac{cov(MU,P)}{E\ MU}$.

Equation (6) relates the expected return of an asset to the return on a bond and a risk premium. An investment of one additional dollar in any asset that satisfies this

equation raises expected welfare exactly as much as does an investment in a bond. Since all LDCs hold dollar-denominated debt, this equation is the equation for the risk-return frontier.

Our two state of nature (bad and good) example is sufficient to show what sort of countries should hold stockpiles and what sort shouldn't. Making the example concrete, let the welfare function be $U(C) = - C^{-1}$ so the value of an additional dollar of consumption is $MU(C) = C^{-2}$. To keep matters simple, let $P_G = 1.2$ and $P_B = 1.0$, for an average return of 10%. Also let $r = 10\%$.

Since only a small percentage of the developed-world work-force has income dependent upon farming and food is only a small part of its consumption, it is plausible that the covariance of consumption and agricultural prices in developed countries is very small. Many other empirical studies have shown that the United States, our prototypical developed country, DC, incurs very little risk from holding food stocks.[1] If we make the extreme assumption that, for the DC $cov(MU,C) = 0$, then, given our numbers, the average return on a stockpile exactly equals the interest rate in the DC and the stockpile is on the risk-return frontier.

Now, let us consider two extremely different developing countries. The first such country is poor so that food is an important part of the family budget and it is a net food importer. The country is dependent upon export earnings. When the world is booming, it does very well selling its products. When the world is booming everyone else also does well selling their products, and consequently the demand for and price of food is high. Therefore, it makes the most money and has the highest consumption when food prices are highest.

For the sake of example, let this country have $C_G = 1.2$, so $MU_G = .69$. Let $C_B = .8$ so $MU_B = 1.56$. Straightforward computation, illustrated in table 1 below, gives a risk premium of -3.86%. Since this country and the DC both make the same expected return from holding a stockpile and this country has a larger risk than the

developed country does, a stockpile is under the risk-return frontier for this country. It should not hold a stockpile.

Table 1

State of Nature	C	MU	MU -EMU	P	P - EP	{P-EP}{MU-EMU}
Bad	0.80	1.56	0.43	1.00	-0.10	-0.043
Good	1.20	0.69	-0.43	1.20	0.10	-0.043
Average (E)	1.00	1.13		1.10		-0.043
Risk premium: E {P-EP}{MU-EMU}/ EMU					-3.86%	

At the other extreme is a country dependent upon its food exports. It shares weather with the other major producing countries, so its food crop is smallest and its income and consumption are least, when prices are highest. Keeping the stockpile payoffs as before but choosing $C_G = .8$ and $C_B = 1.2$, the risk premia is now +3.86%. That is, this country finds that a stockpile is above the risk-return frontier and it should increase its holdings of a food stockpile.

A cost of keeping the algebra simple in these examples was the abstraction from transportation costs. These costs influence the results most in poor countries with extremely limited infrastructure.[2] Such countries have low abilities to import food: When they try to import food to offset local disasters, the cost of transport increases radically. Technically, this is a form of basis risk. In these cases the force driving the decision to store food is a high covariance between the CIF (that is, delivered) price of food and local income. When crops fail, local income and consumption are low and importation is difficult so CIF prices are high. Now it is again right for the LDC to hold a stockpile. Most sub-Saharan countries and Bangladesh during its initial years are in this situation.

The cases given above are those that lead most naturally to the establishment of food-security stocks. They are not necessarily the conditions that one should expect to obtain in LDCs, however. Most countries should be expected to have aggregate consumption that has little correlation with world food prices. Why should world food prices be high if Egypt has a short crop? This is ultimately an empirical matter, to which our attention now turns.

3. Implementation

The key to deciding which type of countries should hold stocks is in estimating the risk premia for developing and developed countries. This calculation of these premia depend upon a large number of issues and this section will provide a brief description of the chiefest of these: the welfare function, data, meaning of E, forecasting of price, and forecasting of MU.

The welfare function is $U = (1 - A)^{-1} C^{1-A}$ for $A = 2$ or 4.[3]

We collected data on 18 developing countries and the United States for as many years from 1972 to 1986 as possible (minimum number of years was 11). The return to holding a stockpile was constructed as the percent change in the imported (exported for the U.S.) price of cereals.[4] Our consumption variable was private final consumption expenditures in constant prices[5]. A real exchange rate was used to make the dollar nominal cereal prices comparable to the own currency real consumption figures.[6]

In our two period example, above, the meaning of expected value was just the sample average. It was the best estimate that could be made of the average value of P with the data available. The same concept applies to EP estimated from real data. It should be the best estimate of prices in period t with information available at t - 1. We implemented our predictions with a regression of the current price on past price and a predictor derived from the U. S. wheat futures market. The forecasting

regressions of the dollar prices of cereal and cereal preparations on its lagged value and on a predictor created from the futures market price were used to predict price. All the regressions were corrected for autocorrelation. The futures based predictor for import price used here was the expected percentage change in the U. S. futures price for wheat times last years import price.[7]   The futures based predictor generally performed well while the lagged price predictor was important only for a few countries. The quantity P - EP is just the residuals from these regressions, the actual forecast errors. That is, for each year in the sample, there was a predicted price and an actual or realized price. The difference between those two prices was our estimate of P - EP for that year.

The same logic applies to forecasting marginal utility. Hall showed that a constant times last year's marginal utility is the best predictor of this year's marginal utility. Based on Hall's logic, we predicted dollar marginal utility by regressing dollar marginal utility consumption on its lagged values. As expected, lagged consumption was statistically significant in all countries studied. Three countries had R-squares in the range of one-half, while all the rest had much larger values. MU - EMU was also estimated as regression residuals, one for each year of our sample.

To see how much difference using residual statistics rather than sample statistics makes, see table 2. It gives the coefficient of variation (standard deviation divided by mean) of consumption (and prices) computed in two ways. The first two columns of the table are calculated from the raw data: The sample standard deviation is simply divided by the sample mean. The second two columns give the standard deviation of the forecast residuals (from simple linear regressions described above) divided by the sample mean. Bolivian consumption, for instance, has a coefficient of variation of 16 percent. Two-thirds of that variation, however, was completely forecastable. It was not risk. The remaining one-third, 5 percent, was not forecastable. Since an asset's risk premium is based on that asset's ability to reduce

Table 2

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

Country	Sample Statistics		Residual Statistics	
	Prices	Consumption	Price	Consumption
Bolivia	53.51%	16.43%	18.44%	5.35%
Chile	34.37%	14.09%	11.89%	11.25%
Colombia	37.05%	19.09%	9.14%	11.91%
Ecuador	40.22%	19.72%	36.74%	2.28%
Egypt	22.48%	20.09%	12.64%	3.96%
Ethiopia	53.52%	10.34%	38.90%	3.14%
Hong Kong	28.12%	30.89%	9.64%	2.40%
Indonesia	35.23%	30.18%	14.84%	4.24%
Kenya	21.98%	12.17%	29.99%	10.48%
Korea	56.80%	20.26%	11.60%	3.50%
Liberia	15.82%	17.03%	10.98%	11.31%
Pakistan	23.19%	22.49%	15.92%	2.14%
Panama	15.90%	18.30%	7.40%	4.02%
Paraguay	29.24%	22.23%	22.57%	5.50%
Philippines	19.82%	13.80%	5.13%	2.87%
Senegal	25.03%	11.38%	15.72%	2.80%
Sri Lanka	23.67%	23.42%	12.18%	4.52%
Sudan	26.94%	33.30%	17.15%	19.79%
United States *	13.30%	9.94%	7.93%	3.13%

*Note: Prices are export prices

variability in consumption, computing risk premia based on consumption forecast errors will produce much lower premia than computing them based on the raw data. When there isn't much risk, there can't be much payoff to reducing risk.

For each of the 19 countries, the covariance of the residuals of the price and dollar marginal utility regressions was calculated. The covariances were divided by once lagged marginal utility to provide an estimate of the risk premium.[8]

4. Results

The risk premia, which are shown in table 2, are all small. Sudan has the lowest premium, -8 percent, and Hong Kong has the highest at 5 percent. In the United States the premium is near zero and it is less than +/- 1 percent in 8 of the 19 countries. Table 3 shows the premia for a relatively high degree of risk aversion, higher than that found for the U. S. by many investigators. At lower degrees of risk aversion, A = 2 or 3, the premia are closer to zero.

The premia do exhibit two patterns. Countries with higher GDP per capita tend to have higher premia (Rank correlation coefficient of .32). This is reasonable because those countries tend to have relatively smaller agricultural sectors and food is a smaller part of consumption. (The rank correlation between agriculture as a percent of GDP and risk premium is -.48.) With a relatively smaller agricultural sector, permanent income and therefore consumption are little influenced by world food prices. Thus a small agricultural sector leads to smaller risk premia. A look at the data in table 3 shows that these effects are not very pronounced.

The premia, plus (one plus) the rate of interest on debt is the required rate of return for a stockpile. To profitably store grain in Hong Kong requires a rate of return 5 percent above the return on debt; in the United States, a return equal to the return on debt, and in the Sudan, a rate of return 8 percent below the return on debt. Only 6 of the countries studied have as much as a 1 percentage point risk advantage over the

Table 3

sk Premium, Percapita GDP, and Percent Agriculture by Country

Country	Risk Premium	GDP/Capita 1980 dollars	Agriculture as percent of GDP
Bolivia	1.16%	480	20.57%
Chile	-3.52%	2,100	8.22%
Colombia	4.51%	1,220	21.46%
Ecuador	3.78%	1,260	13.38%
Egypt	0.35%	490	20.09%
Ethiopia	-2.41%	120	50.81%
Hong Kong	5.32%	5,210	0.00%
Indonesia	-2.75%	480	24.80%
Kenya	0.87%	410	32.36%
Korea	0.09%	1,620	16.55%
Liberia	-0.87%	590	35.86%
Pakistan	-0.40%	290	29.38%
Panama	0.70%	1,680	8.99%
Paraguay	-1.41%	1,290	31.37%
Philippines	-0.57%	700	25.94%
Senegal	-1.76%	490	25.52%
Sri Lanka	-1.04%	260	27.42%
Sudan	-7.95%	430	33.94%
United States	0.30%	12,010	2.82%

Note: Risk premia are calculated for A = 4.

United States in grain storage. Only Chile and the Sudan have over a three percentage point advantage. None of the countries have any advantage in terms of the interest rate on debt so the results overstate the desirability of holding food inventories in LDCs.

5. Conclusions

This paper presented a new method for determining whether food inventories should be held in developing countries or in their developed-world trading partners. When inventories are held in a DC, they must lie on the risk-return frontier. Since LDCs have the same expected gain from inventory holding as the DC's inventories will lie on the LDC risk-return frontier only when the LDC has the same risk as the DC. Since LDCs and DCs have manifestly different patterns of consumption over time and since we have chosen to measure risk based upon the covariance of marginal welfare of consumption with price, DCs and LDCs are not very likely to view stockpiles as having the same risk. If holding a stockpile is more risky for an LDC than for a DC, then the LDC should not hold the stockpile.

Turning to the central question of whether the developing countries should hold the stocks, we found no strong risk-related reason for most developing countries to hold stockpiles of food. All the countries on our list pay more than the rate on U. S. treasury bills for interest on their debt. Differences of a couple of percentage points in the required rate of return are simply not sufficient reason to embark upon a stockpile-oriented food-security program.

This result must be tempered by an analysis of some of the world's more desperate situations. 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. Presumably, consumer prices (or shadow prices) in those distant population centers

would give a very different picture from the dockside computation of risk premia. The empirical results should be taken as indicative for normal, trading countries, rather than for 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]See Barry (1980) or more recently Arthur, Carter, and Abizadeh (1988).

[2]War has the effect of making large scale transport very costly.

[3]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.

[4]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.

[5]Consumption is from United Nations "National Accounts Statistics: Main Aggregates and Detailed Tables" (various years) Table 1.2 or from the World Bank "World Tables 1987" (1988) using the series for private consumption in current prices and the gross domestic product (GDP) deflator.

[6]Real exchange rate were computed from the World Bank "World Tables 1987" (1988) by deflating the nominal exchange rate by the GDP deflator.

[7]More exactly, it was the december price for september delivery, divided by the december price for december delivery, times last years import price.

[8]The calculated numbers actually differ from the true risk premia by the ratio of the rate of time preference to the interest rate, which should represent a small adjustment.

References

Adelman, Irma and Peter Berck, forthcoming, "Food security policy in a stochastic world," *Journal of Development Economics*.

Arthur, Louise M., Colin A. Carter, and Fay Abizadeh, 1988, "Arbitrage pricing, capital asset pricing, and agricultural assets," *American Journal of Agricultural Economics* 70, 359-365.

Barry, P. J., 1980, "Capital asset pricing and farm real estate," *American Journal of Agricultural Economics* 62, 549-553.

Bigman, David, 1985, *Food policies and food security under instability: Modeling and analysis* (Lexington Books, D. C. Heath and Company, Lexington, MA).

Bigman, David and Shlomo Reutlinger, 1979, "Food price and supply stabilization: National buffer stocks and trade policies," *American Journal of Agricultural Economics* 61, 657-667.

Breeden, Douglas T., 1979, "An intertemporal asset pricing model with stochastic consumption and investment opportunities," *Journal of Financial Economics* 7, 297-318.

Hall, Robert E., 1978, "Stochastic implications of the life cycle-permanent income hypothesis: Theory and evidence," *Journal of Political Economy* 86, 971-987.

Hansen, Lars P. and Kenneth J. Singleton, 1983, "Stochastic consumption, risk aversion, and temporal behavior of asset returns," *Journal of Political Economy* 91, 249-265.

United Nations, Department of International Economic and Social Affairs, various years, *National accounts statistics: Main aggregates and detailed tables* (The United Nations, New York).

World Bank, 1988, *World tables 1987* (World Bank, Washington, DC).

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