ECONOMIC ANALYSIS OF BUFFER STOCKS TO STABILIZE THE INTERNATIONAL GRAIN MARKETS: A LITERATURE REVIEW

by

Jacqueline Murray Brux

CENTER FOR RESEARCH ON ECONOMIC DEVELOPMENT
The University of Michigan
Ann Arbor, Michigan 48109

Discussion Paper No. 116 September, 1986

ECONOMIC ANALYSIS OF BUFFER STOCKS TO STABILIZE THE INTERNATIONAL GRAIN MARKETS: A LITERATURE REVIEW

by

Jacqueline Murray Brux

* * *

Discussion Paper No. 116, September 1986.
Published by the Center for Research on Economic Development,
University of Michigan, Ann Arbor, MI 48109-1220, U.S.A.

ABSTRACT

This paper represents a review and discussion of simulation models of buffer stocks to stabilize the international grain markets. It carefully reviews the important economic models to date, with a critical analysis of the limitations and contributions of these models to the discussion of world food security and price stabilization.

RESUME

Ce document présente un compte-rendu et une discussion des modèles de simulation des stocks régulateurs visant à stabiliser les marchés internationaux de céréales. Il examine soigneusement les plus importants modèles économiques élaboré à ce jour, avec une analyse critique des limites et des contributions de ces modèles à la discussion au sujet de la sécurité alimentaire mondiale et de la stabilisation des prix.

TABLE OF CONTENTS

INTRODUCTION

Grain is the single most important commodity on the world market. It is essential for life; hence the critical nature of world grain markets. Grain supplies had been plentiful in the context of a stable world grain market for decades prior to the 1970s. However, the events leading up to and culminating in the world food crisis years of the early 1970s shattered the concept of a stable world grain market. Suddenly the issues were widespread and compelling: shortages were rampant, stocks were depleted, and grain prices soared. Conditions of the world's already malnourished worsened; and in chronic food deficit areas, such as India and Bangladesh, and areas affected by exceptional food shortages, such as central Africa, millions of people suffered and died. Food aid was reduced, and simple economics assured that those with higher incomes throughout the world would command the limited supplies.

Today's grain market has reversed itself from the conditions of the early 1970s. Now, suppliers are troubled by excessive production, record stockpiles, and prices that fail to cover even the costs of production. Yet the issue of food security has not resolved itself. People in developing nations with serious short-term production shortfalls or long-term declines in production face starvation and malnutrition in very serious proportions. The poor even in more developed countries or those countries self-sufficient in grain production suffer as well when incomes are insufficient to purchase available grain supplies. Other developing countries, faced with an appreciated U.S. dollar and a debt burden worsened by low returns on their raw materials and manufactured products, can ill afford to import necessary grain supplies even at low international prices. And the national policies of some large importing and exporting countries contribute to trends of price instability and supply uncertainty that are particularly burdensome to the long-term planning efforts of less developed countries.[1]

In light of these current and recent conditions, and the negative implications for low-income countries and consumers, many who analyze international grain markets do so out of a concern for consumption security for the world's poor. Much of this discussion of grain markets focuses on the subject of international grain reserves, to be held for the various purposes of assuring stable world supplies of grain, maintaining sufficient reserves for generalized food aid and/or emergency relief, or ensuring stabilized international prices of grain. In the latter case, the assumption is made that grain reserves that effectively stabilize international grain prices will enhance world food security, including consumption security for the world's poor. Thus it is important to carefully consider the link between stabilized international grain prices and supply-availability for the poor nations and for poor people within those nations. The link is not a direct one.

It is often argued, for example, that individuals at the village level in less developed countries are so isolated from international commercial markets that international prices are largely irrelevant. More to the point, it has been suggested that consumption insecurity in less developed countries has more to do with domestic production shortfalls than increases in international grain prices (Morrow, 1980), and that for many less developed nations the foreign exchange requirements associated with high international prices of grain imports are not insurmountable (Valdés and Konandreas, 1981). Consequently, programs such as the new International Monetary Fund food-import facility, providing foreign exchange assistance in those cases where need arises, are seen by some as sufficient to deal with international grain price instability.

On the other hand, it is hard to dispute that poor, food-importing countries would benefit if large international grain price swings could be avoided. Import requirements and domestic policies that affect food consumption and production would be far more easily managed. In more free market oriented economies, producers and consumers would face far less uncertainty and fluctuation of incomes and expenditures or of production and consumption, as domestic prices stabilized in response to stable international ones. In addition, most economists agree that food aid and other food security systems could be better and more easily managed if price fluctuations could be moderated. It hardly needs to be stressed that the skyrocketing prices of the early 1970s and the widespread hunger and malnutrition that ensued ought not ever recur. Unfortunately, there is no international agreement of mechanism to prevent such extreme price fluctuations from occurring again.

* * *

With all this in mind, it is important to very carefully consider the empirical work which has been done on the matter of international grain reserves, and specifically the impact they would have on grain price stability and consequent world food security. A number of empirical studies have addressed these issues. However, there has been no careful effort to draw together the conclusions of these studies in a comprehensive framework. That is, there has been no effort to carefully consider the grain models that have been used, the underlying assumptions and simplifications of these models, their limitations and strengths, and the reasonable conclusions which can be drawn. It is the goal of this paper to make these considerations, and in doing so, to determine the implications of international grain reserves for grain price stability and consumption security in the world.

The format of this paper is that of an extended literature review. A previous literature review by researchers at the University of Minnesota presented a comprehensive overview of empirical economic analysis of grain reserves (Houch and Ryan, 1979). The selected review here will update, but will also focus quite a bit more narrowly on those empirical analyses which employ simulation models in international buffer stocks of grain to stabilize the international grain markets.[2] The narrower focus will permit more detailed consideration of the studies, as they relate to price stabilization and security goals.

The current review begins with a careful consideration of various criteria used to represent the complexity, and therefore sophistication, of the various models to be reviewed. This discussion precedes the actual literature review, in order to draw the reader's attention to important considerations and to enable a more enlighted reading of the review. This discussion is important, as it sets the stage for any reasonable conclusions which might be drawn from the analyses themselves. Then the various models are individually reviewed. Following the review, the overall conclusions of the various models are summarized in an effort to discern possible directions and magnitudes of buffer stock implications. Finally, limitations of the models as a whole are discussed, and in this light, recommendations are made.

It should be noted that in addition to the empirical literature, a very wide and sophisticated theoretical literature on price stability and welfare is available. This literature has developed from the relatively simple early works of Waugh (1944), Oi (1961), and Massell (1969), to the very sophisticated later works of Turnovsky (1974 and 1976), Just _et_ _al_. (1978), and others who have incorporated nonlinearities, multiplicative disturbances, supply price responses, and other complexities into the analyses. A review of this literature is available in Brux (1984).

MODEL COMPLEXITY CRITERIA

The empirical buffer stock models vary a great deal in their complexity, and the following criteria are designed to consider the nature of this complexity. This is not to suggest that the simpler models are inferior or inadequate; indeed, many analyses were deliberately kept simple, and they served very well to accomplish the objectives of the researchers. However, certain simplifications do generally bias the results, and it is important to understand the nature and, where possible, the direction of this bias.

Grain Aggregation

In most of the models of grain markets, only a single grain has been considered, or else all grains have been aggregated and considered in one model. The difficulty with the first approach is that it ignores the interactions of the markets for the various grains. Particularly, it assumes no substitutability among the grains, an assumption that is empirically incorrect. Cross price demand and supply elasticities may in fact often approach the sizes of the own price elasticities, especially between the wheat and coarse grain markets (and in some cases may even surpass these sizes). Cross price demand elasticity values assumed in the literature have reached the 0.20s to 0.40s (USDA, 1978, pp. 59-61). Similarly, long-run cross price supply elasticity values have reached the -0.40s to -0.70s or lower for many countries and regions (USDA, 1978, pp. 62-64). Short-run cross price supply elasticities may very well often approach these values. These interactions are particularly important in the context of stabilization analysis, where the stability of one grain market directly affects the stability of another, and the effectiveness of any stabilization mechanism directly depends upon the repercussions in all grain markets. Furthermore, a comprehensive study which is designed to analyze country and region consumption and price instability cannot satisfactorily focus on only a single grain. Different grains are consumed and produced in different proportions in various countries throughout the world, and an analysis of only one grain would necessarily be incomplete.

The second approach, lumping all grains as if there were only one market for them, asumes at the other extreme that the grains are infinitely substitutable. This of course is also incorrect. It tends to exaggerate the stabilizing effects of a buffer stock and the benefits which result. Clearly, an ideal approach ought to disaggregate the grain categories as much as is realistic, and account for the interdependencies (cross price elasticities) between grain categories.

Country Aggregation

The grain market models considered here vary considerably in terms of a world-wide breakdown of markets. In some, demand and supply have been estimated only for the world as a whole. Another disaggregates to a level of three international groupings: developed countries, developing countries, and centrally planned countries. Still others are broken down into many countries and regions, with considerable focus on less developed countries in some.

The more disaggregated the model, the more realistic it is and the greater are the number of country-specific conclusions which can be drawn. In particular, it is important to know the extent to which the stabilization mechanism affects price stability in individual countries and regions, and the extent to which this in turn affects the stability of demand and supply within the individual countries and regions. It is also helpful to know the international distribution of costs and benefits. Certainly these considerations are important for humanitarian, as well as political reasons. Furthermore, to the extent that aggregation occurs, the severity of the implications of price and consumption instability will be underestimated. A deficit in one country may be counterbalanced by a surplus in another country, creating an illusion of no scarcity in an aggregated model. Unless free trade exists between the two countries, however, there is in fact food scarcity and a need to remedy it. This will not show up in the aggregated results.

Trade and Domestic Policy

In light of the above, the role of trade is an important corollary of country aggregation. All global models implicitly assume free trade, and models with various regions implicitly assume free trade within these regions. For those models broken down into various countries and regions, the role of trade between these countries and regions also assumes importance. If each trading country or region seeks self-sufficiency, for example, and refuses to trade despite domestic production fluctuation, then there will be greater consumption variation in these countries and the world (or a greater need for domestic stocks and expense in ensuring stable domestic consumption).

If, on the other hand, countries and regions trade freely in response to domestic production fluctuations and international price fluctuations, the implications will be different. Domestic consumer and producer prices will approximate international ones (differing only by transport and handling costs), and import elasticities of demand will approximate domestic demand elasticities. Domestic production fluctuations will be largely irrelevant for domestic consumption (aside from their impact on international prices and the effects of transport costs), as imported grain is simply substituted for domestic grain. International market fluctuations will be transferred to domestic markets, encouraging some domestic consumption and production adjustment as well as adjustmemt in trade flows.[3]

Free trade in the real world is not the usual case, however, as most trading nations seek to insulate their domestic markets at least to some degree from international price fluctuations. In these cases, domestic prices would differ from international ones, and import elasticities of demand would be less than domestic demand elasticities. The domestic trade policies would serve to remove normally stabililzing influences from the international market (that is, domestic consumption and production adjustment to changing international prices). If these countries also attempt to assure stable domestic consumption despite domestic production fluctuation (by tying import quantities to domestic consumption needs), the impact of their own domestic production fluctuations will be transferred to the world market. If they allow their consumers to bear some of the brunt of domestic production shortfalls, domestic consumption instability will be greater but international instability less.

In regard to these considerations, the models which explicitly consider trade policies at the country and regional level are particularly helpful and interesting. Those models which simulate with alternative assumptions on trade liberalization provide even more illumination to the issue.

Demand and Supply as Functions of Price

All models discussed here include demand equations expressed as some function of price. These range from very simple linear world demand equations to more sophisticated log linear and nonlinear functions for individual countries and regions. Supply, on the other hand, has not always been expressed as a function of price. Clearly, grain production does respond to price, as is evidenced by the frequently large price elasticities noted in the literature (see, for example, USDA, 1978; and Askari and Cummings, 1977). To ignore this supply response would be to ignore the impact of buffer stock price stabilizing influences on world, country and region supply variability, and to underestimate supply adjustment as a possible price stabilizing force. That is, if total supply responds to price in the short-run, market prices vary less than if there were no supply response. (On the other hand, if supply is responsive to price only over the long-run, due to a period of adjustment of actual output to desired output or due to the nature of price expectations, supply response to price may actually worsen price fluctuation. Note, for example, the cobweb model of lagged supply responses to price.)[4]

The models which do include supply response to price do so in varying degrees of sophistication, with supply expressed anywhere from a simple function of one-year lagged prices to more complex functions with a distributed lag. In this regard, the form of the supply response to price will not only have implications for stability, but also for the welfare implications of stabilization (see Sarris, 1976).

Private Stockholding Behavior

Most international models of buffer stocks have ignored private stockholding behavior. (Note that "private" is used here to describe stocks owned by private individuals and companies, as well as by governments; it is used to distinguish between these stocks and those which might be held by an international buffer stock authority.) One model incorporates simple equations for private stockholding, without attempting to model this behavior as a response to price. A few models have attempted to incorporate private stock behavior as a function of price, and one of these expresses net private stock sales as a function of changes in international price, supply, and demand. Some of the private stockholding parameters in this model are assumed, however, rather than estimated, in an effort to bring stability in the overall model to a level more closely approximating reality. (That is, to some extent the model increases private stockholding instability beyond what is realistic in order to reduce international price instability to appropriate magnitudes.)

The matter of private stockholding behavior is an important one. This is because internationally-held buffer stocks operating effectively within very narrow bandwidths will at least partly substitute for stocks which would have been held by private stockholders and governments (see Morrow, 1980, pp. 12-13, 35-36). Because of this substitution, the net increase in stockholding and the reduction in price variation would be smaller than otherwise expected. As the price band widens, the international buffer stock increasingly supplements private stockholding and price variation is reduced. (Of course, if the band becomes too wide, the buffer stock becomes ineffective.) Clearly, careful modeling of private stockholding behavior as some function of price (and ideally of price variation, in order to compare the implications of a world with and without price stabilizing buffer stocks) is necessary in order to accurately predict the substitution which would occur between private and buffer stock storage.

Buffer Stock Price Maintenance

All of the models discussed here are designed to maintain some type of band around international price (except for one model where a quantity band is used). Where a trend in international price is expected (on the basis of a trend in demand or supply, or in a price equation), the band is generally designed to follow this trend. However, most models fail to carefully carry out this goal, and instead often bias operations in the direction of raising average international prices above their trend levels. This often occurs due to lack of care in specifying buffer stock rules of operation, or in failure to deal correctly with beginning and end stocks and buffer stock capacities. In the latter case, if the initial (base year) price is at trend, and if the buffer stock authority begins with zero initial stocks and engages in any net buying of stocks over time, the price will be supported above the equilibrium price which would exist if no stocks were purchased. This is true because any buying of grain by the buffer stock which is not offset by equal selling of grain must raise the price of that grain, all other things being equal. (Average stocks held over time need not equal zero, but net buying over time should.) In raising the average price above trend, the buffer stock is not operating according to definition, and would tend to increase the gains to producers and exporters.

The problem then is to devise a buffer stock operation which is not biased toward the net acquisition of stocks. Assuming the operation begins with zero initial stocks, this would require that the buffer stock authority be equally constrained in the sale and acquisition of stocks. Note that the sale of grain by the buffer stock is constrained by the amount of stocks on hand, while the acquisition of grain is constrained by the capacity constraints (and possible financial constraints). These constraints must therefore have equal effects in both directions, so that ending stocks will approximate zero (on average). The difficulty with zero initial stocks is that capacity would have to be quite small in order to have the constraints operating in both directions by equal magnitudes; and even then it is quite possible that the stock on hand constraint would be more likely to bind than the capacity constraint (as if the early years of operation involved market prices above equilibrium and later years below equilibrium). Furthermore, a reserve of this type may not be able to perform satisfactorily in stabilizing prices, because the constraints would be binding too much of the time. It is preferable therefore to begin the operation with a positive initial reserve, and end the operation with the same amount (on average). These points have not been dealt with adequately in most of the buffer stock models. Certainly the models which assume zero initial stocks cannot avoid this problem; and unless careful attention has been paid to buffer stock maintenance of appropriate price trends, neither have models with positive initial stocks resolved the issue adequately.[5]

An ideal situation would be to devise a means of modeling positive initial stocks without initially raising the market price of the grain. One way to do this would be to assume reserves are obtained from surplus stocks held by major exporting countries. Ownership of these stocks could be maintained by either the buffer stock authority or their initial holders without unduly complicating the analysis, particularly if the base year for simulation is one with fairly large carryover stock levels (as they have been in recent years). Since the stocks would come from surplus reserves not currently on the market, they would not diminish market supply and there would be no initial grain price impact. Initial stocks should be set at a level halfway between zero and the capacity constraint, so that the capacity constraint and the constraint of stocks on hand represent equal bounds on either side of the average stock held. Thus, random price fluctuations from equilibrium price would be expected to call forth releases and acquisitions of grain of approximately equal amounts, and there would be no bias towards either acquisition or release of grain. Only equilibrium (or trend) prices would be maintained.

One other aspect of price maintenance is important. When the buffer stock is designed to follow a particular price trend, some rule for this must be specified in the simulation. Usually this rule has been based on a forecasted price trend, where the trend was obtained by simulating the grain model over the future period in the absence of buffer stock operations and stochastic error terms, or in some similar way. (When simulation over a historical period was used, the actual price trend was used.) The problem is that the rule depicts a "clairvoyant" buffer stock; that is, one able to forecast quite precisely the market trends in prices. Certainly this is unrealistic, and makes for a more effective and less costly buffer stock than might be the case in the real world. It is helpful therefore when alternative rules are tested and compared with the "clairvoyant" operation. One such example is the so called "groping" buffer stock, where the buffer stock authority follows a rule which respecifies the price band in accordance with observed consecutive prices in the buffer stock simulation. Presumably a real world buffer stock authority would have more information than depicted in the "groping" model but less than in the "clairvoyant" type, and actual effectiveness (and costs) might fall in between. Greater real world management flexibility might increase effectiveness as well.

REVIEW OF THE LITERATURE

Cochrane and Danin (1976)

Cochrane and Danin presented a quantitative analysis of an international grain reserve designed to bring reasonable stability to world grain prices. The model is a very simple one, and is highly aggregated both by grain and by countries. It is, according to the authors, not designed to yield unique solutions but to merely illustrate procedures and give estimates that suggest possible magnitudes of the grain reserve problem. Two models, an aggregated world grain model and a U.S. wheat model, were formulated. Attention here will focus on the world model. This model includes a world demand and supply function, and international price is determined by the intersection of these two curves. No econometric work was used to estimate model parameters; instead the specific parameters chosen were based on estimates commonly used in the literature. The demand function is assumed to be nonstochastic and linear, where demand is responsive to current price. Two alternative demand price elasticities of -0.1 and -0.2 are assumed in different runs of the model. The supply function (world grain production) is assumed stochastic, completely price inelastic, and incorporates a growth trend. This trend reflects a constant annual rate of approximately three percent. This rate was estimated on the basis of a logarithmic trend which was fitted to the observations of world grain production for the period 1950-1973. The probability distribution of production is assumed to be normal. The variance of it is estimated using the fluctuations around the trend. Finally, there is no consideration of private stockholding behavior in the model.

The model is simulated over the period 1975-1985. Random disturbances of the supply equation are generated from their probability distribution and plugged into the simulation model. For each value of the disturbance, the model generates an equilibrium price. The probability distribution of the disturbances is thus translated into a probability distribution of prices. This latter distribution is called the free market price distribution. A series of target prices for the years 1975 to 1985 is defined to be equal to the mean equilibrium prices, which are normalized to equal 100. The boundaries are then defined in relation to the target prices of 100.

Various reserve stock decision rules are applied to the free market model, and new probability distributions of prices generated. A bounded price rule is used, requiring that whenever market price falls below the lower bound of the price stabilization range, supplies must be acquired by the stock in sufficient quantities to hold the price at the lower boundary. Whenever the price rises above the upper boundary, supplies must be released, to the extent that they exist, to hold the price at the upper boundary. (Note that various other rules were investigated in an earlier version of this work -- see Cochrane and Danin, 1976.) Since the model forces the buffer stock to follow a specified price band, it implicitly assumes the "clairvoyant" type of operation. No capacity limits are assumed for the buffer stock, and initial stocks are set (initially) at zero.

Assuming a price band of plus or minus ten percent of target price and demand elasticity of -0.1, the model indicates that price variation around the target price is reduced to 15.4 percent in 1975 with buffer stock operations, and it remains at this approximate level through 1985. The probability of the international price staying within the plus or minus ten percent of target range increases from approximately 65 percent in 1975 to about 81 percent in 1980 and 85 percent in 1985. The average reserve stock held in a particular year increases from about 9 million metric tons (mmt.) in 1975 to 57 mmt. in 1985 (about 3.2 percent of world grain production).

As one would expect, use of a wider price band (plus or minus twenty percent of target price) achieves less in the way of price stabilization, and use of a narrower band (plus ten percent and minus five percent of target price) achieves more. (For example, variation around the target price is reduced to approximately 19 percent by 1985 with the plus or minus twenty percent rule, compared to 12 percent with the plus ten and minus five percent rule, 14 percent with the plus or minus ten percent rule, and 27 percent with the free market.) With use of the narrowest band, however, the costs naturally go up. The average reserve stock held under this band approximates 73 mmt. in 1985 compared with average reserve stocks of 39 mmt. under the plus or minus twenty percent rule (and 57 mmt. under the plus or minus ten percent rule). Cochrane and Danin conclude that while it is very difficult to reduce annual price variations around the target price of 100 below ten percent, given the assumptions above, a price band which is carefully specified (such as the plus ten, minus five percent band) could permit a stabilization program to reduce annual variation around the target price to close to ten percent, with the average reserve stock approaching 75 mmt.

The researchers also experimented with positive beginning reserve stocks, with indications that this would substantially reduce early period price variation, but by 1980 and thereafter it would have no strong advantageous effect on price stability. And importantly, experimentation with a world demand price elasticity of -0.2 (as compared with -0.1) suggests that variation in price in both the free market and reserve stock situations is much lower (for example, free market price variation is cut approximately in half,) and stocks necessary to maintain any specified level of price stabilization are greatly reduced. Correct specification of demand elasticity clearly is very important for proper results. In light of this, as well as the simplicity of the model and limitations of the assumptions, one ought to be very cautious in using the results. However, the analysis does indeed present a general approach leading to further productive work on the reserve stock problem, as desired by these researchers.

Reutlinger (1976)

Reutlinger prepared a highly aggregated model of the world wheat market and simulated world buffer stock activity for a period of thirty years. As in the previous model, he analyzed the stabilizing effects of the stock (though attention is focused on quantities rather than prices), and in addition he computed various gains and losses associated with this policy. His analysis was purposely kept simple, and he acknowledges that limitations include the world level of aggregation and implicit assumption of free trade, and the assumption of unchanging demand and supply curves over time. Additional limitations include the model's consideration of wheat alone, no producer supply response to price, and the absence of private stockholding behavior.

World wheat production for each year is estimated by a random sample drawn independently from a known triangular probability distribution, with a mean value of 350 mmt., and varying in the range of 314 to 386 mmt. The mean value roughly corresponds with the trend value of production in 1972-73, and the interval on either side of the mean corresponds to approximately 2.5 standard deviations, the value of which (14 mmt.) was estimated on the basis of past deviations about the long-run trend in world wheat production.

International price is determined for each year on the basis of a simplified, nonstochastic world demand curve for wheat set equal to world supply. This demand curve is kinked at the point of mean world production, and parameter values of the two linear segments are specified to give a lower price elasticity in the range of short supplies than in the range of large supplies. There appears to be some empirical and theoretical justification for this. Under certain circumstances, private forms and governments may choose to accumulate inventories when supplies are short. For example, governments often attempt to maintain consumption levels of the poorest segments of the population when supplies are low, through increased purchases and distribution of food grains on concessional terms. Consequently, the price rises sharply in the face of reduced supplies. On the other hand, when supplies are abundant and the price comes within the range where it is profitable to use wheat as livestock feed, this additional demand tends to increase demand elasticity.[6] An average demand price elasticity of -0.24 is assumed at the midpoint of the segment corresponding to long supplies, and an elasticity of -0.15 is assumed at the midpoint of the segment for short supplies.

A quantity band is used to trigger storage and release activity, with Rule A requiring any wheat produced in excess of 355 mmt. to be stored and any amount produced less than 345 mmt. to call forth release from the stock of the amount of the difference. Rule B uses an upper bound of 355 mmt., but a lower bound of 335 mmt. Various storage capacities are specified, ranging from 5 to 30 mmt. Constraints on buffer activity are that storage of excess production can proceed only up to the physical capacity limit, and grain cannot be released in excess of the amount previously stored. Initial stocks are set equal to zero. As in the Cochrane and Danin analysis, a "clairvoyant" buffer stock operation is implicitly assumed.

The simulation experiments result in probability distributions of world consumption levels and prices associated with different levels of storage capacity. The financial (or storage operator's) costs and revenue, as well as producer and consumer gains and losses are calculated for each year in the thirty year period with and without the buffer stock operations. Net financial benefits include buffer stock net revenue (the difference between the market value us grain sold and bought by the buffer stock authority), plus the value of end stocks, minus variable storage costs (loading and unloading, pest control, and electricity), and investment in storage silos. Producers' gains and losses are measured as changes in producer revenue; i.e., as quantity sold times the difference in price in the buffer stock and free market situations. Consumer gains and losses are measured in terms of consumer surplus. Net economic benefits are calculated as the total of net financial, producer, and consumer benefits. Present values of the discounted streams of the various costs and benefits are calculated, and the expected present values of these costs and benefits tabulated.

Reutlinger's results include the following: The probability of extreme price variability and consumption shortfall is reduced with operation of the buffer stock, with Rule B faring better than Rule A, and additional increments of storage capacity resulting in diminishing marginal reductions in the probability of consumption shortfalls. Extreme shortfalls (quantity less than 324 mmt.) occur with a 1.2 percent probability with Rule A and a 20 mmt. capacity, and a 0.5 percent probability with Rule B and the same capacity, as compared to a 3.9 percent probability without storage. Increasing the storage capacity to 30 mmt. reduces this probability to 0.9 percent with Rule A and maintains the 0.5 percent probability with Rule B. Median range consumption levels (332-359 mmt.) occur with much greater probability under both rules and all storage capacities when compared to the non-storage situation (a range of 70.1 to 85.2 percent probability with storage compared to 57.7 percent without storage). However, Reutlinger argues that the risks of moderately large shortfalls are still severe. That is, a shortage of 18 to 26 mmt. (5.1 to 7.4 percent of the mean) could occur with a 5.7 percent probability under Rule A with a 20 mmt capacity, and 4.6 percent probability with a 30 mmt. capacity, though the probability is decreased by using Rule B.

Correspondingly, prices are kept in the median range of $115 to $188 per metric ton (where the price of mean output 350 mmt. is $125 per metric ton) with a probability ranging from 70.1 percent to 85.2 percent, depending on the rule, and increasing as capacity is increased. This compares with the 57.7 percent probability when no stocks are simulated.

Net financial benefits are always negative; i.e., the costs of the operation always outweigh any net revenue received by the storage operator. In all situations, the expected present value of net economic benefits is very low or negative, and rapidly declines beyond initial low levels of capacity. Hence Reutlinger concludes that any stock levels which are optimal to society in terms of economic costs and benefits are likely to be too small to afford a satisfactory price or consumption stability. In addition to the costs of increasingly large stock levels, gains and losses become seriously imbalanced in favor of consumers and against producers as stock capacities are increased, which is seen by Reutlinger as a possible political deterrent to their implementation.

Reutlinger cautions that all of the results could be strongly affected by the elasticities assumed for the different segments of the demand curve, neither of which could be specified reliably. Sensitivity anaylsis with altered demand elasticities indicates that economic and financial benefits are very sensitive to the specification, though implications for price and consumption stability are not reported.

Behrman (1977)

Behrman presented a study whereby he simulated buffer stock operations for each of the wheat and rice markets, individually, based on models developed for these markets by Behrman and Adams (1976).[7] These models are aggregated at a level of three regions: Developed Countries, Less Developed Countries, and Centrally Planned Countries. Free trade is assumed and a single international price is used in each model, thereby ignoring differences in prices within and between countries due to policy, transport costs, and so on. Each model includes, for each region, an econometrically derived equation for supply as a function of current and lagged deflated prices and time; and for demand per capita as a function of current and lagged deflated prices, income per capita, domestic production per capita, and time. An additional equation is estimated whereby price is expressed as a function of various variables, including lagged demand for stocks as a percentage of world consumption demand, time, and imports to the Centrally Planned Countries. Aside from this equation, private stockholding behavior is not explicitly modeled.

Using these models, Behrman employs nonstochastic simulation to replay the historical period 1963 to 1972, but as if buffer stocks were in operation to stabilize prices. Alternative price bands of plus or minus five and fifteen percent of the known secular trends in real prices for the 1950 to 1975 period are used to simulate buffer stock storage and release operations. Behrman points out that since the buffer stock follows a known price trend, the simulated costs of stockholding are reduced from what they would be if real world errors were made in determining the trend. That is, he recognizes the problems inherent in the "clairvoyant" buffer stock operation. Finally, it is assumed that the buffer stock always operates with sufficient funds, capacity, and stocks (including initial stocks) to maintain real prices within the bands.

Simulated results are compared for various buffer stock operations and the non-buffer stock situation. Results are tabulated for the buffer stock grains (revenue from sale of stocks minus expenditures for purchase of stocks, minus all transaction and storage costs and the present discounted value of initial stocks at actual average 1973 prices). Also reported are costs and benefits to producers in terms of changes in levels of producer revenue, as well as the stability of this revenue. The results include the following: The increase in the present discounted value of real producer revenue for the ten year period (in millions of 1975 U.S. dollars) ranges from $29,866 to $35,897 (depending upon use of a five or a two percent real discount rate) for the plus or minus five percent price band, and $0 for the plus or minus fifteen percent price band in the wheat model. In the rice model, this increase ranges from $75,607 to $91,729 (depending on the rate of discount) for the plus or minus five percent band, and $33,440 to $43,327 for the plus or minus fifteen percent band. These large producer revenue increases are partially the result, however, merely of increased prices over the period due to the buffer stock operations. The mean percentage changes in price between the buffer stock and non-buffer stock situations are 9.0 and 0.1 for the plus or minus five percent and fifteen percent price bands, respectively, in the wheat model; and 21.5 and 11.1 for the same respective price bands in the rice model. The fact that the buffer stocks are raising prices is an implication quite apart from the role of buffer stocks in stabilizing prices.

The ratio of real producer revenue standard deviations (used to measure stability of revenue) in the buffer stock versus non-buffer stock simulations is 2.2 with the plus or minus five percent price band and 0.9 with the plus or minus fifteen percent band in the wheat model. In the rice model, the ratios are 0.8 and 1.0, respectively. Thus, it is not clear that producer revenue stability will be increased with buffer stock operations; indeed in the wheat model it may be substantially reduced.

Finally, the maximum sizes of the buffer stocks held range from 12 to 150 mmt. for wheat (for the plus or minus fifteen and five percent bands, respectively), and 16 to 38 mmt. for rice (for the same bands, resectively). The present discounted values (over the period) of buffer stock net costs, in 1975 U.S. dollars, range from $14 to $15 billion (depending on the discount rate used, and including the value of end stocks) for the plus or minus five percent band and -$2 to $2 billion for the plus or minus fifteen percent band in the wheat model. Values range from $2 to $3 billion for the plus or minus fifteen percent band in the rice model. These costs are larger if the value of end stocks is not included, and Behrman points out that the value of end stocks is probably overestimated.

Despite some of the limitations of the models and simulations, the study sheds greater light on the issues involved in buffer stock operations and analysis of their implications. Particular attention in the study was focused on discovering possible mutual benefits to developing and industrialized countries from commodity agreements.

Sarris (1976) and Abbot (1976)

Sarris presented a comprehensive model of the world wheat market and simulated world buffer stock activity for a period of twenty years. His model takes explicit account of trade restrictions, transport costs and price mark-up, the effects of domestic policies, and producer supply response to price. It is disaggregated into nineteen regions and countries, with excess demand (net import) functions estimated for all of these, and a domestic demand and supply function estimated for most countries. Domestic production depends on previous year domestic prices, and the function includes a growth trend reflecting changes in technology and a random disturbance term to reflect unpredictable variations in production. Domestic demand is a function of current domestic prices, defined in such a way that the price elasticity of demand decreases at higher wheat prices. A growth demand entails no separate random element, it is assumed to vary according to random domestic production fluctuation (on the assumption that producers' incomes, and thus consumption, vary with production; and that market segmentation and other imperfections, particularly in less developed countries, result in some shift in demand in accordance with domestic production shifts). Finally, international price is determined by setting the sum of the excess demand equations equal to zero, where excess demand for each country or region is a nonlinear function of international price, a growth factor, and a shift response to domestic production fluctuation from trend (on the assumption that not all domestic production shortfalls are made up by imports, expecially in developing and centrally planned countries).[8] All equations are estimated econometrically, though some parameters are assumed rather than estimated in certain circumstances. Private and domestic government stockholding behavior is not modeled.

Buffer stock storage capacity is set at 15 mmt., and initial stocks at zero. A price band is used to trigger storage and release activity, with a lower bound of $108.9 per metric ton calling for storage and an upper bound of $108.0 per metric ton indicating release activity. Since buffer stock activity follows a forecasted trend, a "clairvoyant" operation is implicitly assumed. The model is normalized to base year 1974 numbers, and base year equilibrium international price is assumed to be $140.0 per metric ton. Gains and losses to consumers are calculated using consumer surplus measures, while gains and losses to producers are measured as the change in revenue received by them. Net foreign exchange savings are also computed.

All of these gains and losses are tabulated as simple sums over the simulated twenty-year period. Thus benefits and losses to individual countries and regions are determined explicitly with this model. Gains and losses to the buffer stock authority are computed as well. There is no boundary condition on the amount of existing stocks at the end of the simulations, so the buffer stock authority can (and does) end up with some stock. This stock is valued at the equilibrium price in that year.

Simulation results include the following: Reduction in price variability is quite substantial, of an order of 35 percent reduction after the first five or six years of operation. Price variation here is defined as the standard deviation around the mean international wheat price, over 200 simulation runs for each year of the simulation period. The maximum average stock carried over from year-to-year (where this average is over the 200 runs) is about 11 mmt. The buffer stock itself experiences net losses, where gains are defined as revenue acquired from the sale of stocks plus the value of end stocks, minus expenditures made on the purchase of stocks and storage and operating costs. These net losses amount to $58.2 million (undiscounted) over the twenty-year period. Producers in all countries on average lose from the scheme, while consumers in most exporting countries gain (using the consumer surplus measures). However, only in India and Argentina do less developed country consumers stand to gain, using these same measures. All of these gains and losses are generally quite small however. All individual countries and regions for which consumer surplus and producer revenue are calculated experience net losses when consumer and producer net losses are added. Average consumption is slightly lower with the reserve for all individual countries, but there is also lower variation in consumption, indicating a reduced risk of severe food deprivation. (Here again, variation is defined as the standard deviation around the mean, over the 200 simulation runs for each year of the simulation period. Consumption here actually refers to the difference between actual and trend consumption.)

Most importing less developed countries save on foreign exchange, to the amount of $440 million total over the twenty-year period. There are also substantial foreign exchange gains to the Soviet Union and Argentina, and losses to the United States, Canada, Australia, and Eastern Europe. All of these foreign exchange gains and losses are small though, when evaluated as a percentage of total trade expenditures (all are less than 6.0 percent of total trade expenditure over the twenty-year period simulation). The Soviet Union is the largest net beneficiary of the scheme, while the United States is the largest net loser.

On the basis of these results, Sarris concludes that some positive effects of the buffer stock operation include the large reduction in price variation, and specifically for less developed countries, some foreign exchange savings and reduced consumption variation. However, he suggests that the international reserve will do relatively little to the internal markets of developing countries because these markets are so tightly controlled by governments and do not respond substantially to price fluctuations. In this regard, it is particularly important that the parameters of the less developed country and region equations be realistic, and it is helpful that Sarris includes some sensitivity testing of his model. When all domestic and trade elasticity values are arbitrarily cut in half, simulation results show much greater price variations in both buffer stock and non-buffer stock runs, as would be expected. One would also expect individual country consumption variation to critically hinge on specification of these parameters (though these results are not reported).

Finally, Sarris also experimented with alternative stock capacities and price bands for buffer stock operation, and models with alternative forms of trade liberalization. As expected, narrower bands and larger capacities, as well as trade liberalization, reduce price and consumption variation.

* * *

Abbott constructed a wheat and feedgrains model which is quite similar in many respects to the Sarris wheat model. While the country groupings and data base are different, the excess demand equations exhibit the same degree of sophistication as in the Sarris model, and domestic policies and transport costs are incorporated in a similar manner. (Indeed, some of Abbott's work provided a basis for the Sarris model.)

The Abbott feedgrains model was simulated, and is discussed in Sarris, Abbott, and Taylor (1979). With a 10 mmt. capacity, and two alternative price bands centered around the equilibrium price of $110 per metric ton (the upper bounds are $120 and $130 per metric ton respectively), the feedgrains model was found to produce results quite different from the Sarris wheat model. In particular, price variation is reduced only moderately (about 5 to 8 percent under the different bands).[9] Sarris _et al._, argue that the feedgrains market is inherently more stable than the wheat market, and hence there is less room for price fluctuation reduction. Average buffer stock holdings over the period are quite small, about 5 mmt. early in the period and increasing gradually over time. The buffer stock experiences net financial losses ranging from $368 to $520 million (undiscounted) over the twenty-year period. Exporting countries generally gain in foreign exchange savings, while producers in importing countries generally lose. Consumers in all countries generally lose (using consumer surplus measures), though some less developed country consumers do gain. As in the Sarris model, these gains and losses are generally quite small.

In conclusion, Sarris _et al._ argue that only a relatively small reserve scheme should be recommended for feedgrains. Since stabilization in the Sarris wheat model tends to benefit importing countries, while stabilization in the Abbott feedgrains model benefits exporting countries, the two reserve schemes might be sold (politically) as a package. The two buffer stocks functioning together could be expected to generate both benefits and costs to all parties, whereas specific countries would be favored by either one operating alone. (The analysis never explicitly takes into account the interdependencies among the two grain markets, and thus cannot discern the effects of stabilization in one market upon the other market. Indeed, the authors explicitly assume there is little or no interaction among the two markets.) In both Sarris (1976) and Sarris _et al._ (1979), much attention is focused on the needs of less developed countries and how a reserve and other policy measures might benefit such countries.

Zwart and Meilke (1979)

Zwart and Meilke published a summary of their work modeling an international wheat buffer stock, based on a wheat model previously constructed by Zwart (1977). Their work is intended to demonstrate that most countries in the world wheat market have domestic policies which destabilize the world market, and that either buffer stock operations or modifications in domestic policies can bring about stabilization of the international market. Only the buffer stock operations will be discussed here. The model represents seventeen countries and regions, for which "derived" demand and supply equations are estimated. That is, individual country demand and supply are expressed as functions of a single international price (instead of domestic prices), and are intended to summarize domestic demand and supply responses to domestic prices and policies, and these domestic price and policy responses to international price. The fact that these derived elasticity values are substantially smaller than published values for domestic elasticities with respect to domestic prices might indicate that individual countries enact policies which insulate domestic markets from international prices. Private stock demand equations are also included for the large exporting countries to express the relation between their private stock levels, production levels, and international prices. (As previously, "private stocks" refer to private and government held stocks, as opposed to stocks held by the buffer stock.) The model is thus relatively simple, but incorporates more complexity and disaggregation than many of the previous models. The model is limited by its focus on wheat alone.

The model is simulated over the period 1976 to 1990. Stochastic simulation is used, with random drawings for the supply and demand disturbances. Results are averaged for 50 free market (i.e., non-buffer stock) runs, and 50 buffer stock runs. In the buffer stock simulations, it is assumed that initial buffer stocks are set at 40 mmt. of wheat, while private stocks are set at working stock levels (expressed as a fixed proportion of current production levels). The buffer stock storage rule is expressed as an equation,

$$DS_t = \alpha - \delta PW_t + \beta T,$$

where DS_t is the closing level of world buffer stocks in period t, PW_t is the world price of wheat in t, and βT is an intercept shift factor (where T is time). The value of δ is arbitrarily set at 2.5, which represents the change in wheat buffer stocks per unit change in world price. The α and β parameters were calculated from the growth and price levels in the free market simulation in an attempt to maintain an expected world buffer stock level of 40 mmt. (The βT term was necessary to account for the fact that the expected free market price rises over time and would otherwise result in depletion of the buffer stock.)

One major result of the model is that while the expected values of most relevant variables vary only marginally between the free market and buffer stock runs, the average standard deviations of these variables are reduced quite substantially with operation of the stock. (Here, standard deviations refer to yearly fluctuations across simulations, and not over time.) In particular, the average standard deviation of the international wheat price is reduced by about 88 percent with operation of the buffer stock. Total world production and consumption average standard deviations (with standard deviations measured similarly as above) are reduced by about 27 percent and 10 percent respectively. The reduction in the average standard deviations of production, consumption, and trade values for individual countries and regions vary substanitally, presumably depending on the extent to which domestic markets are insulated from international prices (with less insulation resulting in greater reductions). The average size of buffer stocks held increases over time from the initial 40 mmt., and the standard deviation of the stocks held in the buffer is 17.2 mmt. World instability, according to Zwart and Meilke, is in effect replaced by instability of buffer stock profits and losses. The expected value of annual storage costs is $596 million, with a standard deviation of $333 million; and the expected value of annual revenue loss (the expenditure on purchases minus revenue from sales) is $172 million, with a standard deviation of $1,423 million. Total annual expected buffer stock costs therfore equal $768 million. Zwart and Meilke contend that some of these buffer stock costs occur due to rising prices over the simulation period (more so than in the free market simulations), and that if the time shift factor in the buffer stock storage rule (βT) were specified more carefully, this would not result. In this regard, Zwart and Meilke also caution that failure to specify the buffer stock rule very carefully can result in undesirable revenue transfers between countries, due to changes in price trends and individual country and region trends in trade.

Brux (1984)

Following the lead of Sarris (1976) and Abbott (1976), Brux presented a comprehensive model of the world grain markets. This model is broken down into seven countries and regions for which a detailed set of supply curves, and in most cases demand curves, is specified. These curves are expressed respectively as functions of domestic supply and demand prices (where possible), and relationships between these prices and international ones are specified. Divergence between producer prices, consumer prices, and international prices expresses the impact of domestic and trade policy interference, as well as shipping and handling costs. The equations which relate these prices to each other express the degree to which the free market is impeded. Supply response is formulated with a Nerlovian distributed lag which is more appropriate than a simple one-year price lag.[10] The seven countries and regions represent countries with principal impact on the determination of international grain prices, due to their considerable role in world grain production and trade. The rest of the world is appropriately grouped into the Less Developed Region and the Centrally Planned Region. Individual demand and supply functions for these regions are expressed in terms of international prices, where appropriate.

The Brux model adds sophistication to the literature in a couple of different respects. First, the model disaggregates into three categories of grain: wheat, rice, and the coarse grains. Equations are expressed for each of these, and include cross price elasticities to show the relationships between the various grain categories. Secondly, equations for sales from net private stocks (government and private) reflect the degree to which private stocks respond to variation in international price, demand, and supply. Because of its size and complexity, the model is not econometric in the generation of all of its parameters however. Notably, the supply and demand elasticities and the coefficients for the distributed lag in supply are assumed or obtained from the literature. Some of the parameters in the private stock equations are adjusted as well in order to provide stability in the overall model to a degree which better approximates reality.

Alternative storage capacities are assumed, and range from 40 mmt. each of wheat, rice, and coarse grain, to 100 mmt. each of wheat and coarse grain and 40 mmt. of rice. Initial stocks are always set at a level of one-half of capacity. Alternative price bands of plus or minus fifteen, twenty, and thirty percent of trend are used to trigger buffer activity. Use of such price trends represents a "clairvoyant" buffer stock; that is, one which is able to forecast quite precisely the market trends in prices. Two alternative rules are used to represent a "groping" buffer stock; that is, one which is not able to forecast the market trends in prices, but which discovers them as time goes on.

The model is fitted to base year 1977 data, and is simulated both with and without buffer stocks for the ten year period 1978 to 1987. Stochastic simulation is used, so that a value for the error term in each supply and demand equation in the model is drawn randomly from its estimated probability distribution. The simulation over the ten year period is repeated ten times for each buffer stock situation, with different drawings of the random numbers in each simulation. In order to facilitate accurate comparisons of the various buffer stock and non-buffer stock situations, the same set of random errors is drawn for each of the alternative situations. In addition to the basic grain model, alternative versions with altered elasticities in the Less Developed and Centrally Planned Regions, and with altered coefficients in the supply equations with distributed lags are used to test the sensitivity of the model to these parameters. Simulations are also run on an altered base year, to test the sensitivity of the model results to the choice of base year. And finally, a simulation experiment is performed with buffer stock operations for wheat and rice only, in order to test the notion that the interdependence of the wheat and coarse grains markets will have implications for stability and buffer stock effectiveness.

Results of the simulations are calculated as follows: The variation in international price over the simulation run is expressed as the standard deviation of international price over the period, averaged over all simulation runs in each buffer stock situation. The means and standard deviations of consumption and production over the run, averaged over all runs of each buffer stock situation, represent average consumption and production and the year-to-year variation in consumption and production. These calculations are made on a country and region basis for total grain, and a world basis for both individual and total grain. Consumer welfare is measured on a country and region basis as the discounted present value of consumer surplus, averaged over all simulations for each buffer stock situation; and producer welfare is measured similarly using procuder revenue. Country and region total net benefits are calculated as the sum of consumer surplus, producer revenue, and government revenue (where government revenue is relevant whenever the government imports and exports grain). Finally, buffer stock net financial benefits are calculated as the discounted present value of yearly net financial benefits i.e., revenue acquired from the sale of stocks minus expenditures for the purchase of stocks minus total annual costs of storage) plus the discounted present value of end stocks minus the value of beginning stocks.

Results include the following: First of all, it is clear that buffer stock operations are able to reduce international price variation substantially. The initial buffer stock policy, where initial stocks are set at 40 mmt. each of wheat and coarse grain and 20 mmt. of rice, and plus or minus twenty percent price bands following forescasted trends, performs quite well. The average standard deviation of international price is reduced by 34 percent for wheat, 52 percent for rice, and 23 percent for coarse grain from the free market (i.e., non-buffer stock) situation. By increasing the initial stocks of wheat and coarse grain from 40 mmt. to 50 mmt. each, price variation is reduced somewhat more (36 percent for wheat and 26 percent for coarse grain from the free market situation). Quite predictably, reducing the initial stock levels of wheat and coarse grain to 20 mmt. each results in less price variation reduction (23 percent for wheat and 16 percent for coarse grain).

When initial stocks are kept at the initial levels of 40 mmt. each of wheat and coarse grain and 20 mmt. of rice, but the price band is changed, results again are altered predictably. Narrowing the band to plus or minus fifteen percent of the forecasted trend results in the best overall performance in price variation reduction (with average standard deviations reduced by 34 percent for wheat, 58 percent for rice, and 26 percent for coarse grain from the free market situation). Widening the band to plus or minus thirty percent results in much smaller price variation reductions (19 percent for wheat, 39 percent for rice, and 13 percent for coarse grain). Finally, the buffer stock situations with "groping" rules for adjusting the price band perform substantially worse than comparable situations which center the price bands around forecasted trends. (For example, with initial stocks of 40 mmt. each of wheat and coarse grain and 20 mmt. of rice, and alternative "groping" rules to maintain a thirty percent price band, price variation reduction ranges from 13 percent for wheat, 25 to 28 percent for rice, and 7 to 10 percent for coarse grain.)

The impact of buffer stock operations on mean demand and mean supply over the simulation period is very small. Variations in demand and supply are reduced by buffer stock operations however. When price bands are set at fifteen percent of forecasted trend and initial stocks are 40 mmt. each of wheat and coarse grain and 20 mmt. of rice (i.e., the best buffer stock situation in terms of price variation reduction), reduction in average standard deviation of demand ranges from about 15 to 17 percent for total grain in the various developed countries and regions, 10 percent for the Less Developed Region, and 12 percent for the Centrally Planned Region. At a world level, the average standard deviation of demand is reduced by about 16 percent for wheat, 9 percent for coarse grain, and less than a percentage point for rice. Variation in grain supply is reduced by about 12 and 14 percent respectively for the Less Developed and Centrally Planned Regions, and 6 percent for the total developed countries and regions. Average standard deviation of world total grain supply is reduced by 7 percent, with a range of about 5 percent reduction for coarse grain to 15 percent reduction for wheat.

Results indicate that buffer stock operations have very small impacts on the average welfare measures of consumer surplus, producer revenue, and government revenue. These average values rarely differ by more than a few percentage points at most between the various non-buffer stock and buffer stock situations. Buffer stock net financial benefits are positive, indicating profitable operations. The standard deviations about the average values are very large, however, so that in any one simulation run they could well be negative.

Results of the sensitivity analysis are particularly helpful. Indeed, since many of the model's parameters were chosen on the basis of a combination of published econometric studies and personal judgements, they cannot be viewed as precise figures. Sensitivity results in Brux (1984) and further results in the appendix which follows suggests that the model is very sensitive to specification of the Nerlovian coefficients in the supply equations, and the parameters of the Less Developed and Centrally Planned Regions. International price variation changes somewhat when the parameters change (of an order ranging from about 00 to 34 percent for the various grains in the non-buffer stock situation), and price variation reduction between buffer stock situations and the non-buffer stock situation changes as well. When the base year for simulation is altered, results also vary, though generally by smaller magnitudes.

Finally, the simulation experiment with operation of wheat and rice buffer stocks alone (without a coarse grain buffer stock) confirms the expectation that interdependence among the wheat and coarse grain markets does indeed have some effect. Specifically, operation of a wheat and rice buffer stock alone serves to stabilize the coarse grain market a little; and absence of the course grain buffer stock renders the wheat buffer stock slightly less effective in stabilizing wheat prices than before. Brux concludes that if these results can be generalized to other models and to the real world, they indicate that careful consideration of this interdependence among the grain markets must be made when establishing buffer stock policy.

SUMMARY OF CONCLUSIONS

It is difficult to compare the results of the various models directly, because of the important differences between the models, and because of the different ways of reporting the results. However, some general conclusions and comparisons are in order.

First, it is clear that price variation can be reduced by buffer stock operations, though the necessary levels of reserve stocks are less apparent. Several of the models report price variation as the standard deviation around the mean price, for a particular year, over all of the simulation runs. Of these, Sarris reports a reduction in price variation each year of an order of about 35 percent after the first five or six years of operation, and Cochrane and Danin report reductions in a range of 30 to 56 percent (depending on buffer stock rules of operation) by the tenth year of operation. Zwart and Meilke report an average yearly reduction in price variation of about 88 percent over the fifteen years of operation. The maximum average yearly stock held in the Sarris model is about 11 mmt., and average stocks held in the tenth year of operation in the Cochrane and Danin model range from about 39 to 73 mmt. (again depending on buffer stock rules of operation). The average level of buffer stocks held in the Zwart and Meilke model increases over time from the initial level of 40 mmt. The models are not directly comparable, however, because the Cochrane and Danin model includes all grains while the Sarris model and the Zwart and Meilke model include only wheat. To stabilize the entire grain market, one would presumably need larger buffer stock reserves. Price variation reduction in the Abbott feedgrains model (defined similarly as in the models above) is much smaller than the previous models, ranging from about 5 to 8 percent with the different rules of operation. Average reserve stock holdings over the period are also relatively small.

Defining price variation as the average standard deviation of price over time (i.e., the standard deviation around mean price over the ten-year simulation period, averaged over all simulation runs), the Brux wheat, rice, and coarse grain model also indicates substantial price variation reduction. Results depend upon the parameters of the buffer stock operation, notably the size of initial stocks, the price band, and the method chosen to maintain the band around the appropriate price trend. As one would expect, larger initial stocks and narrower price bands, both in the context of a rule which maintains the band around a specified, forecasted price trend, result in the greatest reduction of international grain price variation. In particular, such a buffer stock situation with initial stocks set at 40 mmt. each of wheat and coarse grain and 20 mmt. of rice (and capacities at 80 mmt. each of wheat and coarse grain and 40 mmt of rice), and price bands set at plus or minus fifteen percent of forecasted price trends, results in substantial price fluctuation reduction (to the tune of an average standard deviation reduction over the period of 34 percent for wheat, 58 percent for rice, and 26 percent for coarse grain from the free market situation). To the extent that actual price trends cannot be accurately forecasted, and buffer stock operators instead use relatively inefficient rules to attempt to discover such trends, buffer stock success in reducing price instability is greatly diminished.

Finally, while not reporting actual levels of price variation or variation reduction, the Reutlinger and Behrman models indicate that prices can be kept within desired ranges with substantially greater probability with buffer stock operation than without. Buffer stock capacity is limited to a maximum of 30 mmt. of wheat in the Reutlinger model, and maximum sizes ranging from 12 to 150 mmt. of wheat and 16 to 38 mmt. of rice in the Behrman models.

A reduction in price instability is largely irrelevant unless translated into real measures affecting people in their capacities as producers and consumers. In this regard, it is important to know whether average consumption and production are affected by the operations; and more importantly here, how buffer stock activities affect the stability of demand and supply. Since the parameters of the various models' demand and supply equations generally remain constant, regardless of levels or stability of prices, and since buffer stock operations are ideally designed to maintain price trends which approxiamate the free market situation, one would not expect average demand and supply to vary dramatically between the various models. Usually, they do not. The stability of demand and supply can be expected to change however. In all models, consumption and sometimes production instability is reduced. This is reported at an international level in the Reutlinger model as well as at the domestic and regional levels in the Sarris, Zwart and Meilke, and Brux models. Several analysts caution that the successes are limited however. Focusing on consumption, Reutlinger notes that the risks of moderate world consumption shortfalls are still severe despite operation of the buffer stock, and others aptly point out that reduction in consumption instability in individual countries and regions will depend on the degree to which domestic markets are insulated from international ones. Specifically, reduction in domestic consumption variation will be greater, the more responsive consumers are to domestic prices, and the more responsive these domestic prices are to international ones. Certainly correct specification of domestic demand is important here.

In terms of the traditional economic measures of welfare and the distribution of average welfare benefits between producers and consumers and between countries and regions, the results have generally been mixed. Average welfare benefits have typically been very small however. And finally, the financial costs of buffer stock operations vary considerably among the various models. Only in the Brux model is the buffer stock operation financially profitable. In other models, the buffer stock undergoes net financial losses. That is, any revenue gains the stock might achieve by selling at high prices and buying at low ones are offset by the operating and storage costs. This may sometimes be due to inappropriate buffer stock operation, however, specifically the net acquisition of stocks over time.

LIMITATIONS AND RECOMMENDATIONS

In addition to the simplifications already discussed, all of the models face further limitations. As a result, further caution is required in using the conclusions above.

In all simulations, the probability distributions of the disturbance terms (or of production) were assumed to be normal, with disturbances assumed both independent over time and between countries and regions. While the assumptions of normality may be appropriate, the other assumptions may not be. Particularly with respect to production, it may well be that there is correlation of the disturbances over time or between countries. If production is characterized by systematic cycles, for example, the stabilizing effects of any given stock level will actually be less than depicted by the models. (On the other hand, Reutlinger points out that if managers could predict such cycles with any degree of reliability, storage rules could be designed which would lead to higher benefits than are obtainable from storage rules appropriate to an environment of random independent fluctuations.) To the extent that production disturbances between countries and regions are positively correlated, real world price fluctuation would be more severe, and buffer stock efforts to stabilize prices would be less effective.

A much more serious consideration concerns the functional forms of the model equations and the values of their parameters. The theoretical literature suggests that welfare implications of stabilization may depend on the form of the equation (linear or nonlinear), the form of the disturbance (additive or multiplicative), and the nature of the supply response (what type of function of price). More importantly, the empirical literature cited here strongly indicates that stabilization results (i.e., variations in international prices) depend critically on elasticity and other parameters used in the models. And certainly with respect to individual country consumption and production stability, as well as welfare benefits, it is absolutely important to correctly specify domestic responses to appropriate prices.

Nevertheless, it is extremely difficult to correctly specify an ideally large and disaggregated model. In all such models here, assumptions had to be made on the functional forms, and simplifications had to be introduced. Data limitations are probably at the heart of many of the formulation difficulties. Ideally, a disaggregated model would have carefully specified demand and supply curves as functions of domestic consumer and producer prices, plus equations relating these curves or these prices to international ones. Government trade and domestic price policies would be explicitly modeled, and we could see exactly what the implications of stabilized international prices would be for governments, consumers, and producers. Unfortunately, the necessary price data (consumer, producer, and trade prices for a variety of grains) are not available for a large number of countries nor a sufficiently long estimation period. Furthermore, government policies change so frequently that a long estimation period may not ever be appropriate, and it may not be realistic to use such relationships to predict government policy over any future time period. Given these circumstances, price proxies and assumed elasticity values have frequently been used, calling into question the accuracy of results.

In this regard, it may even be preferable to use simplified equations (such as in the Zwart and Meilke model), whereby domestic demand and supply are specified as functions of international prices. Elasticities of demand and supply with respect to international prices would incorporate domestic government responses to international prices, and consumer and producer responses to domestic policy and prices. (To capture government efforts to tie domestic consumption to domestic production levels, consumption would need to be specified as a function of domestic production as well as international prices.) The flavor in individual country response would be lost, but accuracy of overall results perhaps enhanced, assuming that all parameter values were carefully estimated. As a result of changes in economic conditions over the estimation period, however, elasticity estimates of appropriate magnitude may be difficult to obtain. And, as in any forecasts, it cannot be assumed that the underlying behavior would continue unchanged over the future, particularly over a period of stabilized prices (the simulation period), as opposed to a period of unstabilized prices (the estimation period). For example, domestic government policy of producer behavior based on price expectations might well change in response to a more stable international market. (Risk averse producers may increase production under conditions of greater certainty perhaps.)

From a more global perspective, careful modeling is equally important. Since we are concerned with instability, we want the model to reasonably replicate actual instability in the absence of buffer stocks, and we want the sources of instability to be correctly modeled. Only in this manner can the effects of buffer stock operations be carefully traced through the model, with accurate final results. For example, to the extent that demand and supply tend to stabilize the international markets, through their responses to international prices, it is important that these elasticities be correctly specified. It is also important that their destabilizing impact (e.g., their stochastic disturbances), as well as any other destabilizing influences in the international markets, be correctly included in the model. This would presumably include disturbance terms in any other equations depicting price relationships, government policies, and so on. It is also essential that private stock behavior be correctly modeled as a function of price (and price variation), not only to measure the degree to which buffer stockholdings might substitute for private stockholding, but to carefully measure their stabilizing influences and changes in this influence.

In short, while a complex and disaggregated model is desirable, it is even more essential that the model be very carefully specified, particularly with regard to its own stabilizing influences and how these might change with operation of a buffer stock. Given the limitations of model construction and forecasting, it isn't entirely clear that such a model can be constructed to accurately predict the implications of an international buffer stock. Nor is it clear that the present models have reliably been able to do so. As a result, the results of all such buffer stock models must be cautiously interpreted.

* * *

Given these limitations, it would seem that even the most painstaking efforts and sophisticated models fall short of accurately portraying the international grain markets and effects of buffer stock operations. What then can be gained from these efforts?

Aside from the general directions and magnitudes indicated in the summary of conclusions, I would suggest that the benefits of these analyses lie not so much in their specific results, but in their contributions to the discussion of world food security. A number of events has turned some current thinking away from the concept of international buffer stocks, most notable the breakdown of discussions of the UNCTAD Conference on the International Wheat Agreement in February 1979. It is thought by many that failure to agree on a system of internationally-coordinated and nationally-held reserves in that forum demonstrated that it is politically impossible to agree on a buffer stock arrangement which considers the needs of less developed countries, but has the support of developed country producers. This line of reasoning, as well as a general judgement regarding the expense of holding physical stocks of grain, has led to arguments favoring greater reliance on liberalized trade and/or foreign exchange assistance in dealing with problems of world food insecurity. Attention has also turned to developing country initiatives in enhancing domestic production, reserves, and trade potential.

However, we are still left with a world grain market with tendencies toward large fluctuations in supply and demand and international prices. Politically determined domestic and trade policies enhance this instability. The international market does not assure that the needs of people will be met in times of crisis. Indeed, in the early 1970s, the whims of politicians and the market dictated that human beings in less developed countries would starve while livestock in the Soviet Union and Europe would eat. And there is no protection against a repeat of the panic buying and spiraling prices which occurred at that time.

The contribution of buffer stock analyses to the discussion of world food security lies then in their focus on price stability. Buffer stock analyses suggest that greater price stabilization can occur without undue costs. Results also suggest that widespread benefits can result, such that political impediments could perhaps be overcome. While price stabilizing buffer stocks are not the panacea for all world food problems, they do lend greater consumption and production stability to the world, including the less developed countries. The on-going discussion of world food security need not exclude other proposals for greater security, but rather all proposals should complement each other. Certainly, a more stable international grain market can enhance the efforts to achieve security through trade and foreign exchange assistance, as well as make easier food aid commitments among donors and domestic food policies among developing countries. Such discussions ought to continue, and can do so more intelligently in light of the economic analyses of bufferstocks of grain.

APPENDIX: RESULTS OF SENSITIVITY ANALYSIS IN THE BRUX MODEL

Results of the sensitivity testing of the Brux model are reported in Table 1. Price variation is expressed as the average standard deviation of international price, by grain and by model. Model 1 represents the free market (i.e., non-buffer stock) situation. Model 5 represents the buffer stock operation with initial stocks of 40 mmt. each of wheat and coarse grain and 20 mmt. of rice, and a plus or minus fifteen percent of forecasted trend price band. Model 7 represents buffer stock operations with initial stocks indentical to Model 5, but with a plus or minus thirty percent of discovered trend price band (i.e., a "groping" model). Each model in the absence of a superscript represents the standard model parameters simulated with base year 1977 data. Each model with a superscript "N" represents altered Nerlovian coefficients in the supply equations, simulated with base year 1977 data. A superscript "L" denotes altered Less Developed and Centrally Planned Region parameters in otherwise standard models simulated with base year 1977 data. Finally, a superscript "B" represents models with the standard parameters, but run with the altered base (an average of 1976 to 1978 data). In each case, the model is simulated ten times with different drawings of the random numbers. (In order to facilitate accurate comparisons, the same sets of random errors are drawn for each model and each set of simulations.) For additional information about the models and buffer stock operations, see Brux (1984).

A few comments on the results of sensitivity testing are in order. In the altered Nerlovian coefficient models, these coefficients were arbitrarily reduced by 25 percent. This would have the effect of reducing short-run supply elasticities with respect to price (as the Nerlovian coefficient equals the short-run elasticity divided by long-run elasticity), though the long-run elasticity would remain the same. One might therefore expect world price variation to be greater in the altered models, since producers would have price expectations based less on recent prices, or have less rapid adjustment of actual supply to desired supply, or both. Generally (though not always), results conform to this expectation. Certainly the effectiveness of buffer stock operations in reducing price variation differs substantially in the different situations. The results seem to be more reasonable for alterations of buffer stock Model 5 (the model most effective in reducing price variation) than for buffer stock Model 7.

The altered Less Developed and Centrally Planned Region equations are specified to represent less market-oriented situations (i.e., elasticities of demand and supply with respect to international price are generally smaller, and elasticities of demand with respect to regional supply generally larger). One might therefore expect greater instability of international prices under this alternative, as these two regions respond in a manner less stabilizing of international prices. Only in less than half of the results is this the case, however. And again, the effectiveness of buffer stock operations in reducing price variation differs substantially in the different situations. Here as well, Model 5 seems to operate more reasonably than Model 7.

Finally, note that changes in the base year for simulation also alter the results. To the extent that price variation and reductions in price variation through buffer stock operations change under any of these alternatives, one could reasonably expect other results to vary as well, particularly those relating to demand and supply variation and to reductions in this variation.

TABLE 1

STANDARD DEVIATION OF INTERNATIONAL PRICE[a] ALTERNATIVE MODELS, BY GRAIN, 1978 TO 1987

Model	Grain		
	Wheat	Rice	Coarse Grain
1	6.26 (2.72)	25.12 (9.85)	3.51 (0.59)
5	4.15 (34%) (2.71)	10.65 (58%) (2.24)	2.60 (26%) (0.69)
7	5.46 (13%) (1.76)	18.08 (28%) (4.11)	3.17 (10%) (0.59)
1^N	6.66 (2.96)	25.03 (9.75)	3.14 (0.80)
5^N	5.50 (17%) (4.47)	10.69 (57%) (2.25)	2.70 (14%) (1.07)
7^N	6.74 (-1%) (2.82)	18.10 (28%) (4.17)	2.99 (5%) (0.82)
1^L	4.42 (1.79)	24.04 (5.86)	3.20 (0.54)
5^L	4.26 (4%) (3.03)	19.74 (18%) (3.59)	2.62 (18%) (0.62)
7^L	4.64 (-5%) (2.23)	19.49 (19%) (5.34)	3.02 (6%) (0.51)
1^B	6.33 (3.04)	25.47 (11.13)	3.53 (0.62)
5^B	4.85 (23%) (3.87)	11.70 (54%) (3.55)	2.81 (20%) (0.89)
7^B	6.13 (3%) (2.75)	19.52 (23%) (5.41)	3.28 (7%) (0.87)

NOTE: [a]Standard deviation (SD) over the period, averaged over ten simulations of each model (with the SD about this average in parentheses below). In parentheses next to the average SD is the percentage reduction in the average SD between the free market model and the buffer stock model, defined as the average SD in the free market model, minus the average SD in the buffer stock model, all divided by the average SD in the free market model. Prices are in real U.S. dollars per one-hundred kilograms.

NOTES

[1] Richard Gilmore and Barbara Huddleston (1983) argue that these domestic policies spell instability for the international market in the European Community, where agricultural prices, supplies, and exports are artificially determined, and in Japan and the Soviet Union, where imports depend less on international prices than on domestic policies defining utilization requirements.

[2] A buffer stock is a reserve which provides a "buffer" against normal market or other sources of instability; that is, it generally releases its stocks when prices are high and supplies are low, and acquires stocks when prices are low and supplies are high. Thus prices and/or supplies can be stabilized within a desired band, depending on financing and reserve capacity constraints.

Note that buffer stock analyses with international models of rice only, such as that of Chaipravat (1978), are not reviewed here.

[3] Note that the concept of free trade as it is used here implicitly assumes an absence of domestic policy interference with the market.

[4] In the cobweb model, it is assumed that a lagged response to surpluses and shortages prevents smooth adjustment of prices to market-clearing levels. If the long-run elasticity supply is greater than the long-run elasticity of demand, price fluctuations widen in a cobweb fashion.

Other considerations on supply response and price fluctuation are relevant as well. If, for example, producers cut acreage after a year when prices are low, but unanticipated drops in yield further reduce supply (due to poor weather, for example), then supplies may be more unstable than if acreage does not respond to price.

[5] It is implicitly assumed that random fluctuations in production are symmetric, and that the buffer stock does not have goals other than merely price stabilization (for example, that it does not place a higher priority on prevention of large price increases than large price declines). If these are not the case, then net acquisition of stocks should not necessarily average to zero.

[6] For more discussion and empirical work on this issue, see Hillman, Johnson, and Gray (1975).

[7] Models were also created and simulated with buffer stocks for coffee, cocoa, tea, rubber, jute, sisal, copper, tin, wool, bauxite, and iron ore. Some of these models were intially developed by Agosín (1976) and Behrman (1975), as well as Behrman and Adams (1976).

[8] This may occur due to balance of payments problems in less developed countries and centrally planned countries, where governments do not want to devalue (for political reasons perhaps) and cannot easily borrow.

[9] Alternative capacity levels were also simulated, with the result that price variability is reduced only marginally (as in the Sarris model) with larger capacity levels.

[10] An example of a supply equation with a Nerlovian distributed lag is as follows, where t represents time:

$$S_t = B + bP^*_t + GT + V_t.$$

S is supply, v is the disturbance term, and P^*_t is the expected supply price in the current year, where

$$P^*_t - P^*_{t-1} = ß(P_{t-1} - P^*_{t-1}).$$

The rationale for this equation is that in each period, producers revise their notion of the "normal" (expected) price in proportion to the difference between the previous year's price and their previous idea of "normal" price. Alternatively, the model could assume static (naive) expectations, where the expected price in year t, or P^*_t, is equal to last year's price p_{t-1}, but where actual supply (or in Nerlove's model, actual area) is not equal to desired supply,(area). That is:

$$S^*_t = B + bP_{t-1} + GT + v_t.$$

where S^*_t is desired supply, and actual supply in year t, or S_t, is related to desired supply according to:

$$S_t - S_{t-1} = ß(S^*_t - S_{t-1}).$$

The rationale for this equation is that in each period, actual output is adjusted in proportion to the difference between the desired output and the previous actual output.

BIBLIOGRAPHY

Abbott, P.C. (1976). Developing Countries and International Grain Trade, Diss. Massachusettes Institute of Technology 1976. Cambridge: MIT, 1976.

Agosín, M. (1976). "Preliminary Econometric Models of Sisal, Iron Ore, Rubber, and Copper." New York, UNCTAD, 1976. (Draft.) Cited by J.R. Behrman, International Commodity Agreements: An Evaluation of the UNCTAD Integrated Commodity Program, p. 86 (footnote 51). Washington, DC.: Overseas Development Council, 1977.

Askari, H., and J.T. Cummings (1977). "Estimating Agricultural Supply Response with the Nerlove Model: A Survey." International Economic Review 18 (June 1977): 257-92.

Behrman, J.R. (1975). "Mini Models for Eleven International Commodity Markets." Philadelphia: University of Pennsylvania, 1975. (Report for UNCTAD.) Cited by J.R. Behrman, International Commodity Agreements: An Evaluation of the UNCTAD Integrated Commodity Program, p. 86 (footnote 51). Washington, D.C.: Overseas Development Council, 1977.

__________(1977). International Commodity Agreements: An Evaluation of the UNCTAD Intgrated Commodity Program. Washington, D.C.: Overseas Development Council, 1977.

__________ and F.G. Adams (1976). Econometric Models of World Agricultural Commodity Markets: Cocoa, Coffee, Tea, Wool, Cotton, Sugar, Wheat, Rice. Cambridge: Ballinger, 1976.

Brux, J.M. (1984). Econometric Analysis of Buffer Stocks to Stabilize the International Grain Markets, Diss. University of Michigan 1984. Ann Arbor: University Microfilms, 1984.

Chaipravat, O. "International Rice Buffer Stock Operations, A Simulation Study." In Stabilizing World Commodity Markets, edited by F.G. Adams and S. Klein. Lexington, Mass.: D.C. Health and Co., 1978, pp. 63-81.

Cochrane, W.W., and Y. Danin (1976). Reserve Stock Grain Models, The World and the United States, 1975-1985. Technical Bulletin 305, University of Minnesota Agriculture Station, 1976. Quoted in United States Department of Agriculture, Economic Research Service, Analyses of Grain Reserves, A Proceedings, p. 78. Economic Research Service Report No. 634. Washingtn, D.C.: Government Printing Office, August 1976. "Reserve Stock Grain Models and the World, 1975-1985", by W.W. Cochrane and Y. Danin, pp. 77-91.

Gilmore, R., and B. Huddelston (1983), "The Food Security Challenge." Food Policy (February 1983): 31-45.

Hillman, J., D.G. Johnson, and R. Gray (1975). Food Reserve Policies for World Food Security: A Consultant Study of Alternative Approaches (CSP/75/2). Rome: Food and Agriculture Organization of the United Nations, January 1975.

Houck, J.P., and M. Ryan (1979). Economic Research on International Grain Reserves: The State of Knowledge. Station Bulletin 532. St. Paul: Agricultural Experiment Station, University of Minnesota, 1979.

Just, R.E., E. Lutz, A. Schmitz, and S. Turnovsky (1978). "The Distribution of Welfare Gains: An Internatonal Perspective." Journal of International Economics 8 (1978): 551-63.

Massell, B.F. (1969). "Price Stabilization and Welfare." Quarterly Journal of Economics 83 (May 1969): 284-98.

Morrow, D.T. (1980). The Economics of International Stockholding of Wheat. Research Report No. 18. Washington, D.C.: International Food Policy Research Institute, September 1980.

Oi, W.Y. (1961). "The Desirability of Price Instability Under Perfect Competition." Econometrica 29 (January 1961): 58-64

Reutlinger, S. (1976). "A Simulation Model for Evaluating Worldwide Buffer Stocks of Wheat." American Journal of Agricultural Economics 58 (February 1976): 1-11.

Sarris, A.H. (1976). The Economics of International Grain Reserve Systems. Diss. Massachusettes Institute of Technology 1976. Cambridge: MIT, 1976.

__________, P.C. Abbott, and L. Taylor (1979). "Grain Reserves, Emergency Relief, and Food Aid". In Policy Alternatives for a New International Economic Order: An Economic Analysis, pp. 157-214. Edited by W.R. Cline, Overseas Development council. New York: Paeger, 1979.

Turnovsky, S.J. (1974). "Price Expectations and Welfare Gains from Price Stabilization". American Journal of Agricultural Economics 56 (November 1974): 706-16.

__________(1976). "The Distribution of Welfare Gains from Price Stabilization: The Case of Multiplicative Disturbances." International Economic Review 17 (February 1976): 133-48.

United States Department of Agriculture (USDA) (1978). Foreign Demand and Competition Division. Economics, Statistics, and Cooperatives Service. Alternative Futures for World Food in 1985. 3 vols. Washington, D.C.: Government Printing Office, 1978. Vol. 3: World GOL Model Structure and Equations, by A. Rojko, H. Fuchs, P. O'Brien, and D. Regier. Foreign Agricultural Economic Report No. 151 (June 1978).

_________(1985). Foreign Agricultural Service. Grains: World Grain Situation and Outlook. Foreign Agriculture Circular FG-6-85 (April 1985).

Valdés, A., and P. Konandreas (1981). "Assessing Food Insecurity in Developing Countries." In Food Security for Developing Countries. Edited by A. Valdés. Boulder, Colorado: Westview Press, 1981.

Waugh, F.V. (1944). "Does the Consumer Benefit from Price Instability?" Quarterly Journal of Economics 58 (1944): 602-14.

Zwart, A.C. (1977). "An Empirical Analysis of Alternative Stabilization Policies for the World Wheat Sector." Diss., University of Guelph, 1977. Cited by A.C. Zwart and K.D. Meilke, The Influence of Domestic Pricing Policies and Buffer Stocks in the World Wheat Industry", p. 439. American Journal of Agricultural Economics 61 (August 1979): 434-45.

_________and K.D. Meilke (1979). "The Influence of Domestic Pricing Policies and Buffer Stocks in the World Wheat Industry." American Journal of Agricultural Economics 61 (August 1979): 434-45.

The Center for Research
on Economic Development

at

The University of Michigan

PUBLICATIONS
October, 1987

General Publications Information

The Center for Research on Economic Development (CRED) issues four types of publications:

1. Newsletter. News of CRED activities and alumni, published periodically.
2. Special Publications. Including classroom materials for development courses, administrative manuals, etc
3. Project Reports. Detailed findings of overseas research studies.
4. Discussion Papers. Articles circulated for comments prior to submission to academic journals.

CRED publications may be obtained by writing to:

Publications Coordinator
Center for Research on
Economic Development
Lorch Hall
The University of Michigan
Ann Arbor, MI 48109-1220 USA

Payment should accompany your order, unless otherwise indicated.

Newsletter

CRED publishes a periodic newsletter entitled "CREDITS" which is available free of charge. To have your name placed on this mailing list, write to the Publications Coordinator.

Special Publications

4. Knieriemen, Marily. A Manual for Administration of Research and Development Projects. (forthcoming).
This manual was written during CRED's recent field research in Burkina Faso. It contains many suggestions for improving the administration of field research projects, particularly in the context of Francophone West Africa.

Ralandia Case Studies

These case studies are designed to promote class discussion on economic policy in developing countries. They are problem-solving cases, self-contained, and will not require any additional data.

Price: $5.00 for the set; it is available in either English (SP No. 2) or French (SP No. 3).

3. La République Démocratique Populaire de Ralandie: Deux Etudes de Cas. Jacqueline R. Sherman et David F. Gordon. November 1986. 68 p.

2. The People's Democratic Republic of Ralandia: Two Case Studies. Jacqueline R. Sherman and David F. Gordon. October 1986. 60 p.

1. Barlow, Robin (editor). Case Studies in the Demographic Impact of Asian Development Projects. (Contributors: J. Anderson, H. Barnum, J. Bauer, P. Gosling, A. Jain, H. Mohtadi, and E. Mueller.) 1982. 204 p. $10.00.
This collection is also appropriate for classroom use.

These prices include bookrate postage and handling charges. Please refer to the Special Publication Number (SP#) when placing an order.

Project Reports

48. Saul, Mahir and Green, Ira. La Dynamique de la Commercialisation des Céréales au Burkina Faso, Tome IV: Documents de Travail 5-6. 1987. 290 p. $15.00. (Price for 4-volume French set consisting of PR Nos. 43, 44, 46, & 48 is $85.00 instead of $100.00.)

47. Saul, Mahir and Green, Ira. The Dynamics of Grain Marketing in Burkina Faso, Volume IV: Research Reports 5-6. 1987. 264 p. $15.00. (Price for 4-volume English set consisting of PR Nos. 42, 44 [in French], 45 & 47 is $85.00 instead of $100.00.)

46. McCorkle, Constance M.; May, Charles A.; Szarletta, Ellen Jean; and Pardy, Christopher R. La Dynamique de la Commercialisation des Céréales au Burkina Faso, Tome III: Documents de Travail 1-4. 1987. 400 p. $20.00.

45. McCorkle, Constance M.; May, Charles A.; Szarletta, Ellen Jean; and Pardy, Christopher R. The Dynamics of Grain Marketing in Burkina Faso, Volume III: Research Reports 1-4. 1987. 364 p. $20.00.

44. Dejou, Chantal. La Dynamique de la Commercialisation des Céréales au Burkina Faso, Tome II: Rapports Régionaux. 1987. 768 p. (Part 1 - 412 p.; Part 2 - 356 p.) $35.00. [available only in French.]

43. Sherman, Jacqueline R.; Shapiro, Kenneth H.; and Gilbert, Elon. La Dynamique de la Commercialisation des Céréales au Burkina Faso, Tome I: Analyse Economique de la Commercialisation des Cereales. 1987. 596 p. $30.00.

42. Sherman, Jacqueline R.; Shapiro, Kenneth H.; and Gilbert, Elon. The Dynamics of Grain Marketing in Burkina Faso, Volume I: An Economic Analysis of Grain Marketing. 1987. 576 p. $30.00.

41. Mathes, J.C. and Elon Gilbert. Gestion des ressources en eau et mise en valeur du Bassin du Fleuve Gambie. 1985. 291 p. $15.00. (Price for 5-volume set consisting of PR Nos. 37-41 is $60.00 instead of $75.00.)

40. Ames, Peter. Ecologie terrestre et mise en valeur du Bassin du Fleuve Gambie. 1985. 382 p. $15.00.

39. Derman, William et al. Developpement rural dans le Bassin du Fleuve Gambie. 1985. 368 p. $15.00.

38. Moll, Russel and Dorr, John. Ecologie aquatique et mise en valeur du Bassin du Fleuve Gambie. 1985. 257 p. $15.00.

37. Schneider, Curt R. Maladies liées à l'eau et mise en valeur du Bassin du Fleuve Gambie. 1985. 368 p. $15.00.

36. Mathes, J.C. and Gilbert, Elon. Water Resource Management and Gambia River Basin Development (Gambia River Basin Studies). 1985. 253 p. $15.00. (Price for 5-volume set consisting of PR Nos. 32-36 is $60.00 instead of $75.00.)

35. Ames, Peter. Terrestrial Ecology and Gambia River Basin Development (Gambia River Basin Studies). 1985. 358 p. $15.00.

34. Derman, William et al. Rural Development in the Gambia River Basin (Gambia River Basin Studies). 1985. 330 p. $15.00.

33. Moll, Russell and Dorr, John. Aquatic Ecology and Gambia River Basin Development (Gambia River Basin Studies). 1985. 244 p. $15.00.

32. Schneider, Curt R. Water-Associated Diseases and Gambia River Basin Development (Gambia River Basin Studies). 1985. 346 p. $15.00.

31. Josserand, Henri et al. Projet Elevage Département de Bakel (Sénégal): Rapport Final d'Evaluation (Partie I, Synthèse; Partie II, Gestion des Pâturages; Partie III, Pédologie et Hydrologie; Partie IV, Etude Socio-économique). 1985. 530 p. $25.00.

30. Josserand, Henri et al. Eastern Senegal Range and Livestock Project: Final Monitoring and Evaluation Report (Part I, Synthesis; Part II, Range Management; Part III, Soils and Water Engineering; Part IV, Socioeconomic Study). 1985. 454 p. $25.00.

29. Sherman, Jacqueline R. Grain Markets and the Marketing Behavior of Farmers: A Case Study of Manga, Upper Volta. 1984. 317 p. $20.00.

28. Shapiro, Kenneth H., et al. Agroforestry in Developing Countries. 1984. 195 p. $12.00.

27. Ariza-Nino, Edgar J., et al. Effets Nutritifs de Politiques Agricoles: Cameroun et Sénégal - Partie I: Rapport de Pays. 1982. 369 p. $8.00. Partie II: Méthodologies d'Analyse et Modalités d'Enquête. 1982. 284 p. $7.00.

26. Ariza-Nino, Edgar J., et al. Consumption Effects of Agricultural Policies: Cameroon and Senegal - Part I: Country Reports; Part II: Methodology. 1982. 465 p. $15.00.

25. See 'Special Publications' section: Case Studies in the Demographic Impact of Asian Development Projects has become Special Publications (SP) No. 1.

24. Makinen, Marty et Ariza-Nino, Edgar J. La Marché Offert au Bétail dans la Zone Nigérienne Centrale (Le Projet de Gestion des Paturages et de l'Elevage). 1982. 63 p. $7.50.

23. Makinen, Marty and Ariza-Nino, Edgar J. The Market for Livestock from the Central Niger Zone (Niger Range and Livestock Project). 1982. 55 p. $7.50.

22. Ariza-Nino, Edgar J. et Griffith, J.L.P. Les Fournisseurs - Argentine, Australie, Nouvelle-Zélande; et Ariza-Nino, Edgar J.; Manly, D.W. et Shapiro, Kenneth H. L'Economie Mondiale de la Viande: Autres Pays - Fournisseurs et Consommateurs (Tome IV/V, La Commercialisation du Bétail et de la Viande en Afrique de l'Ouest). 1981. 476 p. $15.00.

21. Delgado, Christopher L., et Staatz, John M. Côte d'Ivoire et Mali (Tome III, La Commercialisation du Bétail et de la Viande en Afrique de l'Ouest). 1981. 567 p. [Out of Print.]

20. Josserand, Henri P., et Sullivan, Gregory. Bénin, Ghana, Libéria, Togo (Tome II, La Commercialisation du Bétail et de la Viande en Afrique de l'Ouest). 1980. 441 p. $15.00.

19. Ariza-Nino, Edgar J.; Herman, Larry A.; Makinen, Marty; et Steedman, Charles. Rapport de Synthèse: Haute-Volta (Tome I, La Commercialisation du Bétail et de la Viande en Afrique de l'Ouest). 1981. 258 p. $15.00.

18. Ariza-Nino, Edgar J.; Manly, D.W.; and Shapiro, Kenneth. The World Meat Economy: Other Supplier and Consumer Countries (Volume V, Livestock and Meat Marketing in West Africa Project). 1980. 183 p. $15.00.

17. Ariza-Nino, Edgar J., and Griffith, J.L.P. Suppliers: Argentina, Australia and New Zealand (Volume IV, Livestock and Meat Marketing in West Africa Project). 1979. 239 p. [Out of Print.]

16. Delgado, Christopher L., and Staatz, John M. Ivory Coast and Mali (Volume III, Livestock and Meat Marketing in West Africa Project). 1980. 439 p. $15.00.

15. Josserand, Henri P. and Sullivan, Gregory. Benin, Ghana, Liberia, Togo (Volume II, Livestock and Meat Marketing in West Africa Project). 1980. 446 p. $15.00.

14. Ariza-Nino, Edgar J.; Herman, Larry A.; Makinen, Marty; & Steedman, Charles. Synthesis: Upper Volta (Volume I, Livestock and Meat Marketing in West Africa Project). 1980. 204 p. $15.00.

13. Eddy, Edward D. L'Utilisation de la Terre et de la Main-d'Oeuvre à l'Interieur des Exploitations Agricoles Intégrées de la Zone Pastorale Nigérienne (Monographie III, La Production et la Commercialisation du Bétail dans les Pays du Conseil de l'Entente). 1980. 406 p. [Out of Print.]

12. Staatz, John M. L'Economique de la Commercialisation du Bétail et la Viande en Côte d'Ivoire (Monographie II, La Production et la Commercialisation du Bétail dans les Pays du Conseil de l'Entente). 1980. 536 p. $15.00.

11. Delgado, Christopher K. L'Elevage par Rapport à l'Agriculture au Sud-Est de la Haute-Volta: Analyse de l'Allocation des Ressources au Niveau de l'Exploitation (Monographie I, La Production et la Commercialisation du Bétail dans les Pays du Conseil de l'Entente). 1980. 405 p. [Out of Print.]

10. Shapiro, Kenneth H. La Production et la Commercialisation du Bétail dans les Pays du Conseil de l'Entente: Rapport de Synthèse. 1980. 445 p. $15.00.

9. Herman, Larry A. The Livestock and Meat Marketing System in Upper Volta: An Evaluation of Economic Efficiency (Monograph IV, Livestock Production and Marketing in the Entente States of West Africa Project). 1983. 266 p. $10.00.

8. Eddy, Edward D. Labor and Land Use on Mixed Farms in the Pastoral Zones of Niger (Monograph III, Livestock Production and Marketing in the Entente States of West Africa Project). 1979. 493 p. [Out of Print.]

7. Staatz, John M. The Economics of Cattle and Meat Marketing in Ivory Coast (Monograph II, Livestock Production and Marketing in the Entente States of West Africa Project). 1979. 589 p. $15.00. [Out of Print.]

6. Delgado, Christopher L. Livestock versus Foodgrain Production in Southeastern Upper Volta: A Resource Allocation Analysis (Monograph I, Livestock Production and Marketing in the Entente States of West Africa Project). 1979. 427 p. [Out of Print.]

5. Shapiro, Kenneth H. Livestock Production and Marketing in the Entente States of West Africa: Summary Report. 1979. 528 p. $12.50.

4. Berg, Elliot J., et al. Commercialisation, Politique des Prix et Stockage des Céréales au Sahel: Etude Diagnostique - Tome I, Synthèse avec Compilation Statistique et Bibliographie Annotée. 1977. 164 p. $8.00
Tome II, Etudes des Pays. 1977. 129 p. [Tome II - Out of Print.]

3. Berg, Elliot J., et al. Marketing, Price Policy and Storage of Food Grains in the Sahel: A Survey - Volume II, Country Studies. 1977. 105 p. $10.00.

2. Berg, Elliot J., et al. Marketing, Price Policy and Storage of Food Grains in the Sahel: A Survey - Volume I, Synthesis with Statistical Compilation and Annotated Bibliography. 1977. 152 p. $8.00.

1. Berg, Elliot J. The Economic Evolution of the Sahel. 1975. 258 p. $7.50. [Out of Print.]

These prices include bookrate postage and handling charges. Please refer to the Project Report Number (PR#) when placing an order.

Discussion Paper Series

CRED publishes discussion papers, providing preliminary reports on the research (institutional or personal) of its senior research staff. In many cases, revised versions of these papers are later published in academic journals or elsewhere.

Prices: Individual discussion papers may be purchased for $3.00 each for delivery to a North American country, or $5.00 each for other continents. An annual subscription (based on a July 1 - June 30 subscription year) is available for $15.00 for delivery to a North American country, or $25.00 for other continents. Subscriptions are also available on an exchange basis for publications from other institutions.

119. Grobar, Lisa M. and Porter, Richard C. "Benoit Revisited: Defense Spending and Economic Growth in LDCs," June 1987. 34 p.

118. Porter, Richard C. "Recent Trends in LDC Military Expenditures," June 1987. 28 p.

117. Derman, Bill. "River Basin Development: Dilemmas for Peasants and Planners," February 1987. 15 p.

116. Brux, Jacqueline M. "Economic Analysis of Buffer Stocks to Stabilize the International Grain Markets: A Literature Review," September 1986. 46 p.

*115. Barlow, Robin. "Correlations Between Population Growth and Economic Growth," March 1986. 11 p.

114. See 'Special Publications' section: The <u>Ralandia Case Studies</u> have become Special Publications (SP) Nos. 2 and 3. They are no longer available as Discussion Paper No. 114.

113. Collange, Gérald. "Econometric Models of Governmental Aid to Multilateral Agencies," February 1986. 21 p.

112. Kleve, J.G. "Planning Experience in Tunisia, Burundi and Syria," September 1985. 15 p.

111. Sherman, Jacqueline R. "Grain Marketing Decisions of Subsistence Farmers in Burkina Faso," December 1984. 29 p.

110. Kouassi, Bernard Y. "Toward An Adoption Decision Model for Processed Foods in Developing Nations," November 1984. 34 p.

109. Kouassi, Bernard Y. "Urban Consumption of Beef in the Ivory Coast," September 1984. 22 p.

108. Gordon, David F and Parker, Joan C. "The World Bank and Its Critics: The Case of Sub-Saharan Africa," March 1984. 43 p.

107. Ranney, Susan I. and Kossoudji, Sherrie. "Historical Migration Patterns and Current Temporary Migration: The Case of Mexican Migration to the U.S.," December 1983. 35 p.

106. Chambas, Gérard. "Rural Income Distribution in Senegal: Changes and Indicators," December 1983. 43 p.

105. Josserand, Henri P. "Small Stock, Large Dividends: Sheep and Goats in Sub-Saharan Africa," October 1983. 30 p.

104. Gordon, David F. "Which Way for Zimbabwe: Development Dilemmas and Prospects," August 1983. 27 p.

103. Grosse, Scott D. "Rural Development and Rural-Urban Migration: The Elusive Relationship," June 1983. 47 p.

102. Ranney, Susan I. "Economic Models of Planned Temporary Migration," June 1983. 26 p.

101. Ranney, Susan I. "International Capital Transfers and the Choice of Production Technique: A Simple Two-Country Model," June 1983. 21 p.

100. Ranney, Susan I. "Time Allocation and Remittance Flows: The Case of Temporary Mexican Migration to the U.S.," June 1983. 25 p.

99. Josserand, Henri P. and Brazee, Richard J. "Domestic and Foreign Effort Applied to a Fish Stock: Getting the Most Over Time, for a Change," May 1983. 14 p.

*98. Berg, Elliot J. and Ainsworth, Martha. "A Strategy for Health Care in West Africa," November 1982. 35 p.

*97. Thomas-Peterhans, Randall. "The Stratification of Livestock Production and Marketing in the Zinder Department of Niger," September 1982. 39 p.

96. Makinen, Marty. "A Benefit-Cost Analysis of Measles Vaccinations in Yaounde, Cameroon," November 1981. 20 p.

95. Porter, Richard C. "Apartheid, the Job Ladder, and the Evolutionary Hypothesis: Empirical Evidence from South African Manufacturing, 1960-1977," September 1981. 34 p.

94. Ranney, Susan I. "Terms of Trade and Domestic Distribution: A Comment," July 1981. 11 p.

93. Berg, Elliot J. "Intergovernmental Health Assistance in Francophone West Africa," June 1981. 46 p.

92. Kemal, A.R. and Porter, Richard C. "Learning by Doing While Remembering Forgetting, With Reminders From Pakistan Manufacturing Data," May 1981. 21 p.

91. Grosse, Scott D. "A Skeptical Perspective on Income Redistribution and Poverty Reduction in Sri Lanka," May 1981. 27 p.

90. Makinen, Marty; Herman, Larry A.; Staatz, John M.. "A Model of Meat Versus Live-animal Exports from Upper Volta," February 1981. 27 p.

89. Barnum, Howard N. "The Economic Cost and Benefits of an Immunization Program in Indonesia," January 1981. 37 p.

88. Ranney, Susan I. "A Note on the Proletarianization of the African Peasantry in Rhodesia," August 1980. 18 p.

87. Ranney, Susan I. "The Open Door Policy and Industrialization in Egypt: A Preliminary Investigation," August 1980. 47 p.

86. Staatz, John M. "The Economics of Cattle and Meat Marketing in Ivory Coast: A Summary," June 1980. 84 p.

85. Ross, Clark G. "A Modeling of the Demand and Supply of Food Grains in Senegal," June 1980. 68 p.

84. Berg, Elliot J. "Alternative Strategies for Zimbabwe's Growth," June 1980. 27 p.

83. Eddy, Edward D. "Prospects for the Development of Cattle Production on Mixed Farms in the Pastoral Zone of Niger: A Summary," June 1980. 91 p.

82. Barlow, Robin. "Economic Growth in the Middle East, 1950-1972," June 1980. 41 p. (Republished in International Journal of Middle East Studies, Vol. 14, 1982.)

*81. Ross, Clark G. "A Village Level Study of Producer Grain Transactions in Rural Senegal," June 1979. 51 p. (Republished in African Studies Review, V. 25, # 4, December 1982.)

*80. Ross, Clark G. "Grain Demand and Consumer Preferences: Dakar, Senegal," June 1979. 26 p. (Republished in Food Policy, Vol. 5, No. 4, November 1980.)

79. Berg, Elliot J. "Reforming Grain Marketing systems in West Africa," June 1979. 50 p.

78. Barnum, Howard N. and Barlow, Robin. "Reducing Mortality When Diseases are Interdependent," August 1978. 25 p.

77. Porter, Richard C. "The Potential Impact of International Trade and Investment Sanctions on the South African Economy," February 1979. 80 p. (Republished in Journal of Conflict Resolution, December 1979.)

76. Berg, Nancy and Elliot J. "Graduate Training of LDC Economists in U.K. Universities - A Statistical Note," January 1979. 35 p.

75. Pinckney, Annette M. "An Analysis of Grain Storage in Three Interior Sahel Countries," January 1979. 75 p.

74. Delgado, Christopher L. "An Investigation of the Lack of Mixed Farming in the West African Savannah: A Farming Systems Approach for Tenkodogo, Upper Volta," November 1978. 71 p.

73. Barnum, Howard N. and Squire, Lyn. "Consistent Aggregation of Family and Hired Labor in Agricultural Production Functions," January 1978. 12 p.

72. Bloch, Peter C. "Labor Relations in Senegal - History, Institutions and Perspectives," January 1978. 41 p.

71. Barnum, Howard N. and Squire, Lyn. "Labor Heterogeneity and Rice Production in Malaysia," December 1977. 11 p.

70. Nziramasanga, Mudziviri T. "Production from an Exhaustible Resource Under Government Control in LDCs," December 1977. 17 p.

69. Henning, Peter H. "The Urban Popular Economy and Informal Sector Production," March 1977. 66 p.

68. Porter, Richard C. "Economic Sanctions: The Theory and Evidence from Rhodesia," March 1977. 19 p. (Republished in Journal of Peace Science, Vol. 3, No. 2, Fall 1978.)

67. Heller, Peter S. "Issues in the Allocation of Resources in the Health Sector of Developing Countries," February 1977. 33 p. (Republished in Economic Development and Cultural Change, Vol. 27, No. 1, October 1978.)

66. Weisskopf, Thomas E. "Dependence as an Explanation of Underdevelopment," February 1977. 32 p.

65. Cross, John G. "A Stochastic Learning Model of Migration," February 1977. 17 p. (Republished in Journal of Development Economics, Vol. 5, No. 2, June 1978.)

64. Lopez, Michael. "The Determinants of Income and Its Distribution in four Villages in India," February 1977. 76 p.

63. Monson, Terry D. "A Note on Measuring Educational Returns in LDCs," February 1977. 12 p. (Republished in Journal of Developing Areas, Vol. 13, No. 4, July 1979.)

62. Heller, Peter S. "A Model of the Demand for Medical and Health Services in West Malaysia," October 1976. 52 p. (Republished in Social Science and Medicine, Vol. 16, 1982.)

61. Montgomery, Barbara B. "The Economic Role of the Ivorian Woman," February 1977. 49 p.

60. Porter, Richard C. "A Model of a South African-type Economy," October 1976. 42 p. (Republished in American Economic Review, Vol. 68, No. 5, December 1978.)

59. Staelin, Charles P. and Jurado, Gonzalo M. "The Impact of Export Incentives and Export-Related Policies on the Firms of the Less-Developed Countries: A Case Study of the Philippines," September 1976. 29 p.

58. Heller, Peter S. and Drake, William D. "Malnutrition, Child Morbidity and the Family Decision Process," September 1976. 43 p. (Republished in Journal of Development Economics, Vol. 6, No. 2, June 1979.)

57. Heller, Peter S. "Interactions of Childhood Mortality and Fertility in West Malaysia: 1947-1970," September 1976. 33 p.

56. Barlow, Robin. "A Test of Alternative Methods of Making International Product Comparisons," September 1976. 15 p. (Republished in Economic Journal, Vol. 87, September 1977.)

55. Elliott, James A.M. "Will Rising Wages in the Controlled Sector Increase Total Employment in Less-Developed Countries?," August 1976. 37 p. (Republished in Journal of Development Studies, Vol. 16, No. 1, October 1979.)

54. Saulniers, Alfred H. "The Economics of Prestation Systems: A Consumer Analysis of Extended Family Obligations with Application to Zaire," August 1976. 27 p.

53. Saulniers, Alfred H. "Unit Equivalent Scales for Specific Food Commodities: Kinshasa, Zaire," August 1976. 22 p.

52. Shapiro, Kenneth H. "Efficiency Differentials in Peasant Agriculture and Their Implications for Development Policies," June 1976. 13 p. (Republished in International Association for Agricultural Economics Occasional Paper No. 1, November 1977.)

51. Berg, Elliot J. "The Economic Impact of Drought and Inflation in the Sahel," May 1976. 35 p.

50. Kendrick, Robin, J. "A Survey of Labor Relations in Cameroon," May 1976. 39 p. (Repub- lished in Industrial Relations in Africa, edited by Ukandi G. Damachi, International Institute for Labor Studies, Geneva, 1979.)

49. Monson, Terry D. and Pursell, Gary G. "An Evaluation of Expatriate Labor Replacement in the Ivory Coast," April 1976. 75 p. (Republished in Actualité Economique, Vol. 53, No. 2, April-June 1977, in French, and in Journal of Development Economics, Vol. 6, No. 1, March 1979.)

48. Berg, Elliot J. "Some Problems in the Analysis of Urban Proletarian Politics in the Third World," March 1976. 17 p. (Republished in Comparative Urban Research, Vol. 4, No. 1, April 1976.)

47. Ketkar, Suhas L. "Economics of Education in Sierra Leone," April 1975. 37 p. (Republished in Manpower Planning and Utilization in West Africa, International Labor Organ- ization, 1979.)

46. Kleve, Jacob G. "The Financing of Investments in Tunisia, 1961-1971," March 1975. 41 p.

45. Kleve, Jacob G. and Stolper, Wolfgang F. "Changes in Income Distribution, 1961-1971 (Tunisia)," March 1975. 30 p.

44. Blake, Robert. "Import Controls and Production in Tunisia During the 1960s," March 1975. 41 p.

43. Heller, Peter S. "An Analysis of the Structure, Equity and Effectiveness of Public Sector Health Systems in Developing Countries: The Case of Tunisia, 1960-1972," February 1975. 105 p.

42. Heller, Peter S. "Factor Endowment Change and the Structure of Comparative Advantage: The Case of Japan, 1956-1969," January 1975. 23 p. (Republished in Review of Economics and Statistics, Vol. 58, No. 3, August 1976.)

41. Weisskopf, Thomas E. "China and India: A Comparative Survey of Economic Performance," October 1974. 43 p. (Republished in Economic and Political Weekly, Vol. 10, Nos. 5-7, February 1975.)

40. Elliott, Howard J.C. "Animation Rurale and Encadrement Technique in the Ivory Coast," September 1974. 33 p.

39. Herman, Barry M. "Multinational Oligopoly in Poor Countries: How East Africa Got Its Petroleum Refineries," September 1974. 32 p. (Republished in Journal of Development Economics, Vol. 2, 1975 and in Readings on the Multinational Corporation in Kenya, edited by Raphael Kaplinsky, Oxford University Press, Nairobi, 1978.)

38. Porter, Richard C. "Measuring the Cost of Granting Tariff Preferences," September 1974. 44 p.

*37. Stolper, Wolfgang F. "Investments, Employment and Output per Man in the Tunisian Economy, 1961-1971," September 1974. 112 p. (Republished in Weltschaftliches Archiv, Vol. 114, No. 3, September 1978, and in Annales Economiques, No. 14, 1980, in French.)

36. Shapiro, Kenneth H. and Muller, Jurgen. "Sources of Technical Efficiency: The Roles of Modernization and Information," April 1974. 40 p. (Republished in Economic Development and Cultural Change, Vol. 25, No. 2, January 1977.)

35. Weisskopf, Thomas E. "American Economic Interests in Foreign Countries: An Empirical Survey," April 1974. 56 p.

34. Porter, Richard C. and Staelin, Charles P. "On the Rationality of 'Cascaded' Export Subsidies and Taxes," March 1974. 9 p.

33. Hoopengardner, Thomas. "Rural-Urban Migration: A Dynamic View," January 1974. 15 p.

32. Weisskopf, Thomas E. "Sources of American Imperialism: A Contribution to the Debate between Orthodox and Radical Theories," November 1973. 46 p. (Republished in Review of Radical Political Economics, Vol. 6, No. 4, Fall 1974.)

31. Porter, Richard C. "Some Doubts About Kenya's Future as an Exporter of Manufactures," October 1973. 30 p. (Republished in Eastern Africa Economic Review, Vol. 6, No. 1, June 1974.)

30. Heller, Peter S. "An Econometric Analysis of the Fiscal Behavior of the Public Sector in Developing Countries: Aid, Investment and Taxation," October 1973. 39 p. (Republished in American Economic Review, Vol. 65, No. 3, June 1975.)

29. Porter, Richard C. "Labor Migration and Urban Unemployment in Less-Developed Countries: Comment," July 1973. 19 p.

28. Dia Bondo, Theophil Lukusa and Porter, Richard C. "A Constant Market-Share Look at African Exports in the 1960s," June 1973. 25 p.

*27. Barlow, Robin. "Planning Public Health Expenditures with Special Reference to Morocco," April 1973. 68 p. (Republished in International Journal of Health Services, Vol. 6, No. 1, February 1976.)

26. Staelin, Charles P. "A General Equilibrium Model of Tariffs in a Non-Competitive Economy," March 1973. 29 p. (Republished in Journal of International Economics, Vol. 6, No. 1, February 1976.)

25. Winegarden, Cal R. "Determinants of International Differences in Educational Effort," September 1972. 31 p. (Republished in Eastern Economic Journal, Vol. 2, No. 1, January 1975.)

24. Heller, Peter S. "The Strategy of Health-Sector Planning in the People's Republic of China," July 1972. 62 p. (Republished in Medicine and Public Health in China, edited by M. Wegman and T. Lin, Josiah Macy Foundation, New York, 1973.)

23. Heller, Peter S. "A Model of Public Sector Expenditure Dynamics in Less-Developed Countries: The Kenyan Case," May 1972. 50 p. (Republished in Quarterly Journal of Economics, Vol. 88, No. 2, May 1974.)

22. Staelin, Charles P. "The Cost and Composition of Indian Exports," May 1972. 41 p. (Republished in Journal of Development Economics, Vol. 1, No. 2, June 1974.)

21. Johnson, George E. "The Determinants of Hourly Earnings in Urban Kenya," May 1972. 36 p.

20. Osayimese, Izevbuwa G. "An Application of Control Theory to Rural-Urban Migration and Urban Unemployment," May 1972. 19 p. (Republished in Geographical Analysis, Vol. 4, No. 2, April 1974.)

19. Fields, Gary S. "Private Returns to Investments in Higher Levels of Education in Kenya," April 1972. 16 p. (Republished in Education, Society and Development: New Perspectives from Kenya, edited by David Court and Dharam P. Ghai. Oxford University Press, Nairobi, 1974.)

18. Naranjo, John and Porter, Richard C. "The Impact of the Commonwealth Preference System on the Exports of Latin America to the United Kingdom," March 1972. 37 p. (Republished in Journal of Development Studies, Vol. 9, No. 4, July 1973.)

17. Kennedy, Michael. "An Empirical Evaluation of the Two-Gap Model of Development," November 1971. 29 p.

16. Aho, C. Michael. "The Use of Export Projects in Allocating Foreign Aid Among and Domestic Resources Within Developing Countries," July 1971. 59 p. (Republished in Journal of Development Studies, Vol. 10, No. 3/4, April/July 1974.)

*15. Andriamananjara, Rajaona. "Labor Mobilization: The Moroccan Experience," April 1974. 119 p.

14. Hutcheson, Thomas L. and Porter, Richard C. "The Cost of Tying Aid: A Method and Some Colombian Estimates," January 1971. 58 p. (Republished in Princeton Studies in International Finance, No. 30, March 1972.)

13. Berg, Elliot J. "Wages and Employment in Less-Developed Countries," December 1970. 23 p. (Republished in The Challenge of Unemployment to Development and the Role of Training and Research Institutes of Development, OECD, Paris, 1971.)

12. Adalemo, Isaac Aylinde. "Distribution of Market Centers, Market
Periodicities and
Northwestern Nigeria,
57 p. (Republish
Notes, Vol. 5, No

11. Porter,
a Bill Market,"
(Republished in
Studies, Vol. 9,

10. Stol
"Limitations of
in the Fac
Uncertainty: C
Crisis of Pla
44 p. (Republ
liches Archiv,
March 1971.)

9. Eckstein
Integrated Th
August 1969. 41

8. Porter,
Effectiveness
Colombia," July
lished in We
Review of Worl
No. 3, Septembe

7. Eckstei
tative Measureme
Performance: A
Eckstein and a R
and Cynthia Taft
37 p. (Republi
Economic Review,
March 1970.)

6. Porter, Richard C. "Some Implications of Post-War Primary Product Trends," February 1969. 17 p. (Republished in Journal of Political Economy, Vol. 78, No. 3, May-June 1970.)

5. Berg, Elliot J. "Trade Unions and Wage Levels - The Nigerian Case," January 1969. 19 p. (Republished in Economic Development and Cultural Change, Volume 17, No. 4, July 1969.)

Elliot J. "Industrial
stems in Colonial West
Comparative Analysis of
Africa and the Gold
ber 1968. 50 p. (Repub-
ican Dimensions: Essays
William O. Brown, edited
rp, Boston University,
)

r, Wolfgang F. "Economic
Political Instability in
Growing Together Again,"
38 p. (Republished in
vleopment of the Nigerian
ed by Carl K. Eicher and
edholm, Michigan State
ess, East Lansing, 1970.)

in, Peter C. "Account-
s a Tool of Development
bruary 1968. 84 p.

, Elliot J. "Wage
in Less-Developed
January 1968. 51 p.
in Wage Policy Issues in
evelopment, edited by
Smith, International
for Labour Studies, Geneva,

refer to the Discussion
ber (DP#) when requesting one
titles. Bookrate postage and
charges are included in the
l and subscription prices.

*Available in French and English.