Staff Papers Series

STAFF PAPER P78-4 MARCH 1978

INTERNATIONAL FARM PRICES AND THE SOCIAL COST OF CHEAP FOOD POLICIES

Willis L. Peterson

Department of Agricultural and Applied Economics

University of Minnesota
Institute of Agriculture, Forestry and Home Economics
St. Paul, Minnesota 55108

INTERNATIONAL FARM PRICES AND THE SOCIAL COST OF CHEAP FOOD POLICIES

*Willis L. Peterson

For some time now we have been aware that farmers in many if not most of the world's less developed countries (LDCs) face relatively unfavorable prices (Schultz; Hayami and Ruttan; Johnson, Schuh). A number of policies and practices have contributed to this situation. Perhaps most important have been the imposition of export taxes on farm commodities which have the effect of holding domestic prices below world market levels, the overvaluation of currencies which reduces the export demand for farm products, and the use of state marketing monopolies with power to set farm prices below the levels that would be determined by competitive free markets. Also the P.L. 480 and similar programs of the developed countries (DCs) have provided subsidized, low cost substitutes for home produced commodities thereby lowering their prices.

The underlying motivation for these policies and practices no doubt vary between countries. In the LDCs export taxes on farm commodites have provided an easy-to-tap source of government revenue in view of their difficulties in collecting income taxes. Also these policies have been utilized in attempts to control inflation, or to hold down the price of food to industrial workers and low income people. In addition to the humanitarian motive underlying the P.L. 480 and similar programs, one should acknowledge that such programs have provided a means of disposing of surplus commodities resulting from price supports on farm commodities in the donor countries.

Staff Papers are published without formal review within the Department of Agricultural and Applied Economics

It also happens that the prices of inputs and consumer goods purchased by farm people in many LDCs have been maintained at artificially high levels primarily through the imposition of tariffs, quotas, and embargoes on imports. Attempts to protect local industry from foreign competition, to conserve an foreign exchange, and to collect additional tax revenue appear to be the major motivations for these policies.

It also is recognized or at least argued by some economists that the long run unfavorable price relationships faced by farmers in the LDCs have had the effect of reducing agricultural output from what it otherwise would have been, causing food shortages, and dampening agricultural as well as overall economic growth. However, we know relatively little about the magnitude of these price distortions and their impact on agricultural production in the LDCs. The main purpose of this paper is to augment our information bearing on these two questions. In the first section of the paper "real" prices received by farmers in 53 countries are presented. In the following section, a long run aggregate agricultural supply elasticity is estimated by fitting a supply function to cross section data. In the third and final section, this supply elasticity is used to estimate the loss of agricultural output and resulting social costs in countries exhibiting relatively low farm prices.

International Farm Prices

The Food and Agricultural Organization of the United Nations (FAO) has gathered and published prices received by farmers for a large proportion of all farm commodities produced in 81 countries (United Nations). For most of these countries the coverage extends over the 1961-70 period.

In an effort to mitigate year-to-year price fluctuations and measure overall levels of prices, 2 three-year periods of price averages are constructed: 1962-4 and 1968-70.

In order to accurately gauge the economic environment experienced by farmers and make comparisons between countries. it is necessary to obtain a comprehensive measure of commodity prices. In countries where the prices of certain products are supported above market equilibrium levels it is common to have some kind of area or production control in an effort to hold down surpluses. As a result additional land may be devoted to the production of unsupported, noncontrolled commodities causing their prices to be lower than they would otherwise be. Hence the overall level of farm prices in these countries may not be quite as attractive as one might be first led to believe. Similarly in countries where prices of certain products are held artificially low, farmers have an incentive to shift resources to the production of more profitable items. As a result the overall level of prices in these countries may not be quite as unfavorable as might first appear.

In order to combine the prices of many diverse commodities, all prices are converted to wheat equivalent terms. The procedure is to first divide the average world market (export) price of each commodity by the average world market (export) price of wheat to obtain a price relative for each commodity for each period.[1/] Then the local currency price of each commodity is converted to a wheat equivalent price by dividing by its price relative. For example, the 1968-70 world market price of maize averaged .88 that of wheat. Therefore, the local currency price of maize in each country for the

1968-70 period is converted to a wheat equivalent price by dividing by .88.

The overall average output price for each country is a weighted average price obtained by multiplying the wheat equivalent price of each commodity by the proportion of that commodity in the country's total farm output and summing over all commodities. Before calculating the quantity weights, quantities also are converted to wheat equivalent units by multiplying domestic production of each commodity by its respective world price relative. Production figures for 1963 and 1969 as presented by the FAO Production Yearbook are used to compute the 1962-4 and 1968-70 weighted average prices respectively.

The following expression summarizes the preceding computations.

$$\sum_i \frac{p_i}{\bar{p}_i/\bar{p}_w} \cdot w_i = P$$

where:

p_i = average domestic price of the ith commodity during each three-year period.

$\bar{p}_i$ = average world market export price in U.S. dollars of the ith commodity during each three-year period.

$\bar{p}_w$ = average world market export price in U.S. dollars of wheat during each three-year period.

w_i = proportion of ith commodity in total output of each country in wheat equivalent units.

P = overall average wheat equivalent price for each country during each of the three-year periods.

The resulting wheat equivalent prices for the various countries are given in terms of domestic currencies which of course are not amenable to international comparison. One could convert these prices to a single currency such as U.S. dollars using official exchange rates. However, distortions in exchange rates also would distort the farm price figures. In countries where the dollar was overvalued during the two periods, mainly Western Europe and Japan, the dollar price of farm products would be biased downward. Conversely where the dollar was undervalued, mainly in the LDCs, dollar prices would be biased upward.

In order to avoid the problem of exchange rate distortions, domestic currency prices are converted to price ratios by dividing by the weighted average domestic currency price of commercial fertilizer. The use of fertilizer price as a "deflator" has two advantages. First, fertilizer price data are available for a relatively large number of countries. Reasonably complete data on fertilizer prices and consumption are available in the FAO Production Yearbook for 53 of the 81 countries for the 1968-70 period, and for 44 countries during 1962-4. The second desirable feature of fertilizer price is that quality of the input is reasonably constant between countries because prices are quoted on a per unit of plant food basis. Quality differences between countries for a number of other inputs probably would be so great as to preclude their use as a deflator even if the data were available. As mentioned, the overall fertilizer price is constructed as a weighted average with the weights for nitrogen, phosphorus, and potassium equal to their respective proportion in the total fertilizer consumption of each country.

The price ratios for the 1968-70 period are presented in table 1. These figures are to be interpreted as the number of kilograms of commercial fertilizer in terms of plant food that can be purchased with 100 kilograms of wheat equivalents. The higher the ratio, the higher the "real" price received by farmers. The nations are ranked from highest to lowest in terms of "real" prices received by farmers.

The figures presented here clearly support the hypothesis that real farm prices are more favorable to farmers in the developed countries than to their counterparts in the LDCs with a few possible exceptions including South Korea and Pakistan. The figures also reveal that the price differences are significant and substantial by most interpretations of the terms. Real prices received by Japanese farmers were over seven times greater than farmers in the Niger during the 1968-70 period. Prices received in the top ten countries averaged 3.7 times larger than prices in the lowest ten.

The same general pattern of prices exists for the 1962-4 period both in terms of ranking of the DCs and LDCs and in magnitude of the difference between the highest and lowest. In regard to the latter, the average price received in the highest eight countries (out of 44) was 4.7 times greater than in the lowest eight so there appears to have been some narrowing of price differences between countries during the 1960s.

One should, of course, bear in mind the possibility of an upward bias in these estimates as a measure of the true real prices received by farmers in the LDCs due to fertilizer subsidies in at least some of these countries. The existence of such subsidies is likely to cause the figures in table 1 to understate the true range in real prices received between the DCs and LDCs to the extent that not all inputs are subsidized in the latter countries.

Table 1. *Real Prices Received by Farmers, 1968-70

Japan	52.5	Mexico	25.8
Hungary	51.9	Chile	25.4
Switzerland	45.5	Colombia	25.4
Finland	44.5	Morocco	25.2
United States	44.0	Greece	23.1
S. Korea	43.8	Tunisia	23.0
Norway	43.3	Portugal	22.0
France	41.2	Kenya	20.8
Sweden	40.4	Ghana	20.7
W. Germany	38.0	Panama	19.9
Belgium	37.6	Jordon	19.7
United Kingdom	36.7	Senegal	19.1
Poland	36.3	Guatamala	18.2
Denmark	35.9	Iraq	18.0
Ireland	35.9	Cameroon	16.1
Austria	35.5	Ivory Coast	15.9
Yugoslavia	32.4	Peru	15.8
Pakistan	32.2	Uruguay	15.5
Spain	31.2	Philippines	15.0
Turkey	29.8	Upper Volta	14.3
Netherlands	29.4	Argentina	13.4
Italy	29.2	Dahomey	13.0
Israel	28.5	Burma	12.2
Sri Lanka	27.9	Guyana	10.8
Canada	27.8	Khmer Republic	10.2
Cyprus	27.8	Paraguay	8.4
		Niger	7.1

*Kg. of fertilizer that could be purchased with 100 kg. of wheat equivalents.

Also it is likely that the terms of trade between farm commodities and consumer goods purchased by farmers in the LDCs are somewhat less favorable to farmers in these countries than to farmers in the DCs because of tariffs and embargos on imports together with relatively high excise taxes on domestically produced consumer goods in the LDCs. Relatively unfavorable terms of trade between farm commodities and other consumer goods can be expected to dampen farmers' incentives to produce in the LDCs even more than is implied by the figures in table 1.

International Agricultural Supply Function

In order to measure the impact of low farm prices on agricultural output in the LDCs, it is necessary to have an estimate of the long run aggregate agricultural supply elasticity. While there seems to be fairly widespread agreement that this figure is some positive value, there is still considerable uncertainty over its exact size.

Most of what we know of agricultural supply elasticities has come from the estimation of supply functions utilizing time series data. Understandably the lack of significant variation of prices within a country at a point in time requires the use of such data. However in generating these data, markets do not perform very good "experiments" for us. What we generally observe are short term, year-to-year fluctuations in prices received. It is not unreasonable to believe that when prices are abnormally high most producers expect them to return to a more normal level in the near future. Hence we would expect producers to be reluctant to invest heavily in order to increase production for just a short period. Similarly when prices are unusually low, the reasonable expectation will be a return to somewhat more favorable prices in the near future. In this case we should not expect producers to disinvest heavily in order to reduce output during what is expected (or hoped) to be a relatively short period.

Although we do observe some response to these short-run price fluctuations, the response should be small in comparison to what we might expect to observe when there is a change in the overall average level of prices. In the latter case it becomes more profitable to invest or disinvest in response to price changes.

It is reasonable to believe that policy action tends to change farm prices over a somewhat longer duration than market induced changes, in effect changing the overall average level of prices. Consequently we would expect the supply response to be greater in the former than in the latter case. There is some danger, therefore, of underestimating the response of farmers to policy induced price changes if their response to short-run market induced changes is used as a guide.

The cross section price data presented in table 1, together with the 1962-4 observations, provide an opportunity to measure the response to differences in average levels of prices. The measured response should, therefore, come closer to a true long-run supply elasticity than that obtained from short-run, year-to-year price changes. To estimate this response a simple log-linear supply function of the following specification is fitted to the cross section observations.

$$Q = A\, P^{\alpha}\, w^{\beta}\, T^{\gamma}\, e^{\mu}$$

where:

Q = total agricultural output in quintals of wheat units per hectare of agricultural land.[2/]

A = the constant term

P = "real" prices received for all farm products in terms of kg. of commercial fertilizer that could be purchased with 100 kg. of wheat equivalents. For 1968-70 these are the same figures presented in table 1. Comparable figures are used for the 1962-4 period.

w = a weather variable approximated by the long run average annual precipitation of each country in the sample.

T = a technology variable approximated by the number of agricultural research publications for each country in the sample.

The sources and construction of the quantity and price variables are the same as discussed in the preceding section. It ought to be emphasized that quantity is measured on a yield or per hectare basis. As a result the function cannot measure changes in output resulting from changes in land utilization that can be expected to occur because of price changes. Consequently the estimated supply elasticity is likely to be a lower bound of the full or true output response to price changes when both yield and area are allowed to change. Also it is likely that the land which is brought into production when price increases (or taken out when price decreases) is of a lower than average quality. If so this phenomenon will accentuate the downward bias of the estimated supply elasticity mentioned above.

Long-run average precipitation is used as a proxy measure of growing conditions.[3/] Admittedly this is a rough measure of growing conditions not only within large countries where weather and other characteristics such as soil type, topography, length of growing season, etc. vary greatly, but also between countries where there is even more variation. It might be mentioned, however, that the precipitation figure is an average of a large number of reporting stations, at least for large countries (104 for the U.S.). Also the obvious extreme readings from deserts, rainforests, and mountain tops are deleted.[4/]

The other shift variable in the supply function is technology. As a proxy measure of differences in technology between countries, the agricultural research publications figures gathered by Boyce and Evenson are utilized (Boyce and Evenson). Total number of agricultural research publications form 1948 to 1962 are used as a proxy for the "state of the art" or stock of knowledge for the 1962-4 observations, while the total 1948 to 1968 publications figures are applied to the 1968-70 observations. In the equations this variable enters on a per hectare of agricultural land basis.

To guard against the possibility of simultaneous equation bias as well as bias in the coefficients due to measurement errors, the coefficients are estimated by an instrumental variable (IV) technique in addition to ordinary least squares. (OLS)[5/] Because the set of coefficients is not significantly different between the two time periods, the observations are pooled into a single regression. The log form of the equation allows us to interpret the coefficients as elasticities. The results are presented in table 2.

The estimated supply elasticities ranging from 1.25 to 1.66 are substantially larger than the highly inelastic figures, in the neighborhood of about .15, that are generally obtained from aggregate agricultural supply

Table 2. *Agricultural Supply Function

	OLS		IV	
	1	2	3	4
Price	1.65 (11.9)	1.25 (6.65)	1.66 (11.8)	1.27 (6.47)
Precipitation	.366 (2.81)	.344 (2.74)	.303 (2.18)	.293 (2.19)
Research/Ha.		.123 (2.95)		.122 (2.84)
D 68-70	.372 (2.59)	.297 (2.11)	.379 (2.64)	.303 (2.15)
R^2	.613	.646	.612	.646

*Figures in parentheses are t-ratios. N equals 97 in all equations.

functions fitted to time series data, even with distributed lags (Griliches, 1960). However Griliches argues that the .15 estimate "underestimates severely the 'true' long run elasticity since much of what is here attributed to trend and technological change is actually due to changes in relative prices that are not caught by the conventional price indexes" (Griliches, 1960, pp. 286-8). Estimates of the aggregate agricultural supply elasticity for the United States obtained from less conventional methods range in value from 1.20 to 1.79 (Griliches, 1959, Tweeten and Quance). The results obtained from the cross section data in this study together with the evidence cited above suggest that we ought to at least entertain the possibility that the long run aggregate supply elasticity for agriculture may be eight to ten times larger than the .15 figure which seems to be widely accepted. If it is, then the impact of policy induced price changes on production is substantially larger than generally assumed.

In regard to the two shift variables (precipitation and research), perhaps the most interesting thing is the substantial reduction in the price coefficient that occurs when research enters the equation. In one sence this is to be expected; in another sense not. From a statistical standpoint, the positive correlation betwen price and research ($r = .70$) helps explain why the price coefficient declines when research enters the function. Research simply picks up some of the variation formerly caught by price. However, from an economic standpoint, we should expect research to have the effect of shifting supply to the right thereby reducing price for a given level of demand. In other words, price and research should be negatively correlated, other things constant. As a result the addition of a research or technology variable could be expected to increase the price coefficient rather than decrease it.[6/]

The problem is that "other things" are not constant. One might explain the positive correlation between price and research by policy differences between countries. In nations where policy favors agriculture we would expect more generous support for agricultural research as well as the enactment of price support programs, or at least absence of programs or policies which discriminate against agriculture.

A second and perhaps more likely explanation for the positive correlation between the price and research variables is that research is highly correlated with the two main demand shifters for agricultural products, namely population and per capita income. The extent of this correlation is demonstrated by the regression results presented in table 3. The dependent variable is the same research variable used in the supply function: research publications per hectare of agricultural land. Population also enters the equation on a per hectare of agricultural land basis while income is measured as National Income per capita in U.S. dollars. The price variable is the same as in the supply functions. Both equations are in log form and estimated by OLS.

The strong positive correlation of research with population and per capita income should not be unexpected. Agricultural research benefits consumers; the greater the number of consumers (population) the greater the absolute benefits of research. Perhaps even more important is the fact that in every country there are many competing uses for investment resources. The more people there are in a country and the greater their per capita income, the more resources available for investment purposes. Hence the more that will likely be made available to agricultural research.

Table 3. *Research Regressions

	1	2
Population/Ha.	.846 (5.47)	.835 (5.39)
NI/pop.	1.56 (9.94)	1.50 (6.91)
Price	-.087 -(.206)	-.119 -(.276)
D 68-70	-.124 -(.493)	-.105 -(.409)
D. C. dummy		.175 (.365)
R^2	.765	.765

*The dependent variable is research publications per hectare. The figures in parentheses are t-ratios.

The first reason cited above (total benefits of agricultural research increase with the number of consumers) might be thought of as affecting the demand for agricultural research while the second would bear on its supply.

The negative but insignificant coefficient on output price in the research regressions is a bit of a puzzle. A priori one might expect price to be positively correlated with research since price should be a reflection of how much society values an increase in agricultural output. A possible explanation for the negative and insignificant coefficient on price is that if high agricultural prices are the result of price supports, the resulting surpluses of agricultural products probably dampen the demand for agricultural research.

The rather close correlation between research and the two main demand shifters is a bit worrisome at least in regard to estimating supply functions. To obtain an accurate estimate of the supply elasticity, it is necessary to include the major supply shifters in the supply function being estimated, but it is also necessary that the supply shifters are reasonably uncorrelated with the demand shifters. If one of the main supply shifters, such as research, happens also to be highly correlated with the two main demand shifters, than the resulting regression line could well be closer to a demand function than it is to a supply relation.[7/] At any rate, if there is a bias in the price coefficient due the correlation of research with population and per capita income, it is likely to be in a downward direction towards a negative value.

The D.C. dummary shown in table 3 represents an interesting sidelight of the research regressions. This is a developed country dummy variable which is assigned the value of one for the developed countries in the sample and zero for the LDCs.[8/] The fact that this variable is not statistically different from zero suggests that given their population and per capita income, support for agricultural research in the LDCs is comparable to the support it receives in the developed countries.[9/] On the basis of this evidence, it does not appear that the LDCs are in a position to substantially increase the resources allocated to agricultural research in the near future. What we are more likely to observe is a gradual increase in agricultural research as more resources become available due to population and income growth, particularly the latter. This is not to deny that growth of income will be maximized for a given level of investment only if the rates of return to the various components of total investment are equalized. Thus if the rate of return to investment in agricultural research is greater than it is in other investments, then a nation can increase its rate of economic growth by allocating more resources to agricultural research and less to other investments. Of course, the opposite also holds true.

In view of the relatively high long run aggregate agricultural supply elasticity presented in this paper, it would appear that agricultural production in the LDCs could more readily be increased by allowing agriculture to become a more profitable industry than by achieving large shifts in the agricultural supply function through large increases in research, at least over the next 10 to 20 years. Granted, more favorable farm prices in the LDCs would likely have the effect of speeding up the production and distribution of new technology because of the increase in demand by farmers for modern inputs. This process likely would be facilitated by making the input markets in the LDCs more accessible to the farm supply industries of the developed nations.

Social Costs

In using the estimated supply elasticity presented in this paper to compute the loss of agricultural output and net social costs due to low farm prices in the LDCs, it should be kept in mind that this coefficient represents an average supply response across all the countries in the sample. One might question whether the supply response is in fact the same between countries. For example, it is sometimes argued that peasant farmers in the LDCs are less responsive to price than their commercial counterparts in the developed nations. However, partitioning the data between the DCs and LDCs, running separate regressions, and applying the Chow test, revealed no significant difference in the set of coefficients between the two groups of countries.[10/] In fact the observed difference in the supply elasticity ran in the direction of a larger elasticity for the LDCs, although the difference is not statistically significant at the conventional levels.[11/] At least it seems fairly safe to say that the estimated supply elasticity definitely is not smaller in the LDCs than in the DCs, and may even be larger. One should also be mindful of the likely downward bias in the estimated supply elasticity due to the measurement of output on a per hectare basis and the high correlation of the research variable with the two main demand shifters.

To obtain a rough idea of the magnitude of the reduction in annual agricultural output in the LDCs stemming from low farm prices, the potential level of 1969 output for the 27 countries shown in the right hand column of table 1 is computed using the lower IV estimate of the supply elasticity (1.27) as obtained from equation (4) of table 2. Potential output is estimated

Table 4. Loss of Agricultural Output and Social Cost of Price Distortions in 27 LDCs: 1969

	Loss of Output in Wheat Equivalents with a Bench mark price of:		*Social Cost in U.S. Dollars	
	36.89 (1000 MT)	27.04 (1000 MT)	Total (1000 $)	% of NI
Country				
Mexico	18,258	2,787	8,347	.03
Chile	3,388	663	2,871	.05
Colombia	9,403	1,839	7,963	.12
Morocco	5,001	1,073	4,764	.16
Greece	12,635	4,932	48,727	.58
Tunisia	1,489	588	6,007	.52
Portugal	7,399	3,406	42,728	.74
Kenya	3,820	2,024	31,453	2.45
Ghana	4,752	2,793	43,711	2.53
Panama	1,610	922	16,071	1.89
Jordon	888	516	9,278	1.48
Senegal	3,658	2,233	43,468	5.63
Guatemala	3,042	1,962	42,468	2.94
Iraq	4,952	3,231	71,372	2.73
Cameroon	4,439	3,188	84,578	8.77
Ivory Coast	6,916	5,008	136,194	10.34
Peru	8,581	6,241	170,441	4.74
Uruquay	4,576	3,369	94,601	4.49
Philippines	21,158	15,879	460,412	5.76
Upper Volta	1.646	1,294	40,217	6.63
Argentina	53,206	42,097	1,392,358	6.21
Dahomey	1,713	1,372	46,449	25.24
Burma	23,801	19,531	700,187	38.16
Guyana	1,135	965	38,025	17.77
Khmer Rebpulic	7,395	6,449	263,442	33.60
Paraguay	4,311	3,847	188,733	37.08
Niger	2,284	2,084	100,626	28.92
Total	221,556	140,293	4,095,644	

*Assuming $5.88 per 100 kg of wheat equivalent as an equilibrium price. This is comparable to the 27.04 price ratio.

using both the average price for the 26 countries in the left hand column of table 1 (36.89), and the overall average price for the 53 country sample (27.04) as bench marks. The percent difference between actual and potential output for each country in the right hand column of table 1 is estimated to be 1.27 times the percent difference between the actual and bench mark prices using the bench mark price as the base. One can interpret these figures as the annual loss of food production (in wheat equivalents) in the LDCs resulting from unfavorable farm prices. The results are presented in the first two columns of table 4. The computations reveal that if the 27 countries in the right hand column of table 1 had enjoyed the average price which prevailed in the 26 countries on the left (36.89) over an extended period their 1969 output would have been about 220 million metric tons greater than it was, which amounts to a 63 percent increase over actual output. Using the overall sample average as the bench mark price (27.04), yields a potential output for these countries that is about 140 million metric tons greater than actual output which is equal to a 40 percent increase.

On the basis of this evidence, one strongly suspects that if farmers in the LDCs had enjoyed the level of prices that prevailed in the developed nations, or even in the world market, there would be no such thing as a "world food problem". The likelihood of this being true is reinforced by the fact that the 27 countries listed on the right hand column of table 1 have substantially more agricultural land per capita than the 26 countries on the left. The 27 countries on the right had an average of .95 persons per hectare of agricultural land, in 1969, whereas the corresponding figure for the 26 countries on the left was 3.40. Indeed one might go so far as to say that if farm prices in the LDCs were to approach world market levels these countries likely would become substantial exporters of agricultural products.

Should the governments of LDCs change their policies and allow their internal agricultural prices to approach world market levels (net of transport costs) the resulting increases in agricultural output in these countries would seem to have important repercussions on farmers and consumers in the U.S. and other developed countries. For one thing the exports of agricultural products by the U.S. and other developed countries to LDCs either in the form of P.L. 480 shipments or through commercial channels could be expected to decrease substantially. Perhaps more important would be the increased supplies of agricultural products on the world market which would compete with U.S. and other developed countries products both at home and abroad. The end result would be lower prices for U.S. and other developed country farmers, unless there were severe restrictions on imports of agricultural products from LDCs. Of course consumers in the developed countries should benefit from lower food prices. By the same token, farm supply industries in the developed nations probably would experience some slackening of demand in their domestic markets. However these firms should find greatly expanded opportunities in the LDCs, provided they are allowed to do business in these countries.

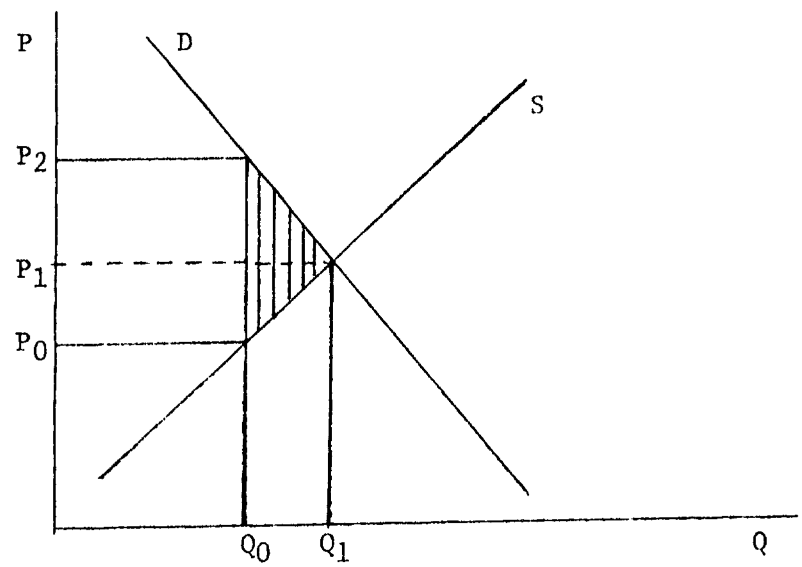
The increased production of agricultural products would not, of course, be free. In the short run resources would have to be drawn from other industries, or imported, in order to increase agricultural output. But even after paying for these resources either in terms of an opportunity cost of domestic nonagricultural production or in the expenditure of foreign exchange, the LDCs still would have something left over as a net gain. One can view this potential net gain as the social cost of holding real price below the market equilibrium level.[12/]

The social cost for countries which hold farm prices below their market equilibrium is illustrated by the shaded triangle in Figure 1. Bear in mind that points on the supply curve represent the opportunity cost or value of output given up to produce a marginal unit of the product, whereas points on the demand curve are a measure of the value to society of the marginal unit of that item. Maintaining price at P_o results in output Q_o. The opportunity cost of producing a marginal unit of Q_o is P_o while the value to consumers of this unit is P_2. Thus the net gain to society of producing one more unit beyond Q_o is equal to the difference between P_2 and P_o. The expansion of output from Q_o to Q_1 continues to result in net gains to society albeit in smaller and smaller increments.

The information necessary to calculate the value of the shaded triangle includes the elasticities of demand and supply as well as values of P_o, P_1, P_2, Q_1 and Q_o. Unfortunately it is not possible to estimate a demand elasticity from the international data. Because of the disequilibria resulting from government price policies, a price-quantity relationship cannot be observed along a demand curve. A demand elasticity figure can be chosen, however, which would likely be an upper bound of the true figure. A price elasticity of demand of minus one should in turn yield a lower bound of the true social costs.[13/]

In order to compute social costs, it is necessary to use a monetary price for each of the values of P_o, P_1, and P_2 rather than a price ratio or pure number as presented in table 1. A U.S. dollar price per 100 kg. of wheat equivalent is computed for each country in the sample by first dividing

Figure 1. The Social Cost of Cheap Food Policies



each country's domestic currency wheat equivalent price by the official exchange rate. The same procedure is utilized to compute a U.S. dollar price of fertilizer for each country. Then a price paid index is constructed by dividing each country's fertilizer price, now in U.S. dollars, by the sample average price for that period and multiplying by 100. The U.S. dollar wheat equivalent price series is then deflated by the prices paid index by the usual procedure of dividing through by the index and multiplying by 100. The resulting deflated dollar price figures are free of any bias caused by exchange rate distortions because the bias runs in the same direction for both the wheat equivalent and fertilizer prices; in the deflating process the bias cancels out.[14/]

With regard to price, the crucial figure is P_1, the equilibrium price for each country. No doubt this price varies between countries depending on how much of the nations' food is imported or exported, and differences in transportation costs. The overall average price of $5.88 per 100 kg. of wheat equivalent for the 53 country sample is selected as a plausible equilibrium price. (This is equivalent to the 27.04 price ratio). The true equilibrium probably is above this value for some countries and below it for others. Utilizing the observed values of P_0 and Q_0, the estimated supply elasticity of 1.27, and the assumed values of minus one and $5.88 for the demand elasticity and equilibrium price, the dollar value of social cost resulting from price distortions is estimated for each of the 27 countries listed on the right-hand side of table 1. The results are presented in the third and fourth columns of table 4. The figures in the third column are the annual (1969) social costs for each country in terms of U.S. dollars, and in the fourth column these figures are expressed as a percent of each country's National Income for 1969. These figures represent the estimated annual reduction in the value of output or "dead weight loss" resulting from price distortions.

For the 27 countries as a group the $4095 million social cost for 1969 is equal to 3.76 percent of their combined National Income. At first glance this appears to be a small figure, but it is interesting to note that a nation which is able to add 3.76 percent to its real National Income each year, by eliminating social costs or for any other reason, will more than double its output every 20 years. Of course, as is shown by the figures in table 4, the estimated social costs differ greatly between countries. As expected, the cost is most significant in countries where the distortion is greatest (doubling the distortion much more than doubles the social cost) and where agriculture makes up a large share of the economy.

Summary and Conclusions

The evidence suggests that real prices received by farmers in the LDCs have been substantially lower than prices received by their counterparts in the developed countries. Differences in real farm prices in the order of magnitude of 4 to 5 times are common between the most and least favorable nations. The evidence also supports the hypothesis that the long run aggregate supply elasticity of agriculture is substantially greater than one and may be eight to ten times larger than the highly inelastic figures generally assumed. The results also indicate that the supply elasticity is not smaller among the LDCs than the DCs, and may even be larger. The inclusion of a research or technology variable in a supply function presents a serious problem for supply estimation because of its high correlation with the two main demand shifters: population and per capita income. Including a research or technology variable in a supply function is likely to have the effect of biasing the estimated supply elasticity downward towards a negative value.

Given their population and per capita income, support for agricultural research in the LDCs appears to be comparable to the support it receives in the developed countries.

The results indicate that if farmers in the 27 LDCs of the sample where farm prices were below the sample average had in fact received the average price which existed in the 26 above average countries (mainly DCs) over an extended period, their output would have been 63 percent greater than their actual output. Or if farm prices in these 27 countries would have been just equal to the overall 53 country average, their output would have been 40 percent greater than what they actually produced. If farmers in the LDCs had been receiving world market prices for their products (net of transport costs) and paying world market prices for purchased inputs, the evidence is quite strong that there would be no such thing as a world food problem. Indeed, under more favorable farm prices the LDCs likely would emerge as major exporters of agricultural products, and in the process would become major competitors to farmers in the U.S. and other food exporting countries, unless the LDC products were shut out of the world market by import restrictions.

Estimates of the social cost or "dead weight loss" resulting from agricultural price distortions in the 27 LDCs of the sample average out to be 3.76 percent of the combined National Income for the group. A nation that is able to add 3.76 percent to its real National Income each year, through the elimination of social costs or for any other reason, will more than double its total output every 20 years.

It is somewhat ironic that so called "cheap food policies" which attempt to hold down food costs for urban people, end up having the opposite effect, at least over the long run. By reducing agricultural output and in the process dampening economic growth, these policies have the effect of increasing the opportunity cost of food for urban people from what it would otherwise be. This occurs because of their dampening effect of economic growth and because people in low income countries give up a larger proportion of their incomes for food than people in the developed nations. For the poorest of the poor in the LDCs, giving up 100 percent of their income sometimes is not enough to save them from starvation during times of adverse growing conditions.

Levying high taxes on purchased inputs used for the production or marketing of food such as fertilizer, pesticides, farm machinery, transportation equipment, and fuel, or restricting their import, have a similar long run effect, although in this case the short run cost of food also is increased. The irony of this case is that attempts to conserve on foreign exchange through taxes or other import restrictions end up reducing the amount of foreign exchange available to a country from what it would otherwise be, as well as reducing its level of output. As long as an extra unit of an imported input increases the export value of output by more than what it costs, the input can be paid for with foreign exchange and there will still be something left over.

As for the inflation problem, there is no evidence to suggest that controls on prices and exchange rates have ever prevented inflation. Such policies may postpone an increase in legal prices for a short time but do nothing to remove the main underlying cause of inflation, namely the practice of printing money by governments to finance their deficits. In fact, the end result of these policies probably is a even larger "inflationary explosion" when shortages and black market prices force the controls to be scraped or revised upward. But of greater consequence is the harm done to the economy because of the price distortions and the resulting decline in economic growth.

Footnotes

*Professor, Department of Agricultural and Applied Economics, University of Minnesota, St. Paul. The author wishes to thank John Blackmore, James Houck, Glenn Nelson and two anonymous referees for helpful comments on previous drafts of this paper without implicating them to any of its shortcomings.

1/ The world market (export) price of each commodity is calculated by dividing the total world value of exports of that commodity (in U.S. dollars) by its corresponding quantity. The source of export prices and quantities is the FAO Trade Yearbook. Some commodities are not exported in the same form as priced at the farm level. Perhaps most important are meat, whole milk, and sugar crops. In an effort to make dressed meat export prices somewhat more comparable to liveweight prices, the former is divided by 2.0 before computing price relatives. In the case of whole milk the price relative is obtained by dividing the price of milk received by U.S. farmers by the world market price of wheat. The price relatives for sugar beets and cane are derived in a similar manner using U.S. and Puerto Rican, beet and cane prices respectively. Cassava (maniac) is not listed among the export commodities.To approximate the price relative of this starchy root, the world export price of potatoes is utilized.

2/ In constructing the quantity variable, the wheat equivalent output of beef, pork, poultry, milk, and eggs was reduced by two-thirds to eliminate the possibility of double counting feed grains used to produce these products.

3/ See British Air Ministry reference for data source.

4/ A current year (1963 and 1969) precipitation variable also was tried but explained slightly less variation in output than the long run average figures. The source of the annual precipitation data is U.S. Dept. of Commerce, Environmental Services Administration, "Monthly Climatic Data for the World." The inclusion of the precipitation variables has relatively little effect on the price coefficient. For example, in equation 1 of table 2, the addition of the long run precipitation variable increases the coefficient on price from 1.62 to 1.65. Adding current year precipitation instead causes the price coefficient to increase to 1.63 in a comparable regression.

5/ The general form of this technique is $\hat{b} = (Z'X)^{-1} Z'Y$, where Z is the matrix of instrumental variables, X is the matrix of independent variables, and Y is the column vector of the dependent variable. Durbin's technique is utilized whereby the deviations from the mean for each independent variable are calculated and then rank ordered from smallest to largest. The deviates compose the X matrix and the rank ordering the Z matrix. It can be shown that $\hat{b}$ is a consistent estimator of each slope coefficient (see Durbin).

6/ Omitting the research or technology variable when it should be in the equation will result in a specification bias of the price coefficient if research and price are correlated. The direction of the bias will be downward if there is a negative correlation between the two variables. This can be shown by the "auxiliary regression" whereby the left out variable (technology or T) is regressed on the included variables, price and weather (P and W), as follows: $T = A + p_1P + p_2\ w + e$. The expected value of b_1, the true price coefficient, is given by $E(b_1) = B_1 + B_2p_1$ where B_2 is the true coefficient on the technology variable and p_1 is the auxiliary regression coefficient on price as shown above. Since B_2 is positive and according to economic theory p_1 should be negative, $E(b_1) < B_1$. This means that the coefficient on price should be biased downward when technology is left out of the equation. (See Theil for the development of specification bias and Griliches, 1957, for an application to production function estimation).

7/ This is analogous on the supply side to Henry Moore's classic mistake on the demand side as pointed out by E. J. Working (See Working).

8/ The developed countries include all of those in the left-hand column of table 1 except South Korea. Pakistan, Spain, Turkey, Sri Lanka, and Cyprus.

9/ The size and significance of the D.C. dummy remains virtually unchanged when price is excluded from the regression.

10/ The countries are grouped as specified in footnote 8. The computed F static is 1.5 whereas the "critical" value of F with 4 and 92 degrees of of freedom is about 3.5 at the .01 level of significance and 2.5 at the .05 level.

11/ Estimating the supply function from the pooled data with a developed country slope dummy on the price variable in an equation comparable to (2) of table 2 yields a coefficient of -.956 (t = -1.87). The LDC price coefficient in this regression is 1.39 (t = 6.29). (A shift dummy is included along with the slope dummy in this case to allow for a difference in the intercept between the DCs and LDCs.) One probably should not make too much out of this measured difference in price coefficients, however, because of the greater variation in price among the LDCs than among the DCs.

12/ There also is a social cost of holding price above the market equilibrium level.

13/ Given the reduction in output, the greater the demand elasticity in absolute terms, the smaller the area of the shaded triangle.

14/ The simple correlation coefficient between the deflated U.S. dollar prices and the price ratios presented in table 1 is .997.

References

Boyce, James K., and Robert E. Evenson, Agricultural Research and Extension Programs, Agricultural Development Council, New York, 1975.

British Air Ministry Meteorological Office, Tables of Temperature, Relative Humidity, and Precipitation for the World, London: Her Majesty's Stationary Office, 1958.

Durbin, J., "Errors in Variables" Rev. Intern. Statist. Inst. 22(1954): 23-32.

Griliches, Zvi, "The Demand for Inputs in Agriculture and a Derived Supply Elasticity," J. Farm Econ. 41(1959):309-22.

________, "Estimates of the Aggregate U.S. Farm Supply Function" J. Farm Econ. 42(1960):282-93.

________,"Specification Bias in Estimates of Production Functions" J. Farm Econ. 39(1957):8-20.

Hayami, Yujiro and Vernon W. Ruttan, Agricultural Development: An International Perspective, Baltimore: The Johns Hopkins Press, 1971.

Johnson,D. Gale, World Food Problems and Prospects, American Enterprise Institute for Policy Research, Washington, D. C. 1975.

Schuh, G. Edward, "General Economic Policy as a Constraint to the Development of Agriculture," in Agricultural Policy: A Limiting Factor in the Development Process Inter-American Development Bank, Washington, D.C. 1975.

Schultz, Theodore W., Economic Growth and Agriculture, New York: McGraw-Hill Book Company, 1968.

Theil, H., "Specification Errors and the Estimation of Economic Relationships," Rev. Intern. Statist. Inst. 25(1957) 41-51.

Tweeten, Luther G. and C. Leroy Quance, "Positivistic Measures of Aggregate Supply Elasticities: Some New Approaches," Am. J. Agr. Econ. 51(1969) 342-52.

United Nations, Food and Agriculture Organization, Agricultural Producer Prices, 1961-70 Rome: 1975.

Working, E. J., "What Do Statistical 'Demand Curve's Show?", Quar. J. Econ. 41(1927) 212-35. Reprinted in George J. Stigler and Kenneth J. Boulding, editors, Readings in Price Theory, Homewood, Illinois: Richard D. Irwin, Inc. 1952, pp. 97-115.