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A major policy confrontation is brewing over United States technical assistance to agricultural development efforts in developing countries. The longer U.S. farming remains in a financial depression due to competitive pressures on its agricultural exports, the more vehement is the criticism that U.S. bilateral and multilateral aid to developing countries, especially to their agricultural sectors, is stabbing American farmers in the back. Directors of international agricultural programs in the nation’s land grant universities feel this heat most directly, as their budgets are subject to review by state legislatures. Most of the faculty involved in these programs also have speaking and extension responsibilities that put them in day-to-day contact with farmers. United States Department of Agriculture and USAID officials are grilled on this topic during their testimony to Congress.

The response to these pressures has been a careful and documented appeal to the empirical record based on a growing volume of academic analysis of the relationship between agricultural growth in developing countries and trends in agricultural imports, especially from the United States. There now seems to be a rough consensus in the agricultural development profession that a positive connection exists between these two dimensions of the development process. The best summary of this view is from Earl Kellogg, an agricultural economist who serves as associate director of the International Agriculture Program for the University of Illinois, in a state that feels very keenly the competitive pressures on exports:

Developing countries continue to be the best potential growth markets for U.S. agricultural exports. To realize this poten-
tial, they must achieve economic growth that results in increased per capita incomes and foreign exchange availability. Because of the size and economic importance of the agricultural sector in developing countries, it must contribute to this economic growth. In addition, developing countries must be able to export products in which they have a comparative advantage. To accomplish this growth in income and exports will require that developing countries obtain capital and technical assistance for agriculture and other economic sectors. If growth and development are achieved, developing countries can continue to be important customers for U.S. agricultural exports.

For a number of reasons, then, improving agricultural and food production in developing countries is important to U.S. interests. These efforts benefit people living in poverty, improve the chances for world peace and stability and also contribute to the long-term prosperity of American agriculture.¹

Most of us in the economic development profession hope that this view—that development assistance benefits both recipient and donor—is true. The historical record is reassuring. A study of the 1961 to 1976 period by Bachman and Paulino for the International Food Policy Research Institute (IFPRI) noted a positive relationship between agricultural production and staple food imports.

The data suggest that staple food exporters have little cause to worry about the rapid growth of food production in the developing countries. Staple food imports in the rapid-growth countries increased much faster than exports, and, consequently, net imports continued to grow. Although the increases in food production in the study countries are impressive, it is evident that in most of these countries food production growth rates need to be maintained or further augmented to meet the increasing demand for staple foods.

The expansion of both staple food exports and imports reflects on one hand the increased production capacity in particular crops in these countries and, on the other, the rapidly increasing demand generated by population growth and rising income levels. Income-induced increases in demand appear to arise from the growing demands for a greater variety of foods as consumption patterns change. Data from a number of rapid-growth countries indicate that part of the
increased demand for staple foods arose from the expanding use of staple foods for conversion into livestock and poultry products.\textsuperscript{2}

Kellogg cites analysis carried out at USDA that also supports this hypothesis.\textsuperscript{3} Lee and Shane present Malaysia as an example of a country that is becoming a consistent and growing importer of U.S. agricultural commodities, especially feedstuffs, while rapidly developing both domestic and export-oriented agriculture.\textsuperscript{4} A masters thesis at the University of Illinois conducted statistical analysis of 77 countries and found that in "no estimated equation were results obtained that showed a negative coefficient significantly different from zero for the correlation between per capita agricultural production in developing countries and their per capita imports of agricultural products."\textsuperscript{5} Case study analysis of Brazil and South Korea as rapidly-growing countries and of Sierra Leone as a slowly-growing country further substantiated these statistical results.\textsuperscript{6}

Thomas Morrison of the IMF Research Department has investigated the long-term and short-term factors affecting cereal imports in 1979/80. On the basis of a regression model for 48 countries which incorporated such long-run factors as GNP per capita, population density on arable land, average annual cereals production per capita (for the years 1977-79), and share of population living in urban areas, as well as short-run factors such as cereal production in 1979 as a percentage of the average, food aid (cereals) per capita, and gross international reserves available at the end of January 1979, relative to the average for the 1977-78 period, Morrison concluded as follows:

Of the long-term determinants, level of economic development is the most significant in explaining cereal imports. The coefficient . . . is positive and significant at the 99 percent confidence level. This result is consistent with the hypothesis that level of economic development, through its relation to consumption demand . . . positively influences per capita cereal imports. The urbanization variable . . . without the GNP variable, has the expected positive coefficient, but the coefficient is not significant.

Of the variables indicating domestic production capacity, only population density is significant. The coefficient is
positive and significant at the 95 percent confidence level. . . . This variable, indicating population pressure on arable land, is the most reliable variable representing total domestic food production capacity.

Cereal production per capita [average] has the expected negative coefficient, but is not significant. One reason why the coefficient is not significant is probably . . . that in many countries non-cereal crops represent significant shares of total food production.

. . . The regression equations explained between 41 and 82 percent of the variation in per capita cereal imports across countries. Since government policies can have a significant influence on the level of cereal imports regardless of country characteristics and circumstances, one cannot expect such regression equations to have greater explanatory power. The fact that the equations have as much explanatory power as they do probably reflects the strong influence the country characteristics and circumstances have on government policies toward cereal imports.

. . . The empirical results yield certain implications for the future of cereal imports by developing countries. It appears that the rapid growth of cereal imports by developing countries during the 1970s, particularly by the middle-income countries, will continue to the extent that these countries experience economic growth and pass into higher stages of economic development. Although population growth in the developing countries has declined from its peak of about 2.4 percent in the mid-1960s to about 2.2 percent currently, increasing population pressure on arable land will continue to be a significant factor affecting cereal imports in the foreseeable future. While food aid as a share of the cereal imports of developing countries has declined considerably over the 1970s, it will continue perhaps in a more limited way to provide cereals to those who could otherwise not afford them. Thus, the same factors that caused the rapid growth of cereal imports by the developing countries during the 1970s will continue to exert their influence in the 1980s.7

This line of argument is reasonable and comforting, but it is now demonstrably wrong for the 1980s. Why? The world debt crisis, the overvalued U.S. dollar, and U.S. farm policy are usually cited as reasons
why exports of U.S. agricultural products to the developing countries have not grown since 1980. Kellogg, for example, drawing on the work at ERS by Longmire and Mory on exchange rate problems and by Shane and Stallings on the debt crisis, offers the following summary and observations:

Although agricultural exports to developing countries have increased in the past several years, total U.S. agricultural exports have recently decreased from $43.8 billion in 1981 to $38.0 billion in 1984. There are three major reasons why this has happened.

1. The exchange rate of foreign currencies for U.S. dollars has increased. For example, it now takes 32 percent more German marks to buy one U.S. dollar's worth of U.S. goods than in 1981. A recent USDA study [Longmire and Mory] concluded that the stronger dollar cost the United States about $6 billion in lost farm exports over the two-year period 1981-83.

2. Some U.S. domestic agricultural policies tend to result in U.S. agricultural commodities being priced above world prices. This is obviously not good policy if one wants to encourage agricultural exports in a competitive world economy.

3. Total world agricultural trade has decreased since 1980 because of reduced economic growth in many countries and increased indebtedness of many developing countries. Shane and Stallings have estimated that the debt problem alone has lead to a loss in potential export sales to developing countries of up to 20 percent.

None of these major reasons for declining U.S. agricultural exports has to do with increasing agricultural production in developing countries which is one of the objectives of U.S. universities and AID collaboration. From 1981 to 1984, developing country per capita agricultural production has essentially remained constant. Therefore, in the aggregate, increases in agricultural production within developing countries has not caused the decline in U.S. agricultural exports since 1981.8

This paper argues that all of these factors—the overvalued dollar, U.S. agricultural policy, and the mounting debt in developing countries—are connected and in turn are related to changing agricultural produc-
tion in developing countries. Although a focus on any specific factor results in a positive relationship between U.S. assistance for agricultural development and subsequent value of U.S. farm exports, the picture is not so positive when all the factors are considered together. In other worlds, a global general equilibrium perspective has different conclusions from those of a partial equilibrium one and has important implications for the role and impact of U.S. foreign assistance. The ultimate conclusions in this paper remain positive, but they contain potentially unhappy messages for American agriculture and the need for it to adjust to new competitive pressures in world markets.

**Explaining Import Demand for Grain**

Why do countries import grain? To ask the question in such a bald way raises several possibilities other than trade patterns determined by short-run costs as reflected in the comparative advantage of trading partners. Recent emphasis on the food price dilemma faced by many developing countries suggests that grain imports might equally be treated as a policy instrument of governments attempting to reach an implicit or explicit set of objectives for their food sectors. These objectives can range from maintaining a price level (frequently "low") for a preferred foodgrain, assuring price stability, providing "control" over foodgrain markets through a government food agency, provisioning a livestock-feeding industry that produces meat for urban consumers, or even gaining the benefits of free trade.9

If the volume of grain imports is determined simultaneously with other important government policy actions, models designed to predict import levels must come to grips with the basic dynamics of each country's political economy. In those countries where foodgrain prices are an important ingredient in those dynamics, as they are in most countries of the world, a complex relationship exists among microeconomic demand patterns, macroeconomic policies, including basic foodgrain prices, and conditions in the world market for food and feedgrains. It is as wrong to think that grain imports are determined by relative costs and comparative advantage as it is that they are determined solely by
"political decisions." Each factor influences the other, primarily through macroeconomic and budgetary forces. Hence, it is necessary to model international grain trading activities in a macro food policy framework.

Figure 1 shows the first of four different levels of detail in specifying such a model. Few would quarrel with the basic relationship specified in Model 1, which says simply that a country's import level is functionally related, through some "black box" of causal mechanisms, to its rate of economic growth. What is in the black box is, of course, crucial. The figure shows that the primary exogenous factor influencing the contents of the black box is a country's development strategy, especially whether an import-substitution or export-promotion strategy is being followed. Much evidence points to a significant influence of this strategic choice on the rate of economic growth itself, not just on its import intensity. This reverse connection between development strategy and economic growth will be incorporated in Model 4 where feedback mechanisms are considered. Obviously, other factors such as a country's size, its natural resource endowment, and so on also influence the relationship shown in Model 1.

**Figure 1**

*Relationship Between Economic Growth and Imports*

**MODEL 1**

<table>
<thead>
<tr>
<th>Expected Statistical Relationship (positive)</th>
<th>Economic Growth</th>
<th>Development Strategy</th>
</tr>
</thead>
<tbody>
<tr>
<td>Import Demand</td>
<td></td>
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</tbody>
</table>
Although Model 1 says nothing at all about demand for agricultural imports from the United States, its trade balance is strongly influenced by the connections in Model 1. In fact, one of the arguments here is that, from the point of view of promoting U.S. exports, far more is at stake in the overall growth process reflected in Model 1 than in agricultural imports per se.

Agricultural imports are the focus of Models 2 and 3. Figure 2 presents a rough summary of the structural relationships posited implicitly or explicitly in the work cited by Kellogg and summarized in a recent report from the Curry Foundation, authored by Paarlberg. The chain of causation is still fairly simple. Agricultural development, including rising staple food production per capita, positively influences the overall economic growth process through another black box mechanism. This growth translates into import demand through the same factors as in Model 1. Overall import demand leads to growing demand for agricultural imports, again through a set of complex causal relationships contained in a black box. In Model 2 the black box connecting agricultural development with overall economic growth is mediated by a country’s food policy. The mechanisms that connect overall level of imports with agricultural imports includes a system of supply and demand relationships for individual commodities as well as the influences of income distribution, urbanization, other demographic factors, and changing tastes. As stressed above, these mechanisms also include the set of food policy objectives, instruments, and interventions.

The expected sign of the statistical relationship between factors connected by black boxes is also shown in figure 2. Normally, each of the three relationships should be positive. Agricultural development leads to economic growth; economic growth leads to larger import demand; and larger overall import demand also leads to larger agricultural imports. The last relationship is the least certain in terms of economic logic and rests primarily on empirical evidence. Since the relationship between rapid income growth and food consumption provides a key piece of that evidence, a review of this nexus is a major part of this paper. Whatever the historical record, however, it is easy to postulate mechanisms that would lead to reduced agricultural imports even in the face of economic growth and rising nonagricultural imports.
Model 2 provides a rough vehicle for understanding the positive relationship that exists in the historical record between a country's agricultural development and its resulting agricultural imports. Each of the black boxes, however, contains important economic and political relationships which are subject to change compared with the historical record. In addition, Model 2 is incomplete in terms of explaining the "stabbed in the back" phenomenon because the role of technical assistance is not yet connected to agricultural development in developing countries, nor are agricultural imports into a particular country translated into the value of U.S. agricultural exports.

Figure 2
Relationship Between Agricultural Development and Agricultural Imports
Model 3 attempts to specify these additional relationships. Great controversy exists over the efficacy of technical assistance in helping low-income countries develop their agricultural sectors. Some would argue that the record is mostly negative; inappropriate technologies and commodities are stressed at the expense of village-level knowledge and foods of the poor. At the other end of the spectrum is a “science solves all food problems” approach which sees a strong positive link between foreign assistance and agricultural development. The black box connecting these two components of Model 3 reflects these controversies by linking technical assistance and agricultural development through the choice of an aid strategy. Perhaps the critical strategic choice is whether the aid focuses on project or policy assistance, a topic which is now receiving much attention in the donor community, with results that are beginning to show in world markets.

Model 3 shows two additional components relative to the simple structure of Model 2. A connection between a country’s agricultural imports and the volume of U.S. agricultural exports is mediated by factors determining the competitiveness of U.S. commodities in international markets, especially exchange rates and domestic pricing policies, as well as by market development efforts by the United States, including the role of the PL-480 program. But the United States is concerned with not only the volume of agricultural exports but their value as well. To connect volume with value, it is necessary to determine the price received for the exported commodity. This connection is shown in Model 3 by the black box that contains the mechanisms of price formation in international commodity markets. This particular black box contains many of the global general equilibrium mechanisms that provide cause for concern that the historical record of the 1960s and 1970s will not play out so nicely for American farmers in the 1980s and 1990s.

Just as in Model 2, all of the expected statistical relationships contained in the black boxes in Model 3 are positive in sign. Considerable debate exists, however, over the two relationships at the bottom. There is no doubt that the total volume of U.S. grain exports, for example, is positively related to the volume of world trade in grain. But figure 4 shows that the structure of that relationship depends critically on the
Figure 3
Relationship Between Technical Assistance and the Value of United States Agricultural Exports

Expected Statistical Relationship

MODEL 3

Technical Assistance

Aid strategy (project versus policy assistance)

Agricultural Development

Agricultural Imports

Market Development -PL-480

U.S. competitiveness -farm policy
-exchange rate

Volume of U.S. Agricultural Exports

Price formation in world commodity markets

Value of U.S. Agricultural Exports
Figure 4
Relationship Between Percentage Change in World Grain Trade and Percentage Change in United States Grain Exports

Statistical Relationship:
\[
\% \text{ change in U.S. grain trade} = -0.0311 + 1.861 \times \% \text{ change in world grain trade}
\]
(1960–1984)  \( R^2 = 0.743 \)  D-W = 2.16
role of the United States in world grain markets. If, as many analysts have argued, the United States has become the de facto "supplier of last resort," the slope of the line that relates percentage changes in the volume of world grain trade to percentage changes in U.S. grain exports will be significantly greater than one. If the U.S. were a large but fully competitive country, the slope should be approximately one. If the United States were a small country in world grain trade, the slope should not be significantly different from zero. For the 25 years between 1960 and 1984 the coefficient was 1.86 and the $t$-statistic 8.2.

An additional issue concerns the strength of the relationship between the volume of U.S. agricultural exports and the value of those exports. If there were a fixed and known elasticity of demand for those exports, the sign could be determined unambiguously. But that elasticity is an outcome rather than a cause of the relationship. Again, three relationships are plausible, depending on the role of the United States in world grain markets and the size and competitiveness of those markets. As figure 5 illustrates, if the United States acts as a supplier of last resort, there should be a positive relationship between changes in the price it receives for grain exports and changes in the volume of those exports, which thus guarantees a positive overall relationship between export volume and export value.

If the United States is merely a regular competitor in world grain markets, there should be no significant relationship between its export volume and price received. If the United States acts as a large competitor in pursuit of market share in world grain markets, however, a significant negative relationship should exist between its export volume and price. This is the critical elasticity of demand for U.S. exports that is needed to determine whether export volume and value are positively related under this trade strategy, but it is precisely the elasticity that is unobservable from historic data if previous policy has not pursued this strategy. The statistical record for the same 25 years shows no significant relationship between percentage changes in either nominal or deflated world grain prices and percentage changes in U.S. grain exports, with or without a one-year lag, although the sign is always negative in the estimated functions.
Figure 5
Relationship Between Percentage Change in United States
Grain Exports and Export Price of Grain

Statistical Relationship:
% change in U.S. grain trade = 0.065 - 0.188 x % change in real price
(1960-1984) (1.7) (1.6) R² = 0.063 D-W = 1.86
= 0.065 - 0.041 x % change in lagged real price
(1.6) (0.3) R² = -0.045 D-W = 2.35
The question can now be put directly: what is known from Model 3 about the relationship between technical assistance and agricultural development in developing countries at the one end and the volume and value of U.S. agricultural exports at the other? The historical record suggests that each black box is likely to encompass a set of mechanisms that generate a net positive relationship between the input factor and the resulting output. If all the black boxes have positive signs, the overall relationship between agricultural development and U.S. agricultural exports should also be positive. This is exactly the result that Kellogg and his colleagues have found. So we have some confidence that Model 3 captures the short-run and partial equilibrium mechanisms connecting these two factors.

Two potentially important elements are missing in Model 3. First, the short-run links treated in Model 3 may be superimposed on more powerful, but lagged, connections that operate in the opposite direction. Some of these lagged relationships are economic but some work primarily through political choices made in the face of pressures emanating from the outcomes in Model 3. Second, price formation in world commodity markets cannot be treated in a partial equilibrium framework. The potential commodity substitutions and impact of financial variables such as debt and exchange rates have a powerful influence on these prices, which in turn enter the economic and political feedback mechanisms just noted. When these concerns are added to the linear format of Model 3, a much more complex set of relationships emerges, as is shown in Model 4 in figure 6.

The unidirectional causation of Model 3 gives way in Model 4 to several circular feedback mechanisms. Two have already been noted: the impact of inward- or outward-looking development strategies on the rate of economic growth and import demand; and the impact of food policy on agricultural development and its mediating role between that development and overall economic growth.14

The broader feedback mechanisms incorporate connections from both markets and political economy dynamics. On the left side of figure 6, signals from world commodity markets influence both agricultural development and economic growth, although with various lags. To the extent that market prices are communicated directly to farmers, the
Figure 6
Feedback Effects in the Relationship Between Technical Assistance and the Value of United States Agricultural Exports

MODEL 4

Technical Assistance

Aid strategy (project versus policy assistance)

Agricultural Development

Food Policy

Economic Growth

Development Strategy

Import Demand

Structure of demand and supply, income distribution, food policy

Agricultural Imports

Market Development

-PL-480

U.S. competitiveness
- farm policy
- exchange rate

Volume of U.S. Agricultural Exports

Price formation in world commodity markets

Market Feedback

Value of U.S. Agricultural Exports

Political Economy Feedback
crucial issue is the supply responsiveness of a nation's farmers to price incentives. This responsiveness is obviously a function of time and of public sector responsiveness as well. At the farm level, farmers might shift the area devoted to various commodities in the short run, or change fertilizer applications. In the longer run they can invest in water control, better production technology, and greater specialization if the market will take away their output and provide ample supplies of needed household consumption items in return.

The influence of world commodity markets on economic growth is through different mechanisms. By determining the amount of foreign exchange earned for a given volume of commodity exports, these markets directly influence how binding the foreign exchange constraint is. At the same time, the signals provide incentives to local entrepreneurs to supply export markets as opposed to domestic markets. Depressed world commodity markets tend to lead to depressed domestic markets through local price competition. Consequently, in those countries that permit relatively free transmission of world market prices into their domestic economies, a strong link exists between those markets and performance in agricultural development and overall economic growth. If one consequence of previous rapid agricultural development (and other factors influencing commodity prices) is to push down those prices on world commodity markets, then at least one market mechanism is established that will dampen further agricultural development and economic growth and thereby lead to a reduction in demand from developing countries for commodities from these markets.

The right side of figure 6 shows that there are important political economy mechanisms that establish this connection as well. Growing agricultural imports, especially at high prices, induce countries to devote more attention to their agricultural sectors to reduce their political exposure to unstable world markets. This wariness must be one of the major outcomes of the world food crisis in the mid-1970s. Some of the high prices of that period were felt directly by farmers as countries simply lost control of their domestic price stabilization programs. More important for the long run, however, was the signal to governments that it would be both expensive and politically dangerous to rely on
world markets for basic grains, a lesson that was reinforced by the soybean embargo and Soviet grain embargo attempted by the United States. The result was implementation of price policies with better incentives for farmers, more investment in rural infrastructure such as roads and irrigation, and far more serious attention to the development of an indigenous agricultural research and extension capacity (all of which are now the ingredients of "good" policy advice).

All of these changes take time to manifest themselves in terms of increased output, but when it arrives on domestic markets, a double-edged effect is felt on import demand from world commodity markets. Higher real prices in domestic markets induce both greater production and reduced demand. The result is sharply reduced import demand or even a switch to exports of important food and feed grains, as in the case of Indonesia, China, and India. If related factors such as falling petroleum prices and high debt levels are contributing to slowed economic growth in low- and middle-income countries, the added market supplies meet very sluggish growth in demand and thus exacerbate the downward price pressures on agricultural commodity markets. In a rather perverse twist, the falling petroleum prices and attempts to earn foreign exchange to meet debt repayment schedules reinforce these dynamics because agricultural exports have a shorter lead time and learning curve than industrial exports and face less protection in developed countries (until now). A rather vicious downward spiral is set in motion, which was initiated by an apparently healthy response to the world food crisis of the 1970s and the recycling of petrodollars.

How does the United States respond in such a situation? With surplus agricultural commodities on hand and a stark picture of hunger televised on the evening news, one temptation is to renew the market development thrust of the PL-480 program, to feed the hungry with America’s bounty. But the potential dangers to agricultural development efforts of dumping our surpluses in substantial quantities into a country’s domestic food markets are now well recognized. Most countries would accept such food aid only if it directly offset commercial imports otherwise planned. Since this is contrary to both the letter and intent of the law, sharply expanded PL-480 shipments do not seem possible.
The commercial competitiveness of U.S. commodities is determined primarily by the value of the dollar in foreign currency markets and by domestic farm policy. Both of these factors are affected by prices in world markets and, in turn, have feedback effects on the outcome of each of the relationships shown in Model 4. Just as the devaluation of the dollar in the early 1970s for reasons unconnected to agriculture stimulated U.S. agricultural exports and farm earnings, so did its progressive revaluation during the early 1980s dampen those exports and earnings. The U.S. Congress does not legislate much positive agricultural trade policy; it does, however, set domestic agricultural price policy to protect farm incomes. The effect until the 1985 Farm Bill was to set the prices of many U.S. export commodities above those of the competition and thus lose market share, which resulted in higher prices for our competitors than would prevail with open competition.

The political economy dynamics of this approach are now becoming clear. Large budget deficits forced Congress to design a more competitive farm price policy even in the face of existing low incomes in the American farm sector (but large deficit costs remained because of continued target price support). Additional commodities will move onto world markets and drive prices down even further, at least temporarily. The lower prices make imports even more attractive to those countries open to international grain trade, but they simultaneously threaten further those countries that maintain active price policies on behalf of their farmers. Providing better price incentives to farmers in developing countries has become a main theme of policy advice that accompanies technical and financial assistance. A major contradiction is emerging between market signals and important elements in the agricultural development process. As American farmers watch more and more countries protect themselves from the pressures of low-priced U.S. agricultural commodities, the political pressures will increase on the land grant universities, USAID, and USDA to stop their assistance to agricultural development programs. Slowing the pace of agricultural development, however, will in fact slow the pace of economic growth in the developing countries. They will then serve as less dynamic markets for U.S. exports of all goods and services, including, in the short run, exports of agricultural commodities.
The Historical Record and Income-Led Growth

Despite the perilous and complicated feedback mechanisms that seem to be operating in Model 4, the long-run growth of agricultural imports in developing countries has been a stimulus to U.S. agricultural exports. Figure 7 shows the shares of U.S. agricultural exports to various destinations for fiscal year 1976-77 and projected for 1984-85. The share of developing countries, including China, rose from 35.5 percent in 1976-77 to 40.4 percent in 1984-85. The nominal value of total exports rose roughly 60 percent during that time while the consumer price index rose about 80 percent. After inflation, the real purchases of U.S. agricultural commodities by developing countries remained almost constant, helping to offset a decline in the real value of purchases from Western and Eastern Europe, Canada, and Oceania. Real purchases from Japan and the U.S.S.R. increased significantly.

Two quite separate forces seem to be at work in generating the increased demand for agricultural imports in developing countries. The first, and the smaller in absolute terms, is the failure of domestic agricultural production to keep pace with population growth and food demand in urban areas. This is primarily an African phenomenon. Table 1 shows that African imports of grain have increased from a total of 5.9 million metric tons in 1970 to an average of 24.9 million metric tons for the 1980-83 period, or by 13.3 percent per year. During the same period, production of corn, rice, and wheat increased 2.2 percent per year, substantially behind the 2.9 percent per year increase in population. Real per capita incomes have also been falling during this time, although certain regions and countries have shown significant increases.16

The great bulk of increased demand for U.S. agricultural exports over the past two decades has come from income-induced patterns of food consumption. This is most readily apparent from table 2, which is reproduced from Monke’s paper on international grain trade for the World Bank.17 Total growth in import demand for cereals between 1948-52 and 1979-81 was over 170 million metric tons, of which Monke attributes about 30 million metric tons to declines in per capita grain production and about 33.5 million metric tons to population growth.
Figure 7
U.S. Agricultural Export Percentage Shares to Selected Destinations 1976-77 and Projected 1984-85 Fiscal Years

Fiscal Year 1976-77

Western Europe—36.5
Latin America—6.0
Canada—6.6
Africa—5.6
Middle East—4.6
USSR—4.4
Eastern Europe—2.7
Oceania—0.6
Others—7.5
Japan—13.6
Taiwan & Rep. Korea—8.9
People's Rep. China—0.003

Fiscal Year 1984-85

Latin America—13.9
Western Europe—24.5
Canada—4.6
Africa—7.2
Middle East—4.8
USSR—10.2
Eastern Europe—2.0
Oceania—0.7
Others—1.9
Japan—17.6
Taiwan & Rep. Korea—11.6
People's Rep. China—1.0

The remainder, 107 million metric tons, is a residual that must be accounted for by rising per capita incomes, changing tastes, urbanization, and so on.

Table 1
African Grain Imports by Region in Millions of Metric Tons
1970 and Yearly Average 1980-83

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Corn</td>
<td></td>
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<tr>
<td>N. Africa</td>
<td>.10</td>
<td>2.03</td>
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<tr>
<td>S. Africa</td>
<td>.20</td>
<td>.37</td>
<td>+85</td>
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<tr>
<td>Sub-Saharan Africa</td>
<td>.41</td>
<td>1.46</td>
<td>+256</td>
</tr>
<tr>
<td>Total</td>
<td>.71</td>
<td>3.87</td>
<td>+445</td>
</tr>
<tr>
<td>Rice</td>
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<td></td>
<td></td>
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<tr>
<td>N. Africa</td>
<td>.05</td>
<td>.25</td>
<td>+400</td>
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<tr>
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<td>+100</td>
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<tr>
<td>Sub-Saharan Africa</td>
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<td>2.43</td>
<td>+274</td>
</tr>
<tr>
<td>Total</td>
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<td>Wheat and Wheat Flour, Wheat Equivalent</td>
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<td>S. Africa</td>
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<tr>
<td>Sub-Saharan Africa</td>
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<tr>
<td>Total</td>
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<td>+312</td>
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</table>

Totals may not add up due to rounding.

The patterns of food demand generated by rising incomes have been studied for well over a century, and Engels Law—the declining share of food expenditures in total household expenditures as per capita incomes rise—has been well-documented from both time series and cross
Table 2
Sources of Growth in Import Demand for Cereals
1948/52 - 1979/81

<table>
<thead>
<tr>
<th>Region</th>
<th>Total growth</th>
<th>Declines in per capita production</th>
<th>Population growth</th>
<th>Residual</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>(million metric tons)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Developed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market economics</td>
<td>46.02</td>
<td>9.33</td>
<td>17.83</td>
<td>18.86</td>
</tr>
<tr>
<td>CPEs</td>
<td>46.30</td>
<td>0</td>
<td>1.74^a</td>
<td>44.56</td>
</tr>
<tr>
<td>Developing</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market economics</td>
<td>58.34</td>
<td>19.02</td>
<td>10.80</td>
<td>28.52</td>
</tr>
<tr>
<td>Africa</td>
<td>(11.50)</td>
<td>(9.66)</td>
<td>(1.11)</td>
<td>(0.73)</td>
</tr>
<tr>
<td>Latin America</td>
<td>(18.59)</td>
<td>(1.90)</td>
<td>(4.04)</td>
<td>(12.65)</td>
</tr>
<tr>
<td>Near East</td>
<td>(17.04)</td>
<td>(2.34)</td>
<td>(1.80)</td>
<td>(12.90)</td>
</tr>
<tr>
<td>Far East</td>
<td>(11.21)</td>
<td>(5.12)</td>
<td>(3.83)</td>
<td>(2.26)</td>
</tr>
<tr>
<td>CPEs</td>
<td>19.58</td>
<td>1.38</td>
<td>3.14^a</td>
<td>15.06</td>
</tr>
<tr>
<td>Total</td>
<td>170.24</td>
<td>29.73</td>
<td>33.51</td>
<td>107.00</td>
</tr>
</tbody>
</table>


^a Calculations for CPEs are made for the 1960-80 period, due to lack of data on intra-CPE trade for the 1948/52 period. Trade between market economics and CPEs was extremely small during this period, but increased substantially during the 1950s. If per capita imports by CPEs during the 1948/52 period were assumed equal to those of 1960, the effects of population growth on trade would increase to 2.77 and 4.15 million metric tons for the developed and developing CPEs, respectively. These calculations yield overestimates, and do not alter the conclusions presented in the text.
section data. The changing composition of the diet with rising incomes has also been scrutinized as agricultural ministries search for commodities with bright prospects for consumer demand in order to maximize the payoff to their research and extension efforts.

Relatively less attention has been given to the indirect demand for commodities generated by the food consumption patterns of the more affluent. In 1974, Lester Brown presented a striking table showing the indirect demand for grain at income levels at which grain-fed livestock products became affordable. Grain demand per capita in the United States and Canada, for example, totaled five times the amount in India or China. In times of grain shortages and pessimism over future supplies, this large indirect demand for grain was interpreted as a threat to the world’s capacity to feed its poorer population. In times of surplus, indirect demand for grain is seen as an important source of export markets for U.S. farmers, and so it is worth examining the relationship between income and grain demand more closely.

The relationship depends heavily on the distinction between quantity and quality of the diet. Both of these attributes change as incomes increase, but the quality dimension is much more income-elastic after minimum caloric intake levels are reached. Tables 3 and 4 report the results of a systematic attempt to quantify these different trends; Appendix 1 shows the sources of data for the 34 countries in the sample and the composition of the 117 cases drawn from those countries. The income variable is measured in purchasing power parity as determined by Kravis and his colleagues. Prices are measured with similar adjustments to market or official exchange rates; consequently much of the real income effect of different price levels between poor and rich countries has already been captured in the income variable. Any significance of the variable measuring food prices relative to nonfood prices is thus capturing a pure substitution effect rather than an overall market effect, which includes both the real income effect of price changes as well as the substitution effect.

The first seven equations have log of caloric intake as the dependent variable. For the total sample, per capita income has a very high explanatory power, and the income elasticity is equal to 0.20 when income is entered alone in Equation C1. It remains as high as 0.15 in
Table 3
Elasticity Coefficients from Calorie Intake Regression Analysis
Using Double Logarithmic Functions
(r-statistics in parentheses)

<table>
<thead>
<tr>
<th>Equation</th>
<th>Per capita income</th>
<th>Food prices</th>
<th>Calorie requirement</th>
<th>Constant terms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Overall</td>
<td>Low income</td>
<td></td>
</tr>
<tr>
<td>Number</td>
<td>R²</td>
<td>Sample</td>
<td></td>
<td></td>
</tr>
<tr>
<td>C1</td>
<td>0.75</td>
<td>Total</td>
<td>0.20 (18.77)</td>
<td>7.24</td>
</tr>
<tr>
<td>C2</td>
<td>0.76</td>
<td>Total</td>
<td>0.19 (16.04) -0.10 (1.37)</td>
<td></td>
</tr>
<tr>
<td>C3</td>
<td>0.77</td>
<td>Total</td>
<td>0.18 (13.77) -0.20 (2.44)</td>
<td></td>
</tr>
<tr>
<td>C4</td>
<td>0.78</td>
<td>Total</td>
<td>0.15 (9.07) 0.81 (3.58)</td>
<td></td>
</tr>
<tr>
<td>C5</td>
<td>0.78</td>
<td>Total</td>
<td>0.15 (8.58) -0.12 (1.46) 0.70 (2.96)</td>
<td></td>
</tr>
<tr>
<td>C6</td>
<td>0.04</td>
<td>DC</td>
<td>0.06 (1.30) -0.05 (0.30)</td>
<td></td>
</tr>
<tr>
<td>C7</td>
<td>0.60</td>
<td>LDC</td>
<td>0.15 (8.67) -0.10 (1.48)</td>
<td></td>
</tr>
</tbody>
</table>
### Table 4
Elasticity Coefficients for Various Aspects of Diet Quality
Using Double Logarithmic Regression Functions
(r-statistics in parentheses)

<table>
<thead>
<tr>
<th>Equation</th>
<th>Per capita income</th>
<th>Constant terms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Overall</td>
<td>Low income</td>
</tr>
<tr>
<td><strong>Starchy staple ratio</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Q1 0.74 Total</td>
<td>-0.39</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>(18.25)</td>
<td>(1.57)</td>
</tr>
<tr>
<td>Q2 0.75 Total</td>
<td>-0.35</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(11.50)</td>
<td>(5.57)</td>
</tr>
<tr>
<td>Q3 0.80 Total</td>
<td>-0.67</td>
<td>0.45</td>
</tr>
<tr>
<td></td>
<td>(10.19)</td>
<td>(5.58)</td>
</tr>
<tr>
<td>Q5 0.56 DC</td>
<td>-0.64</td>
<td>0.25</td>
</tr>
<tr>
<td>Q6 0.41 LDC</td>
<td>-0.23</td>
<td>0.04</td>
</tr>
<tr>
<td></td>
<td>(6.39)</td>
<td>(0.85)</td>
</tr>
</tbody>
</table>

**Protein**

| Q7 0.64 Total          | 0.25    |            | 3.46    |            |                          |
|                        | (14.32) |            | (14.32) |            |                          |
| Q8 0.01 DC             | 0.04    |            | 4.36    |            |                          |
|                        | (0.85)  |            | (0.85)  |            |                          |
| Q9 0.22 LDC            | 0.15    |            | 3.69    |            |                          |
|                        | (4.11)  |            | (4.11)  |            |                          |

**Animal Protein**

| Q10 0.81 Total         | 0.77    |            | 0.72    |            |                          |
|                       | (22.39) |            | (22.39) |            |                          |
| Q11 0.41 DC            | 0.47    |            | 2.00    |            |                          |
|                       | (6.19)  |            | (6.19)  |            |                          |
| Q12 0.52 LDC           | 0.65    |            | 0.97    |            |                          |
|                       | (8.03)  |            | (8.03)  |            |                          |
Equation C5 when variables are included for calorie requirements (which reflect average body size, activity levels, and climate) and for price response in low-income countries.

When the price variable is added in Equation C2, the income elasticity drops only slightly; the price elasticity is \(-0.1\) and significant only at the 10 percent level. Prices and incomes are negatively correlated after the Kravis adjustments, and so the income variable captures some of the price effect. With prices alone in the equation, the estimated elasticity rises in absolute value from \(-0.10\) to \(-0.66\).

The elasticities for developing countries are expected to be larger than those for developed countries. The income elasticity should be higher because caloric intake has physical limits—"the narrow confines of the human stomach." The price elasticity estimated here, which is close to a pure substitution effect, should be higher because of the "Timmer effect," which states that "the pure substitution elasticity tends to decline in absolute size as incomes rise at about half the rate of decline in income elasticities..." 20

These issues are tested in Equations C6 and C7, which report separate equations for subsamples of the developed and less-developed nations. The income and price elasticities for developed countries are much lower than those for the developing countries and were not statistically significant. The Timmer effect was roughly confirmed. The decline in income elasticity from 0.15 for low-income countries to 0.06 for the high-income countries represents a decline of 60 percent. The decline in the substitution elasticity should therefore be about 30 percent. The actual decline is 50 percent, but a 30 percent decline is well within the likely margin or error.

The estimates of the "calorie requirement elasticity" in Equations C4 and C5 have little operational meaning other than the obvious: a 1 percent increase in "requirements" does not automatically lead to a 1 percent increase in caloric intake. Per capita incomes and food prices play a critical role in determining whether requirements can actually be satisfied.

Three measures of dietary quality are analyzed in table 4. Equation Q1 shows the starchy staple ratio regressed against income. The elasticity
of -0.39 is highly significant and has substantial predictive power, as
the simple equation has an $R^2$ of 0.74. Even the introduction of low-
income slope and intercept shifters, along with a price term, raises the
$R^2$ only to 0.80. Per capita incomes are clearly the dominant factor ex-
plaining this measure of dietary quality. To the extent a difference is
likely to exist in income elasticities for the starchy staple ratio, the
elasticity for developed countries should be larger in absolute terms.
This would happen partly because the population of poor countries would
exhibit a certain inertia in behavior—many wealthy individuals in Asia
do not feel they have "eaten" without rice at a meal. In addition, signifi-
cant scope exists for upgrading the diets of low-income populations
within the context of starchy staples. Wheat can thus substitute for
sorghum, or maize for cassava, and then rice for maize. Only when
diets begin to diversify dramatically in quantitative terms to meat, sugar,
fish, milk, and other high-quality and expensive calories does the
starchy staple ratio decline rapidly.

This hypothesis is borne out in Equations Q5 and Q6. Separate equa-
tions for developed and developing countries show that the income
elasticity of the starchy staple ratio is -0.64 and -0.23, respectively.
Both coefficients are highly significant. A different formulation in Equa-
tion Q3 using dummy variables for low per capita incomes found vir-
tually identical results.

The three equations for protein illustrate a characteristic of this par-
ticular sample and a behavioral relationship of some significance. Equa-
tion Q7 shows a protein-income elasticity of 0.25 when the total sam-
ple is combined. When the sample is split, the elasticity for developed
countries is 0.04 and the low-income elasticity is 0.15. Neither elasticity
from the split sample is as high as from the combined sample. Normal-
ly, the elasticity for the total sample should be a weighted average of
the two subsamples. That is not true here for two reasons. First, the
developed country sample represents a different population from that
of the developing country sample due to different calorie requirements
as well as to a host of other "modern" traits that do not come immediate-
ly with higher incomes. Second, patterns of behavior take considerable
time to adjust to changed income levels. The elasticities for each sam-
ple separately can be thought of as representing short-run adjustments to income change, whereas the elasticity for the combined sample represents a long-run adjustment.

Equations Q10 to Q12 examine the relationship between animal protein and incomes. The income elasticity for animal protein is 0.77 for all countries but only 0.65 and 0.47 for developing and developed countries, respectively, which again shows the potential importance of short-run versus long-run dietary adaptations to income change. The implications of these large income elasticities for animal protein can be seen in table 5, which is patterned after Brown and reports both direct consumption of grain per capita and indirect consumption through livestock feeding, for a variety of countries from the United States to India.21 Despite direct intake of grain in the United States of almost exactly one-half the Indian level, total grain consumed is 4.5 times as large as India’s total grain consumption per capita—646 kilograms per years as opposed to 143 kilograms. The level was even higher before U.S. livestock feeders sharply reduced their feeding of grain in the wake of high grain prices in the mid-1970s.

A significant impact will be felt on world grain markets if “follower” countries adopt American-style diets and the indirect demand for grain implicit in them. If all the countries from Japan and below in table 5 were to reach the average level of grain consumed in the United Kingdom and Germany (340 kilograms per capita per year, a figure only slightly more than half the United States level), more than 300 million metric tons of additional grain would be needed, a figure equal to one-sixth of global production of grain. Excluding both India and China from the calculation leaves an added grain demand of more than 60 million metric tons, more than one-quarter of world grain trade in recent years.

If income growth proceeds rapidly in these countries, the derived demand for grain through increased meat consumption will be a major factor determining the balance between supply and demand in world grain markets. Failure of incomes to grow as rapidly as in the past, however, will depress demand and could lead to significant grain surpluses in years of good harvests. If, in addition, there has been a structural change in the interaction of developing countries with world grain markets, as was argued previously, the outlook for American
grain farmers is bleak indeed. This bleak outlook stems not from "sur-
prises" in the black boxes, that is, in fundamentally different mechanisms
connecting each level of a developing country's food system with the
next. Rather, the changed outlook comes through the relatively greater
importance of feedback mechanisms as income growth slows down. The
more that income growth is stimulated through assistance to agricultural
development, the more powerful will the feedback effects become. In
addition, a set of largely external factors are impinging to make the pros-
ppects for U.S. grain exports in the 1980s less favorable than they were
in the 1970s or even the 1960s.22

Table 5
Annual Per Capita Grain Consumption in Selected Countries
1975-1977 Average

<table>
<thead>
<tr>
<th>Country</th>
<th>Grain consumed directly (kgs)</th>
<th>Grain consumed indirectly (kgs)</th>
<th>Total grain consumed (kgs)</th>
<th>Total grain consumed as multiple of India's consumption</th>
</tr>
</thead>
<tbody>
<tr>
<td>USA</td>
<td>63</td>
<td>583</td>
<td>646</td>
<td>4.5</td>
</tr>
<tr>
<td>USSR</td>
<td>141</td>
<td>444</td>
<td>585</td>
<td>4.1</td>
</tr>
<tr>
<td>Argentina</td>
<td>100</td>
<td>275</td>
<td>375</td>
<td>2.6</td>
</tr>
<tr>
<td>Germany</td>
<td>67</td>
<td>288</td>
<td>355</td>
<td>2.5</td>
</tr>
<tr>
<td>U.K.</td>
<td>71</td>
<td>254</td>
<td>325</td>
<td>2.3</td>
</tr>
<tr>
<td>Japan</td>
<td>132</td>
<td>144</td>
<td>276</td>
<td>1.9</td>
</tr>
<tr>
<td>Korea</td>
<td>199</td>
<td>54</td>
<td>253</td>
<td>1.8</td>
</tr>
<tr>
<td>Brazil</td>
<td>91</td>
<td>124</td>
<td>215</td>
<td>1.5</td>
</tr>
<tr>
<td>China</td>
<td>156</td>
<td>52</td>
<td>208</td>
<td>1.5</td>
</tr>
<tr>
<td>Philippines</td>
<td>131</td>
<td>35</td>
<td>166</td>
<td>1.2</td>
</tr>
<tr>
<td>Indonesia</td>
<td>142</td>
<td>10</td>
<td>152</td>
<td>1.1</td>
</tr>
<tr>
<td>India</td>
<td>128</td>
<td>15</td>
<td>143</td>
<td>1.0</td>
</tr>
</tbody>
</table>

NOTE: Grain consumed indirectly is not corrected for imports and exports of meat and poultry.
The first of these factors is the unusual pattern of economic growth in the 1970s. The especially successful examples of agriculturally-led economic growth spilling over into rising agricultural imports have been in East Asia—Japan, South Korea, and Taiwan. All three countries have very low ratios of land to population, and all have relied heavily on industrial exports to the United States and Western Europe to fuel their growth, which has been extraordinarily rapid by either historic or contemporary comparative standards. While further gains in U.S. agricultural exports to these markets are possible, the largest increases have already been achieved. In addition, the United States faces sharp competition for these markets from other Asian countries whose export sectors have been stimulated by market-oriented food policies and the new structure of world commodity markets. Thailand, China, and Indonesia have the capacity to meet much of the rising demand for feedgrains in South Korea, Taiwan, and Japan. If Burma and Indo-China ever adopt market-oriented food policies that provide better farm incentives and public infrastructure for improved agricultural productivity, Asia could be awash in surplus grain.

The opportunities to reproduce the East Asian pattern of the 1960s and 1970s are practically nil. The lucrative markets of the OECD countries are increasingly closed to exports from newly industrializing countries. To earn the foreign exchange needed to import capital goods and to pay existing debt, most countries will be forced to export agricultural rather than industrial goods. The result will be added competition in world commodity markets, either directly as with rice, corn, soybeans, or cotton, or indirectly as with palm oil, rubber, or jute. As more countries seek sources of growth in agriculture, these competitive pressures will increase, and commodity prices will remain depressed.

Second, the technological basis for agricultural development in the 1980s and 1990s is likely to be significantly different from that in the 1970s. The Green Revolution of the 1970s was primarily based on wheat and rice systems with good water control. Much of the increase in U.S. agricultural exports in the 1970s was in coarse grains and soybeans, crops for which little new technology was applicable to the tropics. Because of significant progress in breeding and cultivation techniques,
substantially higher yields for most of the coarse grains are now possible in the humid tropics, and similar progress may be in sight for legumes.23

A third factor depressing the outlook for U.S. agricultural exports is the erosion of its cost advantage in producing higher value-added products such as broilers, soymeal and oil, and textiles. When the basic commodities that provide the raw materials for these products cost more for domestic producers than they do for international competitors such as Thailand, Brazil, or China, it is impossible to retain markets previously established or to gain new ones. Between 1980-81 and 1983-84, the export of oilseed meals and poultry dropped by 34.4 percent, whereas overall U.S. agricultural exports fell by "only" 10.8 percent.

In total, three general sets of factors seem destined to make the 1980s a very different decade from the 1970s for American farmers: reduced global rates of growth in incomes; general equilibrium feedback effects on world commodity markets; and several specific features with respect to countries, technologies, and cost structures. There is only a limited response that U.S. policy can make in this new environment. Reducing the value of the dollar by bringing government expenditures in closer balance with revenues may raise the dollar price of commodities in world markets and help make American farmers more competitive, but it will make exports from developing countries less competitive and slow their rate of growth. The net effect on commodity markets is not clearly positive, and the dollar's decline since February 1985 has not helped very much by early 1987.

A more competitive pricing structure for U.S. farm products will help regain market share and also lower input costs for value-added products. But it will also drive down prices in world markets, at least in the short run, leaving basic commodity producers worse off.

United States technical assistance can focus on raising agricultural productivity in developing countries and rely on historical relationships to speed their economic growth and demand for agricultural imports. But if the lagged feedback mechanisms from both the market and political economy continue to push countries toward smaller food imports and increased emphasis on agricultural exports, the general equilibrium con-
sequences of this strategy mean it will backfire as a vehicle for assisting American farmers.

One can only conclude that no solution exists to the problem of low incomes of American farmers if the policy intends for present farmers to produce more output at higher prices. A competition-oriented policy that drives down world prices may eventually force some high-cost competitors, especially smaller farms in Europe, out of the market, but it will lead to a significant shake-out of American producers as well. From the comfort of a university it is easy to say that this is inevitable, even good for farmers, because they will earn higher incomes in the industrial or service sector. Jobs in those sectors, however, depend on the general health of the United States economy, and this in turn depends on overall American competitiveness and capacity to sell abroad. And this returns the story to the very simple relationship in figure 1, in which economic growth in developing countries leads to increased import demand in general. Finding ways to help these countries speed their general development process is the critical task for the United States if it wants a healthy economy at home. The evidence and logic point to rapid agricultural development as the key to this process, even if it increases competitive pressures on American agriculture through a complicated web of feedback and general equilibrium processes. Policies that help farmers cope with these pressures by easing the pain of structural change are the only appropriate response.

NOTES


6. The analysis is contained in a thesis being written by Richard Kodl at the University of Illinois.


11. This food policy also has feedback effects on the agricultural development effort itself, in analogous fashion to the feedback effects of development strategy on overall economic growth noted in Model 1. These effects are incorporated in Model 4.


22. The following discussion has benefited from ongoing conversations with Wally Falcon about these topics.

Appendix 1

Sources of Data


FAO, *Fourth World Food Survey*, 1977, for data on calorie requirements.


The 34 countries in the sample, with the number of observations for each, are as follows:

**Developed countries**

- Austria (3)
- Hungary (2)
- Luxembourg (4)
- Spain (4)
- Germany (4)
- Belgium (4)
- Ireland (4)
- Netherlands (4)
- United Kingdom (4)

17 countries; 56 cases

**Less-developed countries**

- Brazil (3)
- Jamaica (3)
- Malaysia (4)
- Sri Lanka (4)
- Zambia (3)
- Colombia (4)
- Kenya (4)
- Mexico (4)
- Syria (3)

17 countries; 61 cases

**TOTAL SAMPLE:** 34 countries; 117 cases