DIVISION OF AGRICULTURE AND NATURAL RESOURCES
UNIVERSITY OF CALIFORNIA

Working Paper No. 435

AGRICULTURAL DEVELOPMENT LED INDUSTRIALIZATION IN A GLOBAL PERSPECTIVE

by

Irma Adelman, Jean Marc Bournieux, and Jean Waelbroeck

California Agricultural Experiment Station
Giannini Foundation of Agricultural Economics
December, 1986

AGRICULTURAL DEVELOPMENT LED INDUSTRIALIZATION IN A GLOBAL PERSPECTIVE

Irma Adelman
University of California, Berkeley

Jean Marc Bournieux

Jean Waelbroeck
Free University of Brussels

Paper presented at the International Economic Association World Congress on Agriculture-Industry Interactions, December 1-6, 1986, New Delhi, India.

Preliminary draft

AGRICULTURAL DEVELOPMENT LED INDUSTRIALIZATION IN A GLOBAL PERSPECTIVE

1. Introduction

The theme of this conference is the balance between agriculture and industry. The aim of our paper is to explore this issue within the framework of a global agricultural model, which traces out the static and dynamic effects of alternative strategy sequences with respect to the two sectors.

While we believe that in the long run agricultural and industrial expansion must be in balance, several strands of research indicate that an optimal development pattern in the next decade will require unbalanced investment strategies. First, historical research on the early stages of growth of currently developed countries indicates that the Industrial Revolution started in countries that had already experienced substantial increases in agricultural productivity (Bairoch (1973); Jones (1967); Adelman and Morris (1984)). Economies that had not done so (e.g., Tsarist Russia) quickly ran into trouble with their industrialization programs and were unable to maintain high rates of industrial development. By contrast, developing countries have generally neglected their agricultural sectors and invested the overwhelming bulk of their resources in other branches of activity, thus starting their industrialization programs in economies characterized by low productivity agricultural sectors. The World Bank report on agriculture, for example, indicates that in most developing countries the share of investment in agriculture is only between 5 and 10 percent of total investment (World Bank (1982)).

Secondly, individual country experience with agricultural strategies implemented in open economy trade regimes has been quite favorable. This is evidenced by the recent experience of India and Mainland China as well as by the earlier experience of Korea and Taiwan in the late 1960s and early 1970s. By contrast, the experience of most developing countries in the 1970s has demonstrated that, in the absence of increases in agricultural productivity, countries quickly find themselves in balance-of-payments problems as they find themselves compelled to import food in order to avoid upsurges in real wages that would jeopardize their industrialization programs.

Third, simulations with single-country computable general equilibrium (CGE) models (Adelman (1984); de Janvry and Sadoulet (1986)) have indicated that, with current initial conditions and in the present low-growth world environment, an Agricultural Development Led Industrialization (ADLI) strategy leads to higher rates of economic growth, better income distribution, more rapid industrialization, and a stronger balance of payments than does continuation of a purely export-led growth strategy. The main reasons for the favorable result of the ADLI strategy are that: (1) the strong domestic linkages of agriculture with manufacturing, through both the demand and the input sides, lead to high domestic demand multipliers for agricultural output; (2) investment in agriculture is less import intensive and more labor intensive than investment in industry and so is agricultural production; (3) the rate of return to investment in agriculture is high, equal to, or exceeding that of investment in industry as indicated in the World Bank study devoted to agriculture (World Bank (1982)); and, last but not least, (4) as long as the agricultural sector is poorer than the urban sector, policies that raise the incomes of farmers improve the domestic size distribution of income.

But can the benefits indicated by single-country CGE models be achieved if all less-developed countries (LDCs) were simultaneously to implement ADLI strategies, or would the inelasticity of world demand lead to a sufficiently large decline in world prices for agricultural commodities to more than counterbalance the favorable domestic effects of the agricultural strategy, once domestic import substitution possibilities are exhausted? These are important empirical issues which the current paper is designed to examine.

The structure of this paper is as follows. In the next section, we describe the ADLI strategy. We then sketch the structure of the Rural-Urban, North-South (RUNS) model with which the policy experiments relating to alternative agricultural and industrial strategies will be performed. Next, we look at the simulation results for the policy alternatives examined. We conclude with a more reflective section in which we interpret the policy import of the simulations.

2. Description of the ADLI strategy

The essence of the ADLI strategy lies in shifting a greater share of total investment to the agricultural sector, with a view to improving agricultural productivity. Within the agricultural sector, the emphasis is on food production rather than on export crops and on medium to small owner-operators rather than on large farms, plantations, and estates. The rationale for these choices is partially in terms of induced growth effects and partially in terms of distributional consequences. It is described in detail in Adelman (1984).

The strategy is implemented in an open-economy trade regime in which incentives are biased neither in favor of exports nor of imports and in which there is no discrimination either way between agricultural imports and exports and manufacturing ones. From the point of view of trade in agricultural commodities, the initial impact of the implementation of the ADLI strategy will be to replace agricultural imports as the ratio of domestic to international prices declines. The next phase will involve becoming an exporter of food grains.

As the simulations below will indicate, the ADLI strategy cannot be pushed too far. If not counteracted by policy measures, a very large increase in output of wage goods will result in a drastic drop in the agricultural terms of trade and transfer all the benefits of ADLI to the urban-industrial classes domestically. When the strategy is generalized to all LDCs, the resulting drop in the international terms of trade between agricultural and other products will transfer some of the benefits of ADLI to consumers of imported foods in food-importing countries. Thus, the implementation of the ADLI strategy requires supporting policies to partially counteract the internal terms-of-trade consequences of these policies. We examine some of the options below.

The same reasoning also implies, however, to limitations of purely manufacturing export-led growth strategies that also cannot be pushed to an extent where the development of the agricultural sector is threatened. Here

also, the agricultural terms of trade provide the essential link. If pushed too far, such strategies will increase the demand for wage goods without increasing their supply, thus resulting in price increases for the wage good basket, which will generate pressures for increasing urban wages and reduce the international competitiveness of manufacturing exports.

Thus, in the long term, the arguments are for balanced growth of the two sectors. However, in the next decade or so, since there has been a long policy of little investment in agriculture and of surplus transfer from agriculture to the manufacturing sector and since the decline in the rate of growth of the OECD countries now makes the ADLI option relatively more attractive (see our simulations below), some unbalancing in favor of agriculture is now needed.

3. The model

The RUNS model used is the Burniaux (1986) version of the model built in Brussels for use in the World Development Reports of the World Bank. This version trades off a smaller amount of regional disaggregation than in the "Varuna" version of the system, against a more elaborate description of agriculture.

The regions described are: developing oil-exporting countries; Mediterranean countries (a nondescript group of countries bordering the Mediterranean, including Spain, Greece, the Maghreb, Lebanon, and the island states, with Yeman and Portugal added because this seemed the most logical place to include these countries); Africa south of the Sahara; low-income Asia (i.e., the Indian peninsula plus Burma, East Asia, and other nonoil exporting countries of Asia); Latin America and the Caribbeans; the rest of Western Europe and resource-rich developed countries, including South Africa; and the rest of the world (i.e., the CMEA countries, Continental China, and Japan).

For nonagricultural products, the model is slightly more detailed than the other version of the Brussels model, as it adds fertilizer to the capital goods, other manufacturers, energy, and services identified in that world

model. It includes 13 agricultural products: wheat, rice, coarse grains, coffee, cocoa, tea, cotton, wool, tobacco, vegetable oils, sugar, meat, and other foods.

Construction of the model was greatly facilitated by the availability of two valuable data bases. One is the world social accounting matrix constructed by the Economic Projections Department of the World Bank, under the direction of P. Miovic. The other is the aggregation of the Food and Agriculture Organization (FAO) trade and utilization data tape undertaken at the International Institute for Applied Systems Analysis (IIASA), principally by U. Sichra, which we were able to use thanks to permission of the FAO and of the IIASA Food and Agriculture program (FAP) group. Construction of a world model without this assistance would have been a questionable undertaking for a small University team.

As to coefficients, we followed the conveniently cheap and established procedure of "picking up coefficients from the literature," except for the agricultural production function. A substantial effort to estimate Extended-Linear-Expenditures-System demand functions was also undertaken. This largely confirmed the indications provided by such studies as those of Lluch, Powell, and Williams (1977) in particular. Another critical source for a model that emphasizes agriculture was Mundlak's (1978) study of the determinants of rural-urban migration.

The structure of the model may be sketched as follows. As in the other Brussels models version, the rural and urban sectors are modeled entirely separately so that they may be regarded as separate countries whose trade flows could, if needed, be calculated explicitly. This sharp separation is warranted by the crucial importance of agriculture in the development process.

Price determination is competitive. Market distortions are modeled defining policy-determined wedges between supply and demand prices. For urban goods, demand is defined by a standard Armington (1969) specification, i.e., it is assumed that the goods exported by various countries are imperfect

substitutes. For energy, the world price is determined exogenously in terms of the numeraire, the average export price of manufactures by OECD countries, reflecting the market power of OPEC, and the assumption that this organization seeks by and large to index oil prices to the export prices of manufactures produced by the main developed trading nations. This well-known specification is not adopted for agricultural goods: those produced by the various regions are assumed to be perfect substitutes.

The price system is distorted by various wedges and rigidities. The market power of OPEC is represented by specifying an export tax which absorbs the difference between the cost of production of oil and its exogenous selling price. Each region subjects its imports of nonagricultural goods to fixed ad valorem tariffs. The determination of agricultural protection is more complex. The basic assumption is that governments seek to influence the parity between agricultural and nonagricultural prices. These policies are represented by estimated equations that define the regional support price of each agricultural product as a weighted average of the product's world price and of the price index of urban value added. This specification reflects the varying national commitments to maintaining a stable parity between urban and rural prices and to keeping the average level of agricultural prices in some specific relation to world prices. Variable import and export levies and subsidies implement these policies.

For urban labor incomes also, the model recognizes political realities by assuming that unemployment is prevalent both in the developed and in the developing worlds. This reflects wage rigidities. The rigidity is partial, however. The wage rate lies three-quarters of the way between an exogenous target wage and the wage rate that would clear the labor market in each region, subject to the wage behavior observed in the rest of the world. This is not thought of as a reflection of trade union power, which is often weak in the developing world, but rather of the diffuse, yet potent, resistances which exist in these countries and find expression in sudden political explosions when urban living standards are under pressure.

An important feature of the model is the strict separation between urban and rural consumers. The consumption functions are derived from extended

linear expenditures system utility functions and allocated to the production sectors by an input-output scheme. The two subsectors' production functions are also quite separate. In the urban sector, constant elasticity substitution (CES) production functions define the energy and nonenergy value addeds as functions of the labor force and of available capital stock. Labor flows freely between urban industries. The energy and nonenergy capital stocks are specific, and the allocation of investment between these two sectors is a policy variable. In agriculture, the production system is defined by a multi-input, multi-output production function. This is built up in two steps. Separate CES production functions define "aggregate resource" variables for animals and for vegetal products. The arguments of those production functions are physical capital inputs (such as bullocks, tractors, and irrigation), labor, and such basic intermediate inputs as fertilizer. Farmers allocate these "resources" to the various productions by strictly concave transformation functions that take account of decreasing returns in the production of each of the various goods. Calibration of the system ensures that the supply elasticities for the various agricultural products match the values found in the econometric literature.

Saving that is generated in the rural sector finances agricultural investment, while urban saving is used in urban areas--a weak assumption made necessary by the lack of data. The allocation of foreign aid is a policy variable; it may be used in either sector.

In the cities, the allocation of urban investible funds to the energy and nonenergy sectors is exogenous. The growth of the available labor force in urban and rural areas depends on demographic factors (United Nations projections) and on migration from country to town. The latter is influenced by the relevant population levels and by per capita income differentials. The calibration of these functions reflects the work of Mundlak (1978), who used time series/cross-section data for different countries, drawn from the World Bank's world tables.

4. Key mechanisms in the model

Before describing the simulation results, it is useful to review some key mechanisms through which an increase in agricultural output in a region influences the economy according to the RUNS model.

The region's net exports of agricultural products, of course, rises. This increased supply reduces the ratio of agricultural to nonagricultural prices on world markets. Through a feedback, the region's export prices for nonagricultural goods tend to rise. This is mediated by the strengthening of the region's balance of payments. There is less need to export these goods and, since their demand is not perfectly elastic with respect to price, the export prices of the region's manufactures improve in relation to those of other regions. This increase is large if the initial level of nonagricultural exports is small and if the elasticity of substitution between the region's nonagricultural products and those of its competitors is low.

Within each region, the relative prices of agricultural and nonagricultural products also depend on the government's parity policy. The reader will recall that, in "nonadjusting" regions, the authorities use variable subsidies and levies to stabilize this ratio while, in "adjusting" ones, domestic prices reflects changes on world markets. In the first type of region, therefore, the official price policy will prevent world prices from affecting the domestic price ratios. This, of course, is good for farmers, who can maintain their selling prices in spite of the increase in output, and bad for urban workers. Domestic food demand rises less than would be the case if prices were allowed to move freely. Exports of agricultural goods increase even more than would be the case if the region were "adjusting," while the fall of nonagricultural net exports is also greater.

Finally, there is an important production feedback. Agriculture is the main producer of "wage goods"--the important commodities that must be provided to urban workers at affordable prices if industrialization is to proceed successfully. As the ADLI strategy emphasizes, any drop in farm-good prices

relative to those of urban goods provides an indirect boost to industrialization. In the model, this effect is mediated by the rigidity of the real wage. Lower food prices make possible a reduction of the wage with respect to the product price which encourages firms to raise output. The enhanced competitiveness of urban producers also helps them to raise exports, strengthening the balance of payments and increasing the scope for import-intensive investment. The increase in urban GNP provides, of course, a secondary boost to the agricultural sector since the increase in urban purchasing power, in turn, raises the demand for agricultural products.

In "nonadjusting" regions there is also a stimulation, though this is less powerful, and operates differently. The price mechanism described in the last paragraph is blocked by the nonadjusting price policy. Yet, the ADLI strategy does favor industrialization. Thanks to stable, government-guaranteed prices, the income of farmers rises in proportion to their output, causing an increase in their purchases of urban goods. Any increase in the international terms of trade which the ADLI strategy brings about (the simulations suggest that in most regions the strategy does lead to such a result) raises the region's overall purchasing power and, in particular, its domestic demand for local manufacturers.

5. Model properties

Any model is a trade-off between realism, on the one hand, and system transparency and manageability on the other; RUNS is no exception. There is no space in this paper for a critical review of RUNS; but it does seem useful, before presenting the results, to review two of the model's characteristics, an awareness of which will help in interpreting the simulation results.

The first of those is a consequence of the modeling strategy adopted in which the world economy is envisaged as a system of interacting regions. This makes estimation of coefficients almost impossible due to data problems and has led us to use estimates from the literature. These tend to understate differences in behavior between regions. As a result, the model does not

reflect as well as might be desirable the differences in economic flexibility that seem to differentiate various types of countries. Casual observation suggests, for example, that much of the success of the East Asian newly industrializing countries (NICs) is due to the speed with which their producers manage to adjust to changes in the international environment. This could be captured, for example, by selecting higher trade elasticities for such countries than for their less flexible competitors. This was not done in the RUNS model. On the other hand, the labor market equations in RUNS do assume that wages adjust more flexibly in East Asia than in other regions. It does remain true, however, that regional models like RUNS provide a picture of the world that understates differences among regions.

The second problem stems from the assumption that world markets for manufactures are imperfect so that, when a country reduces is exports, its prices rise in comparison with those of its competitors. As developing countries shift to ADLI strategies, two mechanisms affect the terms of trade of farmers versus the urban population. On world markets, the supply of agricultural products rises, driving down their prices in comparison with those of industrial goods. In addition, the shift to the ADLI strategy slows down the increase of the urban capital stock. This tends to limit the growth of their exports of manufactures to the rest of the world, raising their prices above those of developed competitors. The combination of the two effects implies a substantial deterioriation of the rural-urban terms of trade and may well overstate the deterioration.

6. Run design

The run design is meant to highlight the implication of various aspects of ADLI strategies. The model is used to investigate the implications of the three basic ways of increasing agricultural production.

The first of the basic runs investigates the impact on growth of a switch of investment from the urban to the agricultural sector in developing countries. The simulation assumes that the switch brings about a 40 percent

increase in agricultural investment in the middle-income developing countries. In the low-income ones in Africa and in Asia, the rural sector still represents a large fraction of output and employment. When such a policy shift is assumed, its impact on the economy is so large that urban growth is depressed to an extent that appears to be unacceptable. Accordingly, investment is assumed to be increased by 30 percent only in those two regions.

Increasing the productivity of land is the second basic way of fostering faster growth of the agricultural sector. There are many policies that may be used to pursue this goal--from the introduction of improved seed varieties, to the improvement of the access of peasants to supplies and to markets for their goods, and the fostering of improved methods of cultivation by extension services. In the run, a "pure" case is envisaged where the productivity gain is secured costlessly. This covers situations when the required investments have a very short payoff period or where (as in the case of better seeds, for example) what is made available is a new or improved intermediate input.

The third approach involves an increase in the amount of economic aid provided by the rest of the world which is assumed to be earmarked for use in the agricultural sector. Such an allocation of aid has often been advocated as a means of combating hunger or of improving the balance of economies after a period of excessive industrialization, though in practice the amounts so provided have been small. Such aid would, for example, probably form a substantial fraction of the aid package to Black Africa which many economists feel will be necessary to enable that region to escape from its present stagnation.

In the simulations, adoption of ADLI strategies by all developing regions, as will be seen, does have a large impact on the world prices of agricultural products. In the model, governments are not assumed to respond to world price changes in a passive way; price-setting equations reflect the way in which politicians have in the past tried to strike a satisfactory compromise between a policy of allowing domestic prices to reflect the world ones and maintaining

an appropriate parity between urban and rural per capita incomes. The large changes in world prices caused by a general shift to ADLI might change the price-setting patterns which the model describes. But, for the present runs, the patterns of response of governments are assumed to remain unaltered.

7. Simulation results

We now comment on the simulation results obtained with the model.

Table 1 describes the impact of shifting investment resources from the industrial to the agricultural sector. The impact is positive both for GNP of developing countries and for their real income (nominal GNP deflated by the price index of consumption). Not all regions gain, however. An improved supply of "wage goods" is more beneficial to semiindustrialized regions with their large urban sectors than to less-industrialized countries in low-income Asia and, especially, in Africa.

In lower income Asia, GDP drops slightly. This region follows nonadjusting prices policies so that the increase in agricultural output does not reduce the cost of wage goods to urban workers and limits the benefits to its substantial industrial sector. Also, it has limited amounts of spare land, and this is reflected in agricultural capital coefficients that are higher than those that characterize urban production. Thanks to a favorable balance of trade in manufactures, its terms of trade improve markedly, as the general shift to the ADLI strategy changes relative prices on world markets in a way that is favorable to manufactures and services. As a result, though GNP falls slightly, the region's international puchasing power actually increases.

In both of the lower income regions, the increase in agricultural investment tends to choke off the supply of capital to industry to an extent that may be excessive, leading to a sharp rise in the prices of urban goods. This, again, reflects the high initial weight of agriculture in these economies.

TABLE 1

Impact on Key Variables of a Shift in Investment
from the Urban to the Rural Sector in All Developing Regions[a]

	Real income	GNP total	Rural GNP	Urban GNP	International terms of trade
	percent differences in comparison with the base run, 1993				
Poor regions	0.2	-1.0	2.5	-2.4	5.3
Asia	1.2	-0.5	2.4	-1.5	8.2
Africa	-2.0	-2.3	2.7	-4.6	1.1
Middle income					
Nonoil	1.4	1.1	7.4	0.4	1.5
Latin America	2.4	2.2	8.8	1.3	1.6
Southeast Asia	1.2	0.5	3.6	0.2	1.1
Mediterranean	0.5	0.3	7.2	-0.4	2.1
Oil	0.0	0.1	3.2	-0.2	0.2
All developing	0.8	0.5	4.8	-0.1	1.3
Developed	0.8	0.6	-1.0	0.7	0.2
Europe	1.3	0.9	0.1	1.0	0.6
North America, Oceania	0.5	0.4	-1.9	0.5	-0.6

[a]A 40 percent increase in agricultural investment in the middle-income regions; a 30 percent increase in the poor ones.

The strongly favorable impact on the middle-income NICs confirms Adelman's (1984) earlier results for Korea. The result that the ADLI approach is unambiguously favorable to outward-oriented countries that are still past the takeoff stage appears to be a robust one. Latin America is the strongest beneficiary from the shift. This reflects favorable capital coefficients in agriculture, that reflect an abundant supply of available land as well as the strong gain registered by a region where governments have tended to underinvest in agriculture. (That the same is not true of Africa is due to the fact that, partly as a result of poor management, that region's agricultural capital coefficients have tended to be rather high and the domestic supply of manufactures is inelastic.)

The oil-exporting countries are not strongly affected by the policy change. They tend to pursue nonadjusting pricing strategies that insulate their domestic prices from fluctuations on world markets and block much of the feedback from agricultural to industrial growth. The other reason for their lack of sensitivity reflects the inevitably arbitrary assumption that was made about the price of oil. In the model, this is assumed to be indexed to the prices of manufactures exported by developed countries, a huge aggregate that covers much of the goods which oil producers import. As a result, their terms of trade vary very little in response to the policy shift described by the simulation.

Developed countries, finally, are also overall gainers from the policy shift. Their gain may seem small in percentage terms, but a more realistic perspective is obtained perhaps by comparing it to the roughly 0.25 percent of their GNP that developed countries devote to development assistance. In terms of international diplomacy, there would seem to be grounds for arguing that it would be fair to ask the developed world to support such a policy turnaround in the South by providing additional aid.

Aid to agriculture, the result of which is considered in Table 2 is, of course, more beneficial to the developing world than a shift in the allocation of domestic investment between industry and agriculture. (In examining Table 2, the reader should bear in mind that the results are not comparable to

TABLE 2

Impact of Increased Aid to Agriculture[a]

	Real income	GNP total	Rural GNP	Urban GNP	International terms of trade
	percent differences in comparison with the base run, 1993				
Poor regions	1.8	2.2	1.3	2.5	1.4
Asia	2.1	2.2	1.1	2.6	2.5
Africa	1.1	2.2	1.8	2.4	-0.1
Middle income					
Nonoil	2.2	2.2	4.1	2.0	0.7
Latin America	3.6	3.0	4.6	2.8	0.7
Southeast Asia	2.2	2.1	3.0	2.0	0.3
Mediterranean	1.3	1.4	4.0	1.1	1.3
Oil	0.8	0.8	1.4	0.8	0.2
All developing	1.7	1.8	2.6	1.7	0.6
Developed	0.8	0.6	-0.6	0.6	0.3
Europe	1.2	0.9	0.1	1.0	0.5
North America, Oceania	0.5	0.3	-1.2	0.4	0.0

[a]Aid to each region increases by $2 billion; the aid is granted by the residual region.

those in Table 1 as the nature of the shocks and the changes in investment that are induced are basically different; we will try to make a more comparable run.) In the run, aid is forthcoming from the "residual region" which includes Japan and the CMEA countries (this will be changed). Aid raises total investment; reallocating investment funds merely changes its distribution. Aid also strengthens the balance of payments by making it possible to run a deficit. This permits an improvement of the terms of trade, thanks to which a dollar of aid adds more than a dollar to the resources available; it is the "transfer burden" of trade theory operating in reverse. Both effects account for the very favorable results evidenced by the simulation.

The Table reflects the fact that granting additional aid is particularly beneficial to the lower income countries. This is a robust result which is discussed in detail in the basic paper on the Brussels model (see Gunning et al. (1982)).

Table 3 finally considers the impact of an increase in the productivity of additional capital in agriculture. It is assumed that this is achieved through "embodied technical progress." (The result obtained by assuming disembodied technical progress are very similar and are, therefore, not presented in the paper in order to save space. Here again, it is necessary to bear in mind that the modus operandi of the boost to output is basically different from that which is described by Table 1; hence, caution is necessary in comparing the tables.) This can be thought of as resulting in part from better planning, which can eliminate the sometimes extraordinary errors to which agricultural planners appear to be prone, of which the Assuan Dam is the best-known example. (The dam was meant to make possible a substantial extension of the cultivated area in Egypt. However, elimination of the yearly deposit of silt, from which Egyptian agriculture had benefited for millennia, that reduced output on existing land and the salination of the newly irrigated areas were so detrimental that there is reason to doubt that the dam has brought about any increase in output.) The "bottoms up" approach of the ADLI strategy focused at the grass roots level is, of course, designed to

TABLE 3

Impact of an Acceleration of Technical Progress in Agriculture[a]

	Real income	GNP total	Rural GNP	Urban GNP	International terms of trade
	percent differences in comparison with the base run, 1993				
Poor regions	3.1	2.9	3.0	2.9	1.8
Asia	3.7	3.0	2.5	3.1	3.9
Africa	1.8	2.9	4.0	2.3	-3.3
Middle income					
Nonoil	2.9	3.0	8.2	2.4	0.4
Latin America	4.9	4.8	10.2	4.1	0.6
Southeast Asia	1.2	1.4	2.1	1.4	-0.2
Mediterranean	1.6	1.7	8.1	1.1	1.0
Oil	1.1	1.3	5.8	0.8	0.3
All developing	2.3	2.4	5.9	1.9	0.5
Developed	1.1	0.9	-1.2	1.0	0.3
Europe	1.9	1.6	0.1	1.6	0.5
North America, Oceania	0.6	0.4	-2.2	0.5	-0.1

[a]An 80 percent increase in the productivity of newly invested capital, starting in 1983.

facilitate the elimination of this waste. The other source of technical progress that may be borne in mind is further progress in creating improved plant varieties, both through a continuation of the research on plant hybridization which brought about the Green Revolution, and through more "exotic" breakthroughs involving plant genetics.

From an economic point of view, the acceleration of technical progress considered here is equivalent to a form of aid that does not pass through the balance of payments. It is as though the country benefited from additional capital resources without the gains which a direct inflow of foreign currency yields.

Once again, the policy has a strongly favorable impact on the world economy. The only "minuses" in the table are caused by the pressure of falling agricultural prices on the U. S. farm sector. European producers are insulated from this by the very protectionist Common Agricultural Policy implemented by the European Community.

In our simulations, we have looked at the individual elements of a global ADLI strategy separately. In practice, they would be combined: increases in investment in agriculture would increase technical progress in agriculture. In turn, especially in Africa, the increased investment in agriculture would be financed by increased foreign aid. The results of an actual ADLI strategy would, therefore, be a weighted sum of the individual experiments and, hence, more favorable than indicated in Tables 1-3.

8. Conclusion

Several policy conclusions emerge from our simulations. First, the ADLI policy survives quite well its generalization to all developing countries. It raises world GNP and world real income, with the benefit split almost equally between developed and developing countries. The ADLI strategy is most advantageous for the middle-income NICs that benefit not only from the domestic production, demand, and terms-of-trade effects but also from the

international terms-of-trade changes which raise the relative prices of their manufacturing exports. In African low-income countries, the policy requires financing through international assistance. Otherwise, the cost of withdrawing resources from domestic manufacturing is too high. Even the developed grain-exporting countries benefit from ADLI because of the increase in the prices and incomes of urban producers.

Second, the productivity of foreign aid directed at investment in agriculture appears to be quite high. This is especially true of investment in agricultural projects in the low-income developing countries. Of course, the productivity of the use of resources by the recipient countries is critical to the results. The simulations assume that the productivity of the marginal aid-financed investment in agriculture is the same as that of the average investment in the past. To the extent that the marginal aid-financed investment is either more or less productive, the results either understate or overstate the favorable impact of aid to agriculture in less-developed countries.

Third, the effects of agricultural policies within the individual groups of countries on other countries are quite significant. The current effort to bring domestic agricultural policies into GATT could, therefore, have major welfare consequences.

Fourth, in LDCs terms-of-trade policies, which share the potential income benefits of ADLI between urban and rural producers, are desirable for equity and incentive reasons. In our simulations, the balance between stimulating agricultural output and maintaining incentives to farmers appears to be very delicate, for stimulating output has a strong effect on prices. The model does not recognize that the marginal productivity of investment in agriculture is not independent of incentives facing farmers. To the extent that productivity of resource use and price incentives in agriculture are linked, and we have strong evidence from China that they are, the conflict between equity and growth is overstated in our simulations.

Model simulations seem dry; it is interesting to use historical experience to translate simulation assumptions into the concrete terms of historical experience. Historical analysis (Morris and Adelman, forthcoming) indicates that the start of industrialization was dependent on the existence of a large overall agricultural surplus. In the initial stage, that could be accomplished with dualistic agricultural sectors containing both large and subsistence farms. For a time, governments could implement policies that substituted for the tenurial reforms and price policies that were required for sustained, widely distributed agricultural growth. But ultimately, no country succeeded in generating more than narrowly based, temporary industrialization if they did not have a prosperous small farming sector.

The simulations point to the sequential nature of the role of agricultural development that is also evident in history. ADLI, the model suggests, is most beneficial in growth terms in the middle-income NICs and somewhat less in low-income Asian countries. In African nations, in fact, the creation of an adequate agricultural surplus cannot it seems be financed internally; it must be financed by foreign aid.

What are the policies that enabled successful "growers" to strike an appropriate balance between industrial and agricultural expansion in the 19th Century? Of all the development paths followed by countries in the 19th Century, only two led to widespread, sustained economic growth. These were the balanced growth path followed by the small European economies and the industrialization path of the firstcomers to the Industrial Revolution. The common characteristics of these two paths that distinguished them from the other paths were (1) high productivity agricultures, (2) tenurial arrangements in agriculture that gave rise to a widely dispersed agricultural surplus, (3) policies that tenurial arrangements that generated incentives for cultivators, and (4) open-trade policies. The successful countries had undergone their agricultural revolutions prior to industrialization. This enabled them to maintain flexible and dynamic agricultural sectors throughout the period of rapid industrialization and to avoid having growth choked off by rising prices of food that would jeopardize the competitivity of their

industrial sectors. This is precisely what the implementation of ADLI would produce in LDCs.

The largest food-deficit countries--India and China--have, in effect, already implemented the ADLI strategy in the past decade or so. They have shifted investment from industry to agriculture, given incentives to farmers, have benefited from the more rapid technical progress of the Green Revolution, and shifted from being major grain importers to being grain exporters. India has, in addition, benefited from a substantial amount of additional aid. Their growth rates have increased remarkably as a result, just as our simulations would predict. Other Asian countries, such as Thailand and Indonesia, appear to be following in their footsteps. Thus, with appropriate policies, the potential for improving agricultural productivity in all but the African countries is clearly there. But Latin America and Africa have yet to improve the productivity of their agricultural sectors.

At the same time, the OECD countries are all faced with agricultural surpluses and are all responding by increasing their subsidies to domestic agriculture. Our simulations indicate that, with current policies, ADLI would be of benefit to them by raising the prices of their manufacturing exports despite the fact that it would curtail their agricultural exports to LDCs. Counterintuitive though this result might appear to be, it would, therefore, be in their interest to invest aid dollars in furthering the agricultural development of LDCs.

References

Adelman, I. (1984). "Beyond Export-Led Growth." World Development, Vol. 12, No. 5, pp. 937-949.

Adelman, I., and C. T. Morris (1984). "Patterns of Economic Growth, 1850-1914, or Chenery-Syrquin in Historical Perspective." In Economic Structure and Performance, ed. M. Syrquin. L. Taylor, and L. E. Westphal. New York: Academic Press.

Armington, P. (1969). "A Theory of Demand for Products Distinguished by Place of Production." IMF Staff Papers, Vol. 16, pp. 159-178.

Bairoch, P. (1973). "Agriculture and the Industrial Revolution, 1700-1914." Edited by C. Cipolla. Vol. 3: The Fontana Economic History of Europe. London: Collins, Fontana Books, pp. 452-506.

Burniaux, J. M. (1986). Analyse des Dilemmes Alimentaires. Paris: Economica.

de Janvry, A., and E. Sadoulet (1986). "Growth and Equity in Agriculture-Led Growth." Paper presented at IEA Conference, New Delhi, India, December 1-5.

Gunning, J. W., G. Carrin, J. Waelbroeck and Associates (1982). "Growth and Trade of Developing Countries: A General Equilibrium Analysis." Discussion Paper 8210, C.E.M.E., University of Brussels, Belgium.

Jones, E. L. (1967). Agriculture and Economic Growth in England: 1650-1815. London: Methuen.

Lluch, C., A. Powell, and R. Williams (1977). Patterns in Household Demand and Saving. London: Oxford University Press.

Morris, C. T., and I. Adelman (forthcoming). Where Angels Fear to Trend: Quantitative Analysis of Economic History. Baltimore: Johns Hopkins Press.

Mundlak, Y. (1978). "Occupational Migration Out of Agriculture--A Cross-Country Analysis." Review of Economics and Statistics, Vol. 60, No. 3, pp. 392-398.

World Bank (1982). World Development Report. New York: Oxford University Press.