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9. ABSTRACT

A summary of the research findings of the Growth Center on employment and underemployment in the developing countries. It begins with a theoretical formulation of the problem - particularly appropriate to a labor-surplus economy but also applicable to the land-surplus type. Results of studies of individual countries, sectors, and functions are described and based on them, the following suggestions are made: 1) factor and product prices should better reflect factor endowments, at least at the firm level; 2) markets should be allowed and encouraged to function more efficiently, and for effective price and market adjustments, there must be at least a minimum of domestic infrastructure, entrepreneurial skills, and technology; 3) increased education should provide more necessary skills, responsiveness to changing markets, and improve agriculture; 4) with gradual changes in monetary, fiscal, and exchange rate policies, employment and production should increase; and 5) adaptive agricultural and industrial research should be encouraged.

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LDC EMPLOYMENT AND GROWTH:

A SYNTHESIS OF ECONOMIC GROWTH CENTER RESEARCH

Gustav Ranis

July 1975

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I. Introduction

Until recently, development efforts originating within the LDCs and supported by foreign aid have focussed primarily on aggregate growth rates or per capita income as the main societal objective. Lessons drawn from the actual economic performance of the 1950s and 1960s, however, as well as increasing socio-political pressures within the third world, have forced policy makers to reassess their priorities. While overall LDC income grew at about five percent on the average during the 60s and per capita incomes close to UN target levels overall, the distributional effects of development were very uneven. Even in developing countries which have experienced respectable rates of growth of income, the benefits of that growth have not been sufficiently widely shared. The cities, as compared with the countryside, the commercialized sectors as compared with the traditional, and the educated as compared with the uneducated (even including the educated unemployed), appear to have gained more from recent growth patterns. A major reason for this uneven sharing of benefits is that employment has not generally grown rapidly enough. Consequently, unemployment and underemployment (i.e., inefficient utilization) of labor and the demographic pressures which fuel it have, in fact, become among the most pressing problems of the developing world. They constitute both economic and human waste, contributing heavily to the maldistribution of income and to the making of a dangerous socio-political powder-keg in the third world.

The unemployment problem, however, is even more complex than the distributional aspects alone would suggest. First, there is a whole set of

social and political questions: Who are the unemployed? Where do they come from? What is their political power? The political consequences of unemployment will surely depend, for example, upon whether the unemployed are educated or uneducated, recent migrants or long-term residents, what communal groups they belong to, etc.

Second, there is the fundamental question of whether massive LDC unemployment is inevitable or not. Domestic development policies and international assistance have often themselves biased technology in favor of labor saving methods of production, and the composition of output towards luxury and other capital intensive goods. Much of what looks like an inevitable conflict between employment and growth objectives, when the actual historical record is examined, does not have to be accepted for the future but may be viewed as subject to corrective policy change.

Finally, any policy aimed at increasing employment must take into account the economic and institutional constraints under which any given society is forced to operate. The choice of development strategies is limited not only by technological but also by social, cultural, administrative and political factors which are difficult for the economist to incorporate in his framework of analysis.^{1a} Moreover, the prominent features of both the economic and non-economic environment are affected by the phase of development in which a given LDC finds itself.

^{1a}Several economists have tried to integrate economic and these other institutional and cultural factors, but more work is needed in this area. See, for instance, James Pickett's work at the University of Strathclyde or Louis Wells' on multinational corporations. The Growth Center is now studying the choice and adaptation of industrial technology from a broader perspective than the usual economic environment only.

Over the past five years, the Yale Economic Growth Center has undertaken a series of studies on employment and underemployment in the developing countries. This activity grew out of issues raised in the Growth Center's prior theoretical work on labor surplus and disguised unemployment and has drawn upon methodology used there. It also benefitted substantially from the earlier typology-oriented country analysis work under which the growth path of some twenty-five developing economies had been examined. Our findings confirm that an analysis of the relation between employment and output generation requires both sensitivity to typological differences and an understanding of the sub-phases of growth in the attempted transition to economic maturity. During the historical process of development, both the resource and institutional constraints change and, consequently, so do the feasible and desirable policies of government. For instance, as a country passes from the import to the export substitution^{1b} phase of its development, changes in the resource endowment, along with changes in policy, yield changes in the output mix as well as in the volume and type of employment generated. Our research has tried to place the study of employment and underemployment in its appropriate historical and typological context.

We have, thus, found it very useful to examine the relation of employment generation to output growth in the context of the particular type of LDC considered. Broad, multi-country cross-sectional comparisons have

^{1b} During an "import substitution" phase, government policy is used to reduce domestic consumption of imports and to encourage domestic production. "Export substitution" refers to a period when non-traditional exports replace traditional exports. This phase usually has as a prerequisite an import substitution period.

their place but we firmly believe that the search for an understanding of behavior must take place at the country level or, at least, among countries which belong to particular sub-families or typologies. We expect small, export-oriented countries, such as Taiwan, for example, to behave differently from large, domestically-oriented ones, such as India, as different resource endowments and internal market sizes result in different economic and institutional constraints. Policies might be designed, for example, to increase employment via the promotion of labor intensive manufacturing exports in a small country, whereas, in a large country, attention might better be focussed on rural infrastructure to allow the balanced growth of production for a mass domestic market. This typological point of view has allowed us to develop approaches which have some transferability and may serve as a guide to policy, without being vacuously general.

Our empirical research has also taken the form of the analysis of the choice of factor proportions in specific sectors--such as agriculture, industry and services--and the role of specific functional activities--such as agricultural research and education. These studies have been more micro in nature, but have taken into account the interactions among sectors in the development process. We have tried to go from general models of sectoral interdependence to an analysis of particular sectors in different countries. Sometimes these sectoral analyses can themselves be placed in a typological context, i.e., related to a particular class of developing economy. For instance, we have found that, in the labor surplus economy, it is necessary to achieve sustained productivity increase in the large agricultural hinterland if the total economy is to move forward and total employment as a percentage of the labor force is to increase. In other cases, we have found a

complex set of functions served by one sector. Therefore, the sector's relation to the employment problem is not as easily summarized. An example would be the services sector which sometimes acts as an employer of last resort and sometimes as a source of quality improvement and technical change.

In every case, whether our research has been primarily country- or sector-oriented, it is clear that the relation between growth and employment is influenced by institutions and government policy. We have paid attention to the effect on resource allocation and employment at the micro level of such dimensions as land tenure relations, pricing and tax policies, and the existence of competing public, multinational and private firms. While more work clearly needs to be done on the precise nature of these economic and institutional constraints, we have made considerable progress towards incorporating policy choices into our growth theoretic framework. The Center's findings thus provide policy implications for reducing unemployment which go well beyond those associated with the conventional production function approach. While trade policies have been emphasized as the principal means of achieving a more labor-intensive output mix and possibly greater income equality, especially in the smaller LDCs, some consideration has also been given to wage and migration policies and to changes in the consumption bundle associated with an exogenous redistribution of income.

This summary paper attempts to synthesize the research findings of the Growth Center on employment. We begin with a theoretical formulation of the problem which is particularly appropriate for a labor surplus economy, but which has been extended to apply as well to the land surplus type.

We then proceed to particular country studies, and finally to the sectoral or functional studies, drawing conclusions about the transferability of our knowledge to other countries within the same typology.

II. Theoretical Framework

Most of the Growth Center's research effort has been designed to shed light, one way or another, on the existence and nature of the presumed trade-off between the growth of output and of employment. The objective has been to determine whether such a conflict has, in fact, existed historically, whether it will inevitably exist in the future, and what policy conclusions follow. It is helpful, however, to start with a brief discussion of the underlying models used to explain the observed empirical phenomena. We have found that such a theoretical structure is essential for any understanding of behavior in different typological and temporal contexts--and thus for the choice of policy mixes to affect that behavior.

Macro-Economic Models

The Open Dualistic Economy Model. Fei and Ranis¹⁹ have in the course of this research activity developed a model linking agricultural production to urban employment via the supply schedule for industrial labor. When, as a consequence of the slow growth of agricultural production, the terms of trade shift against industry (i.e., the price of agricultural goods rises relative to that of industrial goods) the real wage (expressed in terms of industrial goods) must rise. Under these circumstances the industrial entrepreneur is likely to offset the possible encroachment of his

¹⁹J.C.H. Fei and Gustav Ranis, "Development and Employment in the Open Dualistic Economy," Malaysian Economic Review, October 1971.

profits by adopting labor-saving innovations. Also, reduced agricultural saving and industrial profit margins will cause savings to decline and the rate of urban/industrial capital formation to decrease. For both of these reasons, industrial employment growth is adversely affected.

Another factor detrimental to urban employment growth is the possibility of a rise in the agricultural real wage as development progresses. Fei and Ranis contend that while some rise is inevitable once agricultural productivity increases, a sustained increase should be expected to take place only when, with the elimination of disguised unemployment, the agricultural real wage is increasingly determined by market forces rather than institutional arrangements. Any "premature" rise in the agricultural real wage will cause the industrial labor supply schedule to shift to the left and help bring on some of the employment difficulties described above.

Any exogenous change in the real wage between the two sectors, e.g. via union pressure to raise the industrial real wage, will have a similar effect. But one way of preventing the terms of trade from shifting against industry in the open economy is to expand food imports by means of labor-intensive industrial exports. By maintaining relative industrial real wage stability in this manner the country can sustain a much higher pace of industrial output and employment growth in the face of relative agricultural stagnation than would have been possible in the closed economy.

Fei and Ranis emphasize that it may be necessary to attempt an increase in domestic agricultural productivity before reliance on an industrial export drive as a means of generating income and employment growth becomes really feasible in any but the smallest city-state type of LDC. They indicate

that if a very large fraction of the population initially resides in the agricultural sector, the system must concentrate on agricultural mobilization as a prerequisite for solving its total unemployment problem. Only in cases where the resource endowment is basically unfavorable to the expansion of agricultural productivity, or when the agricultural hinterland is really small, e.g. Singapore, can immediate stress be placed on industrial exports.

Fei and Ranis show that we need to distinguish carefully between real world situations in which agriculture first fulfills its role of providing a surplus for the growing industrial labor force and then runs out of steam (e.g. historical Japan turning to food imports from her colonies after 1900) and countries which don't fully utilize agriculture from the outset (e.g., South Korea).

An analysis of the Korean and Taiwanese experience from a typological viewpoint emphasizing these differences, as well as the underlying family resemblance, has been undertaken.² Both countries shared the open dualistic and labor surplus characteristics at the beginning of their transition to modern growth in the 1950s, plus, as ex-Japanese colonies, a relatively strong agricultural infrastructure. In the post-war decade, both countries experienced two sub-phases of transition: an import substitution sub-phase followed by an export substitution sub-phase. In the former, entrepreneurial experience was accumulated, along with a further strengthening of the rural infrastructure, e.g., by land reform. In the latter, both countries rapidly developed labor intensive manufacturing exports to the world market. While the import substitution phase thus laid the groundwork for export substitution

²J.C.H. Fei and Gustav Ranis, "A Model of Growth and Employment in the Open Dualistic Economy: The Cases of Korea and Taiwan," Journal of Development Studies (January, 1976).

to follow, there is a marked contrast in the rate of surplus labor absorption. It was clearly the latter growth phase that contributed most markedly to the solution of the unemployment problem via a change in the nature of the growth path, thus permitting the labor surplus condition to be gradually terminated, i.e. by the end of the 60's.

Brecher's minimum wage model complements much of Fei and Ranis' work on the open dualistic economy.³ His approach is derived from the pure theory of international trade, incorporating the institutional constraint of a minimum real wage. One can view this floor either as set by government or union policy, or as the subsistence income determined in a labor surplus agricultural hinterland. Brecher's two sector model, therefore, is really a further disaggregation of Fei and Ranis' commercialized sector, which produces both capital and labor intensive manufactured goods. As expected, a reallocation of resources between the commercialized trade sectors (when there is a realistic exchange rate and no import barriers) towards labor intensive exports should alleviate the unemployment problem. If, however, exports are relatively capital intensive, tariffs are likely to increase employment and welfare over the free trade level. The optimal government policy, then, depends on the capital intensity of the major cash crop export (e.g. cocoa in Ghana), the government's ability to overcome such constraints as the minimum wage, and the overall export competitiveness of the system.

These two models demonstrate, with the help of a theoretical framework applicable to at least one, possibly two, types of LDCs, that the

³Richard A. Brecher, "Minimum Wage Rates and the Pure Theory of International Trade," Quarterly Journal of Economics, February 1974.

necessity of contemplating a trade-off between employment and GNP growth may, in fact, be illusory and based on a misinterpretation of the historical record. The whole array of available policy measures (e.g., high protective tariffs, exchange controls, artificially low official interest rates, overvalued currencies, price inflation) adopted to facilitate the import substitution process -- via the exclusion of foreign competition and the augmentation of the profits of domestic industrialists -- is, of course, subject to change. Moreover, changes to facilitate the transition to an export orientation can induce more efficient utilization of the economy's relatively abundant resources via embodiment in labor-intensive industrial goods which are sold abroad. Whether this historical growth process applies to other than labor surplus types of LDCs is explored by Brecher's work on Ghana.

The Surplus Labor-Surplus Land Model

According to the usual view⁴, most African countries fall under the rubric of a land surplus, rather than a labor surplus economy. The employment strategies of the two types of countries could thus be assumed to be quite different. What Brecher shows, however, is that it is quite possible to have both surplus land and surplus labor at the same time⁵. Once disguised unemployment of both land and labor is considered -- here defined as differing marginal productivities as between sectors rather than as a gap between the marginal product and wages in any one sector -- Brecher's African type model retains many similarities with the Fei-Ranis model.

Brecher introduces particular economic and institutional features relevant to Ghana, such as share-cropping in cocoa, wage rigidities in

⁴See Gerald K. Helleiner, "Typology in Development Theory: The Land Surplus Economy (Nigeria)," Food Research Institute Studies, Vol. VI., No. 2, 1966.

⁵Richard A. Brecher, "The Labor-and-Land Surplus Economy (Ghana)," E. G. C., October, 1972.

the manufacturing sector, and an infinite supply of land in the subsistence food sector. With these institutional constraints, he finds that surplus labor and surplus land are not mutually exclusive phenomena when capital is scarce. Moreover, and the most interesting from our point of view, his policy recommendations are closely related to those derived from the Fei-Ranis model: the way to increase employment depends crucially on the relative capital intensity of cocoa. If cocoa should empirically turn out to be capital intensive, due to the long gestation period of the trees, then an increase in cocoa exports would increase disguised unemployment. If, however -- as appears more likely according to Brecher's recent empirical work on cocoa technology -- cocoa is less capital intensive than manufacturing, an increase in exports will increase employment. In addition, technological change in the subsistence food sector which raises labor's marginal productivity would gradually reduce disguised unemployment à la Fei-Ranis.

In spite of the quite different typological framework, Brecher's results are thus consistent with the open dualistic economy model of Fei and Ranis. Both frameworks suggest that labor intensive exports, whether manufactured goods such as in Taiwan and Korea, or cocoa as in Ghana, will constitute the major contributing factor to solving the unemployment problem in the context of growth. In both cases, also, improved agricultural technology (especially, perhaps, chemical and biological innovation) is necessary for reducing the level of unemployment in the economy as a whole.

III. Country Case Studies

As already mentioned, Taiwan and South Korea before about 1970 fit into the typological framework of the open labor surplus economy. These two countries are important exceptions to the overall experience of LDCs during the 1950s and 60s, which has been one of increasing under-employment and rising open unemployment rates, in spite of rapid per capita income growth. Fei and Ranis show that the extent of the so-called conflict between output and employment objectives is very sensitive to the government policies followed.⁶ During the import substitution phase, when prices are severely distorted and the veil between factor endowment and factor use is most pronounced, the output mix tends to be weighted towards capital or natural resource-intensive commodities. Technology is mainly imitative or transplanted from the more developed countries.

Once entrepreneurial skills and the necessary infrastructure have been built up, the economy is capable of moving into the production of new non-traditional exports, an export substitution phase, reducing unemployment. The success of this policy is documented by not only a relative but also an absolute decline in the number of underemployed persons during the late 1960s in both countries. Moreover, partly as a consequence of these employment promoting policies, the decade of the 1960's was a period of more rapid output growth and a better distribution of income than the 1950's in both countries.

Ranis has some hesitation, however, about the continued success

⁶J. C. H. Fei and G. Ranis, "Growth and Employment in South Korea and Taiwan," E. G. C., November, 1971.

of Korean export expansion.⁷ Unlike in Japan and Taiwan, Korea's agricultural productivity growth was not sufficient to fuel the necessary rate and type of industrial growth. As a result, many special incentives have had to be established to artificially fuel the progress of the industrial export sector rather than being able to rely on agricultural saving. Instead of moving first to labor intensive, then to skill intensive, and finally to capital intensive production for export, Korea has been forced to move directly into at least some fairly technology intensive and capital intensive activities, as industrial exports have had to carry the burden of not only a further expansion of the industrial sector itself but also of providing the foreign exchange for food imports. Whether growth can be maintained with such heavy reliance on foreign capital and without more mutual interaction between a large-sized domestic agricultural sector and non-agricultural activity is doubtful.

The open dualistic model was developed with the small, natural resources poor export-oriented economies in mind. Whether the Fei-Ranis solution to the unemployment problem in the context of growth applies to all but the very large (and therefore domestically-oriented) labor surplus LDC's, is the question we try to investigate by looking at some Latin American cases. For one thing, Taiwan and Korea successfully altered their relative factor and commodity prices as they moved from import to export substitution in order to be more in line with their changing factor endowments and capacities. Many other LDCs, especially in Latin America, by contrast have, instead, attempted

⁷Gustav Ranis, "The Role of the Industrial Sector in Korea's Transition to Economic Maturity," in Basic Documents and Selected Papers of Korea's Third Five-Year Development Plan (1972-1976), Sung-Hwan Jo and Seong-Yawng Park editors, Sogang U., 1972.

to prolong import substitution by moving from primary (consumer goods) to secondary (capital, durables and processing goods). Largely as a consequence, the exports of most Latin American countries (except for Venezuela and the Central American Common Market) have grown more slowly than those of LDC's generally, with those who adopted the export substitution policy package leading the way.

In order to determine whether government incentives to increase exports are necessarily associated with an improved employment and output picture, or whether Latin American countries behave differently from the Asian model, Diaz⁸ divides the Latin American countries according to their size, so that we can separate the large, and presumably more domestically-oriented, from the small and more trade-oriented. What is most striking is the structure of the increased exports between 1960 and 1971, when many of these countries began to encourage exports. For every size category, at least 62% of the increase is attributed to primary products. Given the relatively rich resource endowments of most Latin American countries, this is not surprising. Only the largest countries -- Argentina, Brazil, Colombia and Mexico -- show significant manufacturing exports outside of Latin America. Among the smaller countries, the Central American Common Market has increased its manufactured exports within Latin America. But these exports reflect more the trade diverting policies of the Common Market than a transition to labor intensive manufacturing exports. Both in the large and small countries, the major exports are generally still made up of primary products.

It appears that the manufacturing exports, mainly to other LDCs, which have been encouraged by government subsidies, tax concessions, drawback schemes

⁸Carlos F. Diaz-Alejandro, "Some Characteristics of Recent Export Expansion in Latin America," EGC Discussion Paper, No. 183, July 1973.

etc., are not labor intensive, such as in Korea and Taiwan. Rather, the traditional Latin American protectionist schemes are now being used to promote exports, just as they were formerly used to promote import substitution. Diaz shows that Colombian exports to other LAFTA countries, for instance, are both more capital intensive and higher in the use of imported inputs than its exports to the rest of the world. In general, it appears that Latin American trade expansion has been quite different from the Asian experience; it is closer to export promotion via the subsidization of exports in the context of continued protection, rather than to export substitution defined as the "natural" transition to non-traditional, labor intensive exports, as domestic entrepreneurial capabilities mature and policies are liberalized.

Detailed micro studies confirm this suspicion. Berry's work on Colombian industry⁹ is consistent with the view that public policy has had little positive impact on promoting employment through exports. He finds that small scale firms tend to have both higher output-capital ratios, higher labor-capital ratios and lower levels of labor productivity than the large firms. Most exports, however, continue to be produced by the largest firms in the country; for example, Diaz finds that 24 industrial companies accounted for 62 percent of all industrial exports in 1970. An important question for policy then is the extent to which small scale producers can be linked to international trade in a situation in which market intermediaries are not usually efficient aggregators of small scale production for such purposes. Given the closeness of the relationship between size and capital intensity, there exists doubt that industrial exports will contribute much to the unemployment problem unless small scale firms can somehow become part of this phenomenon.

⁹Albert Berry, "The Relevance and Prospects of Small Scale Industry in Colombia." EGC Discussion Paper No. 142, April 1972.

The case of the Japanese trading company may be worth examining in this context. Berry's work on small scale industry in Colombia suggests that efficiency could be increased, employment expanded and income distribution improved if public policy did not favor the large firm. In fact, the 1958 exchange reform, consisting of both exchange rate devaluation and liberalization measures, did result in a decrease in the share of capital and in the extent of underemployment.¹⁰ Similarly, his work on Colombian agriculture,¹¹ where land and capital productivity are substantially higher on small farms than on large, implies that social efficiency of resource utilization could be improved. For example, redistribution and/or credit reallocation are likely to have a positive impact on output (as well as on income distribution) in Colombian agriculture.

Mamalakis shows that Chile achieved a significant reduction in open unemployment through an increase in the output share of the labor-intensive domestic capital goods industry. Contrary to, say, the Taiwan case, however, where high rates of agricultural production tended to keep the real industrial wage down, the demand for industrial labor high and the industrial capital-labor ratio low, Chile's relative agricultural failure had the opposite results. Mamalakis notes that the land reform combined with inappropriate agricultural pricing policies in Chile caused marketed agricultural output to decrease, even though it increased the amount of labor employed in agriculture. To the extent that this food shortage may cause rapid increases in the real wage expressed in terms of the industrial commodity, the rate of industrial sector labor absorption may be substantially decreased. This

¹⁰Albert Berry, "Some Determinants of Changing Income Distribution in Colombia: 1930-1970," EGC Discussion Paper No. 137, March 1972.

¹¹Albert Berry, "Land Distribution, Income Distribution, and the Productive Efficiency of Colombian Agriculture," EGC Discussion Paper No. 108, March 1971.

problem, Fei and Ranis fear, may also impede future rapid growth in industrial employment in Korea.

While public policy differences seem to explain a large share of the differential experience in Asia as compared to Africa and Latin America, a realistic Latin American model surely must incorporate the continued importance of natural resources in the composition of output. The continuing protectionist policy in many Latin American countries resulted in an industrial structure quite different--in terms of output mix, technology and size of firm -- from the Asian examples considered. But what made the continuation of import substitution possible was the relatively plentiful supply of natural resource based fuel for the process.

The two Latin American cases, examined by Baer and Mamalakis, i.e. Brazil and Chile, have relatively rich natural resource endowments and little population pressure on the land. Brazil, some time ago, moved beyond primary and into secondary import substitution fuelled first by raw material exports and, especially in recent years, by the promotion of industrial exports. Chile has continued to be more dependent on raw material exports and grown less rapidly than Brazil, especially during the past decade. But both cases have shown a worsening of the unemployment and underemployment picture side by side with satisfactory (Chile) and extraordinarily rapid (Brazil) rates of growth. The attempt to prolong import substitution has been accompanied by the relative neglect of food producing agriculture in both countries. Baer,¹² however, places much of the blame for undue capital intensity in Brazilian industry on the extensive use, especially among large scale firms, of foreign consulting firms.

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Jose Almeida and Werner Baer, "Transfer of Technology and Labor Absorption in Brazil," mimeograph (University of Illinois) October, 1974.

Brecher uses the Ghanaian example¹³ to deal with the distribution of employment between a low productivity, traditional food sector, and high productivity commercialized cocoa and manufacturing sectors. The traditional food producing sector, with its elastic supply of land, absorbs the labor not employed within the commercialized sectors; the volume of such "surplus labor" depends on the volume and distribution of capital between the other two sectors.

Brecher investigates the importance of sector-specific, heterogeneous capital goods with differing gestation periods. He finds that investment, such as in Ghanaian cocoa trees, may appear to be labor-using, but in fact involves long gestation periods which tie up the economy's limited quantity of investible funds. Such investments may for many years have detrimental repercussions on the overall level and structure of capital and employment.

Brecher's estimates of the time structure of yields and labor inputs in cocoa suggest that cocoa is unlikely to be intensive in the use of Ghana's scarce savings. An increase in foreign demand, then, with a shift of resources into cocoa, should increase both national income and employment in the commercialized sectors of the economy, by drawing labor out of subsistence agriculture where it was underemployed.

Again, there appears to be no necessary conflict between the two goals of output and employment generation. Brecher's model can be viewed as an extension of the open, labor-surplus model, but one which incorporates the African element of surplus land. In addition, it points out the importance

¹³Richard A. Brecher and Ian C. Parker, "Cocoa, Employment and Capital in the Ghanaian Economy: A Theoretical and Empirical Analysis," E. G. C. Discussion Paper No. 210, July 1974.

of the structure of demand in determining the levels of the long run capital stock and modern sector employment.

McCabe's work on Zaire¹⁴ focusses on quite a different aspect of the African model. Rather than concentrate on the role of exports, such as Brecher does for Ghana, McCabe concentrates on the problems of distribution in the large internal market. He develops a theory linking transport cost to rural employment and then tests the theory using data from the 1970 agricultural census of Zaire.

The basic approach makes allowance for the fact that the transport cost/employment relationship in the LDC may be significantly influenced by market imperfections, in particular, the monopsony power of middlemen in the rural areas. While transport investments tend to increase overall employment in competitive markets, they may have a negligible effect on overall employment and even decrease employment in some areas if monopsony power is present. The empirical evidence presented in this paper gives considerable support to the argument that, unless market imperfections are eliminated, transport infrastructure investments in Zaire may well benefit one region at the expense of another.

Other economic variables amenable to policy manipulation besides transport cost are considered. Evidence is presented that lack of competition in certain agricultural processing industries has a depressing effect on agricultural employment. Another variable shown to have a significant association with agricultural employment is the producer's price of agricultural goods. The findings indicate that an effectively-enforced minimum agricultural price policy may well be a significant stimulant to rural employment in Zaire. Such direct

¹⁴Lucy Cardwell and James McCabe, "Transport Costs and Other Determinants of Employment in Rural Zaire," E. G. C., September, 1974.

intervention in the market could be a more effective way of increasing agricultural employment and production than an improvement in transport.

McCabe's work on Zaire thus emphasizes the important differences between large, domestically oriented, and smaller, export oriented countries. In the former, such as in Zaire, the structure of markets and the cost of transport and communications create major problems not faced in Ghana, with its relatively integrated markets.

IV. Sectoral and Functional Studies

Other work done at the Growth Center, based upon micro studies across countries, has focussed on particular functions or sectors of the economy. One of the most important of these has involved research into the choice and adaptation of technology. We have found it impossible to isolate the question of employment from an understanding of the production process and of the economic and institutional factors which determine the choice of production technique and output mixes. Two major conclusions emerge from our research. First, there appears to exist considerably more scope for factor substitution in most industries than has often been thought. Second, the choice of technique is not exogenous, but can be influenced by government policy, as well as by institutions that change during the growth process. Much of our experience, whether in Asia, Latin America or Africa, seems to provide transferable knowledge about technology choice and related government policies.

Ranis¹⁵ work in countries that fit the small, open economy typology suggests that there is considerable potential for labor-capital substitution in manufacturing. He has undertaken an extensive analysis of methods used to increase the labor intensity of production techniques at the individual process level. On the basis of Japanese, Taiwanese, and South Korean

¹⁵Gustav Ranis, "Industrial Sector Labor Absorption," Economic Development and Cultural Change, March 1973.

experience, he shows that even when the choice of machine type is limited, considerable change in factor proportions from those appearing in more developed countries may be effected. This change, which Ranis has labeled "capital stretching", takes three forms, i.e. innovations relating to the machine proper; innovations relating to the production process as a whole, emphasizing the importance of activities within the plant but peripheral to the machine; and innovations with respect to the production process as a whole but emphasizing plant size and organization at various stages of the process. The most common examples of the first type of innovation are machine speedups and increases in the number of shifts. Ranis' work illustrates several cases of such increases in utilization in the textile industries of post-Restoration Japan (after 1868) and of contemporary South Korea and Taiwan. One especially interesting innovation involves the substitution of cheap for expensive raw materials in Japanese cotton spinning, with extra labor used to upgrade the yarn to the same standard quality. Intra-plant machine-peripheral increases in labor intensity may be achieved through the use of humans as "conveyor belts", hand packaging, storage etc. In Korean cotton weaving, for example, there is no mechanical conveyor belt in the carding and combing operations. The third type of innovation is mainly plant-saving via the use of a cottage industry type of "putting-out" system and rural sub-contracting.

The results are consistent with the basic hypothesis that, in a developing country which is open and not too large in size, more appropriate price incentives may be expected to produce a substantial increase in the employment-capital ratio, despite a substantial dependence on imported

machinery in the first instance. There is, in other words, substantial potential flexibility in both the initial choice of technology from abroad and the domestic adaptation potential "on top of" the imported technology. Further evidence on these points is given in the following discussion.

Diaz's¹⁶ cross-country study comparing Latin American cement plants with plants in Australia, Canada and the United States supports Ranis' finding of more than anticipated capital-labor substitution possibilities. Factor proportions even in the so-called "fixed proportions" case of cement seem to be sensitive to relative factor prices. The estimated elasticity of substitution, though not high, is significantly positive. But differences in average labor productivity between Latin American and non-Latin American plants, Diaz concludes, are only partly attributable to differences in capital-labor ratios and scale. Structural differences are so great that it may be true that the industry operates on different production functions in different country contexts. Diaz's results thus bear on the factor substitutability and efficiency issues as they arise in one fairly important industry. They also point to the importance of further work at the micro level, as well as across industries if we are to learn more about the substitution and choice process.

In the same vein, Howard Pack has concentrated on the choice of production techniques in Kenyan manufacturing, using actual plant data.¹⁷

¹⁶Carlos Diaz-Alejandro, "Labor Productivity and Other Characteristics of Cement Plants: An International Comparison," in Jagdish Bhagwati and Richard Eckaus, eds., Development and Planning: Essays in Honor of Paul Rosenstein-Rodan (Allen and Unwin in collaboration with the MIT Press) 1973.

¹⁷Howard Pack, "The Substitution of Labor for Capital in Kenyan Manufacturing," E.G.C. May, 1972.

While it is clear that adjustments in the relatively small manufacturing sector cannot solve the aggregate employment problem, it is nevertheless noteworthy that the relatively rapid growth in manufacturing output had only a weak employment impact. Once again, this time in the Kenyan context, Pack's findings indicate that the adoption of capital intensive techniques is not due to the lack of other efficient choices, but mainly to incorrect relative factor prices combined with inefficient management capacity.

Pack finds that there apparently exists considerable variation in feasible production methods, with much of the choice involving modification of processes to allow manual rather than machine oriented materials handling. Moreover, there exists substantial choice of major production equipment, e.g., new versus old and high speed versus low speed equipment. With respect to the adoption of feasible labor intensive production methods, he finds it dependent on two factors: the existence of factor prices that are reasonable; and perhaps as important, the existence of management capable of innovative discovery and adaptation. Finally, substantial gains in labor productivity without capital deepening may occur due to the existence of considerable (disembodied) productivity gains not embodied in new equipment. Rather, the gains are due to reorganization and learning by doing, and can result in the gradual elimination of excess capacity in both capital and labor. Organizational improvements appear to be very important for relatively labor intensive processes.

Both Pack's work on Kenya and Ranis' on Japan-Korea-Taiwan point out the importance of building up a source of skilled labor and of developing

an industrial infrastructure. Pack and Todaro consider in some detail the role of a capital goods industry in an LDC.¹⁸ As long as capital goods production is concentrated almost exclusively in developed countries, the relatively insignificant demands of the LDCs for these goods can have only a negligible impact on both current production decisions and, more important, on the direction the factor saving bias will take in the future. The authors argue that, to help alleviate or even remove the output/employment conflict, the LDCs, especially the larger ones, should produce their own machinery: (for both domestic use and export to smaller LDC's), initially copying the earlier, more labor intensive designs, of the advanced countries. This would permit the adoption of more recent labor saving techniques to be introduced at a speed consistent with changing domestic factor availabilities. Moreover, domestic users of the equipment are thus enabled to work more closely with the producers--a feature which is of considerable importance given the made-to-order nature of most machinery.

The authors further support their case by presenting data which suggest that the capital/labor ratio in the machinery industry itself is typically quite low. The absence of substantial economies of scale (a result of the specialized non-mass production nature of the industry) also makes the industry a natural choice. Probably the main precondition for

¹⁸Howard Pack and Michael Todaro, "Industrialization, Employment, and the Choice of Alternative Vintage Equipment in Less Developed Countries," E.G.C. Discussion Paper No. 95, September 1970.

the establishment of a light capital goods industry is the availability of limited amounts of skilled and semi-skilled labor. Evidence from a number of countries (e.g. Argentina, Brazil, India, Pakistan) suggests that LDCs can be competitive in the production of machines. Since international specialization does provide substantial advantages in this branch of industry, trade among LDCs would further increase the overall potential of the proposed strategy.

Ranis and Fei also think that the possibility of innovation and technological adaptation might be more important than factor substitution within the known technology. They discuss the principles and rules under which it appears that LDCs could benefit most from borrowed technology.¹⁹ At any given time, an LDC may be thought of as having access to a shelf of technology corresponding to the various vintages in the more developed countries, with the more recent vintages typically characterized by higher capital/labor ratios. The shelf continuously expands and changes composition as technological change proceeds in the more developed countries, but it always involves some range of choice among capital/labor ratios. The authors emphasize the fact that the technology which can be adapted at a point in time is closely related to the skill and education characteristics of the labor force. A wise borrower is constrained by the education and skill attainment levels of its own economic agents.

¹⁹Gustav Ranis and John C.H. Fei, "Technological Transfer, Employment and Development," in Economic Development and Planning, W. Sellekaerts, ed., MacMillan, 1974.

skill attainment levels of its own economic agents.

Technological borrowing may involve "pure transplantation" or "technological assimilation." In the latter, domestic innovative effort is imposed on the imported technology in order to modify and adapt its initially capital using character to make it more suitable to the labor rich/capital scarce factor endowment situation of the typical LDC. Such assimilation has been documented for Japan (Ranis), Mexico (Strassman), and the Soviet Union (Granick). The importance of technological borrowing, and especially of successful assimilation, helps to make human resource development, somewhat disregarded in the early phases of contemporary theory, a key factor. Economies which try to borrow ahead of their skill level find it more difficult or even impossible to effectively assimilate what they borrow.

The authors develop a model to analyze the relationship between technological transfer and technical unemployment. They focus on the complementarity (for the resolution of the unemployment problem) of an adequate level of domestic saving, the creation of the proper educational pre-conditions in terms of both quality and quantity, and sufficient ability and willingness to adopt imported technology. In this model, the twin social objectives of raising per capita income and reducing unemployment are not in conflict.

The conclusion emerges that, if there is only pure transplantation, successful growth can occur if and only if increasing labor productivity in the mature economy (from which borrowing occurs) is accompanied by a

sustained decrease in the capital/output ratio. Empirical studies have shown that the capital/output ratio in mature countries, in fact, seems to have undergone long swings in both upward and downward directions. Therefore, for success in the LDCs, adaptation is required.

Ranis and Fei outline a plausible model of the interaction of relevant economic variables and present some evidence that the historical evolution of the Japanese economy between 1878 and 1939 is consistent with the interpretation proposed. In doing so, they pinpoint the possibly substantial benefits which may accrue to the country that borrows wisely, i.e. at factor proportions as consistent with its own as possible; that exercises a substantial effort to assimilate and modify the technology; and that develops its own human resources in such a way as to complement the foreign technology and to permit its assimilation. As a consequence, from an initial level of technological unemployment of 10-20 percent in 1878 (which could not be eliminated by a simple reallocation of resources or alternative choice of techniques), the Japanese economy reached the turning point (where unemployment ended) by the 1930's.

A final example of work relating technical change to employment is Robert Evenson's research on Indian agriculture.²⁰ His results are reasonably optimistic about the potential for factor substitution, for significant increases in agricultural output, and even for gains in real wages in the wake of the Green Revolution. For instance, a moderate

²⁰Robert Evenson, "Labor in the Indian Agricultural Sector," E.G.C., October, 1972.

long-run substitution elasticity (.6 to .7) is estimated between labor and bullocks, fertilizer and seeds and traditional implements. The elasticity of substitution between labor and implements (tractors) is estimated to be even higher (1.44). But public policy might limit the benefits of potential factor substitution. For instance, artificially low prices of capital goods may thus lead to "premature" mechanization and labor displacement. Even less heartening is the evidence that Evenson presents on the regional distribution of the benefits of the Green Revolution. Some areas report significant gains in total factor productivity accompanied by increases in real wages; others, less favored by water and credit availability, report declines.

The policy implications of such uneven productivity gains within a country such as India are quite important. Uneven shifts in labor demand which show up quite dramatically in regional wages, labor migration and unemployment patterns put pressure on public policy to modify the regional pattern of productivity gains in dealing with labor markets generally in disequilibrium.

Overall, Growth Center research into industrial technology choice has indicated the high potential for adaptation once a country reaches a certain stage of development. South Korea, Taiwan and Japan, for instance, each passed through a historical import substitution phase, accumulating infrastructure and managerial skills. During their subsequent export substitution phase they were able to extensively adapt imported industrial technology to fit local conditions. Evenson sees a similar

situation in agriculture,²¹ where new seed varieties must be suited to local conditions. While there is some transferability of agricultural research through international research institutes, much adaptation is usually required at a regional and local level. Inadequate attention to this fact may, parenthetically, have much to do with the apparent current disenchantment with the continued force of the Green Revolution. Pack and Todaro generalized the same finding to an argument for building up a domestic capital goods industry. Local capital goods producers (whether of national or foreign background) are bound to be more sensitive to local requirements and factor prices, both in manufacturing and in agriculture, than are producers abroad. There is no substitute for domestic adaptive capacity.

One avenue of research into the employment question has thus led us to look even more closely at the available technological alternatives, statically and dynamically. Another has focussed on the relation between unemployment, underemployment and the distribution of income. The attention given to employment problems reflects a concern for poverty and income distribution; so-called underemployment, much more prominent than open unemployment in the typical LDC, cannot really be identified independent of a "low incomes" context. It has become increasingly clear, nevertheless, that the conceptual connections between growth, unemploy-

²¹Robert Evenson, "The 'Green Revolution' in Recent Development Experience," E.G.C. January, 1974.

ment or underemployment, on the one hand, and the size distribution of income on the other, in the labor surplus economy, are not as yet clearly understood. More work on such a deterministic or positive approach to income distribution is currently going forward.

Much of the EGC work to date on the relation between employment and income distribution grew out of our work on the services sector. The evidence is somewhat contradictory, suggesting that this sector has several economic functions and should not be treated as a homogeneous unit. Four main threads run through the argument: first, the sector provides a quality and productivity improving function; second, it absorbs the rural underemployed unusually well; third, income earned in this sector is spread among the urban underemployed, resulting in a somewhat more equal distribution than could be achieved through modern commercial production; fourth, those classified as employed or underemployed in this sector may be less well off than the so-called openly unemployed.

Mamalakis examines the services sector primarily from the point of view of the functions it serves,²² concentrating on the education, health services and quality improvements generated. Looked at in this way, it is clear that the sector can play a useful role in stimulating technical change and in affecting the distribution of income through the

²²Markos Mamalakis, "Services in the Contemporary Latin American City: The Case of Chile," mimeograph, Department of Economics, University of Wisconsin

supply of consumer services.

Ajit Bhalla's work on the services sector supports the position that a system of work sharing, such as is often found in traditional services sectors, will distribute the food required to keep everyone alive both more efficiently and more equitably than competitive pricing arrangements. He argues²³ that pressures of labor supply tend to show up in increases in self-employment in commerce and, to a lesser extent, in other economic activities. There exists no viable theory of the allocation and supply of labor effort. But it appears that self-employment is highly correlated with unemployment. While some authors have described services sector employment as simply disguised unemployment, Bhalla's work on retail trade suggests that it can be a useful and efficient method of production. He provides evidence²⁴ of high substitutability between both fixed and working capital and labor in retail trade. His estimates of the elasticity of substitution range between .6 and 1.4 in Colombia and as high as 2.3 in Taiwan. The higher the elasticity, the less wages must fall to absorb more labor. The retail trade sector, then, can act as an "employer of last resort" without a substantial fall in wages; it may thus be viewed as an important contributor to income and employment and not simply as a socially wasteful "parking lot."

²³ Ajit S. Bhalla, "A Disaggregative Approach to LDC's Tertiary Sector," EGC Discussion Paper No. 96, September 1970.

²⁴ Ajit S. Bhalla, "Economic Efficiency, Capital Intensity and Capital Labor Substitution in Retail Trade," EGC Discussion Paper No. 94, September 1970.

James McCabe's work on Zaire similarly stresses the useful function of the services sector in improving both overall efficiency and equity. Where social institutions in urban Zaire have developed what appear to be efficient mechanisms for work sharing, it may be an error to try to tear down these institutions prematurely. His study of employment and the distribution of labor incomes in urban Zaire addresses itself first to the problem that summary measures of wage inequality, computed for Kinshasa, tend to overstate the degree of total labor income inequality among sharing units of comparable size.²⁵ McCabe argues that this is true for two reasons: earnings covering female commercial activity are not recorded in the available statistics; and the 1960 U.N. definition of households upon which the measures of inequality are based understates the size of the actual sharing unit. The policy implication of this study of urban unemployment is that well intentioned modernization of the commodity distribution system may provide an unfortunate disincentive for sharing and a reduction in opportunities for female employment.

Gary Fields' view of the services sector, or as he revealingly calls it, the "murky" sector--is much less optimistic.²⁶ His theoretical work on rural-urban migration treats this sector more as a way station between low wage agricultural employment or underemployment and possible

²⁵ James L. McCabe, "The Distribution of Labor Incomes in Urban Zaire," in Review of Income and Wealth, Series 20, No. 1., 1974.

²⁶ Gary S. Fields, "Rural-Urban Migration, Urban Unemployment and Underemployment, and Job Search Activity in Less Developed Countries," EGC Discussion Paper No. 168, December, 1972.

high wage, modern sector employment. Not only are some people willing to be unemployed much of the time in order to earn high wages if they should obtain modern sector employment, but others are willing to be underemployed by working for very low wages (less even than they could earn in agriculture) in order to have a better chance of being hired for those same modern sector jobs. In Fields' simple model, built in the Harris-Todaro tradition, the expected income in the urban areas equals the expected income in agriculture. Thus, the unemployment and underemployment phenomenon has no explicit distributional effect.

Fields' work is based on his perception of the Kenyan unemployment situation. Albert Berry's empirical work²⁷ on Colombia, however, comes up with a somewhat different interpretation of the openly unemployed and underemployed (often in the services sector). Although unemployment per se is not a good indicator of poverty or of relative income inequality, it is not a random phenomenon. In fact, it appears as if much of the open urban unemployment which existed at the end of the 1960's was essentially among workers with white collar education. Those who had high aspirations and could afford to choose among jobs could remain unemployed while the poor would be forced to accept low paying employment, for instance in the services sector, and could be called underemployed. Changes in underemployment might thus be a better indicator of changes in income inequality than changes in open unemployment. For example, from 1945 to 1953, Colombian underemployment rose at the same time that income distribution worsened. After the 1958 devaluation, on the other hand, Berry finds that the underemployment rate fell along with inequality.

²⁷ Albert Berry, "Some Determinants of Changing Income Distribution in Colombia: 1930-1970," EGC Discussion Paper No. 137, March 1972; and "Unemployment as a Social Welfare Problem in Urban Colombia: Some Preliminary Hypotheses and Conclusions," EGC Discussion Paper No. 145, May 1972.

An additional related finding has to do with the relationship between income distribution and growth. Berry's conclusions are consistent with Fei and Ranis' work on Korea and Taiwan, namely his work indicates that, while growth and income distribution have often moved in opposite directions during the 1950's and 60's, these patterns can be largely attributed to government policy favoring large scale, capital intensive firms. The fast growth periods of the early 1950's and up to the mid 1960's were accompanied by worsening distribution. But Berry argues that the apparent conflict between growth and distribution cum employment goals can be largely attributed to the policies followed.

While Berry and McCabe deal with the question of income distribution indirectly, by considering the role of the services sector and looking closely at the unemployed and underemployed in the course of growth, Soligo's approach²⁸ is quite different; it turns the problem upside-down by asking what is the employment effect of an exogenous income redistribution. While --at least in Taiwan, Korea and Colombia--it appears as if income redistribution and growth can move together in a mutually reinforcing fashion during the export oriented phase of growth, Soligo is asking whether there is a trade-off between employment and growth when a policy of the redistribution of increments in income is somehow pursued (e.g. by fiscal means). The result depends on the factor intensity of consumption bundles, assuming that adjustments don't come through trade. Using West Pakistan data,

²⁸Ronald Soligo, "Factor Intensity of Consumption Patterns, Income Distribution and Employment Growth in West Pakistan," EGC, November, 1972.

Soligo finds that short-run employment is quite insensitive to changes in the sectoral and size distribution of income. Long-run employment and output growth rates, however, could increase by as much as 10 percent when income is distributed more equally. Nevertheless, the experiment indicates that, to get this result, a larger exogenous redistribution than is likely to be possible in most LDCs would be required. With this in mind, Soligo's results indicate that income redistribution within the limits of current fiscal practice could not have more than a negligible impact on both output and employment and hence, the fashionable hypothesis that exogenous income redistribution can cause both output and employment to increase significantly by increasing the output share of the relatively labor-intensive goods is not supported. Nor is it clear how the exogenous change in distribution is to be achieved in the first place--given the limited fiscal capacity of most LDC governments. However, as we have seen, changes in the structure of the economy, i.e. in the nature of the growth path itself, as a country moves into a phase of labor-intensive export orientation, can result in both greater employment and growth, and, endogenously, to a more equitable distribution of income.

Our past work on employment has pointed us in the direction of two major lines of future inquiry. The first of these--the relation between growth, employment and the distribution of income--is of obvious importance since our interest in unemployment and underemployment is, to a large extent, based on our concern with the distribution of income.

Moreover, our results relating income distribution to growth to date suggest that we need to know a great deal more about the anatomy of the historical process of growth as it affects the size and distribution of income within and between sectors. We think it will be important to distinguish a country's typological framework and then analyze the effects of government policy within that framework.

The second area for further research involves a more in-depth analysis of the choice and adaptation of technology. While it is clear that the structure of technology choice and of innovation choice form the basis for employment possibilities, it is not yet at all clear just how flexible or constrained these changes are. We think it is important to obtain a better understanding of the production process at the micro level, along with the economic and institutional factors which determine the entrepreneur's final choice of production technique. The overall environment in which individual entrepreneurs find themselves includes not only relative factor prices, but also the competitiveness or non-competitiveness of product markets and such public sector activities as R & D, educational strategies and the provision of informational access.²⁹

²⁹For a preliminary statement of some of the traditional as well as non-traditional components of the environment affecting technology choice, see Ranis, "Some Observations on the Economic Framework of Optimum LDC Utilization of Technology" in Technology, Employment and Development, Lawrence J. White, ed., Council on Asian Manpower Studies, Manila, 1974.

Policy Conclusions

Most of Economic Growth Center research has been aimed at a better understanding of the relationship between employment and development in an historical context in the belief that an understanding of behavior must precede policy conclusions and planning. Yet the ultimate purpose of all such research must be in its usefulness to LDC and DC policy makers. A number of conclusions relevant in this sense can be derived from the Growth Center's work. They fall into a number of areas: those relating especially to relative prices and the integration of markets; those relating to technological developments and adaptation; and those relating to education and fertility.

Throughout the Growth Center's work, whether the focus has been on small or large-scale; Asian, Latin American, or African cases; domestically or export oriented; we have found that factor and product prices should more realistically reflect factor endowments, at least at the firm level. In many countries, the distortions include subsidies to credit resulting in credit rationing, accelerated depreciation and other tax incentives, wage premiums in the form of social security type benefits, and exchange rate overvaluation requiring tariffs or foreign exchange controls. This structure of taxes and subsidies must eventually be substantially dismantled if a developing country is to reallocate its scarce capital and skilled labor to their most productive uses, increasing in the process employment, family wage bills, and, finally, wage rates.

Closely related is our strong conclusion that markets be allowed and encouraged to function better. Most frequently mentioned are capital markets. But the integration of the rural economy into the commercialized sectors, or of the national economy into the international, should not be forgotten. To benefit from a greater reliance on markets, a developing country must have an

incentive structure with signals more related to resource endowments and comparative advantage. This does not mean an absence of government intervention but government intervention via a greater use of markets.

For such price and market adjustments to be most effective, a minimum base of domestic infrastructure, entrepreneurial skills and technological know-how is a prerequisite. During the earlier stages of economic development, a policy of protection and import substitution can be useful and necessary to develop the resource base for later export substitution policies leading to the production of labor intensive goods. The role of trade has been emphasized in much of Growth Center research, whatever the country typology. While we repeatedly touch on the importance of labor intensive exports, we do not ignore domestic infrastructure and skills which will allow adjustments to a changing world environment. Often, this foundation of entrepreneurial skills and of a skilled work force can only be begun during a transitional period of import substitution which may be a necessary prerequisite for the more market-oriented phase to follow.

Investment in education should, on the one hand, provide a skill base for local innovations, allowing responsiveness to changing markets, and on the other hand, affect fertility. As for the first, we are convinced that local research on agricultural and industrial technology--in addition to the (well-recognized) international research of the IRRI type--is necessary to adapt methods from developed countries to the environment of a particular LDC. While we do not yet know enough about industrial technology, it appears that both in industry and in agriculture, adaptations "on top of" basic processes are possible, but must be made within the framework of the local economy. An educational system oriented towards domestic requirements, and

not towards the frontiers of knowledge is a necessary prerequisite. Along with expenditures on education and training, this requires a flexible system of adaptive local industry-oriented research organizations, as well as a local capital goods industry which draws on a supply of mechanically skilled labor, not on highly trained engineers.

Given the severe distortions in capital import and labor costs in many LDC's and our findings of substantial factor substitutability, the most important contribution donors can make clearly is to argue for gradual changes in monetary, fiscal and exchange rate policies which can be expected to significantly increase employment along with output. As is well accepted now, the benefits and costs of a proposed specific project should be based as closely as possible on the opportunity cost of factors used and an equilibrium price for the product. It is difficult, moreover, for donors to effectively discuss distortions in favor of the use of capital when their own contribution, via aid tying, a "projects only" approach or a bias against local cost financing, tends in the same direction.

Growth Center research also indicates that the payoff to adaptive agricultural research has been very high--much higher than to most physical capital investments. Geological differences which limit the transferability of research from one area to another make local research stations important. Apparently the analogy with industrial research on technology may have substantial validity. Local variations in raw material supplies and in factor costs require local technological adaptations here as well. Donor agencies should seriously consider the potential value of encouraging adaptive industrial research, perhaps by linking international research on an industry-specific basis to the encouragement of local adaptive R & D institutions.

Finally, if developing countries are to successfully carry out investment projects, they will need local entrepreneurship and skills. Donor support should go, however, not primarily to the training of engineers and basic scientists, but to the development of para-engineering skills and applied scientific know-how.