Productivity and Industrial Development in Sub-Saharan Africa

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Summary This paper considers the current state and prospects for efficient development of the large scale industrial sector in Sub-Saharan Africa. It is argued that the liberalization of the international trade regime is unlikely to be sufficient for successful development unless the technological ability of firms is increased to allow an elastic supply response. Alternate modes for improving supply responsiveness are considered.

* Mr. William Steel provided helpful comments on an earlier draft.
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1. INTRODUCTION

There is great concern about the prospects for the industrialization of Sub-Saharan Africa.¹ Much of the literature dealing with this question has typically employed a neoclassical view that assumes underlying elasticities of supply are very high and that all that is necessary is improving the price structure and privatizing or rationalizing publicly owned enterprise. Limited attention has been given to technical and allocative inefficiency within firms, which shift industry supply curves upwards. The emphasis on trade liberalization is mainly devoted toward obtaining gains from intersectoral reallocation of resources, the expansion of efficient sectors and firms, and the exit or improvement of inefficient ones. Evidence through 1990 indicates that structural adjustment policies including both macro and trade liberalization have had as their major effect increased capacity utilization as more raw materials and intermediate goods became available.² There is no documentation of improvement in performance in either total factor productivity or firm level choice of technology.

While it is obvious that incentive structures matter, the emphasis on prices in policy discussions is not consistent with simultaneous assertions about the constraints imposed on development by limited human capital, partly reflecting the colonial heritage. In agriculture, a fairly elastic supply of output is likely as the technology currently employed remains largely traditional, the knowledge of production activities is relatively routinized, and farmers can thus respond to price incentives. In contrast, there is limited systematic knowledge in the large scale industrial sector of the technology of production, reflecting the paucity of trained personnel. As an extreme example, Mlawa (1982) found that there were six trained textile engineers in Tanzania's eight large locally owned textile factories. In contrast, multinational owned textile firms in Kenya utilize about twenty trained textile technicians per plant.

While price denominated policies have been critical in Asia and could undoubtedly contribute greatly to Latin America's growth, the current conditions of early industrialization in Africa militate in favor of simultaneous attention to the generation of technological competence.³ Without an increase in proficiency, the responsiveness of output to even the best designed structural adjustment program is likely to be limited. Prices are one half of a scissor, the other being technical skill. Successful NICs do not develop solely from the correct pattern of relative prices.

Price and technology improving policies are not mutually exclusive: indeed they may reinforce each other. Thus, the evidence suggests that in Korea and Taiwan, the move towards neutral incentives between domestic and foreign sales stimulated technologically simple labor intensive exports and these in turn facilitated the acquisition of technical skill as a result of advice from foreign purchasers. Moreover, the export earnings made possible payments for technology licenses and foreign machinery that embodied considerable technology.⁴ The imported equipment provided an opportunity for local technicians to gain mastery in its use and adapt it to domestic conditions. In sum there was a process of learning facilitated by exporting. While the same sequence of liberalization-simple exports-technology purchases may be feasible in Africa, there are important differences.
In particular, the Asian NICs clearly had considerably more human capital at the beginning of their rapid growth period than do current African countries and a higher flow of education in the last two decades. Comparisons of stocks and flows of education confirm this. Moreover, Hong Kong and Taiwan benefited from the substantial influx of experienced industrialists and technicians from mainland China while Koreans had gained considerable technical skills during the Japanese occupation. If there are useful lessons to be drawn from the NICs for Africa, it may be from Singapore which compensated for relatively low levels of education and skills in production engineering by the extensive use of foreign technical knowledge, particularly that transferred by MNCs. Price policies in Asia were necessary but not sufficient to account for the growth of industrial output. Growing technical competence was a critical facilitating factor.

The paper concentrates on the generation of technical capability in large scale industry. It does not consider in detail the pricing policies of governments nor the export facilitating activities of government and the private credit markets. The former are by now part of the general lore of development economists and the latter has been the subject of considerable recent research.

Section 2 presents an analytic framework employed in the following sections. Section 3 provides an overview of some of the current issues in African industrial development. Section 4 discusses the policy environment and strategies such as resource based industrialization and basic industries that have been advocated. Sections 5 and 6 analyze the possibilities for improving the performance of industries and their constituent firms. Sections 7 and 8 briefly consider the quality of labor and the role of the small scale industrial sector. Conclusions are presented in Section 9.

2. ANALYTIC FRAMEWORK

Many of the issues that are addressed in this paper exemplify recent concerns about the development of industrial skills, particularly those possessed by managers and technicians. The literature addressing these issues commonly refers to technological capability or capacity. It is closely related to conventional concerns with the evolution of total factor productivity, TFP, as well as to the earlier literature on the choice of appropriate technology.

LDC firms, particularly where firms are protected from competitive pressure, typically exhibit low levels of TFP, operating on unit isoquant $A_1A_1$ at total cost $TC_1$ in Figure 1 where K and L indicate capital and labor per unit of output. They may also have chosen a technique of production such as $x_1$ that does not minimize production cost at the initial wage rental ratio, $w/r$, where $w$ is the wage rate and $r$ the user cost of capital. Investment by the firm in response to trade liberalization may induce training, R & D, and quality control, and move the firm to $AA$, from $x_1$ to $x$, along the best practice unit isoquant which shows the level of output obtained in best practice plants throughout the world. This move reduces production (net of training) cost from $TC_1$ to $TC_2$. Such effort may also allow the firm to alter the
proportions in which primary factors are employed, thus reducing unit cost to $TC_3$
because factor intensity at $y$ is cost minimizing given relative factor prices, w/r. If firms that have achieved such success can also replicate and establish a new plant that operates along AA, they have acquired investment capability.

![Figure 1: Sources of Inefficiency](image)

Figure 1
SOURCES OF INEFFICIENCY

To establish whether the investment activity of firms that moves them toward AA is socially as well as privately profitable requires augmenting the simple framework of Figure 1. In particular, the domestic resource cost (DRC) criterion can be used to evaluate the social optimality of technological activity at the end of the
learning period. Although numerical values of DRCs will not be presented, this framework permits a unified exposition of many of the relevant issues.

The domestic resource cost of good $j$ is:

$$\text{DRC}_j = \frac{(w^* L_j + r^* K_j)}{(P_{wj} - \Sigma a_{ij} P_{wi})Q_j} \quad (1)$$

where $w^*$ and $r^*$ are the shadow price of labor and capital respectively, $P_{wj}$ and $P_{wi}$ are the border price of output and inputs respectively, $Q_j$ is the level of output, and $a_{ij}$ are input-output coefficients. The denominator thus defined is value added at international prices, $VA_w$, and the value of the isoquant in Figure 1 can be viewed as $VA_w$ while the numerator is the opportunity cost of domestic resources employed in generating $VA_w$. Technological activity of firms alters $K_j$, $L_j$, or $a_{ij}$ - reductions in any of these, which will be measured ex post as an increase in total factor productivity, will decrease the DRC. In addition, if firms are initially operating along a ray through $x$ which is excessively capital intensive given social opportunity costs of factors, substituting labor for capital so that it operates at $y$ will further reduce the DRC.

The DRC as defined in (1) is static. In the short run the major quantitative change in DRCs is likely to arise from alterations in the level of capacity utilization, the level of $Q_j$. Smaller reductions may be achievable by technical improvements that reduce $K_j$, $L_j$, or $a_{ij}$. In the long run, all of the elements of (1) may change as a result of foreign or domestic technical effort and as a result of changing prices both internationally, $P_{wj}$ and $P_{wi}$, and domestically, $w^*$ and $r^*$. It is important to note that even if a low DRC is achieved in an activity after the period of learning, this does not by itself demonstrate that the technical effort was socially profitable. Social profitability requires that the present discounted value of producers' surplus after international competitiveness is achieved be larger than the discounted cost of protection, namely, foregone consumer surplus and any excess of production cost (inclusive of R & D) over international prices of the protected commodity. To be complete, the effects of externalities that result from technological activity such as R & D spillovers or learning that is diffused to other firms by the movement of workers should be added to the benefits. Unfortunately, these are exceptionally difficult to quantify and can result in arbitrary alterations of the basic welfare measure.

3. WHAT IS WRONG WITH AFRICAN INDUSTRIAL DEVELOPMENT?

To ask the question of this section is to accept that an area as poor as Africa should engage in large scale industrial production. It is now widely understood that since the major economic activity in terms of both employment and output is agriculture, any sustained growth in living standards will require improvement in
agricultural productivity. Methods of achieving such improvement in smallholder agriculture are fairly well understood: local agricultural research, an expanded improved extension system, improved rural infrastructure, and importantly, a price structure designed to provide incentives rather than one discouraging production.\textsuperscript{12}

No such relatively robust prescriptions are available for the large scale industrial sector. Appropriate economic evolution should emphasize small scale industrial activities, particularly in rural areas. Nevertheless, some types of products that will be demanded, given observed income elasticities and requirements for productive inputs (e.g. fertilizer), are more efficiently manufactured in the large scale sector. While these can be imported, many countries have already begun their production, and to ignore the existing assets might constitute a waste of scarce resources. There is also an argument for a limited expansion of the sector to allow some types of learning whose major benefits will accrue two decades hence as the demand for the products of the large scale sector inevitably increases.\textsuperscript{13}

Past inefficiency in African industry is fairly well documented using measures of efficiency relative to international production such as the domestic resource cost and effective rates of protection (ERP).\textsuperscript{14} Unfortunately, these measures, though instructive about the overall magnitude of inefficiency leave the analyst without a firm basis for prescribing means of ameliorating the situation. A high DRC level can be the result of technical or allocative inefficiency within firms. Technical inefficiency, a high value of $K_j$ or $L_j$ for a given value of international value added in (1) indicates that firms do not achieve the same total factor productivity as do firms employing an identical technology in other countries. Allocative inefficiency, an excessively high value of $K_j/L_j$ in (1) implies that firms incur higher than necessary costs by choosing the incorrect combination of capital and labor given the factor prices they currently face. For example, if the prevailing market price, $w/r$ coincides with the shadow price $(w/r)^*$, they choose to be at $x$ rather than $y$ in Figure 1.\textsuperscript{15} A high DRC also does not provide much information about the extent of dispersion of total factor productivity within an industry. Rather, it provides a notional measure of the degree of protection afforded the marginal firm without indicating whether significant possibilities exist for improving productivity by the diffusion of skills from better to weaker firms or whether all firms are relatively inefficient.

Without detailed studies of the sources of inefficiency, analysts typically impute to African industry the difficulties that have been observed in import substitution regimes in other countries. Insufficient utilization of capacity due to excessive plant size in small markets or the unavailability of foreign exchange, technical inefficiency reflecting the absence of adequate competitive pressure in the protected domestic market, and low labor productivity alleged to result from the absence of an industrial past are typically offered as explanations of high costs. Intrafirm allocative inefficiency is infrequently noted even though it is one potential source of higher costs and its empirical importance has been shown in Ghana (Page, 1980) and Kenya (Pack, 1987).

Nevertheless, some of these explanations are not self evident. Small domestic markets and high protection levels characterized both Korea and Taiwan in the
1950s and early 1960s yet there was quite rapid growth in TFP that stemmed from learning about important aspects of production engineering.\textsuperscript{16} Such learning was possible because of prior industrial experience, higher investment in education, and a greater interest in industrial management than in recently independent African countries in which many ambitious professionals entered government service.

Some of the inefficiencies are amenable to at least partial correction by macroeconomic policy intervention. Successful devaluation can reduce excess capacity by encouraging exports from underutilized plants and providing the foreign exchange for essential imported intermediate goods. A lowering of the general tariff level and a move toward unification of ERPs across sectors may generate competitive pressure to induce firms to improve productivity, the major question being their ability to respond and move toward best practice. Resource reallocation toward sectors with low DRCs may occur if there is sufficient management ability in these sectors to absorb more factors and market the additional output, primarily abroad. Moreover, the waste of resources entailed in rent-seeking activity will be reduced. A move away from domestic orientation towards exporting can be encouraged by a more neutral trade regime that does not set the effective exchange rate for imports above that for exports.

While in principle these policy measures could ameliorate many of the current problems of Sub-Saharan industry, some of the expected benefits from the standard package are based on assumptions that have had limited empirical verification in Africa. For example, unless a move toward best practice results from learning by doing simply as cumulative output increases, technical efficiency may not be improved by greater competitive pressure. Insofar as technical improvement requires conscious, coordinated effort by managers as well as investment in productivity augmenting activities, increased competition will yield its presumptive benefits only where capable managers are in place who respond purposively to new incentives.

Available evidence suggests that the response to an improved policy environment has been weak, certainly not generating the rapid growth rates in industrial output and exports characteristic of many of the Asian countries in recent years. A few nations, notably Mauritius, have responded to a higher effective exchange rate for manufactured exports but much of this additional supply has been accounted for by Hong Kong based multinationals that possess the technological capability that is missing in much of the continent's large scale manufacturing.\textsuperscript{17} In other African countries, adjustment cum liberalization programs have had little success except for the greater utilization of capacity permitted by newly available foreign exchange.\textsuperscript{18} While important in the short run, greater utilization of capacity cannot be a source of sustained growth in total factor productivity.

In summary, while industrial productivity in Africa might be improved by the typical macroeconomic cum liberalization policy package, the magnitude of the gain is not likely to be particularly large given the scarcity of experienced industrial managers and the paucity of general industrial experience. These factors suggest that African industry may require more than the efficient pricing policies if productivity growth is to occur. Even in the case of the Gang of Four, particularly in S. Korea and Taiwan, price policies were hardly neutral and were often designed to galvanize
technological efforts, particularly to improve the prospects of new industries. (Pack and Westphal, 1986).

The following sections analyze the actions necessary at the national, industry, and firm levels if productivity is to be increased in African industry. The analysis and policy prescriptions assume that the typical set of macro policies from reduced fiscal deficits to tariff reduction to freer capital markets is also put into place though the precise time phasing of such changes should be coordinated with the policies suggested here.

4. THE NATIONAL POLICY ENVIRONMENT

The nationwide policies to be implemented obviously depend on an empirically based diagnosis of current ills and some rough notion of the best (in the sense of comparative advantage as measured by DRCs) evolution of the industrial sector. In the short term, say three years, effort should be devoted to increasing the productivity of existing plants and sectors. In many instances, achieving previous peak levels of output is an appropriate near term goal. National policies such as improved education have too long a gestation period to exert a quick impact. Macro policies that eliminate foreign exchange shortages and quantitative restrictions can have an immediate effect when plants are underutilized because of shortages of raw materials or spare parts that are attributable to deficient foreign exchange levels or the inability of firms to spend sufficient time to obtain licenses for required intermediate inputs. Policies to improve the reliability of publicly provided services such as electricity and transportation will also affect capacity utilization as well as long term marginal cost.¹⁹

Analysis of the interaction of long term evolution of the industrial sector and national economic policies involves two issues: (a) which sectors are likely to improve their DRC relative to others; (b) the effect of increasing levels of education on long term DRCs.

(a) Sectoral Strategies

What are likely to be the characteristics of industries that can compete internationally, whose long term DRC will be low? On conventional Heckscher-Ohlin grounds, African manufacturing development should be unskilled labor intensive given the fact that in 1989 adult illiteracy rates typically exceeded 30 percent, 60 percent not being unusual, and high school enrollment rates averaged 23 percent.²⁰ Other characteristics of sectors likely to achieve DRCs <1 include: (i) continuous flow rather than job shop arrangement of production; (ii) relatively self contained production, requiring few deliveries of inputs from other domestic sectors; (iii) absence of products with rapidly changing characteristics or products whose production technology has been subject to rapid technological progress in competitor nations.

(i) Job shops. Without providing detail here, job shop production processes such as those characterizing machinery production are unlikely to be efficient. They are difficult to organize efficiently, put a premium on the production
planning skills of management, and require workers with both high formal education and considerable experience in production. This general statement does not imply that small plants manufacturing simple agricultural tools cannot be cost efficient. But it does suggest skepticism about the probable success of more complex operations such as the attempt to produce numerically controlled machine tools in Tanzania (Rweyemamu, 1973).

(ii) **Linkages.** Many analysts favor promotion of industries with extensive backward linkages. If, however, domestic suppliers are themselves either inefficient or unreliable, they will adversely affect a potentially efficient sector as their prices will exceed border prices. In terms of (1), domestic input prices \( P_{di} \) greater than \( P_{wi} \) reduce domestic private profitability unless the government insures access to intermediate inputs at international prices as is done in some of the Asian countries. Establishment of large industries with extensive backward and forward linkages to domestic firms may be a mistake. Ever since the early discussion of the stagnation of enclave economies due to the absence of "backwash and spread effects" there has been a view advocating the establishment of sectors with linkages, a stance most vigorously advocated by Hirschman who had a much more complex view than many who have since followed his lead. Nevertheless, unless the sector to be promoted as well as the linked sectors are themselves efficient at international prices (have normalized DRCs \( \leq 1 \)), linkages are only an entry in an input-output table, without any normative basis.

Arguments that strategic sectors with large linkages may nevertheless be "dynamically" efficient implies that their establishment is justified by the Mill-Bastable criterion, i.e., the present value of their future social benefits (inclusive of any external economies) exceeds the present value of their excess costs. While it is possible that some investment in strategic sectors may be justified on this basis as substantial learning ensues after a sector is established, there is no empirical evidence that confirms this.\(^{21}\)

(iii) **Rapid technology changes.** Finally, it is difficult to initiate low cost production in industries with limited supplies of the critical engineering and managerial manpower that are required to assimilate new production technologies and to insure the quality control necessary in products such as electronics with rapidly changing characteristics.

The Heckscher-Ohlin model of comparative advantage does not provide predictions about specific sectors that will emerge in the long run in response to market signals. In more advanced countries, market solutions to the choice of sector are likely. Entrepreneurs, on the basis of current and estimated future prices and productivities can make their own calculations and the only argument for intervention is the existence of capital market failures. Although there have been some successes in choosing industries and fostering their development in East Asia, its political environment, particularly the ability to withstand rent seeking activities and the astuteness and depth of competence of the public bureaucracy are not readily replicated in other countries.\(^{22}\) The evolution of sectoral structure should, in general, be market determined. However, a fully informed market determined
expansion faces particular difficulties in Africa because of the major changes in relative factor supplies that result from relatively small flows of educated manpower. These difficulties are compounded in sectors in which product design and production processes change rapidly, changing $P_{wi}$ and $K_j L_j$ and $a_{ij}$ in (1).

Two long term industrialization strategies with respect to Africa, namely, resource-based industrialization (RBI) and basic industries have been widely discussed and may be viewed as focusing on sectors that are not subject to rapid market changes, thus narrowing the range of industries which investors, including the government, need to scan for profitable investments. The basic industry strategy envisions self-sufficiency in a large number of sectors, particularly those manufacturing "producers" goods, defined as exhibiting large forward linkages. Increased self-sufficiency through more import substitution is often espoused apparently regardless of cost (Economic Commission for Africa, 1982). As noted above high forward linkages are not a useful criterion for investment decisions.

RBI is best interpreted (Roemer, 1979) as arguing that industries processing local raw materials have a cost advantage in such activities. Despite the potential it affords, the mere presence of natural resources does not establish a case for processing the resource or establishing industries based upon this material. Unless the processing or production can be carried out at internationally competitive costs, it is best to export the raw material. Proponents of RBI focus on the low local cost of the primary product rather than the export price, $P_{wi}$ in (1), in calculating the profitability of the activity. They also overlook the possibility that productivity of labor and capital in the promoted activity may be very low so that the DRC is quite high. To take one example, local processing of long staple cotton in Egypt has been characterized by extremely high DRCs. Especially where the processing involves substantial scale economies and downstream marketing occurs within an oligopolistic market, skepticism about RBI is warranted.

(b) The Effects of Additional Education

Changes in the stock of skilled manpower, and its likely major effect on scarcity prices, may militate in favor of some intervention. A full derivation of the DRC should include several types of labor. The current opportunity cost of skilled labor $w^*_S$ is likely to be above the long run shadow price if there have been sustained increases in enrollment rates. It is thus possible that projects that would prove (privately and publicly) profitable in the long run will not be undertaken in the absence of correct signals about future prices.

Cotton textiles, for example, satisfies many of the criteria for successful industrialization and might emerge as a low DRC activity; the capital-labor ratio is potentially low (assuming the correct choice of technology), it is process based, and interactions with other manufacturing sectors are limited. Yet the emergence of an efficient sector might be severely constrained by the absence of sixty key technicians. In more industrialized countries with a greater general education base and many trained workers, a relatively small increase in the wage of textile technicians would
provide the requisite incentive to elicit the small additional amount of necessary training. A similar response to market signals is unlikely in a poor African country with few persons with the necessary general education background or skills to make marginal changes in wages a quantitatively sufficient source of additional supply of textile engineers.

Thus, the DRCs currently calculated given existing resources and prices may differ widely from those that would emerge with a relatively small addition to the pool of specific high level skills. Measures of static comparative advantage such as the DRC are unlikely to be robust with respect to small changes in factor availability. Long term or dynamic comparative advantage can vary widely insofar as small flows of the scarcest factors will have a large impact on relative stocks and hence on \( w^* \) and \( r^* \).

The sensitivity to small changes in resources may militate in favor of selecting a subset of industries that conform to the general Hecksher-Ohlin criteria and fostering their development while relatively narrow long term training geared to these sectors is pursued. This approach is clearly risky - international consultants, domestic bureaucrats, and international civil servants have no obvious advantage in projecting the path of DRCs at the seven digit level. And, it would be critical if such an effort were made, to allow wrongly chosen sectors to atrophy, a difficult political issue within the African context.

Can governments do anything to improve industrial sector prospects? A strategy that is not tied to specific sectoral evolution would consist of sending successive cohorts of students for foreign training in business administration and a wide mix of engineering programs not geared to specific subsectors but appropriate for the broad sectoral categories likely to be important in Africa. These guidelines militate in favor of mechanical and chemical engineering and against training in electrical engineering and biotechnology in which industrial products and processes change so rapidly that success requires very large numbers of trained persons. The training should be at the master's degree level; more advanced education reduces the probability of return to one's country and may reduce concern with production problems as opposed to research. One of the highest returns to aid donors would accrue from financing the provision of such training. While most economists point to the great benefits derived from price denominated policies by the Gang of Four, there is substantial evidence that the accumulation of human capital was an important permissive factor in fostering industrial growth.

With a set of skills obtained from technical and business education, the additional industry-specific training will not be lengthy as particular sectors emerge. The general training will serve as a basis for either internal education by firms or formal industry-wide education. This strategy for providing a broad range of training that can be transformed relatively quickly to sector specific skills will work best if the development is undertaken in conjunction with agents who already have the specific skills, for example MNCs, so that the sector can emerge "naturally" as dictated by comparative advantage. I will return to the question of the appropriate agents for long term industrial development below.
The preceding may also provide some tentative guidelines for short term strategy. In particular, relatively low rates of effective protection could be granted to sectors whose production is based on mechanical and chemical engineering, no protection to sectors based on electronics or biotechnology. Even within the (slightly) protected sector, non-process industries such as the production of complex machinery should not be protected at all. Whereas a high percentage of production workers for the process sectors can be relatively quickly trained, the very high level of formal education and apprentice training required in machine manufacturing and similar activities imply that these are not sectors that exhibit either a current comparative advantage or one likely to emerge in the near future. In addition, their organization in job shops increases the coordination abilities required of management.

5. PRODUCTIVITY IMPROVEMENT AT THE INDUSTRY LEVEL

Where many firms currently constitute an industry, rather than one or two in sectors like pulp and paper, an important potential source of productivity growth is bringing each of the firms towards the level of TFP of the most efficient domestic firms, assuming that significant dispersion exists. It has been found that textiles, sawmilling, and other industrial activities in several African countries exhibit considerable intrasector variation in TFP (Page, 1980, Pack, 1987). Moreover, even the best local firms may fall far short of internationally realized productivity levels (AA in Figure 1) and a further fillip to domestic output can be obtained if all firms, both those locally efficient and those falling short of this standard, move towards international best practice.

The conventional wisdom is that a compression of the variation in productivity will occur automatically if all firms face heightened competitive pressures from tariff reduction or the elimination of quotas. However, if weaker firms cannot respond to these inducements, they may simply face bankruptcy. This is undesirable for two reasons. First, the firms and their workers may generate significant political opposition to such national policy changes, undermining the possibility of liberalization. Second, most African markets are not filled with potential entrants who will buy the physical assets of defunct firms. Hence, bankruptcy may imply the loss of the productive power of physical equipment that is potentially profitable as well as the dispersion to lower marginal product activities of workers with accumulated industry-specific skills. Thus a phased approach to liberalization is likely to be superior to a shock treatment.

Assuming that the industry consists largely of privately owned firms, how can the government reduce the dispersion of productivity without coercive measures that force the sharing of managerial information among existing firms. The particular policy instruments chosen depend on the source of low productivity. For example, if the problem results from excessive product diversity or insufficient intraplant training of workers due to the fear of worker mobility (assuming that firms perceive that they bear the cost of training), explicit measures need to be taken on an industry-wide basis. If it is determined that a major problem lies in the insufficient command of production engineering, the solution lies at the firm level, discussed in the next section.
For industry-wide mechanisms to work, it is necessary to induce cooperation by the constituent firms. Assuming that firms are privately owned, a carrot and stick are both required. The stick is the threat to profitability of preannounced liberalization. The carrot is use of the tax system or loans to help firms adjust where capital market imperfections exist. Consider first the case of industry-wide training centers for manual workers and supervisors. Unless all firms are compelled to pay for such a facility, it will not be established given that benefits will accrue to each firm regardless of whether it has shared in the cost, the classic free-rider problem. Given that substantial social benefits are likely to accrue from such training, firms can be required to contribute, the specific mechanism depending on the structure of industry and the government's administrative ability.

A more difficult industry-wide issue arises where low productivity results from insufficient product specialization within firms. Firms often accept very small orders in order to utilize existing equipment more fully. In some major sectors such as textiles, quantitative evidence (Pack, 1987) indicates that the absence of horizontal specialization decreased TFP by 30 percent in many integrated textile mills. Firms produce a wide range of products but the economies of scope they achieve are more than offset by the higher costs incurred by frequently stopping the production process to allow changes in machine settings and the excess learning costs on each short run. An optimal solution requires a narrow range of specialization by each firm, rents being precluded by the entry of each product at international prices.

The conundrum here is how to achieve such specialization if it does not arise spontaneously from liberalization. While it is possible that more product specialization will be engendered by the greater openness associated with general tariff reductions, this is by no means certain. The domestic structure of industries including the extent and nature of vertical integration plays a key role in the determination of specialization and this structure is not readily amenable to macro policy manipulation. In much larger, more open economies such as Canada, excessive intraplant product diversification remains a problem and it is far from clear that this would not be the case in most African countries, even with extensive liberalization.

Given the large social benefits that may be obtained, what mechanisms can be employed? The Korean solution has often been a cartel-like arrangement in which individual products are assigned to particular firms, efficiency incentives being provided by the threat of withdrawal of various government preferences unless exports are realized (Pack and Westphal [1986]). This method involves considerable intervention by an extremely able bureaucracy, the political will and ability to terminate preferences, and the capacity to carefully monitor exports by type. While this form of supervision has worked very well and can be justified by reference to the social losses involved where a pure market solution results in significant interim losses in output, the political and bureaucratic requirements for success are not met in Africa. In most of the countries a mechanism is needed that results in the appropriate level of specialization without the need for guidance and monitoring by the government.

One option is government enforcement of agreements that assign products to individual firms who would base their product division on their calculation of their
current and prospective comparative advantage among products. Assuming that trade liberalization will be implemented, the possibility of extracting rents from a monopoly position in one product is minimized. The argument for government enforcement of the privately reached cartel agreement is that of a market failure similar to natural monopoly. Each firm's cost declines as its output of the specialized product increases whereas larger total production of a varied bundle of goods will not result in reduced costs.

6. THE FIRM LEVEL

Two sets of issues need to be addressed at the firm level: the productivity of existing firms and the choice of management and ownership alternatives likely to result in the most efficient performance of new firms.

(a) Improving the Productivity of Existing Firms

It is not necessarily socially desirable to keep up with international best practice. DRCs are decisive and a low TFP may be partly offset by a low value of w\* Moreover, the cost of matching changing norms may be high. It is desirable that the production engineering capability of all firms should move towards the prevailing level of international best practice only if the marginal (social) cost of achieving such a movement is less than the marginal (social) revenue from the resulting additional output. In addition, where there is substantial diversity among companies within a country, the diffusion of knowledge from more to less productive firms can provide a significant addition to the benefits from international diffusion.

A considerable literature, based largely on historical evidence, suggests that the diffusion of technology - both new processes and new products - results mainly from the movements of individuals from firm to firm and from country to country; a critical dimension of this mode of technology transfer is sustained contact between transmitters and recipients of knowledge. The precise behavioral reason for the importance of sustained person-to-person contact is rarely articulated (but see Arrow, 1969): among the plausible reasons are the role of tacit or uncodified knowledge (Nelson and Winter, 1982); the importance of an advocate of a particular change in breaking down an organizational equilibrium that favors the low productivity status quo (Pack and Pack, 1977); and the reduction in uncertainty and the cost of information acquisition when a person with production experience is physically present - as opposed to the abstract and locally untested technical possibilities available from written documentation of the experience of others. Whatever combination of reasons accounts for the decisive role of individuals in the transmission of operational command over new processes and products, there is no evidence that the diffusion of best-practice routines can be effectively achieved by other modes such as that provided through technology licenses unaccompanied by sustained individual interaction.35

In most African countries there are a small number of firms in each modern industrial subsector, a desirable pattern (assuming eventual competition from
imports) given the smallness of the typical market and the need to realize economies of scale. This industrial structure implies that firms cannot rely on interfirm mobility or informal contacts with other firms to derive new production knowledge or knowledge of better practices. Rather than the knowledge leakages from firm to firm that constitute a quasi-public good in more developed countries, processing information is likely to be more closely guarded in the African context - firms cannot assume that they will receive inflows roughly equal (statistically) in value to the outflows of information that would characterize a more thickly populated industrial sector.

Given the absence of interfirm mobility, limited informal contact, and little transfer of foreign methods by returning nationals or purchasers of exports, some mechanism to substitute for these modes of technology transfer is desirable. Licensing of technology, technical aid from foreign machinery manufacturers or consultants, and a central consulting group composed of domestic technicians constitute alternative mechanisms for achieving greater efficiency. The necessary changes in production engineering are not, however, likely to be successfully implanted on a one-shot, short term or sporadic basis typical of these various modes for transferring knowledge.

Problems arising from the variation in products or processing environment occur frequently. Changes in the nature of raw materials, new product designs, and new developments in production engineering will pose unanticipated problems whose solutions will differ from those obtained with earlier practices in different locales. Adaptability in these dimensions is particularly important as industries become export oriented. The changing world market, even in relatively standard products such as textiles, necessitates changes in design or material use. The critical importance of maintaining an ability to keep up with changes is carefully developed by Lall (1987) in the case of India. Successful absorption of improved production engineering practices requires not only initial learning but also an ability to modify practices as circumstances change. Otherwise, even firms that achieve a low DRC after some technological effort, will later experience an increase in it. The implementation of the necessary adaptations on an ongoing basis can be undertaken best by those with a medium to long term commitment to the firm. Moreover, learning by local personnel about how to respond to similar future challenges is also likely to be learned best by observing specific behavior in a sequence of responses to external changes rather than from one or two cases. The role of interpersonal contact is critical in all of these activities.

Given these considerations, the best mechanism for achieving improved performance is the hiring, for three to five years, of a group of skilled foreign nationals. They can provide personal supervision and interaction on a long term basis. Contracts should have incentive clauses in which remuneration is linked to agreed upon and measurable changes in productivity or specific engineering variables. Government policy can make the long term hiring of individuals more attractive to firms by allowing technical aid costs to be deductible at rates greater than 100 percent when taxes are calculated and by not subjecting foreign nationals to local personal income taxes.
A textbook view of industry dynamics might suggest that explicit policy efforts to spread knowledge are unnecessary. Faced with sufficient competitive pressure, firms will be compelled to devote greater effort to obtaining technical proficiency to maintain profit rates equal to those in other endeavors. This position has much force. Any effort to promote the diffusion of knowledge must be embedded within a wider policy framework, especially trade liberalization, designed to increase competition. Nevertheless, the view that competition is all that is required is too facile. Attribution of the success of the superexporters of East Asia solely to their reliance on market forces does not accord with the facts (Pack and Westphal, 1986). In some of these countries, particularly Korea, competitive forces have been allowed full sway only after substantial technical learning has taken place and firms are internationally competitive. A liberalized economic milieu and a policy to increase technical competence are the two blades of the scissors necessary to achieve decreased cost. Either is likely to be considerably less effective without the other. In the African context, a low level of technical managerial skills is widely acknowledged. If the industrial sector were exposed to competition without an attempt to improve its technological base, few gains in technical or allocative efficiency would be forthcoming.

(b) Obtaining High Productivity from Newly Established Firms

In the short run, if new manufacturing capacity is to be established, mechanisms are necessary to substitute for absent domestic skills. Several examples in Africa suggest that MNCs are an obvious vehicle for establishing new plants in the absence of adequate local abilities. Detailed analyses of productivity in Kenya and Zimbabwe (Pack, 1987, 1986) demonstrate that MNCs operating integrated textile mills have achieved production engineering performance close to that of best practice plants in the developed countries. If intermediate inputs were available at international prices, many could profitably export. In contrast, productivity in domestically managed textile plants is low (Pack, 1987, Mlawa, 1983), and poor quality production engineering is a major cause.

The relatively high TFP of some textile mills in Kenya and Zimbabwe and their rapid achievement of such status results from the efforts of high quality MNCs from India, Japan, and Western Europe which have been able to transfer their skills. These abilities, embodied in five to twenty expatriates per firm, have been critical to the success of these textile mills. The presence of these managers has resulted in very low marginal costs of acquiring relevant technological information, or implementation of desirable organizational changes, and the marginal productivity of such knowledge was high. Where the staff did not possess technical information it knew where to identify relevant sources quickly and cheaply and knew how to incorporate such information productively within the plant. It is precisely these abilities, allowed full scope by an improving policy environment, that have been the technological basis for the rapid growth of clothing exports from Mauritius by Hong Kong based multinational corporations.38

The generation of greater technological capability is the presumptive objective of initiating industrialization before local capacities fully warrant it. Hence, any enterprise begun on a base of MNC skills should have mechanisms, (and not just in the initial agreement) to insure that relevant skills are transferred. Within
some reasonable period, indigenous managers should be able to operate the plant at levels sufficiently close to best practice so that the DRC of production is less than 1.

Apart from their benefit in terms of relatively rapid achievement of high productivity, new plants based on MNC investment are likely to confer two other major benefits, namely, a more appropriate initial choice of technology and a greater ability to export because of their marketing expertise.

An early, largely polemic, literature asserted that MNCs choose excessively capital-intensive projects at prevailing market wage-rental ratios. It was claimed that firms simply transfer, without modification, technologies developed in advanced countries. Investigation of this hypothesis (Pack, 1976, Forsyth and Solomon, 1977) did not confirm it in Kenya and Ghana. More recent analysis by Ahiakpor (1989) supports earlier research in Ghana that MNCs do not use inappropriate technology. A survey of numerous studies in Asia and Africa (Pack, 1979) finds no systematic evidence of the choice of excessive capital-intensity by MNCs. In contrast, locally owned firms, especially state-owned enterprises, often exhibit much greater than appropriate capital intensity, many examples of this being found in Tanzania and other African countries (James, 1989, Ahiakpor, 1986). The correct choice of technology is important not because it provides more employment per se; rather, intrafirm allocative efficiency, the equation of relative factor marginal productivities with relative factor prices provides one route to obtaining lower private costs, and social costs as well where shadow prices prevail in factor markets. Firm costs depend not only on technical efficiency or relative total factor productivity but on allocative or economic efficiency.

These findings are surprising because MNCs typically pay higher wages and face a lower user cost of capital insofar as they can borrow at lower interest rates either in the host country or internationally and are the beneficiaries of tax provisions (accelerated depreciation and exemption from excise taxes and tariffs on imported equipment) denied to local companies. Several factors explain why, despite these differences in factor price, MNCs typically choose appropriate factor proportions. First, their information processing capability is greater so they can easily identify and transfer equipment among subsidiaries, especially equipment that has become too expensive to use in countries with higher wages because of its labor intensity. Indeed, the parent company may have established a new plant partly to use such equipment in the production of exports. Second, the office of the parent company typically will provide advice on the purchase of used or new appropriate equipment available internationally. Given the high information cost incurred in identifying reliable equipment, such low cost aid to the local manager, in both time and explicit costs, clearly increases the likelihood of his employing appropriate equipment to take advantage of the local factor prices. Third, the home office can obtain a better price insofar as the market for used equipment is better viewed as having a bilateral monopoly structure rather than a competitive one.

The characteristics of sectors in which African industry are likely to be competitive were noted earlier. Such sectors produce standardized intermediate goods such as gray cloth which are not subject to rapidly changing designs. If consumer goods rather than intermediates are to be exported, maintaining an awareness of changing trends in the OECD markets including design and material
components is an important activity. Even if local entrepreneurs did not need MNCs to acquire technical production knowledge, the design and marketing functions would militate strongly in their favor. While this knowledge could be provided by local buying offices of major retailers, as has been the case in East Asia, the initial location of such buying offices usually comes after demonstrated production and timely delivery capacity. The latter is particularly difficult to realize for many local firms (Morawetz, 1981).

MNCs constitute an excellent instrument to overcome many current shortages of human and institutional capital. Nevertheless, a robust tradition in developing countries views the activities of MNCs with suspicion. In the 'sixties and 'seventies some African countries nationalized MNCs or forbade their entry despite the benefits they confer. Often they were replaced by state owned enterprises which were notably deficient in the skills which the MNCs possess. Given this history and current defects in the policy environment, the scarcity of social overhead capital, and the options they have in Eastern Europe and Asia, MNCs may be hard to attract. Their investment and knowledge are likely to remain in excess demand. Absent MNCs, new large scale industrialization in many African countries will have to be postponed.

7. LABOR

It is usually asserted that Africa suffers from a deficiency of skilled labor. Such statements lack precision. Labor productivity may be low because: (a) firms fail to realize scale economies, economies of specialization or economies of scope; (b) low managerial capability, for example, delays in inputs arriving at work stations; (c) lower machine to worker ratios or lower capacity machines than in comparable plants abroad; (d) deficient cognitive and manual labor skills. The implication of conventional statements is that the last is the major source of lower productivity. A study that attempts to adjust for many of these factors (Pack, 1987) finds Kenyan textile workers almost as productive as those in the U.K. They are employed by MNCs that have engaged in systematic training of relatively short duration. In textiles, and in many other process oriented branches, substantial previous experience of production workers is not a prerequisite for success. Relatively short periods of classroom and on-the-job training in firms can be quite successful assuming that workers are literate and numerate, i.e. have good elementary education.

Even for such industries in which almost all production workers can be quickly brought up to high standards by a skilled management team, a shortage may exist of highly trained technicians such as electricians, machine repairers, and so on. In the short run, firms hampered by an absence of such skills should have access to expatriates. While indigenization is a laudable goal, it may be very expensive in terms of the value of foregone output. While employing a small number of expatriate workers to relieve critical bottlenecks, domestic training should simultaneously be expanded in vocational schools combined with on-the-job training in operating firms. Firms should receive subsidies for cooperating given the costs incurred by them and the probability of not being able to retain a high percentage of the workers so trained.
8. THE SMALL SCALE INDUSTRIAL SECTOR

This paper has been entirely devoted to a discussion of the modern, relatively large scale industrial sector. At the other end of the spectrum is the informal sector characterized by small workshops with a few employees, using little electric powered equipment, and typically producing products with low income elasticities of demand. In Asia and Latin America, there is also a robust small and medium scale industrial sector with 10 to 50 employees that are often efficient manufacturers of a variety of products with high income elasticities of demand. Although there is some activity of this sort in West Africa, there is little of it in other regions of Sub-Saharan Africa. Unfortunately, very little is understood about the requirements for fostering either this sector or the informal one. While it is tempting to try to implant a sector which in other environments has proved to be efficient, and an important source of growth of output and employment, the conditions necessary for success may not be present and artificial stimulation may yield low marginal returns.

The current conditions in Africa militate in favor of industries that do not require local subcontracting. Conventional wisdom often argues that measures to foster subcontracting improve smaller firms which in turn diffuse the benefits of larger scale development to low income owners and workers. However, the existing evidence on the small scale sector suggests that it mainly produces simple consumer goods such as clothing and furniture. Trying to establish a new sector that benefits from subcontracting from larger firms would require a substantial effort to generate a broad range of skills. At current levels of education and skill, the transactions costs of extensive subcontracting are likely to be very high.

While specific policies designed to remedy one or two deficiencies of firms in an existing small scale sector may be feasible and effective, building an entire sector de novo is likely to hamper rather than help larger firms insofar as subcontractors would likely have high initial costs rather than being able to provide lower cost inputs by exploiting economies of scope. Subcontracting is encouraged by large markets, low transactions costs, and the efficiency of potential suppliers. In the African environment, these prerequisites are not satisfied.

9. CONCLUSIONS

There is a substantial amount of existing capacity in large scale industry in Sub-Saharan Africa. Most of it, both private and public, is not competitive at international prices. The conventional policy package which progressively exposes economic agents to increasing competition may not have the desired effects. Elasticities of output and exports with respect to price may be low and many firms may fail if policy consists only of pricing policies. This paper sets out a number of dimensions in which the existing industrial sector can be strengthened. The emphasis on improving the technological capacity of firms does not imply that economic incentives should not be altered as well. Rather, both types of measures are required and indeed, it seems unlikely that either, without the other, will
work. Even in the Asian countries, with a considerably longer and deeper industrial history, sustained efforts were undertaken by national governments to foster improved industrial skills. While incentive policies were critical, they were not the entire story. This will inevitably be even more true in Africa.

Finally, although the precise details of any industrial improvement effort will depend on country-specific circumstances, the provision of new machinery should be low on the agenda of planned industrial policies. One of the most important lessons of the past two decades is the relatively minor role of simple physical capital accumulation. The accumulation of technical capacity appears to be much more important to sustained development success.
Sub-Saharan Africa includes the countries other than those bordering on the Mediterranean Ocean but excludes South Africa. In the remainder of the paper this group will be referred to as Africa.

See, for example, the analyses of World Bank staff members with respect to Ghana, Cote d'Ivoire, Nigeria and Zambia in Meier and Steel, 1989, Chapter 6.

For an exposition of the issues surrounding technological competence see Dahlman and Westphal (1981). A thorough review of most of the literature is contained in Lall (1990).


African pricing policies are discussed in Steel and Evans (1984) and Meier and Steel (1989).

For a good survey of the many financial and infrastructure requirements for entry into export markets see Rhee (1989).


K and L are both vectors of inputs, omitted here for expositional convenience.

For a useful decomposition see Nishimizu and Page (1986).

Foreign technical effort may induce a change in the domestic DRC insofar as it becomes public knowledge and induces domestic technical effort.


This is part of the broader issue of "learning to learn," Stiglitz (1989).

For a sample of such studies see Meier and Steel (1988).

For evidence that firms choose techniques that do not minimize cost given actual factor prices see Pack, 1987, Chapter 4. Altering the capital-labor ratio may require considerable time. If the equipment in place allows ex post substitution of labor for capital, changes in factor prices can have a short term effect. However, the full impact, likely to be larger, will be felt in the long run as net additions of more appropriate machinery are added to the capital stock.
For estimates of sectoral growth in total factor productivity in Taiwan see Wang [1990]. For Korea see Dollar and Sokoloff [1990].

There is also a substantial Indian minority present in these industries.

Meier and Steel (1988), Chapter 6 gives evidence from recent experience in Nigeria, Cote D'Ivoire, Ghana, Zambia and Mauritius.

See the analysis of the effects of infrastructure deficiencies on manufacturers in Nigeria by Lee and Anas (1990).


The most obvious cases to support such views arise in East Asia, particularly in Korea and Japan but there have been no empirical case studies even there confirming that the Mill-Bastable criterion was satisfied. The most thorough review of the evidence on infant industries is Bell, Ross-Larson, and Westphal (1984).

Pack and Westphal (1986) provide an analysis of the potential benefits from government intervention, its risks, and the exceptionally complex policies followed by Korea in achieving many of the gains. But even there, major costly mistakes arose from government intervention.

A good discussion of the RBI strategy is contained in Roemer (1979). The employment implications of RBI and heavy industry strategies are analyzed by Roemer, Tidrick, and Williams (1976).

See Ikram (1980), Chapter 11 as well as references cited therein.

Justman and Teubal (1990) explore the implications of investment in social infrastructure in some detail within the context of a neoclassical growth model.

This does not imply there should be no training in these areas as the LDCs may benefit from the selective adoption and utilization of electronic and biological products that are produced in other countries.

See, for example, Pack and Westphal (1986) on Korea, Pack (1992) on Taiwan, and Oshima (1988).

Much of the literature on acquisition of technological competence explores these questions. See the references in footnote 4.

For a detailed discussion see Pack (1987, chapter 9).
It is assumed that TFP dispersion is not due to differences in the quality of equipment, a realistic assumption in light of existing evidence. See, for example, Pack (1987) on Kenya.

In the African context, a number of institutional features militate against the likelihood that workers bear the cost of training. These include minimum wage legislation, imperfect capital markets, and a highly elastic supply of labor to the formal sector at existing wages.

A detailed analysis is presented in Pack (1987), Chapters 2 and 3.

For a review of the literature on the role of market size in developed countries see Caves (1989).

In the longer term the current constraint on economic management is not a datum. For a discussion of methods to improve government management see The World Bank (1990).

Information collected in the Republic of Korea confirms the role in knowledge diffusion of informal personal contacts although more formal modes such as advice from purchasers of exports and knowledge obtained from recently returned Koreans with U.S. work experience are also important. See Westphal, Kim, and Dahlman (1985) and Westphal, Rhee and Pursell (1981).

All of these requirements constitute a strong case against the hiring of international consulting firms. Many of these firms have their origin in and primary loyalty to the industrial sectors they serve in their home country. As a result, they may be reluctant to strengthen its potential competitors. Moreover, they have a predilection to suggest that the solution to low productivity lies in additional equipment, particularly where their country produces such machinery. Rather than addressing the difficult problems of improving the technical and organizational abilities of the firms to whom they are consulting, they often recommend a short term technical fix embodied in new equipment. While such injections of technology occasionally redress some of the initial problems that exist, within a short period a new generation of difficulties reappears as a result of the yet to be addressed fundamental organization and production engineering problems.

One pool of candidates from which technical help could be recruited are persons currently working in similar plants in more advanced LDCs who are familiar with LDC problems. A second pool consists of persons who have recently retired from similar pursuits in DCs.

Meier and Steel, op. cit., pp. 142-45. On the role of multinationals in transferring technology efficiently in Indonesia see Tsurumi (1980). Rhee (1990) provides a careful description of the ability of a Korean textile firm to
establish an export oriented textile mill in Bangladesh. Its workers then began their own companies, generating further exports.

39 On these information issues see Pack (1976).

40 See the data on the share of manufacturing value added accounted for by public and private firms in Meier and Steel, op. cit., p.89. Many of the private firms in the four countries on which they provide data are MNCs. To take an extreme case, the share of value added originating in parastatals in Tanzania increased from 5 to 31 percent between the mid-1960s and 1980.

41 The literature on small scale enterprises in Africa with more than ten employees is surveyed by Page and Steel, 1984. Recent evidence on the life cycle and robustness of microenterprises, firms with less than ten employees, is presented by Liedholm and Parker, 1989, and for Ghana, see Steel and Webster (1991).

42 Liedholm and Parker, 1989, review the evidence.

43 For a detailed economic-technological strategy to improve firm level productivity see Pack, 1987, Chapter 8.
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