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CENTER DISCUSSION PAPER NO. 116

INDUSTRIAL SECTOR LABOR ABSORPTION

Gustav Ranis

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Industrial Sector Labor Absorption

The recent increased focus on the LDC unemployment problem takes many forms; like development itself, the issue is complex and many-faceted. But perhaps no link in the chain of attempted understanding has been as uncertain and controversial as the question of the range of technology choice actually physically open to the contemporary LDC in its non-agricultural sector--even if it were of a mind to listen to relevant advice on the subject.

This paper is intended to throw some light on the particular question of LDC industrial sectors' ability to efficiently absorb unemployed or underemployed labor in the course of the development process. We know that even where countries have been growing at 5 or 6% annually in real terms in the past--and overall growth has generally been quite satisfactory in the 60's, as the Pearson Commission records--industrial sector growth rates of from 8 to 10 percent annually have been accompanied by labor absorption rates of only 2 or 3 percent. Moreover, the elasticity of industrial employment with respect to output has not only been low but apparently falling over time.¹ Consequently, virtually everywhere in the LDC world some combined index of unemployment or underemployment seems to have been on the rise--and accompanied by an even more pronounced rise in the awareness of the inadequacy of per capita income as the main indicator of adequate performance.

When this somber historical record is combined with the fact that even if "zero population growth" policies were adopted everywhere tomorrow, the age structure of the LDC population presently in existence will yield a labor force explosion of major proportions (3 1/2 to 4 percent annually over the

¹See Werner Baer and Michel E. A. Hervé, "Employment and Industrialization in Developing Economies," Quarterly Journal of Economics, Vol. LXXX, No. 1, February 1966.

next decade or so) the dimensions of the problem become clear. If the developing world should be unable to absorb these inevitable projected additions to their labor force--never mind mopping up the substantial pool of underemployment already in existence in most places--the prospects are indeed grim.

The role of the industrial sector in this context--even when we define it broadly as including all non-agriculture except the "spongy" services--of course tells only part of the story. Clearly, if an LDC is developing at all, it is likely to have to activate its preponderant agricultural sector in the process. Whether or not agricultural productivity increase in this context turns out to be labor-using or labor-displacing is extremely important to the size of the burden placed on non-agricultural sector absorption, for any given rate of aggregate growth. But we shall here concentrate on the capacity of non-agriculture to efficiently absorb labor. Not only is there more misunderstanding on this--somehow most people seem to accept the realism of alternative scale, tenure and input combinations in agriculture, while holding religiously to fixed proportions in industry--but we also know, regardless of how the inquiries into the employment consequences of the Green Revolution come out, that, over time, people inevitably will be pushed out of agriculture, in the case of success, and pulled out, in the case of failure--and that the non-agricultural sector's ability to absorb them efficiently will play a crucial role in any total balanced development story.

In Section II, we try to place the generally poor record of industrial labor absorption in its proper historical and policy perspective. Section III advances some preliminary notions of the differential nature of the innovation process over time in that context; and Section IV attempts to demonstrate

the empirical relevance of these notions, under conditions of a favorable policy environment, by reference to historical Japan and contemporary Korea and Taiwan.

II

It has by now become part of the conventional wisdom to criticize the so-called import substitution regime most LDC's followed during the 50's and 60's. This regime usually comprised a well-known syndrome of policies including exchange controls cum import licensing; budget deficits cum inflation; low (sometimes negative) real rates of interest. The aim, generally speaking, was to redirect pre-independence traditional colonial flows to the creation of social and economic overheads and import replacing consumer goods industries. The consequence for economic performance was often a spurt in industrial output growth, but inefficient, i.e. capital and import-intensive, in character, accompanied by the discouragement of exports and of agricultural output, low rates of industrial employment, low rates of technological change, low domestic saving rates, and a relatively heavy dependence on foreign aid.

As LDC governments became increasingly aware of the economic costs of this set of policies, one could observe, during the 60's, a tendency, at least in some countries, to consider turning to an alternative set of policies. This set can be characterized, if again at the cost of oversimplification, as aiming at a reduction of some of the gross inefficiencies attending industrial development through the readjustment of a number of crucial, previously distorted, relative prices, including the exchange rate and the interest rate. By replacing quantitative controls in the foreign exchange market with tariffs and moving towards more realistic exchange rates, via either a de jure or de

facto devaluation, and replacing severe credit rationing with higher interest rates, developmental access and participation could now be offered to medium and small-scale industrial entrepreneurs for the first time. In the course of this second, or export substitution phase, industrial development is based less on natural and more on human resources; exports-- especially of the non-traditional labor-using variety--are no longer discriminated against and can begin to expand; domestic saving rates can move up into the Rostow take-off range; agriculture is no longer discriminated against by unfavorable terms of trade and can play its historical role of generating surpluses which, when successfully channeled, can provide simultaneous employment opportunities for the unskilled labor force simultaneously being released; and indigenous technological change in both sectors can assume much greater importance.

While there exists as yet no marked trend towards such export substitution policy packages in the less developed world generally, its adoption had indeed had remarkable results, e.g., in Korea, Taiwan and West Pakistan, in turning some situations of virtual overall stagnation in the 50's into high growth situations in the 60's.

Perhaps most important for us here is the fact that the new and better signals in this phase are likely to induce the adoption of different, more labor-using or unemployment reducing, technologies and output mixes. In this context the vital role, for better or worse, of technological flows between rich and poor countries inevitably comes into play. The very co-existence of countries at very different levels of technology has to represent one of the most important influences on the performance of LDC's, past, present and prospective. It is the precise nature of these technological flows and the way

in which they have been accommodated by LDC's which has, in our view, had a decisive impact on overall performance during these past two decades of development. Alternatively put, it is also in this area in which the greatest potential for improved LDC performance in the 70's on both output and employment grounds can and must be located.

Under the influence of the record of the past many have concluded that a conflict between these two objectives is inevitable. But before we accept such fundamentally dismal conclusions we have an obligation to carefully examine the validity of the proposition, especially in countries which seem to have performed well with respect to both output and employment growth in the past. Certainly such an examination is necessary before we can intelligently address the question of how the LDC world as a whole will be able to efficiently absorb the inevitable projected additions to their labor force, not to speak of mopping up the existing backlog of the unemployed and underemployed.

As we look into the 70's, three major schools of thought seem to be emerging with respect to the solution of the unemployment problem. One suggests we need more growth, i.e. a higher growth rate, traditionally arrived at, with enough "trickle down" to achieve full employment. This is clearly, at best, an expensive and unrealistic proposition, requiring huge volumes of foreign capital, for instance, if the rickety import substitution dominated machinery of the 60's is to yield, without restructuring, substantially more employment. The second approach also assumes no major parameter shift in the behavioral relations of the system. It suggests, however, that after the traditional planning exercise has been consummated, a "supplementary strategy" must be employed to mop up the remaining unemployed. This customarily means instituting labor-intensive public works programs, either in the rural or urban

areas. There is a real possibility here, especially where the rural infrastructure, for example, is inadequate--but evidence to date indicates that blue-printing and executing capacity may be a constraint as one goes from project to project. But most importantly, this approach fails to make the employment issue part of the primary strategy of development and relegates it to an after-thought, which--despite all 5-year plan protestations to the contrary--was essentially the situation in the 50's and 60's.

The third approach attempts to change the nature of the growth pattern itself by making it more responsive to the factor endowment. This means that we don't try to "dethrone the GNP," except perhaps in political terms, but we try to place it on a sturdier throne. In other words, once the open dualistic economy moves out of its administered-prices import substitution hothouse, and into a more market-oriented export substitution phase, it becomes possible for major efficient changes in output mix and technology--both in a labor-using direction--to take place. Such restructuring, as can be demonstrated in the cases of Taiwan and Korea, may permit the economy to have more of both, i.e. more output and more employment, rather than having to make a choice between them. Moreover, such a move towards more market-oriented signals has absolutely nothing to do, as it is sometimes alleged, with a return to colonialism or handing the country over to unbridled free enterprise. The same desirability of letting the endowment be heard in production decisions applies to the socialist countries; and, in fact, the market is increasingly being used as a tool of socialist planning, and in pursuit of socialist objectives, in Eastern Europe today.

Finally, we should note that income distribution, a third and increasingly important dimension of developmental performance, also stands to benefit. There

are those who assume that any tendency at wage restraint at low levels, in keeping with the condition of labor surplus, must be bad for the "little man." In fact, quite the opposite is likely to be the case. Where the poverty problem is in considerable part an unemployment problem--due either to inadequate government willingness or ability to redistribute fiscally--the "little man" who is hurt by wage restraint is the already employed, not the usually disenfranchised, unemployed or underemployed. Not only total output and hence per capita income but also the wage bill is likely to rise once the economy moves to efficient labor-intensive technologies and output mixes. Figures on income distribution in a number of countries interestingly enough indicate that Taiwan is the best performer here as well, i.e. sporting the most equal distribution of income in the sample. Even more instructive is the fact that Taiwan shows up as a much better performer on this count in 1964--when export substitution was in full swing--than in 1953--during its import substitution phase. While economists who are conditioned to think always in terms of trade-offs will hate to admit it, labor surplus developing countries, well within their efficiency frontier, may be able--with the right policy changes--to enjoy more employment, more growth, and more income distribution at the same time.

With this realization, a lot more attention is now being paid to the importance of factor price distortions, over-valued exchange rates, inappropriate fiscal policies, "premature" welfare legislation and other institutional constraints which have obviously contributed to the low rate of labor utilization, especially in the LDC's' growing non-agricultural sectors. But much less attention has been paid to date to the actual technological choices available to the typical LDC--on the assumption its entrepreneurs and government

officials could be brought to the point of facing a more reliable set of signals relative to the existing factor endowment and skill capacities. In other words, even if domestic fiscal, monetary, credit and exchange rate policies were ideal, would the choice of technology from the shelf available abroad and/or producible at home yield a substantially different kind of technology--or are there other, overwhelmingly severe, choice constraints forcing acceptance of technology currently available in the most advanced of the capital exporting countries?

Many LDC officials, aid donors, and scholars still share the point of view that most technological change, especially in non-agriculture, must take place abroad, and that the borrowing LDC's, in fact, have only a very narrow set of technological choices open to them. If only the coefficients attaching to the latest vintage machinery produced in the most advanced countries are relevant all the talk about alternative factor proportions in response to alternative resource endowments becomes largely irrelevant--or restricted to changes in output mixes via trade.

Such skepticism on the scope of technological choice is, of course, not unrelated to the still considerable dragging of the feet on abandoning the import substitution policy package in much of the less developed world. In spite of the real world demonstration of what can, in fact, be accomplished, there remain formidable obstacles to the dismantling of the import substitution regime. Direct controls imply absolute power--as well as supplementary income--for the civil service which it is loath to surrender lightly. Moreover, the inevitably greater role for private enterprise under any liberalized regime runs up against associations with colonialism and fears of anti-social give-aways. But one of the more powerful arguments on the side of conservative

policy-makers remains the supposed rigidity of the choices actually available. In large part it results from deducing the inevitability of fixed proportions from their historical prevalence during the import substitution phase. We intend to investigate this issue by first attempting to elucidate the differential nature of the innovational process in each phase, and then to demonstrate the potentially substantial scope for labor-using innovations by reference to the cases of historical Japan and contemporary Korea and Taiwan.

III

First, and foremost, it should be remembered that, unlike in an advanced country where technological change is viewed as rather automatic and routinized, or as capable of being generated through R and D expenditures according to some rules of cost/benefit analysis, in the contemporary developing societies technological change cannot either be taken for granted or afforded through R and D allocations. In this situation we cannot avoid the question of what, given the existence of a shelf of technology from abroad, is the pattern by which the typical less developed economy, in fact, manages to innovate. This question in turn forces us to look at least at the following dimensions more carefully: 1) the precise nature of that technology shelf; 2) the availability within the LDC's of required initial managerial and entrepreneurial capacity; and 3) the changing nature of that required managerial and entrepreneurial capacity in the course of transition to modern growth.

The technology shelf developed in the mature industrial economies abroad may be described by a set of unit activities following a smooth envelop curve as in Diagram I. A particular technology can be described by an L-shaped contour producing one unit of output with a given pair of capital and

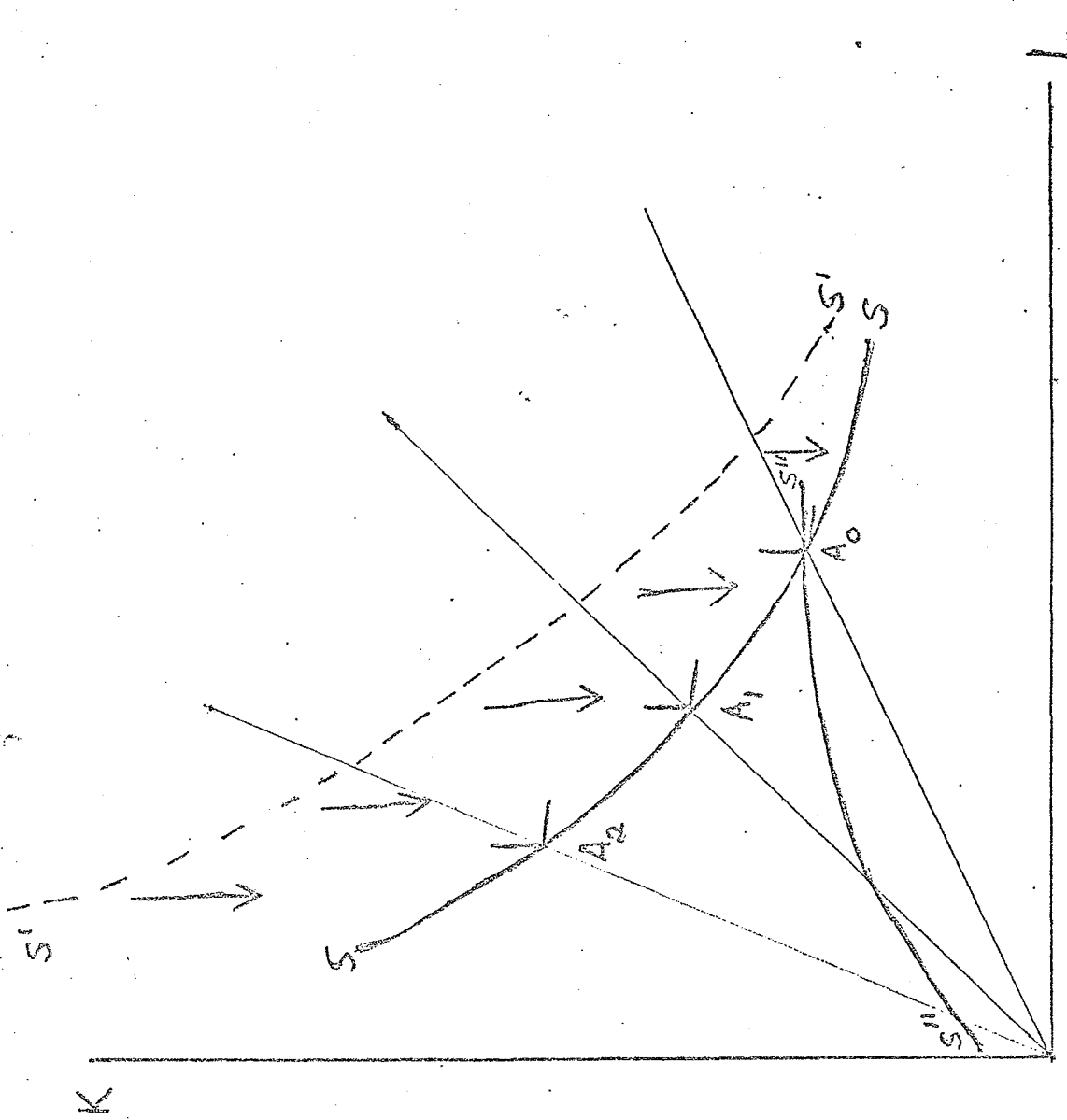


Diagram I

labor coefficients. The technology shelf is composed of the complete set of such activities or technologies which have been demonstrated to be feasible somewhere in the advanced countries at some historical point in time, including the present. Since there exists a number of technology exporting countries, e.g., the U.S., Germany, U.K., Japan, with continuous technological transfers amongst themselves as well as with the LDC's, it is not unreasonable to postulate the existence of a single technological shelf for the lending world as a whole. For example, unit technology A_0 may have been generated in Germany in 1920, A_1 in the U.S. in 1920, A_2 in the U.S. in 1950, etc. In other words, as we move to the left along the shelf we run into more modern technology, i.e. technology of more recent vintage and of higher capital intensity. As capital per head increases this means that the typical worker has learned to cooperate with more units of capital of increasing technical complexity. This capital deepening process, in other words, is more complicated than the textbook version of "homogeneous" labor being equipped with more units of "homogeneous" capital.

At any point in time the typical LDC is then theoretically free to borrow a particular unit activity from anywhere along this shelf. What technology is chosen and what happens as an immediate and ultimate consequence of that choice, i.e. what secondary processes and reactions are set off, is, of course, all part and parcel of the innovational process taken as a whole. The quality of that process, each step of the way, in turn depends on the nature of the entrepreneurial, managerial and skilled labor capacity of the borrower.

The role of innovation must thus be seen as intimately related to the stage in which the developing economy finds itself. In other words, the role of technological change in output and employment generation must be viewed as

sensitive to the same discernable phases of growth as the economy moves in transition from open agrarianism to Kuznets' modern economic growth. In the first post-independence, or import substitution phase, previously mentioned, an effort is made to increase the supply of domestic entrepreneurship and the economy's learning capacity, partly through the importation of people via aid, but mainly through the system of protection established by government policies. In fact, the most reasonable explanation for the import substitution syndrome is that it is a response to a real or imagined shortage of entrepreneurship and that it permits time, through informal learning-by-doing or more formal educational processes, for this entrepreneurial capacity to develop.¹

In terms of our Diagram I, this means that, although the technological shelf may look as indicated by curve SS, the actual choices available to the developing country during the import substitution phase are more aptly described by S'S'. In other words, due to the inadequate state of entrepreneurial capacity during the early post-independence period of physical controls, the efficiency of generating output per unit of capital in the borrowing country is likely to be substantially below that in the lending country. This is likely to be more true the more capital-intensive the import, i.e. the further removed from the cultural inheritance and experience of the borrower. Such technological imports are often accompanied by imported engineers, even managers and supervisors--adding up to what is often called a turn-key project. The most advanced and sophisticated technology can, of course, be made to "work," in the physical sense, even in the most backward developing economy.

¹Some few countries, like Malaysia, with command over a very strong and reliable natural resources base, may be able to avoid such a phase altogether. Moreover, there clearly exist better and worse (i.e. less and more costly) import substitution packages to choose from, e.g. comparing Brazil and Ghana, but we cannot expand on this very interesting subject in the context of the present paper.

But a shiny new plant imbedded in a society many decades distant is bound to be substantially less efficient. This is true for a thousand direct reasons, such as the absence of even minimal skilled labor supplies, domestic subcontracting and repair and maintenance possibilities, as well as for many more subtle sociological reasons which enter into the total milieu in which the plant is asked to operate. The more sophisticated and removed from the rest of the economy the technological transplant, in other words, the greater the relative inefficiency, as indicated by the shape of the S'S' curve.

If and when the economy then moves away from the import substitution phase and enters into the second phase of liberalization and export substitution, a second important, if unintentional, type of innovation is likely to make its appearance, namely a reduction in the extent of the inefficiency of the original transplanted technology. Call it X-efficiency if you like, but the cost of the pure transplantation is likely to be reduced, quite unintentionally, i.e. largely as a result of factors external to the profit maximizing behavior of the productive unit itself. This increase in productive efficiency over time will increase in quantitative significance as the import substitution hothouse temperature is gradually turned down and a more competitive economy emerges. In Diagram I the effects of gradual enhancement of efficiency may be represented by the arrows tending, over time, to move S'S' back towards the original SS position.¹

Another, more conscious, and quantitatively more important type of innovation begins to gather importance during this same, second phase of

¹A more sophisticated analysis, differentiating between the labor and capital -saving nature of this move, depending on the region in which the economy is operating, is possible, but will not be introduced here. See also "LDC Innovation Analysis and the Technology Gap," (with J.C.H. Fei) paper presented to the IEA Conference on "The Gap Between the Rich and the Poor Nations," to be published in 1971.

transition. This phenomenon may be called innovational assimilation, i.e. innovating "on top of" imported technology in the direction of using relatively more of the abundant unskilled labor supply. As the economy shifts from a natural resource based growth pattern in the import substitution phase, to a human resource based system in the export substitution phase, this means an increasing sensitivity to the continuously changing factor endowment, first in terms of the efficient utilization of the domestic unskilled labor force, and later in terms of the incorporation of growing domestic skills and ingenuity. In other words, the appropriate type of technology finally in place must be one in which not only the initial choice from the shelf but also the adaptations and adjustments consciously made thereafter in response to changing domestic resource and capability constraints play an important role.

The more liberalized the economy, in terms of the government's performing a catalytic role through the market, by indirect means, rather than trying to impose resource allocation by direct controls, the better the chances that the millions of dispersed decision-makers can be induced, by the sheer force of profit maximization, to make the "right" decisions. Even in the absence of technological change, as long as surplus labor overhangs the market, and the expectation is for even more of the same in the future, we can expect little upward movement in real wages and little capital deepening. Superimposed on this is the aforementioned assimilation type of innovational behavior which tends, for the same reason, to be slanted in a labor-using direction. In the typical labor surplus type of economy--or one likely to become one over the next decade (as is probably the case in much of Africa)--all this means as much efficient accommodation of pure labor services as

possible.¹ Whether this will lead to a sectoral output shift in favor of labor intensive export commodities or a mix predominantly addressed to the domestic market, of course, depends, ceteris paribus, on the type, e.g., size, of the economy. No strong generalization as to the relative importance of shifts in output mix vs. changes in technology for given mixes is likely to be valid. It should be clear, however, that the important issue is that the search for innovation can now be considered a conscious activity of the individual entrepreneur and--given the combination of more realistic relative price signals after liberalization plus greater entrepreneurial capacity--that it is likely to be directed towards various forms of indigenous capital stretching on top of the imported technology. Such capital-stretching can be represented by a reduction in the capital coefficient per unit of output. The effective post-assimilation set of unit technologies, i.e. after domestic assimilation, may thus be represented by curve S''S'' in diagram I, with the strength of the indigenous labor-using innovative effort indicated by the amount of the "downward" shift in the capital coefficient.

It should be noted here that a negatively sloped technology shelf, e.g. SS, representing pure technological transplantation, permits, as you move to the left, higher labor productivity levels, but only at increasing capital cost. In a country characterized by capital scarcity this may mean increased technical unemployment (a la Eckaus) and hence a lower value of per capita income for the economy--in spite of the higher level of labor productivity achieved. Domestic capital stretching, however, can materially affect that situation by enabling more workers to be employed per unit of

¹It is important to emphasize the word "efficient" since we are not concerned here with the, possibly also legitimate, objective of employment creation as a separate social goal, to be traded off against output growth.

the capital stock. If the post-assimilation unit technology set, e.g. S''S'', is upward sloping, as the economy moves to the left by first borrowing abroad and then innovating domestically on top of that borrowed technology, higher labor productivity levels become consistent with lower capital-output ratios.¹

In summary, once the overall policy setting has turned more favorable and permitted the economy to enter the second phase of transition, it is this indigenous capital-stretching capacity which we consider to be of the greatest importance--especially for the contemporary developing economy facing the formidable labor force explosion predicted for the 70's and 80's. It is in this specific area also where the skepticism of planners, engineers, and aid officials generally is most pronounced--especially with respect to the range of technological choice really available when all the dust has settled. Historical examples from the Japanese case, as well as contemporary evidence from Korea and Taiwan, permit us to demonstrate the existence and potential importance of such capital-stretching innovations for the labor surplus developing country.

IV

As has been pointed out by many observers, including Allen and Lockwood,² the most significant feature of the Japanese landscape in the early Meiji period--following hard on two centuries of self-imposed, nearly complete,

¹The historical evidence within individual developed countries over time seems to indicate an approximation to constancy in the capital-output ratio, i.e. approximating a horizontal position.

²George C. Allen, Japanese Industrialization: Its Recent Development and Present Conditions, New York: Institute of Pacific Relations, 1940; W. W. Lockwood, Economic Development of Japan, 1868-1928, Princeton, N.J.: Princeton University Press, 1954.

isolation--was her ability to choose relatively freely from among the items on a technological shelf perfected in the West. The reopening of foreign trade and the resumption of other related contacts, especially the flow of technical personnel in both directions, led immediately to the stimulation of technological change by direct borrowing. But while the Japanese have often been characterized as possessing a consummate ability to copy and imitate, it is noteworthy that, in fact, very soon the majority of domestic innovation activity "consisted of the adaptation of foreign techniques to domestic conditions."¹

The reasons for this relatively early move to a responsiveness of the industrial sector's technology to domestic endowment conditions are complicated and cannot be dealt with here. Suffice it to say that post-Restoration Japan did not engage in very extensive or prolonged import-substitution policies--partly because extra-territoriality deprived her of the ability to establish strong protective import barriers, and partly because the government quite early thought it more efficient to work through the market, i.e. by using taxes and subsidies, rather than through extensive controls and government ownership. Those government plants in directly productive areas which were established during the immediate post-Restoration period were viewed mainly as pilot projects and sold off to private interests by 1890. Thus Japan moved relatively quickly into the export substitution phase.

In assessing the importance of capital stretching innovations, it is useful to recognize distinctions between innovations relating to the machine

¹M. Miyamoto, Y. Sakudo and Y. Yasuba, "Economic Development in Pre-Industrial Japan: 1859-1894," Journal of Economic History, December 1965, p. 557. The same authors also report (p. 563) that similar capital or land stretching innovations took place during the same period in the agricultural sector, mainly via new cultivation methods on the intensive margin.

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, emphasizing plant size and organization at various stages of that process.

With respect to machine-related capital stretching innovations, the simplest and quantitatively probably most important example was the running of imported U.K. and U.S. machinery at rates and speeds substantially in excess of those used abroad. For example, once the kerosene lamp made night work possible, spinning could be done on two, sometimes three, shifts daily, with but two or three rest days a month. This meant that the average work week per machine was two to three times that encountered in the country of origin; and, since physical depreciation is much less important than economic obsolescence, using a machine twice as intensively does not wear it out twice as fast. This heavy use of machinery typical of the 19th century Japanese industrial sector meant that the normal gap between the physical and economic life of a machine was substantially narrowed and capital was considerably "stretched."

Moreover, there was in evidence a related speed-up of the very same spinning machines. By running the machines at faster speeds and/or by substituting cheaper raw materials, i.e. raw cotton--and making up for it by increasing the number of women to handle the resultant increase in the number of broken threads--an additional major saving in capital could be achieved:

Certain differences in the industries of the two countries are important and must be noted. The raw material is essentially different. Though the Japanese do use some American raw cotton, the bulk of their cotton is from India and is of shorter staple,

more likely to breakage...and requiring more labor to put it through the machinery. The yarn spun has much more of the coarser counts that require more labor...By adding more labor it is run somewhat faster than American practice...All of these factors are in some way related to the cheap labor policy. They are there because the labor is cheap.¹

Japanese spindles were equipped with a 7/8 inch instead of a one inch front roll to accommodate the shorter staple cotton when operated at higher speeds.

For these several reasons, i.e. differences in the yarn count and differences in the speed of the machine, as well as differences in the number of shifts, we find that there was a very marked substitution between capital and labor in the cotton spinning industry. For example, Orchard reports that a competent Japanese spinner working on a 20 yarn count operated from 300 to 400 spindles, while an American spinner on the same count yarn tended from 1,020 to 2,688 spindles, that is, between 2 1/2 and almost 7 times as many.² As the U.S. Tariff Commission reported:

In order to distribute the fixed overhead charges in the way of high interest and depreciation costs, and to earn the large amounts needed to pay a normal rate of dividend, every effort has been made to obtain the largest possible output from the expensive equipment and plant. Machinery is therefore run at high speed, and almost since their inception the Japanese spinning

¹John E. Orchard, Japan's Economic Position, New York: McGraw-Hill Book Co., Inc., 1930, p. 367.

²Ibid., p. 367.

mills have been operated night and day, employing two 12-hour shifts (22 actual working hours) for an average of 27 days a month.¹

Here again, given a standard count of yarn, the average Japanese spinner is seen as tending 240 spindles, while the American counterpart on the same machine tends about 1,000 spindles. As late as 1932 weekly man-hours per 1,000 homogeneous spindles of the same quality ranged from 328.8 in Japan to 164.8 in the United Kingdom and 143.1 in the United States.²

A somewhat similar story can be told with respect to cotton weaving. Once again,

the high cost of mill construction is considerably reduced if you consider the hours during which the mill is being put to effective use. So far in Japan the wheels have turned round during 20 out of 24 hours, while in Europe only 8 hours are being worked. Effective working time in England is less than 38 hours per week, as 2 hours out of these are devoted to cleaning; this is done in Japan after working hours.³

Again, the U.S. Tariff Commission reports that "in weaving staple cotton sheetings, the ordinary Japanese weaver seldom operates more than two plain looms, while the American weaver, with perhaps some assistance in supplying fresh bobbins, normally tends from 8 to 10 plain looms."⁴

¹The Japanese Cotton Industry and Trade, U.S. Tariff Commission, Government Printing Office, Washington, 1921, p. 99.

²The World Textile Industry: Economic and Social Problems, Vol. 1, International Labour Office, Geneva, 1937, p. 209.

³Arnold S. Pearse, Japan and China. Cotton Industry Report, International Federation of Master Cotton Spinners' and Manufacturers' Association, Manchester, 1929, p. 86.

⁴The Japanese Cotton Industry and Trade, op. cit., p. 100.

Perhaps the most convincing evidence that these adjustments along the machines proper constituted a rational response to very marked differences in factor endowments was that in weaving, in contrast to spinning, the latest automatic equipment from abroad was not, in fact, invariably imported. Quite frequently, non-automatic looms were taken from the shelf instead, permitting more stretching than would have been possible in the case of initially more capital intensive technologies. Unlike some of the contemporary less developed countries, Japan clearly did not wish to import ahead of its entrepreneurial and skilled labor capacities.¹ As the Tariff Commission put it,

the price of the automatic loom is more than twice that of the plain loom, which, with the additional expense involved in the importation from the United States or Great Britain, made the total outlay too high in a country where the interest charges on money were relatively much higher than the cost of labor. Japanese mill managers have, therefore, hitherto preferred to employ more workers and to forego the more labor-saving but more expensive machinery, in contrast to the situation in the United States where the high-priced labor is economized rather than the machinery.²

Taking cotton spinning and plain loom weaving on similar products together, they concluded, in summary, that

¹The U.S. Tariff Commission (op. cit., p. 116) reported that a shipment of automatic looms, imported shortly after the turn of the century, had been found so difficult to operate, that, after removing the batteries and warp-stop motions, they were instead run as plain looms, two looms to a weaver.

²The Japanese Cotton Industry and Trade, op. cit., p. 116. A related interesting example of technical flexibility far beyond what most engineers are willing to admit to is provided by the Toyoda automatic loom, one of the few indigenous Japanese inventions in this area. Subsequently manufactured by Platt's and Oldham's under a Japanese patent, it was advertised to require 20 girls per loom in England; 50 girls had always been used in Japan.

the average Japanese spinner or weaver tends about one-fourth the number of spindles or looms usually assigned to one person in an American mill. A comparison of the total number of persons employed in the two countries to operate individual plants of similar size, and, viewed more broadly, a comparison of the total number of persons employed in the whole American industry, per 1,000 spindles, with the number that would be required on the similar balanced basis under the Japanese conditions, confirms the general relation observed, that the Japanese mills require between three and one-half and four times as many operatives as the American.¹

In the case of silk production, which, together with cotton, made up more than 70 percent of total industrial output until the turn of the century, we have similar evidence of the ability to innovate in a capital-stretching direction on the machine proper. In raw silk, for example, the Japanese employed more than twice as many girls as did the reeling basins in Italy. In other areas, well into the twentieth century, Japanese railways employed 19 workers per mile of track compared with 7 in the U.S.² In the production of printed goods, the following episodal account may be instructive:

Recently, a Japanese manufacturer of plain linoleum decided to undertake the production of printed goods. He dispatched a representative to the United States to purchase the necessary equipment. The representative was familiar with the modern

¹Ibid., p. 113.

²Orchard, op. cit., p. 375.

linoleum printing machine, printing several colors at one time and turning out as much as 15,000 square yards in 9 hours, but he considered it too expensive a piece of equipment, especially since his labor was being paid only about 50 cents a day, and so he sought out, in an American plant, an old hand block printing outfit. It was not for sale. Its parts were lying about in a storeroom of the factory. Some of them were 40 years old, and the whole outfit had been discarded 15 years before. But the Japanese representative purchased it and had it shipped to Japan. In the immediate outlay of capital he saved money, for he purchased the old equipment at the price of a printing machine or even below the price of a new hand outfit, but he installed in his plant equipment that could only have been disposed of as junk in the United States. He started in Japan a new industry in a stage of technical development that had become obsolete years before in the older industrial countries.¹

Many of the extra workers in Japanese plants were not engaged on the machine proper, but in what might be called machine-peripheral or handling activities. In place of mechanical conveyor belts, human conveyor belts were devised. Packaging was more often done by hand. As Orchard again reports, "at one of the largest copper smelters in Japan, clay for the lining of the furnaces is carried down from a nearby hillside on the backs of women. At the plant of the Tokyo Gas Company, coke is put into bags by hand and then carried by coolies, some of them women, to the barges in the adjacent canal.

¹Orchard, op. cit., p. 246.

Coal, even in the larger Tokyo plants, is unloaded by hand and carried in baskets to the power houses."¹ The ability to substitute labor for capital in such activities peripheral to the machine proper apparently existed and the quantitative incidence was substantial. Very often such activities were machine paced in the Hirschman sense, i.e. while they might have looked wasteful to the untrained Western eye, they were, in fact, paced by well-spaced machinery as part of the same production line which contained large numbers of unskilled laborers.²

A third type of capital-stretching innovation of which much use was made in historical Japan is ^(of) what might be called the plant-saving variety. This is often characterized by the co-existence of different historical stages of production in the same industry. Raw silk production and cotton weaving represent outstanding examples. In the former industry silkworm rearing and cocoon production were handled mainly by farmers' wives in small home-made sheds, extensions of the rural households. In cotton weaving, most of the yarn was "put out" to farm households, with individual looms dispersed in farm houses and worksheds. But even in the more modern factory-style spinning industry, preparatory and finishing processes were carried out largely at the cottage level.

This rather remarkable survival of domestic industry on a subcontracting basis must be explained largely in terms of the exploitation of complementarities between many small labor-intensive operating units and the large industrial management unit. The traditional merchant middleman, as a representative

¹ Ibid., p. 255.

² This is very similar to contemporary methods of construction with the use of reinforced concrete in India and Pakistan. Here a cement mixer is linked to the final pouring of the concrete by a long chain of workers passing the cement from hand to hand; the cement is put in place just before it is ready to cool and harden.

of the sub-contracting unit, served as both supplier and market for the goods to be worked up domestically. A specialization of functions as between workshops, even as between the members of a given family, developed. One-roof economies could be achieved in this fashion, i.e. by using cheap labor in cooperation with old-fashioned machinery at the workshop level, while economies of scale could be achieved in the financing, purchasing and merchandising stages.¹ The continued relative importance of this household type of enterprise is quite remarkable; cottage style industry contributed more than 2/3 of industrial output in 1878, almost 60 percent in 1895, and retained substantial importance well into the twentieth century. Not only lacquerware, pottery, porcelain, sake, fruit and fish canning but also such new consumer goods coming to the fore over time as bicycles, electric lamps and rubber, were to exhibit the same characteristics.

Plant amounts to more than 50 percent of total investment in plant and equipment in most countries. The ability to utilize households for putting-out operations and thus reduce expenditures on plant undoubtedly amounted to a major kind of capital stretching innovation. By deploying familiar but improving machinery over large numbers of scattered mini-plants, large amounts of unskilled labor could be deployed in both direct production and in satisfying the resulting increased demand for transportation and handling activities. In this fashion, Japanese entrepreneurs were able to, first, incorporate pure labor services and, later, domestic ingenuity and skills, into the industrial production processes, largely for export.

¹"Sometimes even a single part is not completed in one shop or home but is shaped in one and painted or plated in another." H. G. Aubrey, "Small Industry in Economic Development," Social Research, September 1951.

An examination of the capital-labor ratio in the non-agricultural sector in Japan during the period discussed indicates the effectiveness of capital stretching innovations at the aggregative level, i.e. while the average annual rate of capital deepening was 4.3% between 1906-1917, the earlier period, between 1892 and 1900, was characterized by capital-deepening at a rate of 2.8% annually, declining to 1.7% between 1900 and 1906.

This seems to at least suggest that Japanese entrepreneurs were getting better and better, through a learning-by-doing process, at innovating in a relatively labor-using direction before the unlimited supply of labor condition came to an end as the reserve army of the unemployed and underemployed was substantially mopped up after World War I.

In contemporary Korea, devaluation in 1963 and a major interest rate reform in 1964 laid the basis for major changes in technology as well as output mix. Examples of capital-stretching adaptations of imported technology abound in textiles, electronics and plywood production. In the manufacture of silk, for example, 1 girl mans 2 looms as contrasted with 6.8 equivalent looms in contemporary Japan. In reaction to the now rising wages in Japan, Korea is taking over the lower quality yarn spectrum where more girls can be employed to make up for the inferior quality of the raw material. In cotton weaving, one Korean girl mans 3 looms as contrasted with 4 in Japan; in spinning the contrast is between 600 and 900 spindles. Moreover, Korean machinery is run for 3 eight-hour shifts daily as contrasted with only 2 such shifts in Japan. Peripheral to the machines proper, we may note that the contemporary Japanese use of a conveyor belt system, for example between the carding, gilling and combing operations, is replaced by human hands in Korea.

In the production of plywood what at first appears as production processes very similar to those carried on in the U.S., i.e. fixed proportions, in fact, turn out to be quite flexible--interestingly enough mainly because of the greater machine speed combined with much more labor-intensive repair methods used. In the United States, defective pieces of lumber are cut out automatically by machine and discarded. In Japan, defective pieces of lumber are cut out by hand and the section is discarded. In Korea, defective sections are cut out by hand, the scraps saved, and the defect plugged manually. Here once again a lower quality raw material can be upgraded to an equivalent quality output through the application of cheap labor. Consequently, overall we found twice as many workers per unit of capital equipment in Korea, i.e. 123 workers are engaged per equivalent capital production line as contrasted with 72 in Japan; moreover, a Korean line is worked a 22-hour day as compared to 20 in Japan. At the same time between 10 and 15 percent more workers are engaged in inspection, repair and maintenance of both materials in process and the machinery in place.

In electronics, machine-related labor-using innovations and adaptations are most prominent. In transistor assembly operations, for instance, given wage rates 10X lower than equivalent operators get in the U.S. (for the same firm), the machinery is run at physical full capacity, i.e. six days, three shifts a day which is 20 percent above the U.S. equivalent. Moreover, certain special operations such as feeding and packaging are usually done by hand on the assembly line, instead of automatically. In spite of the greater use of labor, productivity per worker seems to be higher due partly to the faster learning process (it was repeatedly stated to take at least two weeks less to train Korean girls in assembly than Americans) but mainly to the greater discipline and attentiveness on the assembly line

throughout. For example in one firm the difference in speed of assembly on identical equipment yields a 30 percent differential in output (from 68 units per machine hour to 85) and in a die mounting process it rises to more than 100 percent (from 113 units per hour to 240). These greater speeds of operation, either due to faster machine or operator pacing, are once again accompanied by putting additional girls into more intensive testing, inspection and repair efforts than is encountered in Japan or the U.S. Defective pieces are not thrown away but repaired by hand. Similarly, with machinery itself working at physical full capacity, considerably more manpower is allocated to the maintenance and repair of the in-place capital equipment.

With respect to other, organizational and plant-related technological choices, the most important phenomenon clearly resides in the area of subcontracting, both domestically and internationally. Domestically, subcontracting to local equipment and parts manufacturers is being increasingly practiced, especially in the electronics industry; sometimes, as the experience of several companies indicates, it takes two to three years before the domestic subcontracting supplier, via a learning by doing process, has become a lower cost producer than the main plant or import alternatives. While such capital saving innovations, mainly via the reduction of plant and large-scale urban overhead requirements, are not yet as wide-spread in Korea as in historical Japan (and contemporary Taiwan), they are markedly on the increase in a number of other industries as well. Internationally, of course, accepting a sub-contract for the labor intensive phase of a multi-stage, and elsewhere technologically demanding production process, is a potentially very efficient way of harnessing virtually pure labor services to the development process. Bonded export processing schemes, consisting of tariff free zones into which,

often under subsidiary or subcontracting arrangements with Japanese or American firms, raw materials are imported, and then reexported, after value in the form of cheap labor has been added, can be most helpful. This scheme now yields close to 20 percent of a Korean export volume which itself has been rising at an almost incredible 30-40 percent annual rate over the past three years.

But it is to the larger question of the productive absorption of labor through changes in the output mix and trade that we must turn in this connection. In 1962 land-based food-stuffs and raw materials made up 75 percent of total exports while labor-based light manufacturing industries as a whole, including plywood, raw silk, cotton textile, wigs and footwear amounted to 15 percent. By 1968 the situation had been completely reversed, with 77 percent of the exports in manufacturing and only 14.5 percent in food-stuffs, livestock and raw materials. It should, moreover, be noted that small-scale manufacturing exports, i.e. in units of less than 10 workers, undoubtedly the most labor-intensive part of the spectrum, grew from 18.6 percent of the total in 1963 to 31.4 percent in 1968.

As a consequence of all this manufacturing employment doubled between '63 and '69, with light industry, in particular, increasing its employment at a rate even in excess of value added (see Table 1).¹ At least until Korea began to reverse its liberalization trend, after 1968,² the capital-labor ratio for manufacturing as a whole actually declined after 1964 (see Diagram II). We also have evidence, for example in Table 2, that there exists a good deal of disparity by scale here

¹I would like to acknowledge the assistance of Professor Sung-Hwan Jo of Sogang University, Seoul, in this context.

²This reversal is part of a larger story which cannot be dealt with in the context of this paper.

Table 1

KOREA

<u>Year</u>	<u>Employed Industrial Labor Force</u> (annual)	<u>Employed Industrial Labor Force</u> (3 Year Moving) Average	<u>Annual Growth Rate</u>
1952			
1953			
1954			
1955	1,789		
1956	2,223	2,242	
1957	2,716	2,461	
1958	2,444	2,629	
1959	2,729	2,745	5.5% ('56-'62)
1960	3,062	2,643	
1961	2,139	2,912	
1962	3,536	3,101	
1963	3,630	3,658	
1964	3,809	3,879	
1965	4,199	4,106	6.3% ('63-'66)
1966	4,312	4,397	
1967	4,680		
1968			
1969			

Diagram II - Korea K/L Ratio

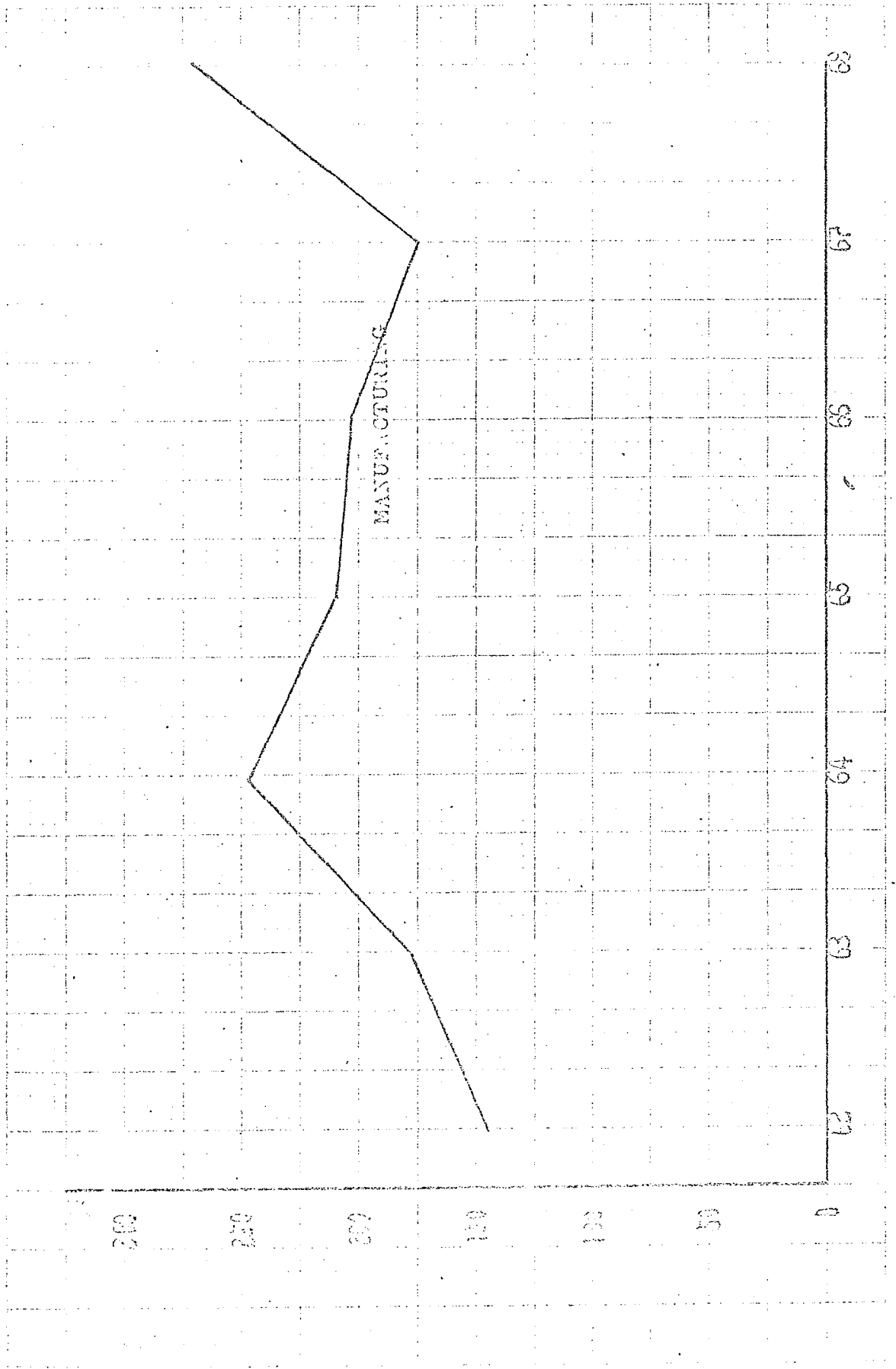


Table 2

Capital Intensity by Establishment Size:
Korean Mining and Manufacturing, 1968

<u>Est. Size</u>	<u>Fixed Assets</u>	<u>No. of Workers</u>	<u>Capital/Labor Ratio</u>
5-9	23,722	82,183	.289
10-19	28,601	79,141	.361
20-49	38,367	100,586	.381
50-99	28,695	73,467	.391
100-199	28,406	76,485	.371
200-499	68,512	120,875	.567
500+	188,421	258,446	.729

Source: EPB-KDB, Report on Mining and Manufacturing Census, 1968 and Paul Kuznets, "Labour Absorption in Korea Since 1963," paper presented to the Conference on Manpower Problems in East and Southeast Asia in Singapore, May 22-28, 1971, Table 8.

as in many other, less "well-behaved" countries.¹ This is due to the well-known discrepancies in residual factor price distortions affecting large and small firms, with real wages lower and capital costs higher for the smaller units.

Relevant micro-economic data are harder to come by, as firm interviews proved unsuccessful in eliciting reliable data at the firm level. The leading Korean timber company, however, did show a decline in its capital-labor ratio from 35.8 in '65-66 to 27.8 in '68-69.

In Taiwan too, once the liberalization policies of the early 60's had substantially reduced some of the major distortions in relative prices which comprise the import substitution syndrome, marked labor-using innovations took place in the textiles, electronics and food processing industries. Large-scale mushroom and asparagus production as forms of agricultural by-employment (similar to silk in early Japan),² combined with related processing and canning activities, provided major markets for surplus unskilled labor, especially female. With time, and facilitated by the establishment of the Kaohsiung Export Processing Zone, export substitution via a dramatic expansion of labor intensive manufacturing took place.

Again, at the macro-level first, consequent to all this, industrial employment grew at rates of 3.0% annually between '52 and '59 (see Table 3), but accelerated to 8.1% annually. for the decade of the 60's, once the transition to export promotion had been completed. If we divide non-agriculture into Kuznets' M and S sectors we see that the rate of labor absorption rose from

¹From Paul Kuznets, "Labour Absorption in Korea Since 1963," paper presented to the Conference on Manpower Problems in East and Southeast Asia, op. cit.

²In fact, such non-farm earnings comprised 72% of agricultural incomes in '62.

Table 3

TAIWAN

<u>Year</u>	<u>Employed Industrial Labor Force</u> (annual)	<u>Employed Industrial Labor Force</u> (3 Year Moving Average)	<u>Annual Growth Rate</u>
1952	1,198		
1953	1,223	1,227	3.1% ('53-'59)
1954	1,261	1,258	
1955	1,291	1,285	
1956	1,304	1,320	
1957	1,366	1,363	
1958	1,418	1,422	
1959	1,481	1,478	
1960	1,536	1,538	8.1% ('60-'68)
1961	1,598	1,597	
1962	1,689	1,678	
1963	1,781	1,760	
1964	1,843	1,851	
1965	1,938	1,935	
1966	2,034	2,067	
1967	2,239	2,251	
1968	2,480	3,466	
1969	2,679		

4.8% annually in 1950-60 to 7.5% in 1960-69, in the M sector, and from 3.2% to 6.5% for the same periods, in the S sector.¹ Equally significant is the fact that once interest rates and other reforms had been completed--in addition to the exchange and land reforms which took place earlier--this trend seems to have accelerated, i.e. for the '64-69 period the relevant rates are 8.7% for the M sector and 7.2% for the S sector.

In 1952 rice and sugar constituted 78 percent of Taiwan's export earnings. By 1969 this had shrunk to 4.8 percent. During the same period non-traditional agricultural products, including fresh and canned fruits and vegetables rose from zero to 10 percent of the total; and, most impressively, manufactured goods, including wood and plywood products rose from 5 percent to 69 percent of the total. The full dimensions of this structural change are recognized when we again note that total export earnings were rising very rapidly, at rates in excess of 20 percent annually, especially during the 1960's.

At the micro-level on the basis of 20 firm interviews conducted, most of the capital-stretching in evidence clearly took place in fabricating, as opposed to continuous processes.² One large plastics factory produced both raw materials (PVC plastics) and finished products (various plastic products including furniture and toys). Its board chairman reported that in the continuous process (of producing resin for PVC plastics) the capital-labor ratio of his plant was about the same as that of other plants of the parent company in the United States, while in the fabricating process the capital-labor ratio was about one-half of that of the American plants.

¹These data are from Harry Gshima, "Experience of Labour Absorption in Postwar Taiwan," a paper presented to the Conference on Manpower Problems in East and Southeast Asia in Singapore, May 22-28, 1971.

²I would like to acknowledge the assistance of Professor N. R. Chen of Cornell University in this context.

The use of labor is most intensive in electronics assembly industry. While parts are mainly assembled with the aid of machines in the United States, this work is performed by women workers in Taiwan. According to the general manager of one major electronics firm, the amount of labor used in assembling one set of television in the Taiwan factory is 50 percent greater than that in a factory of the parent company in the United States. In fact, most of the electronics firms interviewed were making efforts in one way or another to introduce labor-intensive methods. The capital-labor ratio of these firms has been generally rising through time. The largest electronics factory in Taiwan has experienced an increase of capital by nine times and an increase of employment by sixteen times between 1965 and 1969. Throughout the electronics industry, capital-labor ratios have apparently fallen during the 60's. Many of the managers interviewed pointed out that the wage bill was lower in spite of the substantially larger relative volume of employment.

One tentative conclusion which may be derived from these plant visits is that the closer the production process is to the raw material processing stage, i.e. backward linkages, the smaller the chances for efficient labor/capital substitution statically or capital-stretching innovations dynamically; the closer the process to the finished product stage, the greater are these possibilities.

This episodal approach is consistent with, though it admittedly does not conclusively prove, our main point, i.e. that the typical developing country, especially one which is open and not too large in size, can expect--with appropriate policy changes taking place--to transit from import substitution, with pure technological transplanted the order of the day, to export substitution with labor-using innovations taking on major significance.

Once shortages in domestic entrepreneurial capacity and other economic overheads have been repaired, if and when the hothouse temperature is gradually reduced, labor-using types of technological change, both of the unintentional and of the intentional variety, assume increasing importance. In this phase the famous conflict between output and employment objectives in industrial development may be subject to fundamental challenge. Both the historical experience of Japan and that of Korea and Taiwan in recent years illustrate that the current wide-spread skepticism concerning the supposed tyranny of the rigid technical coefficients may be seriously in error. This error derives in the main from an underestimate of the potential inventiveness of indigenous entrepreneurs, once they are given access, at a price, to the required inputs. And this is no trivial matter. For if our skepticism here is unwarranted, this would be among the most powerful arguments for accelerating the current, rather slow and uneven, trend towards liberalization and the erosion of the substantial shadow price/market price differentials in factor and commodity markets.