Analytics of the Technology Transfer Cost Issue

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I. Introduction

An increasingly important issue of trade and development is the high cost of the transfer of technology from the developed countries to the developing world. Rough estimates suggest that payments by developing countries for the use of patents, licenses, trademarks, and managerial and technical services amounted to about $1.5 billion in 1968 [19]. For Pakistan, the issue is of particular importance.[1] Based on conservative estimates by Mahbub ul Haq, Pakistan's annual payments for technology transfer in 1965-70 averaged $102 million; this magnitude—again reflecting payments for the use of patented knowledge and technical services only—represents a payment rate of almost 16 percent of annual export receipts [19]. If other costs such as profit repatriation and transfer pricing are included, the payment rate is substantially higher.

The implications of the high cost of transferring technology are four. First, it is evident that technology is not a free commodity; if available, it is available only at a cost. Second, it is equally evident that this cost is largely a contractual cost and is separate from the production cost necessary for the utilization of technology: once acquired, the technology must still be supplemented by the application of capital, labour, and raw material inputs to the production of the final product. Third, it is not evident but nonetheless true that if the latter inputs are 'packaged' with the technology transfer, then the form of the packaging determines whether the average production cost of the final product is in fact the minimum attainable average cost; if there is an insufficient regard for factor proportions an efficiency cost is added in the transfer of technology. Finally, in view of the high contractual cost and the likely efficiency cost, it is not evident that technology transfer is an attractive form of technological improvement; alternative forms may be less costly.

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[1]All data references for Pakistan are for pre-1971 undivided Pakistan.

Taken together, these implications suggest the need for a rethinking of the current policy underlying the transfer of technology. The current policy is based on two premises. The first premise is that a technology gap exists between countries which must be bridged if developing countries are to reach parity with developed countries. The second premise is that a transfer of technology between countries is an inexpensive method of bridging the gap. The current policy, therefore, is for developing countries to rely exclusively on the transfer of technology as an instrument for bridging the technology gap.

Critics of this policy have noted that an exclusive reliance on technology transfer leads to technological dependence. The danger in technological dependence is that a country can transfer a technology inappropriate for the efficient growth of its trade and domestic output [15]. This adverse situation results when insufficient regard is given to cost considerations in the choice of technology: the decision to import technology implies a decision on the choice of techniques; if the latter choice is suboptimal, then resources are misallocated and inefficiency occurs. The consequence of such technological dependence, then, is that competitively priced exports are not possible, and import substitution requires heavy protection and subsidization. Frequently, the latter involves a substantial use of imported materials so that the net decline in imports is low.

Given the high cost of the transfer of technology [19], the possibility of adverse technological dependence is also high. Current policy should recognize that technology transfer is costly, and that the transfer process should be selective. Not all technologies should be transferred; those that are shoud be desirable after a consideration of their transfer costs. If these costs are excessive (that is, they exceed the technology benefits), then an effort to reduce them is necessary.[2] If such an effort is not possible, then alternative forms of technological progress—such as the development of indigenous technology—should be encouraged.[3]

In order to stimulate such a policy rethinking, this paper examines the transfer cost issue further. We focus on transfer costs as these determine the relationship between technology transfer and technological dependence. We first clarify this relationship with the aid of elementary economic theory. We then suggest that the transfer of technology is a necessary but insufficient condition for adverse technological dependence. The latter can result from technology transfer; but it need not if adequate regard is given to cost considerations in the choice of technology.

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[2]Although a tautology, this view is recent; for the alternate view, Harry Johnson questions the desirability of reducing costs as contractual costs—regardless of magnitude—constitute legitimate returns to investment in knowledge: "Usually this complaint is a simple case of wanting to have one's cake and eat it too, that is, specifically, of wanting to have the benefits of knowledge developed by others without contributing anything to defraying the costs they have incurred in developing it. High measured rates of profit on capital, often taken as an indication of "exploitation", may in fact not be so, since the "excess" profits may represent a return on past investments in creating capital in the form of knowledge, which does not appear on the firm's books as an addition to material capital". [7, pp. 39-40]. If this view is accepted then transfer costs remain unchallenged and the possibility of adverse technological dependence is high.

[3]This alternative is also referred to as promoting import substitution in technology.

II. The Gain from Technology Transfer

We begin with some basic notions. The first is the concept of technology. In economic theory, technology is viewed very generally as a constraint on a country's production set: not all production possibilities are feasible, and technology determines the feasible production set. The economic interest in technology, therefore, is in the type of constraint imposed on the production set. Relatively, a flexible constraint implies a greater choice of production possibilities, while a neutral constraint implies the lack of a capital-using or labour-using bias.

Economic theory also views technology as being of two types: embodied and disembodied. Disembodied technology determines the general constraint on the production set. Embodied technology (in say, a machine or person), though, determines a further, more specific constraint on the quality of capital and labour. The latter considers human and physical capital to be heterogenous; each unit varying in productivity according to the vintage of its technological embodiment. Although this consideration is realistic, for simplicity, we do not distinguish between embodied and disembodied technology.

The next concept is that of the technology gap. In economic theory, the gap is defined as the differential in the production technology available to the developed and developing countries. In its simplest form, the differential is strictly positive for all production possiblities so that the production set of the developing country is contained in that of the developed country. For the one commodity, two factor, constant returns to production case depicted in Figure 1, the technology gap is the distance between the isoquants of the developed country, DC and that of the developing country, LDC, measured along an arbitrary capital-labour ratio ray emanating from the origin.[4] Although the choice of the particular capital-labour ratio ray is arbitrary, one choice is the ray intersecting the point of tangency of the LDC isoquant with the relative factor price line prevalent in the developing country, AB.

The significance of the technology gap is that resources are less productive in the developing country relative to the developed country. In Figure 1, more of both capital (K) and labour (L) is required to produce the same level of output (Y) at a given capital-labour ratio on the LDC isoquant than on the DC isoquant. The motivation for bridging the gap is therefore apparent. By standard optimality criteria, the developing country is clearly better off with the advanced technology, *ceteris paribus*. The potential gain to the developing country from bridging the technology gap is thus in the reduction in production cost due to the adoption of the advanced technology.

This gain is readily conceptualized with the aid of Figure 2; again, for the one commodity, two factor, constant returns to production case. Assume that relative factor prices are constant in the developing country. Then, the optimal production choice for the developing country prior to bridging the gap is represented by the tangency of the factor price line, AB with the existing isoquant, LDC; while the optimal production choice after bridging the gap is

[4]This definition of the technology gap is presented in [10]. It is clearly a simplification: the technology gap is a more complicated phenomenon; however, as our interest is only in the production cost of the gap, the simplification is adequate.

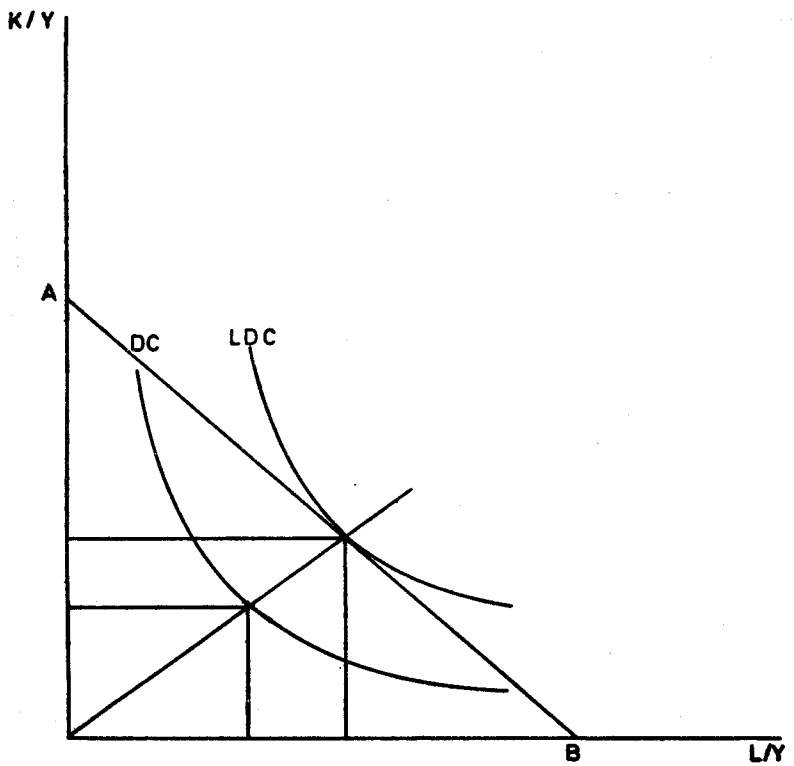

Fig. 1
The Technology Gap

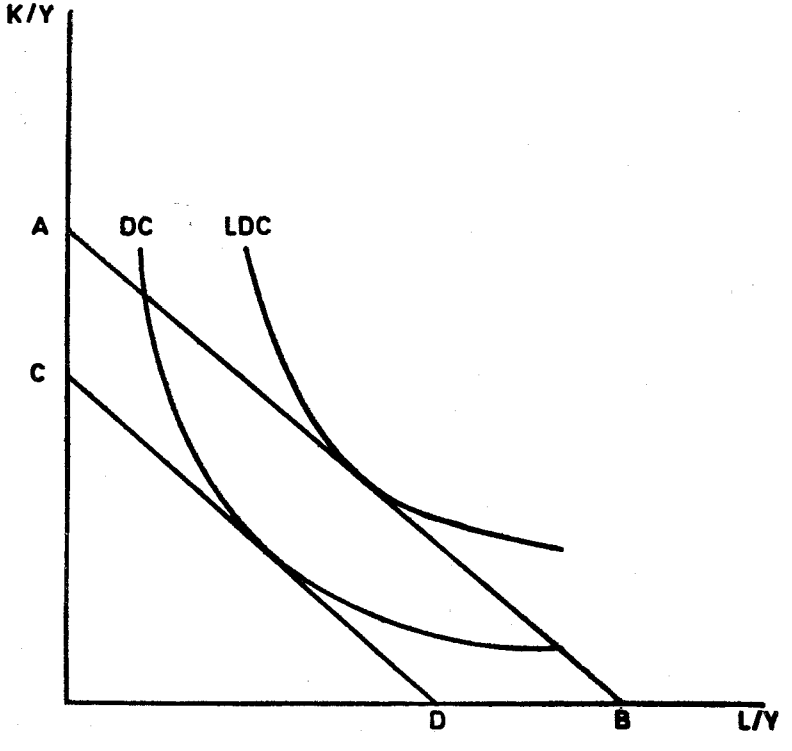

Fig. 2
The Gain from Bridging
the Technology Gap

represented by the tangency of the parallel factor price line, CD, with the advanced technology isoquant, DC. The gain from bridging the gap is therefore the reduction in the average production cost measured either in units of capital, AC, or in units of labour, DC. Clearly, the greater is the technology gap, the greater is the gain from bridging it.

The mechanism for realizing this gain is identified by the theory of the 'late start' [2]. According to the theory, a developing country can attain the advanced technology represented by the technology gap more quickly than did the developed country. This is so as the developing country is, by virtue of starting late, in a position to avoid the earlier innovation errors of the developed country and to reduce but not increase existing errors. It is assumed that errors alone are not educative for the developing country. The policy implication of the theory is that technology accumulated in the developed country is more easily transferred to the developing country than duplicated indigenously.

III. The Costs of Technology Transfer

A. The Contractual Cost

The ease in technology transfer, however, varies inversely with its cost and, as already noted in the initial section, technology transfer is costly. Transfer costs are of two types. First, there is a contractual cost incurred by the developing country for the use of imported technology. This cost is negotiated on a project basis and is specified in a transfer of technology agreement between the foreign supplier and the domestic importer. As this cost includes a variety of direct and indirect monetary payments and several trade restrictions, it is discussed in detail in the next part of this section; here, we only note its aggregate implication: the overall gain to the developing country from bridging the technology gap must in consequence be viewed as a net gain. (The latter is equal to the gross gain—AC or DB in Figure 2—less the unit contractual cost of technology transfer.)

A normative conceptualization of the aggregate contractual cost is important. In economic theory, technology, once available, is a free item in that knowledge of a particular production possibility by one producer does not prevent another producer from also utilizing the knowledge [11]. So that, from an efficiency, welfare perspective, the marginal social cost of sharing existing technology is zero. Optimal resource allocation, therefore, requires that the contractual cost of technology transfer just equal the transport or transmittal cost of transferring technology to the developing country.[5] Hence, an excess of the contractual cost over the transmittal cost represents a welfare loss to the developing country.[6]

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[5]If the technology is adapted specifically to factor price ratios, income levels, and environmental conditions in the developing country, then the cost of this adaptation should be viewed as part of the transmittal cost.

[6]On the above, Harry Johnson states: "This argument leaves unanswered the question of how the production of additional knowledge is to be motivated, and so is inconsistent and incomplete as a basis for policy". [7, p. 40]. There is, however, no empirical evidence that the production of knowledge is motivated by the market size of the developing countries; on the contrary, there is some evidence that the producton of new knowledge is unmotivated by the granting of patent monopolies of any market size. See: [8, pp. 39-49]. Most probably, the motivation of new knowledge depends on a number of factors relating to the domestic market in which the innovating firm principally operates, only one of which is market size—and that too only domestic market size; if this is realistic, then Johnson's concern is unnecessary.

A positive conceptualization of the contractual cost is also important. In a private economy, innovations are made profitable by the establishment of property rights—through patents, licenses, trademarks, and other legal mechanisms—so that a technology-owning firm is able to behave as a monopolist [3]. Should the firm choose to share these rights, therefore, it is in a position to specify the contractual terms of transfer. It is more appropriately shown in the next part of this section but we now note that these terms necessarily aim to maximize the firm's monopolistic profit. Hence, in practice, the contractual cost of technology transfer tends to exceed the simple transmittal cost.

The extent of the excess depends on market conditions in the developed country. Generally, the more monopolistic is the supplier's market the greater is the excess. That is, for an early vintage of technology with lapsed property rights, a competitive market is possible and an excess is not likely; but for a recent vintage of technology with rights extending exclusively to a single firm, a monopolistic market exists and an excess is probable. Presumably, intermediate market situations are plausible. Finally, note that the excess is limited, for all practical purposes, by the degree of the advanced technology: the unit contractual cost cannot exceed the unit cost reduction if the developing country is to achieve a net gain.

The above discussion is clarified with the stylized representation in Figure 3. In the figure, the production possibilities for a single commodity are indexed by their respective vintages, and the aggregate contractual cost and the gross gain to the developing country of each are mapped. The gross gain of each is simply its unit cost reduction with respect to the base vintage technology, while the contactual cost is the aggregate per unit cost specified in the technology transfer agreement. The gross gain is shown to increase with technological development: first rapidly, and then at a decreasing rate. And the contractual cost is shown, initially, level with the transmittal cost (which is assumed constant for simplicity),and, later, rising at an increasing rate to reflect the monopolistic ownership of recent vintage technology.

It is apparent from Figure 3 that the net gain to the developing country from bridging the technology gap can be negative. This results, in the figure, when the developing country's most advanced technology is represented by a production possibility left of A, or right of B. In the former situation, the technology gap is small and the gain from bridging it is less than the transmittal cost. In the latter situation, the gap is substantial but to fully bridge it is undesirable as the contractual cost of the most recent technology exceeds its gain. Consequently, in either situation, the implication of the aggregate contractual cost is that the net gain from bridging the technology gap is negative and that a small, positive gap is desirable.

The policy implications that follow from the discussion of the contractual cost are two. First, if the cost is positive, then only a transfer of particular technologies is beneficial to the developing country. A proper cost-benefit identification of these technologies is essential. Second, the intermediate nature of these technologies is such that they enable the country to narrow the technology gap but not necessarily to bridge it fully; so, when the latter is true, an exclusive reliance on technology transfer maintains the gap and, thus, the dependence on the developed country for the supply of existing technology in a future time period places the developing country at a technological disadvantage

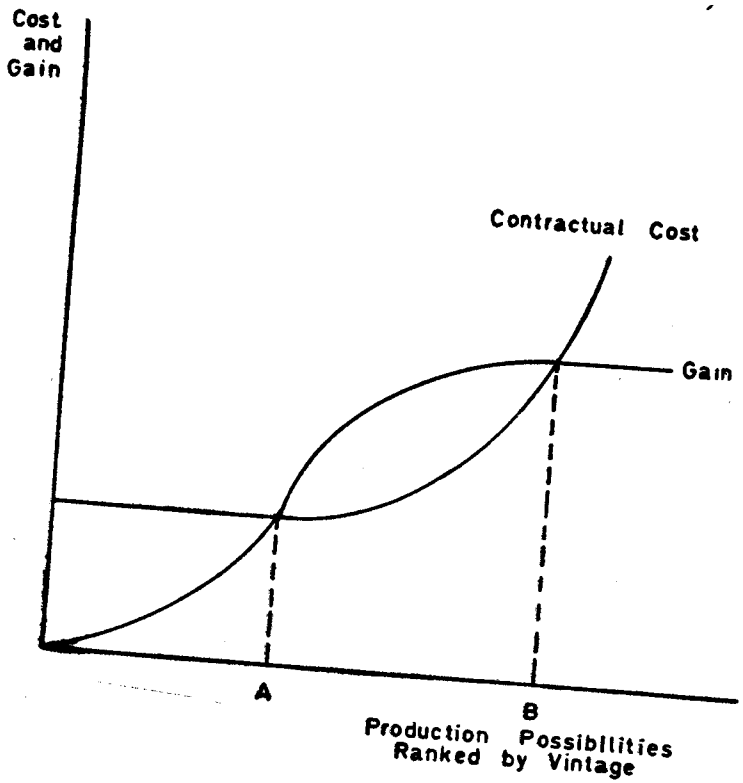

Fig. 3

The Gain and Contractual Cost of Technology Transfer for Different Technology Vintages

in the present.[7] Technology transfer, therefore, is not in itself a satisfact alternative to the development of indigenous technology but only a desira prerequisite, the desirability of which depends inversely on the magnitude of aggregate contractual cost.

B. A Disaggregation of the Contractual Cost

As already indicated, the aggregate contractual cost incurred by t developing country in actuality consists of various direct and indirect costs whi are agreed to by the domestic importer in the developing country throug direct negotiation with the technology supplier, and are specified in a transfer

[7]Alternatively, the developed country is placed at a comparative advantage; see th literature on the technology gap and product cycle trade theories [6, 12, 21]. Whether technological disadvantage to the developing country is undesirable is an empirical consideration.

technology agreement.[8] Although these costs are numerous, the UNCTAD Secretariat has noted five broad categories of social costs which relate to the use of foreign exchange [16]. The first two categories represent direct contractual costs and consist of royalty payments for the use of patents, licenses, and trademarks, and payments for technical and managerial services. The remaining three categories represent indirect contractual costs and involve profit repatriation on foreign equity participation, the overpricing of tied-purchases, and export restrictions. We briefly list each of the costs in turn; we then note the existing empirical estimates for Pakistan.

Royalty payments constitute the first category of contractual costs. In practice, a royalty is a single, combined unit payment—usually specified as a given percentage of average revenue—for the use of the patents, licenses, and trademarks through which a technology-owning firm has established exclusive Property rights. As noted earlier, the Latter exclusivily permits the firm to act as a monopolist both in its domestic market and in determining the royalty payment. In economic theory, if the firm is a profit maximizing monopolist, then it necessarily sets the payment equal to its average monopolistic profit in the domestic market. This is easily shown with the aid of Figure 4.

As before, assume that returns to production are constant and that the gross gain of the patented technology is a reduction in the average cost from C_0 to C_1, (for simplicity, ignore factor price differences between countries in the calculation of these costs). Since the technology-owning firm is a monopolist, the demand curve, AR, and the marginal revenue curve, MR, are depicted as downward sloping. Clearly, the firm earns an average monoplistic profit of AB at its optimal output level, X.[9] Now, if the firm allows access to the restricted technology to a developing country importer, it can assess an optimal royalty payment of AB as a higher royalty would imply that the import of the commodity rather than the technology is profitable, while a lower royalty would imply a loss of profit. Hence, the royalty is set equal to the firm's average monopolistic profit.[10] (Note that, in the figure, AB is shown to be less than the unit cost reduction; however, if this is not the case, then both the monopolistic profit and the royalty are limited by the cost reduction).

Aside from theory, three institutional aspects of the technology agreement are relevant to the understanding of the royalty determination. First, the technology supplier is frequently denied access to the developing country's market by trade barriers so that it incurs no opportunity cost in sharing the technology. Second, the technology supplier frequently restricts the developing

[8]For a detailed discussion of the conditions determining technology agreements, see: [17, 18].

[9]For an alternate algebraic treatment, see [3].

[10]On the above, Harry Johnson remarks: "This mplies, incidentally, that because poorer and less-developed countries are likely to have more elastic demand curves for knowledge-intensive products than richer and more advanced countries, the former are likely to pay less, and the latter more, than their *pro rata* share of the costs of development of the knowledge; in other words, there is a general presumption that discriminating monopoly redistributes real income from the rich to the poor". [7, p. 41]. Johnson, however, does not provide any evidence to show that developing countries do in fact have more elastic demand curves so that his point is unsubstantiated and can be discounted.

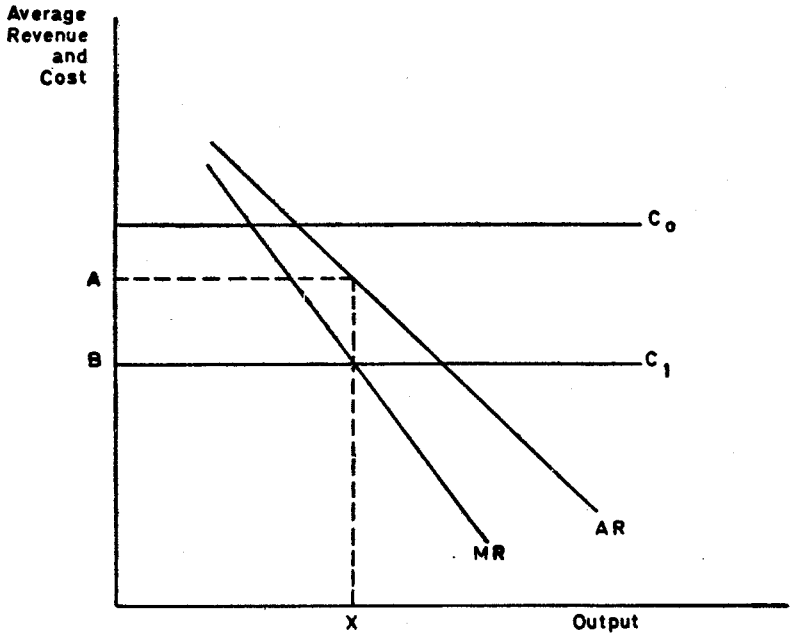

Fig. 4

The Technology Supplier's Optimal Royalty Payment

country importer to production for the local market so that the supplier's competitive position in its domestic market is unaffected. And third, the technology supplier typically grants exclusive rights to the patented technology to the developing country importer so that the latter behaves as a monopolist in its local market. As the first two ensure that, if the royalty is positive, the supplier always gains, and the third ensures that, though the importer's average production cost is raised by the unit royalty, the importer's local monopolistic profit is always positive (assuming that the importer's perception of demand is accurate), both parties to the technology agreement gain from the royalty determination.

The social cost of the royalty to the developing country is evident, however: the gain from the adoption of the advanced technology—the unit cost reduction—is lowered by the amount of the unit royalty payment. Ghulam Radhu has observed, in a sample of fifty technology transfer agreements in Pakistan, that the payment generally varies between two and four percent of the local sale price of the product [13]. If the latter is a monopolistic price, though, the percentage increase in the average cost is higher. An alternate measure of the social cost of the royalty which emphasizes the scarcity of foreign exchange is the calculation of the royalty payment as a percentage of domestic value added [16]. Clearly, this measure yields an even higher social cost if the import content of intermediate inputs is substantial.

Payments for technical and managerial services constitute the second category of contractual costs. These payments are necessary as the simple acquisition of access rights to restricted technology is rarely sufficient for the application of that technology to production. Frequently, the developing country importer lacks the technical and managerial knowledge required for such an application and must obtain it from the technology supplier along with the access rights. In the case of Pakistan ninety percent of the technology transfer agreements sampled by Radhu include both acquisitions [13]. The implication, then, is that the average production cost rises—and, so, the gain from the adoption of the advanced technology declines—not only by the amount of the unit royalty but also by the extent of the average payment for technical and managerial services.

Profit repatriation on foreign equity participation constitutes the third category of contractual costs. Often, as a partial reimbursement for the provision of its technology, the technology supplier acquires a percentage share of the ownership of the local firm. Faizullah Khilji has observed that the dominant firms in the three Pakistani industries which account for 60 percent of the technology transfer agreements in Radhu's sample, chemicals and pharmaceuticals, electrical machinery, and tobacco, have foreign equity ownership of at least 50 percent [9]. Such equity participation enables the technology supplier to control the local firm's decision-making on the use of the technology and, in addition, earn revenue through dividend payments. As the dividend payments are in foreign exchange, these represent a social cost to the developing country and, therefore, an indirect contractual cost.

The overpricing of tied-purchases constitutes the fourth and potentially the most important category of contractual costs. Generally, transfer agreements contain a tied-purchase clause which requires that the developing country importer purchase particular intermediate inputs, capital equipment, and technical and managerial services specifically from the technology supplier; in Radhu's sample, 44 percent of the Pakistani transfer agreements had such a clause (13). If the supplier is not a competitive seller, then the consequence of tied-purchase is the overpricing of these inputs and an increase in the average production cost for the developing country importer. This cost increase is simply measured as the sum of the products of the unit quantity requirement of each tied-purchase input and its respective price differential from the world market price. Note that this is a conservative measure of overpricing as the market price usually includes a valuation for the embodied technology in the intermediate input, a valuation which, presumably, is already included in the royalty payment.[11]

Finally, export restrictions constitute the fifth category of contractual costs. As previously noted, these restrictions are intended to preserve the technology supplier's competitive position in its domestic market. In Radhu's sample of Pakistan's transfer agreements, 32 percent of the agreements prohibit exports, 4 percent prohibit exports to specific countries, and 8 percent require that the technology supplier approve all export decisions (13). For the developing country, the cost of such restrictions is the amount of foregone foreign exchange earnings which are possible if exports are permissible. Ostensibly,

[11]The UNCTAD Secretariat regards this point as a separate contractual cost, see [16].

an argument in favour of the adoption of recent technology is that it provides the developing country with a competitive position in the international market, yet, if export restrictions exist, then the gain in export potential is clearly not realizable.

The policy implications that follow from the disaggregation of the contractual cost are three. First, it is apparent that the technology supplier strives for the dual objectives of profit and the control of technology use, and that these objectives are sought through multiple instruments: the former through royalty payments, profit repatriation, and overpricing; the latter through the provision of technical and managerial services, equity participation, and export restrictions. Second, associated with each instrument is a contractual cost which lowers the gain to the developing country from technology transfer, either directly through an increase in the unit production cost or indirectly through an implicit social cost. And third, as the combined impact of these costs is to lower the capability of transferable technology to promote: (1) exports due to the increase in production cost and (2) import substitution due to a substantial use of imported intermediate inputs, the developmental importance of technology transfer is reduced by the extent of the costs. We conclude this part of the section by noting the existing cost estimates for Pakistan.

No aggregate estimate of all five categories of the contractual cost is available for Pakistan; however, rough estimates do exist for three of the categories. For the first two categories, the UNCTAD Secretariat has placed the average payment at a $ 102 million annually in 1965-1970; this figure is based on Mahbub ul Haq's conservative estimate of the annual payment for technical and managerial services at a $100 million [5], and Shahid Chaudhry's estimate of the average annual royalty payment at $ 2 million in 1964-1968 [4]. For the remaining three categories, the only partial estimate is Chaudhry's calculation of the average annual profit repatriation at $17 million in 1964-1968 [4]. In other countries, estimates of overpricing exist and these indicate that the cost is sizeable: input overpricing typically varies between 30 and 500 percent [20]; no estimates of the cost of export restrictions exist. Returning to Pakistan, the payment rate for the first three categories amounts to 20 percent of annual export receipts; however, as this does not include the cost of overpricing and export restrictions, it is evident that the aggregate payment rate of the contractual cost is considerably higher.

C. The Efficiency Cost

For simplicity, we have assumed up to now that technology transfer involves a substitution between optimal production choices so that the unit cost reduction associated with any transfer is always maximized. Thus, in Figure 2, optimal production choices (represented by the tangencies of the factor price lines, AB and CD, with the respective isoquants, LDC and DC) were selected to measure the maximum unit cost reduction (AC or DB). In actuality, however, a developing country may not be in a position to select its optimal production choice when transferring technology. Frequently, this occurs when the transfer is packaged with machinery and scarce, skilled labour inputs in a production mix appropriate for factor proportions in the developed country but not for those in the developing country [14]. When this is the case, the potential unit cost reduction from technology transfer is not realized and, therefore, a second type of transfer cost—an efficiency cost—exists which must be considered in addition to the contractual cost.

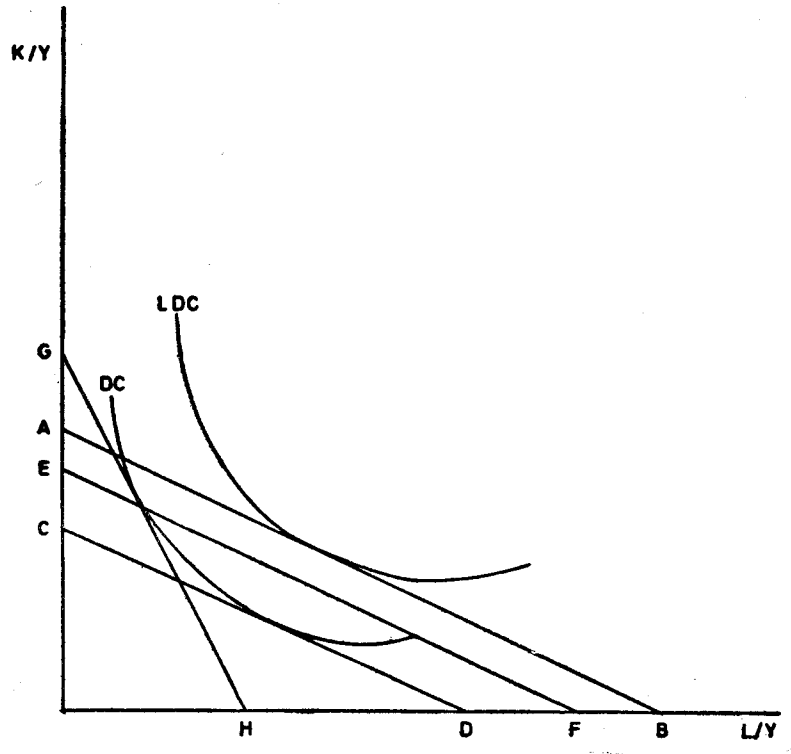

Fig. 5
The Efficiency Cost

If the efficiency cost is defined simply as the difference between the actual and the potential unit cost reductions available from technology transfer, then its conceptualization for the earlier one commodity, two factor, constant returns to production case is straightforward. Again, assume that relative factor prices are constant in the developing country, but are different from those in the developed country and that the difference reflects the relative abundance of labour in the developing country. Then, as before, the optimal production choices for the developing country are represented in Figure 5 by the tangencies of its price lines, AB and CD, with the pre-and post-transfer isoquants, LDC and DC, and the potential unit cost reduction is AC or DB. However, the optimal production choice for the developed country is different, being represented by the tangency of its factor price line, GH, with its production isoquant, DC, so that a packaged transfer of this production mix yields an opportunity loss equal to EC (or DF) measured in units of capital (or labour).[12] It is apparent that the effect of the efficiency cost is to lower the overall gain from technology transfer to a net amount equal to AE (or FB), and that the latter can be negative if the technology gap is small and the factor price differential is wide.

[12]For an alternate representation in the induced invention analysis, see [1].

Two less apparent implications of the efficiency cost are noteworthy. First, as the packaged, transferable technology has a high capital intensity relative to the existing technology in the developing country, the capital-labour ratio and, possibly, the capital-output ratio rise with its transfer. (Both are shown to increase in Figure 5, but the latter need not necessarily.) The consequence of their rise is that less employent and, possibly, output, can be generated from a given amount of investment. Clearly, therefore, those shifts are undesirable: not only because capital is scarce in the developing country and should be economized, but also because labour is abundant and should be employed.

The second implication of the efficiency cost is the possibility of an adverse shift in relative factor prices. Due to the high capital intensity of the packaged, transferable technology, labour productivity is also necessarily high. Consequently, at the given initial prices, there exists a divergence between relative factor productivities and prices; (this is shown in Figure 5 by the nontangency of the price line, EF, with the production isoquant, DC). There will therefore be economic pressure—perhaps, through such institutions as trade unions—to raise wages. Clearly, any pressure of this type is undesirable in a capital scarce, labour abundant economy.

Finally, the efficiency cost has a broader implication for technological dependence. Frances Stewart maintains that, as technology transfer is too expensive for developing countries to sustain on a large scale, the above inefficiencies will accentuate imbalances. Specifically, these imbalances tend to be principally between the modern and traditional sectors due to the orientation of advanced technology to modern sector production activities. Hence, inefficient technology transfer is responsible for the economic dualism characteristic of developing countries [14]. Since dualistic development is undesirable, the policy recommendation of efficient technology transfer is immediate.

Measures to implement the above recommendation centre on the notion of technology adaptation. If technology transfer is an imitative process which does not necessarily respond to economic conditions in the developing country, then it is important to incorporate in the process a facility to adapt the technology to such conditions.[13] The objective of adaptation therefore is to establish an endogeneous link between technology transfer and the developing country's economy. Given the labour abundant character of the economy, successful adaptive measures involve the unpackaging of the developed country's production mix to allow for the use of: a limited quantity of intensively operated advanced machinery in principal production activities, nonrecent machinery

[13]On the above, Harry Johnson maintains: "This complaint overlooks the two considerations of the cost of developing new technologies, and the need for an appropriate payoff. If it is presumably cheaper to transplant an already known technology to a different environment to which it is not entirely appropriate, paying some extra cost in terms of inferior efficiency, than to develop a new technology more appropriate to that environment; otherwise firms would not engage in the practice, and there would be no direct foreign investment" [7, p. 41]. However, it is not as much a question of payoff—we have already noted that the technology supplier is in a position to demand and get a payoff—as it is a question of a lack of private (in contrast to social) incentive to improve efficiency. If the developing country were to insist on an appropriate technology, then the technology supplier would respond and there would continue to be technology transfer. The resulting payoff to the supplier would not be negative as the technology adaptation cost is part of the transmittal cost incurred by the developing country (note that the cost is incurred anyway through the inefficiency cost).

in secondary activities, and simple labour-intensive methods in peripheral activities, such as transport and packing [14]. The effect of successful adaptation is a decline in the capital-labour and capital-output ratios of transferable technology, which promotes capital productivity, employment, and efficient resource allocation.

IV. Conclusion

The above examination of the transfer cost issue suggests the need for a rethinking of the current policy underlying the transfer of technology in three directions. First, there is a need for a realistic understanding of the function of technology transfer. The existing premise that transfer is a method of bridging the technology gap is simplistic: while it is in some instances, in other instances it only narrows and not fully bridges the gap. In either instances, transferable technology does not necessarily promote exports or import substitution so that the developmental importance of bridging the technology gap is debatable. A rethinking of the developmental function of technology transfer is needed therefore.

Returning to basics, we earlier noted that the functional importance of technology is in the type of constraint it imposes on production. The developmental function of technology transfer is then to alleviate the constraint in a manner which achieves desired developmental goals. Different types of transfer further different goals: the transfer of a labour-using technology furthers employment and income redistribution towards the poor, the transfer of a capital-using technology does not [14]. Recognizing this, policy should stress the transfer of a particular type of technology and not simply the bridging of the technolgy gap. With an identification of the desired technology type, the measures needed to transfer it (such as the promotion of particular products and production processes) are readily identifiable.

Second, there is a need for a recognition and accurate estimate of the cost of technology transfer. The existing premise that the magnitude of the cost is slight is unsubstantiated; in fact, much evidence indicates that the cost is high [19]. A proper recognition of the cost focuses attention on the relationship between technology transfer and technological dependence: dependence on external technology is costly; but, if the cost is reducible so that the net gain from transfer is positive than dependence need not be adverse. An accurate estimate of the cost is necessary to suggest the components (such as transfer pricing) which are potentially reducible. Suitable measures are needed to realize the cost reduction.

Finally, there is need for a consideration of alternatives to technology transfer. The existing premise that alternative forms of technological progress are unnecessary is unacceptable in view of the high cost of transfer. Perhaps one necessary form is the development of an indigenous technology based on the selective adaptation of transferable technology. The development of indigenous technology is particularly attractive for certain sectors such as agriculture for which simple transfer is specially costly. For agriculture, the development of an indigenous village level food processing technology is one alternative, there are others; for all sectors, alternatives exist and these should be explored.

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