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TRANSFER OF TECHNOLOGY TO DEVELOPING NATIONS: TOWARDS A BROAD CONCEPTUAL FRAMEWORK

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ABSTRACT

This paper is presented in four parts. In the introductory part, the importance of 'technology gap' as one of the main explicators for the differences in the economic conditions of the DC's and LDC's is identified. In part II, two streams of international economic theories dealing -- directly or indirectly -- with technology transfer are examined. Their inadequacies to explain observed phenomena, among many LDC's are identified. In part III, a few "strategic" and "structural" variables are identified to explain the observed phenomena. Based on these, 12 propositions are hypothesised which may, on further testing, provide a better explanatory and probably predictive base for the technology acquisition behaviour of LDC's. In the last part, an attempt is made to relate the strategic and structural variables and the 12 propositions into a conceptual schema. Policy implications are also briefly explored.

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TRANSFER OF TECHNOLOGY TO DEVELOPING NATIONS: TOWARDS A BROAD CONCEPTUAL FRAMEWORK

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A much-lamented technology-gap, between industrially developed countries (DC's) and the less developed ones (LDC's) is now an agreed explicator of the difference in standards of material well being of the two sets of nations and their nationals. Much development effort has therefore focussed on closing this gap. Some have even considered developing all technology indigeneously. But the process is too slow and the progress inadequate. The politician-policymaker in some of the LDC's is in a hurry to catch up. For him, acquiring the latest technology is more than just a national economic imperative. It symbolises power and the ability to do things big - an emotive appeal. This hurry might mean that technology must be imported i.e., transferred from developed nations. But the technology-transferrer, usually, has a more business-like interest. So does the financier, who is often, either an aid giving DC or DC influenced international developmental agency.

From LDC's point of view, many of them have oriented themselves to a development strategy based more on technology transfer and less on technology development. There are however questions such as what technology to obtain, when to seek, and from where to get. Different nations have had different answers to these. Their history over the last couple of decades provide some clues to these answers, which will be explored in this paper.

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There are also political motives both for the seeker and giver of the technology which means that technology-transfer cannot be equated to "acquisition" in a literal sense. It involves a play of opposing and/or divergent forces, generated by a variety of "needs" and exercised through diverse and multiple channels.

Some of these forces and factors find expression in theories of trade. These theories, however, have been quick to explain technology-transfer. Most of these also focussed on either some specific aspect of commodity-demand or of its supply. They stressed the technology-trade linkage to the complete exclusion of autonomous technology-demands, whereas the great variety in patterns of technology acquisition by LDC's points to the latter factor being extremely dominant. We have, therefore, proposed a framework here which takes this factor explicitly into account. The rest of the paper develops this framework. In the next section, some trade theories as applied to technology transfer are briefly surveyed, which is followed by a discussion of our framework in the light of recent technology transfer data from 13 LDC's. The final section summarises our major propositions about why different LDC's acquire technologies for different products, or acquire them in different chronological order.

II

Do We Need Another Theory?

Transfer of technology has largely been treated as a by-product of the economic theory of trade, viz., the theory of comparative advantage[1]. This theory postulates that nations specialise in

commodities whose production uses relatively more of the more abund factor of production (labour/capital) in the land. Labour surplus economies, accordingly, would produce and export labour-intensive products. Consequently, such economies would shun acquiring capital-intensive technologies. However, this two-factor naivete got a jolt from the finding of Leontieff that exports from US, a capital-rich country, were dominated by labour intensive products.[2] Ever since, economists have been working to question assumptions and to augment this theory.[3] One current explanation views human capital or special skills as an additional factor. US is predictably rich in this factor too and therefore Leontieff's above paradox is "explained".[4] Or is it? How are we to explain the emergence of skill advantage itself? Is it a dynamic transformation of capital-abundance, or do some sociological and/or imperialistic (unequal exchange) arguments provide the answer? The neo-Heckscher-Ohlin theory remains silent on this issue.

Drawing implications for technology transfer from the classical and neo-classical theories raises further doubts. Technology is still treated as a free good, there are no informational costs, and no barriers to trade other than tariff walls. The country as a whole is presumed to exhibit some kind of optimising behaviour. In operational terms, every trading country is supposed to maximise "simultaneously" some long run consumption, based on an aggregate production function, and thus to derive its "choices" of technologies. For a free trade economy, these "choices" are made worthwhile for

entrepreneurs through suitable fiscal means. Else, central decision-makers exercise the "choices" acting as the "international technological gate keepers".[5] Such unrealism may justify a vision, it certainly helps no theory.

There are at least two problems here. First, nations or entrepreneurs do not all have a uniform goal-structure and decision process, still less are they likely to maximise a simple criterion that the neoclassical economic paradigm builds on. We shall further explore this point later in the paper. The other drawback in using neoclassical theory for technology-transfer issues is the obvious neglect of barriers between national markets, market sizes and price elasticities of demand, and the actual mechanics of learning and progressive economies in a new production establishment. It is this latter set of issues, especially demand, that the product life cycle theory sought to incorporate in a new approach to international trade.

The product life cycle[6] theory views developed countries as the only innovator of new products and technologies. These countries, particularly US, have large markets with a sufficiently large segment of high income buyers who have a low price elasticity of demand for new products. Hence, despite the fact that innovations have a high initial price, they find a ready market. In addition proximity to such a market ensures (a) that needs of consumers in this market are easily perceived by innovators, (b) risk capital is easily available, and (c) market reaction to an innovation is quickly fed back to the innovation process. Besides, innovators need not initially commit

new plant and equipment because an industrially developed economy provides access to specialised skills in a ready market.

Further, the PLC theory postulates stages in the life of a product. The early stage is marked by low price elasticity for aggregate and firm demand, short production runs and changing techniques with low capital intensity but high skills, and a very small number of firms. However, opportunities cause competition, more firms enter, technology begins to settle after market reaction so that mass-production is possible. This also means that some producers have to cater to segments which are more price sensitive. Competition on price therefore emerges in the growth stage. In the mature i.e., final stage, the process of competition continues but differentiation through marketing may emerge, production tends to get automated, and mergers and marketing failures tend to reduce the number of firms.

For technology transfer to LDC's, the PLC implies a perpetual technological gap. As an LDC's demand for a product picks up, MNC's would attempt to maintain their world share by 'foreign direct investment' (FDI) in that country. Alternatively, technological collaboration with a local may emerge. The time-lag of transfer will depend on:

a) Economies of scale

b) Tariff and Transportation cost

c) Size of local market (demand structure), and

d) Extent of skill needed in the production.

Therefore, technologies for products with very high economies of scale may never reach LDC's, except where regional (multi-country) markets can be more cheaply serviced from a regional location, in which case just one of the countries in the region gets the technology. Besides, high tariff walls around a reasonable sized economy may make it worthwhile to reap the benefits of protection through FDI. Finally, towards the more mature part of a product's life, the technology may become so standardised that only unskilled labour is required. Then, it may even be economical to produce in an LDC and export to the developed countries.

Technology transfer in this theory too is <u>derived</u> from trade implications, as our last paragraph must show. However, the emphasis is on demand aspects, unlike the supply-emphasis of the neoclassical theory. The technology of production, instead of being a free good, is here a very scarce commodity internal to a few firms in developed nations. But the theory admits of only one kind of technology for a commodity at a particular stage. Hence, choice of capital intensity for a recipient does not exist. Acquiring dated technology, factor-appropriate technology, unbundling etc., do not fit into this <u>linear</u> theory. Which leads to the single most damning feature - it does not recognise that <u>LDC's may themselves have different strategies of development (right or wrong) and consequent policies for technology acquisition</u>. In PLC theory, MNC is the solitary engine of technology transfer. This is consistent with a perfectly free trade world, but not with fervent nationalism, active state direction, and conscious choice of even

costlier import substitution as followed by many LDC's. It also ignores the technology adaptation processes and differences in the capabilities of different LDC's.

Indeed, the assumption, here and in the neoclassical paradigm, that technology transfer springs from trade may count for only a small subset of transfer to LDC's. There is ample evidence that over the last thirty years, many LDC's have acquired technologies which neither theory would predict.[7] Yet, there are also transfers which factor proportions (including raw material -- mostly minerals -- availability) or market size would support. The next section, therefore, reassembles these and other factors behind technology transfer and, with the help of some actual data, attempts to show their impact on technology transfer to LDC's.

III

Towards A Broader Framework

Technology and Economies of Scale

In our context of transfer of manufacturing technology, it is necessary to define technology narrowly. We include in technology (a) the techniques, processes, or formulations for the manufacture of a product, (b) the physical plant or machinery, and (c) the patent for manufacture. This definition does not follow the ones adopted in the existing literature, but is chosen to facilitate explanation of actually observed behaviour among many nations and their firms. This will be clear as we further develop our argument. The emphasis in the definition is more on 'transfer' than on 'technology' per se.

for example, getting a patent may not add to knowledge, still it may the most crucial transfer. This is true for export of a patented arti or a patented process, and sometimes for its domestic marketing for brand based selling. On the other hand, the crucial transfer in steel or petrochemicals manufacturing could be the plant itself. Whereas tractors or rail-coaches could be manufactured from transfer of techniques -- design knowhow, drawings, and process charts -- given general purpose machine tools and a supply of machinery and other general skills. Thus, our three-way classification of technology has a direct bearing on the case or otherwise of transfer.

Economies of scale refers to reduction in unit costs of production through higher capacity plants. As we mentioned, this partly determines transfer in PLC. However, PLC takes a very narrow view of foreign investment decision criteria of MNC's. The evidence indicates that profitability - least cost - is not the only criterion in this process.[8] Nor is there much sanctity in the estimates of economies that decision-makers are deemed to act upon. So, the causal logic of PLC does not appear to be fully valid.

However, it is useful to approach the issue from the angle of the LDC entrepreneur or government. Let us distinguish between cases where plants are to be transferred and those where techniques or processes suffice. In the former case, the choice is between plants of, say, two types operating in two countries. The question is -- do we import a plant of the type operating in country A or in country B? In some cases more than one firm in a country may operate plants of different

sizes. If there are very large scale differences, say, steel plants of 50,000 and 1 million MT, the economies are clear. But with narrower differences, which are more common, it is difficult to reliably compare. The choice-set is, further, constrainted by availability of tied credit, payment terms, export conditions etc. Besides, the evaluating ability in LDC's is frequently not upto the task. Hence, plants are usually transferred as 'operational' and as 'available'. The typical MNC from a transferring country is most likely to transfer technology which is already under use in its country for quite some time and has proved economical in its context, without any adaptation. Hence, we may propose:

Proposition 1

In transfers involving plants, choice between plants on the basis of appropriate scale economies is rarely followed.

In the case of technologies where techniques only need be transferred, viz., most engineering goods, scale-economies become somewhat more a matter of choice. It, therefore, affects transfer. For example, later stages of engineering (assembly, painting, packing, etc.) are of lower scale-economy and reach most LDC's earlier. We can, therefore, surmise:

Proposition 2

When transfers of techniques occur, it is mostly the transfer of later stages of production having lower scale economies.

Factor Proportions and Wage Rate

Most LDC's have a surplus of labour and are short of capital. Wage rate compared to developed countries is very low. Some have abundant natural/mineral resources of specific types. This conventional logic leads us to the following propositions:

Proposition 3

The technologies needed for further processing of the indigeneous natural resources or minerals (for forward integration) will be high in the priority of the LDC governments.

Proposition 4

Technologies for labour intensive production will be high in the priority of most of the LDC's.

Also, there is recent evidence[9] that MNC's shift the more labour intensive parts of their vertical integration chain of manufacture or service to LDC's with extremely low wage rates. Hence, it can be said that:

Proposition 5

LDC's acquire technologies for the more labour-intensive segments of MNC operations, when they are prepared to function as links in an international production network.

The difference between propositions 2 and 5 is that the latter depends on large inter-country wage differences while the former is a matter of suitable match between technological scale economies and market size . The latter is a recent phenomenon in which the final product may not be directed to LDC's at all.

Market Size, Regional Integration and Strategic Location

Size of a market depends on population, income, and its distribution. A high income, distributed inequitably, would provide a market for new and luxury goods, as PLC theory indicates. LDC's having small markets are therefore unprofitable to MNC's. Yet, regional trade agreements (LAFTA, Andean Pact etc.) may overcome the market limitation. Besides, some countries may find their location itself to be of strategic political importance. So, an industrially developed superpower may transfer sophisticated technologies through MNC's, despite small market size. The "donor" state may also arrange for cheaper funds for it to be worthwhile to the MNC. Taiwan is an example. In summary, we may propose:

Proposition 6

Market size determines transfer through MNC.

Proposition 7

Regional integration allows small-sized nations to obtain technologies with high scale economy, and

Proposition 8

Strategic location may lead to acquiring, or increasing the bargaining power for, sophisticated technology.

Thus, in eight propositions, we have linked technology transfer to LDC with scale economies, factor and natural resource endowment, wage rate, market size, regional integration and strategic location. These factors, however, constitute only the structure of given differences between LDC's. There is another factor, strategy, which in many cases is the prime mover. It gives direction to progress, and prevents the nation from moving along the path of least resistance, that of established "comparative advantage".

National Strategy

Most development literature identified two strategic typologies - inward looking and outward looking. Outward looking strategy emphasises openness in trade and factor movements. It is exhibited in export promotion. While the opposite type, inward looking, restricts trade and develops import-substituting industry.[10] This two-way classification, however, does not explain much of what happens in LDC's. Nowhere is import substitution a blanket policy for all goods. Nor is export promotion emphasised in all sectors. Besides, there is evidence of LDC's having tight import controls and yet making considerable export e.g., Nigeria or Venezuela.

Therefore, looking at strategy from a rational decision perspective may be misleading. Instead, particularly for the technology-transfer issue, we prefer to look at apparent strategic action.
We do not believe that national decisionmakers in LDC's have any unidimensional exclusive inward or outward looking strategies. Policies to restrict import may, for example, be a response to balance

of payments pressure. In most cases, policies towards imports may be only loosely connected with those towards exports. The expectations of aid, of personal or group gains from specific actions, a disregard of the spectre of devaluation etc., may all loosen this connection. As a result, there is greater meaning in treating import restrictiveness and export orientation, as independent policy variables. The first construct refers to how much the nation restricts imports as a matter of policy. The other refers to how much the leadership emphasises exports.

In addition to these two, we identify another independent force, a deeper commitment, more long-term and probably related to the common "life-worlds" of the people and their leaders. This we call the self-reliance orientation. By self-reliance orientation we refer to the aspiration in an LDC to become independent of foreign sources in the further growth of the economy. This independence is usually seen in terms of having an industrial structure capable of producing sufficient consumption goods, intermediates, and investment goods, often in that order. This "order" implies that the country would first have only a minimum necessary consumption goods capacity, then the capacity for intermediates necessary for these consumption goods, and then the investment goods. This strategy may be termed backward integration as opposed to diversification of the consumer goods industry. Usually, the former implies higher capital intensity and lower growth of employment. Besides, the relevant technologies involve high volume production.

The three orientations together constitute elements of strategy, perceived from actions, and relevant to technology-transfer.

Measuring Strategic Orientation

To operationalise these three constructs, we studied 13 LDC's through "country-studies" which recount their developmental patterns and policies in recent history. The first two orientations -- import restrictiveness and export orientation -- were partly evaluated through data on exports and imports as percentage of GNP, and partly through a reading of the actual import and export actions. This latter view is impressionistic, but is also meaningful because policies have wavered and what we want to construct is the overall emphasis. The hard data is shown in Exhibit 1, for a particular year 1973. Here, a very high export percentage will obviously imply a HI (High) export orientation, as in Singapore and Malaysia. On the other hand, LO (Low) export orientation is exhibited in India and Paraguay. The remainder would be moderate (M) on this dimension. This matches with impressions from country studies, except in case of S.Korea, where the export orientation has been all-pervasive in the policies and action of the government hierarchy. Also, export incentives were liberal, though, in mid-sixties, indirect incentives (exchange rate, credit preference etc.) replaced direct ones.[11] In view of this, we classify S.Korea as HI on export orientation. We have similarly treated Panama as having moderate (and not LO) orientation based on evidence that its growth has largely been export-dependent.[12]

Regarding import restrictiveness, we have classified a country as LO if imports ratio greatly exceeds exports ratio, i.e., in Singapore, Panama and S.Korea, and HI if the opposite is true, i.e., in Venezuela and Nigeria. However, in case of Malaysia, other rules and actions indicate a LO (and not M) restrictiveness.[13]

Finally, our classification along the self-reliance orientation is judgemental. What we have looked for in the various country studies[14] to arrive at our judgment is the sub-section on "development planning". Within such a sub-section, if we notice an emphasis on meeting "most requirements through domestic production," and explicit negative attitude towards imported goods, we classify the nation as HI on the scale. On the other hand, if we find no talk of development planning or find an appreciation of trade only, we classify it as LO. The remainder we categorised as moderate (M).

Strategy and Technology Transfer

We have ranked, in Exhibit 1, 13 LDC's on the three dimensions of strategic orientation. The significance of this ranking can be seen if it is related to the data in Exhibit 2, which gives a chronological record of technology transfer to these nations. The dates show when the technologies became operational in the receiving country. The list excludes processed primary products of local origin (vegetable oils, plywood etc.) and traditional labour intensive products (textiles, footwear etc.). Plastic and wooden items, glassware, pottery etc., are also excluded. In these cases, the kind of manufacturing technology involved has been widely disseminated. They

have very low scale economies too. Therefore, their relevance to technology transfer is minimal.

The classification of goods that we have considered is five-fold:

* Consumption diversifying goods (cars, TV, etc.)
* General transport (motor-coach, railway wagon etc.)
* Agri-linked chemicals (superphosphate, insecticides, power-tillers, etc.)
* Infrastructual goods (steel, cranes, bulldozers, etc.)
* Industries with high scale economies (manmade fibre, bulk drugs etc.

Some Illustrative Explanations

Now, to analyse the effect of strategy, let us make a few two-way comparisons.

Venezuela and Malaysia, are both of comparable size and natural endowments (petroleum in Venezuela vs. rubber in Malaysia). But Malaysia is HI on export orientation with LO on the rest. Venezuela is HI on import restrictiveness and on self-reliance orientation. Correspondingly, Malaysia has given priority to consumption diversifying and general transport goods. However, Venezuela opted first for import substitution of aluminium and steel.

We can also look at the record of S.Korea with HI export orientation and LO import restrictiveness. Hence, the consumption diversifying, agri-linked and high scale economy goods for export (manmade fibre, electronic goods) took priority. On the other hand, Algeria, with HI self-reliance orientation opted first for steel, and rail-coach

making, then for agri-linked goods and other infrastructural equipment.

A similar comparison can be done between Cuba and another small country, Panama. Being HI on self-reliance, Cuba has acquired infrastructural technologies - railway wagons, cranes, bulldozers. None of these was chosen by other smaller nations, not even by relatively larger LDC's like S.Korea or Malaysia or Thailand.

The examples of Ghana and Nigeria show the "inherent wastefulness" of being just import restrictive. Ghana and Nigeria are both exporters of cocoa. In addition, Ghana exports gold while Nigeria exports oil. Nigeria is freer in trade, Ghana somewhat more oriented to self-sufficiency and somewhat less to export. The consequences on technology transfer are then clear. Ghana developed its aluminium industry early to use the local ore. It also acquired technologies for manufacture of telephones and assembly of lorries. Only later did it go for assembly of cars. Nigeria, on the other hand, got the labour-intensive TV receiver and tyres and tubes technologies to start with. Even paper manufacture started later and sewing machines only recently. Its oil, now exported in crude form, has yet to be a source for any valuable processing,much less of further uses of petroleum. Thus, while it has a low self-sufficiency orientation, its export orientation is also not strong enough to integrate forward.

Nigeria, with such a policy, has acquired much the same mix of industries as Ghana, a much smaller country. However, Ghana and Indonesia, both having similar moderate stances, have acquired similar sets — consumption diversifying and general transport. However, the

largeness of Indonesia has allowed it to be more diversified. Besides, a comparison with S.Korea shows that the Indonesian consumption goods industry is considerably more diversified, while S.Korea has acquired selected technologies. That is, lack of a sharp strategy may be reflected in a muchmore diversified consumption goods industry, to an exclusion of other sections than a sharp export oriented strategy.

Cuba acquired wagon, motor-coach, crane, and bulldozer technologies to the exclusion of others. It already had a prosperous sugarcane industry but instead of diversifying, it integrated backwards. The fact that it could not go further, say, to integrated steel production, is however due to its evident smallness.[15] (Note that the above acquired technologies are of the type that need transfer of technique and have fairly low economies). In case of India, this strategy is superposed on the autonomous influence of a large market. Integrated steel, petrochemicals and bulk drug technologies reflect this strategic influence. The diversification in consumption industries (not shown in Appendix II) may however be attributed to the market size itself. The lack of such a strategy, as we see in Paraguay, has resulted in a structure with none of the above technologies.

In Thailand, industry has diversified into car (assembly) and motorcycles. However, possible backward integration to manufacture superphosphates and pesticides for Thai agriculture has clearly not occured. Thus, we find clear support that a high self-reliance oriented strategy in an LDC tends to encourage earlier transfer of backward integrated technologies.

The general consequence of import restrictiveness is to "distort" the prices in the economy. Simultaneously, however, it gives a boost to local non-comparative advantage industry. Thus, the transfer of manmade fibre technology to India, Algeria, and Indonesia in the private sector are the result of this restrictive orientation. In fact, this particular orientation is directly related to protection of local industry measured by the "effective rate of protection" in market oriented LDC's. It is worth mentioning that regional integration, which we mentioned earlier, as a factor in technology transfer can result in an orientation which is restrictive to the world but free to the union. For example, the LAFTA nations (including Venezuela and Paraguay) may be moving towards more comparative advantage technologies. Thus, while Paraguay continues with its consumption goods based on livestock and timber, Venezuela has expanded vertically into steel and petroleum based chemicals as well as diversified into refrigerators and batteries.

Thus, a low import restrictiveness strategy in an LDC encourages transfer of technology for goods in whose manufacture the country has a higher comparative advantage. A restrictive orientation encourages transfer of technologies in non-comparative advantage goods. This may lead to diversification of the consumption goods sector if there is low self-sufficiency orientation, and to backward integration otherwise.

Export orientation appears strong in Singapore, Panama, and S.Korea, but weak in India. Cuba, though less open, still has a fairly strong export orientation. This strategy builds usually on labour intensive manufacture or on the existence of mineral wealth or natural resources. Cuban sugar is an example of the latter.

A combination of export orientation and reasonable free trade orientation comes closest to the PLC-predicted post-mature transfer of manufacturing facilities from LDC to developing countries. This, for example, has caused S.Korea to obtain sophisticated technologies for semi-conductors and integrated circuits, almost all the output being exported.

It may appear that a high export oriented strategy in an LDC encourages transfer of technologies for forward integration on minerals. When combined with free trade orientation, the LDC tends to receive (through FDI by MNC's) technologies for high volume production of consumption goods or intermediates.

Venezuela and Algeria are not strictly comparable, Algeria being of recent independence. But both are oil states. Algeria is restrictive in imports and high in self-sufficiency orientation. Consequently, we find in Algeria an early steel plant with high technology, rail-coach, tractor and crane manufacturing, manmade fibre and naptha. Venezuela, on the other hand, started with refrigerators, batteries and petro-chemical complex. That is, while Algeria (through self-sufficiency strategy) attempted to extend the structure backwards, Venezuela diversified and integrated forward in petroleum (based on freer trade and export orientation).

These comparisons yield, as shown in Exhibit 3, the apparent priorities that different strategies led. Based on these analyses,

the following further propositions may be advanced:

Proposition 9

A high export oriented strategy yields transfers of consumption diversifying, general transport, agri-linked, and high scale economy goods, in that order.

Proposition 10

With self-reliance as a dominant strategy, technologies for infrastructural goods, agri-linked, general transport goods, and consumption diversifying goods are obtained, in that order.

Proposition 11

A purely import restrictive nation obtains technologies for general transport, and then for consumption diversifying.

Proposition 12

Lack of a sharp strategy leads to transfers for consumption diversifying goods and then for general infrastructure.

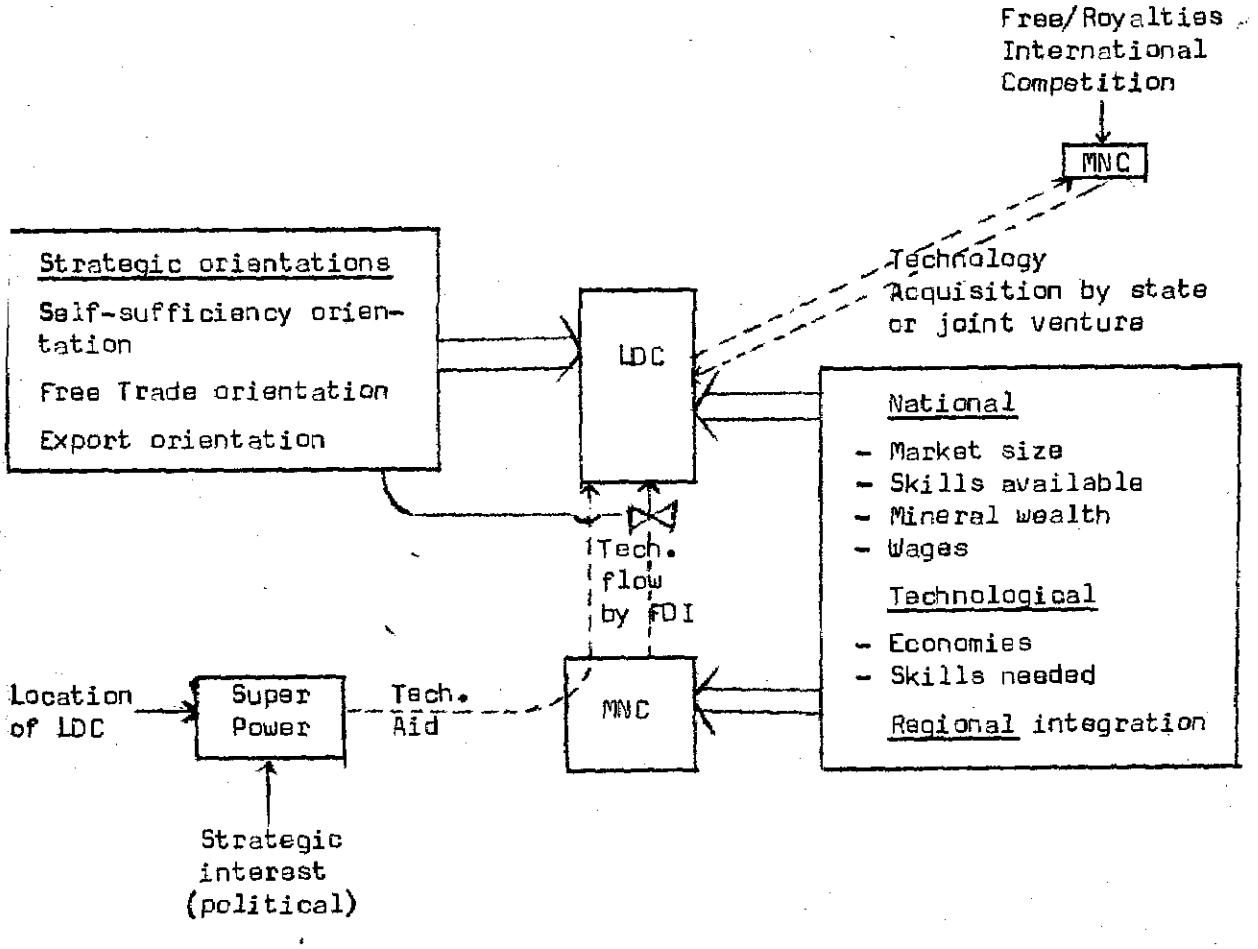
We have attempted to use the strategy-structure conceptual schema as an explanatory model, that is, to explain the technology acquisition behaviour among a selected band of LDC's. Before it can be used as a prescriptive/predictive model, the twelve propositions generated during the discussion need to be empirically tested out over a larger sample and over a longer period of time. More importantly,

the "reasons why" behind these propositions need to be explored and understood with greater clarity. Some of the impressionistic measures also need to be refined before the model can be used with more confidence. This could be the next phase in pursuing research in this area.

Before we conclude, an attempt is made in the next part to relate the strategic and structural variables and the 12 propositions into a conceptual schema. The policy implications will also be briefly explored.

IV

A Conceptual Schema



We have considered a variety of factors and shown that they are all relevant to the technology transfer space. In the above schema, we have summarised the arguments. It shows that technology transfer to an LDC occurs by acquisition, or by FDI by an MNC. The strategic orientations along with the other national and technological data influence an LDC's decision to acquire a technology, or an MNC's decision to transfer technology by FDI. Besides, if an LDC is located strategically for a superpower, it may cause a flow of technology at extremely favourable terms. In fact, this may take the form of outright aid. The manner in which all these variables interact is already described earlier.

Conclusion and Policy Implications

The above schema, it should be clear, is an exercise in understanding what LDC's have been doing and why. Yet the analysis goes no deeper than the surface of the political black-box which throws up our three strategic orientations. It is common with policy-specialists to recommend, for example, that one or more of these strategic orientations be changed. The hitch of course is that since we are ignorant of *how* these orientations are formed, still more of *how* they can be changed, we are only shooting in the dark at a black bear. However, if we keep away from the more crucial, though obviously unclear, elements of the schema, we can pinpoint certain of the more inane possibilities.

For example, if an LDC is strategically located, the tendency for a super-power to force down consumption-diversifying industries can be counteracted. The needs of the superpower can be balanced with the strategic orientation in the LDC so that internal goals are satisfied.

Looking from the viewpoint of an MNC, investment opportunities can be more effectively screened through an explicit consideration of LDC strategies. On the other hand, some LDC's have suffered through an excess of import restrictiveness, leading, in the long run, to severe foreign exchange crises. An MNC which perceives the LDC's need to shift towards an export oriented strategy can accelerate the process by providing its own marketing expertise.

Finally, the long run effects of strongly pursuing any of the strategic orientations can be seen in terms of the industrial structure, foreign dependence, and employment. These can be evaluated within the constraints of national endowments so as to assess the pros and cons of alternative strategies. Where decisionmaking is centralised and the economy can be tightly directed, this analysis of strategy can be used as an input to decisionmaking for realignment of the economy.

The augmented model quite explicitly accounts for differences in the transfer-histories of different developing nations. This is through viewing technology-acquisition as a function of basic structural and technological factors (market size, wage rate, natural resources, regional integration, location and technical economies of scale) combined with three strategic dimensions. It is argued, and demonstrated, that, other things remaining equal, nations high on self-sufficiency orientation will give priority to technologies for backward integration. Those not restrictive on imports will get comparative advantage technologies, while restrictiveness would result in technologies for

the diversification of consumer goods sector. A highly export oriented strategy will usually encourage forward integration based on processing etc., of local mineral resources.

Some tentative attempts have been made to show how the various factors interact. Further operationalising of the factors, and processual study of their individual effects, on the lines of our suggested schema, can be the immediate research needs in this area.

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Exhibit 1

Strategic Orientations in 13 LDC's

Import/GNP (1973)	Export/GNP (1973)	Country	Export* orienta-tion	Import* restrictive-ness	Self-reliance** orientation
.29	.20	Cuba	M	M	
.36	.10	Panama	M**	LO	LO
.11	.13	Paraguay	LO	M	LO
.16	.30	Venezuela	M	HI	HI
.29	.22	Algeria	M	M	HI
.13	.22	Nigeria	M	HI	M
.15	.19	Ghana	M	M	M
.40	.49	Malaysia	HI	LO**	LO
1.18	.84	Singapore	HI	LO	LO
.18	.21	Indonesia	M	M	M
.34	.26	S.Korea	HI	LO	M
.22	.17	Thailand	M	M	LO
.04	.04	India	LO	M	HI

* Derived from import-export ratios as explained in text. Except items marked (**) which take into account descriptions of policies in country-studies.

** Derived purely through impressions from country studies as explained in text.

Source of import-export data: United Nations, Handbook of International Trade and Development Statistics (New York: United Nations, 1976).

Exhibit 2

Recent Technology Transfers to 13 LDC's

	Cuba	Panama	Paraguay	Venezuela	Algeria	Nigeria	Ghana	Malaysia	Singapore	Indonesia	S.Korea	Thailand	India	
Domestic market size: Small (S), Medium (M), Large (L)	S	S	S			L			S	L			L	
Whether predominantly[a] Agricultural or industrial			Agri.	Ind.	Ind.		Agri.		Ind.	Agri.		Agri.	Agri.	
Export orientation		LO	LO					HI	HI		HI		LO	Strategic orientations
Import restrictiveness		LO		HI		HI		LO	LO		LO			
Self reliance orientation	HI	LO	LO	HI	HI		LO	LO				LO	HI	
	The Year When Domestic Production Started													
Consumption Diversifying goods				X	X		72	68		73	X	X	X	
					74					70		72	55	
				71						71	60		52	
	X			67	X	67	68	68		69	66		69	
	75													
	X			71	74					70	X		X	
						75				70	60		X	
General transport	70			69	X		X	70		72	X		X	
				X	X	X	68	68			X	X	X	
	X	X		X	X	67	70	68		X	X	67	X	
				X		68			72	69		X	X	
Agri-linked equipment					73								X	
				70							62		65	
				X	X						61		X	
	X			X	72			X	72			67	X	
				X	X			72				68	X	
	X			X	70			68		X			X	
	X	67			X					70	X	67	X	
Infrastructural goods					69								X	
	70				73								X	
	70				72								X	
	71												69	
				68	69								60	
				67			67						X	
High scale economy industries					69					67	59		55	
		74		70							70		66	
													60	
											68		71	

INDUSTRY

Car (assg.) ...
Motor cycles etc. ...
Refrigerators ...
TV Receivers ...
Batteries ...
Sewing M/c ...
Motor-coach ...
Lorries ...
Tyres and tubes ...
Lube oil ...
Tractors ...
Power Tillers ...
Pumpsets ...
Sulphuric Acid ...
Naphtha ...
Superphosphate ...
Nitrofertiliser ...
Insecticides ...
Rail-coach ...
Railway Wagons ...
Cranes ...
Bulldozers ...
Steel (Integrated) ...
Aluminium
Manmade Fibre ...
Petro-chemicals ...
Bulk drugs
Semi-conductors, IC's, computers ...

SOURCE: United Nations: Yearbook of National Statistics, Commodity Production, Vol.II, 1977, Supplemented by various country-studies.

NOTES: "X" denotes that production began before 1966, Except in cases of India and S.Korea where it indicates that production began before 1955.

(a) "Agri" indicates that GDP from Agriculture is markedly greater than that from Industry (in seventies).

Blanks indicate 'not-too-great' a difference.

Exhibit 3

The Effect of Strategic Orientation on Technology-Priorities in LDC's

Sharp strategic orientation	LDC's exhibiting such strategy	Technologies for consumption diversifying goods	Technologies for Agri-linked chemicals and Equipment	Technologies for general transport goods	Technologies for infrastructural goods	Technologies for high scale economy goods
High Export Orientation	S. Korea Malaysia	1	2	2		3
High self-reliance orientation	Cuba Venezuela	3	2	3	1	
High import restrictiveness	Nigeria	2		1		
Moderate orientation	Ghana Indonesia	1		2		

Note: The numbers indicate the order of acquisition.

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2) W.W. Leontieff "Factor Proportions and US Structure of American Trade: Further Theoretical and Empirical Analysis" Review of Economics and Statistics, November 1956. Also see Takayama, op. cit., p.73.

3) Some assumptions questioned are - homogeneity of factors, exclusion of demand, identical production functions for a cimmodity in all countries, existence of only two factors of production. See Takayama, op. cit., p.74. Also see G.C. Hufbauer, "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods." R. Vernon (ed.)The Technology Factor in International Trade (New York: NBER, 1970).

4) See Frances Stewart "Trade and Technology" in P. Streaten (ed.) Trade Strategies for Development (London: Macmillan, 1973) p.234. Also P.B. Kenen "Nature, Capital and Trade" Journal of Political Economy, October 1965 and J.Bhagwati "The Pure Theory of International Trade" in Surveys of Economic Development, Vol.II, 1965.

5) T.J. Allen et al "The International Technological Gatekeeper", Technology Review, March 1971. While Allen's gatekeeper is a useful concept for innovating firms, its significance at the national level is not at all obvious.

6) L.T. Wells, The Product Life Cycle and International Trade (Boston: Harvard University Press, 1972). There are precursers to this approach. They all emphasise different aspects of national structure to explain trade. Some of these are - Hume Skill, Scale Economy, Stage of Production, Technological Gap etc. See, G.C. Hufbauer, "The Impact of National Characteristics and Technology on the Commodity Composition of Trade in Manufactured Goods", in R.Vernon, op. cit.

7) Brazil's and India's integrated steel plants, Singapore's acquisition of large scale chemical plants, S.Korea's high-technology semi-conductors and integrated circuits provided obvious examples.

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