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Working Paper No. 20 FACTOR PROPORTIONS, LINKAGES AND THE OPEN DEVELOPING ECONOMY

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by James Riedel

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Working Paper No. 20 FACTOR PROPORTIONS, LINKAGES AND THE OPEN DEVELOPING ECONOMY

> by James Riedel

A92358 74 Holter 14

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Kiel Working Papers are preliminary papers written by staff members of the Kiel Institute of World Economics. Responsibility for contents and distribution rests with the author. Critical comments and suggestions for improvement are welcome. Quotations should be cleared with the author. FACTOR PROPORTIONS, LINKAGES AND THE OPEN DEVELOPING ECONOMY^X

The purpose of this paper is to examine the theoretical rationale underlying the growth of "footloose", import-dependent industry observed in many of the most successful developing countries (Hong Kong, Taiwan, S. Korea, for example). A second objective is to develop empirical formulations appropriate for analyzing the resource allocation consequences of a "footloose" industrial structure in a developing country. It is argued that previous applications of input-output techniques to factorintensity measurement have in general ignored the implications of trade in intermediate inputs. The "Leontief test" of the Heckscher-Ohlin trade theory is perhaps the first and certainly the most widely adopted application of input-output techniques to the measurement of the factor intensity of production.¹ The first section of this paper will attempt to demonstrate that the procedure developed by Leontief is not strictly appropriate in an open economy which utilizes imported as well as domestically supplied inputs. An alternative formulation is developed in this paper, which when compared to the "Leontief" formulation yields a measure of the domestic resource cost or saving resulting from the use of imported rather than domestically produced inputs.

In section II, the formulations developed in section I are applied to the Taiwan economy in an effort to demonstrate the resource allocation consequences of an import-dependent, "footloose" industrial structure typical of the island economies in East Asia which dominate the exclusive group of superlative economic development performers. In concluding

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¹ W.W. Leontief, "Domestic Productions and Foreign Trade: The American Capital Position Re-examined", Proceedings of the American Philosophical Society, (1953) and "Factor Proportions and the Structure of American Trade: Further Theoretical and Empirical Analysis", <u>Review of Economics</u> and Statistics, Vol. XXXVIII (November 1956) p. 386-407.

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(section III), the overall importance of linkages in the development process is discussed in light of the results derived in section II. It is argued that the role of linkages as "generators" of economic activity may be less important than the resource allocation consequences in terms of factor proportions or economies of scale.

I. FACTOR INTENSITY MEASUREMENT AND IMPORTED INPUTS

Perhaps the most important contribution of the "Leontief test" aside from its interesting revelations about neo-classical trade theory, was its recognition that the factor intensity of production of any given commodity is determined not only by the factor requirements at the last stage of production, but also by the factor requirements at each intermediate stage. Applying input-output techniques, Leontief measured the total (direct and indirect) labor required to produce one unit of commodity j by

$$L_{j} = \sum_{i} \ell_{i} r_{ij}$$
(1)

where l_i is the direct labor-output ratio at the ith stage of production, and r_{ij} are elements of the inverted Leontief matrix $[I-\bar{A}]^{-1}$.

¹ Standard input output notation is used.

 $[A] = \{a_{ij}\}$

 $a_{ij} = \frac{X_{ij}}{X_j} \quad \text{where } X_{ij} \text{ is the total input of i in production of j,} \\ and X_j \text{ is the total value of production of j.} \\ [I-A]^{-1} = \{r_{ij}\}.$

Note, the element r_{ij} is the total (direct and indirect) output requirement of i per unit final demand of j. $\ell_i r_{ij}$ is thus the total labor required to produce that amount of commodity i used to produce one unit of commodity j for final demand, and $\sum_{i} \ell_i r_{ij}$ is the labor required at each and every stage in the production of commodity j. Similarly,

 $K_{j} = \sum_{i} k_{i} r_{ij}$ (2)

is the total capital required to produce one unit of j for final demand, where k_i is the capital-output ratio at the ith stage of production. If, e_j is the proportionate share of the jth commodity in total exports, and n_j is the proportionate share of jth commodity in total imports, then the Heckscher-Ohlin theory is confirmed by the Leontief test, if

$\sum_{j} \left[\sum_{i=1}^{\Sigma} k_{i} r_{ij} \right] e_{j}$	greater (less) than	$\sum_{j \in k} \sum_{i=1}^{r} r_{ij} n_{j}$
$\sum_{j} \left[\sum_{i}^{\Sigma} \ell_{i} r_{ij} \right]^{e_{j}}$		$\sum_{j} \left[\sum_{i}^{\Sigma} \ell_{i} r_{ij} \right]^{n}_{j}$

in countries relatively well endowed with_capital (labor).

The author is unaware of any application of the Leontief test which deviates from the above procedure. It will be argued, however, that the above procedure is appropriate only in the case in which a country imports strictly for final consumption.¹ Consider a country which imports intermediate goods; in such a case, elements of the $[I-A]^{-1}$ matrix $\{r_{ij}\}$ do not measure the amount of <u>domestic</u> output per unit of final demand. They measure instead the total "output" (or input) required, which may be supplied externally or domestically.²

¹ The main interest of this paper is in deriving an appropriate measure of factor intensity in an economy utilizing imported inputs, not in providing an alternative test of Heckscher-Ohlin <u>per se</u>. Testing Heckscher-Ohlin is, however, one of the possible applications of the factor intensity measure formulated here.

² What is measured is the factor intensity of the goods which go into the production of commodity j. This is in itself interesting, but it does not reveal the factor intensity of the domestic structure of production, if imported inputs are utilized.

Consequently, the sum

$$L = \sum_{i} \ell_{i} r_{ij}$$

and

$$K = \sum_{i}^{k} i^{r} i^{j}$$

do not measure the direct and indirect labor and capital required in the domestic economy to produce a given commodity (j). The domestic output required directly and indirectly per unit final demand is given by

$$[I-D]^{-1} = \{s_{ij}\}$$

where

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$$[D] = \{d_{ij}\}$$

$$d_{ij} = \frac{X_{ij}}{X_{j}} - \frac{M_{ij}}{X_{j}} = a_{ij} - m_{ij}$$

and where M_{ij}/X_j (= m_{ij}) is the per unit_import requirement of i in the production of j. Thus,

$$L_{j}^{*} = \sum_{i} l_{i} s_{ij}$$

and

$$K_{j}^{*} = \sum_{i}^{k} k_{i} s_{ij}$$

and capital

measure the labor/required in the production of commodity j at the last stage of production and in the production of domestically supplied intermediate inputs. Inter-industry transactions in imported inputs are omitted because the demand for imported inputs does not directly affect employment or capital investment in the domestic economy. Nevertheless, imported inputs are not freely available to the economy, much less the domestic producer; they can be acquired (in equilibrium) only through the exchange of domestically produced goods and services, which in turn involve a cost in terms of domestic resources -- capital and labor, to keep everything in neo-classical terms.¹ The total factor cost per unit of production is, therefore, the sum of (1) the labor and capital employed in producing domestic inputs and at the final stage of production, and (2) the labor and capital cost implicit in earning the foreign exchange (exporting) with which to purchase imported inputs required directly and indirectly in the production process.

The labor and capital cost of earning one unit of foreign exchange (in equilibrium) is the labor and capital required to produce one unit of exports, which in turn can be defined as the average labor and capital requirements per unit output in each sector of the economy weighted by the distribution of exports from each sector. The labor and capital required at the last stage of production and in the domestic production of inputs which go into exports is thus

$$L_{f}^{*} = \sum_{j} \left[\sum_{i}^{\Sigma} l_{i} s_{ij} \right] e_{j} = \sum_{j}^{\Sigma} L_{j}^{*} e_{j}$$

and

$$K_{f}^{*} = \sum_{j} \begin{bmatrix} \sum_{i} k_{i} s_{ij} \\ i \end{bmatrix} e_{j} = \sum_{j} K_{j}^{*} e_{j}$$

respectively. Of course the production of exports itself requires

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¹ The analysis throughout abstracts from international capital flows. The assumption is that the balance on goods and services is in equilibrium; imports can be traded only for exports -- an assumption neither uncommon nor extremely restrictive.

imported inputs. If M_i^* , defined as

$$M_{j}^{*} = \Sigma M_{i} s_{ij},$$

is the total (direct and indirect) import requirement per unit output of commodity j, then

$$\mathbf{M}_{\mathbf{f}}^{*} = \sum_{j} \begin{bmatrix} \Sigma \mathbf{M}_{i} \cdot \mathbf{s}_{j} \\ \mathbf{i} & \mathbf{j} \end{bmatrix} \mathbf{e}_{j} = \sum_{j} \mathbf{M}_{j}^{*} \cdot \mathbf{e}_{j}$$

is the direct and indirect import requirement per unit export. Thus to produce one unit of exports we need L_f^* units of labor and K_f^* units of capital at the last stage of production and for domestically produced inputs; and we need $L_f^* M_f^*$ and $K_f^* M_f^*$ of labor and capital, respectively, to produce additional exports to finance the imports which were employed in the original production of one unit of exports. In addition, we recognize that the additional exports (required to finance the imports used in the first round) also require imported inputs. In the first round M_f^* units of imports (foreign exchange = exports) are required; thus in the second round $M_f^* M_f^*$ units of imported inputs are required, which in turn will entail the employment of $L_f^* (M_f^{* 2})$ labor and $K_f^* (M_f^{* 2})$ capital in the production of exports with which to finance these additional imports. The second round of additional exports, likewise, requires imported inputs $(M_f^{* 2} . M_f^*)$ and consequently more exports and hence the employment of still more labor and capital, and so on. The sum of all labor and capital required in the production of one_unit of exports (i.e., foreign exchange) is thus

$$L_{f}^{*} + L_{f}^{*} M_{f}^{*} + L_{f}^{*} M_{f}^{*2} + L_{f}^{*} M_{f}^{*3} + \dots + L_{f}^{*} M_{f}^{*n}$$

and

$$K_{f}^{*} + K_{f}^{*} M_{f}^{*} + K_{f}^{*} M_{f}^{*2} + K_{f}^{*} M_{f}^{*3} + \dots + K_{f}^{*} M_{f}^{*n}$$

respectively. Since $0 \le M_{f}^{*} \le 1$, the above expression reduces to

$$\frac{L_{f}^{*}}{1 - M_{f}^{*}}$$

and

$$\frac{K_{f}^{*}}{1 - M_{f}^{*}}$$

For any given commodity j, therefore, the factor intensity of production as measured by total factor requirement per unit outputs is given by

$$\mathbf{L}_{j}^{*} = \sum_{i}^{\Sigma} \boldsymbol{\ell}_{i} \mathbf{s}_{ij}^{*} + \mathbf{M}_{j}^{*} \begin{bmatrix} \mathbf{L}_{f}^{*} \\ 1 - \mathbf{M}_{f}^{*} \end{bmatrix} = \mathbf{L}_{j}^{*} + \mathbf{M}_{j}^{*} \begin{bmatrix} \mathbf{L}_{f}^{*} \\ 1 - \mathbf{M}_{j}^{*} \end{bmatrix}$$

and

$$K_{j} = \sum_{i} \ell_{i} s_{ij} + M_{j}^{*} \left[\frac{K_{f}}{1 - M_{f}^{*}} \right] = K_{j}^{*} + M_{j}^{*} \left[\frac{K_{f}}{1 - M_{j}^{*}} \right]$$

which expresses the two components of total factor cost in an open economy: (1) employment and capital cost at the last stage of production and producing domestic inputs; and (2) employment and capital cost implicit in earning the foreign exchange (fraction of one unit of foreign exchange) with which to purchase imported inputs required directly and indirectly in the production of commodity j.¹

¹ Note that

$$\sum_{j} L_{j} e_{j} = \frac{L_{f}}{1 - M_{f}} \text{ and}$$

$$\sum_{j} K_{j} e_{j} = \frac{K_{f}}{1 - M_{f}}$$

Recognizing the interrelatedness of the economy, not only explicit but also implicit relationships, points to the fact that the factor intensity of a given production activity is dependent upon the technology in the final stage of production, the technology in each and every sector of the economy from which it is supplied, and in an open economy, upon the technology which underlies the structure of foreign trade. In other words, when an economy, like Taiwan for example, imports steel, machinery, synthetic fibre and other relatively capital intensive intermediate goods with foreign exchange earned by exporting transistor radios, plastic toys, garments and the like, it is implicitly substituting the latter labor-intensive goods for the former capital-intensive goods in the production process. One can easily see that to evaluate the factor intensity of the structure of production on the assumption that all inputs are supplied domestically, can easily produce misleading conclusions in such an economy. It may very well be, for example, that automobile manufacturing is a relatively labor-intensive activity, if the steel for the body, the engine, the headlights and other relatively capital intensive inputs are imported, particularly if they are imported with foreign exchange earned by exporting relatively labor intensive goods.

The orthodox measure of total factor intensity, as developed by Leontief, indicates the factor intensity at the last stage of production and of the goods which go into the production process, only when all of the goods which go into the production process are supplied domestically does the Leontief measure indicate the total factor intensity of the prevailing structure of production. Comparing the Leontief measure of total factor intensity with the one developed above reveals the net factor cost or saving derived from the utilization of imported rather than domestically supplied intermediate goods. For example, $L_j < L'_j$ and $K_j > K'_j$ indicate that the importation of inputs (i.e. the implicit substitution of exports for otherwise domestically supplied inputs) reduces the overall capital requirement in the economy, but entails a greater demand for labor than would be the case if all intermediate inputs were supplied domestically. In a labor-abundant, capital-scarce LDC presumably such a trade-off indicates that the importation of intermediate inputs is in accordance with neo-classical principles of comparative advantage, though of course the resource allocation consequences of any such trade-off can be precisely weighed and evaluated only if one has knowledge of the shadow prices of labor and capital, from which the net resource cost (saving) can be derived.

It should be recognized that the total factor intensity of production in an open economy is highly sensitive to the structure of exports. In such cases where the export pattern is drastically out of line with comparative advantage considerations, the comparison of factor intensities under the existing structure of production with those under a hypothetical structure which assumes all intermediate inputs are supplied domestically will yield little in terms of "explaining" the existing structure, or as a guide for planning and policy. It may be, for example, that relatively capital-intensive intermediate inputs are imported in a given LDC with foreign exchange earned by exporting equally, or even relatively more capital-intensive commodities. In such a case, even though we may find K < K and L > L; the optimal solution would not be the substitution of domestic inputs for imports (though it might be an improvement), but rather a restructuring of exports toward more laborintensive commodities. If the relevant problem is one of deriving an ex ante measure of comparative advantage then certainly a more general concept of "domestic resource cost" than the one discussed above is required.1

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¹ Such as developed by M. Bruno, <u>Interdependence</u>, <u>Resource Use and Structural Change in Israel</u>, (Jerusalem: Bank of Israel, 1963); and elaborated in his recent article "Domestic Resource Costs and Effective Protection: Clarification and Synthesis", <u>Journal of Political Economy</u>, Vol. 80 (Jan/Feb. 1972) p. 16-33.

11. FACTOR INTENSITY IN THE TAIWAN ECONOMY

Among the countries struggling to industrialize none has been more successful than several east Asian island economies (Hong Kong, Singapore, Taiwan, S. Korea); among this exclusive group perhaps Taiwan has witnessed the most remarkable gains. The manufacturing sector in Taiwan has grown at a compound growth rate of 18 percent per annum over the last decade, 1961-1971, providing the engine of growth in real per capita income of 7.0 percent per annum over the same period.¹ The industrialization process of the East Asian island economies exhibits two outstanding characteristics: (1) strong orientation toward exports; (2) heavy reliance on imported inputs. In Taiwan, for example, 30 percent of manufactured output was exported in 1969, while 14 percent of the value of manufactured output was contributed by imported inputs.² Applying the formulations developed above we attempt to demonstrate the rationale of these key features of industrualization in Taiwan in terms of neo-classical, factor-proportions theory.

Table I presents measures of total labor and capital requirements per million NT\$ in each of 52 sectors of the Taiwan economy given the existing structure of production and alternatively assuming all intermediate inputs were domestically supplied. In columns $(_M = _M = _)$ and $(_M = _M = _)$ the difference between factor requirements under the two alternative production structures has been calculated to reveal the capital and labor cost or saving attributable to the importation of intermediate inputs.

where q_j is the proportion of the jth sector in total value of manufacturing output.

^{1 &}lt;u>Taiwan Statistical Data Book</u>, CIECD, ExecutiveYuan, Taipei, Republic of China, 1972.

² According to <u>Input Output Table for Taiwan, 1969</u>, CIECD, Executive Yuan, Taipei, Republic of China. The percent of value contributed by imported inputs is calculated by

 $[\]sum_{j} \left[\sum_{i} M_{i} s_{ij} \right] q_{j}$

Table i

TOTAL LABOR AND CAPITAL REQUIREMENT PER MILLION NT \$ ONTPUT IN THE TAIWAN ECONOMY: 1969/70

Sector		Per Unit Imported Input Requirement	Direct Labor Requirement Per Million NT \$ Output	Direct Capital Requirement Per Million ST \$ Output	я <mark>х</mark> -	1 .	к" -	Total Labor Requirement Per Million	Total Capital Requirement Per Million	fotal Labor Requirement Per Million	Total Capital Requirement Per Million	Utilization of Inputs Fer M Output		Sectoral Sh are of Total Exports	Sectora Share o Total Output
		N _i	٤	k _i (ST \$)	52 ∑.N. s.j i=1 ij	52 E [£] i ^s ij i=1	52 Σki ^s ij i=1	NT \$ Output	NT \$ Output	NT \$ Output	NT \$ Output ^K i (NT \$)	L _j -L _j (man-years)	к _ј -к _ј (NT 5)	• j	٩j
			(man-years)	(NT 3)		(man-years)	(NT \$)	(man-years)	(NT \$)	(man-years)	(31 2)	(man-years)	(01.8)		
Agriculture	1	.0188	56,970	246000	.0895	77.187	513060	80.037	603896	80.813	601590	0.776	-2306	,053	.130
Forestry	2	.0029	50,000	184500	.0197	52.412	249760	53.039	269754	52.867	269570	-0.172	- 184	.006	. 008
Fishing	3	.1245	36.256	585200	. 1920	41,263	766570	47.377	961436	46.018	955390	-1.359	-6046	.043	.017
Mining	4	.0118	22,847	738100	.0589	27.650	904170	29.526	963949	28.149	924120	-1.377	-39829	,004	.016
Sugar	5	,0021	8.550	1298692	.0651	48.652	1757515	50,725	1823587	50.694	1840263	-0.031	16676	.034	.010
Canned Food	6	.0280	7.787	242365	. 1554	46.356	698351	51.305	856071	47.867	854255	-3.438	-1816	.068	.011
Tobacco	7	.0627	3.081	321641	.0839	11,041	446853	13.713	532005	12.438	505772	-1.275	-26233	.002	.014
Alcoholic Beverage ¹	8	.0039	4.000	400000	.0395	12.324	551520	13.582	591609	13.655	591080	0.073	- 529	.001	.010
M.S.G. (Flavoring)	9	.0105	5.939	280677	.0844	18,410	873247	21.098	958907	20.522	959403	-0.576	496	.004	.002
sheat Flour	10	.6964	3.111	533878	.7147	6.970	631021	29,730	1356392	60.212	1015072	30.482	-341320	.000	.006
dible Veg. Oil	11	.6614	2,148	210167	.6805	13,258	339825	34.929	1030485	63.621	707109	28,692	-323376	.000	.003
Non-alcoholic Beverage	12	.0359	5.568	367042	.0982	16.624	802920	19.751	902586	18.874	903496	-0.877	910	.001	.002
Tea	13	.0024	7.508	448014	.0613	61,540	866457	63.492	928672	63.213	924052	-0.279	-4620	.009	.002
fiscellaneous Food	14	.1491	8,123	260209	. 3066	31.226	712513	40.990	1023690	51,356	909457	10,366	-114233	,014	.024
Artificial Fibre	15	. 3367	4.489	1280546	.4128	8.967	1596490	22.113	2015453	16.915	2351993	-5,198	336540	.017	009
Artificial Fabric	16	. 2320	5.764	597855	.4416	13.833	1323599	27.896	1771792	23.098	2209460	-4.798	437668	.088	.021
Cotton Fabrics	17	. 2796	9.095	557415	.4866	19.095	1064935	34, 591	1558800	50,735	1405319	16.144	-153481	.041	.021
ool & Worst Fabric.	18	. 3508	6.156	427474	,4685	11,786	689426	26.706	1164921	46.492	1131493	19.786	-33428	.010	.006
Apparel	19	.0490	16,623	404585	. 2355	29,500	888655	37.000	1127671	42.058	1114892	5.058	-12779	.029	.016
lumber	20	.0084	6.111	371877	.0463	40.412	642105	41,887	689096	41.830	687947	-0.057	- 1149	.014	.ooa
lywood	21	. 5505	5.518	370496	.6074	9.634	525323	28.977	1142292	40.513	753849	11.536	-388443	.044	.008
amboo, Rattan Prod.	22	,0276	15,856	115481	.0923	35.873	407299	38.812	500977	38.804	485407	-0,008	-15570	.014	,006
aper/Pulp	23	. 1309	7.614	520619	.2369	22.475	1047173	30.019	1287610	29.177	1339397	-0.842	51787	.000	,012
Printing/Publications	24	.0469	10.685	422377	.1418	19,518	806455	24.034	950372	23.435	976681	-0.599	26309	.004	.009
eather & Products	25	. 3169	8.689	354884	.4346	15.319	623773	29.159	1064862	41.405	1043152	12.246	-21710	.005	.002
ubber & Products	26	. 3247	8,147	241660	.4020	15,321	519430	28,123	927432	26,852	953379	-1,271	-25947	,012	.005
Chem. Fertilizer	27	,0703	3.390	1241972	. 2437	14,217	2013051	21,978	2260389	20.334	2288390	-1.644	28001	.005	.008
edicines	28	. 1408	8,524	515814	.2036	15.228	804663	21,712	1011302	19,712	1026313	-2.000	15011	,002	.004
Plastic & Products	29	. 1970	3.887	392530	.3353	10,768	788642	21,446	1128948	18,581	1176112	-2,865	47164	.051	.017
Petroleum	30	, 3053	1,781	676605	. 3432	3,451	792559	14.381	1140883	11.948	1112679	-2,433	-28204	.017	.023
Non-edible Veg. Oil	31	. 1259	2,500	200000	,1724	39.462	516043	44.952	691017	47.147	644227	2.195	-46790	.002	.001
tisc. Industrial Chemicals	32	. 1902	3.088	665978	.2922	13,205	1173168	22.510	1469730	20.451	1489438	-2.059	19708	.003	.014
lisc. Chemical Manu-	1														
facturers	33	. 3528	4.262	191486	.4089	10.634	423162	23.656	838167	21,566	929033	-2,090	90866	,004	.009
ement	34	.0547	1,559	783263	.0965	8.038	1021118	1.11	1119058	10.549	1123138	-0.562	4080	.009	.011
ement Products	35	,0414	15.377	588430	.1503	24.036	1192471	28.823	1345015	27.437	1365772	-1.386	20757	,000	.002
lass Products	36	.0381	6.921	735390	.1224	16,532	1214539	20,430	1338766	19,273	1336531	-1,157	-2235	,006	.003
lisc. Non-Metal Mineral Products	37	.0451	14.249	392638	. 1036	24.374	771557	27.673	876703	27.016	874754	-0,657	-1949	.004	.005
iteel & Iron	38	.3173	3.218	384765	. 4704	8.699	690864	27.673	1166287	17,351	1264854	-6,328	-1949 96567	.004	.005
teel & Iron Products	39	. 3701	10,507	395387	.4970	8.699	630418	30,747	1168287	23,934	1264854	-6.328	96567	.011	.008
luminium	40	.1455	5.922	1545269	. 2824	16.414	2779985	25,407	3066601	22,719	3224579	-0.813	104329	.002	.003
luminium Products	41	.0198	12.830	597957	.1922	25.067	2197543	31,188	2392612	22,719	2482649	-1.921	90037	.002	.003
isc. Metal Products	42	, 3010	7,026	297588	. 1922	11.967	537631	23.397	901889	19,054	931106	-1.921	29217	.003	.003
achinery	43	. 2268	11,505	348764	. 3989	17.412	659536	29.797	1054242	25.366	1115222	-4.431	60980	.005	.003
.H. Electrical Appl.	44	. 1699	5,291	356492	. 2756	11.976	1						17586		.013
munication Equipment		.4184	5.366	219267	. 5028	11,976	671212	20,753 27,231	950926 921659	17.975	968512 891637	-2.778	- 30022	.005	,020
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ervices	34 1	.0243	9.787	233100	.0516	12.197	385320	13,840	437690	13.248	425780	-0.592	-11910	,188	. 353

Notes:

¹ estimated by author $\mathbf{x}_{f}^{n} = \sum_{j=1}^{52} \mathbf{x}_{j}^{n} \mathbf{e}_{j} = .2662; \quad \mathbf{L}_{f}^{n} = \sum_{t=1}^{52} \mathbf{L}_{j}^{n} \mathbf{e}_{j} = 23.368 \; (man-years); \quad \mathbf{K}_{t}^{n} = \sum_{j=1}^{22} \mathbf{L}_{j}^{n} \mathbf{e}_{j} = 744758 \; (NT \; \mathbf{f}) = \frac{\mathbf{L}_{f}^{n}}{1 - \mathbf{M}_{t}^{n}} = 31.846 \; (man-years) = \frac{\mathbf{K}_{f}^{n}}{1 - \mathbf{M}_{t}^{n}} = 1.014.931 \; (NT \; \mathbf{f})$

Sources: Input-Output Tables Taiwan 1965, CIECO, Executive Yuan, Taipei, Taiwan, Republic of China Report on Industrial and Commercial Surveys, No. 2 (1969), Ministry of Economic Affairs, Taipei, Taiwan, Republic of China Taiwan Agricultural Yearbook 1972, Department of Acticulture, Provincial Government of Taiwan, Republic of China.

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It is of course inappropriate to sum the factor requirements over all sectors since the factor requirements of any one sector are measured in terms of total requirements throughout the entire economy. However, taking the average factor cost (saving), weighted by the distribution of output over all sectors, reveals that the utilization of imported inputs in the Taiwan economy entailed a saving of .189 man-years of employment and an additional capital cost of NT\$ 224 per million NT\$ output. The apparent paradox (of the Leontief type) which/result poses is resolved upon closer inspection of Table I. Note, it is precisely in those sectors which rely heavily on imported natural raw material inputs that exhibit the paradoxical L > L', K < K': wheat for flour; cotton for textiles; timber for plywood; hides for leather products, etc. In sectors more dependent upon imports of processed intermediate inputs the expected result (L < L', K > K') is found. It is of course well known that neo-classical factor-proportions theory is unable to explain trade in natural resources, and this fact has been used to resolve the paradox which Leontief descovered in the United States trade as well.

Total factor requirements per million NT\$ output in each of 46 manufacturing sectors -- excluding the indirect requirements in the primary sector (1-4), construction (51) and services (52) -- under the two alternative production structures are presented in Table II. Column 1 of Table II indicates the direct and indirect import requirement of manufactured intermediate inputs.² Calcutation of the implicit factor

2

 $M_{i}^{\prime} = \sum_{i=5}^{m} M_{ij}^{\prime}$

¹ Seija Naya, "Natural Resources, Factor M. and Factor Reversals in International Trade", <u>American Economic Review</u>, Vol. 57 (May 1967) p. 561-570.

Bibliothek des Instituts für Weltwirtschaft Kiel

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TOTAL LABOR AND CAPITAL REQUIREMENT IN THE MANUFACTURING SECTOR PER MILLION NT \$ OUTPUT 1969/70

Table II

Source: See Table L.

costs of imported inputs (i.e. the export equilivant) is based on average factor requirements of manufactured exports.¹ Comparisons of (L, K) and (L', K') in Table II reveal the resource (labor and capital) cost or saving resulting from the importation of manufactured intermediate inputs, assuming these inputs were imported with foreign exchange earned by exporting strictly manufactured commodities.

Abstracting from trade in non-manufactured goods clearly resolves the paradox we found in our previous results. On the average (weighted by the distribution of output in the manufacturing sector) the trade off manufactured exports for imports of manufactured intermediate inputs saved the economy NT\$ 59,893 in capital and entailed an additional labor cost of .083 man-years per million NT\$ output -- as compared the alternative of supplying all manufactured inputs domestically. Although we would need to know the shadow prices of capital and labor to precisely calculate the net resource cost of this trade off, it is quime apparent that resource savings in terms of capital well out weigh resource costs in terms of labor? In other words, import-dependent, "footloose" industry in a developing country such as Taiwan is quite justifiable in terms of resource allocation as judged by strictly factor-proportions considerations.

$$\frac{L_{f}}{I-M_{j}^{*}} = \frac{50 \left[50 \right] \left[\sum_{i=5}^{50} \ell_{i} \cdot s_{ij} \right] e_{j}}{1-\sum_{j=5}^{50} \left[52 \right] \left[\sum_{i=1}^{50} M_{i}^{*} \cdot s_{ij} \right] e_{j}}$$

where e_j is the proportion share of the jth sector in total export of manufactures.

² The yearly average wage in the manufacturing sector in Taiwan in 1969 was NT\$ 16,000.

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III. CONCLUSION: LINKAGES AND ECONOMIC DEVELOPMENT

The conclusion that the optimal allocation of resources in a developing country might well rule against industries with strong backward linkages goes against much of the conventional wisdom of development planning.¹ In particular it is the antithesis of the prominant Hirschman model of development.² The Hirschman model singles out the scarcity of decision-making as the primary constraint to development and argues that the most important and effective means of stimulating growth is to creat circumstances that make the advantage of a certain course of action so obvious that even weak decision-makers will act. The appropriate development strategy, so the argument goes, should emphasize investments which induce further investment decisions. The interrelatedness of the economy provides the mechanism (in fact, the deus ex machina) through wich decisions are induced. Hirschman described two directions in which the mechanism works -- one through backward linkages, the other through forward linkages, though the former is recognized to be by far the stronger of the two. In terms of input-output terminology, the appropriate strategy of development is one which gives preference to industries for which Σ s_{ij} is relatively high. The sum Σ sij can be thought of as the total domestic income (output) multiplier from the expansion of one unit of commodity j and is in effect a measure of the inducement to expand production throughout the economy resulting from the decision to expand the production of a given commodity j.

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¹ For example in discussing the pro's and con's of multinational corporate investment in developing countries it has been suggested that one of the most serious "con's" of this type of investment is that it typically entails few backward linkages to other sectors of the economy. D.K. Helleiner, "Manufactured Exports from Less Developed Countries and Multinational Firms", <u>The Economic Journal</u>, Vol. 83, No. 329 (March 1973) p. 21-47.

² Albert O. Hirschman, <u>The Strategy of Economic Development</u>, (New Haven: Yale University Press, 1958).

Having singled out decision-making ability as the binding constraint to development, Hirschman's model ignores other considerations which may in reality be equally important. As we have demonstrated, factor proportions considerations may rule against industries with strong backward linkages to other relatively capital intensive industries. Moreover, economies of scale considerations might also mitigate the appropriateness of the linkage hypothesis in a particular developing country. If, for example, a country is small either in terms of population or domestic resources, economies of scale considerations may recommend concentration on a relatively few, self-contained, "footloose" industries. If we examine the economies in which footloose industry has flourished, we find generally small, export oriented countries in which the structure of production conforms rather well to existing factor endowments. The fact that these countries dominate the exclusive group of superlative economic performers in post-war period provides some casual evidence that linkages are not particularly important.¹

There is little doubt that the supply of entrepreneurship is a severe constraint to development. What is at question, however, is whether linkages provide an effecitve mechanism for generating entrepreneurship, and decision-making. According to the Hirschman hypothesis, the creation of bottlenecks induces entrepreneurs to come forward. At the same time, we know from the experience of many underdeveloped countries, particularly those of Latin America, that the creation of bottlenecks has other consequences which most profoundly inhibit the supply of entrepreneurship. Moreover, if one considers the intricate and innovative

¹ A direct test of the linkage hypothesis à la Hirschman has recently been published. However the results (which rejected the extreme interpretation of the theory, but confirmed a modified interpretation) are highly suspect on methodological grounds. See, Pan A. Yotopoulos and Jeffrey B. Nugent, "A Balanced-Growth Version of the Linkage Hypothesis: A Test", <u>The Quarterly Journal of Economics</u>, Vol. LXXXVII, No. 2, (May 1973) pp. 157-71.

ways in which people of developing countries deal with adversity (black markets are a prime example) it is apparent that decision-making ability is not altogether lacking. What is lacking is the incentive to apply this ability to productive enterprise. Whether the lack of incentive is the result of not knowing what to do because perhaps the bottlenecks (opportunities) are not obvious enough, or the result of government policy and the consequences of government policy which inhibit the market mechanism from transmitting the appropriate incentives is an open question which demands more attention than it has yet received. Certainly the mere existence of linkages is insufficient to ensure that inducements will indeed be generated. To speak of a certain amount of decision-making (output or employment) being "generated" throughout the economy via backward linkages implicitly assumes that demand creates its own supply. Such an assumption for developing countries at this point in history is at least as naive as the reverse assumption was for industrial countries in earlier times (pre Keynes). To conclude, one can find little a priori reason to favor linkage considerations à la-Hirschman over factor proportions or economies of scale considerations in designing the appropriate industrialization strategy for a developing country.

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