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AIMS AND SCOPE OF *INDUSTRY AND DEVELOPMENT*

Industry and Development attempts to provide a link between practitioners and theorists working on economic and related aspects of industrialization. The focus of the journal is on applied economics, particularly in areas emphasized in the Lima Declaration and Plan of Action on Industrial Development and Co-operation.

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The Supervisory Panel of *Industry and Development* welcomes readers' opinions and comments, and will be glad to consider for possible publication articles relevant to the aims and scope of the journal (see "Information for contributors", back cover).

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Explanatory notes

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The following abbreviations are used in this publication:

Organizations

BEL	Bharat Electronics Company
CEERI	Central Electronic Engineering Research Institute
EEC	European Economic Community
ESPRIT	European Strategic Programme for Research and Development in Information Technologies
FII	Foundation for Engineering Research and Development
IIT	Indian Institutes of Technology
ITI	India Telephone Industries
KETRI	Korean Electrotechnical and Telecommunications Research Institute
KAIST	Korean Advanced Institute of Science and Technology
KIET	Korean Institute of Electronics Technology
MITI	Ministry of International Trade and Industry
NIE	National Institute of Electronics
SCL	Semiconductor Complex Limited
SDI	Strategic Defense Initiative
TIFR	Tata Institute for Fundamental Research

Technical abbreviations

CAD/CAM	computer aided design/computer aided manufacturing
CAE	computer aided education
CMOS	complementary metal-oxide semiconductor
FGCS	future generation computer systems
IC	integrated circuit
ISDN	integrated services digital network
IT	information technology
LIPS	logical inferences per second
LSI	large-scale integration
MNC	multinational corporation
MSI	medium-scale integration
NMOS	non-volatile metal-oxide semiconductor
RAM	random access memory
R and D	research and development
SSI	small-scale integration
ULSI	ultra-large-scale integration
VHSIC	very high speed integrated circuit
VLSI	very-large-scale integration

ESTIMATING THE SHIFTING OF PROTECTION ACROSS SECTORS: AN APPLICATION TO MAURITIUS

David Greenaway* and Chris Milner**

Introduction

Diverse and frequently conflicting industrial and trade policy measures are used in many industrializing countries. Some imports and traditional exports may nominally be taxed, while other production (of non-traditional exports, for example) is subsidized. Such diverse measures are frequently applied in a piecemeal and incremental fashion in response to diverse objectives and to changing problems, and without consideration of the net impact of the measures on the overall structure of relative incentives.

The intention of the policy-maker may be to protect or promote one particular type of industrial activity. Protection of this activity will tend however to disprotect another. If relative incentives are altered and un- or under-utilized resources are not available, then relatively disprotected activities inevitably bear certain costs.

These outcomes emerge because policy-makers invariably adopt a partial equilibrium perspective. The aim of a particular strategy or the impact of a specific measure is considered in isolation and without regard for general equilibrium effects. For example taxes on imports allow the absolute prices of import substitutes to be raised. If we assume, in textbook style, that substitution in production and consumption is possible to and from importables, but also that domestic prices of other goods remain constant, then the focus is mistakenly only on the protection of importables and the restriction of imports achieved by a tax nominally paid by importers or domestic consumers of imports. The partial analysis does not capture the production, consumption and

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price effects of the import tax outside the importables sector. A general equilibrium framework, by contrast, permits consideration of resource effects on other sectors and changes in relative prices. The relative price changes induced may mean that the protection of importables is achieved by the (implicit) taxing of other domestic activities besides imports. Examination of the ways in which these burdens of taxes and subsidies are shifted onto other groups of producers and consumers ought therefore to be a critical element in the evaluation of policy. This is especially so when measures are used simultaneously to promote import-substitution and export activities.

This paper applies a general equilibrium framework developed by Sjaastad [1] and Sjaastad and Clements [2], and extended by Greenaway and Milner [3] to the analysis of the shifting of net protection across sectors in Mauritius. Section A provides a simple, analytical framework for illustrating the shifting of protection principle. Section B outlines the actual commercial and industrial policies of Mauritius. Section C describes the empirical methodology used to apply the model and the results obtained for Mauritius. Sections D and E evaluate the results and compare them with results from other studies. Finally section F discusses the implications of shift analysis for future trade and industrial strategies in developing countries.

A. The analytical framework

The traditional, general equilibrium model of international trade is usually based on two industries and two factors of production. Such a model allows us to predict which factor loses from trade restriction and which gains. But since both factors are used in both sectors, it is not possible to examine the incidence of protection in sectoral terms. Import protection raises the price of importables relative to exportables, but nothing can be said about the incidence of protection across the sectors. If a third sector is included, namely non-tradables, a second relative price ratio - the price of non-tradables relative to tradables - is introduced. An examination of how an import tariff alters the price of importables relative to exportables, compared with the way in which it affects the price of non-tradables relative to exportables, indicates the true protection of importables and the extent of the shifting of the burden of protection onto exportables and non-tradables.* The share or incidence of this burden depends essentially on the degree of substitutability (in demand and production) between importable products and those of other unprotected sectors.**

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*By introducing non-tradables as the point of reference for expressing relative prices, we are implicitly assuming that factor proportions in non-tradables (H) lies somewhere between importables (M) and exportables (X). Substitutability is therefore between M and H or X and H, and not between X and M.

**Burden can be experienced in both public finance and resource diversion terms.

1. The shifting principle

Table 1 below sets out some hypothetical changes in the prices of importables (P_m), exportables (P_x) and home goods (P_h). In each case a uniform import duty of 45 per cent raises the domestic price of importables relative to the internal price of exportables (initially assumed fixed) by 45 per cent.* In case (a) the relative prices of importables to home goods is unaltered, but the price of exportables and real income generated in this sector has fallen relative to both other sectors. The incidence** in this particular case therefore falls totally on exporters. The tariff is then fully equivalent to an export tax. By contrast, in case (b) the price of importables rises by 45 per cent relative to both exportables and home goods. In this case the tax is shifted equally onto producers in both the unprotected sectors. Importables are protected fully relative to both other sectors, that is, the true protection conferred on the import substitute sector is equivalent to the nominal tariff of 45 per cent. Case (c) illustrates an intervening possibility. The price of importables rises by 45 per cent relative to exportables, but only by 15 per cent relative to home goods. The price of exportables falls by 30 per cent relative to home goods. Thus, although the tariff is initially (nominally) paid for by importers, the ultimate changes in relative prices are such that 66 per cent of the tariff is shifted

Table 1. The impact of an hypothetical tariff increase of 45 per cent

Item	Alternative absolute price changes		
	Case (a)	Case (b)	Case (c)
Importables (P_m)	45	45	45
Exportables (P_x)	Constant	Constant	Constant
Non-traded home goods (P_h)	45	Constant	30
Shift parameter	1	0	0.66
True tariff	0	45	11.5
True subsidy	-31	0	-23

Note: Figures indicate percentages, except for the shift parameter.

*This is a small-country case where the external price is given.

**The incidence refers to the share of the tax rate; the tax base, that is, the share of importables in consumption, may differ between producers in each sector. When the incidence is shared equally between exportables and home goods, it is shared in the sense that the implicit tax rate on the consumption of both exportables and non-tradables is the same. The actual burden will differ if the share of importables in consumption differs.

onto producers of exportables as an implicit tax levied in the form of diminished purchasing power: the rest of the ultimate burden falls on producers of home goods the price of whose products have declined relative to importables. The extent of this decline in the price of home goods relative to importables determines the extent of the implicit subsidy to domestic producers of importables given by an import tax; the greater the relative fall, the larger the implicit subsidy.

2. The role of substitutional relationships

Protection of one sector must therefore "disprotect" at least one other sector, the nature and extent of the disprotection depending on the nature of the substitutional relationships in both production and consumption. For example, the internal price of importables relative to home goods can change little if the goods of these two sectors are close substitutes in demand and production. An initial rise in the price of importables will cause resources to be diverted from home goods production towards production of importables and demand to shift from importables to home goods, the resulting rise in the price of home goods tending to continue until the initial relative price is restored. An import duty must in this instance pull up the price of both importables and home goods relative to exportables. Hence the effects of the import tariff are similar to those of an export tax levied at the same rate. If, by contrast, the exportables and home goods are close substitutes in demand and production, an import tax must raise the domestic price of importables relative to both of the other sectors. Protection of import-substituting activities imposes costs in this case on all other sectors.

3. Countervailing distortions

In many industrializing countries the desire to industrialize has induced simultaneous attempts at import substitution and export promotion. The actual, net effects of simultaneously operating conflicting policies (in terms of their effects on internal, relative prices) will be considerably different from the intended effects. The protection of import-competing activities in isolation disprotects exporters, while the promotion of exports in isolation disprotects import-substitution activities. If import protection would, in isolation, result in a marked fall in the price of exportables relative to home goods, then the imposition of an export subsidy merely acts as a countervailing distortion.

The extent to which export subsidies offset the effects of import duties on relative prices depends on the relative magnitudes of the nominal rates of duty and subsidy and the nature of the substitutional relationships present in the economy. Traditional exports of primary products are invariably raw-material-intensive or resource-intensive. As such one would anticipate somewhat limited substitution possibilities in demand and production between these and other sectors. By contrast, non-traditional exports, or exports of manufactures, tend to be labour-intensive and are therefore likely to have closer substitution relationships with other sectors, in particular the

differences in the proportion of protection which is shifted, with a higher incidence on traditional exports.*

4. True tariffs and subsidies

If import duties and export subsidies are used simultaneously the true rates of each will differ from their nominal rates. Since each instrument has offsetting influences on relative prices, the net effects of policy can be evaluated by reference to how they alter prices relative to the price of home goods.

Consider table 1 again, where the nominal tariff is 45 per cent and the nominal subsidy is zero. We can use the change in the price of importables relative to home goods as a measure of the net or true effect of the tariff in protecting the importables sector. Thus:

$$t^* = \Delta(P_m/P_h) \qquad (1)$$

where t^* = true tariff rate and the initial, pre-tariff price ratio

$$P_m^0/P_h^0 = 1$$

In case (a) in table 1 the true tariff rate is zero, since purchasing power of importables in terms of home goods is ultimately unaltered by the nominal tariff of 45 per cent. In case (b), with the price of home goods unaltered the true tariff and nominal tariff are equal at 45 per cent. In the intermediate case represented by case (c), a nominal tariff of 45 per cent produces a true tariff of only 11.5 per cent.

Similarly, the true subsidy (s^*) is defined as:

$$s^* = \Delta(P_x/P_h) \qquad (2)$$

where $$P_x^0/P_h^0 = 1$$

In table 1 where the nominal subsidy is zero, the true subsidy in case (a) is $s^* = -0.31$ (approximation) (a negative, true subsidy, that is, an export tax, of about 30 per cent). In case (b), $s^* = s = 0$, and in case (c), $s^* = -0.23$. The negative subsidy or export tax increases as the price of home goods increases relative to exportables.

Thus the greater the shifting of protection from importables to exportables, the greater the disprotection of exportables, but also the lower the true protection of importables. The apparent perversity of this conclusion serves to emphasize the limitations of simultaneously attempting to protect import substitutes and promote exports. The distinction between true and nominal protection is in fact the key to understanding the hidden nature of

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*The burden is greater on traditional exports in terms of the tax shifted, although the resources that can be diverted may be limited.

the costs of protection, and understanding why the failure of export promotion policies can be easily attributable to extraneous factors. The fact that true protection is likely to be less than nominal protection not only reduces the security offered to the import-competing sector below that expected, but also provides a motive for pressing government for further nominal protection. The erection of protective barriers tends to be a continuous process, which never seems to satisfy importers. By contrast, exporters often appear satisfied with the promotion policies on offer, but are unable to identify a root cause for their difficulties.

5. Deriving the shift parameter

The raising of the absolute price of importables must raise the price of importables relative to exportables. The extent to which the rise in the relative price of importables "taxes" exportables depends on the extent of the rise in the price of home goods; the larger the increase in the prices of home goods relative to exportables $\Delta(P_h/P_x)$, the greater the shifting of the burden onto exporters. Thus, assuming initial price ratios are unity,

$$\Delta(P_h/P_x) = w\Delta(P_m/P_x) \qquad (3)$$

where w = shift or incidence parameter and $0 < w < 1$.

The shift parameter (w) will be non-negative and unity or less. In other words, the price of home goods will not fall with the imposition of a tariff and will not increase by more than the rise in the price of importables.* Where importables and home goods are close substitutes in demand and production, the increase in P_h (relative to P_x) will tend towards the increase in P_m (relative to P_x) and w will tend towards unity. Alternatively, w will tend towards zero if home goods and exportables are close substitutes and there is a small proportionate increase in the price of home goods. The extent of the shifting of the incidence of protection onto exportables is therefore directly related to the value of w; the higher is w, the greater the shifting effect.

6. "True" protection

We can now demonstrate the impact of nominal tariffs and subsidies where a country simultaneously uses import duties and export subsidies. (Again we will assume uniform rate structures.) Equations (1) and (2) show that what happens to the price of home goods has a critical influence on the true rates. The proportionate increase in the price of home goods (P_h) following the imposition of an import tariff and export subsidy is composed of two elements; that part of the increase shifted on from the rise in the price of importables due to the tariff (wt), and that part of the increase shifted on from the domestic price of exportables due to the subsidy ((1-w)s). That is:

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*The non-negative condition requires that there is no complementarity between home goods and importables or exportables.

$$P_h = wt + (1-w)\,s \qquad (4)$$

where t = nominal tariff rate
s = nominal rate of subsidy
w = shift or incidence parameter

If $t = s$, we have the result that $P_h = t = s$: the prices of all goods (tradables and non-tradables) have risen by the same proportion and no sector is protected because relative prices are unaltered.

The case where $t > s$ is probably of greater practical relevance. The division of net (true) protection now depends only on the value of w. The policy-makers can set the extent to which actual or nominal t exceeds nominal s, but they cannot influence the final relative price structure and therefore the true tariff and subsidy; this is determined entirely by substitutional relationships in the economy which are dependent on preferences and technological characteristics. We would expect w to be between zero and unity given the degree of substitutability that might be expected between the production of distinct sectors. However, consideration of the impact of extreme values for w on equation (4) is instructive. If $w = 0$, then $P_h = s$ and home goods and exportables are such close substitutes that their relative prices cannot be altered. Since $t > s$ (by assumption), the positive net protection ($t^* > 0$) for importables is paid for equally by exporters and producers of home goods (the true tariff is, however, less than the nominal tariff, because the price of home goods has risen by the amount of the nominal subsidy, and, for the same reason, the true subsidy is zero). By contrast if $w = 1$, equation (4) establishes that $P_h = t$: home goods and importables are such close substitutes that P_m/P_h cannot be altered. Since P_h (=t) $> s$ (by assumption), then the entire burden of import protection falls on exporters. Since $P_h = t > s$, the true subsidy is negative and the true tariff zero. If w is equal to or near unity, then net protection of importables (relative to home goods) is virtually impossible: an import duty serves only as an export tax (= negative export subsidy). From this examination of its possible extreme values, we can give a clear interpretation to the incidence coefficient (w). It is that part of net protection in the tariff-cum-subsidy case that is shifted as an implicit tax on exporters. For a more formal derivation of the theoretical concepts developed in this section, see Sjaastad [1].

B. Industrial policy and commercial policy in Mauritius

The current industrial and commercial policy of Mauritius has evolved over a number of years and embraces a wide range of legislation and administrative measures. Many of the policies which are significant for the industrial sector, such as those relating to transport, education and employment are beyond the scope of a brief survey. The focus here will be on the broad strategy of trade policy as expressed in legislation and on the nature of the instruments (fiscal and other) of trade policy.

1. The legislative framework

(a) Import substitution

The Development Certificate Scheme was initiated in 1963 - the current legislation is set out in the Development Incentives Act, 1974 - and is designed to encourage the establishment of import substitute industries in Mauritius. Its primary objective is to create employment in the manufacturing sector. Incentives to companies with Development Certificates include a tax holiday on corporate profits, exemption for a period from income tax on dividends, advanced factories, investment finance at preferential rates, investment allowances, and import duty relief (or exemption) on machinery, raw materials and semi-finished products. Protection from foreign competition is given through tariff and quota restrictions on imports.

In mid-1983, 154 companies with Development Certificates were in operation, employing a total of about 8,600 people. The main concentrations of the manufacturing companies were in food and beverages and engineering.

(b) Export promotion

The Export Processing Zones Act (1970) was intended to encourage the development of export-based manufacturing and processing industry in Mauritius through investment by local and overseas interests.* The incentives offered to companies under the Act again include a tax holiday on corporate profits (longer than for Development Certificate status), exemption from income tax for distributed dividends (again for a longer period than in the case of Development Certificates) advanced factories, investment and export finance preferential rates, investment allowances and import duty exemption on machinery, components, raw materials and semi-finished products.

By mid-1983, 133 companies were operating under the Export Processing Zones Act (1970), employing about 24,400 people, the major production and employment being in spinning, knitting and made-up garments.

2. Trade policy measures

(a) Import duties

The Mauritius tariff schedule identifies general customs duty, preferential customs duty and fiscal duty. Imported commodities are subject to fiscal duty and general or preferential customs duty. All the major trading partners of Mauritius attract the preferential rate. The (unweighted) average nominal rates shown in column (a) of table 2 record therefore the visible (fiscal and preferential) duties. Progressively, since the mid-1970s, a number of supplementary duties have also been applied to all

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*There is no special geographical zone as such. Mauritius has encouraged the dispersal of establishments and specific factories and sites have been bonded and designated as within the Export Processing Zone.

imports, including the import surcharge (10 per cent), the special levy (10 per cent) and stamp duty (12 per cent). Average nominal tariffs (by industry) which include these additional tariffs are listed in column (b) of table 2. These nominal rates do not of course indicate the effective protection offered to domestic industries.*

Table 2. Average nominal tariffs in Mauritius, 1980

Activity	Nominal tariff	
	(a)	(b)
Beverages	188	220
Tobacco	300	332
Textiles	13	45
Wearing apparel	48	80
Leather products	75	107
Footwear	50	82
Wood products	25	57
Furniture	88	120
Paper products	40	72
Printing	16	48
Basic chemicals	5	37
Other chemicals	29	62
Rubber	53	85
Plastic	20	52
Glass	40	72
Base metals	2	34
Fabricated metals	32	64
Lime etc.	21	53
Non-electrical machinery	19	51
Electrical machinery	41	53
Transport equipment	70	102
Watches and lenses	37	69
Arithmetic mean	55.1	86.2

Note: Figures indicate percentages, except for the arithmetic mean.

(b) Quotas

In addition to import duties levied for general protective and revenue purposes, specific quota protection of up to 80 per cent of the domestic market has also been offered on a discretionary basis to companies with Development Certificates. The

*The authors did calculate comparable effective tariff rates; the estimated unweighted average effective rate ranging from 88 per cent to 128 per cent, according to the measure of nominal duty used.

extent and level of this type of protection is not highly visible, but these measures were commonly used during the period chosen for the empirical analysis and are likely therefore to have had a significant impact on relative prices.

C. An econometric model of shifting in Mauritius

1. Specification

Multivariate regression analysis was deployed in order to estimate the shift coefficients. A variety of specifications were tested using several estimation techniques.

Equation (3) can be expressed in continuous terms:

$$\hat{P}_h - \hat{P}_x = w\,(\hat{P}_m - \hat{P}_x) \qquad (5)$$

where ^ denotes a proportionate change.

Given time series data on prices of home goods (P_h), importables (P_m) and exportables (P_x), equation (5) can be estimated as a linear regression equation in double logarithmic form:

$$\log(P_h/P_x) = a + b\,\log(P_m/P_x) + u \qquad (6)$$

where u is a stochastic disturbance term.

The estimated coefficient b provides an estimate of the shift coefficient.

2. Data samples

The principal data input, as we can see from equation (6), is price index data on importables, exportables and non-traded goods, more specifically data on Mauritian prices of each of these activities. Some countries do prepare alternative price series for importables and exportables and sometimes even non-traded goods; this however is not the case where Mauritius is concerned. Price data, in the form of the Consumer Price Index, are extensive and comprehensive. It was possible therefore to compute composite price indices for importables, exportables and home goods from subgroup information. The components of the price index of importables for Mauritius are shown in table 3. Both indices include five commodities which are unambiguously importables, and which enjoyed some degree of import protection. Since the consumer price index changed in January 1969 there is one minor difference between the two baskets, namely the absence of footwear from the index in the earlier period. No subgroup or item which clearly applied to footwear existed for the earlier period, and it therefore had to be omitted. Apart from this the two series are identical. In designing the composite index for home goods, the guiding objective was the need to select items of consumer expenditure for which no actual or potential trade exists. Most commentators tend to focus on the output of the service sectors when discussing non-traded goods. This convention has recently been challenged since in countries which have contiguous frontiers a substantial amount of cross-border trade in services may occur. Since

Mauritius has an island economy and there is a substantial distance between it and other islands, such trade is not a problem and the use of services in the index of home goods is permissible. The items included in the home goods index are listed in table 3. Again there are five items in each composite index. As with the index of importables, the components for each period are virtually identical.

Table 3. Construction of the composite price indices

Price index	Consumer price index reference numbers		Commodity description
	Group	Subgroup	
(a) Components of composite price indices 1969-1976			
Importables	0	05	Furniture
	0	06	Furnishings
	0	07	Household appliances
	2	20	Alcoholic drinks
	3	33	Cotton yarns
Non-tradables	0	04	Household operations
	3	35	Shoe repairs
	4		Medical care
	7	70	Education and reading
	8	05	Entertainment
Exportables	3	30	Men's ready-made clothing
	3	31	Women's ready-made clothing
	3	32	Children's ready-made clothing
(b) Components of composite price indices 1976-1982			
Importables	1	11	Alcoholic beverages and intoxicants
	3	03	Furniture and furnishings
	3	04	Household appliances and utilities
	4	02	Clothing materials
	4	03	Footwear
Non-tradables	3	05	Household services
	4	05	Miscellaneous clothing services
	5	01	Medical care
	5	03	Education and reading
	5	05	Recreation and amusement
Exportables	4	01	Ready-made clothing

Of all the indices, exports provided the most interesting problems. It is well known that the principal export from Mauritius for a great many years has been unrefined sugar, and recently an increasing amount of refined sugar. One might refer to this as a traditional export. One of the principal objectives of industrialization is of course to lessen dependence on this primary commodity and diversify into manufactured exports which, inter alia, can provide more stable export earnings, in other words, to diversify into non-traditional exports. From the standpoint of resource allocation, it is more interesting to consider shift analysis with respect to the non-traditional export sector than to the traditional export sector. Traditional exports (sugar) are land-intensive. There are limited opportunities for substitution away from sugar production into non-tradables and importables, and although shifting will take place, a priori one would expect it ultimately to affect rental values on land. In other words, shifting may impose a tax burden on sugar producers; but since the resources used intensively in sugar production cannot be redeployed into importable or home goods production, there will be limited resource allocation effects.

Three price indices of exportables were constructed, two for traditional exports and one for non-traditional exports. In the case of the former, it was not possible to use the consumer price index for sugar since this refers to refined sugar, and since, furthermore, its domestic price is rigidly controlled. Instead, a proxy for the export price was used, namely an export unit value series for sugar. This series was constructed from Mauritian free-on-board value and quantity data. Unfortunately, however, these data were only available on a quarterly basis, which restricted the number of observations available. Moreover, shift factors for traditional exports could only be estimated for the 1976-1982 period. Export unit values for 1973, 1974 and 1975 were distorted by the sugar price boom which occurred then. The loss of these observations (with quarterly data) resulted in an insufficient number of observations for meaningful analysis. Since the principal focus of analysis is the 1976-1982 period, this is not unduly worrying. Nevertheless, to reinforce the analysis for the second period, a second index of traditional export was deployed, namely an index of unit values for sugar and tea.*

Since Mauritius is an industrializing economy, the number of non-traditional exports is perforce limited. There is, however, one commodity in which Mauritius unambiguously enjoys a comparative advantage, and which is clearly a manufactured exportable, namely ready-made clothing. Close and careful inspection of production, trade and consumer price data revealed that this in fact was the only manufactured export for which reliable and comprehensive data existed for both subperiods. Consequently, the price index for exportables was taken as the price index for ready-made clothing for both periods.

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*Export unit values are rightly regarded with suspicion when used as proxies for prices of manufactured commodities. They are extremely sensitive to changes in product composition and product quality. As we are dealing here with primary commodities which are homogenous, this is not seen as being a particular problem.

3. Time periods

In any time series analysis directed at evaluating the effects of policy a time period which is sufficiently long to permit the possible effects of policy to be manifested is clearly desirable. In the Mauritian context it is especially interesting since the period covering the late 1960s through to the early 1980s spans several policy regimes as we saw in section B. Reliable consumer price data are available continuously back to 1962. The series is not however continuous and falls into the following three distinct subperiods: January 1962-June 1976; July 1976-December 1982; and January 1982 to late 1983.

The base for each of these subperiods differs (January 1962, January to June 1976 and July to December, 1981 respectively). Furthermore the composition of each basket is different as are the weights associated with specific items. To complicate matters further, indices for the post-1976 period are compiled at the section and subsection levels of aggregation. By contrast, in the pre-1976 period indices are only compiled at the section level, although raw data for computation of indices at the subgroup level were available. In view of these data constraints, it was decided to work with two subperiods, namely January 1969-June 1976 and July 1976-December 1982, with particular emphasis being placed on the latter given the greater reliability of data and their greater potential significance from a policy standpoint. This satisfied the objective of covering the change-over of policy regimes. Since the data being used were monthly data they provided an adequate number of observations for each subperiod (79 for the later period and 86 for the earlier period). From a technical standpoint, splitting the period into two subperiods avoided the possibility of introducing further biases into the series through rebasing without reassignment of weights.

4. Results

Table 4 shows the results of estimating equation (6) for non-traditional exports using ordinary least squares (OLS) methods. Equation (1) in table 4 reports the coefficient estimates and summary statistics for the 1976-1982 subperiod, while equation (2) refers to the subperiod 1969-1976. As is clear from the estimates of b, these results suggest that for both subperiods approximately two thirds of the cost of protection is shifted to the export sector in Mauritius and takes the form of an implicit export tax. Interestingly, these figures are similar to those reported for a variety of Latin American industrializing economies (see table 6). There is clear evidence, however, that the residuals in both equations are autocorrelated. Durbin-Watson statistics of 0.36 (for 1976-1982) and 0.21 (for 1969-1976) are consistent with positive autocorrelation in both series. Since we are dealing with monthly price observations, this was to be expected and clearly means that the coefficient estimates are inefficient.

In order to correct for autocorrelation the model was re-estimated using the Cochrane-Orcutt procedure. This commences

Table 4. Estimation of shift coefficients: non-traditional exports

Equation number	a	b	$\bar{R}^2$	DW	N	Period	Estimation procedure
(1)	0.0153 (5.63)*	0.6636 (18.99)*	0.83	0.36	78	1976-1982	OLS
(2)	-0.0324 (10.76)*	0.6724 (19.93)*	0.93	0.21	86	1969-1976	OLS
(3)	0.0036 (2.81)*	0.5895 (7.45)*	0.42	2.25	78	1976-1982	CO
(4)	0.0005 (0.57)	0.4785 (4.52)*	0.30	2.02	86	1969-1976	CO

Notes: CO Cochrane-Orcutt estimation
DW Durbin-Watson
OLS Ordinary least squares estimation
* Statistically significant at 1 per cent level
t values in parentheses.

from the assumption that the autocorrelation takes the form of a first-order autoregressive scheme, as follows:

$$u_t = ru_{t-1} + \varepsilon_t \qquad (7)$$

where $-1 < r < 1$

and $\varepsilon_t \sim N(0,1)$

The Cochrane-Orcutt procedure regresses the OLS residuals on their lagged values to estimate r, as follows:*

*Equation (8) is derived as follows:

assume

$$Y_t = \beta_0 + \beta_1 X_t + u_t \qquad (i)$$

where $Y_t = \log (P_h/P_x)$

$X_t = \log (P_m/P_x)$

taking first differences

$$Y_{t-1} = \beta_0 + \beta_1 X_t{-1} + u_{t-1} \qquad (ii)$$

multiplying both sides by r

$$rY_{t-1} = r\beta_0 + r\beta_1 X_{t-1} + ru_{t-1} \qquad (iii)$$

subtracting (iii) from (i)

$$Y_t - rY_{t-1} = \beta_0(1-r) + \beta_1(X_t - rX_{t-1}) + \varepsilon_t \qquad (iv)$$

since

$$\varepsilon_t = u_t - ru_{t-1}$$

$$e_t = \hat{r}e_{t-1} + \varepsilon_t \qquad (8)$$

$\hat{r}$ is then substituted into the generalized shift model:

$$\log (P_h/P_x) - \hat{r}[\log(P_h/P_x)-1] = a(1-\hat{r}) + b\{\log(P_m/P_x) - \hat{r}[\log(P_m/P_x)-1]\}+e \qquad (9)$$

Equation (9) then becomes the general estimating equation. The revised coefficient estimates for non-traditional exports using the Cochrane-Orcutt technique are set out as equations (3) and (4) in table 3. The estimated shift factors are lower than those reported above using the OLS methodology. Nevertheless, equation (3) suggests that for the period 1976-1982 59 per cent of the cost of protection is shifted in the form of an export tax. The estimated coefficient is statistically significant at the 1 per cent level and the overall explanatory power is reasonably good (with an $\bar{R}^2$ of 0.42). Finally, given the DW statistics of 2.23, the null hypothesis of no positive or negative serial correlation cannot be rejected.*

Equation (4) gives the results of the Cochrane-Orcutt estimation for the 1969-1976 period. As we can see, the difference between the OLS and the Cochrane-Orcutt shift factors is greater for the 1969-1976 period than for the 1976-1982 period, suggesting that autocorrelation was more problematic in the earlier period. Nevertheless the b coefficient is statistically significant at 1 per cent and suggests that 50 per cent of the cost of protection is shifted in the form of an implicit export tax. From the standpoint of incidence analysis, the contrast between the 1969-1976 and 1976-1982 periods suggests that the extent to which import

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*In order to explore the robustness of the estimated shift coefficient additional explanatory variables were included, namely $(\log P_m/P_x)^2$ and $(\log (P_h/P_x)-1)$. The former variable may indicate whether there are non-linearities in the relationship, while the latter may indicate something about speed for adjustment of the prices of home goods relative to imports. The full estimating equation therefore becomes:

$$\log (P_h/P_x) - \hat{r}[\log(P_h/P_x)-1] = a(1-\hat{r}) + b\{\log(P_m/P_x) - \hat{r}[\log(P_m/P_x)-1]\} + c\log(P_m/P_x) + d[\log P_h/P_x)-1]$$

In the event, none of the estimates of c or d turned out to be statistically significant and the overall explanatory power of the model altered little. What is striking, however, is the impressive stability of the shift coefficient. Its value increases to around 0.66, which was the estimated OLS value, and is almost identical across all four equations. All of these coefficients are significant at the 1 per cent level, and the Durbin-Watson statistics again mean that the null hypothesis of no autocorrelation cannot be rejected.

protection has been shifted through implicit export taxes to (non-traditional) manufactured exports may have increased in the second half of the decade.*

Table 5 shows the results of estimates using indices for traditional exports of sugar and of sugar and tea. Our principal interest again is in the estimated values of the b coefficient. The range for the estimated b coefficients is greater than with manufactured exports, but all estimated coefficients are significant at the 1 per cent level. All their values are in excess of the estimated coefficients for manufactured exports - every coefficient except one exceeds 0.80. This suggests that shifting in implicit tax terms is as expected greater for traditional exports. The coefficients suggest that there are very limited substitution possibilities between home goods and traditional exports, and given the factor inputs of the latter this is entirely plausible.

D. Evaluation of the results for Mauritius

The results of this econometric analysis provide the following important insights into the effects of industrial and commercial policy in Mauritius during the 1969-1982 period.

(a) Protection of import substitution activities in Mauritius imposes a significant burden on the export sector;

(b) The proportion of import protection which is shifted in the form of export taxes may currently be as high as 66 per cent for exporters of manufactures and over 80 per cent for exporters of sugar and tea;

(c) Where the manufacturing export sector is concerned, the implicit export taxes associated with import protection appear to have increased through time from just under 50 per cent in the first half of the 1970s to up to 66 per cent in the second half of the 1970s and early 1980s;

(d) Any incentives provided to producers of manufactures for export only serve to offset in part the disincentives associated with import protection;**

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*For all periods autocorrelation was also corrected using the Durbin two-stage procedure. The results obtained using this method were consistent with those of the Cochrane-Orcutt procedure.

**If, for illustrative purposes, we take the overall average nominal tariff given in table 2 (86 per cent) as a proxy for the appropriately weighted nominal tariff, a rough estimate of the nominal subsidy on non-traditional exports of 40 per cent and a shift parameter of 0.6, then from equations (1), (2) and (4) the average true tariff would be approximately +11 per cent and the average true subsidy on manufactured exports would be approximately -16 per cent.

Table 5. Estimation of shift coefficients in Mauritius, traditional exports 1976-1982

Equation number	a	b	R^2	DW	N	Estimation procedure	Data	Exportables
(1)	0.0082 (1.89)	0.7171 (12.29)*	0.86	0.80	26	OLS	Quarterly	Sugar
(2)	-0.0019 (-0.46)	0.8643 (13.28)*	0.96	1.74	26	CO	Quarterly	Sugar
(5)	0.023	0.8303	0.95	1.12	26	OLS	Quarterly	Sugar and tea
(6)	0.0000 (0.00)	0.8543 (28.82)*	0.97	1.87	26	CO	Quarterly	Sugar and tea

Notes: CO Cochrane-Orcutt estimation
DW Durbin-Watson
OLS Ordinary least squares estimation
* Statistically significant at the 1 per cent confidence level
t values in parentheses.

(e) Given the magnitude of the estimated shift coefficients it is inevitable that industrialization through development of the export sector is being adversely affected by a highly protected import substitute sector.

The importance of these results should not be underestimated. They suggest that there is inconsistency in the deployment of policy instruments. A variety of incentives are provided as inducements to potential investors in the export sector through the Export Processing Zones Act (1970). In practice, however, these appear to do little more than offset to some extent the disincentives to invest in that sector which are provided by the protection conferred on the import substitute sector. Furthermore, the incentives to exporters have remained unchanged for a considerable period of time, while the protection conferred on the import substitute sector - and hence incentives to invest in that sector and disincentives to invest in exporting - have increased. The net effect of this has probably been to induce resources into import-competing activities rather than export activities. Not only does this result in resource misallocation in a static sense, in a dynamic context it provides limited opportunities for industrialization.

E. Estimates of shifting in other developing countries

Attempts have been made in a number of studies to estimate shift factors using the methodology outlined in section C: Sjaastad [4] and [5] for Argentina and Uruguay, respectively; Diaz [6] for El Salvador; Fendt [7] for Brazil; Garcia [8] for Columbia; and Sjaastad and Clements [2] for Chile.* The results of most of this work are in fact summarized in Sjaastad and Clements [2], but the essential features are noteworthy for purposes of comparison with the above analysis of shifting in Mauritius.

The summary results of other work are presented in table 6. The time periods covered are in some cases longer than that deployed in the case of Mauritius, although it must be recognized that in many of these cases annual (as for Argentina) or quarterly (as for El Salvador) data were relied upon. Thus the present study had as many degrees of freedom as most of the other work. Conventions with respect to the construction of the price index also vary from study to study. In some cases single-product indices are relied upon, in others multi-product indices are deployed. Moreover, in some cases exportables refer to traditional exports and in others to a composite index of both. Although results are available for only six other developing countries, all Latin American, they do at least encompass a variety of time periods and rely upon alternative data bases.

As may be seen from table 6, estimates of the proportion of import protection which is shifted in the form of an implicit export tax vary from 53 per cent in the case of Uruguay to 95 per

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*The only attempts to apply shift analysis to developed market economies have involved the United States and Australia. One interesting feature of these studies has been the attempt to estimate w directly from general equilibrium models.

cent in the case of Colombia, with the unweighted mean being 67 per cent. The results reported above for Mauritius are not wildly at variance with these findings. The estimated shift parameter for non-traditional exports is lower than the mean for both periods (49 per cent for 1969-1976 and 59 per cent for 1976-1982), while that estimated for traditional exports is greater (at 85-86 per cent).* In line with previous work, our analysis suggests that a substantial proportion (at least half) of the protection conferred on import substitute activities is shifted in the form of an implicit export tax. Since (to the authors' knowledge) this is the first attempt to estimate shift factors for a non-Latin American developing country, the results are particularly interesting.

F. Policy implications of shifting analysis

Much of the theoretical and empirical analysis of industrial and commercial policy in developing countries is founded in partial equilibrium analysis. Thus one might be concerned with the ranking of instruments of intervention to meet specific objectives. For example, the World Bank is currently attempting to persuade Governments of the superiority of tariffs over quotas (see Krueger [9], [10]). Another direction of analysis which is partial in spirit is the estimation of effective rates of protection, since this indicates something about relative resource pulls between protected industries (see Corden [11] and Greenaway [12]). Yet another area of interest is the design of effective export promotion policies.

Table 6. Estimates of the proportion of import protection shifted to implicit export taxes in Latin American countries

Country	Period	Percentage shifted
Uruguay	January 1966-October 1979	53
Chile	July 1959-December 1980	55
Argentina	1935-1979	57
El Salvador	First quarter, 1962-fourth quarter, 1977	70
Brazil	1950-1978	70
Colombia	January 1970-December 1978	95
	Average	67

Source: Compiled from Clements and Sjaastad [2], table 1.

*The burden in public finance or shifted tax terms is greater on the traditional export sector. Greater substitutability between the home goods and non-traditional export sectors means that import protection may divert more resources from the production of manufactured exports.

Shifting analysis is not a substitute for such partial analyses but rather serves to complement them in an analytically useful manner. Although partial analyses of effective protection, tariff equivalents etc. provide a great deal of detailed information relating to intervention in particular sectors, by their very nature they do not permit one to evaluate the consequences of intervention at the sectoral level. By contrast, shifting analysis permits us to focus on the relative price effects of all interventions across sectors. This ability of the technique to focus on ex post general equilibrium effects has a number of important implications for policy evaluation and formulation.

First, the technique permits one to make explicit the relative price effects of invisible as well as visible interventions. For example, as long as quantitative restrictions have relative price effects, these will influence the value of the estimated shift parameter. Without having to undertake the very demanding (and resourse-intensive) exercise of estimating individual tariff equivalents of quotas, one can gain some guidance as to their sectoral relative price effects (along with tariffs) through the shift coefficient.

Second, through the medium of the true tariff and true subsidy concepts one can establish the true protection given to a particular sector. As long as separate incentives are given to different sectors, true protection will be less than apparent protection.

Third, the technique allows one to make explicit the cancelling, or offsetting nature, of many interventions. Since most economies tend to pursue simultaneously policies of import protection and export promotion, this is an important feature of the methodology.

Fourth, leading on from the above, the technique emphasizes the need to design consistent policies in order to meet a given strategic objective - whether this be import protection or export promotion.

Fifth, by focussing on relative prices across sectors, one can infer something about relative investment incentives across sectors. From the standpoint of explaining why non-traditional exports fail to grow at a rapid rate despite apparently generous incentives, this is extremely useful.

Sixth, the analysis suggests that if the overall objective is export promotion, then one of the most direct routes to this goal may be simply to alter relative incentives through import liberalization.

One can usefully apply some of these ideas to the case of Mauritius. As outlined in section B, there have been endeavours to protect against imports and promote exports simultaneously, through the Development Certificates and Export Processing Zone provisions respectively. Although the incentives associated with the latter are superficially generous and certainly contributed to the impressive growth of some non-traditional exports (most notably clothing) during the 1970s, there is manifest disappointment that the provisions of the Export Processing Zone Act (1970) have not

been more successful, especially with regard to fostering local investment in exportables. Coupled with the widespread recognition in official circles that, as a classic small open economy, export promotion is fundamental to any industrialization programme, this has been viewed as a cause for concern.

The evidence of the econometric analysis of section C suggests that a central reason for the less rapid than expected, and currently decelerating, growth of manufacturing exports is the incentives which are provided to invest elsewhere. The results suggest that the incentives to invest in importables may offset to some exent the incentives to invest in non-traditional exportables by operating in large measure as an export tax. Not only are average (nominal and effective) import tariffs relatively high, but quota protection is an integral feature of the Development Certificates programme. The estimated shift coefficients suggest that this is an altogether more attractive package for local investors than those provided under the Export Processing Zone scheme.

G. Concluding comments

This paper has been concerned with estimating the general equilibrium and relative price effects of industrial and commercial policy in Mauritius. The objective of the estimation was to comment on the net relative price effects of policies which are applied simultaneously to protect against imports and promote exports. The analysis suggests that between 49 per cent and 86 per cent of all intervention operates as an export tax, depending on whether we treat exportables as traditional or non-traditional. It is likely that the net effect of these policies is to induce resources into import substitution activities and away from export promotion activities.

If, however, the strategic objective of policy is export promotion, which is probably the more reasonable assumption in the case of Mauritius, then policy is clearly not having the desired consequences. If one takes the view that the long-term prospects for industrialization are likely to be more promising if this is pursued through a strategy which gives greater emphasis to export promotion, and this is a view which has much to recommend it, then the implications of this analysis for policy reform are clear. In order to attract resources into the export sector one must either provide additional incentives to offset current disincentives, or reduce current disincentives, or both. The latter option is clearly the more efficient; unfortunately, however, it is also politically the more difficult one.

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OVERVIEW OF THE MICRO-ELECTRONICS INDUSTRY IN SELECTED DEVELOPING COUNTRIES

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MICRO-ELECTRONICS TECHNOLOGY, INDUSTRY AND TRADE

Introduction

The micro-electronics revolution could be said to have begun with the invention of the transistor in 1948 and the subsequent replacement of the thermionic valve by it as the basic electronic device. Semiconductor technology has since developed dramatically and equally far-reaching advances have been made in software, the second basic technology.

The combination of semiconductor and software technologies has fuelled a revolution that has created vast industries producing completely new products and services:

Consumer products;

Computer systems;

Telecommunications systems;

Industrial equipment etc.

The markets for these new electronics products and services are large with high growth rates and are fiercely contested, primarily by the developed economies of the United States of America, Japan and Western Europe.

The widespread application of these technologies and their products has fundamentally changed traditional ways of doing things. This change has effects in many areas of endeavour throughout the world, not only in the developed world but also increasingly in developing countries.

Governments everywhere now recognize the importance of what is happening and the question is no longer: "Is this of interest to us?" but "What must we do in our specific circumstances to maximize the benefits from this new technology and minimize its threats?"

The technological, industrial and trade background is sketched in the first part of this paper and the following issues are dealt with:

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(a) What is the state of the art of this technology and where is it going?

(b) What are the dimensions and nature of the industry and trade it has created?

(c) What policy measures are employed by the Governments of developed countries to promote the industry?

Technology

There are many ways to segment the industry: technology is discussed here under the headings semiconductors, software, computer and telecommunications systems and other applications.

Semiconductors

Electronic components are now based on materials such as silicon, germanium and gallium arsenide, which have semiconducting properties. Three categories of device may be distinguished:

(a) Discrete components such as transistors, rectifiers and diodes;

(b) Integrated circuits (ICs), for example, microprocessors and memories;

(c) Special purpose devices and circuits.

The rate at which semiconductor technology is advancing may be illustrated by the evolution in the scale of integration of ICs (see figure I). Different degrees of integration (number of transistors per chip of, for example, silicon) are described in table 1.

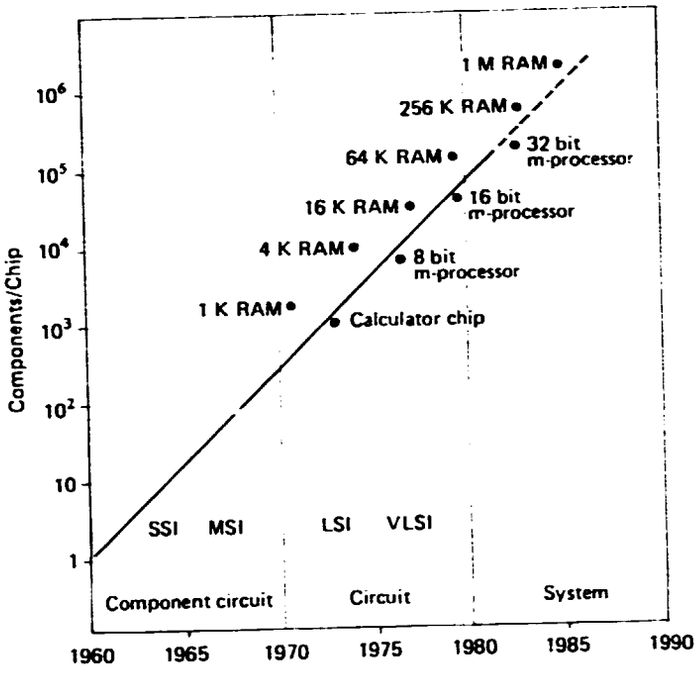
Table 1. Definition of degree of integration

Degree of integration	Number of transistors per chip
Small-scale integration (SSI)	30-80
Medium-scale integration (MSI)	300-800
Large-scale integration (LSI)	3 000-8 000
Very-large scale integration (VLSI)	30 000-100 000
Ultra-large scale integration (ULSI)	About 1 million

In figure I, 64K RAM, for example, means a chip containing 64 kilobits of random access memory, which is a device for temporarily storing data. Chips containing 256K RAMs are already commercially available in volume, and 1 megabit RAM chips should be commercially feasible in the next few years.

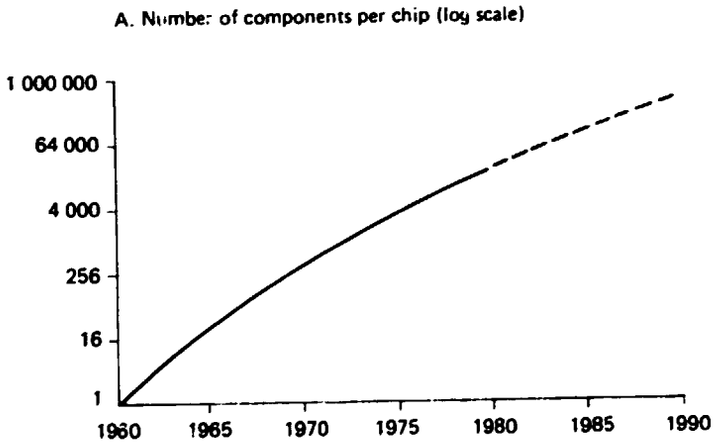
Even though the scale of integration per chip has increased exponentially with time, the costs per chip have fallen drastically. Figure II shows two characteristic curves for the evolution of integrated circuits.

Figure I. Evolution in the scale of integration of integrated circuits

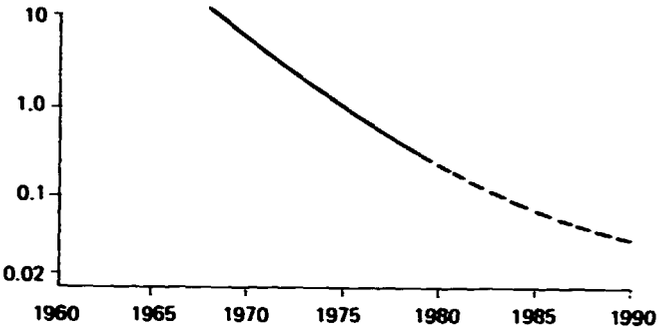


Source: Siemens.

Figure II. Characteristic curves for integrated circuits



B. Cost per chip (cents) (log scale)



Source: Intel Corporation.

These advances have occurred following substantial investment by companies and governments in research and development (R and D) on materials, and on the design and fabrication of devices. Typical industrial R and D investment amounts to about 7-10 per cent of sales in the United States and up to 15 per cent of sales in Japan.

Software

Limiting the analysis of micro-electronics to the semiconductor industry would give a very inadequate picture of its scope. It is the combination of electronics hardware and software into systems and applications that gives the sector its importance.

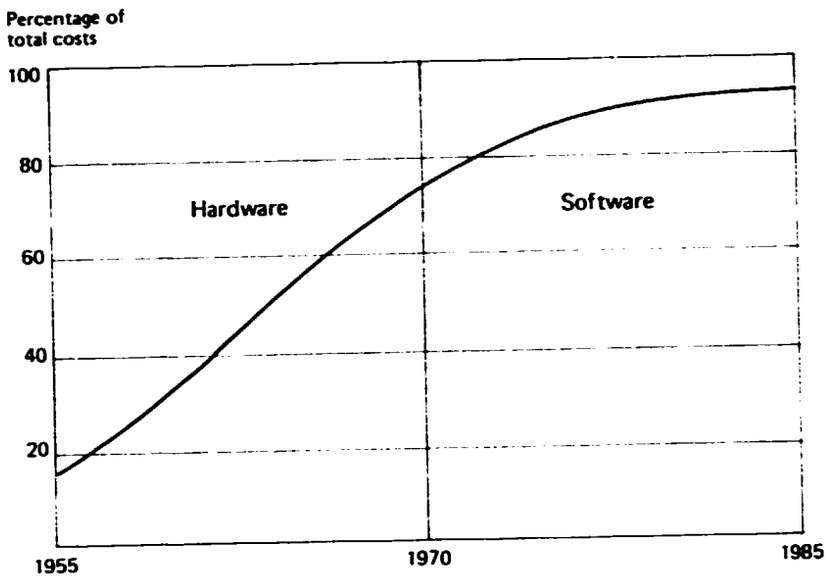
Software, defined as sets of purely conceptual data and instructions, is at the heart of all types and sizes of information technology applications. Computers and word processing systems, industrial automation systems, data banks, communication and telecommunication systems, electronic fund transfer systems, industrial products based on micro-electronics, air, sea and road transport control systems and various national defence systems are all built around and operate via their software.

The scope and pace of micro-electronics applications is limited by the state of the art of the software. There is much talk of a software bottleneck, which is, perhaps, most graphically illustrated by the well-known figure III, showing the evolution of the partitioning of costs of systems between hardware and software. Whereas the costs of components have fallen millions of times and of system hardware thousands of times, software costs have remained constant in the last two decades.

Software development is skill-intensive rather than capital intensive, but it is still very expensive, with, perhaps, thousands of man-years of development required for major new systems. Increasingly large sums are being spent by industry and governments in this area. The European ESPRIT programme will have a significant component dealing with software. The Japanese-initiated Fifth Generation Computer System (FGCS) will make major and far-reaching

advances in software technology over the next decade. The Strategic Defense Initiative (SDI), sponsored by the United States Department of Defense, is expected to be a major driving force in the development of software technology in the next five to seven years.

Figure III. Hardware/software cost evolution



Source: Computer, 1983.

Computer and telecommunications systems

Computers have become more powerful, faster, smaller, more reliable and cheaper over the last two decades. With the advent of the microprocessor, the new generation of microcomputers can today have comparable performance to some of the mainframe computers and minicomputers of earlier times, while being many times less expensive. In general, it can be said that from 1960 to 1980, the effectiveness of computers increased by a factor of 20, whereas the cost declined by 100: a 2,000-fold improvement.

Technical development continues rapidly and in the United States, where the industry continues to dominate world markets and where companies typically spend about seven per cent of sales revenues on R and D, new much improved systems will continue to be introduced. Japan is developing a new supercomputer, which should be 1,000 times faster than currently available machines.

The Japanese FGCS is largely based on the implementation of radically new software in VLSI. The proposed new concept is based on Prolog, a language used for artificial intelligence applications, and will use inference techniques in the development of expert systems. Whereas current computers can perform 1,000-10,000 of the logical inferences per second (LIPS) required in expert sys-

tems, the goal for the 1990s is to perform 100 million to 1,000 million LIPS. Another goal is to build a data flow machine comprising 1,000-10,000 processors, a storage capacity of 1-10 gigabytes and a speed of 1,000 million to 10,000 million instructions per second.

Current developments in telecommunications, involving digital switching and transmission, optical fibre technology and satellite systems, are enabling a wide range of new communications and information services to be provided. Many PTTs are planning to introduce integrated services digital networks (ISDNs) over the next decade or so, in which all information, whether voice, data, text and still or moving pictures, will be distributed to users over the same digital network.

Development costs for telecommunications systems are comparable with other electronics-based systems. For example, it has been estimated that about $1,000 million is required to develop a new digital switching system. This development cost is too large for even the largest European country to recoup from sales on its own domestic market.

Other applications

Computer and telecommunication systems are applications of micro-electronics that have produced huge new industries. Such, however, is the nature of the technology that it can be applied in an extraordinary variety of ways in many kinds of activity: manufacturing, service, commercial and social. The constraint on its application lies more with the imagination of the developer than with technical limitations.

Many new products are being introduced as a result of the application of micro-electronics: word processors, intelligent instruments, process controllers, games etc. However, the process improvement resulting from such applications is seen to be at least as important because of the enhanced efficiency and the ability to remain competitive in a very wide range of conventional manufacturing and service sectors.

Much attention is being focused on the manufacturing environment, with computer aided design (CAD) and computer aided manufacturing (CAM) undergoing significant development. CAM encompasses:

Numerically controlled machine tools;

Automated manufacturing systems;

Automatic monitoring and reporting systems;

Automatic warehousing;

Industrial planning and control;

Industrial robots.

Once more Japan, the United States and Western Europe, through national programmes and through the ESPRIT programme, are investing heavily in R and D in this area.

Industry and trade

Semiconductors

World production and consumption of semiconductors amounted to about $20 billion in 1983.

The United States and Japan are net producers of semiconductors. The United States produces nearly two thirds and consumes about one half of world production. Japan produces more than one quarter and consumes less than one quarter. The United States actually imported $4 billion worth of semiconductors in 1982, of which $3 billion was from United States offshore facilities in four Asian countries: Malaysia, the Philippines, the Republic of Korea and Singapore.

Western Europe and the rest of the world are net consumers of semiconductors. Whereas Europe consumes about one fifth of total world production, it produces less than half of that amount. The rest of the world consumes less than 10 per cent and produces about 2 per cent of total world production.

Electronic equipment

Although semiconductors are critical components of electronics systems, they may constitute a relatively small fraction of total equipment and systems cost. Telecommunications equipment, for example, had sales in 1984 of about $59 billion (estimated to be $100 billion in 1990), whereas the value of the semiconductors used in this equipment is approximately $3.5 billion.

The total world market for electronic equipment is currently more than $400 billion and is growing rapidly. Consumption of electronic equipment in the United States is broken down by subsector for 1984 with projections for 1987 in table 2.

Table 2. United States consumption of electronic equipment
(Billions of dollars)

Subsector	1984	1987
Data processing and office equipment	79.0	125.0
Software	15.0	24.6
Consumer	21.3	23.8
Communications	11.5	15.3
Industrial and military	57.1	70.6
Total	184.0	239.3

Source: Electronics, January 1984.

The anticipated high growth rates in data processing and office equipment and in software are particularly noteworthy.

Equivalent data for Western Europe and Japan for 1984 are given in table 3.

Table 3. Western European and Japanese Consumption of electronic equipment in 1984 (Billions of dollars)

Subsector	Western Europe	Japan
Data processing and office equipment	60.5	41.8
Consumer	15.8	11.2
Communications	12.8	3.0
Industrial and other	15.8	21.6
Total	104.9	77.6

Source: Electronics, January 1984.

Policy measures in developed countries

This section contains some brief indications of the policy measures used by the Governments of developed countries to promote the growth of their micro-electronics industries. Three regions are discussed separately: Western Europe (primarily the member States of the European Economic Community (EEC)), Japan and the United States.

Western Europe

Western Europe is a collection of sovereign States, each of which promotes its own industry with its own national programme. In addition to this, the member States collaborate and co-ordinate their activities in certain areas.

The measures adopted by Western European Governments to promote their industries may be categorized under the following headings: funding of R and D and other industrial support; promotion of awareness; and use of public purchasing.

The Governments of the 10 EEC member states spent about $3.25 billion in support of its micro-electronics industries during 1984. The national programmes of the United Kingdom of Great Britain and Northern Ireland and the Federal Republic of Germany are large, that of France being even larger.

The support is directed towards the following categories of activity: pre-competitive research; product-specific development; and other industrial support.

The sums directed to pre-competitive research are roughly one tenth of those devoted to product-specific development.

The areas of micro-electronics receiving most of these funds are: components; opto-electronics; telecommunications; information processing; software engineering; and computer integrated manufacturing.

The necessity to raise the level of awareness of the value of the application of micro-electronics in order to increase the efficiency of processes and the functionality of products is widely recognized by European Governments. Most countries have explicit government-funded programmes to meet this need. A total of about $300 million is spent by EEC member states on these programmes.

Most EEC member States use the substantial purchasing power of their public sectors to support the development of their national micro-electronics industries. This is the case for computers and especially so for telecommunications equipment purchased by national PTTs. In fact, most European PTT markets are regarded as essentially closed, i.e. it is extremely difficult for foreign companies to break into these markets.

It is recognized that, from the national point of view, there are positive and negative factors associated with these practices. On the positive side, the skilful and creative use of public contracts can develop new firms and improve the product range of established firms. On the other hand, the protectionism and lack of international competition for national firms in these markets can lead to inefficiencies and lack of competitiveness.

Public purchasing is one of the areas mentioned above in which EEC member states are co-ordinating their activities. It is recognized that none of the internal markets of any member State is large enough to develop industries capable of competing internationally with United States and Japanese companies in the long run. The internal market of the Community as a whole, however, is of a sufficient scale to develop a number of large internationally competitive companies. The co-ordinated use of the public markets across the Community is one approach to developing these companies.

The need for European firms to be competitive internationally with Japanese and United States firms also motivated the EEC member states to establish ESPRIT, a co-operative Community-wide programme undertaking pre-competitive research in the information technology (IT) field. The programme will cost $1.5 billion (50 per cent Community funds, 50 per cent industry funds) over the next five years and support the following five research areas: advanced micro-electronics; software technology; advanced information processing; office systems; and computer integrated manufacturing.

The programme is heavily industry oriented. It involves international collaboration between firms and research institutes in different countries and is aimed at complementing and integrating national programmes. Its ultimate objective is to provide the technological basis for European industry to achieve parity within ten years in the trade of IC products between Europe and the rest of the world.

Japan

Although Japan would claim to be less interventionist in the affairs of business than, say, Western European Governments, the Ministry of International Trade and Industry (MITI) plays a powerful role in developing Japanese industry. Together with the extraordinary degree of national co-ordination and co-operation between companies and Government this gives an impression of great coherence of policy and operation to the rest of the world.

A major strength of the Japanese system is the ability to plan long term and to institute and execute programmes to carry the plans to completion. Thus, the VLSI project brought Japanese industry to the forefront of IC technology at a cost of $250 million (50 per cent industry, 50 per cent government) between 1976 and 1979. A new range of MITI-sponsored projects is poised to have equal or more dramatic results in the next decade or so:

(a) The FGCS is a 10-year project, established jointly by MITI and eight leading electronics manufacturers, to transform completely the concept of a computer;

(b) The Supercomputer Project is intended within eight years to develop a computer 1,000 times faster than those presently available for scientific and technological use, at a cost of $100 million;

(c) A robotics project will develop the next generation of robots over eight years with $100 million from MITI and involve a wide range of public and private research institutions.

Japanese firms co-operate readily in the pre-competitive phase of these projects but then compete vigorously with one another and with the rest of the world in the market-place.

In support of these activities, the Japanese have developed, over the last several decades, an extraordinarily sophisticated system for acquiring relevant technological information around the world. They also have highly developed skills for acquiring technology through licences, know-how agreements etc. with foreign technology leaders and in transforming this technology to their own use.

United States of America

The United States, both by explicit policy and by actual practice, intervenes less than most countries in the affairs of business. Government action is intended to create an appropriate environment within which individual and corporate entrepreneurial effort will flourish. The Government will intervene if the public good is threatened by, for example, monopolies or quasi-monopolies wielding an excessive amount of economic power. However, the market is generally seen as the best regulator and the determinant of success or failure.

This view of United States policy is largely true but requires some modification in certain high technology fields and notably in the field of micro-electronics. It is widely acknowledged that the

public purchasing efforts relating to United States space and military programmes have had far-reaching spin-off effects in this area. A number of substantial programmes can be mentioned:

(a) The United States Government invested $280 million in IC-related R and D between 1978 and 1982;

(b) A military research programme, the Very High Speed Integrated Circuit (VHSIC) Project, will cost $225 million during the period 1980-1985 and is expected to have major spin-off benefits for non-military products in the telecommunications and computer fields;

(c) The SDI programme, another United States Department of Defense sponsored project, deals with software development for military systems but is expected to have significant spin-off effects on software generally.

In general, however, companies fund their own R and D and do not expect contributions from Government. The recently created MCC consortium provides an interesting contrast to European and Japanese approaches. The consortium consists of major United States companies in the electronics field (not including IBM) that have come together to some extent in response to the European ESPRIT and the Japanese FGCS to collaborate and share expertise in advanced pre-competitive research in IT sectors. Unlike the European and Japanese efforts, however, MCC was initiated solely by private companies and receives no explicit United States Government aid.

POSITION OF SELECTED DEVELOPING COUNTRIES

Introduction

This section presents a summary and synthesis of five country reports, separately prepared by local experts in each of the countries: The Republic of Korea, India, Pakistan, Bangladesh and Venezuela. Further analysis and recommendations are provided in the next section.

Three caveats must be made:

(a) The selected countries are at radically different stages of economic and industrial development. At one extreme, the Republic of Korea has a well-developed and internationally competitive electronics industry. At the other extreme, Bangladesh is at the very early stages of industrialization. The issue of level of development is dealt with in the next section;

(b) Although the case study experts worked from identical terms of reference, the interpretation differed from study to study, leading to a lack of uniformity and some gaps in the data presented;

(c) This summary is inevitably an incomplete statement of the situation in the selected countries. The country reports should be consulted for further detail.

Government strategies and policies

The importance of acquiring and applying micro-electronics technology for national development paths and particularly industrialization prospects has been recognized, by statement and action, by all the Governments of the countries studied. However, only the Republic of Korea and, to a lesser extent, India have what could be regarded as an articulated strategy and related policies for micro-electronics technology. In the Republic of Korea, the micro-electronics industry is classified as a strategic industry and is given appropriate emphasis in the latest five-year plan (1982-1986). In India, the area is also accorded special significance in national science and technology and industrial policy. In Pakistan, the profile of the electronics industry has been raised in the sixth plan (1983-1986). In its scheme for Export Processing Zone industries, the micro-electronic products industry has highest priority. However, the absence of a clear Government policy in Venezuela, based on an objective technical analysis, is perceived as a hindrance to the appropriate nature and pace of micro-electronics development. Apart from petroleum-related R and D, no particular fields have yet been defined as priorities. Bangladesh has also not yet defined its technology strategy and policies in the electronics area, but steps are being taken through a recently established national committee for science and technology and other relevant committees to frame a national policy and strategy in different technical fields.

The perception of Government's role in intervening in industrial development and the appropriate balance between public and private sectors varies from country to country. In the Republic of Korea, it is seen as essentially that of co-ordinating the environment for the industry with the primary thrust coming from the private sector. The Government also sets frameworks for the education system and for the national research laboratories. In Pakistan, while the mixed economy approach will continue, the public sector role is seen as a promotional one, with major emphasis on encouraging private investment.

The kind of environment within which private investment in high technology industries, including electronic industries, is to flourish is being cultivated in different ways:

More liberal overseas interface with respect to foreign capital inducement and technology acquisition procedures (Republic of Korea);

Guarantees of capital and profit repatriation (Pakistan);

Commitment not to nationalize industries (Pakistan);

Tariff restructuring (India and Pakistan);

Reduction in duty on capital equipment (India and Pakistan);

Tax exemptions or tax holidays (Pakistan).

Other elements of active "environmental" promotion are discussed below under R and D, manpower and training and the acquisition of technology.

In Venezuela and India the Governments play a more substantial role than environment setting. They intervene by owning companies, regulating privately owned companies and creating a protected market environment.

Electronics manufacturing industry

The Republic of Korea is the only one of the five countries studied whose output of electronic products is significant in world terms. Its share of the world market has increased from 1.3 per cent in 1977 to 1.8 per cent in 1982 and is growing at more than 30 per cent a year. Furthermore, it is the only country that is a net exporter of such products. It has widespread involvement in consumer products, industrial products and components. The highest rate of subsectoral growth in recent years has been in industrial products and firms in the Republic of Korea have a significant presence in the more advanced products of these industry subsectors.

All major corporate groups are investing heavily in the micro-electronics industry and many small companies are also actively involved. Government is actively promoting the industry and the technology, as evidenced by the emphasis in the fifth five-year plan (1982-1986) and in other longer term planning exercises, namely for the electronics industry (1983), the semiconductor industry (1982) and the computer industry (1984). The exercise of effective planning and promotion of the industry in the Republic of Korea is facilitated by the dominance of domestic investment in the industry. For example, in 1982, 58 per cent of output was produced by domestic firms, 22 per cent by joint venture firms and just 20 per cent by foreign firms. The highest growth rate for 1981-1982 was in the domestic sector.

India also has significant industrial activity in the following subsectors: consumer products, industrial products and components. However, it is not self-sufficient in any of these areas.

Communication and broadcasting equipment and aerospace and defence equipment figure large in the industrial products category. The rate of growth in output of electronics products in India is high, averaging more than 20 per cent (compound) over the past three years.

Certain Government plans are expected to provide a considerable boost to demand for integrated circuits: the opening up of new television stations, digitalization of the communication network, the introduction of a public switched network and a circuit switched data network (and possibly packet switched data network), the modernization of industrial sectors like steel, fertilizers, petrochemicals, cement etc. Micro-electronics will also be used in railways, agriculture and health care and computers will be introduced in schools and colleges. Preliminary estimates suggest that about two thirds of the greatly increased demand could be met by indigenous production, providing appropriate investment is made in production, R and D, materials and the manpower base. A Government Task Force on LSI/VLSI, set up in 1982, is preparing its final report, but has already identified the major gaps and made recommendations for an investment programme covering R and D, production and manpower over a period of ten years.

In Pakistan, the annual requirements of all electronic equipment are estimated to be $300 million, of which consumer products constitute 38 per cent, industrial products 52 per cent and components 10 per cent. The annual proposed production in the sixth plan (1983-1988) for manufacturing industry and products is expected to meet about 70 per cent of requirements.

The amount to be invested in electronics under the sixth plan represents a tenfold increase in investment in that area under the fifth plan. Top priority is being given to electronics in the export processing zone scheme, which allows foreign investment with added incentives.

Bangladesh is still at the stage of assembling consumer electronic products from imported components. These products are mainly television sets, radio receivers and radio cassette recorders for the domestic market. Only five companies are actually using ICs in manufacturing and most are dependent on technical collaboration agreements with foreign companies. None of the basic components are manufactured in the country. The national organizations for communications, aviation and airlines and meteorology all use ICs in their equipment, but most of the equipment is supplied and maintained by Japanese and other suppliers.

In Venezuela, the pattern of industrial production is as follows:

(a) In telephone production, the country is virtually self-sufficient and now technologically independent. The telephone company's production is mainly oriented to meeting internal requirements (about one-quarter of a million new telephone lines per year);

(b) In the field of professional and consumer electronics goods, the market is dominated by many foreign based companies. These are mainly dedicated to the sale of their own products with only one having even a local assembly operation for television sets and sound equipment;

(c) A number of recently established indigenous electronic companies produce capital goods in the areas of telephones, electricity, control and instrumentation. Total assets of these companies are about $4.5 million; annual sales are about $11 million and are increasing rapidly with rates of 20, 50 and 66 per cent being achieved in the years 1980-1983, respectively. Their establishment is regarded as a very significant first step in the development of an autonomous electronic industry in the country.

Applications of micro-electronics

Applications in this context means the use of microelectronics-based equipment, instruments and devices in manufacturing and service activities other than in the manufacturing of electronics equipment itself.

A wide range of such applications can be identified, including:

Computing and data processing in public administration, finance and insurance, management information and control etc.;

Manufacturing, e.g. process control and CAD/CAM (many applications throughout all sectors of industry);

Communications services, meaning telecommunications over both networks and broadcast media;

Other public services, e.g. transport, energy, aviation, meteorology and medical services.

All of the countries surveyed have some appreciation of the value of the appropriate use of this technology, the actual use depending largely on the general state of development of the economy.

Micro-electronics are most widely used in the Republic of Korea and India; the former is introducing increasingly sophisticated industrial uses and India has a wide range of public services applications.

In Pakistan and Venezuela the use of electronics is less sophisticated and comprehensive but is growing in all the above sectors.

Bangladesh's experience of micro-electronic applications is small and lies largely in the public service area.

Research and development

Not suprisingly, the R and D status of the countries in question reflects the industrial profile outlined in the preceding sections.

The efforts of the Republic of Korea are highly organized at the public, private and academic levels. The Indian effort seems set to benefit from improved organization and specialization as a result of several recent governmental initiatives. Pakistan's efforts are still at the initial stages of development, while the activities in Bangladesh are extremely limited although steps to define a suitable national R and D programme are in progress. In Venezuela, there is a steadily improving base in the recently established Foundation for Engineering Research and Development (FII) and in some of the universities for the development of electronics R and D.

The situation in each of the countries is summarized below.

Republic of Korea

Increasingly, industrial R and D is carried out in the firms themselves. In addition, substantial industrial R and D activities are carried out in national research laboratories, mainly funded by Government or public corporations. One of these laboratories, the Korean Institute of Electronics Technology (KIET), was established in 1979 and jointly funded ($29 million) by the Government and the World Bank. Limited research activities in the universities are funded by public and private sectors.

The national laboratories specialize to a large extent. KIET focuses on the design and fabrication of ICs. The Korean Electrotechnical and Telecommunications Research Institute (KETRI) focuses on R and D activities for public telecommunications networks. Its main areas are: advanced electronic switching systems; fibre optics networks; and information networks such as ISDNs. Its programmes are carried out on a multi-annual (five-year) basis.

A division of the Korean Advanced Institute of Science and Technology (KAIST) also carries out research activities in many areas of micro-electronics.

India

Most R and D activities in micro-electronics are carried out in established national research institutes (one of which is the Central Electronic Engineering Research Institute (CEERI)); in the R and D wings of two public corporations, Bharat Electronics Co. (BEL) and the recently established Semiconductor Complex Ltd. (SCL); in the research laboratories of dedicated government departments (atomic energy, space, defence, railways and communications); and in five of the Indian Institutes of Technology (IITs), which have fairly extensive facilities.

The Government is encouraging national laboratories and other organizations to conduct design and development work to suit specific industrial, scientific and other civilian needs, recognizing that, except for the captive R and D units of manufacturing organizations, the level of technology transfer has not yet been very effective.

The basic interest of CEERI lies in the NMOS process and it has already developed some circuits of LSI complexity.

In 1971, the Tata Institute of Fundamental Research (TIFR) developed the first IC to be made in the country. The institute's strength lies in IC design and fabrication, CAD systems and software packages. Its current work includes CMOS metal gate and silicon gate technologies.

The R and D department of India Telephone Industries (ITI) also has a strong group working on the design of LSI subsystems using CAD and is now piloting the fabrication of custom LSI circuits.

The five IITs have an infrastructure capable of developing ICs of LSI complexity. A certain degree of specialization is evident in the building up of the respective strengths in various aspects of the technology.

The recently stabilized SCL is building up a comprehensive production and R and D base up to the level of LSI/VLSI. It will undertake LSI/VLSI design and projects aimed at establishing and upgrading the company's capability for meeting national needs. India's largest company in the field, BEL, has already been carrying out some R and D activities in addition to drawing know-how from a United States company.

While several institutes possess CAD facilities, competence in IC design is limited to a few individuals in each centre. The recent launch of a four-year national CAD programme with support of the United Nations Development Programme (UNDP) will provide training/education facilities for CAD and establish CAD software exchange systems.

The Government is also planning to promote a chain of decentralized design centres for IC, feeding centralized chip production facilities (eventually at SCL and BEL).

Pakistan

Recently established Government institutes predominate; the National Institute of Electronics (NIE), set up in 1980, commenced active research work in 1983. The main areas of activity relate to test equipment, computer/microprocessor applications, communication projects, control applications and medical instruments. The Carrier Telephone Research Laboratories set up in 1981, with Japanese collaboration, concentrate on various aspects of telecommunications requirements. A Silicon Technology Development Centre was set up in 1981, with assistance from the United Nations. It will seek to transfer this technology and acquire indigenous skills and information. It will conduct research and have pre-production facilities to support the development of silicon microchips and semiconductor devices, silicon-based practices and solar cell technologies.

A limited R and D effort in the application of microelectronic products and development of hardware and software in computer technology is carried out in a number of university departments.

Other Government organizations conduct a certain amount of R and D in micro-electronics technology appropriate to their own needs.

Five institutes, funded by private individuals and, in one case, sponsored by a bank, have also recently been established.

Bangladesh

University departments and two national institutes carry out what limited R and D is in progress.

The Institute of Electronics and Materials Science has the most relevant programme. The University of Dhaka has initiated a scheme for the creation of an Institute of Silicon Technology.

Venezuela

Government and Government-sponsored agencies and national universities fund and carry out most of the research in microelectronics. The principal institution, the FII, has 70 researchers, which is expected to increase to 200 by 1988.

The Venezuelan Institute of Scientific Research has a limited profile, dealing mainly with theoretical analysis of existing and new semiconductor devices.

The universities of Carabobo and Simon Bolivar also do research in the area, while activities at other universities are mainly concerned with microprocessor applications and software development for microchip systems design.

Major State-controlled telephone and telephone manufacturing companies have done little development (except that related to specialized instruments for their own use) and no research.

In addition to electronics, the FII covers other fields of engineering and is increasingly directing attention to various aspects of micro-electronics, particularly hybrid circuitry. Other projects are being developed at FII under contract agreements with confidentiality requirements. One of these relates to design and construction of an automatic machine voting system to be ready before 1989. Areas in which expanded R and D activities are foreseen include: microstrip elements; gallium arsenide technology; fibre optic systems and components; solar cells; digital image processing (which is expected to increase tenfold in the next five years); and software. The main Government funding agency for R and D projects, CONICIT, still continues to apportion funds on the basis of technical quality rather than by reference to strategic priorities.

A proposal currently being considered by the Government to introduce a tax on the productive sector to provide funds for the financing of local R and D activities is being hailed as a positive step in the country's development.

Manpower and training

All Governments realize that skilled manpower is an essential prerequisite for an electronics industry that goes beyond mere assembly operations. The education and training of such manpower is universally accepted as a responsibility of Government.

Each of the countries surveyed actively participates in this area and their programmes are presented below.

Republic of Korea

There is sufficient manpower overall, despite rapid growth, but there are certain shortages of experienced personnel in management and engineering. There is an acute shortage of middle-level managers and design engineers, which is exacerbated by job-hopping and by engineers being promoted too early to management.

Training is provided by educational institutes, by research institutes and overseas. Overseas training is common now, with many comprehensive technology acquisition agreements including intensive training, particularly in manufacturing technology and maintenance. Training in design and project management necessary to develop next generation products is still inadequate. Recently concluded arrangements with two companies in the United States will seek to remedy these limitations.

Instruction in junior colleges needs to be improved, while facilities and instruction at graduate schools, except for a few institutions, are generally out of date and inadequate.

Postgraduate training in-house and at national institutes is improving. Industry is also paying more attention to in-house training. KAIST offers good training, but costs are much higher than at universities.

India

The lack of adequate manpower of appropriate calibre has been a major bottleneck in the development of composite technology for ICs. The good engineers who acquire basic training often go abroad to more lucrative assignments. There is also a lack of incentive among students to undertake IC technology as a major discipline. However, the situation is improving: in certain areas of the technology a high level of expertise is now available and the major expansion of LSI production now embarked on will provide greater opportunities. The need for incentives to promote and retain the indigenous competence is recognized.

Several nationwide training programmes are being launched:

(a) Microprocessor training is being phased into the graduate and undergraduate curriculum. About 3,000 teachers will be trained in micro-electronics by 1985;

(b) Computer education is being introduced on a pilot basis in about 50,000 secondary and higher secondary level schools;

(c) The Appropriate Automation Promotion Programme of the Department of Electronics, funded by Government and UNDP/UNIDO, is training engineers and scientists from industries and other organizations in the field of micro-electronics and applications. Another such programme on microprocessor applications engineering is planned;

(d) Computer Maintenance Corporation offers training in various aspects of software technology under INTERACT, another UNDP assisted programme;

(e) The Centre for Electronics Design offers specialized training to sponsored personnel from small industries in all aspects (theory and practice) of electronics design. Another such centre is planned;

(f) Professional bodies also offer training.

Pakistan

Qualified manpower in subjects allied to micro-electronics is produced in abundance by the 24 universities and polytechnics (400 professionals and 300 sub-professionals per year since 1978). Enrolment in 1983/84 in professional disciplines of electronics was 500. Up to 300 high level and 200 lower-level technicians qualify from polytechnics each year.

The approximately 1,000 Pakistani engineers or scientists and up to 2,000 technicians working abroad in the field of electronics technology are taken into account in concluding that sufficient manpower is available to undertake any electronics ventures in the country.

In addition to degree courses, other institutes provide training in micro-electronics technology and the use of computers:

(a) A recently established computer training centre emphasizes "hands on" training in the facilities available at the centre;

(b) Various computer programming and data processing courses are available;

(c) The NIE is looking at digital and microprocessor developments;

(d) Suppliers of foreign technology train Pakistani engineers in the maintenance and after-sales service aspects of their products.

Bangladesh

There is a constant flow of trained personnel out of the country. Engineers and scientists trained at universities, including the Engineering and Technology University, do not find attractive employment prospects at home, either from the point of view of facilities to apply their skills or the salary levels available.

Existing facilities at university level and in-house training at the telephone and television companies etc. are insufficient to produce the numbers of personnel needed to develop the industry.

Intensive training at technician and supervisory level is also inadequate. An integrated approach for delivery of such training is necessary, including inter-country or bilateral co-operation in this area.

Ad hoc arrangements with suppliers for training related to the maintenance and servicing of electronic equipment are inadequate.

Venezuela

The small number of trained professional engineers and the low quality of their training are not barriers to achieving indigenous technological development. However, in general the use of their engineering skills is kept to a minimum since they find jobs in management, sales and purchasing. A more appropriate exploitation of the engineering design skills available is found in engineering consulting firms, in the petroleum industry and in the recently established indigenous electronic companies (200 personnel).

State support via graduate scholarships was significant in the training of a large proportion of the founders of the indigenous electronic companies.

The use of scholarships for training graduate scientists and technicians abroad in the early sixties was significant in establishing indigenous expertise in electronics. It continues to be used as such a tool.

The National Telephone Co. operates a training centre for telephone engineers.

Training in the maintenance of Hewlett-Packard products is given to sizeable groups of Venezuelan technicians and engineers.

All of the major academic institutions offer microprocessor courses in the regular electrical engineering study programmes.

Major state R and D organizations are also a major source of trained personnel.

Acquisition of technology

Technology can be acquired from abroad by a country in a number of ways, for example through direct foreign investment, licensing of packaged technologies, licensing of unpackaged specific technologies, know-how agreements for specific technologies, training abroad, joint venture agreements and comprehensive agreements, including the outright purchase of proprietary technology.

The means by which technology is effectively transferred to a country is critically dependent upon the indigenous expertise or the capacity of the host country to receive it. This is illustrated by the approaches adopted by the countries surveyed.

The Republic of Korea has used all the above approaches and is by far the most successful of the surveyed countries in this regard. The final section of this paper gives an analysis of the various stages of development the country has undergone.

Most technology acquisitions are financed by domestic funds, but some have been carried out with loans from the World Bank, the EXIM Bank and the Asian Development Bank.

The country is currently in the process of changing from a positive to an automatic acquisitions policy. Companies can acquire technologies automatically by simply submitting an application form, unless Government decides to seek further information.

India has used the direct foreign investment route and the licensing of both packaged and unpackaged technologies. Indians trained abroad and returning to their own country constitute a valuable source of technology transfer. The country has been less successful in joint venture arrangements or comprehensive acquisition. Technology importation is strictly Government controlled.

The conventional methods of transferring technology have not worked well in Pakistan in this field, due to the difficulty of absorbing the technology with its high rate of obsolescence.

Using the export-processing zone industry scheme, the Government has, therefore, sought to acquire technological know-how, train professional manpower and establish an industrial infrastructure to improve the capacity for indigenous absorption and adaptation of technology. The micro-electronics industry has the highest priority within the scheme. Joint ventures with reputable foreign firms are seen as a desirable future path.

A global approach to technology acquisition has not yet been defined for Venezuela. Only a few examples exist of technology genuinely transferred to indigenous use from multinational

companies. Training of Venezuelans abroad over the last two decades has, however, been valuable and has led to the growth of the emerging indigenous electronics sector. There is an awareness of the need for a more systematic approach to the acquisition of technologies in the field.

As the electronics industry in Bangladesh is mostly limited to assembly operations, the transfer of technology is limited. Those companies using imported micro-electronics in television production mainly rely on technical collaboration agreements with reputable foreign companies (e.g. from Japan and Thailand). Another company manufacturing electronic fences has entered in a joint venture with a Swedish company.

Foreign suppliers of equipment and technology

The information is most easily presented in the following tables.

Republic of Korea

Table 4. Suppliers of equipment and technology in the Republic of Korea

Equipment/technology	Suppliers
Semiconductors Including NMOS, CMOS, linear, hybrids; process, design and fabrication technology; 32K ROM, 64K RAM, 8-bit microprocessors	Companies in Japan and the United States
Telecommunications Including electronic switching systems, private branch exchanges, electro-mechanical switching systems	Companies in the Federal Republic of Germany, Japan and the United States
Computers and industrial Including CAD, robots, monitoring and control systems	Companies in Japan and the United States Three suppliers are owned 100 per cent by local firms in the Republic of Korea

India

Table 5. Suppliers of equipment and technology in India

Equipment/technology	Suppliers
Computer systems	United States, United Kingdom, Union of Soviet Socialist Republics, Netherlands
Computer peripherals Including floppy disk drives, tape drives, hard disk drives	United States, United Kingdom, Japan, Federal Republic of Germany
Process control equipment Digital equipment and computers	United States, United Kingdom, France, Sweden, Federal Republic of Germany
Data acquisition and control systems	United States, Japan, France, United Kingdom
Communication equipment	France, United States, Switzerland
Electronic instruments Including special applications	United States, Europe (United Kingdom, Netherlands and others)

Pakistan

Most of the micro-electronic technology and equipment has been imported from the United States, Western Europe and Japan.

Table 6. Suppliers of computers in Pakistan

Manufacturers	Number	Percentage
IBM	60	58.8
ICL	19	18.6
NCR	17	16.6
Others	6	5.9
Total	102	100

Products from Japan, the area of Hong Kong, the Republic of Korea and Singapore are now finding wider acceptance in Pakistan and other Asian countries.

Bangladesh

Japan is the main foreign supplier of micro-electronic technology and equipment to Bangladesh.

Venezuela

The main suppliers of electronic consumer and professional goods are foreign-based companies operating in the country, e.g. companies based in Germany, Federal Republic of, the Netherlands and the United States.

Raw materials and the infrastructure for sub-supply

Raw materials, particularly for IC production (e.g. IC grade silicon, high purity chemicals, high grade metal products, fine ceramics, specialized resins), are mostly unavailable from local sources and must be imported. Both the Republic of Korea and India are creating the capacity for the indigenous production of certain essentials.

The infrastructure for the supply of materials, components and subassemblies to local electronics equipment manufacturing units is poorly developed in all countries. Once more, the Republic of Korea and India are making most progress in this area.

Areas for international co-operation

Suggestions made for international co-operation in each of the country case studies are summarized below.

The Republic of Korea identified needs and opportunities in the following areas:

IC design centre with CAD;

Joint large-scale R and D programmes;

Training centres for managers and engineers;

Regional computer networks;

Pilot plant for wafer production for custom chips;

Consultancy and systems study.

The partners for such co-operation and the methods to be employed were not identified.

The Indian case study identified the following areas where it could offer assistance to others in the region:

Design and fabrication facilities for custom/semi-custom chips;

Hosting of a regional centre for IC design and technology;

Creation of a centre of electronic design technology in Thailand;

Expertise in micro-electronics applications engineering;

Expertise in applications software;

Expertise in programmes promoting the use of micro-electronics;

Consultancy skills in certain areas;

Exchanges of scientists and engineers;

Student training.

India needs assistance from more advanced countries for software for LSI design, skills in system software, exchanges of scientists and engineers and student training.

Pakistan identified the following areas where it could offer expertise:

Education and training in electronics and computer science;

R and D collaboration in computer hardware and software and component technology.

Areas where it needs assistance include CAE/CAD/CAM/robotics, fibre optics, LSI/VLSI design and fabrication technologies, on the job training in advanced countries and equipment and system design. Regional co-operation agreements are seen as the preferred approach.

Bangladesh requires industrial support for the proposed National Institute for Electronics and instructors and equipment for the Institute for Scientific Instrumentation. It seems scope for sharing facilities with India and Japan and is particularly interested in the recommendations of an international symposium in New Delhi (1983) to establish an Asian Institute of Electronics Technology in Bangladesh.

Venezuela sees scope for technology agreements between middle-tier developing countries in Latin America and for trade agreements, political treaties and natural resource supply contracts between developing and developed countries.

It is particularly interested in a proposal to UNIDO to establish a Regional Centre for Applied Micro-electronics centred on the FII in Venezuela. Activities of this centre could include:

R and D directed towards design and applications relevant to the needs of partially developed countries;

Technical assistance to new industry establishments;

Technical training;

Technical information focus.

Such a centre could be networked with other similar institutions in co-operating countries.

ANALYSIS AND RECOMMENDATIONS

A model of development

In order to facilitate the analysis, a model is described first of the development of a national micro-electronics industry. The stage of development of selected developing countries is then discussed by reference to the model. Finally, recommendations are made with a view to helping these countries to advance along the path of development.

The model [1] envisages three stages:

(a) Implementation;

(b) Assimilation;

(c) Improvement.

Implementation

The implementation stage presumes no indigenous innovative capacity.

Production at this stage is merely the assembly of foreign components and parts with equipment purchased from overseas. Technology is acquired through direct investment or through "packaged" technology from overseas. Packaged technology includes assembly processes, together with product specifications, production know-how, technical personnel and component parts.

The focus is either on import substitution or, if the firms are off-shore production units of MNCs, exports to markets developed by the parent company overseas.

The technological task is the implementation of the transferred foreign technology in order to produce products whose technology and markets have been tested and proven elsewhere. For this purpose, only limited engineering efforts are required.

The implementation stage allows a country to establish an industry where none existed before, but does not enable it to develop new products or new markets.

Assimilation

At the assimilation stage firms acquire a certain mastery over the production technology and are able to produce modified or differentiated products for differentiated markets. It requires indigenous effort to assimilate the foreign technology. Technical emphasis is placed on engineering and limited development rather than on research.

A cadre of experienced technical personnel is created or spun-off from existing companies and the mobility of these experienced people leads to a diffus of production technology within the country.

Competition may develop in local markets and also be influenced by foreign market developments. Entrepreneurs will develop the capacity to use technology for competitive advantage by lowering production costs and making limited product and quality improvements.

At the assimilation stage an industry can develop that is organically growing and, to some extent, under the control of the indigenous entrepreneur. It does not, however, result in an industry developing completely new products for existing and new markets.

Improvement

The improvement stage, which sees the improvement of foreign transferred technology and the production of significantly improved or new products, requires significant inputs of local technical efforts. It is characterized by training and education programmes to produce highly skilled people and significant national R and D efforts. It may entail further inward technology transfer but, at this stage, the technology will be "unpackaged". Licensing, know-how agreements and joint ventures with foreign technological capacity will be pursued.

It is also likely that the sub-supply of materials and components will be at the local level. Competition on local markets will be stronger and foreign markets will be pursued, probably through national export promotion schemes.

A successful transition through this stage may see an internationally competitive industry, capable of taking on world leaders in certain niches of the market.

Stage of development of selected developing countries

The model was employed to characterize the stage of development of micro-electronic activities reached by selected developing countries or areas in East Asia, Latin America and Southern Asia.

Selected developing countries for areas of East Asia

The Republic of Korea, Taiwan Province of China, the area of Hong Kong and Singapore account for 80 per cent of all electronics exports from the less developed countries. When they started developing their electronics industries over the last 20-25 years, they were faced with the problems of working from a very low base of technology, skills and international marketing capability, a lack of organizational strength in existing indigenous electronics firms and poor infrastructure for the industry in terms of suppliers of parts and services. They are also located at a considerable distance from the most advanced countries, the United States and Europe, and so from the sources of technology and the largest markets.

Initially, the indigenous firms entered the industry by producing the simple products that were at the mature stage of the industry life cycle, especially the simpler consumer products such

as radios, black and white television sets, and audio equipment. The technology for these products was easily obtainable and was changing slowly, so that there were low technological barriers to entry. The firms competed on price using their extremely low labour costs as a competitive advantage. The technology was imported in a "packaged" form, with the licence deals involving product designs, production specifications, supply of parts, and import of foreign technical personnel to oversee production start-up. The products were usually marketed abroad by the technology suppliers under the suppliers' own brand labels.

Later, as the firms' technical capabilities improved through learning the simpler technologies, they developed the capability to imitate foreign technologies and to modify the technologies imported through licensing. They were gradually able to move to more complex consumer products such as cassette players and colour television sets. The larger firms began to develop their own international marketing capabilities, which helped to overcome some of the major problems of peripheral location by feeding back information on market and technology developments to the home country. The industry has grown dramatically in the most successful countries: in the Republic of Korea, for example, employment grew from 30,000 in 1970 to 250,000, or 13 per cent of the work-force in manufacturing, in 1983.

The success of their industrializing efforts has resulted in higher labour costs, so that other developing countries, such as the Philippines and Sri Lanka, began to pose a competitive threat in the products with low barriers to entry. This has forced firms in China (Taiwan Province), the area of Hong Kong and the Republic of Korea to move to products that are at a more advanced stage of the industry life-cycle, where the technological barriers to entry in particular are higher, such as with video cassette recorders, instruments, telecommunications products, and computer-related products. However, the companies have now run into a major problem. Foreign firms are refusing to license the relevant technology, since they do not want to encourage direct competition in products that they are still producing themselves, especially from the more threatening firms in the Republic of Korea and Taiwan Province of China. This has forced the latter firms to do their own R and D work, a difficult task, since the technologies concerned are changing rapidly: the products that they painstakingly develop are quickly made obsolete by advances in the developed countries.

The larger firms have adopted a number of strategies to overcome the obstacles. They have mounted large R and D efforts at home, have bought into small high-technology firms in the United States in order to transfer the technology back home, and have set up R and D facilities in the most advanced locations such as Silicon Valley, employing highly skilled researchers at very high salaries. However, only the very large firms in the Republic of Korea and Taiwan Province have been able to afford these strategies. The smaller firms such as those in the area of Hong Kong have run into major hurdles. In the past, they managed to compete in products with mature technologies where the technology made small-scale assembly economically viable, notably with radios, watches and calculators. These firms also competed on price with

low labour costs. They have tended to remain in a very dependent technological position without any R and D of their own, depending on technology transfer from foreign firms that marketed their products. They cannot afford the costly strategies open to the larger firms.

Taiwan Province of China and, especially, the Republic of Korea have moved firmly into stage three of the development model described above. They are significant forces in the world's electronics marketplace. Their continued success in consolidating or advancing their position will be watched with interest.

Latin America

The countries or areas of East Asia discussed above may be described as being in the advanced developing category. Latin American countries such as Mexico, Brazil and Venezuela are in a middle category. Although these countries are at present undergoing severe economic difficulties, including crippling foreign debt, they are nevertheless rich in resources, with substantial potential for development in the future.

The manufacturing sectors of these countries are characterized by considerable protectionism of the internal markets, low product and process innovation, and lack of experience in export markets. Consequently, many firms are inefficient and their products are lower quality and expensive by the standards of international competition, despite labour cost advantages.

Mexico has an indigenous electronics sector that is large but uncompetitive in the consumer subsector and fragmented but improving in the professional subsector. Joint venture companies with transnational corporations manufacturing locally supply the national PTT market. Very recently, Mexico has taken positive action to attract foreign investment in the professional electronics field and a number of the world's leading computer companies have established modern production plants. The Mexican policy, which is being implemented, is to negotiate arrangements with these firms:

(a) To procure a well-defined and increasing percentage of subsupplies (component, sub-assembly etc.) from local Mexican companies;

(b) To employ a number of practical measures (R and D levy, training etc.) to transfer state-of-the-art technology to indigenous enterprises;

(c) To target exports.

An important part of this policy is to build up the technological, manufacturing and managerial competence of the indigenous subsupplier firms.

Venezuela's electronics industry is made up of three parts:

(a) Large firms, partially state owned, supplying the national PTT market with licensed foreign technology;

(b) Private firms associated with foreign companies, mainly selling imported products or assembling consumer electronic products;

(c) Venezuelan privately owned firms in the professional electronics subsector. These are small firms with varying degrees of technical sophistication. The total sales of these companies are still small but rapidly growing.

In both of these countries, State scientific and technological support services, although containing pockets of excellence, are fragmented, largely uncoordinated and relatively poorly oriented towards the needs of industry. They are, therefore, for the most part largely in stage one of the development model, with some increasing inroads into stage two but no presence in stage three.

Southern Asia

India, Pakistan and Bangladesh have a significantly lower GNP per capita than the previous two groups, and significantly less natural resource-based wealth than the Latin American countries discussed. They nevertheless have an important resource in their sizeable numbers of highly trained and well-educated people.

Their electronic industries are, for the most part, based on simple consumer products such as radios, television sets and tape recorders. In recent years, a significant professional sector has grown in India involving computers, communication equipment, process control equipment and instrumentation. Very recently, India has started production of small volumes of ICs.

India has been attempting to model its electronics industry and the supporting technological infrastructure on the large industrialized countries like the United States and Japan. It has been attempting to create, largely from internal resources, a self-sustaining, integrated and self-sufficient sector covering most if not all product areas. Baark [2] provides an interesting critique of India's policy in this area.

The main objective of industry in these countries is to supply their national markets and avoid the need for imports, although in most cases this is not achieved. Experience of international competition is limited. Technology levels, in general, lag significantly behind the world state-of-the-art and rates of indigenous innovation are relatively low.

The industry in these countries is, therefore, largely in stage one of the model, with the exception of India and, to some extent, Pakistan.

Recommendations

The model of development outlined at the beginning of this section is considered to be broadly valid and is recommended to Governments as a framework for planning the development of their electronics industries.

It is characterized by:

(a) Three stages: implementation, assimilation and improvement. Each of these stages must be taken in turn. It is not possible to move to stage three without going through stages one and two;

(b) The key to moving successfully from one stage to another is the development of sufficient indigenous competence (technological, manufacturing, managerial, marketing etc.) to do so. This applies whatever the origin of foreign expertise or the modalities employed to transfer it to local use.

Of the countries and areas surveyed, the Republic of Korea is by far the most advanced in terms of this model. Whereas it is accepted that no countries would aspire to, or would be likely to achieve, the success of the Republic of Korea in developing an internationally competitive electronics sector, it is confidently predicted that each of the others considered could significantly improve their present positions.

A number of recommendations are made below that, focus largely on the development of indigenous competence. The scope of the recommendations is broad and general. The details of the specific application of these recommendations would depend on local conditions and circumstances.

The development of an indigenous manufacturing sector

Expertise and experience in technology, manufacturing practice and the key business functions must be painstakingly acquired, there are no short cuts.

The scale of the growing world market in this area, the dominance of certain countries and firms and the cost and rate of development of technology prevent any newly industrializing country from developing a national competence that would be internationally competitive across the whole range of IT products and services. It would be foolish, for example, for a newly industrializing country to try to develop a new digital telecommunications public switching system. It will be necessary for industrializing countries to select their niches in the micro-electronics sector. Niches are relatively narrow or specialized markets and the markets can be specialized in any of the following ways: by product, by customer, by geographical area or by a combination of these. Once the niches or specialized market segments are selected, national developmental resources can be concentrated in the form of State R and D funding, specialized manpower development, public procurement measures, development contracts etc.

This niche or selectivity policy is recommended for all countries surveyed. No policy of self-sufficiency in all products will succeed and the pursuit of such policies (by, for example, India) is likely to dissipate available resources over too wide a range, with the possibility of no great success in any segment of the sector.

In the earlier stages of development, a focus of indigenous effort might usefully be on the creation of a healthy and competent sub-supply sector. Indigenous firms in this sector would supply the (probably foreign) electronic consumer and professional equipment manufacturers operating within these countries with materials, components and sub-assemblies. In this manner, local, probably small, firms could gain experience of sophisticated high technology business within their own country. It would be important to ensure that the local firms meet the standards of technology, quality and delivery of their products that apply generally in the industry. They could be assisted in this regard both by Government policy measures and directly by the equipment manufacturers that they are supplying.

In a later stage of development, local innovative effort will have mastered and improved existing technologies in the selected niche areas to compete on the national and international markets with new or improved products.

The role of competition as a stimulus to enterprise and as a method of ensuring efficiency should not be neglected. Countries that protect their internal markets from foreign competition and allow a monopoly supply position for preferred national companies on those markets inevitably find inefficiencies developing, such as low quality, high cost, lack of innovation and a general falling behind with respect to the standards applying to similar products in the outside competitive world. Countries that must protect their internal market might consider one of the following approaches:

(a) Allow a certain fraction of their national market in certain product areas (e.g. telecommunications equipment) to be open to competition between foreign firms (possibly manufacturing locally) and national firms, the rest of the market being closed to foreign suppliers;

(b) Build competing national firms to supply market segments and use Government policy measures (e.g. through public procurement contracts) to foster competition between them.

Clearly, countries that wish to enter foreign markets must gain experience of international competition. This could start either on their own markets or in selected foreign markets in their region but preferably in both.

The role of foreign investment

Direct foreign investment could be an important element in the development of a sector. It is by no means a sufficient means of developing a thriving and organically growing industrial sector but the benefits that derive from it may be of significant value. These benefits include:

The capital resource invested;

The employment generated;

The imports substituted;

The exports generated;

The work experience gained by operatives, technicians, engineers and management;

The somewhat intangible but very important "manufacturing ethos" created. (The value of the experience of the manufacturing environment and practices, including the maintenance of standards, quality control etc., prevalent in developing countries, should not be underestimated.)

On the other hand, the foreign investor is normally motivated not by the altruistic intention of benefiting the host economy but by other interests such as gain the desire to access to the local market. The host Government will, therefore, have a certain leverage that it will seek to exploit in the interests of its national economy. It is recommended that this leverage be used to ensure the maximum transfer of expertise to the host country.

In the early stages of development, with limited indigenous competence, the focus could be on ensuring that the foreign investor contributes to:

The development of relevant national technological infrastructure;

The development of the technological competence of indigenous sub-supply and service firms through, for example, training programmes, technical assistance, transfer of know-how and granting of development contracts.

These initiatives could be funded by a levy on the sales of foreign-owned firms. The host Government should ensure that any schemes adopted are relatively simple and easy to administer, can be monitored against targets to determine success or failure and are directed towards the practical achievement of clearly identified national needs.

Joint ventures between indigenous companies and foreign companies may be a valuable approach in a later stage of development. It is important to realize that technology will not generally be successfully transferred in a joint venture arrangement unless both partners are of roughly comparable technological competence. Many joint ventures between firms from developed and developing countries are not of this nature and are undertaken because of a Government's requirement for local equity participation in foreign manufacturing enterprises. The author believes that these are less beneficial arrangements than those where real competence is transferred.

<u>The development of local applications</u>

The electronic equipment sector is advanced, rapidly changing and fiercely competitive. Most developing countries will not succeed in creating an internationally competitive industry of any substantial proportions in the sector. A compromise, determined by local circumstances, between importing equipment and local production, will have to be arrived at in almost all cases.

The question of the application of this equipment and technology in the local environment is, however, a different issue. Because of the specificity of local need and the local control over how this need is to be addressed, the balance of advantage lies with indigenous effort rather than foreign competence in this area. It should be remembered that the cost of the basic equipment, such as a minicomputer or a microprocessor, may only be a small fraction of the cost of the application, e.g. air traffic control or industrial process control. There is frequently very substantial scope for adding local value.

This does not mean that the necessary application competence is easily acquired, but it is less capital-intensive, less dominated by giant transnational firms and more controllable by local effort.

All countries should, therefore, seek to develop their micro-electronics applications competence to the full within their available resources. It has been stressed before that the benefits that accrue from this activity come from the added efficiency and effectiveness of all industrial and service sectors and not simply from the electronics sector itself.

Areas of basic technology that should, therefore, receive priority Government attention include:

(a) Software, which is at the heart of all applications and, while not capital-intensive in its creation, is nonetheless an extremely sophisticated business;

(b) Design of ICs, particularly customized ICs to meet specific applications. The necessary infrastructure to fabricate and test IC designs, at least on a prototype basis, should also be considered, even by countries that do not intend to have a significant semiconductor manufacturing industry of their own. Systems engineering and design is another necessary competence to develop in each country.

In addition to the development of these basic skills, there will be a need to promote the appropriate application of micro-electronics technology throughout the industry, commerce and administration in each country. This frequently requires State-supported institutions to raise awareness, provide information, assist in feasibility analysis and sometimes implement applications in particular environments.

Research and development and skilled manpower

No form of technology transfer to a country will succeed without the presence of an indigenous innovative capacity and the skilled manpower necessary to absorb, assimilate and apply it to local conditions and national needs.

The ideal location of industrial innovation, including industrial R and D, is in the firm itself. Governments encourage firms to invest in innovation through various environmental measures such as tax concessions, by subsidizing in-firm R and D and sometimes by subsidizing the cost of acquiring or retaining skilled manpower.

In addition to these firm-oriented measures, Governments build national innovation capacity through the support of: basic and applied R and D in universities; the education and training of skilled manpower in universities and technical colleges; and the build-up of applied R and D capacities through the establishment and support of mission-oriented laboratories and institutions.

To complete the picture, some Governments provide positive measures and mechanisms to link the expertise of the largely State-funded universities and institutes to the needs of industry, whether private or public.

All Governments are aware of these issues and approaches. Variations lie in the measures used to orient the national innovation capacity, wherever it is located, to national needs, and the success of the measures employed.

In many developing countries, including those surveyed, the national innovative capacity in the universities and research institutes is not well planned. It is frequently poorly co-ordinated and inadequately linked to real industrial needs.

The criteria that decide research priorities in universities and institutes take only limited account of the actual present and short term future innovation requirements of industry in their regions. Mechanisms to make university expertise available in a meaningful way to industrialists are either non-existent or poorly functioning. Industrialists may be unaware of or suspicious of universities' and institutes' research efforts and researchers in these establishments may be uninterested in practical industrial problems. This is a quite unsatisfactory situation.

It is recommended therefore that Governments:

Preferentially build up innovation capacity, both R and D and skilled manpower, in the technical areas underlying the selected industrial niche areas;

Identify actual industrial needs;

Preferentially build innovation capacity in university and research institutes to meet these needs;

Establish practical and effective mechanisms, such as university/industry liaison offices, to build bridges between industrial needs and university competence.

These ideas are by no means novel but their successful application could lead to significant improvements in the existing procedures in both the surveyed and other countries. In contrast to the development of the technology and market generally, these approaches are under the control of national authorities.

The scope for international co-operation

Co-operation (as distinct from aid) can only work well between partners with comparable or complementary abilities. Developed countries can assist developing countries by:

Training engineers and technologists from developing countries in the universities, institutes and industrial laboratories of developed countries;

Helping (either bilaterally or through the medium of international organizations) to establish and fund the technological infrastructure in developing countries and train the necessary expert manpower.

Regional co-operation among developing countries at a comparable stage of development can assist these countries to achieve a critical mass of effort through sharing tasks and sharing experience and information. Some practical suggestions in this regard include:

Common or networked regional facilities for IC design;

Common regional facilities for the fabrication of customized ICs;

Centralized production or procurement of special or strategic raw materials and components;

Common or networked centres for software development;

Common or networked centres for systems engineering and design.

Networked centres for information, advice, feasibility studies and assistance to industry on micro-electronics applications.

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SOURCES OF MANUFACTURING EFFICIENCY: SOME EVIDENCE FROM EAST ASIAN ECONOMIES AND IMPLICATIONS FOR CURRENT REFORMS IN CHINA

Secretariat of UNIDO*

Introduction

The Chinese economy has been undergoing a series of reforms and experiments since 1979. The aim of these reforms is to accelerate the modernization of the economic system with the goal of quadrupling economic output by the year 2000. One of the major components in the reform package deals with the problem of incentive systems for the management of industrial enterprises. The main question concerns how to devise an incentive system which will help to promote efficient use of resources by managers. The strategy adopted for discovering a new system best suited to Chinese conditions is described as "proceeding from China's own established practices to put together a management system with distinctive Chinese characteristics by drawing on the strengths of other countries, to draw lessons from past experiences in management and administration and also gradually set up a Chinese-style scientific management system" [1]. Indeed, several versions of an incentive system have been experimented with during the last six years (an account of which will be given later).

The purpose of this paper is to present some statistical evidence from the experience of Japan, the Republic of Korea and Taiwan Province of China concerning the source of allocative efficiency in manufacturing industry and to examine the implications of their experience for China's efforts to implement a new profit-oriented incentive system. Emphasis is placed on a diagnosis of the incentive-policy-efficiency-consequence linkage. As China, judging from official policy statements, introduces into its economy more emphasis on the price system and competition, more independence of industrial enterprises for the pursuit of profit, and more linkage with the world economy than before, the experience of neighbouring economies would appear to become increasingly more relevant. Thus, a comparative study of China and its neighbours could prove useful for gleaning insights into the efficiency issue. Cultural proximity between them underlines the necessity and usefulness of a comparison. However, the unavailability of statistical information on a comparable and comprehensive basis at the moment precludes the possibility of systematically analyzing the efficiency-related performance of industry in China. The analysis contained in this paper must to a certain extent therefore remain of a qualitative and ad hoc nature.

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The paper is organized as follows. The first section briefly reviews various forms of experimental incentive systems and the problems associated with each of them in enhancing efficiency at the enterprise level. It is noted that the series of experiments undertaken in China seem to have been progressing more towards an incentive system similar to that existing in neighbouring countries, although in principle private ownership of property is not permitted in China. This suggests that China's problems associated with achieving efficiency through the market mechanism will also become gradually similar to those of its neighbours. The second section presents the results of regression analyses of profit rates, enabling us to judge allocative efficiency (or inefficiency) for Japan, the Republic of Korea and Taiwan Province. The third section deals with the possible implications of the experiences of these economies for China's efforts to improve enterprise efficiency through the new market-oriented incentive system. The final section contains some brief remarks on the need for data and possible future research.

Chinese experiments in quest of industrial efficiency

The policy shift embodied in the incentive-efficiency linkage aims at promoting greater managerial efforts and ingenuity to achieve increased efficiency through material rewards to managers. The most recent government decision explains the reason for change as follows [2]:

> "The well-spring of vitality of the enterprise lies in the initiative and creativeness of its workers by hand and brain. When the status of the working people as masters of their own enterprise is guaranteed by its rules and regulations and when their labour is closely linked with their own material benefits, their initiative, wisdom and creativeness can be brought into full play. This will arouse their deep interest in the operation and effectiveness of their enterprise, so that their performance is closely linked with their social prestige and material benefits."

The motivational system envisioned in this statement represents a turn-about from the earlier emphasis on "social conscience, reinforced by group pressures from fellow workers, rather than monetary rewards" [3].

As is well known from literature on the subject, enterprise managers in an earlier period were paid little more than skilled workers. The State siphoned off profits with scarcely any material reward to encourage workers and managers to exert extra efforts for superior performance. Production quotas were assigned to each enterprise by the State and output was sold at State-determined prices. The State marketing agency had to sell whatever was produced by the State-owned industrial enterprises. Furthermore, the State allocated investment funds from the budget according to production targets and priorities for industrial

sectors and geographical regions. Workers were virtually assigned to be employed in factories according to State-planned output. Under such an incentive system, managers had little motivation to economize on scarce resources or to improve product quality and technology. This state of affairs seems to have contributed to widening the technology gap between China and more developed economies. It has been reported, for example, that in Shanghai, the industrial centre of China, "about 80 per cent of all machinery and equipment in the textile industry and other branches producing consumer goods is nearly 40 years old" [4]. Overstaffing [5] and output mismatch (that is, inventory accumulations for some commodities and supply shortages for others) [6] were prevalent problems. The State had to subsidize inefficient enterprises to save them from dying. In effect, the system taxed the efficient to support the inefficient. Moreover, seventy per cent of the inefficiency in enterprises was reported to have arisen from mismanagement in one form or another [7].

The above observations are difficult to verify owing to a lack of comprehensive information. However, they seem to represent views widely held by outside observers.

The current reform package for enterprise management differs radically from the earlier system. Under the new system, the enterprise will be given the autonomy to [8]

> "... plan its production, supply and marketing; keep and budget funds it is entitled to retain; appoint, remove, employ or elect its own personnel according to relevant regulations; decide on how to recruit and use its work-force, and on wages and rewards; set the prices of its products within the limits prescribed by the State; and so on."

In short, enterprises will gradually become independent (subject to the timing of the phase-out process, the indicative plan established by the Government and macropolicies) and responsible for their own profits and losses. State ownership will not, in principle, affect the day-to-day operation of enterprises,* which will be in competition for profits. However, the precise mode and extent of profit retention as a reward for efficiency has been the subject of debate and experimentation in China in recent years. The heart of the issue is how to devise a rule for profit-retention

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*"Temporarily however some goods will be subject to State-determined production quotas and will be sold at State-fixed prices including coal, oil and oil products, rolled steel, non-ferrous metals, timber, cement chemicals, fertilizers, some machinery, synthetic films, and cigarettes." See The Economist Intelligence Unit, Quarterly Economic Review of China, North Korea, No. 4, 1984, p. 11.

so as to induce maximum possible efficiency within enterprises.*

In the context of Chinese experiments on profit-retention as a reward for enterprise performance, the following systems are noteworthy:**

1978: Some enterprises fulfilling plan targets were allowed to retain an amount of profits equivalent to a fixed percentage of the wage bill (enterprise funds system);

1979: Some enterprises were entitled to a fixed share of base profits plus 10 to 30 per cent of incremental profits (incremental profit system);

1981-1983: (a) Retention of a large share of profits above a target profit (profit target system);

(b) Sharing profits between the enterprise and the State according to a scale determined by the authorities (profit-sharing system);

(c) Paying taxes rather than sharing profits (profit tax system).

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*The problem is closely akin to Leibenstein's notion of the "effort-responsibility-consequences" connection (ERC) and whether ERC is confined within the appropriate decision-making entity. Briefly, if ERC is retained by the enterprise (or individual), then naturally the enterprise (or individual) is completely responsible for the results of its activities. And if the connections are broken, then responsibility can be shifted to entities outside the enterprise (or to other individuals), and work efforts would be reduced, innovative risk-taking avoided, and inefficiency in resource use would result. See Harvey Leibenstein, General X-Efficiency Theory and Economic Development (New York, Oxford University Press, 1978), chapter 8. For a theoretical critique of the X-efficiency paradigm, see Louis de Alessi, "Property rights, transaction costs, and X-efficiency: an essay in economic theory", American Economic Review, March 1983, pp. 64-81.

**The analysis is based on materials drawn from secondary sources such as the following: Armin Bohnet and Gunther Giessen, "China's new economic policy", Intereconomics, January-February 1985, pp. 43-51; Gordon White, "State and market in socialist development: the case of Chinese industrial planning", IDS Bulletin, vol. 15, No. 2 (1984), pp. 4-10; Gordon White, "Socialist planning and industrial management: Chinese economic reforms in the post-Mao era", Development and Change, vol. 14, 1983, pp. 483-514; Craig R. Little and Martin Lockett, "Trends in Chinese enterprise management, 1978-1982", World Development, vol. 11, No. 8 (1983), pp. 683-704; World Bank, China: Recent Economic Trends and Policy Developments (East Asia and Pacific Regional Office, March 1983); Andrew Watson, "The management of the industrial economy: the return of the economists", China's New Development Strategy, Jack Gray and Gordon White, eds. (London, Academic Press, 1982).

The earliest reform (sometimes called the enterprise funds system) allowed enterprises to retain profits equal to an agreed percentage of the total wage bill (5-11 per cent). The sum could be used for reinvestment, bonuses or welfare schemes. However, the profit retention was subject to the condition that the enterprise had achieved eight plan targets involving total output value, product mix, product quality, consumption of raw materials and energy, wage fund, unit cost of production, profits and working capital.

The incentive system thus encouraged enterprises to haggle for low targets every year and to increase the wage bill by paying more or increasing employment. Often this system resulted in giving lower targets to poorly managed enterprises and higher targets to well-managed ones. Efforts to improve efficiency were not fairly rewarded in the end.

The second experiment (incremental profit system) was intended to reward greater economy in the use of resources and particularly improved capacity utilization of plant. Enterprises under this system were likely to push up profit targets from their actual profit of the previous year. The system thus ended up rewarding enterprises which performed poorly in previous years. Enterprises which already achieved high levels of efficiency found it difficult to increase retained profits. Furthermore, enterprises with fluctuating yearly profits tried to even out in profit reporting so as to maximize the long-run total of retained profits, unrelated with actual improvements in efficiency.

A slight variation from the incremental profit system was attempted in the third experiment (profit target system), which linked retained profits to the planned profit level and the unplanned profit portion above that level. A higher retention rate was applied to the above-target level of profits. This created an incentive for enterprises to haggle again for a lower planned profit target than their actual capability in order to maximize above-target profits.

The fourth experiment (profit-sharing system) was designed to eliminate haggling for lower planned profit targets. The retention of profit was determined by the total sum of current profits realized and a certain rate decreed by the competent authority. Despite progressive improvements to link rewards directly to performance, the formally announced rights of enterprises had not been translated into actual independence of managers. For instance, even under the profit-sharing system, enterprises had to meet basic plan targets in one after another before profit retention could be claimed. [illegible] still to apply for permission to purchase materials from State supply agencies.

Furthermore, managers more or less [illegible] buted retained profits earmarked for bonuses to employees regarding individual productivity differentials. So [illegible] enterprises used their funds to expand productive capacity for goods already in excess supply or to launch investment programmes without consideration of the availability of adequate energy and material supplies. The reason for this behaviour seems not difficult to

find. The managers were not yet directly responsible for losses, which were covered by State subsidies, and State funds for investment were allocated for expansion not necessarily according to performance criteria but largely on the basis of State priorities. The incentive still remained for enterprises to strive to maximize the amount of State funds received for capacity expansion regardless of performance. Overinvestments by enterprises was a natural outcome under all the profit-retention schemes experimented with.*

The latest reform announced in 1984 was an attempt to reduce State control more radically and to give more complete independence and responsibility to enterprises than before. Under this scheme, enterprises became completely responsible for both profit and loss, retaining profits after paying four sets of taxes and charges (income tax, revenue-adjustment tax, fixed asset charge, and a working capital charge) which were designed to syphon off above-average profits due to locational or technical factors and to favourable cost-price relationships.** About 60 per cent of retained profits should be reinvested in the enterprise, which must bear any losses incurred without State subsidies to cover them.

This brief review of the Chinese experiments reveals that the enterprise performance criterion has gradually shifted toward one which resembles that of market-oriented economies. In the latter economies, profit earned after taxes belongs to the enterprise, which uses the earnings for such purposes as it sees fit, including reinvestment, bonuses for workers or cash holdings. An interesting aspect of the Chinese experiments is that the amount of rewards (retained profit) is determined by two components, namely, the absolute amount of profit earned and another element such as the wage bill, incremental profits, the target profit quota, the rate specified by the authority or the profit tax rate. Though incentives to pursue profits might have increased gradually in the course of these experiments, none of them relates directly to the essential rule for the promotion of efficiency, namely, maximizing the ratio of "social surplus over capital".

By social surplus is meant that portion of profits derived from competitive efforts in improving product quality, technology, management techniques, work habits (harder work and longer hours), firm-specific and manager-specific ingenuity to reduce production costs etc., and not from exercises of monopolistic power such as collusion in price-fixing at a higher level than the competitive price, cartelization (output or market sharing), entry barriers (including input monopolies and advertising effects), State subsidies and other forms of industrial protection (such as tariffs and import quotas). It is important to note that the concept of

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*Despite shortcomings inherent in the incentive systems experimented with, evidence seems to suggest some positive effects on profitability.

**The general profit tax is complicated by numerous other taxes. See the Economist Intelligence Unit, op. cit., p. 12.

social surplus is "ideology-neutral", that is, regardless of the nature of the economic system China might adopt, social surpluses must be maximized per unit of capital in order to promote efficiency. Incentive-efficiency connections can be forcefully linked if enterprise performance is gauged by this ratio and rewarded accordingly in a direct manner, namely, profit retention by some multiple (or fraction) of the ratio.* However, most mixed economies as well as China have adopted the indirect method of taxes and subsidies through business laws designed to maximize social surpluses and to syphon away monopolistic profits. Whatever the method adopted, it is crucial to know the magnitude of profits earned by enterprises and industries from diverse sources if a rational policy package is to be formulated, and if efficiency development is to be monitored and steered properly. Herein lies the reason for the kind of statistical analysis presented in the next section. The question is what are the sources of social surplus in the Asian neighbours of China.

The ratio of social surplus to capital could also be used to bring about efficiency in resource allocation, one of the criteria for investment project evaluation. This will help avoid the problem of overinvestment in some areas and underinvestment in others, which have been repeatedly observed under various incentive schemes experimented with [9]. State funds and bank loans in addition to retained profits can be consistently allocated according to the above-mentioned criterion. Using the same criterion for rewarding enterprises as well as for investment fund allocation would bring consistency to the working of the whole economic system. However, the subject of project evaluation has been fully discussed in other publications, and will not be reviewed here.**

Sources of manufacturing efficiency in Japan, the Republic of Korea and Taiwan Province of China

The purpose of this section is to present some evidence and an interpretation of the sources of efficiency in manufacturing sectors of selected Asian economies, namely, Japan, the Republic of Korea and Taiwan Province of China. These three economies would seem to share several common characteristics, including relatively poor natural resource endowments and high growth rates of gross domestic product, manufacturing value added and exports of manufactured goods under export-led growth policies, although the intensity and timing of government policy intervention may

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*Reportedly similar ideas have been discussed in Sun Yefang, "Justly grasp socialist profit", Jingji Yanjiu, No. 7, 1979, pp. 47-58; He Jianzhang, Kuang Rian and Zhang Ahuoyuan, "On the question of profit rate of capital and production prices in a socialist economy", Jingji Yanjiu, No. 1, 1979, pp. 47-59. See also Watson, op. cit., p. 100 and footnote 73.

**See for instance, Adrian Wood, "Economic evaluation of investment projects: possibilities and problems of applying western methods in China", World Bank Staff Working Papers, No. 631 (Washington, D.C., 1984).

differ among them. Moreover, at one time or another they have relied on various forms of development strategy, including import substitution, export promotion, fostering enterprises of internationally competitive size and government guidance or economic planning, using such tools of policy implementation as tax breaks, fast depreciation allowances, direct subsidies, easy access to credits at below-market rate of interest and cartelization. Undoubtedly, these measures must have influenced profit-earning opportunities for enterprises one way or another.

With these observations, one could easily receive an impression that government policies peculiar to East Asia might have been a major factor of industrial development in the region.* In spite of burgeoning debates on the specific role of government policy in East Asia, industrial development must ultimately originate from basic economic driving forces, namely, efficiency of industries, enterprises and entrepreneurial efforts. To quote W. Arthur Lewis, "... the government can persuade, threaten or induce; but in the last analysis it is the people who achieve." Further, "The possibility of higher individual earnings is the fuel of economic growth, whether in the form of profits, salaries, wages, higher farm incomes, or otherwise. Economic growth cannot be produced by legislation, administrative regulation, or exhortation without the accompaniment of high material incentives. Hence the crucial test of the quality of development planning, in that part of the economy which is left to private initiative, is how effective are the incentives offered to the population to make decisions which will result in economic growth" [10].

The possibilities of higher earnings, however, can arise from many different sources. On the one hand, if earning possibilities come solely from economic rents derived by monopolistic exercises, resources could be misallocated and wasted. Economic development cannot take place in a society where rent-seeking activities dominate. On the other hand, if much of earnings can come as a reward for superior innovative efforts, unrelated with monopolistic power or government favours, sustained growth would be a natural consequence. The actual experience of an economy lies somewhere between these two extreme situations. The task of this section is to analyze firm or industry-level statistics measuring the relative importance of various sources of profit earnings for the three economies chosen for study.**

Method of analysis and variables

The method, adopted to test sources of profitability, borrows essentially from a study conducted by Richard E. Caves and Masu Uekusa [11]. However, our regression equations include some additional variables deemed relevant because of policies and

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*An interesting and provocative account of government policy is given in Kent E. Calder and Roy Hofheinz, Jr., The East Asia Edge (New York, Basic Books, 1982).

**Some day when data becomes available, it is to be hoped that China could be included for comparison.

institutions specific to different economies. By quantifying the sources of profitability, efficiency implications can be inferred. It would have been desirable to apply the method to long-term series data in addition to cross-section data,* but data availability limits our regression analysis to the cross-section data for a few years. The results reported in this paper therefore should be regarded as tentative, exploratory, and preliminary.

The following form of equation is regressed, when pertinent data are available, with the variables explained below:

NAP = f (GRS, RFC, NWA, TOA, ADV, ERP, CNR, EXS, SIZ)

where NAP = net (of taxes) profits over total assets

GRS = growth rate of sales

RFC = financial costs (interest payments and discounts) over total liabilities

NWA = net worth over total assets

TOA = sales over total assets

ADV = advertising expenditures over total sales

ERP = effective rate of protection (tariff)

CNR = concentration ratio

EXS = exports over sales

SIZ = size of enterprise (assets or employment per firm)

This specification of explanatory variables differs from the one that Caves and Uekusa adopted for their study of Japan. Their explanatory variables included only the following: concentration ratio, advertising outlay over total sales, growth rate of sales, exports over total sales and fixed costs plus wages over total costs. In the present study, all these variables are included except the last. For including this variable, Caves and Uekusa argued as follows:

> "The practice of permanent employment and the prevalence of high debt-equity ratios contribute to fixed costs and thereby increase the risk to which large enterprises are exposed. They should raise reported profits because they increase the risk of exposure of equity capital and thus presumably raise the risk premium demanded by those who supply it" [13].

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*"Averaging over ten years should reduce the dangers of bias in reported net profit on equity due to the vagaries of depreciation schedules and other accounting practices .... Of course, the problem remains that long-term average accounting rates of return can still be biased indicators of economic or discounted-cash-flow rates" [12].

In the Republic of Korea and Taiwan Province, the practice of permanent employment or company loyalty does not exist. Indeed, scouting for talent from other enterprises is a form of competition in pursuing profit or wealth maximization. Even in Japan, it is reported, only large enterprises practice permanent employment, and the practice covers only one-third of the total labour force. The reasons for including other variables are given below.

Growth rate of sales

The first variable, growth rate of sales, is included in the regression in order to remove any windfall from the profits of a specific industry. The growth rate of sales differs from industry to industry, as does the ability to adjust output capacity. To the extent that the capacity adjustment involves substantial lags, an unexpected increase in sales would bring windfall profits especially in the short run, as in a one-year period. Caves and Uekusa cautioned, however, that the growth rate of sales could "pick up too many influences to allow a clear interpretation", especially if the data represent long-run averages for individual enterprises [14].

Rate of financial costs

The rate of financial costs refers to the ratio of total interest paid, including discounts, to total debts (short-term plus long-term debts). As such, the ratio expresses an average rate of interest. It has been alleged that the pressure of interest payments jeopardizes an enterprise, especially the financially weak ones without much collateral to offer (presumably smaller enterprises). Some evidence has been cited indicating that smaller enterprises rely on high-cost sources of loans, including the curb market, more than larger enterprises. This variable may pick up the vulnerability of such enterprises, especially when money supply is tight. A negative correlation is therefore expected and included in our analysis. However, it is also possible that borrowing from the high-cost source may be motivated by previously unforeseen opportunities for profit. Hence, if these opportunities are exploited by borrowing, even from the high-cost source, it is possible to show a positive correlation.

Net worth over total assets

This ratio measures the extent of the own capital of the enterprise, including the retained earnings, as a proportion of total assets. Hence, the lower the proportion of net worth, the higher the assets financed by loans from the banking system and other loan markets (often called indirect financing). Much of the net worth is owned by either the entrepreneurs themselves or their family members, since the securities markets are not yet well developed, especially in comparison with Western economies. In particular, the shareholders are not diffused among the citizens at large, and hence the consequences of risk-taking are not passed on to general shareholders. What is called the "effort-responsibility-consequences" connection in Leibenstein's X-efficiency theory, to which reference has previously been made, is kept within the appropriate decision-making unit. Leibenstein argues that if the effort-responsibility-consequences are not kept

within the decision-making unit, irresponsibility increases costs of production and decreases the profitability of enterprises, with important consequences for development.

The above hypothesis provides a contrast with the views held for developed countries. Caves and Uekusa argue in effect that the larger the ratio of net worth to total assets, the smaller the risk exposure and hence the smaller the profits [15]. It is precisely the opposite in the cases of the Republic of Korea and Taiwan Province.

Turnover ratio of total assets

This variable measures total sales over total assets, indicating how many times the total assets are used per year for production and sales. It is used to test whether and to what extent "stretching" capital adds to profits. It has often been recommended that work shifts be increased so that scarce capital in less developed countries could be economized. "This meant that the average work week per machine was two to three times that encountered in the country of origin, and, since physical depreciation is much less important than economic obsolescense, using a machine twice as intensively does not wear it out twice as fast" [16]. Gustav Ranis, as a result of first-hand micro-level observations, reported that "capital-stretching" is common to all three economies [17].* A perusal of sample data indicated a wide variation in the capital turnover ratio (or the sales-to-assets ratio) among industries and among enterprises of different sizes. The variable is supposed to pick up its effect on profitability, and is expected to have a positive correlation.

Advertising expenditures over total sales

Advertising functions as a means of information dissemination, on the one hand, and product differentiation (real or imagined), involving the creation of entry barriers, on the other. Though it is not always clear which of these augments the profit, conventionally the latter is thought to be the more relevant item the variable is supposed to represent. However,

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*In a more systematic study on capital utilization, Jene K. Kwon and Young Chin Kim reported:

> "The Korean experience in the past 10 years clearly demonstrates that the increased utilization has been a very important source of economic growth. It was indicated that the growth of output in Korean manufacturing was far in excess of what could be attributable to the growth of investment and employment. During the same period the overall rate of utilization is found to have doubled. Hence, it can safely be concluded that a major source of Korean economic growth in recent years has been the increasing utilization rate of capital stock."

Jene K. Kwon and Young Chin Kim, Capital Utilization in Korean Manufacturing, 1962-71: Its Level, Trend and Structure (Seoul, Korea Industrial Development Research Institute, 1973), p. 80.

conceptually the function of information dissemination increases awareness of competing products especially where ignorance is prevalent in developing economies, and hence advertising can be a market-perfecting activity. In contrast, the function of product differentiation by advertising in developed countries can be a barrier-creating activity. Nevertheless, since it is operationally impossible to distinguish the two different effects of advertising, we include the variable only as an independent one for inter-economy comparison, and not as a proxy for entry barriers as in some existing studies.

Effective rate of protection

Developing countries often utilize protection from international competition by a high tariff as a means of industrialization. The Republic of Korea and Taiwan Province are no exception, despite their outward-looking policies. The effective (or value-added) rate of protection could be as high as 500 per cent for certain industries. Hence the degree of effective protection could be a source of profit-rate differential among different industries. To the extent that this variable is significant, resources could be misallocated in a static sense, though a dynamic efficiency effect could be positive if a protected industry is truly an infant industry that is viable under such protection. However, the analysis of dynamic effects is beyond the scope of this study.

Concentration ratio

This is a conventional variable (the proportion of output by the three largest enterprises) used to test both the effect of market power on the profit rate and resource misallocation due to the monopolistic rent which results. However, Caves and Uekusa warn that this variable could be insignificant in a rapidly industrializing economy:

> "We suggest reasons why periods of very fast macro-economic growth should translate themselves into micro-economic imbalances. When it appears profitable at the margin to expand production in practically every industry, an industry's profit rate may depend primarily on how fast it can enlarge its capacity. In industries that face long planning and construction delays in expanding capacity, substantial short-term windfalls may accrue even if the industry is potentially competitive enough that they will be eliminated in the long run. Industries adjusting quickly will reap smaller windfalls, even if concentration is high enough to keep profits above the competitive norm in the long run. Thus concentration may fail to register a significant influence on profits in periods of explosive growth, unless we take account of differences in short-run constraints on the expansion of industries' outputs. And inter-industry differences in growth should be a more potent determinant of profit rates in periods when growth is on average very rapid than when it is normal, because windfalls then bulk larger in the inter-industry variance of profits" [18].

In this connection, it should be noted that all three countries enjoyed rather rapid growth. We could therefore expect an insignificant effect of concentration in profit-making.

Export over sales

Ordinarily in a free-enterprise system, the distinction of sales between the domestic market and overseas markets should not arise. However, the export-led growth policy introduced subsidies indirectly for exporters, including low-interest loans, reduced taxes, rebates on public utilities and tariff-free imports of raw materials. Exporters, under the policy, would equate marginal costs and marginal benefits, including policy-contrived marginal gains. The latter would add to the profitability of an exporter over non-export enterprises. The variable is included to pick up the effect of such export incentives on profits, prompting us to expect a positive coefficient.

Size of enterprise

The size variable represents an entry barrier due to the extent of economies of scale in various senses. A large firm can do anything that a small firm can do, but not vice versa. For instance, large borrowers can command lower interest rates due to lower lender's risk, bargaining power, ability to discriminate against small firms, or even varying government policies to favour large firms. The question is an empirical one, namely whether the rationale of scale economies is confirmed by high profitability.

Regression on Japanese data

In the case of Japan, three different sets of data are used for the regression analysis. Inter-industry data come from the Bank of Japan, which annually publishes Shuyo Kigyo Keiei Bunseki (Financial Analysis of Major Enterprises). The bank collects financial information from over 500 large enterprises and classifies it into 50 manufacturing categories for a sectoral average. In this study, 1976, 1977 and 1978 data are used for inter-industry regression. The second source of data is the Ministry of International Trade and Industry, which annually publishes individual financial information from over 300 large enterprises in Wagakuni Kigyo No Keiei Bunseki (Financial Analysis of Our Country's Enterprises). The third set of data comes from a publication by the Small and Medium Enterprise Agency of the Ministry of International Trade and Industry, Chusho Kigyo No Keiei Shihyo (Financial Indicators of Small and Medium Enterprises). It contains financial information from over 10,000 small and medium-scale enterprises and tabulates it into over 600 entries by industry and by size of firm.

Generally consistent regression results are observable for the 1976, 1977 and 1978 inter-industry data (see table 1). Note that the growth rate of sales (GRS) shows a positive coefficient with a one per cent level of significance for all three years. However, it is noteworthy that the same variable is equally, if not more, significant for more disaggregated data of individual

enterprises and "inter-scale" data of the Small and Medium Enterprise Agency (see table 1 (D)). One could interpret this to mean that the so-called windfall is not necessarily due to the industry-specific lag of capacity expansion to meet an increasing demand, but rather that each individual entrepreneur's effort to capture the increasing industry demand influences profitability from this source.

Table 1. Net profit over total assets regressed for data relating to Japan

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
	A. Bank of Japan inter-industry data 1976			
GRS	0.178	3.872	0.258	0.903
RFC	-1.347	-2.361	-0.293	-2.659
NWA	0.326	8.582	0.731	2.523
TOA	0.068	0.053	0.005	0.029
ADV	-0.423	-1.098	-0.088	-0.128
EXS	0.016	0.548	0.039	0.080
SIZ	-0.000	-0.124	-0.009	-0.014
MPL	0.000	2.892	0.191	0.453
Intercept	-0.487	-0.107		
	R^2 0.896	D.F. 41		
	B. Bank of Japan inter-industry data 1977			
GRS	0.124	3.917	0.244	0.247
RFC	-0.932	-2.216	-0.234	-1.398
NWA	0.186	8.843	0.565	1.243
TOA	2.498	2.845	0.230	0.903
ADV	0.024	0.099	0.006	0.006
EXS	0.006	0.337	0.021	0.031
SIZ	0.000	0.074	0.004	0.005
MPL	0.000	3.604	0.196	0.321
Intercept	-1.104	-0.355		
	R^2 0.896	D.F. 41		
	C. Bank of Japan inter-industry data 1978			
GRS	0.119	3.634	0.241	0.120
RFC	-1.590	-2.857	-0.380	-1.559
NWA	0.169	5.739	0.498	0.928
TOA	1.540	1.490	0.150	0.436
ADV	-0.062	-0.230	-0.017	-0.013

continued

Table 1 (continued)

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
EXS	0.003	0.022	0.011	0.012
SIZ	-0.000	-0.957	-0.066	-0.050
MPL	0.000	3.569	0.256	0.306
Intercept	3.281	0.928		
	R^2 0.836	D.F. 41		

D. Small and Medium Enterprise Agency inter-industry and inter-scale enterprise data 1977

GRS	0.007	3.199	0.117	0.014
RFC	-0.169	-1.062	-0.042	-0.038
NWA	0.164	12.761	0.486	0.620
TOA	1.194	4.399	0.172	0.267
ADV	-0.071	-0.392	-0.014	0.004
SIZ	0.008	3.721	0.137	0.072
MPL	0.001	3.324	0.118	0.079
Intercept	-0.083	-0.090		
	R^2 0.292	D.F. 577		

E. Ministry of International Trade and Industry inter-establishment data 1977

GRS	7.277	3.819	0.153	0.233
RFC	-0.007	-0.200	-0.008	-0.032
NWA	0.288	15.414	0.658	2.885
TOA	2.357	4.224	0.175	1.233
ADV	0.000	1.257	0.054	0.066
EXS	-0.011	-0.739	-0.030	0.082
SIZ	0.000	2.464	0.109	0.161
MPL	0.000	3.077	0.128	0.322
Intercept	-8.107	-10.220		
	R^2 0.579	D.F. 296		

F. Ministry of International Trade and Industry inter-establishment data 1978

GRS	10.847	5.398	0.237	0.142
RFC	0.002	0.282	0.012	0.006
NWA	0.185	10.701	0.502	1.133
TOA	2.591	5.065	0.231	0.813
ADV	0.000	0.287	0.014	0.008
EXS	0.036	2.680	0.118	0.161

continued

Table 1 (continued)

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
SIZ	0.000	0.664	0.033	0.024
MPL	0.000	2.322	0.107	0.133
Intercept	-5.201	-6.897		
	R^2 0.484	D.F. 293		

Sources: Bank of Japan, Statistics Bureau, Shuyo Kigyo Keiei Bunseki (Financial Analysis of Major Enterprises) (Tokyo, 1976, 1977 and 1978); Small and Medium Enterprise Agency, Chusho Kigyo No Keiei Shihyo (Financial Indicators of Small and Medium Enterprises) (Tokyo, 1977); Ministry of International Trade and Industry, Waga Kuni Kigyo No Keiei Bunseki (Financial Analysis of Japan's Enterprises) (Tokyo, 1977 and 1978).

Notes: See earlier section on method of analysis and variables for definition of variables.

MPL = machine (money) value per employee (representing the technological level)
D.F. = degrees of freedom
0.000 refers to a negligible number.

Whether such profit could be called solely a windfall is questionable. This view is corroborated by the coefficients of the assets-to-turnover ratio (TOA). Note that the variable is not always significant for inter-industry data, but highly significant for inter-firm and inter-scale data (see table 1 (E) and (F). In particular, an entrepreneur facing increasing industry demand would run capital faster or "stretch" capital to produce a greater amount of output. This is an alternative to the expansion of capacity in anticipation of an increase in demand.

Interestingly, the ratio of financial costs to total liabilities (RFC) affects inter-industry profitability negatively with a 5 per cent significance level, while it shows no statistical significance for individual enterprise data. Having to borrow because of financial difficulties may adversely affect inter-industry profitability, but it does not necessarily do so for individual small and medium-scale enterprises. Some entrepreneurs obviously perform better than others when financial difficulties face an industry.

Net worth over assets (NWA) emerges as the most important variable determining differences in profitability between industries and between individual enterprises. This phenomenon is common to all three economies under study. The greater the ratio of net worth to total assets, the greater the entrepreneurial

efforts towards profit-making.* Further, the Japanese equity market is not as well developed and ownership not as widespread as in Western economies. Hence, spreading risks to a wide range of equity owners does not seem to be a Japanese phenomenon.**

The variable of advertising expenditure over total sales (ADV) is insignificant for all regressions. This is consistent with the findings of Caves and Uekusa for their long-term inter-industry regression (10-year average during the 1960s) "The influence of advertising rates on entry barriers and thus on profitability is weakly significant and somewhat less potent than in Western economies" [20].

The ratio of exports to sales (EXS) also fails to register any significant influence on profitability. This is understandable since Japan had eliminated export subsidies of any kind by 1972. Furthermore, protectionism in the Western industrial countries, which increased during the 1970s, might have played a part. Even during the 1960s, when there was some export subsidizing, this variable seemed insignificant according to the findings of Caves and Uekusa [21].

The size of the enterprise (SIZ) does not appear to be significant in the regression of inter-industry data, while the variable shows a mixed significance for inter-enterprise data. However, scale economies become definitely important among small and medium-scale enterprises. This seems consistent with the finding of Caves and Uekusa that "size influences profits positively but only up to a point" [22].

Finally, a new variable, machine (money) value per employee (MPL), which purports to gauge the influence of the technological level on profitability, is introduced. It has been widely recognized that Japan to a great extent owes its success to technological innovation.*** The question is whether technological improvement shows up in private profitability. The regression results indicate that this variable is significant with a positive sign at the one per cent confidence level for all the data, regardless of whether they are inter-industry or inter-enterprise data.

Regression on data for the Republic of Korea

The equation is regressed on two sets of data, one deali:

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*This evidence is contrary to the view of Caves and Uekusa [19].

**Equity financing in Japanese enterprises amounted to only 8.8 per cent of all sources of enterprise financing during the 1954-1967 period. The proportion for enterprises of the Republic of Korea was 16.5 per cent during 1963-1973. See Il Sa Kong, "An overview of corporate finance and the long-term securities market", Planning Model and Macroeconomic Policy Issues, Chuk Kyo Kim, ed. (Seoul, Korea Development Institute, 1977).

***See Terumoto Ozawa, Japan's Technological Challenge to the West, 1950-1974: Motivation and Accomplishment (Cambridge, Massachusetts, Massachusetts Institute of Technology Press, 1974).

with the inter-industry variation of profits for 68 industry classifications in manufacturing, and the other with the variation of profits among establishments of different size (by number of workers) in 53 subgroups of small and medium-scale enterprises. The former data come from the Bank of Korea publication Financial Statements Analysis (1976, 1977 and 1978), based on a sample of 938 manufacturing enterprises, each selling 100 million won of output or more. The sample is random but stratified by industry classification, by export orientation and by establishment size (thus excluding many small-scale enterprises). The latter data come from Jungso Kiup Siltae Chosa Bogo 1977 (Report on the Survey of Current Status for Medium and Small Enterprises 1977), published by the Medium Industry Bank. The data are compiled on the basis of a stratified random sample of 1,846 small and medium-scale enterprises (defined as those employing less than 300 workers or owning assets of less than 500 million won). Apparently, some of the data of enterprises in the middle range overlap between these two sources. However, the former exclude small-scale enterprises (employing fewer than 20 workers), while the latter exclude large-scale enterprises (employing 300 workers or more).

The results of the regressions are presented in table 2. These years can be considered as normal boom years, the country having recovered from the effects of the oil shock in 1974 and 1975. Gross national product increased by 11.5, 10.5 and 12.5 per cent, and the wholesale price index rose by 12.1, 9.2 and 11.7 per cent, for 1976, 1977 and 1978, respectively. All other development indicators show no abnormal situation which might prompt a special interpretation of the regression result.

The regression indicates that the growth-rate-of-sales (GRS) variable has a positive sign with a high statistical significance at the one per cent level of confidence, except for 1976 inter-industry data. The estimate of the same coefficient for the 1977 Medium Industry Bank data shows no significance. Thus, some windfall profits appear to be making industries more profitable because of the high growth phase of the economy and its attendant demand for the output of some industries. However, it seems that small and medium-scale enterprises were not able to exploit many sales opportunities during this period.

Table 2. Net profit over total assets regressed for data relating to the Republic of Korea

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
	A. Bank of Korea inter-industry data 1976			
GRS	0.014	0.837	0.077	0.127
RFC	-0.196	-0.956	-0.103	-0.390
NWA	0.208	6.296	0.561	1.185

continued

Table 2 (continued)

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
TOA	2.442	3.216	0.294	0.811
ADV	0.489	1.690	0.186	0.101
ERP	0.426	3.068	0.301	0.114
CNR	-0.156	-0.463	-0.041	-0.026
EXS	-0.004	-0.059	-0.005	-0.002
SIZ	0.000	0.367	0.035	0.021
Intercept	-3.940	-1.657		
	R^2 0.503	D.F. 58		
B. Bank of Korea inter-industry data 1977				
GRS	0.056	3.287	0.336	0.562
RFC	0.209	0.764	0.095	0.439
NWA	0.108	2.381	0.250	0.639
TOA	2.032	2.003	0.221	0.733
ADV	1.002	2.383	0.286	0.224
ERP	0.271	1.578	0.167	0.076
CNR	-1.975	-0.722	-0.084	-0.290
EXS	0.115	0.922	0.972	0.050
SIZ	-0.000	-0.034	-0.419	-0.003
Intercept	-5.732	-1.612		
	R^2 0.318	D.F. 58		
C. Bank of Korea inter-industry data 1978				
GRS	0.045	2.911	0.252	0.487
RFC	-0.405	-2.205	-0.220	-0.911
NWA	0.227	6.389	0.548	1.332
TOA	-0.116	-0.126	-0.014	-0.047
ADV	0.997	3.495	0.315	0.234
ERP	0.277	2.223	0.189	0.081
CNR	2.025	1.063	0.095	0.314
EXS	-0.093	-0.545	-0.047	-0.023
SIZ	-0.000	-1.461	-0.157	-0.129
Intercept	-1.285	-0.422		
	R^2 0.540	D.F. 58		
D. Bank of Korea inter-industry data pooled for 1976, 1977 and 1978				
GRS	0.043	4.586	0.248	0.432
RFC	-0.103	-0.855	-0.052	-0.218

continued

Table 2 (continued)

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
NWA	0.173	7.927	0.427	1.008
TOA	1.658	3.310	0.195	0.605
ADV	0.853	4.560	0.277	0.189
ERP	0.342	4.111	0.227	0.096
CNR	-0.196	-0.544	-0.029	-0.031
EXS	0.047	0.842	0.046	0.019
SIZ	-0.000	-0.000	-0.029	-0.019
Intercept	-4.316	-2.739		
	R^2 0.427	D.F. 194		
	E. Medium industry bank data based on establishment size 1977			
GRS	0.006	1.252	0.124	0.061
RFC	0.123	0.893	0.097	0.135
NWA	0.128	4.440	0.883	0.922
TOA	2.650	2.484	0.292	0.592
EXS	0.030	1.793	0.215	0.088
NOF	0.018	2.517	0.287	0.111
SIZ	0.001	0.201	0.032	0.016
Intercept	-6.071	-1.931		
	R^2 0.584	D.F. 46		

Notes: See earlier section on method of analysis and variables for definition of variables.

NOF = number of firms
D.F. = degrees of freedom
0.000 refers to a negligible number.

A scatter diagram of the residuals indicates no heteroskedasticity. A perusal of the simple correlation matrix for all the variables suggests no multicolinearity.

Similar regression exercises for profit rates before taxes yield a slightly better fit than presented in this table in terms of R-squares and T-ratios.

The estimate of ERP for 1978 in a study conducted by the Federation of Korean Industries was adjusted to ensure compatibility with the inter-industry data classification of the Bank of Korea.

The rate of financial costs (RFC) is not statistically significant enough to influence profit rates in any systematic manner except in inter-industry data for 1978. For that year, a negative correlation was found, suggesting that higher financial costs meant a lower profit rate. But the variable is not robust despite the widely held view that high financial costs, especially on loans from curb markets, threaten bankruptcy for many enterprises.

The ratio of net worth to total assets (NWA) shows a positive coefficient and is very significant and robust among the variables for all years, inter-industry data and 1977 medium industry data. These findings appear to provide ample support for the X-efficiency hypothesis, namely, the larger the net worth (private ownership) relative to total assets, the greater the entrepreneurial efforts, thus making enterprises more profitable.

The turnover rate of total assets (TOA) shows a significant positive coefficient for all years except for 1978. The possibility of using capital more intensively to increase the rate of return is enhanced among different industries and different firm sizes within an industry. It should be noted that bank data for 1977 for medium industries is quite significant at the 2 per cent significance level. Along with net worth over total assets, the capital turnover ratio as a variable indicating entrepreneurial effort proved quite significant.

Advertising expenditures over total sales (ADV) appear to be an important determinant of profits for all the inter-industry data except for 1976. It is statistically significant at the one per cent level for 1978, two per cent for 1977 and one per cent for a pooled regression of all three years. It would have been interesting to have estimated the coefficient for the Medium Industry Bank data based on establishment size, but advertising information is not available. As discussed earlier, it is a matter of interpretation whether advertising is a barrier or a market perfecter, especially for a developing country.

The effective rate of protection (ERP) appears also to be a source of profit-making. Note that the variable is significant at the one per cent level of significance for 1976 and for the 1976-1978 pooled data and at the five per cent level for 1978, but not significant for 1977. This seems to support the view that the protected domestic market is more profitable than the subsidized exports.

The concentration ratio (CNR) is insignificant for all the years tested, contradicting both theoretical expectations and a widely held view. Caves and Uekasa's explanation in the case of Japan appears to apply to the Republic of Korea as well. During a period of explosive growth, concentration would fail to influence profits significantly and windfalls through the high rate of sales would dominate over concentration.

Export over sales (EXS) does not explain the variation in profit rates at all, contradicting our expectation of a positive coefficient. This appears to support the allegation that enterprises of the Republic of Korea export in order to receive government subsidies, although exports <u>per se</u> might be unprofitable. The observed lower price for exports than for domestic sales corroborates the findings here.

Size of enterprise (SIZ) shows no significance in explaining the variation of inter-industry profit rates. An explanation of this finding might be similar to that offered for the insignificance of the concentration variable. In a rapidly growing economy, potential entry barriers would be offset by the high rate of sales. Market opportunities could be seized by rising entrepreneurs regardless of firm size. This finding suggests that the emphasis of the Republic of Korea on large-scale enterprises, based on the rationale of scale economies, might have been overemphasized.

Number of firms (NOF) applies only to the Medium Industry Bank data and is not available for the Bank of Korea inter-industry data. The number of firms is a variable reflecting the degree of competition in that industry. It is hypothesized that the larger the number of firms in each category, the greater the degree of competition; and the greater the competition, the more profit-making the firms must be for survival with little access to bank loans. The regression shows a positive coefficient, significant at the two per cent level of confidence.

Overall, these regressions offer little support for profit-making through subsidized export activities, concentration-caused monopoly rent and scale economies (entry barriers). The variable representing the export-to-sales ratio bears little statistical significance in spite of the policy measures providing substantial incentives for exports. Some argue that exporting to the world market enables firms to exploit economies of scale, and hence the efficiency and profitability of exporting firms should have been one of the main sources of growth.* However, our findings apparently fail to corroborate this view. Indeed, as some critics have pointed out, enterprises might export to receive incentive benefits in the form of subsidized bank credits which are often used for domestic speculation, including the purchase of land, because funds are fungible in use. More lucrative business lies in the tariff-protected domestic market rather than in the export market where they must compete with more efficient foreign producers. This view seems borne out by the statistical significance (t-value) of the variable representing the effective rate of protection. Though quantitatively not overwhelming, some market distortions and consequent inefficiency should be recognized here.

Regression on data for Taiwan Province of China

The relative paucity of data, compared with those for Japan or the Republic of Korea, limits the extent of our statistical

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*For instance, Krueger hypothesizes:

> "... technological economic factors imply an overwhelming superiority for development through export promotion. These factors include such phenomena as minimum size of plant, increasing returns to scale, indivisibilities in the production process, and the necessity for competition."

See Anne O. Krueger, "Trade policy as an input to development", American Economic Review, vol. 70, No. 2 (May 1980), p. 289.

analysis for Taiwan Province. Statistical information relative to firm size is quite rare. Fortunately, however, 1970 Industrial Surveys published by the Ministry of Economic Affairs have tabulated some data on net worth, financial costs, and total assets, which are used in this study for inter-industry analysis. Further, the Economic Yearbook 1977, published by the Economic Daily News of Taipei, contained financial information on the 300 largest private corporations, ranging in employment size from less than 100 to over 9,000 for 1975. Also, the Stock Exchange of Taiwan Province began publishing financial information on 100 listed companies. Table 3 shows the results of regression on these data.

Table 3. Profits over total assets regressed for data relating to Taiwan Province of China

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
A. Profits (non-wage component of value added) regressed for the Industrial Survey (inter-industry) data of Taiwan Province, 1970				
SIZ	0.000	0.030	0.009	0.004
NWA	0.019	2.103	0.211	0.943
TOA	1.299	6.387	0.631	1.784
RFC	-0.017	-0.013	-0.004	-0.002
Intercept	-1.344	-3.382		
	R^2 0.44	D.F. 57		
B. Profit rate (net of tax) regressed on financial data of 300 largest industrial corporations, 1975				
GRS	0.000	0.632	0.030	0.005
NWA	21.818	10.346	0.496	2.321
TOA	3.031	6.089	0.302	0.941
SIZ	0.000	1.514	0.075	0.123
KPL	0.868	2.709	0.135	0.314
Intercept	-9.037	-7.698		
	R^2 0.335	D.F. 294		
C. Profit rates (net of tax) regressed on financial data of 100 listed companies in Taiwan Province Stock Exchange, 1978				
GRS	0.006	0.079	0.007	0.006
NWA	0.187	6.652	0.567	1.371

continued

Table 3 (continued)

Variable	Coefficient	T-ratio	Standardized coefficient	Elasticity at means
TOA	0.040	3.212	0.266	0.550
SIZ	0.000	2.005	0.182	0.146
Intercept	-5.820	-3.794		
	R^2 0.401	D.F. 91		
D. Profit rates (net of tax) regressed on financial data of 100 listed companies in Taiwan Province Stock Exchange, 1979				
GRS	-0.005	-0.875	-0.073	-0.012
NWA	0.127	5.387	0.470	1.139
TOA	0.045	4.480	0.374	0.741
SIZ	0.000	2.187	0.186	0.167
Intercept	-4.766	-3.707		
	R^2 0.441	D.F. 84		

Sources: Ministry of Economic Affairs, 1970 Report on Industrial Surveys in the Province of Taiwan (No. 9) (Taipei, 1972); Economic Yearbook 1977 (Taipei, Economic Daily News, 1977).

Notes: See earlier section on methods of analysis and variables for definition of variables.

KPL = capital per employee
SIZ is represented by number of employees in part B and by size of total revenues in parts C and D.
0.000 refers to a negligible number.

With respect to the Industrial Survey data, only four independent variables were usable, and were regressed on the non-wage component of value added over total assets for 62 industrial classifications. Note that the ratio of net worth to assets and the turnover rate of assets are statistically significant. In contrast, the size variable (represented by average assets per firm) and the ratio of financial costs over total debts are not significant. This finding is consistent with that for the Republic of Korea, namely that the X-efficiency of entrepreneurs appears to be quite important in profit-making. It would have been interesting to compare the coefficient of export over sales with other variables. Unfortunately, however, such information was not available.

The regression on individual private enterprise data strengthens our observations even further. Note that in the regression on the 300 largest industrial corporations, the ratio of net worth to assets bears a T-ratio of over 10. Next is the ratio of sales to total assets, with a T-ratio of over 6. In contrast, the T-ratio of the growth rate of sales is insignificant, unlike the case of the Republic of Korea. It seems that windfalls are not an important source of profit-making in Taiwan Province.

A new independent variable is experimented with in the regression, that of fixed assets per employee as a measure of the level of technology. It is assumed that the larger the amount of fixed assets per employee, the higher the level of technology in production. The variable turned out to be significant at the one per cent level of confidence with a positive sign. In other words, the higher the level of technology, the greater the profitability of an enterprise.

Summary of findings

This section has investigated the source of private profitability and its implications for allocative efficiency in the manufacturing sector of Japan, the Republic of Korea and Taiwan Province. Private profitability does not necessarily mean social efficiency of resource allocation. Differences between the two measures could come from a variety of sources. Among others, natural barriers to entry and government policy-contrived distortions could bring about private profits unrelated with social efficiency. Inefficiencies from such sources could be inconsistent with the rapid growth of an economy, since misallocation of scarce resources would hinder growth.

Fortunately, however, the foregoing empirical analysis of the three economies indicates relatively small effects of resource misallocation. By contrast, the efforts of entrepreneurs to innovate, compete, economize on scarce resources and improve technology would appear to dominate as the major sources of differences in profitability between industries and betweeen enterprises. This generalization is supported by findings that export orientation with subsidies, large firm size and concentration are not an important source of profit-making in general, and further that the ratio of net worth to total assets, the turnover rate of assets, and machine value per employee (particularly for enterprise-level data rather than industry-level data) provide the main sources of profitability. Table 4 ranks the strength of variables by T-ratio. The overwhelming strength of the ratio of net worth to total assets in all three economies is striking, suggesting that wealth maximization (incentive) may be the strongest driving force.

Though these findings are informative, some caveats are in order. The analysis suffers from several shortcomings. First, the results of the regressions for the three economies are not strictly comparable because the inclusion of explanatory variables differs among countries (as dictated by the availability of statistical information). Second, to make the findings more conclusive, an analysis of long-run average data is needed (for example, covering a decade) rather than annual data as in this study.

Third, interpretation of the regression results could be further refined by more extensive study of country-specific institutions and policy mixes than presented here. Fourth, dynamic effects of resource allocation, undoubtedly great in the three economies under study, cannot be treated within the static framework of analysis adopted here.

Nevertheless, this study suggests that the driving force for the rapid industrial growth has originated from vigorous entrepreneurship and management striving for profit-making, while allocative efficiency was not hampered by either natural entry barriers or government favours and discrimination.

Table 4. Ranking of variables by the strength of the T-ratio in the regressions of profitability for manufacturing in Japan, the Republic of Korea and Taiwan Province of China

Variable	Year					
	1976*	1977*	1978*	1977**	1977***	1978***
			Japan			
GRS	2	2	2	5	3	2
RFC	4	5	4	6	7	8
NWA	1	1	1	1	1	1
TOA	8	4	5	2	2	3
ADV	5	7	7	7	6	7
EXS	6	6	8	-	8	4
SIZ	7	8	6	3	5	6
MPL	3	3	3	4	4	5
			Republic of Korea			
	1976*	1977*	1978*	1976-1980*	1977**	
GRS	6	1	3	2	5	
RFC	5	7	6	6	6	
NWA	1	3	1	1	1	
TOA	2	4	5	5	3	
ADV	4	2	2	3	-	
ERP	3	5	4	4	-	
CNR	7	8	8	8	-	
EXS	9	6	9	7	4	
SIZ	8	9	7	9	7	
NOF	-	-	..	-	2	

continued

Table 4 (continued)

Taiwan Province of China

	1970*	1975***	1978***	1979***
GRS	-	5	4	4
RFC	4	-	-	-
NWA	2	1	1	1
TOA	1	2	2	2
SIZ	-	3	-	3

Notes: See earlier section on methods of analysis and variables for definition of variables.

NOF = number of firms

A single asterisk indicates that the basic data are inter-industry. Double asterisks indicate that the basic data contain entries of data classified by enterprise size within an industry, and hence more disaggregated than single asterisk series. Triple asterisks indicate that the basic data are strictly individual enterprise data, hence most disaggregated.

There is only a negligible change in the ranking if standardized coefficients are used instead of the value of the T-ratio. Overall conclusions are not altered thereby.

Chinese reform of its incentive system and the experience of its Asian neighbours

It has been noted earlier that the Chinese reform plan for a profit-oriented incentive system would move the economy much closer to its Asian neighbours than ever before (though State ownership of land and factories will remain). The same holds true for the development strategies envisioned for China, namely, the import of foreign capital and technology, expansion of exports, import substitution, rationalization of industrial structure (including adjustments in the mix of heavy and light industries and of small and large-scale enterprises) etc. The Government of China has announced that major policy tools to achieve these objectives will comprise indirect economic levers such as taxes, subsidies, depreciation allowances and access to bank loans, much like those again in neighbouring economies. Undoubtedly these incentives will affect the sources of profitability for individual enterprises. In this section the possible implications of the experiences of neighbouring economies for the reform process in the Chinese economy are briefly considered.

The statistical analysis in the previous section suggests that the major sources of profitability come from innovative activities by wealth accumulators (represented by the ratio of net worth to total assets) and the economy of capital use (capital turnover ratio). The question arises as to how relevant this experience is to Chinese reform of the incentive system. In the economies of China's Asian neighbours, where private ownership of

enterprises is allowed, the desire to maximize wealth seems to provide a major driving force. It is interesting in this connection to note that the ratio of net worth to total assets yields the strongest statistical significance for enterprises in Taiwan Province compared with those of Japan and the Republic of Korea. But in China the law prohibits private ownership of enterprises in principle; instead, the incentive to work would come from income and wages, which would vary according to the performance of managers and workers. Though wealth could conceptually be equivalent to the discounted sum of income flows, incentive provided by wealth-maximizing opportunities could be stronger than that provided by performance-determined incomes and wages.* Nevertheless, greater financial rewards to superior performers would create differences in accumulated monetary savings of families - a position of de facto wealth at least in one form if not in the ownership of productive means. Furthermore, it has been reported that a new inheritance law is being designed to allow private wealth to be accumulated and inherited to a limited extent, particularly in small-scale enterprises and rural areas [23]. These incentive measures could unleash the latent forces of efficiency, producing greater work intensity and ingenuity among managers and workers.

The available (though indirect) evidence seems encouraging. Despite problems associated with transition, such as managers' misunderstanding and misuses of the newly introduced system, wage inflation beyond productivity increases, unemployment from shedding inefficient and redundant workers and price-raising in imperfectly competitive conditions, industrial growth has accelerated in recent years. Starting from an industrial growth rate of 4.1 per cent in 1981, the acceleration reached a rate of 14 per cent in 1984 (5.7 per cent in 1982 and 10.5 per cent in 1983). Policy-makers are currently worried about overheating of the economy and the possibility of inciting general inflation. Likewise, State revenues increased by 6 per cent in 1982, 11.7 per cent in 1983, and 23 per cent (annual rate for the first six months) in 1984 [24]. It must be remembered that over three-quarters of State revenue comes from industrial profits. Although lack of information precludes the possibility of an analysis to isolate the sources of profitability, the new incentive system had undoubtedly played an important role. Efficiency implications of the profit earned cannot be drawn, however, until pertinent data become available.

It would be interesting to know whether profit grows faster in small-scale enterprises or in larger-scale ones, and whether profit rate over capital assets is higher in the one than in the

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*This is basically an empirical question. Scattered evidence from Western countries suggests that profit rates are higher when the ownership component of management is higher. See H. Leibenstein, Beyond Economic Man: A New Foundation for Micro-Economics (Cambridge, Massachusetts, Harvard University Press, 1976), p. 44; H. K. Radice, "Control type, profitability and growth in large firms", Economic Journal, September 1971, pp. 547-562; and J. Shelton, "Allocative efficiency vs. 'X-efficiency': comment", American Economic Review, December 1967, pp. 1252-1258.

other. Such knowledge is important since the problem of fair income distribution is related, though indirectly, to the relative performance of enterprises of different size. The information is also useful for policy-makers to design a policy mix for efficient resource allocation. At the moment, however, the relevant information for an analysis of this issue is unavailable. Nevertheless, the experience of China's Asian neighbours would seem highly significant. Many, including Chinese policy-makers, tend to believe that small-scale enterprises are inherently less efficient than large-scale ones. However, the figures presented in the previous section counter such a belief; that is, the rate of profit compared to capital assets bears no correlation with the size of enterprises. Furthermore, an additional analysis suggests that the smaller the firm size, the higher the total factor productivity* in the case of Japanese manufacturing, and that, over time, total factor productivity improves faster in smaller-scale than in larger-scale enterprises for all three economies studied (Japan, the Republic of Korea and Taiwan Province).

This suggests that the case of China may be similar to the above experiences, and that China, under the appropriate conditions, could perhaps achieve similar results. For this reason, detailed comparative studies of policy effects could prove useful to change industrial structure. At any event, the provisions of a new inheritance law with more generous features for small-scale enterprises, currently under preparation in China, could serve as a potent incentive for promoting efficiency in small enterprises, to judge by the experience of China's neighbours. Efficiency-based growth of small-scale enterprises could help to deal with the income-distribution problem inherent in greater reliance on the market mechanism. This self-help approach could yield far better results than any direct subsidy approach to redress maldistribution of income, which was practiced until the recent reform. The Asian neighbours seem to have demonstrated such a possibility.

Just as in Japan, the Republic of Korea and Taiwan Province, the small and medium-scale enterprises would appear to be dominant in China's industrial output, employment and number of industrial plants, though precise comparison must wait for data availability. Thus, for instance, it has been reported: "It is remarkable that more than 95 per cent of them are listed as small units, although it should be noted that according to Chinese criteria factories with 600, 800 or even 1,000 workers are still classed as small. The justification for this probably lies in the fact that these enterprises can still quite definitely be regarded as small in terms of turnover and capital resources. By contrast, large enterprises numbered 1,584 in 1982 and accounted for only

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*Conventionally, value added per employee is used as an index of labour productivity. In contrast, total factor productivity measures the combined effect of both labour and capital for an enterprise. The analysis is available on request.

0.4 per cent of the total".* And yet, these numerous small industrial enterprises seem to have been discriminated against in access to bank loans and State funds presumably for the alleged reason of inefficiency compared with large enterprises [25]. Such discrimination can, however, create a vicious circle. In particular, small-scale industrial enterprises are hard put to improve on technology and production costs with meagre capital availability, and this widens the technological gap and the cost differential between large modern factories and small ones with traditional (and often artisanal) technology. This in turn results in their credit-unworthiness. Competition in the pursuit of profit could worsen the adverse situation unless supplementary measures are introduced to redress unequal treatment of small enterprises. Herein lies the apparent urgency and importance of preventing the worsening of the "dual structure" by devising policies appropriate to the Chinese situation. The experience of China's neighbours should be taken into account in order to learn from their achievements and avoid their mistakes.

Fierce competition could also come from foreign sources as the Chinese economy is gradually opened up. Partly to fence off foreign competition temporarily so as to nurture infant industries, and partly to encourage foreign joint ventures to invest in new industries in China, tariffs could be used as a policy tool. For instance, China recently raised tariff rates for magnetic video recording equipment (from 80 to 100 per cent), for mimeograph machines (from 40 to 70 per cent), for desk calculating machines (from 30 to 70 per cent), for stainless steel (from 25 to 40 per cent) and for certain polyester fibres (from 70 to 90 per cent) [26]. However, these measures should be only temporary, covering the learning-by-doing phase, since prolonged tariff protection tends to breed inefficiency, while individual enterprises under protection could earn profits solely because of tariffs and the consequent high domestic price.** The distorted price could send a wrong signal in the long run, inviting investors to expand output capacity beyond warranted levels (an aspect that China is trying to correct in its current reform package). Further, export producers using high-priced inputs under protection could lose cost-competitiveness in international markets.

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*Small industrial enterprises are reported to have been recently redefined (in Beijing, Shanghai, and Tianjin) as those "with fixed assets and yearly profits of under 4 million yuan and 400,000 yuan respectively and in other regions those under 3 million yuan and 300,000 yuan". See Akira Fujimoto, "China's economic reforms: the new stage", China Newsletter (Tokyo, Japan, External Trade Organization, Tokyo), No. 54, January-February 1985, p. 4.

**Joel Bergsman has produced evidence to show that enterprises protected from foreign competition tend to become less stringent in cost-reducing efforts and that such relaxation (X-inefficiency) accounted for 2 to 7 per cent of gross national product in four countries. See Joel Bergsman, "Commercial policy, allocative and 'X-efficiency'", Quarterly Journal of Economics, August 1974, pp. 409-433.

In order to reconcile the conflicting needs to protect infant industries and to encourage exports, the neighbouring economies often used tariff refunds or tariff-equivalent subsidies for export producers. This method allowed the latter to import inputs and machines at world prices and sell the output abroad at world prices. But the selling price, owing to the tariff-subsidy scheme, often became lower than the domestic price. Consequently, the price differential provided a cause for official investigation for dumping charges in the importing country (for example, the United States of America). Whether China, a much bigger economy than some of its neighbours, could use the same method without immediate protest from the importing country is a moot question. At any rate, an export-led growth strategy if adopted by China to the same extent as its neighbours would demand huge industrial adjustment in the importing country. The recent trade dispute between China and the United States on textiles and clothing illustrates the political dimension of the problem. For such politico-economic reasons, subsidies as an incentive to encourage exports may prove less effective than in the neighbouring economies.

Concluding remarks

The Chinese economy has embarked upon a long journey for its transformation and efficient industrial growth. As the economy gradually changes during the next five years (a transition time which observers think necessary [27]), many complex problems and policy issues will emerge. The industrial incentive and efficiency linkage considered in this paper is a small, though essential, part of the whole interrelated set of problems. Undoubtedly, the rationalization efforts at enterprise level would create an unemployment problem by shedding redundant labour, a price-inflation problem under the condition of imperfect competition among enterprises, and an income-distribution problem as more able enterprises will be rewarded more under the new incentive system.

The solution of these problems, particularly during the transitional phase, will require a set of mutually consistent policies such as the following: a manpower training and allocation policy to take care of labour shed from enterprises;* an incomes policy (wage increases according to labour productivity) at both enterprise and national level, in addition to a macro-demand-management policy if inflation is to be effectively curbed; and an income redistribution policy to suit the Chinese sense of equality. But one of the most pressing reforms would appear to be a policy to ensure a price structure which will reflect the scarcity value of goods and services. Though these policy issues lie outside the purview of this paper, they provide the foundations for the new incentive system effectively to promote efficiency within enterprises. The "right price" provides an important element determining monetary rewards to efficient enterprises and at the same time a signal for capacity expansion or contraction in

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*Wang Jibo reports that enterprises under the incentive experiment reduced employees by 15 to 20 per cent and raised labour productivity by 10 per cent [28].

an industry. However, the market, unregulated by a proper anti-monopoly law and proper rules for competition, cannot be expected to produce the right price structure. It has been reported that such laws and rules are currently being reformulated in China.

All these reforms would seem to concern, at this juncture, the reconstruction of a basic institutional framework. But when it comes to steering the economy monthly, annually or during a plan period, periodical monitoring is needed. Monitoring the movement of industrial efficiency is no exception. Chinese industry under the new incentive system will no doubt undergo an unprecedented structural and compositional change during the transformation period and beyond. It will be constantly asked whether industrial efficiency is being maximized along with the structural change. To answer such a question, there is a need for empirical research based on comprehensive statistical information about the behaviour of industrial enterprises. Thus, industrial censuses or periodical sample surveys become essential for policy implementation. Furthermore, comparative empirical analysis can help researchers and policy-makers to glean insights into the experiences of other economies. Such insights in turn often make policy formulation and implementation more efficient than they would otherwise be. It would therefore be useful, as a starting-point of comparative research, to devise common definitions of terms to designate characteristics of industrial enterprises, a common classification format of statistical figures and comprehensiveness in statistical coverage between different economies.

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by Kent Jones
London, Trade Policy Research Centre, 1985. 99 pp. Price: £3.00

Despite their differing titles, these two books are concerned with much the same issue. Gautam Sen has the following interesting hypothesis: "the real causes of international trade disputes in manufactures hinge on the division of the international political system into competitive nation states" (p. 249). He takes a long-run view of the issue, suggesting that international trade rivalries (protectionism in its largest and nastiest form) is endemic to the international system. Kent Jones has a similar concern but confines his investigation to the steel industry. He asks what caused the rapid emergence of protectionist sentiment which subsequently grew into an international "policy crisis" in steel trade. How did Governments respond to protectionist pressures and were these responses effective? The two books share other overlapping interests. Sen believes that six industries including steel (others are chemicals, textiles, machinery, paper and paper products and transport equipment) are "strategic" for the common goal of national economic self-reliance. The significance which Governments attach to the steel industry is evident from Jones's account.

Given his all-encompassing approach, the line of reasoning behind Sen's argument is the more complicated of the two. Noting the "primacy of politics", he argues that the international system is dominated by competition between nation States. The currency of this rivalry is power and "the highest denomination of this currency of power is military capability" (p. 66). If this is the crux of Sen's argument, what about his methods of establishing the hypothesis? He begins with an analysis of structural change, drawing on earlier analysts including Kuznets and Chenery. These results suggest similarities in the pattern and composition of manufacturing between countries and over time. But the author proves to be no statistician. His major sources, both for this subject and the discussion of world trade in strategic industries (chapter V), are out of date - originating mainly from the period 1950 to 1971 - even though some more recent analysis (as well as data) would have buttressed his case. The "catalytic impact of military requirements are seen as the principal determinant of the structure of production" (p. 93). From this basis, Sen goes on to

examine the role of the State, the influence of the transnational corporations and the interaction between these two sets of actors on the global distribution of production and trade.

Because his study is confined to trade disputes within the steel industry, Jones's task and methods are somewhat more straightforward. American trade policy has been a key ingredient in the recurrent steel crisis since the late 1960s. Jones provides an interesting account of the rise and fall of protectionist pressures and the evolutions of trade policy restraints from quota systems to a tortuous trigger price mechanism and, finally, a system of "voluntary" restraint agreements. He focuses on the manoeuvrings which have marked trade relations between the United States of America and the European Communities and finds much in both approaches to be avoided. The theme which reappears throughout this study is that trade restraints merely serve to divert, or refocus, a continuing problem. Other suppliers of foreign steel may emerge or the original exporters simply earmark new markets for attention.

The prim value of Sen's book is in highlighting the possible link between the military imperative and industrialization. But because of the weaknesses in his research he fails in establishing the case. Curiously, he devotes comparatively little attention to electronics, an industry many believe to have clear military applications. Like Sen, Jones recognizes that widespread government intervention rules out laissez-faire solutions to trade problems. He concludes that some form of negotiation is necessary. This should be an attempt not to agree on "fair" market shares (as in the case of the Multi-Fibre Arrangement), but to reassert the principle of non-discrimination and to eliminate the constant state of suspicion and crisis among trading partners. Jones's book can be read with benefit by those concerned in the steel industry and by those with an interest in the consequences of widening protectionism. And the latter group would include most of us.

Highlights from

INDUSTRY AND DEVELOPMENT: GLOBAL REPORT 1985

United Nations publication, Sales No. E.85.II.B.1. 296 pp. Price: $23.00

One of the results of the research activities of UNIDO is a new annual series of Global Reports on Industry and Development. The 1985 Global Report is the first issue. The purpose of these reports is twofold: first, to present an up-to-date assessment of the progress which developing countries are making on their industrialization efforts within the broad context of developments in the world economy; and second, to analyse policies that would help to improve the prospects for industrial development in developing countries. The perspective of the report is a global one in that the problems of industrialization faced by developing countries and those of industrial restructuring (reindustrialization) faced by developed countries are seen as interlinked. While it is hoped that such a global perspective will be shared and prove persuasive in its call for co-ordinated reflation by the North, it is recognized that at the present juncture there are no forces to bring such a policy into operation. It is against this background that the policy area examined in detail in the 1985 Global Report is that of South-South industrial co-operation. Part one of the report deals with recent progress on industrialization in a global context, and part two with South-South industrial co-operation. A brief summary of each part is given below.

Recent progress on industrialization in a global context

The 1985 Global Report starts by considering industrial development in a long-term perspective. It argues that the growth of industrial output achieved during the period 1963-1979 was more rapid than in any other period of history. However, since 1979 the growth of industrial output in developing countries has faltered mainly as a result of a policy-induced slow-down in the economic growth of the North. The interruption in the process of industrialization has been greatest in Africa and Latin America. It has been less severe in Asia, where the momentum of economic growth was much better sustained during the years 1981-1983.

The Global Report analyses the slow-down in industrialization of developing countries during the period 1981 to 1984 by assessing the impact of four factors, namely, weak export earnings, the high level of external debts, reduced inflows of external capital and the extraordinarily high level of interest rates. The negative influence of these was somewhat reduced by the rapid recovery recorded in the United States in 1984. Nevertheless, high unemployment remains a global phenomenon, and the debt problem of the South continues to have global implications. Particularly, the prospect of slow growth in Western Europe clouds the outlook for solving the severe unemployment problem in that region. African countries, traditional trade partners of Western Europe, are finding this depressing for their growth prospects. A robust recovery on a co-ordinated and synchronized basis for all industrialized countries is therefore viewed as an essential condition if the connected problems of unemployment in the North and debt in

the South are to be eased. At least a 3.5 per cent rate of long-term growth in the North as a whole is needed to have some real impact on these problems.

The Global Report further advocates the crucial need for industrial restructuring on a co-ordinated basis between the North and the South, if a robust long-term growth of the world economy is to be maintained in a non-inflationary manner. Rapidly shifting comparative advantage has brought unprecedented opportunities for an efficient division of labour in industrial production between the two areas. Retarded adjustment to movement of market forces in the world economy, supported by the resurgence of protectionist sentiment, could pave the way to a return of stagflation. Conversely, growth-oriented demand management, if coupled with efficient restructuring, would provide a means of avoiding its recurrence. In this way, North-South interdependence can be made to work positively for both areas, in other words, to increase production and trade.

To support this conclusion, the Global Report shows through scenario exercises that policies which create increased exports for developing countries are to be preferred to policies which aim to service external debts by reducing imports. The latter type of policies not only would be less beneficial for developing countries, but would also have an adverse impact on the North. The Global Report also considers the impact of limiting debt-service payments of any single developing country to 25 per cent of its export earnings. This would make it easier for the South to regain its growth momentum.

The Global Report therefore proposes a three-point programme to boost the economic growth of developing countries to at least 7 per cent per annum, involving the following measures:

(a) First, co-ordinated policies to sustain economic growth rates of at least 3.5 per cent per annum in the North;

(b) Second, policies to liberalize international trade and eventually eliminate barriers by the North to imports of manufactured goods from the South;

(c) Third, active North-South co-operation for the restructuring of world industry aimed at enhancing global economic efficiency through a rational international division of labour.

The Global Report recognizes the possibility of lack of interest in the North in such a programme to revitalize the world economy. Its second part is therefore devoted to steps which developing countries can take themselves through intensified South-South co-operation in the field of industrial production and trade in manufactured goods.

South-South industrial co-operation

South-South co-operation has been a slogan and a rallying cry for developing countries for at least the last 10 years. Yet the potential for realizing such co-operation has never been quantified. The second part of the Global Report sets out to fill this

gap, first by constructing scenarios to demonstrate the broad economic impact of intensified South-South co-operation, and second by examining the potential increase in South-South trade between 1979 (the base year) and 1990 at the level of 28 branches of industry.

In the 20 years up to 1980, the industrial output of the South increased fourfold and the range of industrial goods produced broadened considerably. The value of South-South trade in manufactured goods (valued at current prices) increased from $6 billion in 1970 to $25 billion in 1975 and $51 billion in 1979. As a result, the share of the South's total imports supplied from within the South rose from 14 per cent in 1970 to 18 per cent in 1979. The Global Report estimates that this share could increase to at least 26 per cent by 1990.

Most of the growth in South-South trade during the 1970s was concentrated in industries producing consumer goods and intermediate products. The proportion of the South's total imports originating in the South in 1979 was over 60 per cent for refined petroleum and over 40 per cent for textiles, clothing, footwear, rubber products and wood products. But in 1979 the South supplied less than 15 per cent of its import requirements of chemicals and iron and steel and less than 10 per cent of its import requirements of capital goods.

The Global Report expects the South to become more self-reliant in all branches of industry by 1990 and to raise substantially the share of imports of chemicals, iron and steel and capital goods supplied from within the South. The sharp increase in South-South trade in capital goods from $1 billion in 1970 to $12 billion in 1979 is noted. Moreover, production of capital goods in the South grew by 9 per cent per annum between 1963 and 1979. With this and other evidence relating to production and trade complementarities made available through South-South co-operation, the Global Report dismisses arguments which have been advanced to cast doubt on the developing countries' capability to expand their production and trade in capital goods.

A novel feature of the Global Report is the identification of potential trade partners at each branch level of industry for South-South co-operation. The value of total imports and the proportion supplied by the South are estimated and compared with the level of domestic production in each branch for each of the five regions of the South. Based on the estimates of production and trade during the 1970s, South-South co-operation scenarios are constructed. In searching for potential trade partnerships and making projections of potential magnitude up to 1990, both demand and supply growth conditions are taken into account for each pair of regions.

Thus, the Global Report provides a description of who will produce which commodity, how much, and for whom in South-South co-operation. It also provides a measure of the additional economic growth in the South which could be generated by such an increase in South-South co-operation. The use of global models allows a measurement of interregional feedback effects on growth and structural change. The result of such an exercise leads to

the conclusion that South-South co-operation brings the benefit of additional growth for the North, and therefore that it pays for the North to help the South to help itself.

The self-reliance of the South is expected to show the fastest improvement between 1979 and 1990 in the equipment and consumer durables components of capital goods.

The impact of intensified South-South trade between 1979 and 1990 is shown to vary from region to region due to their different levels of reliance on exports and different structures of production. UNIDO estimates that a doubling of South-South trade in manufactured goods would over 10 years provide a stimulus for an increase in industrial output of 20 per cent in the Near East, 26 per cent in East Asia, 33 per cent in Latin America, 36 per cent in Tropical Africa and 48 per cent in the Indian Subcontinent.

For the South as a whole, the estimated stimulus to be derived from intensified South-South co-operation would be a 31 per cent increase in industrial output. This would require a much higher level of imports from the North, which in turn would require an increase of almost six per cent in industrial output in the North.

A global perspective is thus reinforced. Given a reasonable chance that the North may launch a co-ordinated recovery with the improved access to their markets for the South, a better global division of labour will occur in the world industrial economy, with the South a much stronger economic and trading partner. But even if such a recovery did not come about, increased South-South co-operation forms an integral part in the industrial development strategy of the South, as envisaged by the 1981 Caracas Plan of Action. Such a prospect, UNIDO argues, should be welcomed by the North, which will reap some benefits from it. The more positive the response of the North, the greater will be the benefits all around.

PROCEEDINGS OF THE SEVENTH INTERNATIONAL CONFERENCE ON INPUT-OUTPUT TECHNIQUES

United Nations publication, Sales No. E.84.II.B.9. 472 pp.
Price: $33.00

The Seventh International Conference on Input-Output Techniques, held from 9 to 13 April 1979 in Innsbruck, Austria, was jointly sponsored by the Austrian Government and UNIDO. This volume contains 23 of the conference papers, from an original total of over 100. The papers have been selected both to reflect the diversity of the conference itself and also to bring together in a more permanent form practical applications and empirical findings that may be useful to those working in the field. As a survey paper at the conclusion of the volume indicates, input-output analysis has developed in many different directions and has found useful applications in many fields of planning, forecasting and other economic analyses. The general theme of the conference was "Changes in the Structure of the World Economy", and the topics covered include world models, international trade and co-operation, national models, economic growth and structural change, and sectoral price and income distribution. Individual papers originate from the United Nations system, and from both developing and developed countries, including centrally planned economies, and they illustrate different approaches to projections of regional and world economic growth, the international division of labour, technological change, national planning methodologies, and other development issues.

HANDBOOK OF INDUSTRIAL STATISTICS, 1984

United Nations publication, Sales No. E/F.84.II.B.8.
Price: $50.00

This biennial publication provides statistics on major trends within the manufacturing sector for up to 100 developed and developing countries. The data indicate rates of growth, patterns of structural change, patterns of consumption in manufacturing commodities and trade in manufactures. Figures have been compiled from a large number of national and international sources as well as from unpublished statistics derived from the UNIDO data base. Results are reported for the manufacturing sector, for industrial branches within manufacturing and for individual manufactured commodities.

SOMMAIRE

Evaluation des conséquences d'un déplacement de la protection entre secteurs : application à Maurice

David Greenaway et Chris Milner

Les données récentes de la recherche ont facilité l'étude de l'"incidence" de la protection, le terme "incidence" étant pris dans le sens qu'il a sur le plan des finances publiques. Cette monographie décrit un modèle économétrique permettant d'évaluer l'incidence de la protection à Maurice. Elle analyse la période 1970-1982 et renferme des estimations de la part de l'incidence qui est à la charge du secteur exportation. Les estimations se rapportent tant aux produits d'exportation "classiques" qu'aux produits "non classiques". La conclusion qui se dégage de la monographie est qu'une part relativement importante de la charge de la protection se trouve déplacée vers le secteur exportation. La monographie analyse le cadre directeur auquel ce résultat est imputable et examine les répercussions que cet état de choses peut avoir sur le plan de la politique générale.

Aperçu de l'industrie microélectronique dans différents pays en développement

Sean Eamon Lalor

Cette monographie expose les différentes méthodes que les pays en développement, à divers stades de leur développement, peuvent adopter pour édifier un potentiel dans le domaine de la microélectronique. Le premier chapitre fait le point de l'état actuel des techniques de microélectronique, et expose l'ampleur et la nature de la branche d'activité industrielle et commerciale qui en résulte ainsi que les mesures prises par les gouvernements des pays développés pour favoriser ce secteur. Le chapitre 2 expose brièvement l'expérience de cinq pays (Bangladesh, Inde, Pakistan, République de Corée et Venezuela). La monographie renferme ensuite des commentaires et des conclusions sur les difficultés auxquelles les pays en développement ont à faire face et les possibilités qui s'offrent à eux pour tirer profit des progrès de la mocroélectronique.

Les bases du rendement dans l'industrie manufacturière : exemples tirés de l'économie de quelques pays de l'Asie orientale et leurs incidences sur les réformes actuellement introduites en Chine

Secrétariat de l'ONUDI

La monographie fournit au Japon, dans la République de Corée et dans la Province chinoise de Taïwan certaines données statistiques sur les bases du rendement respectif des divers secteurs de l'industrie manufacturière et analyse l'incidence de ces données d'expérience sur l'action que la Chine mène pour mettre en place un

nouveau système de stimulants orienté vers le profit. Elle souligne l'importance qu'il y a à établir les liens existant entre stimulants, politique générale et rendement. Le premier chapitre expose brièvement les diverses formes des systèmes expérimentaux de stimulation et les problèmes qui y sont liés pour ce qui est d'accroître le rendement au niveau de l'entreprise. Le deuxième chapitre renferme les résultats d'analyses de régression sur les base du profit, qui permettent de juger de l'efficacité respective de chacune d'elles (ou de leur inefficacité) au Japon, dans la République de Corée et dans la Province de Taïwan. Le troisième chapitre traite des incidences possibles de l'expérience économique de ces trois pays sur l'action que la Chine mène pour améliorer le rendement des entreprises grâce à son nouveau système de stimulants fondé sur l'économie de marché. Le dernier chapitre renferme un certain nombre de brèves observations quant à la nécessité de recueillir de nouvelles données et de procéder éventuellement à de nouvelles recherches.

EXTRACTO

Estimación del desplazamiento de la protección entre sectores: su aplicación a Mauricio

David Greenaway y Chris Milner

Los progresos teóricos recientes han facilitado el estudio de la "incidencia" de la protección, a partir de una interpretación de la "incidencia" en el sentido de la hacienda pública. En este trabajo se establece un modelo econométrico para calcular la incidencia de la protección en Mauricio. El análisis abarca el período 1970 a 1982 y se aportan estimaciones de la participación de la incidencia soportada por el sector de productos exporable. Se hacen estimaciones tanto de los productos "exportables/tradicionales" como de los "no tradicionales". Se concluye que una proporción relativamente amplia del peso de la protección se desplaza al sector de productos exportables. Se investiga el marco de la política a la cual se debe atribuir ese resultado y se comentan las consecuencias políticas de los resultados.

Panorama de la industria microelectrónica en determinados países en desarrollo

Sean Eamon Lalor

Este estudio muestra como pueden enfocar los países en desarrollo que se encuentran en diferentes fases de desarrollo el establecimiento de una capacidad microelectrónica. En el capítulo 1 se expone el estado de los conocimientos sobre tecnología micro-

electrónica, las dimensiones y la naturaleza de la industria y el comercio que se derivan de ella y las medidas políticas que utilizan los gobiernos de los países desarrollados para promover la industria. En el capítulo 2 se resumen los estudios de cinco casos (Bangladesh, la India, el Pakistán, la República de Corea y Venezuela). Después se hacen comentarios y se extraen conclusiones sobre las dificultades y las oportunidades que hallan los países en desarrollo para aprovechar los progresos de la tecnología de la microelectrónica.

Fuentes de eficacia en las manufacturas: algunos datos procedentes de las economías del Asia oriental y sus consecuencias para las reformas en curso en China

Secretaría de la ONUDI

El trabajo expone algunos datos estadísticos de la experiencia del Japón, la República de Corea y la provincia china de Taiwán acerca de las fuentes de eficacia de las asignaciones en la industria manufacturera y examina las consecuencias de la experiencia en esas economías para los esfuerzos de China por aplicar un nuevo sistema de incentivos orientado hacia la obtención de beneficios. Se hace hincapié en el diagnóstico de las vinculaciones incentivo-política-eficacia-consecuencias. La sección primera examina de manera sucinta varias formas de sistemas experimentales de incentivos y los problemas que comporta cada una de ellas en el aumento de la eficacia en las empresas. La segunda sección expone los resultados de los análisis de regresión de las fuentes de beneficios, lo cual permite juzgar la eficacia (o la ineficacia) de las asignaciones en el Japón, en la República de Corea y en la provincia de Taiwán. En la sección tercera se comentan las posibles consecuencias de las experiencias de esas economías para los esfuerzos realizados por China a fin de mejorar la eficacia de las empresas mediante su nuevo sistema de incentivos orientado hacia el mercado. En la última sección se hacen algunas observaciones breves sobre la necesidad de datos y sobre las posibles investigaciones futuras.

INFORMATION FOR CONTRIBUTORS

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