Contribution of Standardization in Technology Transfer

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Abstract

A conceptual system structure of the causal-chain on the progess of industrialization in developing countries in Asia triggered by foreign direct investment (FDI) is charted followed by KSIM for observing the dynamic behavior of a system on which technology-transfer related system elements are based. Brief analysis on production functions observed in Malaysia as the performance indicators of FDI are also performed. Lastly, the authors comment on the potentialities of international standardization related activities for up-grading the industrial- and trade-structure of developing countries.

Keywords

Technology transfer, Industrialization, Foreign direct investment, Standerdization, System analysis

1 Preface

In an age of recent economic internationalization Asian countries achieved the most dynamic growth in the latter half of the 1980's triggered by the direct foreign investment of developed countries such as Japan and other countries[1,2]. As well-ascertained, FDI has accelerated industrialization in ASEAN countries in line with their national strategy for developing export-oriented manufacturing as a means of take-off. The export-oriented trade structure thus introduced, however, has brought about a mono-cultural industrial structure which has been accompanied by bottlenecks in infrastructure and in backward linkage industrial sectors that can supply materials and intermediate goods to the advanced sectors.

The object of FDI is basically acquisition of the right of management over enterprises overseas. Accordingly, FDI carries with it the transfer of managerial resources of foreign investors who possess large amounts of intangible assets relating to production technologies. This kind of technology transfer is particularly appropriate to Japan in the case where the incentive of foreign investment is for the relocation of production systems (or lines) overseas in connection with countermeasures to the rapid appreciation of the yen and realization of an internationally harmonious production structure in Japan.

For developing countries, transfer of technology is import of "Technologies for implementing specified production technologies", and it can be a factor endowment indispensable for creating their own export-oriented sectors of comparative advantage in international specialization in foreign trade. In brief, FDI specialized in relocation of assembly-line for mass-production of goods of developed countries creates comparative advantage structures in developing countries.

In connection with efficient technology transfer under FDI to the developing countries in ASEAN to create export-oriented industries and the effort being paid by the Asian-Pacific countries to create new regional economy, APEC, as the natural consequence of FDI, the authors direct their attention to the series of actions taken by the EC for a single Europe[3] on which they have concentrated all their energies on the elimination of non-tariff trade barriers, including existing national standards for products.

Furthermore for product-standards we must refer to the ISO's comprehensive international standard for "Quality Systems (the so called ISO-9000 series)" because the degree of quality management effort is the ultimate criteria of productivity and business performance.

In this paper the authors discuss the structure of technology transfer using a system structure model into which quality control related concepts are taken and make an observation on production functions in order to measure the effect of technology transfer.

2 Technology Transfer and Standardization

The pattern of the above mentioned international transaction of production systems for matured commodities is the so called "product cycle type (PC-type)", a coordinate concept to the "flying wildgeese type" where industrialization in a developing country is initiated by establishment of import-substitute industries[4]. Moreover through this transaction, the production technologies spread internationally, and a comparative advantage in international trade goes to developing countries abundant in human resources and other resources.

In the case of the PC-type, however, direct investment by multinational enterprises which equip themselves particularly with advanced standards for quality management, is followed by the import of invisible trade (technology trade) in host country which continues in future.

The quality of commodities must be conformable to appropriate standards of products in order to keep up a steady development of exports. Only in the case where the characteristics and performance of products being conformable to product standards to satisfy consumer requirements, do product standards serve as quality standards. As for consumer satisfaction of mass production commodities, information concerning the needs of many and unspecified consumers is needed.

Mass production technologies have been utilized in host countries in ASEAN, but an infrastructure for improving implanted technologies, designing and developing is insufficient to up-grade industrial structure to produce more sophisticate and competitive commodities to export as well as for their supporting industries which are composed of small and medium-sized domestic enterprises.

The prominent merit of quality management is its contribution to the promotion of business efficiency in terms of saving resources.

The problems pending are the narrow scope of coverage of existing national standards, if any exists, and insufficient institutional capacity for standardization that can harmonize the policy on standardization, elaborate national standards, and coordinate national standards with regional and international standards. In this respect, future aid from the developed countries toward this field, however, should be made according to the ODA base in addition to prevailing enterprise base.

3 Structural Description for Technology Transfer Indicated by Direct Foreign Investment

3.1 Conceptual Figure on Causal Chain

Contrary to problems found in the natural science and engineering field, a system structure for social phenomena is a poor defined problem where object, external constraints, boundary, and scale of evaluation are not always clear. Due to its huge degree of flexibility, the identification of a system structure more or less relies upon subjective inference.

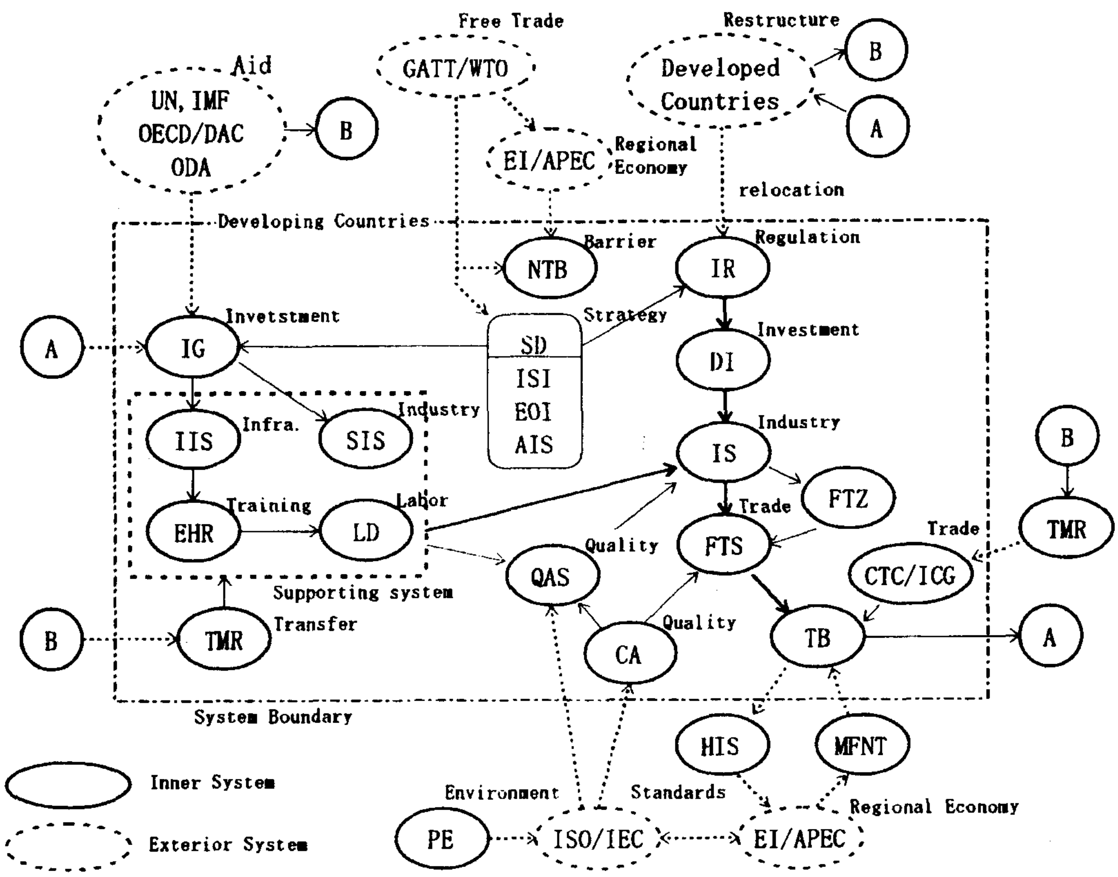


Figure 3.1 Structural description of technology transfer

Table 3.1 Explanation of the abbreviations used in Figure 3.1

Abbreviation	Definition	Abbreviation	Definition
AIS	Adjustment of Industrial Structure	IR	Investment Regulation
CA	Certification Activities	IS	Industrial Structure
CTC	Charge for Technical Cooperation	ISI	Import Substitute Industry
DI	Direct Investment	LD	Labor Demand
EHR	Enhancing Human Resources	MFNT	Most-Favored-Nation Treatment
EI	Economic Integration	NTB	Non-Tariff Barriers
EOI	Export-Oriented Industrialization	PE	Protection of Environment
FTS	Foreign Trade Structure	QAS	Quality Assurance System
FTZ	Free Trade Zone	SD	Strategy for Development
HIS	Horizontal International Specialization	SIS	Structural Imbalances among Sectors
ICG	Import of Capital Goods	TB	Trade Balance
IG	Investment of Government	TMR	Transfer of Managerial Resources
IIS	Insufficiency of Infra-Structure		

The conceptual causal chain structure of FDI and its consequent for national industrial structure is elaborated heuristically in Figure 3.1. The inner sub-system is substantially an industrial development model that involves the strategy of development. The external sub-system has two kinds of function. One is related to international systems such as the UN, OECD, GATT, WTO, ISO, etc.. The other is related to economical action taken by developed countries. The latter function will be discussed later in Chapter 5.

In order to verify the effect of an economical action, the dynamic behavior of system should be observed. A KSIM model[5] is constructed for the purpose in reference to Figure 3.1.

3.2 KSIM

The KSIM model is a simulation techniques[5] for analyzing the dynamic behavior of an ill-defined system such as an econo-system or socio-system where some quantitative and subjective systems variables can exist together.

The value of the i-th system variable at the time $t+dt$ can be expressed as follows:

$$x_i(t+dt) = x_i(t)^{p_i(t)} \quad \text{where } p_i(t) = \frac{1+\frac{cdt}{2}\sum_{j=1}^{n}(\,|a_{ji}|-a_{ji})x_j(t)}{1+\frac{cdt}{2}\sum_{j=1}^{n}(\,|a_{ji}|+a_{ji})x_j(t)}. \quad (3.1)$$

The matrix of a_{ij} in (3.1) is called the cross impact matrix which expresses the mutual influence between two system variables. a_{ij} are integers including zero. Larger a_{ij} indicates a lager influence of i-th on the j-th variable. A positive integer means acceleration effect and a negative integer indicates deceleration effect.

Letter c is a parameter for adjusting influence of the duration of simulation time and by virtue of this adjustment we can assume $0 \leq x_i(t) \leq 1$ under a set of initial values of x_i for every x_i and t.

A simulation was carried out based on the description in 3.1. Number of system variables should be small at most eight so as to get a clear-cut interpretation on the dynamic behavior of the system. After some trial simulations, six system variables can be selected.

Table 3.2 Variables of KSIM

Variable	Country	Definition of the variable
x_1	A	Appreciation of national currency
x_2	B	FDI to a developing country
x_3	B	Monocultural industrial structure
x_4	B	Balance of payment
x_5	A	Trade surplus
x_6	B	Demand on managerial resources

Note: Letters A and B in the Country column represent developed and developing countries for which the variables are intended.

In Table 3.2 each variable is subject to the influence of the all variables on each line. The influences are classified into five classes, −2, −1, 0, +1, +2, according to the circumstances, which must be discussed in detail.

Table 3.3 is the cross impact matrix obtained.

Table 3.3 Cross impact matrix

	x_1	x_2	x_3	x_4	x_5	x_6
x_1	−2	2	0	0	−1	0
x_2	0	0	1	2	−1	2
x_3	0	−2	0	0	1	0
x_4	−1	−1	−2	2	−1	2
x_5	2	2	1	−1	−1	0
x_6	0	0	0	0	1	0

The value $a_{ij} = 0$ does not necessarily indicate there is no causal relationship between i and j, but reveals a situation in which influences via different causal chains are sometimes canceled out by each other. For example, in the case of $a_{65} = 0$, x_6 usually increases import of management technologies to up-grade the productivity and this usually results in improvement of trade balance.

The initial values of system elements are given in Table 3.4.

Table 3.4 Initial values of the variables

	x_1	x_2	x_3	x_4	x_5	x_6
initial value	0.70	0.25	0.50	0.10	0.50	0.10

The simulation covers duration of a 30-year period starting in the middle of the 1980's. Parameters are given by

$$dt = 1, \quad c = 0.05, \tag{3.2}$$

where the unit of dt is one year and influences in unit time are normalized using c.

Figure 3.2 shows the result of the simulation.

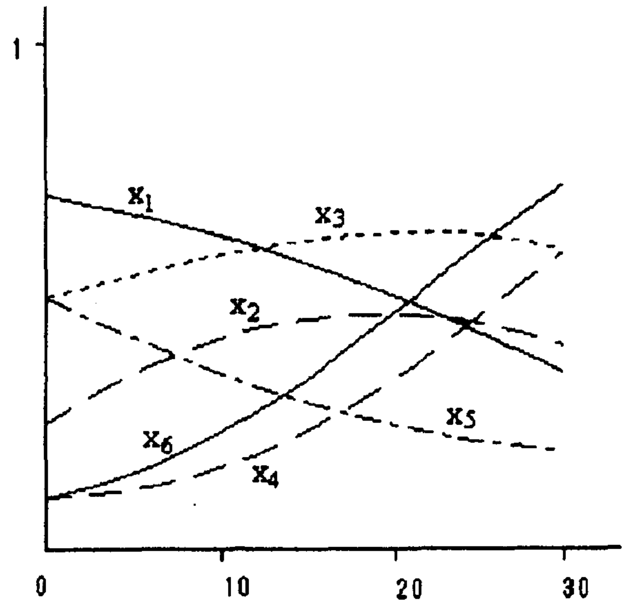


Figure 3.2 The simulation

Appreciation of national currency against other major currencies and balance of payments in a developed country show a steady decrease in our result. On the other hand, the industrial structure in developing countries tends to be a mono-cultural state and will improve later. FDI from the developed countries also shows the same behavior. Finally, the balance of payments and the demand of managerial resources in the developing countries increase steadily. Thus the brief scenario for the process of technology transfer is obtained.

No social systems remain unchaged. A time span of 30 years may be unreal for this kind of forecasting simulation. It is suggested that simulations must be carried out step by step corresponding to change in the strucure of systems to which some different but substantial cross impact matrices correspond.

4 Analysis of Observed Production Function

4.1 Financial Data used in the Analysis

In this paper, in order to clarify the influence of technology transfer, we investigate the time series behavior of the production function of multi-national manufacturing companies in Malaysia. Statistical data of fixed assets, number of employee, total sales, and exports in the reference 6 are used as shown in Table 4.1. The number of employees in 1990 and in 1991 are estimated because they are not available in the references. Giving the number of total employees in 1990 and 1991, the number of employees in multi-national enterprises are calculated extrapolately through the average ratio of the past three years of the number of employees in multi-nationals to the number of total employees.

Table 4. 1 Financial data of foreign-controlled manufacturing companies

Year	Fixed Assets (million ringgit)	Employment (thousands)	Total Sales (million ringgit)	Exports (million ringgit)
1971	778	54.881	3127	1458
1972	872	62.302	3472	1148
1973	1024	73.544	4359	1594
1974	1321	83.554	6468	2607
1975	1754	89.228	5667	2013
1976	1877	107.159	7258	3037
1977	1895	107.980	8003	3493
1978	2062	120.706	9348	4290
1979	2055	120.036	11209	5076
1980	2368	124.935	13765	6112
1981	2970	123.370	15385	6169
1982	3517	120.394	15358	6154
1983	4167	132.127	16701	6588
1984	4346	133.735	17764	8553
1985	4246	119.847	15508	6712
1986	4544	123.390	15331	8856
1987	5225	144.310	19164	12309
1988	6415	178.341	24783	16951
1989	8496	218.495	32983	22317
1980	12498	259.237	42227	28185
1991	16890	295.863	54556	38449

Transition of these data are shown in Figure 4.1.

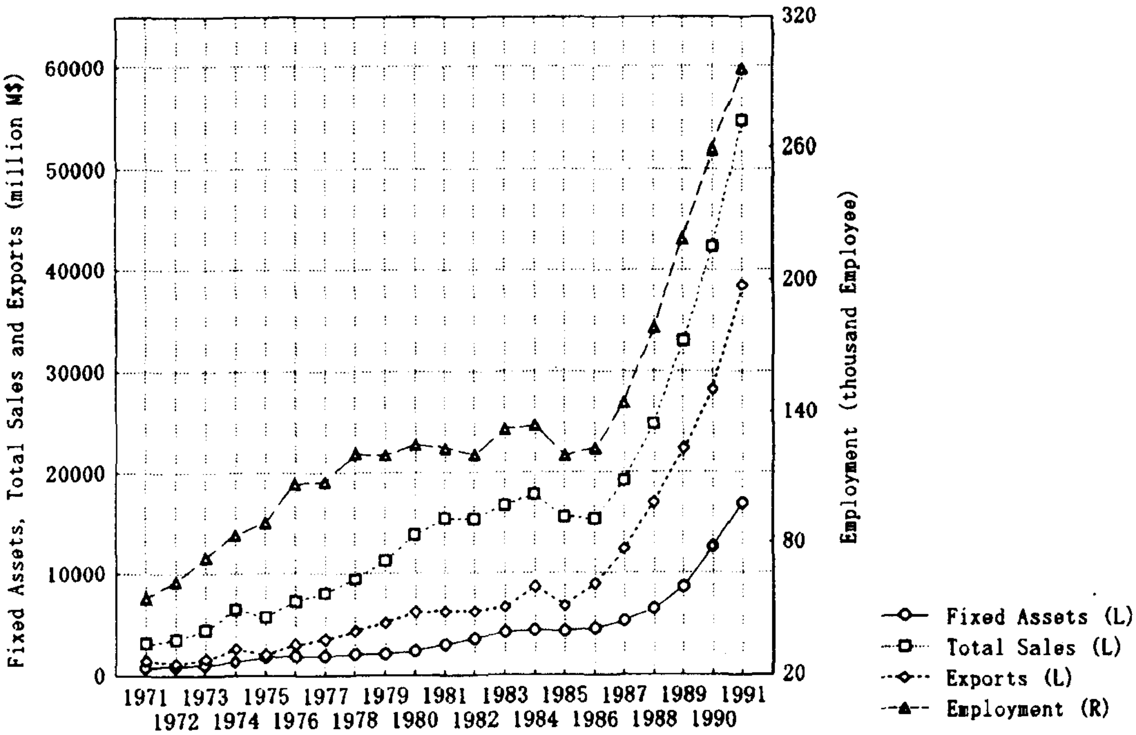


Figure 4.1 Fixed assets, employment, total sales and exports in foreign-controlled companies

The left side of the vertical axis is a measurement of fixed assets, total sales and exports and the right side is that of employment.

4.2 Production Function

In this paper a Cobb-Douglas type production function is employed in the analysis. The form of this production function is given by

$$Y = AK^{\alpha} L^{1-\alpha}, \tag{4.1}$$

where the variables Y,K and L represent the production, capital and labor power of the system respectively. These variables are applicable to the total sales (or exports), fixed assets and number of employees.

This form of the production function has an invariance for aggregation under the following condition. Suppose a set of companies. We assume that the production function of i-th company is $y_i = a_i k_i^{\alpha} l_i^{1-\alpha}$ where y_i, k_i and l_i represent the production, capital and labor power of the company. Parameter α is assumed to be common for all companies but a_i might be proper to each company. An aggregated production function of these companies is given using the rational parameter λ_i and μ_i as follows

$$Y = \sum_i y_i = \sum_i a_i(\lambda_i K)^{\alpha}(\mu_i L)^{1-\alpha} = (\sum_i a_i \lambda_i^{\alpha} \mu_i^{1-\alpha}) K^{\alpha} L^{1-\alpha}. \tag{4.2}$$

The relationship between the total variables K, L and individual variables k_i, l_i are given by $k_i = \lambda_i K$ and $l_i = \mu_i L$. The aggregated production function is also given in the form of equation (4.1). Therefore, we can use the Cobb-Douglas production function for the aggregated production function.

Now we trasform equation (4.1) into the following form

$$\log(Y/L) = \alpha \log(K/L) + \log A. \tag{4.3}$$

Defining the new variables

$$z \equiv \log(Y/L), \quad x \equiv \log(K/L), \quad \beta \equiv \log A. \tag{4.4}$$

equation (4.3) is reduced to a linear equation

$$z = \alpha x + \beta, \tag{4.5}$$

including parameters α and β. We will call this equation a transformed production function. With this transformation we can make use of the linear regression analysis to determine the parameters α and β.

4.3 Results and Discussion of Production Function

We assume the Cobb-Douglas production function for a set of multi-national manufacturing companies. Using the data in Table 4.1 and transforming them to the variables in (4.4), we draw the dispersion graph in Figure 4.2.

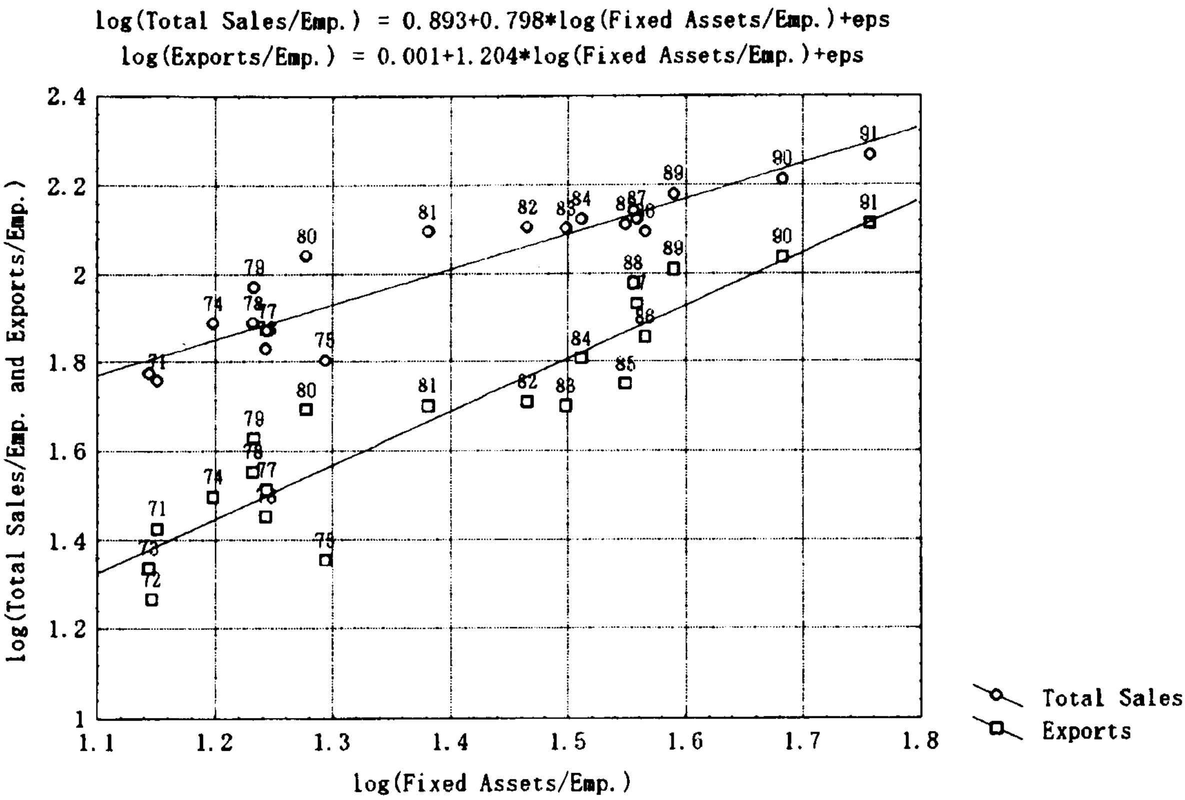


Figure 4.2 Linear regression analysis based on the Cobb-Douglas production function.

The vertical axis indicates logarithms of total sales and exports per thousand employees and the horizontal axis represents the amount of fixed assets per thousand employee. The two lines in Figure 4.2 are regression lines of plots of data. They correspond to the data of total sales and exports, respectively, under the premise that the production function should be equal during the period. The equations of these lines are

$$z = 0.893 + 0.798x, \tag{4.6a}$$

$$z = 0.001 + 1.204x. \tag{4.6b}$$

These equations and the coefficients are significant ($p<0.01$) except the constant term in (4.6b). In spite of the statistical significance, the time series distributions are thought to be biased.

We now assume that the form of the production function is not constant but it is gradually changing with time. If the plots of data are horizontal in order of time and apart from each other, the line connecting these plots is assumed to represent the equation of transformed production function. The basis of this assumption is that the change of the production function in a year is not so small if the slope of the transformed production function is not equal to that of this line.

We examine the periods 1980-1985 and 1989-1991 for total sales and 1980-1983 and 1988-1991 for export. Connecting these data points we draw four regression lines and set numbers for each line, 1,2,3 and 4. The equations of these lines are as follows

$$1:\ z = 1.725 + 0.257x, \tag{4.7a}$$

$$2:\ z = 1.358 + 0.514x, \tag{4.7b}$$

$$3:\ z = 1.618 + 0.057x, \tag{4.7c}$$

$$4:\ z = 1.018 + 0.617x. \tag{4.7d}$$

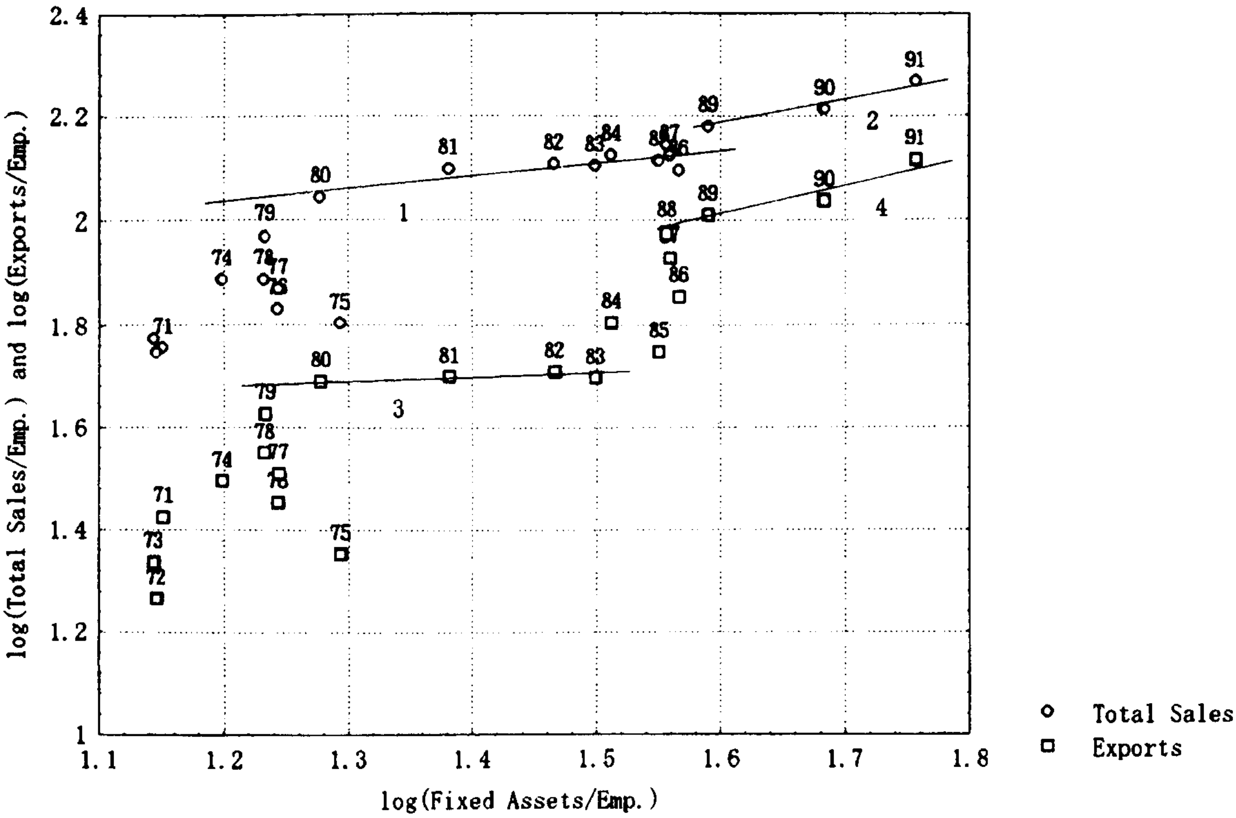


Figure 4.3 Distribution based on the Cobb-Douglas production function.

These lines are thought to represent the transformed production function because the data plots are vertical in order of time and apart from each other*).

Whether the above equation (4.7) represent the genuine production functions is not fully certain although the aggregated input data were used. The aggregated production function in the sense of an average for a set of companies can be calculated by means of regression analysis under the assumption that majority of companies have similar production

*) We use the current market price in Table 4.1, although the constant price should be adopted. We estimate the constant price of fixed assets and total sales determining approximately deflators with the use of reference 6. The analysis is carried out for after 1978. The result is qualitatively equal to the case of current market prices.

functions, as shown in 4.2. However, the scale factor of the function β differs from the previous one.

We will try to determine the production function using data of manufacturing companies in Malaysia. We first select 13 companies whose data for 1991 to 1993 are published in reference 8. The data for 1991 are given in Table 4.2 as an example.

Table 4.2 Data of Manufacturing Companies in 1991

Companies	Manufactures	Employment	Fixed assets	Total Sales
		thousands	million ringgit	million ringgit
1: Aluminium Co. of Malaysia	Aluminum goods	0.604	107.5	153.8
2: Carlsberg Brewery Malaysia	Beer	0.600	94.5	363.0
3: Cement Industries of	Cement	0.560	225.6	156.1
4: George Kent(Malaysia)	Brass goods	0.392	13.6	95.6
5: Goh Ban Huat	Glass and china	0.473	60.1	40.5
6: Guinness Anchor	Beer	1.148	216.9	525.7
7: Land & General	Lumber goods	1.843	180.3	420.9
8: Malaysia Steel	Iron and steel	1.400	130.0	362.4
9: Malaysian Oxygen	Gas	0.400	142.4	163.2
10: Malaysian Pacific Industries	Chemical goods	3.200	158.6	190.4
11: Maruichi Malaysia Steel Tube	Iron and steel	0.290	178.8	223.9
12: MWE Holdings	Textile goods	2.423	47.4	212.2
13: R.J. Reynolds	Cigarettes	0.530	43.3	325.9

In the case where some data are ambiguous and interm one, they are estimated not to spoil the object of model-building. Assuming the Cobb-Douglas production function, we get the following regression lines for each year

1991: $z = 1.37 + 0.501x,$ (4.8a)

1992: $z = 1.35 + 0.501x,$ (4.8b)

1993: $z = 1.36 + 0.494x.$ (4.8c)

These three equations are very similar in spite of dispersion of data. And the values of the slopes in equations (4.8) are very similar to that in

(4.7b). Unfortunately some companies treated here are not multi-national companies. Anyhow the coincidence of the slopes might be an accidental. The difference of annual data in (4.4) must be better than original ones to decide the slope of the transformed production function because it cancels the ambiguity of the constant term in the function. We should find more correct data and examine our result again.

When we consider the lines (4.7) representing the transformed production function, they indicate change of the parameters in the production function. In Figure 4.3, we can divide the plots into two classes. One is the set of data plotted along the vertical axis and the other is along the horizontal axis. For example, as for exports years of gathering data are in the latter half of 1970's and that of 1980's. The data of the total sales in the latter half of 1980's are gathering around a point. In other years the points are straight along the horizontal axis. Lines through these data represent the transformed production function. The transformed production function for export is stable as line 3 for 1980–1983 indicates and it gradually change through 1985–1989 to stable line 4 representing the transformed production function for 1989–1991. Similarly, there might be a considerable change on the production function during the 1970's. For the data of total sales, a large change occurred in 1970's and a relatively small change occurred too in the 1980's.

We think that concentrated technology transfer is caused in a period when the data are plotted along the vertical axis. In this period, the production function gradually changes its form. In the other periods when the data plots are along the horizontal axis, the production continues under the same production function.

To sum up, technology transfer to Malaysia in the course of the 1970's contributed to total sales and exports, and in the 1980's exclusively to exports because of differences in the form of the corresponding two production functions.

4.4 Data Envelopment Analysis

The above interpretation indicates a relationship between technology transfer and efficiency[9,10] of economic entity. We now investigate the annual efficiency of multinational manufacturing companies using the first model of the data envelopment analysis with scale invariance, which has been proposed by Charns, Cooper and Rhodes. In this model, we define input of the decision making unit (DMU) μ as $x_{i\mu}$ $(i=1,\cdots,m)$ and output as $y_{j\mu}$ $(j=1,\cdots,s)$. We should determine the parameters v_i $(i=1,\cdots,m)$ and u_j $(j=1,\cdots,s)$ in order to maximize the efficiency θ of each DMU

$$\theta = \frac{u_1 y_{1\mu} + u_2 y_{2\mu} + \cdots + u_s y_{s\mu}}{v_1 x_{1\mu} + v_2 x_{2\mu} + \cdots + v_m x_{m\mu}} \,. \tag{4.9}$$

Here the parameters should satisfy the following conditions

$$\frac{u_1 y_{1\lambda} + u_2 y_{2\lambda} + \cdots + u_s y_{s\lambda}}{v_1 x_{1\lambda} + v_2 x_{2\lambda} + \cdots + v_m x_{m\lambda}} \leq 1 \quad (\lambda = 1,\cdots,n),$$

$$u_1,\, u_2,\, \cdots,\, u_s \geq 0, \quad v_1,\, v_2,\, \cdots,\, v_m \geq 0, \tag{4.10}$$

if the number of DMU is n.

The fractional programming problem in (4.9) and (4.10) can be reduced to a linear programming problem. Annual transition of efficiency θ on the export are given in Figure 4.4.

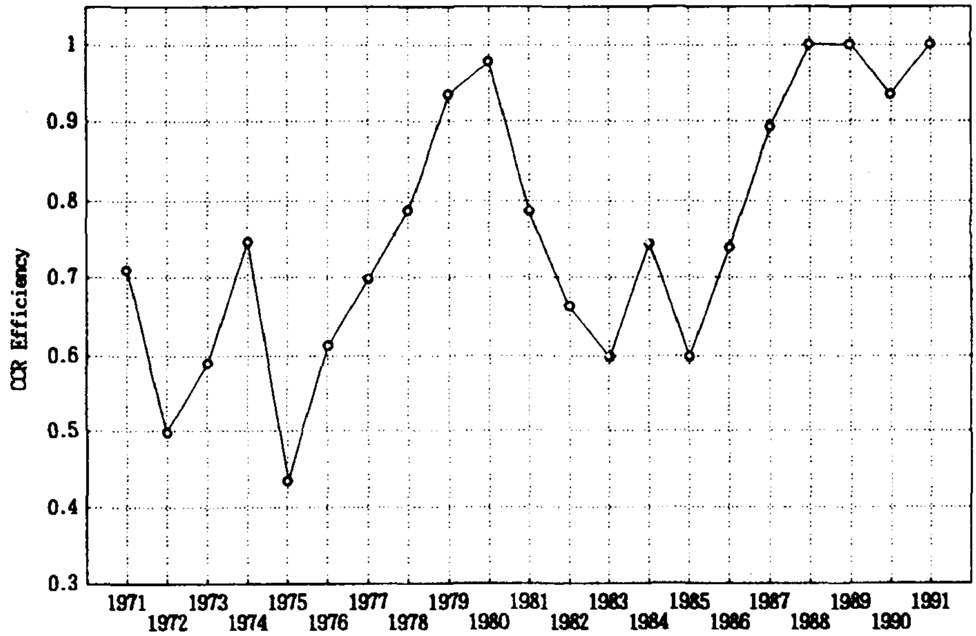


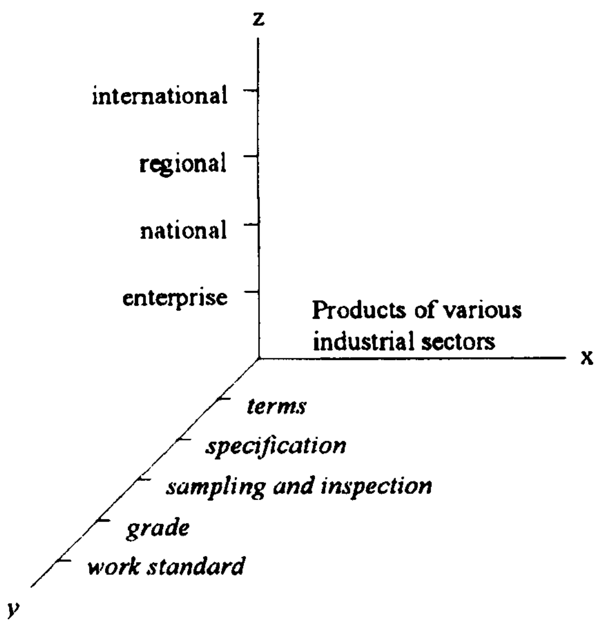
Figure 4.4 Efficiency of exports in foreign-controlled manufacturing companies

To carry out analysis we use the software recommended in reference 10. The peaks of the efficiency realize at the end of the period during which the production function does not remain unchanged. The value of the efficiency is gradually descending during the period where the production function is comparatively stable. This convince us the existence of a relationship between technology transfer and efficiency of production. The authors, however, will discuss this efficiency in a later paper.

5 Contribution of International Standardization

In an age of globalizing economies, having been stimulated by technology innovation including that of information science, modern IE is entering into a new phase of upgrading its scope and function. Standardization, a nucleus branch of IE, has also been increasing its important role in production control.

Along the three axes of standardization space in Figure 5.1, however, competition and harmonization among the existing standards on an axis as shown below in terms of their coverage of scopes have proceeded simultaneously under environmental variation such as emergence of new industrial sectors and interdisciplinary works.



Figre 5.1 Standard space (After T.R.B. Standard[11])

x-axis: subject of standard
y-axis: function of standard
z-axis: level of standard

Significant facts along the *z* axis in this respect are: 1) emergence of comprehensive and normative international standards such as ISO-9000 series for the quality systems and ISO-14000 for environment protection, and 2) a new concept of reciprocal cooperation between regional economies and international standardization organization for developing regional standards such as the Vienna-agreement between EC and ISO/IEC.

In order to reinforce the international competitiveness of products of ASEAN countries, it is necessary to establish product standards and a system of certification for those standards. And harmonization of product standards and quality control activities is one of the important means of reducing barriers within the ASEAN[1].

Furthermore, as seen on the inauguration of EC, a regional economy needs its own standards in order to put free regional trade into practice with certainly. ASEAN as well as APEC is not an exception in this respect. Cooperation with ISO/IEC as well as with developed countries in this field such as Japan who has created a unique quality control activities of TQM is essential for developing its standardization systems including testing systems if necessary in the future. ASEAN estabilshed ACCSQ (ASEAN Consultative Committee in Standards and Quality) as a channel for regional cooperation in the areas of standardization and quality control[11] through which harmonization and mutual recognition of standards and certification are to be promoted.

Since 1989, APEC has been one part of the nucleus of liberalization of international trade whose framework was elaborated in GATT's Uruguay Round. "The agreement on technical barriers to trade (GATT in 1979 and WTO in 1995)" is also a guideline for technology transfer[12].

This agreement summarizes common recognition of international trade, international standardization, and technology transfer through assistance. They are abstracted as follows: 1) International standards and conformity assessment systems can improve efficiency of production and facilitate the conduct of international trade, 2) Technical regulations and standards, etc., shall not create unnecessary obstacles to international trade, 3) International standardization can contribute to the transfer of technology from developed to developing countries, and 4) The developed countries are asked to assist preferentially the developing countries in their endeavors in the formation of regulation, standard, standardization bodies and certification bodies, and participation in international systems.

The ISO-9000 series (ISO-9000, ISO-9001, ISO-9002, ISO-9003, ISO-9004) for quality assurance to customers is the normative standards for furnishing "a quality systems" to enterprise and/or its production line for specified products of tangible and intangible, and the selection of level of ISO-9000 series depends on policy of relocation and the state of industrial structure. For example, most of multinational enterprises in Asia are characterizing their production systems (quality systems) based on *ISO-9002*[13], *Quality systems-Model for quality assurance in production and installation, where as ISO-9001, Quality systems-Model for quality assurance in design/development, production, installation and servicing, and ISO-9003, Quality systems-Modelfor quality assurance in final inspection and test*. This is the natural consequence of PC-type relocation of industry in developed countries in Asia so far.

The economic growth of developing countries will be accompanied by a demand for high quality homemade commodities for export and for the middle class consumption. The production technologies for the above mentioned commodities are not always conventional technologies for mass production, but also technologies for R/D which specialize in marketing and in developing original products. And the developing economies will come to be linked to the framework of the international trade through additional transfer of R/D technologies.

In the above process, it is necessary to create technological experts as a kernel for up-grading the technology level and the developed countries are asked to provide training for trainees from the developing countries.

Needless to say, any standards are "public goods" in economic terms, and they also culturally exist to reflect the history of development. Enhancing human resources in the field of quality management must put emphasis on teaching trainees the extensive diversity of culture in ASEAN, and standards must be established on the common character of sociological safety in addition to teaching technical knowledge to overcome the diversity.

Conclusion

1. A simplified KSIM model was proposed and simulation was carried out to confirm the contribution of technology transfer triggered by foreign direct investments toward promoting industrialization in the developing countries. The behavior of the system observed through the simulation fairly reflects the actual circumstances in ASEAN.
2. Thus there is a possibility that a more practical model for system analysis such as system-dynamics model can be constructed when we can estimate quantitative relations of system variables using time series data of existing individual enterprise in a host country.
3. Analyses on observed aggregated production function for multi-national enterprises in a host country indicate the change of productivity. And a data envelopment analysis was also carried out

for confirming above analyses. The results, however, are not satisfactory enough because of lack of data from individual enterprises to which a production function must be prepared.

4. Productivity depends upon not only endowment of resources but also how to utilize business information as well as how to organize production systems. In this respect, the authors discussed the possible contribution of standardization and international standardization toward up-grading productivity and industrial structure, and developing international trade.

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