THE ANATOMY OF EXPORT-LED GROWTH: AN EMPIRICAL STUDY OF SINGAPORE'S INDUSTRIALIZATION AND TRADE FLOWS, 1967 - 1979

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ABSTRACT

This thesis examines analytically and empirically the reasons which have accounted for the spectacular growth in Singapore's manufacturing sector since her Independence. The principal objective of the study has been to investigate the impact of the industrialization strategy on the growth in manufacturing output, export and investment. In conducting the analysis within the framework of the theories of international trade, the study makes a contribution by discovering new facts and providing empirical insights into some of the contradictions between theoretical predictions and observed facts.

In Chapter 2, the nature and extent of export expansion and import substitution within Singapore's industrial sector is investigated. Export expansion is found to have contributed significantly to the growth in manufacturing output. Chapter 3 examines, with the help of the Constant-Market-Share model, the various components of export growth. The finding reveals that Singapore's increasing share of exports can be attributed, in order of magnitude, to competitiveness, favourable export markets and good commodity composition. The relationship between unit labour costs and cost competitiveness is also examined and reported in Chapter 3.

Chapter 4 provides a rigorous test of Singapore's comparative advantage within the framework of the Ricardian theory and Hecksher-Ohlin model. The results indicate that unit labour costs and skill intensity are important determinants of Singapore's comparative advantage. This is in line with the Singaporean government policy of restructuring the economy into a "brain-service" centre.

The measures of intra-industry trade are critically reviewed in Chapter 5. Intra-industry trade is found to exist between Japan and Singapore and it is increasing over time. Such growth in intra-industry trade between these two countries is found to be related, to a significant extent, to the differences in the relative skill intensities of the two countries.

Chapter 6 provides some background information on the magnitude, direction and contribution of foreign investment to the growth in Singapore's manufacturing sector. The study reveals that skill intensity and unit labour costs are important factors responsible for the rapid growth of foreign investment in Singapore. It is also observed that Singapore is heavily dependent on foreign investment in terms of manufactured output, export and employment. Thus, Singapore's "success" in her industrialization programme seems to be based on her largely "open door" policy towards foreign trade and foreign investment. The indigenous sector, although growing in importance, is still relatively small.

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CHAPTER 1

Introduction

MOTIVATION

The Singapore economy has achieved spectacular growth in its manufacturing output in the past decade. In particular, Singapore has been able to weather the adverse changes in the international economic system of the seventies without great difficulty. As measured in constant 1972 prices, Singapore's total exports rose by 12 percent in 1974 as compared to 18 percent in 1973. Most of the increase resulted from the city-state's growing importance as a manufacturer of machinery, transport equipment and petroleum products. Based on such findings, the export promotion policy of the Singaporean government is often claimed to be a success. In addition, the policy of actively encouraging multinational American, European and Japanese companies to invest in more advanced products and "brain-service" industries has paid off in several aspects. One has been the diversification of manufacturing activities so that no industry category now produces more than 22 percent of total value added. The growth in the exports of newer products through and by multinational corporations has more than offset the decline in traditional types of exports such as textiles, clothing and manufactured consumer goods. In turn, the growing diversification of products has led to growing diversification of markets which is of vital importance to a small domestic market economy like Singapore. The comparative advantage of Singapore does not lie in labour-intensive pursuits as she is basically a labour deficit country. The objective of this study is to investigate the impact of the industrialization strategy on the growth in manufacturing output, export and investment. It also seeks to discover the economic factors that govern Singapore's comparative advantage and investment pattern. An analytical and empirical approach is adopted throughout this study.

ORGANIZATION OF THE STUDY

The nature and evolution of Singapore's industrialization policy is examined in Chapter 2. After a critical review of the theory and measurement of import substitution, the analysis is extended to test if and to what extent exports have come to play a part in the growth of some of these industries - it being an empirical fact that exports have contributed towards the spectacular growth in Singapore's manufacturing output.

The Constant-Market-Share model provides an analytical tool for examining the factors which contribute towards export expansion. Chapter 3 works out the relative effects of market distribution, commodity composition and competitiveness on export growth using such a model. In particular, the factors underlying the competitive effect are examined.

Chapter 4 provides a rigorous test of Singapore's comparative advantage in relation to the Ricardian and Hecksher-Ohlin models. It was found that low unit labour costs may provide an explanation for Singapore's comparative advantage. To what extent can Singapore's exports to the developed and developing economies be explained in terms of her capital and human skills is investigated with the help of simple and multiple regressions.

The growing importance of intra-industry trade in manufactures has been an interesting phenomenon. Chapter 5 critically reviews the theory and measures of intra-industry trade. It also examines the determinants of such trade between Japan and Singapore, both of which are industrialized countries.

In Chapter 6, the importance of foreign investment in the growth of the manufacturing sector is examined. However, the difficulties of obtaining relevant data preclude a more rigorous analysis of the determinants of foreign investment in Singapore than has been attempted in this study.

THE DATA

The statistical information published by the various agencies of the United Nations and those published by government departments have been made use of according to the purposes for which the information was needed. The sources of the data have been cited wherever they have been used but, generally speaking, analyses in which international comparisons are involved have been conducted using the data published by the United Nations. This has made it possible to avoid the problems arising from the different classification systems used by different countries. Where no such comparisons are involved, Singaporean sources have been used. Every effort has been made to avoid the use of data which is likely to introduce bias in the findings, but in some cases, this may not have been entirely possible. In all cases where this may have happened, cautionary notes have been sounded.

CHAPTER 2

A Critical Review of Singapore's Industrialization and Trade Policies

In the eleven year period,1969-1979, the rate of increase in per capita income of Singapore was an average of 12 percent per annum. Over the same period, the output of the modern manufacturing sector increased at an average rate of 24 percent per year.[1] Thus the growth in output of the manufacturing sector far exceeds that of per capita income. The principal focus in this study is an attempt to understand the forces underlying this spectacular growth in modern industry in a small industrial economy. In addition to an examination of the reasons for the rapid growth of total industrial output, this study is also concerned with the explanation of differential growth rates among modern manufacturing industries.

The first section provides some background information on the nature of the structural changes that occurred in Singapore over the period 1963-1979. The different types of industrial policy undertaken by the Singaporean government are also discussed. The second section gives a brief formal treatment of the analytical model underlying the empirical analysis. Finally, the empirical results of "sources" of growth in the manufacturing industries are presented and discussed.

THE BACKGROUND

Industrial Growth

Industrial growth in the postwar years in Singapore may be divided into two broad periods - the period before 1960 when industrial growth was characterized by the lack of any deliberate industrialization policy, and the 1960's when industrialization programmes were launched rapidly. This study is concerned particularly with the latter period of industrial growth.

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1. Yearbook of Statistics, Singapore, 1979/1980, pp.3.

A fundamental objective of industrial policy in the early sixties was the provision of employment opportunities in the manufacturing sector through active government participation and assistance. However, Singapore faced serious obstacles in various areas. Firstly, the abundance of unskilled labour and inexperienced labour resulted in high labour costs. This is evidenced by the high unemployment rate in the early sixties and the small proportion of labour force which was skilled (see Table 1). In addition, industrial stoppages were frequent resulting, amongst other things, in the loss of 388,219 man-days in 1967. As shown in Table 1, there was a drop in the productivity index from 1963 to 1967, and an increase in the remuneration index for the same period which contributed towards the high labour costs. High labour costs was therefore a factor favouring the use of capital-intensive techniques. On the other hand, a surplus pool of unemployed labour necessitated the development of labour-intensive industries in the short-run to "mop up" the unemployed. Secondly, the free port facilities offered by Singapore had led to the entrenchment of brand names and distribution channels which acted as barriers to the development of domestic industries unless the products bore familiar international brand names. The most serious problem however, was the limited size of the domestic market that would provide a ready and easily accessible market in the first stage of the industrialization process. The limited size of the domestic market limited the feasible size of plants below their economic optimum, thus raising production costs and necessitating the more difficult task of seeking export markets for long run expansion and viability.

In view of these barriers, rapid industrialization in Singapore was vital with active government support. The package of incentives included tax exemptions, provision of industrial infrastructure, general improvement of the investment climate and the protection of the domestic market.

The initial strategy of industrialization through import substitution rather than export promotion necessitated the introduction of protective devices like tariffs and quotas. Prior to 1960, in consonance

TABLE 1

Summary Statistics of Singapore's Labour Force

Statistic \ Year	1957	1963	1965	1968	1970	1972	1975	1979
Unemployed as a % of total labour force	5.0	-	8.8	6.7	6.0	4.8	4.5	3.3
Skilled workers as a % of total labour force	6.6	-	-	6.1	10.3	12.3	13.5	14.4
Productivity index of manufacturing	-	62.9	62.7	79.4	100.0	95.5	184.8	256.3
Remuneration index of manufacturing	-	81.1	84.7	85.7	100.0	115.7	187.4	243.3
Man-days lost (1000)	-	388.2	45.8	8.5	2.5	18.2	4.9	-

Source: i) Yearbook of Statistics, Singapore, various issues

ii) Yearbook of Labour Statistics, United Nations, various issues with the free port status, the only import tarrifs were of a revenue nature imposed on liquor, tobacco, and petroleum products. The first protective tariff however, was introduced in 1960 on imports of hard soap and detergents and in 1962 on paints to promote industrialization. Revenue from protective tariffs remained low. In 1967, they generated only 16.5 million dollars or 9 percent of the duty revenue of $183.5 million.[2]

The post-Independence period, that is, the period after 1965, saw a general shift in industrial policy from one of import substitution to one of export promotion. This was due to the growing realization that export expansion provided the only means for long-run economic viability, accelerated industrial expansion and manpower absorption. Concerted efforts to reorientate the manufacturing sector towards production for exports were made only in late 1967, results of which began to be visible in the export statistics for 1969. Tax concessions were granted on profits from the exports of domestic manufacturers to encourage the use of industrial technology and the inflow of foreign capital. Supporting changes were made in labour and educational policies to improve Singapore's competitiveness in world markets. Wage increases were tied to productivity increases and the educational system was restructured with increasing emphasis on technical and vocational education to improve manpower skills.

The success of the industrialization drive is evidenced by the increasing volume of industrial investment and the growing contribution of the manufacturing sector towards national income and employment. With the expansion of the economy, shortages of skilled labour began to be felt. The objective of employment-creation became increasingly superseded by the need to raise productivity and income resulting in the shift of emphasis from labour-intensive industries to skill- and capital-intensive industries.

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2. Tan, Augustine H.H. and Ow, Chin Hock, Singapore, unpublished monograph of the University of Singapore, 1978, pp.284.

In mid-1979, a restructuring programme was undertaken by the Singaporean government to phase out labour-intensive industries and encourage the growth of skill- and capital-intensive industries. Wages were increased for a period of three years so as to induce employers to mechanize and rationalise the use of labour. This policy of restructuring is envisaged to continue into the future although wage increases will be tied to productivity increases after mid- 1982.

Industrial Structure

Industrial development over the past two decades has led to significant changes in the structure of the industrial sector. There has been a widening of the industrial base as an increasing range of products is processed, manufactured and assembled domestically. There has also been a deepening process with the development of increasingly sophisticated industries and the adoption of more modern and efficient methods of production as well as changes in the size structure of industrial enterprises.

The process of industrialization has been accompanied by a change in the composition of manufacturing output. The common pattern of industrial development has been an evolution from the manufacture of final consumer goods requiring comparatively simple technology and low capital to the production of intermediate goods. This is followed by the production of capital goods which are more technologically sophisticated and capital intensive.

The changing industrial structure can be shown in terms of the broad categories listed in Table 2. Category (1) comprises of consumer goods, category (2) largely of intermediate goods and category (3) largely of capital goods.

There has been a relative decline in the importance of consumer goods in terms of output, value-added and exports and a corresponding increase in the importance of capital goods for the period 1963-1979. This is particularly evident in 1979 when the capital goods was the largest contributor in value-added, employment, exports and capital-expenditure. The present trend is likely to persist into the future with the growth of more capital- and skill-intensive industries.

TABLE 2

Industrial Distribution of Singapore (percentage)

Indicators	Year	Categories*			Total
		(1)	(2)	(3)	
Output	1963	32.3	42.2	25.5	100.0
	1969	26.1	50.9	23.1	100.0
	1975	14.8	48.1	37.1	100.0
	1979	12.9	50.1	37.0	100.0
Value-added	1963	28.6	37.0	34.4	100.0
	1969	23.5	39.5	37.1	100.0
	1975	13.7	32.7	53.6	100.0
	1979	13.1	32.5	54.4	100.0
Employment	1963	29.7	33.4	36.9	100.0
	1969	32.6	27.3	40.1	100.0
	1975	25.7	20.3	54.0	100.0
	1979	21.8	17.6	60.6	100.0
Export	1963	41.4	36.6	22.0	100.0
	1969	28.0	42.0	30.0	100.0
	1975	22.0	42.4	35.6	100.0
	1979	20.0	38.4	41.6	100.0
Capital Expenditure	1963	28.1	41.6	30.3	100.0
	1969	26.4	42.3	31.3	100.0
	1975	13.8	29.1	57.1	100.0
	1979	10.6	42.9	46.5	100.0

Source: i) Report on the Census of Industrial Production, Singapore
ii) Commodity Trade Statistics, United Nations

Note: *The categories correspond to the following industry groups are:

(1) Consumer goods: Footwear; Beverages; Food; Tobacco; Textile; Garments; Leather products; Miscellaneous

(2) Intermediate goods: Wood products; Furniture; Paper products; Printing and publishing; Rubber products; Chemical products; Petroleum products

(3) Capital goods: Non-metallic products; Basic metals; Machinery; Electrical machinery; transport equipment

The high proportion of intermediate goods, as shown in column (2) was due largely to the development of Singapore as the leading petroleum refining, blending and distribution centre in South-East Asia. Petroleum refining is Singapore's largest industry and was responsible for over a third (39.5%) of total output in the manufacturing sector in 1979. The second largest industry is the electrical-electronic industry which constituted 16.7 percent of total output in the manufacturing sector. Transport equipment is the third largest industry and contributed towards 7.5 percent of total manufacturing output. These two industries account for the high proportion of capital goods in manufacturing production.

ANALYSING CHANGES IN INDUSTRIAL STRUCTURE

Measurement of "Sources" of Growth

The measurement of import-substitution - of which there are several variants - basically involves comparing the ratios of imports to total availabilities over time. The simplest measure, of course, would be to take the absolute difference between import-availability ratio in period t-1 and that in period t. If m and s stand for imports and total availability, then import substitution can be measured by the formula

$$\frac{m_t}{s_t} - \frac{m_{t-1}}{s_{t-1}} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(1)$$

The absolute magnitudes of (1) can be expressed as a proportion of the base year's import-availability ratio to yield a second variant of formula (1). Thus it can be written as

$$\frac{m_t}{s_t} - \frac{m_{t-1}}{s_{t-1}} \Big/ \frac{m_t}{s_t} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(2)$$

A negative (2) indicates that import-substitution occurs which implies a fall in the import-availability ratio. However, if total domestic demand for a product rises at a faster rate than the total domestic supply, then imports may not decline at all, indeed they may rise. It would therefore be impossible to measure import substitution in this situation by using either of the above formulae.

H. Chenery proposed a method of estimation of import substitution to overcome the weakness of the above simple formula.[3] Chenery defined import substitution as the "difference between growth in output with no change in import-ratio and the actual growth". If q_t^i and q_{t+1}^i stand for outputs of industry i in period t and t+1 respectively, so that u_t^i and u_{t+1}^i are output-availability ratios (that is, q_t^i / s_t^i and q_{t+1}^i / s_{t+1}^i), then $(u_{t+1}^i - u_t^i) \cdot s_{t+1}^i$ would be a measure of import substitution in industry i. Thus,

$$(u_{t+1}^i - u_t^i) \cdot s_{t+1}^i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots(3)$$

measures the import substitution between the period t and t+1. According to Chenery's definition, import substitution occurs if (3) is positive which implies that the import-availability ratio has fallen. Conversely, if (3) is negative, then the import-availability ratio has risen. This definition of import substitution is adopted throughout this study in analysing the "sources" of growth in manufacturing output.

One of the drawbacks of the Chenery type measure of import substitution is that it is too narrow in the sense that it does not take into account the impact of intermediate demands generated by import substitution. If import substitution takes place in the final goods sector, demand for the intermediate goods required in the production of these final goods will go up. It will then be necessary to produce these intermediate goods domestically if import substitution is not to become a mere replacement of final goods by intermediates. In a subsequent paper,[4] Chenery in collaboration with Shishido and Watanabe, developed a more refined measure of import substitution incorporating intermediate demand.

Singapore's existing data base, however, does not enable one to attempt a more elaborate examination of the process of import substitution since it involves the use of sufficiently detailed input-output tables.

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3. Chenery, H. "Patterns of Industrial Growth", American Economic Review, September 1960.

4. Chenery, H. Shishido and Watanbe, "The Pattern of Japanese Growth, 1914-1954", Econometrica, January 1962.

In the empirical study undertaken here, an analysis of the relative contribution of import substitution and export growth to the growth of gross output of the manufacturing sector and individual industries will be attempted. These estimates have been worked out by using the method suggested by Chenery. The change in output according to this method is decomposed into three parts: the change in domestic demand (final and intermediate), the change in export demand and the change in import dependence (or import substitution). Thus,

$$\Delta q^i = u_t^i (\Delta D^i) + u_t^i (\Delta E^i) + (u_{t+1}^i - u_t^i) \cdot s_{t+1}^i \quad \ldots(4)$$

where Δq^i = change in output of industry i;

ΔD^i = change in domestic demand of industry i;

ΔE^i = change in exports of i;

s^i = total availability;

u^i = ratio of domestic production to availability

The importance of the three "sources" of growth for the manufacturing sector as a whole is derived by summing the components for each industry. The aggregate measure is expressed as follows:

$$\Delta q^m = \Sigma_i \Delta q^i$$
$$= \Sigma_i u_t^i (\Delta D^i) + \Sigma_i u_t^i (\Delta E^i) + \Sigma_i (u_{t+1}^i - u_t^i) \cdot s_{t+1}^i \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots(5)$$

where Δq^m is equal to the change in output of the manufacturing sector.

Methodology and Sources of Data

The available methods of measuring import substitution suffer from certain deficiences which have been noted earlier. A further problem is posed by the difference in the levels of aggregation of manufacturing industries for different time periods. Manufacturing industries for the year 1963 are highly aggregated in comparison to 1967 and later years. This study has therefore confined itself to two broad periods. The level of aggregation for 1963-1967 manufacturing industries are higher than that for 1967-1979. The second period is further divided into three sub-periods: 1967-1972, 1972-1975 and 1975-1979 so as to provide a more comprehensive and detailed analysis.

Manufacturing industries are defined according to the United Nations (U.N) standard international trade classification of manufactures so as to make trade-data compatible with industry-data. In order to make inter-temporal comparisons meaningful, appropriate price deflators have had to be used; the choice of the weights used in such deflators however often assumed an arbitrary character. This has been sought to be avoided by using techniques and methodologies used in some of the well-known works in the field.

All value data used in the study have been appropriately deflated to make them inter-temporally comparable. The production data are taken from the Report on the Census of Industrial Production. Trade statistics are taken from the United Nations, Commodity Trade Statistics.

THE RESULTS

Tables 3 and 4 give the summary results of applying expression (4) to individual industries and summing them for the manufacturing sector as a whole using expression (5). The contributions of import substitution, export expansion and domestic demand are reported in absolute as well as in relative (percentage) terms. The absolute amounts shown in columns (2), (3) and (4) are reported as percentages of their corresponding amounts shown in column 1. The bracketed figures in columns (2), (3) and (4) report their percentages.

Looking first at the figures for all industries, there was a striking difference in the attribution of growth to the three "sources" for 1963-1967 and 1967-1979. Virtually all of the growth from 1963-1967 can be attributed to import substitution. Export expansion only assumed its importance as a "source" of growth after 1967. Similarly, domestic absorption remained a relatively stable source of growth for all industries after 1967 as is to be expected in view of Singapore's limited domestic market.

TABLE 3

The Relative Contribution of Export Expansion, Import Substitution and Domestic Demand to the Growth in Output of Manufacturing Industries, 1963-1967

US$million

Industry	Change in Output (1)	Export Expansion (2)	Import Substitution (3)	Domestic Demand (4)
1. Textile, Footwear, Wearing Apparel	15.7	-0.1(-1.3)	17.3(110.2)	-1.4(-8.9)
2. Furniture	1.2	0.7(58.3)	1.9(158.3)	-1.4(-116.7)
3. Printing	4.8	1.5(31.2)	-1.7(-35.4)	5.0(104.2)
4. Leather	1.8	-0.4(-22.2)	1.5(83.3)	0.7(38.9)
5. Rubber Manufactures	4.5	-0.7(-15.6)	5.2(115.6)	-
6. Chemicals and Petroleum	27.8	7.3(26.3)	49.9(179.5)	-29.4(-105.8)
7. Non-Metallic Mineral Products	-1.0	6.1(610.0)	-14.0(-1400)	6.9(690.0)
8. Basic Metals	12.2	0.5(4.1)	10.5(86.1)	1.2(9.8)
9. Metal Products	15.3	1.7(1.1)	6.9(45.1)	6.7(43.8)
10. Non-Electrical Machinery	4.7	1.5(31.9)	-0.1(-2.1)	3.3(70.2)
11. Electrical Products	6.8	-2.4(-35.3)	3.6(52.9)	5.6(82.4)
12. Transport Equipment	14.2	-3.9(-27.5)	15.3(107.8)	2.8(19.7)
13. Miscellaneous	6.7	4.9(73.1)	-15.1(-225.4)	16.9(252.2)
All industries	114.7	16.7(14.6)	81.2(70.8)	16.8(14.7)

Source: As explained in the text

Note: i) Petroleum industry is included because separate figures cannot be obtained from the Production Census for 1963

ii) All values are deflated as follows: Output figures - Wholesale price index; Export figures - Export price index; and Import figures - Import price index

TABLE 4

The Relative Contribution of Export Expansion, Import Substitution and Domestic Demand to the Growth in Output of Manufacturing Industries, 1967-1979

US$million

Industry	Change in Output (1)	Export Expansion (2)	Import Substitution (3)	Domestic Demand (4)
1. Textile	108.9	3.1(2.8)	103.3(94.8)	2.6(2.4)
2. Wearing Apparel	179.1	60.8(34.0)	121.4(67.8)	-3.1(-1.8)
3. Furniture	36.5	28.7(78.5)	-15.6(-42.7)	23.4(64.2)
4. Printing	88.5	21.0(23.7)	31.8(35.9)	35.7(40.4)
5. Leather	6.7	0.1(1.5)	-15.2(-288.6)	21.8(327.1)
6. Footwear	9.8	15.5(158.5)	-20.4(-208.6)	14.7(150.1)
7. Rubber Manufactures	7.3	6.3(86.9)	-43.9(-605.5)	44.9(618.6)
8. Chemicals	144.3	74.7(51.8)	-36.3(-25.2)	105.9(73.4)
9. Non-Metallic Mineral Products	120.3	18.4(15.3)	3.6(3.0)	98.3(81.7)
10. Iron and Steel	51.5	18.0(35.0)	-49.2(-95.6)	82.7(160.6)
11. Metal Manufactures	199.9	39.7(19.9)	-10.4(-5.2)	170.6(85.3)
12. Non-Electrical Machinery	330.2	47.7(14.5)	195.0(59.1)	87.5(26.5)
13. Electrical Products	1236.9	262.6(21.2)	698.4(56.5)	275.9(22.3)
14. Transport Equipment	512.3	100.8(19.7)	99.3(19.4)	312.2(60.9)
15. Precision Equipment	53.3	145.8(273.3)	-302(-566.2)	209.5(392.8)
All Industries	3085.3	843.2(27.3)	759.8(24.6)	1482.6(48.1)

Source: As explained in the text

Note: All values are deflated by using the appropriate price indices described earlier in which prices for 1975=100.

To understand the differences between these two periods, one should recall that exports contracted sharply following the imposition of trade barriers by West Malaysia and the secession of trade with Indonesia in 1963. The slack in export demand was taken up by increased import substitution and by increases in stock held by industrial enterprises. The political separation of Singapore from Malaysia further resulted in a decline in exports to West Malaysia as increasing tariff walls were erected between the two countries in 1966. The rise in domestic demands increasingly took the form of import-substitution as more import items came under tariff and quota restrictions. A significant reversal of the trend was recorded in 1967 when concerted efforts were directed towards the promotion of exports by the Singaporean government. Results of such export expansion were recorded in Table 4a. Export expansion thereafter continued to be an important "source" of growth up to 1979.

The relative pattern of growth differed among industries in the three different sub-periods of 1967-1979. In the first sub-period, 1967-1972, import-substitution was an important "source" of growth for six out of the fifteen industries reported in Table 4a. These were textile, wearing apparel, printing, leather, electrical and transport equipment industry. Import substitution was found to be dominant again in the textile and transport equipment industry for the second sub-period, 1972-1975. These two industries experienced a significant breakthrough in exports only in the last sub-period, 1975-1979.

The results for 1972-1975 indicate that Singapore's economy was able to withstand the world recessionary and inflationary pressures. Industrial output increased by US$912.6 million for all industries as shown in Table 4b. Export expansion was a dominant factor contributing towards industrial growth for most of these industries. However, industries which exported traditional products such as textile, wearing apparel, footwear, leather and rubber manufacturers experienced a decline in exports. In addition, footwear and leather industries were the only two industries which experienced a decline in their output during the recession period. The decline in output

TABLE 4a

The Relative Contribution of Export Expansion and Import Substitution of the Growth in Output of Manufacturing Industries, 1967-72 (first sub-period)

US$million

Industry	Change in Output	Export Expansion	Import Substitution
1. Textile	99.2	1.4(1.4)	91.6(92.3)
2. Wearing Apparel	84.5	33.1(39.2)	62.7(74.2)
3. Furniture	8.0	-0.3(-3.8)	-0.2(-2.5)
4. Printing	36.0	2.8(7.8)	14.8(41.1)
5. Leather	0.03	0.01(33.3)	0.1(333.3)
6. Footwear	9.8	6.7(68.4)	-
7. Rubber Manufactures	6.0	1.7(28.3)	-2.9(-48.3)
8. Chemicals	20.6	16.3(79.1)	-29.9(-145.2)
9. Non-Metallic Mineral Products	36.3	-3.0(-8.3)	-3.5(-9.6)
10. Iron and Steel	10.3	-0.6(-5.8)	-32.7(-317.5)
11. Metal Manufactures	70.3	-0.9(-1.3)	-26.9(-38.3)
12. Non-Electrical Machinery	50.9	21.6(42.4)	-8.6(-16.9)
13. Electrical Products	374.7	44.9(12.0)	227.7(60.8)
14. Transport Equipment	242.6	32.0(13.2)	69.7(28.7)
15. Precision Equipment	-1.4	13.4(957.1)	-197.6(-14114.3)
All Industries	1047.8	170.9(16.3)	164.3(15.7)

TABLE 4b

The Relative Contribution of Export Expansion and Import Substitution to the Growth in Output of Manufacturing Industries, 1972-1975 (second sub-period)

US$million

Industry	Change in Output	Export Expansion	Import Substitution
1. Textile	0.1	-4.9(-4900)	28.7(28700)
2. Wearing Apparel	3.3	-23.0(697.0)	-5.3(-160.6)
3. Furniture	4.0	2.6(65.0)	-9.3(-232.5)
4. Printing	13.1	11.6(88.6)	3.6(27.5)
5. Leather	0.9	-0.5(-55.6)	-7.7(-855.6)
6. Footwear	-0.6	-1.4(-233.3)	-36.2(-6033)
7. Rubber Manufactures	-1.5	-2.6(-173.3)	-5.7(-380)
8. Chemicals	78.6	31.6(40.2)	32.0(40.7)
9. Non-Metallic Mineral Products	68.3	7.1(10.4)	20.3(29.7)
10. Iron and Steel	18.8	6.5(289.2)	-18.0(-95.8)
11. Metal Manufactures	63.9	7.7(12.1)	16.3(25.5)
12. Non-Electrical Machinery	192.6	3.9(2.0)	46.9(24.4)
13. Electrical Products	197.0	125.3(63.6)	41.7(21.2)
14. Transport Equipment	238.2	22.1(9.3)	59.1(24.8)
15. Precision Equipment	35.9	9.9(27.6)	28.1(78.3)
All Industries	912.6	195.9(21.5)	194.5(21.3)

TABLE 4c

The Relative Contribution of Export Expansion and Import Substitution to the Growth in Output of Manufacturing Industries, 1975-1979 (third sub-period)

US$million

Industry	Change in Output	Export Expansion	Import Substitution
1. Textile	9.7	25.6(263.9)	-25.8(-266)
2. Wearing Apparel	91.3	83.1(91.0)	19.8(21.7)
3. Furniture	24.6	17.7(72.0)	5.2(21.1)
4. Painting	39.3	11.4(29.0)	3.3(8.4)
5. Leather	7.6	0.3(4.0)	-0.3(-3.9)
6. Footwear	1.8	2.6(144.4)	5.2(288.9)
7. Rubber Manufactures	2.7	5.3(196.3)	-23.8(-881.5)
8. Chemicals	45.1	39.9(88.5)	-18.2(-40.4)
9. Non-Metallic Mineral Products	15.7	15.6(99.4)	14.3(-91.1)
10. Iron and Steel	22.4	2.7(12.1)	27.3(121.9)
11. Metal Manufactures	65.7	26.8(40.8)	15.5(23.6)
12. Non-Electrical Machinery	86.7	50.7(58.5)	-
13. Electrical Products	665.1	200.9(30.2)	82.6(12.4)
14. Transport Equipment	31.4	95.7(304.8)	-297.9(-948.7)
15. Precision Equipment	18.9	11.4(60.3)	-12.1(-64.0)
All Industries	1128.0	589.7(52.3)	-233.5(-20.7)

Source: As explained in the text

of these two industries can be traced to a decline in export demand. The increase in domestic demand was compensated by an increase in imports.[5]

The electrical-electronic industry emerged as a major export growth area after 1972. The rapid growth was associated with the establishment of export-based electronic assembly plants in Singapore mainly by American and Japanese industries to overcome the rising labour costs at home.[6] The increase in output of this industry was therefore generated by an increase in export demand although import-competiting industries also increased production as a result of decreased imports and increased domestic demand (see Table 4b). In the final sub-period, 1975-1979, output growth in the electrical-electronic industry dominated over the rest of the industries. Export expansion again contributed significantly to the growth in output as shown in Table 4c although it lagged behind the growth in domestic demand.

The above results appear to indicate that the transition from the stage of import substitution to that of export expansion comes about with a time lag. This is particularly evident for the textile industry which managed to achieve a significant breakthrough in export markets in the mid-seventies. Overall, the export expansion policy of the Singaporean government has achieved significant results within a relatively short span of time.

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5. A negative import substitution component implies an increase in the import-availability ratio.

6. The cost competitiveness of Singapore's manufactures is discussed in Chapter 3.

CHAPTER 3

An Empirical Analysis of the Export Growth of Singapore

In the preceding chapter, the various "sources" of industrial growth had been examined in relation to Singapore. It was found that export expansion provided the greatest impetus to industrial growth in Singapore. In addition, Singapore's share of world and industrial countries' exports in manufactures had been increasing since 1967 as depicted in columns 5 and 6 of Table 5. However, the direction of change in Singapore's share of developing countries' exports had not been consistent; declining from 1967-1970, increasing from 1970-1975, and declining again from 1975-1979. This clearly indicates that export expansion is directed towards markets of the industrial countries.

An examination of Table 6 reveals that the share of principal manufactured exports of Singapore such as iron and steel, engineering products and chemicals have been expanding. This is reflected in the consistent increase in Singapore's share of world manufactures from 1967 to 1979. However, Singapore's share of textile and clothing exports in world markets had been either stagnant or declining particularly during the world recession of 1972-1975. It further shows that while Singapore is not increasing her share in exports of textile and clothing, it has been making steady gains in new exports such as engineering products. The growing importance of Singapore among the industrial countries is thus seen in Singapore's rising export share of such goods.

This chapter seeks to determine whether external demand or internal demand conditions could have been responsible for the favourable growth of Singapore's exports relative to that of the world, using the Constant-Market-Share model. The outcome of this investigation will have important implications for Singapore's trade policy. If Singapore's export growth is due to internal factors operating on the supply side of exports, then appropriate policy measures could be undertaken to improve the operations of such favourable factors.

TABLE 5

A Comparison between World, Industrial Area, Developing Area and Singapore

Total Manufactured Exports

Year	Total Manufactured Exports						
	World	Industrial Area	Developing Area	Singapore	Share of (4) in (1)	Share of (4) in (2)	Share of (4) in (3)
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	million U.S.$				percent		
1963	80880	65960	3470	308.3	0.38	0.47	8.88
1967	122610	101470	5730	255.5	0.21	0.25	4.46
1970	190420	158240	10340	427.7	0.22	0.27	4.14
1972	259330	214820	15450	892.5	0.34	0.42	5.78
1975	493890	414740	32910	2232.6	0.45	0.54	6.78
1979	945900	598200	232000	6389.1	0.68	1.07	2.76

Source: i) Studies in International Trade, GATT, various issues

ii) Commodity Trade Statistics, UN, various issues

Note: i) Division 68, non-ferrous metals, has been excluded from total manufactures to maintain consistency in the definition of manufactures

ii) Developing Area includes traditional oil exporters

TABLE 6

A Comparison between World, Industrial Area, Developing Area and Singapore Exports of Principal Manufactures, 1963-1979

Year	World	Industrial Area	Developing Area	Singapore	Share of (4) in (1)	Share of (4) in (2)	Share of (4) in (3)
	CHEMICAL EXPORTS						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	million U.S.$				percent		
1963	-	-	-	-	-	-	-
1967	14880	12760	660	37.7	0.25	0.30	5.7
1970	22000	19170	870	42.4	0.19	0.22	4.9
1972	28800	25060	1430	78.0	0.27	0.31	5.5
1975	62860	54170	3040	200.5	0.32	0.37	6.6
1979	131050	114050	6550	517.2	0.39	0.45	7.9
	ENGINEERING PRODUCTS						
1963	36290	30900	300	128.2	0.35	0.42	42.7
1967	60160	52050	710	109.2	0.18	0.21	15.4
1970	95600	83370	1650	190.0	0.20	0.23	11.6
1972	132300	114380	3150	459.4	0.35	0.40	14.6
1975	279080	237990	9390	1286.7	0.46	0.54	13.7
1979	509200	427900	27200	3959.2	0.77	0.93	14.6

TABLE 6 - continued

Year	World	Industrial Area	Developing Area	Singapore	Share of (4) in (1)	Share of (4) in (2)	Share of (4) in (3)
	TEXTILE AND CLOTHING						
	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	million U.S.$				percent		
1963	8810	6820	1370	63.5	0.72	0.93	4.6
1967	12270	9080	2030	56.6	0.46	0.62	2.8
1970	18500	13560	3230	84.7	0.46	0.63	2.6
1972	26200	18400	5390	165.6	0.63	0.90	3.1
1975	43360	28730	9810	244.1	0.56	0.85	2.5
1979	84250	52250	22500	710.8	0.84	1.36	3.2
	IRON AND STEEL						
1967	10300	8140	260	16.9	0.16	0.21	6.5
1970	17000	13830	550	12.8	0.08	0.09	2.3
1972	20000	16230	680	19.7	0.10	0.12	2.9
1975	45820	38750	1230	86.8	0.19	0.22	7.1
1979	70800	58100	3900	166.7	0.24	0.29	4.3

Source: As in Table 5

Note: Engineering products include SITC 7 and 69. For the year 1963, it excludes SITC 69.

On the other hand, if external factors are recognised as the cause of Singapore's sustained growth in exports, then cautious steps must be taken to make Singapore's exports even more competitive in world markets. This is to reduce the vulnerability of Singapore's exports to external changes in the world economy.

CAUSES OF GROWTH OF SINGAPORE'S SHARE IN WORLD EXPORTS

Singapore's success in expanding her exports of manufactures at least as fast as the world average may be traced back to a combination of three reasons: (1) Singapore's exports may be concentrated on commodities for which world demand is growing more rapidly than the world average for all manufactured commodities; (2) Singapore's exports may be concentrated more on those markets which are relatively fast growing in terms of import demand; and (3) Singapore may be more competitive compared with other sources of supply in products over which she has no monopoly.

Favourable commodity and market composition effects would indicate that Singapore's exports were in line with the growth points in world demand. By and large, these two effects would seem to reflect the influence of external demand on Singapore's export growth. Generally speaking, there are also other external constraints which make it difficult for a country to switch over to expanding commodities and markets. These constraints may not be associated with a country's own industrial and trade policies. For instance, imports from a given country into an expanding market may be discriminated against by institutional factors vis-a-vis other competing countries. This happens more clearly where the formation of a customs union increases intra-trade among the member countries by effectively discriminating against third countries. The effective protection accorded to the textile and electronic industries in the EEC member countries against Singapore and other developing countries is a clear example. In addition, licensing agreements with foreign investors may preclude or encourage the possibility of exporting certain products to certain specified markets.

The internal supply factor is reflected in the growth of competitiveness. The term "competitiveness" embraces a multitude of factors that go into making a product saleable in foreign markets. Prices, as well as non-price elements are equally important in determining a country's strength in exporting. Other things remaining the same, if prices at which a country is able to offer its products for sale in the international market are lower than those of its rivals, the country will most probably be able to compete effectively. In addition to prices, competitiveness is also influenced by the quality and marketing techniques, by the terms of finance and so on. Clearly, prices being the same from all sources of supply, countries which are able to offer better trading terms than others have better chances of success in exporting.

Competitiveness defined broadly to include price as well as non-price elements is influenced for the most part by domestic factors. Price elements of competition are determined by the impact of factors such as the effective exchange rate, costs, productivity, the plant size, the pressure of international demand, etc. These factors in turn are influenced by the state of domestic resource endowments, the character of industrial development and by domestic economic policies, particularly those relating to trade and industrialization. Some of these factors will need to be examined further if competitiveness is found to have a positive impact on growth in exports.

METHODOLOGY

In order to quantify the relative importance of the three causes of Singapore's increasing share in world exports of manufactures, this study makes use of the Constant-Market-Share (CMS) model of export growth.[1] According to the CMS model, the difference between the actual increase of a country's exports and the increase as implied by the constant share norm (that is, if the country's exports had increased at the same rate as the world average) is partitioned into three components: (1) the commodity composition effect; (2) the market distribution effect; (3) a residual, indicating in a broad sense, the competitiveness effect.

1. The approach was first applied to export growth by Tyszynski (1951) and has since been employed by numerous writers in this field. Some of the recent works include those by Richardson, J. David (1971) and Dr Ranadev Banerji (1975).

Algebraically, the relationship is expressed in terms of an identity,

$$\Sigma_i(X_i^1 - X_i^0) - \Sigma_i(rX_i^0) = \Sigma_i(r_i - r)\, X_i^0 \quad +$$

$$\Sigma_i\, \Sigma_j(r_{ij} - r_i)\, X_{ij}^0 + \Sigma_i\, \Sigma_j(X_{ij}^1 - X_{ij}^0 - r_{ij}\, X_{ij}^0)$$

where superscripts 0 and 1 denote the initial and terminal years.

The variables in the formula are defined as follows:

X_{ij} = value of Singapore's exports of commodity i to market (country) j;

X_i = value of Singapore's exports of commodity i to world $= \Sigma_j X_{ij}$;

r = the proportional increase in world manufactured exports between the initial and the terminal years or the world average growth rate in manufactures = world exports ^{1}/world exports^0 - 1;

r_i = proportional increase in world exports of commodity i between the initial and the terminal years;

r_{ij} = proportional increase in world exports of commodity i to market j between two given dates.

The first term on the left hand side of the identity gives the actual change in Singapore's exports of manufactures within a period and the second term indicates what the increase would have been had Singapore's exports increased at the same rate as the world average. On the right hand side, the first term estimates the commodity composition effect. This term would be positive if Singapore had concentrated her exports on those manufactures for which world demand was expanding faster than the world average for all manufactured goods and vice versa. Similarly, the market distribution effect, the second term on the right hand side of the identity would be positive or negative according to whether Singapore had concentrated her exports into markets that were expanding or declining relative to the world average. The final term is a residual, referred to as the competitiveness effect as discussed above. A positive residual would imply that the success of Singapore to maintain her world share was due to her competitiveness in export goods.

It will be recognised that the CMS model discussed above has several limitations.[2] Since it is an identity, it cannot claim to provide an explanation of the past behaviour of a model. Moreover, since the model has no stochastic basis, it cannot be used for the purpose of econometric projection for probable future change in the market share. It should also be added that in interpreting the results of these calculations, not too much reliance should be placed on the movement of the different terms since such analysis is extremely susceptible to differences in levels of aggregation by commodity and market areas and to the order in which these effects are calculated. A high degree of aggregation, for example, will minimize the commodity and market distribution effects and maximize the competitive residual. Again the results will differ for a given country depending on the number of exporters deemed to represent the "world".

World export figures in manufactures at a detailed level of disaggregation for 1975 and 1979 are not obtainable from UNCTAD sources. As a result, market economy export figures have had to be used in calculating world average growth rates for the period, 1975-1979 (since the share of Singapore's manufactured exports to the market economy in her total exports of manufactures was 98% in 1979). It is also not possible to obtain market economy export figures for all the years considered in this study. U.N. International Trade Statistics provide commodity matrices of market economy trade from 1973 onwards. The results presented are therefore best treated as indicative subject to the above data constraints.

Nevertheless, the CMS model is a useful model as it at least helps to identify the areas in which the search for an explanation of export growth may be concentrated. Several testable hypotheses can be put forward concerning Singapore's export performance in manufactured products which may be due to price and non-price factors of competition such as productivity, costs and effects of industrialization and trade policy measures.

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2. Richardson, J. David has identified several problems of the CMS model in terms of definition, theoretical foundation and application.

Subject to data constraints as indicated above, this study has chosen a time span between 1967 and 1979 divided into three sub-periods: 1967-1972, 1972-1975 and 1975-1979. The markets considered here are the major trading partners of Singapore which contributed towards 75 percent of total trade of Singapore in 1979. They include Malaysia, United States, Japan, E.E.C., Saudi Arabia, Hong Kong and Thailand. 15 commodity groups or commodities are selected at the 2-digit or sometimes 3-digit SITC level and they contribute towards 92.5 percent of Singapore's total manufactured exports.

A CONSTANT-MARKET-SHARE ANALYSIS OF THE GROWTH OF SINGAPORE'S MANUFACTURED EXPORTS

Table 7 shows for a selected number of periods the differences between the actual and the hypothetical change in the value of Singapore's exports of total manufactures and their components. The hypothetical change in each period refers to what the increase in the value of Singapore's exports of manufactures and their components would have been had they increased at the same rate as the world average for the respective product groups. The export values are deflated to their base year values using export price indices so that the relative prices of different manufactured exports remain constant between the beginning and the end of a period.[3]

As reported in Table 7, the actual increase in Singapore's total principal manufactured exports consistently exceed the increase as implied by the constant share norm. In respect of individual product groups, there are interesting deviations. Singapore's exports of non-electrical machinery, electrical machinery, transport equipment and precision equipment have increased at a rate faster than the world average for all the periods. These products constitute a major share of total manufactured exports of Singapore particularly for 1979. Their contributions in terms of total manufactured exports are 14.1 percent (non-electrical machinery); 36.3 percent (electrical machinery); 8.7 percent (transport and equipment); and 3.8 percent (precision equipment).

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3. Export values for all the selected years were expressed in terms of 1975 export prices.

TABLE 7

The Actual and the Hypothetical Increase in Different Categories of Manufacturing Exports from Singapore, 1967-1979 (million US$)

Item/Period	Actual Increase (1)	Hypothetical Increase (2)	Difference (1) - (2)
Textile			
1967-1972	67.3	68.6	-1.3
1972-1975	-30.9	-14.6	-16.3
1975-1979	116.2	40.1	76.1
1967-1979	152.6	99.3	53.3
Wearing Apparel			
1967-1972	110.2	27.1	83.1
1972-1975	-33.3	-13.4	-19.9
1975-1979	125.9	35.1	90.8
1967-1979	202.7	39.2	163.5
Furniture			
1967-1972	-0.3	4.1	-4.4
1972-1975	2.6	-0.5	3.1
1975-1979	26.4	2.4	24.0
1967-1979	28.7	6.0	22.7
Printing and Publishing			
1967-1972	4.7	16.6	-11.9
1972-1975	15.9	-2.5	18.4
1975-1979	15.0	13.3	1.7
1967-1979	35.6	24.1	11.5
Leather			
1967-1972	0.01	1.1	-1.0
1972-1975	-0.5	-0.1	-0.4
1975-1979	0.6	0.3	0.3
1967-1979	0.1	1.6	-1.5
Footwear			
1967-1972	6.7	5.0	1.7
1972-1975	-1.4	-1.2	-0.2
1975-1979	10.4	3.7	6.7
1967-1979	15.7	7.2	8.5

TABLE 7 - continued

Item/Period	(1)	(2)	(1) - (2)
Rubber Manufactures			
1967-1972	3.1	8.4	-5.3
1972-1975	-5.3	-1.3	-4.0
1975-1979	13.6	2.9	10.7
1967-1979	11.5	12.2	-0.7
Chemicals			
1967-1972	58.1	63.8	-5.7
1972-1975	55.2	-13.2	68.4
1975-1979	153.3	61.7	91.6
1967-1979	266.6	92.3	174.3
Non-Metallic Mineral Products			
1967-1972	-7.0	20.7	-27.7
1972-1975	17.2	-1.9	19.1
1975-1979	32.5	11.9	20.6
1967-1979	42.7	30.0	12.7
Iron and Steel			
1967-1972	-2.6	28.7	-31.3
1972-1975	50.2	-3.3	53.5
1975-1979	27.2	26.7	0.5
1967-1979	74.8	41.5	33.3
Metal Manufactures			
1967-1972	1.6	34.9	-33.3
1972-1975	17.4	-4.5	21.9
1975-1979	55.9	20.5	35.4
1967-1979	74.9	50.5	24.4
Non-Electrical Machinery			
1967-1972	239.7	63.0	176.7
1972-1975	49.1	-29.0	78.7
1975-1979	241.4	115.4	126.0
1967-1979	530.2	91.2	439.0

TABLE 7 - continued

Item/Period	(1)	(2)	(1) - (2)
Electrical Machinery			
1967-1972	264.3	31.3	233.0
1972-1975	313.3	-27.9	341.2
1975-1979	467.3	190.9	276.4
1967-1979	1544.9	45.2	1499.7
Transport Equipment			
1967-1972	97.1	55.6	41.5
1972-1975	51.5	-15.7	67.2
1975-1979	156.8	69.1	87.7
1967-1979	305.4	80.5	224.9
Precision Equipment			
1967-1972	43.1	14.3	28.8
1972-1975	61.9	-5.7	67.6
1975-1979	43.7	38.3	5.4
1967-1979	148.8	20.6	128.2
Total Principal Manufactures			
1967-1972	885.9	443.1	442.8
1972-1975	562.9	-135.5	698.4
1975-1979	1986.2	632.4	1353.8
1967-1979	3435.0	641.4	2793.6

Source: Calculated from data obtained from

i) Commodity Trade Statistics, UN, various issues

ii) Handbook of International Trade and Development Statistics, UNCTAD, various issues

iii) International Trade Statistics, UN, various issues

Product groups such as textile, wearing apparel, leather, rubber manufactures and footwear experienced negative export "growth" in the second sub-period (that is, 1972-1975). This is a period in which the world was experiencing serious inflation and recession but Singapore's exports of such goods declined at a faster rate than the negative growth of similar goods. These products however resumed positive growth in exports after 1975.

Overall, Singapore's exports have survived the world recession and inflation of 1972-1975, and the share in world exports has been increasing, particularly from 1975 to 1979. The reasons for such favourable growth in exports can be deduced from Table 8.

Table 8 shows the results of decomposing the differences between the actual and the hypothetical increase in Singapore's total manufactured exports into three effects according to the identity discussed above. The component effects are further expressed as a percentage of the actual increase in Singapore's exports for all the periods. Thus we are able to compare how the relative importance of the different causes of Singapore's export growth has changed from period to period.

In all the periods under consideration, the competitive effect has positive values. This indicates that Singapore's exports are competitive in international markets. The market distribution effect is however positive for the second and third sub-periods. This implies that Singapore's exports have grown to become more concentrated on expanding markets. The commodity composition effect is only positive for the third sub-period, 1975-1979. On the whole, if we consider the 1967-1979 period, the general impression conveyed by the market share analysis is that Singapore's increasing share can be attributed in order of magnitude to competitiveness, favourable export markets and good commodity composition.

The Commodity Composition Effect

Overall, the commodity composition effect is positive for 1967-1979. However, for the first and second sub-periods, it is negative implying that Singapore's exports are mainly concentrated on those manufactured products for which the world demand increased relatively

TABLE 8

A Constant-Market-Share Analysis of the Sources of Change in Singapore's Manufactured Exports, 1967-1979 (percentage changes shown in parenthesis)

	1967-1972	1972-1975	1975-1979	1967-1979
Actual Increase in Singapore Exports of Manufactures	885.9 (100)	562.9 (100)	1986.2 (100)	3435.0 (100)
Effect of Increase in World Trade in Manufactures$_a$	443.1 (50.0)	-135.5 (-24.1)	632.4 (31.8)	641.4 (18.7)
Net Difference$_b$	442.8 (50.0)	698.4 (124.1)	1353.8 (68.2)	2793.6 (81.3)
Commodity Composition Effect$_c$	-11.8 (-1.3)	-14.9 (-2.6)	109.8 (5.5)	43.1 (1.3)
Market Distribution Effect$_d$	-41.0 (-4.6)	199.7 (35.5)	146.2 (7.4)	530.3 (15.4)
Competitive Effect$_e$	495.6 (55.9)	513.6 (91.2)	1097.8 (55.3)	2220.2 (64.6)

Note: a - defined as: $r\sum_i X_i^0$

b - net difference is the difference between the actual increase and the increase implied by the constant share norm

c - defined as: $\sum_i (r_i - r) X_i^0$

d - defined as: $\sum_i \sum_j (r_{ij} - r_i) X_{ij}^0$

e - defined as: $\sum_i \sum_j (X_{ij}^1 - X_{ij}^0 - r_{ij} X_{ij}^0)$

slowly ($r_i < r$). There are several problems encountered in trying to distinguish between expanding and declining export commodities. Firstly, the export goods can change their growth characteristics from one period to another. The same commodity may be faster growing in one period but declining or stable in another. Secondly, the high level of commodity aggregation may also blur the real impact of the commodity effect. It is therefore not possible to say which commodities are expanding or declining in world trade in the absence of a broader disaggregation at least at the three digit level of trade classification. However, such limitations are unavoidable in view of the lack of availability of internationally comparable data.

It can be seen from Table 9 that the positive commodity effect for 1967-1979 is due to the high concentration of Singapore's exports on commodities whose world demand is expanding relative to that of the world average for all commodities. These commodities include wearing apparel, furniture, printing, footwear, chemicals, iron and steel, electrical machinery and transport equipment. Their total contribution to the change in Singapore's total exports of manufactures is approximately 66 percent. Similarly, the positive commodity effect for 1975-1979 is also attributed to the high concentration of exports on expanding commodities of 64 percent. The relative contribution of expanding exports is less than 50 percent for the remaining two sub-periods, 1967-1972 and 1972-1975. This accounts for the negative commodity composition effect in both these periods.

The results clearly indicate that there has been a shift in the commodity composition of Singapore's manufactured exports towards expanding commodities particularly after 1975. This study proceeds further to investigate the two other factors in Singapore's favourable export performance.

The Market Distribution Effect

The CMS analysis reveals that the distribution of Singapore's manufactured exports according to markets was becoming increasingly favourable over time. The positive market distribution effect, particularly in the last sub-period contributes towards 36 percent

TABLE 9

The Change in Exports of Individual Commodity Group as a Percentage of Change in Total Manufactured Exports of Singapore and their World Average Growth Rates (shown in parenthesis)

Exports \ Period	1967-1972	1972-1975	1975-1979	1967-1979
Textile	6.29 (0.40)	-5.42* (-0.02)	5.44 (0.26)	4.04 (0.74)
Wearing Apparel	10.29* (1.36)	-5.84 (-0.49)	5.89* (1.69)	5.36* (1.92)
Furniture	-0.03* (1.07)	0.45* (0.36)	1.24* (0.77)	0.76* (4.09)
Printing	0.44 (0.51)	2.79* (-0.02)	0.70* (0.58)	0.94* (1.35)
Leather	0.001* (1.06)	-0.08 (-0.82)	0.03* (1.01)	0.003 (-0.24)
Footwear	0.62* (0.98)	-0.25 (-0.22)	0.49* (0.50)	0.42* (1.32)
Rubber Manufactures	0.29* (0.80)	-0.92 (-0.15)	0.64 (0.18)	0.30 (0.81)
Chemicals	5.42 (0.70)	9.67* (0.15)	7.17* (0.40)	7.06* (1.73)
Non-Metallic Mineral Products	-0.66* (1.08)	3.02 (-0.41)	1.52* (0.37)	1.13 (0.65)
Iron and Steel	-0.24* (0.80)	8.80* (0.29)	1.27 (0.06)	1.98* (1.45)
Metal Manufactures	0.15 (0.61)	3.05 (-0.38)	2.62 (0.25)	1.98 (0.26)
Non-Electrical Machinery	22.39 (0.57)	8.60* (-0.05)	11.29 (0.22)	14.03 (0.82)
Electrical Machinery	24.69* (0.84)	54.91 (-0.15)	45.25* (0.36)	40.88* (1.14)
Transport Equipment	9.07* (0.98)	9.02* (-0.06)	7.34 (0.26)	8.08* (1.35)
Precision Equipment	4.02 (0.31)	10.86* (-0.06)	2.05* (0.35)	3.94 (0.66)

TABLE 9 - continued

Exports \ Period	1967-1972	1972-1975	1975-1979	1967-1979
Total Expanding Exports (percent)	44.03	44.77	64.34	65.48
World Average Growth Rate, r	0.73	-0.09	0.31	1.06
Commodity Composition Effect	Negative	Negative	Positive	Positive

Note: * Expanding commodities in which $r_i > r$

of the total rise in export share. This indicates that Singapore's exports were concentrated relatively more on those markets in which the import demand increased more rapidly than the world average for a particular commodity ($r_{ij} > r_i$).

The results presented in Table 10 show the values and the relative shares of different categories of manufactured exports from Singapore to relatively expanding markets. Since the 1967 figures reported in Table 10 relate to markets which experienced growth in the period 1967-1972; the figures for 1972 and 1975 have also been computed for the markets which expanded between these two years, that is, 1972-1975. Similarly, the 1979 figures relate to expanding markets in the period 1975-1979. This enables straightforward comparisons of the market distribution effect over time periods. It should be noted that income and price elasticities of demand tend to vary from one commodity to another. As a result, markets are usually not expanding or declining in terms of all commodities simultaneously. On the other hand, intercountry variations in the income elasticity of demand for the same commodity or commodity group usually give rise to the expanding and declining markets for the same products within a given period.

It can be seen from Table 10 that the proportion of Singapore's manufactured exports destined for relatively expanding markets was increasing from 21 percent in 1967 to 48 percent in 1979. The majority of the product groups experienced a decline in their proportion of exports to expanding markets in 1975 due to world recession. However, Singapore's exports of electrical and electronic goods did not experience a fall in the proportion of its exports to expanding markets. This may be attributed to the increasing inflow of foreign investors from America and Japan who utilized Singapore as a production and export base for its electrical and electronic goods.

Singapore's exports of electrical machinery and chemicals were also seen to be concentrated on the growing markets in relatively greater proportion than in other products in 1979. The import demand for chemicals and electrical goods have gone up fastest in industrial countries such as Japan and the United States. This may have contributed

TABLE 10

Singapore's Exports of Principal Manufactures to Relatively Expanding Markets (percentage share of total value of manufactured exports shown in parenthesis)

Exports \ Year	1967	1972	1975	1979
Textile	6.49 (16.01)	2.77 (3.20)	5.26 (4.04)	159.18 (44.19)
Wearing Apparel	0.23 (1.44)	60.57 (76.59)	81.41 (71.46)	140.24 (40.01)
Furniture	-	0.32 (11.13)	1.18 (14.92)	28.12 (56.00)
Printing	-	6.77 (45.89)	10.46 (24.12)	27.89 (32.68)
Leather	0.51 (78.58)	0.54 (66.42)	0.41 (39.23)	1.22 (51.5)
Footwear	-	0.88 (12.17)	0.76 (6.30)	15.23 (46.34)
Rubber Manufactures	-	1.25 (15.94)	2.74 (29.33)	16.44 (49.0)
Chemicals	0.35 (0.93)	37.62 (48.22)	81.44 (40.62)	351.17 (67.89)
Non-Metallic Mineral Products	0.19 (1.55)	5.80 (50.67)	24.00 (62.25)	42.23 (40.65)
Iron and Steel	-	10.35 (52.60)	22.70 (26.15)	106.60 (63.94)
Metal Manufactures	0.26 (1.26)	14.03 (52.96)	29.70 (44.50)	108.32 (60.42)
Non-Electrical Machinery	20.71 (55.62)	59.47 (33.97)	150.42 (40.11)	289.31 (32.10)
Electrical Machinery	1.01 (5.47)	38.64 (23.43)	217.71 (35.09)	1562.97 (67.34)
Transport Equipment	18.94 (57.64)	11.56 (12.43)	15.45 (6.88)	163.03 (29.24)
Precision Equipment	4.45 (52.82)	23.74 (70.65)	74.35 (59.71)	78.44 (31.90)
Total Manufactures	53.14 (20.80)	274.31 (30.73)	717.99 (32.16)	3090.39 (48.37)

Note: Expanding markets are defined as those in which the imports of a given commodity group increased by more than the world demand for that particular good, that is, $r_{ij} > r_i$.

to the increasing value of the market distribution effect since the United States was the second largest trading partner and Japan the third largest trading partner of Singapore in 1979. The above analysis further points to the fact that the market distribution effect and the commodity composition effect do not, after all, act independently of each other.

The Competitive Effect

The significant positive values of the residual factor in export growth in all the periods shown in Table 8 reveal Singapore's competitiveness in industrial exports. Factors determining price competitiveness of an exporting country would include labour productivity, wages, the exchange rate and general prices. In addition, non-price factors such as differences in marketing techniques and quality of the product must be considered in measuring a country's competitive power.

Many practical and conceptual problems are involved in a quantitative measurement of competitiveness. Firstly, the most formidable practical problem is to calculate reliable indicators of price changes of broad aggregation of commodity groups for a sufficiently long period of time. Export prices are commonly used to measure competitiveness from a consumer point of view but they ignore non-price factors such as quality which are important determinants of competitiveness. Secondly, it is nearly impossible to quantify the relative importance of non-price elements of competition which are often more important than price factors.

In view of the limitations outlined above, this study attempts to measure price competitiveness in terms of unit labour costs. A rise in Singapore's unit labour costs relative to those of her competitors makes production in Singapore less attractive than overseas. Low costs of labour per unit of output is therefore an important factor which attracts foreign investment. This particular aspect of price competitiveness is of paramount importance to Singapore since foreign investment has been largely responsible for the rapid growth in her output of manufactures.[4] It is observed that export growth in manufactures had been particularly rapid for the period 1975-1979 (see Table 8). An analysis of Singapore's competitiveness can therefore be confined to this period of rapid export growth.

Chart I presents the indices of Singapore's unit labour costs in manufacturing, relative unit labour costs of Singapore with respect to Japan and the U.S., and their respective exchange rates. Unit labour costs of Singapore show some decline over the years due to the relative stability of wage rates and the rapid increase in labour productivity. Labour costs per dollar's worth of manufacturing output declined from 13.4 percent in 1975 to 11.9 percent in 1979, although there was an insignificant increase in unit labour costs from 1976-1978 (see Table 11). The drop in the Singapore dollar relative to the yen from 1975-1978 may have also bolstered Singapore's competitive position in the Japanese market although the relative values of unit labour costs between the two countries remained relatively stable over this period.

Table 12 presents unit labour costs in manufacturing for Singapore, Japan and United States by industry groups. It is observed that unit labour costs for chemicals, electrical machinery, iron and steel industries are lower than the average for all manufacturing industries. These industries are therefore cost competitive relative to other industries. It is important to note that electrical machinery accounted for 36.3 percent of total exports of manufactures in 1979, thus contributing significantly to the positive competitive effect.

In comparison with her major industrial trading partners, Singapore's unit labour costs are lower for all the corresponding years. In particular, electrical machinery is found to be cost competitive against similar industries of Japan and United States over the same period.

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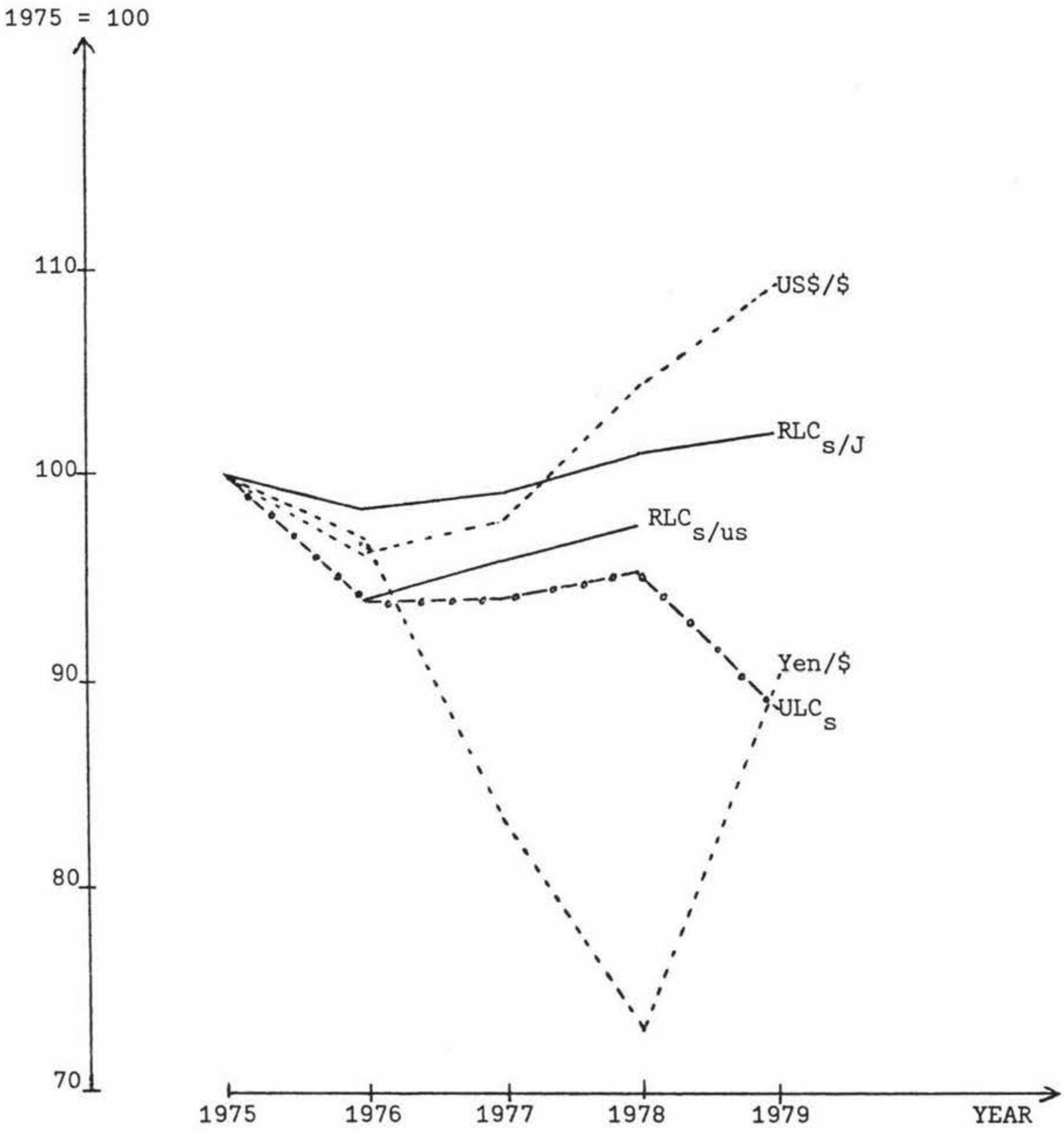
4. The role of foreign investment in the growth of manufacturing output and export will be examined subsequently.

CHART I

Cost Competitiveness



Source: As in Table 11

Note: The curves depict annual values but are not representative of changes in between any two years.

Definition: ULC - Unit labour costs of Singapore

$RLC_{s/J}$ - Relative unit labour costs of Singapore to Japan

$RLC_{s/us}$ - Relative unit labour costs of Singapore to United States

TABLE 11

Unit Labour Costs, Relative Labour Costs and Exchange Rates With Respect to Singapore, Japan and the United States

	1975	1976	1977	1978	1979
Unit Labour Costs(%):					
Singapore (ULC_s)	13.4	12.6	12.6	12.8	11.9
Japan (ULC_J)	15.4	14.7	14.6	14.7	13.4
United States (ULC_{us})	19.6	19.6	19.2	19.2	-
Relative Unit Labour Costs of Singapore to:					
Japan ($RLC_{s/J}$)	87.0	85.7	86.3	87.1	88.8
United States ($RLC_{s/us}$)	68.4	64.3	65.6	66.7	-
Exchange rates:					
Yen per S$	123	119	103	90	111
U.S.$ per S$	0.420	0.404	0.410	0.439	0.459

Source: i) Yearbook of Industrial Statistics, UN, Vol.I, various issues

ii) International Financial Statistics, Supplement on Exchange Rates, IMF, 1981

TABLE 12

Labour Costs per $ of Output (percentage)

Industry \ Country	Singapore	U.S.	Japan	Singapore	U.S.	Japan
	1977			1976		
1. Textile	18.9	20.7	16.4	15.6	20.2	14.1
2. Wearing Apparel	18.8	25.6	30.4	17.2	25.1	28.6
3. Furniture	26.2	27.6	32.2	24.1	28.9	34.1
4. Printing and Publishing	24.0	30.3	26.4	21.3	32.8	23.1
5. Leather	14.1	24.2	29.0	12.9	26.4	24.2
6. Footwear	23.7	27.5	19.2	23.2	28.7	17.0
7. Rubber Manufactures	17.9	21.9	23.6	17.1	21.6	19.4
8. Chemicals	9.1	12.8	10.8	8.5	12.0	10.2
9. Non-Metallic Minerals	10.2	15.2	18.9	10.4	24.7	18.1
10. Iron and Steel	8.5	20.9	11.4	8.8	25.7	11.3
11. Metal Manufactures	13.7	23.2	20.1	15.8	23.0	16.3
12. Non-Electrical Machinery	15.3	25.6	17.9	18.8	24.8	17.3
13. Electrical Machinery	12.6	26.9	17.8	11.6	25.4	14.6
14. Transport Equipment	19.7	20.2	13.5	18.8	18.9	13.7
15. Precision Instruments, Clocks, etc.	20.6	26.6	26.6	20.3	25.9	23.8
Total Manufactures	13.4	15.4	19.6	12.6	14.7	19.6

TABLE 12 - continued

Industry \ Country	S'pore	U.S.	Japan	S'pore	U.S.	Japan	S'pore	U.S.*	Japan
	1977			1978			1979		
1. Textile	15.2	19.5	14.1	15.6	19.9	16.3	14.6		16.9
2. Wearing Apparel	18.1	24.7	22.4	18.8	24.4	22.7	19.1		23.4
3. Furniture	21.5	26.7	29.8	21.6	26.1	18.1	21.2		19.0
4. Printing	20.9	28.2	59.7	23.6	27.7	21.9	25.2		23.0
5. Leather	11.5	22.1	12.1	12.6	25.5	16.1	12.7		16.1
6. Footwear	20.6	26.2	31.4	19.2	25.0	17.3	17.9		
7. Rubber Manufactures	17.4	22.5	14.4	24.1	23.0	18.2	16.1		18.1
8. Chemicals	8.8	10.5	24.6	9.5	12.1	8.6	8.9		9.2
9. Non-Metallic Minerals	9.5	22.3	17.6	9.7	21.7	16.8	16.8		16.2
10. Iron and Steel	9.7	21.9	10.6	6.2	21.9	8.9	7.9		9.6
11. Metal Manufactures	14.6	22.5	16.9	15.9	22.3	17.9	16.0		18.3
12. Non-Electrical Machinery	17.6	24.5	19.5	13.0	24.1	17.5	18.6		25.2
13. Electrical Machinery	11.5	24.8	16.0	11.0	25.1	12.5	11.5		19.5
14. Transport Equipment	20.1	18.6	12.2	20.1	18.6	11.3	21.7		11.9
15. Precision Instruments	20.4	25.7	20.1	20.3	25.0	18.9	20.4		12.0
Total Manufactures	12.6	14.7	19.6	12.8	14.7	19.2	11.9		13.4

Source: Yearbook of Industrial Statistics, UN, Vol.I, various issues

Note: * Figures are not available from the above source

The above study indicates that low unit labour costs have been to a large extent responsible for Singapore's competitiveness in her exports of manufactures. The high levels of labour productivity may be attributed to high levels of general education and extensive vocational training received by her workers as compared to other workers in her region. Wage restraints were also imposed by the National Wages Council since 1972 to maintain export competitiveness although the policy was reverted in mid 1979. These factors, in addition to industrial peace, may have contributed towards Singapore's strong competitiveness in world markets. A rigorous test of Singapore's comparative advantage will be carried out in the following chapter.

CHAPTER 4

Tests of Singapore's Comparative Advantage

THE RICARDIAN HYPOTHESIS

The empirical verification of the "simple" Ricardian theory in the context of a multi-factor, multi-commodity and multi-country world has in the past interested several economists. MacDougall, Stern and Balassa tested the hypothesis that the export ratios of two countries to a third market were a function of the labour productivity ratios of the two countries in question. They obtained positive results. These studies have also shown inter-country ratios of production costs to be negatively correlated with the respective export ratios.

Bhagwati in his survey questioned whether this was a correct testing of the Ricardian theory. Bhagwati's main objection to these tests was that there was no logical reason why the ratio of two countries' exports to a third market should increase as the corresponding price fell. Bhagwati argued that labour productivity first affects prices and then export shares. He therefore regressed for the same data, export price ratios on labour productivity but obtained very poor results.

Recent work in this area by A. Mohan et al[1] used a more comprehensive measure of labour productivity for bilateral tests of the Ricardian theory. The results however, were inconclusive. It again appears that the positive results of the indirect tests for exports to a third market are of dubious significance.

Recognising that the MacDougall procedure does not embody a proper test of the doctrine, it might still be asked whether the successful results constitute a "striking empirical regularity" or are only

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1. Mohan, A., Hossein, A., & Corson, W., "A Testing of the Ricardian Theory of Comparative Advantage", Economia Internazionale, Vol. 28, 1975, pp.341-345.

accidental and due only to some special circumstances surrounding the British-American experience as analysed by MacDougall. To answer this question, the present chapter follows the practice of earlier studies, testing the hypothesis with reference to Japan and Singapore using both cross-sectional and time series data. Throughout this study, exports have been taken to refer to third market destinations.

Evidence from Cross-Sectional Data

At the official exchange rate of 111 yen to S$1, average earnings per employed person in manufacturing in Japan for 1979 were about thrice (2.85) those in Singapore. Consequently, on the basis of MacDougall's formulation, one would expect the value of Japanese exports to exceed that of Singapore in industries where the productivity ratio is above 2.85 and fall below it when the ratio is less than 2.85. Columns 1 and 3 of Table 13 present the productivity and export ratios for the 15 selected industries ranked in order of productivity ratios. More than half of the industries listed (those marked with a star) exhibit behaviour contrary to the expected pattern. Of these 15 industries, five conformed to the expected pattern.

Following MacDougall's formulation, the results are shown in Chart II where the labour productivity ratio is shown on the vertical axis and the export ratio on the horizontal axis expressed in terms of logarithms. The following regression was obtained where x refers to export ratio and y to output per worker ratio:

$$\log x = 0.986 + \underset{(1.74)}{1.58} \log y; \quad F = 30.4, \ r = 0.44, \ n = 15$$

This result may be interpreted to mean that a one percent difference in the output per worker ratio was associated with a similar but slightly larger percent difference in the relative exports. The regression coefficient is significant at the 90 percent level of confidence.

From Chart II, it is observed that there is a positive linear relationship between the productivity and export ratios. This shows that in those industries in which the Japanese productivity is higher than those of Singapore's, the Japanese will capture the

TABLE 13

Productivity and Export Value Ratios for Selected Industries in Japan and Singapore, 1979

Industries in which the Japan/ Singapore Productivity Ratio is 2.85 and above	Productivity Ratio (1)	Labour Costs Ratio (2)	Export Ratio (3)
Transport Equipment	4.07	0.55	46.17
Paper	3.55	0.99	14.99
Precision Equipment	3.32	0.98	22.99
Furniture	*3.29	0.90	1.97
Non-Electrical Machinery	2.89	1.01	19.01
Industries in which the Japan/ Singapore Productivity Ratio is less than 2.85	**(1)**	**(2)**	**(3)**
Chemicals	*2.54	1.15	11.74
Leather	*2.49	1.28	21.08
Rubber	*2.45	1.14	34.11
Electrical Machinery	*2.39	1.39	6.81
Other Manufactures	*2.31	1.35	9.92
Wearing Apparel	2.05	1.22	0.95
Fabricated Metals	*2.01	1.14	17.68
Iron and Steel	*1.86	1.21	83.04
Textile	*1.21	2.11	1.80
Printing	*1.16	2.49	2.47

Source: i) Report on the Census of Industrial Production, Singapore, 1979

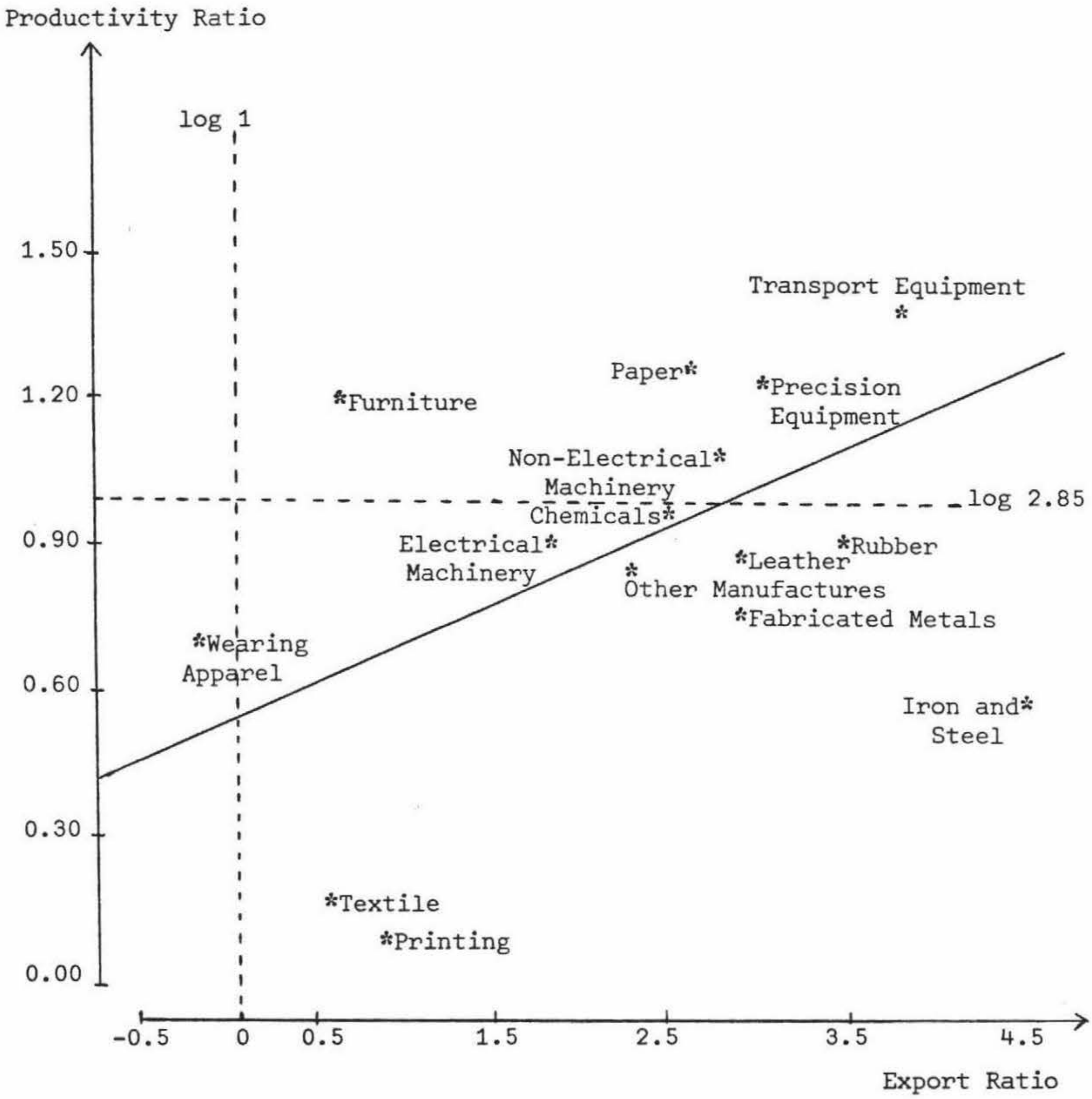
ii) Japan Statistical Yearbook, 1979

iii) Commodity Trade Statistics, United Nations, 1979

Note: Starred (*) industries are those which behave contrary to expectations on the basis of labour productivity ratios

CHART II

Productivity Ratio and Export Ratio in Singapore's Manufacturing by Major Industry Groups, 1979



Source: As in Table 13

Note: The regression equation is given by

$$\log y = 0.582 + 0.15 \log x$$
$$(1.74)$$

larger share of the export market. As the relative advantage of the Japanese falls, the export market share falls too. The regression line passes through the horizontal line marked 1.05 (log 2.85) where the output ratio is equal to average wage ratio at a point well to the right of the vertical line marked zero (log 1) where Japan and Singapore exports are the same. This implies that Japan tended to export considerably more than Singapore even in industries where output per worker was less than thrice that of Singapore. This further indicates that factors other than relative labour productivity differences are of relevance too.

This study also reveals that the process is continuous in the sense that no one country succeeds in capturing the whole of the export market as a result of comparative cost advantages. This may be due to several causes. Firstly, the products shown here are not homogeneous within commodity classifications. Product differentiation may result in that no one country can capture the whole export market. Secondly, perfectly competitive markets seldom exist in the real world. Oligopolistic and monopolistic industries tend to price their products differently from perfectly competitive industries. Various non-price factors may therefore assume significance in imperfectly competitive markets.

Since the inter-industry wage structure may vary from one country to another, it was thought advisable to eliminate such fluctuations by converting relative productivity ratios to relative unit labour costs. The latter variable is obtained by dividing, for each industry, the productivity ratio into the wage ratio. One would expect relative exports to be negatively correlated with relative unit labour costs. The regression results support the above hypothesis as follows:

$$\log y = 2.68 - 1.89 \log x$$
$$(-2.12)$$

where y = relative export ratio;

x = relative unit labour costs ratio;

$n = 15$

Results derived from cross-sectional data for 1979 do offer support for the Ricardian hypothesis. A further robust test of the Ricardian hypothesis would be to run similar regressions for some other selected years. This will serve to indicate whether the Ricardian phenomenon as tested by MacDougall constitutes an "empirical regularity".

Regression equations are constructed for the years 1970 to 1978, excluding 1977 since required data is not available. Inconclusive evidence is obtained regarding the first Ricardian hypothesis as presented in Table 14a. Only four out of the eight regression equations yield a positive relationship between relative exports and relative labour productivity. The regression coefficients are not statistically significant generally.

In Table 14b, the influence on export performance due to variation in inter-industry wage structure is isolated by regressing relative exports against relative labour costs. There is clearly an improvement in the results presented. Seven out of the eight regression equations exhibit a negative relationship between relative exports and relative labour costs as postulated. However, the majority of the regression coefficients are again insignificant. It is observed that the degree of negative correlation between unit labour costs and export performance has been increasing over time as indicated by increasing values of r. This may be attributed to the fact that productivity increases outweighed wage increases thus resulting in a fall in unit labour costs and an increase in relative exports. The productivity index increased from 95.5 in 1972 to 184.4 in 1979 while the remuneration index increased from 115.7 to 187.4 for the same period.[2]

Evidence from Time-Series Data

Instead of dealing with a cross-sectional analysis of industries, the approach adopted in this section is to relate over time, relative labour productivity to relative export performance in the same industry. For 15 industries, data has been gathered on Japan's and Singapore's output per worker. This data has been matched up with the respective exports of the two countries to third markets.

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2. Table 1, Chapter 2.

TABLE 14a

Regressions of Japan/Singapore Export Ratios against Productivity Ratios (in terms of logarithms)

Year	Constant	Productivity Coefficient	F	r
1970	3.54	-0.393 (-0.50)	0.251	-0.139
1971	3.57	-0.111 (-0.18)	0.030	-0.054
1972	3.27	-0.072 (-0.09)	0.007	-0.026
1973	2.91	-0.045 (-0.07)	0.005	-0.020
1974	2.80	0.087 (0.13)	0.020	0.037
1975	2.94	0.013 (0.02)	0.000	0.004
1976	2.69	0.198 (0.25)	0.050	0.063
1978	0.35	1.650 (1.11)	1.230	0.294

TABLE 14b

Regressions of Japan/Singapore Relative Exports against Relative Labour Costs (in terms of logarithms)

Year	Constant	Labour Costs Coefficient	F	r
1970	3.21	0.550 (0.81)	0.650	0.194
1971	3.49	-0.043 (-0.07)	0.005	-0.022
1972	3.26	-0.347 (-0.47)	0.222	-0.141
1973	2.96	-0.141 (-0.26)	-0.067	-0.072
1974	2.91	-0.221 (-0.38)	0.145	-0.105
1975	3.07	-0.437 (-0.56)	0.317	-0.154
1976	2.99	-0.672 (-0.86)	0.738	-0.232
1978	2.61	-2.05 (-1.44)	2.080	-0.372

Source:
i) Report on the Census of Industrial Production, Singapore, various issues
ii) Commodity Trade Statistics, United Nations, various issues

Note: t statistics are shown in parenthesis

From these figures, ratios were computed for the Japan/Singapore labour productivity and export ratios covering the period 1970 to 1979 (excluding 1977), thus yielding 9 annual observations. The two series were then plotted against each other for each of the 15 products with the expectation of a positive association between the Japan/Singapore labour productivity ratio on the one hand and the Japan/Singapore export ratio on the other. The results presented in Table 15a were rather disappointing. In the case of only six products could a positive relation be observed but the correlation is not significant in most cases (see Appendix Table 1).

As observed earlier, variation in inter-industry wage structure from country to country may create a bias in the results presented. It is possible to eliminate this bias by examining the relationship between relative exports and relative unit labour costs. It is therefore hypothesised that there is a negative relationship between relative export performance and relative unit labour costs over time. The results are tabulated in Table 15b.

The results do support the Ricardian hypothesis of comparative advantage in terms of labour costs. About 67 percent of the products examined exhibit a negative correlation between export ratios and relative labour costs. However, the correlations in most cases are not statistically significant. This is in line with the earlier findings using cross-sectional data as reported above.

The burden of the evidence presented in the above study is thus against the Ricardian hypothesis that changes in labour productivity govern export performance. This can result from the fact that labour productivity is not the all important factor determining price behaviour. The use of unit labour costs greatly improve the results for both cross-sectional and time-series tests. Since the unit labour costs of Singapore has been observed to be relatively lower than that of her major trading partners, particularly Japan, it is not surprising that there exists a negative relation between Singapore's exports and unit labour costs.

TABLE 15a

The Relation between Japan/Singapore Labour Productivity and Export Ratios, 1970-1979 (excluding 1977)

Negative/No Relation	Positive Relation
Fabricated Metals	Iron and Steel
Transport Equipment	Industrial Machinery
Precision Equipment	Electrical Machinery
Other Manufactures	Printing
Textile	Chemicals
Wearing Apparel	Rubber Manufactures
Leather	
Furniture	
Paper and Allied Products	

Source: Appendix Table 1

TABLE 15b

The Relation between Japan/Singapore Unit Labour Costs and Export Ratios, 1970-1979 (excluding 1977)

Negative Relation	Positive/No Relation
Iron and Steel	Fabricated Metals
Electrical Machinery	Industrial Machinery
Precision Equipment	Transport Equipment
Wearing Apparel	Other Manufactures
Leather	Textile
Furniture	
Paper and Allied Products	
Printing	
Chemicals	
Rubber Manufactures	

Source: Appendix Table 2

It is however important to recognise that demand rather than supply considerations play a more important role in determining the pattern of international trade in differentiated products. Supply models such as the comparative cost doctrine and Hecksher-Ohlin theory are only useful in explaining trade in homogeneous products.

AN EMPIRICAL INVESTIGATION OF THE HECKSHER-OHLIN THEORY

The purpose in this section is to examine the extent to which the principal manufactured exports of Singapore to the world, developed market economies and developing economies are related to their relative factor endowments.

The Hecksher-Ohlin theory boldly asserts that factor endowments determine trade flows; a country exports goods that use relatively intensively its relatively abundant factor and imports goods that use relatively intensively its scarce factor.

Hypotheses, Methodology and Sources of Data

It is proposed to test the two "orthodox" explanations of the commodity composition of trade for Singapore. The first is the simple factor proportions theory which uses differences in the physical capital intensity as the primary explanation of the structure of a country's commodity trade. The second is the human capital or the skill intensity explanation of trade.

Factor Intensity

In the Hecksher-Ohlin model, certain simplifying assumptions are made. The production function in respect of each good is identical in all countries. The technology or technologies are known and universally available and the real marginal productivity of labour and capital depends only on the ratio in which they are combined and not on their national location. Another characteristic of the production function is the absence of economies of scale. Finally factor reversals are excluded.

Based on these assumptions, countries amply endowed with labour in relation to capital will have an advantage in labour intensive goods. Conversely, countries where labour is scarce relative to capital will have an advantage in capital-intensive goods.

The Methodology

There are basically two approaches to the measure of factor intensity. The first approach adopts value added as a guide to factor intensity while the second approach concentrates on the physical quantity of factors employed.

By the first approach, the higher the total value added per worker, the more capital intensive the industry. On the other hand, the lower the total value added per employee, the more labour intensive it is.[3] The second approach relies on infrequent statistics of stocks of capital as a measure of capital intensity and the number of workers per $1000 of output as a measure of labour intensity.

The following assumptions are made in using value-added as a measure of factor intensity.

Firstly, differences from industry to industry in value-added are assumed to measure differences in the aggregate flow of services from the factors of employment in the manufacturing process. It therefore excludes indirect factor inputs such as materials used.

It is further assumed that these services can be ascribed either to human capital[4] or physical capital. The wage-and-salary part of value-added is frequently used as a proxy for human capital and the remainder of value-added is used as a proxy for physical capital.

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3. Lary, H.B., Imports of Manufactures from Less Developed Countries. He defines total capital as being inclusive of human capital and physical capital.

4. It has being recognised that differences in the quality of labour largely reflect differences in the amount of training and other forms of investment in people.

Table 16 presents the components for wage value-added and non-wage value-added for selected manufacturing industries in 1979. The identification of factor intensity for these major industries can be clearly depicted in Chart III. Industry groups falling on the lower left sector of Chart III may be thought of as intensive in the use of relatively unskilled labour since they are below the Singapore average in both wage and non-wage value-added per worker. Their products include the following:-

Industry Groups

1 .... Textile
2 .... Wearing Apparel
3 .... Leather
4 .... Furniture
5 .... Paper and Allied Products
12 .... Electrical Machinery
14 .... Precision Equipment
15 .... Other Manufactures

Industry groups falling on the upper right sector of Chart III are intensive in the use of relatively skilled labour and physical capital and therefore capital intensive on both accounts. They include the following products:-

7 .... Chemicals
9 .... Iron and Steel
11 .... Non-Electrical Machinery
13 .... Transport Equipment

Qualifications

The criterion of value-added has significant advantages as a measure of factor intensity in manufactures. This measure reflects the flow of services into the manufacturing process from both human and physical capital and permits their treatment on a common basis. Another advantage is that value-added per employee is available in considerable detail for a number of countries whereas statistics on stocks of physical capital are more infrequent.

TABLE 16

Value-Added in Singapore's Manufacturing by Major Industry Groups, 1979

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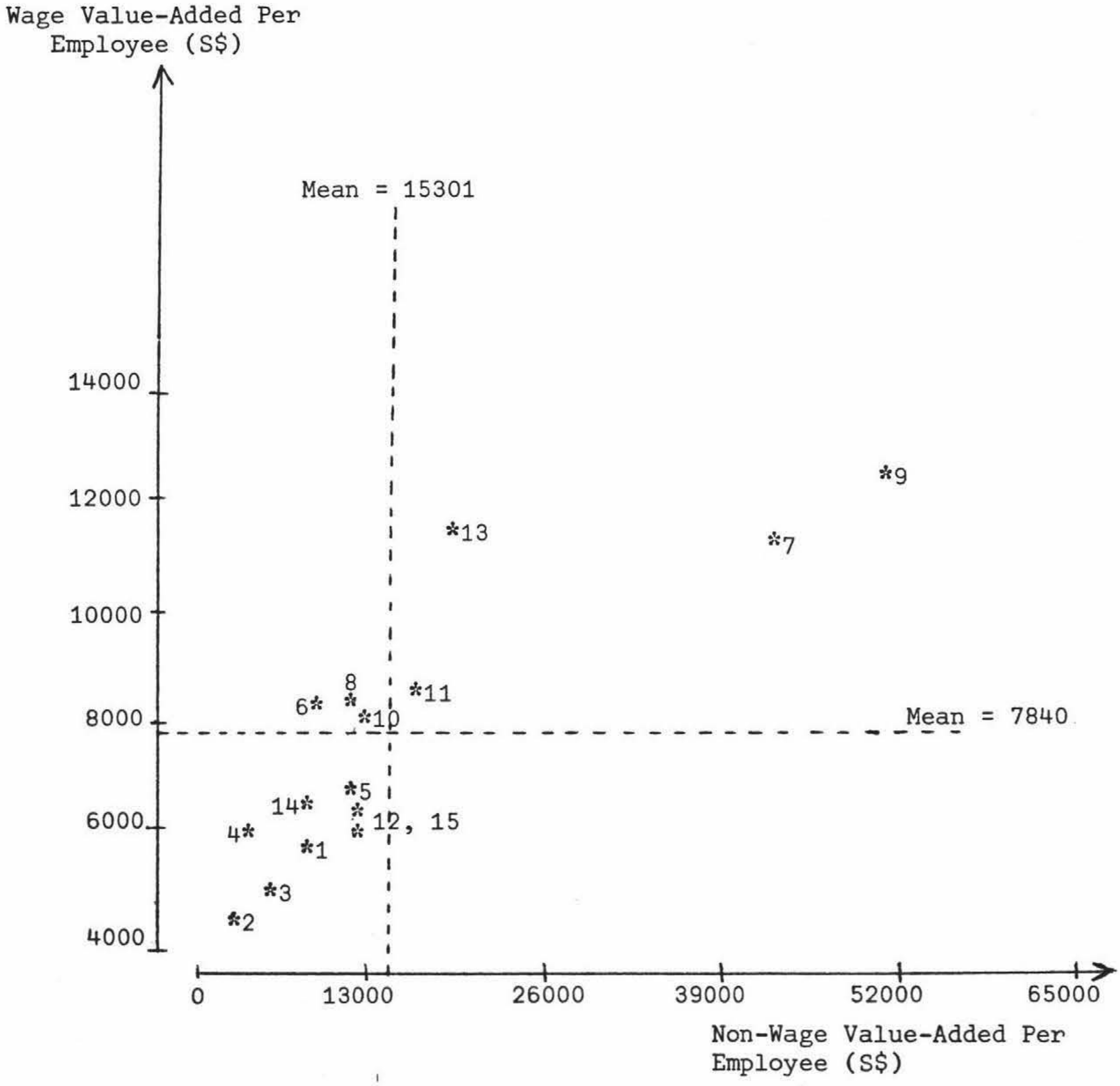
Industry	Wage V-A per worker	Non-Wage V-A per worker	V-A per worker
Textile	6187	7223	13410
Wearing Apparel	4667	3222	7889
Leather	5296	4984	10280
Furniture	5986	4380	10366
Paper and Allied Products	6729	11460	18189
Printing	8500	10416	18916
Chemicals	11520	43211	54731
Rubber Manufactures	8534	12308	20842
Iron and Steel	12375	51731	64106
Fabricated Metals	8054	13759	21813
Non-Electrical Machinery	8968	16114	25082
Electrical Machinery	6424	12251	18675
Transport Equipment	11791	20002	31793
Precision Equipment	6342	7187	13529
Other Manufactures	6222	11266	17488

Source: Report on the Census of Industrial Production, Singapore, 1979

CHART III

Wage and Non-Wage Value-Added Per Employee in Singapore's Manufacturing by Major Industry Groups, 1979



Source: As in Table 16 .

The criterion of value-added is however not an infallible guide to capital intensity. The value-added figures used in the computation of one of the measures of physical capital intensity viz the non-wage value-added per employee are likely to be biased. The returns accruing to capital which the value-added figures contain would include profits as well as an element of "rent". Under competitive normal equilibrium conditions, the returns would coincide with normal profits and given sufficient mobility of factors between industries, the inter-industry differences in factor returns would tend to disappear. Therefore, it is possible for the two measures of physical capital intensity to yield the same result in a risk free equilibrium provided that product, capital and labour markets were perfect and non-wage value-added did not include any item other than capital remuneration. The lack of consideration given to inter-industry differences in depreciation rates and the extent of obsolescence of existing equipment as well as the use of historical rather than replacement values for physical capital represents disadvantages of the stock measure. In addition, the stock measure of physical capital is subject to the severe limitation that such data is not easily available.

However, if both the non-wage value-added per employee and fixed capital per employee are to indicate the physical capital intensity of an industry, their ranking orders must be reasonably close. H.B. Lary for example, had found a very high degree of correlation between the two measures of physical capital intensity for a large sample of U.S. industries.[5] It is therefore in order to use the non-wage value-added per employee as a measure of physical capital intensity.

Skill Intensity

Similarity of "input requirements", that is, material inputs of labour and capital is clearly not sufficient for the conclusion that factor intensities are similar. The composition of value-added must be taken into account. A country may be both exporting and importing for example "wearing apparel", but the human skills required for its main exports of wearing apparel may be quite different from those required for its main imports of wearing apparel.

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5. Lary, H.B., op.cit., chapter 2.

Leontief's finding that the U.S. exports relatively labour-intensive goods to the rest of the world led Keesing to reformulate a testing proposition as follows: "patterns of international trade and location are principally determined for a broad group of manufactures by the relative abundance of skilled and unskilled labour".[6] In other words, one should not limit factor proportions theory to old-fashioned "labour" and "capital". All the developments of the "neo-factor proportions" literature must be taken into account particularly for trade in manufactured goods.

Theoretical Framework and Methodology

Several important works have been done on human capital and trade. Helen Waehrer constructed what she called an "occupational index" and found that an industry's trade balance was more correlated with its skill index than with its yearly wage bill.[7] She also discovered that the skill mix and wage rate of an industry were highly correlated with the wage rate serving as a proxy for skill intensity.

Keesing was concerned with computing a common set of skill coefficients for trade in several countries.[8] He showed that a powerful inverse correlation (a Spearman coefficient of -0.87) existed between the skill intensity of exports and imports.

In this study, Keesing's methodology will be adopted to calculate the skill intensity in the trade of manufactures for Japan and Singapore for 23 industries. According to a recent study by Chow Kit Boey, Singapore's skill mix is found to be more appropriate for measuring

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6. Keesing, D.B., "Labour Skills and Comparative Advantage", The American Economic Review, Papers and Proceedings, Vol. LV1, 1966, pp.249.

7. Waehrer, H., "Wage Rates, Labour Skills and U.S. Foreign Trade" in Kenen P.B., & Lawrence, R., (ed.) The Open Economy: Essays on International Trade and Finance, New York, 1968, pp.30-37.

8. Keesing, Donald B., "Labour Skills and International Trade: Measuring Many Trade Flows With a Single Measuring Device", Review of Economics and Statistics, August 1965.

the skill requirements of trade flows of other countries in East Asia.[9] This provides a strong justification that the ranking of industries by skill intensity for these two countries are similar.

Keesing's mathematical model is formulated as follows:

Let $A = [aij]^{m \times n}$

= set of technical coefficients which represents the employment proportion of n skill classes in each ith industry (i=1, 2, ..., m);

$Z = [zij]^{1 \times m}$

= value of traded goods in the m industries;

$Y = [yij]^{m \times m}$

= levels of employment required to produce a unit of output in each industry on its diagonal and zero elsewhere;

Multiply Z by Y

$ZY = X$

= employment needed to produce the goods traded;

Pre-multiply A with vector X

$XA = S$

= level of employment required in each skill class to produce the trade flow.

Keesing's model was essentially a modification of the standard Hecksher-Ohlin model to incorporate skills as an additional factor. Keesing rationalizes that "the skill requirements of each industry are essentially the same everywhere" and that "capital goods and unskilled labour cannot be substituted for skills but only for each other".[10] This enables the measurement of skill requirements

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9. Chow Kit Boey, "Skill Intensity of Singapore Trade", The Malayan Economic Review, Vol. XX. No. 2, October 1975, pp.72-97.

10. Keesing, Donald B., op.cit., pp.289.

with a single country's skill mix to be universally applicable. To test his basic assumption that the same industries are skill intensive relative to other industries in all countries, Keesing uses the skill mix of U.S. and West Germany. He obtains similar results of an inverse correlation between skill intensity of exports and imports when he ranks the exports and imports of 13 countries by the skill indices of these two countries.

Construction of Singapore's Skill Coefficients

Singapore's classification of occupations lists the major occupational groups as follows:

(I) Professional, Technical and Related Workers
(II) Administrative and Managerial Workers
(III) Clerical and Related Workers
(IV) Sales Workers
(V) Service Workers
(VI) Agricultural Workers and Fishermen
(VII) Production and Related Workers

The 1980 Census of Population provides information on the percentage of workers in the seven occupational groups. The number of workers reported in the Census of Industrial Production is used to calculate employment per million dollar of output. The final set of technical coefficients for 23 manufacturing industries is used because published sources provide information on the breakdown of occupations by industry only at the three-digit level of industrial classification.

Singapore's seven occupational groups are further aggregated into four broad groups of occupations namely,

(I) Professional, Technical and Related Workers
(II) Administrative and Managerial Workers
(III) Clerical, Sales and Service Workers
(IV) Others (Agriculture, Production Workers, etc.)

Identification of Skill Intensity for Major Industries

Table 17 lists the most and least skill intensive industries in Singapore. The industrial chemicals and other chemicals industries

TABLE 17

High and Low Skill Intensive Industries in Singapore, 1980

Combined Occupational Grouping		Industry	% of Labour Force
I. Professional, Technical		Industrial Chemicals	9.4
& Related	(Highest)	Printing	9.0
Workers		Other Chemicals	8.9
	(Lowest)	Footwear	0.6
		Apparel	0.8
		Leather	0.7
II. Administrative and		Industrial Chemicals	11.6
Managerial	(Highest)	Other Chemicals	10.5
Workers		Non-Ferrous Metals	10.3
	(Lowest)	Apparel	2.7
		Optical & Photographic Instruments	2.9
		Electrical Machinery	3.1
III. Clerical, Sales and		Other Chemicals	31.6
Service	(Highest)	Industrial Chemicals	25.9
Workers		Printing	23.6
	(Lowest)	Furniture	9.2
		Footwear	9.5
		Apparel	9.7
IV. Others	(Highest)	Apparel	86.8
		Furniture	85.7
		Footwear	84.9
	(Lowest)	Other Chemicals	49.0
		Industrial Chemicals	53.1
		Printing	59.8

Source: Appendix Table 4

Note: Manufactures are defined according to the trade classification, thus, excluding the petroleum industry have the highest concentration of professionals, administrative and managerial workers. Footwear and apparel industries are the least skill intensive. Their employment of workers in occupational groups I, II and III are among the lowest while group IV workers make up 85 percent to 87 percent of their labour force.

It is observed that in Singapore, skills are concentrated in very few industries.[11] Further evidence of this narrow dispersion of skills in Singapore can be obtained by considering industries with high percentages of labour in occupational groups I, II and III. In Singapore, four industries dominate namely, industrial chemicals, printing, other chemicals and non-ferrous metals. Similarly, industries with low intensity of skills are few in Singapore. They are the footwear, apparel, leather and furniture industries.

Empirical Results of Measuring Trade Flows Using Singapore's Skill Coefficients

According to Chow Kit Boey, Singapore is similar to Japan in both rankings of exports and imports by skill intensity. In 1971, Singapore tops all the developing countries and three developed countries in her exports of skill intensive goods. She ranks seventh on low skill intensity of imports. Singapore's ratio of export and import skill indices is 0.87 and is below Japan's ratio of 0.99.

Table 18 presents the skill requirements for 1979 bilateral trade between Japan and Singapore using Keesing's methodology in its calculations.

Using trade classification of manufactures, only industries falling within SITC 5-8 are considered as manufacturing industries. Industrial classification of manufacturing however includes industries

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11. In her comparison of skill intensity between Singapore and U.S., Chow Kit Boey discovered that Singapore skills are concentrated in ten industries as compared to fourteen industries in U.S., op.cit., pp.78.

TABLE 18

Skill Requirements of 1979 Bilateral Trade between Japan and Singapore in Manufacturing

	Occupational Group (Employment %)							Skill
Trade Classification	I	II	III	IV	V	VI	VII	Index
Singapore's exports to Japan	4.74	4.06	9.00	2.00	0.22	0.05	79.76	0.221
Japan's exports to Singapore	5.50	4.20	9.76	1.22	1.99	0.06	77.27	0.251
Industrial Classification								
Singapore's exports to Japan	7.09	4.67	11.34	1.89	2.28	0.11	72.62	0.323
Japan's exports to Singapore	5.47	4.18	9.71	1.22	1.98	0.07	77.37	0.249

Source: As in Appendix Table 3

Note: Skill Index = $\frac{2(I + II)}{VI + VII}$

not within the trade classification such as the petroleum industry. This creates a bias in the results presented as evidenced by greater skill coefficients using the industrial classification of manufactures (see Table 18).

Chow Kit Boey offered an explanation for this upward bias in Singapore's skill coefficients when the industrial classification of manufactures is used. Firstly, Singapore's skills are concentrated in a few industries. Secondly, the distribution of professional and technical skills is skewed towards the petroleum industry. "Hence the high intensity of skills in Singapore exports is partly attributable to this bias in Singapore skill coefficients since petroleum products in 1971 accounts for about 25% of total exports."[12]

It is also interesting to note that the skill intensity of both country's exports has increased over time. The time pattern of the skill intensity of Singapore's exports is examined with reference to Table 19. The share in employment by the seven occupational groups show percentages which are rising especially for Group I. The greatest change occurred in 1979 which showed a large jump in the skill index. In 1979, the percentage of workers employed in Group I and II comprised of 11 percent of total employment in manufacturing industries. There was a sharp reduction in Group VII workers which consisted mainly of production workers, operators and labourers. This reduction was mainly due to the government's policy of economic restructuring. Economic restructuring is meant to "ease out highly labour intensive, low wage, low productivity economic activities".[13] This trend is continuing into the 1980s as Singapore endeavours to become a regional and international "brain service" centre.

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12. Chow Kit Boey, op.cit., pp.92.

13. Lim Chong Yah, "Economic Restructuring in Singapore", Economic Development in Singapore, Federal Publications Singapore, 1980, pp.140.

TABLE 19

Skill Requirements of Singapore's Manufactured Exports

Year	Occupational Group (Employment %)							Skill Index
	I	II	III	IV	V	VI	VII	
1966	2.41	2.16	7.84	2.92	1.99	0.69	81.95	0.1110
1969	2.78	2.07	7.40	2.73	1.96	0.54	82.48	0.1172
1970	3.29	2.09	7.40	2.52	1.87	0.35	82.44	0.1299
1971	3.56	2.07	7.40	2.43	1.72	0.26	82.57	0.1358
1972	3.77	1.98	7.26	2.21	1.74	0.15	82.82	0.1388
1979	5.76	5.06	11.44	2.30	2.44	0.09	72.90	0.2960

Source: Statistics for years 1966-1972 are adapted from Table 10, Chow Kit Boey, op. cit.

The Variables in the Model: A Summary

The Dependent Variables

Y_i^W = the value of Singapore's exports of commodity i to the world as a proportion of its output;

Y_i^D = the value of Singapore's exports of commodity i to the developed market economies as a proportion of its output;

Y_i^{DG} = the value of Singapore's exports of commodity i to the developing economies as a proportion of its output.

The Explanatory Variables

X_1 = non-wage value-added per employee;

X_2 = skill index

Simple and multiple regressions have been fitted to test the relationship between each of the dependent variables and one or both of the explanatory variables. To avoid specification bias in the model, linear, semi-logarithmic and double logarithmic versions of the equations have been fitted. Table 20 brings together all the statistical information relating to the test.

Empirical Results

The results have been presented in three stages. Tables 21a and 21b list the simple regression equations relating the capital and skill intensity variables in turn to their dependent variables. Table 21c lists the multiple regression equations relating both the explanatory variables to the dependent variable. These equations relate to Singapore's trade in manufactures with the world. In Tables 22a, b and c are listed the simple and multiple regression equations between the dependent and independent variables relating to Singapore's trade with the developing economies. Finally, Tables 23a, b and c list the simple and multiple regression equations relating to Singapore's trade with the developed market economies.

TABLE 20

Principal Manufactured Exports of Singapore and Selected Explanatory Variables, 1979

Industry	Exports as a Proportion of Output			Non-Wage Coefficient	Skill Index
	Y_i^W	Y_i^D	Y_i^{DG}		
Textile	2.12	0.49	1.33	7223	0.15
Wearing Apparel	1.14	0.90	0.19	3222	0.08
Leather	0.10	0.03	0.07	4984	0.22
Furniture	0.76	0.46	0.23	4380	0.12
Paper	0.51	0.03	0.45	11460	0.22
Printing	0.44	0.09	0.18	10416	0.56
Chemicals	1.63	0.28	1.38	43211	0.79
Rubber Manufactures	0.92	0.30	0.49	12308	0.27
Iron and Steel	1.38	0.09	1.17	51731	0.29
Fabricated Metals	0.46	0.08	0.34	13759	0.26
Non-Electrical Machinery	1.73	0.60	1.02	16114	0.37
Electrical Machinery	1.23	0.71	0.14	12251	0.24
Transport Equipment	0.66	0.17	0.45	20002	0.25
Precision Equipment	1.79	0.99	0.77	7187	0.22
Other Manufactures	1.80	0.07	0.07	11266	0.23

Source: i) Commodity Trade Statistics, United Nations, 1979

ii) Yearbook of Statistics, Singapore, 1980/81

iii) Report on the Census of Population, Singapore, 1980

Note: The 15 industries listed above accounted for 92.7 per cent of Singapore's total manufactured exports in 1979.

The results of the regression exercise relating to Singapore's manufactured exports to the world as reported in Tables 21a, b and c are rather disappointing. The coefficients corresponding to capital intensity variable, X_1, are close to zero and not statistically significant. However they possess the expected positive signs. This indicates that capital intensity is not an important factor explaining Singapore's export performance.

The regression coefficients relating to the skill intensity variable have the expected positive signs but their magnitudes are low and statistically insignificant. However, the magnitudes of their coefficients are higher than that of capital intensity. This may suggest that skill intensity is a more important factor determining the trade pattern of Singapore.

In the multiple regression equations, the capital intensity variable maintained its zero or positive sign but the coefficients of the skill intensity variable are negative. This unexpected relationship may be due to collinearity between these two variables. An industry which uses relatively more physical capital per unit of its labour force is also likely to have more skilled labour in its total labour force. It is possible therefore that there is some interrelationship between the two variables themselves and their simultaneous introduction to the equations may distort the relationship between either of them and the dependent variable.

The results, although unreliable, lend some support to the human capital variant of the neo-factor proportions theory. Thus, the comparative advantage of Singapore is most pronounced in the manufacturing commodities requiring a great amount of skilled labour in their production. Physical capital intensity did not perform as well in "explaining" Singapore's trade pattern although it has the expected positive sign.

Singapore's Manufactured Exports to the Developing Countries

It is the purpose of this section to examine the extent to which Singapore's manufactured exports to the developing economies are related to Singapore's relative factor endowments. In terms of the

TABLE 21a

Simple Regressions between Proportion of Manufactured Output Exported to the World by Singapore and their Non-Wage Value-Added Per Employee, 1979

Regression Equations	Summary Statistics
(a) $Y_i^W = 0.96 + \underset{(0.83)}{0.000}\, X_1$	$F = 0.69$ $\bar{R}^2 = -2.3$
(b) $Y_i^W = -0.36 + \underset{(1.04)}{0.000}\, \log X_1$	$F = 1.07$ $\bar{R}^2 = 0.6$
(c) $\log Y_i^W = 2.88 + \underset{(1.06)}{0.295}\, \log X_1$	$F = 1.11$ $\bar{R}^2 = 0.8$

TABLE 21b

Simple Regressions between Proportion of Manufactured Output Exported to the World by Singapore and their Skill Intensity, 1979

Regression Equations	Summary Statistics
(d) $Y_i^W = 1.04 + \underset{(0.24)}{0.239}\, X_2$	$F = 0.06$ $\bar{R}^2 = -7.2$
(e) $Y_i^W = -0.42 + \underset{(0.75)}{0.164}\, \log X_2$	$F = 0.56$ $\bar{R}^2 = -3.2$
(f) $\log Y_i^W = -0.09 + \underset{(0.03)}{0.012}\, \log X_2$	$F = 0.00$ $\bar{R}^2 = -7.7$

TABLE 21c

Multiple Regressions between Proportion of Manufactured Output Exported to the World by Singapore and their Capital and Skill Intensity, 1979

Regression Equations	Summary Statistics
(g) $Y_i^W = 1.02 + \underset{(0.81)}{0.000} X_1 - \underset{(-0.27)}{0.328} X_2$	$F = 0.36$ $\bar{R}^2 = -10.1$
(h) $Y_i^W = -0.25 + \underset{(1.06)}{0.000} \log X_1 - \underset{(-0.41)}{0.638} \log X_2$	$F = 0.59$ $\bar{R}^2 = -6.2$
(i) $\log Y_i^W = -6.91 + \underset{(1.54)}{0.632} \log X_1 - \underset{(-1.11)}{0.638} \log X_2$	$F = 1.19$ $\bar{R}^2 = 2.6$

Note: Y_i^W = Ratio of exports to output of Singapore in relation to the world;

X_1 = Non-wage value-added per employee;

X_2 = Skill index;

$n = 15$;

t values are shown in parenthesis

direction of Singapore's manufactured exports, the developing economies accounted for about 53 percent and the developed economies 45 percent of total manufactured exports of Singapore in 1979. Thus the bulk of Singapore's manufactured exports go to the developing economies. This would appear to be keeping in line with Singapore's "status" as an "industrialized" country. It is therefore proposed to test the hypothesis that Singapore exports relatively capital intensive and/or skill intensive manufactures to the developing economies. Ideally, Singapore's bilateral trade with each individual country within the categories of "developed" and "developing" should be related to her factor endowments for the levels of development differ enormously among countries falling within the general category of "developed" and in particular "developing". But it is difficult to obtain satisfactory data at such a detailed level so the data relating to Singapore's exports to each group of countries had to be used.

Turning now to Tables 22a and b, it can be seen that the performance of Singapore's manufactured exports to the developing economies bear a reasonably strong relationship to both the capital and skill intensities of the exporting industries. The regression coefficients relating to each variable in all the equations are positive in sign. This is in keeping with what one would expect on theoretical grounds since Singapore's comparative advantage vis-a-vis the "developing" economies must be in industries which are capital intensive and skill intensive. The skill coefficients corresponding to the first two equations in Table 22b are significant at the 90 percent level of confidence while those coefficients for the capital intensity variable are significant at the 95 percent level.

It is observed that the magnitude of capital intensity variable is close to zero in equation (a). In addition, the magnitude of skill intensity variable, X_2, is greater than that of the capital intensity variable, X_1, for all forms of the equations. This would seem to suggest that skill intensity is a more important variable explaining Singapore's comparative advantage.

The results of the multiple regressions reported in Table 22c show that the explanatory power of the two independent variables used

TABLE 22a

Simple Regressions between Proportion of Manufactured Output Exported to the Developing Economies and their Non-Wage Value Added Per Employee, 1979

	Regression Equations	Summary Statistics
(a)	$Y_i^{DG} = 0.25 + \underset{(3.03)^{*}}{0.000} X_1$	$F = 9.15$ $\bar{R}^2 = 36.8$
(b)	$Y_i^{DG} = -1.44 + \underset{(2.31)^{*}}{0.218} \log X_1$	$F = 5.35$ $\bar{R}^2 = 23.7$
(c)	$\log Y_i^{DG} = -5.02 + \underset{(2.10)^{*}}{0.441} \log X_1$	$F = 4.42$ $\bar{R}^2 = 19.6$

TABLE 22b

Simple Regressions between Proportion of Manufactured Output Exported to the Developing Economies and their Skill Intensity, 1979

	Regression Equations	Summary Statistics
(d)	$Y_i^{DG} = 0.26 + \underset{(1.55)^{**}}{1.030} X_2$	$F = 2.39$ $\bar{R}^2 = 9.1$
(e)	$Y_i^{DG} = 0.97 + \underset{(1.35)^{**}}{0.294} \log X_2$	$F = 1.83$ $\bar{R}^2 = 5.6$
(f)	$\log Y_i^{DG} = -0.27 + \underset{(1.09)}{0.522} \log X_2$	$F = 1.18$ $\bar{R}^2 = 1.3$

TABLE 22c

Multiple Regressions between Proportion of Manufactured Output Exported to the Developing Economies and their Capital and Skill Intensity, 1979

	Regression Equations	Summary Statistics
(g)	$Y_i^{DG} = 0.19 + \underset{(2.34)*}{0.000} X_1 + \underset{(0.44)}{0.285} X_2$	$F = 4.38$ $\bar{R}^2 = 38.6$
(h)	$Y_i^{DG} = -0.96 + \underset{(2.08)*}{0.198} \log X_1 + \underset{(1.09)}{0.215} \log X_2$	$F = 3.31$ $\bar{R}^2 = 24.8$
(i)	$\log Y_i^{DG} = -4.21 + \underset{(1.88)*}{0.407} \log X_1 + \underset{(0.80)}{0.360} \log X_2$	$F = 2.47$ $\bar{R} = 17.3$

Note : Y_i^{DG} = Ratio of Exports to output of Singapore in relation to the developing economies;

X_1 = Non-wage value-added per employee;

X_2 = Skill index;

** - significant at the 90 percent level of confidence;

* - singificant at the 95 percent level of confidence

TABLE 23a

Simple Regressions between Proportion of Manufactured Output Exported to the Developed Economies and their Non-Wage Value Added Per Employee, 1979

Regression Equations	Summary Statistics
(a) $Y_i^D = 0.44 - \underset{(-0.97)}{0.000} X_1$	$F = 0.95$ $\bar{R}^2 = -0.4$
(b) $Y_i^D = 0.62 - \underset{(-0.38)}{0.029} \log X_1$	$F = 0.15$ $\bar{R}^2 = -6.5$
(c) $\log Y_i^D = -1.55 - \underset{(-0.01)}{0.004} \log X_1$	$F = 0.00$ $\bar{R}^2 = -7.7$

TABLE 23b

Simple Regressions between Proportion of Manufactured Output Exported to the Developed Economies and their Skill Intensity, 1979

Regression Equations	Summary Statistics
(d) $Y_i^D = 0.49 - \underset{(-1.01)}{0.491} X_2$	$F = 1.03$ $\bar{R}^2 = 0.2$
(e) $Y_i^D = 0.03 - \underset{(-1.56)^{**}}{0.232} \log X_2$	$F = 2.43$ $\bar{R}^2 = 9.3$
(f) $\log Y_i^D = -2.36 - \underset{(-0.97)}{0.551} \log X_2$	$F = 0.93$ $\bar{R}^2 = -0.5$

TABLE 23c

Multiple Regressions between Proportion of Manufactured Output Exported to the Developed Economies and their Capital and Skill Intensity, 1979

Regression Equations	Summary Statistics
(g) $Y_i^D = 0.51 - \underset{(-0.54)}{0.000}\, X_1 - \underset{(-0.60)}{0.342}\, X_2$	$F = 0.63$ $\bar{R}^2 = -5.6$
(h) $Y_i^D = -0.11 - \underset{(-0.11)}{0.008} \log X_1 - \underset{(-1.45)}{0.229} \log X_2$	$F = 1.13$ $\bar{R}^2 = 1.8$
(i) $\log Y_i^D = -2.83 + \underset{(0.17)}{0.049} \log X_1 - \underset{(-0.94)}{0.571} \log X_2$	$F = 0.45$ $\bar{R}^2 = -8.6$

Note: Y_i^D = Ratio of exports to output of Singapore in relation to developed economies;

X_1 = Non-wage value-added per employee;

X_2 = Skill Index;

** - significant at the 90 percent level of confidence together is somewhat higher than when they are used in isolation. The coefficient of determination, $\bar{R}^2$ (corrected for the degree of freedom) has a higher value in each form of the multiple regression equation comparedto that of its counterpart in the simple regression equation. These two independent variables can together explain up to 39 percent of the variation of the dependent variable. They also possess the expected positive signs. It thus appearsthat Singapore's comparative advantage vis-a-vis the "developing" economies lies in capital intensive and skill intensive industries.

Singapore's Manufactured Exports to the Developed Countries

The results for the developed economies are presented in Tables 23a, b and c. All the regression coefficients are negative in sign. This is also keeping in line with what one would expect on theoretical grounds since Singapore's comparative advantage vis-a-vis the "developed" economies must be in industries which are relatively less capital intensive and skill intensive. The results are not very encouraging since most of the coefficients are not statistically significant. They however do indicate that skill intensity is a more important variable than capital intensity in explaining Singapore's comparative advantage. The magnitude of the skill intensity variable is larger than the capital intensity variable for all forms of the equation and is statistically significant for the semi-logarithmic version. In the multiple regression equations, the capital and skill intensity coefficients have maintained their negative signs. Their coefficients are however not statistically significant.

In conclusion, it must be remembered that the results of the empirical exercise involving regressions need to be interpreted with caution. On the statistical side, the possibility of multicollinearity between the independent variables, heteroscedasticity in error and non-linearity in the relationship between the dependent and the independent variables can individually or together make the results unreliable. Similarly, on the economic theoretic side, misspecification of the functional relationships and/or leaving out of the model other relevant factors can, amongst other things, make the results less useful for policy making purposes. These results are therefore best treated as indicative.

CHAPTER 5

An Empirical Investigation of Singapore's Intra-Industry Trade

This chapter seeks to examine the nature and extent of the observed similarity in trade structures between Japan and Singapore and also their intra-industry trade in manufactures which is of increasing significance. Various measures are used to quantify the degree of intra-industry trade. The theoretical properties of these measures are discussed. This chapter also attempts to investigate the various determinants of intra-industry trade.

SIMILARITY IN TRADE STRUCTURES

Trade tends to consist increasingly of the exchange of the same type of goods as the output structures of two countries become more similar. The major underlying force is the differentiation of products, production factors and tastes. Thus, an increase in the degree of similarity in the structures of national output and demand can stimulate the growth in intra-industry trade as countries tend to specialise in narrower product groups.

The first quantitative task that arises is to see how close or dissimilar are the trade structures of Japan and Singapore. The following section discusses the various measures of the degree of similarity in trade structures.

Methodology

In considering the similarity of one country's exports to and its imports from another country as a possible variable explaining the extent of bilateral trade, Linneman examined and rejected the

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1. Linneman, H., An Econometric Study of International Trade Flows, North Holland Publishing Company, 1966, pp.140-143.

correlation coefficient as a measure because it varied from -1 to +1. This is due to the difficulty of interpreting negative values within the context. He chose instead the closely related cosine measure. This measures the cosine of the angle between the vectors of exports of commodities and imports of commodities in multicommodity space, that is,

$$\text{Cosine } X_i X_j = (\sum_n x_{in} x_{jn})(\sum_n x_{in}^2 \sum_n x_{jn}^2)^{-\frac{1}{2}}$$

where X_i and X_j represent the respective export or import vectors of the two countries i and j in a given period; x_{in} and x_{jn} refer to exports or imports of an individual product (or product group) n. The cosine coefficient has the desirable property that its values lie between 0 and 1. A value of 0 indicates complete dissimilarity of the two structures and 1 indicates complete similarity.

The Spearman rank correlation coefficient is also used in this study. Its coefficient is given by

$$R = 1 - \frac{6 \sum_i d_i^2}{n^2 (n-1)}$$

where d_i is the difference in rank orderings for country i; and n is the number of products or product groups. When two or more observations are tied, they are assigned an average of the relevant ranks.

The values of these two coefficients of similarity depend a great deal on the degree of disaggregation; the greater it is, the less similar will the structures tend to be.

Industrial Coverage

A number of different classifications of an industry have been used. In Verdoorn's (1960) study, 121 "more or less homogeneous products" were used (equivalent to 3-digit trade classification). Balassa's study used a combination of 3- or 4-digit SITC classification. In Grubel's (1967) study, 3-digit SITC classification was used. In Lloyd's (1972) study, Australian intra-industry trade was calculated at the 1,2,3,5 and 7-digit levels of the SITC. The further studies by Grubel and Lloyd (1972), and Willmore (1972) have concentrated on three-digit SITC.

For the purpose of this study, each statistical classification is regarded as an "industry". The following 4 SITC sections are selected to represent manufactures:-

SITC 5: Chemicals
6: Basic Manufactures
7: Machinery and Transport Equipment
8: Miscellaneous Manufactured Articles

The limitation of this study specifically to manufactures was made for a number of reasons:

(1) A majority of studies dealing with intra-industry trade have been limited to manufactures and consequently, a greater degree of comparison in the methodology and results was made possible;

(2) The growth of trade has tended to be greater in the area of manufactures both for developing and developed economies. This is particularly so for Japan and Singapore for both are industrialized countries;

(3) Trade involving the exchange of primary products for manufactured goods is conceptually simpler to explain in terms of comparative advantage and factor proportions theory. However, trade in manufactures only can no longer be explained simply in terms of these two theories of trade;

(4) The role of product differentiation and of tastes in the determination of trade patterns is more noticeable in respect of manufactured goods.

The analysis here has been confined to 3-digit and 4-digit classification of SITC 5-8 to avoid the objection that the heterogenity of the goods grouped in one class is too great. A list of 33 industrial products representing a large proportion of trade between Japan and Singapore was selected and categorised in concordance with the standard industrial trade classification (see Appendix Table 5).

Presentation of Findings

Tables 24a and 24b provide information on the similarity in trade structures of the two countries at the one-digit SITC level (10 branches),

TABLE 24a

Indicators of Similarity between the Structures of Total Exports of Singapore and Japan, 1979

Coefficient / Level of Disaggregation	Cosine	Spearman Rank Correlation
1 - Digit	0.172	0.56*
2 - Digit	0.267	0.61*
3 - Digit	0.15	0.42*
4 - Digit	0.18	0.41*

TABLE 24b

Indicators of Similarity between the Structures of Total Imports of Singapore and Japan, 1979

Coefficient / Level of Disaggregation	Cosine	Spearman Rank Correlation
1 - Digit	0.77	0.81*
2 - Digit	0.85	0.49*
3 - Digit	0.74	0.37*
4 - Digit	0.05	0.32*

Source: Commodity Trade Statistics, United Nations, 1979

Note: * - significant at 0.05 level for a one-tailed t-test

2-digit SITC level (68 product groups), 3-digit SITC level (237 sub-groups) and 4-digit SITC level (765 items).

The coefficients are high at the 10-branch level with both coefficients exceeding 0.5. There is therefore some evidence that both countries are similar in their export and import structures. However, the coefficients decrease in value as the level of disaggregation increases. This suggests that there is a tendency for narrow product specialisation to take place especially at the 4-digit level of classification. Tables 25a and 25b present detailed findings of the similarity of trade structures in manufactures for individual product groups. The cosine coefficient is higher for total manufactures (0.38) as compared to the cosine coefficient for overall trade (0.18) at the 4-digit level of classification. Similarly, the Spearman rank correlation coefficients are also higher for trade in manufactures as compared to coefficients for overall trade. This suggests that a large proportion of intra-industry trade occurs in manufactures. The two coefficients however do not record the percentages or absolute values of intra-industry trade.

SIMILARITY IN THE COMPOSITION OF EXPORTS AND IMPORTS

Methodology

The index of dissimilarity of exports and imports as advocated by Michaely[2] divided all goods into five classes:- (a) food, beverages and tobacco (sections 0 and 1 of the SITC): (b) raw materials (SITC 2); (c) fuels (SITC 3); (d) chemicals and oils (SITC 4 and 5); and (e) manufactured goods (SITC 6, 7 and 8). It assumes that, within each class, all goods are perfectly "similar" so that their prices tend to move in harmony while all other commodities are "dissimilar" to those within the class. The index of dissimilarity is defined as

$$D_j = \sum_{i=1}^{5} \left| \frac{X_{ij}}{\sum_i X_{ij}} - \frac{M_{ij}}{\sum_i M_{ij}} \right|$$

where X_{ij} = country j's exports of good i;
M_{ij} = country j's imports of good i.

2. Michaely, M., Concentration in International Trade, North Holland Publishing Company, 1962, pp.88.

TABLE 25a

Indicators of Similarity between the Structures of Total Exports of Japan and Singapore in Manufactures (at 4-digit level), 1979

SITC Groups \ Coefficient	Cosine	Spearman Rank Correlation
5: Chemicals	0.46	0.39*
6: Basic Manufactures	0.31	0.48*
7: Transport Equipment and Machinery	0.37	0.67*
8: Miscellaneous Manufactures	0.60	0.38*
5-8: Total Manufactures	0.38	0.51*

TABLE 25b

Indicators of Similarity between the Structures of Total Imports of Japan and Singapore in Manufactures (at 4-digit level), 1979

SITC Groups \ Coefficient	Cosine	Spearman Rank Correlation
5: Chemicals	0.60	0.36*
6: Basic Manufactures	0.25	0.34*
7: Transport Equipment and Machinery	0.62	0.55*
8: Miscellaneous Manufactures	0.66	0.55*
5-8: Total Manufactures	0.38	0.42*

Source: Commodity Trade Statistics, United Nations, 1979

Note: * - significant at 0.05 level for a one-tailed t-test

The larger the value of this index, the less similar is the commodity composition of the country's exports and imports. The lowest possible value of the index is zero if a country exports each of the goods in exactly the same proportion of its total exports as the imports of this class are of the country's total imports. This is the case of perfect similarity. The upper limit of the index is 2 where no class of goods exist which is both exported and imported by the country.

In calculating the index, the absolute values of the five differences are summed up disregarding the signs. Otherwise, the summation would become

$$\sum_i \left(\frac{X_{ij}}{\sum_i X_{ij}} - \frac{M_{ij}}{\sum_i M_{ij}} \right) = \frac{\sum_i X_{ij}}{\sum_i X_{ij}} - \frac{\sum_i M_{ij}}{\sum_i M_{ij}} = 0$$

The device which is used frequently to overcome this problem of "signs" is to take the squares of the values involved,

$$\sum_i \left(\frac{X_{ij}}{\sum_i X_{ij}} - \frac{M_{ij}}{\sum_i M_{ij}} \right)^2$$

This definition is not very satisfactory as it yields an index which describes not just the dissimilarity in the commodity composition of exports and imports. It also describes the degree of their commodity concentration.[3]

Michaely's index of dissimilarity expressed in absolute values thus helps to overcome the problem of "signs". However, it is a rough and admittedly arbitrary index. No explanations were provided as to why only five classes of goods were chosen. The index does not take into account commodities which may be highly dissimilar and differentiated within each class of goods.

The index used in this study does not limit itself to five classes of goods. This study utilizes the generalised version of the Michaely's index,

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3. See Michaely, M., op.cit., footnote 16, pp.89.

$$D_j = \frac{1}{2}\sum_{i=1}^{n}\left|\frac{X_{ij}}{\sum_i X_{ij}} - \frac{M_{ij}}{\sum_i M_{ij}}\right|$$

where n = number of classes of goods. The values of the index range from zero (complete similarity) to 1 (complete dissimilarity).

Presentation of Findings

Global Trade

The indexes of dissimilarity for Japan's and Singapore's global trade are presented in Tables 26a and 26b at different levels of disaggregation.

Singapore's trade with the rest of the world comprises of trade in highly similar goods even at the 3-digit level of disaggregation. The exports of Singapore include both manufactures (54%) and primary products (46%) while her imports also consist of a mixed diet of manufactures (57%) and primary goods (43%).

Japan's indexes of dissimilarity are much higher than Singapore's indexes for trade with the rest of the world even at the 1-digit level of classification. As a developed industrialized country, Japan exports mainly manufactured goods (97%) while 87 percent of her imports consist of primary products such as foodstuffs. Growth was particularly rapid in the food-product categories as characterized by a high income elasticity of demand for livestock products, fish, fruit, feedgrains and soybeans. Among all primary products, those of fuels were expanding most rapidly. Four-fifths of fuel imports consist of petroleum and petroleum products and their growth reflected a rapid shift in the composition of Japan's energy consumption.

For both countries, the indexes increase as the levels of disaggregation increase. This indicates that both countries tend to engage in narrow product specialization in their trade with the rest of the world especially at the 4-digitlevel.

TABLE 26a

Dissimilarity Indexes of Global Trade, 1979

Level of Disaggregation \ Country	Japan	Singapore
1 - Digit	0.722	0.135
2 - Digit	0.781	0.229
3 - Digit	0.812	0.469
4 - Digit	0.832	0.521

TABLE 26b

Dissimilarity Indexes of Global Trade in Manufactures, 1979

SITC Groups \ Level of Disaggregation / Country	3 - Digit		4 - Digit	
	Singapore	Japan	Singapore	Japan
5: Chemicals	0.248	0.333	0.393	0.411
6: Basic Manufactures	0.318	0.671	0.381	0.760
7: Transport Equipment & Machinery	0.278	0.452	0.381	0.521
8: Miscellaneous Manufactures	0.336	0.471	0.414	0.530
5-8: Total Manufactures	0.311	0.591	0.386	0.644

Source: Commodity Trade Statistics, United Nations, 1979

Bilateral Trade

It is postulated that trade between Japan and Singapore would comprise mainly of manufactures since the two countries are not very dissimilar in their degrees of industrialization. The indexes of dissimilarity as presented in Table 27a reveal that trade between the two countries comprises of highly dissimilar goods even at the 1-digit level. It is interesting to note that a major factor to which the dissimilarity between exports and imports may be attributed is the trade in oil. Singapore's exports of fuels to Japan comprise 45% of its total exports to Japan while imports of fuels from Japan comprise only 0.18% of total imports. This creates an upward bias in the results presented.

This bias is removed by focussing on the manufactured products (SITC 5-8) since intra-industry trade is found to exist in these industries. The indexes of dissimilarity are low at the 1-digit and 2-digit level supporting the contention that the two countries trade in similar manufactured goods. However, at the 4-digit level of disaggregation, the composition of exports and imports between the two countries may be quite dissimilar particularly for trade in chemicals (SITC 5) and basic manufactures (SITC 6). This indicates that little intra-industry trade takes place within these two categories.

The composition of exports and imports is quite similar for trade in SITC 7 (transport equipment and machinery) and SITC 8 (miscellaneous manufactures) even at the 3-digit level ($D_j < 0.5$). Products with low indexes of dissimilarity include the following:-

SITC Code	Industry
751-759	Electrical machinery & apparatus
761-762	Radio, television sets, communication equipment and apparatus
784	Parts & accessories of motor vehicles
793	Ships, boats and tankers
831	Leather and leather products
881-884	Photographic and optical goods
894	Toys
897	Jewellery and related articles

TABLE 27a

Dissimilarity Indexes of Mutual Trade between Japan and Singapore, 1979

SITC Groups \ Level of Disaggregation	1-Digit	2-Digit	3-Digit	4-Digit
0-9: Total Trade	0.774	0.834	0.856	0.893
5-8: Total Manufactures	0.278	0.445	0.632	0.736

TABLE 27b

Dissimilarity Indexes of Mutual Trade between Japan and Singapore in Manufactures, 1979

SITC Groups \ Level of Disaggregation	3 - Digit	4 - Digit
5: Chemicals	0.843	0.886
6: Basic Manufactures	0.844	0.888
7: Transport Equipment and Machinery	0.459	0.638
8: Miscellaneous Manufactures	0.468	0.667
5-8: Total Manufactures	0.632	0.736

Source: Commodity Trade Statistics, United Nations, 1979

These products tend to exhibit a high value of intra-industry trade as postulated since the dissimilarity index (D_j) and intra-industry measure (Q_j) is inversely related as given by

$$Q_j = (1 - D_j) .100$$

The empirical evidence of the inverse relation by industry is tabulated in the next section (see Table 30).

EMPIRICAL EVIDENCE OF INTRA-INDUSTRY TRADE

Measures of Intra-Industry Trade

Intra-industry trade is defined as that part of trade that takes place within the same industry. A simple example will illustrate this point. Let us suppose that country A imports \$200 million worth of goods and exports \$200 million worth of goods. We further assume that there are three industries operating as follows:

	Imports (\$m)	Exports (\$m)
Industry a	100	100
Industry b	0	40
Industry c	100	60

It is clear that for industry a, imports are equally "matched" by exports, that is, intra-industry trade is 100%. Industry b depicts a case of inter-industry trade with imports equal to zero. Finally, industry c characterizes a situation in which a certain amount of trade comprises of intra-industry trade.

Algebraically, the measure of intra-industry trade may be expressed as follows:

$$R_i = (X_i + M_i) - \left|X_i - M_i\right|$$

where X_i and M_i are the values of exports and imports in industry i. Let $S = \left|X_i - M_i\right|$ equals inter-industry trade. Total trade,

$$\begin{aligned} T_i &= R_i + S_i \\ &= (X_i + M_i) - \left|X_i - M_i\right| + \left|X_i - M_i\right| \\ &= (X_i + M_i) \end{aligned}$$

It is useful to express all intra-industry trade as a percentage of total trade thus enabling comparison of the extent of intra-industry trade between industries and between countries when international trade is not in balance. The resulting measure as devised by Grubel and Lloyd is as follows:

$$B_i = \frac{(X_i + M_i) - |X_i - M_i|}{(X_i + M_i)} .100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

The values of B_i range from 0 to 100. When exports are exactly equal to imports of an industry, the measure of intra-industry trade, B_i, is 100. When there are exports but no imports or vice versa, the measure has a value of zero.

Aggregating all industries gives the weighted measure,

$$B_j = \frac{\sum_i B_i (X_{ij} + M_{ij})}{\sum_i (X_{ij} + M_{ij})} .100$$

$$= \frac{\sum_i (X_{ij} + M_{ij}) - \sum_i |X_{ij} - M_{ij}|}{\sum_i (X_{ij} + M_{ij})} .100 \quad \ldots\ldots\ldots\ldots (2)$$

The Problem of Overall Trade Imbalance

The unadjusted measure of intra-industry trade, B_j, is a downward biased measure of intra-industry trade if a country's total trade is imbalanced. With an imbalance between exports and imports, the weighted mean, B_j, must be less than 100 no matter what the pattern of exports and imports because exports cannot match imports in every industry. This is an undesirable feature of a measure of average intra-industry trade which is due to the fact that it captures both the trade imbalance and the strength of intra-industry trade. To overcome this problem, an adjusted measure is used which is given by

$$C_j = \frac{\sum_i (X_{ij} + M_{ij}) - \sum_i |X_{ij} - M_{ij}|}{\sum_i (X_{ij} + M_{ij}) - \left|\sum_i X_{ij} - \sum_i M_{ij}\right|} .100 \quad \ldots\ldots\ldots\ldots (3)$$

Aquino[4] argued that this method is unsatisfactory because it fails to detect (and to correct for) the bias where it first appears at the single commodity level. In addition, the country-summary measure, C_j, can be altogether unreliable. This is because $\sum_i |X_{ij} - M_{ij}|$ for any set of commodities for which $X_{ij} \leq M_{ij}$ or $X_{ij} \geq M_{ij}$ for all i is consequently equal to $|\sum_i X_{ij} - \sum_i M_{ij}|$ whatever the values of X_{ij} and M_{ij}. This means that when the set of trade flows under investigation is characterized by a substantial overall trade imbalance; if the bias is not corrected at the single-commodity level, the country-summary indexes give an identical measure of the relevance of intra-industry trade for situations which, even at a glance, appear to be substantially different.[5]

Aquino then proposed a method of adjustment for overall trade imbalance which appears to be capable of overcoming these difficulties. This requires an estimate of what the values of exports and imports of each country would have been if total exports had been equal to total imports. Denoting with a superscript "e", these theoretical values of exports and imports can be obtained as follows:

$$X^e_{ij} = \frac{X_{ij} \frac{1}{2} \sum_i (X_{ij} + M_{ij})}{\sum_i X_{ij}} \; ; \; M^e_{ij} = \frac{M_{ij} \frac{1}{2} \sum_i (X_{ij} + M_{ij})}{\sum_i M_{ij}} \qquad \text{.................................. (4)}$$

It can be easily verified that $\sum_i X^e_{ij} = \sum_i M^e_{ij} = \frac{1}{2} \sum_i (X_{ij} + M_{ij})$. The corrected summary measure of proportion of intra-industry trade in j's total trade is

$$Q_j = \frac{\sum_i (X_{ij} + M_{ij}) - \sum_i |X^e_{ij} - M^e_{ij}|}{\sum_i (X_{ij} + M_{ij})} . 100 \qquad \text{............. (5)}$$

since $\sum_i (X^e_{ij} + M^e_{ij}) = \sum_i (X_{ij} + M_{ij})$. This summary measure, Q_j, is

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4. Aquino, A., "Intra-Industry Trade as Concurrent Sources of International Trade in Manufactures", Weltwirtschaftliches Archiv, Vol. 114, 1978, pp.280.

5. For an example, see Aquino, A., op.cit., pp.281.

equivalent to F_j which is derived by Grubel and Lloyd[6] from Michaely (1962) and defined as follows:

$$F_j = 1 - \tfrac{1}{2} \sum_i \left| \frac{X_{ij}}{\sum_i X_{ij}} - \frac{M_{ij}}{\sum_i M_{ij}} \right| .100 \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots (6)$$

Contrary to Grubel's and Lloyd's belief, F_j is immune from the shortcomings common to B_j and C_j. One can also simply show that $F_j = (1 - D_j)\ .100$. There is therefore an inverse relationship between the dissimilarity index and the intra-industry trade measure, Q_j.

Empirical Performance of Different Indices of Intra-Industry Trade

In this section is presented an assessment of the magnitudes of the difference between B_j, C_j and Q_j with reference to total trade and particularly, trade in manufactures between Japan and Singapore in 1979.

In the first three columns of each Table are given in order, the values of B_j, C_j and Q_j. Column 4 gives the percentage differences between Q_j and B_j and column 5, the percentage differences between Q_j and C_j.

The values in column 4 of Tables 28 and 29 show that B_j is in most cases a substantially downward biased measure of intra-industry trade. As expected, the size of the bias is particularly high for countries with a large imbalance in total trade of manufactures such as Japan. The values of C_j tabulated in column 5 also indicate that C_j is an upward biased measure of intra-industry trade. Again, the size of the bias was found to be higher for Japan than for Singapore in total manufactures (see Table 28b).

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6. See Grubel and Lloyd, Intra-Industry Trade: The Theory and Measurement of International Trade in Differentiated Products, London, 1975, pp.27. The equivalence of Q_j and F_j can be easily shown by substituting (4) into (5).

TABLE 28a

Global Intra-Industry Trade: Total Trade, 1979

Level of Disaggregation \ Measure	Singapore B_j (1)	Singapore C_j (2)	Singapore Q_j (3)	Singapore $\frac{Q_j - B_j}{B_j}\%$ (4)	Singapore $\frac{Q_j - C_j}{C_j}\%$ (5)	Japan B_j (1)	Japan C_j (2)	Japan Q_j (3)	Japan $\frac{Q_j - B_j}{B_j}\%$ (4)	Japan $\frac{Q_j - C_j}{C_j}\%$ (5)
1 - Digit	80.8	90.4	86.5	7	-4	28.5	29.6	28.7	1	-3
2 - Digit	74.2	82.8	77.1	4	-7	22.5	24.4	23.9	6	-2
3 - Digit	53.4	59.8	53.7	1	-10	20.3	21.2	20.8	3	-2
4 - Digit	47.7	53.2	47.9	0	-10	21.2	23.9	21.8	3	-9

TABLE 28b

Global Intra-Industry Trade: Individual Industries in Manufactures at 4-Digit Level, 1979

Measure / Level of Disaggregation	Singapore B_j (1)	Singapore C_j (2)	Singapore Q_j (3)	Singapore $\frac{Q_j - B_j}{B_j}\%$ (4)	Singapore $\frac{Q_j - C_j}{C_j}\%$ (5)	Japan B_j (1)	Japan C_j (2)	Japan Q_j (3)	Japan $\frac{Q_j - B_j}{B_j}\%$ (4)	Japan $\frac{Q_j - C_j}{C_j}\%$ (5)
5: Chemicals	59.1	86.9	75.2	27	-13	58.5	65.1	59.3	1	-9
6: Basic Manufactures	50.9	76.2	65.9	29	-14	19.1	35.1	32.8	72	-7
7: Transport Equipment	57.7	68.3	62.3	8	-9	20.0	82.1	54.8	174	-33
8: Miscellaneous Manufactures	58.6	59.5	54.3	-7	-9	43.9	56.3	52.9	21	-6
5-8: Total Manufactures	56.3	69.8	59.2	5	-15	26.4	56.9	40.9	55	-28

Source: Commodity Trade Statistics, United Nations, 1979

Global Intra-Industry Trade

Judging from the values of Q_j in column 3 of Table 28a, intra-industry trade as a proportion of total trade in Singapore is absolutely higher than the percentage of intra-industry trade in Japan at all levels of disaggregation. One can therefore conclude that the major part of Japan's global trade consists of inter-industry trade since Q_j is less than 50 percent. In fact, Japanese exports comprise mainly of manufactured goods while its imports comprise mainly of fuels, petroleum and other primary products.

Intra-industry trade as a percentage of total trade in manufactures is higher than intra-industry trade in all commodities for both Japan and Singapore (see Table 28b). This percentage of 40.9 is however low for Japan in comparison with other leading industrial countries. For most of the leading industrial countries, this percentage was greater than 70 percent.[7] One would therefore expect intra-industry trade between Japan and Singapore to be low even though both the countries are industrialized.

Bilateral Intra-Industry Trade

Tables 29a and 29b present information on the bilateral relations between Japan and Singapore. Intra-industry trade is low (less than 50 percent) for total trade between Japan and Singapore. For trade in manufactures the percentages are higher, particularly for transport equipment (SITC 7) and miscellaneous manufactures (SITC 8).

A similar kind of analysis by industry is presented in Table 30. The values of B_i, C_i and Q_i have been calculated similarly to B_j, C_j and Q_j. The differences between Q_i and B_i, and Q_i and C_i turned out to be greater than the analysis by country. As for the values of intra-industry trade when measured by Q_i, it accounted for more than 50 percent of total trade in 16 manufactured industries in 1979. They include the following:-

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7. The values of Q_j for some of the leading industrialized countries are: United Kingdom 81.9, Canada 73.5 and Belgium 70.1. For further details, see Aquino, op.cit., Table 1, pp.84 and 85.

TABLE 29a

Bilateral Intra-Industry Trade: Total Trade, 1979

Measure / Level of Disaggregation	B_j (1)	C_j (2)	Q_j (3)	$\frac{Q_j - B_j}{B_j}\%$ (4)	$\frac{Q_j - C_j}{C_j}\%$ (5)
1 - Digit	17.4	25.8	22.1	27	-14
2 - Digit	12.6	18.7	16.5	31	-12
3 - Digit	10.9	16.6	14.3	31	-14
4 - Digit	9.5	14.0	10.7	13	-24

TABLE 29b

Bilateral Intra-Industry Trade: Individual Industries in Manufactures at 3-Digit and 4-Digit Level

	3 - Digit			4 - Digit		
Measure / SITC Groups	B_j	C_j	Q_j	B_j	C_j	Q_j
5: Chemicals	10.8	18.9	15.3	7.8	13.8	11.4
6: Basic Manufactures	3.8	57.6	15.6	3.5	56.1	11.2
7: Transport Equipment	14.1	98.3	50.2	14.5	98.2	51.1
8: Miscellaneous Manufactures	32.8	90.3	53.2	22.1	61.3	33.3
5-8: Total Manufactures	12.6	71.9	36.7	11.3	65.2	24.3

Source: Commodity Trade Statistics, United Nations, 1979

TABLE 30

Different Measures of Intra-Industry Trade in Manufactures by Industry, 1979

Industry	Intra-Industry Trade					D_i
	B_i	C_i	Q_i	$\frac{Q_i-B_i}{B_i}\%$	$\frac{Q_i-C_i}{C_i}\%$	
1. Spinning, Weaving and Finishing of Textile	10.9	52.9	12.9	13	-76	0.87
2. Socks, Singlets and other Knitted Wear	9.2	100.0	45.1	390	-55	0.55
3. Other Outer Garments	38.4	48.2	35.3	-8	-27	0.65
4. Wearing Apparel, except Footwear	46.3	51.7	41.9	-9	-19	0.58
5. Leather and Leather products	34.1	100.0	72.0	111	-28	0.28
6. Printing, Publishing and Allied Industries	24.3	100.0	43.5	79	-57	0.57
7. Paints, Varnishes and Lacquers	9.5	100.0	63.8	572	-36	0.36
8. Medicinal and Pharmaceutical Products	20.1	36.0	29.4	46	-18	0.71
9. Perfumes, Cosmetics and other Toilet Preparations	50.8	69.6	69.6	37	0	0.30
10. Other Rubber Products, except Footwear, nec	7.5	100.0	86.9	1059	-13	0.13
11. Other Plastic Products	4.7	100.0	82.4	1653	-18	0.18
12. Glass and Glass Products	18.5	100.0	20.5	11.0	-80	0.79
13. Non-Ferrous Metal Basic Industries	0.0	0.0	0.0	0.0	0	1.00
14. Iron and Steel	0.6	100.0	4.0	567	-96	0.96

TABLE 30 - continued

Industry	B_i	C_i	Q_i	$\frac{Q_i - B_i}{B_i}\%$	$\frac{Q_i - C_i}{C_i}\%$	D_i
15. Non-Metallic Mineral Products	9.9	100.0	61.7	523	-38	0.38
16. Cutlery, Hand and Edge Tools	16.0	100.0	57.5	259	-43	0.43
17. Structural Metal Products, nec	1.5	100.0	6.7	347	-93	0.93
18. Wire Netting, Wire and Cable Products	5.9	100.0	91.4	1449	-9	0.08
19. Tin Cans, Zinc and Tin-Plate Articles, nec	1.5	100.0	1.4	-7	-99	0.99
20. Industrial and Agricultural Machinery	7.1	97.3	27.8	292	-71	0.72
21. Machinery and Equipment, nec	29.1	100.0	49.1	69	-51	0.51
22. Electrical Industrial Machinery & Apparatus	18.7	100.0	66.5	256	-34	0.34
23. Radios, Television Sets, Communication Equipment	18.2	100.0	68.2	275	-32	0.32
24. Other Electrical Equipment and Supplies, nec	24.1	100.0	41.9	74	-58	0.58
25. Ships, Boats and Tankers	4.5	100.0	60.9	1253	-39	0.39
26. Motor Vehicles	0.2	100.0	50.8	25300	-49	0.49
27. Parts and Accessories, nes of Motor Vehicles	1.3	100.0	99.5	7554	-1	0.01
28. Other Transport Equipment, nec	32.5	88.3	27.0	-17	-69	0.73
29. Professional, Scientific Apparatus, Clocks	30.5	56.4	39.0	28	-31	0.61
30. Photographic and Optical Goods	22.5	100.0	56.7	152	-43	0.43
31. Jewellery and Related Articles, nec	49.7	81.1	81.1	63	0	0.19
32. Toys	2.4	100.0	62.9	2521	-37	0.37
33. Other Miscellaneous Articles, nec	7.0	80.8	31.4	348	-61	0.69

SITC 5

1. Paints, varnishes and lacquers*
2. Perfumes, cosmetics and other toilet preparations*

SITC 6

3. Other rubber products except footwear, nec*
4. Non-metallic mineral products*
5. Cutlery, hand and edge tools*
6. Wire netting, wire and cable products*

SITC 7

7. Electrical industrial machinery and apparatus
8. Radios, television sets, communication equipment and apparatus
9. Ships, boats and tankers*
10. Motor vehicles*
11. Parts and accessories, nes of motor vehicles

SITC 8

12. Other plastic products
13. Leather and leather products*
14. Photographic and optical goods
15. Jewellery and related articles, nec*
16. Toys*

Out of these 16 industries with high values of intra-industry trade, 10 belong to SITC 7 and 8. The indexes of dissimilarity, D_i, for these industries are also low as reported in Table 30. The inverse relationship between D_i and Q_i is thus confirmed. In addition, it is interesting to note that the majority of these 16 industries are producing "Hecksher-Ohlin goods" (denoted by *) following the classification of Hufbauer and Chilas.[8]

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8. Hufbauer, G.C., & Chilas, J.G., "Specialization by Industrial Countries: Extent and Consequences", in Giersch, H., (ed.) The International Division of Labour: Problems and Perspectives International Symposium, Tubingen, 1974, pp.36-38.

The above analysis reveals that intra-industry trade is not very significant between Japan and Singapore. However, a significant amount of such trade is found to take place in certain manufacturing industries especially in industries producing the "Hecksher-Ohlin goods". Does the factor proportions theory explain intra-industry trade in manufactures? If not, are there any other possible explanations for such trade in similar goods within an industry?

The following section seeks to establish the relationship, if any, between differences in factor intensity and the extent of intra-industry trade. It will further examine other determinants of trade such as scale economies and product differentiation, and their relevance to intra-industry trade.

CAPITAL-LABOUR INTENSITY, SKILL INTENSITY AND INTRA-INDUSTRY TRADE

The Model

In this study, it is assumed that there is no reversal of factor intensity and, therefore, ranking of industries by factor intensity will be similar between Japan and Singapore. In fact, H.B. Lary had established that countries do show a strong similarity in the pattern of value-added per employee in different industries.[9] It is therefore sufficient to use Singapore's data in the ranking of Japanese industries by factor intensity.

The basic point of departure in this study is the three-input neo-Hecksher-Ohlin model in which intra-industry trade is related to factor services derived from its physical capital, unskilled labour and human capital. Our model can be written symbolically as

$$\log IIT_i = f(K/L_i, H_i), \; i=1, 2, \ldots\ldots\ldots\ldots, 32$$

where IIT_i = intra-industry trade of industry i;

K/L_i = capital-labour intensity of industry i;

H_i = human capital intensity of industry i.

9. Lary, H.B., op.cit., chapter 3.

Data is available for a cross-sectional study of these variables for 1979. The proxy for capital-labour intensity is non-wage value-added per employee. Human capital is approximated by a dummy variable showing the difference between the ith industry wage and the average wage in all industries. Data on skill intensity by industry is not available at such a detailed level of classification.

The regression that is being used is simply

$$\log IIT = a_0 + a_1 S + a_2 NW$$

where S = dummy variable for skill intensity with 1 assigned to skilled labour and 0 assigned to unskilled labour;

NW = non-wage value-added

Presentation of Findings

Table 31 presents the regression results, starting with a simple regression, before looking at our general form. In regression equation (a), intra-industry trade is simply regressed on human capital. The coefficient for skill intensity is positive and significant at the 90 percent level of confidence. This would seem to suggest that intra-industry trade and skill intensity are positively correlated. Products within a sub-class may differ in their skill requirements in comparison with another sub-class although factor intensities tend to be similar within the same industry. Thus a country may have comparative cost advantages for the products of a sub-class which results from relative differences in the quality of labour and exports these products. Similarly, a country may have a comparative cost disadvantage in the case of another sub-class of products and imports these products.

Non-wage value-added performed very poorly as the only explanatory variable in equation (b). The coefficient for capital intensity is statistically insignificant with poor explanatory power of $\bar{R}^2 = -3.0$. The explanatory power of capital intensity is increased if skill intensity is included in the regression. This is depicted by multiple regression (c). It is evident that capital intensity and skill intensity are highly correlated. The linear correlation coefficient for these two industries is 0.83 and their rank correlation coefficient is 0.64.

TABLE 31

Influence of Capital-Labour Intensity and Skill Intensity on Intra-Industry Trade

Regression Equations	Summary Statistics
(a) log IIT = 3.86 + 0.398 S (1.28)**	F = 1.25 $\overline{R}^2$ = 1.4
(b) log IIT = 3.71 -0.000 NW (-0.30)	F = 0.09 $\overline{R}^2$ = -3.0
(c) log IIT = 3.81 + 0.445 S + 0.000 NW (1.17) (0.27)	F = 0.73 $\overline{R}^2$ = 1.8

Source: i) Table 30

ii) Report on the Census of Industrial Production, 1979, Table 39.

Note: ** - significant at the 90 percent level of confidence

Overall, the results are very disappointing. The F statistic and $\overline{R}$ squared values given in the table are very low. Similar results were also obtained by J.A. Finger and De Rosa in their regressions of measured trade overlap on U.S. industry characteristics and total trade volume at the three-digit SITC level.[10]

According to H. Hesse, "The orthodox factor proportions theorem could give an explanation of the intra-industry trade if the demand did not consider all goods grouped in one class as substitutes and if production differed significantly with respect to factor intensity."[11]

10. Finger, J.M., & Dean A. De Rosa, "Trade Overlap, Comparative Advantage and Protection", in Giersch, H., (ed.). On the Economics of Intra-Industry Trade, International Symposium, 1978, Tubingen, 1979, pp.221.

11. Hesse, H., "Hypotheses for the Explanation of Trade between Industrial Countries, 1953-1970", in Giersch, H., (ed.). The International Division of Labour: Problems and Perspectives, International Symposium, Tubingen, 1974, pp.47.

This condition is only fulfilled if commodities are highly aggregated for instance at the one-digit and two-digit SITC level. One would expect countries relatively well endowed with capital to export relatively capital intensive goods and vice versa within the same industry. Intra-industry trade can therefore be explained to a certain extent by this theorem.

The explanatory power of this theorem is proven to be low as revealed by regression (b). One possible explanation is that within narrowly defined sub-classes of goods at the three-digit or four digit SITC level, it can no longer be maintained that goods are strongly non-homogeneous in their factor intensity. This implies that large comparative cost differences can no longer exist between sub-classes of goods.

OTHER DETERMINANTS OF INTRA-INDUSTRY TRADE: PRODUCT DIFFERENTIATION AND ECONOMIES OF SCALE

Economies of scale play an important role in explaining trade patterns between countries. The argument maintains that countries with a large home market and therefore with the opportunity of producing on a large scale have comparatively high productivity and cost advantages in the case of certain manufactures and therefore export these goods. Product differentiation, in terms of differences in the technical characteristics or in the quality of individual products, enables manufacturers of different countries to realize an intensive division of labour within an industry and thus take advantage of economies of scale. This argument as advanced by Grubel and Lloyd (1975) seems fairly convincing.[12]

The objective of this section is to establish how much of the increase in trade volume of Singapore consists of trade in differentiated goods. In particular, this section also considers the question of whether

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12. A second and more fundamental reason Grubel offers is that patent and copyright laws prevent a company from producing and marketing a product that is identical to that of a rival firm.

Singapore's trade with Japan is more concentrated in differentiated as opposed to standardized products. Finally, the role of economies of scale in trade of differentiated goods is examined.

Measurement of Product Differentiation

There are very few measures that have been employed in the past to measure trade in differentiated goods. Typical measures such as the advertising to sales ratio are neither accessible nor particularly useful in the context of world markets since this type of differentiation cannot be expected to transcend national boundaries.

Hufbauer has constructed a measure of product differentiation defined as the coefficient of variation in U.S. export unit values for shipments of a product to various importing countries. The smaller the variation, the more standardized the product is likely to be. The larger the variation, presumably, the greater is the degree of differentiation. His product differentiation index is given by

$$PD = U_n / V_n$$

In this expression, U_n denotes the standard deviation of U.S. export values of shipments of product n to different countries; V_n denotes the unweighted mean of these unit values.

Hufbauer has admitted that his index is subject to certain shortcomings. It is possible, that cyclical market variations and discriminatory export practices will, to some unknown degree, distort the statistic as a measure of differentiation.

Product Differentiation and the Structure of Singapore's Trade

An examination of the trade statistics of Singapore even at a high level of disaggregation shows that, in most cases, quantities of given commodities are both exported and imported. More than often, the items exported and imported seem to be so closely related technically that the only sensible assumption is that such observed patterns of trade occur as a result of the exchange of differentiated varieties of the same product.

First, some consideration must be given to the concept of product differentiation. Goods may be differentiated based on quality and secondly, based on style, packaging and branding of the product even though they are perfect substitutes in production. This implies that some consumers will be better able to satisfy their requirements by importing from abroad rather than by purchasing domestically produced goods if production costs are the same. This will result in a two-way exchange of differentiated varieties of the same product.

If relative costs of production differ between the two countries, the scope for such an exchange will be limited. Trade will tend to follow closely the traditional comparative cost pattern. Exports of the country with relatively low costs will exceed its imports and vice versa for the high costs country. Some consumers in the low costs country may still prefer to import because of differences in the quality, style, and the branding of the product. Thus, two-way trade in differentiated varieties of the same product will continue but the extent to which such trade occurs will diminish as cost differences increase.

A dimension of this issue has been emphasized by Linder. It is argued that demand and production in rich countries will be biased in favour of high quality goods and that minority consumers who demand low quality goods will find their needs satisfied by importing from poorer countries. Thus, rich countries tend to export high quality goods and import low quality goods from poor countries. However, as rich and poor countries can be expected to have different resource endowments, there will be only a limited range of differentiated varieties of the same products. This gives rise to the following two hypotheses:

I. Small advanced countries having narrow national markets should specialize in high quality product variants. Such products have small markets in large countries in relation to the standard product variants;

II. Countries with similar income levels will tend to engage in the exchange of differentiated varieties of the same product.

These hypotheses will be considered by examining the unit values of manufactured goods traded between Singapore and Japan in 1979. Unit value is used here as a proxy for unit price which is also a simplified measure of product differentiation.

The unit values of exports to Japan for each commodity and their corresponding values for imports from Japan are presented in columns (1) and (2) of Table 32. The number of commodities for which calculations of unit values was possible numbered 23. In ten of them, the unit price of exports exceeds 1.00 and they include the following products:- perfume, soap, disinfectant, motor vehicles, fabrics of man-made fibres, and wire products, etc. This is inconsistent with the first hypothesis since a small advanced country like Singapore is expected to export mainly high quality products.

One can however dismiss this inconsistency since it is not very meaningful to measure product differentiation in absolute terms. A more meaningful approach is to divide the unit values of Singapore's exports to Japan by unit values of its imports from Japan. The results are presented in column (3) of Table 32. The findings show that 57 percent of the quotients are greater than one, indicating that the proportion of goods differentiated and traded between the two countries is roughly the same. This is consistent with Linder's hypothesis since standards of living in Singapore are roughly comparable with those in Japan.

Economies of Scale

Measurement, sources of data and qualifications

Empirical studies have shown that most manufacturing plants in industrialized countries are large enough to enjoy nearly all of the reductions in average costs of production that optimum plant size can yield. Recently, however, it has been apparent that substantial lowering of unit production costs results from increasing the length of runs in the production of commodities in a plant of a given size. Such economies of scale are neglected in this study since it is difficult to measure them empirically.

TABLE 32

Unit Values of Singapore's Exports To and Imports From Japan, 1979

SITC	(1)	(2)	(3)
513..Carbosylic Acids	0.83	0.76	1.09
551..Perfume, Essential Oils	9.77	6.36	1.54
554..Soap, Cleansing and Polishing Products	3.22	1.35	2.38
582..Condensation and Polyadditon Products	0.84	2.27	0.37
583..Polymerization Products	2.46	1.03	2.39
591..Disinfectant, Insecticides, etc	7.94	1.61	4.93
592..Starches, Inulin, Glues	0.29	3.45	0.08
651..Textile Yarn	5.45	5.03	1.08
652..Cotton Fabrics, Woven	0.64	1.51	0.42
653..Fabrics Woven of Man-Made Fibres	1.21	1.22	0.99
654..Other Textile Fabrics, Woven	4.06	1.42	2.86
678..Tubes, Pipes and Fittings	0.36	0.69	0.52
687..Tin	13.16	2.36	5.58
693..Wire Products	2.01	0.97	2.07
751..Office Machines	0.08	12.78	0.06
761..Television Receivers	0.15	0.22	0.68
762..Radio-Broadcast Receivers	0.02	56.37	0.00
763..Gramaphones, Dictating Machines, etc	0.07	0.03	2.33
782..Motor Vehicles for Transport of Goods	22.67	4.48	5.06
843..Outer Garments of Textile Fabrics	0.005	0.005	1.00
844..Under Garments of Textile Fabrics	0.005	0.003	1.67
845..Outer Garments, Knitted or Crocheted	0.004	0.003	1.33
846..Under Garments, Knitted or Crocheted	0.003	0.003	1.00

Source: Commodity Trade Statistics, United Nations, 1979

Note: (1) - Unit values of Singapore's exports to Japan
(2) - Unit values of Singapore's imports from Japan
(3) - Ratios of (1) to (2)

Despite extensive theorising on this subject, there are very few measures of economies of scale which are operative. Some economists have simply employed a measure of firm size as a proxy for the presence of scale economies. Their presence is measured by Hufbauer, by the extent to which value-added per worker rises with increasing size of the establishment and is expressed as follows:

$$\log v = k + \alpha \log n$$

where v = ratio between value-added per man for a particular size class of plant and the average value-added per man for all establishments in the 3-digit industry;

n = average number of men employed per establishment in the give size class;

k = constant ;

α = scale elasticity parameter

An $\alpha = 0.02$ indicates that doubling of a plant size increases output per man by approximately 2 percent.

Hufbauer's measure of economies of scale has been employed in most empirical studies of trade theories. This study will also adopt Hufbauer's measure. The data for computing the scale elasticity parameter is obtained from the Report on Census of Industrial Production, 1979. With such information, it is proposed to test the hypothesis that small industrial countries tend to engage in small scale production.

The results are presented in Appendix Table 7. Most of the scale elasticity parameters are negative suggesting that Singapore's industries are only efficient in small-scale production. In addition, 55 percent of total establishments are small scale, employing 10-20 workers, and only 15 percent are large scale establishments employing more than 100 workers.

Hufbauer's measure of scale economies is, however, vulnerable to several criticisms which he has himself highlighted.

Firstly, there may be biases introduced by systematic relationships between the size of plant and product type, capital intensity, skill intensity and monopoly. More fundamentally, there may be room for doubt as to whether this variable may be measuring something quite unrelated to the existence of scale economies.

Secondly, competitive forces could serve to concentrate factor intensity around the optimum scale. Under certain circumstances, this might impart a downward bias in the estimates of scale economies.

Thirdly, H.B. Lary and others have used value-added per employee not as a measure of "productivity" but as a measure of human capital intensity, physical capital intensity and unskilled labour intensity. Viewed in this perspective, the Hufbauer scale variable can be seen as a measure of the extent to which physical capital and human capital intensity increases with increasing scale in U.S. industry. It thus describes the nature of the technology in the industry rather than productivity, depicting a case in which the production function is not homothetic.

Product Differentiation, Economies of Scale and Intra-Industry Trade

The model to be estimated includes product differentiation and economies of scale as important determinants of two-way trade and is presented as follows:

$$IIT_i = f(PD_i, SE_i)$$

where IIT_i = intra-industry trade for industry i, (i=1, ..., 32);

PD_i = Hufbauer's product differentiation index;

SE_i = Hufbauer's economies of scale parameter

The above regression is estimated for a cross-section of 32 industries in Singapore at the 3-digit level for 1979. Since the semi-logarithm version produces the best results, its results are shown in Table 33.

TABLE 33

Simple and Multiple Regressions between Product Differentiation, Scale Economies and Intra-Industry Trade

Regression Equations	Summary Statistics
(a) log IIT = 3.29 + 0.208 PD	F = 0.42
(0.65)	$\bar{R}^2$ = -2.0
(b) log IIT = 3.77 + 1.35 SE	F = 0.18
(0.43)	$\bar{R}^2$ = -2.9
(c) log IIT = 3.49 + 1.65 SE + 0.27 PD	F = 0.34
(0.69) (0.51)	$\bar{R}^2$ = -4.9

Source: i) Table 30
ii) Appendix Table 8

Note: t values are shown in parenthesis.

The results obtained for the product differentiation index are not impressive. Although the coefficient for this variable possessed the expected positive sign, it was not statistically significant. This could perhaps be accounted for by the crude construction of the variable and the difficulty of defining product differentiation in an international context. Recent studies in the area of multinational corporations however provide an alternative explanation. Such studies suggest that foreign firms have undertaken direct foreign investment of a horizontal nature primarily in oligopolistic industries characterized by product differentiation. The argument is that due to the need of (1) adapting the product and marketing strategy to local conditions; (2) providing specialized consumer services; and (b) overcoming trade barriers, firms have adopted a strategy of substituting direct investment for exports. This process of substitution thus could reduce the observed value of two-way trade in differentiated products. The importance of multinational corporations in the growth of intra-industry trade is examined further in the next chapter.

The coefficient for the scale variable is positive but not statistically significant. This may be due to the fact that the scale variable as measured here is an indicator of standardization rather than economies of long run production runs in differentiated commodities. In addition, intra-industry trade can only be largely explained by product differentiation combined with economies of scale which refers more to length of production runs rather than to plant size. This argument is also advanced by Grubel (1975).

The correlation matrix of Table 34 reveals that economies of scale is negatively correlated with skill intensity and capital intensity. This is expected since large scale production processes (in terms of plant size) allow "the separation of human skills from the production process or rather, the embodiment of human skills in physical capital".[13] This physical capital can then be purchased and operated by relatively unskilled labour. The argument follows that small-scale production processes utilize "general purpose" capital equipment which must be frequently converted to produce a different product variety. This process of frequent conversion is human capital intensive.

TABLE 34

Correlation Matrix of Product Differentiation (PD), Economies of Scale (SE), Skill Intensity (S) and Capital Intensity (K/L)

	K/L	S	PD	SE
K/L	1			
S	0.426	1		
PD	-0.102	0.161	1	
SE	-0.071	-0.115	-0.136	1

13. Finger, J.A., and De Rosa, op.cit., pp.227.

CONCLUSION

The present analysis was geared towards testing empirically factors which have been posited to determine intra-industry trade between Japan and Singapore. While the explanatory power of the model did not turn out to be impressive, the results indeed confirmed a number of hypotheses to explain observed trade flows in manufactures.

The skill intensity variable was found to have a significant positive influence on the level of intra-industry trade. An effort to directly measure product differentiation within industries failed to yield significant results although product differentiation was found to be positively correlated with skill intensity. Part of the explanation for this unsatisfactory finding may lie in the difficulties of adequately measuring product differentiation. The economies of scale variable did not perform very satisfactory. However, it must be pointed out that further research employing better empirical counterparts for the theoretical constructs may be more successful in supporting the dominant hypotheses on the determinants of intra-industry trade.

CHAPTER 6

Foreign Investment, Industrial Growth and Trade

It is without doubt that the industrialization programme of Singapore was export-led and foreign-investment-led. The role of foreign direct investment was particularly prominent in the late 1960s when the export-oriented industrialization strategy was implemented with increasing emphasis on the development of human skills. This was necessitated by a gradual loss of comparative advantage in labour-intensive manufactures as a consequence of rising wage costs, increasing labour scarcity and the emergence of new "cheap labour" manufacturing centres in other parts of Asia.

Singapore saw a role for foreign direct investment to achieve accelerated economic development through increased industrial investment, the inflow of technology and management, and as a short cut to the development of export markets. A liberal policy was undertaken to stimulate the inflow of various ingredients of industrial growth - large pools of capital, entrepreneurship, managerial know-how, technology and skilled manpower. Various forms of investment incentives were offered to foreign investors.[1]

This chapter is a complement to the preceding chapters in which the importance of exports as a "source" of industrial growth and the determinants of export pattern have been discussed. Chapter 6 provides firstly, an overview of the extent and characteristics of foreign direct investment. It then examines the contributions of

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1. For a detailed list of regulations and incentives governing foreign investment in Singapore, see Chia Siow Yue, "Foreign Investment in Singapore" in Narongchi Abrasanee & Vinyu Vichit-Vadakan (ed.) ASEAN Co-operation in Foreign Investment and Transnational Corporations, United Nations, Asian and Pacific Development Institute, Bangkok, Vol. 1, 1979, pp.220-223.

foreign investment to industrial growth and trade. Finally, it seeks to analyse the various determinants of foreign direct investment.

EXTENT OF FOREIGN DIRECT INVESTMENT IN MANUFACTURING

The role of foreign direct investment in the manufacturing sector is a recent development and is kept in line with the industrial development strategy of the Singaporean government. Prior to the 1960s, the growth of foreign firms in manufacturing activities was unspectacular due to political uncertainties, a small domestic market, absence of rich natural resources, and high prevailing wages and fringe benefits.

The main upsurge in foreign investment came in the late 1960s in response to the government's industrialization policy and investment incentives. Table 35 shows the growth of foreign direct investment in the manufacturing sector as measured by gross fixed assets for the period 1960 to 1979.

For the 1960-1965 period investment was small, totalling only about $157 million, reflecting the difficulties of attracting investment under an import-substituting strategy and unfavourable political and labour conditions. Their contribution rose sharply after 1966. This may in part be directly related to the improved investment climate in Singapore consequent upon the introduction of various investment incentives, improved industrial relations climate and external forces. The level of investment inflow reached a peak of 87 percent in 1972 and fell to 74 percent in 1975. The contributory factors responsible for such a decline in foreign investment were the international monetary crisis and ensuing world recession and the political uncertainties in Southeast Asia following the fall of South Vietnam to the Communists. The sharp decline thus highlighted the sensitivity of export-oriented foreign investment to external economic and political developments since the domestic conditions for foreign investment remained highly favourable. Since 1976 foreign investment rose rapidly. This may be attributed to world economic recovery and the intensified promotional efforts by the Economic Development Board which finally succeeded in reversing the downward trend somewhat.

TABLE 35

Foreign Investment In Singapore's Manufacturing Industry

S$Million

Year	FOREIGN INVESTMENT		Foreign Investment As a Proportion of Gross Fixed Assets (%)
	In the Given Year	Cumulative Total	
1960-1965	157	157	-
1966	82	239	45.4
1967	64	303	48.5
1968	151	454	62.6
1969	146	600	54.2
1970	395	995	61.4
1971	580	1575	76.4
1972	708	2283	86.5
1973	376	2659	73.8
1974	395	3054	73.9
1975	326	3380	73.7
1976	359	3739	76.1
1977	406	4145	75.8
1978	1097	5242	78.5
1979	1107	6349	81.2

Source: Kwan Kuen Chor and Lee Soo Ann, "Japanese Investments in Singapore's Manufacturing Industry" in Securities Industry Review, October 1981, pp.22.

COUNTRY AND INDUSTRY DISTRIBUTION OF FOREIGN INVESTMENT

As at the end of 1978, the major foreign investors in Singapore were, in order of importance, United States (31%), Netherlands (19%), Japan (15.3%), United Kingdom (15.1%) and West Germany (3%). Over the years the increase in direct investment has been particularly dramatic for United States whose share rose from 15% in 1965 to 31% in 1978 (see Table 36). British investment in Singapore however did not rank top place despite the long historical and trading ties between the two countries and by mid 1970s, had fallen behind American, Japanese and Dutch investors.

The five countries mentioned above collectively accounted for 81 percent of total foreign investment as at the end of 1978. All the leading investors were developed countries due to the Government's successful policy of shifting the manufacturing sector towards higher technology, more capital intensive, higher value-added and more skill intensive activities.

The United States retained its position as the largest single investor as at the end of 1979, accounting for 29 percent or $1.8 billion of all foreign investment. Japan overtook the Netherlands to occupy the second spot with 17 percent or $1.05 billion.

Table 37 shows the distribution of foreign investment by industry. The industrial distribution of foreign investment has become more diversified over the years, reflecting Singapore's strategy of industrial diversification and deepening. The change is apparent if a comparison is made between investment figures for 1965 and 1979. In 1965 investment in petroleum refining dominated all others, accounting for 63.1 percent of total foreign investment. Smaller concentrations of foreign investment were found in basic metals and fabricated metal products, food manufactures, leather and rubber products, and textile and garment. In the post-1965 period, foreign investment became increasingly export-oriented under the government's selective investment promotion programme. Nevertheless, petroleum investment constituted the major portion of foreign investment in Singapore, accounting for some 41 percent of all foreign investment in 1979. It is the most skill intensive industry; about 31 percent

TABLE 36

Foreign Investment in Singapore's Manufacturing Industry by Major Investing Countries (Gross Fixed Assets as at end of period)

S$Million

Major Investing Countries	1965	1970	1975	1976	1977	1978
United States	23 (14.6)	343 (34.5)	1118 (33.1)	1233 (33.0)	1366 (33.0)	1600 (30.5)
United Kingdom	45 (28.7)	199 (20.0)	481 (14.2)	555 (14.8)	566 (13.7)	791 (15.1)
Netherlands	40 (25.5)	183 (18.4)	473 (14.0)	525 (14.0)	571 (13.8)	904 (17.3)
Japan	27 (17.2)	68 (6.8)	454 (13.4)	525 (14.0)	633 (15.3)	801 (15.3)
West Germany	- -	3 (0.3)	105 (3.1)	112 (3.0)	130 (3.1)	144 (2.7)
Others	22 (14.0)	199 (20.0)	749 (22.2)	789 (21.1)	897 (21.6)	1002 (19.1)
Cumulative Total	157 (100)	995 (100)	3380 (100)	3739 (100)	4145 (100)	5242 (100)

Source: Economic Development Board, various reports

Note: Figures in brackets show the percentage share of individual country's investment in total foreign investment

TABLE 37

Foreign Investment in Singapore's Manufacturing Industry
by Industry Groups (Gross Fixed Assets
as at end of period)

S$Million

Industry	1965	1972	1975	1978	1979
Food, Beverages and Tobacco	9	70	123	176	211
Textile	7	156	154	150	205
Wearing Apparel, Footwear, Made-Up Textile			81	106	137
Leather & Rubber, Processing of Natural Gums	8	43	30	46	53
Wood & Cork Products	3	90	160	163	220
Paper and Paper Products		34	41	59	89
Industrial Chemicals	5	63	90	73	96
Other Chemical Products		61	81	115	154
Petroleum & Petroleum Products	99	1158	1426	2304	2627
Plastic Products	3	30	41	75	98
Non-Metallic Mineral Products	3	41	57	82	93
Basic Metal Products	19	38	39	75	49
Fabricated Metal Products		89	77	130	213
Non-Electrical Machinery			250	487	448
Electrical Machinery, Apparatus, Appliances & Supplies	1	215	354	620	938
Transport Equipment	-	91	209	326	387
Precision Equipment & Optical & Photographic Goods	-	97	142	212	272
Other Manufacturing Industries	-	7	25	43	59
TOTAL (Cumulative)	157	2283	3380	5242	6349

Source: Kuan Kuen-Chor and Lee Soon Ann, op.cit., pp.24

of workers employed in this industry comprised of professional, managerial and technical workers in 1980. Given the positive relationship between skills and productivity, one can expect foreign-owned firms to be much more productive.

Next in ranking but following substantially behind petroleum refining were investments in the electrical and electronic products (14.8%), non-electrical machinery (7.1%) and transport equipment (6.1%). The relative importance of the textile and garment industry declined.

Given the direction of Singapore's industrialization strategy in the next decade and the sensitivity of labour intensive manufactured exports to protectionist tendencies in developed markets and competition from newly developing countries, it can be expected that foreign investment will be increasingly concentrated in skill intensive and technology intensive industries. Foreign investment will also continue to be concentrated in export-oriented industries given the small domestic market of the Singapore economy.

Table 38 presents the industry distribution of selected foreign investors in Singapore for 1973. American investments were concentrated in petroleum, electrical and electronic products, non-electrical machinery and chemicals industry. The main concentration of British investment was in chemicals. Investment from Hong Kong was however heavily concentrated in textiles which may be due to rising wages in Hong Kong. This reflected Hong Kong's position as a middle-level industrial producer. Ship-building and ship-repairing dominated Japanese export-oriented investment in Singapore in 1973. Unlike the American investors, Japanese investors had a greater preference for joint ventures and thus may be more suited to act as a catalyst in inducing local entreprises into industrial ventures.

There is a change in the pattern of Japanese investment from 1973 to 1980. Electrical and electronic products dominated Japanese export-oriented investment in terms of numbers of companies (35%), number of employees (51%) and paid-up capital (36%) in 1980. Chemical products

TABLE 38

Paid-up Capital by Industry of American, Hongkong, Japanese and British-Controlled Companies in 1973

Industry	American	Hongkong	Japanese	British
Food, Beverages & Tobacco	4	14	1	22
Textile	-	95	10	7
- Spinning, weaving & dyeing	-	72	5	-
- Garments	-	17	4	-
- Other textiles	-	6	1	7
Chemicals	16	11	7	46
- Basic industrial chemicals	2	3	-	3
- Paint and ink	1	1	5	3
- Drugs	-	-	-	31
- Soap and cosmetics	-	-	-	1
- Batteries	-	-	1	1
- Plastic products	6	6	-	1
- Others	7	1	1	6
Petroleum & Petroleum Products	153	-	-	4
Metals	12	10	10	17
Machinery and Equipment	24	1	99	13
- General machinery	1	-	11	2
- Shipbuilding and repair	4	1	88	6
- Oil related equipment	19	-	-	5
Electrical Products and Electronic Components	38	11	30	18
- Electrical products	17	8	6	18
- Electronic components	21	3	24	-
Others	37	13	35	51
- Paper and paper products	1	1	-	-
- Rubber and rubber products	-	1	10	7
- Non-metallic mineral products	2	-	4	21
- Wood and wood products	10	8	14	22
- Printing & publishing	24	-	4	-
- Others	-	3	3	1
Total	284	155	192	178

Source: Lee Soo Ann, Singapore Goes Transnational: A Study of the Economic Impact of MNCs in Singapore, MAS, 1977 pp.32

had the second largest concentration of Japanese export-oriented investment followed by transport machinery. These three industries contributed towards 66 percent of paid-up capital and 63 percent of employment in manufacturing as depicted in Table 39.

TABLE 39

Japanese Companies in Singapore's Manufactures, Number of Employees and Paid-up Capital, 1980

Industry	Number of Companies	Number of Employees	Paid-up Capital (S$)
1. Food and Beverages	9	703	24,025,003
2. Textile and Textile Products	8	1718	38,050,000
3. Ferrous and Non-Ferrous Metal Products	37	4643	53,360,002
4. Chemical Products	35	1885	117,788,000
5. Transportation Machinery	9	4189	105,386,012
6. Electrical-Electronic Products	85	28277	265,253,163
7. Industrial Machinery	14	6397	58,062,000
8. Other Manufactures	45	6880	84,694,864
Total Manufactures	242	54692	746,619,044

Source: Japanese Affiliated Firms in Singapore, March 1981, Japan Trade Centre, Singapore, Appendix.

IMPACT OF FOREIGN VIS-A-VIS LOCAL COMPANIES IN MANUFACTURING

There was an increase in the number of wholly foreign owned companies from 55 in 1966 to 447 in 1979. Most of the foreign investment was done after 1966 when the second wave of investment took place in response to the Singaporean government policy change in industrialization and the offer of attractive investment incentives and partly in response to economic changes which made Singapore appear a very attractive production site.

Increased foreign investment brought with it rapid growth in the manufacturing output. Value-added in manufacturing, according to the annual Census of Industrial Production, grew from $145 million in 1966 to $6703 million in 1979 while output increased from $1325.8 million to $24360.4 million. One cannot avoid the conclusion that foreign investment was very much responsible for the growth of the manufacturing sector.

In terms of number, wholly foreign owned firms remained a minority, comprising of 5 percent of total manufacturing establishments in 1966 and 14 percent in 1979. However, their relative contribution in terms of employment, output, and exports had been significant as reported in Table 40.

The picture that emerges is that foreign firms tend to be large and capital intensive. By 1979, wholly foreign firms accounted for 60 percent of gross output, half of value-added, half of capital expenditure and 70 percent of direct exports in all manufactures. If we add to that firms which were more than half foreign, the share of foreign firms was even higher, accounting for more than half of total employment and remuneration in wages.

The contrast between foreign and local firms is more apparent when the figures in Table 40 are expressed on a per worker basis or per output basis. As can be seen from Table 41, value-added per worker in a wholly foreign firm is double that of a wholly local firm while output per worker is triple. The percentage of remuneration to output is however much lower in the wholly foreign firm. This is because the foreign firms are more capital and technology intensive. On the other hand, the foreign firms sell most of their output abroad due to the lack of a sizeable domestic market in Singapore. In addition, they have a higher input-output ratio than have the local firms. Thus, foreign firms are basically interested in Singapore as an efficient production centre located along strategic sea and air routes. These tables show beyond doubt the overwhelming contributions of foreign investment to the rapid expansion of the manufacturing sector.

TABLE 40

Foreign Versus Domestic Capital in Manufacturing, 1979

% Share held by Firms which are	Wholly Domestic	More than ½ Domestic	Less than ½ Domestic	Wholly Foreign
Number of Establishments				
1966	83	7	5	5
1979	64	12	10	14
Number of Workers				
1966	59	16	13	12
1979	29	14	19	38
Inputs				
1966	43	15	15	27
1979	14	9	14	63
Value-Added				
1966	38	18	18	26
1979	19	13	14	54
Capital Expenditure				
1966	24	12	24	40
1979	16	11	18	55
Employee's Remuneration				
1966	-	-	-	-
1979	26	15	19	40
Direct Exports				
1966	-	-	-	-
1979	7	8	11	74

Source: i) Lee Soo Ann, op.cit., Table 11
ii) Report on the Census of Industrial Production, 1979

TABLE 41

Selected Ratios of Manufacturing by Capital Structure, 1979

	Value-Added Per Worker ($)	Output Per Worker ($)	Inputs to Output (%)
Wholly Local	16,975	51,902	62.4
More than ½ Local	23,651	70,830	61.8
Less than ½ Local	17,787	69,497	71.5
Wholly Foreign	34,779	145,762	75.7
	24,889	93,923	71.6

	Remuneration to Output (%)	Direct Exports to Output (%)
Wholly Local	13.8	29.3
More than ½ Local	11.8	46.8
Less than ½ Local	10.9	49.6
Wholly Foreign	5.5	79.8
	8.2	64.1

Source: Calculated from Report on the Census of Industrial Production, 1979, Table 4

Table 42a shows the contribution of direct foreign investment by their major sources of capital. American firms dominated the other investors in terms of contribution towards employment, output, value-added, exports, remuneration and capital expenditure in 1979. The relatively high figures for U.S. owned firms is due to their investment in the very capital intensive petroleum industry. Japanese companies are next on the list.

However, an examination of the data on a per worker or ratio basis changes the picture substantially. Value-added per worker in Japanese-owned manufacturing firms was only \$16713 in 1979 and fell below the \$53719 of the United Kingdom value-added per worker (see Table 42b). Direct exports to total sales ratio of Japanese owned companies is the lowest among the major foreign firms indicating that they are the least export-oriented. In terms of output per worker and capital expenditure per worker, similar trends prevail.

DETERMINANTS OF FOREIGN INVESTMENT

In determining the factors influencing the flow of foreign investment, a distinction must be made between the (i) general factors which lead firms to invest overseas, and (ii) more specific factors which influence firms to invest in Singapore rather than in alternative locations in Southeast Asia and elsewhere. The investment incentives provided by Singapore affect primarily the second set of investment decisions.

Traditionally, foreign investment flowed into the developing countries to exploit natural resources. Subsequently, as an increasing number of less developed countries embarked on import-substituting industrialization, foreign investment entered into these countries to establish tariff factories and protect or extend market shares. In recent years, a growing number of less developed countries have adopted the export-development strategy of industrialization. This has been facilitated by the growing practice of world sourcing by multinational companies in response to the product life cycle phenomenon and the wide and growing differentials in wage costs between the developed countries and less developed countries. In fact, Singapore's unit labour costs is relatively lower than her major investors as discussed in Chapter 3.

TABLE 42a

Contributions of Direct Foreign Investment in Singapore's Manufacturing Industry by Major Sources of Capital, 1979

Contribution (% of total)	U.S	Japan	U.K	Hongkong	W.Germany
Number of Establishments	2.7	4.5	1.9	2.5	0.7
Number of Workers	12.4	14.1	2.1	5.9	3.6
Output	22.8	8.3	3.4	3.1	1.4
Value-Added	20.3	9.5	4.5	3.5	2.2
Direct Exports	29.8	9.2	4.3	3.5	1.9
Employee's Remuneration	13.7	12.5	3.4	5.2	3.0
Capital Expenditure	16.4	14.8	2.5	4.3	2.3

TABLE 42b

Selected Ratios of Contributions of Direct Foreign Investment in Singapore's Manufacturing Industry By Major Sources of Capital, 1979

Ratio	U.S	Japan	U.K	Hongkong	W.Germany
Value-added Per Worker ($)	40651	16713	53719	14496	15256
Output Per Worker ($)	172099	55598	153046	48988	35388
Remuneration Per Worker ($)	8521	6866	12818	6753	6471
Capital Expenditure Per Worker ($)	6980	5552	6465	3838	3415
Direct Exports to Total Sales (%)	85.1	70.7	73.4	75.1	93.9

Source: Report on the Census of Industrial Production, 1979, Table 6, pp.15

It is no wonder that Singapore has managed to develop a comparative advantage in the location of these industries.

Reuber[2] lists the characteristics of such multinational corporate investment as follows: (i) they normally result in the shipment of components to some central location either in the investing country or elsewhere for assembly into finished products; (ii) the principal motivation in making the investment is to protect or improve its competitive position at home or internationally; (iii) the location of such investment is influenced by factors such as low wage costs, the ready availability of skilled and semi-skilled labour, host-country incentives, and political and economic stability in prospective host countries; and (iv) such investment tend to be highly profitable even in the short run on account of the multinational's control over the market and the rapid depreciation allowed on its fixed assets.

The determinants of foreign investment also depend on the type of investment. Foreign investment in industries may be broadly classified into three main categories:- resource-oriented, domestic-market-oriented and export-market-oriented. Resource oriented investment is defined here in a special sense to cover investment in industries which owe their development largely to Singapore's geographical location such as shipbuilding and shiprepairing. The remaining foreign investment may be classified either as domestic-market-oriented or export-market-oriented according to the ratio of exports to total sales.

Domestic-market-oriented investment declined in importance after 1965 due to the recognition of the vital role of exports in industrial growth. Export-oriented investment was first concentrated in the petroleum refining industry. The products of the oil refineries, besides serving the domestic market and the bunkering requirements of the port and the airports are exported largely to Asian markets.

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2. Reuber, Grant L., Private Foreign Investment in Development Clarendon, Oxford University Press, 1972, pp.73.

The second concentration of export-oriented foreign investment may be found in the electrical, electronic and precision industries. The product life cycle hypothesis appears to provide the major explanation for this investment upsurge particularly during the 1968-1973 period. This is particularly so during the maturity phase of the cycle when the technology becomes standardized and labour costs emerged as a significant component of overall production costs. Multinational companies move their production to low cost overseas countries to help preserve their oligopolistic advantages. In addition, internal pull factors such as improved investment climate and the offer of liberal incentives may have also attracted the inflow of such investment.

A third major concentration of export-oriented foreign investment is in the textile and garment industry. The first wave occurred in 1963-1964 with the influx of Hong Kong and Taiwan textile and garment manufacturers; these manufacturers were being pushed out of their own countries as a result of import restrictions imposed by many industrial countries on their exports. At the same time, Singapore was not subject to such restrictions. The second investment wave occurred in the late 1960s as a result of political uncertainties in Hong Kong and Taiwan.

It is difficult, if not impossible, to determine the precise factors determining the decisions of foreign investors to locate their manufacturing facilities in Singapore. For export-oriented investments which are footloose in nature, the main determining factors are production and distribution costs. The provision of efficient and at times subsidized industrial and training facilities tends to lower production costs; in addition, tax exemptions and concessions tend to raise the rate of return on such investment.

In the next section, an attempt is made to see how far location decisions can be explained by economic considerations implied by the market scanning hypothesis. The market scanning hypothesis holds that multinational corporations use their superior knowledge to locate manufacturing activities in countries that are most advantageous from the stand point of market opportunities and cost considerations. Production in a host country is therefore influenced by two sets of interacting factors: country characteristics (such as factor abundance and factor prices) and commodity characteristics (such as factor intensities). This type of overseas investment can therefore be explained within the framework of the Hecksher-Ohlin endowment theory. Before proceeding with the empirical testing using the Hecksher-Ohlin model, it is necessary to examine the specific factors which influence a particular country to invest in Singapore.

Specific Factors influencing Investment from Japan and United States

Factors influencing foreign investment for the periods 1963-1965 and 1966-1979 are not similar. For the first period, the crucial inducement towards manufacturing in Singapore by American investors was provided by Singapore's locational advantages as an entrepot centre for Southeast Asia. American investors were trying to get ahead of their chief international rivals so as to protect their stake in the growing Southeast Asian market.[3] Japanese investors also adopted a similar attitude towards investing in Singapore. They aimed at the anticipated expanded common market of Malaysia.

Up to 1965, foreign investment as a whole was therefore small-scale and defensive in nature. After 1965 came a change in the pattern of investment reflecting the global outlook of the Singaporean government towards foreign investment and trade. An export-oriented strategy was implemented in 1967. With the change in export-oriented manufacturing came a switch in the pattern of investment. U.S. became the largest foreign investor in Singapore manufactures. A major factor to this was the decisions of American electronic companies to come to Singapore other than Hong Kong, Korea or Taiwan. Political uncertainty and high labour costs primarily in Hong Kong resulted in an outflow of American investment into Singapore.

Japanese export-oriented investment in Singapore during the second period was influenced mainly by cost and balance of payments considerations. By the end of the sixties, the Japanese wage levels begin to approach that of high wage countries. The increasing

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3. Lindert, Peter H., "United States Investment" in Hughes, H. and You Poh Seng (ed.) Foreign Investment and Industrialization in Singapore, Australian National University Press, 1969.

costs of land and pollution control pushed Japanese companies abroad. The continued revaluation of the yen made Japanese export industries less competitive. The continued accumulation of foreign exchange reserves encouraged the liberalization of overseas investment until in July 1971, the limit of automatic approval for overseas projects was abolished. Japanese investment increased substantially in 1972 and 1973. By 1979, Japan was the second largest foreign investor in Singapore.

Empirical Tests of the Determinants of Foreign Investment

The determinants of the commodity pattern of direct foreign investment is a new area of interest. Are they the same as those that determine commodity trade? The purpose of this section is to evaluate the determinants of foreign investment in Singapore using quantifiable factors such as capital-labour intensity, skill intensity and unit labour costs. It is however important to recognise that external factors and other factors discussed earlier also affect foreign investment to a certain extent.

The regression model that is tested is as follows:

$$FI_i = f(K/L_i, SI_i, ULC_i)$$

where FI_i = foreign investment in industry i as a % of foreign investment in total manufactures;

K/L_i = capital intensity in industry i, measured by non-wage value-added per worker;

SI_i = skill intensity in industry i;

ULC_i = unit labour costs in industry i

Data for foreign investment by industry groups are derived from the same source as in Table 37. Capital-labour ratios and unit labour costs are taken from the annual Census of Industrial Production. Skill intensity figures are calculated from the Census of Population.

The years selected are 1973 and 1979. Foreign investment declined sharply after 1972 due probably to worldwide recession while 1979 represented the peak year for foreign investment in Singapore. It is interesting, therefore, to compare the determinants of foreign investment for these two years.

The results of testing for the determinants of total foreign investment in Singapore's manufacturing industries are presented in Table 43 for bivariate regressions. Results of multiple regressions are not presented as they do not possess much meaning due to the difficulty of identifying the relationships between independent variables such as skill intensity and unit labour costs.

All the variables are significant as indicated by the t-statistics (in parenthesis), and they possess the expected signs. However, in terms of magnitude, the coefficient of capital intensity is close to zero. This collaborates with the earlier finding that capital intensity is not an important factor explaining exports. Thus exports and foreign investment can be explained by the same variable - capital intensity.

The skill variable has a significant impact on foreign investment in terms of magnitude and high correlation coefficient. Foreign investment is found to be concentrated mainly in skill intensive industries such as petroleum, electrical and electronic and chemicals.

Unit labour costs also play an important role in determining the amount of foreign investment. The negative coefficient implies that low unit labour costs are associated with high foreign investment. It has been observed that the unit labour costs of Singapore are relatively lower than that of major investing countries such as U.S. and Japan. It is therefore an important factor accounting for a significant proportion of direct investment from these two countries. However, without detailed distribution of foreign investment by industry and country, it is not possible to proceed with similar tests of the determinants affecting individual countries.

Overall, the effects of capital intensity, skill intensity and unit labour costs are similar for 1973 and 1979 irrespective of world conditions. It may be possible that such factors have different impacts on foreign investment depending on the type of industry.

TABLE 43a

Simple Regressions of Foreign Investment against Capital Intensity, Skill Intensity and Unit Labour Costs, 1973

Regression Equation	Correlation Coefficient
(a) FI = -0.33 + 0.000 K/L (6.98)*	r = 0.91
(b) FI = -4.80 + 55.3 SI (6.43)*	r = 0.90
(c) FI = 22.20 - 117.4 ULC (-1.85)*	r = -0.50

TABLE 43b

Simple Regressions of Foreign Investment against Capital Intensity, Skill Intensity and Unit Labour Costs, 1979

Regression Equation	Correlation Coefficient
(d) FI = 1.70 + 0.000 K/L (6.98)*	r = 0.90
(e) FI = -3.17 + 31.3 SI (2.65)*	r = 0.62
(f) FI = 22.9 - 115.4 ULC (-2.49)*	r = -0.60

Source: As explained in the text

Note: K/L = Capital-labour intensity;
SI = Skill intensity;
ULC = Unit labour costs;
n = 16;
t values are shown in parenthesis;
* - significant at the 95 percent level of confidence

TABLE 44

Simple Regressions of Foreign Investment against Unit Labour Costs (ULC) by Industry

Industry	Regression Equation	Correlation Coefficient
Textile	FI = 218 - 184 ULC (-0.06)	r = -0.02
Leather	FI = 667 + 263 ULC (2.46)*	r = 0.63
Chemicals	FI = 133 + 73 ULC (0.20)	r = 0.07
Petroleum Products	FI = 1687 - 26270 ULC (-1.45)	r = -0.40
Non-Metallic Mineral Products	FI = 86 - 249 ULC (-0.91)	r = -0.29
Iron and Steel	FI = 105 - 763 ULC (-2.96)*	r = -0.70
Electrical Machinery	FI = 946 - 4666 ULC (-2.08)*	r = -0.57
Transport Equipment	FI = 794 - 2704 ULC (-2.86)*	r = -0.71
Precision Equipment	FI = 54 + 372 ULC (0.61)	r = 0.21

Source: As explained in the text

Note: n = 10;
t values are shown in parenthesis;
* - significant at the 95 percent level of confidence

An attempt is therefore made to relate such factors to foreign investment in a particular industry.

The unavailability of sufficient annual figures which are necessary for the calculations of skill intensity for 1970-1979 made it impossible to test the influence of skill intensity on foreign investment in a particular industry. The results for capital intensity are not presented because the coefficients are low and close to zero for all the selected industries. Table 44 presents the results of regressions for foreign investment in a particular industry to unit labour costs.

It is observed that unit labour costs are an important determinant of foreign investment in leather, iron and steel, electrical machinery and products, and transport equipment. The last two industries are the major export-oriented investments undertaken by U.S. and Japan. One can therefore conclude that United States and Japan are influenced to a great extent by the relatively low unit labour costs in Singapore to invest in these two industries.

CONCLUSION

The foregoing analysis shows clearly that Singapore's heavy dependence on foreign investment in the past two decades has brought with it many benefits not least of which is the accelerated industrial growth. However, heavy dependence on foreign investment is often considered undesirable from an economic, political and social point of view. Foreign investment can be highly uncertain and volatile; heavy dependence also increases the risks of external political pressures and interferences in domestic affairs. It is therefore of vital importance to promote the development of a significant core of domestic industrial entrepreneurs so that local entrepreneurs rather than multinationals will play a more dominant role in the future growth of the country. This requires a re-orientation of government policy, training programmes, financial subsidies and technical and institutional support.

One can only claim that the Singapore industrialization programme is a "success" until such time when domestic capital and entrepreneurship make substantial contribution towards industrial development.

EPILOGUE

This study has served the purpose of providing empirical insights into some of the theories of international trade and investment in their application to an open developing economy. Many of the observed facts are found to be in line with theoretical predictions.

One important conclusion from the analysis is that Singapore's comparative advantage has shifted from labour intensive to skill intensive manufactures particularly in the 1970s. The findings relating to this study are in line with the move by the Singaporean government to restructure the economy into a regional "brain service" centre. This is being done through an expansion of technical education and training, promotion of technological research and development, and encouragement of private business firms to produce more sophisticated goods and services for export.

The study also shows clearly and rather predictably that Singapore's continued growth in her manufactured exports is determined, in order of importance, by competitiveness, penetration into favourable export markets and good commodity composition. The Singaporean government must therefore continue to ensure that the city-state's exports of manufactured goods remain competitive in world markets.

A central element of Singapore's macro-management policy has been the control over labour costs. This has been exercised legally under the 1968 amendments to the Industrial Relations Ordinance, the Employment Act of the same year and the National Wages Council established in 1972. The fact that low unit labour costs in comparison with her major trading partners in the developed world has been responsible, in some measure, for Singapore's export competitiveness needs to be taken note of by Singapore's policy makers.

However, there is also the need to prevent labour and other costs from rising disproportionately to those of Singapore's competitors from developing countries. Singapore's extreme dependence on imported food, raw materials and capital goods has meant that rising world prices are reflected in increasing prices in the domestic market. The question is whether, if the external forces pushing up the cost of living persists, the Singaporean government will be able to maintain the control over the rate of increase of wages and related costs that it has successfully exercised until now.

Singapore's new development strategy clearly involves continued and indeed increased reliance upon foreign investment. However, the predominance of foreign investment has met with increasing opposition from intellectuals, journalists, political leaders and the general public. Hence if foreign companies are to continue to make their indispensable contribution to the success of Singapore's high technology strategy, their role will sooner or later have to be complemented by encouraging the growth of local enterprises capable of engaging in similar activities. To that end, the government maintains firm but reasonable pressure on the foreign companies to train Singaporeans for managerial, professional and technical positions. The comparatively large number of joint ventures involving local business interests also contribute towards this objective.

Singapore's success in surmounting the past challenges has demonstrated her ability to forge ahead in a world of uncertainty. The pragmatism and capabilities of her political leaders and civil servants, the energy and experience of her businessmen and hard work and skills of her people will continue to be important assets in her future success. In addition, she must continue to diversify into higher technology and skill intensive products to overcome the serious threat of increasing competition and protectionism from both developing and developed countries.

APPENDIX TABLE 1

Regressions of Export Ratios against Productivity Ratios for 1970-1979 (excluding 1977)

Industry	Constant	Coefficient of Productivity	F	Durbin-Watson
1. Textile	37.9	-7.35 (-1.10)	1.21	1.30
2. Wearing Apparel	11.6	-2.66 (-0.56)	0.32	0.60
3. Leather	22.3	-0.44 (-0.19)	0.04	1.78
4. Furniture	8.6	-1.27 (-1.02)	1.05	0.98
5. Paper	25.7	-1.50 (-0.36)	0.13	1.88
6. Printing	2.5	0.17 (0.66)	0.44	0.64
7. Chemicals	15.2	0.68 (0.16)	0.03	1.30
8. Rubber Manufactures	36.8	0.66 (0.19)	0.04	1.51
9. Iron & Steel	12.9	-3.64 (-0.16)	0.03	0.72
10. Fabricated Metals	48.7	-13.60 (- 1.49)**	2.22	1.50
11. Industrial Machinery	19.4	1.25 (0.25)	0.06	1.29
12. Electrical Machinery	1.6	6.25 (0.53)	0.28	0.57
13. Transport Equipment	69.9	-0.50 (-1.98)	3.90	1.34
14. Precision Equipment	34.1	-0.23 (-0.60)	0.36	0.54
15. Other Manufactures	52.5	-13.10 (- 0.87)	0.76	0.55

Source: i) Report on the Census of Industrial Production, Singapore, various issues;
ii) Japan Statistical Yearbook, various issues;
iii) Commodity Trade Statistics, United Nations, various issues.

Note: n = 9;
** significant at the 90 percent level of confidence;
t - statistics are shown in parenthesis

APPENDIX TABLE 2

Regressions of Export Ratios against Unit Labour Costs
Ratios for 1970-1979 (excluding 1977)

Industry	Constant	Coefficient of Labour Costs	F	Durbin-Watson
1. Textile	-1.8	25.20 (2.96)*	8.78	1.10
2. Wearing Apparel	14.1	-5.77 (-0.68)	0.46	0.44
3. Leather	25.6	-1.81 (-0.82)	0.67	1.90
4. Furniture	9.4	-3.21 (-0.51)	0.26	0.72
5. Paper	42.0	21.50 (-0.72)	0.51	1.98
6. Printing	3.4	-0.46 (-1.23)	1.51	0.80
7. Chemicals	33.2	-15.70 (-1.11)	1.24	1.76
8. Rubber Manufactures	41.2	-2.46 (-0.22)	0.05	1.51
9. Iron & Steel	204.0	-57.20 (-0.84)	0.71	0.72
10. Fabricated Metals	7.4	12.10 (0.96)	0.93	1.74
11. Industrial Machinery	5.2	17.00 (0.94)	0.88	0.96
12. Electrical Machinery	69.1	-42.90 (-2.47)*	6.11	1.40
13. Transport Equipment	59.9	11.30 (0.53)	0.28	1.28
14. Precision Equipment	32.4	-0.25 (-0.01)	0.00	0.52
15. Other Manufactures	24.3	3.73 (0.26)	0.07	0.44

Source: As in Appendix Table 1

Note: n = 9;
* significant at the 95 percent level of confidence;
t - statistics are shown in parenthesis

APPENDIX TABLE 3

Singapore's Occupational Skill Requirements in Manufacturing Industries, 1980

Industry	Occupational Class (% of Employment)							Skill Index
	I	II	III	IV	V	VI	VII	
321....Textile	2.6	3.5	7.5	1.3	2.6	0.1	82.4	0.15
322....Apparel except Footwear	0.8	2.7	5.3	1.5	2.9	-	86.8	0.08
323....Leather and Leather Products	0.9	7.7	6.0	5.1	0.9	-	79.4	0.22
324....Footwear	0.6	5.0	6.5	2.5	0.5	-	84.9	0.13
332....Furniture and Fixtures	1.2	3.9	6.1	2.1	1.0	-	85.7	0.12
341....Paper and Paper Products	1.7	6.7	11.2	3.8	1.8	-	74.8	0.22
342....Printing	9.0	7.6	18.2	4.1	1.3	-	59.8	0.56
351....Industrial Chemicals	9.4	11.6	19.7	2.5	3.7	0.1	53.0	0.79
352....Other Chemicals	8.9	10.5	21.2	6.1	4.3	0.2	48.8	0.79
356....Rubber Products	2.9	7.0	12.9	1.9	1.9	0.4	73.0	0.27
357....Plastic Products	2.2	7.2	9.0	1.7	1.7	0.1	78.1	0.24
361/2..Glass and Pottery, China	3.1	5.0	9.9	1.7	2.5	1.1	76.7	0.21
363....Structural Clay Products	1.5	4.8	8.6	0.8	2.3	-	82.0	0.05
364/5..Cement and Structural Cement	4.7	5.2	13.0	1.8	2.0	0.2	73.1	0.27
369....Non-Metallic Products	3.9	7.3	11.7	1.2	3.1	0.3	72.5	0.51
371....Basic Metals	4.9	6.1	10.4	1.1	2.4	-	75.1	0.29
372....Non-Ferrous Metals	5.8	10.3	16.5	1.6	3.3	0.4	62.1	0.52
381....Fabricated Metal Products	4.4	5.4	10.6	1.4	2.2	0.1	75.9	0.25
382....Non-Electrical Machinery	7.4	6.0	11.8	1.4	1.8	0.1	71.5	0.37
383....Electrical Machinery, etc	6.3	3.1	9.5	0.9	1.5	-	78.8	0.23
384....Transport Equipment	5.8	3.7	9.6	0.6	3.4	0.1	76.8	0.25
385....Optical and Photographic Goods	5.9	2.9	8.5	1.2	1.4	-	80.1	0.22
390....Other Manufactures	3.0	5.7	9.4	4.1	1.7	0.1	76.0	0.23

Source: Report on the Census of Population, Singapore, 1980

APPENDIX TABLE 3 - continued

Note on Skill Index

Keesing's first formula of the skill index is $\frac{I + II}{IV + V}$.

It is based on the following classification of occupational groups:

I	Professional, technical and managerial
II	Craftsmen and foreman (skilled manual workers)
III	Clerical, sales and services
IV	Operators (semi-skilled)
V	Labourers (unskilled)

This is a crude measure of skill intensity because it does not take into account wage differentials between group I and II workers. Keesing's second formula is based on the following detailed classification:-

I	Scientists and engineers
II	Technicians and draftsmen
III	Other professionals
IV	Managers
V	Machinists, electricians, tool and diemakers
VI	Other skilled manual workers
VII	Clerical, sales and service
VIII	Semi-skilled and unskilled workers

His index of skill intensity if defined as $\frac{2(I + II + III) + V}{VIII}$.

The skill index formula used in this study is adapted from the two formulae used by Keesing. For a concordance between Keesing's and Singapore's occupational groups, see Appendix Table 3, Chow Kit Boey, op.cit.

APPENDIX TABLE 4

Adjusted Singapore's Skill Requirements by 4 Major Occupational Groups

Industry	Combined Occupational Groups (%)			
	I	II	III	IV
321....Textile	2.6	3.5	11.4	82.5
322....Apparel	0.8	2.7	9.7	86.8
323....Leather	0.9	7.7	12.0	79.4
324....Footwear	0.6	5.0	9.5	84.9
332....Furniture	1.2	3.9	9.2	85.7
341....Paper and Paper Products	1.7	6.9	16.8	74.8
342....Printing	9.0	7.6	23.6	59.8
351....Industrial Chemicals	9.4	11.6	25.9	53.1
352....Other Chemicals	8.9	10.5	31.6	49.0
356....Rubber Products	2.9	7.0	16.7	73.4
357....Plastic Products	2.2	7.2	12.4	78.2
361/2..Pottery, Glass, etc	3.1	5.0	14.1	77.8
363....Clay	1.5	4.8	11.7	82.0
364/5..Cement	4.7	5.2	16.8	73.3
369....Non-Metallic Products	3.9	9.3	16.0	72.8
371....Iron and Steel	4.9	6.1	13.9	75.1
372....Non-Ferrous Metals	5.8	10.3	21.4	62.5
381....Metal Products	4.4	5.4	14.2	76.0
382....Non-Electrical Machinery	7.4	6.0	15.0	71.5
383....Electrical Machinery, etc	6.3	3.1	11.8	78.8
384....Transport Equipment	5.8	3.7	13.6	76.9
385....Optical and Photographic Goods	5.9	2.9	11.1	89.1
390....Other Manufactures	3.0	5.7	15.2	76.1

Source: As in Appendix Table 3

APPENDIX TABLE 5

Concordance between SITC and Standard Industrial Classification (SIC) of Singapore's Manufactures Used in This Study

	Industry	SITC No.	SIC No.
1.	Spinning, Weaving and Finishing of Textile	651-654	32111-32112
2.	Manufacture of Socks and Other Knitted Wear	655-656	32132-32133
3.	Manufacture of Other Outer Garments	841-843,845	32202
4.	Manufacture of Wearing Apparel, except Footwear, nec	847-848	32209
5.	Manufacture of Leather and Leather Products	831	323
6.	Printing, Publishing and Allied Products	892	342
7.	Paints, Varnishes and Lacquers	533	35210
8.	Medicinal and Pharmaceutical Products	541	35229
9.	Perfumes, Cosmetics and Other Toilet Preparations	551,553	35231
10.	Other Rubber Products, except Footwear, nec	628	35691
11.	Other Plastic Products	893	357
12.	Glass and Glass Products	664-665	362
13.	Non-Ferrous Metals	681-689	372
14.	Non-Metallic Mineral Products	663	369
15.	Iron and Steel	671-679	371
16.	Cutlery, Hand and Edge Tools	628	35691
17.	Structural Metal Prodcts, nec	691-692	38139

APPENDIX TABLE 5 - continued

Industry	SITC No.	SIC No.
18. Wire Netting, Wire and Cable Products	693	38142,38149
19. Tin Cans, Zinc and Tin-Plate Articles, nec	697-699	38193
20. Industrial and Agricultural Machinery	721-727	38291
21. Machinery and Equipment, nec	736-737 742-749	38292
22. Electrical Industrial Machinery and Equipment	751-759	38311,38319
23. Radios, Television Sets, Communication Equipment and Apparatus	761-762	38321-38322, 38329
24. Other Electrical Equipment and Supplies, nec	771-778	38393
25. Ships, Boats and Tankers	793	38411-38413
26. Assembly of Motor Vehicles	781-783	38431-38432
27. Parts and Accessories, nes of Motor Vehicles	784	38433
28. Other Transport Equipment, nec	785-786 791-792	-
29. Professional, Scientific and Controlling Instruments, nes, Watches and Clocks	871-874,885	38510,38530
30. Photographic and Optical Goods	881-884	38520
31. Jewellery and Related Articles, nec	897	39011,39019
32. Toys	894	39022
33. Other Miscellaneous Articles, nec	892-893,895 896,898,899	39019-39096

APPENDIX TABLE 6

Value-Added in Singapore's Manufactures by Major Industry Groups, 1979

Industrial Code	Wage Value-Added Per Worker ($)	Non-Wage Value-Added Per Worker ($)	Value-Added Per Worker ($)
32111-32112	6750	9594	16344
32132-32133	4983	2983	7966
32202	4635	3113	7745
32209	4674	3766	8440
323	5269	5030	10299
342	8503	10414	18917
35210	11478	18715	30913
35229	11548	1229	12777
35231	10766	30232	40998
35691	7646	9827	17473
357	5858	10618	16476
361-362	11245	21020	32265
369	10375	28312	38687
371	12391	51733	64124
38112	8206	8215	16421
38139	8912	10531	19443
38141,38149	9123	11335	20458
38151,38159	7861	14506	22367
38291	10746	15251	25997
38299	9935	17831	27766
38319,38311	7340	9893	17233
38321-38322, 38329	6163	12312	18475
38399	6824	22326	29150
38411-38413	11914	18535	30449
38432	7929	14055	21984
38433	6150	9917	16067
38434	10095	15047	25142
38510,38530	6391	9212	15603
38520	6309	6061	12370
39011,39019	7795	21471	29266
39022	5554	7086	12640
39091,39096	6174	10768	16942

Source: Report on the Census of Industrial Production, 1979, Table 39

APPENDIX TABLE 7

Product Differentiation and Economies of Scale in Manufacturing Industries, 1979

Industrial Code	PD Index	SE Parameter
32111-32112	0.85	-0.119
32132-32133	0.80	-0.119
32202	0.93	-0.123
32209	2.20	-0.117
323	-	-0.121
342	2.30	-0.056
35210	2.50	-0.225
25229	1.80	-0.226
35231	1.24	-0.225
35691	1.50	0.020
357	1.36	-0.208
361/2	2.20	-0.150
369	1.40	-0.080
371	0.80	-0.151
38112	1.38	-0.187
38139	1.02	-0.187
38141,38149	1.05	-0.187
38151,38159	0.97	-0.187
38291	0.64	-0.096
38299	0.98	-0.116
38319,38311	0.94	-0.105
38321-38322	0.84	-0.105
38329	1.22	-0.095
38399	1.89	-0.118
38411-38413	1.52	-0.071
38432	1.47	-0.117
38433	2.23	-0.118
38510,38530	1.22	-0.088
38520	0.89	-0.089
39011,39019	-	-0.175
39022	2.20	-0.175
39091,39096	2.20	-0.176

Source: As explained in the text

Note: PD - Product Differentiation;
SE - Economies of Scale

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