PRODUCTIVITY, FACTOR ACCUMULATION AND ECONOMIC POLICY: THE CASE OF KOREA AND SINGAPORE

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ABSTRACT

This paper adresses growth measurement within the traditional growth accounting framework, by relating growth in labor productivity and growth in total factor productivity (TFP) to economic policies. Additionally, the relationship between TFP and measurements of human capital and scale economies was analyzed.

The study was conducted by studying two developing countries, Korea and Singapore, characterized by an outward orientation of their economies. In Korea, which followed diversified and flexible strategies export promotion, productivity growth seemingly was due to scale economies and human capital accumulation, whereas in Singapore, an entrepot-based re-export economy, productivity growth was almost zero.

The high growth in Singapore is seemingly originated by factor accumulation rather than by an increase in productivity. The low productivity growth was presumably due to comparative advantages in assembly-type activities, resulting from the immigration of low skilled labor from neighboring countries.

In short, the paper emphasizes the paramount importance of factor measurement, manufacturing industry structure, economic policy, human capital accumulation and productivity as key issues to attain economic growth.

SÍNTESIS

Este trabajo aborda la medición del crecimiento dentro del marco de la contabilidad de crecimiento tradicional filiando el crecimiento de la productividad del trabajo y el crecimiento de la productividad total de los factores (PTF) con las políticas económicas. Asimismo, se analiza la relación entre PTF y las mediciones de capital humano y de las economías de escala.

Para elaborar el trabajo se estudiarán dos países en desarrollo, Corea y Singapur, caracterizados por una orientación hacia el exterior de sus economías. En Corea, que siguió estrategias de promoción de exportación diversificadas y flexibles, el crecimiento de la productividad se debió aparentemente a economías de escala y a acumulación de capital humano, en tanto que en Singapur, una economía de reexportación basada en agregar valor a insumos importados, el crecimiento de la productividad fue casi nulo.

El alto crecimiento de Singapur está aparentemente basado en una acumulación de factores y no tanto en un aumento en la productividad. El bajo crecimiento de la

productividad se debió presumiblemente a ventajas comparativas en actividades de armaduría, derivadas de la inmigración de mano de obra poco calificada desde países vecinos.

En resumen, el trabajo subraya la importancia capital que reviste la medición de los factores, la estructura de la industria manufacturera, las políticas económicas, la acumulación de capital humano y la productividad como elementos esenciales para alcanzar el crecimiento económico.

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1. INTRODUCTION

This paper addresses the issue of measurement of growth within the traditional growth accounting framework. My primary interest is to relate growth in labor productivity and growth in total factor productivity (TFP) to economic policies on the basis of the cases of Korea and Singapore. In addition, I analyze the relationship between TFP and measurements of human capital and scale economies.

Over the last decade many studies have discussed the relations between growth performance, human capital, externalities, political stability and economic policies. Most of these issues have been approached either theoretically or empirically. Empirical studies usually resort to either aggregate data focusing on one particular country or cross-country regressions. Those who share the view that economic phenomena should be expressed in numbers, tend to be suspicious of a theory-based approach because, more often than not, the models are too complex to be contrasted with data or otherwise the concepts are extremely difficult to measure. In adition, authors who favour theoretical models quite oftenly come up with somewhat stylized facts to make their point. The problem here is, then, that it is possible to construct a great diversity of models that could well fit those stylized facts.

The second approach, cross-country regressions, is discussed in Fuentes (1993). One of the main conclusions stemming from that paper is that, given the nature of the aggregate data across countries, more efforts should be made to conduct studies at a more micro-economic level for specific countries. Harberger (1990) carries this conclusion even further. In his view, the key to better comprehend growth is to understand more about TFP. He also encourages economists to conduct studies of specific cases (country level, industry level and even firm level) to build a body of useful lessons. Furthermore, he also claims

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that gains in TFP can happen in different economic sectors at different time periods and illustrates this point by calculating the contribution of TFP for different decades and for different sectors of the economy in the U.S.A.

Harberger (1990) presents this type of studies as a challenge for this decade. This is so in the sense that it is hard to measure many of the concepts that people talk about, especially at the industry or firm level and particularly in developing countries where the data sometimes is practically unavailable or very noisy. This paper points in that direction.

This study is conducted in connection with two developing countries, Korea and Singapore, during the 1963-1983 time period. These two Asian countries have been among the most successful ones in the world in terms of growth rate of per capita GDP during the period studied.[1]

What these countries have in common is their outward-economic policy orientation over the period under study. They do, however, differ in the way that this type of orientation was attained. Korea followed an export-biased strategy with strong government intervention. Between 1964 and 1977 Korean authorities provided several incentives to exports as well as direct and indirect subsidies that fomented the use of more capital intensive technologies. Singapore, on the other hand, could be considered, for almost the entire period, as a small open economy with low barriers to trade and characterized by the participation of the government in the economic activities. I will explore how successful these policies have been in reaching high labor productivity and TFP growth rate.

The data for this study come from the manufacturing industry at three digits level of the International Standard Industrial Classification (ISIC). The participation of the manufacturing sector in GDP in Korea grew from 18 percent in 1965 to 32 percent in 1987. In Singapore growth went from 15 percent up to 30 percent over the same period. My aim is to relate such changes along with changes in the manufacturing industry structure to economic policies and human capital.

To study the evolution and the differences of the TFP growth rate across industries and across countries, it seems reasonable to first study the structure and evolution of key variables like value added distribution across sectors, capital and labor allocation across sectors, per worker value added and per worker capital across sectors and over time. Only after having accomplished this, we are now in a position to estimate the relevant parameters to be used in estimating gains or losses in TFP for the different industries and countries.

[1] From data presented in Summer and Heston (1988), the annual growth rate of per capita GDP for the period 1960-1985 was 5.95 and 7.45 percent for Korea and Singapore, respectively.

I examine these gains or losses in TFP over periods of high growth for both countries. For Korea I examine a period of high growth in productivity (1968-1978) and compare it with 1978-1983, and for Singapore I study the periods 1963-1970 and 1970-1983. There are two key questions that need be answered. On the one hand, whether the economic policies adopted at the time improved the performance of the different sectors. The answer to this question is seemingly in the affirmative, though there is nothing definite in this regard. On the other hand, the next relevant issue hinges on which mechanisms were used by each country to attain high labor productivity. In this context, mechanisms stand for comparative advantages, scale economies, government incentive schemes, geographical location, physical and human capital accumulation. This paper will explore the bearing of these mechanisms.

The structure of the paper is the following. The second section is a data preview providing answers to the questions related to industry structure and its changes over time through some descriptive and exploratory statistics. Section three shows the estimated TFP growth rate for each industry in each country, and for different sub-periods as well as some plausible hypothesis for the findings. In section four, different proxies for aggregate human capital are presented and related to the productivity growth calculated in the previous section. The paper ends with a section consisting of concluding remarks and two appendixes on data construction.

2. DATA PREVIEW

In this section I will analyze the manufacturing industry structure for the two countries under analysis. For a description of the data set and the variable constructions see Appendix 1.

The study is conducted over 21 years (1963-1983)[2] and over 24 industries, which add up to 504 observations in all per country. The data gathering methods of the U.N. survey varies across the countries studied herein. Specifically, the survey covers firms with more than 10 workers for Singapore, and more than 5 workers for Korea.

Tables 1 to 6 show the names and a description (in terms of value added distribution, capital, and labor allocation across industries) of the 24 industries considered in this paper for Korea and Singapore. In the next subsections this description of the manufacturing industry structure is related to the history of the economic policies applied in both countries.

[2] The choice of the time period is to some extent arbitrary. The data from the U.N. begins in 1963 for most of the countries.

Korea

Korea started an 'outward oriented' strategy that could be called an export promotion or an export-biased strategy as early as 1964. Korea's strategy can be summarized as[3]: 1) unification of exchange rate in one floating rate, 2) direct subsidies to exports and reduction in the exporter income tax, 3) reductions in the tariff paid on imported capital goods to be used in the production of exportables, and 4) increases in credit preferences for exporters. The latter was, undoubtedly, one of the most important in terms not only of a successful export-oriented strategy, but also of Korea's industrialization process.

According to Petri (1990), one can also attribute the exceptional fast growth of Korean exports to the entrepreneurial ability within the export sector and to the favorable external environment. Another two important characteristics of Korea's trade were not only the flexible composition of exports, but also their diversification. In Petri's opinion the former was mainly the result of physical and human capital accumulation, efficient labor markets, almost efficient capital allocation and efficient allocation of entrepreneurial talent. A plausible explanation of the latter characteristic could be found in the natural comparative advantages in labor intensive industries and the policy biased towards encouraging more capital intensive techniques (through a subsidy system). Hence, Korea featured this dual industrialization process favoring the development of both capital and labor intensive industries.

At this stage, a brief overview of Korean economic history is in line. During the sixties Korea was poorly endowed with capital relative to labor and hence it is not surprising to ascertain that exports were mainly concentrated in labor intensive commodities. In the seventies, however, the government intervened in the financial market to keep a low real interest rate in order to encourage investment. This intervention, as had been expected, created a gap between savings and investment that was narrowed via international borrowing.

All these policies were reflected by the mid-seventies in a high and positive effective rate of protection (ERP) for capital-intensive manufacturing sectors, and a negative ERP for intermediate and low capital-intensive sectors.

Tables 1 to 3 show the value added distribution and capital labor across the manufacturing sectors. In terms of value added distribution, what immediately draws our attention are the gains experienced, throughout the seventies, by some industries, such as, for instance, Electrical Machinery, Machinery and Transport Equipment. This phenomenon could also be observed in terms of capital and labor allocations which, clearly, were the result of sectoral government policies. Two

[3] For a wider discussion of theses policies see Kwon (1990) and Balassa (1990).

facts stand out very distinctly in Table 2. First, the significant decrease in capital allocated to the Other Chemical Products industry which was not accompanied by such a great decrease in value added and labor participation. Second, the importance gained, in terms of capital allocation, by the Iron and Steel industry accompanied by an increase in value added participation which was not accompanied by an increase in labor participation. This seemingly was due to a clear effect of the capital subsidies provided by the government in order to develop heavier industries.

Korea also experienced two attempts at import liberalization. The first, 1965-1967, was mainly characterized by a reduction in quantitative restrictions; but had a short-lived effect. The second occurred over a longer period (1978-1985) and was characterized by a reduction in both tariffs and quantitative restrictions. According to Kim (1990) none of these processes had any major negative impact on macroeconomic variables such as employment, investment, growth rate, etc.

Section III below will be devoted to an analysis on whether or not all these changes were also accompanied by increases in productivity.

Singapore

This country is an example of an open economy[4]. After Singapore's independence from Great Britain in 1959, the government introduced quantitative restrictions for selected import-competing activities and promoted the establishment of new companies through fiscal concessions. After its separation from Malaysia in 1965, Singapore started to reduce the quantitative restrictions very quickly (3 out of 230 commodity groups, which benefitted from these restrictions at the time, were still protected by them in 1973). In 1967, Singapore introduced several export incentives and reduced tariffs on intermediate inputs. This is a case of a country that developed an export-oriented sector without undergoing an import-substitution phase.

As far as international trade is concerned, the most significant characteristic of Singapore's openness is that this economy was engaged in re-export activities. Another two important features of the period under analysis, are the dominance of manufactures in exports and imports and, the high participation of foreign investors in the exportable sector.

Prior to an analysis of manufacturing exports, we must define what a re-export economy is. A 'narrow' definition will certainly include transit trade and entrepot-based exports. A broader definition would include all those exported commodities

[4] For an excellent discussion of this issue see Lloyd and Sandilands (1986).

with a high imported component. Using this distinction Lloyd and Sandilands (1986) calculated what they called the 'net' or the 'true' domestic export of each commodity. These authors found that the manufacturing sector increased its participation in Singapore's net domestic exports from 41.6 percent in 1964 to 72.3 percent in 1979. Even though the value added component in total exports also increased, the net domestic export did not increase its participation in total exports. Their conclusion is that, in its broader sense, Singapore can still be classified as a re-export economy as of 1982.

It is, however, necessary to analyze this phenomenon in the light of figures. Tables 4 to 6 show the value added distribution across the manufacturing sector, and the capital and labor allocation across sectors. In the beginning, this economy's exports were highly concentrated in Petroleum and Rubber products both of which have a high imported input component. As regards Petroleum Products, they were basically crude oil refined in Singapore to be re-exported subsequently. In value added terms, this sector increased its participation by 90 percent in the 1963-1970 period, corresponding also to a period of high increase in its exports. This increase was not accompanied by a reallocation of factors to that sector in a similar magnitude (Tables 5 and 6), indicating in this wise its category as a re-exportable commodity.

Over the same period (Table 4) two sectors lost importance: Printing and Rubber Products, whereas Electrical Machinery and Transport Equipment quickly increased their importance. The increase of the last two sectors was also accompanied by an important increment in labor allocation to those sectors, but with a slow reallocation of capital in favor of the expanded sectors. This observation suggests that these activities were of the assembly-type and that they were essentially developed for re-export purposes.

Over the seventies the expansion of the Petroleum and Coal sector slows down and it actually decreases its participation in the manufacturing sector (Table 4). Also, the expansion of Transport Equipment slows down and Machinery enters into a dynamic expansion in terms of value added, labor, and particularly capital allocation. It is important to note that sectors associated with natural resources (except petroleum) such as, for instance, food, wood, tobacco, leather, and furniture never increased their participation in a significant magnitude.

There are two more characteristics that should be noted in the case of Singapore. First, the high savings rate (33 percent of GDP)[5] which was even higher than in countries like Korea, Japan and the USA. Since public sector capital formation was never higher than one third of the total, one may assert that the main saving effort came from the private sector.

[5] See Kum-Poh (1986).

Second, the importance of foreign investors as owners of firms in the manufacturing sector[6]. In 1962, 31.4 percent of the manufacturing gross output was produced by wholly foreign-owned establishments and 23 percent of the gross output by joint venture establishments. Twenty years later (1982) 54.8 percent and 27.9 percent of the manufacturing gross output was produced by wholly foreign-owned establishments and joint ventures, respectively. This means an 83.2 percent increase in the importance of foreign investment in the manufacturing sector, taking as a reference establishments operated by either wholly-owned foreign concerns or by joint ventures. Taking gross output of foreign-owned establishments as a reference, the investment was mainly concentrated in Petroleum Products and Electrical Machinery. Concurrently, foreign owners have a significant participation in manufacturing exports, accounting for 84 percent of total manufactured exports. The importance of this fact will be discussed in the section on productivity.

Prior to a cross-country comparison, a few comments on the role of government in Singapore are required. For many authors (see, for example, Chen (1983), Chong-Yah (1986)) the people of Singapore, including its political leadership, played an important role in the development process. Government played an active role not only by dictating the 'right' policies but also because it owned many productive firms. Government provided fiscal incentives for investment such as, for instance, five-year income tax exemptions for pioneer industries, tax exemption for capital invested, tax reduction for manufacturing firms and export-oriented firms (4 percent tax instead of the usual 40 percent). Even at the end of the period under analysis, the Singaporean government provided tax incentives for investments, product development assistance, export incentives, investment guarantees signed with other countries, support for employee training programs, etc. (see Chen (1983) for a good description of all the incentives). On the other hand, Agell (1983) calculates the cost of capital including all these tax incentives and concludes that the taxes levied in the countries he analyzes (he does not include Korea) tended to misallocate investment and, consequently, to reduce overall productivity. This could be one of the factors that might have negatively affected productivity growth in Singapore.

Factor intensity and labor productivity

Tables 7 and 8 characterize each industry in terms of capital intensity and labor productivity[7], for each country. An index of the capital/labor ratio and value

[6] See Siow-Yue (1986) for an excellent description.

[7] Labor productivity is defined as value added per unit of labor. Labor is measured as number of workers engaged either directly or indirectly in the productive process. A better estimation of labor would be the number of hours worked, but this information is not available for all industries, countries and years considered herein.

added per worker was constructed assuming a value of 100 for the aggregate of the manufacturing industry.

Tables 7 and 8 suggest a few questions that immediately come to mind. Which is the ranking of industries in terms of capital intensity?, How does this ranking change over time?, Is this structure similar across countries?. I will provide an analysis through simple inspection and also through some exploratory and descriptive statistics.

Only five industries fall above the manufacturing industry average, in terms of capital/labor ratio, for both years and for the two countries, these are: Tobacco, Industrial Chemicals, Petroleum and Coal Products, Iron and Steel, and Non-ferrous Metals. Apart from these industries, Beverages and Glass are above the average in both countries in 1983. Singapore shows the largest difference between the highest and the lowest capital/labor ratio, with a high value for the index in the Petroleum and Coal Products.

An interesting descriptive statistic is firm size measured by the number of workers per establishment. Unfortunately, these statistics were not fully comparable across countries because of the limitations of the U.N. survey which includes firms with more than 5 employees for Korea and more than 10 employees for Singapore. These data are presented in Tables 9 and 10.

Table 9 shows the data for Korea. It can be ascertained how the outward orientation tended to increase the firms' average size. Most sectors (except Tobacco, Industrial Chemicals, and Iron and Steel) increase the average size of their establishments. Those sectors that increase their importance in the manufacturing sector (as discussed above) such as Machinery, Electrical Machinery and Transport Equipment increase their establishment size more than two-fold. What is surprising is that in most of the sectors firm size decreases during the import liberalization (1978-1983) stage. This could be due to the implicit subsidy to the firms through low interest rates and direct subsidy to capital investments that bring about capital-labor substitution.

In the case of Singapore (Table 10) the majority of the sectors experienced moderate increases in firm size over the sixties. Important exceptions are Electrical Machinery, Transport Equipment, Textiles and Non-ferrous Metals where the increase, over this decade, was significant. As stated above, the first two sectors experience a dynamic expansion over the sixties and it seems that this expansion made it possible to take advantage of scale economies. Petroleum Products, which was an expanded sector, also increased its firm size. In the next period (1970-1983), the industry that was most definitely declining, Rubber Products, continued to do so as it experienced a significant decrease in the average size of the establishments. Textiles and Transport Equipment also saw a decrease in their firm size, and Petroleum Products still found room to increase firm size.

Even though the data in these two tables cannot be compared across countries, they provide us with an insight of the correlation between the foregoing analysis (on policy and structural change) and the changes in firm size over different sub-periods.

Korea and Singapore: A Comparison

In all likelikood these two countries feature two commonalities, namely: the importance assigned to the 'outward' orientation of their economies and the setting up of incentives for investment. Nonetheless, the way in which these targets were reached differed.

In Korea, the government played an active role in leading the outward orientation by adopting an export-biased strategy and inducing investment in both physical and human capital. First, the government subsidized the exportable sector through tax rebates and tariff reductions on imported capital. In the late seventies the government began to eliminate these benefits to exporters and subsidized capital investment in those sectors that were capital intensive in order to develop heavy industries. These sectors also benefitted by an artificially low real interest rate. Second, Korea also went through a fast rate of human capital accumulation by increasing schooling rates and increasing the resources allocated to R&D[8]. As pointed out earlier, these policies were reflected on the sectoral composition of the manufacturing industries.

Singapore's economy could be not only classified as an open one, but also as one characterized by featuring an active government participation. The main characteristic of this economy is the concentration of its trade in re-export activities. In other words, given Singapore's strategic geographic location, the manufacturing sector had an increasing importance in the total exports, but with a high imported inputs component. The participation of the government was important not only on the productive side of the economy, but also in establishing clear rules to encourage foreign and domestic investment. Even though Singapore has also invested in R&D and in human capital, but to a lesser extent than Korea, its exports still seem to be highly concentrated in re-export activities. For this reason I would predict that this trend will be slowly reverted in the future.

[8] See Fuentes and Vatter (1991) and the discussion in the section on human capital below.

3. TFP ESTIMATIONS AND INTERPRETATIONS OF THE RESULTS

In order to compute the variations in TFP we need to calculate the capital output elasticities which in the case of the Cobb-Douglas production function are the same as the share of factor costs on total cost.

Under the assumption of constant return to scale production function and Hicks-neutral technological progress for each industry we can compute

$$(\hat{Y}_{it}-\hat{L}_{it}) = \theta_{Ki}(\hat{K}_{it}-\hat{L}_{it}) + T\hat{F}P_{it} \tag{1}$$

where the left hand side is the growth rate of labor productivity and the right hand side is the sum of the growth rate of capital/labor ratio and the growth rate of TFP. Note that in (1) $\theta \equiv \theta_{Ki} = (1-\theta_{Li})$ and subscript i indicates industry i. This is the traditional decomposition of labor productivity into capital deepening and a residual.

To estimate θ a trans-log production function was specified.[9] A general form of this type of production function, with variable returns to scale, can be written as:

$$\log(Y/L)_{it} = \alpha_i + \beta_{1i}\log(K/L)_{it} + \beta_{2i}[\log(K/L)_{it}]^2 + \gamma_i\log(L_{it}) + \mu_{it} \tag{2}$$

where γ captures the economies of scale. There are economies or diseconomies of scale depending on whether γ is either positive or negative[10].

Using (2), the capital-output elasticity is calculated as $\eta_{iK} = \beta_{i1} + 2\beta_{i2}\log(K/L)_{it}$ and the labor-output elasticity is $\eta_{iL} = \gamma + 1 - (\beta_{i1} + 2\beta_{i2})$. Even if the β's were assumed to be the same for all industries, the elasticities vary from industry to industry according to the capital/labor ratio. A more plausible assumption is that unless the β's are different, theoretically only one commodity will be produced.

However, there is a practical problem in the estimation. It concerns the small variability in the data set to estimate each production function independently.

[9] There are two methods to compute capital shares: an econometric method and direct computations from wage data. The latter gives higher capital shares than the former. See Fuentes (1992) for a sensitivity analysis of the results under both methods of computation.

[10] This formulation comes from the general form:

$$\log(Y) = \alpha + \phi_K \log(K) + \phi_L \log(L) + \phi_2 [\log(K/L)]^2$$

By adding and subtracting ϕ_L log(L) on the right hand side and by subtracting log(L) from both sides of this equation we obtain equation 2 in the text.

There are only 21 observation (1963-1983) for each industry. For this reason, I tried two different methodologies. The first assumes that the same β holds for all industries. The second aggregates industries in three groups according to high, medium and low capital intensity.

Before reviewing the results, it is now necessary to define TFP within this context. With constant return to scale the factor share coincides with the elasticities. But under conditions of variable returns to scale it is necessary to redefine capital share as

$$\theta_K = \frac{\eta_K}{\eta_K + \eta_L} \qquad (3)$$

and labor share as

$$\theta_L = \frac{\eta_L}{\eta_K + \eta_L} \qquad (4)$$

If the production function is homogeneous of degree ν then the factor shares are equivalent to the real return to the factor times the amount of the factor used divided by ν times the output, i.e., $\theta_K = F_K K / \nu y$.

The TFP now can be calculated as

$$TFP = \frac{Y}{K^{\theta_K} L^{\theta_L}} \qquad (5)$$

The change in TFP will be calculated using the variations of labor productivity and the capital/labor ratio variation.

Note that under this formulation the TFP captures two effects: a) scale economies, and b) technological progress and improvement in the factor quality. The calculations of the capital and labor shares are shown in tables 11 and 12. The industries were grouped according to the degree of k-intensity.

There is still one question that remains to be answered. Why are there such differences across countries in the production function and in the industry structure? At first sight it would seen that even though we are working with data at the 3 digits of ISIC classification, we are still faced with data aggregation problems. On the other hand, while industries may be very similar across countries in their classification, they may be producing quite different commodities, but on the other hand, there is a problem concerning an adequate estimation of capital stock. While the capital stock for Korea was computed by the Economic Planning Board, and that for Singapore it was directly obtained from the manufacturing census for 1963 and thereafter, the net investment was added. However, all estimations suffer from the aggregation problem, i.e., capital is a composite commodity, aggregated across the different industries that belong to each of the sectors defined in this paper and, therefore, any change in the relative price of the components of this composite commodity will make important differences in the capital stock used in the estimation of the production function. Also, the possibility of specificity of certain components of the capital stock even within each industry and certainly across industries, has not been considered because of a problem of the data.

There is also a problem concerning labor data. What is needed in the production function is a measure of hours worked rather than the number of workers. This problem is especially relevant in recession periods, when firms tend to adjust the hours worked rather than the number of workers due to the higher costs involved in the latter decision with respect to the former. This point is particularly important for economies severely affected by business cycles.

All these problems may be relevant in explaining the differences across countries in the industry structure. However, the results obtained may be useful when giving consideration to the importance of TFP (or residual) in the economic growth process and how important it is to arrive at a better understanding of what is inside that 'black box'. The purpose of this paper is to gain some understanding of the growth process for developing countries for which the data, required to perform this type of exercise, is difficult to find.

Using equation (2) plus the information in Tables 11 and 12 the TFP growth rates were estimated. I selected a few interesting sub-periods of fast growth to analyze what happened with TFP. For Korea I chose 1968-1983, and for Singapore 1963-1983.

Korea

The computations for Korea tend to confirm earlier studies showing that an important source of labor productivity increases in the manufacturing industry was the increase in TFP[11]. The labor productivity growth rate and TFP rates tended to be high over the period 1963-1973 but slowed down a bit over the second ten-

[11]See, for instance, Dollar and Sokoloff (1990) and Nishimizu and Robinson (1984). On the other hand Kwon and Yuhn (1990) found that the TFP does not contribute very much to labor productivity. This may be due to their production function which considers total output as a dependent variable and materials and energy as inputs apart from K and L.

year period. The analysis of the sub-periods tends to be quite informative for this country. One may follow part of this country's economic history by examining the results shown in Table 13. In 1964 Korea started an outward-oriented strategy, not only in the sense of liberalizing imports and unifying the exchange rate, but also by, what is even more important, providing incentives to increase exports. The effects of these policies, which were in effect as up to 1977, can be seen in Table 8 for the sub-period 1968-1978. Given that these reforms started in 1964 they did not seem to have any effect on the period 1963-1968. The rapid increase in labor productivity over the period 1968-1978 could be explained quite significantly by an increase in TFP. The reason, as already mentioned, may be found in the export-biased strategy that makes it possible to take advantage of international trade basically in two different ways: a) by taking advantage of possible unexploited economies of scale since the domestic firms could take a much wider market at an international level in their stride, and b) by availing itself of imported technology that heightens the possibilities to modernize the domestic productive processes.

The first advantage was discussed in section II (data preview), where an increase was observed in firm size over the period. Dollar and Sokoloff (1990) also found a positive relation between TFP growth rate and this measure of scale economies. Another advantage commonly related to openness is that relative international prices will give the 'right' sign for resource allocation. However, in the case of Korea the government has helped to create a comparative advantage in the manufacturing sector.

At this point, it is also worth mentioning the human capital factor. Among the developing countries, Korea showed one of the highest growth rates in student enrollment in the secondary and tertiary level of education. In addition, the number of people involved in R&D per million inhabitants grew at a high rate after 1973[12].

In 1977, due to short run considerations like business cycle problems, many of the trade reform components were reversed. Korea increased tariffs, reduced exporters' benefits and also kept a revalued exchange rate. All these factors favored both import and inward-trade diversion. This was also accompanied by credits at subsidized interest rates for the more capital intensive industries. There were slow-downs in both labor productivity and TFP over the period. The aggregate annual growth rate for the whole manufacturing industry decreased from 9.72 percent over 1968-1978 to 2.79 percent over 1978-1983. Even though this kind of 'inward' oriented strategy was followed only until 1981, because Korea was becoming engaged in a second period of import liberalization, this

[12]For a comparison of this type of stylized facts across countries and policy implications see Fuentes and Vatter (1991), and Hofman (1993).

could well be the reason why Beverages (313) was a contracted industry (Table 1) and showed a negative productivity growth rate. Given that TFP growth reflects cost reduction, and on account of the policies implemented, all the most capital intensive industries have positive TFP growth rates (see Table 13).

To sum up, if both growth rates in labor productivity and TFP over the entire period 1963-1983 alone are taken into account, an important part of the whole picture would be left out. Korea's manufacturing industry had important fluctuations in both labor productivity and TFP growth rate, and these fluctuations were quite different across industries. The results shown for the period 1968-1978 seem too high compared to those in Dollar and Sokoloff's (1990) study. There are two major differences that deserve being mentioned. The first one is that the elasticities used come from different specifications of the production function; here substantially low capital shares have been used. The second difference is the period under analysis. They study the growth rate over 1963-1979 which includes years 1963-1968 that were not characterized by the same high growth rate as that for the period 1968-1978.

Singapore

Singapore's performance in terms of productivity growth rate was far from being spectacular. It was surprising, in my opinion, that a country with one of the highest growth rates of per capita GDP in the world, and also with a high degree of industrialization did not show an important growth rate in TFP. There are important differences across industries and over the sub-periods defined. While over the period 1963-1970 the high capital intensive industries showed a significantly good performance in terms of both labor productivity and TFP (see Table 14), in the second sub-period (1970-1983), the growth rate of productivity slowed down even for these industries.

The first period, in Table 14, could be explained by bearing in mind that Singapore became independent from Great Britain in 1959 and that it was a multiethnic country with descendants from many and different cultures, such, as for instance, China, Great Britain, India and Malaysia. At the time, this economy was slowly establishing its foundations for the future. Among the important factors, one should mention the active participation of the government in the economic activity, the outward orientation of the economy and the tax structure which not only made this economy hinge on the exportable sectors, but also offered incentives to foreign investment.

The results for the period 1970-1983 are similar to those obtained by Tsao (1985) for the performance in manufacturing industries during the seventies. Basically, she found that there was growth without there being a corresponding increase in productivity. In her study of 28 manufacturing industries only 11 experienced a positive TFP growth rate. In the present study 11 out of 24 industries had positive productivity growth rates. She worked with gross output adding raw materials to the production function, whilst here I am working with value added. Also, she took the capital stock reported by the Census of Manufacturing Industry for 1970 , as the initial year, and then added the gross capital formation and deducted some depreciation rate based on the type of asset. In my particular case, I use figures reported as capital stock by the Census for 1963 (deflated by the domestic gross investment deflator), though adding the gross investment in real terms minus depreciation.

Tsao advanced three hypotheses to explain this 'kind of paradox'. The first one is the predominance of foreign investment made by transnational companies (as I discussed above), which tend to carry out R&D in the parent company and make little effort to adopt new technologies to the Singaporean environment. In my opinion, this could be a reason why heavier industries tend to do better in terms of productivity, since they may be owned by foreign investors. This conclusion flows from Tsao's Table 3 where she shows that the proportion of capital expenditure by foreign investors increased from 42.6 percent in 1968 to 73.1 percent in 1979. While in 1968 they owned only 11.7 percent of the firms, in 1979 foreign investors owned 23.9 percent. Still the number of firms owned by foreign investors was small compared with the capital expenditures.

The second hypothesis is the 'low wage' policy and the immigration of low-skilled workers from neighboring countries. This fact would tend to preserve the assembly-type operations and would not allow for an increase in productivity. The idea underlying this policy was to preserve competitiveness since in the late sixties and early seventies full employment was attained. According to Chen (1983), however, it is necessary to recognize two periods after 1969. The first one (1972-1975) where nominal wages increased very rapidly (16.6 percent) and a second period where the authorities decided to lower wage increases on account of the 1973-1974 recession. But a policy of high wage increases was pursued and this may have negatively affected the performance of some industries. In Table A2.1 (Appendix 2) it is possible to visualize how the labor force composition changed to become more concentrated in less skilled labor over the period 1974-1978.

The third hypothesis focuses on the low technological capability. She arrived at this conclusion by comparing Singapore to Korea where a large increase in human capital investment and R&D took place. This point will be discussed in more detail below. As a matter of fact, in the seventies Singapore did invest significantly in human capital.

Seemingly, Tsao's first two hypotheses point in the right direction, i.e., that Singapore's manufacturing industry tended to concentrate in assembly-type activities. These two reasons, in conjunction with its status as essentially a re-export economy, could well account for this low productivity increase. The fact that Singapore presented fast capital formation, leads the writer to think that the labor productivity increase over 1970-1983 is explained by capital deepening.

Using the same framework of growth accounting but with macroeconomics data, Tsao (1986) arrives at the same conclusion in that there was no productivity growth. Though these hypotheses may be 'reasonable', it is hard to believe that a country can experience such a great growth rate in per capita income without a commensurate increase in productivity. Chen's (1983) view is that an important part of the explanation lies not only in the cultural and the social background of the population, but also on Singapore's strategic geographical location which favors taking full advantage of international trade.

Young (1992) argues that active government policies were a strong trigger mechanism which rapidly activated factor accumulation in Singapore and he further stated that this enhanced factor accumulation, rather than any increase in TFP whatsoever, was responsible for Singapore's spectacular growth over the last decades.

Another hypothesis, which could possibly be derived, is to be found in Agell's study. As indicated above he argues that tax incentives to promote investment have tended to a misallocation of investments across sectors. Therefore, this factor will bring about an overall reduction in productivy.

To put it briefly, I have described the industrial structure and the evolution of industrial productivity in two different countries, both of which display a very dynamic industrialization process. Furthermore, there do exist important differences between these two newly industrialized countries concerning their performance in terms of productivity. Some hypotheses to explain these findings have been roughly described.

4. THE ROLE OF HUMAN CAPITAL

A Conceptual Point

When discussing human capital there is invariably an important issue which comes up as to how it should be measured. In a companion paper I discussed some of the issues involved and also the problems of considering only primary and secondary enrollment as proxies for this variable[13]. The problem becomes more complex if our interest is focused on human capital 'embodied' in the labor force used by industries at the disaggregation level at which I am working here. However, it can still be argued that improvement in the average quality of the

[13]See Fuentes (1993).

labor force will bring about differences across industries. If the production function is re-written in a traditional way:

$$Y = \phi(K,L,t) = R(t)F(K,L) \tag{6}$$

where Y is total output, K is capital, L is labor and t represents time. The first function, ϕ, is a general production function where total output depends on two production factors, K and L, and on the technological stock which is represented by t. The second equality is a special case of the former where a Hicks neutral technological change is assumed. This is the basic formulation presented by Solow (1957). However, it will be seen that R(t) can have a broader interpretation, as it was pointed out by Harberger (1990), as, for example, 'cost reduction'. Also, assuming that F(.) exhibits constant return to scale, R(t) will reflect not only technological changes, but also the existence of increasing returns. Therefore, R could be also a function of Y, K or L (see Fuentes (1992)).

From equation (6), R(t) could be also called TFP, since we can rewrite (1) and define R(t) as:

$$\frac{Y}{F(K,L)} = R(t) \tag{7}$$

The importance of R(t) is clear if we are concerned with the analysis of the growth rate of total output, as the total output growth rate cannot be explained in general by the growth rate of total factors. What concerns the economist is to understand what underlies R(t) and which factors affect this important component of the total output.

Now, writing (6) in terms of growth rate. By differentiating and dividing both sides by Y we obtain the well known equation:

$$\frac{\dot{Y}}{Y} = \frac{\dot{R}}{R} + \frac{F_K}{Y}\dot{K} + \frac{F_L}{Y}\dot{L} \tag{8}$$

where the subscript stands for the partial derivative of the function with respect to that argument and the dot is the derivative with respect to time. By rearranging (8) we can express K and L also in terms of growth rate.

$$\hat{Y} = \hat{R} + \theta_K \hat{K} + \theta_L \hat{L} \tag{8'}$$

where '^' means the growth rate of the variable and $\theta_K = F_K K/Y$ and $\theta_L = F_L L/Y$. Under the assumption of constant returns to scale and the producer equilibrium conditions, θ_K and θ_L are the share of capital and labor on total output and, accordingly, they are added to one.

In equation (8') the variation in R can be calculated as a residual after subtracting the growth rate of all factors weighted by their respective shares on total output from the growth rate of output. Changes in quality of labor and capital, increasing returns and technological changes are some of the variables that will be considered in the variation of R. In the remaining part of this section I focus my attention on the human capital effect.

I will introduce human capital in the above production function as a labor-augmenting type of technological progress. Hence, a distinction is made between labor L which is simply the number of workers and the effective units of labor which includes the correction by human capital. This is a straightforward way to include human capital which Uzawa (1965) introduced in a theoretical study of the process of growth. Since the final goal is to study the TFP at the level of the facturing industry, less attention will be paid to how human capital is produced and it will be deemed to be exogenous to the industrial sector.

Now, if we rewrite equation (6) including human capital:

$$Y_i = A_i(t)F(K_i, L_i(h+\lambda_i)) \qquad (9)$$

where h represents an index of general human capital and λ_i represents an index of specific human capital to the sector i[14]. Note that human capital enters here as a labor augmenting type of technological progress or also called Harrod-neutral technological progress. The main characteristic of this kind of technological process is that the marginal productivity of capital depends only on the ratio K/Y.

The effective unit of labor N is redefined as:

$$N_i = L_i(h_i+\lambda_i), \quad hence \quad Y_i = A_i(t)F(K_i, N_i) \qquad (10)$$

Rewriting this new formulation of the production function as in (3'), we obtain:

$$\hat{Y}_i = \theta_{Ki}\hat{K}_i + \theta_{Ni}\hat{L}_i + \theta_{Ni}(h+\lambda_i) + \hat{A}_i \qquad (11)$$

where the last two components on the right hand side are equal to the change in the residual (R) in equation (8').

[14] F should be also indexed by i since there is no reason for the production function to be the same for all industries; omissions were made to simplify notation.

Note that now the growth rate of the residual has the same component as before and the added improvement in the quality of the labor force. Also note that the effect of human capital can explain why there are differences in the importance of TFP across industries provided that θ_N's are different across industries. As Dollar and Sokoloff (1990) and Harberger (1990) pointed out, the growth rate of TFP seems to be more important in explaining the growth rate of output for some industries than for others. For example, if we assume that λ_i is zero, it is equivalent to saying that human capital is non-specific to sector i, and an increase in the average human capital (h) of the labor force will bring about a more important increase in total output of those industries that are more intensive in effective-units of labor. The magnitude of this effect is represented by θ_{Ni} in equation (11). The point is that differences in the growth rate of the residual could be accounted for by an increase in the average human capital of the labor force. Of course, this effect can be reinforced if the level of specific human capital to a given industry (λ_i) also increases. For example, if the quality of chemical engineers increases, it would be expected to have an important effect on the chemical industry but not elsewhere. So, it is possible to observe a more labor intensive industry (measuring intensity as the ratio of capital to man-hours or number of workers) than another, but the latter could still be more effective labor intensive due to the parameter λ. Note, also, that λ_i can be interpreted as an increase in experience in the labor force used in sector i or an increase in knowledge coming from R&D activities that move up the production function. It should be important to study not only the level of human capital, but also its composition and its allocation[15].

Some Measurements of Human Capital

Now that we know that increases in the aggregate human capital have an important impact for different industries, I will proceed to estimate three different measures of human capital that are related to the labor force quality and to possible externalities. The first measure is based on Selowsky's (1969) work[16] and is described in Appendix 2. It consists basically in estimating the change in the average quality of the labor force, which is the sum of all changes in the labor force composition (according to years of schooling) times each group's relative marginal productivity with respect to the average.

[15]This is one of the greatest problems to be faced in this study. There is no data, known by the author, to use as a proxy for specificity of human capital to each manufacturing sector for the countries covered in this project.

[16]See appendix 2 for a discussion of both the data used and on limitations of the data set.

From the construction of this variable there are two aspects that deserve highlighting. The first one is that while for the first ten-year period there are no important differences across the two countries, in terms of growth rate of human capital, during the second period Korea clearly appears to surpass Singapore with a growth rate of 9.8 percent (see Table A2.2). This is almost four times higher than the ones observed for Singapore (about 2.6 percent) for an elasticity of substitution across labor groups equal to 2. It must be borne in mind that Korea was the country that showed a higher TFP growth rate than Singapore. The second one is the negative growth rate of human capital for the period 1974-1978 in Singapore, due to an increase in the importance of the third group of labor in the total labor force (Table A2.1). The hypothesis that explains this fact in Singapore emanates from the point noted by Tsao (1985) and mentioned in the previous section. During the seventies there was an important immigration of relatively low skilled workers from neighboring countries. For this reason the participation of the first group decreases and the other two increase (Table A2.1).

There are two other measures of changes in human capital that I would like to discuss here: the number of scientists and technicians involved in R&D and the number of students from these countries in the more developed countries[17]. The upper panel of Table 15 shows the total number of people engaged in R&D activities and also as a percentage of the economically active population. Korea, once again, shows a spectacular increase in the relative number of technicians and scientists devoted to R&D when compared to Singapore. The number of students from these countries in more developed countries is shown in the lower panel. Both, Korea and Singapore, show an important increase in the number of students studying abroad as a proportion of the economically active population. Even though these indicators allow us to envisage why the two Asian countries have grown so fast, both of them still do display some limitations that are worth mentioning here. The apparent relation between these indicators and growth does not necessarily imply causality, that is to say, after a country grows it will have enough resources not only to defray R&D, but also to send students abroad. Causality could operate in both ways. Additionally, the second indicator offers two problems. There was no information available regarding fields or level of education (undergraduate or graduate, the data only includes the broad name of tertiary level of education). Second, there is a lack of information about the proportion of students returning to their home countries after studying abroad. Anyway, it seems reasonable to expect an important explanation of the growth of the Asian economies based on accumulation of human capital.

[17]The countries were arbitrarily chosen and were as follows: Japan, Canada, United States, West Germany, France, United Kingdom, Belgium, Austria, and Switzerland.

It should be noted that the figures for people engaged in R&D activities can be related to the idea of externalities in a Romer sense[18], where knowledge is a public good that produces a positive externality across industries and this commodity is generated via R&D. It would appear that this relation does exist in what I have described thus far, but the problem of causality still persists.

The last line of Table 16 shows the number of graduates from the tertiary level of education as a percentage of the economically active population[19]. Korea shows an increase from 0.35 percent to 1.18 percent, while Singapore had a more moderate increase in this indicator from 0.52 percent to 0.71 percent. One could still be leery about these numbers and think that what matters for growth is the composition of higher education. This point was put into context by Murphy et al. (1991) in their discussion on the allocation of talent between rent-seeking activities and productive activities. The distinction they made was between lawyers, who basically tend to redistribute wealth, and engineers who tend to generate wealth. Table 16 also shows figures for the graduates from these two fields of study. The two countries show a reduction in the proportion of law and social sciences students. This could be due to a change in the classification for 1983 compared to 1973. For Korea, the participation of engineering students in the total number of graduates tends to increase, while for Singapore this indicator decreases. However, Singapore shows the highest proportion, between the two countries, of engineers in 1973 and 1983. However, it would be difficult to conclude that the composition of the graduates of the tertiary level of education by itself explains the important differences across these countries.

5. CONCLUDING REMARKS

As stated in the introduction, this paper dwells upon measurement. Economic growth was the subject analyzed from an empirical point of view. Several issues were brought up at different steps in this study, namely: factor measurement, manufacturing industry structure, economic policy, human capital and productivity.

This paper began by analyzing the manufacturing industry structure for Korea and Singapore. There was a lack of similarities in terms of the capital/labor ratio across these countries and also differences over time between both countries. This fact allows for different hypothesis: i) the commodities produced under a broad label of three digits of ISIC code may be very different across countries, ii)

[18]See Romer (1986, 1987). For a different point of view see Benhabib and Jovanovic (1991).

[19]Tertiary level of education entails either Undergraduate degree at College, involving from about three to five years of studies, or Graduate studies.

countries have followed a completely different path of factor accumulation, especially human capital, and iii) the clearly different economic policies followed in the different countries do have a great deal to say about the performance of productivity in them.

The first hypothesis does not need any further explanation since the characteristic of these countries, not only in terms of capital and labor, but also in terms of human capital and R&D investment are different. These characteristics determine the comparative advantages of each country and, consequently, the commodity mix under each industrial aggregate, thereby explaining a great deal of their production structure. The second hypothesis was discussed in the last section and I concluded that these two countries most definitely followed different human capital accumulation paths. If we keep the discussion about capital accumulation in mind, we know that capital formation rates in these countries have been quite different. The last hypothesis has been strongly emphasized as an explanation for both the manufacturing sector structure and productivity. What these two countries have in common is their outward orientation. Korea adopted, at a very early stage, an outward orientation mainly characterized by an export-biased strategy rather than a liberalization of the international trade. Singapore was definitely a small open economy throughout almost the entire period and its main characteristic is given by its condition as a re-export economy.

The results show a high correlation between the labor productivity growth rate and TFP growth rate. One can still argue that it was possible to derive this result due to measurement errors. However, this measurement error will have ambiguous effects on the estimates of capital share with variable return to scale for Singapore. For Korea the effect will be to bias the capital share toward zero, thus favoring the hypothesis that an important component of labor productivity could be explained by the TFP. On the other hand, this result seems to be consistent with Harberger's (1990) ideas. Moreover, there were important differences in labor productivity and TFP across industries and across periods for the same countries. Harberger's 'mushrooms' hypothesis seems to be supported by the data of these two countries.

Korea shows a steady increase in both labor productivity and TFP in its manufacturing industry, over the period 1968-1978. On the other hand Singapore, with an excellent performance at the macro level, does not show a especially high growth rate in labor productivity and TFP when compared to Korea. Human capital accumulation is the hypothesis that has been suggested in the literature. Although, both countries have accumulated this factor, under almost all the indicators presented here, Korea has done it at higher speed than Singapore in the seventies. However, Korea's human capital accumulation was the lowest during the sixties (see Table A2.2) and still this country showed a high growth rate of productivity between 1968-1973. The hypothesis of low skilled labor immigration into Singapore seems important to explain part of the low performance in TFP during part of the seventies, specifically in the period 1974-1978, where a deterioration of the quality of the labor force was brought about by this migrational flow. Prior to and following that period, Singapore recovers its trend.

The productivity growth in Korea seems to be mainly due to scale economies and human capital accumulation in the seventies. Korea takes advantage of scale economies based on its export promotion strategy. With respect to human capital I have argued (Section 4) that increases in the average human capital will favor in greater magnitude human capital intensive sectors, and therefore human capital could still be an explanation for differences in TFP growth rate across industries. The low TFP growth rate observed for Singapore could also be explained by the type of activities developed in that country. Important participation of foreign investors who tend, according to Tsao (1985), to develop R&D activities in the parent company and do not adapt the new technologies to Singapore. However, a counterfactual is that precisely those industries with higher participation of foreign investors experienced a higher TFP growth rate. On the other hand, the low skilled labor migrating from neighboring countries and the fact that it is definitely a re-export economy seems to keep Singaporean advantages in assembly-type activities. The low R&D and human capital investment, as argued by some authors, does not seem to be a good answer since Singapore shows important growth rates in these types of investment, which would make it possible to predict that in the future the comparative advantage of Singapore will tend to move toward more advanced technology intensive commodities.

In my opinion, there is no doubt that additional explanations to those presented in this paper could be given for the performances of the manufacturing industries in these countries. I hope the reader has been persuaded of two facts: a) the importance of economic policies for economic growth, especially at the sectoral level and b) the importance to understand what cannot be explained in terms of pure factor accumulation (in other words the residual left over after we have substracted the factor accumulation from output growth).

Further research along these lines is necessary to gain a better understanding of what underlies TFP and to arrive at a better measurement of the factors that affect it. Even though this paper was not intended as a comprehensive work aiming at a full list of all the variables accounting for the differences in growth performances of these two countries, it does, however, offer a methodology and a point of departure in order to derive measures of variables that explain growth.

TABLE 1

KOREA, VALUE ADDED DISTRIBUTION ACROSS SECTORS

Code	Industry Name	1963	1968	1978	1983
311	Food Products	8.96	7.67	7.52	7.34
313	Beverages	9.29	8.45	5.63	2.95
314	Tobacco	13.94	7.46	5.38	5.97
321	Textiles	17.76	15.95	14.18	10.99
322	Clothing and Footwear	2.49	4.22	5.28	5.31
323	Leather Products	0.33	0.24	1.15	0.81
331	Wood Products e.f.	3.49	4.12	2.29	1.19
332	Furniture e.m.	0.66	0.72	0.57	0.65
341	Paper Products	3.82	2.96	2.23	2.43
342	Printing	4.15	3.20	1.92	2.59
351	Industrial Chemicals	2.80	7.73	4.69	4.61
352	Other Chemical Products	6.43	5.08	5.05	4.97
353	Petroleum and Coal Products	2.49	5.89	4.12	5.08
355	Rubber Products	2.99	2.25	2.82	2.53
356	Plastic Products	0.32	0.72	1.36	1.81
361	Pottery	0.53	0.34	0.34	0.41
362	Glass	0.92	0.75	0.98	0.84
369	Non-Metallic Products	4.69	5.28	3.80	3.78
371	Iron and Steel	2.99	3.34	5.81	7.13
372	Non-ferrous Metals	0.50	0.51	1.02	1.20
381	Metal Products	2.32	2.79	3.74	4.22
382	Machinery	2.32	2.32	4.01	4.22
383	Electrical Machinery	2.49	3.54	9.12	10.35
384	Transport Equipment	3.32	4.46	7.00	8.62

TABLE 2

KOREA, CAPITAL ALLOCATION ACROSS SECTORS

Code	Industry Name	1963	1968	1978	1983
311	Food Products	12.53	9.73	6.27	5.82
313	Beverages	4.64	3.88	1.84	2.75
314	Tobacco	2.58	2.76	1.50	1.10
321	Textiles	17.67	19.61	17.66	13.08
322	Clothing and Footwear	2.10	1.73	2.19	1.74
323	Leather Products	0.46	0.25	0.66	0.51
331	Wood Products e.f.	3.20	3.25	1.90	1.71
332	Furniture e.m.	1.06	0.52	0.27	0.36
341	Paper Products	1.97	3.10	2.21	2.16
342	Printing	4.43	2.81	1.82	1.46
351	Industrial Chemicals	3.05	7.94	5.83	6.65
352	Other Chemical Products	11.59	8.44	2.41	2.02
353	Petroleum and Coal Products	4.03	6.22	3.19	2.55
355	Rubber Products	2.47	1.99	2.19	2.37
356	Plastic Products	0.77	0.48	1.23	1.26
361	Pottery	0.15	0.25	0.30	0.29
362	Glass	0.12	1.45	0.92	1.07
369	Non-Metallic Products	5.23	8.88	5.53	4.86
371	Iron and Steel	5.46	4.70	16.07	21.67
372	Non-ferrous Metals	0.95	0.78	2.07	1.79
381	Metal Products	2.57	1.88	3.26	3.80
382	Machinery	2.56	2.25	5.82	5.69
383	Electrical Machinery	2.12	1.86	6.48	6.53
384	Transport Equipment	8.28	5.24	8.37	8.75

TABLE 3

KOREA, LABOR ALLOCATION ACROSS SECTORS

Code	Industry Name	1963	1968	1978	1983
311	Food Products	9.14	8.98	6.77	6.99
313	Beverages	4.11	3.63	1.39	1.31
314	Tobacco	2.20	1.24	0.73	0.64
321	Textiles	27.97	26.60	21.29	18.20
322	Clothing and Footwear	4.39	7.14	11.88	12.57
323	Leather Products	0.46	0.32	1.57	1.39
331	Wood Products e.f.	3.09	4.43	3.08	2.00
332	Furniture e.m.	1.38	1.43	0.91	1.12
341	Paper Products	2.83	2.61	2.23	2.25
342	Printing	4.16	3.68	2.11	2.44
351	Industrial Chemicals	2.02	3.02	2.44	1.90
352	Other Chemical Products	4.57	3.29	2.66	2.61
353	Petroleum and Coal Products	3.78	2.13	0.76	0.77
355	Rubber Products	4.85	3.67	5.08	5.76
356	Plastic Products	0.35	0.72	1.61	2.35
361	Pottery	1.25	1.24	0.70	0.81
362	Glass	0.77	1.04	0.91	0.85
369	Non-Metallic Products	4.04	4.86	3.12	3.09
371	Iron and Steel	2.61	3.37	3.40	3.43
372	Non-ferrous Metals	0.77	0.54	0.78	1.09
381	Metal Products	3.83	4.48	4.82	5.57
382	Machinery	3.70	3.44	4.38	4.80
383	Electrical Machinery	2.63	3.90	11.64	11.23
384	Transport Equipment	5.11	4.22	5.77	6.82

TABLE 4

SINGAPORE, VALUE ADDED DISTRIBUTION ACROSS SECTORS

Code	Industry Name	1963	1970	1980	1983
311	Food Products	7.09	6.93	3.17	3.68
313	Beverages	8.16	3.19	1.32	1.54
314	Tobacco	6.74	2.28	0.64	0.93
321	Textiles	0.24	2.19	1.91	0.98
322	Clothing and Footwear	1.18	2.74	3.45	3.65
323	Leather Products	0.35	0.27	0.16	0.14
331	Wood Products e.f.	4.97	5.47	2.19	1.45
332	Furniture e.m.	1.77	1.00	1.02	1.15
341	Paper Products	0.71	1.09	1.14	1.52
342	Printing	10.64	4.65	3.36	4.77
351	Industrial Chemicals	0.50	1.46	1.32	1.48
352	Other Chemical Products	2.48	3.10	3.68	5.16
353	Petroleum and Coal Products	10.86	19.16	17.78	14.39
355	Rubber Products	13.12	5.11	1.14	0.76
356	Plastic Products	0.32	1.09	2.10	2.03
361	Pottery	0.48	0.18	0.02	0.03
362	Glass	1.91	0.73	0.28	0.33
369	Non-Metallic Product	6.48	2.10	2.10	3.98
371	Iron and Steel	1.37	1.55	1.60	1.28
372	Non-ferrous Metals	0.40	0.46	0.27	0.34
381	Metal Products	7.09	6.57	5.03	7.20
382	Machinery	2.48	2.55	9.01	9.05
383	Electrical Machinery	3.55	11.59	24.50	24.52
384	Transport Equipment	7.09	14.51	12.82	9.66

TABLE 5

SINGAPORE, CAPITAL ALLOCATION ACROSS SECTORS

Code	Industry Name	1963	1970	1980	1983
311	Food Products	5.51	9.86	4.44	4.18
313	Beverages	16.44	5.31	1.20	1.09
314	Tobacco	4.60	2.31	0.59	0.49
321	Textiles	0.64	3.85	3.79	2.78
322	Clothing and Footwear	0.17	2.60	2.75	2.40
323	Leather Products	0.05	0.28	0.10	0.10
331	Wood Products e.f.	2.49	5.68	3.80	2.77
332	Furniture e.m.	0.53	0.74	0.92	0.89
341	Paper Products	0.86	1.64	1.10	2.02
342	Printing	7.58	6.77	3.32	3.57
351	Industrial Chemicals	2.30	2.06	2.20	2.44
352	Other Chemical Products	1.87	2.29	1.84	2.55
353	Petroleum and Coal Products	23.59	19.95	27.03	24.18
355	Rubber Products	0.85	2.85	1.14	0.88
356	Plastic Products	0.56	1.74	2.80	2.83
361	Pottery	1.38	0.92	0.24	0.29
362	Glass	1.34	0.44	0.31	0.39
369	Non-Metallic Product	8.19	3.69	2.13	2.18
371	Iron and Steel	2.01	1.68	1.28	1.20
372	Non-ferrous Metals	0.26	0.31	0.45	0.45
381	Metal Products	5.19	6.57	5.03	6.56
382	Machinery	1.54	1.86	7.41	8.52
383	Electrical Machinery	2.39	5.28	15.42	17.46
384	Transport Equipment	9.65	11.32	10.71	9.79

TABLE 6

SINGAPORE, LABOR ALLOCATION ACROSS SECTORS

Code	Industry Name	1963	1970	1980	1983
311	Food Products	12.84	7.80	3.73	3.95
313	Beverages	4.66	2.02	0.98	0.95
314	Tobacco	3.02	0.90	0.47	0.33
321	Textiles	0.49	6.07	3.60	1.77
322	Clothing and Footwear	3.64	10.32	10.65	10.90
323	Leather Products	0.49	0.61	0.46	0.37
331	Wood Products e.f.	8.79	7.92	3.85	2.28
332	Furniture e.m.	1.41	1.55	2.28	2.63
341	Paper Products	1.51	2.20	1.59	1.45
342	Printing	11.74	6.04	4.49	5.28
351	Industrial Chemicals	0.51	0.70	0.79	0.87
352	Other Chemical Products	2.73	2.63	1.59	1.75
353	Petroleum and Coal Products	0.97	1.89	1.24	1.44
355	Rubber Products	16.40	5.59	1.51	0.86
356	Plastic Products	0.81	1.89	3.42	3.28
361	Pottery	1.11	0.79	0.06	0.06
362	Glass	1.05	0.75	0.30	0.32
369	Non-Metallic Product	5.74	2.62	1.38	2.51
371	Iron and Steel	0.82	0.93	0.70	0.63
372	Non-ferrous Metals	0.31	0.35	0.17	0.24
381	Metal Products	8.30	7.48	6.55	8.10
382	Machinery	3.74	3.28	7.52	8.58
383	Electrical Machinery	3.54	11.70	32.51	31.11
384	Transport Equipment	5.38	13.95	10.17	10.35

TABLE 7

INDEX OF MANUFACTURING CAPITAL INTENSITY

Code	Industry Names	Korea (1973)	Singapore (1973)	Korea (1983)	Singapore (1983)
300	All Industries	100	100	100	100
311	Food Products	108	110	83	106
313	Beverages	92	138	209	115
314	Tobacco	124	144	171	147
321	Textiles	79	70	72	157
322	Clothing and Footwear	24	24	14	22
323	Leather Products	103	28	37	27
331	Wood Products e.f.	81	78	85	122
332	Furniture e.m.	48	30	32	34
341	Paper Products	115	60	96	139
342	Printing	87	102	60	68
351	Industrial Chemicals	252	373	349	279
352	Other Chemical Products	138	81	77	146
353	Petroleum and Coal Products	475	2103	331	1680
355	Rubber Products	33	64	41	103
356	Plastic Products	69	70	54	86
361	Pottery	36	484	36	463
362	Glass	115	81	126	125
369	Non-metallic Products	213	120	157	87
371	Iron and Steel	360	201	632	190
372	Non-ferrous metal	145	380	165	184
381	Metal Products	60	81	68	81
382	Machinery	74	47	119	99
383	Electrical Machinery	55	34	58	56
384	Transport Equipment	139	84	128	95

TABLE 8

INDEX OF MANUFACTURING INDUSTRY OF PER WORKER VALUE ADDED

Code	Industry Names	Korea (1973)	Singapore (1973)	Korea (1983)	Singapore (1983)
300	All Industries	100	100	100	100
311	Food Products	71	104	105	93
313	Beverages	247	108	225	162
314	Tobacco	376	197	929	278
321	Textiles	69	65	60	55
322	Clothing and Footwear	43	30	42	34
323	Leather Products	86	53	58	36
331	Wood Products e.f.	113	81	60	64
332	Furniture e.m.	29	48	58	44
341	Paper Products	119	71	108	105
342	Printing	58	91	106	90
351	Industrial Chemical	185	279	242	169
352	Other Chemical Products	137	194	190	295
353	Petroleum and Coal Products	585	895	659	1000
355	Rubber Products	50	111	44	89
356	Plastic Products	100	70	77	62
361	Pottery	39	47	50	43
362	Glass	80	90	99	103
369	Non-metallic Products	131	149	122	159
371	Iron and Steel	252	285	208	203
372	Non-ferrous metal	131	157	110	140
381	Metal Products	58	88	76	89
382	Machinery	72	80	88	105
383	Electrical Machinery	78	83	92	79
384	Transport Equipment	114	107	126	93

TABLE 9

KOREA, NUMBER OF WORKERS PER ESTABLISHMENTS

Code	Industry Name	1968	1978	1983
311	Food Products	17.8	42.2	42.9
313	Beverages	14.1	22.6	27.1
314	Tobacco	1466.7	768.4	613.6
321	Textiles	66.7	96.5	68.3
322	Clothing and Footwear	14.5	74.5	66.5
323	Leather Products	32.9	77.3	42.9
331	Wood Products e.f.	28.2	41.8	25.2
332	Furniture e.m.	11.0	19.8	25.8
341	Paper Products	35.5	49.0	39.8
342	Printing	25.6	38.5	27.6
351	Industrial Chemical	128.1	58.1	53.5
352	Other Chemical Products	59.0	86.7	80.4
353	Petroleum and Coal Products	17.6	45.8	51.9
355	Rubber Products	192.6	304.2	202.2
356	Plastic Products	38.9	51.5	32.7
361	Pottery	18.4	43.5	55.4
362	Glass	85.1	112.3	100.0
369	Non-Metallic Product	17.6	34.0	28.0
371	Iron and Steel	136.6	129.1	116.1
372	Non-ferrous Metals	36.9	50.0	52.8
381	Metal Products	24.4	47.5	39.3
382	Machinery	22.2	54.5	39.8
383	Electrical Machinery	68.1	167.2	102.9
384	Transport Equipment	50.8	142.6	120.0

TABLE 10

SINGAPORE, NUMBER OF WORKERS PER ESTABLISHMENTS

Code	Industry Name	1963	1970	1983
311	Food Products	33.0	40.8	35.7
313	Beverages	91.0	106.8	155.6
314	Tobacco	98.3	105.0	145.0
321	Textiles	35.7	143.9	53.1
322	Clothing and Footwear	29.0	59.1	64.4
323	Leather Products	31.7	33.8	26.2
331	Wood Products e.f.	41.8	55.8	54.1
332	Furniture e.m.	45.8	45.0	54.0
341	Paper Products	26.8	42.7	43.1
342	Printing	36.9	42.5	43.0
351	Industrial Chemical	69.0	62.3	45.6
352	Other Chemical Products	43.8	41.4	53.8
353	Petroleum and Coal Products	98.8	244.4	341.8
355	Rubber Products	142.2	104.7	48.7
356	Plastic Products	23.4	38.4	39.8
361	Pottery	143.8	230.0	41.3
362	Glass	102.0	174.0	137.5
369	Non-Metallic Product	78.7	67.6	72.9
371	Iron and Steel	287.0	77.1	110.0
372	Non-ferrous Metals	31.1	102.5	35.6
381	Metal Products	37.7	55.0	49.7
382	Machinery	25.2	37.4	65.8
383	Electrical Machinery	60.0	212.3	258.1
384	Transport Equipment	72.4	193.0	92.9

TABLE 11

KOREA, CAPITAL SHARES USING A VRS PRODUCTION FUNCTION

Code	Industry Name	63-73	73-83
	High Capital Intensive		
353	Petroleum and Coal Products	0.51	0.45
371	Iron and Steel	0.55	0.42
351	Industrial Chemicals	0.53	0.48
369	Non-metallic Products	0.55	0.50
372	Non-ferrous Metals	0.57	0.50
384	Transport Equipment	0.59	0.52
352	Other Chemical Products	0.55	0.56
314	Tobacco	0.56	0.51
	Intermediate Capital Intensive		
341	Paper Products	0.22	0.32
362	Glass	0.33	0.34
311	Food Products	0.22	0.30
313	Beverages	0.18	0.41
342	Printing	0.16	0.26
331	Wood Products e.f.	0.18	0.27
321	Textiles	0.14	0.27
382	Machinery	0.14	0.36
	Low Capital Intensive		
323	Leather Products	0.34	0.34
356	Plastic Products	0.34	0.34
381	Metal Products	0.34	0.34
383	Electrical Machinery	0.34	0.34
332	Furniture e.m.	0.34	0.34
361	Pottery	0.33	0.34
355	Rubber Products	0.34	0.34
322	Clothing and Footwear	0.33	0.34

TABLE 12

SINGAPORE, CAPITAL SHARES USING A VRS PRODUCTION FUNCTION

Code	Industry Name	63-73	73-83
	High Capital Intensive		
311	Food Products	0.27	0.31
313	Beverages	0.31	0.31
314	Tobacco	0.30	0.32
351	Industrial Chemicals	0.32	0.35
353	Petroleum and Coal Products	0.39	0.42
361	Pottery	0.33	0.37
371	Iron and Steel	0.29	0.34
372	Non-ferrous Metals	0.28	0.35
	Intermediate Capital Intensive		
321	Textiles	0.27	0.47
331	Wood Products e.f.	0.25	0.46
341	Paper Products	0.25	0.43
342	Printing	0.33	0.41
352	Other Chemical Products	0.29	0.47
362	Glass	0.41	0.49
369	Non-metallic Products	0.35	0.49
384	Transport Equipment	0.36	0.45
	Low Capital Intensive		
322	Clothing and Footwear	0.13	0.22
323	Leather Products	0.16	0.21
332	Furniture e.m.	0.17	0.27
355	Rubber Products	0.21	0.35
356	Plastic Products	0.26	0.36
381	Metal Products	0.27	0.36
382	Machinery	0.21	0.36
383	Electrical Machinery	0.23	0.30

TABLE 13

KOREA, LABOR PRODUCTIVITY AND TFP VARIATIONS

Code	Industry Name	Y/L (1968-1978) % variations	TFP (1968-1978) % variations	Y/L (1978-1983) % variations	TFP (1978-1983) % variations
	High Capital Intensive				
353	Petroleum and Coal Products	18.42	13.24	9.78	8.78
371	Iron and Steel	16.96	5.95	9.71	4.32
351	Industrial Chemicals	7.60	4.77	10.56	3.39
369	Non-metallic Products	12.02	8.71	5.55	3.25
372	Non-Ferrous Metal	14.34	6.90	1.90	3.19
384	Transport Equipment	12.28	7.60	6.39	4.02
352	Other Chemical Products	13.06	15.35	5.56	3.41
314	Tobacco	13.01	9.93	10.57	8.89
	Intermediate Capital Intensive				
341	Paper Products	9.33	8.33	7.19	5.03
362	Glass	15.27	14.29	3.81	-0.73
311	Food Products	13.68	12.67	4.38	2.80
313	Beverages	17.05	15.46	-6.22	-14.44
342	Printing	11.27	10.07	8.84	8.94
331	Wood Products e.f.	8.29	7.47	0.95	-3.38
321	Textiles	11.91	10.83	3.47	2.28
382	Machinery	14.21	12.28	4.69	2.78
	Low Capital Intensive				
323	Leather Products	10.75	10.67	0.71	-0.70
356	Plastic Products	9.00	6.37	3.49	3.51
381	Metal Products	13.18	9.29	5.05	2.53
383	Electrical Machinery	9.10	6.40	9.02	6.25
332	Furniture e.m.	13.25	11.81	4.04	1.16
361	Pottery	17.24	12.43	6.36	5.27
355	Rubber Products	9.67	8.34	0.67	-1.39
322	Clothing and Footwear	7.61	6.46	4.45	4.04

TABLE 14

SINGAPORE, LABOR PRODUCTIVITY AND TFP VARIATIONS

Code	Industry Name	% variations Y/L (1963-1970)	% variations TFP (1963-1970)	% variations Y/L (1970-1983)	% variations TFP (1970-1983)
	High Capital Intensive				
353	Petroleum and Coal Products	0.68	4.67	3.10	-2.38
361	Pottery	-6.58	-6.15	8.29	0.63
372	Non-ferrous Metals	2.13	2.19	3.84	-1.75
351	Industrial Chemicals	13.90	15.83	1.52	-1.86
371	Iron and Steel	2.13	3.46	4.75	1.18
314	Tobacco	4.03	1.95	3.97	2.05
313	Beverages	0.71	2.04	3.38	2.13
311	Food Products	9.39	5.03	3.58	0.76
	Intermediate Capital Intensive				
369	Non-metallic Products	-2.67	-2.45	8.76	5.48
342	Printing	-0.16	-2.53	4.47	1.83
384	Transport Equipment	-1.21	2.54	2.35	-2.82
352	Other Chemical Products	6.06	5.25	10.75	3.95
362	Glass	-6.58	-3.32	3.67	-4.11
331	Wood Products e.f.	5.19	2.00	2.53	-4.15
321	Textiles	-2.10	0.49	6.64	-1.82
341	Paper Products	3.04	2.24	9.29	2.71
	Low Capital Intensive				
381	Metal Products	2.60	1.39	3.29	-0.40
356	Plastic Products	7.95	6.92	3.71	-0.04
355	Rubber Products	4.17	-3.87	2.94	-3.17
382	Machinery	4.57	3.68	5.63	-0.14
383	Electrical Machinery	2.02	3.39	1.40	-2.50
332	Furniture e.m.	-7.05	-7.57	0.17	-2.01
323	Leather Products	-4.66	-8.31	1.57	0.13
322	Clothing and Footwear	-0.72	-4.16	5.07	2.89

TABLE 15

NUMBER OF SCIENTISTS AND TECHNICIANS ENGAGED IN R&D

KOREA

Year	1973	1978	1983
Total	9974	23658	58720
As % of EAP	0.09	0.18	0.40

SINGAPORE

Year	1974	1978	1983
Total	370	728	3512
As % of EAP	0.04	0.07	0.29

STUDENTS IN DEVELOPED COUNTRIES

KOREA

Year	1973	1978	1983
Total	4554	6157	18283
as % of EAP	0.04	0.05	0.13

SINGAPORE

Year	1974	1978	1983
Total	1095	2985	5648
As % of EAP	0.13	0.30	0.47

Source: UNESCO.

EAP means economically active population.

The data were obtained from ILO.

TABLE 16

GRADUATES FROM THE TERTIARY LEVEL OF EDUCATION
(selected years and selected fields)

	KOREA 1973	KOREA 1983	SINGAPORE 1973	SINGAPORE 1983
as % total				
Engineering	21.87	34.07	48.42	40.86
Law and Social Sciences	17.56	6.14	17.71	1.25
as % EAP				
Engineering	0.10	0.40	0.25	0.29
Law and Social Sciences	0.08	0.07	0.09	0.01
Total	0.35	1.18	0.52	0.71

Source: UNESCO.
EAP: Means economically active population. These data were obtained from ILO. For Korea and Singapore these data were available only for 1974.
The figures for Singapore in 1983 only includes Law students.

APPENDIX 1

Data Construction

I worked with industries at the three digit level of ISIC classification. The codes and the names are shown in table 1. It is worth pointing out that industry 353 (Petroleum Refineries) includes 354 Misc. Products of Petroleum and Coal). For some years in the sixties, some of the industries were aggregated (e.g. 356,385 and 390; 361, 362 and 369). To disaggregate them, in order to get what I have in table 1, I took the first year of completely disaggregated data and using proportions from that year I extrapolated back to the sixties.

Korea. The data of workers and value added was taken from the U.N. Yearbook of Industrial Statistics. The capital stock data was prepared by the Economic Planning Board and appears in "Preliminary Data on Korea Capital Stock by Industry, 1960-1979". In this data industries 322 and 324 were aggregated and also 353 and 354; accordingly, I retained the same aggregation for Singapore.

The value added was in nominal terms and therefore was deflated using the manufacturing GDP deflator published by the U.N. The capital data was million won of 1977, in order to transform it in million won at 1980 value, a deflator of gross fixed capital formation was used.

Singapore. The same sources were used to obtain value added and labor. Figures for capital stock in nominal terms were available from the Census of Manufacturing Industry.

During the sixties many of the industries were aggregated in groups of 2 or 3 industries. In order to obtain the original figures for each sector, the proportion for each industry in the group according to 1970 was used, since this was the first year for which the capital stock was available for each industry according to the three digits level of ISIC classification. In order to arrive at the capital stock series, the nominal stock of 1963 and deflated by the implicit deflator of investment was taken; then I added real gross investment and deducted a depreciation rate equal to 6,5 percent.

APPENDIX 2

Human Capital Estimation

The methodology presented here is the one used by Selowsky (1969) applied to data of salaries and labor force composition provided by the International Labour Office (ILO).[20] The first step is to define different types of labor. ILO divides the labor force in ten groups as follows:

0/1. Professional, technical and related workers.
2. Administrative and managerial workers.
3. Clerical and related workers
4. Sales workers.
5. Service workers.
6. Agricultural, animal husbandry and forestry workers, fishermen and hunters.
7/8/9. Production and related workers, transport equipment operators and laborers.
X. Workers not classified by occupation and individuals seeking a job for the first time.

Clearly, the first two groups tend to have a level of educational attainment above the average than that of any other group. Assumptions about years of schooling are more difficult to make across the other groups, since the range of workers included in each groups is wider. However, I defined three groups.

Group I. Includes groups 0/1 and 2.
Group II. Includes groups 3, 4 and 5.
Group III Includes groups 6 and 7/8/9.
The last group was disregarded

The change in the quality of labor force is defined by Selowsky as:

$$\frac{\dot{Q}}{Q} = \sum_i \frac{w_i \, \dot{a}_i}{W} \tag{A2.1}$$

where the left hand side of (A4.1) is the change in labor quality, W is the average wage, w_i is the wage of individual in group i, a_i is defined as the share of labor type i on the total labor force ($a_i = L_i/L$). The dot indicates derivative respect to time.

[20]The reader interested in additional details is referred to the paper.

The labor force composition was available for certain years for each country. For Korea years 1964, 1968, 1974 and 1983 were available, and for Singapore 1957, 1974, 1978 and 1983 were available. The final goal was to obtain the labor quality annual growth rates.

Table A2.1 shows the variation in a_i over time. The negative change of the first category for Singapore in 1974-1978 is an indicator of the immigration of low skill labor.

Wages for the two countries were obtained from the October inquiry by ILO in the different countries. For Singapore and Korea was available for 1983, and for some past years. In order to make the figures comparable a methodology to generate a time series of relative wages was applied to both countries. This methodology is well explained by Selowsky (1969). Here I will only show the reduced form.

$$\frac{w_i}{W} = d_i \frac{\sum_i L_i}{L_i} \left(\frac{L_i}{L^*} \right)^{\rho} \qquad \text{(A2.2)}$$

where L* is the composite labor or the effective units of labor defined as:

$$L* = \left[\sum_i d_i \; L_i^{\rho} \right]^{1/\rho} \qquad \text{(A2.3)}$$

where d_i is the distribution parameter of the i-th kind of labor, ρ is related to the elasticity of substitution between different kind of labor as follows:

$$\rho = \frac{S_L - 1}{S_L}$$

where S_L is the elasticity of substitution.

According to (A2.2) a time series of relative wages was obtained and it is graphed for each country at the end of the appendix. Two elasticities of substitution were used, s = 2 and s = 8. The differences in relative wages become larger as we move back due to the lower participation of the first group of labor in the total labor force. As was expected, the difference is also smaller, the higher the degree of substitution across labor categories. Korea tends to show lower differences than Singapore due to a smaller difference in salaries across groups.

Finally, Table A2.2 shows the annual growth rate of labor quality for the period indicated and for different values of the elasticity. In the text the lowest elasticity of substitution was used basically due to the belief that between the first group and the other two this elasticity is quite small.

TABLE A2.1

CHANGES IN LABOR FORCE SHARES

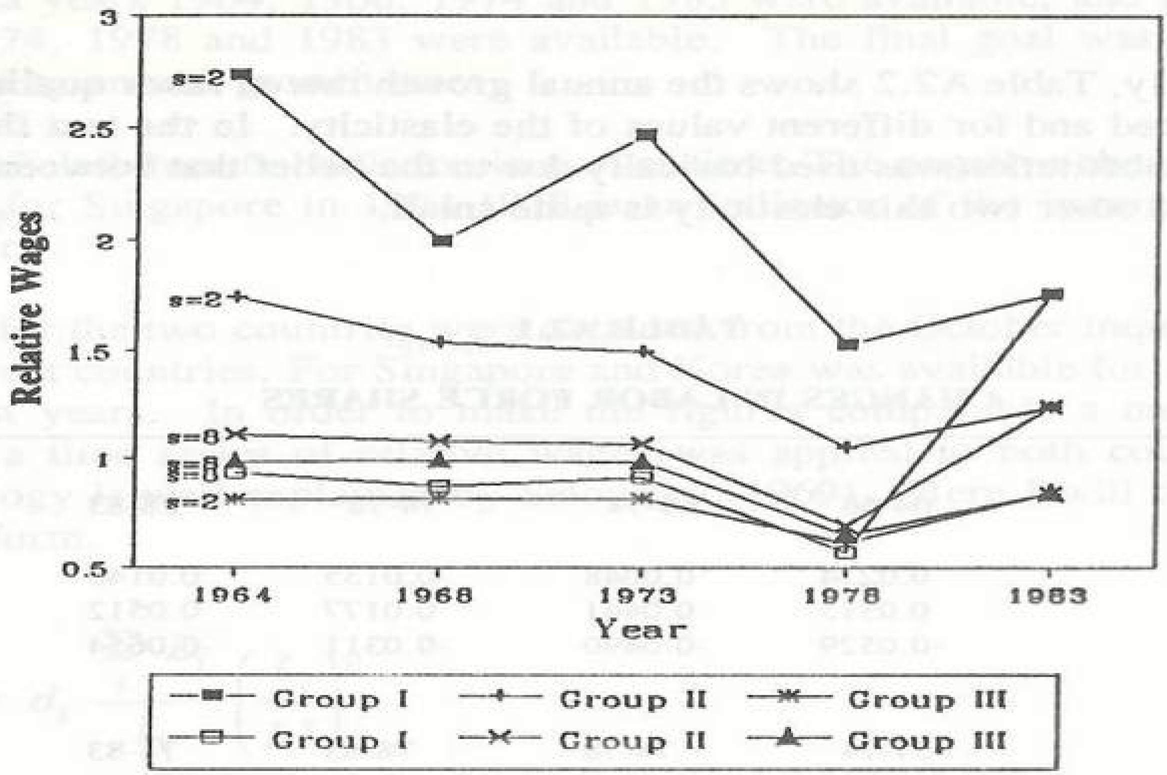
KOREA					
	64-68	64-74	74-78	78-83	74-83
I	0.0214	0.0048	0.0135	0.0143	0.0277
II	0.0315	0.0441	0.0177	0.0512	0.0688
III	-0.0529	-0.0490	-0.0311	-0.0654	-0.0966
SINGAPORE					
	57-74	74-78	78-83	74-83	
I	0.0680	-0.0161	0.0335	0.0175	
II	0.0263	0.0116	-0.0111	0.0005	
III	-0.0943	0.0045	-0.0224	-0.0179	

TABLE A2.2

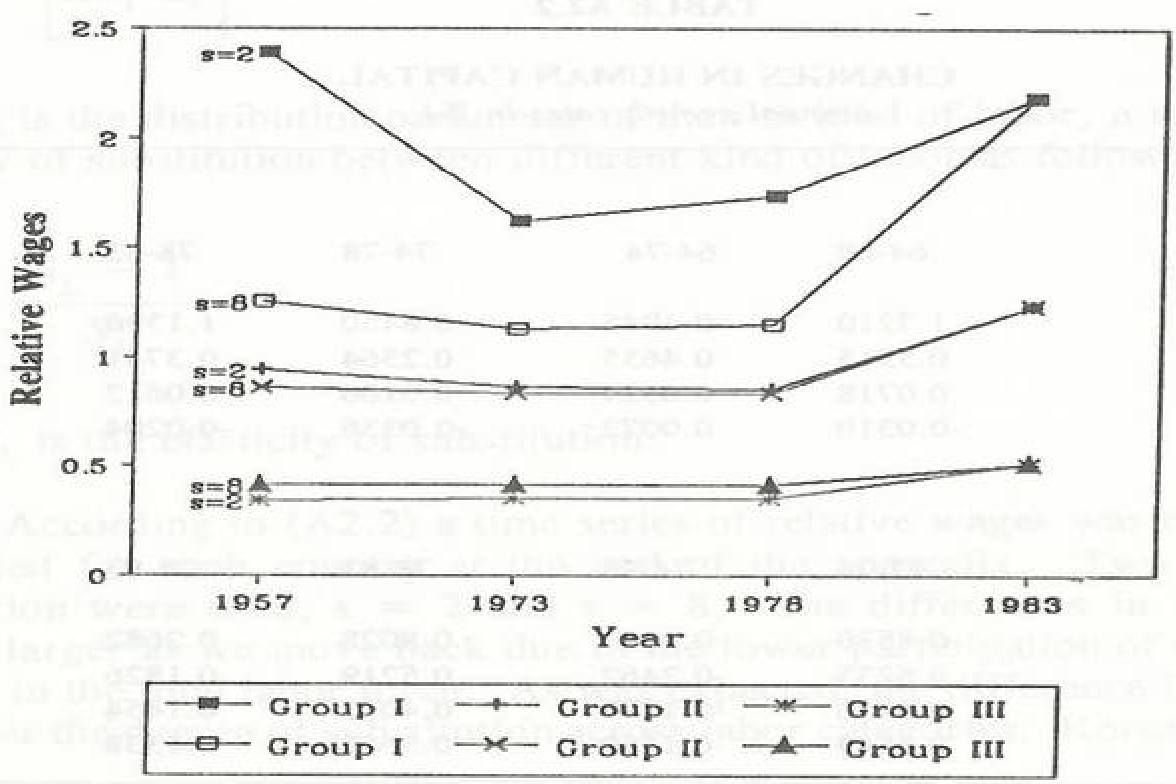
CHANGES IN HUMAN CAPITAL
(annual growth rates in %)

KOREA					
Sigma	64-68	64-74	74-78	78-83	74-83
2	1.7210	0.4945	0.8450	1.1396	0.9881
4	0.5515	0.4655	0.2364	0.3741	0.3109
8	0.0718	0.0524	0.0106	0.0612	0.0387
12	-0.0310	0.0072	-0.0336	-0.0204	-0.0263
SINGAPORE					
Sigma	57-74	74-78	78-83	74-83	
2	0.8530	-0.4123	0.8028	0.2682	
4	0.6235	-0.2462	0.5219	0.1826	
8	0.3950	-0.1770	0.4012	0.1454	
12	0.3549	-0.1559	0.3638	0.1338	

KOREA, RELATIVE WAGES



SINGAPORE, RELATIVE WAGES



REFERENCES

AGELL, J.O. (1983): "Subsidy to Capital Through Tax Incentives in the ASEAN Countries: An Application of the Cost of Capital Approach under Inflationary Situations" *The Singapore Economic Review*, Vol. 28, 98-128.

BALASSA, B. (1990): "Korea's Development Strategy", in J. Kwon ed. *Korean Economic Development*, Greenwood Press.

BENHABIB, J. and B. JOVANOVIC (1991): "Externalities and Growth Accounting", *The American Economic Review*, Vol. 81, 82-113.

CHEN, P. (1983): "Singapore's Development Strategies: A Model for Rapid Growth" in P. Chen ed. *Singapore: Development Policies and Trend"*, Oxford University Press.

CHONG-YAH, L. (1986): "Singapore: Resources and Growth - An Introductory Overview" in L. Chong-Yah and P. Lloyd eds. *Singapore Resources and Growth*, Oxford University Press.

DOLLAR, D. and K. SOKOLOFF (1990): "Patterns of Productivity Growth in South Korean Manufacturing Industries, 1963-1979", *Journal of Development Economics*, Vol. 33, 309-327.

EDWARDS, S. (1989): "Openness, Outward Orientation, Trade Liberalization and Economic Performance in Developing Countries", NBER, Working Paper No. 2908.

________ (1991): "Trade Orientation, Distortions and Growth in Developing Countries", paper presented at the Fourth InterAmerican Seminar.

FUENTES, J.R. (1992), "Economic Policies, Human Capital Formation and their Importance in the Process of Growth: Theoretical and Empirical Implications", unpublished Ph.D. Dissertation, University of California-Los Angeles.

________ (1993): "Recent Cross-Country Studies of Growth: A Survey", *Análisis Económico*, Forthcoming.

FUENTES, J.R. and J. VATTER (1991): "Los Efectos de la Inversión en Capital Humano e Investigación y Desarrollo en el Desarrollo Económico". *Estudios Públicos*, 44, 181-205.

HAINDL, E. and J.R. FUENTES (1986): "Estimación del Stock de Capital en Chile: 1960-1984", *Estudios de Economía*, Vol.13, 40-72.

HARBERGER, A. (1990): "Reflections on the Growth Process", UCLA manuscript.

HELPMAN, E. (1984): "Increasing Returns, Imperfect Markets and Trade Theory", in Jones and Kenen ed. *Handbook of International Economics*, Amsterdam: North-Holland.

HOFMAN, A. (1993): "Chile's Economic Performance in the 20th. Century, a Comparative Perspetive", *Estudios de Economía*, this issue.

INTERNATIONAL LABOUR OFFICE (several issues): "Yearbook of Labour Statistics".

________ (1983): "Bulletin of Labour Statistics: October Inquiry Results".

KIM, K.S. (1990): "Import Liberalization and Its Impact in Korea", J. Kwon ed. *Korean Economic Development*, Greenwood Press.

KUM-POH, W. (1986): "Saving and Capital Formation" in L. Chong-Yah and P. Lloyd eds. *Singapore Resources and Growth*, Oxford University Press.

KWON, J. (1990): "The Uncommon Characteristics of Korea's Economic Development", in J. Kwon ed. *Korean Economic Development*, Greenwood Press.

KWON, J. and YUHN (1990): "Analysis of Factor Substitution and Productivity Growth in Korean Manufacturing, 1961-1981", in J. Kwon ed. *Korean Economic Development*, Greenwood Press.

LLOYD, P. and R. SANDILANDS (1986): "The Trade Sector in a Very Open e-export Economy" in L. Chong-Yah and P. Lloyd eds. *Singapore Resources and Growth*, Oxford University Press.

MURPHY, K., A. SHLEIFER and R. VISHNY, R. (1989): "Industrialization and the Big Push", *Journal of Political Economy*, Vol. 97, 1003-1025.

________ (1991): "The Allocation of Talents: Implications for Growth", *Quaterly Journal of Economics*, Vol. 106, 503-530.

NISHIMIZU, M. and S. ROBINSON (1984): "Trade Policies and Productivity Changes in Semi-Industrialized Countries", *Journal of Development Economics*, Vol. 16, 177-206.

PETRI, P. (1990): "Korean Trade as Outlier: An Economic Anatomy", in J. Kwon ed. *Korean Economic Development*, Greenwood Press.

RAMSEY, F. (1928): "A Mathematical Theory of Saving", *Economic Journal*, 543-559.

ROMER, P. (1986): "Increasing Returns and Long-Run Growth", *Journal of Political Economy*, Vol. 94, 1002-1037.

ROMER, P. (1987): "Crazy Explanations for the Productivity Slowdown", *NBER Macroeconomics Annual*, 1, 163-201.

________ (1990): "Are Nonconvexities Important for Understanding Growth?", *The American Economic Review*, Vol. 80, 97-103.

SELOWSKY, M. (1969): "On the Measurement of Education's Contribution to Growth", *Quarterly Journal of Economics*, 449-463.

SIOW-YUE, C. (1986): "Direct Foreign Investment and the Industrialization Process in Singapore" in L. Chong-Yah and P. Lloyd eds. *Singapore Resources and Growth*, Oxford University Press.

SOLOW, R. (1957): "Technical Change and the Aggregate Production Function", *The Review of Economics and Statistics*, Vol. 39, 312-330.

SUMMER, R. and A. HESTON (1988): "A New Set of International Comparisons of Real Products and Price Level: Estimates for 130 Countries, 1950-1985", *Review of Income and Wealth* Vol. 34.

TSAO, Y. (1985): "Growth without Productivity: Singapore Manufacturing in the 1970s", *Journal of Development Economics*, Vol. 18, 25-38.

______ (1986): "Sources of Growth Accounting for the Singapore Economy", in L. Chong-Yah and P. Lloyd eds. *Singapore Resources and Growth*, Oxford University Press.

UNITED NATIONS (several issues): *Industrial Statistics Yearbook*.

________ (several issues): *National Accounts Statistics: Analysis of Main Aggregates*.

UZAWA, H. (1965): "Optimal Technical Change in an Aggregate Model of Economic Growth", *International Economic Review*, Vol. 6, 18-31.

WANG, F.Y. (1990):, "Reconsidering the "East Asian Model of Development" the Link between Exports and Productivity Enhancement", paper presented at International Economics Workshop.

WORLD BANK (1987): *World Development Report*.

________ (1990): *World Development Report*.

YOUNG, A. (1992): "A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong and Singapore", MIT, Mimeo.