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ANALYSING CHANGES IN INDUSTRY STRUCTURE

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ABSTRACT

In considering changes in industry structure, some framework or lens is necessary through which to view and describe the changes. This paper seeks to contribute in two ways to an improved framework for analysing such changes, with a particular emphasis on the long-run income potential of industry structure. Five key characteristics of industries are outlined and used to describe major industries in the developed nations. These five characteristics are used in order to develop one particular lens – termed the Index of the Long Run Income Potential of Industry Structure – to assess changes in the structure of trade and production of different countries and regions in a global context. The index, an analytical tool for evaluation of the structure of manufacturing, is based on the proposition that, other things being equal, a country with an industry structure showing a high value of the index should be able to generate a high level of per capita income for its citizens. Some examples of the application of the Index are presented in this paper. These allow the author to draw some conclusions about the pace and the direction of the process of structural change over the period 1970-1994 and about structural significance of computers and electronics industries.

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ANALYSING CHANGES IN INDUSTRY STRUCTURE

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1. Introduction

In considering changes in industry structure, some framework or lens is necessary through which to view and describe the changes. The most common approach is to evaluate the degree of specialisation of a country, or a region, in trade of output generated within a particular industry. This method can been applied directly by considering sectoral shares of merchandise exports and imports (see, for example, Drysdale 1988; Garnaut 1989; Anderson 1995) Another way of evaluating industrial structure is to consider the specialisation of a country relative to the global average in the output of a certain industry. This approach, referred to as the Index of Revealed Comparative Advantage or the Index of Specialisation, was developed by Balassa in 1965 and has been widely used by many economists. Discussion about this method and examples of the application can be found in Drysdale (1988), Garnaut (1989), Vollrath (1991), Chow and Kellman (1993), and Sheehan et al. (1995). While the evaluation of the degree of specialisation can be considered as a powerful tool for evaluation of the significance of a particular sector of an economy, the most significant deficiency of this approach is that it is difficult to apply for analysing industrial structure as a whole. In order to make a judgement about the industrial structure and the dynamics of structural change one has to consider specialisation in each and every sector. Sheehan and Tikhomirova have developed an integrated indicator, the Index of Knowledge Composition, for the evaluation of the structure of manufacturing sector as a whole with respect to knowledge embodied in the output of different industries (see Sheehan et al. 1995, Sheehan and Tikhomirova 1996).

This paper seeks to contribute in two ways to an improved framework for analysing such changes, with a particular emphasis on the long-run income potential of industry structure. Firstly, we outline five key characteristics of industries and use these characteristics to describe major industries in the developed nations. Secondly, we use these five characteristics to develop one particular lens – termed the Index of the Long Run Income Potential of Industry Structure – to assess changes in the structure of trade and production of different countries and regions in a global context.

The overall rationale for the analysis is that the level of sustainable income which can be provided by an industrial structure is related to the level of value added per employee and to the extent to which the benefits of that value added can be transferred to employees in the form of wages per employee, rather than retained by the owners of capital. For a given level of value added or wages per employee, however, the long-run potential of an industry structure must also be associated with the extent to which that structure relates to growth and change in the global economy. These elements are captured in this paper by two aspects of the changing global demand for products of a given industry (the rate of growth of world exports and the industry share of total world manufacturing exports) and by an indicator of the degree of innovation in an industry (R&D intensity).

Five indicators are used in the analysis and in the index:

- value added per employee;
- wage per employee;
- global export growth;
- sectoral export intensity, and
- R&D intensity.

The index is based on the proposition that, other things being equal, a country with an industry structure showing a high value of the index should be able to generate a high level of per capita income for its citizens. But the index is an analytical tool for evaluation of the structure of manufacturing only, and no normative claims are made in this paper. Other things are never equal (for example, for a given industry the degree of value added or the level of R&D may be much lower in developing than in developed countries). It is not claimed that a high and/or rising value of this index is invariably associated with high and/or rapidly increasing per capita income, nor that individual countries should pursue an industry structure consistent with a high value of this index as the optimal development strategy. The components of the index serve to highlight relevant features of industries in selected developed countries, and the index provides a perspective on changes in the structure of trade or production globally and in different countries. The index is a descriptive tool, which is capable of compressing five different dimensions of industry structure in a quantitative form, readily available for comparisons over time and across countries.

2. Attributes and Ranking of Industries

The reasons for selecting the five indicators are described in more detail in this section, while some key industry groups are analysed in terms of these characteristics in Section 3.

Value Added per Employee

Value added generated in an economy is a conventional criterion of economic performance (GDP) and GDP per capita is a welfare indicator. The crucial factor for achieving high levels of welfare is the ability of a nation to generate value added production, employing resources in the most productive and efficient way possible. It seems feasible to benchmark each manufacturing industry according to the highest level of value added per employee achieved in the world at a particular time. Three countries, Germany, Japan and the USA are the world leaders in terms of labour productivity achieved in 1988-90. The period is determined by two major factors: the interest in understanding the significance of particular industries for Asian growth in the 1980s and the availability of data for Germany (to consider productivity levels achieved in Western Germany undistorted by the influence of lower productivity of Eastern Germany). Value added per employee has been calculated for the three countries as one whole and averaged for the three year period in order to eliminate the influence of annual fluctuations. The results (in current US $) for 22 industries are presented in Table 3 (column 1).

Wage per Employee

As a second component we consider an average wage per employee. Although value added is commonly used as a welfare indicator, it is of certain interest to find out whether industries associated with high value added also provide high levels of income to the personnel employed, or whether value added is an indicator of capital intensity not necessarily directly linked with income. In this case it is possible that capital intensity will contribute to the economy-wide GDP but not to the actual welfare of the people employed and thus GDP per capita can be a misleading indicator of living standards.

The data for the USA (Table 1) show that the wage levels vary substantially for different categories of occupations. Of the selection of occupations shown, scientists' salaries are the highest, engineers earn about 8 per cent less than mathematical and computer scientists, technicians' wages constitute about two thirds, and production workers' wages are at less than half of the scientists' level.

Table 1

USA **Males Working Fulltime by Selected Occupation Groups** **(3 digit classification)** *Average Hourly Earnings* *1990*	**US $**	**Index, %**
Mathematical and Computer Scientists	21.79	100
Natural Scientists	21.21	97.4
Engineers	20.08	92.1
Science Technicians	15.81	72.5
Engineering and Related Technologists and Technicians	14.54	66.7
Technicians; Except Health, Engineering, and Science	14.59	67.0
Machine Operators	10.43	47.9
Fabricators, Assemblers, and Hand Working Occupations	9.91	45.5

Source: Estimates, based on US Current Population Survey.

In addition, more detailed data (Table 2) allow us to compare the levels of earnings by areas of specialisation within broader categories. Thus, engineers in the petroleum refining industry are the highest earning group among engineers, followed by electrical and electronic engineers. Mechanical engineers earn just slightly less than electrical and electronic engineers, and industrial engineers' salaries on average are less than 80 per cent of the level in petroleum refining. Among engineering technologists and technicians industrial technicians are the highest paid group. Electrical and electronic technicians and mechanical technicians earn on average 94 and 93 per cent of this level respectively, while drafting occupations are about 22 per cent behind industrial technicians. Computer programmers' earnings are more than 30 per cent higher than numeric control and tool programmers' and slightly above industrial technicians' salaries. The divergence of income levels within working occupations is even greater: printing machine operators earn 60 per cent more than woodworking machine operators. Workers in the textile industry are paid at approximately the same level as those in the wood processing industry, at about 62 per cent of the salaries of printing machine operators, while in the metal and plastic processing industries workers earn on average about 93 per cent of this level.

Table 2

USA

Males Working Fulltime by Selected Occupation Groups (3 digit classification)

Average Hourly Earnings

1990

	US $
Engineers	
Petroleum	23.24
Electrical and electronic	20.52
Mechanical	20.41
Aerospace	19.72
Chemical	19.28
Industrial	17.90
Engineering and Related Technologists and Technicians	
Industrial engineering technicians	16.35
Electrical and electronic technicians	15.39
Mechanical engineering technicians	15.24
Drafting occupations	12.77
Technicians; Except Health, Engineering, and Science	
Computer programmers	16.56
Tool programmers, numerical control	12.51
Machine Operators	
Printing machine operators	12.48
Metalworking and plastic working machine operators	11.70
Metal and plastic processing machine operators	11.61
Textile, apparel, and furnishings machine operators	7.82
Woodworking machine operators	7.76

Source: Estimates, based on US Current Population Survey.

The data for the American labour market, the most deregulated in the developed world, allow us to estimate the degree of sophistication of particular jobs, skill requirements (as well as the level of responsibilities) by industry for different occupational categories. The analysis of such information may have important industry policy implications.

In order to benchmark industries in accordance with their potential to generate income we use the same approach that has been applied to the value added per employee criterion: the level by industry achieved by the world leaders in terms of labour productivity. Wages per employee by industry, calculated for Germany, Japan and the USA as one integrated economy and averaged for the three year period, are presented in Table 3 (column 2).

It is worth noting that the approach used to benchmark manufacturing industries according to both value added and average wages per employee does not provide information about actual levels of value added or wages in individual countries. There can be great differences between the levels of value added per employee and wages actually achieved in different countries, and cross-industry proportions can also vary substantially from country to country depending upon the stage of their technological development, specialisation and other country-specific factors. Our purpose is to try to develop benchmark indicators by industry. Analysing the actual situation in the manufacturing sector in different countries is a subject for a separate study.

Global Export Growth and Sectoral Export Intensity

World export average annual growth rates (1986-93) by industry and sectoral export shares for the world (1988-90), columns 3 and 4, Table 3, are used as indicators of global demand for the output of particular manufacturing industries. Domestic demand should not be underestimated: in some countries it is of higher significance than in others. Propensity to consume domestically produced goods can also be different for different types of production, because of a number of reasons including cultural preferences. But in an open world it would be very unlikely for competitive (in a global sense) industries to be locked within the boundaries of domestic demand without trying to expand beyond the national borders. Thus global demand is an important factor for evaluation of the potential of particular industries. Even if some industries are characterised by high value added per employee and also provide high wages it is not apparent that there are reasons to expect substantial potential contribution from these industries to the overall, economy- wide GDP or welfare if there is no significant global demand for their output. This does not mean, of course, that none of the countries can succeed in filling the existing narrow niches of demand, but this is a subject of specific specialisation or a result of previously achieved position in the world in particular types of production.

Table 3

N (R&D)		(VAD/E)i (JPN+USA+GER) Av. (88-90) cur. US $	(W/E)i (JPN+USA+GER) Av. (88-90) cur. US $	WLD Xi Growth 86-93 %	WLD Xi Shares Av. (88-90) %	R&D Intensity
1	Aerospace	75.10	37.25	12.27	2.62	20.2
2	Computers	105.54	32.05	13.54	4.34	12.4
3	Electronics	75.11	27.05	13.63	6.70	10.8
4	Pharmaceuticals	188.46	35.04	12.84	1.23	10.3
5	Instruments	73.59	30.21	9.10	3.30	4.8
6	Motor vehicles	87.54	33.11	7.60	11.55	3.5
7	Chemicals	149.17	34.53	7.49	10.17	3.4
8	Elec. machinery	63.65	26.52	12.91	3.85	3.2
9	Machinery	67.39	29.63	8.39	11.45	2.1
10	Other transport equipment	50.28	26.75	10.29	0.53	1.9
11	Shipbuilding	51.59	27.61	9.28	1.35	1.4
12	Petroleum refining	300.46	39.48	2.81	3.34	1.1
13	Stone, clay and glass	73.16	25.80	9.60	1.68	1.1
14	Other manufacturing	53.45	20.81	11.72	2.16	1.0
15	Rubber and plastics	60.46	23.88	13.14	2.33	1.0
16	Non-ferrous metals	78.43	29.64	5.68	2.99	0.9
17	Ferrous metals	98.52	33.87	4.72	4.28	0.7
18	Fabricated metals	58.11	25.33	9.22	2.97	0.6
19	Food, drink and tobacco	87.99	21.76	7.46	7.41	0.3
20	Paper and printing	74.27	27.37	7.84	3.57	0.2
21	Textiles and clothing	36.83	16.47	10.13	9.46	0.2
22	Wood and furniture	44.00	20.29	11.44	2.29	0.1

Source: Estimates, based on Trade and Production Data accessed through IEDB (ANU); OECD data on industry specific R&D intensities.

R&D Intensity

The final industry-specific criterion to be incorporated is R&D intensity ratios (column 5, Table 3). We apply R&D intensity ratios (1987-89), calculated by OECD as BERD divided by production for 22 manufacturing industries, for 13 OECD countries, weighted by each country's share in total output of OECD-13 presented in common currency PPP, three-year averages (OECD 1994). R&D ratios are considered as indicators of the degree of sophistication of particular types of industrial output, of knowledge embodied in the goods produced, and are thus important as characteristics of

particular industries. The ability to develop and produce new goods allows not only filling of the niches in existing demand, but the generation of new areas of demand and the overcoming of the limits posed by price competition. By targeting knowledge-intensive types of production a country can generate research potential for further development within these industries as well as producing spillovers for other industries and providing a solid base for related sophisticated services. Besides this, R&D requires a highly educated, skilled and creative labour force. By engaging its population in knowledge-based activities a nation provides the members of the society with opportunities for personal development.

Table 3 contains all five indicators for 22 manufacturing industries allocated according to the value of R&D intensity ratio in descending order, as in our previous studies (see Sheehan et al. 1995, Sheehan and Tikhomirova 1996). The 22 industries are ranked according to each indicator, and the higher value of an indicator is associated with the higher value of the rank.

The five indicators (Table 4) can be of different relative significance depending on specific conditions in particular countries, both purely economic and otherwise. For example, if there is a very high rate of unemployment and jobless people are mostly unskilled, high value added per employee can be a relatively insignificant or even a negative factor. In such a situation it may be worth sacrificing economic growth in order to provide a large proportion of the population with labour-intensive, low-paid jobs in order to avoid social problems. Or, in conditions of tough non-economic competition, for example during the Cold War, the development of R&D potential can become a factor of overwhelming importance relative to the characteristics providing economic wealth. In such situations weights can be applied to the components and the overall composite rank can be calculated as weighted index. But generally speaking, where no severe constraints are present, all five factors are of significance: value added per employee – an indicator of economic performance potential; average wage – of income generation, world export growth and sectoral shares – of global demand; and R&D intensity – of science and research potential for future development. In our opinion, it is not worth trying to set preferences between these factors; for many purposes, it is useful to set the relative significance of the five ranked indicators equal. The components' weights in our case, thus, are equal to one and the overall composite rank is derived as an arithmetic mean of the previous five ranks (Table 4). The numeric value of the overall rank indicates the combined effect of all five components, although the relative contribution of each factor is also important and will be discussed further on.

Table 4

N (R&D)		(VAD/E)i (JPN+USA+GER) Av. (88-90) Rank	(W/E)i (JPN+USA+GER) Av. (88-90) Rank	WLD Xi Growth 86-93 Rank	WLD Xi Shares Av. (88-90) Rank	R&D Intensity Rank	Overall Composite Rank
1	Aerospace	13	21	17	8	22	**16.2**
2	Computers	19	16	21	16	21	**18.6**
3	Electronics	14	10	22	17	20	**16.6**
4	Pharmaceuticals	21	20	18	2	19	**16.0**
5	Instruments	11	15	9	11	18	**12.8**
6	Motor vehicles	16	17	6	22	17	**15.6**
7	Chemicals	20	19	5	20	16	**16.0**
8	Elec. machinery	8	8	19	14	15	**12.8**
9	Machinery	9	13	8	21	14	**13.0**
10	Other transport equipment	3	9	14	1	13	**8.0**
11	Shipbuilding	4	12	11	3	12	**8.4**
12	Petroleum refining	22	22	1	12	11	**13.6**
13	Stone, clay and glass	10	7	12	4	10	**8.6**
14	Other manufacturing	5	3	16	5	9	**7.6**
15	Rubber and plastics	7	5	20	7	8	**9.4**
16	Non-ferrous metals	15	14	3	10	7	**9.8**
17	Ferrous metals	18	18	2	15	6	**11.8**
18	Fabricated metals	6	6	10	9	5	**7.2**
19	Food, drink and tobacco	17	4	4	18	4	**9.4**
20	Paper and printing	12	11	7	13	3	**9.2**
21	Textiles and clothing	1	1	13	19	2	**7.2**
22	Wood and furniture	2	2	15	6	1	**5.2**

Source: Estimates, based on Trade and Production Data accessed through IEDB (ANU); OECD data on industry specific R&D intensities.

Finally, the industries are sorted according to the overall composite rank in descending order. In some cases, where the values of this rank are the same for two industries (Pharmaceuticals and Chemicals; Instruments and Electrical machinery; Rubber and plastics, and Food, drink and tobacco; Fabricated metals and Textiles and clothing), the R&D intensity rank is used as a secondary sorting criterion (taking into account the significance of knowledge intensity for future development). The resulting order of industries, is presented in Table 5.

Table 5

Overall Composite Rank		**N (Composite)**	**N (R&D)**
18.6	Computers	1	2
16.6	Electronics	2	3
16.2	Aerospace	3	1
16.0	Pharmaceuticals	4	4
16.0	Chemicals	5	7
15.6	Motor vehicles	6	6
13.6	Petroleum refining	7	12
13.0	Machinery	8	9
12.8	Instruments	9	5
12.8	Elec. machinery	10	8
11.8	Ferrous metals	11	17
9.8	Non-ferrous metals	12	16
9.4	Rubber and plastics	13	15
9.4	Food, drink and tobacco	14	19
9.2	Paper and printing	15	20
8.6	Stone, clay and glass	16	13
8.4	Shipbuilding	17	11
8.0	Other transport equipment	18	10
7.6	Other manufacturing	19	14
7.2	Fabricated metals	20	18
7.2	Textiles and clothing	21	21
5.2	Wood and furniture	22	22

Source: Estimates, based on Trade and Production Data accessed through IEDB (ANU); OECD data on industry specific R&D intensities.

Comparison of the positions of manufacturing industries according to the two ranks, R&D rank and the overall composite rank, gives some interesting results. The most notable of these is that Computers and Electronics occupy the leading positions in the list of manufacturing industries according to the overall composite industry rank while Aerospace, the first in the list according to R&D rank, has been shifted to third place. This fact, in our opinion, is of special interest. As we have pointed out, rapid economic growth in East Asia and ASEAN has been substantially driven by “the ability of many of these countries to capture the production of, and trade in, the new goods emerging from the revolution in computing and communications” (Sheehan and Tikhomirova 1996,

pp. 25-26). The two industries, Computers and Electronics, played a key role in achieving the unprecedented pace of economic development. And although, as we emphasised earlier, the world economy is facing substantial restructuring and moving towards knowledge-intensive economic activities (Sheehan et al. 1995), knowledge intensity on its own can hardly be accepted as a reasonable answer to the question why Computers and Electronics rather than Aerospace, the most knowledge-intensive industry, were at the core of the phenomenon of Asian growth. The composite ranking provides a broader perspective on this issue.

Four other industries, Pharmaceuticals (4), Motor vehicles (6), Textiles and clothing (21) and Wood and furniture (22), have not changed their positions. Some industries have moved up only marginally: Chemicals – from number 7 to 5, Machinery – from 9 to 8, Rubber and plastics – from 15 to 13. For other industries the upward shift has been quite pronounced: Petroleum refining – from 12 to 7, Ferrous metals – from 17 to 11, Non-ferrous metals – from 16 to 12, Food, drink and tobacco – from 19 to 14, and Paper and printing – from 20 to 15.

Another group of industries has moved to lower positions and what is noticeable for almost all the industries in this group is that the shift has been fairly substantial: Instruments from 5 to 9, Stone, clay and glass – from 13 to 16, Shipbuilding – from 11 to 17, Other transport equipment – from 10 to 18, Other manufacturing – from 14 to 19. This fact reflects the effect of low values of some indicators relative to the value of R&D intensity rank. Instruments – the rank of world export growth is twice lower than R&D rank; Stone, clay and glass – export shares rank is 2.5 times lower; Shipbuilding – value added and world export shares ranks are 3 and 4 times lower than ranked R&D respectively. Other transport equipment has the lowest value of export shares rank among all industries while R&D intensity is ranked above the average level. Other manufacturing – the combined effect of low values of ranked wages, value added and export shares indicators relative to R&D is so significant that the high value of export growth rank (16, while R&D rank is equal to 9) can not offset it. The only industries that have moved just two places down are Electrical machinery – from 8 to 10 and Fabricated metals – from 18 to 20.

The analysis of changes in relative positions of manufacturing industries gives us a reason to conclude that it is not sufficient to consider just one industry-specific factor, even as important for the emerging knowledge-economy as R&D intensity. For policy development the combined effect of the whole range of industry characteristics and particular socio-economic conditions in individual countries should be taken into account. Otherwise the expected effect of industry policies may well be far from reality.

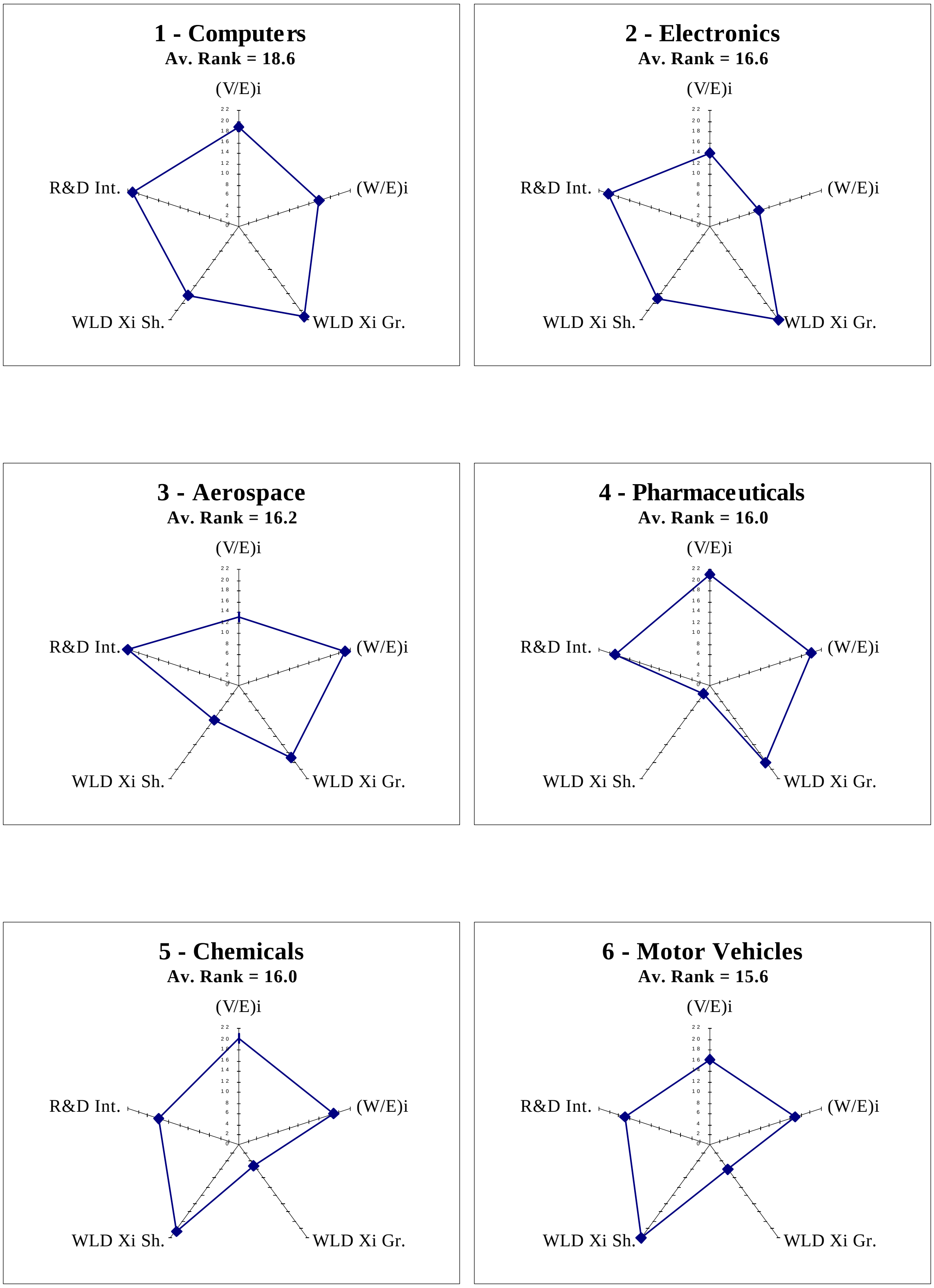
3. Benchmarking Characteristics of Industries

The value of the overall composite rank as a general indicator of income generating potential of manufacturing industries is a useful criterion according to which the industries can be allocated in a certain order and the relative positions of the industries can be evaluated. Nevertheless, for policy development in different countries particular industry characteristics, benchmarks, can be of importance. Let us briefly consider specific industry ranks, presented in Table 4 and Chart 1, their relative significance, and hence their impact on the overall rank.

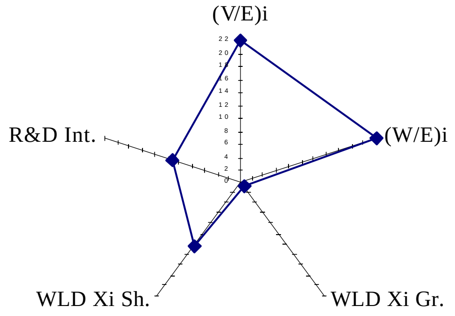
Computers and Electronics – all five components have relatively high ranks, which is reflected by their overall positions. The most distinctive feature of these two industries is the highest ranks for export growth among all industries. The combination of extremely high export growth and high export shares ranks gives cause to expect that the importance of these industries will be maintained in the future. It is notable that for both industries wages per worker are ranked lower than value added, whereas for Aerospace the reverse is the case. Exceptionally high ranks of R&D and wages are an indication of specific skill requirements in the Aerospace industry, while the combination of high R&D and much more moderate wage ranks for Computers and Electronics indicates a wide range of employment options at different qualification levels.

Pharmaceuticals is characterised by very high ranks for all indicators with the exception of world export shares. World demand is rising but from a very low base and the combination of high skill standards, capital intensity and low global demand for the output of this industry raises some doubts about the potential of this industry for development in all countries. Pharmaceuticals is likely to be a prerogative of the developed countries. The situation in Aerospace is similar to that in Pharmaceuticals but lower capital intensity in conjunction with high R&D and wages is a sign of even higher requirements for qualifications and despite the larger scale this industry seems to have a very limited potential for developing countries, other than in sub-contracting or other relationships with the major aircraft manufacturers.

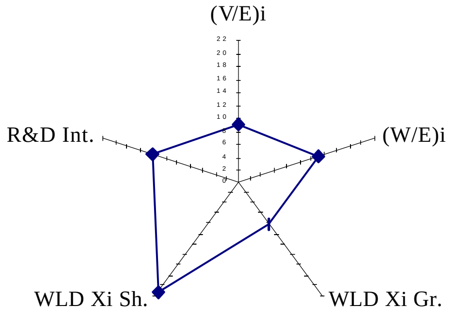
Chart 1


1 - Computers
Av. Rank = 18.6
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.
2 - Electronics
Av. Rank = 16.6
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.
3 - Aerospace
Av. Rank = 16.2
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.
4 - Pharmaceuticals
Av. Rank = 16.0
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.
5 - Chemicals
Av. Rank = 16.0
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.
6 - Motor Vehicles
Av. Rank = 15.6
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

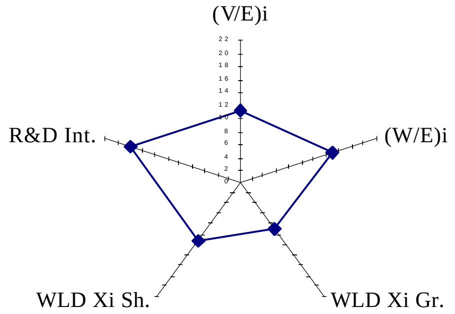
7 - Petroleum Refining
Av. Rank = 13.6



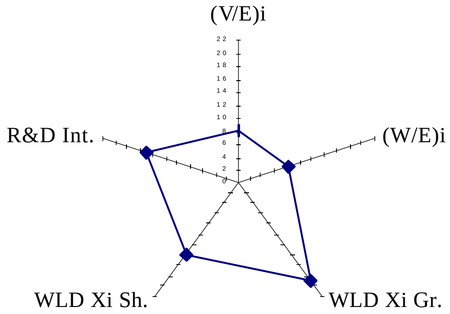
8 - Machinery
Av. Rank = 13.0



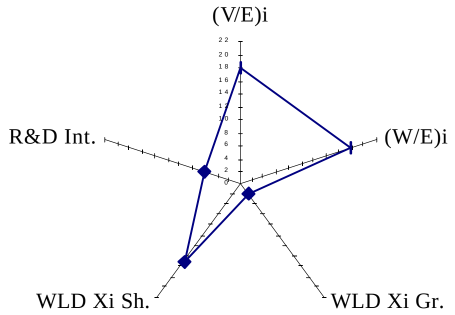
9 - Instruments
Av. Rank = 12.8



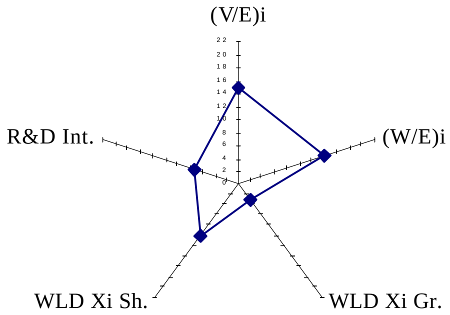
10 - Elec. Machinery
Av. Rank = 12.8

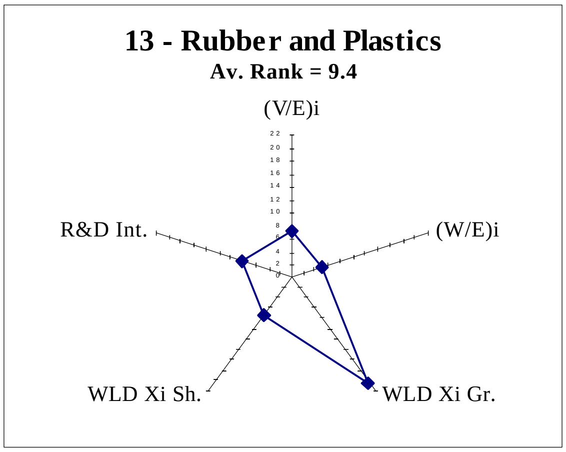


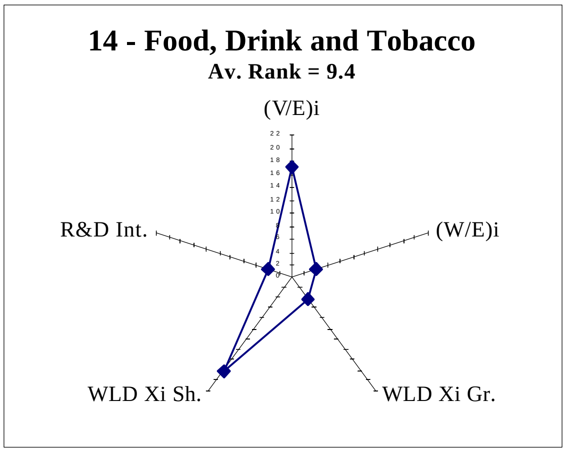
11 - Ferrous Metals
Av. Rank = 11.8

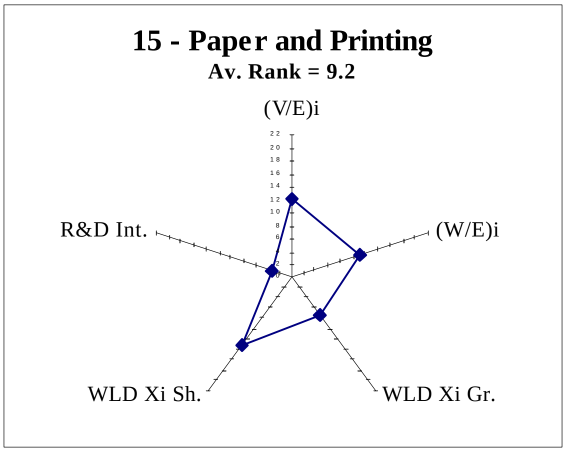


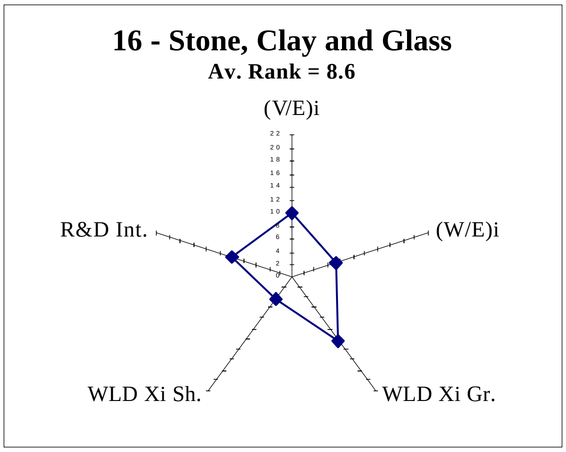
12 - Non-Ferrous Metals
Av. Rank = 9.8

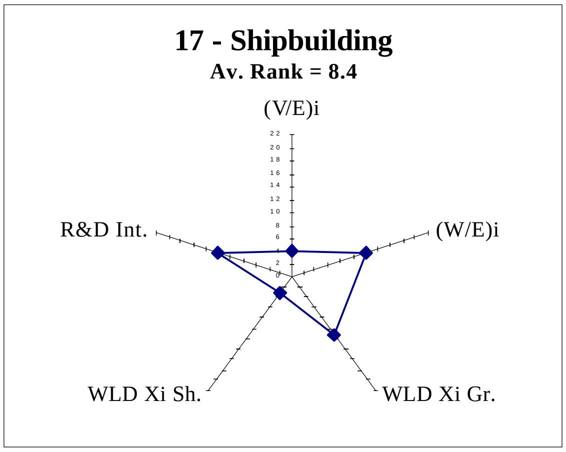


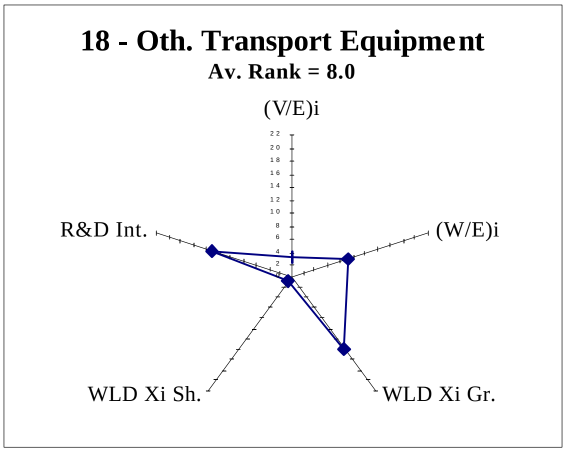

13 - Rubber and Plastics
Av. Rank = 9.4
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

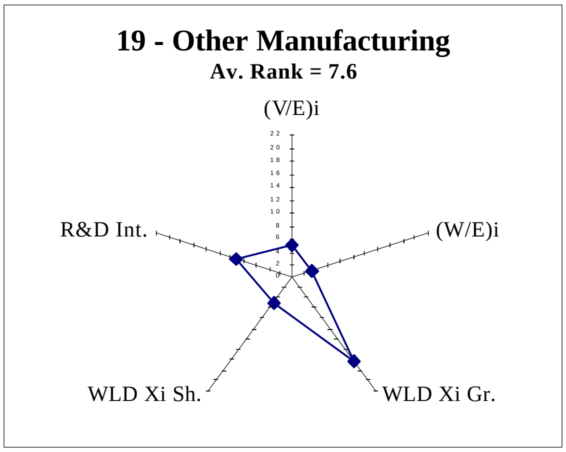

14 - Food, Drink and Tobacco
Av. Rank = 9.4
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

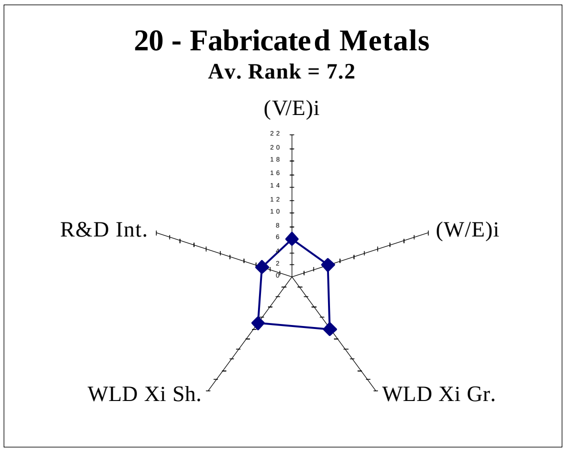

15 - Paper and Printing
Av. Rank = 9.2
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

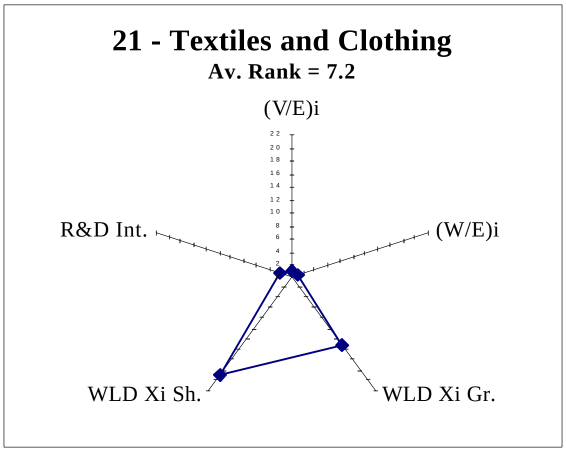

16 - Stone, Clay and Glass
Av. Rank = 8.6
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

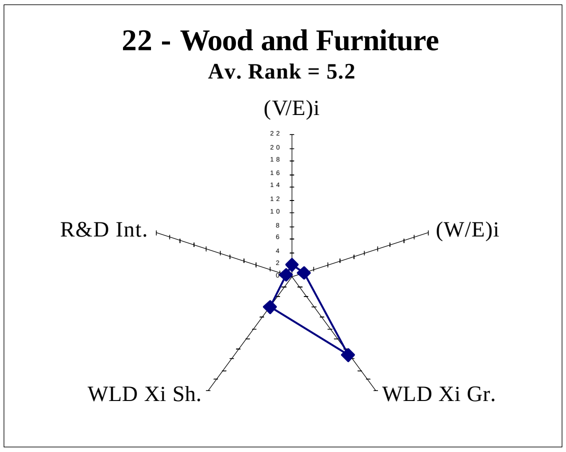

17 - Shipbuilding
Av. Rank = 8.4
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


18 - Oth. Transport Equipment
Av. Rank = 8.0
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


19 - Other Manufacturing
Av. Rank = 7.6
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


20 - Fabricated Metals
Av. Rank = 7.2
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


21 - Textiles and Clothing
Av. Rank = 7.2
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.


22 - Wood and Furniture
Av. Rank = 5.2
(V/E)i
(W/E)i
WLD Xi Gr.
WLD Xi Sh.
R&D Int.

Chemicals – low export growth and high shares ranks indicate the world market has reached a certain degree of saturation and in spite of the high potential contribution of this industry to GDP and its ability to generate income supplemented by a moderate level of R&D, Chemicals appears to be an industry of limited potential relative to the industries noted above. Motor vehicles – average wage and value added ranks are slightly lower than for Chemicals, export growth is higher, so the overall conclusion is that Motor vehicles' potential is moderate. Petroleum refining has the highest value added rank and, what is quite remarkable, this enormously capital intensive industry is also characterised by the highest wages rank although R&D intensity is modest. The combination of high potential contribution to GDP and welfare with fairly low skills required could make this industry extremely attractive for many countries but its potential is severely constrained by the lowest rank for world export growth and by capital intensity.

Machinery, Instruments and Electrical machinery have very similar values of the overall composite index and despite some industry-specific features their potential can generally be classified as average. The major feature of Ferrous and Non-ferrous metals industries is low rank of export growth, so the significance of these industries is likely to decline. Rubber and Plastics as well as Other manufacturing, in spite of the high values of the export growth rank, provide neither high value added nor income. Stone, clay and glass is similar but the export growth rank is even lower.

Food, drink and tobacco has equal low ranks for R&D, wages and export growth, but high values for export shares and value added indicators; a well-established capital intensive industry with fairly low skill requirements may contribute to economic growth, but it is unlikely that the development of this industry will generate much improvement in welfare. Paper and printing – R&D is low, while all other indicators are at the average level. It appears that this industry may be of some interest for developing countries. Shipbuilding and Other transport equipment – moderate in R&D, labour-intensive, capable of providing a fair income level, but their potential is limited by the scale despite the average value of the export growth rank. Fabricated metals – all five components are below the average level.

Textiles and clothing – a traditional, established industry with a high rank for export shares supplemented by a good pace of growth. The industry is the last in the list according to two indicators: value added and wages per employee, and very low in R&D. Textiles and clothing can provide employment but at a very low income level and can hardly stimulate economic growth. Finally, Wood and furniture – another traditional industry, the last in knowledge intensity, similar to Textiles and clothing but of smaller scale.

In this section we have presented only a brief analysis of selected features of manufacturing industries. However, this approach may be used as a basis for more detailed studies.

4. Index of the Long Run Income Potential

In order to evaluate industrial structure and structural changes the proportions between the components of this structure need to be assessed. In other words, we have to consider sectoral shares of manufacturing industries and changes in these shares. This approach can be very efficient when analysing the significance of one or several manufacturing sectors. But for assessing the structure of total manufacturing (consisting of 22 industries) the task becomes enormously laborious and the results are difficult to interpret especially for cross-country comparison. The allocation of industries in a certain order according to a particular criterion that has a numeric value enables the development of a weighted index of structural composition. In our previous work this method has been used for the evaluation of industrial structure according to knowledge intensity applying R&D intensity ratios as industry-specific weights (see Sheehan et al. 1995, p. 61; Sheehan and Tikhomirova 1996, p. 10). The application of the values of the overall composite industry rank as industries' weights allows developing of the Index of the Long Run Income Potential of Industrial Structure. It is worth emphasising once again that the Index is a tool for analysing the manufacturing structure only, but by no means is an indicator of actually achieved levels of per capita income in different countries and regions.

As noted above, we define the Index of the Long Run Income Potential applying the same approach used previously for the Index of Knowledge Composition (see Sheehan et al. 1995, p. 61; Sheehan and Tikhomirova 1996, p. 10).

$$CI_T^i = \frac{\sum_j^n \left(X_j^i \cdot I_j \right)}{\sum_j^n X_j^i} \qquad (1)$$

where: *CI* - the Index of the Long Run Income Potential of Industrial Structure,

i - a country,

j - an industry,

n - the total number of manufacturing industries,

I - a weight (the value of the overall composite industry rank),

X - exports.

If manufacturing exports were equally divided across industries,

$$X_j^i = \frac{X_T^i}{n} = \frac{\sum_j^n X_j^i}{n},$$

where X_T^i - total manufacturing exports for country "*i*",

$$CI_T^i = \frac{\sum_j^n \left[\left(\frac{\sum_j^n X_j^i}{n} \right) \cdot I_j \right]}{\sum_j^n X_j^i} = \frac{\sum_j^n X_j^i \cdot \sum_j^n I_j}{n \cdot \sum_j^n X_j^i} = \frac{\sum_j^n I_j}{n} = \overline{CI_T}$$

$$\boxed{\overline{CI_T} = \frac{\sum_j^n I_j}{n} = \frac{I_T}{n}} \qquad (2)$$

where: $\overline{CI_T}$ - the average value of the Index of Income Potential ($X_j^i = \frac{X_T^i}{n}$),

I_T - the sum of the values of the overall composite industry rank for all manufacturing industries.

The value of $\overline{CI_T}$ can be used as a base for benchmarking the value of the Index of Income Potential:

$$\boxed{RCI_T^i = \frac{CI_T^i}{\overline{CI_T}} = \frac{\sum_j^n \left(X_j^i \cdot I_j \right)}{\left(\sum_j^n X_j^i \right) \cdot \overline{CI_T}}} \qquad (3)$$

where RCI - the Rebased Index of the Long Run Income Potential of Industrial Structure.

If the value of the Index of Income Potential is equal to the average value, the Rebased Index is equal to 1. In the charts, further on, this particular case is presented as a base level.

The same approach can be applied for the evaluation of the structure of imports, gross output, value added and employment.

High values of the index indicate that the industrial structure is biased towards the areas of higher income generating potential, or, in other words, industries characterised by high values of the overall composite rank have high values of sectoral shares of total manufacturing. This implies that such a structure is favourable for generating high levels of welfare, but actual income levels achieved by different countries depend on their ability to utilise the potential of manufacturing sectors with high values of the composite rank. The analysis of industrial structure and of structural changes can provide a good basis for further studies of economic performance in different parts of the world.

5. Some Applications of the Index of the Long Run Income Potential

Although the evaluation of structural change is not the purpose of this paper, let us present an example of the application of the Index.

Table 6 and Chart 2 show the levels of and changes in the Rebased Index of the Long Run Income Potential of Manufacturing Exports for selected regions and countries over the period 1970 to 1994. We can conclude that over this period there was a general shift in industrial structure towards industries that have higher welfare potential, although both the values of the Index and the pace of the structural change vary across regions and countries. ASEAN and East Asian countries experienced substantial restructuring of their manufacturing exports. The percentage change in the levels of the Index for ASEAN is about 4.5, and for East Asia – 4 times higher than for the World. In Japan the structural change was also quite pronounced: the value of the Index increased by 17.9 per cent. In Europe-7 and the USA the process of industrial restructuring over the period 1970 to 1994 was characterised by a much more modest pace, but the value of the Index for the USA at the beginning of the period was just slightly lower than the level achieved by ASEAN in 1994. The value of the Index for Europe-7 at the starting point was above the World level but by 1994 the levels merged. For Japan the picture is the opposite: in 1970 the value of the Index was almost the same as for the World but by 1990 Japan achieved the highest position in the World.

Table 6

Rebased Index of the Long Run Income Potential of Manufacturing Exports

	1970	1975	1980	1985	1990	1994	Percentage Change 1970-1994
USA	1.13	1.13	1.13	1.19	1.18	1.17	2.9
EEC-7	1.05	1.06	1.06	1.08	1.08	1.09	3.7
Japan	1.03	1.06	1.13	1.18	1.21	1.21	17.9
ASEAN	0.89	0.96	0.99	1.03	1.08	1.14	27.5
East Asia	0.78	0.82	0.86	0.88	0.94	0.97	24.9
World	**1.02**	**1.04**	**1.05**	**1.08**	**1.08**	**1.09**	**6.2**

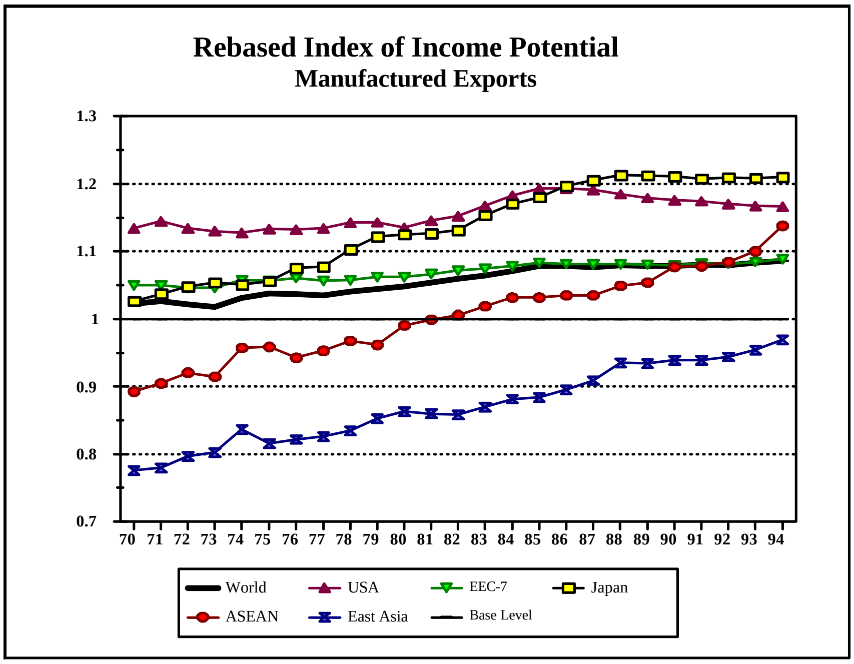
Notes: EEC-7 - Belgium, Luxembourg, Germany, Italy, France, the Netherlands, the United Kingdom;

ASEAN - Brunei, Indonesia, Malaysia, Philippines, Singapore, Thailand;

East Asia - South Korea, Taiwan, China, Hong Kong.

Source: Estimates, based on Trade and Production Data accessed through IEDB (ANU); OECD data on industry specific R&D intensities

Chart 2



The Index of the Long Run Income Potential can be used for analysing the significance of a particular manufacturing sector or a number of sectors in the industrial structure. Here we will describe three methods (based on different assumptions) applying them to manufacturing exports.

I. Let us assume that <u>in a given country the share of a particular industry (*t*) of total manufacturing exports is equal to zero</u>, while the values of other industries' shares and industry-specific weights (the values of the overall composite rank) are unchanged. In this case the sum of the export shares of all other industries is not equal to one. The value of total manufacturing exports remains unchanged.

$$CI^i_{T-t} = \frac{\sum_{j \neq t}^{n} \left(X^i_j \cdot I_j \right)}{X^i_T} = \frac{\sum_{j}^{n} \left(X^i_j \cdot I_j \right) - X^i_t \cdot I_t}{X^i_T} = \frac{\sum_{j}^{n} \left(X^i_j \cdot I_j \right)}{X^i_T} - \frac{X^i_t \cdot I_t}{X^i_T}$$

$$\boxed{CI^i_{T-t} = CI^i_T - \left(\frac{X^i_t}{X^i_T} \right) \cdot I_t} \qquad (4)$$

$$\boxed{CI^i_T - CI^i_{T-t} = \left(\frac{X^i_t}{X^i_T} \right) \cdot I_t} \qquad (5)$$

The difference between the two values of the Index of Income Potential is equal to the share of the industry *t* multiplied by this industry's weight. This measure directly shows the contribution of the industry *t* to the overall value of the Index.

Let us apply the same approach to the Rebased Index of Income Potential. We have assumed that the export share of the industry *t* is equal to zero while export shares of all other industries remain unchanged. Total manufacturing still consists of 22 industries, characterised by the same weights. Then the average value of the Index is the same in both cases:

$$\overline{CI_{T-t}} = \frac{\sum_{j}^{n} I_j}{n} = \overline{CI_T} \qquad (6)$$

$$RCI_{T-t}^{i} = \frac{CI_{T-t}^{i}}{\overline{\overline{CI_{T-t}}}} = \frac{CI_{T}^{i} - \left(\frac{X_{t}^{i}}{X_{T}^{i}}\right)\cdot I_{t}}{\overline{\overline{CI_{T}}}} = \frac{CI_{T}^{i}}{\overline{\overline{CI_{T}}}} - \left(\frac{X_{t}^{i}}{X_{T}^{i}}\right)\cdot \frac{I_{t}}{\overline{\overline{CI_{T}}}}$$

$$\boxed{RCI_{T-t}^{i} = RCI_{T}^{i} - \left(\frac{X_{t}^{i}}{X_{T}^{i}}\right)\cdot \frac{I_{t}}{\overline{\overline{CI_{T}}}}} \tag{7}$$

$$\boxed{RCI_{T}^{i} - RCI_{T-t}^{i} = \left(\frac{X_{t}^{i}}{X_{T}^{i}}\right)\cdot \frac{I_{t}}{\overline{\overline{CI_{T}}}}} \tag{8}$$

The difference between the values of the Rebased Index of Income Potential is equal to the share of the industry *t* of total manufacturing exports multiplied by the weight of this industry and divided by the average value of the Index. In other words, the difference between the two values of the Rebased Index is equal to the rebased weighted share of the industry *t* of total manufacturing exports.

The same method can be used in order to show the contribution of a number of industries to the overall value of the indicator of industrial structure. For example, for two industries we will get the following formulae:

$$CI_{T-(t+s)}^{i} = \frac{\sum_{j\neq t,s}^{n}\left(X_{j}^{i}\cdot I_{j}\right)}{X_{T}^{i}} \tag{9}$$

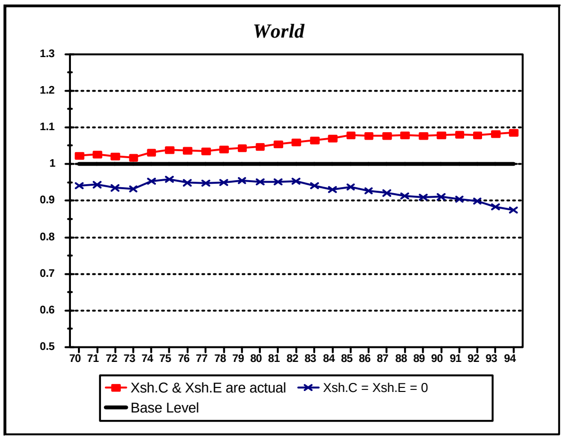
$$RCI_{T-(t+s)}^{i} = \frac{CI_{T-(t+s)}^{i}}{\overline{\overline{CI_{T}}}} \tag{10}$$

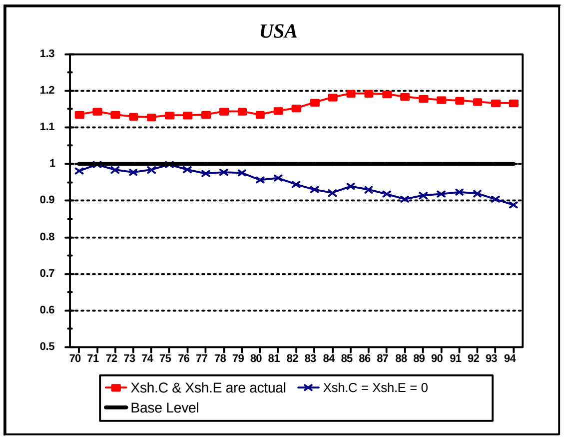
$$CI_{T}^{i} - CI_{T-(t+s)}^{i} = \left(\frac{X_{t}^{i}}{X_{T}^{i}}\right)\cdot I_{t} + \left(\frac{X_{s}^{i}}{X_{T}^{i}}\right)\cdot I_{s} \tag{11}$$

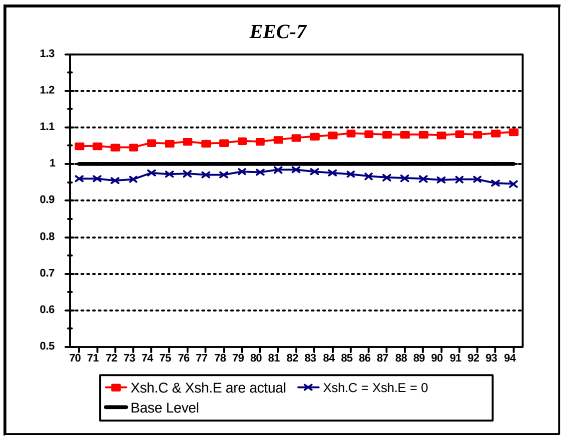
Chart 3 Rebased Index of Income Potential of Manufacturing Exports

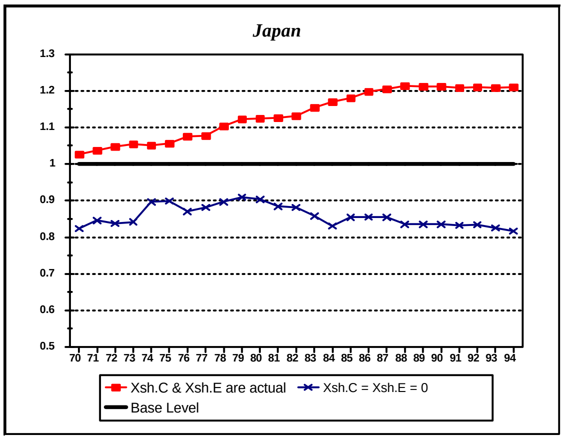
Selected Regions and Countries

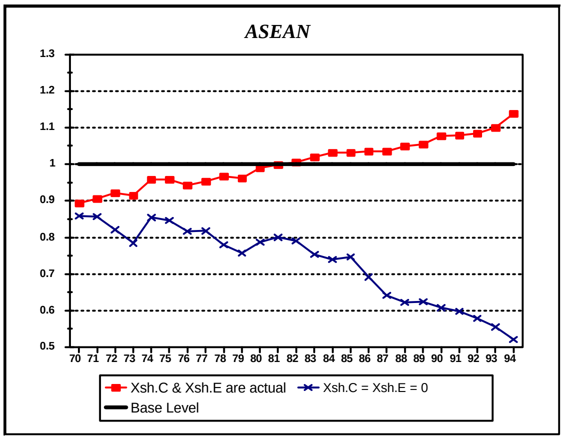
Sectoral Shares of Computers and Electronics: actual and equal to zero

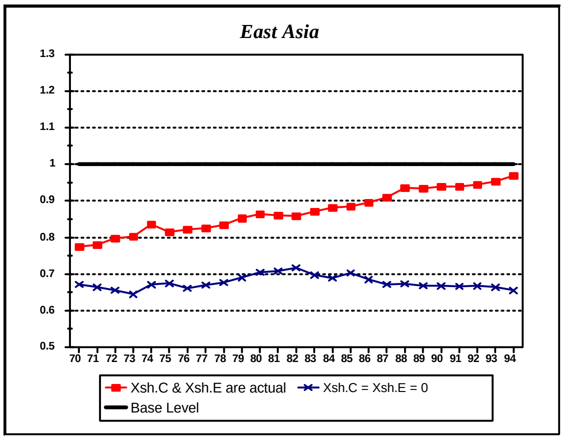












$$RCI_T^i - RCI_{T-(t+s)}^i = \left(\frac{X_t^i}{X_T^i}\right) \cdot \frac{I_t}{CI_T} + \left(\frac{X_s^i}{X_T^i}\right) \cdot \frac{I_s}{CI_T} =$$

$$= \frac{1}{CI_T} \cdot \left[\left(\frac{X_t^i}{X_T^i}\right) \cdot I_t + \left(\frac{X_s^i}{X_T^i}\right) \cdot I_s\right] \qquad (12)$$

Let us present an example of the application of this method. Chart 3 shows the direct effect of two industries, Computers and Electronics, on the overall value of the Rebased Index of Income Potential for selected regions and countries.

II. Another way of looking at the effect of a particular industry's exports on the value of the overall indicator of the structure of manufacturing exports is to assume that there are no exports generated by this industry in a given country.

$$X_t^i = 0$$

The values of other industries' exports are unchanged. Total manufacturing exports are equal to the sum of exports of other (21, in our case) exporting industries.

$$X_{T-t}^i = \sum_{j \neq t}^{n} X_j^i \qquad (13)$$

Thus, the shares of other industries of total manufacturing exports will take different values, compared with the values of sectoral export shares in the case when all (22) industries are exporting and the value of total manufacturing exports is the sum of the exports of 22 industries. The manufacturing sector still consists of 22 industries. The absence of exports of an industry in a country cannot affect the inherent characteristics of manufacturing industries. So, the industry-specific weights remain unchanged for all industries. In other words, for a given country we compare two different structures of manufacturing exports: the first – total manufacturing consists of 22 exporting industries, and the second – of 21 exporting industries, while industry-specific weights are the same in both cases.

$$CI^i_{T-t} = \frac{\sum_{j\neq t}^{n}\left(X^i_j \cdot I_j\right)}{X^i_{T-t}} = \frac{\sum_{j\neq t}^{n}\left(X^i_j \cdot I_j\right)\cdot \sum_{j}^{n}\left(X^i_j \cdot I_j\right)\cdot \sum_{j}^{n} X^i_j}{\sum_{j\neq t}^{n} X^i_j \cdot \sum_{j}^{n}\left(X^i_j \cdot I_j\right)\cdot \sum_{j}^{n} X^i_j} =$$

$$= \frac{\sum_{j}^{n}\left(X^i_j \cdot I_j\right)}{\sum_{j}^{n} X^i_j} \cdot \frac{\sum_{j}^{n} X^i_j}{\sum_{j\neq t}^{n} X^i_j} \cdot \frac{\sum_{j\neq t}^{n}\left(X^i_j \cdot I_j\right)}{\sum_{j}^{n}\left(X^i_j \cdot I_j\right)} = CI^i_T \cdot \frac{X^i_T}{X^i_T - X^i_t} \cdot \frac{\sum_{j}^{n}\left(X^i_j \cdot I_j\right) - X^i_t \cdot I_t}{\sum_{j}^{n}\left(X^i_j \cdot I_j\right)} =$$

$$= CI^i_T \cdot \frac{1}{1 - \frac{X^i_t}{X^i_T}} \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_{j}^{n}\left(X^i_j \cdot I_j\right)}\right)$$

$$\boxed{CI^i_{T-t} = CI^i_T \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}}\right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_{j}^{n}\left(X^i_j \cdot I_j\right)}\right)} \qquad (14)$$

or, alternatively, from (14):

$$= \left(CI^i_T - \frac{\sum_{j}^{n}\left(X^i_j \cdot I_j\right)\cdot\left(X^i_t \cdot I_t\right)}{\sum_{j}^{n} X^i_j \cdot \sum_{j}^{n}\left(X^i_j \cdot I_j\right)}\right) \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}}\right) = \left(CI^i_T - \frac{X^i_t \cdot I_t}{\sum_{j}^{n} X^i_j}\right) \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}}\right)$$

$$\boxed{CI^i_{T-t} = \left(CI^i_T - \frac{X^i_t}{X^i_T} \cdot I_t\right) \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}}\right)} \qquad (15)$$

The first part of the formula (15) is exactly the same as the right-hand part of the equation (4), the value of the second part of (15) is a function of the sectoral export share of the industry *t*. The larger the share, the smaller the denominator, and, consequently, the larger the value of the whole fraction. If the sectoral share of the industry *t* is relatively small the value of the CI^i_{T-t} in the second

method (II) is close to the value of the CI^i_{T-t} in the first method (I). The difference between CI^i_T and CI^i_{T-t} in this case will almost directly reflect the actual effect of the industry t's exports on the value of the Index of Income Potential. If the sectoral share is large the second part of the formula (15) will have a multiplying effect on the value of CI^i_{T-t} . In this case the difference between CI^i_T and CI^i_{T-t} should not be considered as an indicator of the direct effect of the industry's exports on the existing structure of manufacturing exports. The value of CI^i_{T-t} indicates the structural composition of the manufacturing sector that consists of the remaining exporting industries; and comparison of CI^i_T and CI^i_{T-t} (that represent the two structures of manufacturing) allows us to estimate the impact of the industry t's exports on the overall structural composition.

The exact formula for the difference between CI^i_T and CI^i_{T-t} can be easily derived from (14):

$$CI^i_T - CI^i_{T-t} = CI^i_T - CI^i_T \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right)$$

$$\boxed{CI^i_T - CI^i_{T-t} = CI^i_T \cdot \left[1 - \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \right]} \qquad (16)$$

As has been noted above, there are 22 manufacturing industries in both cases: in the first case all 22 industries are exporting, in the second one – 21 industries are exporting and one industry (the industry t) is not generating any exports. The industry-specific weights remain unchanged for all 22 industries. The average value of the Index of Income Potential is the same in both cases, as shown in (6).

The formula for the Rebased Index in this case will take the following form:

$$RCI^i_{T-t} = \frac{CI^i_{T-t}}{\overline{\overline{CI_{T-t}}}} = \frac{CI^i_{T-t}}{\overline{\overline{CI_T}}} = \frac{CI^i_T}{\overline{\overline{CI_T}}} \cdot \left(\frac{1}{1 - \frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right)$$

$$RCI^i_{T-t} = RCI^i_T \cdot \left(\frac{1}{1-\frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \tag{17}$$

$$RCI_T - RCI^i_{T-t} = RCI_T \cdot \left[1 - \left(\frac{1}{1-\frac{X^i_t}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \right] \tag{18}$$

The relationship between RCI^i_{T-t} and RCI^i_T (17) is exactly the same as the relationship between CI^i_{T-t} and CI^i_T (14), and the formula (18) is similar to the equation (16). We can conclude that the Rebased Index can be used for the comparison of the two structures of manufacturing exports in the same way as has been described above referring to the Index of Income Potential. Furthermore, the rebased form of the Index has an additional useful feature for cross-structural comparison, according to the average value of the Index. If the value of the Index of Income Potential is equal to the average value, the Rebased Index is equal to 1. As has been noted above, the average value of the Index is the same for both structures. Therefore we can compare each of the two structures with the same average value, and thus estimate the significance of the industry *t* for the overall composition of manufacturing exports.

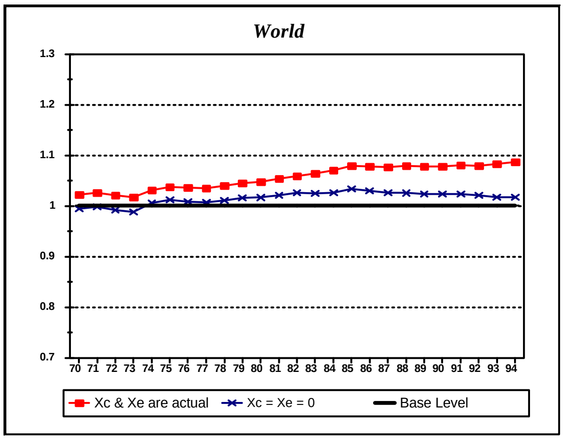
In the case of two non-exporting industries:

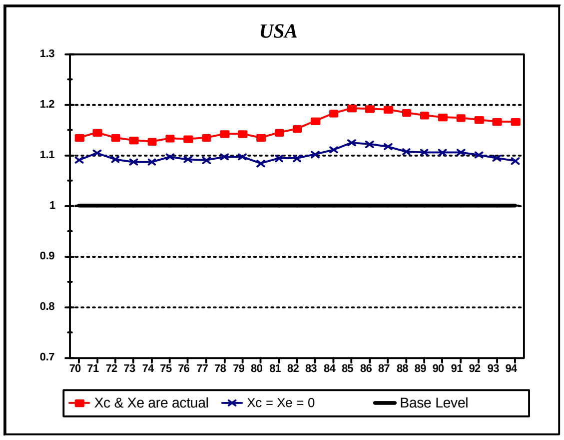
$$CI^i_{T-(t+s)} = CI^i_T \cdot \left(\frac{1}{1-\frac{X^i_t + X^i_s}{X^i_T}} \right) \cdot \left(1 - \frac{X^i_t \cdot I_t + X^i_s \cdot I_s}{\sum_j^n \left(X^i_j \cdot I_j \right)} \right) \tag{19}$$

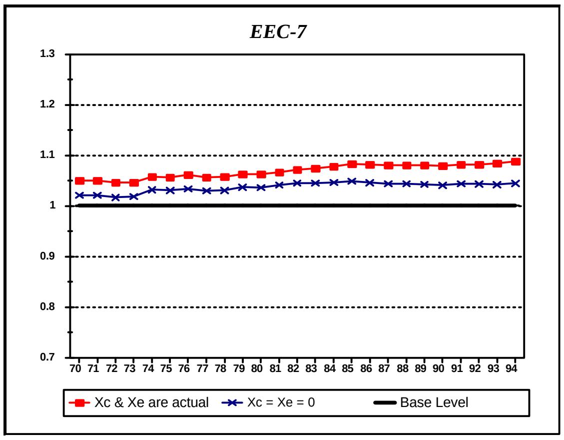
Chart 4 Rebased Index of Income Potential of Manufacturing Exports

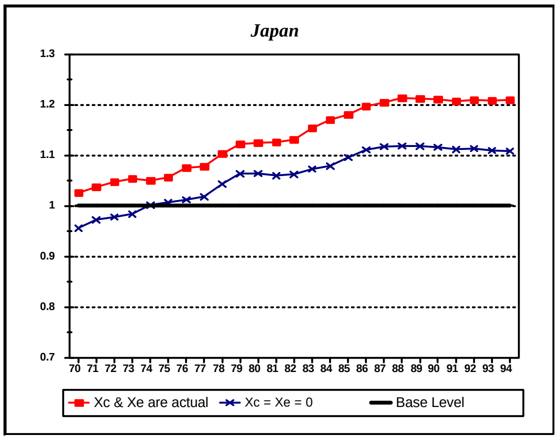
Selected Regions and Countries

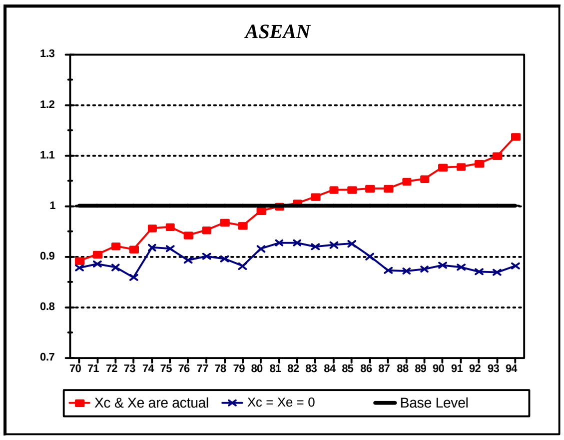
Exports of Computers and Electronics: actual and equal to zero

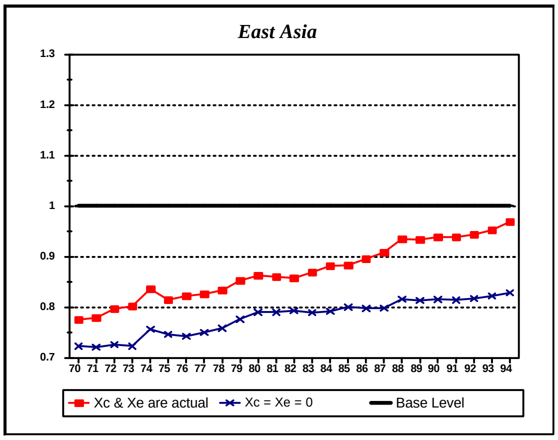












$$CI_T^i - CI_{T-(t+s)}^i = CI_T^i \cdot \left[1 - \left(\frac{1}{1 - \frac{X_t^i + X_s^i}{X_T^i}} \right) \cdot \left(1 - \frac{X_t^i \cdot I_t + X_s^i \cdot I_s}{\sum_j^n \left(X_j^i \cdot I_j \right)} \right) \right] \quad (20)$$

$$RCI_{T-(t+s)}^i = RCI_T^i \cdot \left(\frac{1}{1 - \frac{X_t^i + X_s^i}{X_T^i}} \right) \cdot \left(1 - \frac{X_t^i \cdot I_t + X_s^i \cdot I_s}{\sum_j^n \left(X_j^i \cdot I_j \right)} \right) \quad (21)$$

$$RCI_T^i - RCI_{T-(t+s)}^i = RCI_T^i \cdot \left[1 - \left(\frac{1}{1 - \frac{X_t^i + X_s^i}{X_T^i}} \right) \cdot \left(1 - \frac{X_t^i \cdot I_t + X_s^i \cdot I_s}{\sum_j^n \left(X_j^i \cdot I_j \right)} \right) \right] \quad (22)$$

The same approach can be applied in order to estimate the effect of several non-exporting industries.

Chart 4 presents an example of the application of the second method for the evaluation of the significance of Computers and Electronics for selected countries and regions.

III. This method is based on the assumption that the industry *t* is excluded from the list of manufacturing sectors. In this case the structure of manufacturing is different, total manufacturing exports is equal to the sum of exports of the remaining industries. The purpose of this approach is to compare two different structures: the first – consisting of 22 industries, and the second – of 21 industries (or less, if the effect of a number of industries has to be evaluated).

It is impossible to derive the exact formula for the relationship between the two values of the Index of Income Potential of Industrial Structure. In order to determine the industry-specific weights the ranking procedure has to be applied to the new structure of manufacturing. The values of the ranks depend on the position of the excluded industries in the list of manufacturing sectors. Consequently the values of the overall composite rank will be different for the two structures as well as the average value of the Index of Income Potential of Industrial Structure.

Table 7

N (R&D)		(VAD/E)i (JPN+USA+GER) Av. (88-90) cur. US $	(W/E)i (JPN+USA+GER) Av. (88-90) cur. US $	WLD Xi Growth 86-93 %	WLD Xi Shares Av. (88-90) %	R&D Intensity
1	Aerospace	75.10	37.25	12.27	2.62	20.2
4	Pharmaceuticals	188.46	35.04	12.84	1.23	10.3
5	Instruments	73.59	30.21	9.10	3.30	4.8
6	Motor vehicles	87.54	33.11	7.60	11.55	3.5
7	Chemicals	149.17	34.53	7.49	10.17	3.4
8	Elec. machinery	63.65	26.52	12.91	3.85	3.2
9	Machinery	67.39	29.63	8.39	11.45	2.1
10	Other transport equipment	50.28	26.75	10.29	0.53	1.9
11	Shipbuilding	51.59	27.61	9.28	1.35	1.4
12	Petroleum refining	300.46	39.48	2.81	3.34	1.1
13	Stone, clay and glass	73.16	25.80	9.60	1.68	1.1
14	Other manufacturing	53.45	20.81	11.72	2.16	1.0
15	Rubber and plastics	60.46	23.88	13.14	2.33	1.0
16	Non-ferrous metals	78.43	29.64	5.68	2.99	0.9
17	Ferrous metals	98.52	33.87	4.72	4.28	0.7
18	Fabricated metals	58.11	25.33	9.22	2.97	0.6
19	Food, drink and tobacco	87.99	21.76	7.46	7.41	0.3
20	Paper and printing	74.27	27.37	7.84	3.57	0.2
21	Textiles and clothing	36.83	16.47	10.13	9.46	0.2
22	Wood and furniture	44.00	20.29	11.44	2.29	0.1

Source: Estimates, based on Trade and Production Data accessed through IEDB (ANU); OECD data on industry specific R&D intensities.

In order to evaluate the contribution of particular industries we apply the same formula (3) for the Rebased Index for the two cases and compare the values relative to the average value of the Index. Thus we can evaluate the structural composition of the remaining industries and estimate the effect of the excluded sectors.

Table 8

N (R&D)		(VAD/E)i (JPN+USA+GER) Av. (88-90) Rank	(W/E)i (JPN+USA+GER) Av. (88-90) Rank	WLD Xi Growth 86-93 Rank	WLD Xi Shares Av. (88-90) Rank	R&D Intensity Rank	Overall Composite Rank
1	Aerospace	13	19	17	8	20	**15.4**
4	Pharmaceuticals	19	18	18	2	19	**15.2**
5	Instruments	11	14	9	11	18	**12.6**
6	Motor vehicles	15	15	6	20	17	**14.6**
7	Chemicals	18	17	5	18	16	**14.8**
8	Elec. machinery	8	8	19	14	15	**12.8**
9	Machinery	9	12	8	19	14	**12.4**
10	Other transport equipment	3	9	14	1	13	**8.0**
11	Shipbuilding	4	11	11	3	12	**8.2**
12	Petroleum refining	20	20	1	12	11	**12.8**
13	Stone, clay and glass	10	7	12	4	10	**8.6**
14	Other manufacturing	5	3	16	5	9	**7.6**
15	Rubber and plastics	7	5	20	7	8	**9.4**
16	Non-ferrous metals	14	13	3	10	7	**9.4**
17	Ferrous metals	17	16	2	15	6	**11.2**
18	Fabricated metals	6	6	10	9	5	**7.2**
19	Food, drink and tobacco	16	4	4	16	4	**8.8**
20	Paper and printing	12	10	7	13	3	**9.0**
21	Textiles and clothing	1	1	13	17	2	**6.8**
22	Wood and furniture	2	2	15	6	1	**5.2**

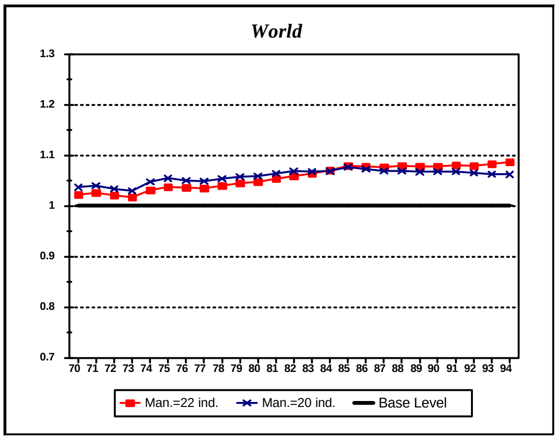
Source: Estimates, based on Trade and Production Data accessed through IEDB (ANU); OECD data on industry specific R&D intensities.

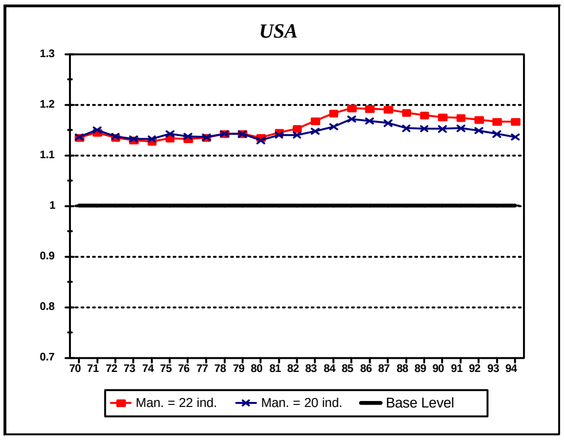
Let us present an example of the application of this method. As for the previous two methods we will evaluate the significance of Computers and Electronics. The two industries are excluded from the manufacturing sector (Table 7). In this case there are 20 industries remaining, therefore the ranks of all five components of the overall composite rank will take values from 1 to 20 (Table 8). The average value of the Index of Income Potential of Industrial Structure is equal to 10.5 (while for the 22-industries structure it is equal to 11.5). Applying the values of the overall

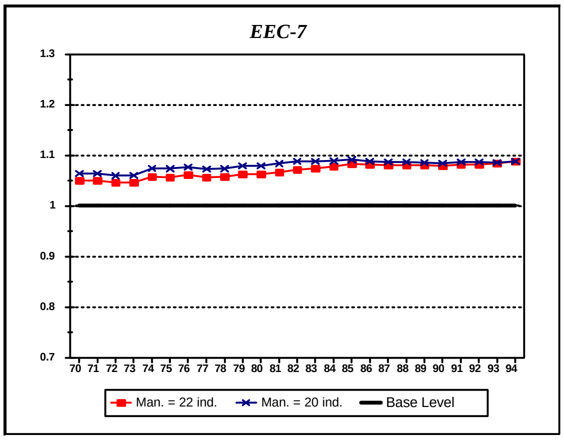
Chart 5 Rebased Index of Income Potential of Manufacturing Exports

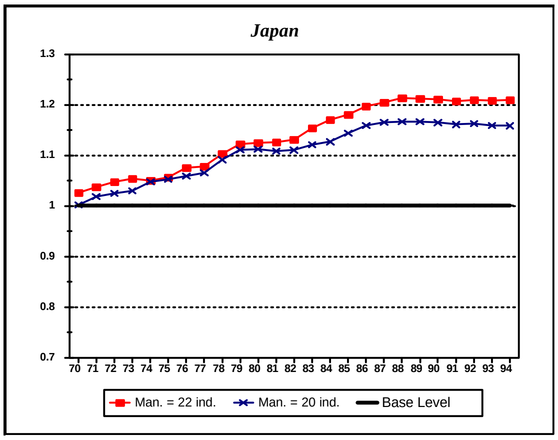
Selected Regions and Countries

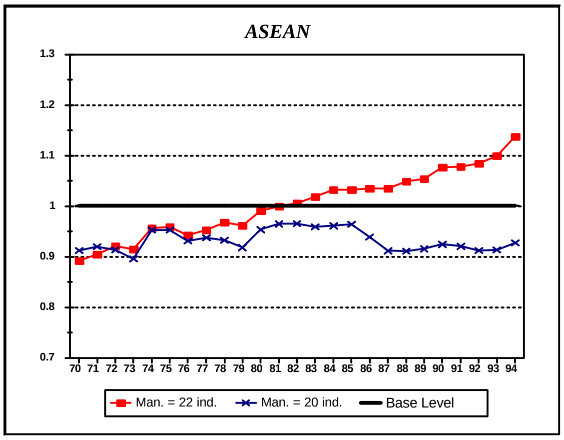
Total Manufacturing and Manufacturing Excluding Computers and Electronics

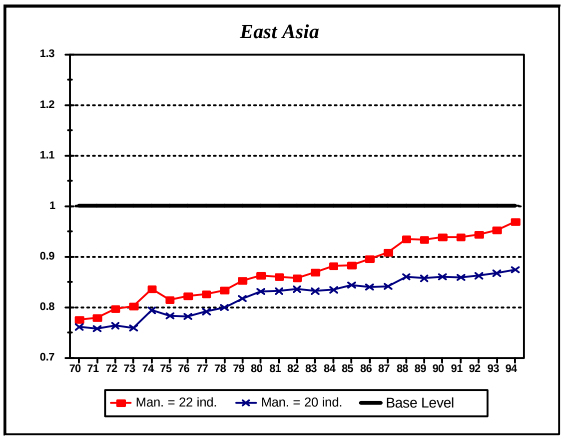








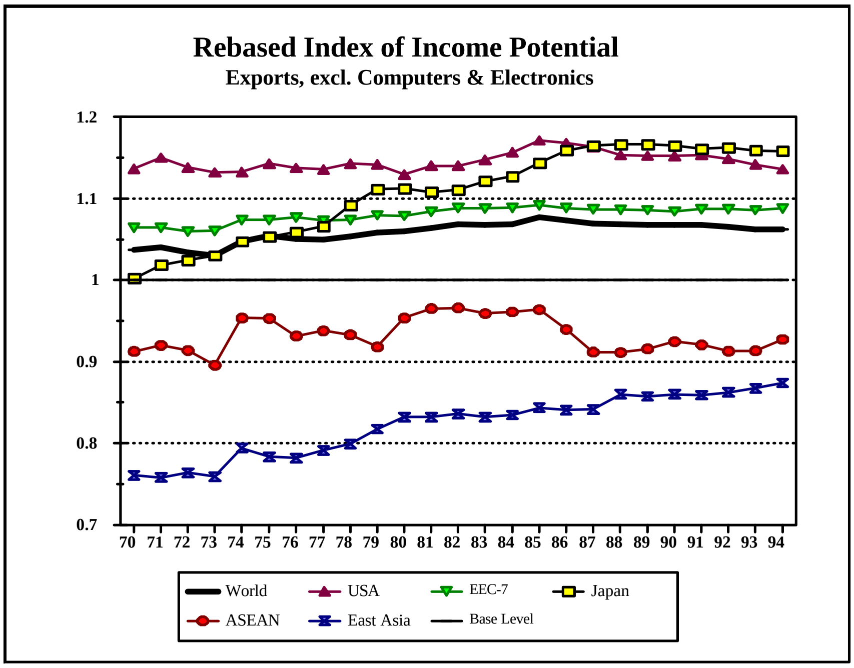




composite rank as weights and of the average value of the Index as the base level, we derive the values of the Rebased Index for the 20-industries manufacturing sector, formula (3).

Chart 5 shows the values of the Rebased Index of Income Potential of Industrial Structure for the two structures of manufacturing sector (for selected regions and countries). Although the average values of the Index are different, they are indicated by the same line, $RCI^i = 1$. If manufacturing exports are equally divided across all industries the value of the Index of Income Potential of Industrial Structure equals the average value in both cases. We can compare the composition of the actual manufacturing sector with the manufacturing structure as if there were no Computers and Electronics at all.

Chart 6



It can also be useful to compare the relative positions of the countries and regions in the two cases, as presented in Charts 2 and 6.

The difference between the two charts is the most noticeable in the case of ASEAN countries. When all 22 manufacturing industries are considered, ASEAN show steady continuous increase in the values of the Index reaching the base level in 1981, overcoming the World's level at the beginning of the 90's and approaching that of the USA in 1994. In the absence of Computers and Electronics there was virtually no restructuring in ASEAN: in 1994 the value of the Index is at about the same level as in 1970, well below not only the World's values but even the base level.

East Asian trends are much more similar: in both cases the values of the Index are the lowest among all countries and regions presented, although restructuring towards industries of higher income generating potential is quite steady and continuous. Nevertheless, the pace of restructuring differ substantially. For total manufacturing exports the trend is steeper and the value of the Index in 1994 is close to the base level; while without Computers and Electronics in spite of some upward movement in the values of the Index the structure of manufacturing is definitely biased towards industries characterised by low income potential.

The trend for the seven European countries in the case of absence of Computers and Electronics steadily follows that of the World, but the values of the Index are higher. For total manufacturing the levels merged, but mostly because of the differences in the World's trends in both cases. EEC-7 shows actually no restructuring starting from the mid 1980s, while the dynamics of the values of the Index for the World is characterised by a minor upward shift for total manufacturing and equally minor downward shift when Computers and Electronics are excluded.

For the USA and Japan the two industries did not affect their positions relative to other regions. In 1986-87 Japan became the leader overcoming the level of the United States; while in the USA a tendency to decline appeared. For both countries starting from the beginning of the 1980s the values of the Index are higher when Computers and Electronics are excluded, although the role of these two industries in the structure of Japanese and American manufacturing exports is much more modest than for ASEAN and East Asian economies.

We can conclude that the methodology described above can be used for the evaluation of the significance of particular industries' contributions to the overall indicator of industrial structure. The application of the three methods has shown that for ASEAN and East Asia Computers and Electronics are of great significance for the structure of manufacturing exports, while for other countries and regions the degree of specialisation in these two industries is much lower. The same approach can be applied for analysing the structural composition of production, value added and employment.

6. Conclusions

In this paper we have presented a new approach for analysing the income generating potential of and changes in industry structure.

- Five key industry characteristics have been determined and the overall composite rank, an integrated indicator of ability of industries to provide economic wealth, has been developed.
- According to this indicator there is substantial difference across manufacturing industries and, thus, industrial structure can affect national economic performance.
- Computers and Electronics were found to be the industries characterised by the highest income potential in the second part of the 1980s.
- The analysis of industry-specific features is of importance for policy development in individual countries.
- Applying the overall composite industry rank the Index of the Long Run Income Potential, an indicator of industrial structure and structural changes, has been developed.
- The Index can be used for the evaluation of the effect of a particular industry or a number of industries on the structural composition of the manufacturing sector. Three different methods have been presented.

Although a detailed analysis of industry structure and of the process of structural change in individual countries has not been targeted in this paper, we have presented some examples of the application of the Index of the Long Run Income Potential that show interesting trends in the structure of manufactured exports.

- Over the period 1970-1994 all countries and regions (considered in this paper) experienced structural change of manufactured exports towards industries with higher income potential, although the pace of these changes and the levels achieved differed substantially.
- The structural change of manufactured exports in ASEAN and to certain extent in East Asia was dominated by exports of products of two industries, Computers and Electronics.

It is also worth noting that the approach, presented in this paper, has some limitations. The estimates of the values of the overall rank are based on real data for the countries that achieved the highest levels of labour productivity in the second half of the 1980s. The ranks, therefore, are benchmarks valid for a particular period of time but do not provide any information about actually achieved productivity or wage levels in individual countries. The Index of the Long Run Income Potential of Industry Structure is an indicator of industrial structure and of the process of structural change, but the value of the index is not a criterion of an optimal structure.

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