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INTERNATIONAL LABOUR ORGANIZATION

Sectoral Activities Programme

The production of electronic components for the IT industries: Changing labour force requirements in a global economy

Report for discussion at the Tripartite Meeting on the Production of Electronic Components for the IT Industries: Changing Labour Force Requirements in a Global Economy

Geneva, 2007

INTERNATIONAL LABOUR OFFICE GENEVA

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Preface

At its 295th Session (March 2006), the Governing Body of the ILO decided to include a meeting on the production of electronic components for the Information Technology (IT) industries in its programme of sectoral meetings for 2006-07, which would look at changing labour force requirements in a global economy. The Governing Body also decided that the meeting could develop a number of points for discussion on the basis of a background report looking at the shift in production of IT components between industrialized, developing and emerging economies; changing skill requirements; gender; age distribution; conditions of work; labour-management relations; and production in industrial zones. The purpose of the meeting should be to exchange views on such topics; to adopt conclusions including proposals for action by governments, employers' and workers' organizations at the national level and by the ILO; and to adopt a report on its discussions.

It was also decided that the meeting would be open to all governments, and would include ten employers' representatives and ten workers' representatives nominated by their respective groups.

The meeting is part of the ILO's Sectoral Activities Programme, the purpose of which is to facilitate the exchange of information between constituents on labour and social developments relevant to particular economic sectors, complemented by practice-oriented research on topical sectoral issues. This objective has traditionally been pursued through international tripartite sectoral meetings for the exchange of ideas and experience with a view to: fostering a broader understanding of sector-specific issues and problems; developing an international tripartite consensus on sectoral concerns and providing guidance for national and international policies and measures to deal with related issues and problems; promoting the harmonization of all ILO activities of a sectoral character and acting as a focal point between the Office and its constituents; and providing technical advice, practical assistance and support to the latter to facilitate the application of international labour standards.

The purpose of this report is to provide background information to stimulate discussions at the Tripartite Meeting on the Production of Electronic Components for the IT Industries: Changing Labour Force Requirements in a Global Economy. As such, it does not seek to provide a comprehensive analysis of each national vocational education and training (VET) system, or to review every individual company or industry requirement. Instead, it focuses on the recent economic developments which form the backdrop against which these requirements can be assessed. The report also provides information on selected trends and issues as illustrations.

The report is organized as follows. Chapter 1 presents some recent developments in the industry – in the areas of production, exports and employment – using internationally comparable statistics to the extent that they were available, plus a case study of the Republic of Korea. Chapter 2 traces the rise of contract manufacturers or electronics manufacturing services (EMS) providers. Chapter 3 looks at the original design manufacturers (ODMs) and the PC and mobile phone industries. Chapter 4 examines recent experiences of countries in attracting foreign direct investment (FDI) and their ability to build up an export industry as a means of participating in globalization. Chapter 5 examines examples of training provided by companies. Chapter 6 outlines some of the social and labour problems emerging as a result of the current division of labour, and Chapter 7 looks at some of the industry and union responses to these problems. Finally, Chapter 8 draws some of the above aspects together and lists some suggested points for discussion.

Contents

Acknowledgements

This report is published under the authority of the International Labour Office and was coordinated by Paul Bailey of the Sectoral Activities Branch. Inputs to various chapters were provided by Ralph Doggett, Gijsbert van Liemt, Susan Hayter, Nick Hoagland, Irmgard Nübler, Jean-Pierre Singa Boyenge, Arianna Rossi, Katrina Fernandez-Stark and Patrice Noukawa. Comments were provided by Roberto Zachman and Robert Pember.

List of terms and abbreviations

BTO	build to order
CDS	contract design services
CPU	central processing unit
CTO	configure to order
EDP	electronic data processing
EMS	electronics manufacturing services
EU	European Union
FDI	foreign direct investment
ICT	information and communications technology
ILO	International Labour Organization
ISIC	International Standard Industrial Classification of all Economic Activities
IT	Information technology
NACE	Classification of Economic Activities in the European Community
NASA	National Aeronautics and Space Administration
NPI	new product introduction
OBM	own brand manufacturer (usually an ODM or EMS that moves up to produce and sell under its own name)
ODM	original design manufacturer (a company that designs products and product platforms that are sold to OEMs, system integrators and other companies that configure them and resell them to end-users)
OECD	Organisation for Economic Co-operation and Development
OEMs	original equipment manufacturers (also known as “brand-name companies”: firms that sell finished goods under their own brand name but do not actually make them)
PC	personal computer
PCB	printed circuit board (made of laminated materials and containing electrical circuits and connectors that transmit electrical signals between the components of electronic devices)
R&D	research and development

RoHS	(European Union) Restrictions of Hazardous Substances (prohibiting, for example, the use of lead and certain other substances in electronic products)
SITC	Standard International Trade Classification
SMEs	small and medium-sized enterprises
UNCTAD	United Nations Conference on Trade and Development
UNIDO	United Nations Industrial Development Organization
VET	vocational education and training
WTO	World Trade Organization

Divestiture transactions are transactions in which EMS providers acquire plants, equipment and inventory from an OEM. In these divestures, the OEM typically agrees to purchase from the new owner its requirements for particular products, in particular geographic areas, and for a specific period of time.

Global supply chain management involves the planning, purchasing and warehousing of product components. The objective of supply chain management services is to reduce excess component inventory in the supply chain by scheduling deliveries of components on a just-in-time, as-and-when-needed basis.

1. Industry overview

1.1. The information technology (IT) industry defined

Given the enormously diverse range of products and services associated with electrical and electronic devices, and the pervasiveness of electrical and electronic equipment in so many other products and services, any definition of the industries that produce those products and services will almost certainly remain subjective. Nonetheless, a number of definitions have been made. The most prominent among them is that of the United Nations International Standard Industrial Classification of all Economic Activities (ISIC). The ISIC undergoes periodic revisions in an effort to keep pace with the changing dynamics of production and distribution, and to accommodate changes brought on by technological advances and invention.

Although the ISIC system has just undergone its fourth revision, data are still presented under Revision 3. Electrical and electronic equipment manufacturing is categorized primarily, but not exclusively, within three broad ("two-digit") divisions among the 23 divisions included in manufacturing (which is more broadly characterized as tabulation category D). The three divisions are:

- 3000 manufacture of office, accounting and computing machinery;
- 3100 manufacture of electrical machinery and apparatus n.e.c.;
- 3200 manufacture of radio, TV and communication equipment and apparatus.

The Organisation for Economic Co-operation and Development (OECD) has developed a definition for the information and communication technology (ICT) industry, based on product and service categories drawn from the ISIC definitions.[1] The OECD definition includes the following industry definitions, along with their ISIC (Revision 3) identifiers.

Manufacturing industries

- 3000 manufacture of office, accounting and computing machinery;
- 3130 manufacture of insulated wire and cable;
- 3210 manufacture of electronic valves, tubes, other electronic components;
- 3220 manufacture of TV, radio transmitters; apparatus for line telephony, telegraphy;
- 3230 manufacture of TV, radio receivers, sound, video recording/reproducing apparatus;
- 3312 instruments and apparatus for measuring, testing, etc.;

[1] See OECD: *Reviewing the ICT sector definition: Issues for discussion*, discussion paper, Stockholm, 17 Apr. 2002.

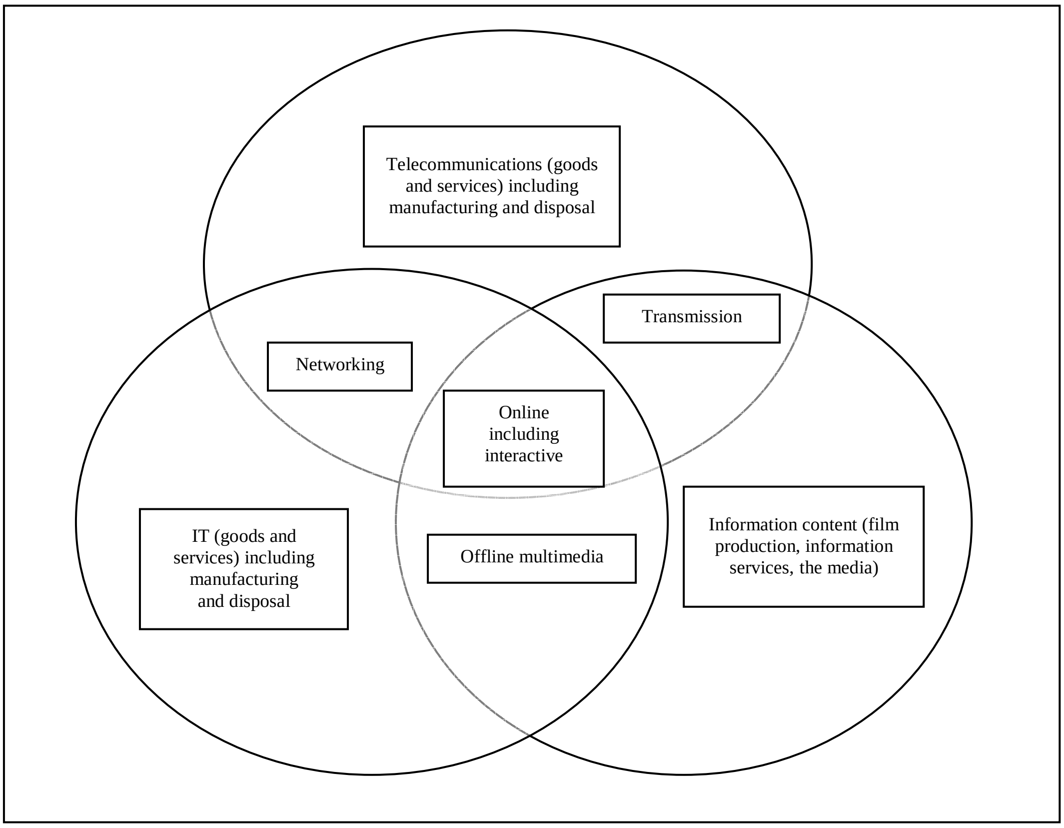
- 3313 industrial process equipment.

Service industries

- 5150 wholesale of machinery, equipment and supplies (part only);
- 6420 telecommunications;
- 7123 renting of office machinery and equipment (including computers);
- 7200 computer-related activities.

The OECD definition, as shown in figure 1.1, is designed to distinguish the ICT sector from other electrical and electronic products manufacturers, and to include segments of the service industries that are dedicated to information and communications technology. This report, and the Meeting on the electrical and electronics products industry for which it has been written, focus on the broader definition of the industry that encompasses at least ISIC 30, 31 and 32.

Figure 1.1. Overlap between the information technology, telecommunication and content activities of firms



Source: ILO, based on OECD report DSTI/ICCP/IIS(2005)6/FINAL adapted from a Finnish model.

Two additional factors are worthy of note. First, the statistical data from readily available sources are limited, especially for service industries exclusively engaged in electrical and electronic product applications, and, to a somewhat lesser extent, for industries that manufacture electrical and electronic products. For manufacturing industries, more information is available at the broader (2-digit ISIC) industry level than is available for the more detailed (4-digit ISIC) industry level, particularly with regard to labour market indicators.

Secondly, one major purpose of this report is to provide information on changing patterns of trade as they affect and have been affected by the dynamics of the electrical and electronics industry in an evolving global marketplace. Trade information from readily available public sources is typically reported and presented in terms of the Standard International Trade Classification (SITC) system, which is commodity based, rather than industry based.

As a consequence of these factors, this report employs a broad and informal definition of the electrical and electronics products industry which essentially follows definitions embodied in readily available industry and trade data.

1.2. Approach adopted in this report

The tables and graphic figures presented in this report, and the discussions surrounding them, are couched in terms of the abovementioned classification schemes and definitions. The sources include the International Labour Organization (ILO), the United Nations Industrial Development Organization (UNIDO), the Organisation for Economic Co-operation and Development (OECD), the Statistical Office of the European Communities (Eurostat), the United Nations Conference on Trade and Development (UNCTAD) and the World Trade Organization (WTO). Discussions and displays based on information drawn from the first three of these sources primarily use the ISIC Revision 3 definitions, with a few noted exceptions. Eurostat data are based on the EU's NACE classification system, which is very closely related to the ISIC. [2] The trade data from UNCTAD and the WTO are characterized by the SITC system. Note that, unless otherwise specifically indicated, none of the data drawn from these sources have been modified or manipulated in any way, other than to calculate ratios, averages, percentages, subtotals and totals. The same data are available from SECTOR*Source*, a database system under development by the ILO Sectoral Activities Programme. More detailed information on the SECTOR*Source* database is given in tables 1.1-1.3.

[2] For details, see http://ec.europa.eu/comm/eurostat/ramon/.

Table 1.1. SECTOR***Source*** data sources

Source	Organization	Details	For more information
ILO	International Labour Organization	Data compiled directly from ILO LABORSTA database. Includes data on paid employment in manufacturing, hours of work in manufacturing, wages in manufacturing, and labour cost in manufacturing. Most data is at the 2-digit level of ISIC Revision 3.	http://www.ilo.org
Eurostat	Statistical Office of the European Communities	Data compiled from the Eurostat web site: Annual detailed enterprise statistics on manufacturing. Data is available at the 4-digit level of the NACE.	http://epp.eurostat.cec.eu.int
OECD	Organisation for Economic Co-operation and Development	Data compiled from the OECD Structural Analysis (STAN) database. Includes labour market statistics plus production and trade statistics. This data is at the 2- and 3-digit level of ISIC Revision 3.	http://www.oecd.org
UNIDO	United Nations Industrial Development Organization	Data compiled from the UNIDO CD-ROM databases (INDSTAT4 2006 and IDSB 2006, ISIC Revision 3, 4-digit level). Includes labour market data plus output statistics.	http://www.unido.org
UNCTAD	United Nations Conference on Trade and Development	Trade by commodity data compiled from the UNCTAD Handbook of Statistics 2004 on CD-ROM; 3-digit SITC Revision 2.	http://www.unctad.org
WTO	World Trade Organization	Trade by commodity data compiled from the WTO web site. Data are presented for aggregate commodity groups based on the SITC Revision 2.	http://www.wto.org

Source: SECTOR*Source* documentation.

Table 1.2. SECTOR***Source*** electronics industry coverage by industry code and data source

ISIC Rev. 3	Industry name	NACE	ILO	UNIDO	Eurostat
3000	Manufacture of office, accounting and computing machinery	3000 3001 f 3002 f	•	• •	• • •
3100	Manufacture of electrical machinery and apparatus n.e.c.	3100	•	•	•
3110	Manufacture of electric motors, generators and transformers	3110		•	•
3120	Manufacture of electricity distribution and control apparatus	3120		•	•
3130	Manufacture of insulated wire and cable	3130		•	•
3140	Manufacture of accumulators, primary cells and primary batteries	3140		•	•
3150	Manufacture of electric lamps and lighting equipment	3150		•	•
3190	Manufacture of other electrical equipment n.e.c.	3160 f 3161 f 3162 f		• • •	• • •
3200	Manufacture of radio, TV and communication equipment and apparatus	3200	•		•
3210	Manufacture of electronic valves, tubes, other electrical components	3210		•	•
3220	Manufacture of TV, radio transmitters; apparatus for line telephony, telegraphy	3220		•	•
3230	Manufacture of TV, radio receivers, sound, video recording/reproducing apparatus	3230		•	•

Note: The flags (f) indicate that the concordance between the classification systems for these sectors is imprecise.

Source: SECTOR*Source* documentation.

Table 1.3. SECTOR***Source*** data categories by theme and source

	ILO	UNIDO	Eurostat	OECD	UNCTAD	WTO
Enterprises/establishments						
Number of enterprises/establishments		•	•	•		
Employment						
Aggregate measures						
Total employment	•	•	•	•		
Categories of workers						
Number of apprentices			•			
Number of female employees	•	•				
Number of home workers			•			
Number of part-time employees			•			
Total number of R&D personnel			•			
Number of unpaid persons employed			•			
Other measures of employment						
Full-time equivalent employment			•	•		

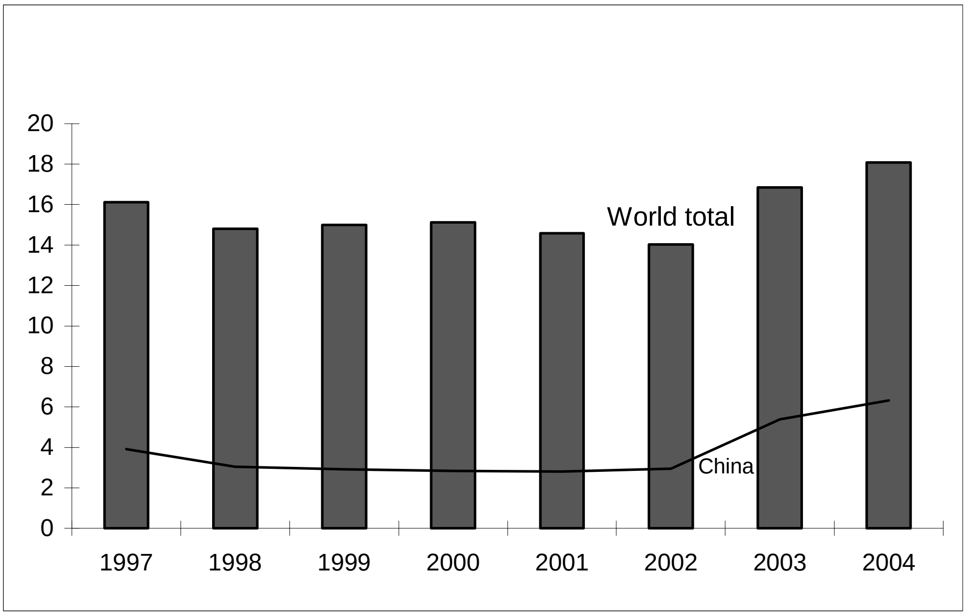
	ILO	UNIDO	Eurostat	OECD	UNCTAD	WTO
Working time						
Aggregate measures						
Hours of work	•			•		
Rates	•					
Labour cost/compensation						
Aggregate measures						
Personnel costs			•			
Labour compensation of employees			•	•		
Wages and salaries	•	•	•	•		
Social security costs			•			
Rates of compensation	•					
Production measures						
Production units						
Output		•	•	•		
Value added		•	•	•		
Trade						
Exports				•	•	•
Imports				•	•	•

Source: SECTOR*Source* documentation.

1.3. Global employment trends in the electrical and electronic products manufacturing industries

The ILO Sectoral Activities Branch estimates that total employment in the manufacture of electrical and electronic products worldwide is over 18 million workers. This estimate for 2004 was derived by careful evaluation and tabulation of data derived from several sources, particularly the ILO's Bureau of Statistics, UNIDO, Eurostat and the OECD, and organized in the SECTOR*Source* database (see figure 1.2). Employment in this industry segment declined from 16.1 million workers in 1997 to a low of 14 million workers in 2002. This 13 per cent reduction meant a decrease of 2.1 million workers in just five years. However, the industry has boomed in recent years, and the losses of the late 1990s have been more than matched by an increase of nearly 30 per cent since 2002.

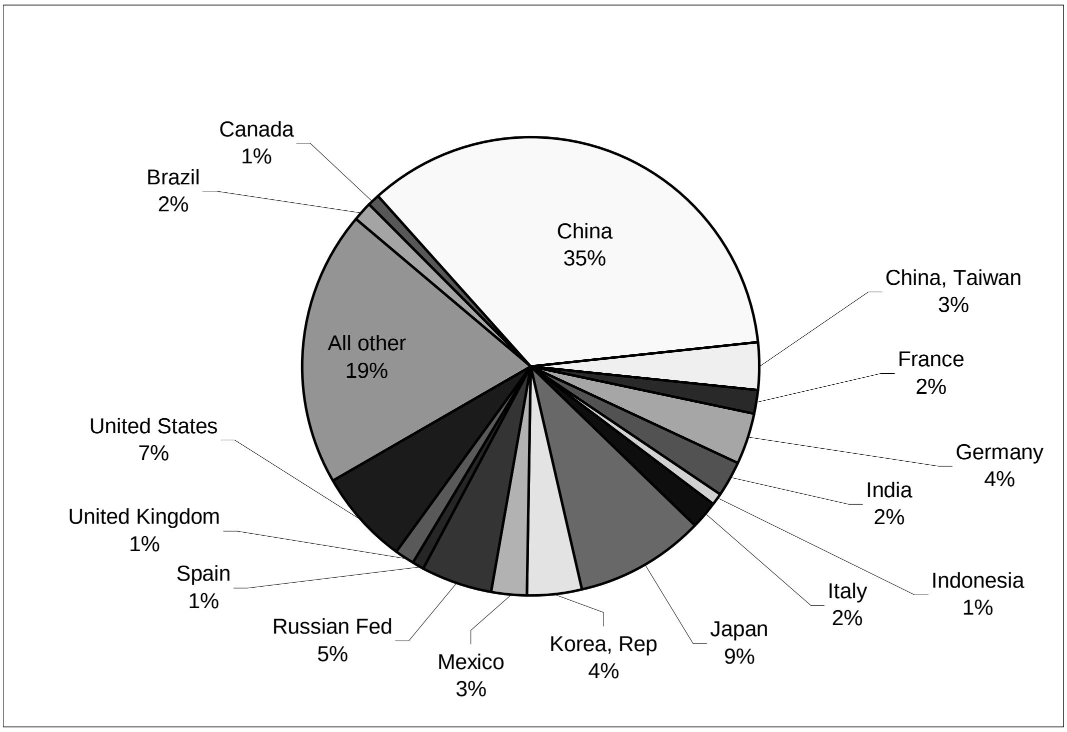
Figure 1.2. World employment in the electrical and electronic products manufacturing industries (1997 to 2004, millions of workers)



Source: Estimated by the ILO Sectoral Activities Branch on the basis of SECTOR*Source* data.

This phenomenal growth has been led by China, which alone accounted for nearly 24 per cent of the world total employment in this industry segment in 1997. This share declined to less than 19 per cent by 2000, but rose again to nearly 35 per cent by 2004. The SECTOR*Source* data collection tells us that the vast majority of workers in this broad industry segment are highly concentrated in some 20 countries, which together account for nearly 87 per cent of the world total. Figure 1.3 shows the distribution of employment in 2004 among most of those countries and an “all other” category. Included among the largest employer countries are Japan (9 per cent), the United States (7 per cent), the Russian Federation (5 per cent), Germany (4 per cent) and the Republic of Korea (4 per cent). These five countries plus China account for nearly two-thirds of total employment in the segment.

Figure 1.3. Global distribution of employment in the electrical and electronic products manufacturing industries (2004)



Source: Estimated by the ILO Sectoral Activities Branch on the basis of SECTOR*Source* data.

Although employment is thus highly concentrated, it is interesting to note that over 100 countries employ at least 100 workers in this industry segment. Nevertheless, the top 50 countries account for 98.8 per cent of total employment. Summary data for total employment in each country are shown in table 1.4. For most of the countries shown, the estimates reflect totals for ISIC 30, 31 and 32, for the year 2000. For some countries, notably China, the estimates are for the broader electrical equipment industry as uniquely defined by those countries.

Table 1.4. Employment in the electrical and electronic products manufacturing industry (thousands of workers, 2002, except as noted otherwise)

Country or territory	Employment	Country or territory	Employment
Albania (2)	2.8	Lithuania (2)	13.3
Argentina (1)	17.0	Luxembourg (3)	0.5
Australia (1)	57.0	Macedonia (‘01, 2)	6.1
Austria (1)	50.0	Malawi (‘01, 2)	0.1
Azerbaijan (1)	4.3	Malaysia (2)	405.4
Bangladesh ('98, 2)	30.2	Malta (2)	4.5
Belgium (1)	50.9	Mauritius (1)	0.5
Bolivia (‘01, 2)	0.3	Mexico (1)	455.4
Botswana (‘99, 1)	0.7	Mongolia (‘00, 2)	0.1
Brazil (2)	235.8	Morocco (2)	21.7
Bulgaria (1)	26.0	Nepal (2)	2.2
Canada (1)	162.1	Netherlands (3)	20.6
China (1)	2 952.1	New Zealand (2)	11.0

Country or territory	Employment	Country or territory	Employment
Hong Kong, China (5)	13.5	Norway (4)	15.5
Macau, China (1)	0.7	Palestine (‘99, 1)	0.4
Taiwan, China, (1)	568.4	Oman (2)	0.9
Colombia (1)	2.0	Pakistan (‘01, 2)	0.4
Costa Rica (‘01, 1)	6.0	Peru (1)	4.0
Croatia (1)	16.0	Philippines (‘03, 1)	280.1
Cyprus (2)	0.5	Poland (1)	115.1
Czech Republic (1)	108.0	Portugal (2)	44.2
Denmark (1)	38.0	Puerto Rico (1)	6.0
Dominican Rep. (‘97, 2)	6.7	Rep. of Moldova (2)	2.2
Ecuador (2)	6.3	Romania (1)	69.0
Egypt (2)	24.5	Russian Federation (1)	849.6
Estonia (2)	2.1	Senegal (2)	0.3
Fiji (‘98, 1)	0.1	Serbia and Montenegro (‘01, 1)	34.0
Finland (1)	54.0	Singapore (2)	101.4
France (1)	328.2	Slovakia (1)	59.0
Georgia (2)	0.7	Slovenia (‘04, 1)	20.9
Germany (1)	759.6	South Africa (2)	93.6
Greece (1)	13.0	Spain (1)	134.1
Hungary (1)	121.0	Sri Lanka (1)	5.8
Iceland (‘97, 1)	0.1	Sudan (‘01, 2)	1.1
India (2)	350.5	Sweden (4)	65.5
Indonesia (1)	59.9	Switzerland (1)	59.0
Iran, Islamic Rep. of (2)	56.6	Syrian Arab Rep. (2)	3.8
Iraq (‘00, 1)	9.0	Thailand (‘00, 2)	327.2
Ireland (1)	44.0	Trinidad and Tobago (‘00, 2)	1.3
Israel (5)	35.6	Tunisia (‘00, 1)	18.0
Italy (1)	321.2	Turkey (1)	70.0
Japan (4)	1 751.2	Turkmenistan (‘00, 2)	1.3
Jordan (1)	3.4	Uganda (‘00, 2)	0.1
Kazakhstan (2)	9.1	Ukraine (1)	160.1
Kenya (‘97, 1)	3.3	United Kingdom (1)	294.2
Korea, Republic of (2)	467.5	United States (1)	1 435.0
Kuwait (‘00, 1)	1.0	Uruguay (‘01, 2)	1.2
Kyrgyzstan (2)	8.6	Viet Nam (2)	23.5
Lao PDR (‘99, 2)	0.1	Yemen (2)	0.1
Latvia (2)	4.2	Zimbabwe (1)	6.0
Lebanon (‘98, 1)	1.5	**World total**	14 030.7

Source: Compiled by the ILO Sectoral Activities Branch.
Source codes: 1. ILO Laborsta; 2. UNIDO INDSTAT4; 3. Eurostat; 4. OECD; 5. National statistical offices.

It can be seen from the available data that of the nearly 14 million workers in this industry segment in 2002, total employment within industries included in the manufacture of office, computing and accounting machinery (ISIC 30) was about 1.1 million workers, while the other two electrical and electronic products industries, that is, electrical machinery and apparatus n.e.c. (ISIC 31) and radio, TV and communication equipment (ISIC 32), each employed about 4.6 million workers. Employment among countries that report other than according to ISIC Revision 3, which include China, totalled about 3.6 million workers. This latter category of course includes workers across all three of the ISIC divisions.

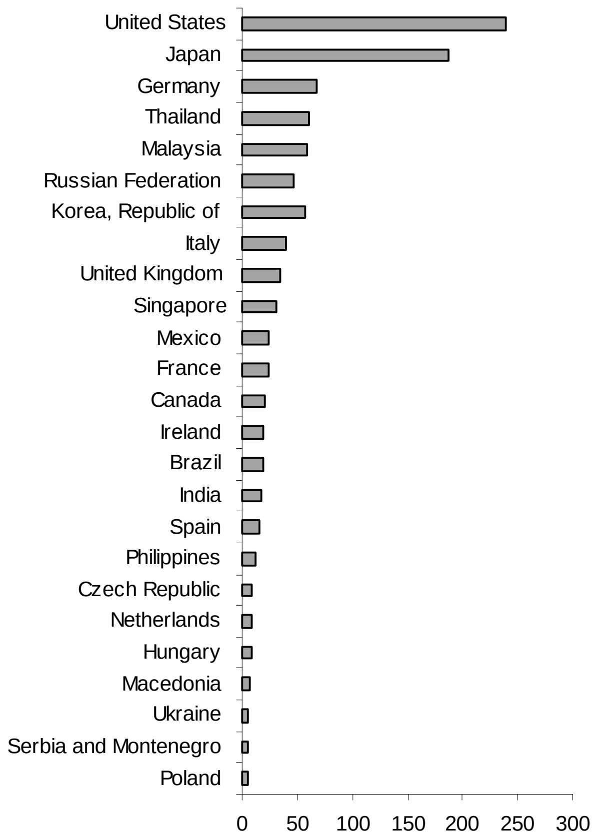
It is also interesting to note that the distribution of employment across the individual ISIC divisions varies greatly among the countries represented. For example, in Italy some 325,000 workers are employed in the electrical and electronics manufacturing industries, and over half of them (about 53 per cent) produce electrical machinery and apparatus (ISIC 31), while about 35 per cent produce radio, TV and communication equipment and apparatus (ISIC 32). In contrast, Japan's electrical and electronics manufacturing workers are more concentrated in the division that produces radio, TV and communication equipment and apparatus. About 55 per cent of the electrical and electronics manufacturing workers in Japan are employed in this division, compared to about 35 per cent in the manufacture of electrical machinery and apparatus (see figures 1.4a, 1.4b and 1.4c).

1.3.1. Employment trends in selected countries

The trend in total world employment in this industry was described in the previous section. The time series for total world employment was derived from estimates for about 30 countries for which the most complete individual time series estimates are available. These countries account for about 85 per cent of total world employment in the industry. The following paragraphs provide some estimates of trends in employment for a number of these "data rich" countries and for a few others for which there is sufficient information available to develop credible time series estimates. These countries generally include major producers of electrical and electronic products, and hence major employers. It is particularly fortunate that there are estimates available for China, since this country is by far the largest single employer in the industry. The trend for China is evident in figure 1.2 showing total world employment.

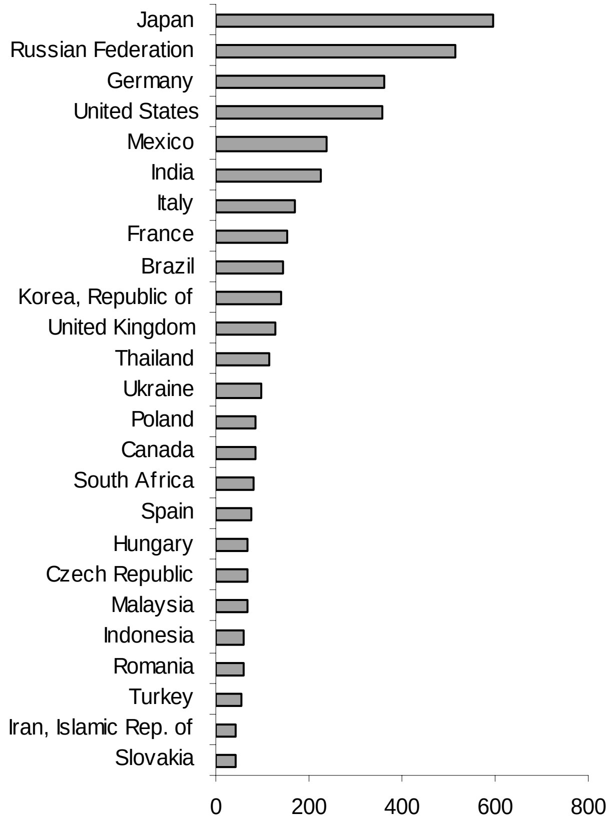
Figures 1.5a to 1.5i show trends in employment in ISIC 30, 31 and 32 for the top 15 countries in each of those industry segments, with five countries shown in each figure. Note that the vertical scales differ in each one, so caution should be applied when comparing trends in one figure with those in another. Nonetheless, the figures clearly show a general decline in employment over the past eight years. In most countries, the decline has been gentle, for the most part. Most of the largest employers in all three industry segments have had flat or declining employment. The United States ranks first, fourth and second among the three industry segments ISIC 30, 31 and 32 respectively. The country saw employment decrease by nearly 550,000 jobs, or over 30 per cent of the workforce, between 1997 and 2004. Between 1997 and 2003, employment in Japan in these three industry segments declined by nearly 20 per cent, which meant a loss of over 400,000 jobs. Reductions in Germany amounted to over 100,000 workers, or about 14 per cent of the workforce, over the period 1997 to 2004. These three countries combined saw a decline in excess of 1 million workers in the electrical and electronic products industries over the seven years between 1997 and 2004.

Figure 1.4a. Employment in ISIC 30: Office, accounting and computing machinery manufacturing (top 25 countries, thousands)



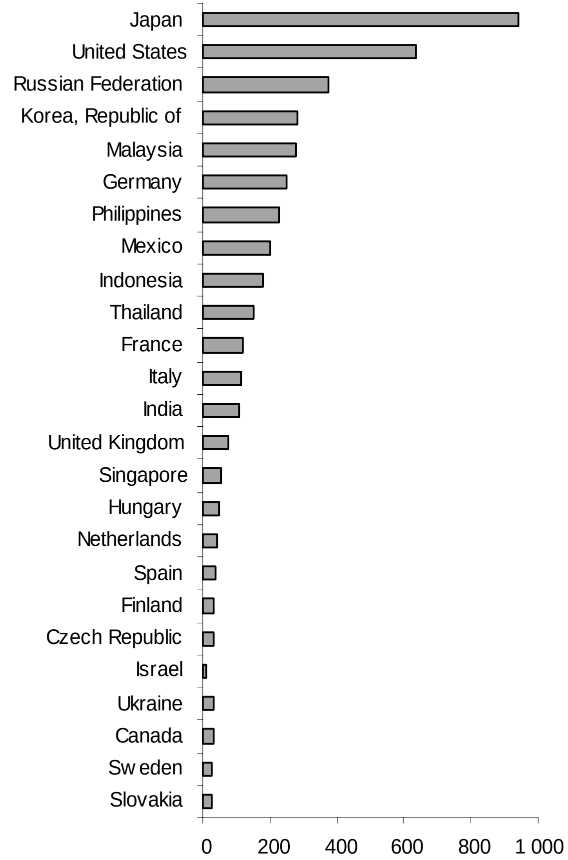
Source: ILO SECTOR*Source* database.

Figure 1.4b. Employment in ISIC 31: Electrical machinery and apparatus manufacturing (top 25 countries, thousands)



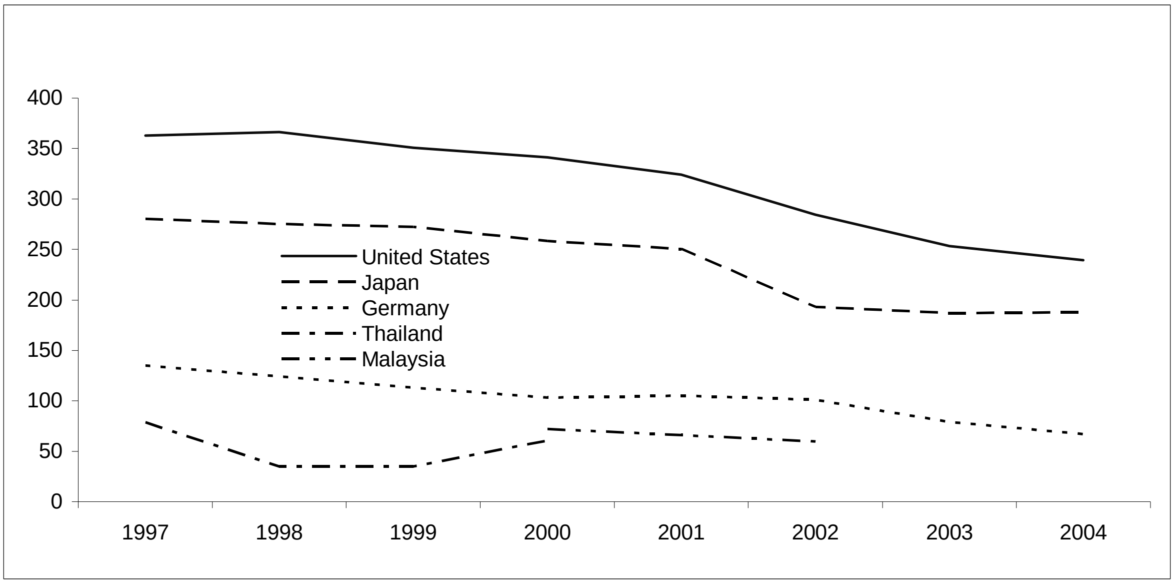
Source: ILO SECTOR*Source* database.

Figure 1.4c. Employment in ISIC 32: Radio, TV, communication equipment and apparatus (top 25 countries, thousands)



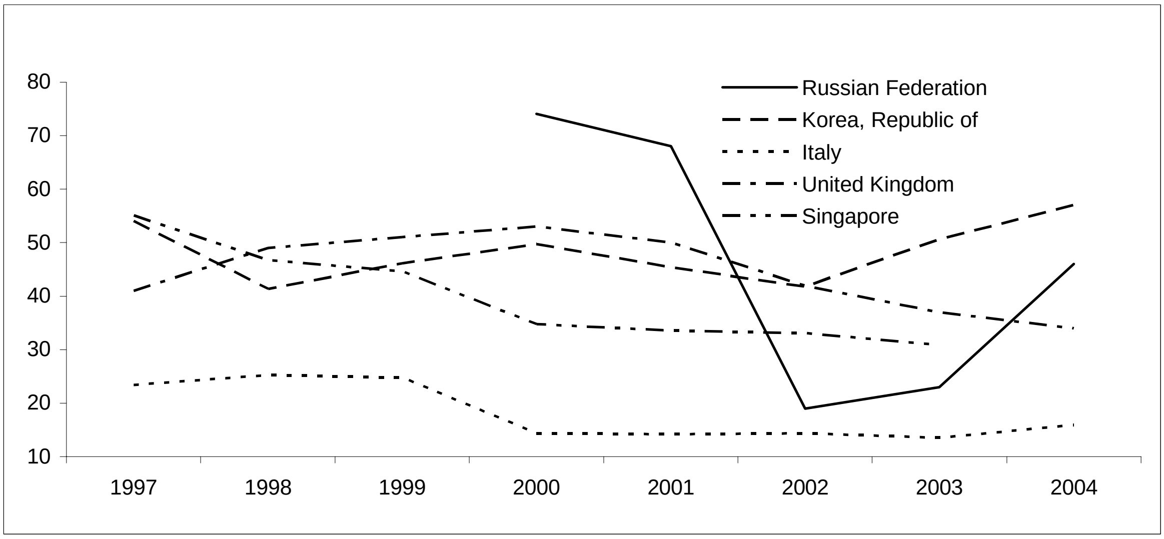
Source: ILO SECTOR*Source* database.

Figure 1.5a. Employment in ISIC 30: Office, accounting, computing machinery (selected countries, thousands)



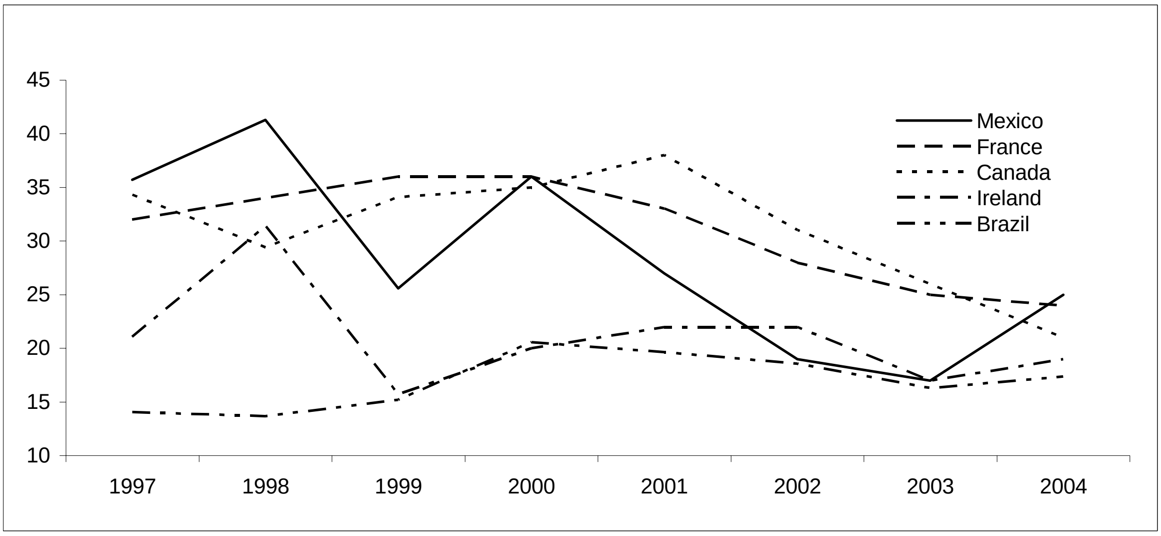
Source: ILO SECTOR*Source* database.

Figure 1.5b. Employment in ISIC 30: Office, accounting, computing machinery (selected countries, thousands)



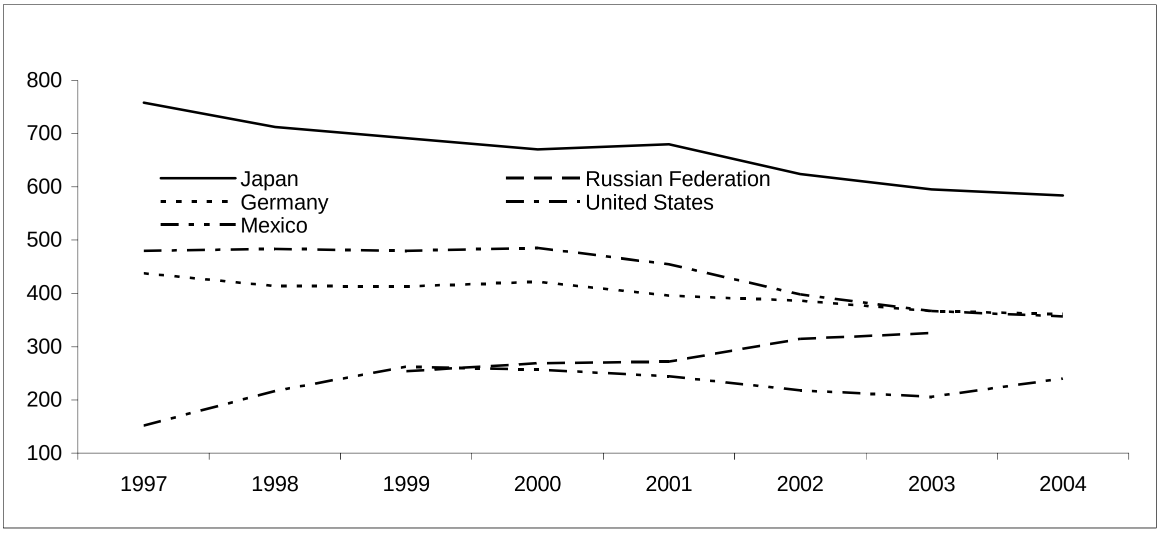
Source: ILO SECTOR*Source* database.

Figure 1.5c. Employment in ISIC 30: Office, accounting, computing machinery (selected countries, thousands)



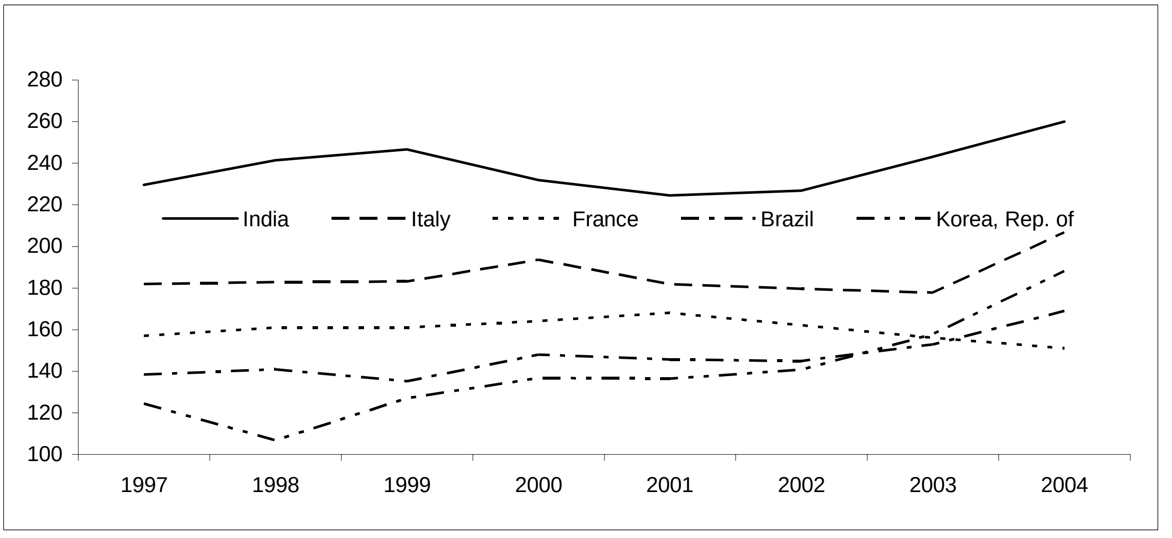
Source: ILO SECTOR*Source* database.

Figure 1.5d. Employment in ISIC 31: Electrical machinery and apparatus n.e.c. (selected countries, thousands)



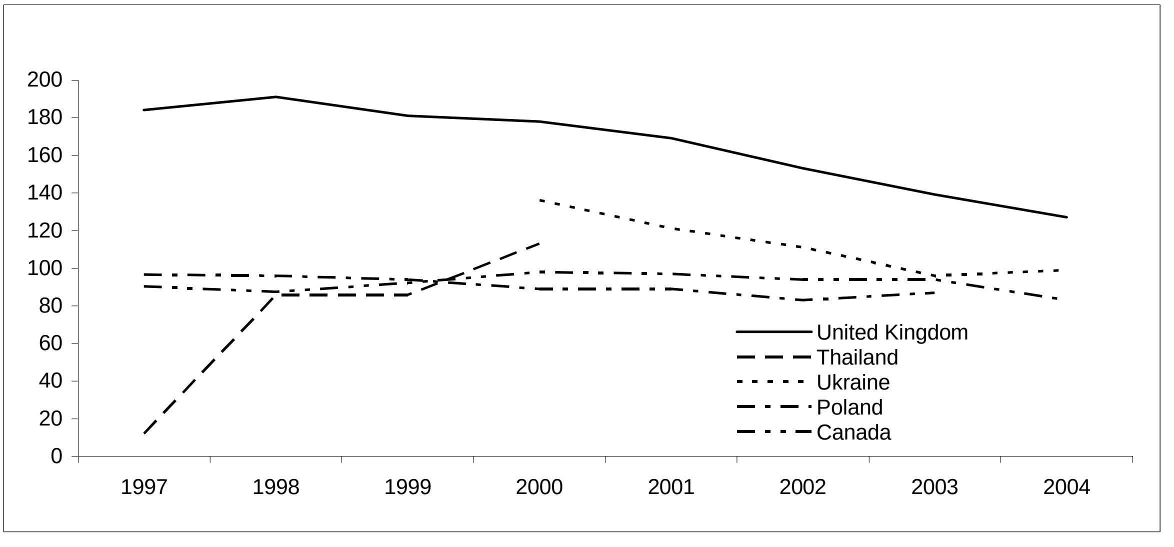
Source: ILO SECTOR*Source* database.

Figure 1.5e. Employment in ISIC 31: Electrical machinery and apparatus n.e.c. (selected countries, thousands)



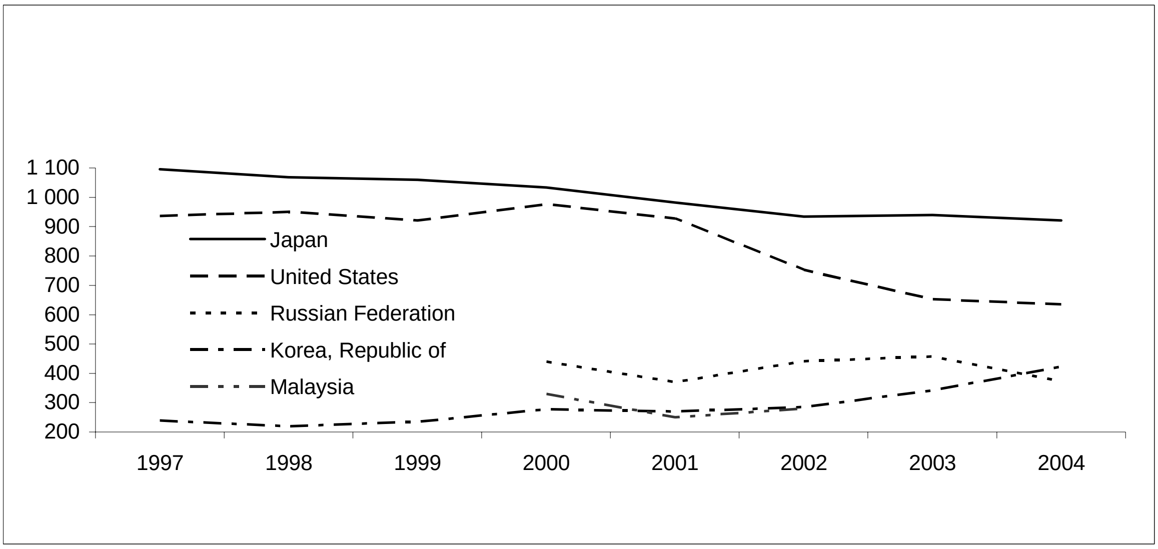
Source: ILO SECTOR*Source* database.

Figure 1.5f. Employment in ISIC 31: Electrical machinery and apparatus n.e.c. (selected countries, thousands)



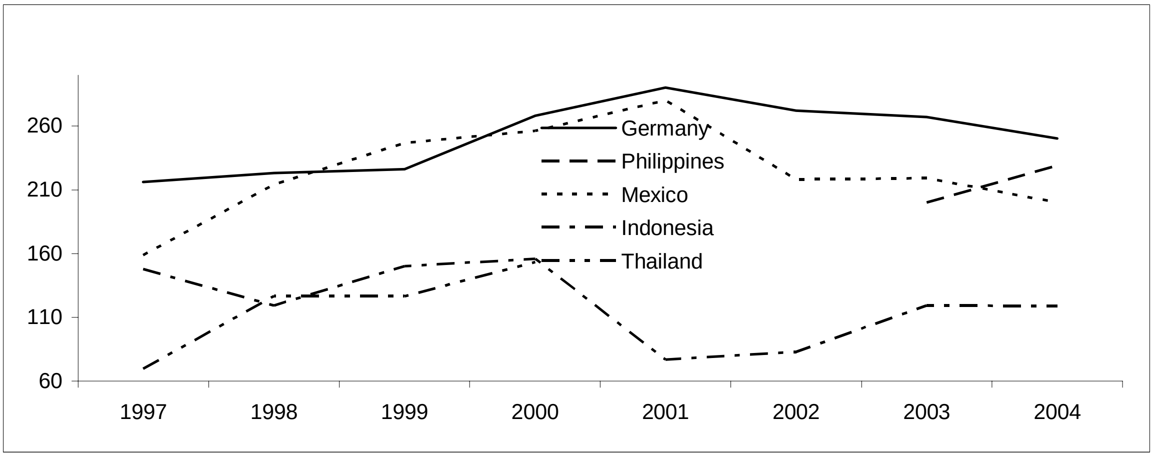
Source: ILO SECTOR*Source* database.

Figure 1.5g. Employment in ISIC 32: Radio, TV, communication equipment and apparatus (selected countries, thousands)



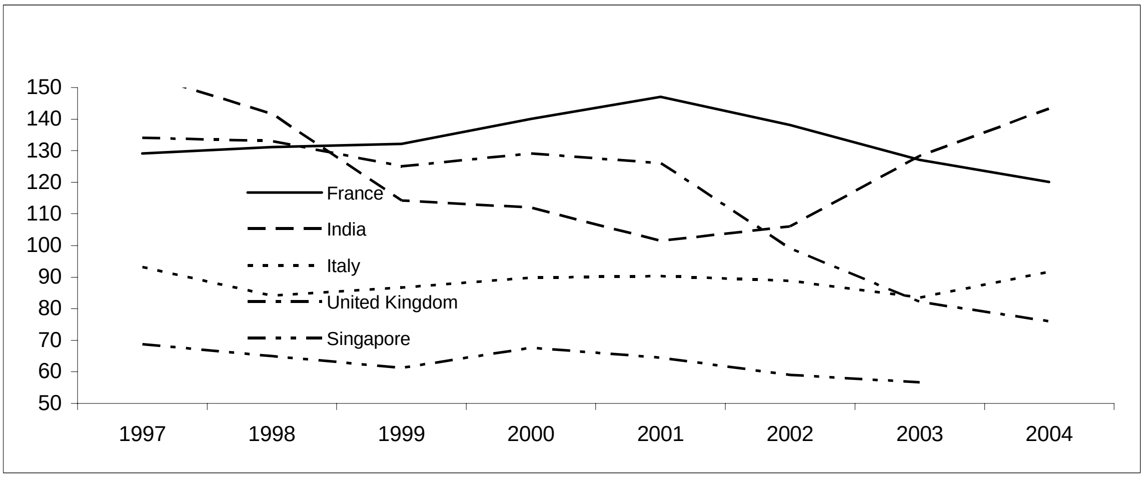
Source: ILO SECTOR*Source* database.

Figure 1.5h. Employment in ISIC 32: Radio, TV, communication equipment and apparatus (selected countries, thousands)



Source: ILO *SECTORSource* database.

Figure 1.5i. Employment in ISIC 32: Radio, TV, communication equipment and apparatus (selected countries, thousands)



Source: ILO *SECTORSource* database.

There are some notable exceptions to the general decline. The Russian Federation has experienced a rebound in its employment in the office, accounting and computing machinery industry (ISIC 30). Mexico and Ireland have seen sharp increases and decreases in employment in this same industry segment over the past decade. Employment in the Russian Federation has been increasing in the electrical machinery and apparatus industry (ISIC 31). A sharp increase is also shown for Thailand in this industry between 1997 and 2000. Perhaps most interesting, however, are the increases in employment in the radio, TV and communication equipment industry (ISIC 32) in several Asian countries, notably Indonesia, the Philippines and Thailand. In the Philippines, the increase of 29,000 jobs in the radio, TV and communication equipment industry (ISIC 32) between 2003 and 2004 offset a decline in the electrical machinery and apparatus industry (ISIC 31). In Indonesia, there were gains of about 65,000 jobs between 1998 and 2001 among the three industry segments combined. In Thailand, employment in these three industry segments more than doubled, from 160,000 jobs in 1997 to 327,000 jobs in 2000. This net increase reflected a decline of 18,000 jobs in ISIC 30 and increases of 101,000 jobs in ISIC 31 and 84,000 jobs in ISIC 32. Does this signify a shift in the electronics industry towards certain industry segments or is it just part of the ebb and flow of a fluctuating global economy?

1.3.2. Employment by gender in selected countries

Some detail on employment by gender is available from the ILO Laborsta and UNIDO INDSTAT4 databases. The data shown in tables 1.5a, 1.5b and 1.5c were compiled from these two sources. [3] Some 44 countries are represented in the available data for ISIC 30 (office, accounting and computing machinery). On average, women account for about 38 per cent of employment in this industry. Their share ranges from as high as 87 per cent to as low as 5 per cent. Based on averages for the countries shown, the proportion of women employees in this industry segment declined from 38.7 per cent in 1997 to 35.1 per cent in 2001. The share has since risen to over 40 per cent.

Table 1.5a. ISIC 30: Office, accounting, computing machinery
(Women's percentage of total employment, 1997 to 2004)

Country	Src	Def	1997	1998	1999	2000	2001	2002	2003	2004
Albania	2	2		40.0	36.4	54.5	21.4	37.5	37.5	
Argentina	1	1	66.7	12.5	61.1	25.0	20.0	50.0		
Austria	1	1	66.7	50.0	57.1					
Azerbaijan	1	1	30.0	33.3	42.9	50.0	50.0	40.0	50.0	
Belgium	1	1					25.0	25.0	32.3	
Botswana	1	1			50.0					
Brazil	1	1	42.0	40.9	38.2	34.0	30.5	37.7		
Bulgaria	1	1	50.0	50.0	50.0	66.7	33.3	50.0	50.0	
Canada	1	1	32.7	34.4	38.4	34.3	28.9	35.5	38.5	33.3
Costa Rica	1	1	55.6	26.1		40.0				
Croatia	1	1	47.1	45.0	33.3					50.0

[3] The unevenness of country reporting of employment generally, and of employment by gender specifically, is apparent in tables 1.5a, 1.5b and 1.5c. Some countries have been providing detailed employment estimates with this type of detail in a timely and consistent fashion for many years. Others report employment data only occasionally, and some only after a long delay. Others have simply not reported at all for many years. A number of countries do not provide any gender detail.

Country	Src	Def	1997	1998	1999	2000	2001	2002	2003	2004
Czech Republic	1	1	33.3	33.3	20.0	28.6	30.0	40.0	33.3	44.4
Denmark	1	1	28.6	34.6			50.0	50.0		
Egypt	2	2	16.7	16.7	16.7	16.7	16.7	20.0		
Finland	1	1	50.0	33.3	50.0					
France	1	1	31.3	29.4	30.6	30.6	30.3	32.1	32.0	29.2
Germany	1	1	25.2	28.2	29.2	25.2	24.7	25.7	25.3	26.9
Greece	1	1	20.0		20.0					
India	2	2		5.3	18.1	8.2	7.6	7.3		
Indonesia	2	2		33.3	25.0	33.3	69.2	10.0	10.0	
Iran, Islamic Rep. of	2	2	15.8	21.4	25.0	25.0	20.0	24.0	25.9	
Ireland	1	1	39.8	45.2	43.9	40.0	36.4	36.4	41.2	36.8
Italy	1	1	33.9	32.7	26.2	27.3	30.2	30.0	30.0	
Japan	2	2	28.7	29.1	27.7	27.4	22.3	24.2		
Kazakhstan	2	2		33.3						
Korea, Rep. of	2	2	33.3	34.1	36.0	34.2	32.6	30.9		
Kyrgyzstan	2	2		50.0	75.0	50.0	33.3	80.0		
Lithuania	2	2	36.4	40.0	33.3	25.0	33.3	33.3	50.0	
Macau, China	1	1	70.3	71.8						
Malaysia	2	2				67.3	64.5	66.4		
Mexico	1	1	31.1	44.1	37.1	38.9	40.7	47.4	41.2	48.0
Rep. of Moldova	2	2	45.5	42.9	40.0	33.3	50.0	50.0	50.0	
New Zealand	2	2	14.3	20.0	33.3	25.0	25.0			
Philippines	1	1							64.3	66.7
Romania	1	1							33.3	
Russian Federation	1	1				54.0	63.2	63.2	52.2	63.0
Slovakia	1	1	42.1		53.3	50.0	50.0	66.7	66.7	33.3
Spain	1	1	34.7	20.8	22.2	33.3	31.6	37.5	40.0	43.8
Switzerland	1	1	23.5	24.2	25.0	33.3	33.3	33.3	33.3	
Thailand	2	2	86.7	84.6						
Ukraine	1	1						42.9	60.0	40.0
United Kingdom	1	1	31.7	32.7	29.4	30.2	32.0	31.0	27.0	26.5
United States	1	1	36.6	36.2	34.6	34.0	33.7	32.4	30.8	30.6
Viet Nam	2	2		59.3	59.3	51.6	54.2	58.3	54.3	

Source codes: 1. ILO Laborsta; 2. UNIDO INDSTAT4.
Definition codes: 1. Paid employment – Women; 2. Number of female employees.
Source: ILO SECTOR*Source* database.

Table 1.5b. ISIC 31: Electrical machinery and apparatus n.e.c.
(Women's percentage of total employment, 1997 to 2004)

Source	Src	Def	1997	1998	1999	2000	2001	2002	2003	2004
Argentina	1	1	17.5	9.0	8.6	5.9	11.8	37.5		
Australia	1	1	28.2	24.0	25.6	26.3	23.1	27.0	22.6	23.3
Austria	1	1	37.9	38.8	40.0	40.7	38.5	44.0	41.7	44.0
Azerbaijan	1	1	40.0	28.6	28.9	45.5	27.0	33.3	45.5	
Belgium	1	1					26.6	28.1	28.0	
Botswana	1	1			40.0					
Bulgaria	1	1	46.3	45.4	44.3	44.4	41.2	42.1	44.4	
Canada	1	1	36.4	35.0	34.7	36.7	37.1	35.1	37.2	36.1
Costa Rica	1	1	14.3	66.7					33.3	
Croatia	1	1	38.5	38.3	39.3	36.4	33.3	36.4	36.4	33.3
Czech Republic	1	1	47.9	48.1	51.0	57.1	53.2	54.8	56.3	55.9
Denmark	1	1	32.0	28.0		37.0	37.5	36.0	30.4	30.4
Egypt	2	2	7.5	6.1	6.1	6.1	6.1	7.0		
Finland	1	1	31.3	33.3	31.6	29.4	27.8	33.3	31.3	31.3
France	1	1	36.3	36.0	36.0	36.0	35.7	35.8	35.9	35.7
Germany	1	1	28.3	29.0	30.5	31.5	30.8	30.1	27.8	28.5
Greece	1	1	26.3	27.9	13.9	28.6	33.3	22.2	16.7	
India	2	2		4.7	4.6	5.8	4.1	4.0		
Indonesia	2	2		39.9	46.0	44.4	39.3	44.3	49.3	
Iran, Islamic Rep. of	2	2	12.3	11.9	12.5	12.5	10.6	10.7	15.3	
Ireland	1	1	49.3	39.1	44.9	42.9	50.0	42.9	33.3	36.4
Italy	1	1	28.8	29.3	30.3	31.8	31.8	29.9	31.0	
Kazakhstan	2	2		36.5	30.6	29.2	28.6	28.2	25.4	
Korea, Rep. of	2	2	34.0	32.6	34.8	35.2	34.3	34.7		
Kyrgyzstan	2	2		44.1	46.0	41.2	35.6	45.1	38.3	
Latvia	1	1	40.0	40.0	33.3	33.3	33.3	33.3	33.3	66.7
Macau, China	1	1	64.3	74.2						
Malaysia	2	2				4.6	5.9	5.4		
Mauritius	1	1			39.5					
Mexico	1	1	38.1	37.8	31.1	42.0	36.9	39.0	36.9	35.4
New Zealand	1	1	40.0	34.6	28.1	35.7	28.6	27.3		
Norway	1	1	20.0	14.3	16.7	20.0	37.5	33.3	20.0	14.3
Peru	1	1		34.7			50.0		16.7	
Philippines	1	1							48.5	55.0
Portugal	1	1	33.9	43.2	52.3	50.0	57.1	53.3	44.0	
Romania	1	1							50.8	
Russian Federation	1	1				46.7	44.1	44.7	47.1	35.5
San Marino	1	1	40.0	33.3	33.3					
Slovakia	1	1	64.8	52.7	42.9	41.4	41.9	52.8	59.5	58.5

Source	Src	Def	1997	1998	1999	2000	2001	2002	2003	2004
Slovenia	1	1								56.1
Spain	1	1	20.1	21.9	23.8	28.9	31.4	28.9	21.9	23.7
Switzerland	1	1	29.8	29.9	29.6	30.6	30.0	29.7	28.6	29.4
Thailand	2	2	48.8	69.6						
Turkey	1	1				22.4	12.5	20.8	13.8	12.5
Ukraine	1	1						46.8	45.8	46.4
United Kingdom	1	1	31.5	33.5	28.2	29.8	30.2	30.7	26.6	26.0
United States	1	1	39.1	39.0	38.9	38.6	37.8	37.4	36.8	36.4
Viet Nam	2	2		46.0	19.1	10.9				

Source: ILO SECTOR*Source* database.
Source codes: 1. ILO Laborsta; 2. UNIDO INDSTAT4.
Definition codes: 1. Paid employment – Women; 2. Number of female employees.

Table 1.5c. ISIC 32: Radio, TV and communication equipment
(Women's percentage of total employment, 1997 to 2004)

Country	Src	Def	1997	1998	1999	2000	2001	2002	2003	2004
Argentina	1	1	37.5	39.6	41.2	28.6	25.0	14.3		
Australia	1	1	23.3	23.2	34.2	29.2	29.2	30.0	35.0	33.3
Austria	1	1						58.3	62.5	84.2
Azerbaijan	1	1	44.0	50.0	50.0		76.9			
Bangladesh	2	2	21.1							
Belgium	1	1					31.6	31.8	31.3	
Bulgaria	1	1	52.4	53.4	52.5	50.0	50.0	60.0	50.0	
Canada	1	1	41.4	26.3	34.6	35.2	29.5	35.1	33.3	30.0
Colombia	1	1				50.0	50.0	50.0		
Costa Rica	1	1	37.9	31.3		33.3	66.7		25.0	40.0
Croatia	1	1	37.8	37.5	46.5	40.0	33.3	33.3	33.3	50.0
Czech Republic	1	1	53.6	55.2	56.3	58.8	57.9	55.6	57.1	60.0
Denmark	1	1	48.1	46.3		41.7	41.7	36.4	40.0	30.0
Egypt	2	2	28.9	27.0	27.0	27.0	27.0	20.3		
Finland	1	1	32.8	35.8	37.9	37.8	39.5	40.0	38.2	31.4
France	1	1	34.1	34.3	34.1	34.3	34.0	34.0	33.8	34.1
Germany	1	1	33.3	33.2	32.8	32.5	32.8	31.6	31.8	30.8
Greece	1	1	33.3	36.4	33.3	33.3	50.0	33.3	33.3	
India	2	2		16.6	17.4	17.0	15.6	13.6		
Iran, Islamic Rep. of	2	2	14.9	13.1	22.2	21.0	19.8	18.0	23.1	
Ireland	1	1	41.5	44.4	41.8	40.0	39.1	40.0	46.2	37.5
Kazakhstan	2	2		25.0	28.6	25.0	53.8	50.0	33.3	
Korea, Rep. of	2	2	45.2	41.3	44.8	45.5	42.4	42.4		
Kyrgyzstan	2	2		86.7	69.2	34.6	21.4	50.0	22.2	
Latvia	1	1	60.0	50.0	50.0					
Malaysia	2	2				67.5	67.8	67.6		

Country	Src	Def	1997	1998	1999	2000	2001	2002	2003	2004
Malta	2	2	50.7	52.7	49.9	49.6	52.4	48.9		
Mexico	1	1	57.6	53.3	54.5	52.3	52.1	45.0	47.9	50.5
Morocco	2	2							72.1	
Nepal	2	2	33.3	33.3	33.3	33.3	33.3	25.0		
New Zealand	2	2	38.6	39.1	38.5	37.9	36.7			
Norway	1	1	33.3	33.3	50.0	40.0	33.3	16.7	16.7	16.7
Philippines	1	1							66.0	66.4
Portugal	1	1	51.9	56.0	50.7	53.3	66.7	64.3	50.0	
Romania	1	1							50.0	
Russian Federation	1	1				51.1	52.7	51.3	52.0	54.3
Slovakia	1	1	58.5	58.2	52.6	56.3	62.5	65.0	57.1	57.1
Slovenia	1	1								33.7
Spain	1	1	21.5	18.8	24.9	35.6	29.3	28.6	30.2	27.8
Switzerland	1	1	32.1	32.0	31.7	31.8	28.6	31.6	33.3	33.3
Thailand	2	2	69.4	80.5						
Turkey	1	1				25.9	19.0	30.0	20.0	21.1
Ukraine	1	1						52.4	52.8	50.0
United Kingdom	1	1	38.0	33.8	32.8	32.5	29.3	28.3	29.2	27.6
United States	1	1	43.0	42.8	42.0	42.0	41.1	39.0	37.8	36.2
Viet Nam	2	2		51.2	29.5	24.5	50.9	48.2	54.6	

Source: ILO SECTOR*Source* database.
Source codes: 1. ILO Laborsta; 2. UNIDO INDSTAT4.
Definition codes: 1. Paid employment – Women; 2. Number of female employees.

Among the more developed economies of Canada, France, Germany, Italy, Switzerland, the United Kingdom and the United States, women’s share of employment tends to be in the 25 to 35 per cent range. Among the emerging economies of Asia, such as Malaysia, the Philippines, Thailand and Viet Nam, the share tends to be over 50 per cent. It is interesting to note the very low share in India.

A similar pattern can be seen in the estimates for ISIC 31 (electrical machinery and apparatus n.e.c.) shown in table 1.5b. The average share of women in the workforce for this industry increased from 31.3 per cent in 1999 to 37 per cent in 2004. Averages in the more developed economies of North America and Western Europe tend to be in the 25 to 35 per cent range. Averages are somewhat higher in Indonesia, the Philippines, Thailand and Viet Nam. The shares in India and Malaysia are quite low in comparison. Overall the shares range from a low of 4 per cent to a high of 74 per cent.

Table 1.5c (ISIC 32: Radio, TV and communication equipment) shows that women’s share of total employment in that segment is slightly higher, with participation rates ranging from 13 to 87 per cent. The rates are particularly high in Malaysia, the Philippines and Thailand. In North America, rates are in the 30 to 45 per cent range for Canada and the United States, and slightly higher for Mexico. The rates in Latin American countries tend to be lower. Higher rates can be found in various European countries, particularly those of Eastern Europe: Bulgaria, the Czech Republic, Latvia, the Russian Federation, Slovakia and Ukraine all have rates that are slightly higher than those found in Western Europe and North America, but not as high as in some of the Asian countries.

1.3.3. Wage data from the ILO October Inquiry: Disparities in earnings of women and men

The figures in table 1.6 show significant differences between women's and men's wages in occupations associated with the electrical and electronic products manufacturing industries. These differences exist even though the hours worked and hours paid for are more or less equal. However, in evaluating the differences between men's and women's earnings it should be kept in mind that the data do not take into account differences in qualifications, levels of education, seniority, or physical demands of work.

These figures represent wage statistics calculated at national levels on two types of ratios for selected occupational activities. The first, average earnings, [4] is used by Costa Rica and Poland and includes family allowances, bonuses together with remuneration for time not worked, such as annual vacations and other paid leave or holidays, and including elements of earnings which are usually received regularly by workers and which are greater for men. The second, wage or salary rates, [5] is used by China, Finland, the Republic of Korea, Poland and Portugal, and excludes family allowances and bonuses which workers receive as part of their earnings.

Nevertheless, it is important to stress that for each activity, the statistics concern women's average wages. Women's proportion being in general lower than men's, this figure does not represent the exact wages of an individual woman working in the sector. The number of women in each occupation affects the average.

There are two main conclusions we can draw from the data:

– women earn less than men, although they work almost the same number of hours;

– in all countries except Finland, the wage discrepancy is increasing over time. Is the discrepancy increasing owing to stagnating women's wages or because of the speed of wage increases among men?

[4] Average earnings are the remuneration in cash and in kind paid to employees, as a rule at regular intervals, for time worked or work done, together with remuneration for time not worked, such as for annual vacations, other paid leave or holidays, and including those elements of earnings which are usually received regularly, before any deductions are made by the employer in respect of taxes, employees' contributions to social security and pension schemes, life insurance premiums, union dues and any other obligations of employees. The following should be excluded: employers' contributions on behalf of employees to social security and pension schemes, benefits received by employees under these schemes, and severance and termination pay, and irregular bonuses such as year-end and other one-time bonuses which accrue over a period longer than a pay period.

[5] Wage or salary rates are the rates paid for normal time of work, comprising: basic wages and salaries, cost-of-living allowances, and other guaranteed and regularly paid allowances. The following should be excluded: overtime payments, bonuses and gratuities, family allowances, other social security payments made by the employer directly to employees, and ex gratia payments in kind supplementary to normal wage and salary rates.

Table 1.6. Women's wages and hours of work as a percentage of men's in the manufacture of electronic equipment machinery and supply (1999-2004)

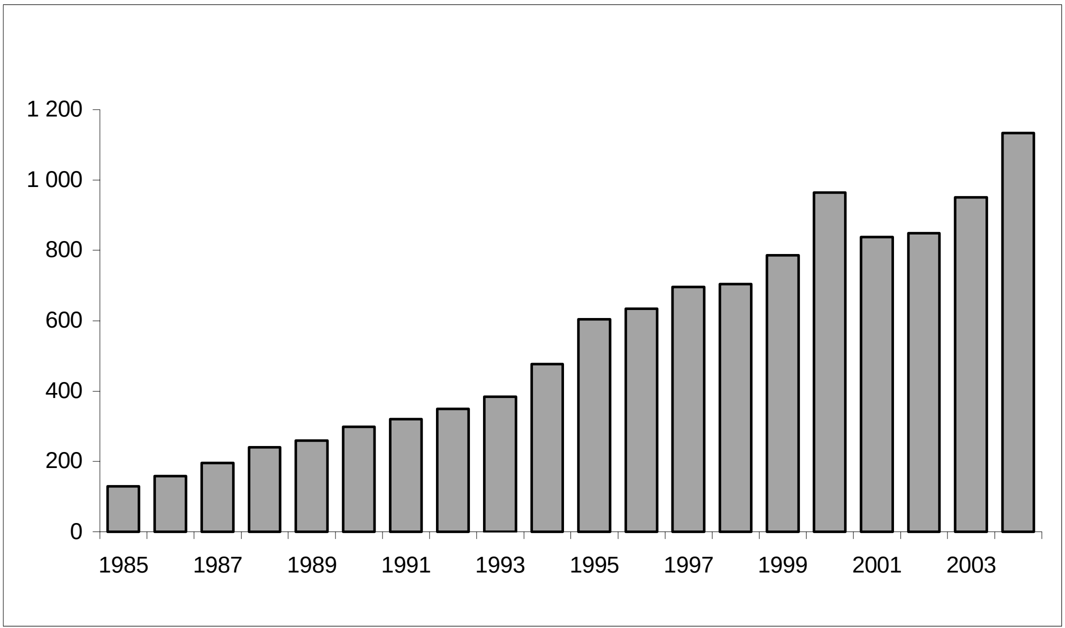
		Women's wages as a percentage of men's						Women's hours of work as a percentage of men's					
Country	Occupational activity	1999	2000	2001	2002	2003	2004	1999	2000	2001	2002	2003	2004
China [1]	Electronic engineering technicians	95.5	85.7	–	–	–	–	–	–	–	–	–	–
	Electronic fitter	–	–	–	–	–	–	–	–	–	–	–	–
	Electronic equipment assembler	118.3	141.9	–	–	–	–	–	–	–	–	–	–
Costa Rica [2]	Electronic draughtsman	20.1	44.7	–	51.8	113.9	95.4	41.1	66.1	–	97.9	95.0	93.5
	Electronic engineering technician	–	73.7	–	114.0	–	–	–	107.0	–	138.6	–	–
	Electronic fitter	–	69.1	–	77.1	48.4	–	–	102.0	–	88.24	108.0	–
	Electronic equipment assembler	109.3	–	–	55.8	100.0	93.4	104.6	107.0	–	102.1	96.5	100.0
Finland [3]	Electronic engineering technician	–	–	–	90.9	98.3	91.3	–	–	–	99.69	100.0	100.2
	Electronic fitter	79.7	99.1	94.1	99.3	100.6	100.7	100.0	100.0	100.0	100.2	100.0	100.7
	Electronic equipment assembler	80.9	91.8	92.4	97.3	94.0	88.2	98.7	100.1	100.0	100.0	100.0	100.0
Korea, Rep. of [4]	Electronic draughtsman	67.6	67.3	71.6	68.0	72.1	70.4	98.8	101.0	100.2	98.7	100.0	100.6
	Electronic engineering technician	67.6	67.3	71.6	68.0	72.1	70.4	98.8	100.7	100.2	98.7	100.0	100.0
	Electronic fitter	65.6	72.7	85.7	79.2	99.5	110.4	96.6	103.5	93.0	91.0	90.1	90.3
	Electronic equipment assembler	64.8	76.2	76.1	68.2	74.5	72.8	101.5	99.0	100.4	100.5	100.5	100.2
Poland [5]	Electronic draughtsman	81.3	–	75.7	77.2	–	73.7	100.0	–	99.5	99.2	–	100.0
	Electronic engineering technician	81.3	–	75.7	77.2	–	75.3	100.0	–	99.5	99.2	–	100.0
	Electronic fitter	89.6		73.4	82.4		73.7	109.5		99.5	99.2	–	97.6
	Electronic equipment assembler	87.9	–	77.6	76.3	–	73.7	107.7	–	99.5	99.2	–	97.6
Portugal [6]	Electronic draughtsman	92.2	94.6	–	82.8	79.5	–	100.0	100.0	–	101.3	101.0	–
	Electronic engineering technician	100.0	89.1	–	87.9	70.1	–	101.2	100.5	–	101.8	101.0	–

Country	Occupational activity	Women's wages as a percentage of men's 1999	2000	2001	2002	2003	2004	Women's hours of work as a percentage of men's 1999	2000	2001	2002	2003	2004
	Electronic fitter	–	86.4	–	83.4	71.7	–	101.2	100.5	–	100.5	100.0	–
	Electronic equipment assembler	93.2	90.1	–	89.6	90.0	–	100.0	100.0		100.0	100.0	–

1 Wages or salary rates per year average.
2 Wages or earnings per month. Hours actually worked per week.
3 Wages or salary rates per month average. Prior to 2001: FIM. Hours actually worked per month.
4 Wages and salary rates. Salary per month average. Normal hours actually worked per week.
5 Average earnings per month. Average hours of work paid per week.
6 Wage or salary rates per month average. Prior to 2001: PTE. Normal hours actually worked per week.
Source: *ILO October Inquiry*. LABORSTA labour statistics database.

1.3.4. Production and trade

Figure 1.6. World exports of office and telecommunications equipment
(US$ billion, 1985 to 2004)



Source: WTO.

While a number of countries have experienced a decline in their exports of electrical and electronic products, the overall trend has been upwards (see figure 1.6). World exports of these products grew at an average rate of 2.7 per cent per year between 1995 and 2004. This growth was interrupted by a sharp decline in 2001, from which exports recovered to reach record levels by 2004. However, it was shown earlier in this chapter that for many countries, employment in this industry has declined. While comprehensive world totals are not available, employment trends in the countries that account for most of the production suggest a general decline among the large, traditional producers, and increases among a larger number of smaller producers. Productivity enhancements can explain some of the decline in employment among the major producers, and the export numbers shown here have not been adjusted for inflation or the persistent weakness of the United States dollar against other currencies. However, the magnitude of the decline in employment and the increases in exports suggest that there is more to the story. If it is generally the case that employment is declining in countries where exports are flat, declining, or growing slowly, and that employment is increasing in countries where exports are increasing, this might suggest that the industry has been shifting production from “flat export” countries to “export growth” countries. In that case, how does this observation align with perceptions of increased outsourcing of component manufacture by producers of finished products?

Unfortunately, time series estimates of production at the level of electrical and electronic products are not available for most countries. The most readily available data are those provided by UNIDO, the OECD and Eurostat. The UNIDO estimates are more detailed, in that they are available for more countries and at the 4-digit level of the ISIC. However, they tend to be less current than estimates from other sources. The OECD estimates, while somewhat more timely, are also more aggregate, at the 2- and 3-digit levels of the ISIC. In addition, the OECD estimates are available only for OECD member countries. Estimates from Eurostat are available only for EU countries, are 4-digit detailed, and tend to lag in the same way as the UNIDO estimates. Nonetheless, for some countries the available information is useful for assessing the global reach and dynamics of the electrical and electronic products industry.

Tables 1.7 and 1.8 show world production figures (2002 and 2003 data) for: electronic data processing equipment, office machinery; insulated wire and cable; electrical equipment; electronic valve tubes, and the like; and TV/radio transmitters, all based on data at the ISIC (Revision 3) 4-digit level. These categories make up the manufacturing industry component of the OECD definition of the ICT industry. The data, provided by the OECD, indicate that China, Germany, Japan, the Republic of Korea and the United States are the largest producers of electrical and electronic products. It is interesting to note the extent to which different countries specialize in different products, as indicated by the different rankings of countries among the individual product categories. For example, the Republic of Korea ranks fourth in the production of office, computing and accounting machinery, but eighth in the production of other electrical equipment, and ninth in the production of measuring, testing and navigating appliances.

The evidence shows that during the 1990s, China dramatically increased its market shares in ICT products and now ranks among the world's top three exporters. China is rapidly expanding its production of various types of ICT goods. Its trade in ICT goods (both imports and exports) went up from just over 12 per cent of total trade in 1996 to more than 27 per cent in 2003. Moreover, China has advanced from mere assembly of imported inputs to manufacturing high-tech intermediate goods. [6]

China is quickly becoming a major assembly line for ICT goods production. In 2003, more than 60 per cent of imported ICT goods consisted of electronic components, while almost four-fifths of exports of ICT goods were made up of computer, telecommunications, audio and video equipment. Wages in the ICT services sector are very high compared to other sectors, and were more than three times the national average in 2002. [7] Tables 1.7 and 1.8 show that ICT production in China grew by about 36 per cent between 2002 and 2003. This is the logical consequence of China's upgrading from mere assembly of imported inputs to direct manufacturing of ICT products.

[6] A. Amighini: *China in the international fragmentation of production: Evidence from the ICT industry* (Milan, Università Commerciale "Luigi Bocconi", Working Paper No. 151, 2004), available at http://eaces.liue.it.

[7] M. Katsuno: *Status and overview of official ICT indicators for China* (OECD, STI Working Paper 2005/4, 2005).

Table 1.7. World production of electronic data processing (EDP) equipment: Office machinery; insulated wire and cable; electrical equipment; electronic valve tubes, etc.; and TV/radio transmitters – 2002 data at 4-digit level of ISIC Code (Revision 3) (value in current US$ million)

Rank	Countries	Total	Office, accounting, computing equip.	Insulated wire and cable	Other electrical equip. n.e.c.	Electronic valve tubes, etc.	TV/radio transmitters and apparatus	TV/radio receivers and equip.	Measuring and testing apparatus	Industrial process equipment
1	United States	385 575	77 083	11 659	43 806	107 534	59 397	8 823	70 104	7 165
2	Japan	321 525	63 197	10 891	24 719	78 240	32 413	90 162	19 828	2 071
3	China [1]	220 171	77 579	–	–	–	142 537	–	–	–
4	Korea, Rep. of	98 636	18 414	3 461	3 068	37 373	26 657	7 722	1 508	429
5	Germany	72 048	12 665	3 741	12 166	12 436	9 461	5 731	13 728	2 116
6	France	62 509	10 613	2 309	5 804	10 294	15 014	4 920	11 004	2 683
7	United Kingdom	52 618	15 567	1 613	5 257	5 510	8 430	4 539	10 456	427
8	Malaysia	41 411	11 443	1 357	176	17 206	1 527	9 282	416	–
9	Italy	37 487	3 586	2 914	10 698	4 893	7 769	1 018	4 649	1 957
10	Singapore	35 692	17 746	560	56	14 650	1 129	1 041	79	427
11	Ireland	19 486	14 774	327	361	3 609	–	–	371	42
12	Canada	18 509	4 057	1 194	1 806	3 852	4 545	165	2 887	18 509
13	Finland	16 899	68	355	345	479	14 422	156	598	473
14	Sweden	15 479	572	565	554	436	10 395	495	2 015	444
15	Brazil	13 418	2 382	974	1 791	1 443	4 486	2 340	–	–
16	Spain	12 912	905	1 359	3 865	1 143	1 515	2 407	1 217	498
17	Hungary	9 836	1 617	198	2 570	980	500	3 685	193	90
18	India	9 705	1 095	1 597	445	1 394	974	3 475	453	268
19	Austria	8 053	718	272	1 253	1 721	2 855	631	497	102
20	Poland	6 269	551	1 031	884	139	999	1 867	479	316
21	Czech Rep.	5 498	1 892	451	1 315	543	749	546	–	–
22	Netherlands	5 307	1 535	535	804	578	155	–	1 465	232
23	Israel	4 816	–	249	–	1 978	1 946	641	–	–

Rank	Countries	Total	Office, accounting, computing equip.	Insulated wire and cable	Other electrical equip. n.e.c.	Electronic valve tubes, etc.	TV/radio transmitters and apparatus	TV/radio receivers and equip.	Measuring and testing apparatus	Industrial process equipment
24	Australia	4 693	480	426	1 536	858	839	–	552	–
25	Portugal	4 293	31	324	1 095	796	841	1 063	33	106
26	Indonesia	4 070	2	411	295	1 797	25	1 535	3	–
27	Norway	3 875	107	292	186	405	647	112	656	1 467
28	Hong Kong SAR	3 791	132			1 973	70		390	1 224
29	Russian Fed.	1 926	508	782	635	–	–	–	–	–
30	Denmark	1 792	259	–	481	217	–	–	785	49
31	Slovakia	956	35	267	159	206	85	70	90	41
Total										
OECD		1 164 255	228 726	44 184	122 732	272 242	197 688	134 112	143 115	39 217
Non-OECD		335 000	110 887	5 930	3 398	40 441	152 694	18 314	1 341	1 919

[1] China's production concerns electric equipment and machinery; electronic and telecom equipment (China stat yearbook).

Source: OECD.

Table 1.8. World production of electronic data processing (EDP) equipment: Office machinery; insulated wire and cable; electrical equipment; electronic valve tubes; TV/radio transmitters, etc.; and TV/radio transmitters – 2003 data at 4-digit level of ISIC Code (Revision 3) (value in current US$ million)

Countries	Total	Office, accounting, computing machinery	Insulated wire and cable	Other electrical equip. n.e.c.	Electronic valve tubes, etc.	TV/radio transmitters	TV/radio receivers	Measuring testing navigating appliance	Industrial process equip.
China	300 380	100 114	–	–	–	200 263	–	–	–
Germany	88 989	14 951	4 141	14 883	17 631	11 964	6 204	16 790	2 733
France	68 289	12 072	2 485	7 106	11 123	15 819	4 857	12 067	2 757
United Kingdom	47 597	11 021	1 724	5 693	5 738	6 935	4 355	10 803	1 324
Italy	42 469	3 529	3 384	11 741	5 597	9 688	1 036	4 947	2 543
Singapore	37 584	17 324	514	52	17 232	1 032	865	111	451
Spain	14 436	984	1 568	4 765	1 359	1 239	2 616	1 404	497
Australia	6 135	655	563	2 014	1 228	935	–	737	–
Netherlands	5 995	1 463	613	976	663	152	–	1 842	283
Czech Rep.	5 641	2 748	469	1 620	803	–	–	–	–
Indonesia	5 425	2	352	474	2 626	148	1 817	3	–
Portugal	5 231	143	392	1 198	1 098	838	1 343	70	146
Denmark	3 795	310	–	572	304	769	767	1 009	61
Russian Federation	3 006	219	1 290	1 495	–	–	–	–	–
Hong Kong SAR	2 564	123		86		125		263	1 183
Slovakia	1 707	245	339	421	361	92	85	105	55
Total	636 681	165 903	17 834	53 096	65 764	249 999	23 945	50 151	12 033

Source: OECD.

1.3.5. Electrical and electronic product industry exports

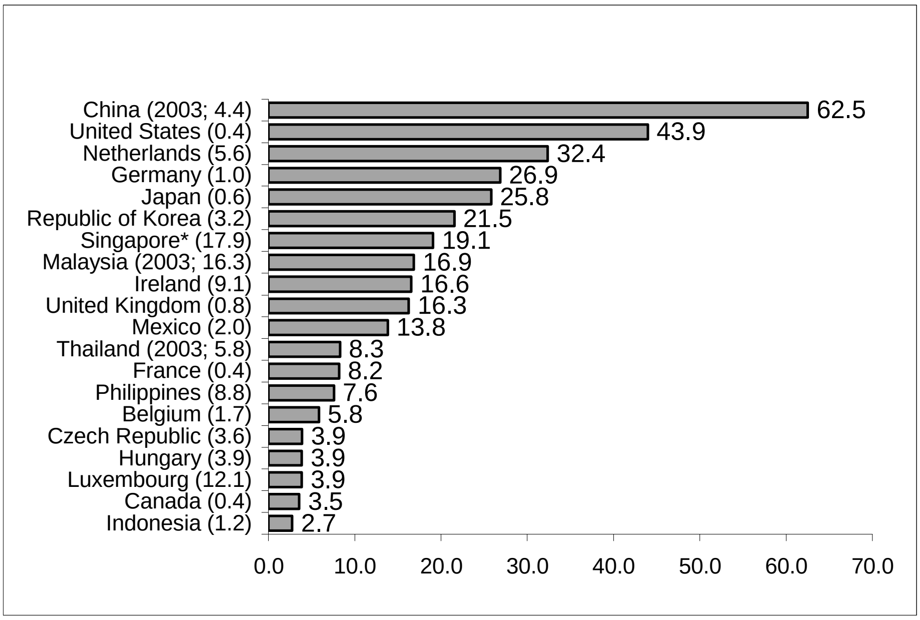
Commodity trade data provide some insights into the geographical distribution of the industry, the interdependencies between countries with respect to the industry, and the changing dynamics of production and consumption. There are three commodity categories that can be singled out to describe trading patterns for the industry, using data provided by the WTO. They are defined by the Standard International Trade Classification system (SITC) and include the following categories: [8]

- electronic data processing and office equipment (SITC division 75);
- telecommunications equipment (SITC division 76); and
- integrated circuits and electronic components (SITC group 776).

As a group, they are defined by the WTO as "Office and telecommunications equipment: office machines and automatic data processing machines; telecommunications and sound recording and reproducing apparatus and equipment; thermionic, cold cathode or photo-cathode valves and tubes". [9]

Figures 1.7a, 1.7b and 1.7c show the relative magnitudes of exports by country and commodity groups for 2004 (except as noted otherwise), in billions of United States dollars. They also show the importance of these exports to each country's economy, expressed as a percentage of GDP. For example, in 2004 the Republic of Korea exported US$36.6 billion worth of telecommunications (telecom) equipment, accounting for about 5.4 per cent of its total GDP.

Figure 1.7a. Exports of electronic data processing and office equipment
(top 20 countries, US$ billion and per cent of GDP, 2004)

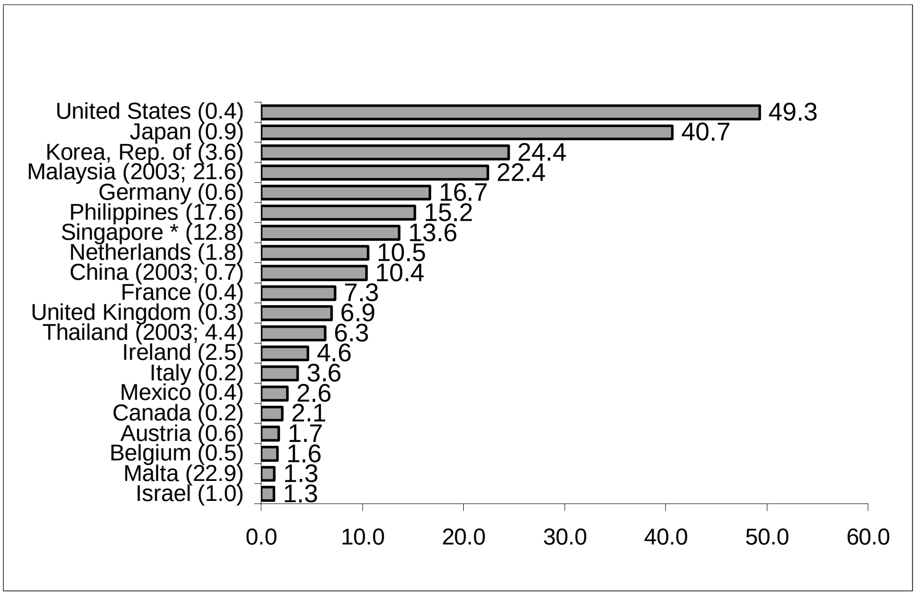


Source: WTO; ILO SECTOR*Source* database; * exports less re-exports.

[8] Excerpt from WTO trade database Technical Notes. See: http://stat.wto.org/StatisticalProgram/ WSDBStatProgramTechNotes.aspx?Language=E#Product_Def.

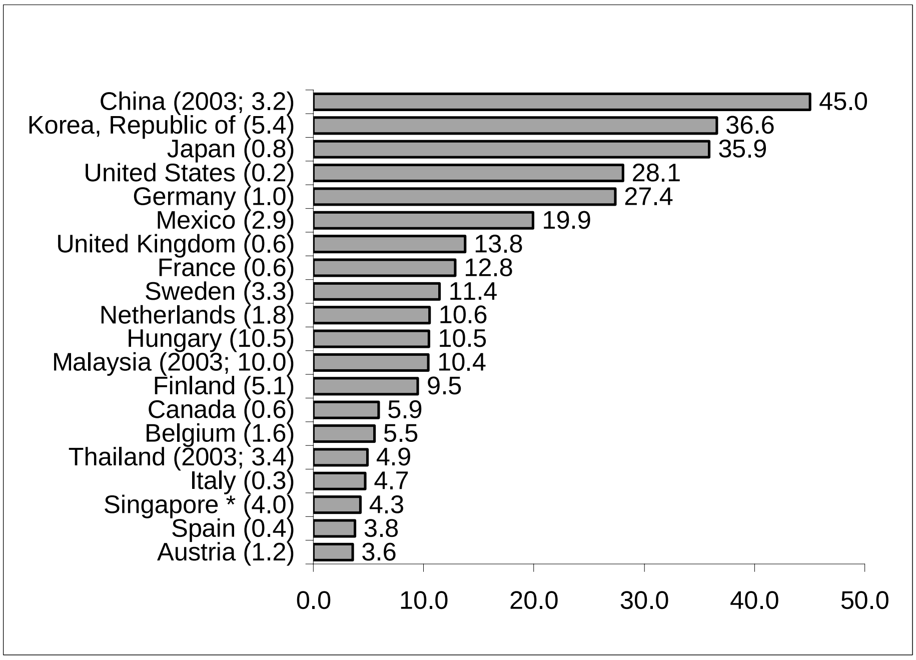
[9] ibid.

Figure 1.7b. Exports of integrated circuits and electronic components
(top 20 countries, US$ billion and per cent of GDP, 2004)



Source: WTO; ILO SECTOR*Source* database; * exports less re-exports.

Figure 1.7c. Exports of telecommunications equipment
(top 20 countries, US$ billion and per cent of GDP, 2004)



Source: WTO; ILO SECTOR*Source* database; * exports less re-exports.

As can be seen, China was by far the largest exporter of electronic data processing (EDP) and office equipment, with US$62.5 billion worth of exports, over 40 per cent more than the figure of US$43.9 billion for the United States, China's closest competitor. Other countries with exports of EDP equipment in excess of US$20 billion in 2004 included Germany, Japan, the Republic of Korea and the Netherlands.

Exports of EDP equipment are particularly important for a number of economies in terms of the ratio of exports to GDP. For Singapore and Malaysia, the value of exports represented over 16 per cent of their total GDP in 2004. Ireland, the Philippines and Luxembourg are also dependent to a significant degree on EDP exports, with shares ranging from 9 to 12 per cent of their GDP. Export levels representing over 3 per cent of GDP were recorded for China, the Czech Republic, Hungary, the Republic of Korea, the Netherlands and Thailand.

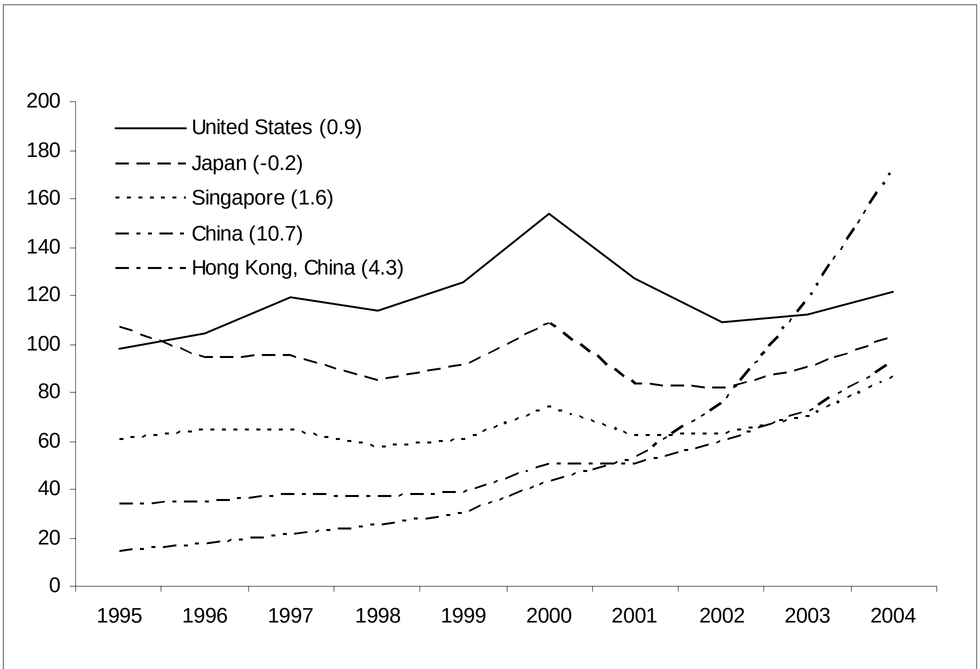
The ranking order is slightly different for the top exporters of telecom equipment. For this commodity, China is again number one, with US$45.1 billion in exports, while the United States is fourth, with US$28.1 billion, about two-thirds the level of China's exports. The second and third place slots are taken by the Republic of Korea (US$36.6 billion) and Japan (US$35.9 billion). Germany, with exports of US$27.4 billion, ranks fifth for this commodity, and the Netherlands, with US$10.6 billion in exports (many of which are re-exports), is in tenth place.

Exports of the telecom equipment product group are most important to the economies of Hungary (10.5 per cent of GDP) and Malaysia (10 per cent of GDP). They also play a major role (that is, greater than 3 per cent of GDP) in the economies of China, Finland, Singapore, Sweden and Thailand.

As for integrated circuits and electronic components, we can see from figure 1.7b that the United States leads the world in exports, with US$49.3 billion in 2004. China was a distant ninth, with a little over one-fifth as much, although measured by their 2003 level. Japan was second, with US$40.7 billion, and the Republic of Korea third, but significantly lower, with US$24.4 billion in exports. Malaysia was close behind the Republic of Korea, with US$22.4 billion. This commodity group is most important to the economies of Malaysia, Malta, the Philippines and Singapore, with exports accounting for between 13 and 23 per cent of GDP. Exports were also greater than 3 per cent of GDP in the Republic of Korea and Thailand.

Figures 1.7a, 1.7b and 1.7c show the geographical distribution of the sources of electrical and electronic components exports. The following paragraphs with their companion figures 1.8a to 1.8d show how exports have been changing among the biggest or otherwise most significant exporting countries.

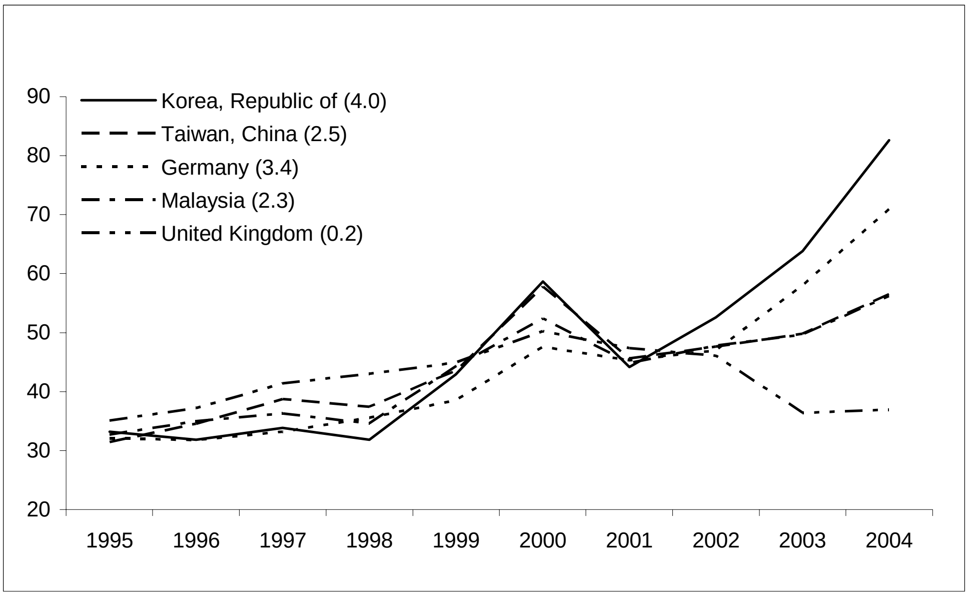
Figure 1.8a. Exports of office and telecom equipment – Group 1
(US$ billion and average annual per cent growth)



Source: WTO.

Figure 1.8a shows export trends for the top five exporters of office and telecom equipment as a whole. This characterization represents the sum of EDP and office equipment, telecommunications equipment, and integrated circuits and electronic components. Average annual percentage growth rates for the period 1995 to 2004 are shown next to each country name. As can be seen, exports from the top three exporters of 1995 (Japan, Singapore and the United States) hardly grew between 1995 and 2000. Export levels then dropped for these three countries in 2001, and in the United States continued to decline through 2002. Their performance over the ten-year period was, all told, lacklustre. Meanwhile, China's exports of office and telecommunications equipment grew rapidly, at an average rate of 10.7 per cent per year over the ten-year period, lifting China from 12th place in 1995 to first place in 2004. Exports from Hong Kong, China, also grew sharply over the ten-year period. This growth, averaging 4.3 per cent per year, was enough for the territory to overtake Singapore in total exports of office and telecommunications equipment and thus maintain its position in fifth place.

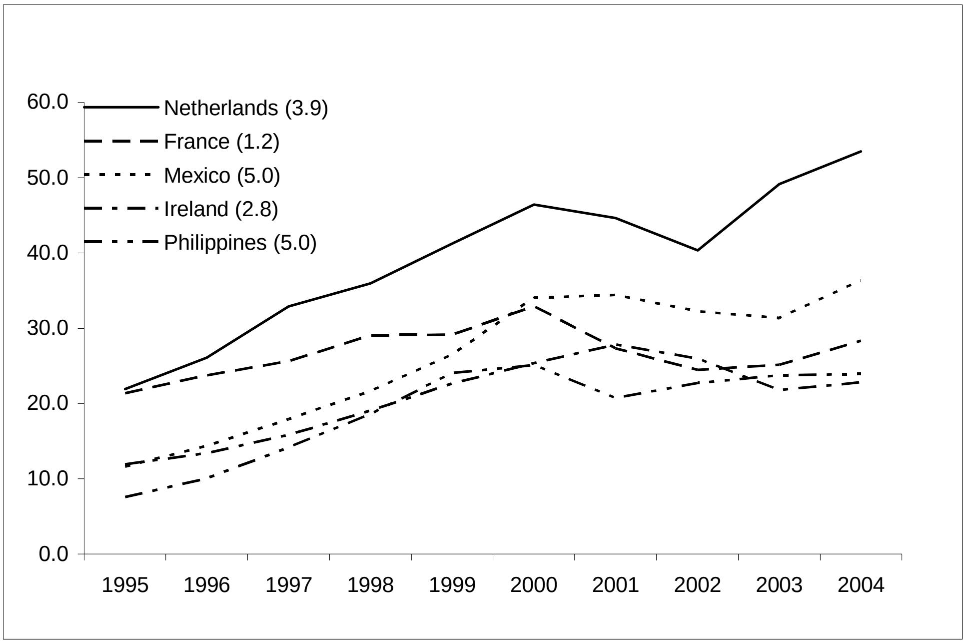
Figure 1.8b. Exports of office and telecom equipment – Group 2
(US$ billion and average annual per cent growth)



Source: WTO.

The second group, comprising Germany, the Republic of Korea, Malaysia, Taiwan (China) and the United Kingdom, was tightly knit in terms of exports of office and telecommunications equipment in 1995 (figure 1.8b). Each had exports of US$31 billion to US$35 billion. However, growth patterns were quite different for each country. The Republic of Korea was the star performer of the group, despite a jagged path that saw a steady decline from 1995 to 1998, followed by a sharp increase until 2000, a freefall in 2001, and a sustained and sharp rise thereafter. The average annual growth rate, despite the declines, was 4 per cent. Germany's exports rose throughout the period, with the exception of a few slight declines in 1996 and 2001, and growth averaged a healthy 3.4 per cent per year. Malaysia and Taiwan, China, showed average growth of more than 2 per cent per year. In contrast, the United Kingdom ended the period with exports at a level not much higher than at the beginning of the period.

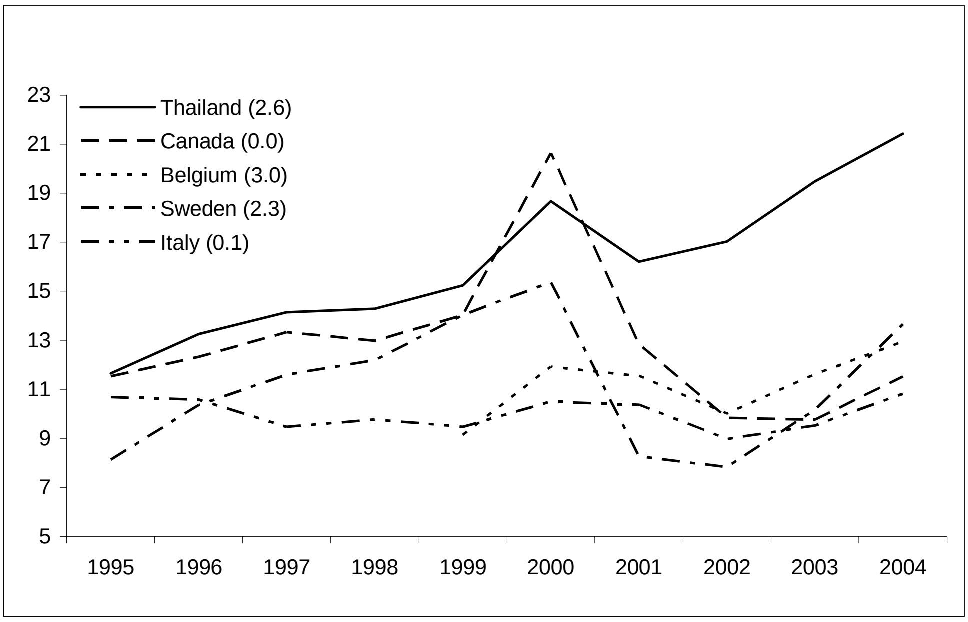
Figure 1.8c. Exports of office and telecom equipment – Group 3
(US$ billion and average annual per cent growth)



Source: WTO.

In group 3 (figure 1.8c), there are some familiar patterns, with robust growth in exports of office and telecommunications equipment by Mexico, the Netherlands and the Philippines. Growth was less rapid in France and Ireland. Growth in the former was indeed sluggish, at only 1.2 per cent per year on average. Ireland's exports grew at an average annual rate of 2.8 per cent.

Figure 1.8d. Exports of office and telecom equipment – Group 4
(US$ billion and average annual per cent growth)



Source: WTO.

The last five countries of the top 20 exporters are represented in figure 1.8d. For two of the five, Canada and Sweden, the patterns of export growth included very sharp rises and falls over the ten-year period. In the end, Sweden recovered sufficiently to post gains at an average annual growth rate of 2.3 per cent. Canada ended the period very much where it began, at about US$11.5 billion worth of exports. Four of the five countries in this group had exports of between US$11 billion and US$14 billion at the end of the period. In contrast, Thailand posted an average annual growth rate of 2.6 per cent, ending the period at the substantially higher level of US$21.4 billion.

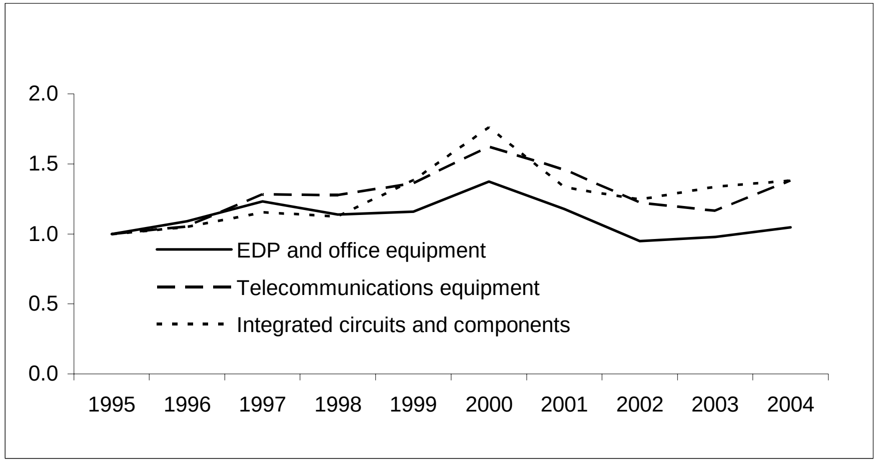
The following countries are not currently major exporters at the levels of those discussed above, but have all recorded strong growth in exports (more than 10 per cent per year on average over the last ten years): Cambodia, Costa Rica, Czech Republic, El Salvador, Georgia, Guatemala, Honduras, Hungary, the Islamic Republic of Iran, Luxembourg, Mauritius, Morocco, Pakistan, Panama, Peru, Romania, Slovakia and Turkey.

The list includes a number of Eastern European, East Asian, Central American, and African countries in which the electrical and electronic products industries are playing an increasingly important role. Conversely, there are nearly 30 countries for which exports of office and telecommunications equipment have declined over the past ten years.

The discussion above is focused on measures of total exports of all categories of electrical and electronic products. The patterns of export growth among the more detailed categories (EDP and office equipment; telecommunications equipment; and integrated circuits and electronic components) vary greatly from country to country. Those patterns help to show how the industry has evolved geographically and over time. Figures 1.9a to 1.9d show patterns of electrical and electronic product exports for the United States, Switzerland, Mexico and Indonesia.

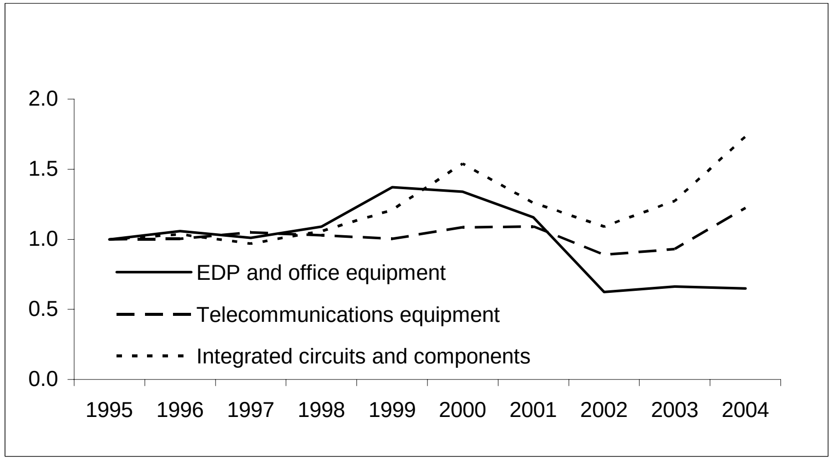
The figures show that exports of electrical and electronic products in all three categories from Switzerland and the United States either declined slightly or increased by as much as 50 per cent. In contrast, Indonesian and Mexican exports increased substantially more in percentage terms. In Mexico, exports of telecom equipment and integrated circuits have doubled in the last ten years, while exports of EDP and office equipment have quintupled. In Indonesia, exports of telecommunications equipment have doubled. Exports of the other two product categories increased fivefold or more between 1995 and 2000. In 2004 they were in the same general range as in 2000, five times the 1995 levels.

Figure 1.9a. United States: Exports of office and telecom equipment (US$ million, 1995 to 2004)



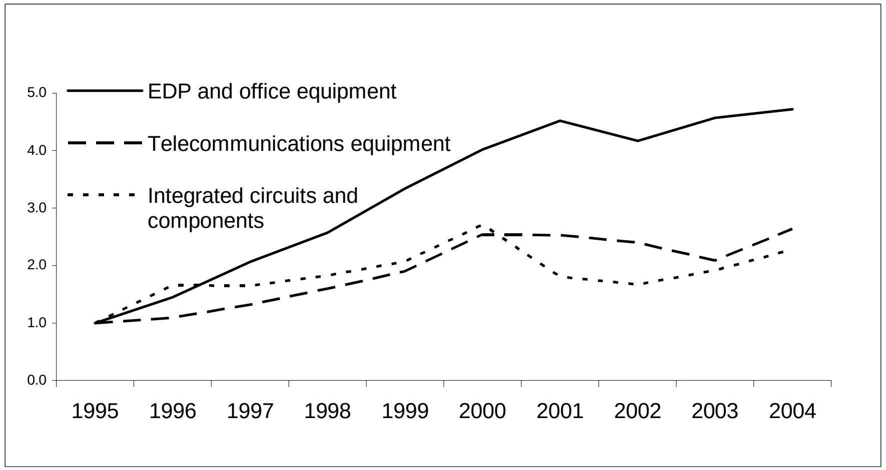
Source: WTO; ILO SECTOR*Source* database.

Figure 1.9b. Switzerland: Exports of office and telecom equipment (US$ million, 1995 to 2004)



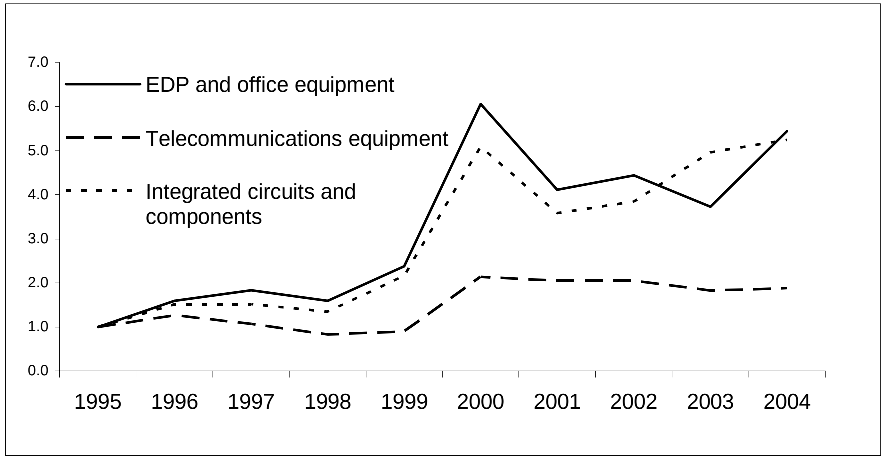
Source: WTO; ILO SECTOR*Source* database.

Figure 1.9c. Mexico: Exports of office and telecom equipment (US$ million, 1995 to 2004)



Source: WTO; ILO SECTOR*Source* database.

Figure 1.9d. Indonesia: Exports of office and telecom equipment (US$ million, 1995 to 2004)



Source: WTO; ILO SECTOR*Source* database.

1.4. A case study: Production, trade and employment in the Republic of Korea, 1997 to 2004

For a number of countries, it is possible to perform a more rigorous and detailed analysis of available data. The Republic of Korea has been chosen to serve as an example. SECTOR*Source* includes production, trade and employment data for the Republic of Korea, collected from UNIDO, the ILO and UNCTAD. UNIDO provides 4-digit level detail for production and employment up to 2002. UNIDO also provides trade data through 2004 at the same level of industry detail. The production, trade and employment estimates presented in the discussion that follows are based on data from those sources.

1.4.1. Production of electrical and electronic products

Since 1997, the Republic of Korea’s production of electrical and electronic equipment has more than doubled, increasing at an average annual exponential rate of about 9.4 per cent. This rate rivals that of its main competitor, China, and has occurred despite a major setback in 1998. The rapid growth in the Republic of Korea’s output has been spurred by exports, which have grown at a remarkable 12.5 per cent per year on average over the same period. At the same time, imports increased rapidly, although not quite as fast as exports, at an average annual rate of 8.9 per cent. Domestic use (output plus imports minus exports) grew at an average annual rate of 7.1 per cent. The domestic market is thus robust, providing a strong backdrop for the world reach of the country’s electrical and electronic products manufacturers, and providing for a steady increase in employment (see tables 1.9a to 1.9d, and figures 1.10a to 1.10d).

Figure 1.10a displays summary measures of employment, output, exports and imports for the aggregate electrical and electronic products manufacturing industry in the Republic of Korea. Figures 1.10b, 1.10c and 1.10d show summary measures for the three industry divisions. The data are displayed as index values, with 1997 equal to 1.0 in all cases, thus providing a view of how these measures have changed relative to 1997 and to each other. Of the three divisions of this broad industry, the telecommunications equipment industry (ISIC 32) has recorded the most rapid output growth, thus maintaining and improving its status as the largest of the three divisions. It accounted for just over 60 per cent of total electrical and electronic product manufacturing in 1997. This share has increased to over 67 per cent. Production increased at an average annual exponential rate of 10.9 per cent over this period.

In terms of the value of production, the second largest division of the three is electrical machinery and apparatus (ISIC 31). However, this division is not much larger than the third one, office, computing and accounting machinery (ISIC 30). These divisions accounted for 21.1 per cent and 18.0 per cent respectively of total production in 1997. However, production of office equipment has increased slightly more rapidly (7.9 per cent per year versus 6.0 per cent per year), so that the respective shares stood at 16.6 per cent and 16.1 per cent in 2004. Details of production, exports, imports and employment for individual industries are provided in tables 1.9a to 1.9d, which show estimates for 1997 through 2004.

Table 1.9a. Republic of Korea: Production in electrical and electronic products manufacturing, 1997 to 2004
(US$ billion and exponential growth rate, per cent)

	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004
Total, ISIC 30, 31 and 32	77.7	57.2	84.5	112.6	93.5	109.5	123.8	150.5	9.4
30 Office, computing and accounting machinery	14.0	9.3	15.8	23.3	18.6	18.4	20.7	24.3	7.9
31 Electrical machinery and apparatus n.e.c.	16.4	10.1	15.9	19.1	17.5	19.4	21.1	25.0	6.0
3110 Electric motors, generators and transformers	3.9	2.6	4.2	4.9	4.4	5.7	5.5	6.1	6.3
3120 Electricity distribution and control apparatus	4.4	2.3	3.3	4.6	4.2	4.6	4.9	5.6	3.5
3130 Insulated wire and cable	4.3	2.9	4.2	4.6	4.0	3.5	4.1	4.9	1.7
3140 Accumulators, primary cells, primary batteries	0.9	0.7	0.9	1.2	1.2	1.2	1.4	1.6	8.5
3150 Electric lamps and lighting equipment	1.1	0.7	1.0	1.1	1.2	1.4	1.8	2.5	11.6
3190 Other electrical equipment n.e.c.	1.8	0.9	2.3	2.6	2.4	3.1	3.5	4.3	12.3
32 Radio, TV, communication equipment and apparatus	47.3	37.7	52.8	70.2	57.4	71.8	82.0	101.3	10.9
3210 Electronic valves, tubes, other electrical components	25.7	23.2	31.9	41.7	30.0	37.4	38.6	44.8	8.0
3220 TV, radio transmitters; telephone and telegraph equipment	12.5	9.9	15.2	21.0	20.7	26.7	32.7	42.8	17.6
3230 TV, radio receivers, recording/reproducing apparatus	9.1	4.7	5.7	7.5	6.7	7.7	10.6	13.6	5.7

Source: Estimates by ILO Sectoral Activities, based on data from SECTOR*Source*.

Table 1.9b. Republic of Korea: Exports in electrical and electronic products manufacturing, 1997 to 2004
(US$ billion and exponential growth rate, per cent)

	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004
Total, ISIC 30, 31 and 32	38.3	34.6	46.3	62.8	48.2	57.2	70.6	91.9	12.5
30 Office, computing and accounting machinery	6.4	5.4	10.6	19.6	13.5	16.4	18.1	21.5	17.3
31 Electrical machinery and apparatus n.e.c.	3.6	2.8	3.2	3.8	3.9	4.2	5.5	7.6	10.6
3110 Electric motors, generators and transformers	1.0	0.9	1.2	1.5	1.3	1.4	1.4	1.7	6.9
3120 Electricity distribution and control apparatus	0.5	0.4	0.4	0.6	0.6	0.7	0.8	1.1	11.8
3130 Insulated wire and cable	0.6	0.6	0.6	0.7	0.9	0.6	0.6	0.8	3.9
3140 Accumulators, primary cells, primary batteries	0.3	0.3	0.3	0.3	0.4	0.5	0.7	0.9	14.7
3150 Electric lamps and lighting equipment	0.2	0.2	0.2	0.2	0.2	0.2	0.3	0.5	11.1
3190 Other electrical equipment n.e.c.	0.9	0.4	0.4	0.6	0.6	0.9	1.7	2.6	14.7
32 Radio, TV, communication equipment and apparatus	28.3	26.4	32.5	39.4	30.8	36.5	47.1	62.7	11.4
3210 Electronic valves, tubes, other electrical components	20.6	20.3	22.8	26.2	15.9	17.3	20.5	26.2	3.5
3220 TV, radio transmitters; telephone and telegraph equipment	1.9	2.2	4.6	6.5	8.4	10.9	14.8	20.5	34.3
3230 TV, radio receivers, recording/reproducing apparatus	5.9	3.9	5.2	6.7	6.5	8.3	11.8	16.0	14.4

Source: Estimates by ILO Sectoral Activities, based on data from SECTOR*Source*.

Table 1.9c. Republic of Korea: Imports in electrical and electronic products manufacturing, 1997 to 2004
(US$ billion and exponential growth rate, per cent)

	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004
Total, ISIC 30, 31 and 32	26.3	20.6	30.6	41.5	33.1	36.0	42.2	49.1	8.9
30 Office, computing and accounting machinery	3.7	2.0	4.3	7.7	5.6	5.5	5.4	5.9	6.5
31 Electrical machinery and apparatus n.e.c.	4.9	3.4	4.9	6.1	5.6	6.7	8.7	11.8	12.7
3110 Electric motors, generators and transformers	1.4	1.0	1.4	1.7	1.6	1.8	2.0	2.5	8.7
3120 Electricity distribution and control apparatus	1.5	0.9	1.3	1.6	1.4	1.6	1.8	2.2	6.3
3130 Insulated wire and cable	0.3	0.2	0.4	0.5	0.3	0.3	0.4	0.4	3.6
3140 Accumulators, primary cells, primary batteries	0.4	0.4	0.7	0.7	0.5	0.5	0.5	0.6	3.9
3150 Electric lamps and lighting equipment	0.2	0.1	0.2	0.3	0.4	0.4	0.5	0.7	15.8
3190 Other electrical equipment n.e.c.	1.0	0.6	0.9	1.3	1.4	2.1	3.3	5.4	23.4
32 Radio, TV, communication equipment and apparatus	17.8	15.2	21.4	27.7	21.8	23.8	28.1	31.5	8.2
3210 Electronic valves, tubes, other electrical components	14.5	13.3	18.0	22.0	17.1	19.1	22.7	25.2	7.8
3220 TV, radio transmitters; telephone and telegraph equipment	1.4	0.7	1.5	3.0	1.8	1.5	1.4	1.4	0.1
3230 TV, radio receivers, recording/reproducing apparatus	1.8	1.2	1.9	2.7	2.9	3.2	3.9	4.9	14.3

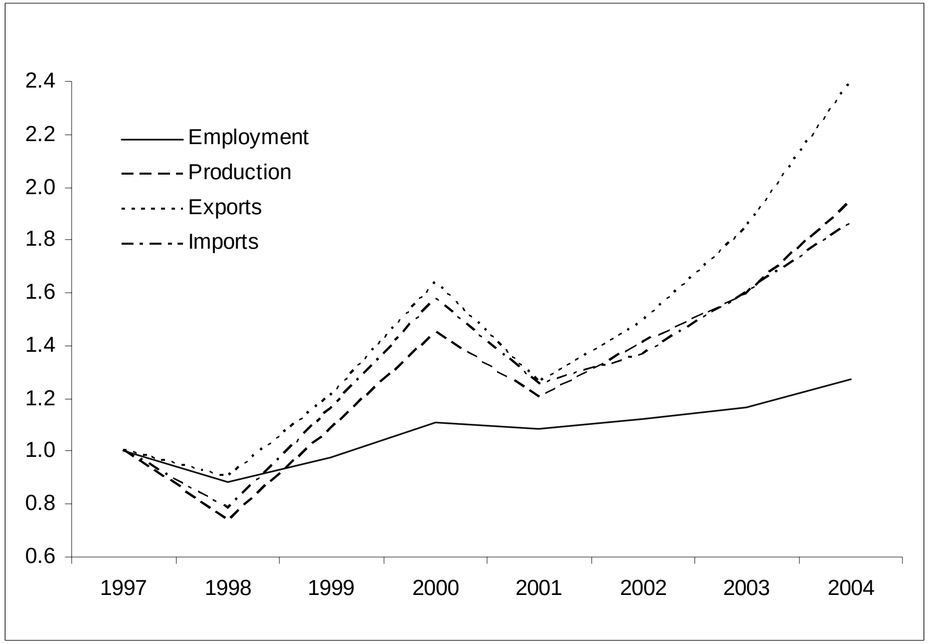
Source: Estimates by ILO Sectoral Activities, based on data from SECTOR*Source*.

Table 1.9d. Republic of Korea: Employment in electrical and electronic products manufacturing, 1997 to 2004
(thousands of persons and exponential growth rate, per cent)

	1997	1998	1999	2000	2001	2002	2003	2004	1997-2004
Total, ISIC 30, 31 and 32	416.9	367.7	408.2	463.8	451.7	467.1	485.0	531.0	3.5
30 Office, computing and accounting machinery	53.9	41.4	46.1	49.7	45.4	41.8	49.3	55.3	0.4
31 Electrical machinery and apparatus n.e.c.	124.3	106.7	127.0	136.6	136.2	140.7	147.1	161.2	3.7
3110 Electric motors, generators and transformers	34.3	32.7	36.3	39.4	39.9	42.9	41.4	43.3	3.3
3120 Electricity distribution and control apparatus	37.0	28.5	33.1	36.4	35.4	35.9	37.0	39.6	1.0
3130 Insulated wire and cable	17.9	15.8	18.1	18.0	16.3	15.5	16.7	17.9	0.0
3140 Accumulators, primary cells, primary batteries	4.9	4.9	5.6	7.0	8.1	7.6	8.0	9.2	8.9
3150 Electric lamps and lighting equipment	12.6	11.4	12.9	13.0	14.3	14.8	16.6	19.6	6.2
3190 Other electrical equipment n.e.c.	17.6	13.4	21.0	22.8	22.3	24.0	27.3	31.6	8.4
32 Radio, TV, communication equipment and apparatus	238.7	219.6	235.1	277.5	270.1	284.7	288.6	314.4	3.9
3210 Electronic valves, tubes, other electrical components	138.9	138.4	145.3	170.8	165.2	171.7	169.2	180.3	3.7
3220 TV, radio transmitters; telephone and telegraph equipment	39.2	38.6	48.8	59.4	60.6	69.5	82.1	102.0	13.7
3230 TV, radio receivers, recording/reproducing apparatus	60.6	42.6	41.0	47.3	44.3	43.5	37.3	32.2	–9.0

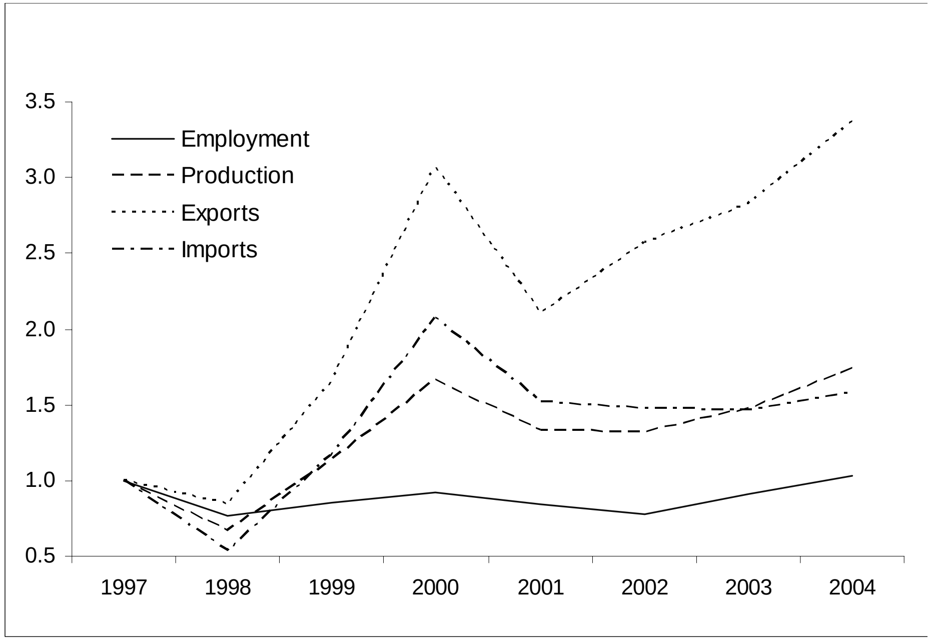
Source: Estimates by ILO Sectoral Activities, based on data from SECTOR*Source*.

Figure 1.10a. Rep. of Korea: Electrical and electronic product manufacturing – Production, employment, exports and imports, 1997 to 2004 (index values, 1997 = 1.0)



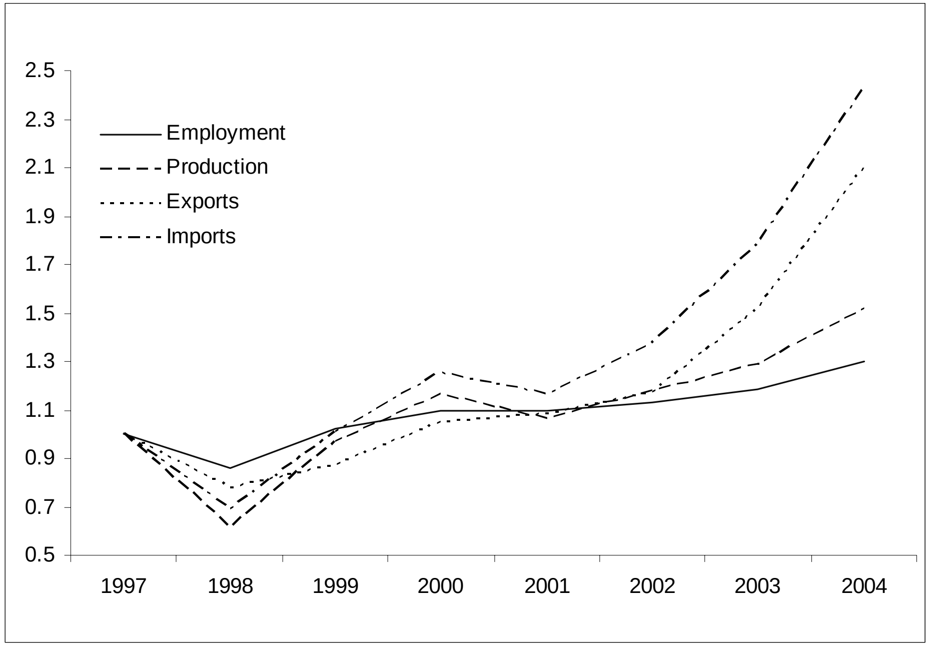
Source: ILO/Sector estimates based on data from SECTOR*Source*.

Figure 1.10b. Rep. of Korea: 30 – Office, computing and accounting machinery – Production, employment, exports and imports, 1997 to 2004 (index values, 1997 = 1.0)



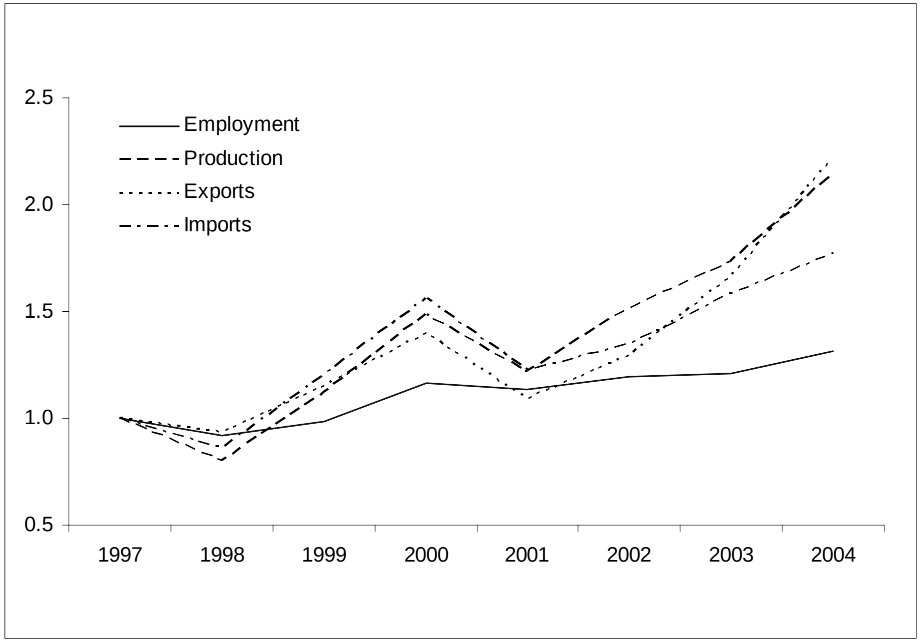
Source: ILO/Sector estimates based on data from SECTOR*Source*.

Figure 1.10c. Rep. of Korea: 31 – Electrical machinery and apparatus n.e.c. – Production, employment, exports and imports, 1997 to 2004 (index values, 1997 = 1.0)



Source: ILO/Sector estimates based on data from SECTOR*Source*.

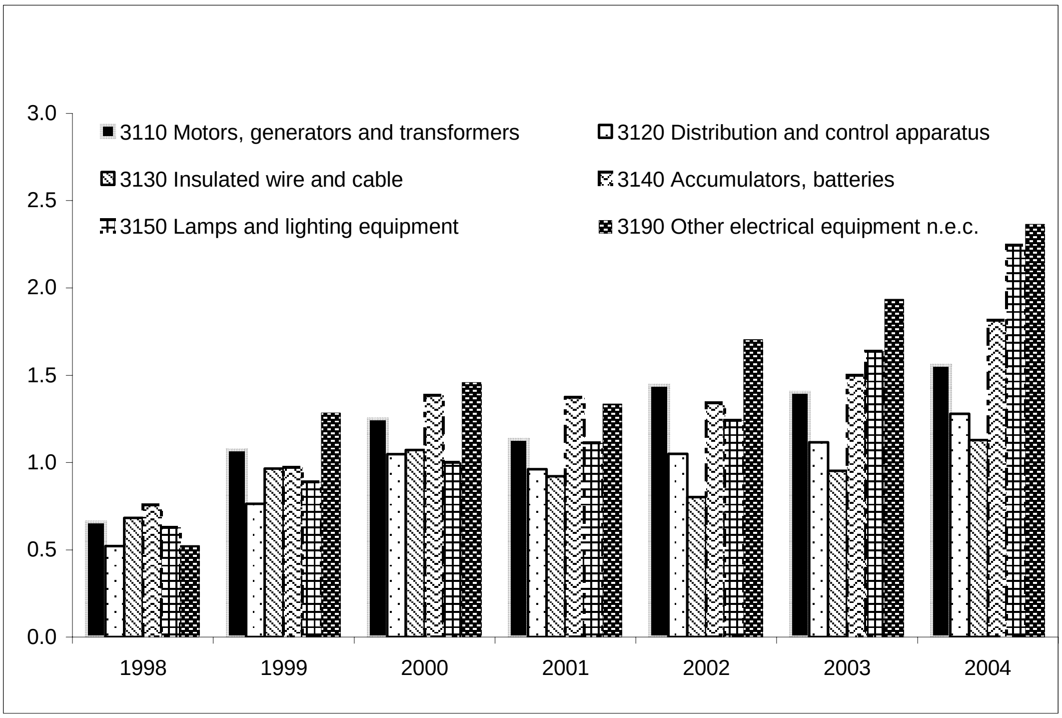
Figure 1.10d. Rep. of Korea: 32 – Radio, TV, communication equipment – Production, employment, exports and imports, 1997 to 2004 (index values, 1997 = 1.0)



Source: ILO/Sector estimates based on data from SECTOR*Source*.

Included in the detail are estimates for six industries within ISIC Division 31 (electrical machinery and apparatus) and three industries within ISIC Division 32 (telecommunication equipment). There is no further disaggregation of ISIC 30 (office, computing and accounting machinery), discussed above. Within ISIC 31, the fastest growing category has been the residual "other electrical equipment" industry which produces items ranging from windscreen wipers and electrical defrosters to carbon or graphite electrodes. [10] The largest industry in this division is 3110 (electric motors, generators and transformers). This industry has grown from third largest in the division in 1997. Figure 1.11a shows the growth paths of each industry in ISIC 31.

Figure 1.11a. Republic of Korea: ISIC 31 industry output, 1997 to 2004 (index values, 1997 = 1.0)



Source: ILO estimates based on SECTOR*Source* data.

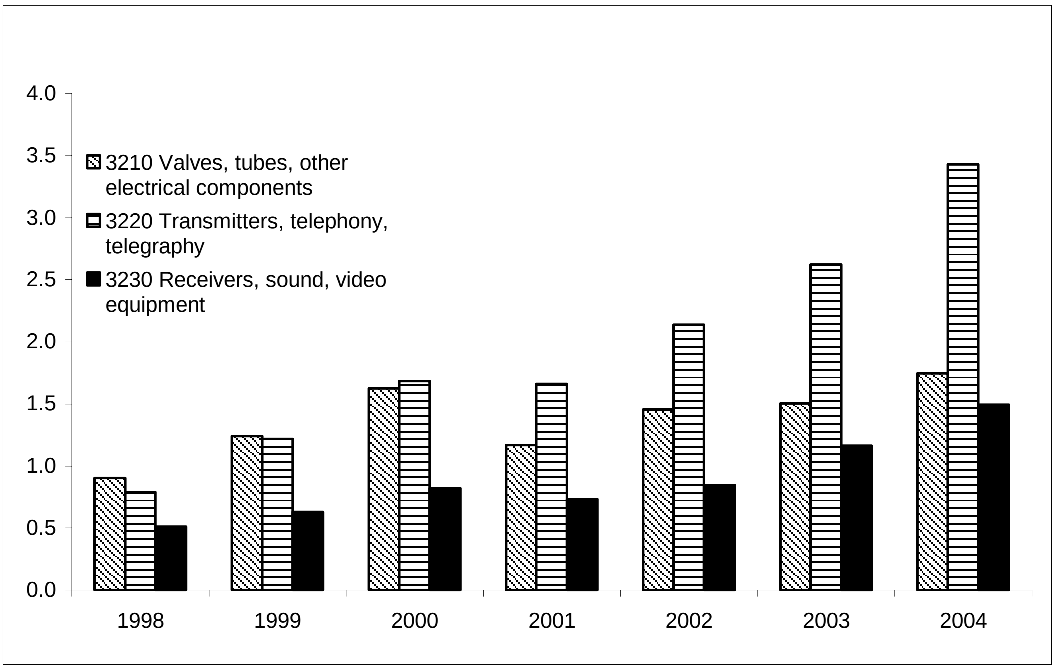
A slightly different set of patterns emerges from a review of trends within ISIC 32, as can be seen in figure 1.11b. It was shown above that the telecommunications equipment manufacturing division was the fastest growing of the three in the Republic of Korea, and here it can be seen that this result stems largely from the growth in production of TV and radio transmitters and telephone and telegraph equipment (ISIC 3220), which includes, among many other things, mobile telephones. [11] This industry is a close second, in terms of

[10] The United Nations Statistical Office provides a detailed listing of products included in each 4-digit ISIC industry. See http://unstats.un.org/unsd/cr/registry/regcst.asp?Cl=17.

[11] ibid. Note that, by definition, ISIC 3220 manufactures include the following: apparatus for television transmission, including relay transmitters and television transmitters for industrial use; television cameras; transmission apparatus for radiobroadcasting; transmission apparatus for radiotelephony: fixed transmitters and transmitter-receivers, radiotelephony apparatus for transport equipment, radiotelephones, other transponders, etc.; apparatus for line telephony: telephone sets, fax machines, automatic and non-automatic switchboards and exchanges, telex and teleprinter apparatus, etc.; mobile telephones; data communication equipment: routers, gateways, hubs, bridges.

output, to the industry that produces electronic components such as valves and tubes, semiconductors, printed circuit boards, picture tubes and LCD displays (ISIC 3210). This industry accounted for one-third of total Korean electrical and electronic product manufacturing in 1997. It then grew at an average annual rate of 8 per cent per year between 1997 and 2004. In 2004, the industry accounted for about 30 per cent of the total output, just above the level for ISIC 3220. Together, these two industries accounted for nearly 60 per cent of electrical and electronic product manufacturing in the Republic of Korea in 2004.

Figure 1.11b. Republic of Korea: ISIC 32 industry output, 1997 to 2004 (index values, 1997 = 1.0)



Source: ILO estimates based on SECTOR*Source* data.

It was shown earlier that in some countries, production growth has slowed among industries producing electronic components, while imports of these goods have grown, suggesting that producers of finished products are outsourcing component manufacturing to other countries. In some cases exports have grown much faster than output, suggesting that products are being manufactured increasingly for foreign markets and less for domestic consumption. The available data for the Republic of Korea shows a mix of patterns which indicate how the country has moved from being predominantly a component manufacturer to being a leading producer of finished goods.

1.4.2. Exports and imports of electrical and electronic products

Trade data for the Korean electrical and electronic products manufacturing industries are summarized in table 1.9b. The extraordinarily high growth rate for exports produced by manufacturers included in ISIC 3220 (TV and radio transmitters; telephone and telegraph equipment) provides one explanation for the rapid growth in output by this industry. Exports of Korean cellphones and other products in this mix grew at the staggering pace of 34.3 per cent per year between 1997 and 2004. During the same period, imports of products in this category remained flat. Exports of ISIC 3220 products were nearly half as large as total output by this industry in 2004. That ratio is in sharp contrast to the ratio of 1:6 seen in the data for 1997. Exports of components for the production of radio and TV communication equipment (that is, products included in ISIC 3210) were 80 per cent of total production by this industry in 1997, compared to less than 60 per cent in 2004. During that seven-year period, imports of components increased at an average annual rate of 7.8 per cent.

In the case of TV and radio receiving equipment, which includes all manner of television sets, CD players, camcorders, and so on, Korean exports also showed very robust growth (14.4 per cent per year on average) between 1997 and 2004. During the same period, imports increased at about the same rate, such that the trade coverage ratio (exports divided by imports) remained relatively unchanged at a little more than 3 to 1.

Looking back now at the data for ISIC division 31 (electrical machinery and apparatus), it can be seen from tables 1.9b and 1.9c that export growth in half of the categories was slower than import growth, and that export growth for the division as a whole was slightly slower than import growth. Import growth was particularly strong in the residual "other electrical equipment n.e.c." industry that produces component parts. These patterns support the notion that the Republic of Korea has continued to emerge as a major producer of finished electrical and electronic products, while maintaining a significant place in the production of components.

1.4.3. Employment trends in the Korean electronics industries

The changing patterns of production and trade have had a mostly positive effect on employment in the Korean electrical and electronic product manufacturing industries. While total production in the electrical and electronic products industry increased at an average annual rate of 9.4 per cent between 1997 and 2004, employment in that industry increased at an average annual rate of 3.5 per cent. The significantly slower increase in employment is due in large part to the very steep drop in employment between 1997 and 1998, the time of the Asian financial crisis. The data suggest that employment in this broad industry group never fully recovered from that shock until after 1999. Average annual growth in employment from 1998 to 2004 was 6.1 per cent.

The difference between the growth rate for production and the growth rate for employment reflects changes in the distribution of production among the individual industries, with production in the less labour-intensive industries growing more rapidly, as well as general improvements in labour productivity and other factors. The data suggest that overall, the employment requirement per unit of production in the Republic of Korea fell at an average annual rate of 6 per cent between 1997 and 2004. However, despite this decline, total employment in the electrical and electronic products manufacturing industry increased from about 417,000 workers in 1997 to about 531,000 workers in 2004, reflecting an increase of 114,000 jobs.

As might be expected from the earlier discussion, the most significant growth in employment was in the industry that produces TV and radio transmission devices, and telephones and telegraph equipment (ISIC 3220). In this industry, employment increased at an average annual rate of 13.7 per cent between 1997 and 2004. No other industry in this focus had double-digit growth over that period, although two industries had employment growth rates in excess of 8 per cent per year. They were producers of batteries (ISIC 3140), which had a growth rate of 8.9 per cent per year between 1997 and 2004, and the catch-all "other electrical equipment n.e.c." industry (ISIC 3190), which had a growth rate of 8.4 per cent per year over the same period. Interestingly, the employment growth rate in the batteries manufacturing industry was greater than the production growth rate, although not by much (8.9 per cent per year for employment and 8.5 per cent per year for production). This apparent anomaly is not readily explained, as one would not expect degradation in production per unit of employment, but there may well be changes in the mix of products manufactured by this industry such that at the ISIC 3140 level of aggregation, production per unit of employment has fallen.

In summary, the industry has clearly benefited greatly from the boom in demand for technology products ranging from mobile phones to flat-screen TVs, as have quite a number of both established and emerging economies. The available information regarding the Republic of Korea's production, exports, imports and employment vividly highlights the dynamics of the industry. The example of the Republic of Korea demonstrates how the industry has evolved in some countries, where production was at one time more highly concentrated in the manufacture and supply of intermediate, rather than finished, goods. Ever larger volumes of trade, both exports and imports, exemplify the growing interdependencies between countries, which have been brought on both by the emergence of new markets for products and by the search for lower-cost materials and labour.

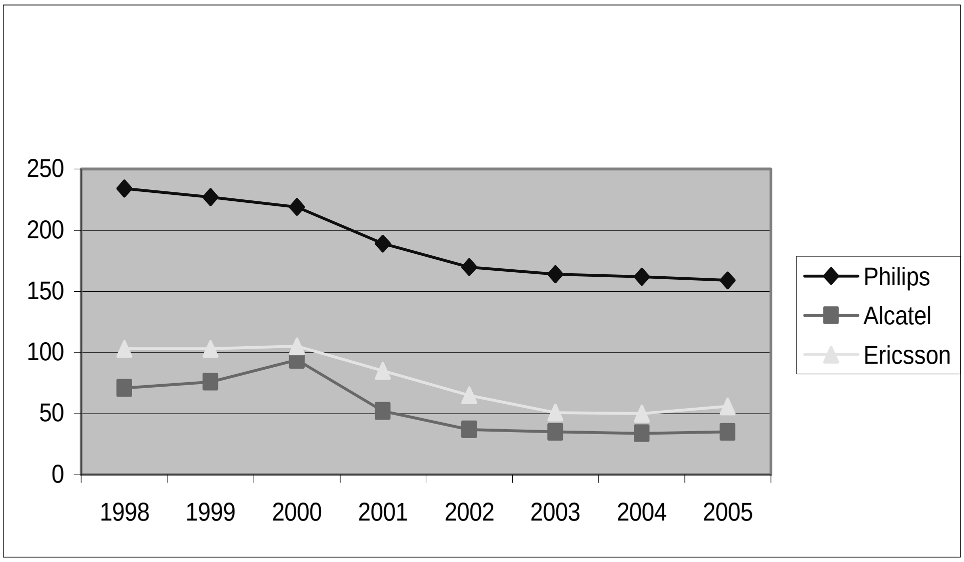
2. Subcontracting in electronics: From contract manufacturers to providers of electronics manufacturing services (EMS) [1]

2.1. Introduction

For over two decades North American companies such as IBM and Hewlett-Packard (HP) have been outsourcing their manufacturing activities to “contract manufacturers”, both at home and abroad in countries such as Brazil, China, India, Indonesia, Malaysia, Mexico and the United Kingdom. Other producers (Cisco Systems, Apple) followed suit. Producers in northern Europe (Ericsson, Nokia, ABB) started to do the same in the late 1990s, as did Philips and Siemens.

This outsourcing has contributed to a drastic decline in the number of workers employed in the brand-name companies or original equipment manufacturers (OEMs). The number of people employed by Alcatel more than halved between 2000 and 2004. At Ericsson, the number also dropped by half in these years (see figure 2.1). In part, this trend was a reflection of the poor business environment of the early 2000s. But another important explanation for the steep decline in the numbers employed was not only the decision to subcontract or outsource a growing range of productive activities but also the sale, or “divestiture”, of entire plants (including machinery, inventory and employees) to contract manufacturers.

Figure 2.1. Employment in OEMs (selected years, number of persons in ’000s)



Source: Company information.

There are many contract manufacturers but six stand out because of their size and international presence: the original “Big Five” (Celestica, Flextronics, Jabil Circuit, Sanmina-SCI and Solectron) plus a newcomer from Taiwan, China (Hon Hai/Foxconn), which has overtaken Flextronics to become the largest of them all. Dubbed by some the

[1] This chapter is based on a background paper prepared by G. van Liemt. It will be available as a working paper in 2007.

best kept secret of the industry, these companies make mobile phones for Ericsson, Motorola and Siemens; iPods for Apple; printers for HP; and electronic games for Microsoft. The original Big Five all originated in North America, had 2005 sales of between US$7.5 billion and US$11.5 billion (except for Flextronics: US$15.9 billion), and employed some 50,000 people each (except for Flextronics, with 92,000 employees and Foxconn, with 166,000).

2.2. Subcontracting and international product fragmentation

2.2.1. The trend towards outsourcing

Today, large companies try to become smaller in terms of employment ("downsizing"). Most companies now rely on others to look after their catering, cleaning, gardening and external security. Many have outsourced personnel management, IT services, logistics and transport. Everywhere, companies are focusing on their "core activities" (often an ill-defined concept which in practice is subject to change over time).

Manufacturing was long seen as such a core activity. In a number of industries it still is. But in sectors such as clothing, automobiles or aircraft, with highly standardized production processes and great differences in the labour-, capital-, and skill-intensiveness of the different stages that make up these processes, it is now common to outsource some of these stages. The more labour-intensive stages are usually the first to be outsourced. Branded companies want to focus on what they are best at: creating and marketing products.

Brand-name companies or lead firms [2] subcontract because they want to spread risks and lower costs. Subcontracting enables them to gain access to key technologies, to reduce their need for working capital, and to adjust their levels of production more flexibly by passing on the burden of idle overheads to subcontracting firms. The advantages for subcontractors are that they can concentrate on production (sales are guaranteed within a set timespan; no need to invest in R&D, distribution or marketing). The risk of not being paid for the work is low.

Subcontracting, outsourcing and vertical disintegration are also referred to in different terms depending on where the emphasis is being placed. "Offshoring" stresses the international dimension. Strictly speaking, "slicing up the value chain" and "production fragmentation" both refer to the phase preceding subcontracting: only after the production process has been split up into distinct activities (or modules) can these activities be outsourced or subcontracted.

[2] These "production organisers … decide what to produce, where, how and by whom, and from where to supply which market … As the case may be, the 'production organisers' sell brand loyalty; superior organisation, design and marketing; their hold over the distribution network; access to a protected market; quality control (or a combination of these)". Gijsbert van Liemt: "Summary and conclusions", in G. van Liemt (ed.) *Industry on the Move: Causes and Consequences of International Relocation in the Manufacturing Industry* (ILO, Geneva, 1992), p. 312.

2.3. Contract manufacturing in electronics

2.3.1. Introduction

The reasons for outsourcing discussed in the previous section (to spread risks and to lower costs) and the preconditions for doing so (the existence of clearly distinct stages in the value chain, and global standardization of the manufacturing process) are valid for many parts of the electronics and telecommunications industry. [3] In addition, the pressure on margins is great, competition is fierce, and market conditions are highly volatile.

From cell phones to Internet services to wireless applications, end-users want more, but are not necessarily willing to pay more. This forces brand-name companies to focus intensively on costs. [4]

Flexibility is at a premium. The days when production could be planned one year ahead are long gone. "Market leaders are unseated with stunning regularity." [5] New products are being introduced at great speed. A product generation is measured in weeks and months rather than years, making production planning ever more critical but exceedingly difficult. Delivery times have become much shorter.

The intensely competitive nature of the electronics industry, the ever-increasing complexity and sophistication of electronics products, the pressure on OEMs to reduce costs, and the shorter product life cycles, have led to rapidly growing demand for advanced manufacturing capabilities and related services. In the past, brand-name companies could do it all themselves and remain competitive. Now, it takes too much time, money and energy to be an expert at everything. So OEMs focus on what they do best: developing innovative products and services, reaching key markets and building brand loyalty.

2.3.2. Benefits of outsourcing in electronics

The benefits to OEMs of subcontracting to EMS providers can be summarized as follows. Subcontracting enables them to:

- reduce time-to-market and time-to-volume production for their products;
- lower operating costs, capital investment requirements and other fixed costs;
- improve inventory management;
- access world leading manufacturing technology, engineering and logistics capabilities;

[3] See for example, B. Lüethje: *Electronics Contract Manufacturing: Transnational Production Networks, the Internet, and Knowledge Diffusion in Low-Cost Locations in Asia and Eastern Europe* (East-West Center Working Papers, Economics Series, No. 18, East-West Center, Honolulu, 2001).

[4] Solectron: Annual Report 2000.

[5] T.J. Sturgeon: *Turn-key Production Networks: A New American Model of Industrial Organization?* (Industrial Performance Center, Massachusetts Institute of Technology, Cambridge, MA, 23 Mar. 2000; mimeo), p. 29.

- produce the same product on a global scale by making use of parallel production facilities;
- focus on their core competencies;
- optimize supply chain management; and
- enhance purchasing power (EMS providers purchase large quantities of electronic components and other raw materials and receive volume discounts and other more favourable terms from suppliers more often than their OEM customers would).

2.3.3. Development of the industry: From contract manufacturing to EMS providers

The leading contract manufacturers have greatly expanded their sales volume, the number of people employed, the range of services offered, as well as their "geographic footprint", that is, their presence outside North America, and in Asia in particular. At first, contract manufacturers were used by OEMs to help them overcome supply problems when faced with a sudden surge in demand, especially in the assembly of printed circuit boards (PCBs). Contract manufacturers generally only manufactured components or partial assemblies.

As industry-wide pressures to reduce costs intensified, more assembly processes were automated, the capacity of the contract manufacturers increased and OEMs came to rely on contract manufacturers for more complex manufacturing services.

Faced with thin and shrinking margins, the contract manufacturers in turn started to offer a broader range of services to "serve their customers better" and become involved in activities with higher levels of value added. They came to purchase the needed components for customer firms, to engage in testing services, prototyping, new product introductions (NPI), repair services and end-of-life support.

With an eye to the original design manufacturers (ODMs), which in addition to assembly operations also take care of product design and development and own the corresponding patents, the contract manufacturers also began to offer design services. Some EMS companies manufacture and test complete systems and aspire to manage the entire supply chains for their customers. Leading EMS companies aim to offer end-to-end services, which include product design and engineering, volume manufacturing, final assembly and test, direct order fulfilment, after-sales product service and support, and global supply chain management. [6]

[6] The European Union Directive on the Restriction of Hazardous Substances (RoHS) came into effect on 1 July 2006. It requires the removal of six hazardous substances from all electronic products shipped into the EU. The European Union Directive on Waste Electrical and Electronic Equipment (WEEE) came into effect in August 2005. It shifts the responsibility for waste management towards the producer. Solectron and Celestica also offer "green" or environmental compliance services to help customers comply with new environmental legislation including RoHS and WEEE. This legislation and the compliance requirements impact the entire supply chain, causing operational, business and product-reliability challenges. They help OEM customers to address compliance issues so that their products meet regulatory requirements within appropriate deadlines.

2.3.4. Origin of the contract manufacturers

There are two ways of looking at the origin of the contract manufacturers. One is to focus on their geographic roots, i.e. *where* they originated. Four locations stand out, three of which are in North America. The first is the south-eastern part of the United States where, among others, SCI (Space-Craft Inc.) originated. SCI was originally a supplier of electronic equipment to the National Aeronautics and Space Administration (NASA), the United States space agency. In the 1980s, it became a supplier to IBM's personal computer (PC) division. The second is Silicon Valley, where Flextronics (see case study at the end of this chapter) and Solectron started out. Solectron was set up by some former IBM engineers. The solar energy boom in the mid-1970s was a major influence in the creation of this company (Solectron is a combination of "solar" and "electronics"). The third place of origin is the United States Midwest and the neighbouring Canadian Province of Ontario. Jabil Circuit started life in 1966 as a supplier to the Control Data Corporation. Later, it became one of the first contract manufacturers also to work for the automotive industry. Jabil also worked for IBM's PC division early on. Toronto-based Celestica is a spin-off of IBM. For years it was active as an "in-house" contract manufacturer to IBM. In 1993, it began to provide EMS services to non-IBM customers, and in 1998, it became a company quoted on the stock exchange. The fourth location is Taiwan, China, where Hon Hai (which uses the trade name Foxconn) started in 1974 as a maker of plastic parts for black and white TVs. Today it makes desktop computers for HP, mobile phones for Nokia and Motorola, and PlayStations for Sony. It also manufactures computer parts for Dell, Intel, Sony and Cisco Systems.

The other approach is to ask *how* companies came into being. Here, two reasons stand out. First was the strategic decision in the early 1980s by IBM to use only standard components in its PCs' central processing units (motherboards, mice, disk drives and printers) produced by outside suppliers. "The PC created a mass market for personal computers as well as literally thousands of new producers of a diverse range of components, peripherals and applications." [7] In contrast, in Silicon Valley the emergence of contract manufacturers came about out of sheer necessity. Early Silicon Valley start-ups, such as Apple, simply lacked the resources to engage in vertically integrated manufacturing and as early as the 1970s this led to a fast-growing group of independent assembly operations.

Today's start-ups in electronics probably could not develop without the help of contract manufacturers. When starting out, entrepreneurs have to rely on contract manufacturers out of sheer necessity: they do not have the capital or expertise to set up their own production. Contract manufacturers in turn see their expertise in, for example, prototyping and manufacturing process technology, as a source of dynamism for the industry. Solectron notes that it is involved in developing products for emerging companies – typically in their embryonic stage – in a variety of markets.

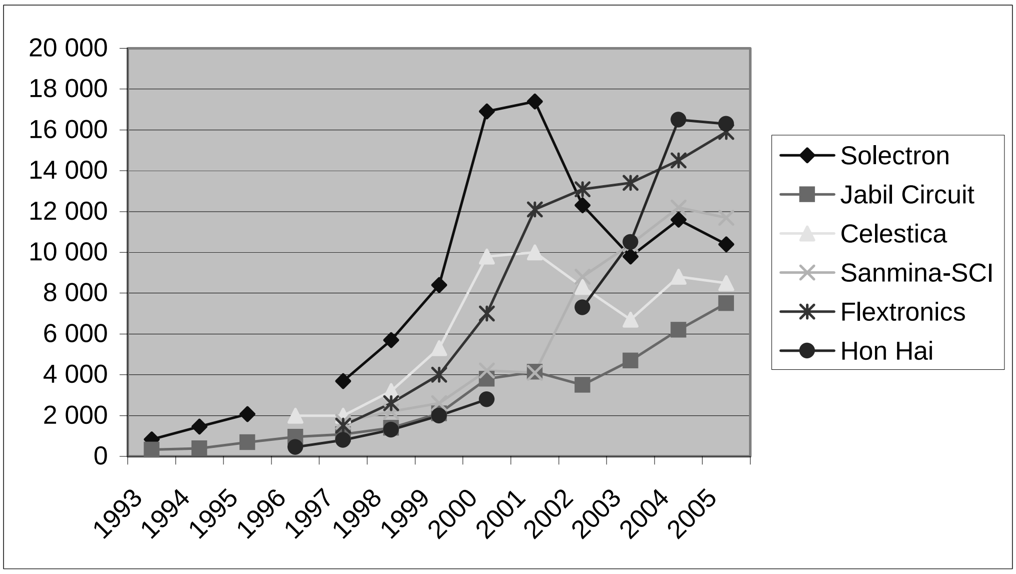
2.3.5. The "Big Six"

Among the many contract manufacturers, six stand out because of their size and global reach. Sanmina-SCI, Celestica, Jabil Circuit and Solectron each had around 50,000 employees in 2005 (in 2005 Flextronics had 92,000 employees and Foxconn had over 166,000 – 100,000 of them in China).

[7] A. Saxenian: *The New Argonauts: Regional advantage in a global economy* (Harvard University Press, Cambridge, MA, 2006).

Except for Hon Hai Foxconn, they share the following characteristics: they all originated in North America (although Flextronics is now incorporated in Singapore); they all have a large number of production facilities around the globe; and they have all grown rapidly. Solectron went from 11,000 employees in 1995 to 53,000 in 2005. In the same period, Jabil Circuit went from 2,600 to 55,000 employees. Solectron had sales of US$60 million in 1986; US$836 million in 1993 and US$8,400 million in 1999. Flextronics' sales increased by a factor of ten between 1997 and 2005 when they reached US$15,900 million (see figure 2.2 and the section on Flextronics at the end of this chapter).

Figure 2.2. Sales by contract manufacturers (various years, US$ million)



Source: Company information.

(Note: The above graph is based on different sources, with company information being the main one. Nonetheless, the information given should be treated with care as, on occasion, different sources give different sales figures. Even the companies themselves restate earlier figures in light of the consolidation of acquisitions, or the deconsolidation of spin-offs).

The contract manufacturers work for many different OEMs or brand-name companies. In turn, the OEMs make use of different contract manufacturers. IBM has worked with Solectron, Celestica and Sanmina-SCI; NEC with Jabil Circuit and Celestica; and HP with Jabil Circuit, Solectron, Celestica and Sanmina-SCI.

2.3.6. Diversification

Traditionally, the contract manufacturers have been active in communications (including mobile phones and networking equipment), personal and business computing (including storage), consumer electronics (including PlayStations), semiconductor systems and testing (see the section below on the case of Flextronics). In recent years, they have tried to deepen and broaden the range of services they offer, in addition to developing new markets. One of these promising areas is the automotive sector, which is perhaps not surprising given the high share of electronics in the value of today's automobiles. Automotive made up 3.2 per cent of sales at Solectron in 2005. At Jabil Circuit, automotive made up 14 per cent of 2005 sales. Defence and aerospace has also been earmarked as a growth sector. This sector is particularly important for Sanmina since its 2001 merger with SCI that has been a supplier to the defence and aerospace industries since the early 1960s. Medical equipment has also been identified as an "underpenetrated target market". Sanmina-SCI is active in magnetic resonance imaging equipment, blood glucose meters, respiration monitors, ventilators, infusion pumps and thermoregulation devices, among other things. Medical equipment makes up a large and fast growing part of Jabil Circuit's activities.

2.3.7. *Determinants of sales volume growth*

Contract manufacturers' sales volumes are influenced by several factors:

(1) The dynamism (or lack of it) that OEMs encounter in their end markets.

(2) The degree to which the trend towards outsourcing among existing clients continues or accelerates (the weak economic environment of the early 2000s drove EMS customers increasingly to outsource their products in an effort to reduce costs and increase flexibility).

(3) The extent to which new clients in traditional or new industries start to make use of the outsourcing model. Opportunities to win additional business from OEMs in certain markets or industry segments that have yet to make substantial use of EMS providers are to be found in the Japanese market and the industrial, medical and automotive segments.

(4) OEM divestures. OEMs transfer entire manufacturing operations to EMS partners. Under these agreements, the contract manufacturer generally acquires the inventory, equipment and other assets from the OEM, and leases or acquires its manufacturing facilities, while simultaneously entering into supply agreements ranging from two to five years for the production of their products. In these divestures, OEMs typically agree to purchase from the new owner their requirements for particular products in particular geographic areas and for a specific period of time, but do not commit themselves to purchasing minimum quantities of products. In the absence of firm, long-term commitments, OEMs can cancel their orders, change production quantities or delay orders. To contract manufacturers, the divestures can be attractive particularly when these enable them to access new customers, technologies and geographical markets and to strengthen the implementation of their vertical integration strategy.

(5) For the big contract manufacturers, there is a fifth factor: concentration. The acquisition of other EMS providers has provided a significant contribution to their growth. This includes "mega-mergers" (such as Sanmina taking over SCI, or Solectron taking over the electronic assembly operations of Singapore's NatSteel in 2000) as well as dozens of smaller-scale takeovers. As a result, concentration keeps increasing (for example, in 2000, the top five EMS providers were responsible for 49 per cent of the EMS market, up from only 33 per cent two years earlier).

The contribution of each of these factors to the overall growth of the EMS providers naturally differs by company and depending on the time period concerned. Jabil Circuit in its Annual Report, 2005, quantified the contribution that different factors made to its 2005 sales growth as follows: "conversion to the outsource model" was found to be responsible for 51 per cent; new customers for 24 per cent; consolidation of outsourcing suppliers 20 per cent; and other 5 per cent.

All in all, the market for EMS grew rapidly in the 1990s (by 25 per cent per year on average).[8] From 2001 to 2003, the industry experienced demand weakness, particularly in the computing and telecommunications markets. The downturn created overcapacity in the EMS industry which, faced with numerous order reductions, reschedulings and cancellations, was forced to restructure and cut capacity in the light of continued pricing pressures. Customers' profits dropped precipitously and many OEMs abandoned local manufacturing for lower-cost sites, making many existing locations no longer viable.

OEMs made tens of thousands of people redundant in order to cope with the drastic downturn in demand for their services. The impact on EMS firms was ambiguous. On the one hand they also made tens of thousands of people redundant. At Celestica, around 26,000 employees were made redundant as a result of restructuring activities (70 per cent of the employee terminations were in the Americas, 25 per cent in Europe and 5 per cent in Asia). Over 40 facilities were closed or downsized. At Solectron, over a period of three years, around 27,000 full-time positions were eliminated, primarily in the Americas and Europe. Overall capacity was cut by 25 per cent and staffing levels by 30 per cent (see also section on Flextronics). On the other hand, the crisis offered contract manufacturers many opportunities to buy up entire OEM plants identified for divesture.

End markets began to show signs of recovery in the latter part of 2003. Jabil Circuit estimated that in 2004, the top 25 providers of electronic outsourcing services enjoyed revenue growth of US$30 billion. The company estimated that another US$20 billion would be outsourced in 2005.

2.3.8. Internal international division of labour

The original Big Five contract manufacturers (plus Hon Hai) have become increasingly international in their operations. The 1990s was the period of expansion outside North America. Solectron became active in Malaysia (Penang) in 1991. Celestica went from operating two facilities in North America in 1996 to operating 24 facilities in eight countries only two years later. The 2000-05 period saw a move towards Asia and to low-cost locations. When Celestica started its restructuring in 2001, it had 81 per cent of its facilities in "higher-cost geographies". Four years later, in 2005, it had 80 per cent of its employees in "low-cost areas". By 2005, Flextronics' net sales in the Americas, Europe and Asia represented 17 per cent, 35 per cent and 48 per cent of total net sales, respectively. Tables 2.1 and 2.2 show the situation for Solectron and Celestica. It is generally considered that a key competitive advantage of Hon Hai is its presence in China, where it has over 100,000 employees.

[8] B. Lüthje, W. Schumm and M. Sproll: *Contract Manufacturing: Transnationale Produktion und Industriearbeit in der IT-Branche* (Campus Verlag, Frankfurt am Main, 2002).

Table 2.1. Solectron: Sales by main region (various years, per cent)

Year	United States	Other America	Europe	Malaysia	China	Other Asia
1995	62	--38--				
2000	46	13	24	10	7	
2002	39	12	17	12	21	
2004	28	16	14	16	17	10
2005	30	16	14	19	12	9

Source: Solectron, annual reports (various years).

Table 2.2. Celestica: Sales by region (various years, per cent)

Year	Americas	Europe	Asia
1996	100	–	–
2001	62	29	9
2003	46	21	37
2005	36	18	47

Source: Annual reports (various issues).

The Asian region is attractive because it is a cost-competitive region and has a strong, well-developed supply base. With the world's largest and fastest-growing population, Asia is also a growing consumer end market, and has an abundant supply of highly educated engineers at competitive costs. Solectron is expanding not only its Asian manufacturing capacity, but also its design, supply-base and post-manufacturing services there. Sanmina-SCI has design centres in Asia and Jabil Circuit has its product development headquarters in Shanghai, in addition to design centres in India and at locations in China. Hon Hai is opening an R&D centre in Tucheng (Taiwan, China) that will employ 3,000 people and will complement its other research centres in Tokyo (precision machinery), Beijing (nanotechnology research), and San José, California.

How do EMS providers distribute production among their many plants? Faced with small margins and the need for production with short delivery times, EMS firms have to optimize the use of available capacity overall and across regions. They also have to optimize the match between product mix and services offered, on the one hand, and available skills and expertise at each location, on the other.

Many factors play a role. EMS providers stress the importance of being close to their OEM customers and to their customers' end markets. This is particularly important when a factory is dedicated exclusively to one OEM, such as Flextronics, which is operating a manufacturing plant fully dedicated to major Cisco product lines. The virtual integration of this plant into the Cisco organization has to be secured by a sophisticated manufacturing data control system on the part of Cisco and through a high degree of personal interaction between engineers of both companies, supported by the physical proximity of the respective operations in Silicon Valley. A leading Nokia subcontractor commented on the move of its production facilities to Chennai, India where Nokia was opening a big factory: "The logistics cycle is so frenetically fast that we do not have time to import products or components to India from abroad." [9]

[9] H. Suominen: "More, faster, cheaper", in *Helsingin Sanomat*, 19 Feb. 2006.

Low labour costs and the presence of supplier industries are other variables. China offers both. When closeness to the OEM is also critical, which of these variables will prevail? The relative weight of each variable (and thus the decision as to where to locate) may well change over time and over the product cycle, as they did in Mexico and China. When Microsoft was preparing to launch the Xbox in mid-2001, it chose to centralize production for the US market at Flextronics' Guadalajara facility so that its engineers could easily fly down for last-minute design tweaks. However, a year later Microsoft transferred production to two Chinese plants to be closer to their supply base.

With the contract manufacturers becoming involved in increasingly complex activities (new product introductions (NPI); prototype development; repair services) and serving an expanding range of industries, their decisions on where to locate particular activities becomes a sophisticated exercise, particularly when they have (as some do) over 100 facilities worldwide. Sanmina-SCI manufactures products in over 20 countries on five continents. It has located near customers and their end markets those plants that are focused on final system assembly and test, while its plants located in lower-cost areas engage primarily in less complex component and subsystem manufacturing and assembly (Sanmina-SCI, 2005). Solectron describes in detail how the company has organized its internal division of labour in the main regions where it operates.

Box 2.1
Global presence of Solectron

Our US *facilities* focus on higher-value added activities, such as design services; NPI; system integration and testing; product fulfilment; repair and logistics; as well as the manufacture of lower volume, highly complex products.

Our *facilities in Latin America* support the North and Latin American markets particularly for high volume products. *Mexico's* proximity to North America is useful for production of low cost and time-to-market, and/or geographical diversity are particular concerns for OEMs. We operate facilities that provide design, manufacturing and post manufacturing services in the United States, Canada, Mexico, Puerto Rico and Brazil.

Our *operations* in the *Asian* region offer high- and low-volume and basic and high-complexity manufacturing to many geographic markets around the world. In addition to manufacturing, our facilities in Asia provide design services; NPI; system integration and testing; product fulfilment; repair and logistics.

In *Western Europe* we concentrate on higher value added services such as design; NPI; high-complexity, low-volume manufacturing; system integration and testing; product fulfilment; parts management; logistics and repair. *Eastern European* locations provide lower cost, higher volume electronics manufacturing services for the West European market.

2.3.9. Global presence as a competitive advantage

The big contract manufacturers now have a presence around the globe. This enables them to manage the inflow of components worldwide, optimize production between factories and continually balance inventories with demand. Celestica argues that its global network of facilities allows it to simplify and shorten its supply chain. This, in turn, enables it to significantly reduce the time it takes simultaneously to bring products to key markets. According to Sanmina-SCI, most of the company's customers compete and sell their products on a global basis and therefore require global solutions that include regional manufacturing for selected end markets, especially when time-to-market, local manufacturing or content and low-cost solutions are critical objectives.

One reason for the ongoing concentration among contract manufacturers is that OEMs want to limit their partnerships to top-tier EMS providers with the scale, capital and global reach to provide comprehensive global solutions. The big contract manufacturers consider that enabling OEMs to launch the same product in different parts of the world simultaneously constitute a key competitive advantage. Global mobile phone giant Nokia demands that contract manufacturers also be global.

The competitive importance of the global presence is underscored by Hon Hai/Foxconn, which, from a low-cost Chinese foundation, has been diversifying geographically by buying up facilities in Europe and North America. In addition to China and Taiwan, China, Hon Hai has facilities in Australia, the Czech Republic, Hungary, Mexico, Scotland and the United States (its Finnish facility having been closed in 2006).

2.3.10. Vertical integration vs. virtual vertical integration

As contract manufacturers take on more tasks and deepen the range of services offered, they become more vertically integrated. Hon Hai considers it to be a key factor in its success that it can make everything from components to finished products. By manufacturing many components on its own, it can work with fewer suppliers. As a result, it can undercut its rival's prices by as much as 20 per cent and generate better margins. Another contract manufacturer, Sanmina-SCI, argues that by manufacturing key system components and sub-assemblies itself, it can enhance continuity of supply and reduce costs for its customers.

But not all EMS providers believe in the virtues of vertical integration. Celestica considers that by focusing on its horizontal service offerings (design, assembly, test, repair) it has the best capability and global scale to provide the most competitive and flexible offer. Vertical integration would divert capital to non-core operations and lead to competition with its suppliers. It feels strongly that its suppliers will have better scale, better focus or better deployment of what is a non-core service to us but core to them. It favours a "*virtual* verticalization" model that allows it to provide its customers with the best solution without owning those services.

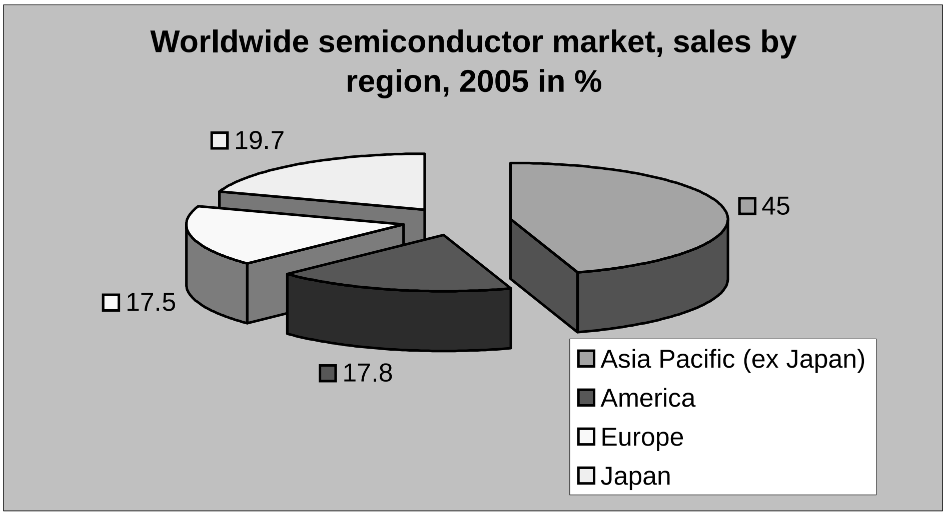
There are undoubtedly more angles to the vertical vs. virtual integration model. The strategy to become more vertically integrated is nonetheless an interesting one for EMS companies that owe their growth, if not their existence, to OEMs wanting to become less vertically integrated. Sooner or later, the vertically integrated EMS providers must also decide which are their core and non-core activities. Some recent divestures among these EMS providers suggest that this process may well have already begun.

Table 2.3. Top ten suppliers of semiconductors for consumer electronics (2004)

Company	Revenues, (US$ millions)	Percentage change	Percentage of total
Toshiba	5 163	16.6	16.5
Sony	3 768	22.6	12.0
Matsushita Electronic	2 708	19.0	8.6
Samsung Electronics	2 103	84.2	6.7
Renesas Technology	2 067	7.6	6.6
STMicroelectronics	1 868	31.6	6.0
NEC Electronics	1 626	16.3	5.2
Philips Semiconductors	1 560	1.8	5.0
Rohm	1 377	16.6	4.4
Sanyo Electronics	1 147	–10.0	3.7

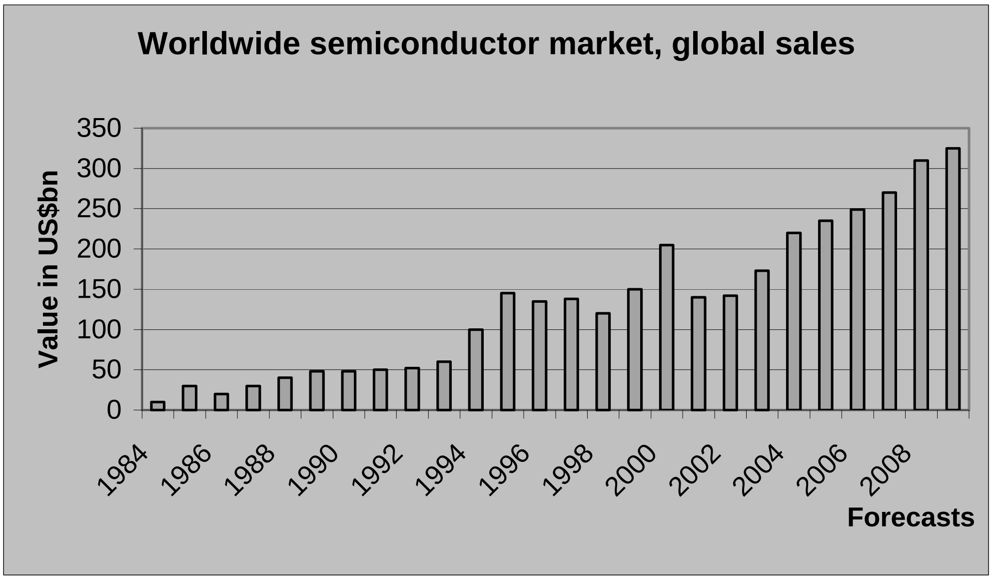
Source: iSuppli Corp., Oct. 2005.

Figure 2.3.



Source: ILO, based on *Financial Times* 2006, Semiconductor International Association (SIA).

Figure 2.4.



Source: ILO, based on *Financial Times* 2006, Semiconductor International Association (SIA).

2.4. The case of Flextronics [10]

Flextronics started in 1969 as a small business in Silicon Valley, where it provided circuit board assembly ("board stuffing") to local companies that needed extra capacity for periods of peak demand. Its customers provided both the raw materials of the printed circuit board and the components that needed to be added. In 1981, it opened a facility in Singapore.

[10] Source: Flextronics 2005 Annual Report and other company information.

Today, Flextronics is one of the world's largest contract manufacturing firms. In 2005, its worldwide sales were US$15,900 million, with the Americas, Europe and Asia representing 17 per cent, 35 per cent and 48 per cent of total net sales respectively. In that year, the company had 92,000 employees and total manufacturing space of approximately 12.8 million square feet in almost 30 countries (see table 2.4). It provides electronics manufacturing services for OEMs in connection with:

- handheld devices such as cellular phones and personal digital assistants (PDAs);
- computer and office automation (including copiers, scanners, desktop and notebook computers and printers);
- communication infrastructure (including wireless base stations, routers and broadband access equipment);
- consumer devices (including set-up boxes, cameras and home entertainment equipment);
- information technology infrastructure (including servers, workstations, storage systems and mainframes);
- a variety of other industries such as the automotive and medical industries.

Table 2.4. Flextronics global locations (July 2006)

Corporate Headquarters
Flextronics International Ltd.
2 Changi South Lane
Singapore 486123

Africa

- South Africa
  - Randburg

Asia

- China
  - Beijing
  - Changzhou
  - Dongguan
  - Doumen
  - Gongming
  - Guangzhou
  - Nanjing
  - Qingdao
  - Shajing
  - Shanghai
  - Shenzhen
  - Xixiang
  - Zhuhai
- Hong Kong (China)
  - Tsuen Wan
- India
  - Bangalore
- Japan
  - Aichi
  - Okaya
- Korea, Rep. of
  - Gunpo
- Malaysia
  - Melaka
  - Penang
  - Senai
  - Shah Alam
  - Tampoi
- Singapore
  - Singapore
- Taiwan (China)
  - Taipei

The Americas

- Brazil
  - Manaus
  - Resende
  - São Paulo
  - Sorocaba
- Canada
  - Calgary
  - Montreal
  - Ottawa
- Mexico
  - Aguascalientes
  - Guadalajara
- United States
  - California
    - San Diego
    - San José
  - Illinois
    - Elk Grove Village
  - Massachusetts
    - Boston

Minnesota
- Northfield

North Carolina
- Raleigh

Oregon
- Hillsboro

Tennessee
- Memphis

Texas
- Dallas
- Houston

Europe

Austria
- Althofen
- Vienna

Czech Republic
- Brno

Denmark
- Skive

Finland
- Haapajärvi
- Kuopio
- Oulainen
- Oulu
- Sievi

France
- Montilliers
- St. Etienne

Germany
- Boeblingen
- Paderborn

Hungary
- East Hungarian Industrial Park
- West Hungarian Industrial Park
- Tab

Ireland
- Cork
- Dublin
- Limerick
- Shannon

Israel
- Eilat
- Migdal-Haemek
- Tel Aviv

Italy
- Milan
- Treviso

The Netherlands
- Venray

Norway
- Oslo

Poland
- Gdansk

Sweden
- Gothenburg
- Kalmar
- Karlskrona
- Linköping
- Stockholm

Switzerland
- Baar

Ukraine
- Kiev
- Vinnitsa

United Kingdom
- Belfast, Northern Ireland
- Birmingham, England
- Bristol, England
- Larkhall, Scotland
- Linwood, Scotland
- Lutterworth, England
- Newbridge, Scotland
- Slough, England
- Warrington, England

Source: Flextronics.

In 2005, Flextronics' main customers were: Alcatel; Motorola; Siemens; Sony Ericsson (for mobile phones, accessories and telecommunications infrastructure); Dell (desktop computers); HP (printers); Casio (consumer electronics); Nortel and Ericsson (telecom infrastructure); Microsoft (computer peripherals and electronic games); and Xerox (office equipment and components). Its top ten customers made up 62 per cent of sales in 2005, with two of these (Sony Ericsson and HP) accounting for more than 10 per cent (but less than 15 per cent) of sales.

Flextronics considers that its competitive strengths lie in its global presence and its extensive design and engineering capabilities. The company designs, develops and manufactures components (such as camera modules) and complete products (such as cellular phones) for sale under the OEMs' brand names; its vertically integrated end-to-end solutions enable it to design, build and ship a complete packaged product. It offers low-cost manufacturing services (in 2005, more than 70 per cent of its manufacturing capacity was located in low-cost locations such as Mexico, Brazil, Poland, Hungary, China and Malaysia) and advanced supply management (it purchased more than US$14 billion worth of components in 2005, enabling it to achieve advantageous pricing and supply chain flexibility for its OEM customers).

Flextronics generates most of its revenues from assembly and manufacturing operations, mainly PCB assembly and assembly of systems and subsystems that incorporate PCBs and complex electromechanical components. It also offers computer-aided testing services for assembled PCBs, systems and subsystems. It is an industry leader in high-density, multilayer and flexible PCB manufacturing. It manufactures PCBs on a low-volume, quick-turn basis, as well as on a high-volume production basis. Its quick-turn prototype service allows it to provide small test quantities to consumer product development groups in as little as 24 hours.

With a global team of 6,000 design engineers, the company offers a range of services from contract design services (CDSs), whereby the customer purchases services on a time and materials basis, to original product design and manufacturing services, whereby the customer purchases a product that is designed, developed and manufactured by Flextronics.

Its worldwide logistics services include freight forwarding, warehouse/inventory management and outbound/e-commerce solutions through its global supply chain network. Flexible, just-in-time delivery programmes allow product shipments to be closely coordinated with customers' inventory requirements. Increasingly, products are shipped directly into customers' distribution channels or directly to the end-user. Its inventory management expertise enables it to achieve competitive cost reductions and reduce total manufacturing cycle time for its OEM customers. Its aftermarket services include product repair, re-manufacturing and maintenance at repair depots, logistics and returns processing.

In its industry parks, third party suppliers of components are located in its immediate vicinity so as to reduce material and transportation costs, simplify logistics and facilitate inventory management (see box 2.2).

Box 2.2

Flextronics industry parks – Concept (campuses)

Flextronics operates fully integrated industrial parks in Brazil, China, Mexico and Poland. These are self-contained campuses in low-cost regions where it co-locates its manufacturing and logistics operations with its strategic suppliers, allowing it to minimize logistics costs throughout the supply chain. It also reduces manufacturing cycle time by lowering distribution barriers, improving communications, increasing flexibility, lowering transport costs and reducing turnaround times. Each park incorporates the manufacturing of PCBs, components, cables, plastics and metal parts needed for product assembly.

Flextronics' global workforce more than doubled between 2001 and 2005 to 92,000 people. In fact, the gross increase was even 28,000 higher if one counts the number of people made redundant during these years. The company closed many facilities in a near-continuous restructuring exercise that saw a shift of operations to lower cost locations and from the United States (and Europe) to Asia. The vast majority of those made redundant were active in North America and Europe.

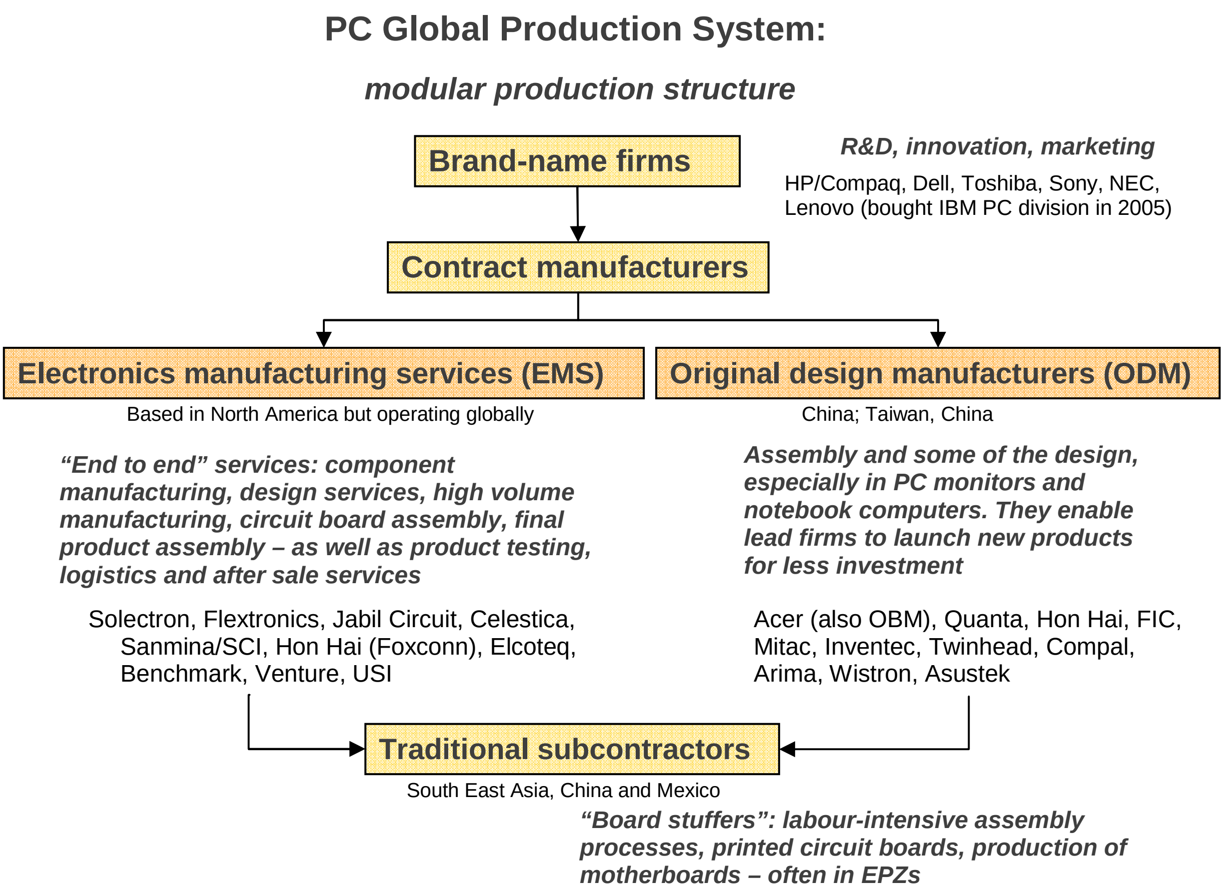
3. Original design manufacturers (ODMs) and global value chains for personal computers and mobile phones

The previous chapter described the main characteristics of the electronics manufacturing service providers. This chapter focuses on two specific product subsectors and ODMs.

3.1. Personal computers

The computer production system is composed of several specific value chains, corresponding to different products, such as the personal computer, notebook computers, monitors, processors, Internet gateways and access servers. Within the computer production system, we will focus on the personal computer (PC) global value chain.

Figure 3.1. PC global value chain



Source: ILO.

Figure 3.1 shows the main actors in the PC global value chain. Brand-name companies such as Lenovo (ex-IBM), Hewlett-Packard, Dell and Compaq, can be found at the high end of the value chain. These firms used to be vertically integrated in a "producer-driven" governance structure. However, vertical disintegration of production has given way to the development of contract manufacturers, or "turnkey" suppliers, which have become able to offer "full-package" manufacturing as well as supply chain management and logistics. Two types of contract manufacturers can be identified: electronics manufacturing services (EMS) providers – discussed in the previous chapter – and original design manufacturing (ODM) companies. EMS and ODM companies are different in many ways in terms of value chain scope, product/customer scope and geographical scope.

In terms of value chain scope, from the start of making laptops and up to the late 1980s (when value chain modularity took off), ODM firms provided a wide range of value chain activities, especially with regard to product design and development, whereas EMS providers used to concentrate on the base manufacturing processes, e.g. circuit-board and product level assembly, without entering into design activities. ODM companies have a competitive advantage and own the design of their products, which are sold in the market under the brand name of the lead firms.

EMS companies can provide the full range of "end-to-end services", including product design and engineering (detailed design, pre-production services and manufacturing design), volume manufacturing of complete systems, components and sub-assemblies (including high-end printed circuit boards (PCBs), optical modules and memory modules), final system assembly and testing, direct order fulfilment and logistics and after-market product services and support. [1] However, they do not own the intellectual property rights over the design work they undertake.

These differences are also reflected in the product/customer scope. In fact, ODM companies have refined their design competence towards the provision of a fairly limited range of products (in personal computers, notebook computers and monitors), whereas EMS firms have wider competences that apply to a wider range of product categories, including personal computers, telecommunications equipment (such as portable telephones), game consoles, portable music players, and the like.

Finally, EMS and ODM companies have a different geographical scope. During the 1990s EMS companies established a global-scale network of factories, managed from their headquarters in North America. On the other hand, ODM firms are almost entirely based in China and in Taiwan, China.

Because of their difference in scope, EMS and ODM companies are subjected to different types of risks. ODM companies, thanks to their patented intellectual property, may decide or have already started to sell products under their own brand, becoming own-brand manufacturers (OBM). One example of this trend is Acer, which successfully upgraded from ODM to OBM but still retains manufacturing and ODM activities for other brand-name firms. This situation also introduces risks in terms of intellectual property: with a shift to OBM, the ODM company effectively becomes a competitor for the brand-name firm it previously supplied. Brand-name firms or OEMs are therefore reluctant to share sensitive information on their design owing to the threat of potential competition. [2] This explains the rapid growth of EMS companies over ODM companies. On the other hand, EMS companies face a different type of risk because their strong dependency on a small set of customers implies that the loss of one customer has a direct impact on their success. In order to avoid that, marketing and product development by EMS companies are crucial to match the increasingly rapid changes on the demand side.

[1] I. Schipper and E. de Haan: *CSR issues in the ICT hardware manufacturing sector*, SOMO ICT Sector report (Centre for Research on Multinational Corporations, Amsterdam, 2005), p. 32.

[2] Conversely, few ODMs risk trying to become brand-name companies as they know this will limit their ability to work for OEMs.

Figure 3.2. EMS vs. ODM companies

	EMS	ODM
Value chain scope	"End-to-end" services: component and high-volume manufacturing, circuit-board and product-level assembly, design services, direct order fulfilment, logistics, after-sales services and support	Provision of complete products based on their own design, of which they own intellectual property
Product/customer scope	Competences apply to a wider range of product categories: PC, telecom, medical electronics, industrial electronics, etc.	Limited range of computer-related products, e.g. PC, notebook computers and monitors
Geographical scope	Based in North America, but operating globally	Taiwan, China; China
Advantage for lead firms	Offer flexibility of production and ensure supply of key components. Allow changes in production volumes without changing in-house capacity.	Enable the launch of new products with lower investment due to cost sharing. Allow a shortening of the product development cycle.

Source: Adapted from I. Schipper and E. de Haan: *CSR issues in the ICT hardware manufacturing sector*, SOMO ICT Sector report (Centre for Research on Multinational Corporations, Amsterdam). http://www.somo.nl; and T. Sturgeon and J. Lee: "Industry co-evolution and the rise of a shared supply base for electronics manufacturing", paper presented at the Nelson and Winter Conference (Aalborg, Denmark, 12-15 June 2001).

3.1.1. Around the world in one laptop

Table 3.1 depicts a breakdown of the components in an IBM ThinkPad X31 in 2004. Many are assembled in Mexico by Sanmina-SCI for export to the United States, but other ThinkPads are assembled in Scotland for the European market and in Shenzhen in China, whose 4,000 workers constituted at the time 40 per cent of the total IBM PC workforce.

Personal computers that have the IBM name on them are built from an international array of components. The same is true for Apple's iPod.

Table 3.1. Composition and origin of parts for an IBM ThinkPad X31 (2004)

Component	Description and origin	Cost*
Display screen	Two of the major screen makers are Samsung and LG Philips in the Republic of Korea	A 15-inch screen costs about US$200; 17-inch about US$300.
Graphics controller chip	ATI: Made in Canada TSMC: made in Taiwan, China	US$30 to US$100
Microprocessor	Intel: made in the United States	Intel's Centrino chip includes wireless capabilities: US$275 to US$500.
Hard drive	Made in Thailand	Laptop hard drives range from US$1.50 to US$2 a gigabyte. A typical drive has about 40 gigabytes.

Component	Description and origin	Cost*
Battery	Made in Asia to IBM specifications	US$40 to US$50 for a typical laptop battery
Wireless card	Intel: made in Malaysia	If not packaged with the microprocessor, US$15 to US$20
Case and keyboard	Made in Thailand	US$50
Memory	Ten manufacturers worldwide, the largest in the Republic of Korea	512 gigabytes for about US$60
Final assembly	Mexico, Scotland, or Shenzhen, China	
Selling price		US$2,349

* Costs are estimates of what manufactures pay for components.
Source: ILO based on S. Berger: *How we compete: What companies around the world are doing to make it in today's global economy* (Random House, 2005), p. 147; and *New York Times*, 4 Dec. 2004.

Box 3.1
Trade today: Consider the iPod

It contains a Toshiba hard disc, a Nidec disc drive, an ARM core processor, a Texas Instruments firewire controller, a USB interface chip from Cypress, and flash memory from Sharp. It is assembled by the Taiwanese company, Inventec. Half of the retail cost of the iPod is made up of the cost of all the components and services that Apple buys in.

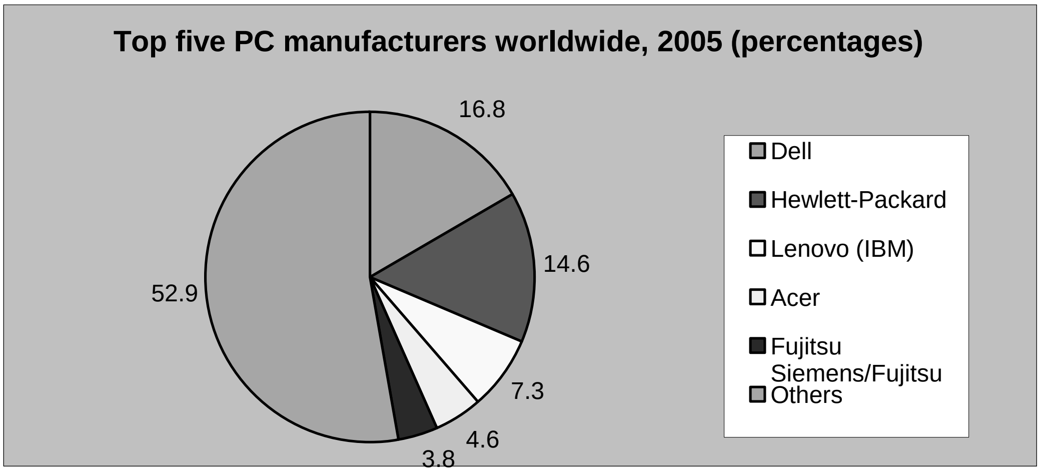
It is the combination of modularity and the break-up of the production system, together with the opening of the international economy, that delivers the real punch of globalization. Reorganization and relocation go hand in hand, creating threats and opportunities at home and abroad.

Source: S. Berger: *How we compete: What companies around the world are doing to make it in today's global economy* (Random House, 2005).

Traditional subcontractors are found at the lower end of the PC value chain. They are involved in general, standardized activities such as the manufacture of motherboards and printed circuit boards and other labour-intensive activities, which give them the appellation of "board stuffers". Sturgeon and Lee [3] define these actors in the value chain as commodity suppliers, connected to customers via market transactions. Since the products are standardized, only a thin customer interface is needed and the switching costs between traditional suppliers are therefore low. For these reasons, commodity suppliers are often associated with supplier networks, where challenges in terms of labour and social practices are more likely to be found. This is because price factors are crucial in the customers' outsourcing decisions at the low-value end of the chain. This means that, because of cost advantages, commodity suppliers are often found in export processing zones in low-wage developing countries. In recent years, China has emerged as a very popular destination for this type of outsourcing. The lower end of the value chain is therefore of particular importance when we consider the labour and social challenges arising from participation in global value chains, and especially from the operations of multinational enterprises.

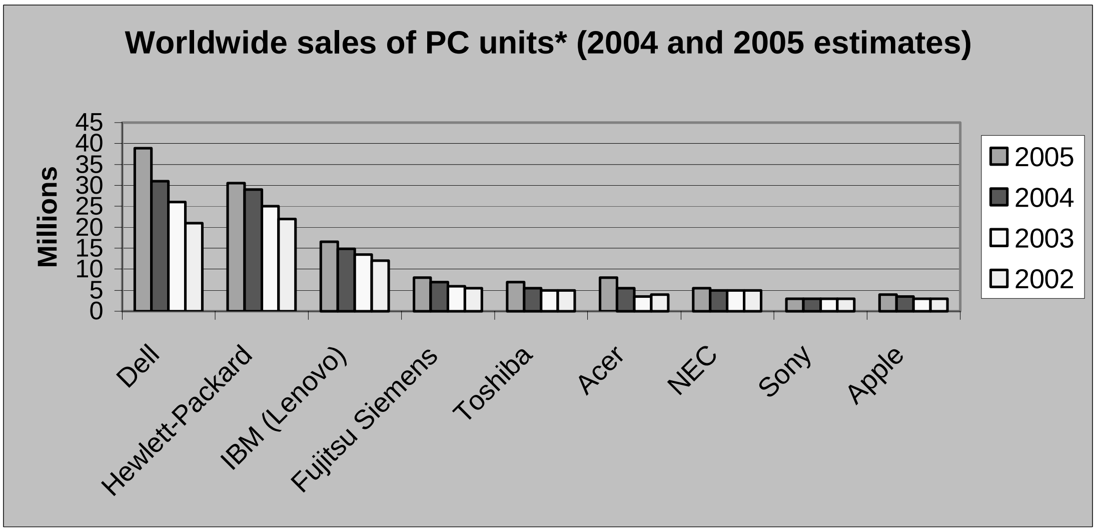
[3] T. Sturgeon and J. Lee: *Industry co-evolution and the rise of a shared supply base for electronics manufacturing*, paper presented at the Nelson and Winter Conference (Aalborg, Denmark, 12-15 June 2001).

Figure 3.3. Sales and market shares in PC unit industry



Source: The Gartner Company, reprinted in *International Herald Tribune*, 9 Mar. 2006.

Figure 3.4.



* Morgan Stanley total PC unit forecast 2002-05.

Source: Schipper and de Haan, *CSR issues in the ICT hardware manufacturing sector*, op. cit.

The largest ODM companies are based in Taiwan, China, with subsidiaries in China. They started off as motherboard companies and then upgraded their design and manufacturing capabilities. Table 3.2 illustrates the top ten ODM companies, ranked according to their annual revenues in 2005: Quanta, Asustek, Compal, Lite-On, Inventec, BenQ, Wistron, Inventec Appliance, Tatung and Mitac.

Table 3.2. Top ten ODM companies

Rank 2005	Rank 2004	Company	Revenue (2005) (millions of US$)	Revenue (2004) (millions of US$)	% change
1	1	Quanta	12 523	9 655	30
2	2	Asustek	10 737	7 826	37
3	3	Compal	6 860	6 433	7
4	5	Lite-On	5 054	4 959	2
5	6	Inventec	5 048	4 236	19
6	4	BenQ	5 043	5 016	1
7	7	Wistron	4 814	3 545	36
8	9	Inventec Appliance	3 577	2 454	46
9	8	Tatung	2 338	3 216	–27
10	11	Mitac Intl	2 307	1 543	50
		Total	58 300	48 449	20

Source: Data by iSuppli Corp.

It should be noted that in the case both of EMS and of ODM companies, contract manufacture is not limited to the PC subsector but also occurs within other sectors such as telecommunications and consumer electronics.

As mentioned above, the presence of ODM companies as first-tier suppliers might create tensions with the multinational enterprises at the top end of the value chain in terms of intellectual property, especially taking into account potential future competition. If ODM companies upgrade further and start to sell their products under their own brand name, they find themselves being both suppliers and competitors of the OEMs. This situation is difficult to sustain in the long term, and lead firms might therefore increasingly resort to outsourcing to EMS companies, which are also developing design capabilities without raising intellectual property issues. This may lead to a further consolidation of the industry, reducing even further the number of first-tier suppliers for the lead firms.

At the bottom end of the value chain, traditional subcontractors are still very numerous and relatively small. At this level, concentration takes place geographically rather than in terms of market power.

3.1.2. *Advantages to an EMS or ODM of participating in a global production network* [4]

- Manufacturing for an OEM is a significant source of knowledge.
- The knowledge acquired may facilitate the supplier working on an OEM basis for other multinationals.
- It allows the local supplier/designer to achieve economies of scale, which in turn justify the installation of capital equipment that would otherwise be too costly.

[4] C. Pietrobelli: "Upgrading and technological regimes in industrial clusters in Italy and Taiwan", in C. Pietrobelli and A. Sverrisson (eds.): *Linking local and global economies: The ties that bind* (Routledge, 2004), p. 152.

- Letters of credit by the foreign purchaser allow local suppliers to borrow additional capital.

- Participation in a production network saves the cost of building distribution, sales and service networks. This reduces the expense of acquiring knowledge about foreign consumer preferences, and of setting up the distribution and service networks, a formidable challenge even to large multinationals.

3.2. The mobile phone value chain [5]

The mobile phone industry is characterized by two key features that affect the competitiveness of companies and the nature of the industry: the rapid pace of technological change and continuous innovation in products and standards. New technologies in telecommunications often bring about discontinuity, and thus incompatibility with the old technology. A company's existing competencies can rapidly become obsolete, thus requiring them to invest constantly in new technologies to upgrade and retool in order to remain competitive. This impact (of technological change) is felt on fixed-asset investment in plant capacity, employment levels and skills, direction of R&D, supply chain capacity, range and type of competitors and even the legal environment, which includes licences and thus requires leading players to have flexible organizations that can respond to change. [6]

This technological intensity has always been a feature of the telecommunications industry. Brand-name companies have recognized the need for structuring their value chains in a manner in which they are not only competitive on any current technological spectrum but also flexible enough to be able to shift to a completely new product or technology. Leading mobile phone makers have tended to organize themselves in a fashion that allows them to create a network of innovation around their production capabilities.

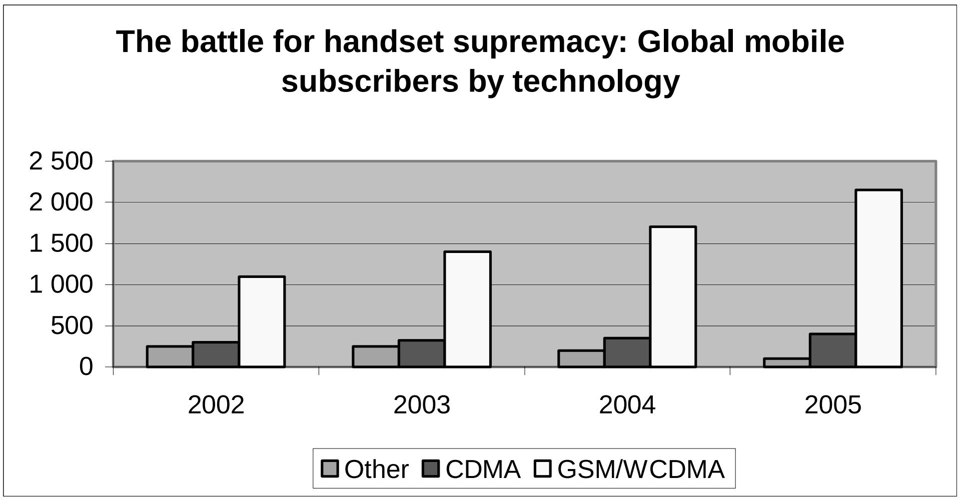
GSM ("Global System for Mobile communication") telephony spread rapidly, and by the end of 1996 it had been adopted by 120 networks in 84 areas. Analogue phones had taken 11 years to reach the 10 million mark, but it took the GSM phones only three and a half years to reach the same point. [7]

[5] This section was contributed by the ILO's Multinational Enterprises Programme.

[6] B.M. Sadowski, K. Dittrich and G.M. Duysters: "Collaborative strategies in the event of technological discontinuities: The case of Nokia in the mobile telecommunications industry", in *Small Business Economics* (Springer Netherlands, 2003), Vol. 21, No. 2, Sep.

[7] Cellular Communications: Global Market Development, Norwood, MA, 1998.

Figure 3.5.



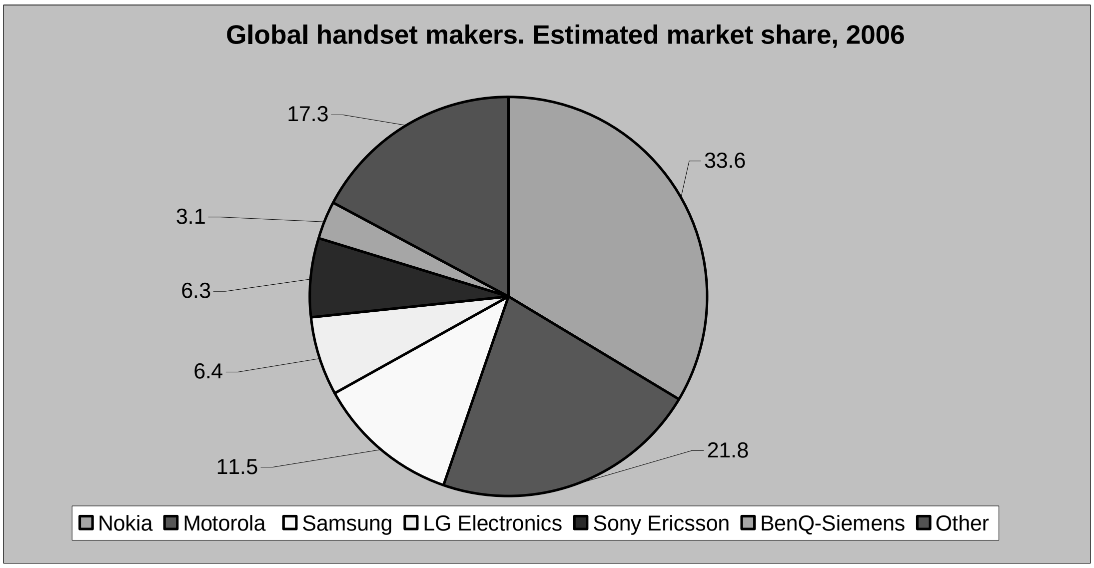
Source: iSuppli.

The mobile phone value chain is thus continuously adapting and is one of the most dynamic value chains in the electronics industry. While the computer chip industry followed "Moore's Law", according to which computing power doubles every 18 months, wireless capability (computing power) is said to triple every 16 months. The complexity of the value chain has also increased considerably. Between 1983 and 2001, the number of components in a mobile phone increased from 250 to 900. [8] This complexity has had a direct impact on the modular nature of the industry.

The mobile phone value chain comprises numerous players. Brand-name firms focus on developing new technologies and products at the beginning of the value chain. They essentially own the brands and are responsible for marketing and distribution at the terminal end of the value chain. The suppliers to the device manufacturers focus on activities that have lower value added and are essentially easier to replicate. These "turnkey" suppliers may or may not make a niche component and, depending on their focus, may have strong linkages or may simply be "arm's length suppliers". The value chains thus have economies of scale on activities at the level of both the lead firms and the turnkey suppliers.

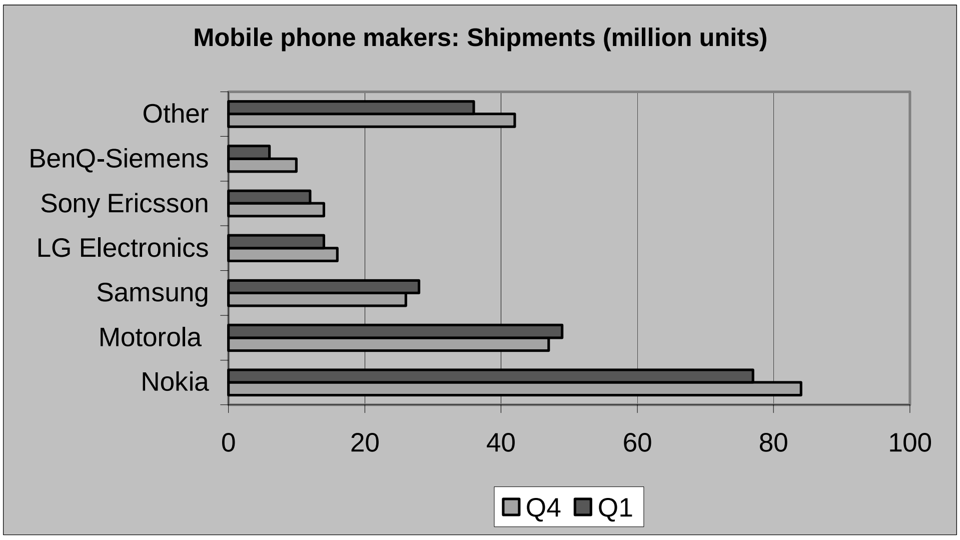
[8] S.C. Constance and J.R. Gower: *A value chain perspective on the economic drivers of competition in the wireless telecommunications industry* (Cambridge, MA, MIT, 2001).

Figure 3.6.



Source: "Strategyanalytics", in *Financial Times*, 9 May 2006.

Figure 3.7.



Source: iSuppli.

Most mobile phone companies have shifted the entire manufacturing process to large contract manufacturers (based in the United States or in Taiwan, China). These contract manufacturers manage the manufacturing, assembly, software applications, testing and logistics for the mobile phone companies. The contract manufacturer typically sets a "product fulfilment centre" close to the market. [9] Much lower-end manufacturing is carried

[9] B. Luthje: "Electronics contract manufacturing: Global production and the international division of labour in the age of the Internet", in *Industry and Innovation* (London, Taylor and Francis, 2002), Vol. 9, No. 3.

out in China [10] and other locations which also handle assembly and support functions. An engineering support facility (normally located in a developed market and owned by the contract manufacturer) provides support to the PCB manufacturing operation at the low-cost location. Once the PCBs are shipped to the product fulfilment centre, software is added. This is a highly complex job, as different markets (retailers, operators, languages) impose their own requirements. A logistics carrier normally on contract to the contract manufacturer then ships the finished product to customers. [11] In summary, the manufacturing process can be split into three steps – surface-mounted assembly or printed wiring boards/cards, mobile phone assembly, and packaging and shipping. [12]

The brand-name mobile phone firms face intense competition, with many firms vying for business by offering both similar and differentiated products. As we have seen with the brief takeover of Siemens mobile phones by BenQ, it is difficult for smaller companies to challenge the market leaders for market share. Competition is stiff at both the brand level and the cheaper functional phone level. Normally, the leading firms have greater control over their suppliers; this is particularly true for captive or exclusive suppliers and includes telecom product specialist suppliers. Most such vendors and suppliers have one lead firm that buys the bulk of their products. However, some vendors are large electronics industry turnkey suppliers that have customers across different industries and are thus present in numerous value chains. Here the power of lead firms is weaker, though it is still dominant in the overall structure.

Vendors and suppliers can broadly be classified into two categories: circuit board manufacturers, like Intel, National, ADI and TI, that make ROM chips, microprocessors, flash memory and radio frequency (RF) transceivers; and non-silica component manufacturers, like Sharp, Philips, NEC and Fujitsu, that make microphones, batteries, casings and dial-pad buttons. [13] This subcontracting trend and the modular value chain is now a key feature of the entire electronics industry. The innovation dynamic of the mobile phone industry means that this structure is temporary, and a new paradigm shift can change the entire nature of the production system.

Ericsson was the first European OEM in the mobile phone business to sell its production units in 1997 to Flextronics and Solectron; Siemens followed soon after in 2000. [14] The slump in the IT industry and the global slowdown in general in 2001 hastened many mobile phone companies to shift to fully outsourced models.

[10] China is the leading manufacturing location for mobile phones and accounted for over one-third of world production in 2004. The Chinese market also accounted for roughly 20 per cent of world demand for mobile phones in the same year. The last decade has seen a rapid growth from five players producing in 1997 to 37 companies in over 200 sites by 2004. Almost all global manufacturers own units and in 2004 there were 22 foreign companies present. The remaining Chinese companies also have partnerships or links with foreign companies.

[11] Luthje, op. cit.

[12] M. Catalan and H. Kotzab: "Assessing the responsiveness of the Danish mobile phone supply chain", in *International Journal of Physical Distribution and Logistics Management*, issue 33, 8, 2003.

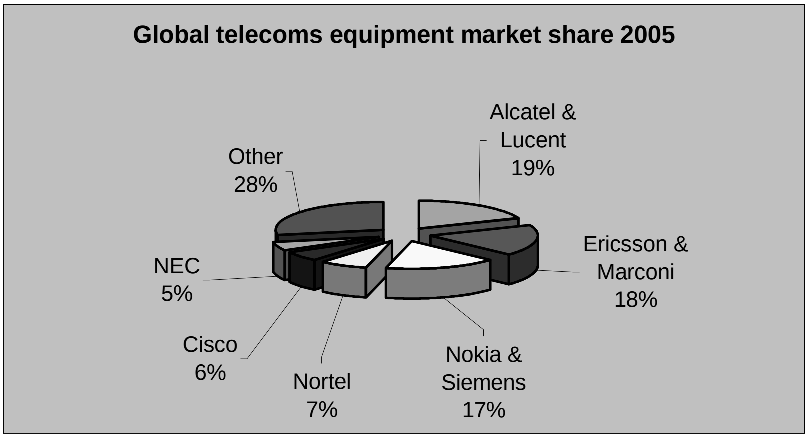
[13] Constance and Gower, op. cit.

[14] Luthje, op. cit.

Elcoteq is an example of a contract manufacturer that focuses on the assembly and final manufacture stage late in the technology cycle. The case of Elcoteq allows an analysis of how firms in the mobile phone industry have laid out their supply chains. These activities are not considered core, and knowledge of these processes is available to all in the industry – which means that competitors sometimes award contracts to the same subcontractor (e.g. Elcoteq produces for Nokia and Ericsson). This activity is cost-sensitive and hence firms are likely to set up operations in low-cost locations. Another example of a contract manufacturer is JOT Automation, which provides advanced assembly equipment on a turnkey basis to lead firms. JOT is a niche firm and has a broad customer base that extends beyond mobile telephony. There is, however, a difference between the two suppliers originating from the kind of material they supply. Elcoteq seems to have a "relationship" with its lead firms, while JOT is more an "arm's length supplier". [15]

Lead firm behaviour is another factor in understanding the dynamic of the value chain. Nokia, for example, purchases 60 per cent of its materials from ten large suppliers and has long-term relationships with them. Its relationship with other suppliers seems to be more contractual. It uses a cost leadership philosophy though driving this through trust and collaboration with its key suppliers. It leverages its strong intellectual property rights (IPR) position in technology outsourcing while simultaneously leveraging supplier R&D competences and resources. Nokia was also one of the first telecom companies to create a cluster of assemblers and suppliers specializing in GSM manufacturing in Xingwang Industrial Park in Beijing, China. Nokia considers this cluster a key component of its global strategy, and chose Beijing because of the availability of a strong labour market and R&D capabilities. Many suppliers moved to the park without any written guarantees from Nokia; at the same time, tax privileges that Nokia received were also granted to its suppliers. Both points highlight the power structure of lead firms in the mobile phone business. At the same time, though, Nokia is the largest customer for the suppliers, and many have diversified to find other customers for a small part of the business in order to reduce risks. [16]

Figure 3.8.



Sources: Nokia and Siemens, based on sales to carriers.

[15] J.L. Rice and M.A. Shadur: *The mobile telephone cluster in the Nordic countries: Policies to foster innovation and success through provider competition and knowledge alliance development*, paper published by the Queensland University of Technology.

[16] H. Wai-Chung Yeung, W. Liu and P. Dicken: "Transnational corporations and networks effects of a local manufacturing cluster in mobile telecommunications equipment in China", in *World Development* (Elsevier Ltd., 2005), Vol. 34, No. 3.

4. Country and local strategies

By and large, success in attracting or developing an IT industry does not come about by accident. The existence of a large number of universities in close proximity to government research laboratories or company R&D centres provides the active ingredients for such achievements. Individual countries, regions and even cities contribute. Subsidies can play a role, but are insufficient on their own if the human capital is not available. Home-grown talent is also not absolutely essential since it was estimated in 2000 that half of Silicon Valley's engineers were foreign born (although most had taken out citizenship or become permanent residents) – and most developing countries now generously offer work permits to foreign engineers from the parent company.

This chapter will look, inter alia, at some of the key policies pursued by the United States, Japan, Malaysia, China, Taiwan (China), the Philippines, the city of Shanghai, and Asia as a whole, with respect to chip design. Large-scale government procurement initially fuelled the production of chips in the United States, while in Japan an astute application of tariff and non-tariff barriers protected domestic industries with a favourable trade structure.

Box 4.1
Strategic trade policy: The semiconductor rivalry

Since the debut of the transistor in 1947, semiconductors have been at the heart of the electronics revolution. The many products and processes that have evolved alongside this industry span the high-technology "food chain", from equipment and materials upstream to computers downstream. Not surprisingly, policy-makers have long identified success in the semiconductor industry as a necessary prerequisite for competing in high technology more generally, resulting in US-Japan "chip rivalry". In the context of this rivalry, the President of the US Semiconductor Industry Association urged Congress in 1990 not to abandon the industry in its trade dispute with Japan as "there was a difference between semiconductor chips and potato chips that mattered for the nation as a whole".

US Government spending on R&D has contributed to most developments in semiconductor technology. Through the 1960s, procurement by the National Aeronautics and Space Administration (NASA) and the Department of Defense accounted for most of the nation's semiconductor output (100 per cent until 1962). In more recent years, federally funded R&D has helped realize gains in the design and fabrication of successive generations of chips, for instance through its support of the Semiconductor Manufacturing Technology consortium (SEMATECH).

The Japanese Government, too, intervened significantly in the semiconductor market. Through the mid-1980s, tariffs and non-tariff barriers protected the Japanese market from imports of chips. This protection helped the domestic semiconductor industry to achieve the necessary production efficiencies to compete in export markets. Once trade was liberalized, state-funded R&D programmes continued to assist the industry. For example, the Very Large Scale Integration (VLSI) projects underwritten by Nippon Telephone and Telegraph (NTT) and the Ministry of International Trade and Industry (MITI) sought to help Japan's consumer electronics giants cope with imports.

Source: WTO: World Trade Report 2006, box 9, p. 87.

Newcomers pursued different strategies to enter the chip market, as the case of Malaysia demonstrates (see box 4.2).

Box 4.2
Multimedia super corridor in Malaysia

The Malaysian Government's Multimedia Super Corridor (MSC) was launched in 1996 as an initiative to support the development of the information and communication technology industry. Ten years later, the MSC hosts around 900 multinationals, foreign-owned and home-grown Malaysian companies focusing on multimedia communication products, solutions, services and R&D.

Companies settling in the MSC can take advantage of a broad range of facilities and financial and administrative incentives. These include:

- high-quality infrastructure and infostructure supported by secure cyberlaws;
- unfettered employment of local and foreign knowledge workers;
- exemption from local ownership requirements;
- exemption from corporate income tax for five years (or an investment tax allowance);
- qualification for R&D grants;
- duty exemption on multimedia equipment imports.

Companies settling in the MSC are also assisted by the government-funded Multimedia Development Corporation (MDC) in a number of ways. The MDC:

- ensures a rapid turnaround for applications for entering the MSC;
- assists companies in permit and licence approvals; and
- introduces companies to potential local partners and financiers.

Source: Information based on http://www.mdc.com.my accessed in January 2006, in WTO World Trade Report, 2006, box 8, p. 86.

4.1. From electronic street to technology park (Zhujiang Road, Nanjing)

Already in 1989, the Nanjing municipality had decided to start an "electronic road". [1] The enterprises occupying plots along Zhujiang Road were notified that this street would be reserved for IT companies and that they would have to move if IT were not their core business. Alternative locations were offered, and empty plots and buildings were allocated to IT firms. By 1999, over 900 enterprises had found a place on this road or along neighbouring streets. In addition, the Government built a number of "enterprise buildings" reserved for IT companies and offered some common services such as accounting, security and cleaning.

However, by 2006, with over 3,000 technology enterprises, [2] Zhujiang Road had transformed itself from a mainly hardware-producing city into what is now a technology park, concentrating more on software development.

[1] M.P. van Dijk: "Can Nanjing's concentration of IT companies become an innovative cluster?", in C. Pietrobelli and A. Sverrisson (eds.): *Linking local and global economies: The ties that bind* (Routledge, 2004), pp. 170 ff.

[2] http://www.sinoces.com/2006/en/exhibitors/exhibitors_021.aspx?id=1634 (visited 28 Aug. 2006).

Table 4.1. Location and number of software companies in Nanjing (2004) [3]

Districts	Location	Parks in district	Number of IT companies
Xuanwu	Centre	Jiangsu Province Software Park South East University Science Park Zhujiang Road Software Park	JPSP 171 software companies SEU SP 110 IT companies, 30 per cent of them are software companies, or about 33 Some 1,500 small IT companies mainly concentrating on computer selling, of which around 30 software companies
Gulou	Western	Nanjing University-Gulou District University Science and Technology Park	160 companies in S&T Park, of which some 20 real software companies
Jiangning	South	Jiangning Development Zone	Around 10 IT companies related with hardware manufacturing
Xixia	North-east	Nanjing Economic and Technical Development Zone	Around 10 IT companies related with hardware manufacturing
Pukou	North-west	Nanjing High Tech Development Zone and Nanjing Software Park	160 software companies
Total		Software companies: IT companies:	Almost 400 software companies Some 2,000 IT companies

Nanjing now has several different parks which also compete with one another. Who attracts the most promising IT companies? From the evidence so far, the available infrastructure, the distance from the city centre and the type of companies one finds in the different parks are all relevant factors. On top of that, the service level is different. Some of the parks have incubator services, others do not; some have serious relations with universities, while others do not. Finally, physical location is important, the south of the city is close to the airport and the road to Nanjing, while the northern part is across the river, and far away from the city centre, the airport and road links with Shanghai.

4.1.1. IT human resources management

What are the characteristics of IT talent and which factors determine whether such talent is available in Nanjing? Salaries and secondary work conditions, the culture of the company and career opportunities are important factors. The human resources paradox in Nanjing is that the city produces the highest number of skilled workers but software companies complain about the shortage of skilled workers for employment in Nanjing's IT sector.

[3] M.P. van Dijk: *A software boom leading to skill shortages in Nanjing* (European Congress on ITC, the knowledge society and changes in work, The Hague, June 2005).

Box 4.3

Mobile telecommunications R&D by foreign multinationals in China

Since the early 1990s, China's mobile telecommunications market has expanded rapidly to become the world's largest in terms of both network capacity and number of subscribers. Rapid infrastructure build-up has encouraged many telecom equipment makers to invest in local production in the country. These enterprises also engage in local R&D in China which has come to play an increasingly important role in new product development.

R&D by selected MNEs in mobile telecoms technology in China, 2004

	No. of R&D centres	No. of R&D employees
Motorola	15	1 300
Nokia	5	800
Ericsson	9	700
Siemens	4	–

Source: UNCTAD, based on Chinese newspaper accounts and information from companies.

Initially the main function of these R&D centres was to adapt technology developed by the parent company to the specific market requirements in China. However, since mobile telecommunications products are highly standardized and the size and sophistication of the Chinese market has been rapidly increasing, local adaptive R&D has evolved into global innovative R&D. For example, in the case of mobile handsets, the Nokia 3610 model, introduced to the Asia-Pacific market in 2002, was the first product developed entirely by the Nokia Product Development Centre in Beijing. Now every tenth mobile handset sold globally by Nokia has been designed in Beijing.[a] Examples of globally oriented R&D centres in China include: Nokia China R&D Centre (1998), the Motorola China Research Institute (1999), Nortel China R&D Centre (2001), Ericsson China Central R&D Institute (2002) and Sony Ericsson's Global R&D Centre in Beijing (2004).

Many of the R&D centres have capabilities in the area of 3G technologies and now develop products for both the Chinese and global markets. Nine cities in China host 3G-related R&D centres owned by foreign TNCs or domestic companies (Huawei and ZTE), with emphasis on different global standards recognized by the International Telecommunication Union.[b] Although the Chinese Government has not granted 3G licences to telecom operators, 3G equipment developed and manufactured locally by both foreign TNCs and domestic firms has begun to supply the global market. In this way, the R&D activities in China have helped the firms concerned expand their business in other locations as well, which in turn has had positive effects on their respective home countries.

(a) "Ten per cent of Nokia handsets are designed by its Beijing centre, which is developing products for market five years later", in *West China Metropolitan News*, 17 Sep. 2004.

(b) "3G R&D distributed in nine cities", in *Southern Metropolitan News*, 16 Nov. 2004.

Source: UNCTAD, World Investment Report 2005, box VI.8, p. 196.

Box 4.4

The role of local governments in building domestic capabilities: The case of Shanghai

Following decisions taken by the Central Government in China in June 2000, the municipal government of Shanghai took a series of steps to develop the local semiconductor industry. [a]

- For projects on integrated circuit (IC) manufacturing it granted exemptions and reductions of local taxes and fees, facilitated the import, export and international travel of company employees and provided a 1 per cent interest deduction of commercial loans denominated in renminbi.
- For IC design, it provided preferential treatment to firms and set up specific funds for the establishment of a technical platform, including a semiconductor intellectual property bank.
- Various agencies of the municipal government worked together to accelerate the upgrading of the semiconductor industry. Specific funding programmes (e.g. the Product-Design-Chip Project) were introduced and existing ones (e.g. the Technology-oriented SME Innovation Fund) were leveraged to enhance local technological levels and innovative capabilities.
- In terms of manpower development, education and research centres in relevant areas at local universities were encouraged and specific policies were adopted to attract highly skilled human resources from within China and abroad. The municipal government also established a programme to attract Chinese returnees to form start-ups for conducting R&D in Shanghai.
- In 2003, a semiconductor intellectual property exchange centre was set up to serve as a platform for IPR protection and trading, and a specialized guarantee fund was launched to address the financing problem facing small IC design companies.
- To encourage linking together downstream and upstream firms in the value chain, the local government also introduced the Specialized Project to Encourage the Collaboration between Final Product Industry and IC Design Industry.

[a] This took place right after the Central Government had introduced “Several Policies to Encourage the Development of the Industries of Software and Integrated Circuit” (File No. 18).

Source: UNCTAD: World Investment Report 2005, box VII.8, p. 221.

The solution will have to be found in matching the qualifications required in the emerging software sector against the skill profile of the science and technology workers and students turned out by the higher education system in Jiangsu Province. What can be done to get a better match and to make Nanjing more attractive for the highly skilled workers needed in its emerging software sector? The local government has formulated policies and provided incentives to skilled IT specialists to return to Nanjing. It will also be necessary to formulate local IT training based on an integration of the activities of universities, vocational schools and training organizations. At a company level, the main factors are salary, training, corporation culture and career perspectives. This is particularly important if Nanjing wants to continue in its role as an up and coming global city with a significant IT sector and compete for the best students, who tend to prefer foreign multinationals, go overseas for further studies or migrate to the larger cities.

4.2. Moving up the value chain [4]

Taiwan, China, was able to move out of the textile and clothing industry due to joint ventures with Japanese electronics companies and foreign direct investment (FDI) by semiconductor multinationals such as General Instruments, Texas Instruments and Philips,

[4] C. Pietrobelli: “Upgrading and technological regimes in industrial clusters in Italy and Taiwan”, in C. Pietrobelli and A. Sverrisson (eds.): *Linking local and global economies: The ties that bind* (Routledge, 2004), pp. 144-152.

or TV producers such as RCA, Zenith and Philips. Two different strategies were employed: the Japanese targeted the domestic market, whereas the American companies focused on export-oriented assembly activities. Small and medium-sized enterprises (SMEs) making wires, sockets, resistors, capacitors transformers and other components were in great demand. Finally, local TV manufacturers were able to engage as original equipment manufacturers (OEMs) suppliers, exporting components or supplying to local producers.

Initially, Taiwanese firms reversed existing engineered technologies to produce low-cost personal computers, peripherals and components. Subsequently, they developed their own design and process engineering capabilities to move into more complex, higher value added products.

The rapid expansion of the IT industry provided SMEs with the opportunity to take off. Cable and wire manufacturers could upgrade themselves from TV cables to computer wires, socket producers became connector makers and resistor firms started to produce chip resistors for notebook computers. Other SMEs diversified to produce integrated circuits (ICs) designs, chipsets, scanners, add-on cards and multimedia products. A significant structural change occurred in the product mix of both electronics production and exports, with a continuous shift towards exports of more complex information and electronics components products.

Further adjustments occurred at the end of the 1990s in the computer sector, spurred on by structural imbalances, high volatility of OEM orders and an increasingly competitive environment. As the price of computers and peripherals declined, Taiwanese companies were forced increasingly to rely on offshore production in the region. At the same time, the financial crisis in Japan forced Japanese companies to be more willing to transfer technologies or release key components, such as liquid crystal display technology, to Taiwanese firms.

There are a number of reasons for the success of Taiwanese firms on the international market. These include: abundant human capital; strong information networks among local and overseas Chinese engineers; flexible and specialized production systems and broad-based supporting industries. A distinctive feature was that the supplier-user relationship was not static but responded to constant pressure to squeeze input suppliers and reduce costs.

In addition, half of the founders of the electronics SMEs located in Hsinchu county and Taoyuan county had previously been employed in multinationals. OEM/ODM orders also helped SME manufacturers to acquire technological and product design capability from foreign companies and to gain relevant experience in product management and shipping procedures. At the same time, a high percentage of the equipment used by SMEs was purchased abroad, with crucial elements of technical know-how being embedded in this equipment. As OEM/ODM suppliers, Taiwanese SMEs were also able to participate in the global production networks of foreign electronics companies.

4.3. The Philippines [5]

According to the WTO, manufacturing exports increased during the 1990s, with electronics accounting for almost 70 per cent of merchandise exports in 2003, as compared to clothing, which only accounted for 5 per cent of exports. FDI is significant in manufacturing, with foreign-owned firms generating well over half of output and a high share of exports.

While exports declined slightly in 2003, to US$24.2 billion, they have grown by about 12 per cent annually since 1999. Most growth has come from foreign-owned multinational firms assembling imported components in export processing zones (EPZs). The electronics industry covers mainly semiconductors (70 per cent of electronic exports in 2003), electronic data-processing equipment, office equipment, telecommunications equipment, automotive and consumer electronics. Most favoured nation (MFN) tariffs on electronics and other electrical goods generally ranged in 2004 from zero to 15 per cent, and averaged below 5 per cent, compared with rates ranging from 3 per cent to 20 per cent and an average of almost 8 per cent in 1999.

The Government intervenes minimally in the sector. However, as a preferred activity listed on the Board of Investment's (BOI) Investment Priorities Plan (IPP), registered electronic firms, as well as those located in EPZs that export at least 70 per cent of production, are entitled to tax and non-tax incentives.

4.4. Austria: IT sector social partners agree on lifelong learning

In December 2004 the sectoral social partners concluded a new framework agreement for the IT industry, the first such collective agreement to include provisions on a so-called further training certificate *(Bildungszertifizierung)* scheme. [6] The certificate is designed to guarantee further training standards for most IT employees in Austria on a comparable basis.

The new collective agreement recommends that all IT companies with a certain number of employees comply with the requirements of this certificate. The further training certificate is valid throughout the entire country. Its purpose is to record and promote the readiness of businesses and employees to play an active role in the process of lifelong learning. In the long run, this measure aims to improve IT workers' employability and companies' competitiveness through having better-qualified employees.

The certification of companies will be carried out by an independent institute specializing in management consultancy and company certification on behalf of both sides of industry. The certificate's validity will automatically expire three years after its award. During this three-year period, each company awarded a certificate may be inspected at short notice. After this period, a follow-up certificate may be awarded. A company's eligibility for certification is contingent on its further training regulations, either unilaterally implemented or agreed with the works council. It has to provide fair and equal

[5] *Trade Policy Review*: *The Philippines*, WTO, 2005, http://www.wto.org/English/tratop_e/tpr_e/tp249_e.htm.

[6] "IT social partners agree further training certification", European Industrial Relations Observatory online, 2005, http://www.eiro.eurofound.eu.int/2005/02/inbrief/at0502203n.html, accessed 21 Apr. 2006.

training opportunities for all its employees without discrimination in terms of gender and age, in particular with respect to the funding of further training courses (including repayment obligations for training costs).

Box 4.5

The rise of chip design in Asia: An UNCTAD case study

Chip design has recently moved from centres of excellence in the United States, Europe and Japan to sites in some developing countries, notably in South-East and East Asia.

From practically nothing during the mid-1990s, this region's share of semiconductor design reached around 30 per cent in 2002. South-East and East Asia are now the fastest growing markets for electronic design automation tools, expanding by 36 per cent in the first quarter of 2004 compared to 5 per cent for North America (which has 60 per cent of the world market), 4 per cent for Europe, and -2 per cent for Japan.

Developing Asia is not only undertaking more chip-related R&D, but also the levels of complexity are rising in terms of the line-width of process technology (measured in nanometres), the use of analogue and mixed-signal design (substantially more complex than digital design), the share and type of system-level design (e.g. system-on-chip) and the number of gates used in these designs.

Annual cost of employing a chip design engineer, 2002 (US$)

Location	Annual cost [a]
United States (Silicon Valley)	300 000
Canada	150 000
Ireland	75 000
Republic of Korea	< 65 000
Taiwan Province of China	< 60 000
India	30 000
China (Shanghai)	28 000
China (Suzhou)	24 000

[a] Including salary, benefits, equipment, office space and other infrastructure.

Source: UNCTAD, based on PMC-Sierra Inc., Burnaby, Canada (for Silicon Valley, Canada, Ireland, India) cited in Ernst 2005.

Chip design is also becoming increasingly complex. First, progress in manufacturing technology ("miniaturization") has made it possible to fabricate millions of transistors on a single chip. This increased complexity needs to be matched by a dramatic improvement in design productivity. Second, the convergence of digital computing, communication and consumer devices has raised the requirements for essential features of electronic systems – they need to become lighter, thinner, shorter, smaller, faster and cheaper, as well as more multifunctional and less power consuming. These features are expected to continue to improve.

At the same time, companies are forced to speed up time-to-market as product life cycles have been reduced to only a few months for some products. Time compression is therefore key in designing chips for such systems.

Vertical specialization within design networks has transformed the structure and the competitive dynamics of the global semiconductor industry. It has also increased the organizational complexity of the networks. A typical system-on-chip design team now needs to manage at least six types of design interfaces with: system designers, silicon intellectual property providers, software developers, verification teams, electronic design automation tool vendors and foundry services (fabrication). These design communities are rarely located in the same place, which makes coordination difficult. As design teams become larger and geographically dispersed, more formal interfaces are necessary for effective communication between them.

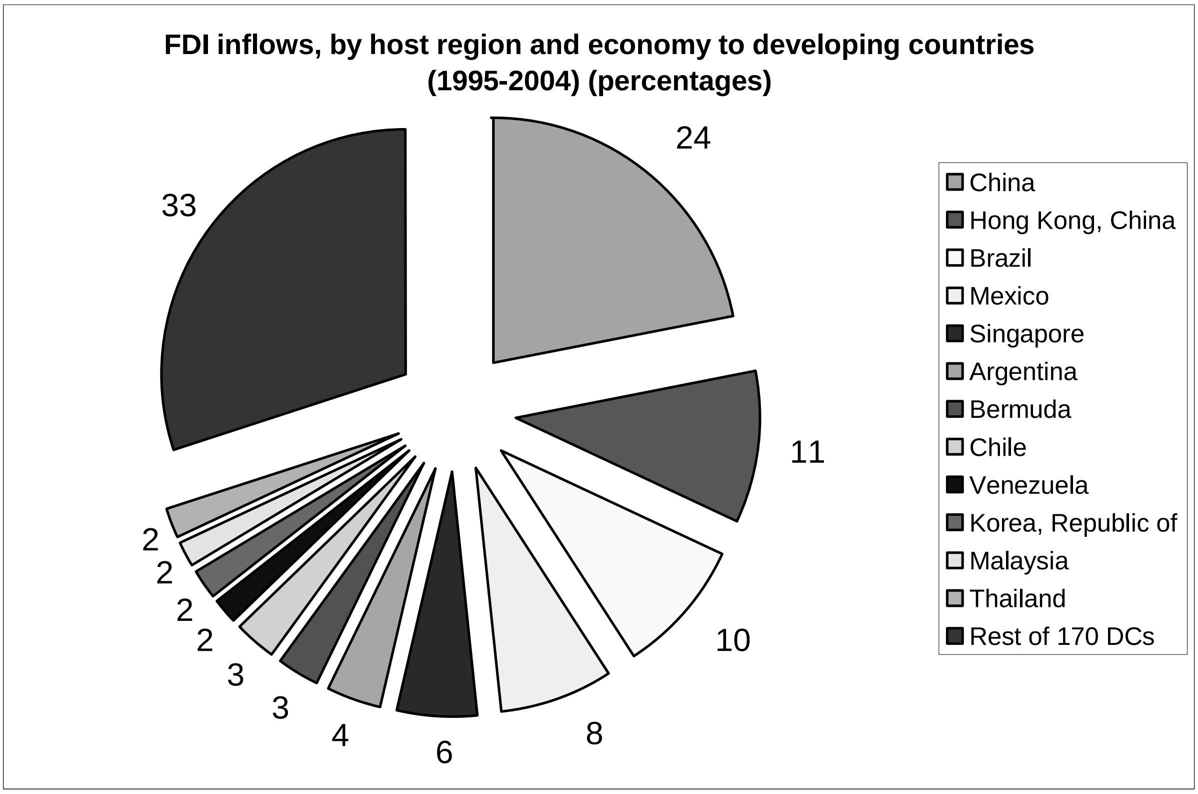
Hence *proximity and face to-face contact* become critical: global design networks increasingly need to locate in Asia those chip design stages that closely interface with local companies in mobile communications and digital consumer electronics. As most of the world's leading chip contract manufacturers ("foundries") are in Asia, this creates powerful pressures to locate important stages of chip design in this region. New processes and changes in design methodology require closer interaction between designers and process engineers.

Source: UNCTAD: *World Investment Report*, Annex to Chapter V, pp. 173-177.

4.5. Flow of FDI to developing countries

The top 12 developing countries attracted two-thirds of all FDI going to developing countries during the last ten years. The other 170 countries had to be content with the remaining third. Among the leading recipients are major exporters of electronic goods and components such as China, Hong Kong (China), the Republic of Korea, Malaysia, Mexico, Singapore and Thailand.

Figure 4.1.



Source: ILO calculations, based on UNCTAD online database.

4.5.1. Industrial production zones

Data published by the World Trade Organization indicate those countries a significant amount of whose electronics' exports originate in, or pass through, export processing or special economic zones. Many of these countries are major recipients of FDI. The countries with published EPZ exports include: China, Costa Rica, Malaysia, Mexico, Morocco and the Philippines.

4.5.2. Comparing the textiles and electronics industries in EPZs

A very high proportion of the enterprises located in EPZs are in the electronics and the textiles and clothing industries. Both have changed dramatically in the last 25 years. Up until the expiry of the Multi-fibre Arrangement (MFA) in 2005, the existence of a system of import quotas strongly influenced how and where garments were manufactured.

Changes in offshore production in the electronics industry have outpaced the textile industry in the last two decades. Although more countries have EPZs specializing in textiles, those concentrating on electronics have generated more jobs.

The degree of industrial development of the host nation affects the industrial specialization of the EPZ activity. The greater the share of industry in GDP, the higher the share of electronics companies in EPZs.

Some of the countries where EPZs specializing in electronics have increased the share of domestic value in total output over time. It seems logical to assume that more capital-intensive firms have less flexibility to move from one place to another when economic conditions change.

The Philippines is considered by assemblers as being strategically located, with relatively easy access to the different countries of East and South-East Asia, which serve both as sources of parts and components and as markets for hard disk drives (HDDs). An important consideration is the country's proximity to Japan where, at present, all R&D and ramp-up take place. Japan is also the country where benchmarking of productivity levels is undertaken, where most of the engineers and trained technicians originate, and where Filipino engineers, technicians and even operators are sent for training. Because of the short technological life cycles of the industry's products, it is important that technology be transferred fast, from ramp-up to mass production. Hence, there is a need for constant movement, not only of parts and components, but also of personnel between Japan, the Philippines and third countries. Also HDD makers have to react fast to market changes because of the stiff competition among multinational assemblers. Speed in delivery of components and shortened lead times are additional reasons for the strategic advantage of the Philippines as an assembly point.

But one factor even more important than the supply and low-wage operators seems to be the relatively more abundant supply of engineers and technical graduates in the country. The Philippines turns out about 30,000 engineering graduates annually. In terms of enrolment in technical subjects of direct relevance to industrial competitiveness (such as science, mathematics and engineering) the Philippines has a higher rate of enrolment in the so-called "core technologies" than Indonesia, Malaysia and Thailand, although a lower rate than in the Republic of Korea and Taiwan, China.

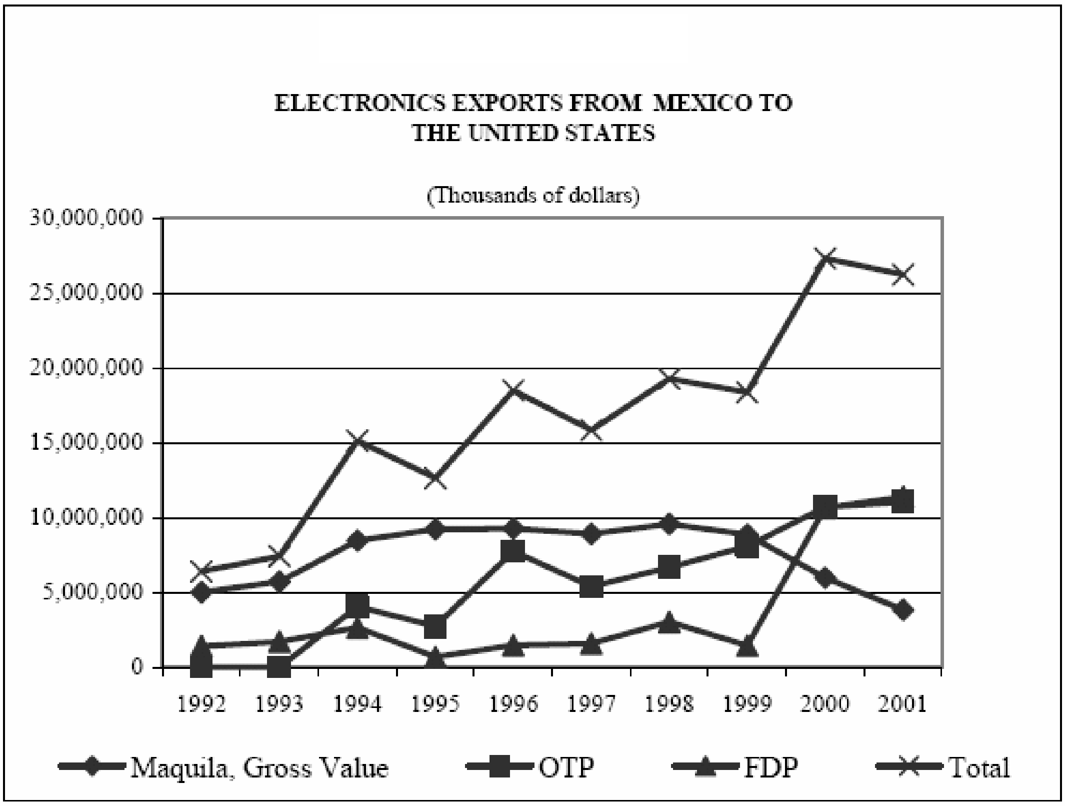
Most of the good engineering colleges and universities are located in Metro Manila, so that locating in the zones which lie south of the national capital region eases the problem of recruitment of technicians. However, since Laguna and Cavite are still in the countryside in relation to Metro Manila, it still takes some motivation and incentives to coax them either to relocate or bear the burden of commuting.

A more serious problem lies in the weaknesses of the technical training given at all but the top universities and state colleges that offer engineering and technical courses. Even the best engineering schools are plagued by a lack of funding, leading to a serious shortage of equipment, a major problem in a technically relevant and strong engineering faculty. The foremost engineering department in the University of the Philippines is constantly facing the problem of losing faculty members in the electronics and communications engineering department to the private sector, particularly to foreign electronics firms.

4.5.3. The **maquiladora** *electronics industry in Mexico*

The electrical/electronics industry in Mexico has experienced considerable growth in the last decade. Between 1992 and 2001, exports of electronics products to the United States quintupled in value (see figure 4.2). The boom of the early 1990s in Mexico's electronics industry [7] had its origin in the large investment flows from Japan and the Republic of Korea. These flows were part of a strategy seeking to evade the import levies applicable to various Asian countries, which the United States had imposed on these products.

Figure 4.2.



Source: C. Schatan and L. Castilleja: *The Maquiladora Electronics Industry and the Environment along Mexico's Northern Border* (Montreal, Commission for Environmental Cooperation. Third North American Symposium on Assessing the Environmental Effects of Trade, 30 November-1 December 2005) http://www.cec.org/files/pdf/economy/final-schatan-T-E-Symposium05-paper_en.pdf.

The *maquila* category includes United States imports from Mexico entering under the tariff categories 806 and 807. These only consider the value added in Mexico for tariff purposes and exclude the value of inputs from other countries, including the United States, assembled and re-exported by the *maquiladora* industry. The OTP category (other preferential) includes imports with other preferential treatments (mainly all goods entering under the auspices of NAFTA). In this case, the product's total value is included for tariff purposes without distinguishing between value added in Mexico and value added elsewhere. Tariffs imposed on the total value of these products are either less than those on imports from third countries – or they pay no tariffs at all. FDP (full duty paid) refers to imports paying full tariffs upon entry into the United States. The total includes the total value of imports of electronics products from Mexico entering the United States, minus the inputs originating from the United States that are assembled in Mexico.

Another incentive to FDI in this sector was the opportunity to enjoy the preferential tariffs granted by the United States to Mexico if they were in compliance with free trade agreements (FTA) rules of origin. [8] The portion of exports attributable to *maquiladora* plants, as such, stagnated or declined after 1994. However, this was due to the fact that

[7] Including both the *maquiladora* and the *non-maquiladora* sectors, especially regarding the production of television sets and other mass consumer electronics items.

[8] D. Roma Murillo: *Foreign direct investment in the Mexican industry: Spillovers and the development of technological capabilities* (Princeton University, 2002).

many of the exports originally classified under tariff categories 806 and 807 [9] started entering the United States as products of Mexican, American or Canadian origin, that is, as tariff-free products under the "other preferential" (OTP) category, which includes North American Free Trade Agreement (NAFTA) goods, or under the "full duty payment" (FDP) category, which covers products assembled in Mexico that do not, however, comply with rules of origin due to inputs from third countries.

Table 4.1. Changes in ***maquila*** employment by city and sector (1994-2003)

City	January 1994	October 2000	September 2003	Job losses
Cd. Juárez	129 991	264 241	197 000	73 350
Tijuana	80 506	199 428	143 489	58 461
Reynosa	34 874	67 275	72 564	< 5 018 >
Matamoros	39 126	69 989	52 684	17 745
Mexicali	19 495	65 494	50 597	13 847
Cd. Chihuahua	28 336	53 319	43 953	10 993
Sector				
Electronic	190 940	467 508	328 088	139 420
Auto parts	126 061	250 635	236 145	14 490
Apparel	67 269	293 576	200 287	93 289
Industry total	546 433	1 347 803	1 056 553	291 250

Source: *INEGI, Banco de Información Económica, Industria Maquiladora de Exportación*.

[9] "806" is an abbreviation for tariff category HTSUS 9802.00.60, while "807" is an abbreviation for tariff category HTSUS 9802.00.80.

Figure 4.3.

Mexico – Geographical location of the main electronics industry companies

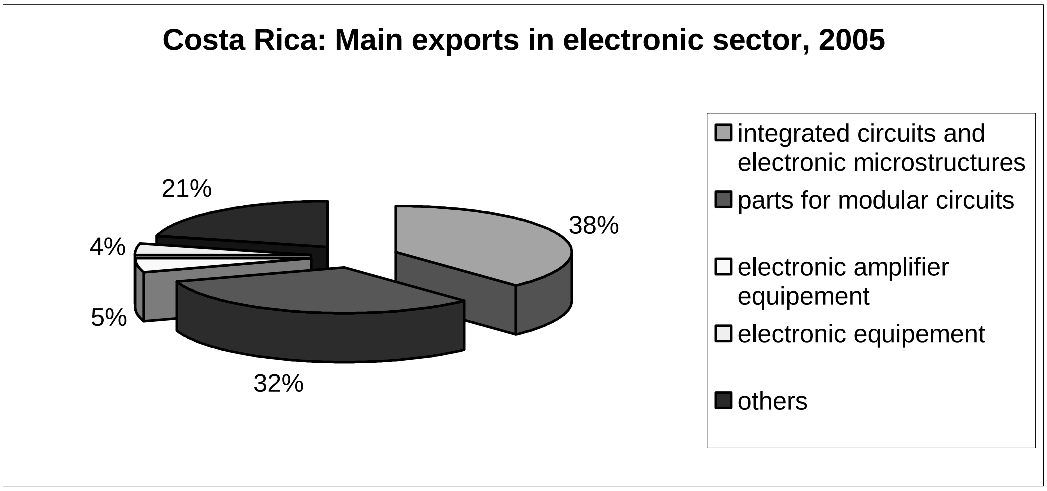
Source: *Centro de Relflexión y Acción Laboral (CEREAL)*: New Technology Workers: Report on Working Conditions in the Mexican Electronic Industry, 2006, p. 10.

4.5.4. Costa Rica

Costa Rica's ability to attract foreign direct investment into the electronics industry relies on a combination of factors: a well-educated, multitask and productive workforce at all levels from operators to engineers and management; positive cost/benefit relation; reliable infrastructure; friendly business environment; and a government committed to making things happen.

From a couple of pioneer companies established during the late 1970s, the industry stands today as the largest contributor to the country's manufacturing output, capital investment, employment and exports. Along with these pioneer multinational corporations, there are currently more than 50 companies directly employing over 12,000 people, and exports worth US$2,000 million in 2005.

Figure 4.4.



Source: PROCOMER *(Promotota del comercio exterior de costa rica)*, http://www.electronicsinvestment.com/, Nov. 2006.

4.5.5. In summary

OEMs purchasing from EPZs are looking for maximum flexibility, in order to deliver products as fast as possible and at the lowest price. This flexibility is wage-based on piece rates and a considerable amount of overtime.

The labour-intensive part of the industry has shifted to countries where wages are low, including to EPZs where worker rights are not given priority and where labour laws are not enforced properly. Workers often face opposition when attempting to organize. It is therefore not surprising that the rate of unionization in the electronics industry is extremely low.

Table 4.2. Exports of ICT products from selected EPZs

Exports of office and telecom equipment of selected economies – Includes significant exports from processing zones, 1990-2004 (US$ million percentage ranked by 2004)

	Value					Share in economy's total merchandise exports	
Countries	1990	2000	2002	2003	2004	2000	2004
China	3 126	43 498	75 522	117 939	171 782	17.5	29.0
Malaysia	8 207	52 382	47 827	49 678	56 172	53.3	44.4
Mexico	4 535	34 042	32 249	31 359	36 320	20.5	19.2
Philippines	1 835	25 138	22 724	23 776	23 915	63.2	60.3
Costa Rica	–	1 688	983	1 497	1 200	28.8	19.1
Morocco	114	506	525	644	683	6.8	7.0
Mauritius	3	2	14	42	45	0.1	2.3

Exports of EDP[1] and office equipment of selected economies – Includes significant exports from processing zones, 1990-2004 (US$ million percentage ranked by 2004)

	Value					Share in economy's total merchandise exports	
Countries	1990	2000	2002	2003	2004	2000	2004
China	375	18 638	36 228	62 506	87 101	7.5	14.7
Malaysia	676	20 689	17 988	16 855	20 188	21.1	16.0
Mexico	–	11 757	12 192	13 370	13 798	7.1	7.3
Philippines	–	7 208	7 153	6 943	7 605	18.1	19.2
Costa Rica	–	1 628	903	1 375	803	27.8	12.8
Morocco	0	2	4	18	23	0.0	0.4

[1] Electronic data processing equipment.

Exports of integrated circuits and electronic components of selected economies – Includes significant exports from processing zones, 1990-2004 (US$ million percentage ranked by 2004)

	Value					Share in economy's total merchandise exports	
Countries	1990	2000	2002	2003	2004	2000	2004
Malaysia	4 321	18 729	19 208	22 406	23 500	19.1	18.6
China	128	5 352	7 277	10 401	16 184	2.1	2.7
Philippines	–	16 663	14 488	15 900	15 185	41.9	38.3
Mexico	–	3 064	1 892	2 172	2 585	1.8	1.4
Morocco	110	480	502	601	634	6.5	6.5
Costa Rica	–	51	51	96	258	0.9	4.1
Mauritius	1	0	1	2	3	0.0	0.1

Exports of telecommunication equipment of selected economies – Includes significant exports from processing zones, 1990-2004 (US$ million percentage ranked by 2004)

	Value					Share in economy's total merchandise exports	
Countries	1990	2000	2002	2003	2004	2000	2004
China	2 623	19 508	32 017	45 032	68 497	7.8	11.5
Mexico	–	19 221	18 165	15 817	19 937	11.6	10.5
Malaysia	3 209	12 965	10 631	10 418	12 484	13.2	9.9
Philippines	–	1 267	1 083	933	1 125	3.2	2.8
Costa Rica	–	9	29	26	139	0.2	2.2
Mauritius	3	1	11	36	39	0.0	2.0

Source: ILO (Sectoral Activities Department), based on WTO: *International trade statistics 2005*, pp. 145-160.

5. Training needs and requirements

5.1. A skills- and knowledge-based approach to employability

A knowledge-based concept of employability connects the core elements of the ILO's Global Employment Agenda (GEA) [1] with the Human Resources Development Recommendation, 2004 (No. 195) [2] by distinguishing between capabilities of workers, entrepreneurs, managers and policy-makers as determinants of employability. As discussed by the Governing Body, this is the main value added of the knowledge-based employability approach which allows changing skill requirements to be addressed at various levels. [3]

- *At the individual level,* skills and competencies define the capacity to make use of job and income opportunities and to adapt to changes in the labour market brought about by technological progress and globalization. Skills and knowledge for improved performance in internal and external labour markets and adaptability are key to employability. In addition, education in workers' rights and other citizenship skills empowers women and men who are discriminated against in labour markets to gain access to education, training, decent jobs, opportunities to start a business and, if needed, the judicial system.

- *At the enterprise and organizational level,* entrepreneurs' and managers' business skills determine the capability of firms to create and use opportunities and to invest in workforce skills. These business skills, and the capacity to promote a learning culture, workplace learning and to facilitate knowledge sharing between workers, determine the employability of workers within a firm. Firm-specific skills and organizational knowledge are essential for a firm's capacity to absorb technology, to innovate and to grow.

- *At the economic and social level,* capabilities of decision- and policy-makers to make effective policy choices in training and labour markets are critical for employability. Discriminatory recruitment practices limit the employability of men and women, regardless of their occupational skills endowment. The skills of decision-makers to design legal institutions and apply governance tools which support equal opportunities and workers' rights, together with the skills of social partners to engage in a meaningful social dialogue, enhance employability and sustainable economic and social development.

The competences of governments to design and implement coherent economic policies which address the demand side of the economy are central to ensuring that the potential of an employable workforce is maximized. Competent policy choices in trade, investment, finance, technology and migration determine economic growth, job creation and the demand for labour. Coherent macroeconomic policies reduce the level of

[1] In March 2003 the Governing Body approved the Global Employment Agenda (GEA), the principal aim of which, as the employment pillar of decent work, is to make employment central in economic and social policy.

[2] Recommendation No. 195 deals with education, training and lifelong learning.

[3] ILO: *Employability by improving knowledge and skills,* doc. GB.295/ESP/2(Rev.).

uncertainty in the economy and, in combination with economic growth and the redistributive effects of pro-poor growth, increase incentives for workers and firms to invest in training and skills.

For employability to be effective, there is a crucial role for employment services to facilitate the matching of supply and demand in the labour market. The knowledge-based approach to employability identifies skills, knowledge and employability as a central component of employment strategies, draws attention to the relevance of capabilities of workers – but also of managers, policy-makers and other decision-makers – and demonstrates the links between the core elements of the GEA.

5.2. Training needs, acquisition, testing and certification [4]

Formal education and training systems are not always well adapted to respond quickly to rapid changes in skill requirements or to the constant demand for new technology-specific expertise. Current educational systems provide neither the necessary cutting-edge skills nor the flexible schemes required to update rapidly evolving requirements, a prominent characteristic of the information technology (IT) field. IT companies have therefore organized their own skills training – over and above the qualifications people bring with them from universities and colleges – according to their needs and the need to provide solutions to the users of their technologies. Such a training strategy is highly flexible and the skills needed can be acquired in many different ways such as e-learning, on-the job, Internet and courses offered by institutions, etc.

Although the report for the ILO's Tripartite Meeting on Lifelong Learning in the Mechanical and Electrical Engineering Industries [5] briefly touched on the subject of IT vendor certifications, the phenomenon is increasing in popularity. This system lies outside of the formal education structure. As a consequence, many IT companies have seized this gap as an opportunity for a business strategy in a world that is in high demand of IT.

Today, most IT professionals possess, in addition to their formal qualifications, at least one vendor certification or are in the process of obtaining one. This new format has created an organized system of accreditation that is being implemented worldwide, in which a certification granted in one country is recognized globally. Therefore, the system introduced the portability [6] of IT skills where it is not strange to find a certified person either seeking a job in the global labour market or obtaining a salary rise or promotion due to the certification acquired, which has prompted the mobility of workers to increase.

IT certification originated as a business credential in which companies validated the knowledge of their own staff. Novel Inc. was the first company to introduce IT certifications in 1989; their main purpose was to ensure that their internal specialists had the capability of both supporting customer calls as well as communicating information clearly regarding their products, thereby linking education and skills with product success.

[4] Based on a paper prepared by K. Fernandez-Stark: *Information technology vendor certification: Challenges for decent work and fair globalization* (Geneva, ILO, 2006 (mimeo.)).

[5] *Lifelong learning in the mechanical and electrical engineering industry* (Geneva, ILO, 2002), pp. 34-35.

[6] The Committee on Employment and Social Policy of the ILO's Governing Body will discuss the question of portable skills in March 2007.

The next step was part of a business strategy to reduce the warranty as well as the support costs of their products; IT companies offer this type of certification not only to their own employees, but to external clients employed in a variety of industries that use IT technologies. IT companies are, therefore, not only selling products but offering "solutions" with the addition of skills.

Many firms, such as Microsoft, Oracle, Sun, IBM and Cisco, have developed their own certifications. Today there are more than 120 IT vendors offering more than 1,000 IT certifications. A partial estimate for the year 2000, found that 2.5 million certifications had been earned by approximately 1.65 million people worldwide – half outside the United States – a figure which has certainly increased since then. Microsoft alone, for example, has granted more than 1.8 million certifications to date (http://www.microsoft.com, 2006).

Although the IT companies provide the training, specialized testing companies are responsible for this stage in the certification process. The two most popular are: Pearson VUE, which serves over 145 countries, at more than 3,700 authorized locations, and administers examinations for approximately 40 IT firms; and Thomson Prometric, which has testing centres in 131 countries.

Still, this "parallel world" outside the formal education system, where commercial providers have the authority to issue credentials, lies in a domain where governments have little or no information about the scope of the phenomenon, which is neither regulated nor monitored.

In recent years, however, many tertiary educational institutions, rather than competing with this type of certification, have instead included it in their curricula through training partnerships with IT vendors. The majority of individuals who gain a certification are actual workers in IT companies, since the system requires competency-based examinations and that candidates be able to perform specific tasks that are usually only learned in the workplace.

Nevertheless, vendor-neutral certifications have been increasing in the past few years and offer a good base of IT knowledge and skills. For example, the largest IT association, the Computing Technology Industry Association (CompTIA), which has more than 20,000 members and operates in 102 countries, is offering IT vendor-neutral certifications. Since its inauguration, it has granted more than 900,000 certifications worldwide. These often apply toward advanced certifications in Microsoft, Novell, Apple, IBM, Cisco and HP, among others.

Some countries, such as the United Kingdom with its Qualifications and Curriculum Authority (QCA) and the Department of Trade and Industry, have been evaluating the possibility of including vendor certification in their national qualifications system.

Figure 5.1. Process IT vendor certification

Phase 1 Standardization of skills	Phase 2 Training	Phase 3 Examination	Phase 4 Certification	Phase 5 Recertification
Each IT vendor sets the performance standard to support its products according to different specializations and levels of expertise.	Students acquire the competences in the most suitable manner for them. When they feel prepared, they take the test. *Most common ways of training:* – on-the-job training; – self-study (books, CDs, software, practice examinations, on the Web); – training courses.	Vendors can administrate the test, but frequently testing companies with branches worldwide offering the test in different languages are used. The two most important testing companies are: – Thomson Prometric, 131 countries; – Pearson VUE, 145 countries, 3,700 locations.	IT vendors grant the candidate a certification after receiving a test score that is above a benchmark.	Generally, certified individuals have to reassess and update their competences regularly to keep their credentials current, leading to lifelong learning.

Box 5.1
Competency-based examination

Cisco: Less than 3 per cent of Cisco certified professionals earn the Cisco Certified Internetwork Expert (CCIE) credential. In addition to a multiple-choice written examination, CCIE certification requires an eight-hour, hands-on laboratory examination. For more information, see http://www.cisco.com/go/ccie. Cisco also includes simulation-based items in examinations for its other certification levels.

Microsoft: Microsoft has added simulation-based questions to many of its certification examinations. The Microsoft Certified Architect certification requires candidates to submit an architectural solution to a board for review, similar to the way Ph.D. candidates submit a thesis for review as the culmination of their academic careers. For more information, see http://www.microsoft.com/learning.

Novell: The Novell Certified Linux Professional (CLP) and Novell Certified Linux Engineer (CLE) certifications both require candidates to pass a performance-based Practicum examination – two-and-a-half hours of testing in a real-world, hands-on environment. For more information, see http://www.novell.com/training/certinfo.

Oracle: The Oracle 9i DBA Certified Master (OCM) certification requires candidates to sit an intensive two-day, hands-on practical examination. For more information, see http://www.education.oracle.com.

Red Hat: Red Hat has long been known for its tough laboratory examination, required for the Red Hat Certified Engineer (RHCE) certification. RHCEs must pass a two-part laboratory examination of five-and-a-half hours total. The Red Hat Certified Technician (RHCT) requires a two-part performance-based laboratory examination of three hours total. RHCEs can go on to earn the Red Hat Certified Architect (RHCA) or Red Hat Certified Security Specialist (RHCSS) certifications. Both of these credentials require various performance-based endorsement examinations, ranging from two to eight hours in length. For more information, see http://www.redhat.com/training.

Source: Kellye Whitney, http://www.certmag.com.

IT certification is one of the few credential systems that formally requires and enforces the constant new assessment of up to date skills. Certifications either have an expiration date or provide for holders to receive notification when they need to be renewed. After the expiration date, the certification is invalid. In other words, lifelong learning is obligatory to maintain a certification. This also offers mobility to workers who can take the certification to another subsidiary within the same company or even to a competitor.

5.3. Costa Rica: The case of Intel Components and Cisco Systems [7]

5.3.1. Intel Components of Costa Rica [8]

Intel Corporation started operations in Costa Rica under the name of “Componentes Intel de Costa Rica” in 1998 as a microprocessor (i.e. Pentium II and Celeron) assembly and testing business. In 2001 Intel expanded its operations in Costa Rica by establishing the Latin America Engineering Services Group (LAES) and hiring 28 engineers, most of them (two-thirds) Costa Ricans, and the rest from other Latin American countries such as Colombia, El Salvador and the Bolivarian Republic of Venezuela. LAES offers R&D services in cutting-edge technologies, such as design of circuits and software.

Since 2004 LAES has been divided into two work groups, both of them located in Costa Rica: Latin American Design Services (LADS) and Latin American Software Services (LASS). LADS absorbed most of the initial group of engineers with which LAES was created, and its focus was basically oriented to Intel Corporation spearhead projects that are two or three years ahead of current technology. The group has since doubled its size and diversified its staff, which currently consists of engineers and technicians in equal proportions. As of June 2006, 60 higher level engineers and technicians work there. [9] LADS has participated in developing five microprocessors, including the recently launched “Core Duo™” and “Core Solo™”.

LASS, on the other hand, provides services to Intel Corporation, developing the software applications it requires. Its success is shown by the growth of its activities; its personnel requirement went from the initial group of three employees to nearly 100. It works in the creation of computing tools for process automation, database administration, global administration and client support services, web applications services, and other different types of software projects.

Elementary and secondary education

For Intel, improved teacher training makes it possible to provide students with the skills they will need to meet today’s demands. With the purpose of improving education in sciences, mathematics, technical education and computing, Intel invests around US$300,000 per year in Costa Rica. More than 9,500 teachers have been certified in the Intel®*Educar para el Futuro* training programme.

[7] Case study contributed by R. Monge-Gonzàlas and C. Gonzàlez-Alvarado: *The role and impact of MNEs in Costa Rica on skills development and training: The case of Intel, Microsoft and Cisco Systems*, prepared for the ILO’s Multinational Enterprises Programme (forthcoming, 2007).

[8] The authors would like to thank Gabriela Llobet (Public Affairs Manager) and Mary Helen Bialas (Academic Relations Manager) for their insights and for providing most of the material presented in this section.

[9] It is understood that higher level technicians are those who graduate from university colleges.

Other programmes

Every year Intel promotes improvement in the quality of science and mathematics teaching as the sponsor of several activities carried out by the CIENTEC Foundation. About 500 Costa Rican teachers participate each year and Intel gives scholarships to 25 teachers to participate in the conferences offered. Intel is sponsoring the creation of a "self-instruction" training manual for rural teachers. More than 1,000 elementary school teachers have completed this training to date.

Intel Costa Rica invested US$50,000 to establish a training programme for science educators at secondary school level in June 2004. The 40-hour training is formally accredited by the civil service and the University of Costa Rica's School of Education. By the end of 2005 more than 1,200 teachers had been trained in the Students as Scientists programme, whose goal for 2007 is to reach 5,000 teachers.

High school mathematics teaching

In 2004 Intel started a new pilot project to strengthen teaching of mathematics in seven Costa Rican secondary schools. It donated five portable computers to each institution, introducing a learning-by-project methodology and other practices focused on students' needs. In July 2005 six teachers were sponsored to receive a special two-week training in Boston and then share the course with another 240 mathematics teachers.

Technical education

During 2004-05 Intel donated industrial equipment to the Ministry of Public Education's Technical Education Department valued at over US$20 million, to be distributed among various technical schools. Teachers and students develop very innovative projects with this equipment, and in 2004, an inter-institutional fair with 20 technical schools was held in which 120 students from different regions participated, presenting innovative products they created using the equipment donated by Intel.

Higher education

Through different "active" programmes in higher education, Intel Components maintains a strategic academic relationship with the University of Costa Rica (UCR) and the Costa Rican Technological Institute (ITCR). It works jointly with both institutions to modernize and update the curricula for electrical engineering, electronics, and materials science engineering, physics and mathematics, providing advice, support and training for teachers.

5.3.2. Policies and practices for skills development and training

A feature of the skills development and training system of Intel Components in Costa Rica is *lifelong learning*. This process involves three clearly defined types of training, with some overlap between them. The first consists of 40 hours of training on Intel's values, plus a *job training plan* drawn up by new recruits with their superiors. The training may include courses, tasks and even temporary relocation of employees to other Intel plants outside the country (for up to two years).

The second type of training consists of *specific training* when employees' positions within the firm change, or as part of the continued training they require as a result of the rapid technological changes that take place in the electronics sector at a global level.

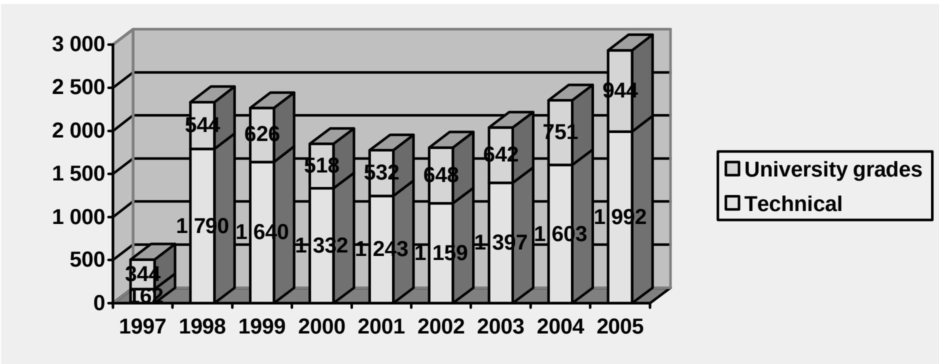
Temporary tasks and relocations may be involved. [10] The third and last type is the *individual development plan* – an instrument to help employees design and execute a training plan that will allow them to reach their goals, according to where they see themselves within the firm's organization in the medium term.

For employees to reach their proposed goals in the various categories of the training and skills development programmes, the firm uses two training methods: (i) on-the-job training; and (ii) off-the-job training. For off-the-job training Intel has a policy of subsidizing university tuition up to 50 per cent, as long as it is related to the firm's activities. For language training Intel covers the total.

5.3.3. Impact of skills development and training programmes on the economy

Due to the large number of highly qualified personnel hired by Intel in Costa Rica (figure 5.2) and the training received by its employees, this firm's operations have had a considerable impact on the Costa Rican economy. This may be classified in two categories: (i) direct impact on employment and wages, and (ii) indirect impacts.

Figure 5.2. Costa Rica: Intel employment by year
(2006: ≈ 3600)



Source: *Componentes Intel de Costa Rica.*

Direct impact (employment and wages)

Because of the support provided by Intel to the curriculum and teaching teams in engineering courses at the ITCR and the UCR, the number of students enrolled in these careers has increased considerably, from 577 in 1997 to 874 in 2000. Furthermore, while only 60 electrical engineers graduated in 1997, by 2005 the figure had risen to more than 200. Taking into account that Intel absorbs only about 10 per cent of these new graduates per year, there has been a significant increase in the number of these professionals available to other MNEs and to local firms.

Regarding wages, the average monthly wage for Intel employees as of December 2005 was US$836, while the average for employees in the manufacturing sector was US$491.

[10] For instance, in 2005 more than 270 Costa Rican engineers were sent to other Intel plants around the world to receive training and then return to Costa Rica. This was more than one-quarter of the total number of engineers hired by Intel.

Indirect impact (spillover and spin-off effects)

The fact that training received by Intel Components' employees is to a certain degree specific to the firm, and that the firm tries to keep a relatively low turnover rate, supports the hypothesis that only part of that training may become available to the rest of the country, if and when employees leave the firm. Since no empirical evidence exists, 13 former employees of the firm were interviewed.[11]

Almost all the interviewees have university degrees and most of them worked for Intel for over a year. All these former employees received skills development and training – most of them in Costa Rica (12), and an important group overseas (seven). Most of them took jobs in another multinational company established in Costa Rica (nine), but not all of them took jobs in the same productive sector (five went to the same sector and four to another sector). Two former employees said they had created their own businesses after they left, one of them immediately and the other several years later. All 13 former employees stated that the training received at Intel had allowed them to improve their performance in their new jobs, in eight cases with higher wages.

5.3.4. Cisco Systems[12]

Cisco Systems started operations in Costa Rica in 1996 with only two staff members, under the name of *Cisco Sistemas de Redes S.A.* One of the staff members was an electrical engineer and the other a systems engineer. Currently this office has 30 workers, of which 29 are professionals and from the operating area. Cisco's office in Costa Rica operates as the headquarters for Central America, the Caribbean and northern South America. Its service areas are sales, technical support and marketing.

The regime's first laboratory of this type was established in Costa Rica, where it provides fast access to the newest technologies available in internet networks. Investment in the laboratory is close to US$3 million and it is oriented towards clients, channels and students throughout Central America.

Role in public education programmes and special funds

Since it was established in Costa Rica in 1999, the Cisco Networking Academy (box 5.2) has become one of the principal entry points to information technologies in the country, integrating students into the human resource platform required by the country to be more competitive.

[11] Since the number of former employees of Intel in Costa Rica is unknown and the sample of former employees interviewed for the purposes of the present study is very small, the results of this analysis must be considered only as an indication of the potential indirect effects on the rest of the Costa Rican economy of the training provided by Intel to its employees.

[12] Cisco Systems, founded in 1984 by a group from Stanford University, is an American manufacturer of telecommunication equipment that sells software as well as hardware. The company has developed internet protocol-based network technologies. To date, Cisco has issued more than 700,000 certifications.

Box 5.2
Cisco Networking Academy Programme

The Cisco Networking Academy Programme (CNAP), created in 1997, is a not-for-profit global training initiative that provides students with networking-centric skills. The main characteristic of the CNAP is its extensive network of participants creating a solid public-private partnership. Today the programme partners with governments all over the world, educational institutions, leading technology companies such as Sun Microsystems, Adobe Systems, Panduit and Hewlett-Packard, businesses, international organizations (for example, the World Bank and UNDP), trade unions and non-profit organizations.

Originally, the initiative was created to prepare students for Cisco certifications such as Cisco Certified Network Associate (CCNA) and Cisco Certified Network Professional (CCNP); however, the curriculum has changed, introducing broader IT network competences as well as soft skills such as conflict management, leadership and other core skills needed to succeed in the world of work. The Networking Academy delivers web-based content, online assessment, student performance tracking, hands-on laboratories, instructor training and support, and preparation for industry standard certifications.

The programme is not only a preparation for IT certifications; it also provides basic IT knowledge and skills. After completion of the programme, every student receives a certificate of completion; however this does not guarantee a Cisco or other IT certification. The student must pass an examination that calls for extensive practical knowledge. For example, a partner academy in Chile (INACAP) is running the programme and only few students, no more than ten, have obtained a Cisco certification – less than 1 per cent of the students enrolled (Douglas, 2006). As a result, there has been no increase in the number of individuals certified through training in formal education institutions; certifications are mainly acquired by workers who have access to, and use, the necessary equipment on a daily basis.

The initiative, which has helped students to obtain knowledge in IT, operates in high schools, colleges and universities and technical schools; community-based organizations that possess non-profit status are also eligible to become academies. In addition, the programme has been expanded to the least developed countries, addressing issues of equity by allowing access to people with low incomes, women and indigenous populations.

Scope of the Cisco Networking Academy Programme:

- implemented in 151 countries;
- more than 1.9 million students, currently over 400,000;
- taught in nine different languages;
- over 10,000 academies worldwide.

In Costa Rica, Cisco has donated the programme to 15 public and private educational institutions. Since implementation began, 6,834 Costa Rican students have participated; 1,656 are currently taking the Cisco Certified Network Professional (CCNP) course, the Cisco Certified Network Associate (CCNA) course, the elementary course on information technology, and the security and wireless networks course.

Skills development and training policies

Cisco Systems’ training policies for its employees in Costa Rica are not very different from those used by Intel described above. Two procedures are used: e-learning training and new hiring training. In the engineering and commercial areas training involves lifelong learning, because of the nature of the information and communication technology (ICT) sector.

Its training plans are on-the-job and off-the-job, and depend on guidelines from Cisco headquarters. Moreover, Cisco Systems has a very strong philosophy which requires that each employee must seek his/her own development, for which Cisco will provide the tools they need. It is considered a responsibility of each employee to take advantage of the options available for training in each area.

Cisco Systems' participation in improving certain public education programmes, as well as in training its own employees, had a considerable impact on the Costa Rican economy by increasing the availability of qualified human resources.

Direct impact (employment and wages)

Because of the high competition for human resource development in the Costa Rican labour market, Cisco Systems employees enjoy a higher income level than the average in the country. Moreover, because of the Cisco Networking Academy Programme many other Costa Rican workers have benefited as the country has become relatively successful in attracting other multinational enterprises (MNEs).

5.3.5. Concluding remarks

In Costa Rica the two MNEs examined have supported the development of a highly educated and dynamic labour force, which has played a key role in the country's success in attracting foreign direct investment (FDI).

Despite the ability of Costa Rica to attract FDI, there are still major obstacles in the field of skills development and training that must be overcome for Costa Rica to continue to attract MNEs. It is important to strengthen relationships between universities and businesses in order to establish priorities regarding occupational training, to help define careers that more closely respond to the demand of the productive sector, to create more dynamic curricula, to develop and implement online education, and so forth.

With regard to the effort of MNEs from the electronics sector to support public training programmes as well as conduct their own internal training, Intel Components and Cisco Systems appear to have made a substantial contribution. They have also had a considerable direct impact on the economy with respect to employment generation and wages, as well as an indirect impact in the form of spillover and spin-off effects (particularly in the case of Intel).

5.4. Examples of training by other multinationals

Box 5.3

Collaboration between foreign affiliates and local universities: Selected examples

Microsoft Research Asia partners with universities and governments throughout the Asia-Pacific region to foster innovative research, advance education and promote science and engineering. It pursues collaboration with local universities and relevant organizations through four avenues: research collaboration, curriculum innovation, talent fostering and science exchange.

In research collaboration it has established joint research laboratories at Tsinghua University, Zhejiang University, Harbin Institute of Technology, Hong Kong University of Science and Technology and University of Science and Technology of China. It conducts theme-based project funding to help research in specific areas.

Intel had more than 250 sponsored research projects under way at various international universities in early 2005. Its teacher training programme, launched in 2000, has offered training to more than 2 million classroom teachers in 30 countries, and the company collaborates with ministries of education or other government entities to adapt the curriculum in some countries.

Seagate Technology in Thailand cooperated with Khon Kaen University to open the Khon Kaen-Seagate Cooperation Research Laboratory for applied R&D in recording-head manufacturing technology. The laboratory uses system level technology and a systems research approach to broaden students' knowledge and expertise. The laboratory will be a shared resource for Seagate staff and students of Khon Kaen University, who will be working together on projects. Cooperation between the industrial sector and universities offers opportunities to develop further and drive future growth in the hard-disk drive and other related industries in Thailand.

In Brazil, the University of Campinas in São Paulo collaborates with a number of foreign affiliates in R&D. More than 250 partnership agreements with private companies and 60 agreements with public companies have been established at the university to date. Among participating foreign affiliates are *Ericsson* for the development of fibreglass technology for optical amplifiers and *Motorola* for the development of professional capabilities in electronics-related areas. Other agreements involve foreign affiliates of *Aventis, Bayer, Compaq, Hewlett-Packard, IBM, Monsanto, Novartis, Roche and Tetra Pak*. In Rabat, Morocco, *STMicroelectronics* has established a training centre to train teachers and students from engineering schools and to provide a syllabus that will help them contribute to innovation activities in the semiconductor industry.

Source: UNCTAD: *World Investment Report 2005*, box VI.8, p. 183, based on company information.

Box 5.4

Motorola's R&D network

Telecommunications equipment manufacturer Motorola (United States) is the world's 19th largest R&D spending firm. As of the end of 2004 it operated major R&D centres (those with over 100 R&D staff) in 19 countries worldwide: two in North America, six in the EU, one in Poland, three in other developed countries, six in developing countries, including Brazil, China, India, the Republic of Korea, Malaysia and Singapore, and one in the Russian Federation.

The first overseas R&D centres were opened in 1950 in Canada and the United Kingdom, followed by various other European locations in 1960. Motorola began conducting R&D in developing countries fairly early, with operations in Malaysia and Singapore already in place in 1970. Most R&D centres concentrate on product development rather than on research.

The latter is conducted in only five countries, three of them developed (Israel, the United Kingdom and the United States) and two of them developing (China and India).

The R&D activities of Motorola in China illustrate well the interaction between a transnational corporation with a global network of R&D centres and a wide-ranging host-country R&D structure including business and government R&D units.

Motorola has also entered into a number of collaborative research agreements with local universities, which also explains the broad presence of its R&D centres in the country.

Motorola originally focused on manufacturing in China where, in the early 2000s, it increased its R&D activities to be closer to the local market and to be more cost efficient.

Source: UNCTAD: *World Investment Report 2005*, box IV.6, p. 143.

Box 5.5
STMicroelectronics' design and software centre in Rabat

The presence of the seventh largest semiconductor producer in the world (49,000 employees worldwide) in Morocco dates back to 1952. Operations in Morocco were expanded in 1979 to carry out subsystem development, and again in 1997 to create a state-of-the-art "back-end" assembly and test plant.

In 2000 STMicroelectronics (registered in the Netherlands and with headquarters in Switzerland) located parts of its design activities in Morocco. The Rabat Design Centre is part of a global network of 16 advanced R&D centres and 39 design centres in the Czech Republic, France, Germany, India, Italy, Morocco, Tunisia, the United Kingdom and the United States.

Within this network the primary mission of the Rabat Design Centre is to develop advanced system-on-chip products for digital TVs, DVD players and flat-screen displays, along with digital still and video cameras. The Rabat Centre currently employs 170 people, scheduled to grow to 700 by 2009.

In addition, the firm has established a training centre, the first of its kind in the country, to train teachers and students from engineering schools and to provide them with the necessary syllabus to enable them to make a valuable contribution to the innovation needs of the semiconductor industry. In 2001 it launched its first cooperative activity with the Mohammed V-Agdal University in Rabat, which included scholarships, exchange programmes and sponsorship of microelectronics courses. It also established a design centre at the Mohammadia School of Engineers, within the Mohammed V-Agdal University.

STMicroelectronics chose Morocco as the location for the design centre for several reasons: a favourable educational and communications infrastructure, the availability of a rich pool of engineering talent, the proximity of Europe and competitive costs. Rabat was chosen specifically for its schools and universities that train engineers specialized in the computer/IT industries.

Source: UNCTAD: *World Investment Report 2005*, box IV.10, p. 147.

Table 5.1. Links between education, training and globalization

Level of education/ globalization indicator	Schooling	Vocational education	Tertiary education	Foreign education
Trade (exports)	Promote basic skills which firms can build on. Good schooling is the basis for further education, training and entrepreneurship.	Export promotion linked to education and higher value exports. Incentives to increase training to remain competitive (Thailand). Communication and leadership skills to participate in global value chains.	Export promotion linked to education. Stimulus needed for education to move in tandem with export opportunities (Rep. of Korea). The more years of education, the more sophisticated and diversified the exports.	Industrialized countries control most of the market, but some developing countries emerging.
Inward FDI	Promote basic skills which firms can build on. Adequate or above average schooling attracts FDI.	Involve the private sector in planning of skills development, and kick-start public-private interactions. Foreign MNEs can provide more training. Technical and engineering skills needed to attract FDI. Little effect on assembly operations.	Availability of technical and engineering graduates facilitates FDI in manufacturing (Costa Rica, Malaysia, Singapore).	Foreign investors require expatriates.
Migration	Overseas remittances can foster/finance schooling in home country. Temporary migration may fill gaps and prevent brain drain. Loss of teaching capacity worsens schooling.	Develop accreditation of training courses to ensure full recognition of diplomas and experience. Trained IT specialists are in demand in industrialized countries.	Loss of domestic capacity such as in teaching. Strong impact on emigration.	Develop own university system to keep students. Students from developing countries seek education abroad, then stay away to work. MNEs employ highly skilled foreigners. Return migration?

Based on D.W. de Velde: *Globalisation and education: What do the trade, investment and migration literatures tell us?* Overseas Development Institute, Working Paper 254 (London, Aug. 2005).

6. Emerging social and labour issues affecting working conditions

6.1. Employment

The global electronics and telecommunications industries experienced a period of rapid growth up until early 2000, followed by a slowdown and a modest recovery (at least through 2006). The effects of these demand fluctuations on contract manufacturers (or EMS providers) were twofold. On the one hand, they suffered from the slowdown in end-demand of the early 2000s just as the OEMs did. [1] On the other hand, they benefited from the increased trend among OEM companies to outsource production; contract manufacturers bought up many OEM facilities that were earmarked for divesture. On balance, employment levels at Flextronics and Jabil Circuit more than doubled between 2000 and 2005 even though Flextronics alone made some 28,000 people redundant during that period.

Underlying the questions of which facilities to acquire and which to close is the ongoing strategic reorientation of both the OEMs and EMS providers. "Where to situate my company in the value chain; and, what is a core activity and what is not?" have become the main questions, not just for OEMs, but also for EMS providers and ODM companies, as the latter two seek to deepen the range of services offered and become more vertically integrated.

In this strategic reorientation, the geographic balance of production and sales of the big EMS companies has shifted away from their region of origin (North America) towards Asia. Employment has naturally followed and a growing share of EMS jobs is now to be found in Asia and in China in particular. The same is true for ODM companies.

In part, this move to Asia, where labour costs are lower, is a logical consequence of the focus on cost-cutting that has become all-important since the turn of the century. But there are also other reasons. The Asian region is home to some huge and fast-growing markets. Brand-name OEMs are establishing more and more production facilities there, obliging EMS providers to follow. The Asian region's share of R&D is increasing, and all ODMs are located there. The region also offers highly skilled, educated and motivated workers at competitive costs. As the previous chapters have shown, the implicit assumption that only simple assembly jobs are being relocated to Asia is not entirely true.

6.2. Flexibility and the pace of production

The shifts in aggregate demand in end markets and in EMS provider volume of production are only one dimension of the demand fluctuations that the industry is facing. EMS providers have great difficulty forecasting demand. Customers are reluctant to commit themselves to long-term production schedules, making it difficult to plan production and achieve maximum efficiency in manufacturing. In addition, anticipated

[1] Lucent's workforce declined from 106,000 to 40,000 between 2000 and 2002 (J. Moules: "Lucent issues warning with hint at more job cuts", in *The Financial Times* (London, 14 Sep. 2002). Motorola reduced its headcount by one-third, or nearly 50,000 in that period (C. Daniel: "Motorola to make 7,000 more redundant", in *The Financial Times* (London, 28 June 2002). At Alcatel the number of people employed dropped from 130,000 to 60,000 between 2000 and 2003.

orders from customers may fail to materialize and delivery schedules may be deferred as a result of changes in customers' business needs.

New products are being introduced at a fast pace. Some of these may fail to generate the expected demand. Others may be a great success, with sales volumes far exceeding expectations. In both cases, it is critical that production may be adjusted rapidly up or down. A product generation is now measured in weeks and months rather than years, making production planning ever more critical, but also exceedingly difficult.

How to cope with the instability in demand (and how to distribute production among their many facilities around the world) is a key management challenge for EMS providers. There is a premium on the capability to adjust production quickly to demand changes.

Workers play a key role in the upward and downward adjustment of production volumes through shift work, irregular hours, overtime and the use of temporary staff. Short-term contracts are used to make it easier to hire and lay off staff. Temporary agencies supply over 50 per cent of the workforce in the United States and contract manufacturers are no exception. Outside the United States, contract manufacturers also make intensive and growing use of short-term contracts and temporary agencies.

6.3. Divestures

Contract manufacturers play a major role in the global restructuring of the electronics and telecommunications industries. They started life by taking over some of the less glamorous and more labour-intensive parts of production of North American electronics companies. They internationalized their operations when they were invited to take over some of the overseas subsidiaries of these companies. Next came the takeovers of plants owned by European telecom and electronics companies.

Although manufacturing was once considered a "core activity", OEMs now prefer to own as few fabrication units as necessary. The pressure on prices, capital costs, the speed with which demand can rise or fall, and the associated logistical and inventory problems, made the OEMs decide to let contract manufacturers do the work for them.

For the employees involved, divestures often come as a rude awakening. From working for some of the more prestigious employers in the country (IBM, Ericsson, Philips), they suddenly had to deal with new, previously unknown employers who believed that they could run their plant more efficiently and achieve a lower cost base. In the process, seniority rights were often placed in question, and working time, pay arrangements and pension schemes reviewed.

The actual impact of these measures on individual workers is likely to be case- and location-specific. Seniority rights are typically important for older workers but less so for their younger colleagues. When there is an ample supply of alternative jobs on the local labour market, dissatisfied workers can vote with their feet without doing great damage to their incomes. Moreover, a very large percentage of the shop-floor workers are not hired directly by the company but through temp agencies. Lastly, changes in pay and working conditions must also take into account the changes taking place regarding competitors in the local labour market. The pressure on workers is increased everywhere.

A striking example is provided by the sale of Siemen's mobile phones unit to BenQ of Taiwan, China. Less than one year after the sale, BenQ announced in September 2006 that it would no longer support the ailing unit. This prompted the former parent Siemens to announce that its executives would forgo pay rises and freeze payment of dividends to shareholders in an attempt to support its former employees by injecting additional capital into the Munich-based unit. Siemens had originally made funds, patents and even its name available to BenQ in the hope of securing a stable future for the unit. [2]

6.4. Standardization, cost comparisons and applying global best practice (GBP)

American contract manufacturers try to achieve global standardization of production processes, globalized "just-in-time" production, and the application of best practices throughout their global operations. With dozens of plants scattered around many countries on all continents bar Africa, their strategic goal is to achieve rapid interchangeability of manufacturing processes between plants. This facilitates the worldwide integration and coordination of work at these plants. It also makes work practices and manufacturing standards more comparable (and thereby increases competition between individual plants and the workers employed in them).

But the transfer of company best practices is never 100 per cent complete. [3] Local traditions, labour legislation, differences in industrial relations and in union density and strength, together with tightness of the labour market, may make it difficult to apply company best practice. [4] Contract manufacturers have found it easier to apply best practice at "greenfield sites" than in factories acquired following a divesture. Workers in acquired plants frequently receive guarantees that their working conditions will not deteriorate in the aggregate after the takeover, but in practice two different pay scales may be applied when new recruits are hired on less favourable terms. [5]

American contract manufacturers are keen to introduce more working time and pay flexibility in their European plants. They are eager to introduce variable pay systems such as bonus payments linked to a consumer satisfaction index in the plants they have taken over. In the United States, payments in case of illness have become less generous. In countries with a tradition of "seniority", the loss of seniority rights for older workers can have drastic consequences. Contract manufacturers regard all employees in the acquired plants as new recruits. The loss of seniority which this implies affects holidays (which are more generous for long-time employees), as well as decisions on promotions, vacation time, shift work and dismissals.

[2] "Siemens comes to aid of its ex-employees", in the *International Herald Tribune*, 2 Oct. 2006, http://www.int.com/articles/2006/10/02/business/siemens.php.

[3] In a sense, GBP methods function as a mould. Across countries, there are wide discrepancies in the degree of sophistication of industrial relations and the way in which producers and suppliers interact. As the mould applied to different settings, and different industrial relations situations in particular, it brings out the incompatibilities with prevailing local practice. Efforts are then made by those who want to apply the mould, to ensure that it fits. This can be more difficult than anticipated (G. van Liemt: *Applying global best practice: Workers and the "new" methods of production organization* (ILO, Employment and Training Papers 15, Geneva, 1998).

[4] The interested reader is referred to Lüthje et al., op. cit., 2002, who did in-depth research on the differences and similarities in work practices at electronics plants in Germany and the United States.

[5] Subsequently, "old" employees are often offered a "transit bonus" in an effort to return to a unified set of pay and working conditions.

In high labour cost countries, it is not uncommon for the divested plant to close after two to five years, the period during which the previous owner had agreed to continue to source certain products from the plant. When this demand dries up and no alternative sources of demand are found (or because a sister plant elsewhere produces at lower cost), closure may be unavoidable. In fact, between 2000 and 2005, the contract manufacturers together closed dozens of plants (mainly in high labour cost countries) making many people redundant. Could closure have been avoided? Would redundancy benefits have been different had the workers still been employed by their previous employer?

6.5. Other emerging labour and social issues

Since the barriers to entry at the bottom end of the value chain are increasingly low, competition among suppliers, especially in developing countries, is intensifying. Given this situation, suppliers may be willing to lower labour and social standards, for example by extending working hours, in order to be more competitive.

Unlike the textiles and clothing industry, which has been under scrutiny and consequently under pressure to improve working conditions in so-called “sweatshops” in developing countries, the electronics sector has until recently been viewed as relatively “clean” and has consequently been untouched by criticism. However, much of the overall manufacturing process is low-tech and labour-intensive, and therefore faces similar challenges to those facing the garment and footwear sectors. In addition, the electronics sector uses toxic chemicals in the manufacturing process, which can have a significant impact both on workers’ safety and health and on the local environment. Recently, the industry has increasingly come under scrutiny. Particularly significant in this context has been the Catholic Agency for Overseas Development (CAFOD) report entitled *Clean Up Your Computer*, which highlighted the absence of labour and environmental standards in the industry, pointing to examples in China, Mexico and the Philippines.

The factors that impact on social and employment issues in the electronics sector are both external and internal to the global value chain. External factors are determined outside the chain, by global financial and trade trends, national policy and regulatory environment, especially in terms of labour law and inspectorates and recognition of trade unions. In addition, external factors that have an impact on labour issues include the characteristics and the capacity of the local workforce, such as human capital, skill levels and the strength of social networks. Factors internal to the electronics sector, and in particular to the PC global value chain, relate to product and process characteristics, such as the high rates of innovation and product obsolescence, increasing competition and falling prices, as well as to buyer purchasing practices, such as just-in-time supply, variable orders, tight ordering timescales and new demands in terms of higher product quality.

6.6. At the top of the value chain: Brand-name firms

Brand-name firms at the top of the value chain account for the largest portion of value added by retaining property rights over the most intangible activities of the production chain, such as the brand name itself and its marketing. The labour and social issues that emerge do not directly concern the employees in this segment of the value chain (since they tend to benefit from high standards), but rather the suppliers in the lower value added segments of the global value chain who are almost exclusively located in the developing world.

6.7. At the bottom end: Traditional subcontractors

Workers at the bottom end of the supply chain are the most disadvantaged. Various organizations have identified the following issues in the electronics sector which need to be addressed.

Safety and health: Exposure to hazardous chemicals is the largest single health risk for workers in the electronics sector. Although specific studies on the long-term effects of exposure to such chemicals in these industries do not exist, it has been alleged [6] that workers are rarely given appropriate protection and training to avoid direct contact with hazardous substances. Potential human health effects include a high incidence of miscarriages, birth defects, different types of cancer, respiratory problems, skin irritation and rashes, liver damage, and occupational diseases such as repetitive strain injury, neck and back pain, eye strain, hearing deficiencies and dizziness, all of which are intensified by long working hours. The so-called "board stuffers", who deal with the manufacture of PCBs, are those most likely to suffer health damage because of their direct contact with chemicals.

Wages: According to the case studies carried on by CAFOD, in China and in the Philippines, wages in the electronics sector are relatively high when compared to other manufacturing sectors. However, the question remains as to whether they are adequate. [7] In Mexico, wages are said to be often below the legal minimum wage. For this reason, many workers are willing to accept long working hours in order to earn enough to cover living costs. The perception of low wages has sparked "sweatshop" allegations by the media and civil society.

Hours of work: Producers in supplier countries follow a "just-in-time" manufacturing principle (for example in China, Mexico and the Philippines) which may involve extensive overtime in order to meet export deadlines. Such situations are often labelled as "emergency cases" and can lead to the cancellation of days off, or failure to pay adequate overtime. Such excessive overtime can be counterproductive, since workers frequently suffer from fatigue, occupational diseases and accidents.

Equality: Most complaints involving discrimination involve gender, with claims that women are paid less than men and hold few managerial positions. Many cases of pregnancy-based discrimination have been reported in Mexico, where women have been obliged to undergo medical checks, including pregnancy tests, before being officially employed. Recruitment practices used by employment agencies have been alleged to be discriminatory, for example, refusing employment on the basis of medical and psychological tests. Discrimination against homosexuals, pregnant women or people with personal relationships with lawyers and unions, has been observed by CAFOD, especially in Mexico. Furthermore, there is age discrimination, since it is very difficult for workers over 30 years of age to be employed in the electronics sector.

[6] I. Schipper and E. de Haan, *CSR Issues in the ICT Hardware Manufacturing Sector*, SOMO ICT Sector Report, Amsterdam, 2005, p. 68; CAFOD, *Clean Up Your Computer: Working conditions in the electronics sector*, 2004, p. 23; *The ICT Sector: The management of social and environmental issues in supply and disposal chains*, ISIS Asset Management plc, 2004, p. 1a, http://www.e-innovation.org/stratinc/files/library/ict/30.ICT_issues.pdf.

[7] Schipper and de Haan, op. cit., 2005, p. 66; CAFOD, op. cit., 2004, p. 23.

Freedom of association and collective bargaining: The industry has historically been characterized by very low or non-existent unionization. The prevalence of employment agencies reduces the ability of workers to organize themselves, especially in EPZs. In the Asian ICT industry, many countries have put restrictions on unions in EPZs. In China, there is only one union, the All China Federation of Trade Unions (ACFTU). The lack of representative organizations prevents effective collective bargaining. The obstacles to unionization are manifold. On the industry side, they arise because of firms' concern with lowering costs and maintaining a flexible labour force; from the government side, unions are often considered an impediment to the inflow of foreign direct investment and therefore increased employment. In some cases, these obstacles have caused unions to seek a dialogue-based approach to representation in the electronics sector.

The next chapter will look at some responses by industry to these issues.

7. Labour and industry responses

In response to concerns regarding labour and social issues in the IT electronics manufacturing industry, many multinational enterprises adopted programmes of corporate social responsibility and some now also participate in voluntary industry initiatives. Labour and civil society have formed a network in an attempt to improve working conditions in global supply chains. This section looks at some of these responses. [1]

7.1. Corporate social responsibility (CSR)

Over the last few years, original equipment manufacturers and contract manufacturers in the ICT manufacturing sector found themselves the target of public campaigns to rouse consumer concerns about working conditions in global supply chains. In January 2004, the Catholic Agency for Overseas Development (CAFOD), a UK-based NGO, published a report “Clean up your computer”, alleging labour rights violations in the ICT sector. The report was based on case studies of subcontractors in China, Mexico and the Philippines, and was widely reported on in the media. It was followed by other reports, such as the report of the Centro de Reflexión y Acción Laboral in 2006 on working conditions in the Mexican electronics industry. Most recently, Apple became the subject of negative publicity when, on 11 June 2006, the British newspaper, *Mail on Sunday*, and the BBC reported on low pay and excessive overtime at subcontractor Foxconn in China, manufacturer of Apple’s iPod.

In response, a number of brand-name firms started or intensified their CSR programmes and, in particular, adopted company codes in respect of their suppliers. Dell adopted supplier principles in February 2004 and IBM adopted its Supplier Conduct Principles in April 2004 and revised them in July 2004.

Most companies in the sector are implementing their codes of conduct through a system involving supplier self-assessment with conformity performance against the code of conduct, which is made a condition of the contract. This is in some cases supplemented by social audits of the suppliers, either by the brands themselves or by a private audit firm, and by the requirement of corrective action in areas where performance is not consistent with the code of conduct. Dell, for example, requires its suppliers to provide documented evidence of their commitment to implementation of its supplier principles by means of a self-assessment tool. [2] Enterprises such as IBM and Motorola state that they require immediate correction when non-compliance issues are discovered. [3]

Nokia requires the suppliers to define a corrective action plan for any non-conformance areas found, and Nokia-appointed social auditors are required to track progress. [4] Nokia has, however, pointed out that sectoral features can pose challenges to code implementation and compliance. For example, Nokia claims that a big challenge is posed by specially designed parts and intellectual property, which create greater buyer

[1] This section was contributed by the ILO’s Multinational Enterprise Programme (MULTI).

[2] Dell Sustainability Report, *Dell Fiscal Year 2006 in Review*, pp. 26-28.

[3] *IBM Innovations in Corporate Responsibility 2004-2005*, p. 12; 2005 Motorola Corporate Citizenship Report, pp. 31-33.

[4] *Nokia CR Report 2005*, p. 81.

dependency on suppliers than, for example, ready-to-wear clothing. Greater dependency reduces the credibility of threats to cut contracts if suppliers do not comply, and increases resistance from sourcing managers on the ground.

Many of these MNEs also publish CSR reports based on the Global Reporting Initiative or other guidelines.

Box 7.1
Hewlett-Packard: Code implementation system

In 2002, HP established its Supply Chain Social and Environmental Responsibility (SER) policy, which has been applied to 450 high-priority suppliers, making up 98 per cent of HP purchasing expenditures. In October 2005, it revised its code of conduct to bring it into line with the Electronic Industry Code of Conduct (EICC). With regard to freedom of association, HP has supplemented the EICC provisions with additional requirements (see HP Supplier Code of Conduct, Labour, section 7: http://www.hp.com/hpinfo/globalcitizenship/environment/pdf/supcode.pdf).

HP's code of conduct is implemented through a management system which includes an initial assessment of the supplier for "risk", a conformity assessment programme, a validation process and possible capacity building.

HP supply chain SER management system

Phase 1: Introduction	Phase 2: Assessment	Phase 3: Validation	Phase 4: Continuous improvement
HP conducts preliminary risk assessment of the supply base to determine priorities. ↓ Risk criteria include geographic location, chemical or labour-intensive processes, length of supplier relationship with HP and commitment to global citizenship. ↓ Suppliers identified as a potential SER risk are formally introduced to HP's SER requirements and asked to sign a supplier agreement with an SER clause.	Supplier completes biannual self-assessment. ↓ HP reviews the assessment and provides feedback, which often leads to extensive dialogue. ↓ Based on several factors, HP determines if the supplier is a priority for an on-site audit.	HP conducts on-site audits. ↓ When audits reveal non-conformance with code provisions, HP works with the supplier to establish a corrective action plan. At a minimum, the supplier must submit an improvement plan and schedule for completion. ↓ After implementation, HP verifies that the non-conformance and its causes have been addressed.	HP helps suppliers acquire the necessary skills, tools and expertise to improve continually. This includes education and capacity building. HP is working with several organizations to identify the most important focus areas for education.

Source: http://www.hp.com.

In their 2006 Global Citizenship Report, HP reported that the greatest challenges they faced was a lack of awareness at the factory level of code expectations and the fact that only a few suppliers have integrated these concepts sufficiently into their own management systems. Since HP's model (see box 7.1) is based on supplier engagement rather than policing or independent monitoring, a major focus of their programme has been to work with suppliers to improve these systems, including documentation (such as accurate payslips showing wage and pay calculations), the availability of material for workers outlining rules and regulations and procedures for establishing open communication between workers and management. HP is currently working on cross-industry training programmes for suppliers, auditors, workers and purchasing managers, the objective of which is to improve human resource systems and to integrate code implementation into management systems.

7.2. Voluntary industry initiatives

7.2.1. The Global e-Sustainability Initiative (GeSI)

In order to help facilitate the sustainability reporting process in the telecommunications sector, the Global e-Sustainability Initiative was launched in 2001 by a number of major ICT telecom companies, with the support of the International Telecommunication Union (ITU) and the United Nations Environment Programme (UNEP).

Box 7.2
Members of the GeSI

Alcatel	Lucent Technologies
Bell Canada	Microsoft
British Telecommunications plc	MM02
Carbon Disclosure Project	Motorola
Cisco Systems	Nokia (member of the supply chain working group)
Deutsche Telekom AG	Orange
Ericsson	Panasonic Mobile Communications
European Telecommunication Network Operators Association (ETNO)	Sun Microsystems
France Telecom	Telefonica SA
Hewlett-Packard	US Telecom Association
Intel	Vodafone plc

The GeSI has established a supply chain working group. This group explores ways in which ICT sector companies can collaborate so as to manage social and environmental issues in their supply chains more effectively. Its initial focus has been to align the various codes and policies already used by member companies and avoid unnecessary duplication and proliferation. By subscribing to the sustainable development principles, GeSI members contribute to the United Nations Global Compact. [5]

The GeSI working group has issued tools for supplier risk assessment, including an online supplier self-assessment questionnaire. The questionnaire is aimed at raising suppliers' awareness of CSR issues, helping suppliers assess the extent to which they are conforming to the code, and assisting GeSI members in determining whether follow-up action is needed. The GeSI/EICC working group also intends to develop common audit methodology for suppliers and participant companies and identify criteria for selecting qualified auditors and determining when a supplier is considered to be in acceptable alignment with the EICC.

[5] The United Nations Global Compact was launched in 2000 as a network of United Nations agencies dealing with social and environmental issues, forming an ideal CSR framework. The Global Compact asks companies to embrace, support and enact, within their sphere of influence, a set of core values in the areas of human rights, labour standards, the environment, and anti-corruption: businesses should; (i) support and respect the protection of internationally proclaimed human rights; (ii) make sure that they are not complicit in human rights abuses; (iii) uphold freedom of association and the effective recognition of the right to collective bargaining; (iv) eliminate all forms of forced and compulsory labour; (v) promote the effective abolition of child labour; (vi) eliminate discrimination in respect of employment and occupation; (vii) support a precautionary approach to environmental challenges; (viii) undertake initiatives to promote greater environmental responsibility; (ix) encourage the development and diffusion of environmentally friendly technologies; (x) work against all forms of corruption, including extortion and bribery. See http://www.unglobalcompact.org [accessed on 25 Oct. 2006].

The GeSI has held forums, stakeholder consultation meetings and presentations. The purpose of these has been to inform numerous stakeholders of the efforts being undertaken by the GeSI supply chain working group and of the tools and practices being developed by the GeSI to implement CSR in their supply chain.

At a stakeholder meeting organized by GeSI together with the EICC implementation group in September 2006, a number of important issues were raised. These included improving the credibility of code implementation and auditing methodology by involving third-party auditors, including workers' views and using additional bottom-up assessments. The issue of improving transparency and shifting from a policing to a supplier engagement model, and of capacity building for workers and managers as part of the remediation stage, was also raised. With seven out of 50 invited stakeholders participating, the industry recognized that its stakeholders' involvement strategy has not been sufficient. The industry has therefore stated that a clear stakeholders' policy will be developed in the upcoming period to involve a broader representative stakeholders' group and to bridge practical obstacles such as costs and distances.

7.2.2. The Global Reporting Initiative (GRI) and the telecommunications sector supplement

The Global Reporting Initiative established in 1997 is a multi-stakeholder process and an independent institution whose mission is to develop and disseminate globally applicable sustainability reporting guidelines. The GRI is a collaborating centre of UNEP. The guidelines are for voluntary use by organizations for reporting on the economic, environmental and social dimensions of their activities, products and services. [6] Because of the increasing need for detailed reporting, there are now multiple sector-specific supplements for various industries. [7]

GRI and GeSI convened a series of four multi-stakeholder task force meetings (with financial support from the European Commission), which led to the adoption in July 2003 of a telecommunications sector supplement for service providers and equipment manufacturers, to be used with the GRI 2002 sustainability reporting guidelines. Some of the indicators are more applicable to equipment manufacturers, while others are more relevant to service providers. Twelve manufacturing companies participated in the process through telephone interviews or provided written comments.

[6] The latest G3 version for reporting under the sustainability guidelines, adopted on 5 Oct. 2006, can be found at http://www.globalreporting.org.

[7] GRI has sector supplements for automobiles, financial services, logistics and transportation, mining and metals, public agencies, tour operators and telecommunications.

Box 7.3
Mobile phones partner initiative (MPPI)

Representatives of the world's leading manufacturers of mobile phones – Alcatel, LG, Matsushita (Panasonic), Mitsubishi, Motorola, NEC, Nokia, Philips, Samsung, Sharp Telecommunications Europe, Siemens and Sony Ericsson – signed a declaration, entitled "Sustainable partnership on the environmentally sound management of end-of-life mobile phones" in December 2002, at the sixth meeting of the Conference of the Parties to the Basel Convention. Three telecom operators (Bell Canada, France telecom/Orange and Vodafone) signed the declaration in December 2004. All have agreed to work with the Secretariat of the Basel Convention and joined with parties and signatories to the Convention to develop and implement MPPI activities. The overall objective of the MPPI is to promote the objectives of the Basel Convention in the area of the environmentally sound management of end-of-life mobile phones.

In particular, it should:

- achieve better product stewardship;
- influence consumer behaviour towards more environmentally friendly actions;
- promote the best re-use, refurbishing, material recovery, recycling and disposal options;
- mobilize political and institutional support for environmentally sound management.

Source: http://www.basel.int.

7.2.3. The Electronic Industry Code of Conduct (EICC)

Concerned with the proliferation of codes in the industry and perceived inefficiencies arising from different systems for their implementation, the electronics industry (both original equipment manufacturers (OEMs) and electronics manufacturing services (EMS) providers) in October 2004 formed a private industry initiative and adopted yet another sector-wide code, the Electronic Industry Code of Conduct (EICC).

Box 7.4
Members of the EICC

Adobe	Celestica
Apple	Flextronics
Cisco Systems	Foxconn
Dell	Jabil Circuit
Hewlett-Packard	Quanta Computers
IBM	Sanmina-SCI
Intel	Seagate
Lenovo	Solectron
Microsoft	STMicroelectronics
Philips	
Sony	
Xerox	

The EICC outlines standards to ensure that working conditions in the electronics industry supply chain are safe, that workers are treated with respect and dignity and that manufacturing processes are environmentally responsible. As a minimum, multinationals subscribing to it are required to apply the code to first-tier suppliers.

The present code [8] is divided into five sections: labour, health and safety, environment, conformity management and business ethics. In the labour section, the EICC covers the following areas:

(1) Freely chosen employment, forbidding forced, bonded or indentured labour, or involuntary prison labour.

(2) Avoidance of child labour at any stage of manufacturing. The definition of a "child" refers to any person employed under the age of 15 (or 14 where the law of the country permits) or below the age for completing compulsory education, or below the minimum age for employment in the country.

(3) Working hours should not be more than 60 hours per week, including overtime, except in emergency or unusual situations. Workers must be allowed at least one day off per week.

(4) Wages and benefits: workers should be paid in compliance with minimum wage regulations, overtime hours and benefits regulated by national law.

(5) Inhumane treatment is forbidden, including sexual harassment and abuse, corporal punishments, coercion and verbal abuse.

(6) Non-discrimination is to be pursued, not engaging in any type of discrimination. Workers or potential workers should not be subjected to medical tests that could lead to discriminatory treatment.

(7) Freedom of association: workers have the right to associate freely, join or not join labour unions, seek representation, and join workers' councils.

Trade unions and civil society have criticized the EICC for not being consistent with international labour standards, particularly in respect of the ILO core labour standards. No mention is made of promoting the effective recognition of the right to collective bargaining, and the present wording of the clause on freedom of association is limited. While it has become common practice for codes to specify that overtime should be voluntary and compensated at a higher rate, the EICC code does not address this issue. [9] Unions in particular deplore the fact that they were not involved in its drafting.

Implementing the code

The Steering Committee of the EICC set up an EICC implementation working group in February 2005 to provide participating firms with assistance on code implementation, including the development of tools, and to establish forums for stakeholder dialogue.

Tools are being developed by the EICC implementation group to assist member firms in code implementation. These include:

– a risk assessment tool to identify the areas of greater need in their supply base;

– a self-assessment questionnaire and web tool to gather information and assess supplier performance;

[8] Available at http://www.eicc.info/EICCversion2.0-Oct.10,2005.pdf.

[9] Schipper and de Haan, op. cit., p. 80.

– a common auditing approach such as auditor guidance, on-site audit checklists, audit report templates, supplier preparation guidelines, and identifying and selecting qualified auditors;

– capacity building, training and awareness programmes for suppliers and auditors;

– a common reporting framework for measuring supply chain social and environmental performance against the EICC.

The EICC foresees accrediting third-party auditors identified by the implementation group and the possibility of sharing the results of audits among companies. So far, trade unions have not been involved in assessing company compliance with the EICC or relevant codes of conduct. Some argue that workers are being instructed to comply with codes only for the duration of the audits. [10]

The EICC states that it is not seeking to exclude suppliers on grounds of non-conformity with the common code, but rather to introduce a mechanism for continuous improvement of a supplier's programmes and performance. EICC member companies are not compelled to implement the supplier conformance provisions of the EICC; rather these are provided as model policies and programmes.

Stakeholder consultation

The initial code was heavily criticized for the lack of stakeholder involvement and consultation. In response, the EICC held a consultation in October 2005 with multiple "stakeholders" from civil society and industry and revised the code. Organized labour was not consulted in this process. A second version of the code was released in October 2005.

A code revision team has been formed to review all feedback collected during the year and to determine what revisions are feasible and what can be incorporated into the implementation tools.

7.2.4. Participation in voluntary industry initiatives

The codes of conduct of the EICC and GeSI and the reporting arrangements under the GRI telecommunications sector supplement may create divergent requirements or lead to duplication in the efforts of enterprises in the supply chain, which may be supplying firms that are both members of industry initiatives and reporting under the GRI guidelines. In an attempt to alleviate the situation the EICC implementation group established a partnership with the GeSI supply chain working group in 2005, to collaborate on the development of common methods of implementing the various codes of conduct in the supply chain.

Table 7.3 provides an overview of leading MNEs and the different voluntary private initiatives to which they subscribe.

[10] CEREAL computer conditions update report 2006. Available at http://www.cafod.org.uk/var/storage/original/application/0788568b70a3b716f223722ad2729a0c.pdf, p. 49 [accessed on 25 Oct. 2006].

Table 7.1. Overview of policies, association with industry initiatives and reporting practices of electronics sector lead firms, contract manufacturers and ICT lead firms

	Code of conduct	Member of EICC	Member of GeSI	CSR report	GRI guidelines
Electronics sector lead firms					
Adobe	EICC	X		Annual community report (2006)	
Acer				Corporate environmental report	
Apple	Supplier code of conduct (2005)	X			
Cisco Systems	Supplier code of conduct	X	X	2005	GRI content index
Dell	Supplier principles	X		2006	GRI content index
Hewlett-Packard	Code of conduct (2002)	X	X	2006	In accordance with GRI
IBM	Supplier conduct principles (2004)	X		Innovations in corporate responsibility (2004-05)	Reference to GRI
Intel	Corporate business principles	X	X	2006	In accordance with GRI
Lenovo	EICC	X			
Microsoft	Standards of business conduct	X	X	2005	GRI content index
Philips	Code of conduct statement	X		2006	GRI content index
Sony	Supplier code of conduct (2005)	X		2006	Reference to GRI
Toshiba	Standards of conduct			2006	GRI content index
Xerox	Code of conduct	X		2005	GRI content index
Contract manufacturers					
Flextronics	EICC	X			
Foxconn	EICC	X			
Jabil Circuit	Code of ethics	X			
Celestica	Business conduct governance policy	X		X	
Quanta Computers	EICC	X			
Sanmina-SCI	EICC	X			
Seagate	EICC	X		2006	
Solectron	EICC	X		X	
STMicroelectronics	Code of conduct	X		2006	In accordance with GRI
ICT lead firms					
Ericsson	Yes		X	2006	GRI content index

	Code of conduct	Member of EICC	Member of GeSI	CSR report	GRI guidelines
Siemens	Business ethics and conduct policy			2006	GRI content index
Motorola	Code of business conduct		X	2006	GRI content index
Nokia	Yes		Member of the supply chain working group	2006	GRI content index
Samsung	Global code of conduct	X	No	2006	GRI content index

7.3. Labour and civil society response: The network of NGOs and trade unions

A broad alliance of civil society organizations and trade unions, which had been working to highlight labour and social issues in global supply chains, was formalized in August 2006. Provisionally named the International Electronics Network, it aims to strengthen and stimulate civil society organizations and trade unions worldwide in their actions to improve human rights and environmental conditions in the electronics industry, as well as to improve corporate and public policy and practice in the electronics industry based on common demands. The focus is also on bridging local activities with global initiatives and on linking human rights with environmental initiatives.

Members of the network include the International Metalworkers' Federation (IMF), a global union federation which also represents workers in the electronics sector; Bread for All (Switzerland); and the Catholic Agency for Overseas Development (CAFOD), a United Kingdom NGO.

The network has a steering committee made up of the following eight members: CAFOD, Centro de Reflexión y Acción Laboral (CEREAL), Interfaith Center on Corporate Responsibility (ICCR), IMF, Students and Scholars Against Corporate Misbehavior (SACOM), Centre for Research on Multinational Corporations (SOMO), Silicon Valley Toxics Coalition (SVTC) and Transnational Information Exchange-Asia (TIE-Asia), which have end responsibility for the network's content. One NGO and one union from a developing country will be added to make a total of ten members.

The central aim of the Network is to improve compliance with human rights (including labour rights) and sustainable (environmental) production in the electronics industry. These objectives are considered through five forms of action:

- consolidating the international network through better communication and round tables for a global network;
- exchanging relevant information on electronics industry issues within the network;
- facilitating activities of network participants;
- initiating activities where relevant;
- building the capacity of local organizations.

8. Summary and suggested points for discussion

This report has looked at one segment of the IT industry – the manufacture of electronic components and products – once termed by the WTO “the hardware that drives the IT revolution”. The ILO’s SECTOR*Source* database has estimated that it is an industry that directly employed some 18 million people in 2004, a figure which has no doubt increased. If R&D, software development, programming, sales, marketing, repair and waste disposal were counted, the figure would certainly be much higher. Despite employment losses, the United States and Japan are still major players. Nevertheless, as in almost all other industries, China has advanced to the head of the class in a relatively short period of time, in terms both of employment (6.3 million in 2005) and of exports. However, all of this growth was due mainly to investment by foreign multinationals. Relatively new entrants can also be observed, such as India, Indonesia, Ireland, Malaysia, the Philippines and Thailand, plus some countries in Central and Eastern Europe, including the Czech Republic, Hungary, Poland and Slovakia. Only Costa Rica and Mexico seem to be participating in Central America. For the most part, Africa and South America are absent from the manufacturing side of the IT industry. Many of the components manufacturing or IT assembly factories in developing countries are located in export processing zones (EPZs).

Since 1996 exports of ICT goods have doubled and have grown at a faster pace than merchandise exports. Between 1996 and 2003 merchandise exports increased by 60 per cent, while ICT goods exports increased by 100 per cent. In 2003 exports of ICT goods exceeded US$1.1 trillion, accounting for 15 per cent of world merchandise exports. The value of international trade in ICT goods thus exceeded the combined value of international trade in agriculture, textiles and clothing.

Trade in ICT goods continues to be highly concentrated: the top ten exporters alone accounted for 72 per cent of global ICT exports. Concentration is even higher in developing countries: the top ten developing country exporters account for over 98 per cent of all developing countries’ exports.

Many chips, semiconductors, cell phones, flat-screen TVs, CD players, portable media players, flash memory cards, and the like, or at least their basic components, are made in Asia. For example, electronics accounted for 70 per cent of Philippine merchandise exports (of which 70 per cent were semiconductors). Recent UNCTAD statistics show that almost 50 per cent of all electronic exports are from developing countries, all of which are Asian except Mexico (the world’s leading exporter of TVs).

While the United States and Japan are still major exporters, China had already been catapulted into second place in 2003, with a growth rate of 55 per cent (2002-03), and was already the world’s number one exporter of electronic goods by 2004. The major developing country exporters include: China, Hong Kong (China), Taiwan (China), Indonesia, Republic of Korea, Malaysia, Mexico, Philippines, Singapore and Thailand, and account for almost half of the world’s exports of IT products. According to the WTO, many of theses exports originate in or pass through EPZs. European players include: Austria, Belgium, Finland, France, Germany, Hungary, Ireland, Italy, Netherlands, Spain, Sweden and United Kingdom, which all together account for a quarter of world exports.

Recently, there has been a minor industrial revolution as Asian suppliers, or contract manufacturers, have been buying up the brand-name companies they had previously supplied. Details regarding these acquisitions are provided below.

Buyer	Target	Date
Lenovo Group (China)	IBM PC Division (United States)	December 2004
BenQ (Taiwan)	Siemens mobile phone unit (Germany)	November 2005
TPV (Taiwan)	Philips computer monitor and entry-level flat-screen TV unit (Netherlands)	December 2004
Videocon (India)	Thomson TV tubes unit (France)	October 2005
	Thomson consumer electronics (France, for sale)	
TCL Int. Holding (China)	Thomson TV (France)	December 2003

Chapter 2 of this report also discussed how a group of largely anonymous contract manufacturers – supplying the larger brand-name companies in the industry – evolved into providers of electronics manufacturing services (EMS) by deepening and broadening the range of services they offer and by diversifying into markets other than computing and telecommunications. Original design manufacturers (ODMs) occupy another niche in the product development cycle, a function which some EMS providers can also perform. These names are unfamiliar to the general public but collectively they make sure that personal computers, mobile phones, routers, hand-held game consoles and a host of other electronic and telecommunication hardware are designed, manufactured and delivered to consumers around the world. It is difficult to pinpoint the moment when the contract manufacturers turned into EMS providers, and some started on this road sooner than others. Occasionally, contract manufacturers or EMS providers, such as Acer or BenQ, emerge as own brand manufacturers (OBMs) themselves, but few do as this is not without risk since they lose guaranteed orders and must compete with original equipment manufacturers (OEMs), which dominate the market.

Yet the growing weight of EMS providers in world electronics output and employment and their role in the shift of output towards Asia and lower-cost locations make the study of their strategies important for those responsible for innovation, industrial and industrialization policies. This report considered the “Big Six” EMS providers as a fairly homogeneous group. Time and resource constraints did not allow it to discuss how their strategies differed, how they took different paths often towards the same goal, nor how and why some were more successful than others. They work with very small margins. Some are not profitable at all. Fast growth is no guarantee of high profits. Still, they have many things in common. For example, they grew extraordinarily rapidly in the 1990s but at a slower pace in the early 2000s. They grew because brand-name holders decided to outsource more – and a growing range – of traditionally “in-house” activities. The EMS providers expanded their geographical presence; from just operating in North America they have become true world players and are active in all continents except Africa (though their presence is marginal in Japan, which is largely home to OEMs).

Consolidation is a key factor behind the growing concentration in the EMS industry. This consolidation is in part explained by the desire of the brand holders or original equipment manufacturers to deal mainly or exclusively with big players that have a global presence. Global presence has become a key competitive advantage in the eyes of the EMS providers because it enables OEMs to launch the same product in different parts of the world simultaneously.

The IT components manufacturing industry is also characterized by relatively high participation rates of women. On average, women accounted for about 38 per cent of employment in the electronics industry, with shares ranging from as high as 87 per cent to as low as 5 per cent. Among the more developed economies, women’s participation rate in employment tends to be in the 25 to 35 per cent range (but slightly higher in Central and Eastern Europe), whereas in the developing economies of Asia, their share tends to be over

50 per cent. In the radio, TV and telecommunications equipment subsector, their share was generally higher in all countries. Although women worked more or less the same hours as men, their wages were generally 10 to 25 per cent lower. Given the high participation rate of women, especially in developing countries, the question arises as to whether maternity leave, crèches and other protective measures are in place.

The report has also shown the enormous amount of training that is provided by companies themselves to ensure that they have the workforce required for their specifications. Rapid changes in skill requirements plus the demand for technology-specific skills means that formal education and training systems are unable to respond quickly enough. This would seem to confirm the hypothesis that universities, colleges and vocational training institutions can only ensure that basic learning skills are acquired; those skills then have to be upgraded by the companies and workers themselves as new products and processes are developed. The IT industry organizes training in skills according to its needs and provides a solution to the needs of technology users. Such a training strategy is highly flexible and the skills needed can be acquired in many different ways, such as e-learning, on-the-job training, Internet or courses offered by institutions.

The testing of these competencies enforces skill standards and ensures the quality of skills acquired. This self-certification system by the companies means that the skills are both recognized and highly portable at a global level. Such certified workers enjoy a high degree of mobility and increased chances of finding employment where they can use these skills. This results in higher returns for the workers. It in turn creates incentives for workers to invest in these skills and to have them certified. The requirement to renew certification constantly requires lifelong learning and provides incentives to update skills. Despite the duality of the public-private systems, there are efforts to integrate and complement formal vocational and educational training and IT-vendor training certification schemes.

Nevertheless, the rapid pace of change and the need to reduce costs and meet strict export deadlines have led to the concentration of industries in developing countries in industrial and similar estates that have given rise to questions about the conditions of work under which such IT products are being manufactured and assembled. Compared to more mature sectors such as motor vehicle manufacturing, the electronics industry is characterized by low levels of unionization throughout the value chain.

In response to criticism, or potential criticism, it has been noted that several of the major manufacturers have developed either their own codes or industry-specific codes of conduct, or are participating in reporting under the general umbrella of the Global Reporting Initiative.

Suggested points for discussion

Although the Governing Body originally proposed seven points for potential debate, [1] the decision to hold a three-day meeting means that only a selection of topics can be discussed within the limited time available. These might include:

(1) After reviewing recent developments in the industry, what role can social dialogue play when companies divest, restructure or outsource design, production and manufacturing services?

[1] (1) the shift in production of IT components between industrialized, developing and emerging economies; (2) changing skill requirements; (3) gender; (4) age distribution; (5) conditions of work; (6) labour management relations; and (7) production in industrial zones.

(2) In today's globalized economy, how can brand-name companies (OEMs) or contract manufacturers (EMS providers) ensure adherence to recognized standards throughout their supply chains with respect to their suppliers?

(3) What role can lifelong learning play in ensuring that workforces remain or become competitive? How can the process be supported to give positive outcomes for enterprises, workers and member States? Can you provide examples of best practice?