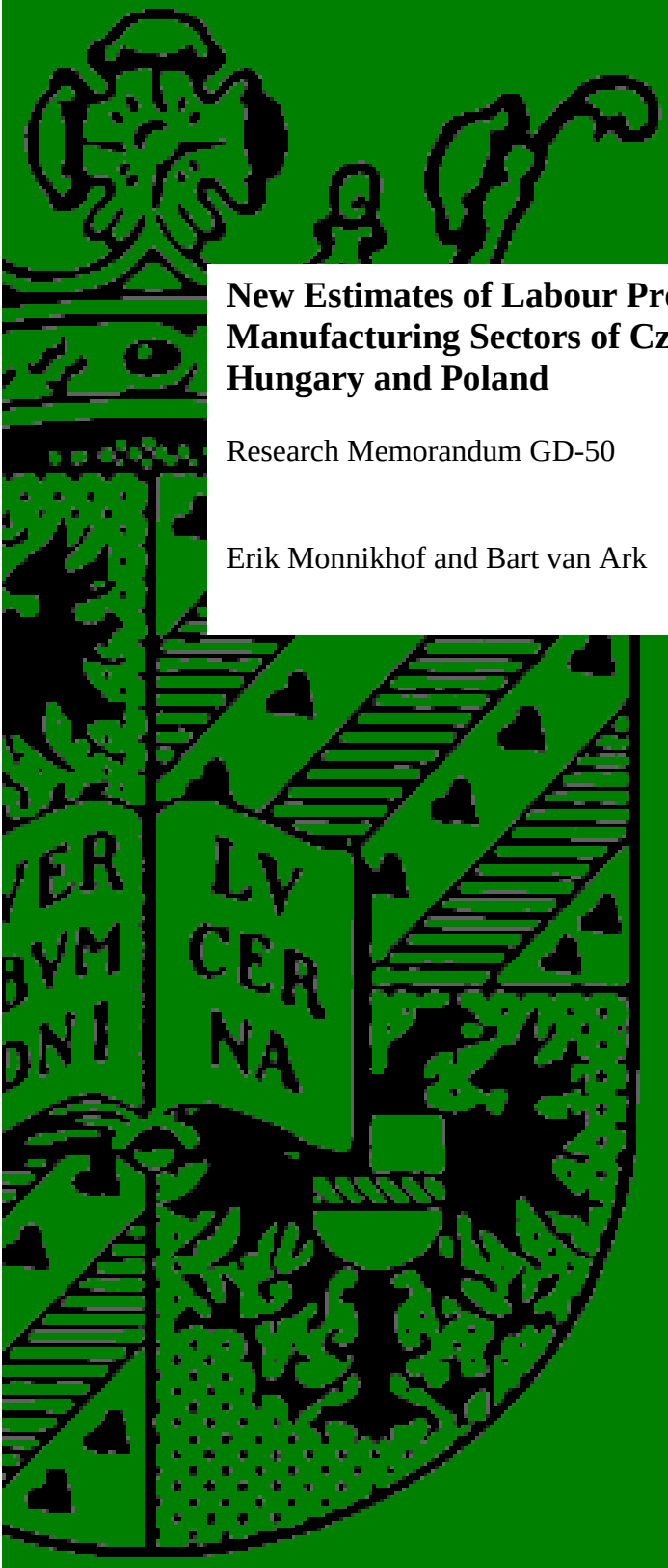
University of Groningen

Groningen Growth and Development Centre

RuG



New Estimates of Labour Productivity in the Manufacturing Sectors of Czech Republic, Hungary and Poland

Research Memorandum GD-50

Erik Monnikhof and Bart van Ark

RESEARCH MEMORANDUM

New Estimates of Labour Productivity in the Manufacturing Sectors of Czech Republic, Hungary and Poland, 1996

Research Memorandum GD-50

Erik Monnikhof and Bart van Ark

Groningen Growth and Development Centre
January 2002

New Estimates of Labour Productivity in the Manufacturing Sectors of Czech Republic, Hungary and Poland, 1996

by Erik Monnikhof and Bart van Ark*
Groningen Growth and Development Centre
University of Groningen & The Conference Board

Abstract

In this paper we provide benchmark comparisons of manufacturing unit value ratios and productivity levels for the Czech Republic, Hungary and Poland relative to Germany in 1996. On average, manufacturing prices were about half of those in Germany for all three countries. Hungary was characterised by relatively low price levels in Food Processing, but relatively high price levels in Chemicals, Rubber and Plastic Products, Non-Metallic Mineral Products and Electrical Equipment. Poland appeared weak on price competitiveness in Wood and Wood Products and Printing and Publishing. The Czech Republic has relatively low price levels in Chemicals. For Total Manufacturing, Hungary shows a clear productivity advantage despite a comparable relative price level (compare Figure 1). The Hungarian productivity advantage is in strong Food Products, Paper and Printing, and Wood Products (even though in the latter case it is benefitting from low relative price levels), but also in Machinery and Transport Equipment and in Other Manufacturing. The Polish productivity level is high in Rubber and Plastic Products, and in the Czech Republic it is high in Chemicals, which in both cases is reflected by relatively low price levels. Czech productivity is also relatively high in Non-Metallic Minerals.

* This paper is a contribution to a larger project on "CEEC's Catching-Up, Comparative Advantages and Trade Structure at Industrial Level"carried out by the Vienna Institute for International Economic Studies (WIIW).

1. Introduction.

International comparisons of productivity for transition economies are sparse. Before the transition period comparisons of growth rates and levels were hampered by differences in statistical systems, pricing techniques, etc., between the former socialist countries and the western countries. Since the early 1990s, a major overhaul in the statistical system of the transition countries complicated comparisons further. However, for recent years the quality of the statistics is sufficient to carry out new benchmark comparisons of manufacturing productivity.

The work on productivity and purchasing power parities ("unit value ratios") by industry is meant to provide an input in the project described above. The methodology is based on the industry of origin approach which has been used and further developed by the ICOP (International Comparisons of Output and Producitivity) group at the University of Groningen since 1983 for international comparisons of productivity levels[1]. For East European countries earlier ICOP benchmark comparisons have been provided for East Germany/West Germany (1987 and 1992), Hungary/West Germany (1987) Czechoslovakia/West Germany (1989), Poland/West Germany (1989) and Poland/All Germany (1993).[2] The estimates were extrapolated from benchmark years using national time series at constant prices.

In this paper we provide benchmark comparisons of manufacturing unit value ratios and productivity levels for the Czech Republic, Hungary and Poland relative to Germany in 1996. Section 2 of this paper describes the methodology by which we obtained the conversion factors we used to express productivity levels into a common currency. Section 2.1 describes the general procedure followed in the ICOP research in calculating UVRs. Sections 2.2-2.4 show the calculations for respectively the Hungary/Germany comparison, the Poland-Germany comparison, and the Czech-Germany comparison for 1996. Section 3 uses the calculated UVRs to measure labour productivity levels in manufacturing for Hungary, Poland and the Czech Republic relative to Germany. Section 4 summarises the main competitiveness indicators to be derived from this research, i.e. relative price levels and comparative productivity ratios.

2. Development of Unit Value Ratios

2.1 Introduction

To compare productivity levels between countries a conversion factor is needed to convert values (for instance gross output or value added) into a common currency. For several reasons the use of the official exchange rate is inappropriate. The exchange rate is based upon traded goods only, it is affected by exchange rate policies and currency market fluctuations, and it can change rapidly in short periods of time due to capital movements. Indeed the conversion factors computed for this study are only about half the official market exchange rate.

1 For a description and presentation of the ICOP project, see Maddison and van Ark (1994) and van Ark (1996). Summary results for 30 countries are available from the ICOP website at http://www.eco.rug.nl/ggdc.

Since the 1950s conversion factors have been calculated through the work of the International Comparisons Project (ICP), which provides purchasing power parities (PPPs) using the expenditure approach.[3] ICP concentrates on comparisons of national accounts categories such as private consumption, government consumption and capital formation. PPPs are derived at a detailed item level by gathering expenditure prices for a sample of narrowly specified products in each country. Purchasing power parities are derived from the ratios of these item prices, which are subsequently aggregated into higher level PPPs. Expenditure PPPs are available on a regular basis for most countries from the UN, EUROSTAT and the OECD.

Expenditure PPPs are less useful for international comparisons by industry of origin as they only apply to final output. For example, the output of intermediate products, which in manufacturing accounts for at least one third in value, is not covered by such PPPs at all. Other drawbacks are that expenditure PPPs include margins, and indirect taxes and subsidies. Moreover these PPPs include import prices, while export prices are excluded. Attempts have been made to apply the expenditure PPPs to industry output (the so called proxy PPPs) by adjusting these PPPs to a domestic output factor price basis, and allocating expenditure PPPs to specific industries. However, only rough adjustments could be made.[4]

For comparisons by production sectors the industry of origin approach is the appropriate method. Industry specific conversion factors are computed using output data at producer level instead of at final expenditure level. Ideally, these industry PPPs should be based on specified product prices. However, detailed output prices are not available on a large international comparable scale. As an alternative ratios of unit values (UVRs) are used. Unit values are computed by dividing the value of output for a product category by the produced quantities. A unit value can be considered as an average price, averaged throughout the year for all producers and across a group of nearly similar products. The information is mostly derived from production censuses or industrial surveys.

The unit values for the matched products are used to derive the unit value ratios (UVR). Product UVRs are aggregated in a stage wise procedure to higher levels: industry, branch and finally to total manufacturing level. An industry is defined as the lowest level at which economic activities can be compared between countries, that is where output, value added and labour input data are available for both countries. The re-weighting procedure is performed for two reasons: 1. to derive industry and branch output conversion factors which are interesting in themselves, and 2. to ensure that original product UVRs are re-weighted according to their relative importance in the aggregate.

2 For a detailed account of ICOP measures for East European countries, and the specific problems involved for comparisons for the pre-transition period, see van Ark (1996a). For historical comparisons, see Horlings and van Ark (1998).
3 See for example Kravis, Summers and Heston (1982).
4 See for example Hooper (1996). For a more detailed overview of these issues, see van Ark (1996).

Aggregation Step 1: Industry UVR's

The computation of industry UVRs is based upon two alternative indexes: the Laspeyres index, using the quantity weights of the base country ($UVR^{XU(U)}$) and the Paasche index, using the quantity weights of the other country ($UVR^{XU(X)}$). They are expressed below, respectively, for an industry j. As not all products in an industry can be matched it is assumed that the average UVR for the matched products (1,..., $I_j(M)$) is representative for the average UVR of all products (1,..,I_j) in industry j, i.e.:

$$UVR_j^{XU(U)} \equiv \frac{\sum_{i=1}^{I_j} uv_{ij}^X q_{ij}^U}{\sum_{i=1}^{I_j} uv_{ij}^U q_{ij}^U} = \frac{\sum_{i=1}^{I_j(M)} uv_{ij}^X q_{ij}^U}{\sum_{i=1}^{I_j(M)} uv_{ij}^U q_{ij}^U}$$

at quantity weights of base country U, and:

$$UVR_j^{XU(X)} \equiv \frac{\sum_{i=1}^{I_j} uv_{ij}^X q_{ij}^X}{\sum_{i=1}^{I_j} uv_{ij}^U q_{ij}^X} = \frac{\sum_{i=1}^{I_j(M)} uv_{ij}^X q_{ij}^X}{\sum_{i=1}^{I_j(M)} uv_{ij}^U q_{ij}^X}$$

at quantity weights of country X.

However, the assumption of representativeness cannot always held true. In case the average coverage percentage of the matched products in terms of total output value within the industry is lower than 25%, the assumption is not deemed justified (the so called 25%-rule of thumb[5]). To obtain a UVR for those industries that do not meet the 25 % rule we use a UVR based upon all products in the branch to which the non-matched industry belongs. The "non-matched" industries are then treated as a separate industry in each branch.

Aggregation Step 2: Branch Level UVR's

The following step is to derive branch level UVRs. These are obtained through a weighted averaging of the UVRs of industries belonging to a particular branch, using the industries' shares in the branch gross value added (GVA) as weights. With this reweighting procedure one assures that industries which are important in value will get a greater weight in the branch UVR, irrespective of their percentage of matched output (the coverage ratio). Let J_k be the number of industries in branch k ($j=1,..,J_k$). Then the UVR for branch k is given by:

[5] See van Ark (1993, p.28). For a discussion of alternative methods using a stratified sampling method instead of the rule of thumb, see Timmer (2000).

$$UVR_k^{XU(U)} = \frac{\sum_{j=1}^{J_k} GVA_j^{U(U)} \text{ X } UVR_j^{XU(U)}}{\sum_{j=1}^{J_k} GVA_j^{U(U)}}$$

at value added weights of base country U, and:

$$UVR_k^{XU(X)} = \frac{\sum_{j=1}^{J_k} GVA_j^{X(X)}}{\sum_{j=1}^{J_k} \frac{GVA_j^{X(X)}}{UVR_j^{XU(X)}}}$$

at valued added weights of country X. If no matches are made in a branch, the total manufacturing UVR is assumed to be representative.

Aggregation Step 3: Manufacturing UVR

The manufacturing sector UVR (UVR_{manu}) is derived by aggregating branch UVRs in the same way as the aggregation from industry to branch level. Let K be the number of branches in the manufacturing sector (k= 1,..,K), then:

$$UVR_{manu}^{XU(X)} = \frac{\sum_{k=1}^{K} GVA_k^{X(X)}}{\sum_{k=1}^{K} \frac{GVA_k^{X(X)}}{UVR_k^{XU(X)}}}$$

at value added weights of country X, and:

$$UVR_{manu}^{XU(U)} = \frac{\sum_{k=1}^{K} GVA_k^{U(U)} \text{ X } UVR_k^{XU(U)}}{\sum_{k=1}^{K} GVA_k^{U(U)}}$$

at valued added weights of base country U.

In case a single currency conversion factor is required, the Laspeyres and Paasche indices are combined into a Fisher index. It is defined as the geometric average of the Laspeyres and the Paasche.

2.2 Hungary-Germany, 1996

There are several reasons why we choose to compare the East European countries with Germany as the base country. Germany is an obvious choice since East European economies are strongly oriented towards the German economy. In addition, from a technical viewpoint, the German economy is large enough to cover most products produced in Eastern Europe which guarantees a sufficient number of

product matches. Moreover the quality of the German manufacturing census is good in the sense that for many products on quantities and values could be collected. The German census no longer makes a difference between former West and East Germany, except for a few variables at an aggregated level.

Both Germany and Hungary conducted an industrial product survey for 1996. In recent years a new European product classification (PRODCOM) has been introduced by Eurostat, which has been adopted by Germany and in an adapted format by Hungary. PRODCOM includes up to 4000 separate product codes. The Hungarian product survey includes quantity and value data for about 900 product codes. The Germany product list shows quantity and price figures for about 2500 product codes. This difference in product details can lartly be explained by the greater variety of products produced in Germany and confidentialy of information for the much smaller Hungarian manufacturing sector.[6] Most importantly Hungary did not publish all available product information but just the most important products in terms of output value.[7]

The first step in computing the ratio of unit values is identifying the same products in both countries (matching). Since both countries use, up to a certain level, the same product classification, matches could be made relatively easily. However, since Hungary used its own product headings below a six digit PRODCOM code, the actual identifying of similar products still had to be done product by product.

In some cases quantities had to be expressed in the same unit for which we used quantity conversion factors[8]. In both countries more than one quantity unit was in some cases. This meant UVRs depended on the quantity unit chosen. We aimed to use those units that were the most objective in terms of quality, if possible weight units. This problem is particularly important for textiles.

Step two is the matching of the industries. Although the Hungarian industry classification is considerably less detailed than in Germany (Germany had 247 four digit industries, and Hungary only 154), most industries compared well. The surveys in both countries also included a considerable amount of service activities related to manufacturing activities, such as repair and installation services.

Industry coverage ratios were calculated on the basis of the percentage of the sales value of matched products in an industry compared to the total sales value of the industry. Using the rule of thumb (a minimum output coverage of 25%) the industry was considered either matched or non-matched, and the UVR calculated from the matched products was considered either representative or not representative for non-matched products.[9] Subsequently the UVRs of the matched industries were weighted with their value added. For the non-matched industries a UVR based upon all the product matches within a branch was calculated. The latter UVR was given the weight of the value added of

[6] As Hungarian manufacturing employment is only 10% of that in Germany, a substantial part of the information is withheld for confidentiality reasons as there too few companies in many industries.
[7] The Hungarian CSO has product information on a large number of additional small products, which has not been used for this study.
[8] For this we used mostly the Economist Measurement Guide and Reckoner.
[9] Since in some cases for Hungary not all industries within a branch were known (which may lead to an underestimation of the output value and therefore an overestimation of the matched percentage) the matching percentages for Germany were given more weight in identifying matched and non-matched parts of the branch.

the non-matched industries in the branch. The outcome of this weighting procedure provided the branch UVR. A UVR for total manufacturing was then calculated as the value added weighted average of the branch UVRs.

Table 1

Number of Matches, Matching percentages and Unit Value Ratios, Hungary-Germany, 1996

Branch	Number of Matches	Percentage of Output Matched		Unit Value Ratios		
		Hungary	Germany	Hungarian Weights	German Weights	Geometric Average
Food products	48	57	58	59.4	59.3	58.8
Beverages	9	86	76	42.5	42.3	42.4
Tobacco	1	92	58	35.5	35.5	35.5
Textiles	57	38	51	44.3	44.9	44.6
Wearing apparel	48	23	35	47.3	56.3	51.6
Leather and leather products	10	19	27	47.5	54.7	51.0
Wood and wood products	13	33	52	48.6	45.2	46.9
Paper, printing and publishing	34	51	58	36.7	50.8	43.2
Refined petroleum products	9	31	22	166.0	164.4	165.2
Chemicals	62	38	22	69.7	77.7	73.6
Rubber and plastic products	27	56	61	57.3	56.4	56.8
Non-metallic mineral products	26	68	59	50.2	64.6	56.9
Basic and fabricated metal products	39	43	34	63.1	65.6	64.3
Machinery and transport equipment	32	15	10	35.4	45.8	40.3
Electrical equipment	29	34	24	49.7	70.2	59.1
Other manufacturing sectors	39	29	44	38.2	49.6	43.5
Total excl. Refining	474	43	32	48.1	57.0	52.4
Total incl. Refining	483	42	31	51.1	58.0	54.4

Exchange rate 1996: 101.44 Forint/DM
Source: See Appendix A

Table 1 shows the number of matches, the matching percentage and the resulting unit value ratios. These figures give an indication of the the distribution of the product matches between the branches within the manufacturing sector. In general more product matches and higher matching percentages are preferable to less, though the variability of the individual product UVR's within an industry and between branches can be meaningful as well.[10] We show two results for the total manufacturing sector, one inclusive oil refining activities and one exclusive oil refining activities. This was done in order to show a total comparable to that in the Poland – Germany comparison (see below) for which we had to exclude the oil refining branch.

[10] See van Ark (1993) and Timmer (2000) for a more detailed discussion of the issues in determining the quality of comparisons based upon the ICOP procedure.

In most branches the percentage of total branch output that is covered by product matches is higher for Hungary than for Germany. The most important reason for this is that the Hungarian manufacturing sector is smaller and thus has a narrower range of products. Therefore a given number of products matched will account for a larger share of total manufacturing output in Hungary than in Germany. In addition, due to the procedures used in matching products, simpler less advanced products have a higher probability of being included in the comparisons. This type of products is in general more important in the less developed economy. The matching percentages were lowest in the Machinery and Transport Equipment branch. This is related to the fact that this branch is dominated by the production of passenger cars. Due to lack of data for Hungary we were not able to include this important product in the comparison, which leads to a low matching percentage.

Table 1 also shows the unit value ratios that were calculated. Both ratios, either using the Hungarian production structure as weights or those using the German production structure as weights, as well as their geometric averages are shown. A large spread between the two is an indication of a greater difference between the production structures in both countries. As can be seen from the table there are large differences in unit value ratios between the branches.

2.3 Poland-Germany, 1996

For Poland product data for 1996 were available for about 300 products. Some mining activities were included with oil refining, which is commonly classified in manufacturing. Since it was not possible to divide these two in a satisfactory way, oil refining was excluded from the comparison. Poland uses its own product classification scheme, which is different from PRODCOM. In combination with problems in translating some of the Polish product description, the task of finding identical product categories in both countries was more difficult.

Table 2 shows the results of the Poland-Germany UVR comparison for 1996. The number of product matches was 210. Few matches were made in the electrical equipment branch, and none at all in Other Manufacturing. However, in contrast to the Hungary-Germany comparison, we were able to match passenger cars, which contributes to the relatively high percentage of output matched in machinery and transport equipment. Although the number of product matches is only about half that of the Hungary-Germany comparison, the percentage of output covered by these matches is slightly higher. This implies that the level of aggregation of the product matches is higher, and the problems resulting from aggregation may therefore be more important. The unit value ratio for Total Manufacturing was about 54 percent of the 1996 exchange rate level (the ratio between UVR and exchange rate is an indicator of the relative price level). Again we find that the resulting UVRs differ greatly between branches.

Table 2

Number of Matches, Matching percentages and Unit Value Ratios, Poland-Germany, 1996

Branch	Number of Matches	Percentage of Output Matched		Unit Value Ratios		
		Poland	Germany	Polish Weights	German Weights	Geometric Average
Food products, beverages	52	67	59	1.07	1.23	1.14
Tobacco	2	75	63	0.50	0.50	0.50
Textiles	23	49	38	0.72	1.03	0.86
Wearing apparel	9	39	30	0.47	0.46	0.47
Leather and leather products	4	52	33	0.71	0.76	0.73
Wood and wood products	9	26	33	1.08	1.23	1.15
Paper, printing and publishing	4	26	40	1.28	1.46	1.36
Chemicals	22	32	24	1.01	1.13	1.07
Rubber and plastic products	9	53	51	0.60	0.54	0.56
Non-metallic mineral products	21	41	45	0.79	0.84	0.81
Basic and fabricated metal products	32	46	45	1.00	1.23	1.11
Machinery and transport equipment	17	34	23	0.60	0.88	0.73
Electrical equipment	6	20	6	0.55	1.43	0.89
Other manufacturing sectors*	0	0	0	0.85	1.12	0.97
Total excl. Refining	210	52	31	0.80	1.06	0.92

* - For the sector other manufacturing we used the UVR for total manufacturing.

Exchange rate 1996: 1.794 Zloty/DM.

Source: See Appendix A

2.4 Czech Republic-Germany, 1996

The data on the quantities and values of manufacturing products for the Czech Republic in 1996 are not published. However, we were given access to data provided by the Czech Statistical Office for about 450 products, which represented the most important items in terms of output value. These product data excluded information on the production of wearing apparel. The Czech Republic uses a classification related to PRODCOM.

Table 3

Number of Matches, Matching percentages and Unit Value Ratios, Czech Republic-Germany, 1996

Branch	Number of Matches	Percentage of Output Matched		Unit Value Ratios		
		Czech Republic	Germany	Czech Weights	German Weights	Geometric Average
Food products, beverages, tobacco	74	91	76	9.8	12.0	10.9
Textile and Wearing apparel	38	60	46	7.5	8.9	8.2
Leather and leather products	4	60	41	8.2	8.9	8.5
Wood and wood products	15	66	80	8.5	8.4	8.4
Paper, printing and publishing	33	63	74	10.8	13.6	12.1
Refined petroleum products	7	32	21	8.0	5.3	6.5
Chemicals	77	53	27	6.8	9.4	8.0
Rubber and plastic products	28	84	75	7.5	8.4	7.9
Non-metallic mineral products	28	52	55	7.1	8.9	8.0
Basic and fabricated metal products	60	55	52	10.2	12.1	11.1
Machinery and transport equipment	25	15	21	6.6	8.6	7.5
Electrical equipment	34	27	25	7.7	10.3	8.9
Other manufacturing sectors *	6	7	4	8.0	10.0	9.0
Total excl. Refining	422	51	38	7.8	9.9	8.8
Total incl. Refining	429	50	38	8.0	10.0	9.0

* - For the sector other manufacturing we used the UVR for total manufacturing.
Exchange rate 1996: 18.04 Kc/DM.
Source: See Appendix A

Table 3 shows the results of the Czech Republic-Germany comparison. Few matches were made in Other Manufacturing. Hence in accordance with other ICOP comparisons for this branch we used the UVR for Total Manufacturing. Like in the Poland-Germany comparison we were able to match passenger cars, which contributed to a relatively high percentage of output matched in Machinery and Transport equipment. The unit value ratio for Total Manufacturing was about 50 percent of the 1996 exchange rate level (the ratio between UVR and exchange rate is an indicator of the relative price level).

3. Labour Productivity Estimates

3.1 Hungary

For Hungary the figures on production quantities and sales value of products refer to enterprises with more than 20 employees. Industry employment data refers to enterprises with more than 20 employees as well, but industry output figures refer to enterprises with more than 10 employees. In order to adjust for the latter, we made use the Hungarian Statistical Yearbook, 1996, which provides value added and output data for enterprises employing over 20 employees on a two digit level. These figures were subsequently linked to the employment data and divided between three digit industries using the distribution of output between the industries for enterprises with more than 10 employees. This means that although all data refer to enterprises with more than 20 employees for Hungary, we used a different source for the employment and output and the ratio of value added to gross output data. All data for Germany refers to enterprises with more than 20 employees.[11]

In addition to adjusting figures to represent the same size class of enterprises, the definitions of the variables were checked to ensure comparability. Employment as used here is the total of all employees, part time and full time, excluding proprietors. Both manual and non-manual employees are included. In Hungary this includes pensioners, and people with a labour relation with the enterprise without discontinuing their pension.

Gross output represents the value of the output and service activities related to industry performed. Value added is defined as the gross output value from which the value of intermediate consumption - the value of goods and services used for the production - are subtracted. The Hungarian CSO uses the recommendations of the internationally harmonised system of national accounts (SNA93) in order to calculate value added. Both are at factor cost, in other words corrected for consumption taxes, value added taxes and other indirect taxes or subsidies.

When combining the UVRs from section 2 with the output and employment measures we can calculate levels of labour productivity for Hungary relative to Germany. Table 4 shows the results, showing two measures of labour productivity, namely gross output and value added per person employed. Because the ratio of intermediate inputs to gross output can differ between countries the preferred measure of labour productivity is value added per person employed. In the present case both productivity measures show comparable relative levels for Total Manufacturing, because the ratio of Value Added to Gross Output (or in other words the share of intermediate inputs in production) is quite similar between Hungary (30 percent) and Germany (31 percent). However, there are more substantial differences between the two countries at the branch level.

The relative level of labour productivity in Hungarian manufacturing was 38.0 percent of that in Germany. The distribution among the branches suggests a relatively good performance in the Wood and Wood Products, Paper, Printing and Publishing and Machinery and Transport Equipment.

[11] See for the underlying data on output and employment in Appendix B.

Textiles, Chemicals and Oil refining and Leather and Leather products showed relatively low productivity levels (see also figure 2 below).

Table 4

Output per Person and Value Added per person, Hungary and Germany, 1996

Branch	Gross Output per Person			Value Added per Person		
	Hungary	Germany		Hungary	Germany	
	1000 DM	1000 DM	Ratio	1000 DM	1000 DM	Ratio
Food products	155	376	41.3	32	77	42.1
Beverages	231	490	47.1	49	133	36.4
Tobacco	460	855	53.8	127	226	56.0
Textiles	54	243	22.2	20	77	26.6
Wearing apparel	36	268	13.4	21	66	31.2
Leather and leather products	35	269	13.1	18	73	24.8
Wood and wood products	128	264	48.4	46	84	54.9
Paper, printing and publishing	205	306	67.2	65	114	56.9
Refined petroleum products	122	3,714	3.3	43	276	15.6
Chemicals	128	459	27.9	43	140	30.4
Rubber and plastic products	141	265	53.3	44	96	46.2
Non-metallic mineral products	92	274	33.5	36	103	35.4
Basic and fabricated metal products	115	277	41.5	32	96	33.9
Machinery and transport equipment	208	350	59.5	60	110	54.4
Electrical equipment	107	320	33.3	36	106	33.7
Other manufacturing sectors *	111	226	49.0	49	87	59.9
Total excl. Refining	129	326	39.6	39	104	37.3
Total incl. Refining	131	338	38.7	40	104	38.0

* - For the sector other manufacturing we used the UVR for total manufacturing.

Source: Table 1 and appendix table B1.

3.2 Poland

For Poland, industry data at a slightly more disaggregated level than that of the branch was obtained from the *Statistical Yearbook of the Republic of Poland* for 1998. These figures refer to enterprises employing over 20 employees. This source contained data on gross output, value added and employment. As was the case for the Hungary-Germany comparison, we made no attempt to calculate productivity levels on an hourly basis. In order to obtain an industry weighting system at a more disaggregated level we used information from the *1997 Yearbook of Industry*.

Table 5 shows the results in terms of labour productivity for Poland relative to Germany. As can be seen from the table the relative productivity levels in Polish manufacturing were 25.4 percent for gross output per person employed and 24.9 percent for value added per person employed respectively. The higher outcome in terms of value added per person employed is due to the slightly

lower ratio of intermediate inputs used in Poland as compared to Germany. The ratio of value added to gross output was 34 percent in Poland and 31 percent in Germany.

Overall the relative productivity levels in Polish manufacturing were below those in Hungary. However, when we comparing relative productivity levels for branches we find less variability between branches in Poland as compared to Hungary (see also figure 2 below).

Table 5

Output per Person and Value Added per person, Poland and Germany, 1996

Branch	Gross Output per Person			Value Added per Person		
	Poland	Germany		Poland	Germany	
	1000 DM	1000 DM	Ratio	1000 DM	1000 DM	Ratio
Food products, beverages	96	395	24.2	20	85	23.6
Tobacco	343	855	40.2	90	226	39.6
Textiles	54	243	22.2	20	77	25.5
Wearing apparel	52	268	19.5	24	66	36.8
Leather and leather products	51	273	18.8	19	74	25.8
Wood and wood products	52	264	19.5	17	84	20.5
Paper, printing and publishing	80	306	26.1	29	114	25.5
Chemicals	129	459	28.2	41	140	29.1
Rubber and plastic products	157	265	59.2	54	96	56.5
Non-metallic mineral products	78	274	28.5	31	103	29.8
Basic and fabricated metal products	75	281	26.6	23	96	23.9
Machinery and transport equipment	103	360	28.5	33	110	30.1
Electrical equipment	94	320	29.2	33	106	31.3
Other manufacturing sectors *	56	226	24.7	21	87	23.6
Total	83	328	25.4	26	104	24.9

* - For the sector other manufacturing we used the UVR for total manufacturing.

Note: Refining included some products usually included with Mining. Estimates refer to enterprises with 20 or more persons employed

Source: Table 2 and appendix table B2.

Labour productivity in Poland turned out to be considerably lower than that in Hungary. Still Poland performed relatively well in the branches Tobacco, Wearing Apparel, Rubber and Plastic products and in Electrical Equipment, but productivity levels were below average in Food Products and Beverages and in Wood Products.

3.3 Czech Republic

For the Czech Republic figures on industrial output and employment were taken from CSU, *Industry of the Czech Republic, 1996.* Again the industries are fairly aggregated compared to the German classification. Compared to the other two binary comparisons, the Czech industry figures differ in two important ways. Firstly they refer only to enterprises employing over 100 employees (in the other two

comparisons they refer to enterprises employing over 20 employees). Secondly the figures for employment are for employees only, whereas a more encompassing definition which also includes self-employed persons was included in the previous two cases. These differences limit the comparability between the Czech Republic-German comparison on the one hand, and the Hungary-Germany and Poland-Germany comparisons on the other.

The relative productivity level measured in value added terms came out at only 26.7 percent of the German level in 1996, which was only slightly higher than in Poland. However, in gross output terms, the Czech manufacturing sector performed much better since the ratio of value added to gross output in the Czech Republic was substantially lower (24 percent) than in Germany (31 percent). Relative to Germany, Chemicals and oil refining, Rubber and Plastic products and Non-metallic mineral products showed relatively high productivity levels in the Czech Republic. The lowest relative productivity level was found for Paper, Printing and Publishing.

Table 6

Output per Person and Value Added per person, Czech Republic and Germany, 1996

Branch	Gross Output per Person			Value Added per Person		
	Czech Republic	Germany		Czech Republic	Germany	
	1000 DM	1000 DM	Ratio	1000 DM	1000 DM	Ratio
Food products, beverages, tobacco	157	455	34.5	33	96	33.8
Textiles, wearing apparel	70	270	25.7	20	77	26.5
Leather and leather products	63	307	20.6	19	75	25.7
Wood and wood products	101	296	34.1	25	93	27.5
Paper, printing and publishing	106	331	31.9	27	196	13.8
Refined petroleum products	1,595	3,868	41.2	105	284	37.0
Chemicals	249	464	53.6	62	142	43.4
Rubber and plastic products	127	279	45.5	39	99	38.8
Non-metallic mineral products	119	276	43.2	45	106	42.3
Basic and fabricated metal products	120	305	39.4	24	101	23.9
Machinery and transport equipment	122	367	33.1	32	113	28.5
Electrical equipment	82	335	24.5	26	109	23.9
Other manufacturing sectors *	81	246	32.8	25	92	27.3
Total excl. Refining	123	351	35.0	31	114	27.3
Total incl. Refining	125	365	34.3	31	114	26.7

* - For the sector other manufacturing we used the UVR for total manufacturing.

Source: Table 3 and appendix table B3.

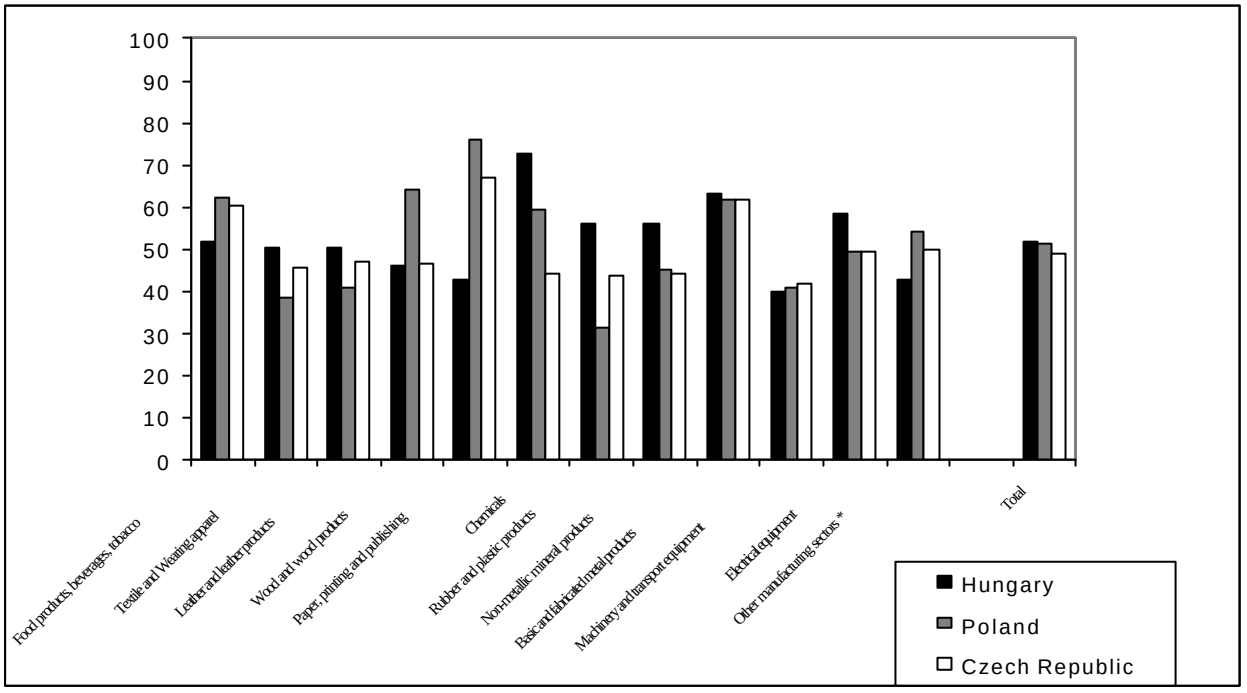
4. Competitiveness Indicators

4.1 Price Competitiveness

Figure 1 shows the distribution of the relative price levels (measured as the UVRs divided by the exchange rate) among branches for all three countries, which provides an indication of the price competitiveness of these branches. On average, manufacturing prices were about half of those in Germany for all three countries. Hungary was characterised by relatively low price levels in Food Processing, but relatively high price levels in Chemicals, Rubber and Plastic Products, Non-Metallic Mineral Products and Electrical Equipment. Poland appeared weak on price competitiveness in Wood and Wood Products and Printing and Publishing. The Czech Republic has relatively low price levels in Chemicals.[12]

Figure 1

Relative Price Levels (Unit Value Ratio divided by Exchange Rate, Hungary-Germany, Poland-Germany, Czech Republic-Germany, 1996



Source: Tables 1 to 3

The spread between the results using Hungarian weights and German weights was considerably lower than the comparable price spreads for the Poland-Germany and Czech Republic-Germany comparisons (see Tables 1 to 3). When we compare the Paasche and Laspeyres results in the case of Hungary the spread is about 13 percent of the geometric average. In the case of the Poland-

[12] Figure 1 excludes the relative price level for Refined Petroleum Products. The composition of oil products and the excise tax structure shows relative price levels which are not representative of actual price competitiveness. The relative price level for this branch is also excluded from the result for Total Manufacturing (see Tables 1 and 3 for results including Refined Petroleum Products for Hungary-Germany and Czech Republic-Germany.

Germany comparison this figure is 29 percent, and for the Czech Republic-Germany comparisons it is 23 percent. This suggests that the price structure in Hungary was more alike that of Germany than in the other two East European countries.

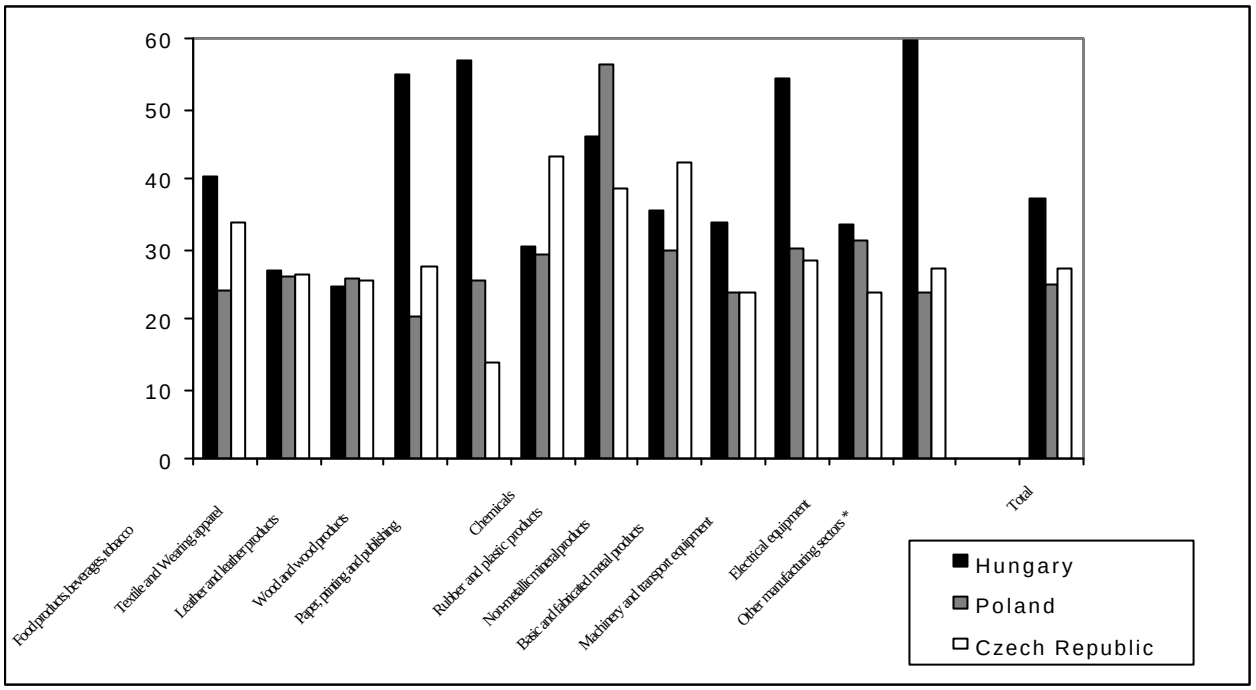
4.2 Productivity Competitiveness

Figure 2 shows competitiveness in terms of productivity. For Total Manufacturing, Hungary shows a clear productivity advantage despite a comparable relative price level (compare Figure 1). The Hungarian productivity advantage is in strong Food Products, Paper and Printing, and Wood Products (even though in the latter case it is benefitting from low relative price levels), but also in Machinery and Transport Equipment and in Other Manufacturing. The Polish productivity level is high in Rubber and Plastic Products, and in the Czech Republic it is high in Chemicals, which in both cases is reflected by relatively low price levels. Czech productivity is also relatively high in Non-Metallic Minerals.

These indicators do of course not provide a full picture of competitiveness. This would also require measures of costs. In particular this research could be usefully extended with comparisons of unit labour cost. Furthermore, as mentioned before, these indicators may not fully take account of important quality differences which reduce the price competiveness and productivity levels of these countries. In particular, measures of product variety and detailed product characteristics would be useful extension for the present data.

Figure 2

Comparative Levels of Value Added per Person Employed in Manufacturing, Hungary-Germany, Poland-Germany, Czech Republic-Germany, 1996 (Germany=100)



Note: Hungary and Czech Republic relative to Germany refers to enterprises with 20 or more employees. Czech Republic relative to Germany refers to enterprises with 100 or more employees.

Source: Tables 4 to 6

Appendix A. Sources used for the benchmark comparisons of labour productivity, Germany, Hungary, the Czech Republic and Poland, 1996.

(Industry data for Hungary and Poland refer to establishments employing 20 or more employees, for the Czech Republic figures refer to establishments employing 100 or more employees)

Germany

Quantities and Values of Output on product level:

Statistisches Bundesamt, *Produzierendes Gewerbe, fachserie 4, reihe 3.1, Produktion im Produzierenden Gewerbe* 1997, Wiesbaden, 1998.

Industry data on Output and Employment:

Gross Output, Value Added and Employment from:

Statistisches Bundesamt, *Produzierendes Gewerbe, fachserie 4, reihe 4.3, Kostenstruktur der Unternehmen der Verarbeitenden Gewerbes sowie des Bergbaus und der Gewinnung von Steinen und Erden*, 1997, Wiesbaden, 1998.

Hungary

Quantities and Values of Output on product level:

Kozponti Statisztikai Hivatal, Ipari es Epitoipari Statisztikai Evkonyv, 1997 (Hungarian Central Statistical Office, Yearbook of Industrial and Construction Statistics, 1997), Budapest, 1998.

Industry data on Output and Employment:

Gross Output and Employment from:

Kozponti Statisztikai Hivatal, Ipari es Epitoipari Statisztikai Evkonyv, 1997 (Hungarian Central Statistical Office, Yearbook of Industrial and Construction Statistics, 1997), Budapest, 1998.

Ratio Value added to Gross Output from:

Kozponti Statisztikai Hivatal, Magyar Statisztikai Evkonyv, 1996 (Hungarian Central Statistical Office, Statistical Yearbook of Hungary, 1996), Budapest, 1997.

Czech Republic

Quantities and Values of Output on product level:

These data were not published for 1996, and were provided to us by the industrial statistics division of the Czech Statistical Office.

Industry data on Output and Employment:

Cesky Statististicky Urad, Prumysl Caske Republiky, za leden az prosinec 1996 (Czech Statistical Office, Industry of the Czech Republic, 1996), 1997.

Cesky Statististicky Urad, Vybrane Financni Ukazatele v Prumyslu CR v roce 1996 (Czech Statistical Office, Industry of the Czech Republic, Selected Financial Indicators, 1996), 1997.

Cesky Statististicky Urad, Statisticka Rocenka Ceske Republiky (Czech Statistical Office, Statistical Yearbook of the Czech Republic, 1997), 1998.

Poland

Quantities and Values of Output on product level:

Glowny Urzad Statystyczny, Produkcja Wyrobow Przemyslowych w 1996 R. (Central Statistical Office, Industrial Production 1996), Warsaw 1997.

Industry data on Output and Employment:

Gross Output, Value Added and Employment from:

Glowny Urzad Statystyczny, Rocznik Statystyczny 1998, (Central Statistical Office, Statistical Yearbook of the Republic of Poland, 1998), Warsaw 1999.

lowny Urzad Statystyczny, Rocznik Statystyczny Przemyslu 1997, (Central Statistical Office, Statistical Yearbook of Industry, 1997), Warsaw 1997.

Appendix B. Data on Gross Output, Value Added and Employment on branch level, Hungary, Czech Republic, Poland and Germany, 1996.

Table B1

Output, Value Added and Employment, Hungary-Germany, 1996

Branch	Hungary Gross Output Mil. Forint	Value Added Mil. Forint	Employ-ment 1000's	Germany Gross Output Mil. DM	Value Added Mil. DM	Employ-ment 1000's
Food products	998,780	208,793	109.4	189,841	38,944	505.0
Beverages	112,910	23,604	11.5	38,892	10,538	79.4
Tobacco	36,317	10,002	2.2	11,330	2,999	13.2
Textiles	115,921	44,036	38.0	31,439	9,942	129.2
Wearing apparel	88,300	50,927	55.1	21,835	5,414	81.6
Leather and leather products	40,775	20,867	22.7	7,117	1,929	26.5
Wood and wood products	95,606	34,689	16.0	30,600	9,778	115.8
Paper, printing and publishing	240,595	76,216	27.2	127,558	47,713	417.5
Refined petroleum products	316,711	111,134	15,7	77,772	5,777	20,9
Chemicals	407,826	136,074	43,3	233,311	71,446	508,7
Rubber and plastic products	170,466	53,298	21.2	91,909	33,168	346.9
Non-metallic mineral products	158,295	62,857	30.3	69,706	26,236	254.8
Basic and fabricated metal products	485,101	136,803	65.5	234,185	80,683	844.0
Machinery and transport equipment	703,587	202,280	83.9	677,335	213,014	1934.9
Electrical equipment	346,852	116,057	55.1	200,206	66,221	624.7
Other manufacturing sectors	166,562	73,294	34.5	102,006	39,391	450.9
Total excl. Refining	4,167,893	1,249,797	615,9	2,067,271	657,417	6,333,3
Total incl. Refining	4,484,604	1,360,931	631.6	2,145,043	663,193	6354.2

Table B2

Output, Value Added and Employment, Poland-Germany, 1996

Branch	Poland Gross Output Mil. Zloty	Value Added Mil. Zloty	Employ-Ment 1000's	Germany Gross Output Mil. DM	Value Added Mil. DM	Employ-ment 1000's
Food products, beverages	60,539	12,658	552,4	222,935	47,972	564.1
Tobacco	2,281	596	13,3	11,330	2,999	13.2
Textiles	7,538	2,735	161,6	31,439	9,942	129.2
Wearing apparel	7,706	3,597	316,6	21,835	5,414	81.6
Leather and leather products	3,422	1,274	90,9	7,117	1,929	26.0
Wood and wood products	8,904	2,996	149,8	30,600	9,778	115.8
Paper, printing and publishing	14,372	5,272	132,3	126,796	47,451	415.0
Chemicals	19,465	6,161	140,6	233,328	71,464	508,7
Rubber and plastic products	9,975	3,431	112,5	91,909	33,168	346.9
Non-metallic mineral products	11,819	4,661	186,6	69,706	26,236	254.9
Basic and fabricated metal products	30,264	9,291	365,9	234,205	80,703	844.0
Machinery and transport equipment	38,251	12,373	510,3	677,335	213,014	1,935.0
Electrical equipment	12,140	4,306	146,0	200,206	66,221	624.7
Other manufacturing sectors	13,689	5,065	251,9	102,006	39,391	450.9
Total	240,364	74,415	3,130	1,919,503	606,091	5,847

Sources: see appendix A.

Table B3

Output, Value Added and Employment, Czech Republic-Germany, 1996.

Branch	Czech Republic		Employees	Germany		Employees
	Gross Output	Value Added		Gross Output	Value Added	
	Mil. Kc.	Mil. Kc.	1000's	Mil. DM	Mil. DM	1000's
Food products, beverages, tobacco	178,952	37,155	105	195,288	41,307	429
Textiles and wearing apparel	56,764	16,638	100	40,742	11,604	151
Leather and leather products	13,519	4,112	25	5,180	1,265	17
Wood and wood products	16,149	4,070	19	19,605	6,135	66
Paper, printing and publishing	47,521	12,159	37	101,815	60,165	307
Refined petroleum products	51,761	3,405	5	77,347	5,676	20
Chemicals	93,495	23,170	47	220,623	67,578	475
Rubber and plastic products	30,267	9,186	30	73,152	26,044	262
Non-metallic mineral products	56,809	21,331	60	50,853	19,500	184
Basic and fabricated metal products	235,121	46,999	176	188,901	62,423	620
Machinery and transport equipment	219,323	58,081	239	630,942	194,008	1,720
Electrical equipment	66,022	20,838	90	186,395	60,523	556
Other manufacturing sectors	36,195	11,245	50	78,462	29,282	318
Total excl. Refining	1,050,137	264,984	978	1,791,959	579,833	5,107
Total incl. Refining	1,101,898	268,389	983	1,869,305	585,509	5,127

Note: Estimates refer to enterprises with 100 or more persons employed only

Sources: see appendix A.

References

B. van Ark (1993), International Comparisons of Output and Productivity, Ph.D. thesis, Monograph Series No.1, Groningen Growth and Development Centre.

B. van Ark (1995), "Produccion y productividad en el sector manufacturero español. Un analisis comparativo 1950-1992", *Información Comercial Española. La actividad empresarial en España*, Madrid, October, no. 746, pp. 67-77.

B. van Ark (1996), "Issues in Measurement and International Comparison of Productivity - An Overview", in OECD, *Industry Productivity. International Comparisons and Measurement Issues*, Paris, pp.19-47.

B. van Ark (1996a), "Convergence and Divergence in the European Periphery: Productivity in Eastern and Southern Europe in Retrospect", in B. van Ark and N.F.R. Crafts, eds., *Quantitative Aspects of Post-War European Economic Growth*, CEPR/Cambridge University Press, pp. 271-326.

B. van Ark and R.D.J. Kouwenhoven (1994), "La productivité du secteur manufacturier français en comparaison internationale", *Économie Internationale*, no. 60, Centre d'Études Prospectives et d'Informations Internationales (CEPII), Paris, 4th quarter.

B. van Ark and A. Maddison (1994), "An International Comparison of Purchasing Power, Real Output, and Productivity in Manufacturing Industries: Brazil, Mexico and the USA in 1975", *Research Memorandum*, no. 569 (GD-8), Groningen Growth and Development Centre.

J.E. Birnie (1996), "Comparative Productivity in Ireland: The Impact of Transfer Pricing and Foreign Ownership", in K. Wagner and B. van Ark, eds., International Productivity Differences. Measurement and Explanations, North Holland, pp. 194-223.

M. Freudenberg and D. Ünal-Kesenci (1994), "France-Allemagne: prix et productivité dans le secteur manufacturier", *Economie Internationale*, no. 60, CEPII, pp. 33-70.

P. Hooper (1996), "Comparing Manufacturing Output Levels Among the Major Industrial Countries", in OECD, *Industry Productivity. International Comparisons and Measurement Issues*, Paris, pp. 263-292.

G. de Jong (1996), "Canada's Postwar Manufacturing Performance. A Comparison with the United States", *Research Memorandum GD-32*, Groningen Growth and Development Centre.

R.D.J. Kouwenhoven (1996), "A Comparison of Soviet and US Industrial Performance", *Research Memorandum GD-29*, Groningen Growth and Development Centre, Groningen.

I.B. Kravis, Heston, A. and Summers, R. (1982), *World Product and Income*, John Hopkins, Baltimore.

B.Z. Liberda, E.J. Monnikhof and B. van Ark (1996), "Manufacturing Productivity Performance in Poland and West Germany in 1989", *Economic Discussion Papers*, No. 25, Faculty of Economic Sciences, University of Warsaw, May.

M. Maliranta (1994), Comparative levels of labour productivity in Swedish, Finnish and American manufacturing, Helsinki School of Economics, mimeographed.

E.J. Monnikhof, (1998), "Productivity Performance in Manufacturing, Hungary and West Germany, 1987" Mimeographed, Groningen Growth and Development Centre, University of Groningen.

L. Peres Lopes (1994), "Manufacturing Productivity in Portugal in a Comparative Perspective", *Notas Economicas no. 4*, Universidade de Coimbra.

A. Soete (1994), "The Evolution of the Competitiveness of the Belgian Manufacturing Industry in the Long Run, 1880-1990", paper presented at the Economics Department of the Catholic University Leuven.

A. Szirmai and R. Ren (1998), "China's Manufacturing Performance in Comparative Perspective", in M. Fouquin and F. Lemoine, eds., *The Chinese Economy*, Economica, London, pp. 49-64.

M.P. Timmer (2000), *The Dynamics of Asian Manufacturing. A Comparative Perspective, 1963-1993*, Edward Elgar Publishers, Northampton.

Papers issued in the series of the Groningen Growth and Development Centre

Papers marked * are also available in pdf-format on the internet: http://www.eco.rug.nl/ggdc/

536 (GD-1) Maddison, Angus and Harry van Ooststroom, The International Comparison of Value Added, Productivity and Purchasing Power Parities in Agriculture (1993)

537 (GD-2) Mulder, Nanno and Angus Maddison, The International Comparison of Performance in Distribution: Value Added, Labour Productivity and PPPs in Mexican and US Wholesale and Retail Trade 1975/7 (1993)

538 (GD-3) Szirmai, Adam, Comparative Performance in Indonesian Manufacturing, 1975-90 (1993)

549 (GD-4) de Jong, Herman J., Prices, Real Value Added and Productivity in Dutch Manufacturing, 1921-1960 (1993)

550 (GD-5) Beintema, Nienke and Bart van Ark, Comparative Productivity in East and West German Manufacturing before Reunification (1993)

567 (GD-6) Maddison, Angus and Bart van Ark, The International Comparison of Real Product and Productivity (1994)

568 (GD-7) de Jong, Gjalt, An International Comparison of Real Output and Labour Productivity in Manufacturing in Ecuador and the United States, 1980 (1994)

569 (GD-8) van Ark, Bart and Angus Maddison, An International Comparison of Real Output, Purchasing Power and Labour Productivity in Manufacturing Industries: Brazil, Mexico and the USA in 1975 (1994) (second edition)

570 (GD-9) Maddison, Angus, Standardised Estimates of Fixed Capital Stock: A Six Country Comparison (1994)

571 (GD-10) van Ark, Bart and Remco D.J. Kouwenhoven, Productivity in French Manufacturing: An International Comparative Perspective (1994)

572 (GD-11) Gersbach, Hans and Bart van Ark, Micro Foundations for International Productivity Comparisons (1994)

573 (GD-12) Albers, Ronald, Adrian Clemens and Peter Groote, Can Growth Theory Contribute to Our Understanding of Nineteenth Century Economic Dynamics (1994)

574 (GD-13) de Jong, Herman J. and Ronald Albers, Industrial Output and Labour Productivity in the Netherlands, 1913-1929: Some Neglected Issues (1994)

575 (GD-14) Mulder, Nanno, New Perspectives on Service Output and Productivity: A Comparison of French and US Productivity in Transport, Communications Wholesale and Retail Trade (1994)

576 (GD-15) Maddison, Angus, Economic Growth and Standards of Living in the Twentieth Century (1994)

577 (GD-16) Gales, Ben, In Foreign Parts: Free-Standing Companies in the Netherlands around the First World War (1994)

578 (GD-17) Mulder, Nanno, Output and Productivity in Brazilian Distribution: A Comparative View (1994)

579 (GD-18) Mulder, Nanno, Transport and Communication in Mexico and the United States: Value Added, Purchasing Power Parities and Productivity (1994)

580 (GD-19) Mulder, Nanno, Transport and Communications Output and Productivity in Brazil and the USA, 1950-1990 (1995)

581 (GD-20)	Szirmai, Adam and Ren Ruoen, China's Manufacturing Performance in Comparative Perspective, 1980-1992 (1995)
GD-21	Fremdling, Rainer, Anglo-German Rivalry on Coal Markets in France, the Netherlands and Germany, 1850-1913 (December 1995)
GD-22	Tassenaar, Vincent, Regional Differences in Standard of Living in the Netherlands, 1800-1875. A Study Based on Anthropometric Data (December 1995)
GD-23	van Ark, Bart, Sectoral Growth Accounting and Structural Change in Postwar Europe (December 1995)
GD-24	Groote, Peter, Jan Jacobs and Jan Egbert Sturm, Output Responses to Infrastructure in the Netherlands, 1850-1913 (December 1995)
GD-25	Groote, Peter, Ronald Albers and Herman de Jong, A Standardised Time Series of the Stock of Fixed Capital in the Netherlands, 1900-1995 (May 1996)
GD-26	van Ark, Bart and Herman de Jong, Accounting for Economic Growth in the Netherlands since 1913 (May 1996)
GD-27*	Maddison, Angus and D.S. Prasada Rao, A Generalized Approach to International Comparisons of Agricultural Output and Productivity (May 1996)
GD-28	van Ark, Bart, Issues in Measurement and International Comparison of Productivity - An Overview (May 1996)
GD-29*	Kouwenhoven, Remco, A Comparison of Soviet and US Industrial Performance, 1928-90 (May 1996)
GD-30	Fremdling, Rainer, Industrial Revolution and Scientific and Technological Progress (December 1996)
GD-31	Timmer, Marcel, On the Reliability of Unit Value Ratios in International Comparisons (December 1996)
GD-32	de Jong, Gjalt, Canada's Post-War Manufacturing Performance: A Comparison with the United States (December 1996)
GD-33	Lindlar, Ludger, "1968" and the German Economy (January 1997)
GD-34	Albers, Ronald, Human Capital and Economic Growth: Operationalising Growth Theory, with Special Reference to The Netherlands in the 19th Century (June 1997)
GD-35	Brinkman, Henk-Jan, J.W. Drukker and Brigitte Slot, GDP per Capita and the Biological Standard of Living in Contemporary Developing Countries (June 1997)
GD-36	de Jong, Herman, and Antoon Soete, Comparative Productivity and Structural Change in Belgian and Dutch Manufacturing, 1937-1987 (June 1997)
GD-37	Timmer, M.P., and A. Szirmai, Growth and Divergence in Manufacturing Performance in South and East Asia (June 1997)
GD-38*	van Ark, B., and J. de Haan, The Delta-Model Revisited: Recent Trends in the Structural Performance of the Dutch Economy (December 1997)
GD-39*	van der Eng, P., Economics Benefits from Colonial Assets: The Case of the Netherlands and Indonesia, 1870-1958 (June 1998)
GD-40*	Timmer, Marcel P., Catch Up Patterns in Newly Industrializing Countries. An International Comparison of Manufacturing Productivity in Taiwan, 1961-1993 (July 1998)
GD-41*	van Ark, Bart, Economic Growth and Labour Productivity in Europe: Half a Century of East-West Comparisons (October 1999)

GD-42* Smits, Jan Pieter, Herman de Jong and Bart van Ark, Three Phases of Dutch Economic Growth and Technological Change, 1815-1997 (October 1999)

GD-43* Fremdling, Rainer, Historical Precedents of Global Markets (October 1999)

GD-44* van Ark, Bart, Lourens Broersma and Gjalt de Jong, Innovation in Services. Overview of Data Sources and Analytical Structures (October 1999)

GD-45* Broersma, Lourens and Robert McGuckin, The Impact of Computers on Productivity in the Trade Sector: Explorations with Dutch Microdata (October 1999, Revised version June 2000)

GD-46* Sleifer, Jaap, Separated Unity: The East and West German Industrial Sector in 1936 (November 1999)

GD-47* Rao, D.S. Prasada and Marcel Timmer, Multilateralisation of Manufacturing Sector Comparisons: Issues, Methods and Empirical Results (July 2000)

GD-48* Vikström, Peter, Long term Patterns in Swedish Growth and Structural Change, 1870-1990 (July 2001)

GD-49* Wu, Harry X., Comparative labour productivity performance in Chinese manufacturing, 1952-1997: An ICOP PPP Approach (July 2001)

GD-50* Monnikhof, Erik and Bart van Ark, New Estimates of Labour Productivity in the Manufacturing sectors of Czech Republic, Hungary and Poland, 1996 (January 2002)

Groningen Growth and Development Centre Research Monographs:

Monographs marked * are also available in pdf-format on the internet

No. 1* van Ark, Bart, International Comparisons of Output and Productivity: Manufacturing Productivity Performance of Ten Countries from 1950 to 1990 (1993) (http://www.eco.rug.nl/GGDC/pub/Arkbook.shtml)

No. 2 Pilat, Dirk, The Economics of Catch-Up: The Experience of Japan and Korea (1993)

No. 3 Hofman, André, Latin American Economic Development. A Causal Analysis in Historical Perspective (1998)

No. 4 Mulder, Nanno, The Economic Performance of the Service Sector in Brazil, Mexico and the United States (1999)

No. 5* Smits, Jan-Pieter, Edwin Horlings and Jan Luiten van Zanden, Dutch GNP and Its Components, 1800-1913 (2000) (http://www.eco.rug.nl/GGDC/PUB/dutchgnp.pdf)