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COMPARATIVE PRODUCTIVITY IN EAST AND WEST GERMAN MANUFACTURING BEFORE REUNIFICATION*

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1. Introduction

The reunification of the Federal Republic of Germany and the former German Democratic Republic[1] in 1990 has changed the political and economic landscape of Western Europe. This study aims to contribute to an assessment of the relative performance of the West- and East German economies before reunification.

The better access to statistical sources for East Germany, and the recent attempts by the statistical offices in Germany to improve the comparability of the data in East- and West Germany, has made it easier to make consistent estimates not only for recent times but also for earlier years.

For this study we made detailed comparisons of real output and productivity for 14 manufacturing branches in 1987. Real output is compared in terms of value added, which is converted to a common currency on the basis of unit value ratios for samples of products in the two countries. This method, which originates from Rostas (1948) and Paige and Bombach (1959), has been systematically applied by the ICOP (International Comparisons of Output and Productivity) project at Groningen University since 1983. ICOP studies now include comparisons for 20 countries, and cover agriculture, manufacturing and various other sectors of the economy.[2] One of these studies covers productivity in manufacturing in Czechoslovakia relative to West Germany (Van Ark and Beintema, 1993), and comparisons are also planned for Hungary, Poland and the former Soviet Union.

Studies of this kind which include centrally planned economies raise specific problems which are mainly due to a lack of a meaningful way to value output to make comparisons with Western countries possible. In the case of East Germany there was no market exchange rate for the "Ost-Mark", and the country did not participate in any of the ICP rounds to produce purchasing power parities. Official price quotations are mostly administered prices, which show little or no relation to prices in a market economy. Even comparisons at world prices raise substantial problems, because the quality of exported commodities often strongly differs from items sold domestically.[3] Section 2 shows how we calculated our PPP (or "unit value ratio") converters in this study.

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[1] Hereafter referred to as West- and East Germany respectively.

[2] See, for example, Maddison and van Ark (1988) and van Ark (1993).

[3] See Hare and Hughes (1991) for a study of competitiveness of three former centrally planned economies in Eastern Europe (Czechoslovakia, Hungary and Poland) making use of ratios of border prices to domestic prices.

The information on output and labour input was derived from the production censuses in each country. Section 3 discusses the adjustments we made to arrive at comparable concepts of manufacturing output and labour input. Finally, section 4 compares our results with previous productivity studies before reunification, and it discusses the problems in getting a view on the change in the comparative productivity performance over time.

2. Compiling Unit Value Ratios for East and West Germany in 1987

To convert output to a common currency, we calculated 335 unit value ratios (UVRs) by comparing the ex-factory value per unit of output for the same product groups in each country. Although the East German unit values are based on administered prices, this price concept is the most practical on the basis of which to calculate the conversion factors, because the East German output value which is to be "deflated" is also expressed at administered prices.[4]

An alternative approach to the unit value ratio method would be to take East- and West German physical quantities and value them at West German prices only. However, the objections to that method are twofold. Firstly it would provide us with comparative output ratios which are biased in favour of East Germany, because using prices of another country lead to higher output than prices of the own country due to the "Gerschenkron effect". Secondly the representativity of matched quantities for "non-matched" quantities in the comparison is less than that of matched prices for non-matched prices (see Van Ark, 1993).

For East Germany we used the *Abrechnung der Erzeugnispositionen der Erzeugnis- und Leistungsnomenklatur* (Statistisches Amt der DDR) for 1987, which provides information on output quantities and output values at producer prices for more than 2,000 manufacturing products. This census is carried out annually, but the figures were not officially published.[5] For West Germany the unit values are derived from the *Produktion im Produzierenden Gewerbe* (Statistisches Bundesamt) for 1987 which shows up to 6,000 entries for quantities and ex-factory values excluding value added tax and excise duties.

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[4] Here we abstain from the distortive effect administrative prices can have on the weighting system, which can affect the aggregated results. See, for example, Alton (1982) and Marer (1985).

[5] We are grateful to the Gemeinsames Statistisches Amt in Berlin to provide us with these figures.

Table 1 shows that the 335 unit value ratios together covered 41.2 per cent and 33.3 per cent of the total sales value in East and West Germany respectively. The unit value ratios were allocated by industry and branch. Our overall matching percentages were highest in branches producing consumer goods (such as food products, beverages and wearing apparel) and lowest in the investment goods branches (electrical and non-electrical machinery) and in chemicals. We only made matches for products for which we expected quality problems not to be of great importance, which substantially reduced the number of possible matches, in particular in the investment goods branches.[6]

Table 1
Number of Unit Value Ratios and Coverage of Total Sales for the Comparison between East and West German Manufacturing, 1987

	Number of Unit Value Ratios	Matched Output as a % of Branch Gross Value of Output	
		East Germany	West Germany
Food Products	75	74.2	51.8
Beverages	11	84.8	84.0
Tobacco Products	3	96.4	73.0
Textile Products	35	66.6	47.1
Wearing Apparel	30	64.1	59.5
Leather and Leather Products	7	43.6	49.7
Wood Products and Furniture	8	28.1	24.3
Paper, Paper Products and Printing	8	48.9	29.1
Chemicals, Rubber and Plastic Products	52	20.2	18.1
Non-Metallic Minerals	15	33.1	34.2
Basic Metals and Metal Products	48	56.9	53.3
Machinery and Transport Equipment	20	18.2	32.5
Electrical Engineering	23	29.1	15.7
Other Manufacturing	0	0.0	0.0
Total Manufacturing	**335**	**41.1**	**33.7**

Note: the coverage percentages are somewhat affected by classification differences between the product data and the industry data, but the present estimates give a good proxy indication of the coverage.
Source: Statistisches Bundesamt, *Produktion im Produzierenden Gewerbe 1987*; Statistisches Amt der DDR, *Abrechnung der Erzeugnispositionen der Erzeugnis- und Leistungsnomenklatur 1987*.

[6] A statistical appendix with all 335 product matches can be obtained from the authors on request. In fact we started off with 34 more matches in machinery, but we decided to drop these because their quantities were expressed in terms of tonnage, which clearly is an inappropriate measure to exclude quality differences.

We made a crude quality adjustment only for passenger cars. We arrived at this starting from our earlier comparison between Germany and Czechoslovakia (Van Ark and Beintema, 1992). It is based on a consumer price valuation of a new Czech car (a Skoda) versus that of a new "average" West German car sold on the West German market. This put the quality level of a Czech car at one third of the West German car. As the East German market was dominated at the time by Trabants, which were of a lower quality than Skodas, we put East German quality at a quarter of the West German level for cars.

Our handling of the quality problem is still unsatisfactory, and there is much scope for improvement. One way is to look at the price difference of similar products between East- and West Germany after reunification. A study by Hitchens, Wagner and Birnie (1993) which is based on plant comparisons in manufacturing, puts this difference at some 22 per cent in mid-1991.[7] Another way is to interpret the change in sales prices of industrial products in East Germany between 1989 and August 1990, which fell on average by about 50 per cent, as the quality difference.[8] These measures are likely to overestimate the quality effect because price changes also take into account other factors, among which are changing market conditions. It should be born in mind that a further adjustment for lower quality of East German products implies that the comparative productivity estimates will come out even lower than in the present paper.

The East German production census distinguishes between two different valuation systems. The valuation at "Betriebspreise" (basic prices) equals production costs plus a mark-up for gross profits. "Industrieabgabepreise" are producer prices which include product-oriented duties and exclude part of the product-oriented price subsidies. In East Germany product-oriented duties were particularly high on luxury consumer goods, such as TV sets, cars and washing machines. Product-oriented subsidies were given on a wide range of basic products, such as bread, meat, wearing apparel and other non-durable consumer goods, but many of these were levied as a consumer subsidy rather than as a producer subsidy, and were therefore not excluded from the producer price. For

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[7] See Hitchens, Wagner and Birnie (1993), chapter 2, where the difference between physical productivity and "potential value added per head" (i.e. assuming full capacity utilisation in East Germany) is 22 per cent based on comparing East and West German prices for the same set of products.

[8] Statistisches Amt der DDR, *Index der Erzeugernispreise gewerblicher industrieller Produkte, August 1990*, Berlin.

many products in East Germany purchasers' prices ("Verbraucherspreise") were above producers' prices ("Abgabepreise").[9]

Clearly, product-oriented duties and subsidies in East Germany are conceptually different from product specific taxes in market economies. In East Germany the levy and subsidy structure was a major instrument to plan the economy and to influence demand and supply of goods and services.[10] The "Betriebspreise"-concept, which excludes levies and includes all subsidies, is therefore the preferable concept to compare to West German prices. However, as we were not able to obtain a complete set of data on value added at basic prices (see section 3), we took East German unit values in terms of "Industrieabgabepreise" and compared these to West German ex-factory prices (including excise duties), to arrive at our unit value ratios.

Table 2 compares the unit value ratios (Ost-Marks to the D-Mark) based on "Abgabepreise" and "Betriebspreise" for 14 branches between East- and West Germany in 1987. The UVRs are shown at both East and West German quantity

Table 2
Unit Value Ratios (Ost-Mark/D-Mark) according to "Industrieabgabepreise" and "Betriebspreise" by Manufacturing Branch, 1987

	Industrielle Abgabepreise			Betriebspreise		
	East German Quantity-weights	West German Quantity-weights	Geometric Average	East German Quantity-weights	West German Quantity-weights	Geometric Average
Food Products	1.68	1.51	1.59	2.24	2.00	2.12
Beverages	1.71	1.39	1.54	1.29	1.11	1.20
Tobacco Products	1.74	1.74	1.74	1.18	1.17	1.17
Textile Products	2.17	2.46	2.31	1.46	1.93	1.68
Wearing Apparel	1.71	2.06	1.88	1.45	1.57	1.51
Leather and Leather Products	0.97	1.10	1.03	1.13	1.33	1.23
Wood Products and Furniture	1.61	2.02	1.80	1.46	1.79	1.62
Paper, Paper Products and Printing	2.13	1.86	1.99	2.03	1.83	1.93
Chemicals, Rubber and Plastic Products	1.87	2.12	1.99	1.81	2.01	1.91
Non-Metallic Minerals	1.68	1.77	1.72	1.59	1.65	1.62
Basic Metals and Metal Products	1.90	1.94	1.92	1.90	1.93	1.91
Machinery and Transport Equipment	1.95	1.95	1.95	1.95	2.00	1.97
Electrical Engineering	1.64	2.20	1.90	1.41	1.79	1.59
Other Manufacturing	1.81	1.98	1.89	1.70	1.97	1.83
Total Manufacturing	**1.81**	**1.98**	**1.89**	**1.70**	**1.97**	**1.83**

Note: **"Industrieabgabepreise" in East Germany include product specific duties and exclude subsidies;** in West Germany it includes excise duties.
Source: as for table 1.

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[9] See Collier (1984), Melzer (1989) and Ludwig and Stäglin (1993) for a detailed discussion of the price system in East Germany. See also appendix I.

[10] For a detailed discussion of the importance of these taxes and subsidies in quantitative terms, see Görzig and Gornig (1991).

weights, but often the geometric average of these two measures is used. For the manufacturing sector as a whole the geometric UVR at "Abgabepreise" is only slightly higher than that at "Betriebspreise" (1.89 and 1.83 O-Marks to the D-mark). At branch level the difference is occasionally more substantial, for example in food manufacturing where the UVR at "Abgabepreise" is 1.59 and at "Betriebspreise" (i.e. including certain subsidies) 2.12. On the other hand the UVR for electrical goods is 1.90 at "Abgabepreise" and 1.59 at "Betriebspreise" (i.e. excluding taxes).

The UVR for total manufacturing in terms of "Abgabepreise" is 1.81 Ost-Mark to the D-Mark at East German quantity weights and 1.98 at West German quantity weights, and the geometric average is 1.89. The variation between branches is from 0.97 for leather and leather products at East German weights to 2.46 for textiles at West German weights, but the coefficient of variation of the geometric UVRs for the 14 branches is only 0.16.

As mentioned above there is no official Ost-Mark/D-Mark exchange rate with which our unit value ratio can be compared. However, there have been annual calculations of a so-called "Richtungskoeffizient" (or "Valuta-Gegenwert"), which is defined as the cost in Ost-Mark to earn one Deutsch-Mark of exports. The "Richtungskoeffizient" for 1989 was published in the *Statistisches Jahrbuch der DDR, 1990* (Statistisches Amt der DDR), and was more than 4 Ost-Marks to the D-Mark. This would suggest that East Germany was exporting its industrial products well below producer price.

3. Comparative Output and Productivity by Manufacturing Branch in 1987

To obtain consistent sources for output and labour input to make output and productivity comparisons, we had to consider two basic issues. The first was to obtain figures which are based on the same industrial classification scheme. Secondly, we needed to assess the comparability of the output and labour input concepts between the two countries.

3.1 Reclassification from SVWZ to SYPRO classification

The production statistics of the former GDR were originally based on the "Systematik der Volkswirtschaftszweige" (SVWZ). The coverage of the manufacturing sector according to SVWZ is much wider than on the basis of the West German classification system, the "Systematik für das produzierende Gewerbe" (SYPRO). Görzig (1991) shows that of the 3.2 East German million workers which were classified to the manufacturing sector according to SVWZ

in 1989, only 2.7 million belong to manufacturing on the basis of the SYPRO classification. Especially for chemicals, oil refining, basic metals and machinery the coverage according to the East German SVWZ classification is much broader than in the SYPRO classification.

Fortunately the East German production census has been reclassified to SYPRO for 1987 by the Gemeinsames Statistisches Amt, which was a temporary joint office of the statistical offices of the East- and West Germany. It is from this this source, the *Ergebnisse der Erfassung der Arbeitsstätten der Betriebe des Wirtschaftsbereiches Industrie*, which is a census of local units, that we obtained our basic information on gross production ("Industrielle Warenproduktion") and employment ("Arbeiter und Angestellte").

Our basic West German source, the *Kostenstruktur der Unternehmen* (Statistisches Bundesamt) is also based on SYPRO. However, the main difference with the East German source is that the Kostenstrukturerhebung is based on information for legal units ("Unternehmen", which are enterprises) rather than local units ("Arbeitsstätten", which are units at a single postal address). For the manufacturing sector as a whole the total employment in West German legal units is only 1.3 per cent higher than in local units, but for some branches the differences are more substantial. For example, legal units in food manufacturing, chemicals and electrical engineering have 10 per cent more employees than local units, whereas the employment coverage in wood and paper products and printing is 10 per cent less on the basis of legal units compared to local units.[11]

Recently the Institut für Angewandte Wirtschaftsforschung (IAW) has adjusted original series from the former East German Statistical Office from the SVWZ to the SYPRO classification for the period 1980 to 1989, including series for employment, gross production at "Industrieabgabepreise" and at "Betriebspreise" and raw materials inputs. A close inspection of these data shows that, according to the IAW, employment for manufacturing as a whole was some 20 per cent below the estimates of the Gemeinsames Statistisches Amt. Apparently this is caused by the fact that the IAW data were originally for centrally organised plants only. It blew up the figures to take account of plants which reported to the Ministy for Agriculture (e.g. food processing) or the Ministry for Construction (e.g. stone, clay and glass products), but it may still be an underestimate.

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[11] As the *Arbeitsstättenerfassung* covers all local units, whereas the *Kostenstrukturerhebung* excludes legal units with less than 20 employees, we excluded these smaller local units from the East German figures on output and labour input.

3.2 Output and Labour Input Concepts in East and West Germany

The "Industrielle Warenproduktion at Industrieabgabepreise" in East Germany was the basic output concept used for this study. It is defined as the sum of the production of industrial goods, material services (including repair and maintenance, transport) and production for own use (in particular capital goods). This concept is slightly narrower than the "Bruttoprodukt" concept which is used for West Germany. The latter also includes the production of non-material services (such as trade and administrative functions, etc.) and contains an adjustment for changes in net stocks of unfinished products.[12]

For comparisons of productivity levels we are primarily interested in value added rather than in gross output, because the latter includes double counting of that part of domestic output which is used as inputs in other industries. Unfortunately, our basic East German source (the census of local units) did not provide value added figures. We therefore estimated value added at branch level by applying ratios of "Nettoprodukt" to "Bruttoprodukt" from the East German input-output table for 1987, the *Verflechtungsbilanz des gesellschaftlichen Gesamtproduktes 1987* (Staatliche Zentralverwaltung für Statistik), to the gross product taken from the census of local units. "Nettoprodukt" is defined as "Bruttoprodukt" minus the use of raw materials, but including depreciation and rents. It is comparable to the West German concept of "Nettoproduktionswert", defined as gross output minus the cost of raw materials, packaging, energy inputs and contract work, and which still includes purchases of industrial and non-industrial services.[13]

For food manufacturing we faced a problem in using the census value added/gross product ratios from the input-output tables. As the information on output is at "Industrieabgabepreise", the value of output in food manufacturing (after adjustment for subsidies) turned out to be smaller than the input value, which results in negative value added. For food manufacturing, we therefore used the ratio of census value added to gross output at basic prices (rather than at producers prices) from the IAW data, which we then adjusted upwards by the difference in the "Netto/Brutto" output ratio for total manufacturing from the input-output table.

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[12] See appendix I for a comparison of output and labour input concepts between East- and West Germany.

[13] "Nettoprodukt" should not be translated as "net product" which is gross value added minus depreciation. In the remainder of the text we will therefore translate "Nettoprodukt" as "census value added", which is also used for most other ICOP comparisons in manufacturing (see van Ark, 1993).

Table 3
Gross Value of Output, Census Value Added and Employment in Manufacturing, East and West Germany, 1987

	East Germany				West Germany			
	Production Value of Goods & Material Services (mln. OM) (1)	Census Value Added to Gross Output (%) (2)	Census Value Added derived (2)*(1) (mln. OM) (3)	Number of Persons Engaged (000s) (4)	Gross Value of Output (mln. DM) (5)	Census Value Added to Gross Output (%) (6)	Census Value Added (mln. DM) (7)	Number of Persons Engaged (000s) (8)
Food Products	60,622	25.1	15,198	197.6	107,331	30.9	33,159	363.8
Beverages	13,003	49.1	6,388	44.6	23,286	60.2	14,023	87.3
Tobacco Products	4,633	77.8	3,604	5.3	20,089	88.6	17,791	16.8
Textile Products	30,834	39.3	12,121	198.4	32,560	53.4	17,373	222.0
Wearing Apparel	10,344	40.6	4,200	107.0	20,223	57.1	11,555	171.7
Leather and Leather Products	7,114	29.3	2,082	64.7	6,806	48.1	3,274	54.6
Wood Products and Furniture	12,901	35.9	4,630	106.5	32,973	51.1	16,854	214.3
Paper, Paper and Printing	10,499	30.5	3,199	57.0	53,758	54.8	29,435	293.4
Chemicals, Rubber and Plastics	99,135	35.4	35,090	290.4	239,022	56.2	134,279	949.2
Non-Metallic Minerals	16,471	41.9	6,903	149.6	37,132	62.3	23,123	239.4
Basic Metals and Metal Products	70,912	29.2	20,742	324.9	159,307	54.0	86,049	965.3
Machinery & Transport Equipment	84,066	34.1	28,658	764.1	358,172	54.1	193,626	2,031.2
Electrical Engineering	40,165	35.7	14,343	360.9	147,491	61.9	91,288	1,054.2
Other Manufacturing	6,718	42.6	2,859	92.5	22,210	65.6	14,562	192.3
Total Manufacturing	467,418	34.2	160,017	2,763.6	1,260,359	54.5	686,390	6,855.5

Note: excluding units with less than 20 employees
Source: "Industrielle Warenproduktion" from Gemeinsames Statistisches Amt, *Ergebnisse der Erfassung der Arbeitsstätten der Betriebe des Wirtschaftsbereiches Industrie*. Ratio of net product to gross product from the Staatliche Zentralverwaltung für Statistik, *Verflechtungsbilanz des gesellschaftlichen Gesamtproduktes 1987*. West Germany from Statistisches Bundesamt, *Kostenstruktur der Unternehmen 1987*.

Columns (2) and (6) in table 3 compare the ratios of census value added to gross output for East- and West Germany respectively. This shows that the share of intermediate inputs in total output was substantially larger in East Germany than in West Germany, in particular in basic and investment goods industries. In fact we found similar differences in our earlier comparison between Czechoslovakia and West Germany (Van Ark and Beintema, 1992).

There is no one single explanation for the larger share of intermediate inputs in gross output in East Germany. Firstly there may have been greater wastage of intermediate inputs than in market economies. Although value added rather than gross output was the major performance criterion within the planning system from the mid-1970s onwards, there was no budget constraint on inputs which led to an inefficient use of raw materials, energy and other intermediate inputs. Production prices were raised to allow for greater wastage and product-oriented subsidies were implemented when prices became too high.

Secondly, due to distortions in administrative prices, a misallocation of inputs across industries may also have led to a larger use of intermediate inputs.

Thirdly, firms tended to hold large stocks of materials and semi-finished products which they used in their negotiations with other companies with which they exchanged stocks because of general shortages. Furthermore, much of the production for final use was put in stock, and in many cases it was never sold.

Fourthly, there may have been a trade-off in these countries between a low technology-content and a high raw material-content for many products (for example, simple, but heavy and solid machine tools).[14]

A related point is that the average size of firms in Eastern European countries is relatively large compared to capitalist countries. This is often related to the greater vertical integration of manufacturing firms in planned economies. This would lower rather than raise their ratio of intermediate inputs to gross product, because a smaller share of each firm's gross output turns up as intermediate inputs in other firms. However, we do not think this factor is important here because our East German source is a census of local units rather than firms, so that the effect of vertical integration is of less importance.

However, firms were not only characterised by greater vertical integration but also by a wider extent of horizontal integration, with each plant producing many different items (Ehrlich, 1985). In some cases horizontal integration can lead to "economies of scope" when a firm benefits from a more efficient use of its overhead (including sales, administration, repair and maintenance, etc.). However, even for western countries the evidence for economies of scope is slim. In Eastern Europe it is more likely that horizontal integration led to "diseconomies of scope", creating a greater amount of inputs per unit of output.

It should be emphasised that the evidence on the role of the various factors mentioned above is still somewhat speculative, and their importance is not easy to assess in quantitative terms.

The employment figures in table 3 for the two countries are taken from the same source as the gross output. This is a major feature of our study, because if output and labour input are obtained from different sources, there is a great likelihood that they do not match the same activities. East German employment is taken to represent all employees in local units, including non-productiom employees but excluding homeworkers and apprentices. We were not able to exclude the latter group from the West German statistics.

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[14] The latter also comes out very clearly in the comparisons between manufacturing plants by Hitchens, Wagner and Birnie (1993).

3.3 Relative Levels of Output and Labour Productivity

Tables 4 and 5 show the comparative levels of gross output and census value added in East and West German manufacturing. In the second column of table 4 we show West German gross output converted to Ost-Marks on the basis of the UVR with West German quantity weights (see table 2). This gives a comparative output ratio for total manufacturing for East Germany to West Germany of 0.188. The conversion of East German output to D-Marks with the UVR at East German quantity weights gives a slightly higher ratio, and the geometric average comes to 0.196.

For census value added in table 5 we used the same unit value ratios as above, assuming that the price ratios we derived for gross output were also representative for the intermediate inputs. Although this assumption (which can be contrasted with double deflation if intermediate inputs are converted to another currency with an independent UVR) could not be crosschecked with other evidence, there is no immediate reason to expect a systematic difference between UVRs at gross output level and UVRs for intermediate inputs. Because of the larger share of intermediate inputs in East Germany as discussed above and the use of the same UVRs for value added as for gross output, the comparative census value added ratio is significantly lower than for gross output.

Tables 6 and 7 show the relative productivity performance on gross output and census value added basis respectively. As mentioned above, for a study of productivity the census value added concept is preferred here. On the basis of the geometric average of the UVR at East and West German weights, value added per person in manufacturing was at 30.5 per cent of West Germany in 1987.

To obtain more precise estimates of the output per unit of labour input, labour productivity figures also need to be adjusted for differences in the number of hours per person. Such estimates were compiled by Görzig (1991), but as his classification of branches was not exactly the same as ours, we had to collapse our 14 branches into 6 major branches before which we could use Görzig's estimates on hours worked. Table 8 shows that in 1987, employees in East German manufacturing worked on average 1,736 hours, i.e. 109 hours more than in West Germany. As a result value added per hour worked drops from 30.5 to 28.6 per cent.

Table 4
Gross Value of Output in Manufacturing, East and West Germany, 1987

	at East German prices			at West German prices			Geometric Average
	East Germany (mln. OM) (1)	West Germany (mln. OM) (2)	Ratio *100 (1)/(2) (3)	East Germany (mln.DM) (4)	West Germany (mln.DM) (5)	Ratio *100 (4)/(5) (6)	(7)
Food Products	60,622	166,125	36.5	36,198	107,331	33.7	35.1
Beverages	13,003	33,385	38.9	7,588	23,286	32.6	35.6
Tobacco Products	4,633	35,054	13.2	2,659	20,089	13.2	13.2
Textile Products	30,834	79,907	38.6	14,051	32,560	43.2	40.8
Wearing Apparel	10,344	41,489	24.9	6,045	20,223	29.9	27.3
Leather and Leather Products	7,114	7,485	95.0	7,346	6,806	107.9	101.3
Wood Products and Furniture	12,901	67,109	19.2	7,989	32,973	24.2	21.6
Paper, Paper and Printing	10,499	100,613	10.4	4,886	53,758	9.1	9.7
Chemicals, Rubber and Plastics	99,135	504,126	19.7	53,004	239,022	22.2	20.9
Non-Metallic Minerals	16,471	65,960	25.0	9,885	37,132	26.6	25.8
Basic Metals and Metal Products	70,912	320,084	22.2	36,207	159,307	22.7	22.4
Machinery & Transport Equipment	84,066	697,743	12.0	43,229	358,172	12.1	12.1
Electrical Engineering	40,165	326,247	12.3	24,406	147,491	16.5	14.3
Other Manufacturing	6,718	43,951	15.3	3,705	22,210	16.7	16.0
Total Manufacturing	467,418	2,489,279	18.8	257,196	1,260,359	20.4	19.6

Source: as for tables 1 and 3

Table 5
Census Value Added in Manufacturing, East and West Germany, 1987

	at East German prices			at West German prices			Geometric Average
	East Germany (mln. OM) (1)	West Germany (mln. OM) (2)	Ratio *100 (1)/(2) (3)	East Germany (mln.DM) (4)	West Germany (mln.DM) (5)	Ratio *100 (4)/(5) (6)	(7)
Food Products	15,198	49,962	30.4	9,075	33,159	27.4	28.9
Beverages	6,388	19,423	32.9	3,728	14,023	26.6	29.6
Tobacco Products	3,604	31,013	11.6	2,068	17,791	11.6	11.6
Textile Products	12,121	42,775	28.3	5,584	17,373	32.1	30.2
Wearing Apparel	4,200	23,797	17.6	2,454	11,555	21.2	19.4
Leather and Leather Products	2,082	3,601	57.8	2,149	3,274	65.6	61.6
Wood Products and Furniture	4,630	33,996	13.6	2,868	16,854	17.0	15.2
Paper, Paper and Printing	3,199	54,770	5.8	1,503	29,435	5.1	5.5
Chemicals, Rubber and Plastics	35,090	283,994	12.4	18,726	134,279	13.9	13.1
Non-Metallic Minerals	6,903	40,958	16.9	4,121	23,123	17.8	17.3
Basic Metals and Metal Products	20,742	166,717	12.4	10,946	86,049	12.7	12.6
Machinery & Transport Equipment	28,658	377,933	7.6	14,676	193,626	7.6	7.6
Electrical Engineering	14,343	200,532	7.2	8,765	91,288	9.6	8.3
Other Manufacturing	2,859	28,817	9.9	1,577	14,562	10.8	10.4
Total Manufacturing	160,017	1,358,289	11.8	88,238	686,390	12.9	12.3

Source: as for table 1 and 3

Table 6
Gross Value of Output per Person Employed in Manufacturing, East and West Germany, 1987

	at East German prices			at West German prices			Geometric Average
	East Germany (mln. OM) (1)	West Germany (mln. OM) (2)	Ratio *100 (1)/(2) (3)	East Germany (mln.DM) (4)	West Germany (mln.DM) (5)	Ratio *100 (4)/(5) (6)	(7)
Food Products	306,730	456,593	67.2	183,151	294,998	62.1	64.6
Beverages	291,574	382,250	76.3	170,140	266,620	63.8	69.8
Tobacco Products	877,674	2,085,427	42.1	503,600	1,195,108	42.1	42.1
Textile Products	155,399	359,930	43.2	70,815	146,663	48.3	45.7
Wearing Apparel	96,667	241,676	40.0	56,488	117,799	48.0	43.8
Leather and Leather Products	109,974	137,135	80.2	113,563	124,685	91.1	85.5
Wood Products and Furniture	121,107	313,191	38.7	74,999	153,880	48.7	43.4
Paper, Paper and Printing	184,305	342,865	53.8	85,766	183,196	46.8	50.2
Chemicals, Rubber and Plastics	341,392	531,097	64.3	182,531	251,810	72.5	68.3
Non-Metallic Minerals	110,088	275,525	40.0	66,070	155,104	42.6	41.3
Basic Metals and Metal Products	218,279	331,608	65.8	111,451	165,042	67.5	66.7
Machinery & Transport Equipment	110,019	343,517	32.0	56,574	176,337	32.1	32.1
Electrical Engineering	111,277	309,485	36.0	67,617	139,913	48.3	41.7
Other Manufacturing	72,623	228,545	31.8	40,047	115,492	34.7	33.2
Total Manufacturing	169,137	363,108	46.6	93,067	183,847	50.6	48.6

Source: as for tables 3 and 4.

Table 7
Census Value Added per Person Employed in Manufacturing, East and West Germany, 1987

	at East German prices			at West German prices			Geometric Average
	East Germany (mln. OM) (1)	West Germany (mln. OM) (2)	Ratio *100 (1)/(2) (3)	East Germany (mln.DM) (4)	West Germany (mln.DM) (5)	Ratio *100 (4)/(5) (6)	(7)
Food Products	76,897	137,321	56.0	45,916	91,137	50.4	53.1
Beverages	143,250	222,386	64.4	83,590	160,557	52.1	57.9
Tobacco Products	682,655	1,845,004	37.0	391,700	1,058,414	37.0	37.0
Textile Products	61,087	192,675	31.7	28,142	78,255	36.0	33.8
Wearing Apparel	39,247	138,618	28.3	22,934	67,309	34.1	31.1
Leather and Leather Products	32,179	65,974	48.8	33,229	59,984	55.4	52.0
Wood Products and Furniture	43,465	158,657	27.4	26,926	78,656	34.2	30.6
Paper, Paper and Printing	56,158	186,644	30.1	26,378	100,308	26.3	28.1
Chemicals, Rubber and Plastics	120,841	299,187	40.4	64,485	141,462	45.6	42.9
Non-Metallic Minerals	46,138	171,089	27.0	27,543	96,587	28.5	27.7
Basic Metals and Metal Products	63,846	172,719	37.0	33,694	89,147	37.8	37.4
Machinery & Transport Equipment	37,506	186,066	20.2	19,206	95,327	20.1	20.2
Electrical Engineering	39,737	190,229	20.9	24,283	86,597	28.0	24.2
Other Manufacturing	30,908	149,850	20.6	17,044	75,724	22.5	21.5
Total Manufacturing	57,903	198,132	29.2	31,929	100,123	31.9	30.5

Source: as for tables 3 and 5.

Table 8
Census Value Added per Employee and per Hour Worked in Manufacturing, East and West Germany, 1987

	Census Value Added per Person Employed	Annual Hours Worked		Census Value Added per Hour Worked
		East-Germany	West-Germany	
Food Products, Beverages and Tobacco	45.3	1,806	1,817	45.6
Textiles, Wearing Apparel and Leather	34.9	1,644	1,617	34.3
Chemicals, Rubber and Plastic Products	42.9	1,712	1,644	41.2
Basic Metals and Metal Products	37.4	1,784	1,620	33.9
Machinery, Electrical Engineering and Transport Equipment	21.4	1,753	1,586	19.4
Other Manufacturing Branches	26.7	1,713	1,641	25.6
Total Manufacturing	30.5	1,735	1,627	28.6

Source: census value added per person, see table 7; hours from Görzig (1991)

4. Changes in Comparative East-West German Productivity Performance

To get a view on the dynamics of comparative productivity performance in East- and West German manufacturing, one can follow two different approaches. The first way is to compare our benchmark result for 1987 with comparative productivity estimates for earlier years. Major efforts were made over the years by researchers from the Deutsches Institut für Wirtschaftsforschung (DIW).[15] Table 9 shows the productivity results from these studies compared to the results from the present study. It also shows an estimate by Sturm (1974) for 1964, and a calculation by ourselves for 1937 which was based on figures for the two German territories as they were divided between the Soviet Union and the western allies in 1945.

It is clear from the table that the estimates for earlier years show a more favourable productivity level for East Germany than our estimate for 1987. This partly reflects the deterioration in East Germany's comparative performance over time. However, in addition we believe that there are at least three reasons of a methodological nature which explain our lower estimate:

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[15] As far as manufacturing productivity this includes Wilkens (1970, 1981), Cornelsen and Kirner (1990), Görzig und Gornig (1991) and Görzig (1991). Other comparisons for the total economy including Alton (1982) and Collier (1985) are not discussed in detail here. These estimates are largely based on expenditure data rather than industry of origin comparisons. See also Marer (1985 and 1992).

Table 9
Results from Studies of Comparative Levels of Output per Person Employed in Industry East versus West Germany

Author(s)	Year	Result	Method
Own calculation	1937	83.9	Total sales (in Reichsmarks) and employment in manufacturing on German territory which was occupied by the Soviet Union in 1945 (Soviet Zone and half of Berlin) compared to sales and employment in the area occupied by western allies (American, British and French zones and half of Berlin). Source: Länderrat des Amerikanischen Besatzungsgebiets, *Statisches Handbuch von Deutschland 1928-1944*, Munich, 1949.
Sturm (1974)	1964	76.9	Quantity comparison for 219 industrial products weighted at West German sales value by product and at value added by industrial branch. Incldues mining and utilities.
Wilkens (1970)	1967	67.3[a] 69.3[b]	Quantity comparisons for 200 products weighted West German unit values. Adjusted from gross output to value added with ratios for West Germany. Includes mining.
Wilkens (1981)	1967 1970 1973	72 67 65	Commodity producing sectors. Updated from 1967 to 1970 and 1973 from with official time series.
Görzig und Gornig (1991)[c]	1970 1976 1980 1988	45 47 48 53	Partly based on quantity comparisons weighted at value added or at D-marks, and partly on unit value ratios based on producer prices. No adjustment to value added level.
Görzig (1991)	1980 1987 1989	45.0 43.7 43.4	Based on 1990 comparison of value added according to Kostenstrukturerhebung for East Germany while using value added/gross output ratios from West Germany
This study	1987	30.5	

[a] at West German weights;
[b] at East German weights;
[c] see also Deutscher Bundestag (1987)

1) The earlier estimates were to a large extent based on gross output per person. As we have seen above, gross output in East Germany is relatively high because of the larger share of intermediate inputs. In this study we used census value added.

2) Some of the estimates were based on a valuation of East German physical quantities in D-marks. Because of the "Gerschenkron" effect this leads to a relative overestimation of East German output compared to that of West Germany (see Van Ark, 1993). In this study we used the geometric average of the UVRs at East and West German quantity weights.
3) As far as benchmark estimates have been updated to more recent years with the original East German time series on output and employment, the comparative performance of East Germany becomes overstated as will be explained below.

An alternative method to analyse the change in comparative productivity performance is to apply national time series of value added and employment to our benchmark estimate for 1987. This is the usual procedure for a comparison of productivity between western countries, but there are various reasons why this method may produce unreliable results in the present case. The official East German growth rates of manufacturing value added were substantially overstated. This is mainly because the output growth at current prices was inflated by applying very high prices for new products, while prices of existing products were adjusted downwards insufficiently once cost reductions had occurred. To obtain a real output series, use was made of "constant price" deflator which took only inadequate account of the actual pricing practice of firms.[16]

There have been various attempts to adjust the real output series of East Germany to western computation standards. One method, which was pioneered by Bergson (1961) and replicated for other countries in particular by Alton, has been to adjust these series to an "adjusted factor cost" standard by means of approximate factor cost weights.[17]

Another method to correct the East German real output series was applied by DIW for the period 1980 to 1990. It used a unit value index for East German exports to West Germany (including a correction for devaluation) instead of the original "constant" price index used for deflation by the East German authorities (Görzig, 1991). This adjustment led to a substantially lower estimate of the annual compound growth rate of value added in East German manufacturing from 1980 to 1989, namely 2 per cent compared to 2.6 per cent per year according to the original estimate.

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[16] See Wilkens (1981), Marer (1985) and Mezler (1989).
[17] For a critique of the adjusted factor cost method see Sturm (1974, pp. 156-157) and Marer (1985, pp. 173-178).

Table 10
Annual Compound Growth Rates of Real Output and Labour Productivity in Manufacturing, East- and West Germany, 1950-1987 and 1937-1987

	East Germany		West Germany	
	Real Output	Real Output per Person	Real Output	Real Output per Person
Recorded Growth Rates (1950-87):				
Official Material Product	6.6	5.5	5.0	3.8
Adjusted Factor Cost Series	4.7	3.5	5.0	3.8
Implicit Growth Rates (1937-87) on the basis of 1937- and 1987 benchmarks between East- and West Germany and 1937-87 growth rates for West Germany	-0.1	0.8	2.8	2.9

Sources: Growth rates for West Germany from 1950-87 see Van Ark (1993); for 1937-50 see Broadberry (1992). Material product series for East Germany from Sturm (1974) and Marer (1992). Adjusted factor cost series from Alton (1986; and in Czirjak and Dusek, 1971) and Görzig (1991). Benchmark estimates for 1937 and 1987 see table 9.

Combining the "adjusted factor cost" series for the period 1950 to 1980 with the DIW-series for 1980 to 1987 as described above, gives an average compound growth rate of 4.7 per cent for real output and 3.5 per cent for labour productivity in East Germany (see table 10). This is significantly lower than the estimates of 6.6 per cent for output and 5.5 per cent for labour productivity which are obtained on the basis of the official "Net Material Product" (see table 10).

Even if one uses the "adjusted factor cost" series for East Germany (instead of the material product series), a backward extrapolation from 1987 of the ratio of value added per person employed in East- versus West Germany results in an estimate of only 33.3 per cent in 1950. This latter figure seems implausibly low for a year so shortly after the east and west part of Germany came under a different economic regime. The bottom part of table 10 shows that if one takes the 1937 and 1987 benchmark estimates from table 9 in combination with the recorded growth rates for West Germany, the implicit growth rate of real output in East Germany would have been -0.1 per cent and productivity growth would have been less than 1 per cent per year on average.

Much more work will be required in reconstructing the time series of real output in East Germany before a more conclusive picture on the comparative productivity performance of East- and West Germany for the period 1947-1990 can be obtained.

5. Conclusion

In this paper we applied the ICOP procedure for sectoral output and productivity comparisons, to a comparison for manufacturing between East and West Germany for 1987. In contrast to previous studies for these countries our estimates are based on relative producer prices ("unit value ratios"). Comparative output ratios were adjusted from gross output to census value added by using value added/gross output ratios at national prices.

The unit value ratios were based on "Industrieabgabepreise" for East Germany, which includes production levies and exclude part of product-oriented subsidies. This makes the unit value ratio less appropriate as an indicator of relative price levels, but it was the most practical tool available to convert the value added, which was also expressed in "Industrieabgabepreise", to D-marks.

Our estimates need to improved by scrutinising the unit value ratios in more detail for the existence of quality differences and for their effect on the aggregation of industry and branch results. It is also desirable to carry out a more careful analysis of the reasons behind the difference in value added/gross output ratios in East and West Germany. Nevertheless, we believe that our results are sufficiently robust to provide a good indication of the comparative productivity performance in East Germany just before reunification.

Our estimates of comparative productivity in East German manufacturing are lower than those from most other scholars. However, a previous study of ours showed productivity in manufacturing in Czechoslovakia also to be a good deal lower than was previously thought. Table 11 shows the comparative productivity levels for 1987 of 11 countries according to the ICOP approach. It shows East Germany at a productivity levels between that of Korea (at 18.2 per cent of the US level) and Brazil (at 28.4 per cent of the US level).

Finally our results are roughly in line with comparative productivity estimates from a study by Hitchens, Wagner and Birnie (1993) which are based on plant comparisons. Their study shows value added per head in East Germany in mid-1991, i.e. approximately a year after reunification, at between 27 per cent (for clothing) and 56 per cent (for furniture) of the level in West Germany, with an average sample result of 33 per cent. The authors attributed the relatively low

Table 11
Comparative Levels of Census Value Added per Hour Worked in Manufacturing, 1987, as a % of the USA and West Germany

	United States = 100.0	West Germany = 100.0
India	5.7	6.9
Czechoslovakia	16.2	19.8
Korea	18.2	22.1
East Germany	23.2	28.2
Brazil	28.4	34.6
United Kingdom	58.0	70.6
Japan	67.5	82.2
France	73.3	89.2
West Germany	82.2	100.0
United States	100.0	121.7

Source: Van Ark and Pilat (1993) for Germany and Japan, linked to other countries taken from Van Ark (1993); Czechoslovakia from Van Ark and Beintema (1992). East Germany from this study.

productivity in East Germany partly to an increase in underutilisation of productivity capacity in East Germany in 1991. However, there were other more fundamental reasons for the low productivity performance which can be traced back to the period before reunification. These include the lack of investment in capital with a high technology content, the malfunctioning of the physical infrastructure as well as the lack of organised business services. A more detailed analysis of the causes of the productivity gaps which arose during the four decades of central planning may provide essential information for the present transformation process of ex-socialist countries.

Appendix I - Concepts of Output and Prices

A. Output

East Germany:

Bruttoprodukt
minus
- non-material services
- changes in net stock of inventories of semi-manufactures

= Industrielle Warenproduktion
- production of industrial goods
- material services
- production for own use

minus
- use of materials

= Nettoprodukt

West Germany:

Gross Value of Output
- sales
- changes in net stock of inventories
- production for own use

minus
- use of materials

= Census value added (Nettoproduktionswert)

minus
- industrial/non-industrial services

= Gross value added (Bruttowertschöpfung)

B. Prices

East Germany:

Verbrauchpreise
plus
- consumer product-oriented subsidies

= Industrieabgabepreise
minus
- product specific levies (++)
- other indirect taxes (+/-)

plus
- producer product-oriented subsidies (+)

= Betriebspreise
- production costs
- mark-up for profit

West Germany:

Purchaser Prices

= Producer Prices
minus
- excise duties (+)
- other indirect taxes (+/-)

plus
- product-oriented subsidies (-)

= Basic prices

Note: (++) = very important; (+) = important; (+/-) = moderately important; (-) = unimportant

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