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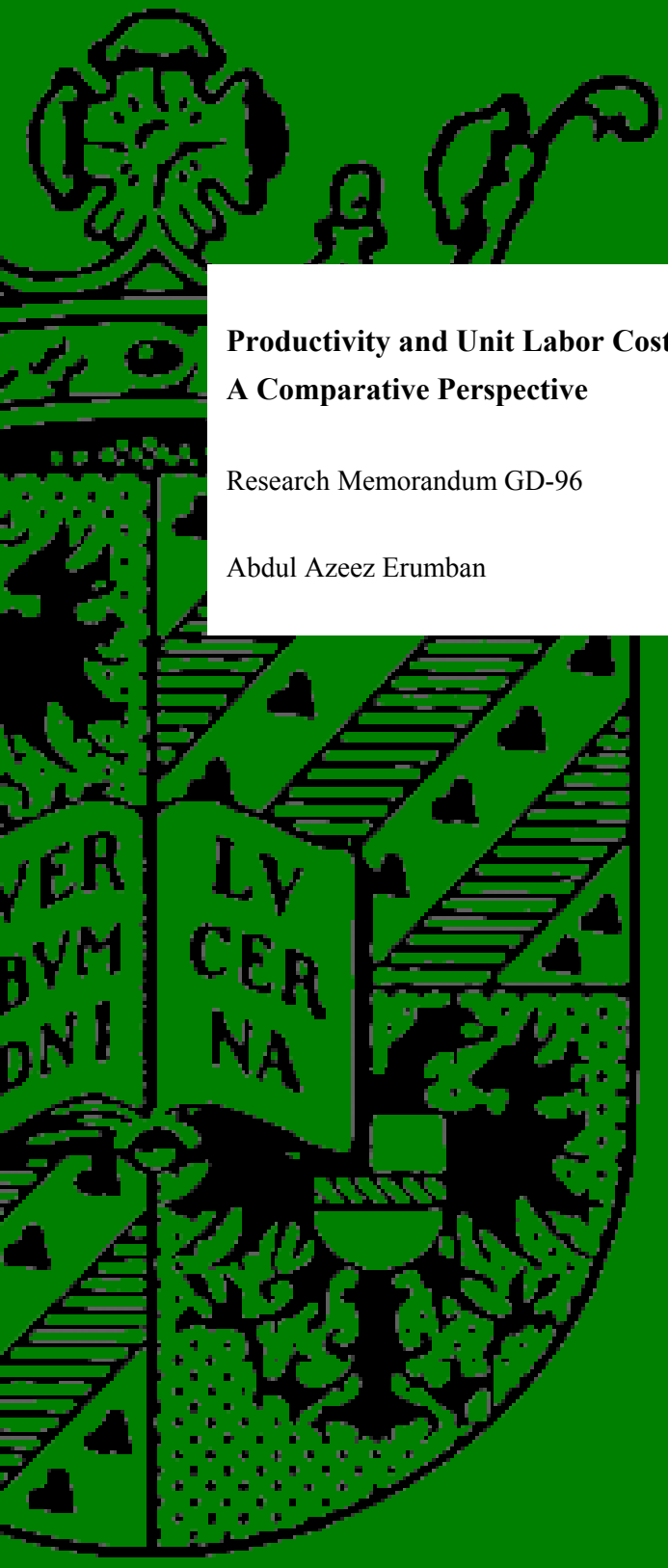

Productivity and Unit Labor Cost in Indian Manufacturing A Comparative Perspective

Research Memorandum GD-96

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RESEARCH MEMORANDUM

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1. Introduction

The industrial sector in India has witnessed significant policy changes since the country's independence in 1947. The government of India has introduced a series of policy reforms in order to create an industrial base for the country. This has been largely done under various five year plans. The initial stress was mostly on the development of heavy industries such as iron and steel and capital goods. Since the second five year plan the capital goods sector has been given the pivotal place in industrializing the country aiming to boost the capacity to invest and to come out of external dependence.[1] However, successive reforms have also realized the importance of consumer goods producing sector. This along with the aim of bringing regional dispersion of industrial activity has resulted in policies that encourage small scale industries, which were protected from any type of competition, domestic or foreign. In other words, the early phase of Indian industrial policy, as is the case with most developing countries, was characterized by restrictive policies. The policy makers advocated a series of guidelines characterized by pervasive licensing, reservation of key areas for public sector, inward oriented trade policy, control over large domestic firms, foreign direct investment and technology transfer and interventions in factor market. These restrictive and state dominated policies, which roughly prevailed till 1985, have helped fostering a diversified industrial base for the country. However, this policy regime created a high-cost industrial structure characterized by technological obsolescence, low rates of productivity, competitiveness, capacity utilization and growth. The sector witnessed stagnation in growth in the mid 60s and early 70s (Ahluwalia, 1985) which has lead to a rethinking on the role of state dominated policy. The result was a shift in the policy towards a more liberal policy regime, based on the grounds of achieving efficiency and competitiveness. In the second half of the 1970s the government started relaxing the foreign trade regime and a number of imported items were placed on the open general license list. The sector witnessed further significant changes in its policy direction during the late 1980s. However, the key role played by the state in allocating resources remained decisive. The shift in the policy paradigm got further stimulus in 1991, when the country faced macro economic crisis (Joshi and Little, 1996). The government of India introduced a new set of economic and industrial policies, where the market is allowed to play a decisive role. Thus the state dominated policy within the high protective barriers has disappeared partly by the initiation of liberal policy regime in the late eighties and fully by the introduction of new industrial policy in 1990s.

The shift towards a liberal industrial policy paradigm during the late eighties and early nineties was expected to bring significant changes to the manufacturing sector. It is expected to make the sector more efficient and competitive. Import liberalization can bring efficiency by exposing domestic producers to greater competition, internal and external, and by improving access to imported intermediate inputs and capital goods. There have been a number of studies examining productivity, capacity utilization, and

[1] This was done under the Mahalanobis Plan which had two main objectives. The first was to develop a heavy industry base for economic development. Given the fact that these heavy industries are highly capital intensive, providing less employment opportunities, the second objective was to generate employment opportunities in the economy. On these grounds, Mahalanobis proposed to concentrate on investment in heavy industries along with subsidized cottage (or small scale) industries.

efficiency in Indian manufacturing after these reforms have been introduced (Erumban, 2005; Goldar and Kumari, 2003; Balakrishnan et al., 2000, among others). It has been clearly shown by previous studies that the performance of Indian manufacturing sector in terms of productivity growth has not been impressive, particularly not in the later phase of reforms. Despite the disagreements over the turnaround in productivity growth in the 1980s (Ahluwalia, 1991, Balakrishnan and Pushpangadan, 1994), which is often attributed to policy changes there has been a general agreement over the fact that there is no significant productivity improvement in the 1990s (Goldar and Kumari, 2003; Balakrishnan et al., 2000). This finding is considered to be puzzling as the liberalization policies are expected to make the sector more competitive and productive.[2]

Figures 1 and 2 depict the growth of output and employment in organized Indian manufacturing[3] over the period 1980-2003. It can be seen that the employment has been declining in the early eighties, and started picking up since the mid 1980s. This trend has continued till the mid 1990s, after which there is a decline in employment, which again started picking up in 2001. Nevertheless, both output and value added has been increasing steadily since 1980, though the rate of increase has accelerated in the nineties. Except for the drop in 2000, both output measures have shown a general increasing trend.

In Figure 3 we provide the change in the composition of Indian industry over years. It is evident from the figure that in Indian manufacturing the traditional and heavy industries contribute the largest share even today. This is true for both registered and unregistered segments. In the unregistered segment the traditional sector dominates significantly across all other sectors. While in the registered sector, the traditional sector has shown a gradual decline in its share, it has maintained its share in the unregistered sector. Similarly, while the resource intensive industries have shown slight improvement in their shares in registered manufacturing, it has deteriorated in unregistered sector. In both these segments the shares of heavy industries have increased, while the share of electrical machinery and transport equipment have remained almost stable.

In contrast to the emerging evidence on the growth in Indian manufacturing since the economic reforms of the early 1990s, there has not been any recent study that has looked in detail at the comparative performance of this sector from an international perspective. Previous studies that examined Indian manufacturing from an international perspective have shown only slight indications of catch-up in Indian manufacturing in the later part of eighties, after a period of relative stagnation in labor productivity (Timmer, 2000; Timmer and Szirmai, 1999).

This paper provides new evidence on the catch up potential and the competitive position of India's growing manufacturing sector. We compare output, labor productivity and unit labor costs levels of Indian manufacturing with Germany over the period 1980-2003. Labor productivity in this paper is measured mostly as value added per employee. Nevertheless, estimates of value added per hour worked

[2] However, Goldar and Kumari (2003) have argued that this is because of the influence of certain adverse factors rather than the economic reforms, such as the decline in agricultural growth and deterioration in industrial capacity utilization.

[3] The manufacturing data in India is collected for two sectors, registered and unregistered. The registered sector includes all those firms who employ 10 (20) or more workers with (without) power. In the present study only the registered segment of manufacturing is considered for detailed analysis, as the data availability on unregistered manufacturing is quite limited.

are also provided whenever the data is available. These estimates are provided for 17 two-digit branches in registered manufacturing.

In order to make this bilateral comparison meaningful, we have expressed the output in both countries in a common currency, that is, in euros. For this, we use unit value ratios (UVRs) (instead of exchange rates or expenditure PPPs[4]), derived using ICOP (International Comparisons of Output and Productivity) methodology for the benchmark year 2002. The sectoral UVRs are derived based on relative output prices of representative baskets of goods using methods developed in the ICOP.

The paper is organized in 5 sections. The second section provides a discussion on the ICOP methodology to obtain UVRs and productivity measures.[5] The third section discusses the basic data and their sources for the present study. The fourth section provides the results for UVRs, labor productivity and unit labor costs and the last section concludes.

2. Methodology

2.1 Unit value ratios (UVR)

The UVR-based method in the industry of origin method was pioneered by Paige and Bombach (1959) for a comparison of the United Kingdom and the United States. The earlier work was conveniently summarized by Kravis (1976). The methodology explained below follows in the footsteps of the earlier studies, but was further refined within the framework of the ICOP project at the University of Groningen (Maddison and van Ark, 2002). Below the method is explained in more detail

In the industry-of-origin approach industry-specific conversion factors are derived on the basis of relative product prices. As a first step, unit values (*uv*) are derived by dividing ex-factory output values (*o*) by produced quantities (*q*) for each product *i* in each country:

$$uv_i = \frac{o_i}{q_i} \qquad (1)$$

The unit value can be considered as an average price, averaged throughout the year for all producers and across a group of nearly similar products. Subsequently, in a bilateral comparison, broadly defined products with similar characteristics are matched. For each matched product, the ratio of the unit values in both countries is taken. This unit value ratio (UVR) is given by:

$$UVR_i^{xu} = \frac{uv_i^x}{uv_i^u} \qquad (2)$$

[4] While the exchange rate is deficient in that it does not account for differences in purchasing power of different currencies, the expenditure PPPs, derived using final expenditure prices includes the price of goods imported by a country, but produced elsewhere, and excludes the price of goods and services exported from a country. They do not reflect relative producer prices.

[5] For an elaborated discussion on the methodology see Timmer et al (2001).

with *x* and *u* the countries being compared, *u* being the base country. The product UVR indicates the relative producer price of the matched product in the two countries.

Within ICOP, the total manufacturing sector is subdivided into 14-16 or more homogeneous branches (equal to the 2 or 3 digit ISIC level), which are subsequently subdivided into industries (equal to 4 digit ISIC level). Product UVRs are used to derive an aggregate UVR for manufacturing industries, branches and total manufacturing. This requires the choice of a particular weighting scheme. The most simple aggregation method is to weight each product UVR by its share in total manufacturing gross output (or in practice, total sales). However, the aggregate UVRs are more representative of the UVRs in underlying industries and product groups if a heterogeneous population is divided into more homogeneous subpopulations. This is illustrated by Figure 4.

In a comparison between two countries not all products in an industry *j* can be matched. This is because of lack of value or quantity data, difficulties in finding corresponding products, and because of the existence of country-unique products, *etc.* Bold lines at the product level in Figure 4 indicate the total output value of the matched products in the different industries. Thus, matched products in an industry can be seen as a subset of all the products within an industry.

The industry UVR (UVR_j) is given by the mean of the UVRs of the sampled products. Product UVRs are weighted by their output value as more important products should have a bigger weight in the industry UVR:

$$\mathrm{UVR}_j^{BA} = \sum_{i=1}^{I_j} w_{ij} \mathrm{UVR}_{ij}^{BA} \qquad (3)$$

with i=1,.., I_j the matched products in industry j; $w_{ij} = o_{ij} / o_j$ the output share of the i[th] commodity in industry j; and $o_j = \sum_{i=1}^{I_j} o_{ij}$ the total matched value of output in industry j. In bilateral comparisons the weights of the base country (*B*) or the other country (*A*) can be used, which provide a Laspeyres and a Paasche type UVR respectively. The geometric average of the Laspeyres and Paasche indices is used (Fisher) when a single currency conversion factor is required.

The next aggregation step is made by using the gross output of industries to obtain an industry-weighted mean of all industry UVRs in a branch:

$$\mathrm{UVR}_k^{BA} = \sum_{j=1}^{J_k} w_{jk} \mathrm{UVR}_{jk}^{BA} \qquad (4)$$

with j=1,.., J_k the number of industries in branch k for which a UVR has been calculated (the sample industries); $w_{jk} = o_{jk} / o_k$; and $o_k = \sum_{j=1}^{J_k} o_{jk}$. Again gross output weights from base country *B* and the other country *A* can be used to arrive at Laspeyres and Paasche index of the branch UVRs. The latter step is repeated for the final aggregation step from branch level to the level of total manufacturing.

The representativity of the UVR for a given industry or sector can be statistically tested on the basis of the coefficient of variation of the UVRs. Statistically, large variations in unit value ratios signal a greater unreliability of the measures. By adjusting the variance for a finite population correction, it is ensured that with an increasing coverage of products, the variance goes down (Timmer 2000 Chapter 3). Together with measures of the Paasche/Laspeyres spread between unit value ratios, which indicate differences in production structure between countries, measures of output covered by matched products, and the number of product matches, the variance of UVRs gives a good indication of the reliability of the unit value ratios.

The Fisher UVRs are used to calculate value added at the branch level into comparable prices. Thus, value added can be compared between the two countries. Using value added at comparable prices, relative labor productivity and unit labor costs are derived by adding information on employment and wages. The definition of unit labor costs requires some further discussion.

2.2 Unit labor costs[6]

Unit labor cost (ULC) is defined as the cost of labor required to produce one unit of output in a particular industry, sector or the aggregate economy. ULC indices can be directly compared between countries. In this section we focus on a comparison of relative *levels* of unit labor cost, which allows comparisons of cost competitiveness in absolute terms not just in relative terms.[7] The unit labor cost measure is a ratio that is constructed from a numerator reflecting the major cost category in the production process (which is labor compensation) and a denominator reflecting the output from the production process (GDP or value added). Countries with a low level of ULC relative to other countries may be regarded as competitive.

The meaning of the ULC concept might be even better understood when expressed in terms of the ratio of labor compensation per unit of labor (for example, the wage or the total labor cost per employed person or per hour worked) and the productivity of labor (measured as output per employed person or per hour). It shows that a country can improve its competitiveness either by decreasing its labor cost per person employed or raising the productivity performance. This implies that an economy can apply different strategies to improve competitiveness, for example, by moderating wage growth in order to cut on cost, raise productivity to create more output, or find an appropriate mix of both strategies.

A specific characteristic of unit labor cost measures is that the *numerator*, which reflects the labor cost component of the equation, is typically expressed in nominal terms, whereas the *denominator*, which is output or productivity, is measured in real or volume terms. This implies that, when comparing unit labor cost levels across countries, the level of wages or labor compensation is converted at the official exchange rate: it represents the cost element of the arbitrage across countries. In contrast, output or productivity relates to a *volume* measure as it resembles a *quantity unit* of output. Hence for level comparisons output needs to be converted to a common currency using purchasing power parity instead

[6] This discussion is taken from van Ark, Stuivenwold and Ypma (2005), pages 2-5
[7] For a comprehensive overview of price and cost competitiveness measures see, for example, Turner and Van ‘t Dack (1993).

of the exchange rate, so that comparative output levels are adjusted for differences in relative prices across countries.

Hence the unit labor measure represents the current cost of labor per "quantity unit" of output produced. For an analysis in terms of comparative levels between countries A and B this implies:

$$ULC^{AB} = [(LC^{A}/ER^{AB})/LC^{B}] / (Y^{A}/PPP^{AB})/Y^{B}] \quad (5)$$

where ULC stands for unit labor cost, LC for total labor compensation, Y for total output (or value added), ER^{AB} for the official nominal exchange rate between countries A and B and PPP^{AB} for the purchasing power parity for output in country A relative to country B. Dividing labor compensation and output by employment or total hours worked, gives the labor cost per labor unit (lc) and labor productivity (y):

$$ULC^{AB} = [(lc^{A}/ER^{AB})/lc^{B}] / (y^{A}/PPP^{AB})/y^{B}] \quad (6)$$

Equation (6) can be rewritten to decompose the difference in unit labor cost between country A and country B into three components, i.e., the difference in nominal labor cost per person, the difference in nominal labor productivity (that is unadjusted for differences in price levels) and the differences in relative price levels:

$$\log (ULC^{A} - ULC^{B}) = \log (lc^{A}/ER^{AB} - lc^{B}) - \log (y^{A}/ER^{AB} - y^{B}) \quad (7)$$
$$- \log (ER^{AB} - PPP^{AB})$$

All these components contribute in their own way to differences in cost competitiveness between the two countries. However, even for tradables, the ULC index should not be interpreted as a comprehensive measure of competitiveness for several reasons. Firstly, ULC measures deal exclusively with the cost of *labor*. Even though labor costs account for the major share of inputs, the cost of capital and intermediate inputs can also be crucial factors for comparisons of cost competitiveness between countries.[8] Secondly, the measure reflects only *cost* competitiveness. In the case of durable consumer and investment goods, for example, competitiveness is also determined by other factors than costs, notably by technological and social capabilities and by demand factors. Improvements in product quality, customization or improved after-sales services are not necessarily reflected in lower ULC. Thirdly,

[8] One might argue that with greater international tradability of capital and intermediate inputs, labor input is the key determinant of cost competitiveness as it is much less mobile across countries.

measures of cost competitiveness may be distorted by the effects from, for example, bilateral market access agreements, direct and indirect export subsidies and tariff protection.

3. Data

To construct the unit value ratios using the ICOP methodology we require data on values and quantities of products manufactured in India and in Germany. For this purpose, we primarily make use of two data sources. They are the PRODCOM product database for Germany, available through Eurostat, and the Annual Survey of Industries (ASI) for India, published by Central Statistical Office. In what follows we provide a brief discussion of these datasets.

3.1 Basic data on values and quantities at product level

PRODCOM data for Germany

The survey on PRODucts of the European COMmunity (PRODCOM) provides statistics on production of manufactured goods together with related external trade data for member states of the European Union. We make use of PRODCOM data on production which provides physical quantity and value of output sold. This data is based on a product list containing about 4500 products. Since each product is classified by an 8 digit codes, which is in accordance with 4 digit NACE codes, it is easy to attribute each product to a particular manufacturing branch under NACE. We take this data for Germany for the year 2002. Note that we take Germany as the base country to construct the UVRs. Previous ICOP studies have used the United States as the base country. However, given the fact that the availability of US product statistics has been deteriorating over years and German statistics provide more detailed data on product quantities and values, we get more accurate UVRs when using Germany as the base country. Since the PRODCOM data refer to aggregates across firms for each product we could directly use them without much cleaning on original product data. Each product has data on value of sales in euros, and quantities provided in specific units of measurements (unit, ton, litre). By dividing the total sales value of a given product by its sold quantity, we obtain the basic price of the product under consideration.

ASI plant level data

ASI provides information on quantities and values of products manufactured and sold, gross output, total persons employed, total compensation and value added among others for Indian manufacturing. For this study we obtained data for the financial year 2002-03, which we compare with the calendar year 2002 for Germany. It is important to mention that the ASI data covers only the organized segment of Indian manufacturing, i.e. those factories which employ 10 or more workers with power and 20 or more workers without power. The data are available for almost 5500 products classified under ASI Commodity Classification (ASICC). Unfortunately, the ASICC product classification does not have any link with any international product classifications, making it virtually impossible to classify these products under

different industry branches.[9] Therefore, it was essential to look at each and every product in detail before making a final decision on match. Moreover, since this data is plant level data, we had to clean the data before aggregating to product level.

In fact, the product data for India are directly taken from individual plant level data on Indian manufacturing. The original dataset on quantities and values provided under *block j* of the ASI schedule contained 95,624 observations for 29,188 firms and 4,121 products. As a first step, we filtered out all those cases where there is no data on either quantity or sales value or both (at firm level for India). This reduced the number of observations on products to 51,329, i.e. 54 per cent of the full sample. From the filtered list we have matched each Indian product with the corresponding German product. Thus in the final sample, we have only those products for which we have a corresponding German match. Hence the number of observation has further declined to 20,312. We have examined the unit values, calculated as total sales value minus total taxes paid divided by total sales quantity for each product at firm level, for outliers. All those firms having extremely high/low unit values for a given product were deleted. This is because inclusion of such firms in the sample may affect the aggregate unit value ratios for the product. However, as there was no clear cut rule on how to delete outliers and, more importantly, the number of firms in each product varied, we have applied a variety of rules. First we identified outliers using the Hadi's outlier index (Hadi, 1992; 1994) for each product with more than 5 firms. Along with this we also computed the mean and standard deviation for each product group across firms. If the firm was found to be an outlier both in terms of Hadi's index and Chebyshev's standard deviation rules, we excluded it from the sample. For those cases for which the number of firms is lower than five, we visually observed using their mean and standard deviation (there were 790 such cases). After these cleansing procedures, we were left with 19,108 cases, with 6 % of outliers.

The firm level data were aggregated across firms resulting in 925 products for which we could find match with the German data. Note that there were many cases where we had to aggregate more than one Indian (German) product to get a better match with German (Indian) product. For instance butter in Germany is matched with different types of butter produced in India, including for instance ghee.[10] We were careful in matching like-with-like. For example, the data on car production in Germany is available for different car types, differing in engine size, while Indian data does not make any such distinction. We assumed that Indian production consisted mainly of small cars. A similar approach was used for a number of machinery and equipment items. However, whenever there was an accurate match we have opted to use that. Effectively we had 456 product groups, consisting of 1015 German products and 868 Indian products. Still it was not possible to use all these 456 matches due to differences in units of measurement.

[9] More importantly, it does not comply with Indian classifications itself (NIC87 and NIC98). For instance, the product code for beef in ASICC is 11202, which belongs to the industry group beef slaughtering and preparation. This code has no correspondence with the corresponding industry codes; this product belongs to industries 15112 (5 digit), 1511 (4 digit) and 151 (3 digit) under NIC 98. It is also strange that this 4 digit code 1511 which represents the meat industry in NIC98 corresponds with alcohol in ASICC; the ASICC for alcohol absolute and edible is 15111.

[10] Note that, however, such aggregation was possible only if all products were expressed in same unit of measurement. If they were expressed in different units, we opted to exclude them from the sample. However, such cases were quite marginal across the components of a given product group within India or Germany, though the problem was very large while comparing German units with Indian units.

Some products in India are expressed in different units compared to that of Germany.[11] While we were able to convert some units using appropriate conversion factors (see appendix Table 3), a large number of units could not be converted to one measure. Another problem was due to outliers in aggregate product level unit value ratios for a given industry. All those products having extremely high/low unit value ratios were excluded; we had 115 such products, which constituted almost 6 per cent of total output produced by the firms in the product data sample. Similarly there were 83 products for which we could not find a unit conversion factor, which therefore had to be excluded. Finally we were left with 258 products for which a useful match could be made between the two countries. These were classified under 43 three-digit industries and 19 two-digit branches.

3.2 Aggregate data

As mentioned in the introduction, we provide estimates of labor productivity and unit labor cost for 2002 and also over the period 1980-2003. The time series results are provided for 17 two-digit manufacturing branches. For this we required data on output, value added, employment, hours worked and employee's compensation at two-digit aggregate level. For India this data is again taken from *Annual Survey of Industries*, compiled and published by Economic and Political Weekly Research Foundation (EPWRF). This data is available since 1973-74 till 1997-98, under the National Industry Classification (NIC), 1987. The data for years after 1997-98 has been taken from the ASI website (http://mospi.nic.in/mospi_asi.htm). However, ASI changed its industrial classification from NIC 1987 to NIC 1998 since 1998-99, so that we had to reclassify the data prior to 1998 using the concordance table provided by the CSO. Finally we have a series, all in NIC 1998, which is largely comparable with ISIC. The variables which we used are gross output, gross value added, total persons engaged, total emoluments and total hours worked. Gross output comprises of total ex-factory value of products and by-products manufactured as well as other receipts (such as receipts from non-industrial services rendered to others, work done for others on material supplied by them, value of electricity produced and sold, sale value of goods sold in the same condition as purchased, addition in stock of semi- finished goods and own construction). Gross value added was derived by deducting total input from total output. Total emoluments is defined as the sum of wages and salaries, employers' contribution as provident fund and other funds and workmen and staff welfare expenses. Total persons engaged include the total employees and all working proprietors and their family members who are actively engaged in the work of the factory. ASI does not provide data on man hours worked. Nevertheless, it provides data on man days worked. We have converted man days data to man hours by assuming that each man day worked is assumed to be equivalent to eight hours. Also the price deflators to deflate output and value added are taken from various publications on wholesale price indices, compiled and published by EPWRF till 1993-94. After 1993-94, we have taken the data from the Ministry of Commerce and Industry website (http://eaindustry.nic.in). For some industries there was no direct price deflator available. In such cases, we used the weights given in each base year for the different component of that particular industry to derive a weighted price deflator or opted to use the nearest industry deflators.

[11] For instance, optical fiber cable in India is expressed in kilometers, while they are expressed in kilograms in Germany.

Output and employment data for Germany are taken from the 60 industry database of the Groningen Growth and Development Centre (GGDC, 2006). We obtained gross value added, total persons engaged, total employees compensation and total hours worked from the GGDC database. For gross output, we obtained the data from OECD STAN database.

4. Results

4.1 Unit Value Ratios

The main results for the UVRs and the comparative price level are given in Table 1. Column 1 in table 1 shows the UVRs weighted at German quantities (Laspeyres), column 2 shows the results at Indian quantity weights (Paasche) and column 3 shows the geometric average of these two (Fisher). The estimated UVR for total manufacturing is 25.2 rupees to the euro which is much lower than 48.1 rupees, which is the exchange value against the euro in 2002. The UVRs vary significantly across industries, with the leather and footwear industries being the lowest and petroleum, coke and nuclear fuel industries being the highest. In the last column we present the relative price level - that is the ratio of Fisher UVR to the prevailing nominal exchange rate in 2002. This ratio is of great importance, as it indicates whether Indian products are relatively cheaper (below 100) or dearer (above 100) than those produced in Germany. It should be noted that in Table 1, we have an additional row for total manufacturing, i.e. total excluding coke, petroleum and nuclear fuel. This is because the latter industry is observed to influence the entire manufacturing sector's result very significantly as it has very high unit value ratios. Therefore we opted to compare the results including and excluding this industry. From the table it is clear that Indian products are cheaper than German products. On average Indian products are priced at only 46 per cent of the German price level excluding petroleum and 52 per cent when oil is included.

The price advantage of Indian manufacturing varies significantly across industries. The largest advantage is in industries leather and leather products, followed by radio television and communication equipment, fabricated metals, other manufacturing, electrical machinery and apparatus, textiles and wearing apparel. While the only industry with a price disadvantage is coke and petroleum, industry office and accounting machinery show an almost near price level. Also wood and wood products, paper and paper products and rubber and plastics are relatively highly priced industries.

In table 2 we provide some reliability statistics for the UVR measures. As mentioned before, there were 258 UVR matches, covering 23 per cent of Indian output and 22 per cent of German output. The largest numbers of matches were found in food, beverages and tobacco, followed by machinery and equipment. The last two columns in table 2 indicate the coefficient of variation (CV) of UVRs within industries. It shows that the UVRs for total manufacturing and most two digit branches are quite reliable, as the coefficient is less than 0.1. A few branches, however, show a high CV. For instance furniture and other manufacturing, and clothing have shown a CV greater than 0.2 in Laspeyres UVR. The results for these branches should therefore be interpreted with caution.

4.2 Output and labor productivity

The estimated unit value ratios are used to convert output in Indian rupees (INR) into euros, so that the output level can be compared with German values. UVR-converted output in combination with labor input, employees and/or man hours, is then used to derive relative output and labor productivity comparisons between India and Germany.

Table 3 presents value added and employment by manufacturing branch, expressed as a percentage of the same measures for the corresponding branch in Germany for 2002. The table suggests that the number of persons engaged in the organized segment of manufacturing in India is about the same as in Germany at about 7 million workers (also see Appendix Table 1). But the Indian employment number is significantly higher than in Germany in food, beverages and tobacco, textiles, clothing, leather and footwear, coke, petroleum and nuclear fuel, non metallic minerals and basic metals. The industries which show a relatively lower level of employment in India are medical precision and optical instruments and machinery and equipment. This may be due to the fact these are industries for which India do not have much dominance. Also high income elasticity and lower per capita income in India may be considered as important explanations for this phenomenon.

The results are quite different for value added though. Overall Indian organized manufacturing constitutes only 20 per cent of German value added. Indian value added is higher than that in Germany in textiles and leather, while in clothing and basic metals it is more than 50 per cent of the German level.

In table 4 we provide labor productivity in India as a percentage of Germany. The relative labor productivity level, both in terms of hours worked and number of employees is much smaller in Indian organized manufacturing than in Germany, i.e. 21 per cent of the German productivity level in terms of employees, and only 11 per cent in terms of hours. This holds true for most industries except radio television and communication equipment, whereas labor productivity in terms of employment is quite closer to Germany.

Relative labor productivity levels, 1980-2003.

We also derived a series of relative labor productivity over the period 1980-2003, using the value added, employment and hours worked data for Germany and India across different two-digit industries. For India this data for the period 1980 to 1998 has been taken from Annual Survey of Industries provided by EPWRF under NIC 1987 and has been re-aggregated to the new industrial classification (NIC98). The data for the period 1999-2003 was directly taken from ASI website. For Germany the aggregate on output, employment, hours and compensation has been taken from GGDC 60 industry database (GGDC, 2006). Labor productivity was then extrapolated for the whole period using the 2002 benchmark labor productivity estimate for the 16 manufacturing branches.[12] In Figures 5 and 6 we plot the relative labor productivity trends in total manufacturing measured respectively using employees and hours. It shows that Indian manufacturing has improved its productivity over years, from 8 (12) per cent in 1980 to 23(23) per cent in 2003 for total manufacturing (between brackets: excluding petroleum), when value added per

[12] Output growth has been calculated using constant price value added in national currencies.

employee is considered. Nevertheless, the rate of catch up is much lower when hours worked is considered for the productivity concept. It has improved from only 8 per cent of the German level to 12 percent (when petroleum is excluded) and from 6 per cent to 11 per cent (with petroleum included). This difference is largely due to the decline in the number of hours in Germany and continuous increase in hours worked in India. Total hours worked in India increased from 13,471 million (88 % of Germany) in 1980 to 18,007 million (173 % of Germany) in 2002, while the German hours declined from 15,270 to 10,425. The catch up process observed appeared to be consistent over the years. More importantly there is sign of slight improvement in productivity catch up in the 1990s, after the much vaunted economic reforms were initiated in India. This indicates that even though there is no sign of improvement in absolute total factor productivity in India (Goldar and Kumari, 2003; Balakrishnan et al., 2000), the competitive position of Indian manufacturing in terms of relative labor productivity has been improving, though at a slower rate, ever since the economic reforms were initiated. Although the relative labor productivity level has shown a deceleration in 2000 and in 2001, it has started to improve again during the last two years. However, even after the reform process was initiated, Indian productivity still hovers around 20 percent of German productivity.

The relative productivity levels for individual manufacturing industries over 1980-2003 are provided in Tables 5 and 6. Most industries have improved their relative productivity performance over years. Nevertheless, as reflected in the aggregate labor productivity, the story in the 1990s is not very positive. Branches with a relatively slow catch up includes wearing apparel etc., wood and products of wood and cork, paper and paper products, and office, accounting and computing machinery.

4.3 Relative Unit Labor costs

In Table 4 we also look at another important factor that determines the international competitiveness of Indian manufacturing sector, which is unit labor costs. This is an important measure, as labor cost constitutes a major share of value added in most developed countries. For instance, in 2002 the share of labor cost in manufacturing value added in Germany was as high as 74 per cent while it was only 26 per cent in India (for the sectors under consideration of our study). Comparisons of unit labor costs (cost of labor per unit of output) are often used in evaluating the competitive position of countries. Following the ICOP methodology, we have calculated this as a ratio of compensation to employees in Indian manufacturing, converted to euros using the exchange rate, to value added in Indian manufacturing, converted to euros using unit value ratios. This ratio is expressed as percent of the corresponding ratio calculated for Germany (see equation 5). This trend is extrapolated to construct a series over 1980-2003. Table 4 shows that the ULC in Indian organized manufacturing was only 18 per cent of Germany in 2002. This varies from 7 per cent in radio, television and communication equipment industry to 44 per cent in wood and wood products industry. In general, the results for relative unit labor costs for manufacturing branches for 2002 shows that almost all branches have competitive advantage over Germany in terms of unit labor costs. In the last two columns of table 4 we have provided compensation per employee (hour) as percent of Germany. India pays only 2 per cent of hourly compensation and 3.5 per cent of employees' compensation.

Figure 7 provides the unit labor cost in Indian manufacturing relative to Germany over the period 1980-2003. The unit labor cost shows a decline during the 1980s from 71 per cent in 1980 to 23 per cent in 1991, and remained stagnant in the 1990s at around 15 per cent (Table 7). This finding is puzzling in combination with the observation of increasing relative labor productivity in the 1980s. It indicates that wages in India have not increased along with productivity. However, stagnant ULC in the 1990s is in line with almost stable labor productivity during this period. The declining trend in ULC is also observed in most branches. In food, beverages and tobacco and other manufacturing the ULC in the initial years of 1980s was as high as in Germany, but declined to 26 and 18 percent of the German level respectively in 1991 and then remained stable at 25 and 16 per cent. However, some branches have shown tendencies of increasing ULC. The clothing industry has shown an increasing ULC since 1990s, rising from 8.4 per cent in 1993 to 14.3 per cent in 2003. The ULC has been highly volatile in industry wood and wood products.

These ULC trends can be better understood by looking at Figures 8 and 9, where we have plotted relative unit labor cost, labor productivity and compensation along with the exchange rate between India and Germany over 1980-2003. It can be discerned from the figure that the decline in ULC in Indian manufacturing is largely mirrored in the exchange rate movements. The exchange rate between Indian Rupees and Euro (INR/EUR) has increased significantly during 1985-1992, reducing the labor cost content of products made in India. Since 1992, the exchange rate witnessed high volatility. ULC has shown sharp decline from in 1980s corresponding to a depreciation of the Indian rupee relative to the euro.[13] The value of the rupee weakened from 8.2 rupees to the euro in 1980 to 38.3 rupees in 1992. However, the correlation between exchange rate and unit labor cost varies a lot across branches, from -0.41 to -0.95. We also observe divergence in labor productivity and employees compensation since mid 1980s till early 1990s. It indicates that even though Indian manufacturing experienced a slight improvement in its relative labor productivity, wage rate has deteriorated. The story remains the same even if we consider hours worked as a measure of labor input. However, the divergence in relative labor productivity and employees compensation has declined in the 1990s.

4.4. Unit labor cost and labor productivity: cross country comparison

Tables 8 and 9 and Figures 10 to 13 provide a view on the relative position of Indian manufacturing in terms of labor productivity along with South Korea, Mexico, Hungary, Poland, Indonesia and Brazil. Figures 14 and 15 and Table 10 provide a view on the relative position of India in terms of unit labor cost along with other countries. The figures for these countries are derived from International Labor Organization (ILO) Key Indicators of the Labor Market (KILM) for total manufacturing. Therefore, all the values are expressed as percent of United States. Also note that while the new results for India are based on 2002 Euros the results for the other countries are based on 1997 PPPs and expressed in US $. Hence, we have converted the Indian results presented in Tables 5, 6 and 7 to a U.S. base, using the relationship between the U.S. and Germany from KILM and India and Germany in Tables 5, 6 and 7.

[13] Note that for the years before Euro has been introduced we have calculated the Euro-Rupees exchange rate using the conversion factor between Euro and German Mark and the exchange rate between German Mark and Indian Rupees.

The tables show that labor productivity in India has been improving at a slower rate compared to South Korea. South Korea witnessed an exceptionally high labor productivity growth since mid 1990s. Indian productivity levels are also much below those in South Korea, Poland and Hungary, and relatively higher than in Indonesia and Brazil. In 2002, Indian productivity levels in manufacturing were at 12 per cent of US labor productivity while the same for South Korea was 49 per cent, for Hungary 22.2 per cent and for Poland 18.6 per cent. Due to declining productivity in Mexico, Indian manufacturing has surpassed the manufacturing productivity level of Mexico in recent years. The relative position of India in terms of labor productivity remains the same even if we consider output per hour as measure of labor productivity. As time series are lacking – as yet –, we have not included here estimates for two other emerging economies, namely China and Turkey. Van Ark et al. (2006) show that the manufacturing sector in China has a productivity level of 13.7 per cent to the United States, which is only slightly higher than in India, whereas Turkish manufacturing performed at 16 per cent of the U.S. productivity level.[14]

India has the lowest ULC among all the countries under consideration. Moreover, the ULC in India has declined significantly over years, in particular during the 1980s. Korea had the highest unit labor cost from 1982 to 1997.[15] However, in 2002, Mexico had the highest ULC, which was as high as United States, while Korean ULC was 65 percent of US, Poland 74 per cent, Hungary 53 percent and India only 21 per cent. The decline in Korean unit labor cost since 1997 can be attributed to the East Asian financial crisis, which has caused a significant dip in the value of its currency. Unit labor cost in China and Turkey were at 21 and 32 per cent of the U.S. level respectively (van Ark et al., 2006).

5. Conclusion

This paper has presented new and up-to-date results on unit value ratios, labor productivity and unit labor costs for Indian manufacturing. These figures help one understand the competitive position of Indian manufacturing from an international perspective. Using two extensive datasets on quantities and values of manufactured products in India and Germany we have derived the relative prices between these two countries which are subsequently used to express the output values in a common currency. This helps us evaluate the productivity levels in both countries in a meaningful way.

We have observed that in terms of relative price levels, India has an advantage over Germany in almost all manufacturing branches. On average Indian products are priced half the German price. On the productivity side, it is observed that the labor productivity in Indian manufacturing is quite lower than that of Germany. It is as low as 21 per cent of the U.S. level when considering value added per employee and 11 per cent for value added per hour. When compared with other countries, it is observed that the labor productivity in Indian manufacturing is considerably lower than in South Korea, Hungary and

[14] Van Ark et al. (2006) also include a crude estimate for the productivity of all manufacturing in India (including unregistered manufacturing) and China (including firms below township level). This shows a much wider gap between India and China at 2.4 per cent and 4.6 per cent of the U.S. level, respectively.
[15] This high and increasing ULC along with high labor productivity in South Korea has been previously highlighted by van Ark et al (2005).

Poland, slightly lower than in Turkey, more or less the same as in China and slightly higher than in Indonesia, Brazil and Mexico. This lower productivity level in India has also translated in lower labor costs per unit of production. India has registered the lowest unit labor cost among the countries we have considered for comparison. Moreover, over years the ULC has shown a declining tendency, indicating that the country maintains a competitive advantage in terms of unit labor costs. This cost advantage, however, has been largely due to exchange rate depreciation, particularly during the 1980s. In the 1990s, however, the exchange rate has been more volatile, during which the unit labor cost relative to Germany has not shown any notable decline.

Tables

Table 1: Unit Value Ratios and Relative Price levels, India, 2002

Industry	Industry codes	Laspeyres	Paasche	Fisher	Comparative price level
Food, beverages & tobacco	15+16	30.81	21.98	26.03	0.54
Textiles	17	26.46	14.23	19.40	0.40
Clothing	18	16.79	22.83	19.58	0.41
Leather and footwear	19	11.18	10.46	10.81	0.22
Wood, products of wood & cork	20	62.82	29.69	43.19	0.90
Pulp, paper & paper products	21	31.24	34.45	32.81	0.68
Coke, petroleum and nuclear fuel	23	127.14	99.81	112.65	2.34
Chemicals	24	26.82	22.20	24.40	0.51
Rubber & plastics	25	33.92	26.93	30.22	0.63
Non-metallic mineral products	26	21.89	22.71	22.29	0.46
Basic metals	27	24.47	19.79	22.01	0.46
Fabricated metal products	28	15.40	12.53	13.89	0.29
Machinery & equipment	29	35.27	13.55	21.86	0.45
Office machinery	30	51.48	42.69	46.88	0.97
Other elect. Machinery	31	15.67	22.90	18.94	0.39
Radio, TV& communication eqpt	32	11.71	11.13	11.42	0.24
Scientific & other instruments	33	25.39	30.86	27.99	0.58
Motor vehicles	34	20.64	22.73	21.66	0.45
Furniture & other mafg	36	17.67	14.65	16.09	0.33
Total		**29.16**	**21.71**	**25.16**	**0.52**
Total - Coke petro. & nuc. fuel		25.96	19.10	22.27	0.46
Exchange rate		48.09			

Note: Comparative price levels are calculated as Fischer UVR/exchange rate.

Source: Own calculation using data from ASI and Prodcom.

Table 2: Reliability indicators of Indian UVR, 2002

		Coverage Ratio		Coefficient of Variation	
Industry	*Nr. of UVRs*	*Germany*	*India*	*Laspeyres*	*Paasche*
Food, beverages & tobacco	63	41.88	43.66	0.03	0.05
Textiles	19	21.93	37.47	0.14	0.12
Clothing	13	6.50	44.80	0.21	0.16
Leather and footwear	3	19.50	22.57	0.01	0.01
Wood, products of wood & cork	5	22.08	9.34	0.07	0.12
Pulp, paper & paper products	10	24.70	39.55	0.07	0.08
Coke, petroleum and nuclear fuel	4	11.19	9.65	0.09	0.17
Chemicals	19	11.82	12.35	0.11	0.09
Rubber & plastics	11	17.06	17.72	0.16	0.16
Non-metallic mineral products	10	12.01	65.57	0.03	0.03
Basic metals	5	9.96	14.03	0.10	0.11
Fabricated metal products	15	11.10	7.73	0.09	0.07
Machinery & equipment	43	10.36	28.67	0.12	0.09
Office machinery	4	27.62	29.57	0.10	0.14
Other elect. Machinery	6	5.00	1.18	0.05	0.09
Radio, TV& communication eqpt	7	6.39	26.66	0.07	0.05
Scientific & other instruments	9	2.84	5.66	0.15	0.09
Motor vehicles	8	48.79	5.80	0.08	0.05
Furniture & other mafg	4	1.00	3.95	0.33	0.07
Total	**258**	**22.13**	**22.95**	**0.03**	**0.04**

Table 3: Value Added and Employment in Indian Manufacturing as % of Germany, 2002

Industry	**Value Added**	**Total Persons**
Food, beverages & tobacco	25.3	185.3
Textiles	163.8	847.9
Clothing	71.7	430.2
Leather and footwear	117.9	472.2
Wood, products of wood & cork	1.6	26.2
Pulp, paper & paper products	12.7	107.4
Coke, petroleum and nuclear fuel	40.2	291.4
Chemicals	37.5	152.2
Rubber & plastics	11.6	63.4
Non-metallic mineral products	31.1	210.5
Basic metals	65.3	193.1
Fabricated metal products	9.5	33.3
Machinery & equipment	7.5	36.5
Office machinery	8.8	39.6
Other elect. Machinery	12.6	42.1
Radio, TV& communication eqpt	45.8	64.6
Scientific & other instruments	3.9	18.6

Motor vehicles	7.7	30.3
Furniture & other mafg	13.6	43.0
Total	**19.8**	**101.3**
Total - Coke petro. & nuc. fuel	20.1	100.6

Source: ASI and GGDC 60 industry database (Appendix Table 1)

Table 4: Relative Unit Labor Cost and Labor Productivity in India (Germany=100), 2002

Industry	Value added/ employee	Value added/ hour	Unit labor cost	Compensation/ employee	Compensation/ hour
Food, beverages & tobacco	13.64	9.06	23.56	3.21	2.13
Textiles	19.32	10.61	20.83	4.02	2.21
Clothing	16.67	8.74	21.78	3.63	1.90
Leather and footwear	24.97	15.81	14.74	3.68	2.33
Wood, products of wood & cork	6.16	4.01	43.91	2.70	1.76
Pulp, paper & paper products	11.83	6.52	30.20	3.57	1.97
Coke, petroleum and nuclear fuel	13.80	8.48	30.28	4.18	2.57
Chemicals	24.64	13.86	15.31	3.77	2.12
Rubber & plastics	18.33	11.01	21.60	3.96	2.38
Non-metallic mineral products	14.75	9.23	17.98	2.65	1.66
Basic metals	33.83	18.22	16.92	5.73	3.08
Fabricated metal products	28.42	17.21	15.13	4.30	2.60
Machinery & equipment	20.44	11.96	23.02	4.71	2.75
Office machinery	22.24	14.58	25.85	5.75	3.77
Other elect. Machinery	29.79	16.86	14.18	4.22	2.39
Radio, TV& communication eqpt	70.94	38.61	7.10	5.04	2.74
Scientific & other instruments	21.12	12.50	30.71	6.48	3.84
Motor vehicles	25.48	14.23	17.42	4.44	2.48
Furniture & other mafg	31.67	18.90	15.66	4.96	2.96
Total	**19.52**	**11.44**	**18.21**	**3.55**	**2.08**
Total - Coke petro. & nuc. fuel	**20.01**	**11.74**	**17.55**	**3.51**	**2.06**

Source: Unit value ratios from Table 1 and basic data for India from EPWRF and ASI and for Germany from GGDC 60 industry database

Table 5: Relative Labor Productivity in India, Germany =100(Value Added/Person engaged)

Industry codes	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
15+16	2.7	3.2	4.0	6.4	5.9	6.2	6.5	6.7	7.7	7.9	7.1	7.4	7.4	8.9	8.7	9.0	10.8	9.6	11.8	13.2	11.6	13.2	13.6	12.4
17	10.9	11.0	10.0	11.2	10.9	11.7	13.3	12.3	12.9	14.7	15.9	13.9	12.1	14.2	13.8	12.0	16.0	16.1	16.1	18.2	18.5	17.6	19.3	17.7
18	12.6	14.4	15.8	14.4	17.2	15.1	20.3	22.3	23.6	25.1	26.9	31.2	27.9	37.1	28.3	23.7	20.8	18.6	22.8	22.8	18.7	18.0	16.7	12.4
19	22.3	23.6	25.2	29.8	31.0	26.1	26.5	36.6	39.5	24.8	39.3	29.5	25.9	35.0	26.1	25.4	27.5	31.1	53.6	26.7	25.0	27.4	25.0	23.9
20	6.4	6.6	6.4	8.7	8.3	6.8	7.6	8.2	9.6	9.2	13.6	12.9	6.1	6.6	5.6	5.6	8.8	3.9	3.9	6.1	5.2	5.4	6.2	6.2
21	10.3	10.5	6.5	7.9	10.0	8.1	9.6	8.3	9.8	12.9	13.6	11.8	9.1	9.3	10.4	13.0	9.3	8.0	9.2	8.8	12.1	10.5	11.8	11.3
23	0.3	0.3	0.4	0.2	0.4	0.9	0.7	1.0	0.9	1.1	0.9	0.8	4.0	4.1	3.5	7.2	4.2	1.1	22.0	18.5	5.6	4.4	13.8	15.4
24	16.5	19.5	20.5	22.9	20.8	20.8	22.2	24.7	25.5	27.7	31.9	28.8	31.2	31.8	27.7	30.0	27.7	25.1	33.5	33.2	25.2	24.1	24.6	25.9
25	6.7	6.1	8.0	7.5	9.7	9.8	10.4	9.7	10.8	10.1	11.4	12.2	12.8	13.4	11.9	11.7	13.0	15.7	14.0	26.4	19.5	18.7	18.3	17.9
26	7.9	8.5	9.9	9.7	10.9	12.0	10.7	12.1	12.4	13.7	16.2	18.2	13.3	12.8	12.8	15.3	14.1	16.8	15.8	22.2	20.9	19.5	14.8	19.7
27	19.2	21.6	21.1	22.7	18.5	19.8	18.2	22.4	27.9	24.9	29.7	24.1	25.5	28.0	30.0	28.7	27.5	35.0	30.9	33.3	27.2	25.6	33.8	37.2
28	17.4	18.9	19.1	20.5	23.1	24.7	21.6	24.5	22.7	20.5	18.8	20.1	20.5	22.2	23.3	26.5	26.1	26.1	26.4	27.7	24.8	27.3	28.4	32.1
29	10.8	11.0	11.7	13.0	13.7	12.5	14.1	15.1	13.6	14.7	14.8	14.9	13.9	16.4	15.7	17.9	17.3	16.7	14.7	17.3	22.4	21.9	20.4	23.2
30 to33	15.0	14.8	18.2	18.7	21.1	17.1	18.4	22.2	21.3	25.2	25.6	26.1	22.9	22.4	29.5	25.7	27.8	33.9	40.4	39.6	32.4	37.6	40.0	41.0
34	9.2	10.5	11.3	11.4	11.7	12.0	13.5	13.0	14.6	15.3	16.0	14.4	13.6	18.2	18.2	25.7	28.8	23.2	18.5	35.7	19.8	23.3	25.5	34.2
36	8.1	7.7	6.0	10.8	13.8	21.1	14.7	14.6	16.8	12.1	11.9	17.0	18.5	36.9	27.1	26.8	26.8	33.6	31.3	48.6	30.8	38.2	31.7	31.8
Total	**7.8**	**8.6**	**9.2**	**10.3**	**10.5**	**11.3**	**11.6**	**12.5**	**13.5**	**13.9**	**14.8**	**14.1**	**14.4**	**16.3**	**16.0**	**16.9**	**17.7**	**17.2**	**18.9**	**21.1**	**18.0**	**18.2**	**19.5**	**20.9**
Total-23	**11.3**	**12.4**	**13.0**	**15.1**	**15.0**	**15.0**	**16.0**	**15.7**	**17.2**	**17.0**	**18.2**	**17.2**	**15.3**	**17.4**	**17.1**	**17.5**	**18.7**	**19.7**	**20.0**	**22.8**	**19.5**	**19.7**	**20.0**	**21.2**

Note: For industry codes see Table 1.

Source: Unit Value ratios from Table 1 and basic time series data for India from EPWRF and ASI and for Germany from GGDC 60 industry database

Table 6: Relative Labor Productivity in India, Germany = 100 (Value Added/Hour)

Industry codes	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
15+16	3.1	3.8	4.3	5.9	5.3	5.2	5.3	5.4	6.2	6.0	5.5	5.5	5.8	6.9	6.6	6.6	7.7	7.3	8.5	9.0	7.7	9.2	9.1	8.4
17	6.4	6.3	5.5	6.3	6.2	6.5	7.2	6.6	7.0	7.8	8.2	7.2	7.0	8.2	7.7	6.4	8.8	9.1	9.1	10.3	10.2	9.6	10.6	9.8
18	7.8	8.6	9.4	9.0	10.5	9.2	12.1	13.2	13.9	14.4	15.3	17.4	16.3	21.2	16.0	13.4	11.4	10.4	12.5	12.7	9.9	9.6	8.7	6.5
19	13.3	13.9	15.1	17.7	18.2	15.4	15.4	20.5	22.3	13.9	21.6	16.0	16.1	19.9	16.1	15.7	16.5	18.9	35.7	18.4	15.6	16.9	15.8	15.0
20	5.4	5.4	4.9	6.9	6.6	5.3	6.0	6.1	7.2	7.0	10.1	9.7	4.5	4.8	4.1	3.8	6.2	3.2	2.7	3.5	2.9	3.7	4.0	4.0
21	6.9	6.8	4.5	5.3	6.7	5.2	6.0	5.1	6.3	7.7	8.1	6.8	5.3	5.4	6.0	7.4	5.3	4.7	5.1	4.8	6.8	5.7	6.5	6.3
23	0.3	0.3	0.2	0.1	0.2	0.5	0.4	0.6	0.6	0.6	0.5	0.5	2.4	2.4	2.0	4.4	2.4	0.6	12.4	10.1	3.2	2.5	8.5	9.4
24	11.2	12.9	13.3	13.9	12.8	13.1	13.4	14.8	15.7	16.4	19.0	16.9	18.9	18.6	16.3	17.4	16.1	14.8	19.8	18.8	14.7	13.9	13.9	14.6
25	4.7	4.3	5.6	5.8	6.6	6.4	6.8	6.3	7.1	6.4	7.3	7.7	8.1	8.1	7.5	7.1	7.8	9.6	9.3	11.5	5.0	11.3	11.0	10.6
26	6.1	6.4	6.0	7.5	8.2	8.9	7.8	8.8	9.0	9.7	11.7	12.8	9.8	9.2	9.2	10.3	9.3	11.2	10.8	14.6	14.1	13.2	9.2	12.5
27	11.8	13.4	12.6	13.3	10.9	11.8	9.9	12.6	16.0	14.1	16.4	13.2	14.0	14.9	16.6	15.7	14.7	19.8	16.7	17.1	14.6	13.6	18.2	20.0
28	12.8	13.6	13.4	14.3	16.3	17.4	15.1	16.5	15.6	13.7	12.4	13.1	13.5	14.2	15.1	17.0	16.2	16.6	16.5	17.5	15.6	17.1	17.2	19.4
29	7.3	7.4	7.6	8.2	8.9	8.1	9.0	9.6	8.7	9.1	9.1	8.8	8.7	9.8	9.6	11.1	10.4	9.4	13.4	13.5	13.4	12.9	12.0	13.5
30 to 33	9.5	9.2	11.3	11.3	12.7	10.3	11.0	12.9	12.5	14.4	14.7	14.7	13.9	13.3	17.5	17.5	16.3	20.3	24.7	21.5	15.6	21.9	22.8	23.6
34	6.0	6.8	7.2	7.0	6.9	7.2	8.3	7.6	8.6	8.8	9.5	8.2	8.1	10.1	10.1	14.4	16.4	13.7	11.3	15.3	7.7	12.8	14.2	19.1
36	5.4	5.2	4.7	7.2	9.3	14.0	9.6	9.6	11.5	8.0	7.9	11.1	12.0	23.7	17.3	16.7	16.8	21.9	18.4	24.5	17.3	21.1	18.9	18.4
Total	**5.8**	**6.4**	**6.4**	**6.9**	**7.0**	**7.4**	**7.4**	**7.9**	**8.6**	**8.6**	**9.2**	**8.6**	**9.2**	**10.1**	**10.0**	**10.4**	**10.7**	**10.7**	**12.1**	**12.5**	**10.2**	**10.8**	**11.4**	**12.3**
Total-23	8.3	9.1	9.0	10.1	10.1	9.8	10.2	10.0	11.0	10.6	11.3	10.5	9.7	10.8	10.7	10.8	11.3	12.3	12.8	13.5	11.1	11.7	11.7	12.5

Note: For industry codes see Table 1.

Source: Unit Value ratios from Table 1 and basic time series data for India from EPWRF and ASI and for Germany from GGDC 60 industry database

Table 7: Relative Unit Labor Costs in India, Germany =100 (Compensation/Value Added)

Industry Codes	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
15+16	109.8	103.5	107.4	80.8	98.7	87.1	63.3	56.1	49.3	46.6	44.4	35.8	26.0	24.1	24.5	23.1	22.2	27.3	23.0	24.5	29.2	26.5	23.6	22.9
17	84.2	93.6	103.2	99.0	106.4	91.1	61.6	57.3	53.8	44.1	34.8	31.3	26.4	24.0	24.3	26.1	20.1	23.8	20.5	20.8	23.6	25.3	20.8	20.0
18	56.8	53.2	49.3	56.8	49.0	51.8	29.4	24.8	22.6	19.6	15.2	10.7	8.9	6.7	8.7	10.2	12.8	16.5	11.8	13.7	19.5	21.2	21.8	25.3
19	47.0	45.0	41.5	39.5	38.1	39.9	30.7	20.7	15.8	24.1	13.1	14.0	10.9	8.4	9.9	9.8	9.9	10.2	6.4	12.1	15.7	14.0	14.7	14.3
20	55.9	60.4	73.5	56.8	68.9	69.9	49.2	43.7	38.2	34.7	19.2	15.4	25.7	27.9	31.9	28.4	21.8	49.2	52.6	53.0	60.0	59.0	43.9	41.5
21	59.4	64.9	97.6	91.0	75.7	87.6	56.8	60.9	46.7	38.4	30.1	28.8	28.3	30.1	26.6	20.1	29.1	38.4	31.9	38.6	31.8	38.1	30.2	29.1
23	1961.8	2118.0	2029.8	4491.6	2983.1	1143.4	1248.6	661.0	733.2	586.2	529.8	517.8	72.4	75.2	91.8	51.1	70.5	328.7	16.8	24.2	112.3	133.3	30.3	24.3
24	37.2	37.6	37.1	38.2	43.4	38.4	29.5	23.7	21.0	18.3	14.1	12.2	9.1	8.9	10.6	8.8	10.3	13.8	9.2	11.7	15.1	16.6	15.3	13.8
25	99.3	108.1	88.8	93.9	87.0	78.4	58.1	54.9	46.7	50.6	36.2	26.9	21.1	22.4	23.4	23.3	24.3	22.7	21.4	19.2	24.6	22.0	21.6	20.3
26	58.8	61.4	58.5	59.9	58.4	48.6	42.1	32.8	30.6	27.8	19.1	14.3	14.7	16.7	17.0	13.2	16.3	16.3	15.7	13.8	16.5	17.4	18.0	14.2
27	36.3	37.2	39.9	42.2	57.7	45.7	38.4	28.6	23.0	25.6	17.4	14.5	12.7	12.9	12.0	12.0	12.8	12.1	13.5	14.1	20.4	21.8	16.9	15.0
28	37.1	39.1	40.7	44.0	40.5	34.6	28.8	23.3	26.4	27.0	24.3	18.3	13.7	14.8	14.2	12.2	13.1	15.9	13.9	14.5	19.4	16.9	15.1	11.9
29	60.8	69.6	68.9	70.0	71.2	71.7	49.1	41.7	43.7	41.9	34.2	29.0	21.7	20.9	20.7	17.1	19.8	24.8	20.3	20.0	23.4	24.4	23.0	19.0
30 to 33	54.4	60.5	54.0	56.0	53.8	60.9	44.4	32.8	33.0	26.7	22.0	17.5	14.8	16.5	12.2	12.3	13.1	13.3	9.5	12.0	14.6	14.6	12.6	11.1
34	72.2	79.5	80.0	87.1	90.6	85.1	56.5	52.3	45.4	44.2	33.9	31.2	24.1	20.0	20.1	14.7	13.3	18.7	19.6	16.4	19.5	20.8	17.4	12.1
36	105.9	117.2	117.0	110.4	87.7	53.6	69.4	59.6	48.5	45.0	35.1	20.2	18.1	9.4	13.4	13.2	13.6	12.9	12.2	9.7	16.1	13.2	15.7	14.3
Total	**71.4**	**72.9**	**73.4**	**74.2**	**79.8**	**67.1**	**50.7**	**41.7**	**37.7**	**35.1**	**27.8**	**23.2**	**17.4**	**16.8**	**16.9**	**15.4**	**15.8**	**19.0**	**15.7**	**16.8**	**21.2**	**21.5**	**18.2**	**15.8**
Total-23	49.3	50.8	51.9	50.6	55.6	50.7	36.7	32.9	29.4	28.5	22.5	18.9	16.3	15.7	15.8	14.7	14.9	16.5	14.7	15.4	19.2	19.5	17.5	15.4

Note: Value added in 2002 Euros using UVR and compensation in Euros using nominal exchange rates. For industry codes see Table 1.

Source: Unit Value ratios from Table 1, exchange rates from Reserve Bank of India and basic time series data for India from EPWRF and ASI and for Germany from GGDC 60 industry database

Table 8: Relative Labor Productivity (Employees) in India: Comparison with other developing countries (US=100)

Year	S. Korea	Mexico	Hungary	Poland	Indonesia	Brazil	India
1980	15.5	29.3	-	-	6.0	10.2	6.6
1981	16.9	27.7	-	-	5.9	9.5	6.9
1982	16.7	26.9	-	-	4.6	9.1	7.4
1983	16.9	24.4	-	-	5.0	9.0	8.1
1984	18.4	23.4	-	-	5.5	8.5	8.1
1985	18.2	22.9	-	-	5.7	8.1	8.7
1986	20.1	21.7	-	-	6.4	7.8	8.9
1987	19.3	19.9	-	-	6.3	7.3	8.7
1988	19.7	19.2	-	-	6.5	6.8	9.3
1989	20.0	20.1	-	-	6.0	6.5	10.1
1990	22.1	20.8	-	-	6.3	5.9	10.9
1991	23.8	20.9	17.1	15.7	6.8	5.7	10.7
1992	25.3	20.1	18.2	16.6	6.9	5.5	11.1
1993	27.1	18.7	21.0	15.9	7.0	5.8	12.1
1994	28.7	17.9	22.2	14.5	6.0	5.7	12.1
1995	31.1	15.6	23.6	14.8	6.6	5.4	12.3
1996	33.9	15.3	23.7	16.8	6.7	5.6	12.6
1997	36.5	14.5	24.8	18.2	6.5	5.7	12.4
1998	39.4	13.8	24.6	18.7	6.3	5.5	13.4
1999	44.0	12.7	24.0	17.2	5.3	5.0	14.0
2000	46.6	12.5	23.5	18.5	5.3	4.6	12.0
2001	51.0	12.7	23.8	20.4	5.4	4.7	12.5
2002	49.4	11.9	22.2	18.6	5.0	4.4	12.4
2003	48.9	11.2	22.9	19.0	5.4	4.2	12.9

Note: All except for India are calculated in US $1997, and for India the values are calculated from Table 4 (in 2002 EUR) using the relationship between Germany and US in KILM in 1997 US$

Source: For India, Table 4 and for others, ILO Key Indicators of the Labor Market.

Table 9: Relative Labor Productivity (Hours) in India: Comparison with other developing countries (US=100)

Year	S.Korea	Mexico	Hungary	Poland	India
1980	10.6	26.9	-	-	5.6
1981	11.5	25.5	-	-	6.0
1982	11.2	24.3	-	-	6.0
1983	11.4	22.6	-	-	6.4
1984	12.6	21.9	-	-	6.5
1985	12.5	21.3	-	-	6.9
1986	13.5	20.2	-	-	6.8
1987	13.2	18.6	-	-	6.8
1988	14.0	18.1	-	-	7.3
1989	14.7	18.9	-	-	7.8
1990	16.4	19.4	-	-	8.5
1991	17.8	19.4	-	-	8.3
1992	19.3	19.0	-	-	8.7
1993	21.0	17.8	23.2	18.3	9.5
1994	22.3	17.0	23.1	15.7	9.5
1995	23.8	14.6	24.3	15.9	9.4
1996	26.4	13.5	24.6	18.4	9.5
1997	29.0	13.0	25.6	20.1	9.5
1998	32.2	12.6	25.2	20.6	10.7
1999	35.3	11.5	24.7	19.1	11.1
2000	36.9	11.4	24.2	20.2	9.1
2001	40.1	11.5	24.9	22.2	9.7
2002	39.3	10.7	23.2	20.3	9.1
2003	39.0	10.2	24.0	20.8	9.8

Note: All except for India are calculated in US $1997, and for India the values are calculated from Table 4 (in 2002 EUR) using the relationship between Germany and US in KILM in 1997 US$

Source: For India, Table 4 and for others, ILO Key Indicators of the Labor Market.

Table 10: Relative Unit Labor Cost in India:
Comparison with other developing countries (US=100)

Year	S.Korea	Mexico	Hungary	Poland	India
1980	85.1	90.6	-	-	72.4
1981	80.9	107.4	-	-	59.8
1982	77.7	69.0	-	-	54.5
1983	80.0	52.6	-	-	53.0
1984	77.0	58.1	-	-	51.6
1985	71.5	58.6	-	-	41.4
1986	70.9	43.2	-	-	42.3
1987	81.8	44.1	-	-	46.3
1988	103.7	51.0	-	-	42.9
1989	110.3	61.2	-	-	35.4
1990	104.4	62.9	-	-	32.6
1991	107.2	70.7	-	-	26.0
1992	102.0	80.8	76.9	52.8	21.8
1993	103.6	87.4	71.2	53.8	20.5
1994	109.3	83.9	66.4	64.7	21.1
1995	126.3	52.7	69.5	78.1	23.3
1996	126.0	57.5	65.8	80.5	23.6
1997	100.7	65.9	59.6	72.8	24.3
1998	63.9	66.5	54.7	74.8	19.5
1999	68.2	75.7	51.2	79.5	20.8
2000	74.0	86.2	50.2	72.3	22.0
2001	58.7	94.5	53.0	74.5	21.5
2002	65.1	100.0	62.1	75.5	20.4
2003	66.6	92.0	-	-	20.4

Note: All except for India are calculated in US $1997, and for India the values are calculated from Table 4 (in 2002 EUR) using the relationship between Germany and US in KILM in 1997 US$

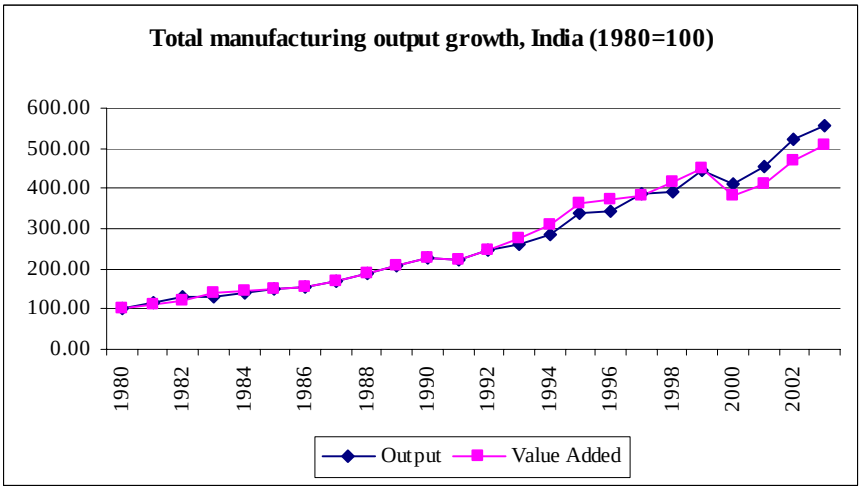
Source: For India, Table 4 and for others, ILO Key Indicators of the Labor Market.

Figures

Figure 1

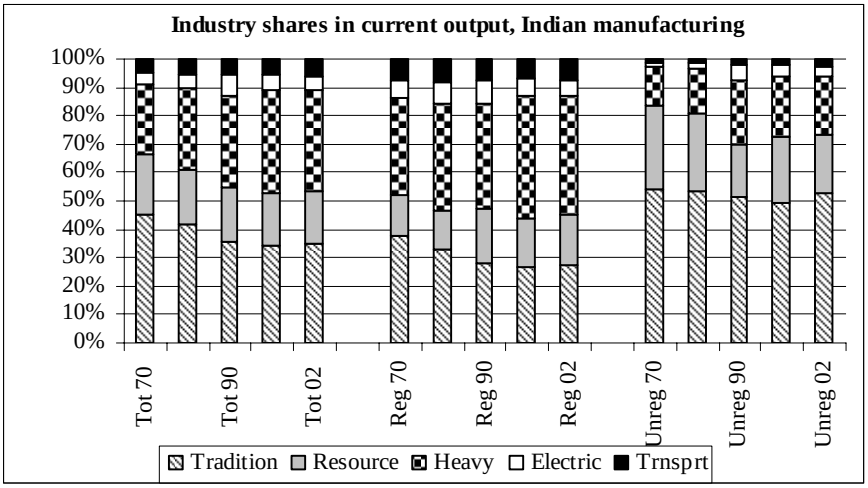
Note: Organized manufacturing only
Source: ASI

Figure 2



Note: Organized manufacturing only
Source: ASI

Figure 3



Note: Reg ** are the shares in registered segment of total manufacturing in year **, Unreg** are the shares in unregistered segment in year ** and Tot** are the shares in the total (registered + unregistered) manufacturing in year **. For registered sector they are industry shares in gross value added, and for unregistered sector they are industry shares in GDP. Traditional sectors include food, beverages and tobacco, textiles, leather, and other manufacturing; resource intensive industries are wood, paper, rubber and petroleum, and non metallic minerals and heavy industries are chemicals, basic metals, metal products and non electrical machinery

Source: National Accounts Statistics, 1950-2002, EPW Research Foundation.

Figure 4: Simplified representation of the four levels of aggregation within ICOP

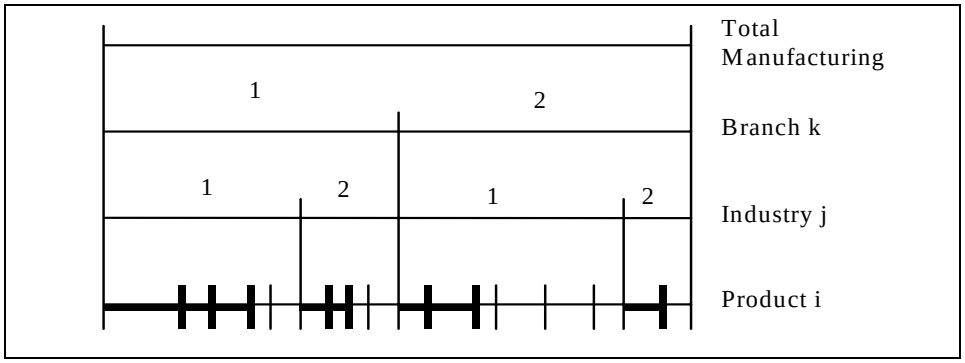
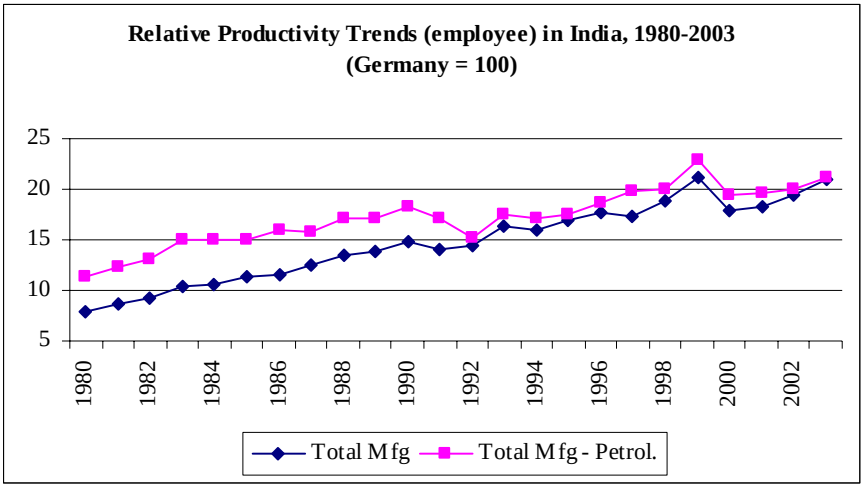
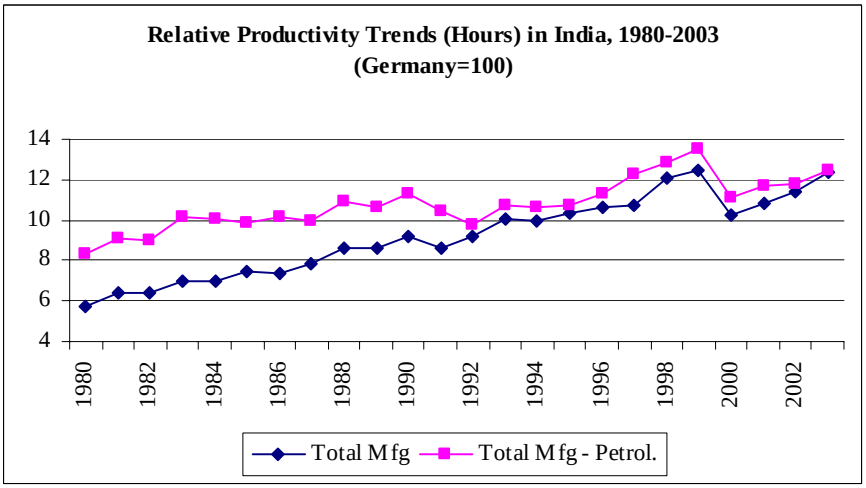


Figure 5



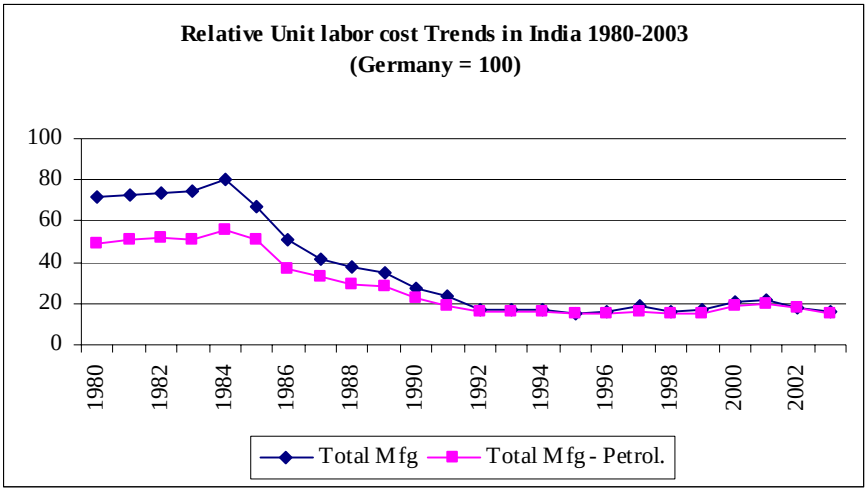
Source: Table 5

Figure 6



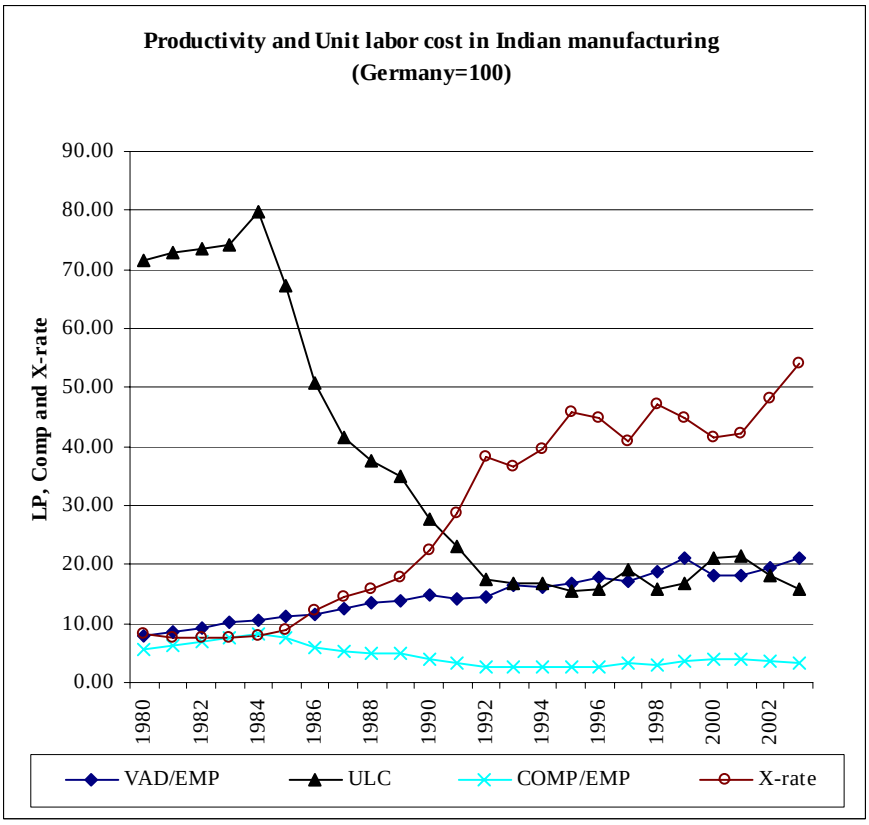
Source: Table 6

Figure 7



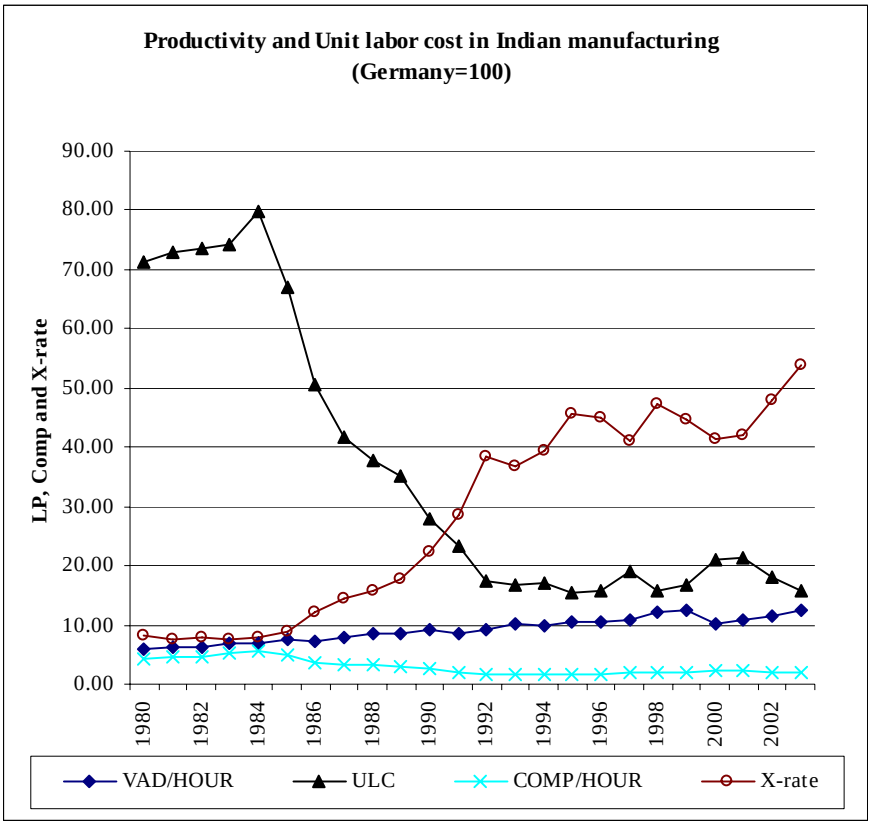
Source: Table 7

Figure 8



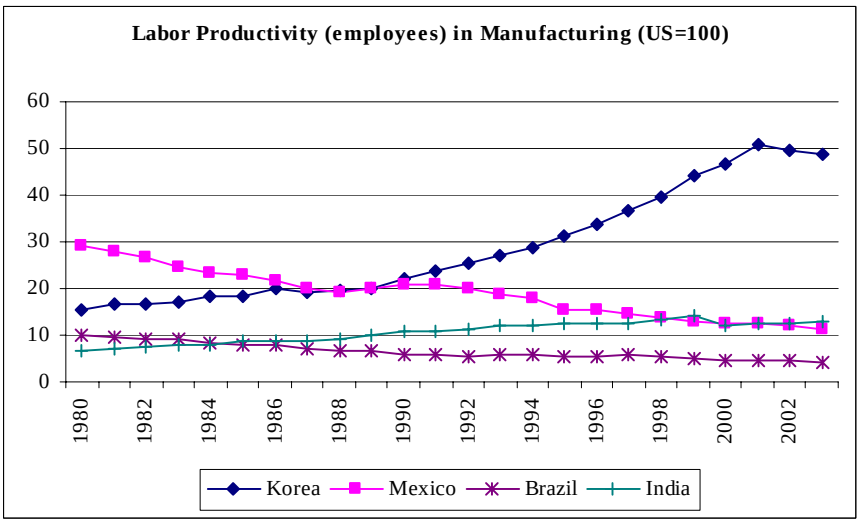
Source: Table 5, 6, Appendix Table 2.

Figure 9



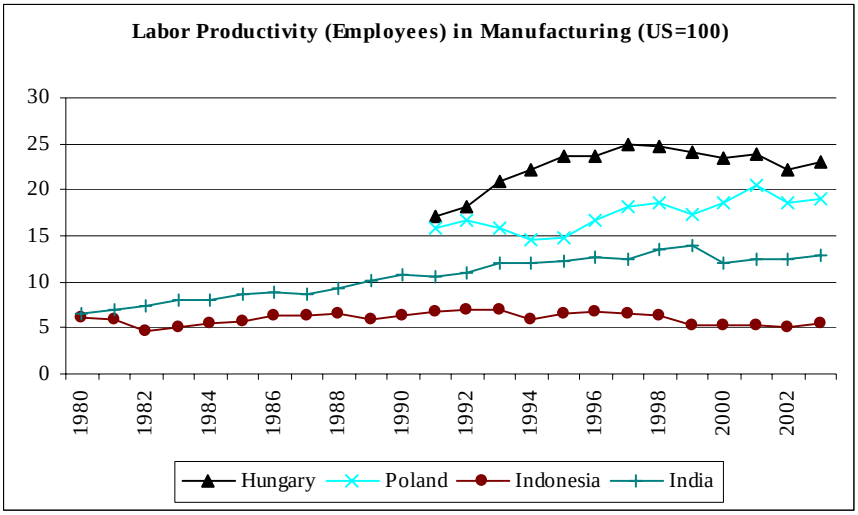
Source: Table 5, 7, Appendix Table 2.

Figure 10



Source: Table 5 and ILO KILM.

Figure 11

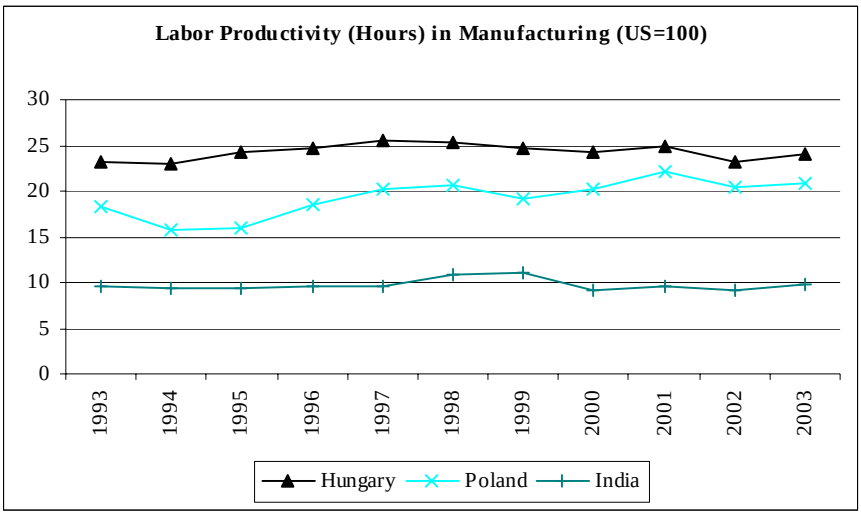


Source: Table 5 and ILO KILM.

Figure 12

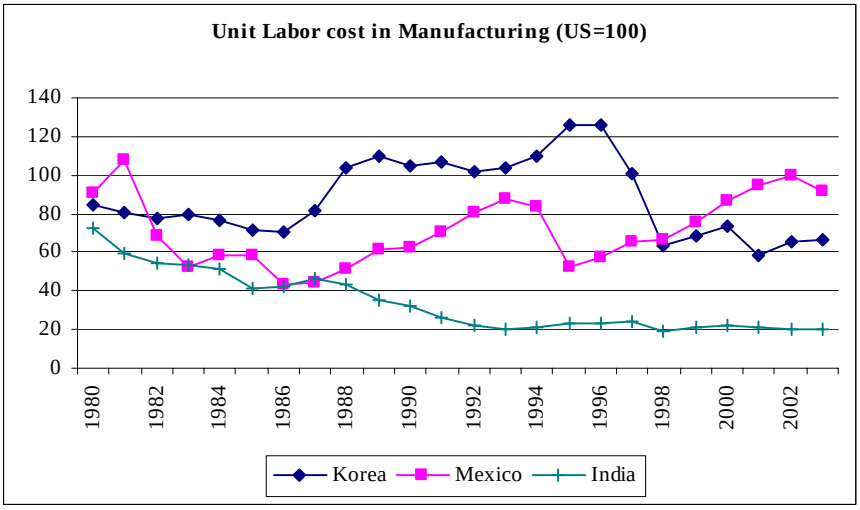
Source: Table 6 and ILO KILM.

Figure 13



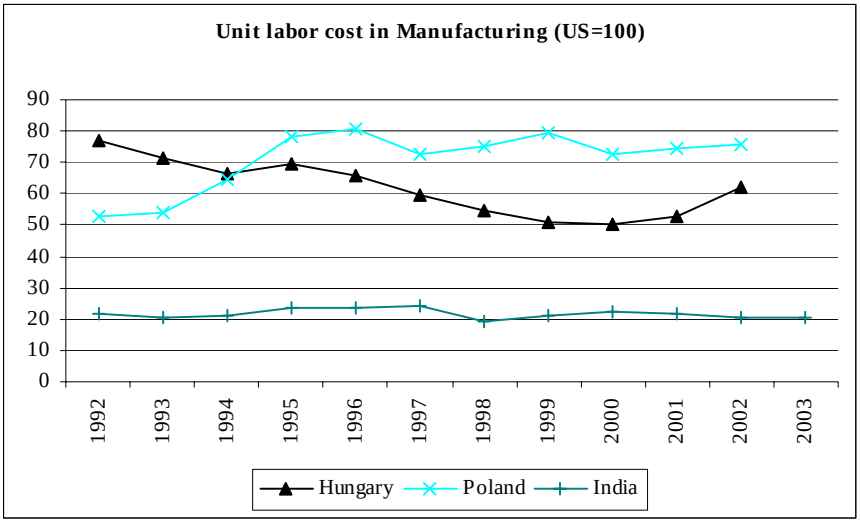
Source: Table 6 and ILO KILM.

Figure 14



Source: Table 7 and ILO KILM

Figure 15



Source: Table 7 and ILO KILM

References

Ahluwalia, I.J (1985), *Industrial Growth in India – Stagnation since the Mid-Sixties*, New Delhi, Oxford University Press.

Balakrishnan, P., K Pushpangadan and M. Suresh Babu (2000), Trade liberalization and productivity growth in Manufacturing: Evidence from firm level panel data, *Economic and Political Weekly*, 35(41): 3679-82.

Balakrishnan, P and K. Pushpangadan (1994), Total factor productivity growth in manufacturing industry: A fresh look, *Economic and Political Weekly*, 29(31), 2028-35.

Erumban, A.A (2005), Economic reforms and industrial performance: An analysis of economic capacity utilization in Indian manufacturing, *Indian Journal of Economics and Business*, 4(2), 305-323

Goldar, B and A. Kumari (2003), Import liberalisation and productivity growth in Indian manufacturing industries in the 1990s, *Developing Economies*, December, 41(4): 436-60.

Groningen Growth and Development Centre, 60-Industry Database, October 2005, http://www.ggdc.net

Hadi, A. S. (1992), Identifying multiple outliers in multivariate data, *Journal of the Royal Statistical Society*, Series (B), 54, 761-771.

Hadi, A. S. (1994), A Modification of a method for the detection of outliers in multivariate Samples, *Journal of the Royal Statistical Society*, Series (B), 56, 393-396

Joshi, V and I.M.D. Little (1996), *India's Economic Reforms 1991-2001*, New Delhi, Oxford University Press.

Kravis, I.B. (1976), A survey of international comparisons of productivity, *The Economic Journal*, Vol. 86, March, pp. 1-44.

Maddison, A and B. van Ark (2002), The international comparison of real product and productivity, in A. Maddison, D.S. Prasada Rao and W.F. Shepherd, eds., *The Asian Economies in the Twentieth Century*, Edwar Elgar, Cheltenham, pp. 5-26.

Paige, D and G. Bombach (1959), *A Comparison of National Output and Productivity*, OEEC, Paris.

Timmer, M.P. (2000), *The Dynamics of Asian Manufacturing. A Comparative Perspective in the late Twentieth Century*, Edward Elgar, Cheltenham

Timmer, M.P and A. Szirmai (1999), International comparison of productivity performance in manufacturing in South- and East Asia, 1963-1993, *Oxford Development Studies*, vol.27(1),pp.57-79.

Timmer, M.P., van Ark, B., Van, Mulder, N., Nayman, L. and Ünal-Kesenci, D (2001), *Formalization of the ICOP methodology for binary manufacturing comparisons*, mimeographed University of Groningen

van Ark, B (1993), *International Comparisons of Output and Productivity*, Monograph series no. 1, Groningen: Groningen Growth and Development Centre (downloadable from http://www.eco.rug.nl/GGDC/ThesisArk.html)

van Ark, B., E. Stuivenwold and G. Ypma (2005), Unit labour costs, productivity and international competitiveness, *Groningen Growth and Development Centre Working Paper*, GD-80.

van Ark, B., J. Banister and C. Guillemineau (2006), Competitive advantage of "Low-Wage" countries often exaggerated, *Executive Action Series*, No. 212, China Center for Economics and Business, The Conference Board.

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