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South African Manufacturing Performance in International Perspective, 1970-1999

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ABSTRACT

This paper analyses the historical performance of the South African manufacturing sector in an international perspective. After a brief overview of the industrialisation process of South Africa during the 20^{th} century, a binary comparison of manufacturing output and productivity between South Africa and the US is presented. The industry-of-origin approach is used to construct unit value ratios (UVRs), as an alternative to the exchange range for converting US and South African output data into the same currency. Subsequently, the UVRs are used to estimate labour and total factor productivity *levels* for total manufacturing and 13 manufacturing branches for the period 1970-1999 in comparison to the USA. Next, these results are used to compute relative unit labour costs, which give shed light on the international competitiveness of the South African manufacturing sector at a detailed level. The study is part of the International Comparisons of output and Productivity (ICOP) project carried out at the universities of Groningen and Eindhoven.

We find that there exists a considerable labour and total productivity gap between the US and South Africa, which is continuously widening over time. In 1970, labour productivity stood at 32 percent of US level, while it was only 20 percent in 1999. With respect to relative unit labour costs, the results show that on average, South Africa is competitive with the USA, albeit there are some industries which show consistent relative unit labour costs above US level.

1. INTRODUCTION

The last decade, South Africa went through a period of economic and social turbulence. After years of struggle, the first democratic elections in 1994 marked the end of the apartheid system. In the same year, GDP growth per capita became positive again after almost 8 years of economic crisis. The new government now faces the difficult task to define industrial policy to put the economy on a new path of economic growth and development, an absolute requirement to solve the poverty problem and unemployment problem of the, mainly black, population. In 1996, the South African government formulated the GEAR (Growth Employment And Redistribution) strategy. Following a long period of protectionist policies, GEAR aims to stimulate economic growth by liberalising the economy, in particular with reference to international trade. For this strategy to succeed, it is of great importance that the manufacturing sector, considered to be the "engine" of economic growth, will increase its performance to gain international competitiveness.

In this paper we analyse the historical performance of the South African manufacturing sector in an international context. Industry specific currency converters are constructed, to estimate labour and total factor productivity *levels* for total manufacturing and 13 manufacturing branches for the period 1970-1999 in comparison with the USA. Next, these results are used to compute relative unit labour costs, in order to examine international competitiveness of the South African manufacturing sector at a detailed level. The results obtained in the analysis of this paper can be of great use in devising industrial policy since it identifies which sectors are performing well and which are falling behind. The study is part of the International Comparisons of output and Productivity (ICOP) project carried out at the universities of Groningen and Eindhoven.

The paper is structured as follows: After a brief overview of the industrialisation process of South Africa during 20th century, section two subsequently explains and applies the ICOP industry-of-origin approach, the methodology to construct unit value ratios for South Africa relative to the USA. In the next two sections, the unit value ratios are applied to estimate comparative labour- and total factor productivity levels for total manufacturing and 13 manufacturing branches, for the period 1970-1999. Section six puts the South African manufacturing performance in a broad international perspective by comparing its labour productivity level with several other countries. Section seven deals with the international competitiveness of South African manufacturing. In this section, relative unit labour costs and relative prices are given vis-à-vis the USA. Finally, the last section concludes.

2. THE SOUTH AFRICAN INDUSTRIALISATION PROCESS

In this section the industrialisation process of South Africa is briefly sketched. We distinguish four periods: first steps towards industrialisation: ...-1925, import substitution led industrialisation 1925-1975, stagnation and transition: 1975-1994 and, finally, the present period of recovery: 1994-...[1] Table 1, gives an overview of basic growth figures in line with the four phases of South African development.

[1] The sections on industrialization up to 1970 are to a large extent based on Lumby (1981a, b). For the others sections use has been made of several sources mentioned in the text..

Furthermore, the contribution of manufacturing growth, the subject of this study, to total gross domestic product (GDP) growth is given. The table shows that after 1975 growth stagnated until around 1994, when there seems to be a trend towards some recovery. Manufacturing was one of the engines behind total growth up to the middle of 1980s. Its share increased from 17% to 23% over the period 1946-1984 and contributed more than 25% to total growth of the economy over the same period. In the following periods, development of the manufacturing slowed down. At the end of the 1980s and beginning of the 1990s, during the crisis, manufacturing even negatively affected total growth. After 1994, manufacturing is expanding again, although its share in total GDP is diminishing.

Table 1: Total GDP and Manufacturing GDP (growth) Figures

Year	Share of Manufacturing in Total GDP	Period	Growth of GDP per Capita	Growth of GDP	Growth of Manufacturing GDP	Contribution of Manufacturing Growth to Total GDP Growth*
1946	16.74	1946-60	1.94	4.35	6.64	25.57
1960	20.07	1960-75	2.29	4.74	7.43	31.44
1975	22.70	1975-84	0.26	2.50	3.33	30.16
1984	23.02	1984-94	-1.29	0.76	-0.10	-3.06
1994	20.92	1994-97	1.20	3.24	3.45	22.51
1997	19.87	1997-01	0.05	2.15	1.40	12.91
2001	18.47					

* Begin of period shares of manufacturing in total and current GDP multiplied by real growth rate of manufacturing GDP and divided by total GDP Growth over the period considered (Timmer 2000).
Source: South African Reserve Bank (SARB), http://www.reservebank.co.za

1.1 First Steps to Industrialisation, ... -1925

The first steps to industrialisation in South Africa were set in the last quarter of the nineteenth century. The first discovery of diamonds and gold triggered the establishment of related industries, such as the manufacture of explosives, cement and engineering. The next 40 years industrialisation was limited to the mining areas. A dispersed population and various conflicting tariffs and monopolistic policies of autonomous areas in South Africa prevented the introduction of large-scale manufacturing. Rapid industrial expansion came with end of the First World War. South Africa was forced to set up basic industries because imports were restricted in the post war period. Low foreign competition also made it easier for local entrepreneurs to set up new factories. Between 1915 and 1919 the number of firms increased by 45% from 3638 to 5287. After the war, increased foreign competition caused an economic downturn in South Africa.

1.2 Import Substitution Led Industrialisation, 1925-1975

In 1924, the Pact government, an alliance between the former opposition of farmers and workers, came into power. The new government was confronted with a growing number of white unemployment, caused by the recession. To solve this problem, two lines of policy were introduced, which have marked the development of the South African economy up to date. First, a deliberate policy to reserve jobs for whites in the labour market was initiated. 'From the mid-1920s a formal colour bar was erected that not only reserved the best jobs for whites but also instituted a “civilised labour policy giving whites precedence when competing with Africans for unskilled work" (Lundahl, p. 3, 1999). Discriminatory policies were even amplified with the election of the National Party in 1948. Since then, a full-scale policy of *apartheid*, systematically favouring whites above blacks throughout society, was implemented. One of the most influencing laws in this respect was the Bantu Education act, which made it virtually impossible for blacks to enter secondary schooling or higher (Lundahl, 1999).

Secondly, the Pact government commenced an explicit policy of import substitution. Through the introduction of Customs Tariff Act No. 36, industries were shielded from competition by quantitative restrictions and other protectionist measures. In line with import substitution policy, large parastatal companies, like the Iron and Steel Corporation of South Africa, ISCOR; the electricity generator, ESKOM; and the oil and energy company, SASOL, were set up. Another aim of import substitution industrialisation was to achieve greater economic independence. Furthermore, it was recognised that the mining sector on which the economy mainly depended as a source of foreign exchange, needed to be replaced in the long run. Industrial output went up by 41% in the next four years. The contribution of manufacturing to total output increased while the share of mining and agriculture both declined.

Besides a period of depression in the beginning of the thirties caused by the world economic crisis, between 1925 and 1970 South African manufacturing grew rapidly with on average around 6% per year (table 1), mainly on the basis of import substitution. The ratio of domestic production to imports for total manufacturing decreased from 52% in 1926/27 to 29 percent in 1956/57 (Bell *et al.*, 1999). Up to the Second World War, the textile and clothing industries were the fast growing sectors, followed by paper and printing, wood and furniture, and food and beverages. Together, they accounted for almost 60% of total manufacturing production. These were also the industries, which received the largest protection. Other relatively fast growing industries were the chemical and metal industry, driven by growth in the mining industry to which they are strongly linked. After the Second World War the manufacturing sector started to mature. The share of more technological advanced industries, transport and general machinery, metal and chemical industry expanded rapidly, at the cost of basic consumer goods industries, except for the paper industry. The share of the food, beverages and tobacco industry declined from 32% in 1945 to 14% in 1976.

1.3 Stagnation and Transition, 1975-1994

1975-1994 was a period of stagnation and economic crisis in South Africa. The growth of GDP per capita stagnated at around 0% over 1975-1984. From 1990 to 1993, the growth rate was even negative, putting the economy in a severe economic crisis. The weaknesses of the import substitution and apartheid policies pursued over the last five decades were clearly revealed.

Import substitution policy had created capital-intensive inefficient industries producing at high cost. Furthermore, the manufacturing sector was still highly dependent on exports of gold to provide foreign exchange. Only a small part of manufacturing output was exported while the rapid expansion in the previous decades had been accompanied by increasing imports of raw materials and machinery.[2] For example, in 1964 the plastics industry imported 70% of its intermediate goods and the clothing and car industry both 60% (Lumby, 1981a, b). A combination of fluctuating gold prices and increasing imports kept on causing balance of payments problems. As policy makers started to realise that import substitution was no longer sustainable, an attempt was made to switch to export led growth. In 1972, the Export Development Assistance programme was introduced to stimulate exports (Fallon and De Silva, 1994). Additionally, quantitative restrictions were replaced by tariffs and a more appropriate exchange rate policy was chosen to liberalise trade. However, because of the ambiguous nature of most reforms, no real progress was made until the end of the 1980s (Jenkins, 1999). Exports increased from 3.6 percent a year between 1972 and 1983 to about 10 percent over the period 1984-1990 (Fallon and De Silva, 1994). In 1990, the General Export Incentive Scheme (GEIS) was set up to help South African exporters overcome the price disadvantage they have in international markets. Exporters obtain a tax-free financial subsidy based on their value of exports and the local content in the products under GEIS.

Besides the import substitution policy, also the apartheid system was hampering further economic growth. Before, the policy had fuelled the mining and agriculture sector with low wage black labour, establishing a fast growing capital intensive 'white' manufacturing industry. The transformation to a more technologically advanced industrial structure demanded more high skilled labour, not available due to the apartheid regime. According to the population census of 1985, 25 percent of black workers had received no schooling while 99 percent of whites had obtained four or more years of schooling (Fallon and De Silva, 1994). Finally, also the high costs of maintaining the homeland administrations started to impede future growth and speeded up the end of the apartheid system.[3]

1.4 Period of Recovery 1993-...?

After a turbulent period of social and economic disruption, the first South African democratic elections were held in 1994, which marked the end of the apartheid system. From 1994 to 1997, GDP increased again with 3.24% of which manufacturing contributed more than 20% (table 1).

The new government set up the Reconstruction and Development Programme (RDP), which defined the economic and social agenda up to 1999.[4] Besides, an elaborate basic needs programme, to promote redistribution and education, the document acknowledged explicitly that future growth should be achieved through trade liberalisation and increased competition. In accordance with this view, an agreement was signed to liberalise South African trade according to the WTO regulations in 1994. Within five years, tariff reductions should be reduced considerably and all quantitative restrictions on imports must be abolished. Also the import subsidies under GEIS have to be phased out within a certain period. The effect of these reforms is that the average nominal tariff on manufacturing will be decreased with 10.4% from

[2] South African international competitiveness was also hampered by Dutch-disease effects caused by the high share of mineral exports, mainly gold.
[3] We thank Dirk Ernst van Seventer for making this point.
[4] The RDP was originally formulated by the African National Congress (ANC) and taken over by the new government after the elections (Lundahl, 1999).

16.6% to 5.8%. Reductions especially apply to the tobacco, clothing, motor vehicles, textiles and footwear industry (Holden, 1996). Up to now, already a large number of protectionist barriers have been eliminated in accordance with the WTO rules. Other polices set up by the government to stimulate industrial output and exports are credit facilities and technological and marketing assistance. In 1996, the government formulated the Growth, Employment and Redistribution (GEAR) strategy. The programme follows the same lines as the RDP but was much more clear in its formulation how to achieve its goals (Nattrass and Seekings, 2000).

Unfortunately, recently there are signs of stagnating growth, of which a part can be contributed to the slowdown of the manufacturing sector. Manufacturing growth decreased from 3.45% from 1993-1997 to 1.40% over 1997-2001, which caused a downfall in contribution to total GDP growth of about 10% (table 1).

3. ICOP METHODOLOGY AND APPLICATION

The scope of this paper is to make a *level* comparison of output and productivity between South Africa and the US. In contrast to *growth rate* comparisons, a conversion factor is required to express outputs and inputs in the same currency before they can be compared. The most straightforward conversion factor is the exchange rate. Although still frequently used in international level comparisons, one can raise a number of objections against its use (Timmer 1996; Timmer, 2000).[5] Firstly, the exchange rate only represents the comparative price level of tradable goods; prices of nontradabele goods are not reflected. Secondly, exchange rates are not only determined by relative price levels, political factors, capital movements and speculation also may cause the exchange rate to fluctuate heavily. Thirdly, the exchange rate is a summary measure of all the price levels of all goods produced in a country and, therefore, less suitable for industry-specific conversions.

There are two alternatives to the exchange rate, Purchasing Power Parities (PPPs), on the basis of the expenditure approach and unit value ratios (UVRs) derived by the industry-of-origin approach (Van Ark, 1996). PPPs are estimated by detailed price comparisons of a large number of final products in categories of private and public consumption and capital formation. Since 1967 the expenditure approach has been applied by the United Nations International Comparison Programme (ICP).[6] Expenditure PPPs, which are now regularly produced by EUROSTAT, World Bank and OECD, are frequently used to compare output and productivity at the level of the total economy.[7] For industry comparisons, however, they are much less suitable. These PPPs are based only on final goods expenditures and, therefore, do not take into account intermediate goods, which make up substantial part of manufacturing. Furthermore, expenditure PPPs still includes indirect taxes, subsidies, transport and distribution margins. Finally, adjustments are required to exclude relative prices of imported goods and include the prices of exports (Van Ark *et al.*, 2000). The industry-of-origin approach is more appropriate for industry and sectoral comparisons because

[5] Kaplinsky (1995), National Productivity Institute (NPI) (1998) and Nordas (1996) use the exchange rate to compare the industrial performance of South Africa with other countries.
[6] The pioneers in this field are Gilbert and Kravis (1954). See also Kravis *et al*., (1982).
[7] See for example, (Maddison, 1991, 1995, 2001) and Dollar and Wolff (1993).

conversion factors are estimated from the production side.[8] In this study, we apply the industry-of-origin methodology as used by the International Comparisons of Output and Productivity (ICOP) project to derive UVRs for the South Africa/US productivity comparison.

3.1 The ICOP methodology[9]

This study is part of the International Comparisons of output and Productivity (ICOP) project carried out at the universities of Groningen and Eindhoven.[10] The research project mainly focuses on international productivity comparisons of total manufacturing and thirteen manufacturing branches.[11] The ICOP project covers about 30 countries in the OECD area, Asia and Latin America. Recently, a start has been made to add African countries as well. So far, Egypt (Cottenet and Mulder, 2000), Tanzania (Szirmai *et al.*, 2001) and Zambia (Yamfwa *et al.*, 2002), and by means of this study, South Africa have been included.

In the ICOP studies, industry specific PPPs are estimated to compare output and productivity between countries. Ideally, one would like to compare producer prices of similar standardised goods across countries but, unfortunately, these are mostly not available. We adopt a second-best practice, by using unit values (uv) based on quantity and value data of product or product groups, instead. A product group is made up of goods with roughly similar characteristics, like carpets and rugs, car tyres, wines or sport shoes. The unit value can be regarded as the average ex-factory price of a product or product group in a given year. It is defined as

$$uv_i = \frac{o_i}{q_i}, \tag{1}$$

where o is output value and q the quantity of goods produced. To derive industry specific PPPs, the unit value ratio (UVR) of matched products between two countries (i.e. similar products or product groups, produced in both countries), in this case South Africa (SA) and the USA, is computed.

$$UVR_i^{SA/US} = \frac{uv_i^{SA}}{uv_i^{US}}, \tag{2}$$

Finally, using output as weights, UVRs are aggregated in three steps to provide industry, branch and total manufacturing specific conversion factors. Appendix 1 provides details about the aggregation procedure.

The main data source for the required data is industrial census. The advantage of these sources is that all data is coming from one primary source, which ensures that the UVRs are consistent among all levels of aggregation.[12] As production censes differ

[8] O'Mahony (1996) provides an overview of the advantages and disadvantages of both the expenditure and the industry-of-origin approach. Also see Van Ark *et al.* (2000) for a discussion and comparison of various estimations of PPPs and UVRs.
[9] This section draws heavily on Timmer (2000).
[10] http://www.eco.rug.nl/ggdc/homeggdc.html
[11] In addition, also efforts have been made to compare international productivity in services (transport and communication), agriculture and mining. For an overview of the ICOP project see Van Ark (1993b) and Van Ark and Timmer (2000).
[12] National account data can also be used as a source for the industry output data but then the consistency between quantity and value data for products and output data disappears because different sources are used for both. On the other hand, the industrial census may not cover all establishments

considerably in terms of product and industry classification and definitions of labour, value added and output, for practical reasons the ICOP industry-of-origin approach is applied on a bilateral basis, in which the US serves as the "numéraire" or base country.[13] The US has been selected as the base country because it is commonly considered to be the world technological leader. The productivity level of a country in terms of that of the US gives an indication of the technology gap of the country under study and its potential to catch-up. Moreover, since every country's productivity is compared with that of the US, mutual comparisons are easy to make.

The ICOP industry of origin approach has been criticised on various grounds of which the two most important are discussed below (Timmer, 1996; Van Ark *et al.*, 2000). These limitations should be taken in mind when interpreting the South African/US UVRs.

1. *Output coverage:* A disadvantage of UVRs with respect to expenditure PPPs is that their coverage is relatively less. An assumption of the industry-of-origin approach is that a limited number of UVRs are assumed to be representative for non-matched products in an industry or branch. Especially in comparisons between developed and developing countries, this might produce problems since some goods are simply not produced in less-industrialised countries. In ICOP studies it has been frequently found that the number of matches in industries which produce relative homogeneous, less sophisticated products, such as the pulp and paper industry or the food industry, are higher than in more advanced industries. A possible solution, already applied by Van Ark *et al.* (2001) is to use UVRs for more than one benchmark year to increase the coverage.
2. *Quality adjustments*: As mentioned above, most matches are between broad product groups in comparison to exactly defined products. In relation to this, two quality problems arise. First, within a group similar products may differ in quality between countries, i.e., the product content problem and secondly, the composition of products within a group can vary, i.e., the product mix problem (Timmer, 1996). Similar to the coverage problem, especially in developing/developed country comparisons, these problems might be considerable. Assuming that developing countries produce lower quality goods than industrialised countries, the product content problem might be an issue. The effect is a downward bias in UVRs, which consequently leads to an overestimation of output and productivity estimates. In addition, product listings of developing countries are usually less detailed, which increases the product mix problem.

Timmer (1996, 2000) has developed a method to compute the sampling variance of branch and total manufacturing UVRs, which measures the reliability of the conversion factors. The variance is higher (and reliability lower) when UVRs are more dispersed within a population (i.e. industry, branch or total manufacturing) and/or their coverage is lower. We also apply these measures to evaluate the quality of our UVRs. Appendix 1 describes the procedure.

while national account data covers the entire manufacturing sector. Here we stick to the industrial census as main source for the data. See Mulder *et al* (2002) for a comparison of both data sources for Mexico, Brazil and the US.

[13] See Van Ark and Timmer (2000) for preliminary research towards multilateralisation of UVRs in the ICOP project.

3.2 South Africa/US Unit Value Ratios

For South Africa the main data source is the *Census of Manufacturing 1993*. In the USA, the industrial census is only undertaken every five year. We use the *1992 Census of Manufacturing* and updated the unit values to 1993 by using 4-7 digit producer price indices from the Bureau of Labour Statistics. Appendix 2 describes in detail the data sources used for this study.

Table 2 presents South Africa/US UVRs for 1993, aggregated at 13 ICOP branch levels. The weighted average UVR for total manufacturing is 3.76 Rand/US$, about 15% higher than the Rand/US$ exchange rate in 1993, measured by the relative price level in the last column. The ratio between UVR and exchange rate indicates whether South African products are relatively cheaper or more expensive than products produced in the US (also see section 7.2 below). Branch UVRs and relative price levels vary considerably, from 1.73 Rand/US$ for leather products to 5.51 Rand/US$ for chemicals, which is equal to relative prices between 53% and 169% of the US. A possible explanation for the wide dispersion among UVRs is the highly varying rates of protection per industry. High levels of protection reduce competition and are therefore correlated with high comparative price levels (i.e. high UVRs). Effective protection of 93.6% on textiles, wearing apparel and leather and 50.6% on chemicals seems to confirm this to some extent (Fallon and De Silva, 1994). However, in case of the paper industry this explanation does not hold because it combines a relatively low of tariff rate (22.2%) with above US comparative price level of 106%.

Table 2: Manufacturing Unit Value Ratios, 1993 South Africa/US Benchmark

	Laspeyres UVR Rand/$	Paasche UVR Rand/$	Fisher UVR Rand/$	Relative price level* %
Food, beverages and tobacco	3.23	2.75	2.98	91.08
Textile mill products	4.57	3.48	3.99	122.05
Wearing apparel	2.87	1.99	2.39	73.05
Leather products and footwear	1.84	1.62	1.73	52.86
Wood products and furniture	2.82	2.43	2.62	79.99
Paper products	3.46	3.46	3.46	105.81
Chemicals	5.80	5.23	5.51	168.39
Rubber and plastics	4.66	4.02	4.33	132.29
Non-metallic mineral products	2.98	2.92	2.95	90.21
Basic and fabricated metal products	4.03	2.65	3.27	99.86
Machinery and transport equipment	5.54	5.29	5.42	165.60
Electrical machinery and equipment**	-	-	3.76	115.04
Other industry	2.62	2.82	2.72	83.10
Total manufacturing	4.32	3.28	3.76	115.04
Exchange rate			3.27	

Source: Own calculations, see text. Basic sources are CSS, Census of Manufacturing, 1993 and Bureau of the Census, US census of Manufactures, 1992. Exchange rate taken from Penn World Tables version 6.0 (Heston *et al*., 2001).
*Comparative price level is the UVR divided by the exchange rate
** Same as total manufacturing because no matches could be made.

Table 3 gives additional information on the number, coverage and reliability of matches per branch and for total manufacturing. In total 189 matches are made, covering 17% of US and 26% of South African output. For the electric machinery branch no products could be matched due to lack of detailed product information in the South African census. The average of all other branches is taken as a proxy instead. As explained in section 3.1, coverage of relative low-tech industries, food, beverages and tobacco, textile mill products and leather products and footwear is high in comparison with the other more advanced industries. An exception is the wearing apparel branch. Coverage in this sector is low because US data on clothes, which makes up the largest part of wearing apparel, are not published for 1992. Table 3 also presents the coefficient of variation for the Paasche and Laspeyres index. Obviously, reliability is less when the coverage rate is lower, such as in the wearing apparel, rubber and other industry branches. These outcomes should be interpreted with care. In contrast, although coverage is relative low, the low coefficient of variation indicates that the UVRs for the non-metallic mineral products and the machinery and are transport sector are reliable.

Table 3: Matching details, 1993 South Africa/US Benchmark

	Number of product matches	Coverage Ratio USA (%)	Coverage Ratio SA (%)	Coefficient of variation Laspeyres	Coefficient of variation Paasche
Food, beverages and tobacco	78	48	53	0.04	0.10
Textile mill products	13	44	51	0.08	0.12
Wearing apparel	3	2	2	0.38	0.58
Leather products and footwear	7	70	44	0.09	0.13
Wood products and furniture	22	21	29	0.06	0.08
Paper products	10	15	37	0.07	0.06
Chemicals	22	28	27	0.04	0.05
Rubber and plastics	4	7	13	0.16	0.20
Non-metallic mineral products	4	7	19	0.01	0.02
Basic and fabricated metal products	18	6	11	0.07	0.11
Machinery and transport equipment	4	0	1	0.07	0.02
Electrical machinery and equipment	0	0	0	-	-
Other industry	4	1	2	0.20	0.12
Total manufacturing	189	17	26	0.03	0.03

Source: see Table 1.

4. THE SOUTH AFRICA/US PRODUCTIVITY BENCHMARK

In this section we estimate relative labour and total factor productivity of South Africa vis-à-vis US for the benchmark year 1993, using the UVRs of the previous section. First, it is important to reconcile the value added, labour and capital data of both countries. As mentioned before, there are no clear international guidelines for industrial census and, therefore, each country has a tendency to use its own definitions, concepts and classifications. We start out by addressing these issues in the South Africa/US benchmark.[14] In the next two parts, subsequently, labour and total factor productivity levels are presented.

[14] See also (Van Ark, 1996) for an overview of measurement issues in international comparisons of productivity.

4.1 Reconciliation of South African and US Data

The data main source used for both countries is the industrial census (see Appendix 2 for details). There design differs with respect to coverage, classification and definition of value added and employment. In the South African census all establishments are surveyed, while in the US only firms only establishments with one or more employees are part of the census. We assume the number of firms with zero employees is negligible. To make branches comparable between the two countries, several industries have to be reclassified. For the US, leather gloves and mittens (SIC 3021) is moved from the leather and footwear to the wearing apparel branch, rubber and plastics footwear (3151 SIC) from rubber and plastics to the leather and footwear branch. For South Africa, coffins are transferred from wood products to other manufacturing and carpets, rugs and mats; cordage rope, twine and netting; and other textiles, from wearing apparel to textile products. One industry, household appliances, is very difficult to classify because there is no product listing available. It is assumed that this industry represents all electrical household appliances, not presented in the product listing at all, and is therefore reclassified from the machinery and transport equipment to the electrical machinery and equipment branch.

It is not clear if the definition used for value added in both censes is the same for South Africa and the US. The US uses the "census" concept of value added, which still includes services purchased from outside manufacturing such as business services (Van Ark, 1993a). The South African definition is not very clear. It seems as if services are included in gross value added (called net output in the South African census). According to the Census of Manufacturing (1993, p. viii), "charges for work done, that is, repair work, installation, erection or assembly and manufacturing of goods from materials of clients" and "sales of articles manufactured by other establishments from an establishment's materials" are still part of value added. For the time being we assume that value added is similarly defined in both countries and can be compared without modifications. With respect to employment, two adjustments are made. The US survey explicitly excludes head office and auxiliary employment, while this is not the case for the South African data. The US branch figures for employment were scaled up with head office and auxiliary employment, presented in the *1993 Annual Survey of Manufactures*. The second problem is the treatment of self-employment and unpaid family workers. In the US, they are excluded from employment. Fortunately, the South African census provides separate information on self-employment and unpaid family workers and is adjusted accordingly. The capital stock data for the benchmark is discussed in Section 4.3 below along with the total factory estimates. Table 4 gives the Basic manufacturing data, which is used for constructing the 1993 productivity benchmarks. Hours worked are also presented.

Table 4: Basic Manufacturing Data, South Africa and USA, 1993

	US					South Africa				
	Gross value of output at factor cost mil US$	Gross value added at factor cost mil US$	Persons (000)	Annual hours worked per person	Gross fixed capital stock mil US$	Gross value of output at factor cost mil Rand	Gross value added at factor cost mil Rand	Persons (000)	Annual hours worked per person*	Gross fixed capital stock mil Rand
Food, beverages and tobacco	451,641	187,500	1,701	1,939	198,816	45,940	17,183	222	2,182	18,195
Textile mill products	739,51	30,980	635	2,024	45,129	6,037	2,624	65	2,132	2,021
Wearing apparel	74,163	37,189	1,016	1,824	16,035	7,029	3,318	140	2,059	755
Leather products and footwear	10,621	4,962	112	1,869	3,802	2,968	1,302	41	2,039	433
Wood products and furniture	141,896	61,970	1,198	1,998	68,761	6,597	3,098	92	2,234	1,785
Paper products	306,223	176,369	2,253	1,897	269,425	16,850	7,960	95	2,020	5,667
Chemicals	459,459	194,794	1,254	2,018	353,091	35,200	15,721	105	2,187	55,288
Rubber and plastics	121,980	62,969	962	2,026	59,787	8,055	3,993	62	2,128	1,787
Non-metallic mineral products	65,574	35,784	494	2,058	64,098	6,928	3,730	70	2,161	5,655
Basic and fabricated metal products	317,522	143,279	2,089	2,037	249,196	31,258	12,786	192	2,226	30,892
Machinery and transport equipment	692,572	306,538	3,605	2,037	384,570	30,679	11,712	163	2,090	9,386
Electrical machinery and equipment	233,343	128,484	1,451	1,969	196,929	8,732	3,826	57	2,148	2,528
Other industry	179,342	115,450	1,345	1,926	71,971	3,504	1,356	27	2,128	647
Total manufacturing	3,128,284	1,486,266	18,114	1,980	1,981,609	209,778	88,610	1,330	2,144	135,039

Source: Gross value of output, gross value of output and employment for the USA from 1993 Annual Survey of Manufactures (ASM), Statistics for industry Groups and Industries, annual hours worked from US Bureau of Labour Statistics, International Comparisons of Manufacturing Productivity and Unit Labour Costs Trends, (Http://stats.bls.gov/news.release/prod4.toc.htm). For South Africa, Gross value of output, gross value of output and employment form CSS report NO 30-01-01, Census of Manufacturing 1993, Statistics According to Major Groups and Subgroups: South Africa. Annual hours worked from South African Statistics, 1995.
* Based on 1992 data but aggregated to branches using 1993 labour data.

4.2 Labour Productivity levels

As is common in productivity studies, we measure labour productivity as value added per worker. The alternative would be gross value of output. However, this measure involves a considerable part of double counting because part of the output is used as intermediate inputs in other firms and industries. The Fisher UVRs in Table 1 are used to convert South African and US gross value added in Table 4 to same currency.[15] Their ratio is computed in the first column of Table 5. South African value added is only 1.6% of that of the US. In addition, relative labour productivity levels per employee and per hour worked are presented for thirteen branches. On average, South African labour productivity is 21.6% of the US level. The productivity gap across branches is fairly constant around the total manufacturing average. Remarkable is the high relative labour productivity in the leather and footwear branch of 41.4% of US level. Furthermore, it is striking that this branch in the US is so small in comparison to its South African peer. These findings are also found for a range of Asian countries (Timmer, 2000) indicating that either the US leather industry performs exceptionally bad and is relatively small or there are inconsistencies in the data. Further research is warranted to explain this phenomenon. The lowest relatively labour productivity levels of 17.5% and 15.6% are found in the chemicals and machinery and transport industry, respectively. All other figures are above 20% of the US level. Further detailed industry studies are required to investigate the relative low performance of these branches.

Labour productivity on the basis of hours worked is slightly less for all manufacturing branches, indicating that South African employees on average work somewhat longer than their American colleagues.

Table 5: Value added and Labour Productivity, South Africa as % of USA, 1993

	Value added	Persons	Hours worked	Value added per person	Value added per hour worked
Food, beverages and tobacco	3.1	13.1	14.7	23.5	20.9
Textile mill products	2.1	10.2	10.8	20.8	19.7
Wearing apparel	3.7	13.7	15.5	27.2	24.1
Leather products and footwear	15.2	36.8	40.2	41.3	37.8
Wood products and furniture	1.9	7.6	8.6	25.0	22.3
Paper products	1.3	4.2	4.5	31.0	29.1
Chemicals	1.5	8.4	9.1	17.5	16.2
Rubber and plastics	1.5	6.4	6.7	22.9	21.8
Non-metallic mineral products	3.5	14.1	14.8	25.1	23.9
Basic and fabricated metal products	2.7	9.2	10.1	29.7	27.1
Machinery and transport equipment	0.7	4.5	4.6	15.6	15.2
Electrical machinery and equipment	0.9	3.9	4.3	20.1	18.4
Other industry	0.4	2.0	2.2	21.4	19.4
Total manufacturing	1.6	7.3	7.9	21.6	19.9

Source: table 1 and table 3. Value added converted by Fisher unit value ratios.

[15] Theoretically it would be more sound use double deflation, i.e. to convert output and intermediate goods separately, to derive value added in a common currency. However, for practical and methodological reasons, only single deflation is used in ICOP studies (Van Ark, 1993a).

4.3 Capital intensity

Two proximate sources of increased labour productivity are commonly distinguished, capital accumulation and total factor productivity growth (Solow, 1957; Maddison, 1987). We start out with discussing the role of capital intensity, followed by a total factor productivity analysis.

Capital inputs are not part of the industrial census. In theory, capital input, the flow of capital services from capital stock installed, can be measured using detailed data on the composition of capital stock and rental prices (Jorgenson and Griliches, 1967). Such data, however, is rarely available; therefore we adopt the standard assumption that capital input is proportional to the capital stock. US gross fixed capital stock for branches and total manufacturing is taken from Timmer (2000) and updated to 1997 with real investment data from Bureau of Economic Analysis (BEA), National Accounts, various issues. Series are generated applying the perpetual inventory method (PIM), assuming a rectangular retirement pattern (Goldsmith, 1951; Harris, 1996). Two assets are distinguished, non-residential buildings and equipment including vehicles, using average service lifes in OECD countries of 45 and 17 years, respectively (Van Ark and Pilat, 1993). South African gross fixed capital stocks is obtained from the South African Standardised Industry Indicator Database, maintained by Trade and Industrial Policy Secretariat (TIPS) (see Appendix 2 for details). The stocks are computed by applying PIM to published Stats SA investment series of three assets, non-residential buildings, transport and machinery and other equipment with life times of 33, 8 and 4 years respectively.[16]

Table 6 shows the capital stocks in local currency for the benchmark year 1993 for South Africa and the US. For both countries, total investment deflators are used to rebase the stock series to 1993 prices.[17] Similar to value added, specific capital converters are required to express capital stocks into a common currency for comparison. UVRs for buildings and machinery, which constitute the major part of capital stock are not available and therefore we use investment PPPs from the Penn World Tables version 6 (Heston *et al.*, 2001). Since investments are expenditures on capital goods, the inclusion of retail and transport margins, and import prices is allowed (Timmer, 2000). Using investment PPPs, capital stocks of both countries is expressed in international dollars first, after which their relative level is estimated (Table 6). Especially, the chemical and the basic metal industry are, in comparison with other branches, capital-intensive vis-à-vis the US. We suspect that strong linkages, with the large mining industry in South Africa have triggered investment in heavy machinery and equipment in these branches, and in particular the chemical industry.

4.4 Total Factor Productivity Levels

Total factor productivity (TFP) growth is normally defined the portion of labour productivity growth not accounted for by measured input (here capital and labour)

[16] We thank a referee for informing us about the life time of the South African assets.
[17] The capital stocks series generated by using PIM are in 1985 and 1995 (if i'm not mistaken) prices, respectively for the US and South Africa.

growth (Steindel and Stiroh, 2001).[18] In this study, we apply a level instead of a growth accounting framework to measure total factor productivity of South African manufacturing relative to the USA. It reflects differences in economies of scale, efficiency, general knowledge and organisation between the two countries not captured by differences in the use of capital and labour. Relative total factor productivity is computed by the following equation, based on a translog production function, replacing points in time by countries (Van Ark, 1993a):

$$\ln \frac{A^{SA}}{A^{US}} = \ln \frac{Y^{SA} / L^{SA}}{Y^{US} / L^{US}} - (1 - \bar{v}_L^{SA\,US}) \ln \frac{K^{SA} / L^{SA}}{K^{US} / L^{SA}} \qquad (3)$$

where Y is gross value added, L is number of employees, K is gross fixed capital stock, A is the level of TFP and $\bar{v}_L^{SA\,US}$ is the unweighted average labour share in gross value added for South Africa (SA) and the United States (US).[19] The total factor productivity level of South Africa vis-à-vis the US is decomposed in relative labour productivity minus relative capital intensity, weighted by the average capital share of both countries. US Labour shares are taken from Timmer (2000) updated to 1997 with data from Bureau of Economic Analysis (BEA). South African labour shares are presented in the South African Standardised Industry Indicator Database. Table 6 shows the outcomes.

Table 6: Capital Stock and TFP, South Africa as % of USA, 1993

	Capital stock	Capital stock per person	Capital stock per hour worked	Total factor productivity person based	Total factor productivity hours worked based
Food, beverages and tobacco	2.3	17.7	15.8	56.1	52.9
Textile mill products	1.1	11.1	10.5	39.9	38.5
Wearing apparel	1.2	8.7	7.7	47.0	42.8
Leather products and footwear	2.9	7.8	7.2	88.8	83.5
Wood products and furniture	0.7	8.6	7.7	56.7	52.6
Paper products	0.5	12.7	11.9	65.4	62.8
Chemicals	4.0	47.5	43.8	25.0	23.9
Rubber and plastics	0.8	11.8	11.3	55.7	54.1
Non-metallic mineral products	2.2	15.9	15.1	45.8	44.3
Basic and fabricated metal products	3.1	34.1	31.2	42.5	40.1
Machinery and transport equipment	0.6	13.7	13.3	28.3	27.8
Electrical machinery and equipment	0.3	8.3	7.6	34.9	32.6
Other industry	0.2	11.3	10.2	56.5	53.4
Total manufacturing	1.7	23.5	21.7	36.3	34.5
Investment PPP		US (US$/I$): 0.85		SA (Rand/I$): 3.35	

Source: Table 2, 4, for capital stock see Appendix 2. Relative TFP computed using equation 3. Investment PPP in national currency per international dollar (I$) for 1993 calculated by multiplying price level of investment with the exchange rate, taken from Penn world Tables version 6.0 (Heston *et al*., 2001)

[18] In the KLEM growth accounting framework, energy and materials growth are also accounted for (Jorgenson *et al.*, 1987).

[19] See Jorgenson (1995a, b) for a detailed explanation and application of translog production functions and related total factory index. Dollar and Wolff (1993) also use this function to analyse US competitiveness in an international setting.

Average South African total manufacturing productivity is 34.5% of US. The highest relative total factor productivity is recorded in the leather industry and paper industry. As explained in the section on labour productivity, the high figure for the leather industry is caused by underperformance of this branch in the US. South Africa shows low total factor productivity in chemicals and machinery and transport equipment (under 30%). In line with the results for labour productivity, the total factor productivity gap is increased with about three percent because of shorter working hours in the USA in comparison to South Africa.

5. SOUTH AFRICA/US PRODUCTIVITY DYNAMICS, 1970-1999

To investigate the degree of catch-up or falling behind of South Africa industrial performance with respect to the USA, the 1993 labour and total factor productivity benchmark estimates are extrapolated back and forward. In the first section labour productivity trends are discussed, followed by an investigation of long run capital intensity and total factor productivity dynamics.

5.1 Labour productivity Trends

The investigate the South African/US labour productivity gap in the long run, we link the 1993 benchmark with growth indices of labour productivity for each country. For the US the indices are based on times series of real GDP and employment from the national accounts for the period 1970-1999. The South African data is based on a variety of sources underlying the Standardised Industry database that is also used for the capital stock data. Appendix 2 provided the details concerning the data.

Table 7: Labour Productivity in Manufacturing, South Africa as % of USA, 1970-1999

	1970	1975	1984	1994	1999
Food, beverages and tobacco	22.1	20.0	20.8	24.0	27.5
Textile mill products	43.7	42.2	30.2	20.8	21.4
Wearing apparel	46.5	34.4	34.0	25.6	24.4
Leather products and footwear	77.3	71.6	63.5	36.4	25.9
Wood products, furniture and fixtures	31.3	31.2	25.6	25.0	25.4
Paper and printing	34.9	29.8	34.6	31.5	33.0
Chemicals	24.3	19.9	23.1	17.3	17.8
Rubber and Plastic	44.8	38.8	35.0	23.3	24.0
Non-metallic mineral products	28.8	29.0	28.2	25.6	35.2
Basic and fabricated metal products	32.5	37.0	32.5	28.8	36.5
Machinery and Transport	25.3	23.8	18.4	14.8	12.6
Electrical Machinery and Equipment	58.2	67.6	56.1	18.1	9.6
Other manufacturing	29.4	29.9	26.4	20.9	25.1
Total manufacturing	32.0	30.7	27.2	20.9	19.8

Source: Table 3 and labour and output time series for both countries, see Appendix 2.

Table 7 shows the extrapolated relative labour productivity for selected years. The bottom line clearly indicates the falling behind of South African manufacturing performance relative to the US. The labour productivity gap increased steadily with 12% points from 32.0% to 19.8%.

Looking at the detailed branch level, the food, beverages and tobacco industry, non-metallic mineral industry and basic and fabricated metal industry have managed to close a (small) part of the productivity gap. For example, in 1994 the Columbus stainless steel plant was taken into production which probably also has boosted labour productivity over the last couple of years (Lundahl, 1999). All other industries are falling behind with respect to US performance, considering the complete period analysed. This is especially true for the leather branch and the electrical machinery and equipment industry. We believe that results for both branches are not caused by a slowdown in South African labour productivity, but to exceptional growth on the US side. Outcomes of the leather industry already have been discussed in previous sections and will not be addressed here anymore. The US times series data (not presented here) confirms the rapid growth of labour productivity in the US electrical machinery and equipment branch, which increased more than thirteen times between 1970 and 1999, by far the highest increase of all branches. Van Ark *et al.* (2000), who use the same dataset for a US-Canada productivity comparison, argue that, besides real productivity increases, a possible explanation for the widening gap are the use of hedonic price indices for semiconductors, which make up a large share of the electrical and machinery equipment. On average, the steepest fall in relative productivity is found between 1975 and 1994, corresponding with the period of stagnation in South Africa. Positive is that, more than half of the industries, textile mill products, wood products, paper and printing, chemicals, rubber and plastic, non-metallic mineral products, basic and fabricated mineral products and other manufacturing, experience a small increase in relative performance, since 1994, possibly indicating recovery.

5.2 Capital Intensity and Total Factor Productivity Trends

Analogue to the extrapolation of labour productivity we extend the capital intensity and TFP levels of the benchmark year in Table 6 to investigate their dynamics. Capital intensity levels are estimated using capital stock series at the branch level, discussed in Section 4.2. For the TFP extrapolation we merge the TFP level in the benchmark year with national TFP growth series, applying a standard translog production function, for each country:

$$\ln \frac{A_{t+1}}{A_t} = \ln \frac{Y_{t+1} / L_{t+1}}{Y_t / L_t} - (1 - \bar{v}_L) \ln \frac{K_{t+1} / L_{t+1}}{K_t / L_t}, \qquad (4)$$

where, A is TFP, Y is value added, L is labour, K is capital, $\bar{v}_L = 1/2(v_t + v_{t+1})$, the average labour share in value added, over period t and t+1. In contrast to value added and labour, capital stock data for the US is only available up to 1997.
Table 8 presents South African capital intensity and TFP levels as percentage of the USA for selected years. A striking result is the increase of relative capital intensity for total manufacturing from 20.8% to 25.3% between 1970 and 1997. This contrasts our earlier finding of a decrease in labour productivity level over the same period (table 7). Consequently, TFP has decreased considerably in comparison with the US. Like before, the results of the leather industry and the electrical machinery and equipment industry stand out and are likely to be responsible for the steep fall in aggregate TFP.

At the branch level, there seems ample space for catch-up through capital investment because capital intensity is under 50% of that of the USA, except for Chemicals and metal industry. In particular the latter went through a phase of rapid expansion since 1970. The TFP level decreased for most branches, with only the food and paper industry managing to maintain their productivity level over the period analysed.

Table 8: Capital intensity and TFP, South Africa as % of USA, 1970-1997

	Capital stock per person					Total factor productivity				
	1970	1975	1984	1994	1997	1970	1975	1984	1994	1997
Food, beverages and tobacco	18.3	17.2	18.8	18.9	19.8	57.0	51.5	49.2	54.8	57.5
Textile mill products	13.8	10.1	9.4	10.3	9.9	83.7	87.0	61.2	41.2	38.6
Wearing apparel	27.9	18.0	12.3	8.6	7.7	62.4	51.0	54.7	44.3	39.7
Leather products and footwear	16.3	14.1	10.4	8.1	7.6	145.7	137.7	130.6	77.1	72.4
Wood products, furniture and fixtures	14.8	12.3	13.3	8.4	9.7	61.3	63.5	50.2	57.4	54.3
Paper and printing	19.3	18.7	29.5	13.4	15.8	66.6	56.3	54.2	64.9	66.6
Chemicals	81.8	74.4	80.8	51.7	67.6	28.2	23.7	24.8	23.5	21.8
Rubber and Plastic	19.4	17.5	14.2	13.1	12.3	89.5	80.7	79.5	54.3	50.5
Non-metallic mineral products	12.9	14.0	20.4	16.9	19.7	58.1	55.5	47.0	45.7	44.0
Basic and fabricated metal products	26.9	36.1	28.4	39.8	55.4	55.8	55.0	50.9	38.9	41.5
Machinery and Transport	12.4	12.5	11.9	12.9	12.3	53.3	49.1	36.2	27.3	26.5
Electrical Machinery and Equipment	37.2	32.5	30.4	8.4	8.6	73.8	88.4	72.9	31.2	23.2
Other manufacturing	30.2	23.5	19.6	9.4	7.9	58.2	62.5	57.2	60.2	69.3
Total manufacturing	20.8	21.0	27.1	24.1	25.3	63.5	58.2	44.8	34.8	33.3

Source: Table 3 and labour, output and capital stock time series for both countries, see Appendix 2.

6. SOUTH AFRICAN PRODUCTIVITY IN AN INTERNATIONAL PERSPECTIVE

To put the production performance of South Africa in a broader international perspective we compare its labour manufacturing productivity with a sample of other countries, also studied within the ICOP project, using the same methodologies used here.[20] The countries have been selected because they represent various stages of industrialisation and, hence, offer ample opportunity for comparison with South African development. South Korea and Taiwan are the best-known examples of countries that managed to transform from low-income to high-income countries (World Bank, 1993); Brazil and Mexico are, like South Africa, classified as middle-income countries; and Zambia and Indonesia are low-income countries.[21]

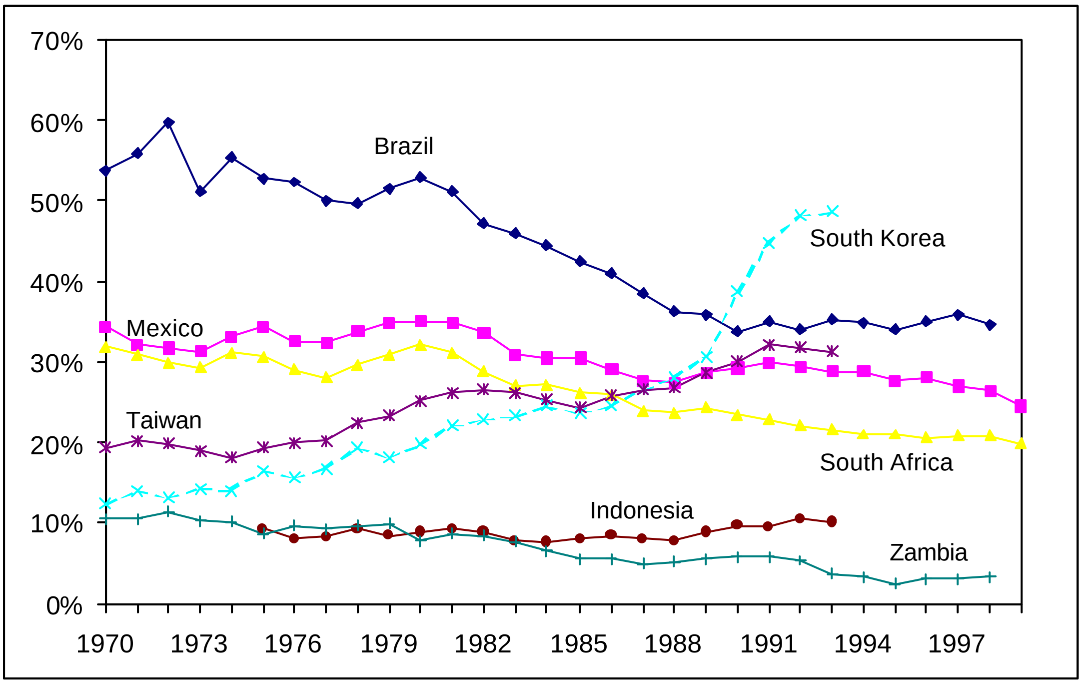
Figure 1 shows the evolution of labour productivity level for the seven countries from 1970 to 1999 as percentage of USA. The results resemble the income classification, mentioned above: Zambia and Indonesia have lowest relative productivity of around

[20] See Van Ark and Timmer (2000) for labour productivity estimates for all ICOP countries.
[21] The classification is taken from the World Bank's website on country data and statistics (http://www.worldbank.org/data/countrydata/countrydata.html) and is based on gross national income (GNI) per capita. Taiwan is not part of the classification because it is considered part of China. The World Bank makes a further distinction between lower- and upper-middle-income countries. South Africa belongs to the former group while Mexico and Brazil are part of the latter.

10 percent; Brazil, Mexico and South Africa perform at between 20% and 40% of USA level, although Brazil used to do much better between 1970 and 1990; and Korea and Taiwan, started at levels slightly above the low-income countries but managed to catch-up with the USA and reach labour productivity levels of around 50% and 30%, respectively, in 1993.

Striking, in the figure is the increase of the productivity gap between four, all non-Asian countries, and the USA. This result has also been found for many OECD countries, studied in the ICOP project, such as Canada, Australia, Germany and the United Kingdom (Van Ark *et al.*, 2000). As already outlined above, the widening of the gap is not due to slowdown of lagging countries but to the forging ahead of the USA, especially in the electrical machinery and equipment branch.

Figure 1: Labour Productivity for Total Manufacturing as % of USA, 1970-1999, selected countries



Source: Brazil and Mexico from Mulder *et al*. (2002); South Africa from this study; South Korea, Taiwan and Indonesia from Timmer (2000); and Zambia from Yamfwa *et al*. (2000)

7. UNIT LABOUR COSTS AND RELATIVE PRICES

Besides productivity, costs are also an important determinant of countries international competitiveness. A direct measure of the relation between productivity and cost are unit labour costs, defined as the ratio between labour costs (compensation per employee) and labour productivity. Since labour is in general less mobile than other factors of production, capital and intermediate goods, unit labour costs are one of the most important determinants of competitiveness. Moreover, labour costs make up 70% to 80% of value added in industrialised countries (Pilat, 1994). International unit labour cost comparisons are not easy to make because, similar to relative productivity levels, an appropriate conversion factor for output is required. Also here the UVRs provide a solution. In the first part of this section, we estimate unit labour costs in comparison with the USA for manufacturing, to assess South Africa's international competitiveness. For emerging economies, like South Africa other costs (e.g. capital, materials and energy costs) may be more important than labour costs. In the final section, we discuss relative prices, which gives an impression of overall price competitiveness.

7.1 Unit labour costs

To analyse the trade-off between labour costs and labour productivity of South Africa vs. the USA, we compute relative unit labour costs (RULC).[22] RULC is defined as the ratio of between relative labour costs and relative labour productivity of South African vis-à-vis the US, formally defined as:

$$RULC^{SAUS} = \left(\frac{\left(\frac{W^{SA}}{L^{SA}} \right) / NER^{SA/US}}{\left(\frac{W^{US}}{L^{US}} \right)} \right) / \left(\frac{\left(\frac{Y^{SA}}{L^{SA}} \right) / UVR^{SA/US}}{\frac{Y^{US}}{L^{US}}} \right), \qquad (5)$$

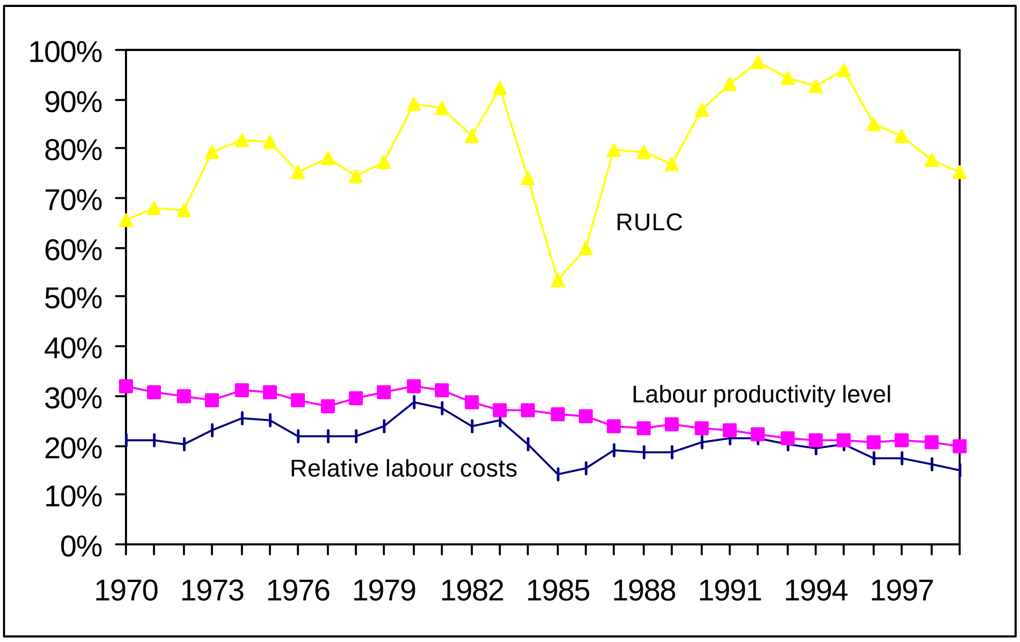
where W is compensation for total labour, L is labour, $NER^{SA/US}$ is nominal exchange rate expressed in Rand per US\$, Y is value added, and, $UVR^{SA/US}$ is unit value ratio.[23] As usual, SA and US denote South Africa and USA. For South Africa, labour costs and employment are directly taken from the South African Standardised Industry Database. US labour costs are computed by multiplying labour share data, also used for computing TFP, with current value added. Both data series are based on national accounts data. RULC based on census data, for the benchmark year 1993, resulted in dramatically different and unreasonable results, especially with respect to the US. The reason for this is differences in the definition of labour compensation between census data and national accounts data.[24] The former does not include employers' social security contributions, some fringe benefits or payments to self-employed, which are included in the latter.[25] In order to compute meaningful RULC estimates, it is important that labour compensation is standardised between countries. South African data for total economy is directly comparable to those of the US because they use the same definitions.[26]

Figure 2 plots labour productivity, labour costs per employee and unit labour costs of South Africa as percentage of US for total manufacturing between 1970 and 1999. Over the whole period, labour costs are below labour proclivity levels, meaning that South African unit labour costs are below US figures. In the beginning of the 1980s, there is a large decrease of RULC, due to the strong depreciation of the Rand, after which it bounced back to a level almost equal to the USA between 1991 and 1995. The last couple of years, the Rand has rapidly depreciated again leading to a second wave of declining RULC. Table 9 shows RULCs for thirteen industrial branches. In

[22] See Pilat (1994) and Mulder *et al*. (2002) for relative unit labour costs of South Korea, Japan, Mexico and Brazil, as percentage of the USA, using the same methodology.
[23] In the actual calculation, labour drops out.
[24] Also differences in the definition of value added play a role, see section 4.1.
[25] we want to thank Marcel Timmer for clarifying this point.
[26] We thank a referee for clarrifying this.

1970, all levels in South Africa are below the US level. Three industries show consistent RULC over 100%, rubber and plastics, machinery and transport, and electrical machinery and equipment, meaning that they are not competitive with the USA in terms of labour costs. RULC for other industries, although below the US level are still relatively high. In contrast, estimates of Mexico/US RULC for 1988 were all, except one, lower than 50% (Mulder *et al.*, 2002), where all the South African RULCs are above 50%. High relative wages, rather than, low labour productivity are the cause of the differences between the results of the two countries as is shown by the small productivity gap between Mexico and South Africa in Figure 1. The high level of wages in South Africa has also been confirmed in other studies.[27] The high relative wage/productivity ratio implies that it will be difficult for South Africa to compete in the international market, especially in low wage labour intensive industries in which developing countries have a comparative advantage.

Figure 2: RULC, labour productivity and labour costs, as % of USA, 1970-1999



Source: for labour productivity levels see table 7 data; relative labour costs computed using times series data on labour costs, also see text; RULC is computed using equation 5.

To assess the robustness of the RULC figures, it is useful to compare them briefly with other studies that investigate RULC for South Africa. Nordas, (1996), using the same methodology but using the exchange rate instead of UVRs as conversion factor, investigates South African unit labour costs in comparison with the US for 22 manufacturing industries in 1990. She finds that the only competitive industry (i.e. RULC lower than 100) is non-ferrous metals. Furthermore, the iron and steel, paper and printing and shipbuilding industry have RULC slightly above the US level. The results of the analysis here only partly confirm Nordas study. We also find that RULC of the basic and fabricated metal industry of which non-ferrous metals and iron and steel industry are part, are among the lowest. However, for other branch's outcomes differ. A likely cause for the discrepancy is the use of different conversion factors. Golub (2000) uses the real effective exchange rate (REER) to transform labour

[27] See studies quoted in Nattrass and Seekings (2000).

productivity into the same currency.[28] His findings resemble the results obtained here. In 1990, South African wages and labour productivity are around 25 percent of the US level, indicating that unit labour costs are approximately equal between South Africa and the US. In our estimates (not shown), relative wages for manufacturing in 1990 are 21 percent and labour productive is 24 percent, resulting in relative unit labour costs of 88 percent of the USA. Golub concludes that South Africa is competitive with almost all industrialised countries but not with many developing countries, mainly caused by the high South African wage level. This finding is also supported by our brief comparison with Mexico.

Table 9: Relative Unit Labour Costs, as % of USA, selected years

	1970	1975	1984	1994	1999
Food, beverages and tobacco	80.0	106.4	86.3	86.0	60.2
Textile mill products	47.7	63.9	76.2	111.0	96.7
Wearing apparel	62.2	86.9	64.3	84.5	69.2
Leather products and footwear	33.3	48.6	37.1	43.6	39.1
Wood products, furniture and fixtures	65.8	79.5	65.9	65.7	54.6
Paper and printing	95.3	124.2	86.8	92.0	68.8
Chemicals	77.1	111.9	89.6	116.4	80.5
Rubber and Plastic	58.0	84.2	102.8	148.4	112.6
Non-metallic mineral products	53.5	67.4	57.3	84.1	54.8
Basic and fabricated metal products	65.2	72.3	67.8	85.4	54.6
Machinery and Transport	94.2	118.3	117.0	141.9	124.5
Electrical Machinery and Equipment	51.5	50.5	45.3	81.0	125.5
Other manufacturing	82.3	90.0	77.6	93.1	51.9
Total manufacturing	65.5	81.5	74.0	92.7	75.4

Source: See figure 2

7.2 Relative prices

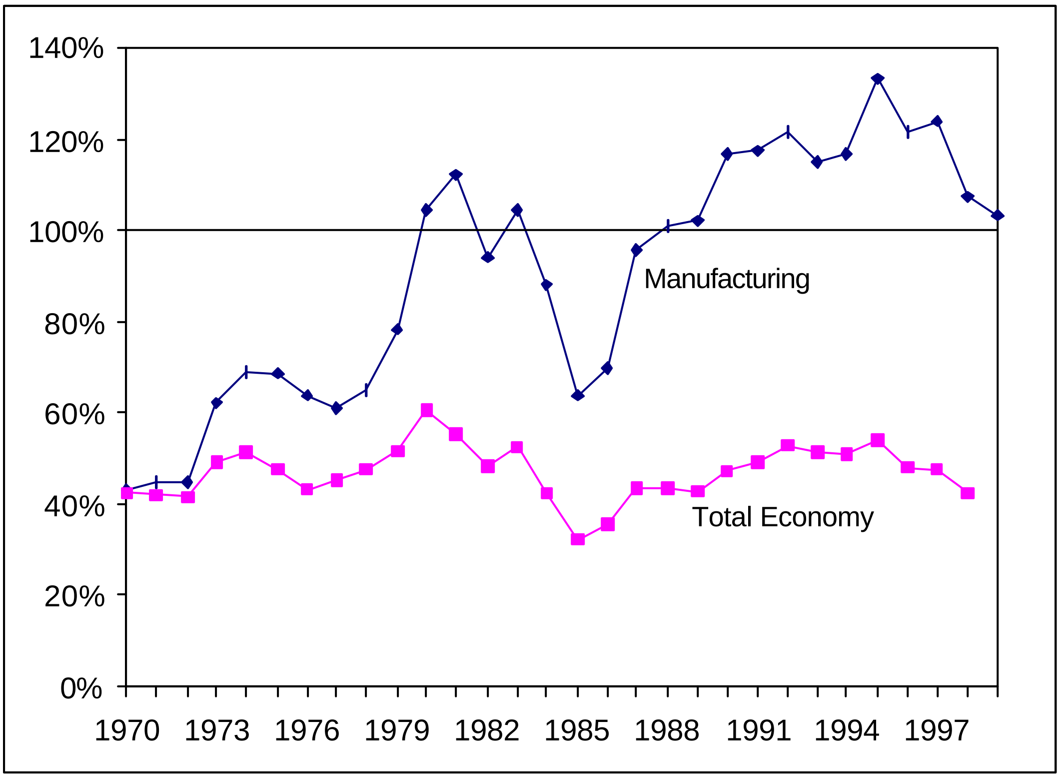
Relative prices are defined as PPP (or UVR) divided by the exchange rate. In section 3.2 relative prices for the benchmark year are already briefly discussed. To derive insights on the dynamics of South African/US price levels, we extrapolate the benchmark estimate for total manufacturing using manufacturing deflators for South Africa and USA. The deflators are obtained by dividing current value added by constant value added. Figure 3 shows that South African prices have steadily increased from about 40% in 1970 to a maximum of 133% in 1995, interrupted by a decline in the beginning of the 1980s due to rapid depreciation of the Rand. Between 1995 and 1999, South African prices decreased to the US level again. This is the same pattern as shown in figure 2 for RULC.

Figure 3 also shows the relative price level of the total economy, computed as PPP divided by exchange rate, which is far below the price level for total manufacturing. Similar results have been found by Pilat (1994) for Korea and, Japan and by Mulder et al. (2002) for Mexico and is a well-known phenomenon for developing countries.

[28] As Golub points out rightfully, at the time of his study neither PPPs nor UVRs were available for South Africa.

Overall price levels in developing countries are lower than in industrialised countries because nontradables (i.e. services) are relatively cheap. Prices of tradables, of which manufacturing makes up the largest share, are assumed to be roughly equal, across countries (Balassa, 1964; Bhagwati, 1984).

Figure 3: South African Relative Price Levels, as % of USA, 1970-1999



Source: Manufacturing: UVR taken from table 1 and extrapolated with GDP deflator for total manufacturing, divided by exchange rate (Rand/US$) from Penn World Tables version 6.0 (Heston *et al*., 2001); total economy: PPP divided by exchange rate, also both from Penn World Tables version 6.0

8. CONCLUSION

The main aim of this paper is to determine the economic performance of South African Manufacturing in a comparative international perspective. We construct industry specific purchasing power parities (PPPs) (here called unit value ratios (UVRs), which are used to compute labour and total factor productivity levels for total manufacturing and 13 manufacturing branches, relative to the USA, for the period 1970-1999. The data points out that there exists a considerable labour and total productivity gap between the US and South Africa, which is continuously widening over time. In 1970, labour productivity stood at 32 percent of US level, while it was only 20 percent in 1999. A positive development is that the majority of the industrial branches show an, although slight, increase in labour productivity over the last five years.

The overall increase in the gap is not due to a slowdown in South African labour productivity growth but rather because of an acceleration of US labour productivity growth. An international comparison shows that other countries have also experienced deteriorating performance levels. The comparative analysis also shows that South Africa is performing on a level between Indonesia and Brazil, almost equal to Mexico.

To investigate international competitiveness of South African manufacturing, we computed relative unit value costs, the ratio between labour costs and labour productivity and relative price levels. The results show that on average, South Africa is competitive with the USA, albeit there are some industries which show consistent relative unit labour costs above US level. Furthermore, a brief comparison with a study on Mexico indicates that South Africa is relatively uncompetitive with developing countries, mainly because of the high wage level. More research is required to give a detailed picture of South African manufacturing performance and competitiveness in an international perspective. In this paper we mainly focussed at an US/South Africa comparison. A fruitful way forward would be to combine the results here, with other International Comparisons of Output and Productivity (ICOP) studies. Already a brief start with this has been made in terms of an international labour productivity analysis.

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APPENDIX 1: ICOP INDUSTRY-OF-ORIGIN APPROACH[29]

This appendix describes aggregation procedure to derive industry, branch and total manufacturing UVRs from product or product group UVRs. Each of these four levels of aggregation is a subset of the other. Manufacturing output is the sum of output of branches, which in turn is the sum of the industries' output value. The value of an industry's output equals the sum of the values of the produced products. Within the comparison of each industry between two countries, only part of products can be matched as quantity information often lacks, it may be difficult to find comparable products, or countries produce unique products. The matched products can be considered as a sampled subset of products within an industry which relative price, under certain conditions, may be considered representative for the non-matched part.

Aggregation Step One: from Product to Industry Level UVRs

The UVR for an industry is the weighted mean of the product UVRs, using output values of base country (USA) or the other country (South Africa) as weights. The UVR for an industry using US weights is estimated as follows:

$$UVR_j^{xu(u)} = \sum_{i=1}^{I_J} \left(\frac{UV_i^{x(x)}}{UV_i^{u(u)}} \times w_{ij}^{u(u)} \right) \quad \text{with} \quad w_{ij}^{u(u)} = \frac{o_{ij}^{u(u)}}{\sum_{i=1}^{I_J} o_{ij}^{u(u)}} \tag{6}$$

with i=1,.,I_J the matched products in industry j, w_{ij} the output share of the ith commodity in industry j. $UVR_j^{xu(u)}$ indicates the unit value ratio between country x and the base country (USA) weighted at base country quantities indicated by the u in brackets. This equation can be rewritten to show that the use of base country value weights leads to the Laspeyres index:

$$UVR_j^{xu(u)} = \frac{\sum_{i=1}^{I_J} q_{ij}^{u} * UV_{ij}^{x(x)}}{\sum_{i=1}^{I_J} q_{ij}^{u} * UV_{ij}^{u(u)}} \tag{7}$$

Instead of US weights, one can also weight the product UVRs by the quantities of the "other" country (South Africa):

$$UVR_j^{xu(x)} = \frac{1}{\sum_{i=1}^{I_J} \left(\frac{UV_i^{x(x)}}{UV_i^{u(u)}} \times w_{ij}^{u(x)} \right)} \quad \text{with} \quad w_{ij}^{u(x)} = \frac{o_{ij}^{u(x)}}{\sum_{i=1}^{I_J} o_{ij}^{u(x)}} \tag{8}$$

Again this index can be easily rewritten to show that it is a Paasche index:

[29] This section draws heavily on Mulder et al. (2002), Van Ark et al. (2000) and Timmer *et al* (2001).

$$UVR_j^{xu(x)} = \frac{\sum_{i=1}^{I_J} q_{ij}^x * UV_{ij}^{x(x)}}{\sum_{i=1}^{I_J} q_{ij}^x * UV_{ij}^{u(u)}} \tag{9}$$

Aggregation Step Two: from Industry to Branch Level UVRs

The aggregation to branch UVRs is done by weighting the industry UVRs, by either US quantities:

$$UVR_k^{xu(u)} = \sum_{j=1}^{J_k} \left(\frac{UV_j^{x(x)}}{UV_j^{u(u)}} \times w_{jk}^{u(u)} \right) \tag{10}$$

with j=1,., J_k the number of industries in branch *k* for which a UVR has been calculated (the sample industries); w_{jk} the output share of the j^{th} industry in branch *k*. The weight of industries depends not only on the size of their output but also on the reliability of the industry UVR, being lower the lower the reliability, as unreliable UVRs should have a limited influence on the branch UVR. Therefore the set of industries J_k is split into two, $J_k(a)$ and $J_k(b)$ depending on their reliability. UVRs of industries belonging to the first set ($J_k(a)$) are weighted with the total industry output at own prices: $o_{jk}^{T\,u(u)}$. The UVRs from the other industries (belonging to $J_k(b)$) are weighted only by the output value of the matched products in the industry: $o_{jk}^{M\,u(u)} = \sum_{i=1}^{I_j} uv_{ij}^u q_{ij}^u$. Hence the weights are given by

$$\begin{aligned} w_{jk}^{u(u)} &= o_{jk}^{T\,u(u)} / o_k^{M\,u(u)} \qquad \forall j \in J_k(a) \\ w_{jk}^{u(u)} &= o_{jk}^{M\,u(u)} / o_k^{M\,u(u)} = \sum_{i=1}^{I_j} uv_{ij}^u q_{ij}^u / o_k^{M\,u(u)} \qquad \forall j \in J_k(b) \end{aligned} \tag{11}$$

with $o_k^{M\,u(u)} = \sum_{J_k(a)} o_{jk}^{T\,u(u)} + \sum_{J_k(b)} o_{jk}^{M\,u(u)}$

To arrive at the Paasche index, the US weights are replaced by South African output valued at US prices:

$$UVR_k^{xu(x)} = \frac{1}{\sum_{j=1}^{J_k} \left(\frac{UV_j^{x(x)}}{UV_j^{u(u)}} \times w_{jk}^{u(x)} \right)} \tag{12}$$

with

$$\begin{aligned} w_{jk}^{u(x)} &= o_{jk}^{T\,u(x)} / o_k^{M\,u(x)} \qquad \forall j \in J_k(a) \\ w_{jk}^{u(x)} &= o_{jk}^{M\,u(x)} / o_k^{M\,u(x)} \sum_{i=1}^{I_j} uv_{ij}^u q_{ij}^x / o_k^{M\,u(x)} \qquad \forall j \in J_k(b) \end{aligned} \tag{13}$$

with $o_k^{M\,u(x)} = \sum_{J_k(a)} o_{jk}^{T\,u(x)} + \sum_{J_k(a)} o_{jk}^{M\,u(x)}$

The split in the industry set is based on an assessment of the reliability of the industry UVRs. Given the homogeneous character of the products belonging to an industry, it is expected that product UVRs in an industry do not differ much. Hence, if the variation of the product UVRs is high, this is an indication of unreliability. Also, reliability increases the higher the percentage of industry output covered by matched products. Therefore the coverage ratio is also taken into account when assessing the industry UVR reliability. The following decision rule is used: when the coefficient of variation is less than 0.1, the industry is assigned to $J_k(a)$, other wise to $J_k(b)$:

$$\begin{array}{ll} \text{if} \quad cv\lfloor UVR_j \rfloor < 0.1 \quad \text{then} & j \in J_k(a) \\ \text{otherwise} & j \in J_k(b) \end{array} \qquad (14)$$

The coefficient of variation of industry j (cv_j) is measured as follows:

$$cv\left[UVR_j\right] = \frac{\sqrt{\text{var}\left[UVR_j\right]}}{UVR_j} \qquad (15)$$

The variance of the industry UVRs is given by the mean of the weighted deviations of the product UVRs around the industry UVR:

$$Var\left[UVR_J\right] = (1 - f_{j)})\frac{1}{I_j - 1}\sum_{i=1}^{I_j} w_{ij}\left(UVR_{ij} - UVR_j\right)^2 \qquad (16)$$

with Ij the number of products matched in industry i and f_j the share of industry output which is covered by the matched products within an industry. (1- f_j) is also referred to as the "finite population correction", and ensures that an increase in the coverage of the sample reduces its variance. This formula can be applied to either the Laspeyres or Paasche UVR using output value weights of the base country for the variance of the Laspeyres, and quantity weights of the other country valued at US prices for the variance of the Paasche. To allocate an industry to one of the two sets, a decision is made on the basis of the (geometric) average variance for the Paasche and Laspeyres.

Aggregation Step Three: From Branch to Total Manufacturing UVRs

The aggregation of branch to total manufacturing UVRs is done in the same way as that from the industry to the branch UVRs. US country output weights are used to arrive at the Laspeyres index, and the South African quantities valued at US prices are used to arrive at the Paasche index. The Laspeyres and Paasche indices are combined into a Fisher index when a single currency conversion factor is required. It is defined as the geometric average of the Laspeyres and the Paasche.

There is one important difference between aggregation steps two and three, i.e. the output weights of the branch do not depend on the reliability of their UVRs. Branches always enter the weighting system with their total production. This is because the estimated UVRs are the most "characteristic" for the branch even when their variance is high or their representativeness low. Nevertheless, it should be stressed that the UVRs for this branch have to be interpreted with caution.

At the branch level, we can also estimate the reliability of the UVRs. As indicated by the stratified sampling theory, branch variance is calculated by the quadratic output weighted average of the corresponding industry UVRs:

$$Var[UVR_k] = (1 - f_k)\sum_{j=1}^{J_j} w_{jk}^2 \ \mathrm{var}[UVR_{jk}] \tag{17}$$

with f_k the share of branch output covered by the matched products within a branch. Two variances are estimated: one using US and one using "other" country weights, of which a geometric average is taken. Finally, the sample variance of the UVR for total manufacturing given by the quadratic output weighted average of the corresponding branch UVR variances:

$$Var[UVR] = \sum_{k=1}^{K} w_k^2 \ \mathrm{var}[UVR_k] \tag{18}$$

A sample industry is defined as the lowest level product (group) UVRs can be compared between countries. In practice this is determined by the lowest level on which industry output data is available. Because most countries use some variation of the International Standard Industrial Classification (ISIC), sample industries generally resemble 4-digit ISIC industries. All UVRs (M) are aggregated at sample industry j, using either a Laspeyres price index, with the output value (w^U) of the base country U as weights,

$$UVR_j^{XU(U)} = \frac{\sum_{i=1}^{I(M)} UVR_i^{XU} w_i^U}{\sum_{i=1}^{I(M)} w_i^U},$$

or a Paasche price index, using the quantity weights, w^X of the other country X:

$$UVR_j^{XU(X)} = \frac{\sum_{i=1}^{I(M)} w_i^X}{\sum_{i=1}^{I(M)} \left(w_i^X \big/ UVR_i^{XU} \right)}.$$ [30]

Next, sample industry UVRs are aggregated at ICOP branch level. In the ICOP studies, 13 standard branches are defined to make comparisons with other ICOP studies easier. The branches consist of one or more three-digit ISIC sectors or one two-digit ISIC division.

The sample industry UVRs are calculated on the basis of a sample of matched products within an industry. An indicator for their reliability, i.e. how well they reflect the real UVR if all products in the sample industry could have been matched, is given by the coefficient of variation determined by the percentage of matched output and the homogeneity of the derived UVRs.[31] To ensure that reliable sample industry UVRs receive heavier weights than less reliable ones, only sample industry UVRs based on at least two matches with a coefficient of variation of less than 0.1 are weighted by

[30] See Timmer (1996) how to derive Paasche and Laspeyres indices in terms of unit values, from the equations shown here.
[31] See Timmer (1996) how to compute UVR coefficient of variation.

sample industry output using the Paasche and Laspeyres index formulae above. All other UVRs are weighted by the output of product matched. Finally, using branch output values as weights, aggregate indices are obtained for total manufacturing.

The Laspeyres and Paasche indices, estimated at each level of aggregation, may differ due to differences in the underlying production structure of both countries. In comparisons between developing and developed countries, the Laspeyres index is generally higher than the Paasche index. This is called the Gerschenkron effect (Gerschenkron, 1952). To construct one single currency converter, the Fisher index, a geometric average of Paasche and Laspeyres indices, is used.

APPENDIX 2: DATA SOURCES

South Africa

The primary data source for South African benchmark is the *Census of Manufacturing, 1993*, published by the Central Statistical Service (CSS). Only the *CSS report NO 30-01-01, Census of Manufacturing 1993, Statistics According to Major Groups and Subgroups: South Africa*, which describes aggregate data on labour, gross output and value added on industry and branch level and *CSS report NO 30-01-02, Census of Manufacturing 1993, Materials Purchased and Manufactured Articles Sold* (unpublished), which contains data on quantity and value of about 4000 goods produced, are relevant for this study. The Census covers all establishments conducting activities in connection with, the manufacture, processing, making or packaging of goods and commodities; the Slaughtering of animals, including poultry; and installation, assembly, completion, repair and related work. For unclear reasons, there is a lack of any formal codification to link product information to industry output data. This relation is required for the aggregation procedure and to compute the UVR variances. In most cases, the US classification provides a guideline. In case of doubt, several industries are taken together to guarantee that all products fall within its boundaries. A disadvantage is that the coverage ratio of any matches within an industry is lower, which reduces reliability. In total 35 industries have been be defined. In addition, for some reason, product data in the tobacco industry was not reported. Annual hours worked is taken from South African Statistics (1995).

Time series for value added (current and constant terms), labour, labour costs and capital are taken from the South African Standardised Industry Indicator Database, maintained by the Trade and Industrial Policy Secretariat (TIPS) to which access is granted on request. Data is provided for 28 manufacturing industries (3-digit SIC sheme). These industries were aggregated to match the 13 branch ICOP sector classification. The manufactured of knitted and crocheted fabrics industry (313) and manufacture of household appliances (358) could not be classified as textile mill products and electrical machinery equipment, respectively, because they are part of other industries. South African capital stocks are discussed in chapter 4.

US

The *1992 Census of Manufactures, Industry Series* published by the Bureau of the Census reports quantity and value data for approximately 11000 products, presented in branch specific volumes, classified according to the standard industrial classification (SIC). All establishments with one or more employee are surveyed. Branch and industry data on labour, value added and output (shipments) are taken from the *1993 Annual Survey of Manufactures(ASM), Statistics for industry Groups* *and Industries*. The ASM is conducted in each of the four years between the industrial censuses. It is a sample of approximately 62.000 (the census covers approximately 380.000 establishments) largest US establishments, which cover approximately 80 percent of the total value of shipments. The data collected by the ASM is subsequently scaled up on the basis complete coverage census estimates to provide estimations for value added, labour and output in accordance with census data. 1992 unit values were extrapolated to 1993 using 4-7 digit producer price indices from the Bureau of Labour Statistics obtained through the internet (http://146.142.4.24/cgi-bin/dsrv). Annual hours worked hours worked are from US Bureau of Labor Statistics (BLS), International Comparisons of Manufacturing Productivity and Unit Labour Costs Trends, (downloadable from: http://stats.bls.gov/news.release/prod4.toc.htm)

Time series for gross real and current value added have been constructed using several sources. Data for the period 1970-1977 taken from a print out of the *National Income and Product Accounts of the United States (NIPA), 1929-82*, Bureau of economic Analysis (BEA), 1986, for the period 1977-1982 from various issues of the *Survey of Current Business*, BEA and for 1987-1997 from a data file on the website of BEA (downloadable from: Http://www.bea.doc.gov/bea/dn2/gpo.htm). The three series are linked by using data for overlapping years and chain indices. For more information, there is a document with the a detailed description of the construction of the industry data, available from the author on request. For labour, the same sources as for value added are used to derive consistent series. In accordance with the benchmark, labour data represents part-time and full time employment excluding self-employment and unpaid family workers. Data and construction of the capital stock are described in chapter 4.