OECD OCDE

Organisation de Coopération et de Développement Economiques
Organisation for Economic Co-operation and Development

A World Free of Poverty

THE WORLD BANK GROUP

PPPs and international productivity comparisons: bottlenecks and new directions

Bart van Ark and Marcel Timmer, University of Gröningen, Netherlands

Agenda item n° 8

JOINT WORLD BANK – OECD SEMINAR ON PURCHASING POWER PARITIES

Recent Advances in Methods and Applications

WASHINGTON D.C.

30 January – 2 February 2001

DRAFT
Tables in Section 4 are preliminary and subject to revision

PPPs and international productivity comparisons: bottlenecks and new directions

by
Bart van Ark and Marcel Timmer
Groningen Growth and Development & The Conference Board

Paper for
ILO SEMINAR ON PRODUCTIVITY COMPARISONS
26 January 2001, Geneva

and

JOINT WORLD BANK-OECD SEMINAR ON PURCHASING POWER PARITIES
30 January – 2 February 2001, Washington D.C.

For this paper we benefited from the contributions of a dozen of researchers in the ICOP programme. We benefited in particular from material we developed in co-operation with Angus Maddison, Erik Monnikhof, Nanno Mulder, Dirk Pilat, Prasada Rao and Adam Szirmai. The International Labour Office is acknowledged for funding the recent extension of service productivity comparisons (Section 4). We are also grateful to M… Kuroda for introducing us into his – as yet unpublished – work on sectoral accounts PPPs for Japan vis-à-vis the US (see Section 5). Alan Heston is acknowledged for his initiative to propose an International Price Archive (PIPA) reported in Section 6. Naturally the content of this paper is our sole responsibility. Financial support from the Dutch Science Foundation (NWO) for Marcel Timmer is gratefully acknowledged.

CONTENT:

1. Introduction

International comparisons of productivity *levels* by industry of origin are a key measure of economic performance next to comparisons of per capita income and other aggregate measures at the economy-wide level. Comparisons of manufacturing productivity have received most attention and are now frequently quoted in the media. Despite greater methodological problems, comparisons of service productivity are also of increasing interest as has appeared, amongst others, from various studies by the McKinsey Global Institute during the 1990s (McKinsey Global Institute, 1992, 1993). Recently international organizations, including the International Labour Office and the World Bank, have also begun to report industry-based productivity measures on a regular basis.[1]

Industry-of-origin comparisons contribute to the understanding of the determinants of differences in economic performance across countries and regions. The relative productivity standing in agriculture, industry and services is considered of fundamental importance in structural growth analysis. As the 'structure' of GDP on the production side involves a bigger service component than on the expenditure side, where some important services such as distribution are 'disguised', industry-of-origin comparisons contribute to a sharper analysis of the causes of economic growth and of patterns of divergence between nations in growth accounts, catch up and convergence analysis and the exploration of lead country-follower country phenomena. It also strengthens the analysis of the locus of technical progress, in particular when supplemented by micro-oriented investigation of variance in performance between industries and between average and best practice firms. Finally these studies shed further light on the relation between productivity and competitiveness.

Even though the industry-of-origin approach and the expenditure approach were originally developed in parallel fashion, ultimately the expenditure approach was adopted as the main approach by the international organizations. The main reason for this was that the expenditure approach could move forward faster through the design of a specific price survey to obtain PPPs that could be aggregated to the GDP level. It has been spelt out in earlier papers that the use of expenditure PPPs for international comparisons by industry of origin can introduce serious errors. The fact that this approach is still widely practised in productivity research, is probably due to the large methodological and data issues in computing PPPs by industry of origin (see, for example, Dollar and Wolff, 1993; Golub, 1999; Bernard and Jones, 1996).

In 1983 the ICOP (International Comparisons of Output and Productivity) project was set up at the University of Groningen under the direction of Angus Maddison to pursue research on industry-of-origin comparisons of output and productivity. This work follows in the tradition of Rostas (1948), Paige and Bombach (1959), Maddison (1952), and is conveniently summarized by Kravis (1976). Despite the wide range of methodology and data problems, the ICOP research programme has consistently aimed to pursue avenues to remedy the objections that were are raised against the

[1] ILO, *Key Indicators of the Labour Market 1999*, Geneva, Chapter 17 (see also van Ark and Monnikhof, 2000), and World Bank, *World Development Indicators 2000*, Table 2.6, pp. 58-61. OECD occasionally publishes such data in working papers, including Pilat (1996) and Scarpetta et al (2000).

industry of origin approach. In earlier review papers, including Van Ark and Maddison (1994), Maddison and van Ark (2001) and van Ark (1996), we have described the progress made over the past twenty years through the research input of a dozen of scholars and work on about 30 countries. This paper does not repeat these review, even though in **Section 2** we will briefly summarize the main achievements so far.[2]

Instead our focus will be on present future directions in the ICOP research programme. In the light of the extension of the research towards the more 'difficult to measure' industries, this paper presents the most recent results and investigates the major problems still on our way and the possible solutions ahead. **Section 3** of the paper deals with international comparisons in manufacturing industries. We will show our progress towards formalizing our 'unit value ratio'-methodology for manufacturing comparisons, which will facilitate the multilateralization for future binary comparisons, starting from 1997 onwards using a common product list of 256 manufacturing products. We will also discuss our approaches towards price comparisons for high tech products, such as IT equipment, cars and pharmaceuticals, which require the use of more detailed price data sources.

Section 4 discusses our recent advances in extending comparisons of productivity towards service industries, including transport and communication and the retail and wholesale sector, based on recent studies by van Ark, Monnikhof and Mulder (1999) and Monnikhof and van Ark (2001). In particular for trade we show that a greater but selective use of expenditure PPPs is complementary to industry-of origin-based price comparisons.

In **Section 5** we go a step further by arguing that a more integrated approach of using both expenditure PPPs and industry of origin UVRs (unit value ratios), complemented by price information from secondary sources, is increasingly needed. In particular of double deflation integration is necessary. Sectoral growth (or level) accounting studies and internationally harmonized accounts could greatly benefit from an integrated approach. We substantiate this argument by an example for a Germany-USA comparison of sectoral productivity by Timmer and Rao (1999) and the most recent work on a Japan-USA sectoral growth accounting study by Kuroda and Jorgenson (2000).

In **Section 6** we discuss a proposal for a joint initiative by the Penn World Tables-group (Heston and Feenstra), the ICOP group and the Conference Board to launch a new research project on constructing an International Price Archive, called PIPA, which might be the next step on the way to an integration of the expenditure and the industry-of-origin to international comparisons.

[2] See also the website of the Groningen Growth and Development Centre (http://www.eco.rug.nl/ggdc) for up-to-date information.

2. A brief history of ICOP research and its relation to ICP

International comparisons of GDP and per capita income are presently mostly made by converting national income to a common currency on the basis of purchasing power parities (PPPs). These PPPs are obtained by expenditure categories (private consumption, investment and government expenditure) which are now provided on a regular basis by Eurostat and the OECD.[3] There is also an academic tradition of comparing output, per capita income and productivity at the economy-wide level using expenditure PPPs for GDP. For example, Maddison (1991, 1995, 1998) used such PPPs for historical comparisons, and Kravis, Heston and Summers (1982) and Summers and Heston (1988, 1991) applied PPPs for the construction of the Penn World Tables. Recently, Van Ark and McGuckin (1999) compared relative levels of per capita income and labour productivity for the total economy for OECD, Asian and Latin American countries.

While comparisons for the total economy can be made using an expenditure approach, it raises problems for comparisons by industry of origin (agriculture, industry, and services) as it requires a subjective allocation of PPPs to individual industries. As expenditure represents not only the production value of the industry in question but also the added value of industries further down the chain, these PPPs require adjustment for taxes and trade and transport margins. While these margins can be "peeled off" as done by, for example, Jorgenson, Kuroda and Nishimizu (1987) and Jorgenson and Kuroda (1990) for Japan vis-à-vis USA, and by Lee and Tang (1999) for Canada vis-à-vis USA, this does not solve all problems. Firstly, at industry level, expenditure PPPs also need to be adjusted to exclude the relative prices of imported goods and include the relative prices of exported goods. Hooper (1996) adjusted expenditure PPPs for margins and import and export prices, but he acknowledges that the latter adjustments involves strong assumptions.[4] Secondly, and most importantly, expenditure PPPs exclude price ratios for intermediate products, which account for a substantial part of output in manufacturing and services. Hence the use of these "proxy PPPs" is not straightforward.[5]

The preferable method here is to use the industry-of-origin approach. In practice one can choose between two methods:

A) direct comparisons of physical quantities of output (tons, litres, units).
B) converting output by industry to a common currency with a currency conversion factor which approaches cross country differences in producer prices.

If all output can be covered the two approaches provide the same results. In practice both methods usually yield different results because of differences in sampling, weighing and coverage of output. In

[3] Expenditure comparisons were pioneered by Gilbert and Kravis (1954) and Gilbert and Associates (1958). Since the late 1960s surveys were conducted at regular intervals by the International Comparisons Project (ICP), firstly by Kravis and associates under auspices of the World Bank (e.g. Kravis, Heston and Summers, 1982), later by the United Nations, Eurostat and the OECD.

[4] Hooper (1996) adjusts the expenditure PPPs by "weighting out" import prices and "weighting in" export prices, assuming the import and export prices equal world prices. World prices are obtained as the output-weighted average of each country's expenditure price levels in dollars. See also Pilat (1996) who uses a combination of UVRs and proxy PPPs (see below).

[5] See Section 5 of this paper for a discussion of a more refined approach based on a mix of expenditure PPPs and industry PPPs for intermediate products by Kuroda and Jorgenson (2000) in a comparison between Japan and the United States.

cases of less than full coverage, method A assumes that the quantity relatives of matched output are representative for the unknown quantity relatives of unmatched output. In case of method B the price relatives of matched output are representative for the unknown price relatives of unmatched output. In the past, international productivity studies often applied the physical quantity method, but during the past four decades most studies switched to the currency conversion method.[6] The switch is primarily caused by the increase in the number of products and product varieties, so that the percentage of output which can be covered by physical comparisons is much lower than in the past. With price comparisons, the representativity of matched output for non-matched output is greater than for quantity ratios. The physical quantity method is still in use for comparisons at plant level – in which case quality differences can be better accounted for – and for comparisons of output in agriculture, mining and part of services, such as transport and communication (see section 4).[7]

Agriculture was the first sector on the ICOP research agenda in 1983. It has a relatively simple commodity structure (about 200 products instead of up to l5,000 in manufacturing). The availability of standardised information on output, feed and seed inputs, farm prices and farm accounts from the Food and Agriculture Organisation (FAO) greatly facilitated the problem of assembling the basic data for multicountry analysis on a reasonably standardised basis. Problems of quality, product differentiation, and coverage are smaller than in other sectors and it is easier to deploy double deflation. Van Ooststroom and Maddison (1984) and Maddison and van Ooststroom (1993) covered 144 farm products for 14 countries in 1975. Maddison and Prasada Rao (1996) used the same data base to calculate Paasche, Laspeyres and Geary-Khamis measures of agricultural output net of feed and seed, using the same technique as ICP for filling holes in the data array; they used the CPD (country product dummy) method invented by Summers (1973), instead of shadow prices.

Mining was the second sector which the ICOP group tackled. The rough international comparison of Wieringa and Maddison (1985) covered the same countries as the agriculture comparisons for l975, and used only US prices as the basis for comparison. The prices were generally taken from the *Statistical Abstract of the United States* and from the US *Minerals Yearbook* and trade sources. Production of 45 minerals in the thirteen countries was generally taken from the UN *Yearbook of Industrial Statistics*. Houben (1990) was a more sophisticated analysis of the mining sector in Brazil, Mexico and the USA from census material, and was similar in approach to our studies for manufacturing. Comparisons for the mining sector were also included by Pilat (1994) for Japan and Korea vis-à-vis the United States.

Most ICOP studies dealt with comparisons of the **manufacturing sector**, which now include almost 30 countries in the OECD area, Asia and Latin America. For the manufacturing studies industry-specific

[6] Rostas (1948) is the best known example of using physical quantity comparisons for a comparison between Britain, the United States and Germany during the second half of the 1930s. Rostas' method was recently revived in a study of British manufacturing productivity in historical perspective by Broadberry (1997). See also Maddison (1952), Heath (1957) and Maizels (1958) for Canada/USA, UK/Canada and Canada/Australia respectively. The pioneering study using currency conversions factors for international comparisons is Paige and Bombach (1959).

[7] See Van Ark and Maddison (1994) for a review of the two approaches and for a description of the conditions under which these yield the same results. See also Kravis (1976). For recent comparisons of productivity in transport and communication, using quantity measures, see Van Ark, Monnikhof and Mulder (1999) and Mulder (1999).

conversion factors were developed using producer output and value data. This method is fundamentally different from the pricing technique in the ICP expenditure approach. Internationally comparable producer prices for specified products are usually not available. ICOP studies therefore use product unit values which are derived from value and quantity information for product groups. Hence each unit value has a quantity counterpart, as quantities times "prices" equal the value equivalent. By matching as many products as possible, unit value ratios are derived which can be weighted up to industry level. These can then be used to express output for different countries in a common currency. Details of the ICOP methodology for manufacturing are discussed in Section 3.[8]

In course of the 1990s an increasing amount of research input has gone into covering other sectors of the economy in particular in the **service sector**. There are some services for which the problems involved in comparing value added, relative prices and productivity are similar to those for manufacturing, and where census sources of information may be available for prices and quantities. This is true of electricity, gas and water supply, and sometimes for transport and communication. Most other services activities are comparison resistant, because it is difficult to measure output and to distinguish prices from quantities. Pilat (1994) was a first attempt to include service sector estimates for all service industries. Mulder (1999) refined the methods, in particular for transport and communication and wholesale and retail trade. Van Ark, Monnikhof and Mulder (1999) included estimates for fivw OECD countries for these two sectors, which was extended most recently by Monnikhof and van Ark (2001). These latest (preliminary) results are discussed in Section 4. Service comparisons is a field which poses major problems for the ICP and ICOP approaches alike. For example, it necessitated changes in ICP methodology in successive ICP rounds (see Heston and Summers, 1992). A further development of methods and data sources is needed most in this sector.

3. The ICOP Programme on Manufacturing

ICOP manufacturing studies have two distinctive characteristics. Firstly, the most solid basis for industry-of-origin studies is provided when for each country all information can be derived from a single primary source, which for manufacturing is the census of production or industrial survey. This source contains great detail on the output and input structure by industry and information on the sales values and quantities of most products. Care is taken to make nominal output and (labour) input comparable. For example, value added and labour input need to be defined in a similar way across countries, industrial classifications have to be matched and adjustments for coverage are required when necessary.[9]

---

[8] The method for manufacturing is more extensively described by van Ark (1993), which is downloadable from the ICOP website (http://www.eco.rug.nl/GGDC/ThesisArk.html) and Timmer (2000). See also van Ark and Pilat (1993).

[9] Naturally the derived UVRs can also be applied to the national accounts information on GDP. The manufacturing tables in this Section are all still on census basis, but we provided national accounts adjusted estimates in ILO (1999) and Van Ark and Monnikhof (2000). For service comparisons we usually have to move directly to the national accounts level, as the census material suffers from serious undercoverage (see Section 4). Naturally the consistency of the price and quantity

A second distinctive characteristic of ICOP studies is the use of industry-specific conversion factors (which are called unit value ratios, or UVRs) based on producer output data instead of final expenditure information. These UVRs are used to convert output into a common currency for a benchmark year. In this section we will mainly focus on recent developments in our work on manufacturing, namely the formalization of the methodology (3.1), multilateralisation of binary UVRs (3.2), the development of reliability indices (3.3), and our approaches to improve the matching of products that differ in quality (3.4). The issue of double deflation is covered in Section 5.

Table 1 provides labour productivity measures for total manufacturing for 26 countries for 1960, 1973, 1987, 1996 and for some countries 1998.[10] This table is a summary of a large number of binary productivity studies which all used the ICOP methodology as described below. The basis comparisons are done for a benchmark year, usually 1987, and in some cases 1975 or 1984. National time series on output labour input are used to extrapolate from the benchmark year to other years. We provide estimates of value added per person employed and, where possible, of value added per hour worked. For low income countries our basic comparisons are usually for the large scale part of industry, as detailed census material for small scale manufacturing usually lacks. However, where possible we make use of secondary sources to provide a comparison for the whole of industry.

3.1 Formalization of the ICOP methodology for binary manufacturing comparisons

A major task in the ICOP approach to manufacturing is to derive industry-specific conversion factors 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 example ladies' shoes, cigarettes, cheese and car tyres. For each matched product, the ratio of the unit values in both countries is taken. This unit value ratio (UVR) is given by

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

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.

data for products vis-à-vis the industry output data disappears when moving from census based comparisons to the national accounts.

[10] See also the website of the Groningen Growth and Development Centre (http://www.eco.rug.nl/ggdc) for up-to-date information.

Table 1
ICOP Estimates of Levels of Labour Productivity in Manufacturing, 1960-1998, USA=100

	1960		1973		1987		1996		1998	
	Value Added per Person Employed	Value Added per Hour	Value Added per Person Employed	Value Added per Hour	Value Added per Person Employed	Value Added per Hour	Value Added per Person Employed	Value Added per Hour	Value Added per Person Employed	Value Added per Hour
India										
all firms	2.1		2.6 g		**2.2**		2.4 i			
registered firms only (a)	6.7		7.0 g		**8.4**	6.8	10.8 i			
China										
all firms					**4.5**		6.4 j			
large firms only (b)					**5.7**	4.9				
Indonesia										
all firms	4.0 e		3.0 h		**4.6**		5.0 k			
medium & large only (c)					**8.0**	6.3	11.2 k			
Hungary	17.6		16.7		**20.1**		25.2			
Poland	23.9		24.9		**21.2**		18.5			
East Germany	24.3		22.5		**22.5**	23.5	57.6			
Czechoslovakia	27.7		23.9		**24.0**	18.9				
Portugal	15.0		24.2		**24.5**		23.2 k			
USSR										
all industry (d)	27.2	27.3	25.5	26.8	**26.1**	27.7				
manufacturing only					**24.8**	26.3				
Mexico	36.8		35.3		**25.5**		25.4			
Korea	9.8 f	6.9 f	15.0	10.9	**26.5**	18.4	40.6	31.7		
Taiwan	11.8 f	8.1 f	19.5	14.0	**26.6**	20.4	34.7	28.3		
Brazil	41.8		46.3		**32.7**		21.9			
Spain	15.1		28.5		**46.5**		39.6			
Australia	40.7	39.6	43.1	43.8	**48.4**	49.9	45.5	47.3		
United Kingdom	49.9	45.9	51.1	52.5	**53.6**	58.0	53.1	61.1		
Finland	47.9	45.5	53.2	56.1	**65.9**	74.3	86.4	103.5		
Sweden	53.6	55.3	73.0	88.3	**68.4**	87.4	83.1	99.4	82.8	99.2
West Germany	63.0	57.9	75.6	79.0	**70.2**	82.2	66.2	84.6	67.8	85.8
France	51.8	49.8	67.6	71.4	**71.2**	84.0	75.4	91.2	76.1	92.1
Japan	24.9	19.9	55.0	47.5	**76.4**	67.5	82.7	83.2	75.8	78.7
Canada	80.4	80.2	83.9	86.0	**77.5**	79.4	73.0	77.4	68.8	74.8
Belgium	42.1	42.2	57.6	67.0	**78.5**	99.8	80.7	104.0	79.1	101.9
Netherlands	54.4	50.2	79.3	87.0	**83.3**	105.4	82.8	108.9	80.1	107.6
United States	100.0	100.0	100.0	100.0	**100.0**	100.0	100.0	100.0	100.0	100.0

(a) establishments with 20 or more employees and establishment with between10-20 employees using power; (b) enterpises above township level; (c) establishments with 20 or more employees except those in oil and gas refineries; (d) including mining and public utilities; (e) 1961; (f) 1963; (g) 1970; (h) 1971; (i) 1993; (j) 1994; (k) 1995

Notes: Countries are ranked according to their level of value added per person employed in 1987. Portugal/UK, Spain/UK, Hungary/W-Germany, Poland/W-Germany and East Germany/W-Germany have been converted to the USA as the base country for the benchmark year. Note: Labour productivity estimates are at census level and not adjusted to national accounts level.

Sources: Benchmark year estimates from India/USA (1983/84), Taiwan/USA (1986) and Indonesia/USA (1987) from M.P. Timmer (2000), *The Dynamics of Asian Manufacturing. A Comparative Perspective, 1963-1993*, Edward Elgar Publishers, Aldershot; China/USA (1985) from A. Szirmai and R. Ren (1998), “China’s Manufacturing Performance in Comparative Perspective”, in M. Fouquin and F. Lemoine, eds., *The Chinese Economy*, Economica, London, pp. 49-64; Korea/USA and Japan/USA from D. Pilat (1994), *The Economics of Rapid Growth. The Experience of Japan and Korea*, Edward Elgar Publishers, Aldershot. Hungary/W-Germany (1987) from E. Monnikhof (1996), “Productivity performance in manufacturing in Hungary and West Germany, 1987-1994”, Groningen Growth and Development Centre, mimeographed; Poland/W-Germany (1989) from B.Z. Liberda, E.J. Monnikhof and B. van Ark (1996), "Manufacturing Productivity Performance in Poland and West Germany in 1989", *Economic Discussion Papers*, No. 25, Faculty of Economic Sciences, University of Warsaw, May; Czechoslovakia/W-Germany and East Germany/W-Germany from B. van Ark (1996), "Convergence and Divergence in the European Periphery: Productivity in Eastern and Southern Europe in Retrospect", in B. van Ark and N.F.R. Crafts, eds., *Quantitative Aspects of Post-War European Economic Growth*, CEPR/Cambridge University Press, pp. 271-326; Poland /Germany (1993) and East Germany/W-Germany(1992) are unpublished ICOP/LCRA estimates (January 1996); USSR/USA (1987) from R.D.J. Kouwenhoven (1996), "A Comparison of Soviet and US Industrial Performance", *Research Memorandum GD-29*, Groningen Growth and Development Centre, Groningen; Portugal /UK (1984) from L. Peres Lopes (1994), “Manufacturing Productivity in Portugal in a Comparative Perspective”, *Notas Economicas no. 4*, Universidade de Coimbra; Brazil/USA (1975) and Mexico/USA (1975) from B. van Ark and A. Maddison (1994), "An International Comparison of Purchasing Power, Real Output, and Productivity in Manufacturing Industries: Brazil, Mexico and the USA in 1975", *Research Memorandum*, no. 569 (GD-8), Groningen Growth and Development Centre; Spain/UK (1984) from B. van Ark (1995), "Produccion y productividad en el sector manufacturero español. Un analisis comparativo 1950-1992", *Información Comercial Española. La actividad empresarial en España*, Madrid, October, no. 746, pp. 67-77; Australia/USA (1987) from D. Pilat, D.S. Prasasa Rao and W.F. Shepherd (1993), "Australia and United States Manufacturing. A Comparison of Real Output, Productivity Levels and Purchasing Power, 1970-1989", *COPPAA Series*, no. 1, Centre for the Study of Australia-Asia Relations, Griffith University, Brisbane, Australia; UK/USA (1987) from B. van Ark (1992), "Comparative Productivity in British and American Manufacturing", *National Institute Economic Review*, November; Finland/USA (1987) and Sweden/USA (1987) from M. Maliranta (1994), "Comparative Levels of Labour Productivity in Swedish, Finnish and American Manufacturing", Helsinki School of Economics, mimeographed; West Germany/USA (1987) from B. van Ark and D. Pilat (1993), "Productivity Levels in Germany, Japan and the United States", *Brookings Papers on Economic Activity, Microeconomics 2*, Washington D.C., December; France/USA (1987) from B. van Ark and R.D.J. Kouwenhoven (1994), "Productivity in French Manufacturing: An International Comparative Perspective", *Research Memorandum*, no. 571 (GD-10), Groningen Growth and Development Centre; Canada/USA (1987) from G. de Jong (1996), "Canada's Postwar Manufacturing Performance. A Comparison with the United States", *Research Memorandum GD-32*, Groningen Growth and Development Centre; Belgium/USA from A. Soete (1994), “The Evolution of the Competitiveness of the Belgian Manufacturing Industry in the Long Run, 1880-1990”, paper presented at the Economics Department of the Catholic University Leuven.
Extrapolations from benchmark years with national accounts series on real GDP, employment and hours in manufacturing from original publications above, updated and extended.

Product UVRs are used to derive an aggregate UVR for manufacturing branches and total manufacturing. This requires the choice of a particular weighting scheme. The most simple aggregation method would be to weight each product UVR by its share in output. However, according to stratified sampling theory, estimates of aggregates can be made more precise if a heterogeneous population is divided into more homogeneous subpopulations, called strata. Strata have to be defined as non-overlapping. Together they should comprise the whole of the population. Within ICOP, the total manufacturing sector is subdivided into more homogeneous branches, which are subsequently subdivided into industries. This is illustrated by Figure 1.

Figure 1 Simplified representation of the four levels of aggregation within ICOP

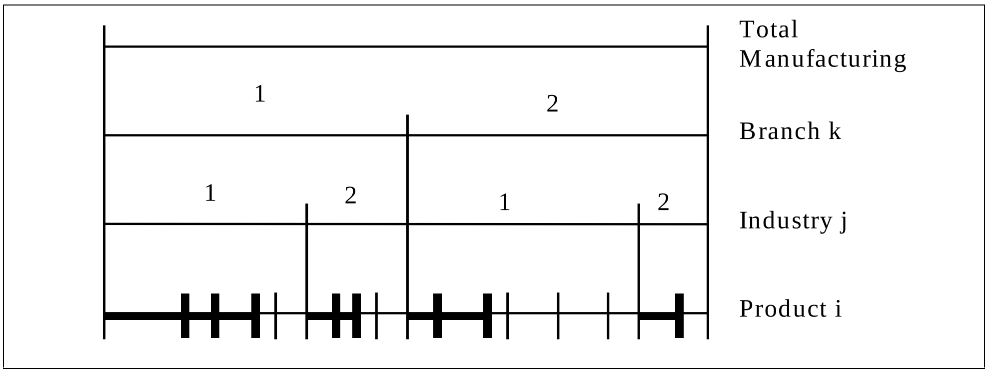

Figure 1 shows the four levels which are being distinguished: products, industries, branches and total manufacturing. These levels correspond with the levels distinguished in the International Standard Industrial Classification (ISIC).[11] ICOP industries consist of one or more four-digit ISIC industries, and ICOP branches consist of two- or three-digit ISIC divisions. The four horizontal level lines in the figure can be thought of as representing manufacturing output value. The total manufacturing output is the sum of branch output, which is the sum of industries' output value. The output value of an industry is the sum of the value of output of its products. In a binary comparison some of these products can be matched, but not all. This is because of lack of value or quantity data, difficulties in finding corresponding products, the existence of country-unique products, *etc.* Bold lines at the product level in the figure indicate the total output value of the matched products in the different industries. Thus, matched products in an industry can be seen as a sampled subset of all the products within an industry in a multi-staged stratified-sampling framework.[12]

[11] The ISIC is based on a combination of both the supply-side and the demand-side approach to the classification of economic activities (Triplett 1990). The supply-side approach classifies activities according to similarities in the production processes. The demand-side approach on the other hand yields a classification system based on similarities in the use of the produced goods. In theory, a classification based on the supply-side approach solely would be more useful for the aggregation of UVRs (Timmer 1996).

[12] The procedure explained here slightly differs in its aggregation procedures from earlier ICOP comparisons (see, for example, van Ark, 1993). The differences between the old and the new method are generally very small, but the present method is preferred from a theoretical and statistical perspective.

1. Aggregation Step One Industry Level UVRs

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:

$$UVR_j = \sum_{i=1}^{I_j} w_{ij} UVR_{ij} \tag{3}$$

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 (u) or the other country (x) can be used. The use of base country value weights leads to the Laspeyres index. Substituting base country weights in (3) gives:

$$UVR_j^{xu(u)} = \sum_{i=1}^{I_j} w_{ij}^{u(u)} \ UVR_{ij} \tag{4}$$

with $w_{ij}^{u(u)} = o_{ij}^{u(u)} / o_j^{u(u)}$; $o_j^{u(u)} = \sum_{i=1}^{I_j} o_{ij}^{u(u)}$; and $o_{ij}^{u(u)} = uv_{ij}^{u} q_{ij}^{u}$. Using (1), (4) can be rewritten as

$$UVR_j^{xu(u)} = \frac{\sum_{i=1}^{I_j} uv_{ij}^{x} q_{ij}^{u}}{\sum_{i=1}^{I_j} uv_{ij}^{u} q_{ij}^{u}} \tag{5}$$

with $UVR_j^{xu(u)}$ indicating the Laspeyres index which is the unit value ratio between country u and x weighted at base-country quantities indicated by the u between brackets. For the Paasche index, weights of the other country quantities valued at base country prices are used in formula (3). This gives

$$UVR_j^{xu(x)} = \sum_{i=1}^{I_j} w_{ij}^{u(x)} \ UVR_{ij} \tag{6}$$

with $w_{ij}^{u(x)} = o_{ij}^{u(x)} / o_j^{u(x)}$; $o_j^{u(x)} = \sum_{i=1}^{I_j} o_{ij}^{u(x)}$; and $o_{ij}^{u(x)} = uv_{ij}^{u} q_{ij}^{x}$. Using (1), (6) can be rewritten as

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

with $UVR_j^{xu(x)}$ indicating the Paasche index which is the unit value ratio between country u and x weighted at the quantities of the other country (x).

2. Aggregation Step Two Branch Level UVRs

The theory of stratified sampling suggests that if in each industry (stratum) the sample estimate of the mean is unbiased, then the industry-weighted mean of all industries' UVRs in a branch is an unbiased estimate of the branch mean (UVR_k). Use of output weights from the base country and the industry UVRs at base country weights, gives the Laspeyres index for branch k.

$$UVR_k^{xu(u)} = \sum_{j=1}^{J_k} w_{jk}^{u(u)} UVR_{jk}^{xu(u)} \tag{8}$$

with j=1,.., J_k the number of industries in branch k for which a UVR has been calculated (the sample industries); $w_{jk}^{u(u)} = o_{jk}^{u(u)} / o_k^{u(u)}$; and $o_k^{u(u)} = \sum_{j=1}^{J_k} o_{jk}^{u(u)}$. To arrive at the Paasche index, the industry output of country x valued at base prices is substituted. This gives

$$UVR_k^{xu(x)} = \sum_{j=1}^{J_k} w_{jk}^{u(x)} UVR_{jk}^{xu(x)} \tag{9}$$

with $w_{jk}^{u(x)} = o_{jk}^{u(x)} / o_k^{u(x)}$; and $o_k^{u(x)} = \sum_{j=1}^{J_k} o_{jk}^{u(x)}$, which can be alternatively rewritten in terms of industry output of country x at own prices instead of base-country prices, using (1) and (2)

$$UVR_k^{xu(x)} = \frac{\sum_{j=1}^{J_k} o_{jk}^{x(x)}}{\sum_{j=1}^{J_k} \frac{o_{jk}^{x(x)}}{UVR_{jk}^{xu(x)}}} \tag{10}$$

3. Aggregation Step Three Total Manufacturing UVRs

The total manufacturing sector consists of the manufacturing branches. Similar reasoning as used for the aggregation of UVRs from industry to branch level applies to the aggregation from the branch to the total manufacturing level. Base country output weights are used to arrive at the Laspeyres index, and the other country quantities valued at base 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.

In Table 2 we provide the Unit Value Ratios used for the benchmark estimates to obtain the comparative productivity estimates in Table 1. We present the Paasche, Laspeyres and Fisher UVRs that results from our binary comparisons as well as the exchange rate. On average the binary comparisons include around 180 product matches, covering on average 30 per cent of the 'own country' output and 20 per cent of the 'base country' output.

Table 2
Unit Value Ratios for Manufacturing in Benchmark Years

	Number of Product Matches	Matched output as % of total		Unit Value Ratios (own currency/US$)			Exchange Rate
		own country	base country	own quantity weights	US quantity weights	Geometric Average	own currency/ US$
	base country: United States						
India/USA (1983)	156	33.0	13.8	6.84	9.53	8.08	10.10
China/USA (1985)	67	37.1	18.9	1.15	1.84	1.45	2.90
Indonesia/USA (1987)	214	60.7	19.6	994	1448	1200	1644
USSR/USA (1987)	132	18.5	16.3	0.346	0.599	0.455	n.a.
Mexico/USA (1975)	130	31.8	22.8	11.97	15.60	13.67	12.50
Korea/USA (1987)	190	36.7	21.0	577	849	700	823
Taiwan/USA (1986)	119	26.4	15.3	21.90	40.00	29.60	37.90
Brazil/USA (1975)	129	27.9	22.9	6.91	8.77	7.79	8.13
Australia/USA (1987)	178	23.1	15.1	1.41	1.58	1.49	1.43
UK/USA (1987)	171	17.6	18.1	0.67	0.75	0.71	0.61
Finland/USA (1987)	275	42.9	19.9	5.28	5.98	5.62	4.40
Sweden/USA (1987)	248	34.5	21.8	7.78	8.30	8.03	6.34
West-Germ/USA (1987)	271	24.4	24.8	2.16	2.25	2.21	1.80
France/USA (1987)	109	15.1	12.5	6.87	7.59	7.22	6.01
Japan/USA (1987)	190	19.1	19.9	149	203	174	145
Canada/USA (1987)	200	27.8	21.6	1.36	1.31	1.33	1.33
Belgium/USA (1987)				41.06	44.17	42.61	37.33
Netherlands/USA (1987)	97	28.7	15.8	2.18	2.46	2.32	2.03
	base country: West Germany						
Hungary/W-Germ (1987)	383	33.1	19.3	12.50	15.30	13.80	25.80
Poland/W-Germ (1989)	236	33.6	19.4	343	343	343	144
East-Germany/W-Germ (1987)	355	41.4	33.7	1.81	1.98	1.89	4.52
Czechoslovakia/W-Germ (1989)	69	32.0	23.2	3.72	4.03	3.87	8.01
	base country: United Kingdom						
Portugal/UK (1984)	130	29.7	14.4	185	195	190	195
Spain/UK (1984)	115	30.7	16.8	190	204	197	214

Note: Only benchmark years and countries which are used for estimates in Table 1
Source: See Table 1

3.2 Multilateralisation of ICOP UVRs

Because of the required adjustments described above, comparisons on a two-country basis are often the only practical approach. For ICOP comparisons, the United States is mostly taken as the 'numéraire' (or base) country, so that in fact one can speak of "star comparisons", with the US being the centre of the star. Bilateral comparisons have the advantage that the PPPs comply with the requirement of country characteristicity. However, since each comparison only involves one pair of countries, the totality of ICOP comparisons lacks internal consistency, i.e. they are not transitive.[13]

To multilateralise the results of the ICOP project, Pilat and Rao (1996) constructed a first set of multilateral UVRs by applying various multilateral indices to original binary ICOP results at aggregate levels of manufacturing branches. While their work is an important step forward in multilateralising the ICOP binary studies, their estimates still sufferfrom non-transitivity below the branch level.

Rao and Timmer (1999) therefore applied multilateral aggregation procedures at the product level. First, they constructed a consistent list of 256 manufacturing products for which price and quantity data were available for at least three countries.[14] Aggregation took place in two stages. First, products were aggregated to branches, and second branches were aggregated to total manufacturing.[15] For the first aggregation step various methods were used, including CPD and unweighted EKS. As the conventional EKS formula gives equal weights to all linked comparisons, effectively assuming that they are of equal reliability, Rao and Timmer also proposed a weighted variant of EKS. The weighted EKS index includes information on the reliability of the various underlying binary comparisons and is therefore to be preferred. For example, for weighting one can use Hill's distance function, based on the spread between the Paasche and Laspeyres (Hill, 1999).[16] The choice of the aggregation method above branch level depends on whether one would like to impose additivity. If additivity is required, the Geary-Khamis can be used, otherwise weighted EKS is the prefered multilateral index. In any case, the results show that the choice of an aggregation formula at the product level is quantitatively much more important than at the branch level (Rao and Timmer 1999, Table 4.3).

Table 3 compares manufacturing price levels relative to the United States for 1987 using alternative methods or data. These are based on PPPs for total GDP, 'proxy PPPs' (i.e., expenditure PPPs allocated to industries, as in Jorgenson et al, 1987; Lee and Tang, 2000), a mix of proxy PPPs and UVRs (as in Pilat, 1996), and variants of bilateral and multilateral unit value ratios. For multilateral UVRs both the Geary-Khamis and the weighted EKS variants are shown for aggregation above branch level. The table shows that:

[13] For a discussion of PPP characteristics, such as country characteristicity and transitivity, see for example, Kravis, Heston and Summers (1982).
[14] See Appendix I for the list of selected items for multilateralisation.
[15] The first step can be compared with the aggregation of products to basic heading in ICP, and the second with the aggregation from basic heading to total GDP.
[16] However, this measure is rather sensitive for values of the P-L spread near one (Rao and Timmer, 1999). The ICOP methodology provides also other reliability measures which can be used for weighting, such as the number of matches which are made in each binary comparison.

- GDP PPPs are distinctly different from UVRs and proxy PPPs.
- Proxy PPPs suggest higher price levels relative to the USA than the UVRs and combined UVR/proxy PPPs.
- The differences between the UVRs and the mixed UVR/proxy PPPs were small at the aggregate level for total manufacturing, even though there were bigger differences at branch and industry level.[17]
- The multilateral UVRs do not differ much from the binary UVRs. However, as the multilateralisation was based on a group of only eight countries (i.e., those in the table as well as Australia, Indonesia, Taiwan and South Korea), the effect may be bigger when more countries are included.

Table 3
Comparison of Relative Price Levels for Manufacturing, 1987

	Canada	France	Germany	Japan	UK	USA
Exchange Rate (national currency/US$)	1.33	6.01	1.80	144.6	0.604	1.00
Relative Price Levels (currency conversion factor/exchange rate):						
Total Economy						
ICP Expenditure PPPs for GDP						
Multilateral (EKS)	98	113	122	147	93	100
Bilateral (Fisher)	96	110	114	136	101	100
Manufacturing						
Proxy PPP from ICP	108	134	131	151	131	100
Combined UVR/Proxy PPP	105	126	128	122	113	100
ICOP Unit Value Ratios (UVRs)						
Original Binary Fisher UVR	100	120	123	120	117	100
Multilateral (Geary Khamis)	102	n.a.	123	118	n.a.	100
Multilateral (weighted EKS)	102	n.a.	122	128	n.a.	100

Sources: ICP expenditure PPPs, multilateral variant from OECD *National Accounts, vol. I* (1993). ICP expenditure PPPs, bilateral Fisher variant provided by Eurostat for 1990 and backdated to 1987 with GDP deflators. Proxy PPP is the "OPR" variant from Hooper (1996) for 1990 backdated to 1987 with manufacturing GDP deflators. Combined UVR/Proxy PPP from Pilat (1996). Original binary ICOP UVRs: see sources to Table 1. Multilateral UVRs from Rao and Timmer (1999).

In the next round of ICOP comparisons for 1997, a larger number of countries will be included for multilaterialization. Binary comparisons for 1997 are presently available for Canada/USA (Van Ark, Inklaar and Timmer, 2000), France/Germany (Nayman and Ünal-Kesenci, 2000), and are under development for Germany/USA (for 1996 and 1997), Japan/USA and Netherlands/USA. In addition 1996 comparisons are available for Czech Republic/Germany, Hungary/Germany and Poland/Germany (Van Ark and Monnikhof 2000a). Comparisons are planned to also include Korea, Taiwan and the UK, and at a later stage (when data become available) Brazil and Mexico.

[17] See Pilat (1996).

3.3 Reliability of ICOP UVRs

There are a number of factors which influence the reliability of UVRs, some of which are specific to ICOP UVRs; others are more general and also affect ICP PPPs. For many goods, a range of different varieties, models, or specifications exist within each country. In the traditional ICP methodology, the PPP is constructed from a sub-set of varieties that exist in both countries. In some cases, this overlapping subset is a very small number of varieties or is characteristic of neither country. Characteristicity is less a problem in ICOP than in ICP, because ICOP does not use specification pricing and more aggregate products are being matched. But the ICOP methodology introduces others problems which include representativeness, sampling bias and quality adjustment.

Representativeness of Unit Value Ratios

It has been argued that unit value ratios are based on a limited sample of items, and that rather farreaching assumptions are employed concerning their representativity for non-measured price relatives. As Table 2 above shows, the average percentage of the total manufacturing output value covered by product matches varies between 15 per cent and 40 per cent, with between 60 and 450 product matches. UVRs for matched items are assumed to be representative for non-matched items within each industry or branch. The validity of this assumption can be tested by looking at the coefficient of variation of the UVRs. Based on the stratified sampling theory, Timmer (1996, 2000) measured the sampling variance of UVRs by branch. 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. 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 reasonably good indication of the reliability of the unit value ratios.[18]

Sampling Bias

Some critics observed that the product groups that are matched are biased towards relatively homogeneous, less sophisticated products, for which values and quantities are more readily available from the industry statistics.[19] For example in basic goods industries, such as pulp and paper, wood products, metallic and non-metallic mineral products, and in transport and communication, output coverage is usually large as there are few quality differences between countries. But product matching is more difficult in manufacturing industries which produce durable consumer goods and investment goods. In these industries, the percentage of output covered by UVRs is often below 10 per cent. Similarly, within some industries, product matches are biased towards the homogeneous and less sophisticated products. Indeed industry statistics suffer, and increasingly so, from lack of information on quantities of heterogeneous products. In recent comparisons we have therefore begun to use information from secondary sources, for example for cars, to enhance our product matchings matchings in these areas. Furthermore, in our latest Canada/US benchmark comparison for 1997 we use unit value ratios

[18] See Appendix 2 for a more elaborate discussion and an example from our latest Canada/USA comparison for 1997.

[19] See, for example, Lichtenberg (1993) in his comment on Van Ark and Pilat (1993), and Collier (1999) is his comment on Van Ark, Monnikhof and Timmer (1999).

for more than one benchmark year which are extrapolated to the same year with producer price indices. An alternative is still to use (proxy) expenditure PPPs for areas where the coverage with unit value ratios is insufficient, referred to above as the “combined UVR/proxy PPP” method. For example, Pilat (1996) used proxy PPP measures for furniture, printing and publishing and for various industries in machinery and equipment. Proxy PPPs may not be too far off in areas where the effect of import and export prices is small and where the expenditure PPPs themselves are of sufficient quality which as an issue of concern, in particular in those areas where we need them most, for example in the cases of furniture and investment goods.[20]

Adjustments for Product Mix and Quality

Another point of critique on the ICOP method is that comparisons of unit values are affected by differences in product mix and product quality. The ‘mix’ problem is caused by the fact that industry statistics report quantity and values for product groups rather than for specified products. This problem aggravates in international comparisons because of the lack of a harmonised product coding system, so that items need to be further aggregated in order to obtain a correct match between countries. Again, using (adjusted) ICP PPPs for specified products is not necessarily a step forward, as there is a clear trade-off between output coverage by unit value ratios and the detail of product specification in the expenditure PPPs. As we will discuss in more detail below we believe the way forward here is to make more extensive use of ‘producer price’ and ‘unit value’ information from secondary sources.

3.4 Improving the matching and coverage of differentiated goods

In a world of rapidly increasing numbers and varieties of goods and services, issues of sampling bias and quality become more and more important. At the same time the reported detail in many production statistics (in particular product detail on quantities and values) is declining, partly because of the increasing cost of traditional data collection and partly to reduce the statistical burden on companies. Over the years ICOP has therefore been looking at alternative sources to obtain product detail. In addition to the census material two general sources prove to be very useful, and the search for industry-specific price data sets is a useful alternative avenue

PRODCOM

For comparisons across European countries output coverage by product matches will increase substantially in the future using product information from a Eurostat data base, called PRODCOM. PRODCOM provides quantity and value information for the development of harmonized producer price indices, using a single product classification for EU member states. PRODCOM contains about up to 6,000 product entries. This data source can also be used for price level comparisons, but unfortunately the officially reported results in PRODCOM are usually for substantially less than 6,000 products, as the submitted information by individual countries depends largely on their existing product survey. Nevertheless, with the help of additional ‘confidential’ information provided by the German Federal Statistical Office and the statistical service of the French Ministry of Industry,

[20] See the “Castles report” (1997), pp. 25-27.

Nayman and Ünal-Kesenci (2000) were able to include 1,158 product matches for their France/Germany comparison of 1997, which is substantially above the average number of product matches reported in Table 2. Strinkingly the coverage percentage of output of these matches was still about 32-35 per cent, which is not much higher than the coverage percentages with much smaller number of matches. For the Germany/USA comparison for 1996, for which we could use PRODCOM for Germany but not for the USA, the number of product matches was as high as 566, covering 29 to 34 per cent of output.[21] This strengthens the point made by Timmer and Rao (1999) that a common product list of about 256 major items provides sufficient coverage for a comparison of total manufacturing, even though finer detail may be needed at the more industry level.

MITI data base on intermediate product prices

Some of the finer detail needed for intermediate products in chemicals, machinery and electrical industry can be obtained from a data set provided by the Japanese Ministry of Trade and Industry (MITI) used for monitoring of pricing behaviour on the world market. In 1994 MITI started an annual survey of intermediate input prices (customer delivery prices including taxes) for eight countries, including USA, Japan, Germany, China, South Korea, Taiwan (added later), Hong Kong and Singapore. The coverage of the survey gradually increased from 108 items of which 17 types of services for industrial use in 1994 up to 152 items (of which 35 industry services) in 1999. The products also includes capital goods.[22] However, the number of firms sampled in the MITI data base is rather small and MITI warns that the survey might not be representative of all business operations. Moreover as these are specified prices it is necessary to use quantity weights from the original production census material to integrate this information into the ICOP data set. The MITI information is presently used in the forthcoming Germany/USA and Japan/USA comparisons of manufacturing productivity in 1997.

Industry-specific data sources on producer prices

The product mix problem may also be resolved by using more detailed information for specific industries from secondary trade and industry sources. Such sources may prove particularly useful for products from typical high-tech industries, such as information technology equipment (computers and telecommunication equipment), passenger cars and pharmaceutical products. In comparisons by the McKinsey Global Institute (1993) for selected industries between the United States, Japan and Germany, quality adjustments were made for cars, computers, and some products in the machinery industry largely using client information. These adjustments can be substantial at a detailed level, but do not all go in the same direction (see Gersbach and van Ark, 1994). Hence the effect on the total

[21] The number of matches in our (as yet unpublished) Netherlands/Germany comparison for 1997 using PRODCOM was much less at 368 matches, given the greater degree of confidentiality in a small country like the Netherlands. Even in the Netherlands/US comparison coverage was almost double that used for our 1987 comparison, i.e. 175 unit value ratios against 97 (Kouwenhoven, 1993).

[22] Kuroda and Jorgenson (2000, p.375) claim that in 1994, the 91 commodities cover 19 per cent of the WPI commodities and the 17 cover 39 per cent of the CSPI services. The survey period is three months each year (sept-nov), so an average price is observed. Nomura (1999) provides an overview of all available data sets in Japan on international prices, including the MITI data base.

measure of manufacturing productivity differentials remains fairly small.[23] Danzon and Chao (2000) accessed industry-specific data sources or a comparison of price ratios of pharmaceutical products for the G7 with product samples ranging between 365 and 438 'molecules' per binary comparison and a global sample of 171 'molecules' that was available for all countries. Internet sources may also increasingly become a source for price collection, even though in most cases these will be retail or at best wholesale prices, which will require further adjustment to producer price level (see Sections 5 and 6). In cases of very heterogenous products (e.g. computers or large machinery) a fruitful, though data demanding, way forward is to make greater use of hedonic price measurement for international price comparisons. Instead of observing the prices of products themselves, the hedonic method obtains the price of a bundle of characteristics of a product through regression analysis. The international hedonic function hypothesis argues that the coefficients of the product characteristics in the hedonic function should be idential across countries (Triplett, 2000). If this hypothesis holds, prices across countries differ as indicated by the constant term in the regressions across countries. These constants directly measure the quality adjusted PPP for all countries in the study. For example, the use of a country-product dummy (CPD) method, which regresses the price of a product on its characteristics and on a dummy variable for the country of origin, makes it possible to pull off the quality adjusted-unit value ratio from the coefficients of the dummy.[24] Even when hedonic functions are not stable across countries, quality adjustments can be made on the basis of country-specific coefficients to derive PPPs.

4. The ICOP Programme on Services

Although the interest in measurement and analysis of productivity in service industries has increased, relatively little work has been done on international comparisons of service productivity. This is partly caused by measurement problems which increase in complexity when concentrating on international comparisons. The other reason is that relative levels of service productivity are strongly determined by the institutional organisation, the legal framework and cultural preferences within each country, so that interpretation of the results at macro level is less straightforward than for manufacturing.

The ICOP industry-or-origin approach towards services adopts the viewpoint that irrespective of the industry, the concepts and definitions of output and inputs should stay as close as possible to those in the national accounts, and that the method applied remains more or less uniform across sectors. In addition full coverage of all activities in a particular sector or industry is needed to facilitate

[23] For a full report of the adjustments in the McKinsey Global Institute study on manufacturing productivity, see Gersbach and Van Ark (1994). The MGI study explicitly based quality adjustments on the 'resource cost' criterion: UVRs are adjusted only when recognised by consumers in such a way that they are willing to pay a price premium, and when these are the result of differences in the product and production process. Remaining notions of quality (which were the result of advertising, taste, etc.) were treated as differences in consumer preferences which may explain differences in productivity and which can improve the competitive situation of companies and industries, but which are not used in adjusting the productivity measure itself.

[24] See van Mulligen (2000) who provides first results of a comparison of unit value ratios for cars between selected European countries.

aggregation to the economy-wide level. Hence this method finds itself between typical case studies and macro studies of economy-wide performance.[25]

The main problem in services is that one cannot clearly distinguish between prices, quantities and quality. Firstly, the 'quantity' of a service is difficult to capture in a single number, as it often represents a process by which a user (consumer) or the users good is changed (Hill, 1977). Secondly, when compared to commodities, many services are characterised by a greater degree of heterogeneity (or perhaps even uniqueness), so that aggregation is difficult. Together these two problems signal the 'multidimensional' nature of services, which implies that output is not only distinguished on the basis of 'product' characteristics but also according to time and place of delivery. In combination with the relative scarcity of data on services, decomposition of service output into prices, quantity and quality is a complex task (Griliches, 1992).

The early ICOP work on services was still strongly based on the use of expenditure ICP PPPs. This seems justified for those service industries that have relatively small transport and distribution margins so that gross output and final sales are comparable.[26] Still for many service industries appropriate expenditure PPPs are not available. In subsequent work we concentrated on comparisons for two major service sectors, i.e. transport and communication and wholesale and retail trade. Mulder (1999) focuses on comparison for Brazil and Mexico relative to the USA. Van Ark, Monnikhof and Mulder (1999) show estimates for these two sectors for Canada, France, Germany and the Netherlands relative to the United States. In our latest work we extended such comparisons to 24 countries for transport and communication and 19 countries for trade.[27] Some major distinguishing features of the methodology used for the latest estimates as compared to the earlier efforts are an improved correction for the terminal element (i.e., the intensity of loading and unloading services relative to transportation services) in the transport and communication sector, and the use of double deflation in the trade sector, i.e., using separate conversion factors for output and for input values.

It should be stressed that the measurement of productivity in the service sectors is still a pioneering activity. Compared to the measures for manufacturing and other goods producing sectors, the service measures are still subject to a much wider range of uncertainty, and the comparability of the estimates between countries is not as good. Further methodological improvements and more detailed data will certainly contribute to the practical usefulness of these measures. Consistent measurement of

[25] In the case study approach a specific industry is analysed in detail using output and input variables which are the most characteristic of the product and the production process in that industry. Such case studies often make use of benchmarking techniques to compare the performance of individual functions of the production process (for example, for air transport, the performance of cockpit staff, cabin attendants, etc., is assessed separately). The case study approach relies heavily on data obtained from individual establishments or enterprises in the industry, so that the performance of individual producing units (firms or establishments) can be compared to the best practice as well. At present there are many of such studies for service sectors, recent examples of which are the studies of the McKinsey Global Institute (for example, McKinsey Global Institute, 1992; Baily, 1993) and studies which measure efficiency frontiers in, for example, air transport, postal services and railways (Good et al, 1993; Perelman and Pestiau, 1994).

[26] See, for example, Pilat (1994) for Japan and Korea vis-à-vis the USA and O'Mahony (1999) for the G5.

[27] This latest work was financially supported by the International Labour Office in the framework of the Key Indicators of the Labour Market (KILM) project. The results presented here are still of a preliminary nature and possible subject to later revisions. Final results will be made available by Monnikhof and Van Ark (2001).

productivity across all sectors of the economy can greatly contribute to the reliability and robustness of total GDP measures which are widely used in policy and academic environments (see Maddison and van Ark, 2001).

4.1 Transport and Communication

For the transport and communication sector we use in principle the same method as for manufacturing. Four levels of aggregation are distinguished. We first distinguish between the transport and the communications branches. Within each branch there are a number of industries, such as within air transport, rail transport, water transport, and postal services and telecommunication. At the lowest level are product measures such as rail freight (usually measured in tons) and rail passenger transport (mostly measured in passenger kilometres), pieces of mail delivered or telephone access lines and number of calls. The unit values are derived in the same way as for manufacturing and are aggregated following the same aggregation procedures (see Section 3.1).

However, the unit value procedure is not feasible for all binary comparisons due to data limitations. The main problem is to find measures for quantities and gross output value that match. In some cases the basic transportation statistics do not provide quantities *and* values, so that secondary sources need to be taken into acocunt. This creates problems in terms of different output coverage, the inclusion or exclusion of transportation services and different treatment of taxes and subsidies.

For those countries where the unit value ratio method cannot be applied, we use the physical quantity approach.[28] Formally, the quantity method can be described as follows. For each matched product in a bilateral comparison, the ratio of the quantities (q) in both countries is taken. This quantity ratio (QR) is given by

$$QR_i^{xu} = \frac{q_i^x}{q_i^u} \qquad (11)$$

with x and u the countries being compared, u being the base country. The branch QR (QR_k) is given by the weighted mean of the QR of the sampled modes of transportation. The QRs are then weighted by their gross revenue:

$$QR_k = \sum_{\mathrm{i}=1}^{\mathrm{I}_k} w_{\mathrm{i}k} QR_{\mathrm{i}k} \qquad (12)$$

with i=1,.., I_k the matched items in branch k; $w_{ik} = o_{ik} / o_k$ the gross revenue share of the i[th] transportation mode; and $o_k = \sum_{i=1}^{I_j} o_{ik}$ the total matched value of output in branch k.

[28] As mentioned above both methods yield the same results when all output is covered, but in practice coverage is less than complete.

However, as the gross revenues for country x cannot be used for the reasons described above, we can only use the shares of the base country (in our case the US). The use of base country value weights leads to a Laspeyres quantity index. Substituting base country weights in (12) gives:

$$QR_k^{xu(u)} = \sum_{i=1}^{I_k} w_{ik}^{u(u)} QR_{ik} = \frac{\sum_{i=1}^{I_k} o_{ik}^{u(u)} QR_{ik}}{o_k^{u(u)}} = \frac{o_k^{x(u)}}{o_k^{u(u)}} \tag{13}$$

with $w_{ik}^{u(u)} = o_{ik}^{u(u)} / o_k^{u(u)}$; $o_k^{u(u)} = \sum_{i=1}^{I_j} o_{ik}^{u(u)}$.

At this point the Unit Value Ratio for each branch k can be implicitly derived by relating the branch QR to the aggregate output in the branch. In this case only a Paasche UVR can be derived by dividing the total branch output value in country x in domestic prices by the Laspeyres QR multiplied by the total output value in country u, i.e.:

$$\mathrm{UVR}_k^{xu(u)} = \frac{o_k^{x(x)}}{\left[QR_k^{xu(u)} * o_k^{u(u)}\right]} \tag{14}$$

As is well known, due to the Gerschenkron effect, the use of a Paasche UVR leads to an underestimation of the ideal Fisher UVR and hence to an overestimation of output in country x. To correct for this we applied Paasche-Laspeyres ratios derived from those countries where we could use both weighting systems. As Table 4 shows had to use the quantity method in only five out of the 23 binary comparisons.

An additional problem in the transport sector is the product mix. Transport includes not only the movement of passengers and freight, but also loading and unloading at stations, terminals, ports and airports. As far as domestic transport is concerned, the terminal element increases in importance when the average distance over which freight and passengers are carried is shorter. For example, the average passenger trip by train in France (74 kilometres), Germany (42 kilometres) and the Netherlands (47 kilometres) was much shorter than in Canada (339 kilometres) and the USA (459 kilometres) in 1992 (see van Ark, Monnikhof and Mulder, 1999, Table 9). In the case of a greater share of terminals in total output the unit value ratio is upwardly biased relative to countries where distances are longer and the terminal share element lower. Hence relative labour productivity is underestimated.

In our earlier work we have corrected for compositional differences in railway output by weighting two quantity measures of the same activity, i.e. movement (in terms of passenger or ton kilometres) and turnover (in terms of the number of people transported) by a factor which takes account of the difference in average distance and population density between countries (Mulder, 1999; Van Ark, Monnikhof and Mulder, 1999). The comparative measures of passenger and ton kilometres for railways (Q^X/Q^{US}) was adjusted for the share of terminals in total output by combining it with an estimate of respectively the total number of passengers and tons transported (T^X/T^{US}):

$$\frac{Q^{X^*}}{Q^{US^*}} = \left[(1-S)\frac{Q^X}{Q^{US}} + S\frac{T^X}{T^{US}} \right] \tag{15}$$

with the weighting factor S obtained from the ratio of the average distance of a passenger or freight trip (H^X/H^{US}) including a correction for the ratio of the population density in both countries (D^{US}/D^X):

$$S = (1 - \frac{H^X}{H^{US}}) * \frac{D^{US}}{D^{UX}} \tag{16}$$

However, in applying this methodology to a larger range of countries, we found this adjustment to give too much weight to the terminal element. Instead we make the adjustment by multiplying the non-adapted ratio of transport services (Q^X/Q^{US}) with a factor based upon the relative average distances travelled $(Q/T)^{US}/(Q/T)^X$:

$$\frac{Q^{X^*}}{Q^{US^*}} = \frac{Q^X}{Q^{US}} * \left[\frac{(Q/T)^{US}}{(Q/T)^X} \right]^{\left[\frac{1}{(Q/T)^{US}/(Q/T)^X} \right]} \tag{17}$$

where Q^{X*}/Q^{US*} represents the adjusted quantity ratio. This function has some desirable properties as it is asymptotic with increases in the terminal element, which means that for a realistic range of differences between average distances traveled the adjustment for the terminal effect has the right direction and magnitude.[29]

Table 4 shows the provisional results of the UVRs as calculated on the basis of the method described. The first column shows that on average conversion factors could be computed for about eight transport modes (passenger rail, freight rail, passenger airlines and freight airlines – sometimes separate for domestic and international – public transport, and shippiing – sometimes inland water and sea –) and two types of communication (postal services and telephone calls). Most country comparisons were originally based on another year than 1990, due to data availability of the basic transportation survey. The UVRs were therefore updated or backdated to 1990 with national price deflators.

The final columns of Table 4 show the relative estimates of labour productivity with the United States as the base country. In contrast to the estimates for manufacturing in Section 3, these figures are directly based on national accounts figures on GDP at current prices and, where possible, labour input information from the same source. The estimates show a substantive variation in comparative productivity performance across countries. The adjustment for the terminal element and other quality differences may play some role here. In addition “real explanations” such as differences in the degree of privitization, the pricing structure of the transportation sector and the extent of innovation in the sector may play a role.

---

[29] The difference in average distance travelled or freight transported for countries compared to the United States in this study lies usually somewhere in the range between 1/3 to 1.5 times the US distance.

Table 4
Unit Value Ratios and Labour Productivity in Transport and Communication, Benchmark Years and Common Year (1990) (preliminary results)

	Number of Industries	Unit Value Ratio: own country weights	base country weights	Geometric average (Fisher index)		Labour Productivity: Value Added per Person Employed (USA=100)	Value Added per Hour Worked (USA=100)
		(local currency to US$)					
Non-OECD Countries							
Brazil/USA							
Transport (1975)	11	3.30	5.47	4.25			
Communication (1975)	3	10.05	10.59	10.32			
Transport and Communication (1975)	13	3.72	7.40	5.25			
Transport and Communication (1990)				48.22	a)	21.0	
Exchange Rate (1990)				284.40			
China/USA							
Transport (1985)	11	0.69	1.13	0.88			
Communication (1985)	4	1.68	2.06	1.86			
Transport and Communication (1985)	15	0.77	1.66	1.13			
Transport and Communication (1990)				0.71		16.4	
Exchange Rate (1990)				4.80			
India/USA							
Transport (1992)	6	3.45	*5.71*	4.44	b)		
Communication (1992)	2	6.26	*6.87*	6.56	b)		
Transport and Communication (1992)	8	3.69	*6.88*	5.04	b)		
Transport and Communication (1990)				3.92		15.7	
Exchange rate				17.50			
Indonesia/USA							
Transport (1992)	4	1820	*3015*	2343	b)		
Communication (1992)	2	1693	*1858*	1774	b)		
Transport and Communication (1992)	6	1802	*3362*	2462	b)		
Transport and Communication (1990)				1971		4.1	
Exchange rate				1843			
Taiwan/USA							
Transport (1992)	7	20.58	36.93	27.57			
Communication (1992)	2	14.29	21.73	17.63			
Transport and Communication (1992)	9	18.09	30.18	23.36			
Transport and Communication (1990)				21.82		43.8	33.6
Exchange Rate (1990)				26.90			
OECD Countries							
Australia/USA							
Transport (1992)	8	0.64	*0.68*	0.66	c)		
Communication (1992)	2	1.39	*1.44*	1.42	c)		
Transport and Communication (1992)	10	0.78	*0.82*	0.80	c)		
Transport and Communication (1990)				0.81		106.3	100.7
Exchange rate (1990)				1.28			

	Number of Industries	Unit Value Ratio: own country weights	Unit Value Ratio: base country weights	Unit Value Ratio: Geometric average (Fisher index)	Labour Productivity: Value Added per Person Employed (USA=100)	Labour Productivity: Value Added per Hour Worked (USA=100)
		(local currency to US$)				
Belgium/USA						
Transport (1992)	8	40.19	*40.18*	40.19 d)		
Communication (1992)	2	35.78	*39.99*	37.83 d)		
Transport and Communication (1992)	10	39.00	*41.72*	40.34 d)		
Transport and Communication (1990)				38.70	90.0	
Exchange rate (1990)				33.42		
Canada/USA						
Transport (1992)	9	1.07	1.13	1.10		
Communication (1992)	2	1.00	1.04	1.02		
Transport and Communication (1992)	11	1.08	1.14	1.11		
Transport and Communication (1990)				1.08	78.8	76.2
Exchange rate (1990)				1.17		
Czech Republic/USA						
Transport (1992)	8	15.19	23.09	18.73		
Communication (1992)	2	5.92	5.92	5.92		
Transport and Communication (1992)	10	11.79	15.46	13.50		
Transport and Communication (1990)				9.60	29.6	
Exchange rate (1990)				21.15		
Denmark/USA						
Transport (1992)	6	2.74	12.48	5.84		
Communication (1992)	2	5.06	5.06	5.06		
Transport and Communication (1992)	8	3.05	9.19	5.30		
Transport and Communication (1990)				5.20	104.6	
Exchange rate (1990)				6.19		
Finland/USA						
Transport (1992)	8	4.04	*4.04*	4.04 d)		
Communication (1992)	2	3.83	*4.28*	4.05 d)		
Transport and Communication (1992)	10	3.97	*4.25*	4.11 d)		
Transport and Communication (1990)				3.97	82.3	86.1
Exchange rate (1990)				3.82		
France/USA						
Transport (1992)	9	9.40	7.50	8.40		
Communication (1992)	2	5.07	5.47	5.27		
Transport and Communication (1992)	11	6.72	6.50	6.61		
Transport and Communication (1990)				6.48	66.0	74.6
Exchange rate (1990)				5.45		
Germany (West-)/USA						
Transport (1992)	8	3.37	3.63	3.50		
Communication (1992)	2	1.90	2.34	2.11		
Transport and Communication (1992)	10	2.79	3.23	3.00		
Transport and Communication (1990)				2.90	61.8	66.3
Exchange rate (1990)				1.62		

	Number of Industries	Unit Value Ratio			Labour Productivity	
		own country weights	base country weights	Geometric average (Fisher index)	Value Added per Person Employed	Value Added per Hour Worked
		(local currency to US$)			(USA=100)	(USA=100)
Hungary/USA						
Transport (1992)	10	25.32	25.32	25.32 d)		
Communication (1992)	2	29.52	32.99	31.21 d)		
Transport and Communication (1992)	12	26.20	28.03	27.10 d)		
Transport and Communication (1990)				15.36	46.4	
Exchange rate (1990)				63.21		
Italy/USA						
Transport (1992)	9	879	1158	1009		
Communication (1992)	2	1115	1115	1115		
Transport and Communication (1992)	11	933	1139	1031		
Transport and Communication (1990)				914	86.2	
Exchange rate (1990)				1198		
Japan/USA						
Transport (1985)	9	243	309	274		
Communication (1985)	2	224	239	231		
Transport and Communication (1985)	11	238	235	236		
Transport and Communication (1990)				239	53.8	43.9
Exchange rate (1990)				145		
Korea/USA						
Transport (1985)	8	489.34	699.90	585.22		
Communication (1985)	3	279.10	329.54	303.27		
Transport and Communication (1985)	11	403.75	361.89	382.25		
Transport and Communication (1990)				340.44	60.8	43.4
Exchange rate (1990)				708.00		
Mexico/USA						
Transport (1975)	11	5.27	8.72	6.78		
Communication (1975)	3	9.96	11.37	10.64		
Transport and Communication (1975)	13	5.58	9.72	7.36		
Transport and Communication (1990)				1.96 a)	31.5	
Exchange Rate (1990)				2.80		
Netherlands/USA						
Transport (1992)	9	1.30	1.47	1.38		
Communication (1992)	2	1.72	1.80	1.76		
Transport and Communication (1992)	11	1.34	1.46	1.40		
Transport and Communication (1990)				1.39	97.7	113.2
Exchange rate (1990)				1.82		
Poland/USA						
Transport (1992)	6	0.608	0.789	0.693		
Communication (1992)	2	0.659	1.053	0.833		
Transport and Communication (1992)	8	0.623	0.906	0.752		
Transport and Communication (1990)				0.251	14.4	14.5
Exchange rate (1990)				0.950		

	Number of Industries	Unit Value Ratio			Labour Productivity	
		own country weights	base country weights	Geometric average (Fisher index)	Value Added per Person Employed	Value Added per Hour Worked
		(local currency to US$)			(USA=100)	(USA=100)
Spain/USA						
Transport (1992)	8	69.51	*69.50*	69.50 d)		
Communication (1992)	3	88.04	*98.38*	93.07 d)		
Transport and Communication (1992)	11	75.21	*80.47*	77.79 d)		
Transport and Communication (1990)				70.11	82.9	
Exchange rate (1990)				101.93		
Sweden/USA						
Transport (1992)	8			e)		
Communication (1992)	2			e)		
Transport and Communication (1992)	10			7.11		
Transport and Communication (1990)				6.47	57.2	59.2
Exchange rate (1990)				5.92		
United Kingdom/USA						
Transport (1992)	6			e)		
Communication (1992)	1			e)		
Transport and Communication (1992)	8			0.799		
Transport and Communication (1990)				0.740	57.2	59.2
Exchange rate (1990)				0.563		

Note: Labour productivity estimates are adjusted to national accounts level.
a) Currency unit updated from 1975 and divided by 1,000
b) Using average Laspeyres/Paasche Ratios for Brazil and Mexico
c) Using Laspeyres/Paasche Ratios for Canada
d) Using average Laspeyres/Paasche Ratios for France, Germany and the Netherlands
e) Detailed matching results are available but could not be provided at the time of preparation of this table
Source: preliminary estimates from Monnikhof and Van Ark (2001, forthcoming)

4.2. Wholesale and Retail Trade

In contrast to other sectors of the economy, the trade sector is the only one where we have systematically applied a double deflation procedure right from the beginning.[30] Double deflation, i.e. separate UVRs or PPPs for the purchases and sales of the goods, is needed for this sector more than elsewhere because the purchase value makes up most of the total sales value in the trade sector.

When treating wholesale and retail trade separately we essentially need three currency conversion factors to carry out a double deflation procedure. Firstly we require a measure of relative price levels for the purchase of goods by the wholesale sector. These are mostly the UVRs obtained from our studies of the manufacturing sector. Secondly we require a relative price measure for the sales of the wholesale sector. Assuming that wholesale goods are largely sold to retailers and assuming no other intermediate services between the wholesale and retail trade, the wholesale sales prices can be equalled to the purchase prices of retail trade. Finally we need a measure of relative retail sales prices.

[30] See Section 5 for further details on double deflation

Two types of conversion factors are directly available. For purchases in the wholesale sector we use specific ICOP manufacturing UVRs to convert the value of purchases of a specified wholesale industry to a common currency. Here we assume that relative prices of imported goods equal those of domestically produced goods. For the sales values of the retail industries we make use of specific ICP expenditure PPPs. The ICOP UVRs and ICP PPPs are then used to calculate the third conversion factor at the intermediate level, i.e., at the sales level of the wholesale industries and the purchase level of the retail industries.

As we generally lack information on prices at the intermediate level, the conversion at the intermediate level needs to be estimated. This can be done in two ways either starting from the wholesale side or starting from the retail side. In the first case we use the UVR and correct it for the relative margin between sales and purchases of the wholesale sector to proxy the intermediate relative price levels.[31] Let IMP_w^{xu} represents the intermediate price level in country x relative to the intermediate price level in the US approximated from the UVR side, then:

$$IMP_w^{XU} = UVR^{XU} \times \frac{1+M_w^x}{1+M_w^u} \tag{18}$$

with M^x_w the wholesale margin in country x.

Alternatively we can start from the retail PPPs and adjust it for the relative retail margin:

$$IMP_r^{XU} = PPP^{XU} \bigg/ \frac{1+M_r^x}{1+M_r^u} \tag{19}$$

with M^x_r the retail margin in country x.

This procedure assumes a flow of goods from the manufacturing sector to the wholesale sector. The wholesale sector adds a mark-up on the price of the goods and sells these to the retail sector. The retail sector again puts a mark-up on the price and sells to the consumers. Hence we implicitly assume that both gross margins together cover the total mark-up from producer prices to consumer prices. In practice not the whole difference between UVR and PPP will be due to differences in margins. As we have information about the retail and wholesale margins and the UVRs and PPPs, the intermediate price can be approximated by averaging IMP_w^{xu} and IMP_r^{xu}. We distribute the difference between the two results and calculate the relative intermediate input price as follows:

$$IMP^{XU} = IMP_w^{XU} \times \sqrt{IMP_r^{XU} / IMP_w^{XU}} \tag{20}$$

[31] The gross margin as used here equals sales minus the purchase cost of the goods sold and an adjustment for changes in inventories over the year.

The empirical implementation of the basic procedure outlined above is far from straightforward. Conversion factors are obtained at the most detailed industry level which is determined by the industry classification used in the statistical sources, usually being the census or survey of the trade sector in each country. As a result the level of detail differs considerably between individual binary comparisons. This is due to differences in the industry detail of the original sources across countries as well as between the wholesale and retail trade sector. In general the wholesale trade industries are classified with greater emphasis on intermediate and investment goods, while the retail sales descriptions have more detail about consumer goods. Hence the number of industries for which separate UVRs or PPPs are provided varies from the minimum of a distinction between only wholesale and retail trade to as much as 54 industries within these sectors (see Table 5).

In order to obtain the most appropriate UVRs and PPPs for each industry, manufacturing UVRs had to be combined using value added weights and PPPs using expenditure weights. We computed bilateral UVRs and PPPs for each country relative to the United States. Where possible we calculated a separate Paasche (using gross margin weights of country x) and Laspeyres (using gross margin weights of the US) result. A geometric average of these results (Fisher) is used in the productivity calculations.[32] At the aggregate level the expenditure PPPs were adjusted for difference rates of Value Added Tax or sales taxes, as these are usually excluded for the output figures. This is an important adjustment as average VAT in most countries is higher than the sales tax in the USA, being the benchmark country for these comparisons.

Table 5 shows provisional results of the PPPs for gross margin as calculated on the basis of the method described. The Table shows large differences between countries in the level of detail at which the conversion factors could be computed ranging from just one industry (Czech Republic) to 96 industries (Germany). Moreover most country comparisons were originally based on another year than 1990, due to data availability of the basic trade survey, the UVRs and/or the PPPs. The PPPs were therefore updated or backdated to 1990 with price deflators to base the estimates on a common year. The relation between the PPPs and the exchange rate in 1990 differs highly across countries. However, a comparison with the final expenditure PPP for consumption for OECD countries in 1990, which was used in the retail studies of McKinsey (McKinsey Global Institute, 1990), shows that the deviations from the exchange rate are usually in the same direction.

[32] The reasons for using a gross margin concept as weights are partly practical, i.e. it is not possible to derive comparative estimates of value added at detailed level for all countries involved in this study. For the other part the gross margin is the best representation of the output of the distributor, which is reflected in the mark-up that distributors can charge customers due to the services they provide.

Table 5
Purchasing Power Parities and Labour Productivity in Wholesale and Retail Trade, Benchmark Years and Common Year (1990) (preliminary results)

	Number of Industries	PPP for gross margin (local currency to US$)			Labour Productivity	
		own country weights	base country weights	Geometric Average (Fisher Index)	Value Added per Person Employed (USA=100)	Value Added per Hour Worked (USA=100)
Non-OECD Countries						
Brazil/USA						
Wholesale trade (1975)	28	11.40	17.60	14.16		
Retail trade (1975)	b)	6.80	14.90	10.07		
Total trade sector (1975)	28	8.50	16.50	11.84		
Total trade sector (1990)				84.63 a)	12.6	
Exchange Rate (1990)				284.40		
Indonesia/USA						
Wholesale trade (1987)	1	1312	1911	1583		
Retail trade (1987)	2	479	698	578		
Total trade sector (1987)	3	924	1374	1127		
Total trade sector (1990)				1261	7.7	
Exchange rate				1843		
Taiwan/USA						
Wholesale trade (1987)	27	37.55	16.14	24.62		
Retail trade (1987)	29	29.52	39.06	33.96		
Total trade sector (1987)	56	31.85	28.75	30.26		
Total trade sector (1990)				29.09	36.7	24.9
Exchange Rate (1990)				26.90		
OECD Countries						
Australia/USA						
Wholesale trade (1987)	36	2.19	2.06	2.13		
Retail trade (1987)	30	1.14	1.72	1.40		
Total trade sector (1987)	66	1.51	1.89	1.69		
Total trade sector (1990)				1.68	69.3	63.2
Exchange rate (1990)				1.28		
Final consumption PPP (1990)				1.43		
Canada/USA						
Wholesale trade (1992)	48			1.67 c)		
Retail trade (1992)	38			1.86 c)		
Total trade sector (1992)	86			1.76 c)		
Total trade sector (1990)				1.88	50.2	44.7
Exchange rate (1990)				1.17		
Final consumption PPP (1990)				1.31		

	Number of Industries	PPP for gross margin			Labour Productivity	
		own country weights	base country weights	Geometric average (Fisher index)	Value Added per Person Employed (USA=100)	Value Added per Hour Worked (USA=100)
		(local currency to US$)				
Czech Republic/USA						
Wholesale trade (1996)				b)		
Retail trade (1996)				b)		
Total trade sector (1996)	1	6.18	14.80	9.57		
Total trade sector (1990)				4.92	72.8	
Exchange rate (1990)				21.15		
Denmark/USA						
Wholesale trade (1992)	19	11.62	14.60	13.02 d)		
Retail trade (1992)	26	6.48	9.02	7.65 d)		
Total trade sector (1992)	45	9.61	11.53	10.53 d)		
Total trade sector (1990)				10.29	85.1	
Exchange rate (1990)				6.19		
Final consumption PPP (1990)				9.77		
Finland/ISA						
Wholesale trade (1987)	6	6.52	8.28	7.34		
Retail trade (1987)	7	3.63	10.31	6.12		
Total trade sector (1987)	13	5.25	8.94	6.85		
Total trade sector (1990)				7.12	59.6	55.7
Exchange rate (1990)				3.82		
Final consumption PPP (1990)				7.01		
France/USA						
Wholesale trade (1992)	30			7.43 c)		
Retail trade (1992)	28			6.46 c)		
Total trade sector (1992)	58			6.91 c)		
Total trade sector (1990)				6.81	110.7	107.9
Exchange rate (1990)				5.45		
Final consumption PPP (1990)				6.62		
Germany (West-)/USA						
Wholesale trade (1992)	50			2.90 c)		
Retail trade (1992)	46			2.66 c)		
Total trade sector (1992)	96			2.84 c)		
Total trade sector (1990)				2.90	62.3	59.0
Exchange rate (1990)				1.62		
Final consumption PPP (1990)				1.98		
Japan/USA						
Wholesale trade (1985)	5	472	445	458 e)		
Retail trade (1985)	9	280	332	305 e)		
Total trade sector (1985)	14	435	389	411 e)		
Total trade sector (1990)				470	31.8	24.9
Exchange rate (1990)				145		
Final consumption PPP (1990)				200		

	Number of Industries	PPP for gross margin			Labour Productivity	
		own country weights	base country weights	Geometric average (Fisher index)	Value Added per Person Employed (USA=100)	Value Added per Hour Worked (USA=100)
		(local currency to US$)				
Korea/USA						
Wholesale trade (1985)	8	651	939	782 e)		
Retail trade (1985)	5	468	838	626 e)		
Total trade sector (1985)	13	534	889	689 e)		
Total trade sector (1990)				637	26.1	16.1
Exchange rate (1990)				708		
Mexico/USA						
Wholesale trade (1975)	28	4.80	15.80	8.71		
Retail trade (1975)	b)	6.10	6.60	6.35		
Total trade sector (1975)	28	5.80	12.00	8.34		
Total trade sector (1990)				3.32 a)	27.3	
Exchange Rate (1990)				2.80		
Netherlands/USA						
Wholesale trade (1992)	33			2.07 c)		
Retail trade (1992)	32			2.65 c)		
Total trade sector (1992)	65			2.38 c)		
Total trade sector (1990)				2.45	69.2	66.1
Exchange rate (1990)				1.82		
Final consumption PPP (1990)				2.07		
Poland/USA						
Wholesale trade (1996)	6			b)		
Retail trade (1996)	2			b)		
Total trade sector (1996)	8	1.464	1.348	1.405		
Total trade sector (1990)				0.206	63.9	54.1
Exchange rate (1990)				0.950		
Spain/USA						
Wholesale trade (1992)	6	278	173	219		
Retail trade (1992)	9	62	86	73		
Total trade sector (1992)	15	107	128	117		
Total trade sector (1990)				104	92.0	
Exchange rate (1990)				102		
Final consumption PPP (1990)				117		
Sweden/USA						
Wholesale trade (1992)	4	12.75	10.05	11.32		
Retail trade (1992)	4	10.57	11.37	10.96		
Total trade sector (1992)	8	11.78	10.77	11.27		
Total trade sector (1990)				11.56	55.3	56.5
Exchange rate (1990)				5.92		
Final consumption PPP (1990)				9.64		

	Number of Industries	PPP for gross margin			Labour Productivity	
		own country weights	base country weights	Geometric average (Fisher index)	Value Added per Person Employed	Value Added per Hour Worked
		(local currency to US$)			(USA=100)	(USA=100)
United Kingdom/USA						
Wholesale trade (1987)	6	0.475	0.561	0.517		
Retail trade (1987)	1	0.415	0.440	0.428		
Total trade sector (1987)	8	0.436	0.528	0.480		
Total trade sector (1990)				0.551	67.0	65.6
Exchange rate (1990)				0.563		
Final consumption PPP (1990)				0.617		

Note: Final consumption PPPs are Fisher estimates. Labour productivity estimates are adjusted to national accounts level.

a) Currency unit updated from 1975 and divided by 1,000
b) Wholesale and retail trade combined
c) Original estimates from Van Ark., Monnikhof and Mulder (1999), with additional adjustments for double deflation. Detailed matching results are available but could not be provided at the time of preparation of this table
d) Intermediate input price level was obtained exclusively on the basis of expenditure PPPs and margins in the wholesale and retail trade sectors.
e) Original estimates from Pilat (1984) adjusted for double deflation

Source: preliminary estimates from Monnikhof and Van Ark (2001, forthcoming). Final consumption PPPs kindly provided by Eurostat.

The final columns of Table 5 show the relative estimates of labour productivity with the United States as the base country. As in the case of transport and communication, the figures here are directly based on national accounts figures on GDP at current prices and, where possible, labour input information from the same source. The estimates show a substantial variation in comparative productivity performance across countries. The complicated adjustments may introduce some noise in the data, but clearly at a more disaggregated level the correction for relative prices at purchase level in trade is necessary. In addition "real explanations" such as differences in the degree of liberalization in the trade sector, in particular in the retail sector, and the extent of innovation, in particular in the wholesale sector, may play a role as well.[33]

5. Double Deflation in Industry and Economy-Wide Sectoral Accounts

A fundamental issue in industry-of-origin comparison, and one reason why it lost ground in terms of applications compared to the expenditure approach, is the need for double deflation of output and intermediate inputs. Indeed most ICOP studies (except for the trade sector – see Section 4.2) have used the 'single deflation' method. This implies that one uses one and the same UVR for gross output and value added in each industry, assuming that the relative prices of intermediate inputs equal those at the

[33] See Van Ark, Broersma and McGuckin (2000) for a detailed comparison of productivity in the retail sector in the Netherlands and the United States.

output level. The reason why the single deflation method still has useful application in international comparisons is due to measurement problems related to the prices of intermediate inputs.[34]

Earlier attempts to change ICOP studies from ‘single deflation’ to ‘double deflation’ (i.e., deducting UVR-deflated intermediate inputs from UVR-deflated gross output) led to volatile or implausible results.[35] One of the main reasons was that the level of industry detail used in these studies was not fine enough to account for the variety in input structures at the industry level. An adequate currency conversion of intermediate inputs requires a larger percentage of the input value in each industry to be covered by UVRs than for output, because in one and the same industry the various inputs are much more heterogeneous than is the case for output. In particular when intermediate inputs make up a large part of gross output, small measurement errors show up strongly in value added. In this respect the problem of double deflation is not unique to the ICOP value-added approach. In the case of the gross-output approach, measurement problems in the input PPPs end up in the contribution of intermediate input to gross output growth.

The double deflation problem can only be tackled when productivity (whether at gross output or at value added level) is measured within a consistent input-output framework at a low level of industry detail. This approach has been developed most extensively by Dale Jorgenson and associates in the KLEM growth accounting research.[36] The methodology for bilateral comparisons of output, input and productivity builds on the work of Nishimizu and Jorgenson (1978). To date, due to its highly data intensive nature, it has been applied to only two comparisons, i.e. in a series of articles for Japan-US (Jorgenson and Nishimizu 1978, Jorgenson, Kuroda and Nishimizu 1987, Jorgenson and Kuroda 1990 and most recently in Kuroda and Jorgenson, 2000), and in a study by Lee and Tang (1999) on Canada’s economic performance vis-à-vis the United States. These studies have exclusively relied on expenditure PPPs from ICP (except Kuroda and Jorgenson, 2000, see below) which introduces a number of serious problems as explained above in Section 2.

The use of ICOP UVRs in combination with ICP PPPs might be part of the solution. Timmer and Rao (2000) improved on the earlier attempts by using more detailed input-output tables and an improved weighting methodology. This method was applied to Germany/US and US/Canada comparisons for manufacturing (Timmer and Rao, 2000; van Ark, Inklaar and Timmer 2001). For Germany/US (1990), the comparable I/O-tables for both countries from the OECD were used which distinguishes 36 industries (OECD 1995). From the ICOP data base they obtained 1992 Fisher binary unit value

---

[34] But the results have been strongly criticized by others. See, for example, Jorgenson (1993), who argues that gross output comparisons are preferable anyway. Of course, the use of gross output may causes double counting when aggregating the results, but this may be largely resolved by using a Domar weighting system (see Gullickson and Harper, 1999). In any case, the use of value added as an output concept for productivity comparisons is maintained as an option in the OECD Productivity Manual (OECD, 2001).

[35] A number of preliminary attempts to double-deflate have been made within the ICOP project using a combination of ICP PPPs, ICOP UVRs and the exchange rate. See, for example, Szirmai and Pilat (1990) for Japan/ US and Korea/US, van Ark (1993) for Netherlands/UK and Pilat (1994) for Japan/USA.

[36] For this work comparative measures of labour inputs (weighted for differences in age, sex and education), capital services and intermediate inputs are needed alongside PPPs for outputs and inputs (see Jorgenson et al, 1987).

ratios for about 470 products in manufacturing industries as well as UVRs for transport and communication and gross margin PPPs for wholesale and retail trade. These were combined with 1990 ICP binary Fisher PPPs for about 250 basic heading categories from the OECD and 1990 Geary-Khamis PPP for agriculture from FAO (1993). The results from the exercise are shown in Table 6. In the last column the implicit value added PPP using the double deflation procedure is given as a percentage of the output PPP. It shows that the importance of this adjustment varies considerably across sectors, and can be large in some cases such as trade, metals and textiles.

Table 6
ICOP Estimates of Output and Input PPPs for German/US 1990 (Dm/US$)

		Output PPP	Tornqvist Input PPP	Tornqvist Implicit value added PPP	Tornqvist Implicit value added PPP as a % of output PPP
1	Agriculture, forestry & fishing	2.69	2.28	3.46	129%
2	Mining & quarrying	1.80	2.09	1.31	73%
3	Food, beverages & tobacco	1.96	2.26	1.49	76%
4	Textiles, apparel & leather	2.75	2.32	4.60	167%
5	Wood products & furniture	2.43	2.27	2.77	114%
6	Paper, paper products & printing	1.94	2.08	1.73	89%
7	Industrial chemicals	2.15	2.11	2.23	104%
9	Petroleum & coal products	1.85	1.86	1.84	99%
10	Rubber & plastic products	2.00	2.11	1.86	93%
11	Non-metallic mineral products	1.80	2.16	1.46	81%
12	Iron & steel	1.82	2.03	1.20	66%
13	Non-ferrous metals	1.73	1.96	1.12	65%
14	Metal products	2.04	2.02	2.07	101%
15	Non-electrical machinery	1.95	2.00	1.89	97%
16	Office & computing machinery	1.95	1.82	2.27	116%
17	Electrical apparatus, nec	1.74	1.94	1.55	89%
19	Shipbuilding & repairing	1.95	2.01	1.83	93%
21	Motor vehicles	1.97	1.98	1.94	99%
22	Aircraft	1.95	1.93	1.99	102%
23	Professional goods	2.00	1.94	2.07	103%
24	Other manufacturing	2.00	2.03	1.97	98%
25	Electricity, gas & water	2.89	2.12	4.89	169%
26	Construction	2.45	2.08	3.08	126%
27	Wholesale & retail trade	2.39	2.17	2.54	106%
28	Restaurants & hotels	2.23	2.11	2.43	109%
29	Transport & storage	3.57	2.44	6.92	194%
30	Communication	2.11	2.03	2.13	101%
31	Finance & insurance	1.79	2.00	1.71	95%
32	Real estate & business services	2.10	2.11	2.09	100%
33	Community, social & personal services	1.51	2.01	1.26	83%
	Total GDP			2.38	
	Total ICP GDP PPP			2.05	
	Exchange rate	1.62	1.62	1.62	

Source: Timmer and Rao (1999), Table 3.

Recent – as yet unpublished – work by Kuroda and Jorgenson (2000) pushes the idea of combining expenditure-based PPPs and industry-based PPPs further. In a new KLEM-growth account for Japan and the US they derive PPPs for output and input. For this purpose they make use of OECD expenditure PPPs for 197 commodity groupings, which are adjusted to producer price level by using trade and transport margins from the I-O tables, and peeling off indirect taxes paid.[37] For 41 out of 163 industries Kuroda and Jorgenson (2000) were not able to find PPPs Previous studies imputed PPPs of 'close substitutes', but in the present study additional data from the MITI survey of intermediate input prices is used (see Section 3.4) From this source they obtained 17 intermediate input PPPs. For construction and retail trade, PPPs were assumed the same as the exchange rate. For the remaining industries, PPPs of close substitutes were used but this was far from satisfactory, especially for the chemical sector for which output contains a large number of intermediate inputs. Ultimately the PPPs were weighted into 30 industries using a bridge table for 163 I/O categories and 56 consumption commodities. A Tornquist index was used for aggregation.

The most recent work by Kuroda and Jorgenson (2000) shows that there is a clear methodology about how to use PPPs in international productivity comparisons. However, the data requirements for applying this method to obtain industry-based PPPs are high as harmonised input-output tables at a detailed level are needed. But clearly this work represents a step forward in merging various data bases on international prices, including expenditure PPPs, ICOP UVRs and industry specific PPPs.

6. Towards an International Price Archive?

Over the years the ICOP approach has developed parallel to ICP. The ICOP research techniques are clearly different from that of ICP. Rather than special surveys, it uses information from production censuses, input-output tables, national accounts, existing price data bases and, in some special cases, information for individual firms. Its integrated approach towards comparing quantities, unit value, and output values permit crosschecks not available to ICP. Among other things, it identifies variations in the coverage of national accounts.

Another reason why the methods and sources used by the ICOP team have been different from those of ICP is that its research strategy and objectives are different. It has been conducted by a group of university researchers rather than by national governments or international organizations. Its research results are those of individuals rather than being institutional. The interests of the ICOP group have been worldwide, but we never aspired to comprehensive coverage. We were satisfied to concentrate our efforts on relatively large countries which would provide a representative picture that covers about threequarters of world population and output and a very wide range of income levels.

[37] The correction for export and import prices as suggested by Hooper (1996) has not been made.

ICOP was created to provide a broad interactive framework for quantitative analysis of economic growth processes as well as levels of performance. We are just as interested in measuring productivity and the forces determining it as we are in price structures. Our interest was not only macroeconomic, but involved close scrutiny of sectors where it was possible to get some appreciation of the processes of technical change. Hence our research has investigated productivity performance at a detailed industry level. We also gave considerable attention to intercountry diffusion of technology and to differences between the lead country (USA in the twentieth century, UK for a good deal of the nineteenth) and the follower countries, and to processes of catch-up, convergence or divergence. This is a major reason why we have emphasized star system binary comparison rather than multilateral techniques which were appropriate to the mondialist and maximalist aspirations of ICP.

But while moving increasingly to measuring prices, output and productivity in the more 'comparison resistant' industries, an integration of forces to improve in particular the price measurement is needed. After all many of the problems faced by the ICOP research team are equally important for ICP research. Such problems include sampling bias towards simple homogenous products, lack of representativity of product samples, lack of adequate weighting systems, etc.

Wider access to internationally comparable price data sets is key to many of the issues at stake. The construction of an integrated international price archive that provides access to absolute prices and unit values of goods and services for different countries of the world could therefore represent a major step forward. Such an initiative, called PIPA, is presently under investigation with a group of intensive producers and users of PPPs, UVRs, etc..[38]

In PIPA goods and services would have to be grouped in the archive into standard categories of expenditure, production and trade. In each standard category there would be analytic subheadings recognizing important socio-economic and technological dimensions of the goods and services entering into the archive. Table 7 provides a summary grouping that illustrates a few of the subheadings, such as the division of consumption goods into those consumed by the poor and other consumption goods; the separation of R&D expenditures; distinguishing information technology (IT) investment in hardware and software from other machinery and equipment investment; breaking down manufacturing production into high, medium and low technology items and further dividing them into final and intermediate goods, and distinguishing traded industrial goods by their quality range. In addition the archive should include lease or rental prices for machinery and prices for used machinery, both national and international; these would include in addition to other characteristics, the year of manufacture and/or purchase.

---

[38] Presently the collaboration is between the Center for International Comparisons at the University of Pennsylvania (Alan Heston, Robert Summers and Bettina Aten), the ICOP research group at the Groningen Growth and Development Centre (Bart van Ark and Marcel Timmer), the Center for International Data at the University of California-Davis (Robert Feenstra), and the Conference Board (Robert McGuckin and Sean Dougherty). As PIPA develops, other centers and international organizations may participate in the work taking on particular segments of the price archive.

Table 8
Subheadings in International Price Archive (PIPA)

Expenditure	Production	Trade
Consumption	Agriculture	Primary goods
Basic goods consumed by the poor	Manufacturing	Industrial goods
Other consumption goods	High-tech goods	High-quality range
Investment	Final use	Medium-quality range
Machinery and Equipment (New and Used)	Intermediate use	Low-quality range
Information Technology	Medium-tech goods	Services
Hardware	Final use	
Software	Intermediate use	
Other Machinery and Equipment	Low-tech goods	
Structures	Final use	
Residential	Intermediate use	
Non-residential	Services	
Business R&D	Business services	
Government	Consumer services	
Government R&D		

The aim of PIPA should be to provide a resource that users would be able to access to carry out a variety of studies of relative prices. Such studies might include, for example, estimation of purchasing power parities (PPPs) for poverty consumption baskets, estimation of PPPs by productive sectors that would facilitate productivity comparisons, estimates of PPPs overall of consumption or GDP, estimation of PPPs relevant to environmental concerns, and testing of certain propositions about price structures from international trade and industrial organization theory. In addition prices of used machinery can be used to build an asset age-price profile that would form a basis for depreciation studies.

Once established this price archive would become a site that would be corrected, supplemented, and improved by the contributions of users, private and official, in various countries. In order for this vision to be realized it is necessary to establish a framework that will permit flexibility in adding or modifying items, as well as the source of prices. Without going into great detail, there would be a code for each item that would be linked to a specification or description of the item including the type of outlet where priced including web-sites and catalogues. Ideally the framework would allow users to go from final product prices including taxes back to producers prices, but in practice it is more likely that some items like cement will have a producers price or unit value and perhaps a separate price (and perhaps a different physical unit of sale) to final users.

The item code will also be linked for each country to a time series that would be applicable to the item so that users could estimate prices for other years than the initial benchmark year for PIPA, 2000 or 2001. The concept of price for many international studies, like ICP or ICOP has been the national average price. In practice prices may also refer to certain cities, ports or regions, and so the price archive would provide for both national prices as well as prices referring to specific markets within a country.

Clearly the construction of such an international price archive will take several years to be established.[39] But this paper aimed to make clear that a more comprehensive approach towards international comparisons of output, expenditure and prices is needed as a next step in the various international programs, including the ICOP program, in this area.

References

Ark, B. van (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)

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

B. van Ark, R. Inklaar and M.P. Timmer (2001), "The Canada-US Manufacturing Productivity Gap Revisited: New ICOP Results", forthcoming in Sharpe et all.(ed.), *Explaining Canada-US Manufacturing Productivity Gap* (downloadable from http://www.eco.rug.nl/MEDEWERK/Ark/canpap7.pdf)

Ark, B. van and D. Pilat (1993), 'Productivity Levels in Germany, Japan and the United States', *Brookings Papers on Economic Activity, Microeconomics,* 2, pp.1-48.

Ark, B. van L. Broersma and R.H. McGuckin, "Productivity in Retail and Wholesale Trade in The Netherlands: Perspectives from Different Aggregation Levels", paper presented at Annual Meeting American Economic Association, Boston, 7-9 January 2000. http://www.eco.rug.nl/MEDEWERK/Ark/aeapaper.pdf

Ark, B. van, E. Monnikhof and N. Mulder (1999), 'Productivity in Services: An international Comparative Perspective', *Canadian Journal of Economics*, 32(2), pp.471-99.

van Ark, B., E.J. Monnikhof and M.P.Timmer (1999), 'Prices, Quantities and Productivity in Industry: A Study of Transition Economies in a Comparative Perspective', R. Lipsey and A. Heston (eds), *International and Interarea Comparisons of Prices, Income and Output*, NBER, Chicago University Press, p.327-364.

Ark, B. van and E.J. Monnikhof (2000), 'Productivity and unit labour cost comparisons: a data base', Employment Paper 2000/5, International Labour Office, Geneva (downloadable from http://www.ilo.org/public/english/employment/strat/publ/ep00-5.htm

Ark, B. van and E.J. Monnikhof (2000a), 'New Estimates of Labour Productivity in the Manufacturing sectors of Czech Republic, Hungary and Poland, 1996', project paper written for WIIW Countdown Project, 'CEEC´s Catching up with the EU, Comparative Advantages and Trade Structures', Vienna Institute for International Economics (downloadable from http://wiiwsv.wsr.ac.at/Countdown/)

Bart van Ark and Robert H. McGuckin (1999), "International Comparisons of Labor Productivity and Per Capita Income", Monthly Labor Review, July, downloadable from: http://www.bls.gov/opub/mlr/1999/07/contents.htm

Baily, M.N. (1993), "Competition, Regulation and Efficiency in Service Industries", *Brookings Papers on Economic Activity, Microeconomics 2*, Washington D.C., December, pp. 71-159.

[39] A detailed five-year plan is included in Appendix 3.

Bernard, A.B. and C.I. Jones (1996), 'Comparing Apples to Oranges: Productivity Convergence and Measurement Across Industries and Countries', *American Economic Review,* 86(5), pp. 1216-38.

Broadberry, S.N. (1997), *The Productivity Race. British Manufacturing in International Perspective*, 1850-1990, Cambridge University Press.

Castles, I. (1997), 'Review of the OECD-Eurostat PPP Program' (downloadable from: http://www.oecd.org/std/ppp/pps.htm)

Collier, I., (1999), 'Comment' on Van Ark, Monnikhof and Timmer (1999)

Danzon, P.M. and L-W. Chao (2000), 'Cross-national price differences for pharmaceuticals: how large, and why?', *Journal of Health Economics*, vol. 19, pp. 159-195.

Dollar, D. and E.N. Wolff (1993), *Competitiveness, Convergence, and International Specialization,* Cambridge MA: MIT Press.

Gersbach, H. and B. van Ark (1994), 'Micro Foundations for International Productivity Comparisons', *Research Memorandum* GD-11, Groningen: Groningen Growth and Development Centre.

Gilbert, M. and I.B. Kravis (1954), *An International Comparison of National Products and the Purchasing Power of Currencies*, OEEC, Paris.

Gilbert, M. and Associates (1958), *Comparative National Products and Price Levels*, OECD, Paris.

Golub, S.S. (1999), *Labor Cost and International Trade*, AEI Studies on Understanding Economic Inequality, American Enterprise Institute, Washington D.C.

Good, D.H., M.I. Nadiri, L-H. Roller and R.C.Sickles (1993), "Efficiency and Productivity Growth Comparisons of European and US Air Carriers: A First Look at the Data", *The Journal of Productivity Analysis*, No. 4, pp. 115-125.

Griliches, Z., ed. (1992), *Output Measurement in the Service Sectors*, NBER, The University of Chicago Press.

Gullickson, W. and M.J. Harper (1999), 'Possible Measurement Bias in Aggregate Productivity Growth,' *Monthly Labor Review*, February, pp. 47-67.

Heath, J.B. (1957), 'British-Canadian Industrial Productivity', *The Economic Journal*, December.

Heston, A. and R. Summers (1992), 'Measuring Final Product Services for International Comparisons,' in Z. Griliches, ed. (1992)

Hill, T.P. (1977), 'On Goods and Services,' *Review of Income and Wealth*, vol. 123, no. 4, pp. 315-338.

Hill, R.J. (1999), 'Comparative Price Levels Across Countries Using Minimum-Spanning Trees', *The Review of Economics and Statistics*, 81(1), pp. 135-42.

Hooper, P. (1996), "Comparing Manufacturing Output Levels among the Major Industrial Countries", on OECD, *Productivity. International Comparison and Measurement Issues*, OECD Proceedings, Paris.

Houben, A. (1990), 'An International Comparison of Real Output, Labour Productivity and Purchasing Power in the Mineral Industries of the United States, Brazil and Mexico for l975,' *Research Memorandum 368*, Institute of Economic Research, Groningen.

International Labour Office (ILO) (1999), *Key Indicators of the Labour Market 1999*, Geneva.

Jorgenson, D.W. (1993), "Comment" on Van Ark and Pilat (1993)

Jorgenson, D.W., F.M. Gollop and B.M. Fraumeni (1987), *Productivity and US Economic Growth*, Cambridge MA: Harvard University Press.

Jorgenson, D.W. and M. Kuroda (1990), 'Productivity and International Competitiveness in Japan and the United States, 1960-1985', in C.R. Hulten (ed.), *Productivity in the U.S. and Japan,* Studies in Income and Wealth, 51, Chicago: University of Chicago Press.

Jorgenson, D.W., M. Kuroda and M. Nishimizu (1987), "Japan-U.S. Industry-level Productivity Comparisons, 1960-1979", *Journal of the Japanese and International Economics*, vol. 1, 1-30.

Jorgenson, D.W. and M. Nishimizu (1978), "US and Japanese Economic Growth, 1952-1974", *Economic Journal,* 88(352), pp.702-726.

Kouwenhoven, R.D.J. (1994), "Productivity in French Manufacturing: An International Comparative Perspective", *Research Memorandum*, no. 571 (GD-10), Groningen Growth and Development Centre.

Kravis, I.B. (1976), "A Survey of International Comparisons of Productivity", *The Economic Journal*, Vol. 86, March, pp. 1-44.

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

Kuroda, M. and D.W. Jorgenson, (2000), *Economic Growth and Structural Change in Japan,* manuscript, Keio university, December 2000.

Lee, F.C. and J. Tang (1999), "Methodological Issues in Comparing Productivity Levels and International Competitiveness in Canada and the United States", paper presented at AEA meetings, 7-9 January 2000, Boston.

Lichtenberg, F.R. (1993), "Comment" on Van Ark and Pilat (1993)

Maddison, A. (1952), `Productivity in Canada, the United Kingdom and the United States', *Oxford Economic Papers*, October.

Maddison, A. (1983), 'A Comparison of Levels of GDP Per Capita in Developed and Developing Countries, l700-l980,'*Journal of Economic History*, March.

Maddison, A. (1991), *Dynamic Forces in Capitalist Development: A Long-Run Comparative View,* Oxford: Oxford University Press.

Maddison, A. (1995), *Monitoring the World Economy, 1820-1992*, Development Centre Studies, Paris: OECD.

Maddison, A. (1998), *Chinese Economic Performance in the Long Run*, OECD Development Centre, Paris.

A. Maddison and H. van Ooststroom (1993), 'The International Comparison of Value Added, Productivity, and Purchasing Power Parities in Agriculture,' *Research Memorandum GD1*, Groningen Growth and Development Centre.

Maddison, A. and D.S. Prasada Rao (1996), 'A Generalized Approach to International Comparisons of Agricultural Output and Productivity', *Research Memorandum* GD-27), Groningen: Groningen Growth and Development Centre.

Maddison, A. and B. van Ark (1994), 'The International Comparison of Real Product and Productivity', *Research Memorandum*, no. 567 (GD-6), Groningen: Groningen Growth and Development Centre.

Maddison, A. and B. van Ark (2001), 'The International Comparison of Real Output and Productivity", in A. Maddison, W. Shepherd and D.S. Prasada Rao, eds., Edward Elgar Publishers Ltd.

Maizels, A. (1958), `Comparative Productivity in Manufacturing Industry: A Case Study of Australia and Canada', *The Economic Record*, April.

McKinsey Global Institute (1992), Services Productivity, Washington D.C.

McKinsey Global Institute (1993), Manufacturing Productivity, Washington D.C.

Monnikhof, E.J. and B. van Ark (2001), Productivity Comparisons in Transport and Communication 1980-1998, Groningen Growth and Development Centre, mimeographed/

Mulder, N. (1999), The Economic Performance of the Service Sector in Brazil, Mexico and the USA, A Comparative Historical Perspective, Monograph series no. 4, Groningen: Groningen Growth and Development Centre.

Mulligen, P.H. (2000), Quality Issues in International Comparisons of Output and Productivity, Groningen Growth and Development Centre, mimeographed

Nayman, L. and D. Ünal-Kesenci (2000), 'Comparaison France-Allemagne des niveuas de production et de productivité dans le secteur manufacturier', CEPII, Paris, mimeographed.

Nomura (1999), 'Measurement of Relative Prices between US and Japan from the point of view of the price interdependency based on international trade', KEO discussion paper, December 1999 (in Japanese)

O'Mahony, M. (1999), *Britain's Productivity Performance 1950-1996. An international perspective*, National Institute of Economic and Social Research.

OECD (1995), *The OECD Input-Output Database,* OECD, Paris.

OECD (2001), OECD Productivity Manual: A Guide to the Measurment of Industry-Level and Aggregate Productivity Growth, OECD, Paris (to be published).

Ooststroom, H. van and A. Maddison (1984), 'An International Comparison of Levels of Real Output and Productivity in Agriculture in l975,' *Research Memorandum 162*, Institute of Economic Research, Groningen.

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

Perelman, S. and P. Pestiau (1994), 'A Comparative Performance Study of Postal Services: A Productive Efficiency Approach,' *Annales d'Économie et de Statistique*, No. 33, pp. 187-202.

Pilat, D. (1994), *The Economics of Rapid Growth. The Experience of Japan and Korea*, Aldershot UK and Brookfield US: Edward Elgar.

Pilat, D. (1996), *Labour productivity levels in OECD countries: estimates for manufacturing and selected service sectors*, OECD Economics Department Working Papers no. 169, Paris.

Pilat, D. and D.S. Prasada Rao (1996), "Multilateral Comparisons of Output, Productivity and Purchasing Power Parities in Manufacturing", *Review of Income and Wealth*, 42(4), pp.1-18.

Prasada Rao, D.S. and M.P. Timmer (2000), "Multilateralisation of Manufacturing Sector Comparisons: Issues, Methods and Empirical Results", *Research Memorandum GD-47*, Groningen Growth and Development Centre, July 2000.

Rostas, L. (1948), *Comparative Productivity in British and American Industry*, National Institute of Economic and Social Research, Cambridge University Press, London.

Summers, R. (1973), 'International Price Comparisons Based Upon Incomplete Data,' *Review of Income and Wealth*, March.

Summers, R. and A. Heston (1988), 'A New Set of International Comparisons of Real Product and Price Levels: Estimates for 130 Countries, 1950-1985', *Review of Income and Wealth*, 34(1), pp. 1-25.

Summers, R. and A. Heston (1991), ‘The Penn World Table (Mark 5): an Expanded Set of International Comparisons, 1950-1988’, *Quarterly Journal of Economics,* 106, pp. 327-68.

Szirmai, A. and D. Pilat (1990), ‘Comparisons of Purchasing Power, Real Output and Labour Productivity in Manufacturing in Japan, South Korea and the USA, 1975-1985’, *Review of Income and Wealth,* 36(1), pp.1-31.

Timmer, M.P. (1996), "On the Reliability of Unit Value Ratios in International Comparisons", *Research Memorandum GD-31*, Groningen Growth and Development Centre, December 1996.

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

Timmer, M.P. and D.S. Prasada Rao (1999), “Double Deflation reconsidered: a preliminary KLEM-PPP study: US-Germany 1990, mimeographed GGDC, November 1999.

Triplett, J. (1990), ‘The Theory of Industrial and Occupational Classifications and Related Phenomena’, in *Proceedings of 1990 Bureau of Census Annual Research Conference*, March 18-21, 1990, Arlington, pp. 19-25.

Triplett, J. (2000), *Internationally comparable price indexes for computers and high tech products: a research proposal*, mimeograph Brookings Institution, Washington, April 2000.

Wieringa, P. and A. Maddison (1985), ‘An International Comparison of Levels of Real Output in Mining and Quarrying in l975,’ University of Groningen, mimeographed.

Appendix 1 List of selected manufacturing products for multilateralisation

Number	Branch	Product	Number	Branch	Product
1	Food	Bacon	68	Tex	Woven fabric of woolen yarns
2	Food	Beef tallow	69	Tex	Woven fabrics of synthetic fibres
3	Food	Beer	70	Tex	Carpets
4	Food	Butter	71	Tex	Synthetic yarn
5	Food	Candy not containing chocolate	72	Tex	Finished broad fabrics
6	Food	Canned meat	73	Wea	Dresses
7	Food	Cattle feeds (incl. dairy feeds)	74	Wea	Girls t shirts
8	Food	Cheese	75	Wea	Woman t shirts
9	Food	Chewing gum	76	Wea	Female blouses
10	Food	Chocolate	77	Wea	Mens dress trousers
11	Food	Cigarettes	78	Wea	Men's coats
12	Food	Cocoa butter	79	Wea	Men's shorts
13	Food	Complete Chicken feed	80	Wea	Men's suit
14	Food	Concentrated milk	81	Wea	Men's sweaters
15	Food	Dog food and cat food	82	Wea	Men's trousers
16	Food	Dry whole milk	83	Wea	Mens t-shirt
17	Food	Fluid milk	84	Wea	Men's woven sport shirts
18	Food	Frankfurter	85	Wea	Overalls
19	Food	Gin	86	Wea	Skirts
20	Food	Glucose syrup	87	Wea	slacks
21	Food	Grape wines 14% or less	88	Wea	Suits and pant suits
22	Food	Ham	89	Wea	Swimsuits
23	Food	Ice cream	90	Wea	Swimwear men
24	Food	Ice milk	91	Wea	Tailored coats
25	Food	Instant coffee	92	Wea	Women pantyhose
26	Food	Jams	93	Wea	Women's trousers
27	Food	Malt	94	Wea	Woven blouses and shirts
28	Food	Margarine	95	Wea	Children dresses
29	Food	Milk powder	96	Wea	Men's jacket
30	Food	Molasses	97	Foot	Athletic shoes
31	Food	Natural cheese	98	Foot	Cattle hide
32	Food	Nonfat dry milk	99	Foot	Men's footwear
33	Food	Pig feeds	100	Foot	Shoes for children
34	Food	Redried tobacco	101	Foot	Shoes with rubber or plastic soles
35	Food	Refined sugar	102	Foot	Slippers
36	Food	Rice milled	103	Foot	upholstery leather
37	Food	Roasted coffee	104	Foot	Women's boots
38	Food	Rum	105	Foot	Workshoes
39	Food	Sausages	106	Foot	Women's shoes
40	Food	Semolina	107	Foot	Rubber footwear
41	Food	Shortening oils	108	wood	Hardwood rough
42	Food	Soy bean oil	109	wood	Hardwood dressed
43	Food	Soybean Meal	110	wood	Hardwood plywood:
44	Food	Starches	111	wood	Softwood rough
45	Food	Tea	112	wood	Softwood dressed
46	Food	Wheat flour	113	wood	Wooden window
47	Food	Whiskey	114	wood	Wood chips
48	Food	Yoghurt	115	wood	Veneer
49	Food	Young chickens	116	pap	Printing paper
50	Food	Beef	117	pap	Disolved pulp
51	Food	Cocoa powder	118	pap	Pulp
52	Food	Turkeys	119	pap	Newsprint
53	Tex	Cotton fabrics	120	pap	Toilet tissue
54	Tex	Cotton yarn	121	pap	Unbleached kraft packaging paper board
55	Tex	Ducks	122	pap	Paperboard
56	Tex	finished fabric	123	pap	Packing paper
57	Tex	Fishing net	124	pap	Napkin paper
58	Tex	Manmade fiber and silk, gray goods	125	pap	Sanitary paper
59	Tex	Mixed broad woven fabrics of synthetic fibres	126	Chem	Ammonium sulfate
60	Tex	Other yarn	127	Chem	Aluminium sulphate
61	Tex	Polyester yarns	128	Chem	Ammonia
62	Tex	Rayon fabric	129	Chem	Asphalt
63	Tex	Rayon yarn	130	Chem	Aviation gasoline, except jet fuel
64	Tex	Tufted carpet and rugs	131	Chem	Beef tallow
65	Tex	Warp knit fabric	132	Chem	Calcium carbide
66	Tex	Weft knit fabric	133	Chem	Carbon black
67	Tex	Wool yarn	134	Chem	Chlorine

135	Chem	Fuel oil (Heavy and light)
136	Chem	Fungicides
137	Chem	Heavy fuel
138	Chem	Synthetic detergent
139	Chem	Hydrochloric acid
140	Chem	Hydrogen
141	Chem	Industrial soaps
142	Chem	Jet fuel
143	Chem	Kerosene, except jet fuel
144	Chem	Lacquers
145	Chem	Light fuel oil
146	Chem	Liquefied gasses
147	Chem	Liquid soda
148	Chem	Mixed fertilizer
149	Chem	Motor gasoline
150	Chem	Naptha
151	Chem	Nitrid acid
152	Chem	Nylon fibre
153	Chem	Organic fertilizer
154	Chem	Oxygen
155	Chem	Polyester fibres
156	Chem	Printing ink
157	Chem	Rayon fibres
158	Chem	Sodium chlorate
159	Chem	Sodium phosphate
160	Chem	Sulpheric acid
161	Chem	Sulphur
162	Chem	Superphosphate
163	Chem	Thinners
164	Chem	Toilet soap
165	Chem	Urea
166	Chem	Wood paint
167	Chem	Zinc oxide
168	Chem	Insecticides
169	Chem	Ammoniumphosphate
170	Chem	Paints
171	Ru&pl	Car tubes
172	Ru&pl	Car tyres
173	Ru&pl	Pressure tubing
174	Ru&pl	SBR latex
175	Ru&pl	small Truck tires
176	Ru&pl	Truck tubes
177	Ru&pl	Big Truck tires
178	Nmmp	Clay bricks
179	Nmmp	Concrete pipe
180	Nmmp	Gold groundmetal
181	Nmmp	Hydrated lime
182	Nmmp	Refractories
183	Nmmp	Portland cement
184	Nmmp	Quick lime
185	Nmmp	Ready-mixed concrete
186	Nmmp	Refractory mortars
187	Nmmp	Wall tiles
188	Metal	Alluminium bars
189	Metal	Alluminium plates
190	Metal	Aluminium foil
191	Metal	Aluminium ingot
192	Metal	Barbed and twisted wire
193	Metal	Castings of aluminium
194	Metal	Cold rolled carbon sheet
195	Metal	Concrete reinforcing bars
196	Metal	Concrete wire
197	Metal	Copper bars
198	Metal	Copper plate and stripe
199	Metal	Copper, highly refined, electric
200	Metal	Ductile castings
201	Metal	Galvanized sheets
202	Metal	Gray castings - plain
203	Metal	Iron castings
204	Metal	Nails and staples
205	Metal	Nuts and bolts
206	Metal	Raw copper
207	Metal	Secundary alluminium
208	Metal	Sheet rolled hot
209	Metal	Steel bars
210	Metal	Steel ingot
211	Metal	Strips Hot rolled
212	Metal	Strips, cold rolled
213	Metal	Structural shapes (heavy)
214	Metal	Tin plates
215	Metal	Wire rods
216	Metal	Wire, plain
217	Metal	Zinc - unwrought
218	Mach	Bicycle
219	Mach	Bus bodies
220	Mach	Buses
221	Mach	Gasoline engines
222	Mach	Machine center
223	Mach	Multistage pump
224	Mach	Ncmachines
225	Mach	Passenger cars
226	Mach	Radiators, complete
227	Mach	Tractor
228	Mach	Truck tractors
229	Mach	Vending machines
230	Mach	Wheels
231	Elec	Audio disc or records
232	Elec	Audio tapes
233	Elec	Braun tube
234	Elec	Car lamp
235	Elec	Car radio
236	Elec	Casseteplayer
237	Elec	Color TV
238	Elec	Computer printers
239	Elec	Electric bulbs
240	Elec	Electric irons
241	Elec	Electric mixers
242	Elec	Elextric hot water boilers
243	Elec	External memory systems
244	Elec	Fluorescent light
245	Elec	Loudspeaker systems
246	Elec	Loudspeakers sold separately
247	Elec	Microphones
248	Elec	Power amplifiers
249	Elec	Refrigerator
250	Elec	Telephones
251	Elec	Vacuum cleaners
252	Elec	Washing machines
253	Elec	Electric fans
254	Elec	Hand type vacuum cleaners
255	Elec	Computers
256	Elec	General lighting:

Appendix 2: Calculation of Coefficients of Variation of Manufacturing UVRs

The variance of the UVRs is measured as follows (see Timmer 1996 for full discussion). Following stratified sampling theory, the sample variance of the UVR for total manufacturing is given by the quadratic output weighted average of corresponding branch UVR variances.

$$\mathrm{var}[\mathrm{UVR}] = \sum_{k=1}^{K} w_k^2 \, \mathrm{var}[\mathrm{UVR}_k] \qquad (11)$$

In a similar vein, the estimated variance of the UVR in branch k is given by

$$\mathrm{var}[\mathrm{UVR}_k] = (1 - f_k) \sum_{j=1}^{J_k} w_{jk}^2 \, \mathrm{var}[\mathrm{UVR}_{jk}] \qquad (12)$$

with f_k the share of branch output which is covered by the matched products within a branch. Branch variance is thus defined as a weighted average of the estimated variances of the industry UVRs, var[UVR_{jk}], corrected by the finite population correction (fpc). The fpc is normally stated as one minus the number of products sampled divided by the total number of products in the population. Here I use the output share of sampled products rather than the number of products to account for the difference in importance of products. The fpc ensures that with an increasing coverage of products, the variance goes down. Thus, branch variance depends on the variance of the industry UVRs, but also on the coverage of branch output. If the coverage ratio is lower, the variance will be higher, and if the variance of the industry UVRs is higher, then branch variance will be higher as well.

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

$$\mathrm{var}[\mathrm{UVR}_j] = \frac{1}{I_j - 1} \sum_{i=1}^{I_j} w_{ij} \, (\mathrm{UVR}_{ij} - \mathrm{UVR}_j)^2 \qquad (13)$$

with I_j the number of products matched in industry j (see also Selvanathan 1991). Formulae (11) to (13) 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 base prices for the variance of the Paasche.

Appendix Table 2.1 shows, by way of example of the results of our latest comparison of manufacturing productivity between Canada and the United States. The unit value ratio for total manufacturing is close to the exchange rate, but price levels in manufacturing branches differ considerably from 1.14 Can$/US$ in food manufacturing, beverages and tobacco to 1.41 Can$/US$ in electrical machinery. This implies that Canadian producer price levels varied from between 84 per cent and 104 per cent of the U.S. price level in these industries. The Table also gives details on the number of matches, the percentage of output covered and the coefficient of variation of the UVRs in the various branches. As is shown, the average unit value ratio for total manufacturing is based on 291 product matches. Together these products account for about 22 per cent of shipments in the US and 32 per cent in Canada. The number of unit value ratios and the matching percentages vary considerably between the branches. For some branches, for example food manufacturing, a large number of UVRs could be calculated while for other branches only a few matches could be made. However, our weighting system reduces the overrepresentation of relatively large matches. The coefficients of variation in Table 3 indicate for each branch the variation of the product UVRs around the mean. A high level of variation indicates a low reliability of the corresponding UVR. It appears that the UVRs for electrical machinery, rubber and plastics and especially wood products are relatively unreliable.

Appendix Table 2.1
Unit value ratios and reliability indicators by manufacturing branch, Canada/United States, 1997

	Unit value ratio (Can$/US$)			Coefficient of variation		Matched output as % of total*		Number of product matches
	US quantity weights	Canadian quantity weights	Geome -tric average	US quantity weights	Canadian quantity weights	USA	Canada	
Food, beverages and tobacco	1.22	1.06	1.14	0.0330	0.0472	43.3	40.3	102
Textile mill products	1.32	1.05	1.18	0.0409	0.1107	39.0	13.8	8
Wearing apparel	1.72	1.49	1.60	0.0353	0.0493	63.3	44.9	38
Leather products	1.62	1.06	1.31	0.0495	0.1217	81.1	31.4	10
Wood products	1.41	1.15	1.27	0.1645	0.1326	35.6	61.9	18
Paper, printing & publishing	1.40	1.24	1.32	0.0482	0.0414	27.3	38.5	17
Chemical products	1.21	1.26	1.24	0.0312	0.0625	26.1	37.7	34
Rubber and plastic	1.40	1.42	1.41	0.1154	0.0891	6.5	20.3	5
Non-metallic mineral	1.23	1.22	1.22	0.0330	0.0389	26.8	35.1	8
Basic & fabricated metals	1.40	1.29	1.35	0.0609	0.0621	13.8	23.0	21
Machinery & transport equipment	1.32	1.46	1.39	0.0368	0.0931	14.9	28.9	23
Electrical machinery and equipment	1.71	1.17	1.41	0.0733	0.0939	1.7	3.6	7
Other manufacturing	1.37	1.27	1.32	---	---	0.0	0.0	0
Total manufacturing	1.37	1.27	1.32	0.0203	0.0353	21.5	32.4	291
Pro memoria								
Exchange rate	1.35	1.35	1.35					

Source: Van Ark, Inklaar and Timmer, 2000

Appendix 3: A Five Year Plan for PIPA International Price Archive

The aim of an international price archive (PIPA) is to launch a new type of price research that would develop a price archive for the world over the next 5 years. It would attempt to make price collection independent of but in cooperation with governments and international organizations so that researchers can directly use the prices underlying purchasing power comparisons without the usual confidentiality constraints binding government collections. The price archive would focus on prices related to those in poverty, namely basic consumption goods; prices related to high technology items; prices in international trade of both sophisticated and simple manufactures; prices in financial and other services; prices of intermediate and final production including those relevant to the state of the environment; prices of used machinery to obtain insights into age-price profiles of assets; rental/lease prices for machinery; and wages and salaries. There are many recent developments that make it more feasible for independent scholars to attempt to launch such a project than was the case when the ICP and ICOP began. The internet which both provides instant access to daily newspapers as well as online markets, bar codes, ILO food price and wage data, and catalog sales, are some examples of publicly available prices that have increased in recent years. Having said this it is also clear that PIPA will serve all users better if there is participation of national statistical offices and international organizations in the development of this project and we hope to achieve this from the beginning.

We think the organization of the project will permit it to be undertaken in the spirit of cooperation and interaction among research centers, international and national statistical offices and with individual users. The two key elements are (1) an overall framework of web-site organization that will provide users with prices, units, specifications, and related temporal price indexes and (2) a decentralized monitoring mechanism. The latter means that responsibility for collection and editing of various components of the archive would be spread among different research organizations including those centers listed in this proposal but others, public or private. This will not only allow expertise of individual researchers to oversee prices in areas they know best, but it will also operate as a focus for fundraising. For example, the OECD might be interested in supporting work on the prices of certain high-tech items, while the World Bank might be willing to support work on prices for items purchased by those in poverty. As noted in the outline of the 5 year plan there will clearly need to be some overall coordination of the classification regime but as PIPA evolves, it is hoped that central organization can be kept to a minimum and that there will be active use and contributions by a wide variety of individuals and organizations.

Phase 1: The Framework

To launch the PIPA project it will require a year of preparation of a classification scheme by those named in the proposal as well as others who may express an interest once the project is publicized. PIPA is proposed as a project independent of national and international statistical organizations but we clearly need as much participation and support from these groups as possible. It is envisaged that there would be a formal Advisory Board as well as an ongoing mechanism for interested persons or organizations provide ideas and data for the archive.

A preliminary item classification system would be developed by the groups initiating PIPA during the year 2001. This would involve one or more face-to-face meetings that might be piggy-backed onto other conferences. This would be circulated to a variety of potential users, advisors, and data providers during the Fall of 2001 for comment. If funding becomes available a working group meeting would be proposed for Winter 2002 to firm up the classification of products.

Phase 2: Establishing PIPA

During 2002 the archive would be established building upon the very substantial data bases of the United Nations International Comparison Programme (ICP) and the International Comparison of Productivity (ICOP) program at the University of Groningen, and other sources. PRODCOM (European Production Data), the ILO retail food prices, the FAO wholesale agricultural prices, MITI's intermediate product prices, and producer price indexes from national statistical offices are sources that will be used in establishing a first version of PIPA.

In our experience with the ICP and ICOP it is important that the initial price archive of PIPA be up on the web as soon as possible after the organization period is over. If the framework is valuable to users and the initial set of prices is sound, it will not only establish credibility for PIPA but will also generate responses that in turn will become a part of the basis for expansion of the archive.

Phase 3: Perpetuating PIPA

The success or failure of PIPA will be become evident in Phase 3 a period of two or three years when several critical thresholds need to be reached. First, the archive must be expanded in terms of coverage and timeliness which in turn may depend on how feasible it is to obtain prices from the internet and other sources. Second, there must be enough users who find the archive of value for their research, analysis or other purposes. And third, the archive must generate enough interest from individuals and organizations so that it can be maintained with a minimal central core. In our view this might be an active Advisory Board and a paid professional administrator.

This is how we view PIPA now. With the rapid changes that take place in communications technology each year, it is likely that there will be developments that affect PIPA in ways that we do not anticipate. For this reason, we offer this five year development plan but also emphasize that flexibility will be a key ingredient in the mix.

Some Questions

Why is such a seemingly large research effort proposed as an independent project, rather than an activity of an international organization? In answer, first let us make clear that the UN Statistical Division, Eurostat, FAO, ILO, IMF, OECD, the World Bank and others have done important work in developing classification systems, harmonizing price indexes and other projects relevant to PIPA. However, in the present climate it seems doubtful that these organizations would undertake such a project, even if as we anticipate, they think it would be very useful. International institutions would find this a difficult project because of their need to work with member governments and national statistical offices. This poses an organizational and resource problem because many statistical offices lag their inclusion of new products and outlets (For example, Nielson for the United States reports that in 1990 there were 950,000 bar codes for items, and 5 years later there were 1,650,000, and who knows today. While bar codes greatly exceed individual items, this illustration remains suggestive of the problem.) Because they have so many other priorities national statistical offices are not fond of taking on new price collection based upon an external classification system even if the items are widely consumed and or their prices are on the web or other public venue.

Why would independent researchers be able to do the job, and with less resources? Well, we do not know that we can, but PIPA will be launched with partial country coverage so that its feasibility can be gauged over the three Phases outlined above. Further with its decentralized organization, it is planned that the price collection can be developed according to the interests and strengths of the different collaborators. Another very real consideration is that the statistical standards that national offices aspire to for their time to time price indexes are generally higher than used in existing place to place comparisons. Independent researchers can develop a very good price archive employing less resources than national statistical offices would feel obliged to devote to it.

What would be the relationship of this project to other activities like the ICP and ICOP? We believe this project would be complementary to the ICP and other international efforts and wherever possible the archive would contain ICP and ICOP generated prices/unit values. PIPA would have two advantages, the first being that the prices would be publicly available so that countries can see how their price data are used, replicate these uses, and help improve the archive. Secondly, PIPA would essentially provide the inputs for the denominator or conversion factor to be used with numerators in national prices, like poverty lines value added by industry per worker, wage or salary levels or GDP per capita. Many comparisons of such ratios are criticized as implausible, where often the problem is the numerator not the denominator of the ratio, that is producing the questionable result. PIPA will not solve the problem of non-comparable denominators, but it will make it clearer where the problem lies.