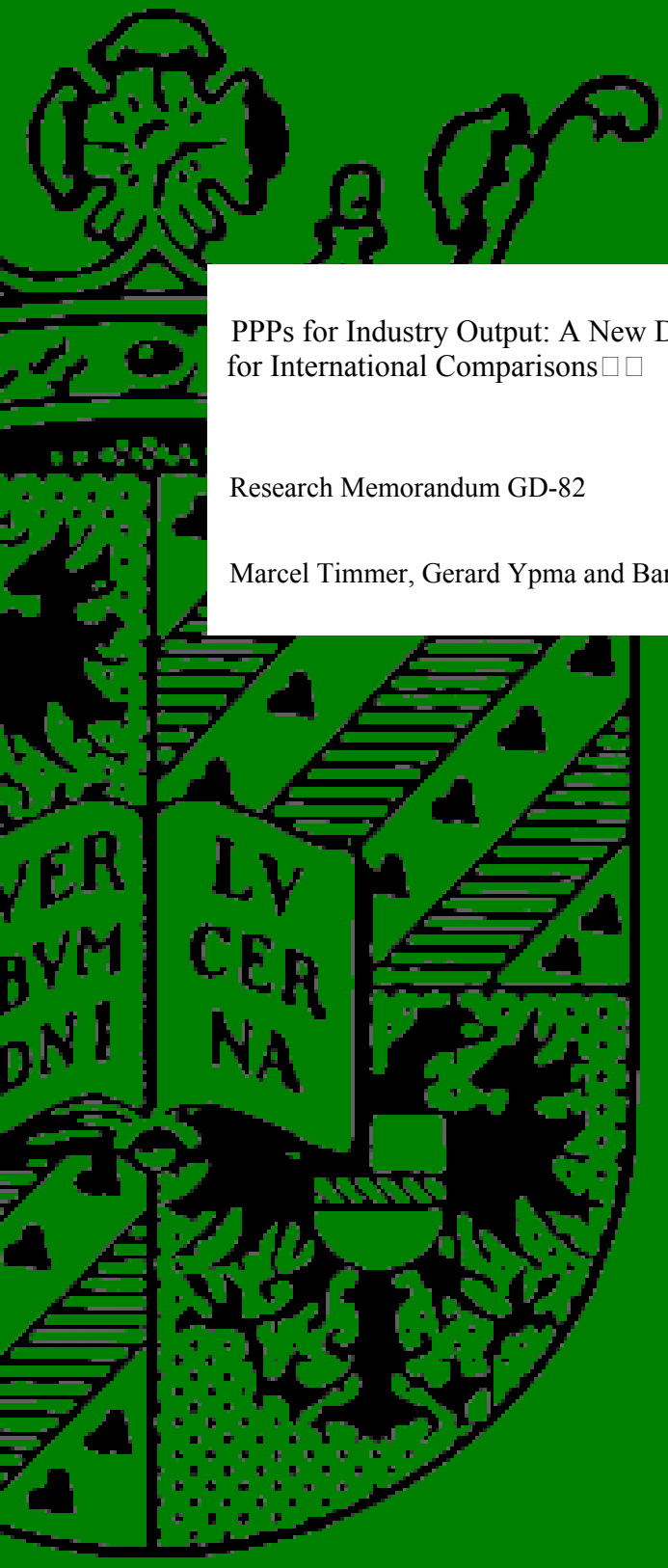
PPPs for Industry Output

Timmer, Marcel; Ypma, Gerard; van Ark, Bart van

University of Groningen

Groningen Growth and Development Centre

RuG



PPPs for Industry Output: A New Dataset for International Comparisons□□

Research Memorandum GD-82

Marcel Timmer, Gerard Ypma and Bart van Ark

RESEARCH MEMORANDUM

PPPs for Industry Output: A New Dataset for International Comparisons

Research Memorandum GD-82

Marcel Timmer, Gerard Ypma and Bart van Ark

Groningen Growth and Development Centre
March 2007

PPPs for Industry Output:
A New Dataset for International Comparisons

by Marcel P. Timmer, Gerard Ypma and Bart van Ark[1]
Groningen Growth and Development Centre
University of Groningen

March 2007

Abstract
International comparisons of output, prices and productivity have been hampered by the unavailability of comprehensive sets of PPPs at the industry level. Existing expenditure PPPs and production PPPs both have their limitations. This paper proposes to use a mix of both for industry level comparisons. On the basis of a supply-use framework, the paper identifies how expenditure prices and output prices are conceptually related. It develops criteria on the basis of which an optimal mix of expenditure PPPs and production PPPs can be chosen. The paper then shows a PPP dataset for gross output for 45 industries (capturing the total economy) and 25 advanced countries. This dataset is the first comprehensive dataset of PPPs covering this large number of industries and countries. We illustrate its potential for research purposes by analysing patterns of relative prices in manufacturing and services.

[1] This paper has been prepared under sponsorship from the National Science Foundation research project on "Improved Methods of Estimating Production and Income Across Nations" and the "EU KLEMS project on Productivity in the European Union" (6th Framework Programme, Priority 8, "Policy Support and Anticipating Scientific and Technological Needs"). The authors are grateful to participants in the *OECD Workshop on Productivity Analysis and Measurement*, Bern 16-18 October 2006 for useful comments and suggestions. Corresponding author: Marcel P. Timmer, Groningen Growth and Development Centre, Faculty of Economics, University of Groningen, P.O. Box 800, NL-9700 AV Groningen, The Netherlands, e-mail: m.p.timmer@rug.nl

1. Introduction

The use of Purchasing Power Parities (PPPs) for a range of analytical purposes has recently received renewed attention in the literature. Traditionally, PPPs are used for international comparisons of income, expenditure, output and productivity. They play a pivotal role in research on growth and convergence in the world economy (Maddison, 2001, 2005). On-going debates on, for example, the law of one price, the theory of the real exchange rate and the Balassa-Samuelson hypothesis have been revisited by several scholars (Rogoff 1996, Taylor and Taylor, 2004). PPPs have also been readdressed in various studies of price convergence of goods and services, for example in the European Union (Canzoneri et al., 1999; Goldberg and Verboven, 2004). They also play an important role in historical comparisons of relative income and productivity, both at aggregate and industry level (Broadberry, 1997; Ward and Devereux, 2003; Broadberry, 2003). PPPs are also indispensable in empirical applications of international trade and endogeneous growth theories (Harrigan, 1999; Griffith, Redding and van Reenen, 2004).

Most studies, however, are based more or less exclusively on a purchasing power parity concept that is rooted in the expenditure approach. Such studies make use of expenditure PPPs which are directly obtained from the International Comparisons Project (which are constructed under the auspices of Eurostat, OECD and the World Bank) or, more indirectly, from the Penn World Tables which are based on ICP (Summers and Heston, 1991; Heston et al., 2002).

A major part of the research in this area, however, by definition requires PPPs by industry (agriculture, manufacturing and services), rather than by expenditure category. This is especially true for studies that focus on sectoral price and productivity issues. Balassa-Samuelson type studies also require measures of relative price levels of tradeable vis-à-vis non-tradeable sectors. Convergence studies are increasingly made at the industry level and tests of endogeneous growth models require level measures relative to the world productitivity frontier by industry. More generally, studies that focus on the dynamics of growth from a perspective of structural change, need to take account of industry-specific PPPs (Szirmai and Pilat 1990; van Ark, 1996; O'Mahony 1999; Timmer, 2000). The need to complement PPPs based on the expenditure approach with PPPs from the production approach is generally acknowledged. For example, Bernard and Jones (2001) state that "…future research is needed to construct conversion factors appropriate to each sector and that research relying on international comparisons of sectoral productivity and income should proceed with caution until these conversion factors are available" (p. 1169).

However, most studies claim that production PPPs are scarce and empirically difficult to obtain. Until recently, available datasets included only a small number of countries, and were often based on bilateral (pairwise) comparisons instead of multilateral comparisons (see van Ark and Timmer, 2001; Maddison and van Ark, 2002). This precludes cross-country regression work and hampers generalisations. In addition, the coverage of industries is incomplete with several studies for agriculture and manufacturing, but a lack of production PPPs for services and no possibility to develop aggregate PPPs for the total economy from the industry side. More fundamentally, it is

often pointed out that there are measurement and data difficulties with existing production PPPs, which mainly relate to the lack of readily available producer price surveys. The main practical objection against using production PPPs is that these are mostly based on ratios of unit values, which might not adequately reflect differences in product mix and product quality between countries (see, for example,. Jorgenson, 1993; and Lichtenberg, 1993). Hence except for some pioneering attempts for a few countries, there has so far not been a comprehensive production PPP dataset, both in terms of country and industry coverage.[2]

As an alternative to using production PPPs, some studies resorted to the use of 'adjusted' expenditure prices as a proxy for prices for industry output in the PPP literature, for example Jorgenson, Nishimizu and Kuroda (1987) and Lee and Tang (2001). But this approach has its own disadvantages. Whereas PPPs for output should be based on a domestic basic price concept, expenditure PPPs are based on purchasers' prices and include prices of imports. Hence they need to be adjusted to a basic price concept. Unfortunately the exact nature of these adjustments have not been clearly spelled out in the literature so far. Moreover some of the adjustment factors, especially for international trade prices, are often not available. Moreover expenditure PPPs are not always a feasible option for certain industries because no data is available for prices of intermediate product items.

Some scholars have therefore made a case for the use of expenditure PPPs alongside production PPPs to increase the coverage of industries and countries (Pilat 1996, O'Mahony 1996, Van Ark and Timmer 2001). In this paper we follow this up by introducing, for the first time, a comprehensive dataset of PPPs for industry output based on a mix of adjusted expenditure PPPs and production PPPs. We first set out a framework to reconcile measures of expenditure and domestic output prices, based on the Supply and Use framework of the European System of Accounts (ESA) 1995. We use this framework to investigate under which circumstances adjusted expenditure prices are a reasonable proxy for basic output prices, and which adjustments need to be made. This information is used to prepare a set of PPPs at industry level which consists of adjusted expenditure PPPs and production PPPs. Given available data sources we select for each industry the best possible proxy for the relative price of gross output. The new dataset includes PPPs for gross output 45 major industries, covering the total economy, and 25 countries for 1997.

This study builds upon earlier work in the International Comparisons of Output and Productivity (ICOP) project at the University of Groningen. Over the past two decades more than 60 ICOP studies have appeared, which together add up to comparisons for more than 100 countries in agriculture, over 30 countries in manufacturing, and more than 10 countries in a variety of services industries.[3] In particular this study makes use of recent work by Ypma (2007) for transport and communication, Timmer and Ypma (2006) for distributive trade, and Inklaar, O'Mahony, Robinson and Timmer (2003) for manufacturing. In these studies new data sources

[2] See Mulder (2002) for Brazil and Mexico and Pilat (1994) for South Korea and Japan for early examples.
[3] Van Ark and Timmer (2001) and Maddison and van Ark (2002) provide overviews. See http://www.ggdc.net for downloadable studies

for various industries have been exploited, including the use of farm producer price data from the FAO and a harmonized database on manufacturing production for European countries (PRODCOM), which is much more detailed than the data sets used before. The main differences between the earlier studies and the present one are the following:

This study uses a mix of PPP sources. Alongside production PPPs based on producer prices or output unit values, it makes use of adjusted expenditure PPPs from ICP where appropriate.

It applies a multilateral (EKS) weighting system for all industries, building up from a detailed 3-digit industry level and using a single set of output weights in aggregation.

The country and industry coverage is much bigger than in earlier datasets.

The remainder of the paper is organised as follows. Section 2 of this paper sets out the framework to reconcile measures of prices based on expenditure and production approaches. Our key result is the derivation of a precise relationship between final expenditure prices and industry output prices. Using a supply-use framework, we show that final expenditure prices need to be adjusted for trade and transportation margins, for taxes and subsidies, for prices of exports and imports and for prices of intermediate use, to provide a good proxy for domestic output prices. We also indicate how well the expenditure PPP proxy can be used for different groups of products. Section 3 discusses the basic set up of the present database. At the most detailed level, we derive binary PPPs for 221 three digit industries. The basic 3-digit production PPPs are based on a mix of expenditure PPPs and production PPPs. These binaries are multilateralised above the 3-digit level by using the EKS method. Section 3 also provides a general motivation of the particular mix of expenditure PPPs and production PPPs which is chosen. This is discussed in much more detail in Section 4, providing data sources and methodology on an industry-by-industry basis. Section 5 introduces the new dataset of PPPs for gross output. This data can potentially shed new light on a wide range of issues as discussed above. We illustrate this by discussing some of the first results on relative price levels in manufacturing and services. Section 6 concludes and indicates next steps, including work on PPPs for intermediate and factor inputs, and the derivation of value added and productivity measures.

2. The link between output and expenditure prices within a Supply-Use Table (SUT) framework

For aggregate comparisons, expenditure prices are the common basis for measures of GDP PPP, hereafter named 'expenditure PPPs. For comparisons of industry output, however, the conceptually correct PPP is based on basic output prices by industry, hereafter named 'production PPPs'. As discussed in the introduction, production PPPs have not been not available on a large scale, and certainly not for all industries. Therefore there has been an increasing plea for using expenditure PPPs alongside production PPPs to increase the coverage of industries (Pilat 1996, O'Mahony 1996, Van Ark and Timmer 2001). However, so far it has not been clearly outlined, under which conditions expenditure PPPs provide a good proxy for the PPPs of gross output and what kind of adjustments are needed. In the pioneering work of Jorgenson, Nishimizu and Kuroda (1987) two adjustments were made. First, expenditure PPPs were re-allocated from expenditure categories to industry groups. For example, expenditure prices of bread and sugar were allocated to food manufacturing. In a second step, the expenditure PPPs were adjusted to a basic price concept by 'peeling off' trade and transport margins and taxes net of subsidies. We call these 'adjusted expenditure PPPs'. However, as pointed out by other authors, the adjustments made are not sufficient. A correction for international trade is also needed, as expenditure prices include prices of imports and exclude prices of exports. This is especially important for comparisons involving small-open economies (Hooper and Vrankovich, 1995).[4] Finally, output prices reflect not only prices for final consumption, but also for intermediate use, for which expenditure PPPs are not available at all (van Ark 1996).

So far, the exact nature of the adjustments required to obtained adjusted expenditure PPPs at industry level has not been clearly spelled out in the literature. Moreover, the criteria on the basis of which to choose between adjusted expenditure PPPs and production PPPs has not been motivated. In this section, we use the basic balance equation between supply and use of goods in the Supply-and-Use table (SUT) framework to derive an exact relationship between expenditure and industry output prices. This relationship is used to indicate which adjustments need to be made to expenditure prices to be a reasonable proxy for basic output prices (Section 2.1). Next, we describe under which circumstances, and for which industries, these adjustments are likely to be empirically important (Section 2.2). In the remainder of this paper this framework is used to compile a mix of production PPPs and adjusted expenditure PPPs, which together provide the best possible set of PPPs for industry output, given current available datasources.

2.1 The link between output and expenditure prices

Supply and use tables provide a convenient way of summarising and presenting a coherent set of economic transactions within a country. For the purpose of this paper, its usefulness is in the clear link between various price concepts of products: basic price, producer price and purchasers' price. These are linked in the following way:

[4] Jorgenson, Nishimizu and Kuroda (1987) provided a comparison of U.S.-Japan productivity levels for which this problem is less urgent, although not insignificant

Producer price = basic price of the product received by the producer + taxes on the product - subsidies on the product

Purchasers' price = producer price + trade and transport margins in delivering the product to the purchaser

In the SUT framework, the valuation of domestic output is at basic prices, while the use of products (intermediate and final use) is recorded at purchasers' prices.[5] Below we provide an exposition of the full structure of the SUT framework. The following notation is used:

Commodities i, i=1,..,m and industries j, j=1,..,n

S_i = the quantity of total supply of product i

U_i = the quantity of total use of the product i

M_i = the imported quantity of product i

F_i = quantity of product i for final domestic demand

E_i = quantity of product i exported

Y_{ij} = the quantity of commodity i produced by industry j

X_{ij} = the quantity of commodity i used as intermediate input by industry j

p_{ij}^{Y} = the basic price received by industry j for selling commodity i

p_{ij}^{X} = the purchasers' price paid by industry j for intermediate consumption of commodity i

p_i^{M} = the basic (c.i.f) price of imported commodity i.

p_i^{F} = the purchasers' price for final domestic demand of commodity i

p_i^{E} = the purchasers' (f.o.b) price of exported commodity i

T = total taxes net of subsidies on products

R = total trade and transport margins

r_i^{S} = trade and transport margin rate on supplied product *i*

t_i^{S} = net tax rate on on supplied product *i*

GVA_j = value added of industry j at basic prices

A capital *V* in front of a symbol is used to indicate value.

[5] Exports are valued at free on board (f.o.b.) prices and the imports at cost, insurance and freight (c.i.f.) prices. The export fob price is essentially a purchasers' price including net taxes and trade and transport margins up to the border of the exporting country. The import cif price is essentially a basic price but excluding net taxes levied after crossing the border and trade and transport margins within the country.

Table 1 - Outline of Supply and Use Table

USE table at purchasers' prices

	Industries 1 .... j .... n	Total interme-diate use	Final domestic demand	Exports fob	Total use at purchasers' price
Commodities 1 : i : m	: .... $PX_{ij}X_{ij}$ .... :	: VX_i :	: PF_iF_i :	: PE_iE_i :	: $VX_i+VF_i+VE_i$:
Total intermediate input at purchasers' price	.... VX_j	VX	VF	VE	VX+VF+VE
Gross value added at basic price	.... GVA_j				
Gross output at basic prices	.... VY_j				

SUPPLY table at basic prices

	Industries 1 .... j .... n	Total domestic supply	Import cif	Total supply at basic prices	Taxes minus subsidies	Trade and transport margins	Total supply at purchasers' prices
Commodities 1 : i : m	: .... $PY_{ij}Y_{ij}$ .... :	: VY_i :	: PM_iM_i :	: $VS_i= VY_i + VM_i$:	: t_iVS_i :	: r_iVS_i :	: $(1+t_i+r_i)VS_i$:
Total at basic price	.... VY_j	VY	VM	VS= VY + VM	T	R	VS+R+T

Table 1 provides a simplified outline of a Supply and Use Table. Both tables have commodities in the rows, and industries in the columns. The Use table indicates for each product *i* its usage: intermediate, final domestic demand or exports. The last column indicates total use. The entries are at purchasers' prices. In addition, the Use table contains a value added block. For each industry *j*, total intermediate input at purchasers' prices plus value added at basic price adds up to gross output at basic prices. This is given in the last row.

The Supply table indicates the origin for each product, which is either domestic production or import. The fifth column records total supply at basic prices. The other columns provide information on taxes and subsidies on products and trade and transport margins. These are needed to arrive at total supply at purchasers' prices which can be set against total use at purchasers' prices from the Use table. Output of all products produced in industry *j* valued at basic prices sums to gross output at basic prices in this industry. This total is given in the last row in the supply table.

The Supply and Use tables are linked by two basic identities: the row identity which requires balance between use and supply for each product, and the column identity which requires identity for each industry between the sum of gross output over all products produced in an industry on the one hand, and value added plus intermediate consumption on the other. For this study, the first identity is important. It links the expenditure and production approach at the product level. The identity should hold both in terms of quantities and values. In quantity terms:

$$X_i + F_i + E_i = S_i \quad \forall i \quad (1)$$

This identity states that the quantity of supply of product *i* must be equal to its use, consisting of intermediate use, final domestic demand and exports. In value terms, at purchasers' prices, the identity is :

$$VX_i + VF_i + VE_i = VS_i + T_i + R_i \quad \forall i \quad (2)$$

The value of total intermediate use of *i* (VX_i) is equal to the sum of values of intermediate use of *i* by all producers, and the total value of supply (VS_i) is equal to the value of supply by all producers and imports. By rewriting values as the product of prices and quantities, (2) can be stated as:

$$\sum_j P_{ij}^X X_{ij} + P_i^F F_i + P_i^E E_i = (1 + t_i^S + r_i^S)\left(\sum_j P_{ij}^Y Y_{ij} + P_i^M M_i\right) \quad \forall i \quad (3)$$

By rewriting equation (3), the relationship between purchasers' prices (P_{ij}^{X} P_{i}^{F} P_{i}^{E}) on the one hand and basic output prices (P_{ij}^{Y}) on the other can be derived. This identity provides the basic relationship between the final domestic demand price and output price at the product level which we are looking for. To bring out this relationship more clearly we assume, without loss of generality, that there is only one basic price in the system for an individual product *i*, that is, the basic output price of a product is independent from its industry of origin:

Assumption 1

$$P_{ij}^{Y} = P_{i}^{Y} \qquad \forall i, j \qquad (4)$$

By rearranging equation (3), substituting (4) and using identity (1), the following basic result can be derived (omitting index *i* for clarity)

Result 1

Under assumption 1, the general relationship between basic output prices and final domestic demand prices can be written as

$$P^{Y} = \tilde{P}^{F} + A^{E,M} + A^{X} \qquad (5a)$$

Result 1 shows the key result for our purpose. It indicates that three types of adjustments are needed to derive an output price from a final domestic demand price: (1) an adjustment for margins and taxes ($\tilde{P}^{F}$); (2) an adjustment for international trade ($A^{E,M}$) and (3) an adjustment for intermediate consumption (A^{X}). The adjustments can be spelled out as follows

$$\tilde{P}^{F} = \frac{1}{(1+t^{S}+r^{S})} P^{F} \qquad (5b)$$

$$A^{E,M} = \frac{1}{(1+t^{S}+r^{S})} \left[\left(P^{E} - P^{F}\right)\frac{E}{Y} - \left((1+t^{S}+r^{S})P^{M} - P^{F}\right)\frac{M}{Y} \right] \qquad (5c)$$

$$A^X = \frac{1}{(1+t^S+r^S)}\sum_j \left(P_j^X - P^F\right)\frac{X_j}{Y} \qquad (5d)$$

The first term (5b) is the final expenditure price[6], adjusted for average net taxes and margins on total supply of the product. In fact, this adjusted final expenditure price has been used as a proxy for output prices by, for example, by Jorgenson, Nishimizu and Kuroda (1987) and Lee and Tang (2001). However, our result shows that two further adjustments are needed. The second adjustment is for international trade (5c). The size of the adjustment depends on the differences between the final expenditure prices and the export and import prices, and on the ratio of export and import to total domestic output. In a pioneering attempt, Hooper and Vrankovich (1996) have tried to adjust for international trade prices, but their methodology was ad-hoc and the adjustments based on very aggregate data, which has not been pursued further. Finally, the third adjustment (5d) depends on the size of the differences between the final expenditure price and the intermediate consumption price for a particular item, and on the ratio of intermediate consumption to total domestic output for that item. Adjustments for intermediate consumption have never been tried so far.

This basic result suggests that for products which are characterised by large shares of imports and exports and/or intermediate consumption in total output, adjustments for margins and taxes are not sufficient. Hence the more important international trade and intermediate use is, the weaker the proxy approach using adjusted expenditure PPPs. For industries which are mainly producing for final consumption, and which products are not (or hardly) internationally traded (e.g. personal services industries), the adjusted final expenditure price might be a reasonable proxy for the industry output price.

2.2 Biases in output price proxies based on expenditure prices

Next, we try to pin down more precisely the direction of the bias in using adjusted expenditure prices rather than basic output prices. This is important to know, because as stated in the introduction, production PPPs are not available for all industries and countries. Hence expenditure PPPs will always be needed to provide a complete set of PPPs for output covering the total economy. By making some additional, relatively harmless, assumptions, one can indicate the direction (under- or over-estimation) of the bias in using adjusted expenditure PPPs. To do so, we assume the following inequalities:

[6] We use the term final expenditure and final domestic demand interchangeably.

Assumption 2

$$P_{ij}^X < P_i^F \qquad \forall i$$
$$P_i^E < P_i^F \qquad \forall i$$
$$(1+t_i^S + r_i^S)P_i^M < P_i^F \qquad \forall i$$

We assume that the intermediate consumption and export purchasers' prices, and the import price adjusted with total supply net taxes and margins, are all lower in absolute terms than the final expenditure price. The plausibility of this assumption is motivated as follows. Trade margins for final expenditure are generally higher than for other uses. While wholesale margins may be identical across the board, final consumers typically purchase their goods through retailers and hence pay an additional retail margin on top of what intermediate users or exporters pay. Also, product tax rates for final consumers frequently differ from tax rates paid by producers for the same good. This is especially true for countries which have a VAT-system. Typically, VAT (value added tax) is being paid by final consumers, not by producers. In addition, one can deduce that net taxes and margins for total supply will be lower than the net taxes and margins for final expenditure.[7]

With these assumptions we can assess the difference between the adjusted expenditure price and the domestic output price. **Table 2** provides an overview of various possibilities for a particular good *i*. We distinguish the following two dimensions: the use of the product and the international tradability of the product. The use-dimension subdivides into the following exclusive categories: final expenditure only, intermediate consumption only or both uses. The trade-dimension can be subdivided into: no trade, only exports, only imports, and both. For each case we indicate whether a adjusted expenditure price is a good proxy for the domestic output price. When the adjusted expenditure price is equal to the basic output price, this is indicated with a 0. When there is no expenditure price available, this is indicated by (n.a.). In all other cases the direction of the bias is known and indicated by the bias due to international trade ($A^{E,M}$) and/or intermediate consumption (A^X), or the direction of the bias is unknown as indicated by a '?'.

Table 2 Bias in adjusted final expenditure price as a proxy for domestic output price

	No int. trade	*Only Export*	*Only Import*	*Both*
Only Final use	(1) 0	(4) $A^{E,M} < 0$	(7) $A^{E,M} > 0$	(10) ?
Only Intermediate	(2) n.a.	(5) n.a.	(8) n.a.	(11) n.a.

[7] We assume that there is no data on margins and taxes by use category, only for total supply. Margin and tax matrices are scarce indeed. If not, one could adjust final expenditure prices by the margins and taxes for final expenditure only, rather than for total supply.

use				
Both uses	(3) $A^X < 0$	(6) $A^{E,M} + A^X < 0$	(9) ?	(12) ?

One can allocate each product in the economy to one of the 12 cells in Table 2, based on the proportions of final use, exports and imports. In Appendix Table 1 we show the shares of expenditure, intermediate and export demand in total use, and the shares of domestic production and imports in total supply for each major sector for a large economy (the U.S.) and a small open economy (the Netherlands),. Based on this information, we discuss examples of products which fall into each of the 12 possible cases.[8]

Case 1: when the product is not internationally traded and all domestically produced goods are for final expenditure, the adjusted expenditure price is equal to the basic output price. This is typically true for products in the construction sector, hotels and restaurants, real estate and public services (including education and health).

Cases 2, 5, 8 and 11: when the product is only used for intermediate consumption, no final expenditure price exists. Obviously, the domestic output price cannot be proxied by expenditure prices in these cases, and seeking an independent basic output price is the only alternative. For a large number of agricultural, mining and basic manufacturing products this holds true, as well as for large parts of business services.

Case 3: when the product is not internationally traded, but is partly used for intermediate consumption and partly for final use, the adjusted final expenditure price overestimates the basic output price. In this case, E and M, and hence $A^{E,M}$ are zero and as we assumed that the intermediate consumption price is lower than the final expenditure price, A^X will be negative. This is the case for products from utilities, distributive trade, finance and personal and other services.

Cases 4 and 6: when the product is exported, but not imported, and used both as a final and an intermediate good, the adjusted final expenditure price also overestimates the basic output price. In case 4, $A^{E,M}$ is negative and A^X zero, while in case 6 both are negative. This situation is rare, but includes examples such as products from the transport sector in the Netherlands.

8 Most products will of course be used for both final and intermediate uses, and there will always be some importing and exporting. The empirical distinction here is referring to "mainly" used for final consumption, rather than "only" used for final consumption, and likewise for the other categories.

Case 7: when the product is only imported and only used as a final good (X=E=0), the adjusted final expenditure price underestimates the basic output price. This is opposite to case 4, as A^X will be zero and $A^{E,M}$ positive. Examples include non-durable manufacturing goods in the U.S.

Case 10: when the product is only used as a final good, but both imported and exported, the bias is unknown. On the one hand, it underestimates due to imports (see case 7), but it overestimates due to exports (see case 4). The combined effect is unknown. Examples include products from durable manufacturing, and from some other manufacturing industries in the Netherlands (non-durable and food)

Case 9 and 12: when the product is imported and both a final and intermediate good, the bias is also unknown. On the one hand, it underestimates due to imports (see case 7), but it overestimates due to exports and intermediate use (see case 6). The combined effect is unknown.

Table 2 can be summarised in the following result:

Result 3
Under assumption 2, result 1 leads to the following:

Only for final goods, which are not internationally traded, the adjusted final expenditure price are equal to the basic output prices.

When the product is only used for intermediate consumption, the domestic output price cannot be estimated on the basis of a final expenditure price.

When a product is mainly exported, the adjusted final expenditure price will overestimate the basic output price.

In all other cases, the adjusted final expenditure price provides a biased estimator of the basic output price which size depends on the differences in purchasers' prices and the ratio of import, export and intermediate consumption to total output.

When price comparisons are made between countries as for PPPs, the important question in this context is whether the biases are of equal sign and size in both countries. When the bias can be assumed to be in the same direction and of a similar size in both countries, final expenditure price ratios might be a reasonable proxy of output price ratios. But if these assumptions do not hold, the adjusted final expenditure price provides a biased estimator of the basic output price ratios between the countries. This is most likely to be the case when comparing economies with very different trade/GDP ratios, such as a small open economy, like many small European economies, with a big economy like the U.S. or Germany.

3. A new dataset for gross output PPPs

In this paper we present a new database of PPPs for gross output for 45 industries and 25 countries for the year 1997. The 25 countries include 24 major OECD countries and Taiwan[9]. The basic set-up of the database is as follows. At the most detailed level, we derive binary PPPs for 221 three digit industries. The basic 3-digit production PPPs are based on a mix of expenditure PPPs and production PPPs. These binaries are multilateralised above the 3-digit level by using the EKS method. In section 3.1 we describe the basic set up of our database above the industry level, in particular aggregation schemes. This includes the issues of weighting production PPPs to obtain higher aggregates. In section 3.2 we motivate our overall approach in choosing either an adjusted expenditure PPP or a production PPP at the detailed industry level. For some industries only one of the two alternatives are available, but in other cases the sets of PPPs are overlapping, especially for manufacturing industries. The choice will be based on the criteria laid out in the previous section, combined with practical considerations, which also play an important role. We subsequently discuss in section 4 in much more detail our approach towards individual major sectors

3.1 Basic set-up above the 3-digit industry level

In compiling the new PPP dataset, we make a clear and consistent distinction between methodologies used above industry level and those below industry level, that is, for individual products or product groups. At the industry level there are 221 3-digit ISIC (rev 3) industries.[10] For aggregation of industries the EKS method, proposed by Elteto and Koves (1964) and Szulc (1964), is applied. This method is designed to construct transitive multilateral comparisons from a matrix of original binary/pairwise comparisons which does not satisfy the transitivity property. The EKS method in its original format uses the binary Fisher PPPs (F_{jk}: j,k=1,..M) as the starting point. The computational form for the EKS index is given by:

$$EKS_{jk} = \prod_{l=1}^{M} \left[F_{jl} \cdot F_{lk} \right]^{1/M} \qquad (6)$$

with EKS_{jk} the EKS PPP between country j and k. The formula defines the EKS index as an unweighted geometric average of the linked (or chained) comparisons between countries j and k using each of the countries in the comparisons as a link. The EKS method does not only produce comparisons that are transitive, but the indices also satisfy the important property that the index deviates the least from the pair wise Fisher binary comparisons.[11]

---

[9] An extended version of this dataset, including PPPs for Cyprus, Estonia, Latvia, Lithuania, Malta, New Zealand and Slovenia is available on the EU KLEMS Website (www.euklems.net).

10 This is comparable to the number of basic headings used in the ICP programme. The basic heading is the lowest level in the ICP expenditure approach from which aggregation takes place.

11 Since the Fisher index is considered to be "ideal" and possesses a number of desirable properties, the EKS method has a certain appeal since it preserves the Fisher indices to the extent possible, while constructing multilateral index numbers. This property is in line with the property of characteristicity discussed by Drechsler (1973). See Prasada Rao and Timmer (2003) for weighted variants of the EKS.

The weights used in the industry aggregation are based on gross output.[12] As there is no readily available data source on gross output covering all 221 industries, gross output by industry was specifically constructed for the purpose of this study. The dataset is based on gross output figures from the OECD STAN database. However, STAN only provides a limited amount of information on industries at 3 digit level. The gaps were filled with output shares obtained from Use tables (obtained from Eurostat or from NSI's in individual countries) and industry statistics, such as the OECD Industrial Structure Database (I&S), the Eurostat Structural Business Statistics Database, national censuses and industry surveys, etc.. In all cases, however, the consistency with OECD STAN at a higher level was maintained.

In specifying the aggregation weights, we take account of the reliability of the 3-digit PPPs. Reliability depends on the percentage of output covered by the PPPs, the coefficient of variation of the PPPs and/or the number of product matches within an industry (see section 4 for precise definitions). If the PPP was considered to be reliable, the gross output for the entire industry was used as a weight. Otherwise only that part of industry output that is covered by the item PPPs (so-called "matched output") is used, effectively giving a lower weight compared to a reliable PPP. Below the basic heading (3-digit) level a variety of methods have been used, depending on data availability. These are described in the next sections.

3.2 Production PPPs or adjusted expenditure PPPs?

For the PPPs at 3-digit industry level, we compiled two sets of PPPs where possible, that is, production PPPs based on output unit values and producer prices, and a set of adjusted expenditure PPPs. In this section we motivate our general approach to making a choice, using the criteria laid out in the previous section. For some industries only one of the two alternatives are available. Production PPPs are not available for a number of services industries due to a lack of appropriate value data at industry level and the difficulty of defining quantities. In some manufacturing industries the use of expenditure PPPs is not an option because no expenditure price data are available for intermediate product items.

At industry level, the production PPPs, as traditionally developed in the ICOP programme, are theoretically the most preferable PPPs. However, practical considerations must be taken into account as well. The main practical objection against using production PPPs is that these are mostly based on ratios of unit values. Basic prices for specified items at producer level are often not available. Unit values often suffer from 'product mix' and 'product quality' problems in international comparisons. Unit value ratios may also be biased towards samples of products which are relatively homogeneous, less sophisticated goods. Production PPPs are then not representative of the more upgraded, high-quality varieties in the same industry. These criticisms have surfaced in the past (see e.g. Jorgenson 1993 and Lichtenberg 1993), and have been dealt

[12] Gross output weights were preferred over value added weights (as in previous ICOP studies), because the PPPs reflect relative prices of gross output, not value added.

with in various ways in the ICOP research program. For example, the availability of an EU-wide harmonized survey with quantity and value data at basic prices on product basis (PRODCOM) is an important improvement to international comparability. In addition the number of unit values which can be calculated is much higher than in earlier studies, due to more detailed product data on values and quantities. Finally, the use of secondary sources on prices either derived from business data sources or from industry specific surveys, have helped to reduce the biases in production PPPs. Nevertheless, in some cases expenditure PPPs are still a better choice. In sum, the decision on whether to use an expenditure PPP (with imperfect adjustments) or an production PPP (which is often based on a unit value) is largely an empirical one, and will differ between industries. It may also change over time as new data become available and old data sources are discontinued.

In **Table 3** a qualitative assessment is made of the usefulness of existing sets of expenditure PPPs and production PPPs for 17 major sectors of the economy. Expenditure PPPs are taken from the OECD (1999 round) and production PPPs from the ICOP-project (1997 round) at the University of Groningen. The table reflects our key results from section 2: for an industry in which the share of final expenditure in total use is low, adjusted expenditure PPPs might serve as a bad proxy for domestic output prices (e.g. agriculture, mining, basic manufacturing, transport). A high share of imports in total supply of goods also indicates the possibility of mismeasurement (e.g. durable and non-durable manufacturing) when using expenditure PPPs. However, expenditure PPPs are acceptable proxies for domestic output prices when expenditure shares are high and import ratios low as, for example, is the case in sectors such as construction, hotels and catering and real estate. In the production PPP column we assess the usefulness of the production PPPs. The production PPPs are mainly based on unit value ratios and cover agriculture, mining, manufacturing, transport, communication and trade industries. Their usefulness depends mainly on the severity of the quality problem as discussed above. In the final column of table 3 we indicate our final choice for adjusted expenditure PPPs or ICOP production PPPs in putting together a set of PPPs for deflating gross output at the industry level.

Table 3: Assessment of usefulness of adjusted expenditure PPPs and production PPPs for industry output comparisons in the OECD

		Grade		Remark		
Industry	ISIC rev. 3 code	Adjusted expenditure PPP	Production PPP	Adjusted expenditure PPP	Production PPP	Final choice in this database
Agriculture	01-05	0	5	Not available	-	production
Mining and quarrying	10-14	0	4	Not available	-	production
Manufacturing	15-37					
Food, drink & tobacco	15,16	3	4	Trade intensive	-	Mainly production
Basic goods	17,20,21,23-28	1	4	Small expenditure share	-	Mainly production
Non-durable	18,19,22,36,37	2	4	Trade intensive	-	Mainly production
Durable	29-35	2	2	Trade intensive	Quality problem	production/expenditure
Electricity, gas and water supply	40,41	3	2	Low expenditure share	Quantity problem	expenditure/production
Construction	45	4	0	-	Not available	expenditure
Trade	50-52	0	2	Not available	Quality problem	production
Hotels & catering	55	4	0	-	Not available	expenditure
Transport	60-63	1	3	Small expenditure share	Quality problem	production
Communications	64	2	3	Small expenditure share	Quality problem	production
Finance	65-67	1	0	Reference PPP	Not available	expenditure
Real estate activities	70	4	0	-	Not available	expenditure
Business services	71-74	1	0	Small expenditure share	Not available	expenditure
Public administration and defence, education and health	75, 80,85	1	0	Mainly based on input PPPs	Not available	expenditure
Other services	90-95	2	0	Small expenditure share	Not available	expenditure

Note: ranking indicates 0 (not available), 1 (very poor), 2 (poor), 3 (acceptable), 4 (useful) and 5 (very useful).

Source: assessment based on expenditure PPPs for OECD from 1999 round and production PPPs for 1997 from Groningen Growth and Development Centre, ICOP-project, see section 4.

4. Detailed Sources and methods for three-digit PPPs

In this section, we provide an in-depth discussion of the sources and methodologies used to generate the 3-digit PPPs. The discussion is organised by major economic sector: agriculture, mining, manufacturing, public utilities, wholesale and retail trade, transport and communication, and other services. We motivate our choice for the mix of expenditure PPPs and production PPPs, describe the underlying sources and methodologies used for their derivation, including the adjustments made to expenditure PPPs. Occasional reference is made to Appendix Tables 2 and 3, which provide reliability measures of the PPPs for eleven broad sectors and 21 detailed manufacturing industries respectively. For each sector and country, the table shows the number of producer prices or unit value ratios used (in case of production PPPs) and the number of basic headings used (in case of expenditure PPPs). The last column indicates the percentage of gross output covered by the price data.

Agriculture, forestry and fisheries

Agricultural output consists almost exclusively on products used for intermediate input by other firms, not for final consumption. Therefore, expenditure PPPs cannot be used as a proxy for agricultural output PPPs. The agricultural PPPs for this study are developed along the same lines as earlier ICOP work on agriculture (Rao, 1993). We rely exclusively on production PPPs based on producer prices from the FAOSTAT Database of the FAO. This database contains a very extensive set of quantities and farm-price values of up to 146 agricultural products.[13] The "price received by farmers" in the FAO series refers to the national average prices of individual commodities comprising all grades, kinds and varieties received by farmers at the farm gate or first-point-of-sale.[14] We computed EKS PPPs for all 25 countries in the dataset for the 3-digit industries crops (ISIC rev 3 industrial code 011) and livestock (012). The average of the PPPs for crops and livestock were used for the other 3-digit industries which are not covered, including fishing and forestry.

Appendix Table 2 shows that output coverage in the agricultural sector is very high. On average about 70% of gross output is covered by our price data. Low coverage is found for Finland and Norway (which have a large fishing sector which is not included in the data), but as high as almost 100% in Greece.

Manufacturing

Compared to other industries, the construction of PPPs for the manufacturing sector has been most common. Most earlier ICOP studies were binary comparisons that were based on censuses

13 The FAO does not show data for Taiwan and only shows an aggregate for Belgium and Luxembourg for 1997. Data for Taiwan were obtained from the Statistical Yearbook and agricultural production statistics, and the figures for Belgium and Luxembourg have been split from the aggregate with the 2002 shares.
14 The gross output consists only of the goods that have been supplied on the market, the production of products for own use has been omitted.

and industry surveys, with the matching of products mostly done manually. Some studies have applied multilateralisation procedures, but these were mostly at the level of individual industries or for a limited set of countries (Pilat and Rao, 1996; Rao and Timmer, 2003). The main novelty of the new PPP dataset for manufacturing is the use of PRODCOM, which a harmonized set of product data for European Union member states. PRODCOM greatly enhances the number of product matches on the basis of which unit value ratios (UVRs) were constructed. In addition, the new dataset makes use of adjusted component expenditure PPPs from ICP where appropriate, and applies hedonic UVRs for cars.

Unfortunately it was not possible to create a multilateral dataset for manufacturing at the product-level. This is due to the fact that, except for the EU countries, we do not have an common product listing for all countries involved, as was the case for agriculture.[15] Therefore we opted for a bi-polar star system of binaries at the 3-digit industry level, which was multilateralised above the 3-digit level as discussed in section 3.1. The two-star countries are Germany, which was the star for binary comparisons of all EU countries, and the United States, which served as the star country for the other five non-EU countries. These two countries were chosen as these were the countries with the greatest amount of information on products. Subsequently, Germany was linked with the U.S., so that all countries can be (indirectly) compared to each other.

The PRODCOM database, which is available for all "old" EU-15 countries and Norway, includes quantities and sales values by product item, linked to the NACE classification, for up to 7,000 product items. The PRODCOM database is essentially based on the original national production censuses and industry surveys, but uses a harmonized product coding system. Since its start in the mid 1990s, PRODCOM's coverage has greatly expanded, although there are still some gaps at 3-digit industry level (and also for 2-digit mineral and oil refining).[16]

Using the PRODCOM database, production PPPs were made for individual product items. These production PPPs rely on the ratio of the unit value for each matched item with that of Germany, the so-called unit value ratios (UVRs). The new member states of the EU were also matched with Germany based on national census and production survey data. Subsequently the German PRODCOM dataset was matched with data from the *U.S. Census of Manufactures* for 1997. All non-EU countries were directly matched with the U.S. on the basis of national production censuses and industry surveys. For all binaries, Fisher UVRs were computed at the 3-digit level, using quantity weights for the matched products of a country and the base country (the U.S. or Germany).

In addition to the unit value ratios, a set of adjusted expenditure PPPs was constructed for 3-digit industries where UVRs did not suffice. This was the case when no UVRs were available, the

[15] In principle, multilateral product PPPs could be derived for countries using the same product classification, as the European countries in the PRODCOM database. But it appeared that the overlap in production structures was often small for quite a number of binary comparisons.

[16] The raw PRODCOM data has been cleaned for outliers. All unit values that fell outside the range of 0.2 and 5 times the EU average were removed. This was applied recursive, so the EU average reflects the average of the data which is in the cleaned dataset, not the original one.

UVR was based on less than three matches, or the 'product quality' issue was too big for allowing the use of a UVR. Adjusted expenditure PPPs were applied for all 3-digit industries in industries (ISIC rev 3 code) 30 (Office equipment), 33 (Scientific Instruments) and 35 (Other Transport vehicles), but also for some 3-digit industries in 23 (mineral and oil refining) and other durable goods manufacturing (31, 32 and 34). For each 3-digit industry in these major groups, the expenditure PPPs from the International Comparisons Program (ICP) have been browsed for a matching of a PPP at basic heading level. The expenditure PPPs for 1999 have been used as the main source, but 1996 PPPs were considered in case 1999 results could not be used. The expenditure PPPs have been adjusted for trade and transport margins, and for taxes as suggested in section 2.[17] In addition a hedonic production PPP was developed for automobiles for France, Germany, Italy, Japan, UK and the U.S. (see van Mulligen 2003).

Appendix Table 3 shows the summary statistics on the number of matches (product UVRs and basic heading expenditure PPPs) used, and their coverage of gross output for each country at a 2-digit industry level. Coverage ratios are generally much higher than in previous ICOP studies due to the additional use of expenditure PPPs. Coverage ratios were up to almost 40% in eight countries including Australia, Canada, Italy and Spain. This is indicated by the third column in Appendix Table 3, which provides the percentage of output covered by the mix of production and expenditure PPPs. The last column in Appendix Table 3 indicates the output coverage by expenditure PPPs alone. Typically, this is less than 7%, but in some cases it can be up to 10%, for example for countries like Australia, Canada, France and Portugal. The comparison for Slovakia entirely relies on expenditure PPPs as no production PPPs could be constructed. The most important difference with previous studies, however, concerns the number of product matches used. Whereas in previous studies, the number of UVRs used was typically below 300, the use of the PRODCOM dataset allowed many more product matches, e.g. more than 1,000 product matches for Italy, and in between 600-800 matches in Denmark, France and the U.K. This indicates that the 'product mix' problem of unit values, which was due to the aggregate nature of past UVRs, is much less in the present study than in the earlier work.

As outlined in section 3.1, the EKS procedure was applied to generate multilateral PPPs at the 2-digit level. The set of binary 3-digit manufacturing production PPPs was aggregated by generating a matrix of Fisher PPPs using the two bridge-countries, Germany and the U.S.. In the weighting procedure from 3-digit to 2-digit level, both gross output and matched output weights were used as described in Section 3.1. For the aggregation of UVRs the choice for the use of matched output or industry output weights is based on the number of matches and the coefficient of variation. If the number of matched products is lower than three or the coefficient of variation

[17] The PPPs were adjusted to 1997 with detailed industry deflators from the GGDC 60-industry database. The ICP PPPs were adjusted for Value Added Tax and trade margins. Data on trade margins directly come from the data used for the construction of PPPs for retail and wholesale trade (see below). To make an adjustment for Value Added Tax (VAT), we used product-specific rates from the OECD publication on *Consumption Tax Trends 1999* and the European Commission's *VAT Rates applied in the Member States of the European Community*.

is higher than 0.1, matched output is used as the weight. For expenditure PPPs the number of PPPs within a 3-digit sector is mostly lower than three. We therefore used a somewhat different rule: if the output covered by an ICP PPP is lower than 20% of industry output, matched output is used as weight.

Mining

The set-up for mining PPPs is similar to that for manufacturing with a bi-polar star system based on binaries with the U.S. or Germany. As mining products are almost exclusively used for intermediate consumption, expenditure PPPs are not available and we must exclusively rely on production PPPs. For the old EU-15 countries these are mainly based on PRODCOM data. As the 1997 version of PRODCOM was still rather incomplete, the dataset was extended with matches from other years, which were converted to 1997 prices with industry deflators from the OECD STAN database. The PRODCOM database for European countries was extended by national *Mining or Industrial Surveys* to provide information for some important products that were missing from PRODCOM.[18] Similar sources were also used to add figures for new member states of the EU and for non-EU countries. For the United States a combination of two sources was used, namely the *Statistical Abstract of the United States 1999*, which contains values and quantities for broad mining products, and the *1997 US Census of Manufactures*, with very detailed product information. For a limited number of items different sources were combined to obtain quantities and values. For example, for large homogenous products that cover a total 3-digit industry like hard coal (10.1), lignite (10.2), peat (10.3), salt (14.4), aggregate industry output values were combined with quantity measures from the *United Nations 2001 Industrial Commodity Statistics Yearbook.*

Compared to previous ICOP studies in mining, the inclusion of mining products from the PRODCOM database has considerably raised the number of product matches to an average of 12 product matches per country with high scores of up to 36 product matches. Average coverage of mining output is about 50% (see Appendix Table 2).

Public Utilities

For derivation of output PPPs for public utilities, production PPPs and expenditure PPPs can in principle both be used as utility output is mostly domestically produced and used for intermediate consumption by firms and final consumption by private customers. Production PPPs have been developed in past studies, but it appeared to be very difficult to find a proper way of matching output value and output quantities. There is no source that contains both production quantity and value data. Hence we relied on a combination of expenditure PPPs for household consumption in combination with new developed PPPs for the intermediate deliveries to industries. The 1999 ICP

18 To eliminate outliers, the unit values that are not within the range of 5 or 0.2 times the average of all European countries are filtered out.

expenditure PPPs are peeled off for taxes and deflated to 1997. The information about VAT and excise taxes on electricity is obtained from the International Energy Agency's *Energy Prices & Taxes* (2nd quarter 2006)[19]. This publication was also the main source for the calculation of PPPs for intermediate consumption by firms. It provides prices for both natural gas and electricity with a distinction between prices for households and for industries. We take the price excluding taxes. The PPP for electricity consumption by firms is therefore calculated as the ex-tax price of country *x* divided by the ex-tax price of the US. For gas, a different procedure was used. For the United States only the total gas price including taxes was available, which is why we take the total price for natural gas and peel off the taxes to get the PPP. In most cases the government does not levy taxes to industries, or makes them refundable. Only in Canada, Germany, Finland, Japan, Netherlands and Korea industries have to pay non-refundable (excise) taxes.

For water supply (NACE 41) and steam and hot water supply (NACE 40.3) no price data was available to construct an energy PPP for intermediates. Three-digit PPPs for these industries are therefore completely based on peeled ICP PPPs. The tax-rates for the peeling procedure come from the European Commission (2004) 'VAT rates applied in the European Community' and deflators are from the GGDC 60-industry database.

The aggregation of energy PPPs for final consumption and intermediate input has been done with final household consumption and intermediate industry use as weights. These weights were taken from Use tables or input-output tables. In most cases the detailed split-up between electricity, gas and water was possible, but if those industries were not separated we used the split up at a higher level (40 or even 40-41).

Appendix Table 2 shows that coverage ratios in the utilities sector are close to 100%, but the number of PPPs differs across countries. Typically there are six PPPs, but for Luxembourg (electricity and gas), and for Denmark, Norway, Portugal and Sweden (only gas) no energy PPP for intermediate use could be calculated. This means that the respective PPPs are also only based on the household PPP. For Taiwan no ICP PPPs were available, so the PPPs are purely based on UVRs from the ICPA project. Given developments in the energy markets in many countries, one of the challenges for the future is a split in utilities between the production and the distribution of electricity, gas and water. So far, this type of data is lacking.

[19] For missing data, the European Commission (2004) 'VAT rates applied in the European Community' and the OECD (1999) Consumption Tax Trends formed a good back-up.

Wholesale and Retail Trade

Comparisons of prices in services industries are complicated by the fact that the output concept is often not unambiguously defined, and a price per unit of output is therefore difficult to develop. The distributive industry has an additional complication. Gross output of distribution industries can be measured in terms of sales or turnover[20], which is the concept mostly used for industries other than trade, or as the margin value (sales minus cost of goods sold). In countries' national accounts, trade output is defined as margin value. It therefore measures the services delivered by making goods available at alternative places and times, without modification of the product itself. The correct price for deflation of trade output would therefore be margin prices. A margin price represents the price a consumer pays for a unit of trade services. However, whereas the sales price of a good of service can be directly measured, the margin price is much more difficult to determine. The direct measurement of margin prices, taking the difference between the price of the good received when it is sold to the consumer and the price of the same good when purchased by the trade firm, is only being experimented with by some national statistical institutes. Most NSIs use the so-called "sales-indicator method", using deflated sales as an indicator for margin volumes, taking into account changes in the margin-to-sales ratios over time.

Until recently international comparisons of the distribution sector used a single deflation method, based on the use of expenditure PPPs (retail sales prices). The approach adopted in this study is different, as it aims to mimic the procedure for the deflation of output in trade services in national accounts. In contrast to single deflation, the sales-indicator method makes use of differences in the margin-to-sales ratios between countries. The crucial assumption is that sales transactions represent the same quantity of trade services in both countries. Obviously this is a strong assumption as service quality levels can differ between countries, even for the same set of goods and type of outlet. However, without detailed information on service quality levels, this assumption is necessary to separate prices and quantities and proxy a double deflated PPP (which separately deflates sales and purchases) as good as possible. The method sales-indicator method is superior to single-deflated measures.[21] A full scale double deflation procedure, which provides independent measures of sales and purchase prices, is still too difficult to implement empirically at this moment (but see van Ark et al, 1999; van Ark and Timmer, 2001 for early attempts).

The available price data is different for the wholesale and retail industries. In the case of retail, expenditure PPPs for individual expenditure categories were directly applied to sales output. The PPP at margin level is derived as a weighted average of the sales PPP of all goods, corrected for differences in margin-to-sales ratios between two countries. In the case of wholesale trade, only prices of goods purchased by the wholesale sector are observable. In this case, margin PPPs are derived by adjusting for differences in margin-to-cost ratios between two countries.

Information on retail and wholesale sales, purchases and margins were obtained from national trade census and survey data at 3- or 4 digit level. Expenditure PPPs for retail sales were available

[20] Adjusted for inventory changes.
[21] See Timmer and Ypma (2006) for an elaborate discussion

from the International Comparisons Program (ICP) for 1999. These expenditure PPPs were allocated to 4-digit retail industries on the basis of their presumed retail trade channel.[22] The prices of goods purchased by the wholesale industry are obtained through the output price of the domestic producer of these goods. Relative output prices for agricultural and manufacturing goods are obtained from the measures in the present database, as discussed above. Two-digit manufacturing industries have been linked to each of the wholesale industries on the basis of their importance in wholesale industry purchases.

In Appendix Table 2, one can see that for more than sixty 4-digit trade industries margin PPPs could be calculated for most binary comparisons. This is due to a fine level of industry-detail, which is important given the fact that margin prices differ considerably across trade industries (Timmer and Ypma, 2006).

Transport and Communication

In transport a large share of services are used for intermediate consumption and international trade. There is also a clear difference in the product mix of transport services used by private households and businesses. For example, trucking and shipping services are mostly for intermediate use, whereas bus services are mainly for final consumption. The usefulness of expenditure PPPs for the transport sector is therefore limited, and we relied rather exclusively on UVRs, following previous ICOP-research. In the transportation sector, activities are divided in passenger transport (train, bus, domestic air and international air) and goods transport (train, truck, domestic air, international air, coastal shipping and ocean shipping). Passenger-kilometres and ton-kilometres were the most frequently available measures for quantities.

The key challenge in transport and communication is to match value and quantity data from the same source in order to ensure consistency. This could be done for the railway sector, for which the *World Bank Railway Database* was used, containing data for many countries. For the air transportation sector both quantities and values were obtained from the *Civil Aviation Statistics of the World 1997* of the ICAO. For the other land transportation and water transport, various sources needed to be combined. The *Annual Bulletin of Statistics for Europe and North America 1999* of the United Nations was the main source for the quantity data, while value data mostly stems from detailed national sources, the OECD *Industry and Statistics* database or Eurostat *Structural Business Statistics*.

[22] The 1999 expenditure PPPs are converted to 1997 on the basis of price deflators from the GGDC 60-industry database. Expenditure PPPs are corrected for deductible VAT or sales tax by using the OECD *Consumption Tax Trends 1999* and *VAT Rates Applied in the Member States of the European Union* from the European Commission. To get a total sales tax rate for the United States, state rates have been weighted with their share in U.S. GDP, providing a weighted sales tax of 5.3%. We also made an adjustment for excise taxes in the case of fuels sale. For other products with large excise taxes such as tobacco and alcohol, differences between countries are relatively small and no adjustment has been made.

In previous work, a special adjustment was made for terminal services. Because terminal services (ports, airports, stations) could not be distinguished from movement services, a terminal adjustment was made for each transportation mode, using adjustment factors which were obtained from the inverse of the ratio of relative average distances travelled (van Ark *et al.*, 1999). Fortunately, the change in industrial classification from ISIC rev. 2 to rev. 3 allowed for the creation of a separate new industry for handling services (ISIC rev. 3 63). For cargo handling and storage (63.1 and 63.4) and other supporting transport activities (63.2), measures of tonnages and passenger numbers could be used to measure quantities. Value data for the various types of supporting services were obtained by assuming that the shares of transport of persons and freight in gross output by transport mode were also applicable to supporting services for rail, road and air transport.[23]

For the communications sector, a similar approach was used as for transport. Communication activities are divided into postal activities and telecommunication. In previous work, typically only two service activities were taken into account (postal deliveries and number of phone calls), but in this study this was expanded to 10 activities. We made use of two databases with both quantities and values. The postal sector is described in the *Universal Postal Database 2004* of the Universal Postal Union. This database contains various quantity measures (domestic and international letter post, registered items, insured letters, newspapers, parcels) for the postal sector in developed countries, as well as the operating revenue of the postal sector. Measures of the number of local and national calls, international called minutes and cellular subscribers as well as the revenue from these services was obtained from OECD's *Telecommunication Database 2003*.

In Appendix Table 2 one can see that typically twenty or more UVRs have been used to derive the output PPP for the transportation and communications sector, covering about 60% or more of gross output in this industry. This is a major improvement compared to previous work. However, a major challenge for the future is the need to take international differences in the quality of transport and communication services into account (see, for example, O'Mahony and Oulton 2000).

Other Services

For a range of service industries, no production PPPs are available as yet and we had to rely solely on adjusted expenditure PPPs.[24] We adopted a disaggregated approach by obtaining ICP PPP for individual 3-digit industries.[25] Almost all ICP basic headings could be allocated to one or more 3-digit industries. In some cases we used an ICP PPP for more than one sector, because the

[23] See Ypma (2007) for an elaborate discussion.

[24] There have been some attempts to derive unit values for these sectors, by using quantity measures such as number of houses built (for construction), number of students (for education) or size of M2 money supply (for finance) (see Pilat, 1994; and Mulder, 2002). However, we deem these proxies to be too crude to apply widely across countries.

[25] As for previous sectors, PPPs were converted to 1997 with value added deflators from the GGDC 60-industry database. The PPPs were also adjusted for value added taxes (or sales taxes in the U.S.), taking into account tax exemptions of some service industries.

PPP was too broad for one 3-digit PPP.[26] Still it has to be stressed that the usefulness of expenditure PPPs differ greatly across industries. For example, adjusted expenditure PPPs provide a very good proxy for the PPPs for gross output in the construction, hotels and restaurants, and real estate activities as almost all output of these industries is for final expenditure, with very little export and import activity. Consequently, coverage ratios are very high, see Appendix Table 2.[27]

For other industries, expenditure PPPs are poor proxies. For community, social and personal services only nine PPPs could be found, covering 50 to 80 % of output. This is due to the fact that a sizeble share of these services is used for intermediate, not final consumption. Furthermore the mix of services used by producers will differ considerably from the services used by final consumers. One might argue that the products in this industry fall into two categories: products for final consumption for which the expenditure PPP should be a good proxy (case 1 in Table 2), and products of intermediate use for which no expenditure PPP is available (case 2 in Table 2). This situation is also typical for business services, which output is mainly destined for other firms.

The expenditure PPPs for finance, public administration, education and health bear little relation with output prices. The expenditure PPP for finance is a reference PPP, which is based on the overall expenditure PPP, rather than on relative prices of financial services. Given the way in which financial output is currently deflated in most national accounts, this practice is perhaps defendable. Expenditure PPPs for the other sectors are mainly PPPs for inputs. However, as long as output of these sectors in the national accounts is also measured by inputs (costs) only, these PPPs have at least some validity.

For the R&D industry (73), no specific ICP PPP was available, but a PPP could be obtained from an R&D cost-based study by Dougherty et al. (2006), which obtains separate PPPs for the compensation of R&D workers combined with an aggregate GDP PPPs for other cost categories.

[26] The basic heading system of ICP is based on internationally harmonized classifications, such as the (H)ICP (Household consumption categories), COFOG (Classification of Government functions) and COPNI (Non-profit institutions functions), so detailed descriptions could be used to match expenditure PPPs and industries.

[27] Coverage ratios for adjusted expenditure PPPs are calculated as nominal consumption from ICP over gross output.

5. Comparisons of industry output prices and relative price levels

There is a wide range of applications of gross output PPPs for research in economics. As discussed in the introduction, one of the main applications is in sectoral price and productivity studies. In this section we focus on a comparison of relative price levels for 1997. A relative price level is defined as the ratio of a PPP by the official exchange rate. Relative price levels above one indicate that the output price of the industry in a particular country, converted at the exchange rate, is higher than the output price in the base country, in this case the U.S.

Table 4 presents the relative price levels for all 25 countries relative to the U.S. at the broad level of ten major sectors. The countries are ranked in ascending order on their GDP per capita level in 1997. The results suggest considerable price differences between sectors and countries. Summary statistics on the average of relative price levels and the coefficient of variation in relative price levels between countries are given in the bottom rows. We divided the countries into two groups: "low" income countries (from Poland to Spain), and "high" income (from Ireland to Luxembourg). A number of general observations can be made.

For agriculture relative price levels vary widely. This sector has the highest coefficient of variation of all ten sectors. This is mainly due to high price levels in the agricultural sectors in Japan, Norway and South Korea which are characterized by high protection level. For example, in Japan agricultural prices are almost five times prices in the U.S. and more than three times in France.

Manufacturing price levels are much closer together as indicated by the coefficient of variation which is the lowest of all sectors (0.21). While relative prices in manufacturing are quite high in Austria, Japan and Norway and much higher than in the U.S., they are particularly low in the Eastern European countries, at typically 60 to 70% of the U.S. level. This variance might come as a surprise. One of the cornerstones in international trade theory is the so-called *Law of One Price*: the price of an internationally traded good should be the same anywhere in the world once that price is expressed in a common currency. This law is based on an international goods arbitrage argument: in case prices of goods would differ, a riskless profit could be made by shipping them from countries where the price is low to countries where the price is high. This law is the foundation of the *PPP hypothesis* which states that the nominal exchange rate between two currencies should be equal to the ratio of aggregate price levels between the two countries; hence the relative price level should be one. However, there are many reasons for the PPP hypothesis not to hold in the short run, including volatile exchange rate behaviour and the many barriers to arbitrage which include tariff and non-tariff barriers, transport costs, product differentiation and price discrimination (Anderson and Wincoop, 2004). In general there is consensus that PPP should hold in the long run, but not necessarily in the short run (Taylor and Taylor, 2004). Our finding suggests indeed that PPP did not hold true for manufacturing goods in the OECD in 1997.

Table 4 Relative price levels for gross output (US = 1), broad sectors, 1997

Industry *ISIC rev. 3*	Agricul-ture 01-05	Mining 10-14	Manufac-turing 15-37	Utilities 40-41	Construc-tion 45	Trade 50-55	Transport and Communi cation 60-64	Financial and business services 65-74	Other services 90-95	Public services 75-85	Services sector average 50-95
Poland	0.80	0.71	0.67	0.57	0.45	0.53	0.62	0.37	0.36	0.20	0.41
Slovakia	0.96	1.72	0.71	0.40	0.35	0.48	0.58	0.30	0.26	0.17	0.36
Hungary	0.84	0.67	0.68	1.04	0.56	0.63	0.57	0.36	0.29	0.18	0.41
Czech Republic	0.95	0.73	0.65	0.69	0.36	0.50	0.69	0.44	0.33	0.16	0.42
South Korea	2.28	1.49	1.02	0.98	0.77	1.05	1.00	0.85	0.73	0.42	0.81
Taiwan	1.94	2.26	0.80	0.94	0.57	1.08	1.14	1.08	0.65	1.15	1.02
Greece	1.79	1.66	1.07	1.03	0.73	1.18	1.26	0.77	0.77	0.47	0.89
Portugal	1.30	1.55	1.04	1.39	0.59	0.78	0.82	0.64	0.68	0.46	0.67
Spain	1.24	0.85	0.87	1.16	0.84	0.84	1.06	0.81	0.95	0.61	0.85
Ireland	1.32	1.52	1.19	1.53	1.06	0.96	1.43	0.97	0.89	0.77	1.00
Finland	1.69	1.40	1.14	1.18	0.73	1.01	1.25	1.34	1.21	0.89	1.14
Sweden	1.30	1.87	1.27	0.83	1.31	1.37	1.02	1.38	1.18	0.93	1.18
Italy	1.49	1.18	0.95	1.09	0.85	1.17	1.24	0.83	1.05	0.75	1.01
Germany	1.20	1.20	1.15	1.42	1.31	0.95	1.30	1.20	1.07	0.93	1.09
Canada	1.05	0.78	0.92	0.82	0.73	0.91	0.76	0.97	0.85	0.69	0.84
U.K.	1.41	1.44	1.20	1.34	1.10	1.21	1.04	1.03	1.12	0.74	1.03
France	1.34	1.53	1.22	1.27	1.40	1.06	1.20	1.38	1.14	0.84	1.12
Australia	1.04	0.85	1.12	0.98	0.87	1.20	0.96	1.07	1.03	0.69	0.99
Belgium	1.27	1.39	1.08	1.46	1.03	0.97	1.45	1.04	1.09	0.81	1.07
Austria	1.22	2.20	1.35	1.45	1.11	1.15	1.49	1.20	1.16	0.87	1.17
Netherlands	1.33	0.98	1.14	1.45	1.29	0.91	0.84	1.06	1.01	0.70	0.91
Japan	4.86	2.38	1.50	1.96	1.57	2.07	1.72	2.10	1.74	1.00	1.72
Denmark	1.30	1.87	1.28	1.66	1.32	1.05	1.40	1.18	1.13	0.96	1.14
U.S.	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00
Norway	2.00	2.05	1.40	0.82	1.16	1.33	1.79	1.27	1.45	0.96	1.36
Luxembourg	1.31	1.32	1.18	1.31	1.24	0.95	0.98	0.86	1.07	1.05	0.98
average, all	1.47	1.41	1.06	1.15	0.94	1.01	1.10	0.98	0.93	0.71	0.95
average, low	1.34	1.29	0.83	0.91	0.58	0.79	0.86	0.62	0.56	0.42	0.65
average, high	1.54	1.47	1.18	1.27	1.12	1.13	1.23	1.17	1.13	0.86	1.10
coef of var, all	0.53	0.36	0.22	0.31	0.36	0.31	0.30	0.39	0.38	0.41	0.32

Table 5 Relative price levels for gross output (US = 1), manufacturing industries, 1997

	ISIC rev. 3	Austria	Belgium	Czech Republic	Denmark	Finland	France	Germany	Greece	Hungary
Food, beverages and tobacco	15-16	1.16	1.01	0.60	1.07	1.20	1.20	1.02	1.22	0.58
Textiles	17	1.94	0.79	0.60	1.49	1.18	1.23	1.36	1.00	0.66
Wearing apparel	18	2.51	1.57	1.06	1.43	1.98	2.66	1.92	1.36	0.82
Leather	19	1.43	1.32	0.68	1.32	1.43	1.04	1.33	1.15	0.63
Wood products	20	1.55	1.32	0.55	1.34	1.06	1.06	1.20	0.78	0.58
Pulp, paper and paper products	21	0.96	0.81	0.57	1.05	0.90	1.09	0.98	1.12	0.66
Printing and publishing	22	1.24	1.11	1.12	2.16	1.03	1.43	1.24	0.65	0.48
Coke, refined petroleum products and	23	1.53	1.27	0.87	1.67	1.39	1.10	1.08	1.08	1.08
Chemicals and allied products	24	0.90	0.90	0.44	1.08	0.64	1.02	0.98	0.67	0.62
Rubber and plastics products	25	0.75	0.57	0.37	1.00	0.89	0.74	0.84	1.00	0.44
Non-metallic mineral products	26	0.93	0.73	0.33	1.10	0.90	0.92	0.85	0.52	0.42
Basic metals	27	1.33	0.95	0.64	1.16	1.20	1.06	0.98	0.78	0.67
Fabricated metal products	28	1.62	1.12	0.51	1.39	0.85	1.12	1.21	0.82	0.59
Machinery, nec	29	1.49	1.11	0.61	1.23	1.08	1.07	1.12	0.78	0.38
Office, accounting and computing mac	30	0.87	0.92	0.55	1.33	1.17	0.85	0.97	0.72	0.66
Other electrical machinery and appara	31	1.09	1.08	0.63	2.34	0.98	1.29	1.16	0.73	0.56
Radio, television and communication e	32	1.85	1.31	0.66	1.51	1.55	1.26	1.42	1.36	0.78
Instruments	33	1.36	1.41	0.58	1.38	1.49	1.45	1.30	1.17	0.72
Motor vehicles, trailers and semi-traile	34	1.71	1.77	0.80	2.06	2.09	1.68	1.56	1.64	1.38
Other transport equipment	35	1.31	1.16	0.87	1.94	1.50	1.10	1.16	1.27	0.82
Manufacturing nec, recycling	36-37	1.56	0.88	0.71	0.81	0.83	1.30	1.14	0.90	0.50
Total manufacturing		1.35	1.08	0.65	1.28	1.14	1.22	1.15	1.07	0.68
Coefficient of variation		0.30	0.27	0.31	0.29	0.31	0.32	0.21	0.29	0.34

Table 5 Relative price levels for gross output (US = 1), manufacturing industries, 1997 (continued)

	ISIC rev. 3	Ireland	Italy	Luxem-bourg	Nether-lands	Norway	Poland	Portugal	Slovakia	Spain
Food, beverages and tobacco	15-16	1.07	1.02	1.14	0.94	1.25	0.62	1.04	0.57	0.90
Textiles	17	1.05	1.06	1.47	1.17	1.39	0.70	0.85	0.62	0.85
Wearing apparel	18	1.32	1.67	1.36	0.98	3.08	0.42	1.01	1.38	1.05
Leather	19	1.32	0.59	1.32	1.13	1.62	0.56	0.75	0.93	0.66
Wood products	20	1.09	1.02	1.36	1.99	1.24	0.56	0.85	0.72	0.77
Pulp, paper and paper products	21	1.03	0.95	0.81	1.06	1.24	0.67	0.91	0.42	0.88
Printing and publishing	22	1.45	0.94	1.25	1.37	1.34	0.68	1.02	0.44	0.83
Coke, refined petroleum products and	23	0.94	1.45	1.23	1.45	1.71	0.56	1.66	1.14	1.34
Chemicals and allied products	24	0.67	0.77	0.83	0.77	1.15	0.50	0.83	0.56	0.71
Rubber and plastics products	25	0.71	0.52	0.71	0.78	1.11	0.28	0.46	0.55	0.52
Non-metallic mineral products	26	0.90	0.57	0.68	0.88	1.12	0.36	0.59	0.38	0.50
Basic metals	27	0.87	0.71	0.86	0.99	1.41	0.72	0.72	0.72	0.80
Fabricated metal products	28	1.02	0.57	1.05	0.89	1.28	0.61	0.74	0.90	0.72
Machinery, nec	29	1.20	0.72	1.21	1.35	1.35	0.77	1.01	0.91	0.79
Office, accounting and computing mac	30	0.98	1.10	1.07	1.03	1.40	0.80	0.92	0.30	0.83
Other electrical machinery and appara	31	1.27	1.01	1.26	1.32	1.51	0.76	0.93	0.77	0.81
Radio, television and communication e	32	2.37	1.18	1.27	1.35	1.80	1.46	1.10	0.90	1.25
Instruments	33	1.31	1.22	1.28	1.20	1.41	1.06	1.06	0.66	1.11
Motor vehicles, trailers and semi-traile	34	1.93	1.30	1.78	1.91	1.96	0.74	2.04	1.02	1.00
Other transport equipment	35	1.45	0.78	1.21	1.03	1.59	1.28	1.32	0.71	1.15
Manufacturing nec, recycling	36-37	0.97	0.69	1.07	1.28	1.49	0.97	1.15	0.65	0.75
Total manufacturing		1.19	0.95	1.18	1.14	1.40	0.67	1.04	0.71	0.87
Coefficient of variation		0.33	0.33	0.23	0.27	0.28	0.40	0.35	0.36	0.25

Table 5 Relative price levels for gross output (US = 1), manufacturing industries, 1997 (continued)

	ISIC rev. 3	Sweden	U.K.	U.S.	Australia	Canada	Japan	South Korea	Taiwan	OECD unweighted average	Coeffi-cient of variation
Food, beverages and tobacco	15-16	1.18	1.23	1.00	1.00	0.93	2.44	1.48	1.08	1.01	0.35
Textiles	17	1.51	1.27	1.00	1.53	0.89	1.15	1.06	0.79	1.14	0.29
Wearing apparel	18	2.40	1.50	1.00	1.24	1.11	1.35	1.43	0.90	1.70	0.36
Leather	19	1.24	1.23	1.00	0.81	0.98	1.71	0.99	0.75	1.15	0.28
Wood products	20	1.06	1.81	1.00	1.20	0.89	1.85	0.95	1.32	1.05	0.37
Pulp, paper and paper products	21	0.91	0.89	1.00	1.08	0.99	1.24	1.12	0.76	0.90	0.22
Printing and publishing	22	1.68	1.07	1.00	1.24	1.00	1.51	0.97	0.83	1.16	0.32
Coke, refined petroleum products and	23	1.51	0.97	1.00	0.85	0.99	2.28	1.16	0.93	1.23	0.29
Chemicals and allied products	24	0.94	1.06	1.00	1.17	0.90	1.32	0.59	0.94	0.81	0.27
Rubber and plastics products	25	0.99	0.72	1.00	1.24	0.98	1.40	0.75	0.82	0.73	0.37
Non-metallic mineral products	26	1.25	0.99	1.00	0.99	0.91	1.35	0.66	0.61	0.75	0.37
Basic metals	27	1.24	1.38	1.00	1.13	0.94	1.11	1.05	0.88	0.97	0.23
Fabricated metal products	28	0.85	1.08	1.00	1.26	0.90	1.45	0.90	0.84	1.02	0.28
Machinery, nec	29	1.24	0.96	1.00	1.18	0.77	1.21	0.91	0.79	0.99	0.26
Office, accounting and computing mac	30	1.04	1.06	1.00	1.10	0.82	1.26	1.05	0.52	0.89	0.28
Other electrical machinery and appara	31	1.31	1.16	1.00	0.88	0.69	1.13	0.68	0.54	1.09	0.34
Radio, television and communication e	32	1.53	1.44	1.00	1.70	1.19	1.16	1.09	0.60	1.30	0.29
Instruments	33	1.23	1.32	1.00	1.46	1.18	1.51	0.86	0.71	1.21	0.22
Motor vehicles, trailers and semi-traile	34	1.91	1.76	1.00	1.34	0.90	1.26	0.91	1.08	1.63	0.27
Other transport equipment	35	1.41	1.21	1.00	1.47	0.85	1.15	0.74	0.56	1.24	0.25
Manufacturing nec, recycling	36-37	1.09	0.69	1.00	1.20	0.94	1.82	0.77	0.79	0.96	0.32
Total manufacturing		1.27	1.20	1.00	1.12	0.92	1.50	1.02	0.80	1.07	0.21
Coefficient of variation		0.28	0.25		0.19	0.13	0.25	0.24	0.24		

Also for detailed manufacturing industries PPP does not hold true. In **Table 5**, relative prices levels for twenty-two two digit manufacturing industries are given, including, in the last columns of the table, the coefficient of variation for each manufacturing industry. Prices show a particularly high variance across countries in Coke, refined petroleum products and nuclear fuel, Rubber and plastics products and Non-metallic mineral products, while in more basic industries like Pulp, paper and paper products and Basic metals price variance is the lowest. Further research that links the characteristics of these industries to the impact on international trade costs seems to be a promising avenue for explaining the industry-level variances and can provide new insight into the role of transaction costs in international trade.

Another standard assumption in international trade theory is the Balassa-Samuelson hypothesis which states that relative prices of non-traded products between countries should be larger than for traded products. This is especially true the further apart countries are in terms of their productivity. This phenomenon has been reported on the basis of expenditure PPP work in ICP, where it was found that relative expenditure prices for services in less developed countries are typically much lower than relative expenditure prices for manufactured goods. Our data confirms this regularity from an industry perspective. For less developed countries, PPPs for output of services sector (see the last column of Table 4) is typically well below one (which is the US level). On average, low income countries have a services output price level of 0.65 relative to the U.S., while high income countries show a relative price level of 1.10 on average. This range is much larger than for manufacturing output. On average, for low income countries the manufacturing price level is 0.82 while for services 0.65. For high income countries, there is almost no difference (1.15 versus 1.10). The lower output prices in less advanced countries is notably true for the construction industry, for public services and for other services. For distributive trade and for transport and communication industries relative prices are much higher. This provides further support for the Balassa-Samuelson hypothesis as it predicts that the price differences will be bigger in sectors with higher intensity of labour. Arguably, sectors such as construction, public services and other services are more labour-intensive than other services industries.

6. Concluding remarks

In this paper we set out to derive a new database on PPPs for gross output at the industry level, covering the total economy for OECD countries. In principle, production PPPs best reflect relative producer output prices. However, due to data limitations, production PPPs are only available for a restrictive set of products and industries. For complete coverage of the economy, production PPPs must be combined with expenditure PPPs from the OECD. Such expenditure PPPs need to be adjusted to reflect relative output prices. To support an optimal strategy in selecting production and expenditure PPPs, we derived the relationship between expenditure prices and output prices by applying a Supply and Use-table framework. We found that three types of adjustments are needed to derive an output price from a final domestic demand price: an adjustment for margins and taxes, an adjustment for international trade and an adjustment for intermediate consumption. In practice only the first adjustment is often made. As a result, expenditure PPPs can be biased, depending on the share of international trade and intermediate consumption in total demand. Based on the SUT framework, we motivate our mix of expenditure and production PPPs for each industry in compiling a dataset covering the total economy. We show the potential of this new database by a study of relative industry prices in the OECD region. It was found that PPP does not hold within the OECD, not even in manufacturing industries: relative prices differ considerably across countries. The biggest variance is found for output price levels in services, confirming the Balassa-Samuelson hypothesis.

A number of issues stand out for future reseach. First of all, the PPPs for output presented here need to be complemented by PPPs for labour, capital and intermediate inputs. Only then comparisons can be made of value added and total factor productivity across countries in a full scale KLEMS framework along the lines of Jorgenson, Kuroda and Nishimizu (1987), taking account all inputs of production. Inklaar and Timmer (2006) provide a pilot study for seven OECD countries for the year 1997, which will be extended to more countries in the framework of the EU KLEMS project.

Second, the industry PPPs provide a potential alternative for deflation of aggregate GDP. By aggregating industry-level gross output PPPs in an input-output framework, a PPP for GDP can be derived from the production side. These production PPPs for GDP can be compared with existing expenditure PPP for GDP from ICP. Building up a consistent set of industry level output PPPs and product level expenditure PPPs in a supply- and use-framework can deliver new insights into the reliability and consistency of the various PPPs. Issues which need to be addressed include the deflation of intermediate inputs, imports and exports, and the treatment of net taxes on products.

Finally, it should be recognised that although this paper represents the first attempt to construct a comprehensive and large-scale set of PPPs for industry-level output, its future looks bleak. This is mainly due to the large budget cuts by NSI's which leads to a reduction in the provision of information on products, which is needed to derive production PPPs. Surveys of production spend less and less resources on collection product-level information on quantities produced. For

example, the number of products for which quantity data is shown in the U.S. *Census of manufacturing* has dramatically declined from the year 1997 to 2002. The future of the European PRODCM database, which is the main building block for production PPPs for manufacturing industries, is also uncertain. This would mean that future updates of this database must increasingly rely on adjusted expenditure PPPs. This stresses the importance of the main theoretical results in this paper.

References

Anderson, J.E. and E. van Wincoop (2004), *Trade Costs*, NBER Working Paper no. 10480.

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

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.

Ark, B. van and M.P. Timmer (2001), "PPPs and International Productivity Comparisons: Bottlenecks and New Directions", paper for Joint World Bank-OECD seminar on Purchasing Power Parties, 30 January – 2 February, Washington D.C. (downloadable from www.oecd.org/dataoecd/24/0/2424747.pdf)

Bernard, A.B. and C.I. Jones (2001), "Comparing Apples To Oranges: Productivity Convergence and Measurement Across Industries And Countries: Reply", *American Economic Review*, September, 91(4), pp. 1168-1169.

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

Broadberry, S.N. (2003) "Relative per capita income levels in the United Kingdom and the United States since 1870: reconciling time-series projections and direct-benchmark estimates", *Journal of Economic History*, 63 (3), pp. 852-63.

Canzoneri, M.B., R.E. Cumby and B. Diba (1999), "Relative labor productivity and the real exchange rate in the long run: evidence for a panel of OECD countries", Journal of International Economics, no. 47 , pp. 245–266.

Dougherty, Sean D., R. Inklaar, R.H. McGuckin and B.van Ark (2006), "International Comparisons of R&D Expenditure: Does an R&D PPP Make a Difference?", in E.R. Berndt and C.M. Hulten, eds., *Hard-to-Measure Goods and Services: Essays in Honor of Zvi Griliches*, NBER/CRIW, The University of Chicago Press.

Drechsler, L. (1973), "Weighting of index numbers in multilateral international comparisons", *Review of Income and Wealth*, series 19, No. 1, March.

Elteto, O. and P. Koves (1964), "On an Index Computation Problem in International Comparisons" (in Hungarian), *Statisztikai Szemle*, Vol. 42, pp. 507-518.

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

Goldberg, P.K and F. Verboven (2004), "Cross-country price dispersion in the euro era: a case study of the European car market", *Economic Policy*, no. 40, October.

Griffith, R., Redding, S, and J. aan Reenen, John (2004), "Mapping the Two Faces of R&D: Productivity Growth in a Panel of OECD Industries", *Review of Economics and Statistics*, v. 86, iss. 4, pp. 883-95

Harrigan, J. (1999), "Estimation of cross-country differences in industry production functions", *Journal of International Economics*, vol.47, pp. 267-293.

Heston, A., R. Summers and B. Aten (2002), "Penn World Table Version 6.1", Center for International Comparisons at the University of Pennsylvania (CICUP), October.

Hooper, P. and E. Vrankovich (1995), "International Comparisons of the Level of Unit Labor Costs in Manufacturing", in *International Finance Papers*, No. 527, Federal Reserve Board, Washington D.C.

Inklaar, R., M. O'Mahony, K. Robinson and M.P. Timmer (2003), *Chapter 7* in O'Mahony, Mary and Bart van Ark, eds. (2003), *EU Productivity and Competitiveness: An Industry Perspective Can Europe Resume the Catching-up Process?* Office for Official Publications of the European Communities: Luxembourg.

Inklaar, Robert, Mary O'Mahony and Marcel P. Timmer (2005), "ICT and Europe's Productivity Performance; Industry-level Growth Account Comparisons with the United States" *Review of Income and Wealth*, 51(4), pp. 505-36.

Inklaar, Robert, and Marcel P. Timmer (2006), "International Comparisons of Industry Output, Inputs and Productivity Levels: Methodology and New Results" paper prepared for the Intermediate Input-Output Meetings 2006 on Sustainability, Trade & Productivity in Sendai, Japan.

Jorgenson, D.W., (1993), "Productivity Levels in Germany, Japan, and the United States: Differences and Causes: Comment" *Brookings Papers on Economic Activity, Microeconomics 1993*, pp. 49-56

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.

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

Lee, F.C. and Y. Tang (2001), "Productivity Levels and International Competitiviness between Canada and the US", in Jorgenson and Lee (ed.) (2001).

Lichtenberg, F. R. (1993) “Productivity Levels in Germany, Japan, and the United States: Differences and Causes: Comment” *Brookings Papers on Economic Activity, Microeconomics 1993*, pp. 56-61

Maddison, A. (2001), *The World Economy: A Millennial Perspective*, OECD, Paris.

Maddison, A. (2005), *Growth and Interaction in the World Economy: The Roots of Modernity*, The AEI Press, Washington, D.C.

Maddison, A. and B. van Ark (2002), "The International Comparison of Real Product and Productivity," in A. Maddison, D.S. Prasada Rao and W.F. Shepherd, eds., *The Asian Economies in the Twentieth Century*, Edwar Elgar, Cheltenham, pp. 5-26.

Mulder, N. (2002), *The Economic Performance of the Service Sector in Brazil, Mexico and the USA,A Comparative Historical Perspective*, Aldershot UK and Brookfield US: Edward Elgar.

Mulligen, P.H. Van (2002), *Quality Differences And Hedonic Pricing In International Comparisons*, Ph.D. Thesis, University Of Groningen.

OECD (1999), *Purchasing Power Parities and Real Expenditures – EKS Results, 1996*, Paris.

OECD (2000), *Purchasing Power Parities and Real Expenditures, 1999 Benchmark Year*, OECD, Paris.

O’Mahony, M. (1996), “Conversion Factors in Relative Productivity Calculations: Theory and Practice”, in OECD, *Industry Productivity. International Comparisons and Measurement Issues*, Paris: OECD, pp. 245-262.

O’Mahony (1999), *Britain’s Productivity Performance 1950-1996 – An International Perspective*, National Institute of Economic and Social Research, London.

O’Mahony and N. Oulton (2000), “International Comparisons of Labour Productivity in Transport and Communications: The US, the UK and Germany”, *Journal of Productivity Analysis*, 14, 7–30.

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(2), pp. 113-30.

Prasada Rao, D.S (1993), *Intercountry Comparisons of Agricultural Output and Productivity*, FAO Economic and Social Development Paper, Rome.

Prasada Rao, D.S. and M.P.Timmer (2003), "Purchasing Power Parities for Industry Comparisons Using Weighted Elteto-Koves-Szulc (EKS) Methods", *The Review of Income and Wealth*, 49(4), pp. 491-512.

Rogoff, K. (1996), "The Purchasing Power Parity Puzzle", *Journal of Economic Literature*, vol. 34, pp. 647-668.

Summers, R. and A. Heston (1991) , "The Penn World Table (Mark 5): An Expanded Set of International Comparisons, 1950-1988" *Quarterly Journal of Economics*, May 1991, v. 106, iss. 2, pp. 327-68.

Szulc, B. (1964), "Index Numbers of Multilateral Regional Comparisons" (in Polish), *Przeglad Statysticzny*, Vol.3, 239-254.

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.

Taylor, A.M. and M.P. Taylor (2004). "The Purchasing Power Parity Debate", *Journal of Economic Perspectives*, v. 18, iss. 4, pp. 135-58.

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

Timmer, M.P. and G. Ypma (2006), *Productivity Levels in Distributive Trades: A New ICOP Dataset for OECD Countries*, Groningen Growth and Development Centre GD-83 (April 2006)

Ward, M. and Devereux, J. (2003) 'Measuring British decline: direct versus long-span income measures', *Journal of Economic History*, 63 (3), pp. 826-51.

Ypma, G. (2007), *PPPs for Transport and Communication*, Groningen Growth and Development Centre GD-86 (forthcoming)

Appendix Table 1: Composition of Supply and Demand in the Netherlands and the United States, 1999.

			The Netherlands, 1999					United States, 1999 (d)				
			as % of total use (b)			as % of total supply (c)		as % of total use (b)			as % of total supply (c)	
	Industry (a)	ISIC rev. 3 code	Final expen-diture	Inter-mediate use	Ex-ports	Dom-estic	Im-ports	Final expen-diture	Inter-media te use	Ex-ports	Dom-estic	Im-ports
1	Agriculture	01-05	13%	50%	37%	69%	31%	13%	81%	6%	92%	8%
2	Mining and quarrying	10-14	1%	80%	19%	46%	54%	1%	96%	3%	71%	29%
3	Manufacturing	15-37	27%	32%	41%	52%	48%	41%	48%	11%	82%	18%
4	*Food, drink & tobacco*	15,16	34%	26%	40%	76%	24%	62%	33%	5%	94%	6%
5	*Basic goods*	17,20,21,23-28	15%	45%	40%	58%	42%	19%	73%	7%	87%	13%
6	*Non-durable*	18,19,22,36,37	52%	27%	20%	58%	42%	66%	29%	5%	73%	27%
7	*Durable*	29-35	29%	22%	49%	34%	66%	50%	33%	17%	75%	25%
8	Electricity, gas and water sup	40,41	34%	66%	0%	98%	2%	48%	52%	0%	100%	0%
9	Construction	45	58%	40%	2%	100%	0%	79%	21%	0%	100%	0%
10	Trade	50-52	50%	50%	0%	100%	0%	66%	30%	4%	101%	-1%
11	Hotels & catering	55	72%	28%	0%	100%	0%	81%	19%	0%	100%	0%
12	Transport	60-63	21%	29%	50%	91%	9%	37%	53%	10%	92%	8%
13	Communications	64	33%	59%	9%	91%	9%	49%	50%	1%	100%	0%
14	Finance	65-67	64%	33%	3%	97%	3%	53%	44%	3%	100%	0%
15	Real estate activities	70	73%	27%	0%	100%	0%	63%	35%	2%	100%	0%
16	Business services	71-74	17%	68%	15%	86%	14%	26%	73%	2%	100%	0%
17	Public administration and def	75	95%	5%	0%	100%	0%	not available				
18	Education and health	80,85	94%	6%	0%	100%	0%	96%	4%	0%	100%	0%
19	Other community, social and	90-95	28%	52%	19%	83%	17%	61%	33%	5%	100%	0%

Notes: (a) based on use and make tables which list supply and demand of products rather than industries.
Products have been used as proxies for industries by allocating them to their primary sector of production.
(b) by definition total use is sum of intermediate use, exports and final expenditure
(c) by definition total supply is sum of domestic production and imports
(d) Due to differences in ISIC rev 3 and the classification used in the U.S. Input-output tables, the results for industries 20, 22, 24, 34 and 50 are proxies.
Sources: Statistics Netherlands, *Supply and use tables*, 1999 and Bureau of Economic Analysis, *Input-Output Accounts* for 1999.

Appendix Table 2 Summary statistics of price data used for derivation of output PPPs (broad sectors)

Broad sectors		Australia Number of production PPPs	Number of of expen PPPs	Coverage of output	Austria Number of production PPPs	Number of of expen PPPs	Coverage of output	Belgium Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	67	0	75%	49	0	70%	29	0	87%
Mining and quarrying	10-14	36	0	73%	11	0	54%	6	0	37%
Manufacturing	15-37	216	58	39%	465	56	30%	351	63	22%
Electricity, gas and water supply	40-41	2	4	100%	2	4	100%	2	4	100%
Construction	45	0	11	98%	0	11	100%	0	11	77%
Trade	50-52	64	0	100%	67	0	100%	18	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	18	0	63%	23	0	76%	20	0	66%
Financial and business services	65-74	0	15	82%	0	15	81%	0	15	87%
Other community, social and persona	90-95	0	9	82%	0	9	52%	0	9	65%
Public administration, education and h	75-85	0	39	89%	0	39	78%	0	39	88%

		Canada Number of production PPPs	Number of of expen PPPs	Coverage of output	Czech Republic Number of production PPPs	Number of of expen PPPs	Coverage of output	Denmark Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	56	0	53%	52	0	69%	37	0	69%
Mining and quarrying	10-14	22	0	81%	8	0	66%	10	0	80%
Manufacturing	15-37	277	59	41%	409	63	38%	600	43	34%
Electricity, gas and water supply	40-41	2	4	100%	2	4	100%	1	4	100%
Construction	45	0	11	100%	0	11	50%	0	11	86%
Trade	50-52	60	0	100%	18	0	100%	36	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	21	0	57%	20	0	64%	18	0	43%
Financial and business services	65-74	0	15	84%	0	15	89%	0	15	97%
Other community, social and persona	90-95	0	9	46%	0	9	73%	0	9	56%
Public administration, education and h	75-85	0	39	77%	0	39	86%	0	39	85%

Appendix Table 2 Summary statistics of price data used for derivation of output PPPs (broad sectors) (continued)

		Finland			France			Germany		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	28	0	38%	70	0	67%	48	0	70%
Mining and quarrying	10-14	16	0	60%	15	0	51%	38	0	100%
Manufacturing	15-37	349	52	23%	696	48	36%	1936	26	26%
Electricity, gas and water supply	40-41	2	4	100%	2	4	100%	2	4	100%
Construction	45	0	11	100%	0	11	90%	0	11	100%
Trade	50-52	62	0	100%	66	0	100%	62	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	22	0	87%	25	0	82%	26	0	82%
Financial and business services	65-74	0	15	97%	0	15	85%	0	15	84%
Other community, social and persona	90-95	0	9	59%	0	9	78%	0	9	66%
Public administration, education and h	75-85	0	39	85%	0	39	91%	0	39	85%

		Greece			Hungary			Ireland		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	67	0	100%	58	0	72%	33	0	69%
Mining and quarrying	10-14	1	0	0%	11	0	21%	7	0	33%
Manufacturing	15-37	506	49	29%	461	49	36%	248	64	19%
Electricity, gas and water supply	40-41	2	4	100%	2	4	100%	2	4	100%
Construction	45	0	11	100%	0	11	100%	0	11	84%
Trade	50-52	67	0	100%	64	0	100%	64	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	18	0	57%	21	0	78%	17	0	62%
Financial and business services	65-74	0	15	71%	0	15	85%	0	15	96%
Other community, social and persona	90-95	0	9	79%	0	9	28%	0	9	87%
Public administration, education and h	75-85	0	39	92%	0	39	64%	0	39	96%

Appendix Table 2 Summary statistics of price data used for derivation of output PPPs (broad sectors) (continued)

		Italy			Japan			Luxembourg		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	70	0	89%	55	0	75%	9	0	74%
Mining and quarrying	10-14	18	0	30%	19	0	12%	0	0	0%
Manufacturing	15-37	1075	35	38%	214	58	27%	6	93	10%
Electricity, gas and water supply	40-41	2	4	100%	2	4	100%	0	4	32%
Construction	45	0	11	81%	0	11	82%	0	11	100%
Trade	50-52	64	0	100%	38	0	100%	67	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	22	0	66%	23	0	94%	16	0	49%
Financial and business services	65-74	0	15	82%	0	15	83%	0	15	95%
Other community, social and persona	90-95	0	9	74%	0	9	93%	0	9	58%
Public administration, education and h	75-85	0	39	89%	0	39	94%	0	39	76%

		Netherlands			Norway			Poland		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	44	0	60%	30	0	34%	41	0	74%
Mining and quarrying	10-14	5	0	83%	10	0	100%	10	0	57%
Manufacturing	15-37	309	54	24%	143	77	28%	191	64	35%
Electricity, gas and water supply	40-41	2	4	100%	1	4	81%	2	4	100%
Construction	45	0	11	80%	0	11	100%	0	11	100%
Trade	50-52	63	0	100%	67	0	100%	67	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	22	0	72%	23	0	76%	21	0	69%
Financial and business services	65-74	0	15	88%	0	15	88%	0	15	88%
Other community, social and persona	90-95	0	9	68%	0	9	54%	0	9	65%
Public administration, education and h	75-85	0	39	87%	0	39	84%	0	39	82%

Appendix Table 2 Summary statistics of price data used for derivation of output PPPs (broad sectors) (continued)

		Portugal			Slovakia			South Korea		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	60	0	67%	56	0	66%	48	0	70%
Mining and quarrying	10-14	7	0	31%	4	0	63%	8	0	50%
Manufacturing	15-37	650	48	36%	0	127	17%	205	57	28%
Electricity, gas and water supply	40-41	1	4	67%	2	4	100%	2	4	100%
Construction	45	0	11	64%	0	11	66%	0	11	79%
Trade	50-52	18	0	100%	56	0	100%	30	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	0	4	100%
Transport and communication	60-64	20	0	65%	21	0	59%	24	0	67%
Financial and business services	65-74	0	15	85%	0	15	80%	0	15	86%
Other community, social and persona	90-95	0	9	81%	0	9	81%	0	9	93%
Public administration, education and h	75-85	0	39	92%	0	39	91%	0	39	95%

(a) For Taiwan, no ICP PPPs are available. UVRs for 45, 55, 65-74, 90-95 and 75-85 stem from the ICPA project

		Spain			Sweden			Taiwan (a)		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	76	0	80%	37	0	43%	26	0	43%
Mining and quarrying	10-14	10	0	50%	18	0	26%	9	0	15%
Manufacturing	15-37	1203	35	37%	255	53	25%	112	0	20%
Electricity, gas and water supply	40-41	2	4	100%	1	4	81%	3	0	100%
Construction	45	0	11	90%	0	11	92%	5	0	66%
Trade	50-52	67	0	100%	64	0	100%	31	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%	1	0	100%
Transport and communication	60-64	24	0	66%	23	0	73%	18	0	61%
Financial and business services	65-74	0	15	80%	0	15	98%	5	0	99%
Other community, social and persona	90-95	0	9	87%	0	9	53%	2	0	100%
Public administration, education and h	75-85	0	39	95%	0	39	84%	2	0	100%

Appendix Table 2 Summary statistics of price data used for derivation of output PPPs (broad sectors) (continued)

		U.K.			U.S.A.		
		Number of production PPPs	Number of of expen PPPs	Coverage of output	Number of production PPPs	Number of of expen PPPs	Coverage of output
Agriculture, forestry and fishing	01-05	42	0	57%	94	0	63%
Mining and quarrying	10-14	14	0	16%	22	0	57%
Manufacturing	15-37	832	34	29%	510	47	34%
Electricity, gas and water supply	40-41	2	4	100%	2	4	100%
Construction	45	0	11	72%	0	11	14%
Trade	50-52	60	0	100%	67	0	100%
Hotels and restaurants	55	0	4	100%	0	4	100%
Transport and communication	60-64	26	0	57%	27	0	65%
Financial and business services	65-74	0	15	88%	0	15	85%
Other community, social and persona	90-95	0	9	77%	0	9	72%
Public administration, education and h	75-85	0	39	91%	0	39	91%

Appendix Table 3 Summary statistics of price data used for derivation of output PPPs (manufacturing industries)

		Australia				Austria				Belgium				Canada			
		Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	62	0	61%	0%	107	5	50%	2%	103	7	43%	5%	100	3	45%	3%
Textiles	17	12	1	42%	6%	19	2	15%	2%	27	1	21%	1%	7	2	27%	15%
Wearing apparel	18	41	0	60%	0%	81	0	66%	0%	36	0	10%	0%	38	0	47%	0%
Leather	19	6	0	72%	0%	6	0	64%	0%	0	3	9%	9%	12	0	41%	0%
Wood products	20	10	0	36%	0%	29	0	61%	0%	20	0	51%	0%	16	0	79%	0%
Pulp, paper and paper products	21	5	0	33%	0%	7	0	23%	0%	6	0	18%	0%	13	0	68%	0%
Printing and publishing	22	0	5	9%	9%	10	3	28%	0%	10	3	28%	0%	0	5	10%	10%
Coke, refined petroleum products and nuclear fuel	23	5	1	81%	1%	0	3	43%	43%	0	3	16%	16%	9	1	82%	2%
Chemicals and allied products	24	32	2	26%	1%	24	2	13%	2%	43	2	12%	1%	29	2	23%	9%
Rubber and plastics products	25	0	2	15%	15%	21	0	30%	0%	13	0	13%	0%	3	1	29%	8%
Non-metallic mineral products	26	5	1	14%	0%	26	0	40%	0%	19	0	34%	0%	9	1	39%	1%
Basic metals	27	13	0	49%	0%	14	0	8%	0%	12	0	6%	0%	18	0	35%	0%
Fabricated metal products	28	4	4	9%	4%	45	0	39%	0%	28	0	26%	0%	3	4	8%	7%
Machinery, nec	29	14	8	34%	17%	22	9	12%	1%	10	10	10%	5%	16	9	16%	10%
Office, accounting and computing machinery	30	0	2	26%	26%	0	2	27%	27%	0	2	43%	43%	0	2	37%	37%
Other electrical machinery and apparatus nec	31	4	3	6%	2%	16	2	25%	1%	3	3	6%	5%	1	3	12%	11%
Radio, television and communication equipment	32	3	2	14%	10%	1	4	12%	5%	1	4	19%	17%	0	4	15%	15%
Instruments	33	0	7	23%	23%	0	7	6%	6%	0	7	26%	26%	0	7	50%	50%
Motor vehicles, trailers and semi-trailers	34	0	6	40%	40%	2	6	24%	16%	0	6	13%	13%	3	1	47%	2%
Other transport equipment	35	0	7	21%	21%	0	7	19%	19%	0	7	33%	33%	0	7	43%	43%
Manufacturing nec, recycling	36-37	0	7	73%	73%	35	4	44%	9%	20	5	59%	10%	0	7	71%	71%
Total Manufacturing	**15-37**	**216**	**58**	**39%**	**9%**	**465**	**56**	**30%**	**4%**	**351**	**63**	**22%**	**5%**	**277**	**59**	**41%**	**9%**

		Czech Republic				Denmark				Finland				France			
		Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	74	0	61%	0%	168	0	70%	0%	108	2	53%	1%	183	2	65%	1%
Textiles	17	38	0	59%	0%	14	2	21%	5%	13	2	39%	6%	33	2	17%	9%
Wearing apparel	18	0	4	40%	40%	89	0	66%	0%	68	0	40%	0%	17	0	9%	0%
Leather	19	2	3	38%	27%	9	0	86%	0%	4	0	39%	0%	19	0	48%	0%
Wood products	20	15	0	23%	0%	10	0	10%	0%	13	0	42%	0%	36	0	51%	0%
Pulp, paper and paper products	21	26	0	61%	0%	21	0	15%	0%	20	0	36%	0%	34	0	33%	0%
Printing and publishing	22	7	3	19%	1%	0	5	10%	10%	13	3	24%	0%	11	3	39%	0%
Coke, refined petroleum products and nuclear fuel	23	6	3	31%	31%	0	2	24%	24%	0	3	19%	19%	0	3	41%	41%
Chemicals and allied products	24	76	2	43%	2%	68	2	25%	6%	29	2	12%	1%	101	2	32%	13%
Rubber and plastics products	25	27	0	36%	0%	11	1	7%	4%	0	2	4%	4%	42	0	48%	0%
Non-metallic mineral products	26	27	1	27%	1%	25	0	30%	0%	10	1	7%	0%	55	0	42%	0%
Basic metals	27	47	0	73%	0%	14	0	8%	0%	7	0	3%	0%	42	0	23%	0%
Fabricated metal products	28	7	4	13%	10%	10	2	4%	3%	5	3	7%	5%	38	1	8%	1%
Machinery, nec	29	13	14	20%	12%	77	0	12%	0%	22	2	10%	1%	58	7	14%	7%
Office, accounting and computing machinery	30	0	2	28%	28%	3	2	19%	19%	0	2	10%	10%	0	2	17%	17%
Other electrical machinery and apparatus nec	31	27	3	20%	6%	15	3	35%	3%	11	3	16%	2%	1	3	7%	7%
Radio, television and communication equipment	32	3	4	28%	23%	12	0	25%	0%	1	4	6%	5%	1	4	17%	17%
Instruments	33	0	7	23%	23%	19	7	14%	14%	3	7	16%	16%	11	7	19%	19%
Motor vehicles, trailers and semi-trailers	34	10	0	15%	0%	0	6	25%	25%	3	5	40%	7%	3	1	63%	32%
Other transport equipment	35	0	7	31%	31%	3	7	35%	35%	0	7	8%	8%	0	7	14%	14%
Manufacturing nec, recycling	36-37	4	6	46%	45%	32	4	59%	5%	19	4	39%	7%	11	4	17%	12%
Total Manufacturing	**15-37**	**409**	**63**	**38%**	**7%**	**600**	**43**	**34%**	**4%**	**349**	**52**	**23%**	**3%**	**696**	**48**	**36%**	**10%**

Appendix Table 3 Summary statistics of price data used for derivation of output PPPs (manufacturing industries) (continued)

		Germany				Greece				Hungary				Ireland			
		Number of production PPPs	Number of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	232	0	53%	7%	113	5	36%	2%	58	5	56%	3%	77	2	66%	4%
Textiles	17	131	0	27%	7%	43	0	27%	0%	57	0	32%	0%	10	2	21%	7%
Wearing apparel	18	113	0	26%	5%	101	0	22%	0%	48	0	19%	0%	37	0	36%	0%
Leather	19	21	0	29%	13%	12	0	19%	0%	10	0	14%	0%	0	3	5%	5%
Wood products	20	48	0	26%	0%	23	0	11%	0%	13	0	29%	0%	10	0	25%	0%
Pulp, paper and paper products	21	66	0	27%	1%	12	0	39%	0%	26	0	81%	0%	0	2	15%	15%
Printing and publishing	22	20	3	28%	3%	10	3	7%	4%	5	3	11%	1%	10	3	19%	12%
Coke, refined petroleum products and nuclear fuel	23	0	3	26%	27%	0	3	17%	17%	9	3	31%	31%	0	0		
Chemicals and allied products	24	164	2	15%	3%	40	2	34%	10%	61	2	34%	5%	14	2	1%	1%
Rubber and plastics products	25	71	0	22%	3%	13	1	17%	1%	27	0	44%	0%	10	1	17%	0%
Non-metallic mineral products	26	98	0	29%	1%	16	1	47%	1%	24	1	45%	2%	10	2	43%	1%
Basic metals	27	93	0	21%	0%	12	0	24%	0%	15	0	54%	0%	0	0	0%	0%
Fabricated metal products	28	146	0	17%	4%	28	1	15%	1%	22	1	12%	2%	21	0	31%	0%
Machinery, nec	29	354	0	15%	6%	36	2	24%	4%	27	2	24%	2%	16	14	15%	7%
Office, accounting and computing machinery	30	11	2	28%	28%	0	2	24%	24%	0	2	28%	28%	3	2	6%	6%
Other electrical machinery and apparatus nec	31	90	0	15%	4%	19	2	47%	1%	23	2	41%	3%	10	3	12%	1%
Radio, television and communication equipment	32	31	0	23%	18%	0	4	63%	63%	3	4	27%	26%	1	4	1%	1%
Instruments	33	104	7	26%	25%	0	7	27%	27%	7	7	23%	23%	0	6	3%	3%
Motor vehicles, trailers and semi-trailers	34	27	0	29%	19%	4	5	53%	46%	0	6	21%	21%	1	6	22%	21%
Other transport equipment	35	21	7	30%	30%	0	7	15%	15%	0	7	31%	31%	0	7	57%	57%
Manufacturing nec, recycling	36-37	95	2	54%	17%	24	4	38%	12%	26	4	42%	8%	18	5	33%	12%
Total Manufacturing	**15-37**	**1936**	**26**	**26%**	**9%**	**506**	**49**	**29%**	**5%**	**461**	**49**	**36%**	**9%**	**248**	**64**	**19%**	**5%**

		Italy				Japan				Luxembourg				Netherlands			
		Number of production PPPs	Number of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	190	0	64%	0%	21	16	33%	16%	6	36	49%	31%	125	0	53%	0%
Textiles	17	0	3	11%	11%	13	2	38%	10%	0	3	32%	32%	15	1	35%	1%
Wearing apparel	18	0	4	38%	38%	19	0	26%	0%	0	0			32	0	24%	0%
Leather	19	17	0	34%	0%	11	0	48%	0%	0	0			1	3	17%	13%
Wood products	20	38	0	50%	0%	3	0	48%	0%	0	0	0%	0%	5	0	19%	0%
Pulp, paper and paper products	21	41	0	37%	0%	9	0	26%	0%	0	0			8	0	20%	0%
Printing and publishing	22	17	3	23%	0%	0	5	5%	5%	0	5	5%	5%	5	3	32%	1%
Coke, refined petroleum products and nuclear fuel	23	0	3	34%	34%	8	1	59%	2%	0	0			0	3	8%	8%
Chemicals and allied products	24	101	2	26%	9%	36	0	14%	0%	0	4	1%	1%	41	2	11%	1%
Rubber and plastics products	25	52	0	32%	0%	5	1	12%	4%	0	2	1%	1%	4	1	2%	0%
Non-metallic mineral products	26	63	0	43%	0%	8	1	25%	1%	0	2	1%	1%	12	1	40%	0%
Basic metals	27	67	0	33%	0%	40	0	38%	0%	0	0	0%	0%	5	0	9%	0%
Fabricated metal products	28	90	0	34%	0%	4	4	7%	4%	0	4	8%	8%	4	4	10%	7%
Machinery, nec	29	210	0	35%	0%	29	0	14%	0%	0	15	10%	10%	19	3	9%	3%
Office, accounting and computing machinery	30	0	2	21%	21%	0	2	54%	54%	0	2	48%	48%	0	2	5%	5%
Other electrical machinery and apparatus nec	31	43	1	17%	1%	0	3	12%	12%	0	3	5%	5%	12	3	19%	1%
Radio, television and communication equipment	32	17	0	12%	0%	4	2	33%	5%	0	2	56%	56%	0	4	3%	3%
Instruments	33	37	7	47%	47%	0	7	45%	45%	0	1	56%	56%	0	7	18%	18%
Motor vehicles, trailers and semi-trailers	34	19	0	64%	25%	4	1	29%	15%	0	0			4	5	18%	9%
Other transport equipment	35	8	7	31%	31%	0	7	20%	20%	0	7	67%	67%	0	7	25%	25%
Manufacturing nec, recycling	36-37	65	3	55%	11%	0	6	29%	29%	0	7	4%	4%	17	5	30%	12%
Total Manufacturing	**15-37**	**1075**	**35**	**38%**	**7%**	**214**	**58**	**27%**	**9%**	**6**	**93**	**10%**	**9%**	**309**	**54**	**24%**	**3%**

Appendix Table 3 Summary statistics of price data used for derivation of output PPPs (manufacturing industries) (continued)

		Norway				Poland				Portugal				Slovakia			
		Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	80	5	51%	2%	52	2	55%	2%	115	10	49%	8%	0	44	52%	52%
Textiles	17	3	3	12%	6%	22	0	38%	0%	52	0	20%	0%	0	3	11%	11%
Wearing apparel	18	12	0	35%	0%	10	0	37%	0%	110	0	34%	0%	0	4	41%	41%
Leather	19	0	3	12%	12%	2	3	43%	33%	15	0	48%	0%	0	3	34%	34%
Wood products	20	9	0	39%	0%	9	0	22%	0%	29	0	22%	0%	0	0	0%	0%
Pulp, paper and paper products	21	0	2	1%	1%	1	2	23%	23%	16	0	20%	0%	0	2	7%	7%
Printing and publishing	22	7	3	26%	0%	0	5	14%	14%	18	3	24%	0%	0	5	6%	6%
Coke, refined petroleum products and nuclear fuel	23	0	2	13%	13%	3	3	31%	31%	0	2	39%	39%	0	3	0%	31%
Chemicals and allied products	24	9	3	5%	2%	19	3	23%	4%	46	2	23%	7%	0	4	4%	4%
Rubber and plastics products	25	0	2	6%	6%	8	0	41%	0%	30	0	20%	0%	0	2	9%	9%
Non-metallic mineral products	26	5	2	21%	1%	21	0	24%	0%	38	0	52%	0%	0	2	5%	5%
Basic metals	27	5	0	37%	0%	21	0	52%	0%	12	0	20%	0%	0	0	0%	0%
Fabricated metal products	28	2	4	4%	3%	10	1	18%	1%	56	0	36%	0%	0	4	7%	7%
Machinery, nec	29	1	15	7%	7%	5	15	19%	15%	50	0	19%	0%	0	15	16%	16%
Office, accounting and computing machinery	30	0	2	0%	0%	0	2	28%	28%	0	2	59%	59%	0	2	28%	28%
Other electrical machinery and apparatus nec	31	0	3	3%	3%	5	3	16%	5%	12	2	32%	15%	0	3	5%	5%
Radio, television and communication equipment	32	0	4	14%	14%	0	4	23%	23%	0	4	20%	20%	0	4	16%	16%
Instruments	33	0	6	37%	38%	0	7	27%	27%	6	7	25%	25%	0	7	26%	26%
Motor vehicles, trailers and semi-trailers	34	0	6	6%	6%	3	1	13%	1%	7	5	46%	43%	0	6	27%	27%
Other transport equipment	35	0	7	39%	39%	0	7	31%	31%	0	7	50%	50%	0	7	31%	31%
Manufacturing nec, recycling	36-37	10	5	39%	8%	0	6	62%	62%	38	4	55%	16%	0	7	62%	62%
Total Manufacturing	**15-37**	**143**	**77**	**28%**	**8%**	**191**	**64**	**35%**	**9%**	**650**	**48**	**36%**	**9%**	**0**	**127**	**17%**	**19%**

		South Korea				Spain				Sweden				Taiwan			
		Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	53	8	45%	1%	182	5	50%	4%	84	2	63%	2%	21	0	35%	0%
Textiles	17	9	2	12%	1%	102	0	31%	0%	6	2	23%	3%	7	0	36%	0%
Wearing apparel	18	11	0	21%	0%	113	0	52%	0%	10	0	15%	0%	11	0	69%	0%
Leather	19	12	0	58%	0%	14	0	26%	0%	0	3	2%	2%	2	0	24%	0%
Wood products	20	3	0	33%	0%	43	0	39%	0%	16	0	68%	0%	3	0	74%	0%
Pulp, paper and paper products	21	3	2	39%	3%	34	0	31%	0%	19	0	43%	0%	7	0	20%	0%
Printing and publishing	22	0	5	14%	14%	20	3	31%	0%	9	3	38%	0%	0	0	0%	0%
Coke, refined petroleum products and nuclear fuel	23	8	1	49%	0%	0	3	34%	34%	0	3	22%	22%	0	0	0%	0%
Chemicals and allied products	24	26	3	17%	2%	98	2	35%	16%	25	2	13%	4%	8	0	9%	0%
Rubber and plastics products	25	0	2	5%	5%	51	0	28%	0%	10	0	10%	0%	2	0	2%	0%
Non-metallic mineral products	26	5	1	15%	1%	59	0	59%	0%	7	2	16%	1%	2	0	21%	0%
Basic metals	27	33	0	36%	0%	35	0	22%	0%	10	0	8%	0%	21	0	52%	0%
Fabricated metal products	28	3	4	10%	8%	109	0	29%	0%	13	1	9%	0%	0	0	0%	0%
Machinery, nec	29	16	3	22%	4%	166	0	26%	0%	17	3	13%	2%	5	0	6%	0%
Office, accounting and computing machinery	30	4	2	3%	3%	0	2	53%	53%	0	2	20%	20%	3	0	20%	0%
Other electrical machinery and apparatus nec	31	1	2	2%	1%	65	1	43%	1%	8	3	19%	2%	3	0	2%	0%
Radio, television and communication equipment	32	3	2	16%	1%	14	2	23%	16%	2	4	10%	8%	8	0	24%	0%
Instruments	33	0	7	26%	26%	22	7	49%	49%	0	7	14%	14%	1	0	5%	0%
Motor vehicles, trailers and semi-trailers	34	6	1	51%	1%	18	0	29%	0%	7	5	17%	13%	4	0	46%	0%
Other transport equipment	35	0	7	36%	36%	0	7	25%	25%	0	7	13%	13%	2	0	22%	0%
Manufacturing nec, recycling	36-37	9	5	32%	22%	58	3	48%	6%	12	4	38%	6%	2	0	1%	0%
Total Manufacturing	**15-37**	**205**	**57**	**28%**	**4%**	**1203**	**35**	**37%**	**5%**	**255**	**53**	**25%**	**5%**	**112**	**0**	**20%**	**0%**

Appendix Table 3 Summary statistics of price data used for derivation of output PPPs (manufacturing industries) (continued)

		UK				US			
		Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: coverage by exp PPP	Number of production PPPs	Number of of expen PPPs	Coverage of output	of which: ICP coverage
Food, beverages and tobacco	15-16	112	2	54%	1%	133	0	61%	0%
Textiles	17	73	0	40%	0%	25	1	46%	3%
Wearing apparel	18	89	0	55%	0%	38	0	84%	0%
Leather	19	12	0	45%	0%	12	0	67%	0%
Wood products	20	15	0	17%	0%	13	0	24%	0%
Pulp, paper and paper products	21	5	0	5%	0%	18	0	45%	0%
Printing and publishing	22	10	3	36%	1%	0	5	2%	2%
Coke, refined petroleum products and nuclear fuel	23	0	3	38%	38%	10	2	40%	40%
Chemicals and allied products	24	101	2	20%	1%	58	2	28%	12%
Rubber and plastics products	25	24	0	11%	0%	0	2	2%	2%
Non-metallic mineral products	26	44	1	19%	1%	20	0	22%	0%
Basic metals	27	15	0	6%	0%	42	0	48%	0%
Fabricated metal products	28	21	2	9%	7%	10	4	6%	2%
Machinery, nec	29	138	0	18%	0%	52	0	12%	0%
Office, accounting and computing machinery	30	3	2	9%	9%	6	2	36%	36%
Other electrical machinery and apparatus nec	31	39	1	27%	1%	18	2	34%	3%
Radio, television and communication equipment	32	12	2	13%	7%	15	2	19%	8%
Instruments	33	45	7	17%	17%	16	7	42%	42%
Motor vehicles, trailers and semi-trailers	34	13	0	57%	26%	4	6	54%	27%
Other transport equipment	35	5	7	14%	14%	0	7	39%	39%
Manufacturing nec, recycling	36-37	56	2	49%	5%	20	5	38%	16%
Total Manufacturing	**15-37**	**832**	**34**	**29%**	**6%**	**510**	**47**	**34%**	**11%**

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

Papers marked * are also available in pdf-format on the internet: http://www.ggdc.net/
Hardcopies of other papers can be ordered (as long as available) from ggdc@eco.rug.nl

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

581 (GD-20) Szirmai, Adam and Ren Ruoen, China's Manufacturing Performance in Comparative Perspective, 1980-1992 (1995)

GD-21 Fremdling, Rainer, Anglo-German Rivalry on Coal Markets in France, the Netherlands and Germany, 1850-1913 (December 1995)

GD-22* Tassenaar, Vincent, Regional Differences in Standard of Living in the Netherlands, 1800-1875, A Study Based on Anthropometric Data (December 1995)

GD-23* van Ark, Bart, Sectoral Growth Accounting and Structural Change in Postwar Europe (December 1995)

GD-24* Groote, Peter, Jan Jacobs and Jan Egbert Sturm, Output Responses to Infrastructure in the Netherlands, 1850-1913 (December 1995)

GD-25* Groote, Peter, Ronald Albers and Herman de Jong, A Standardised Time Series of the Stock of Fixed Capital in the Netherlands, 1900-1995 (May 1996)

GD-26* van Ark, Bart and Herman de Jong, Accounting for Economic Growth in the Netherlands since 1913 (May 1996)

GD-27* Maddison, Angus and D.S. Prasada Rao, A Generalized Approach to International Comparisons of Agricultural Output and Productivity (May 1996)

GD-28 van Ark, Bart, Issues in Measurement and International Comparison of Productivity - An Overview (May 1996)

GD-29* Kouwenhoven, Remco, A Comparison of Soviet and US Industrial Performance, 1928-90 (May 1996)

GD-30 Fremdling, Rainer, Industrial Revolution and Scientific and Technological Progress (December 1996)

GD-31 Timmer, Marcel, On the Reliability of Unit Value Ratios in International Comparisons (December 1996)

GD-32 de Jong, Gjalt, Canada's Post-War Manufacturing Performance: A Comparison with the United States (December 1996)

GD-33 Lindlar, Ludger, “1968” and the German Economy (January 1997)

GD-34 Albers, Ronald, Human Capital and Economic Growth: Operationalising Growth Theory, with Special Reference to The Netherlands in the 19th Century (June 1997)

GD-35* Brinkman, Henk-Jan, J.W. Drukker and Brigitte Slot, GDP per Capita and the Biological Standard of Living in Contemporary Developing Countries (June 1997)

GD-36 de Jong, Herman, and Antoon Soete, Comparative Productivity and Structural Change in Belgian and Dutch Manufacturing, 1937-1987 (June 1997)

GD-37 Timmer, M.P., and A. Szirmai, Growth and Divergence in Manufacturing Performance in South and East Asia (June 1997)

GD-38* van Ark, B., and J. de Haan, The Delta-Model Revisited: Recent Trends in the Structural Performance of the Dutch Economy (December 1997)

GD-39* van der Eng, P., Economics Benefits from Colonial Assets: The Case of the Netherlands and Indonesia, 1870-1958 (June 1998)

GD-40* Timmer, Marcel P., Catch Up Patterns in Newly Industrializing Countries. An International Comparison of Manufacturing Productivity in Taiwan, 1961-1993 (July 1998)

GD-41* Ark, Bart van, Economic Growth and Labour Productivity in Europe: Half a Century of East-West Comparisons (October 1999)

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

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

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

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

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

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

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

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

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

GD-51* van Ark, Bart, Robert Inklaar and Marcel Timmer, The Canada-US Manufacturing Gap Revisited: New ICOP Results (January 2002)

GD-52* Mulder, Nanno, Sylvie Montout and Luis Peres Lopes, Brazil and Mexico's Manufacturing Performance in International Perspective, 1970-98 (January 2002)

GD-53* Szirmai, Adam, Francis Yamfwa and Chibwe Lwamba, Zambian Manufacturing Performance in Comparative Perspective (January 2002)

GD-54* Fremdling, Rainer, European Railways 1825-2001, an Overview (August 2002)

GD-55* Fremdling, Rainer, Foreign Trade-Transfer-Adaptation: The British Iron Making Technology on the Continent (Belgium and France) (August 2002)

GD-56* van Ark, Bart, Johanna Melka, Nanno Mulder, Marcel Timmer and Gerard Ypma, ICT Investments and Growth Accounts for the European Union 1980-2000 (September 2002)

GD-57* Sleifer, Jaap, A Benchmark Comparison of East and West German Industrial Labour Productivity in 1954 (October 2002)

GD-58* van Dijk, Michiel, South African Manufacturing Performance in International Perspective, 1970-1999 (November 2002)

GD-59* Szirmai, A., M. Prins and W. Schulte, Tanzanian Manufacturing Performance in Comparative Perspective (November 2002)

GD-60* van Ark, Bart, Robert Inklaar and Robert McGuckin, "Changing Gear" Productivity, ICT and Services: Europe and the United States (December 2002)

GD-61* Los, Bart and Timmer, Marcel, The 'Appropriate Technology' Explanation of Productivity Growth Differentials: An Empirical Approach (April 2003)

GD-62* Hill, Robert J., Constructing Price Indexes Across Space and Time: The Case of the European Union (May 2003)

GD-63* Stuivenwold, Edwin and Marcel P. Timmer, Manufacturing Performance in Indonesia, South Korea and Taiwan before and after the Crisis; An International Perspective, 1980-2000 (July 2003)

GD-64* Inklaar, Robert, Harry Wu and Bart van Ark, "Losing Ground", Japanese Labour Productivity and Unit Labour Cost in Manufacturing in Comparison to the U.S. (July 2003)

GD-65* van Mulligen, Peter-Hein, Alternative Price Indices for Computers in the Netherlands using Scanner Data (July 2003)

GD-66* van Ark, Bart, The Productivity Problem of the Dutch Economy: Implications for Economic and Social Policies and Business Strategy (September 2003)

GD-67* Timmer, Marcel, Gerard Ypma and Bart van Ark, IT in the European Union, Driving Productivity Divergence?

GD-68* Inklaar, Robert, Mary O'Mahony and Marcel P. Timmer, ICT and Europe's Productivity Performance, Industry-level Growth Accounts Comparisons with the United States (December 2003)

GD-69* van Ark, Bart and Marcin Piatkowski, Productivity, Innnovation and ICT in Old and New Europe (March 2004)

GD-70* Dietzenbacher, Erik, Alex Hoen, Bart Los and Jan Meist, International Convergence and Divergence of Material Input Structures: An Industry-level Perspective (April 2004)

GD-71* van Ark, Bart, Ewout Frankema and Hedwig Duteweerd, Productivity and Employment Growth: An Empirical Review of Long and Medium Run Evidence (May 2004)

GD-72* Edquist, Harald, The Swedish ICT Miracle: Myth or Reality? (May 2004)

GD-73* Hill, Robert and Marcel Timmer, Standard Errors as Weights in Multilateral Price Indices (November 2004)

GD-74* Inklaar, Robert, Cyclical productivity in Europe and the United States, Evaluating the evidence on returns to scale and input utilization (April 2005)

GD-75* van Ark, Bart, Does the European Union Need to Revive Productivity Growth? (April 2005)

GD-76* Timmer, Marcel and Robert Inklaar, Productivity Differentials in the US and EU Distributive Trade Sector: Statistical Myth or Reality? (April 2005)

GD-77* Fremdling, Rainer, The German Industrial Census of 1936: Statistics as Preparation for the War (August 2005)

GD-78* McGuckin, Robert and Bart van Ark, Productivity and Participation: An International Comparison (August 2005)

GD-79* Inklaar, Robert and Bart van Ark, Catching Up or Getting Stuck? Europe's Troubles to Exploit ICT's Productivity Potential (September 2005)

GD-80* van Ark, Bart, Edwin Stuivenwold and Gerard Ypma, Unit Labour Costs, Productivity and International Competitiveness (August 2005)

GD-81* Frankema, Ewout, The Colonial Origins of Inequality: Exploring the Causes and Consequences of Land Distribution (July 2006)

GD-82* Timmer, Marcel, Gerard Ypma and Bart van Ark, PPPs for Industry Output: A New Dataset for International Comparisons (March 2007)

GD-83* Timmer, Marcel and Gerard Ypma, Productivity Levels in Distributive Trades: A New ICOP Dataset for OECD Countries (April 2006)

GD-86* Frankema, Ewout, and Jutta Bolt, Measuring and Analysing Educational Inequality: The Distribution of Grade Enrolment Rates in Latin America and Sub-Saharan Africa (April 2006)

GD-87* Azeez Erumban, Abdul, Lifetimes of Machinery and Equipment. Evidence from Dutch Manufacturing (July 2006)

GD-88* Castaldi, Carolina and Sandro Sapio, The Properties of Sectoral Growth: Evidence from Four Large European Economies, (October 2006)

GD-89* Inklaar, Robert, Marcel Timmer and Bart van Ark, Mind the Gap! International Comparisons of Productivity in Services and Goods Production (October 2006)

GD-91* Akkermans, Dirk, Carolina Castaldi and Bart Los, Do 'Liberal Market Economies' Really Innovate More Radically than 'Coordinated Market Economies'? Hall & Soskice Reconsidered (March 2007)

Groningen Growth and Development Centre Research Monographs

Monographs marked * are also available in pdf-format on the internet: http://www.ggdc.net/

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

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

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

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

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