Productivity Levels in Transport, Storage and Communication

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Abstract

This working paper provides industry-specific purchasing power parities for gross output in the transportation and communication sector. The calculation of these output PPPs builds on earlier work by the International Comparisons of Output and Productivity (ICOP) project in this field. The paper reviews the existing methods and develops a new system which takes full advantage of the improved data situation. The study captures the transportation and communication sectors of 32 countries (EU-25, Australia, Canada, Japan, Korea, New Zealand, Taiwan and United States). The second part of the paper applies the PPPs to productivity measures obtained from the EU KLEMS database and the 60-industry Database of the Groningen Growth and Development Centre. This results in a consistent and comparable set of productivity levels at detailed industry level. We find that differences in productivity between the United States and other industrialized countries are only partly due to differences in industry structure. The United States especially outperform the EU-15 and Asia on productivity levels in land transport. Eastern European countries are still showing much lower productivity levels, except for land transport where they can become a though competitor for the former EU-15.

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1. Introduction

In the modern world, the transportation and communication sector make up an important part of the economy. It is obvious that the transportation sector is essential as input for other economic activities as well as the driver of mobility of people. Hence it is worthwhile to take a closer look at this specific sector. What are the comparative prices at which transportation services are produced? And how does that affect the relative productivity and cost performance between countries? For example, do low cost countries, such as those in Eastern Europe form a threat for Western European transportation firms? Or is their output and productivity level that low that low prices do not constitute a real competitive threat.

To answer these questions, this paper develops a set of relative price measures (purchasing power parities) and productivity measures for the transportation section in 32 relatively advanced countries. For international comparisons of output and productivity, we need a set of output PPPs. Previous work has shown that there are two main problems in making comparisons for the transportation sectors consistent: the separate treatment of terminal services and movement services in transportation, and the issue of quality differences of transportation services across countries. This working paper introduces a new set of PPPs based on an improved methodology and making best use of the data available. With the new PPP set we make a first step towards a consistent and reliable comparison of relative price and productivity performances in transportation activities of 32 countries in Europe, North-America, Asia and Oceania.

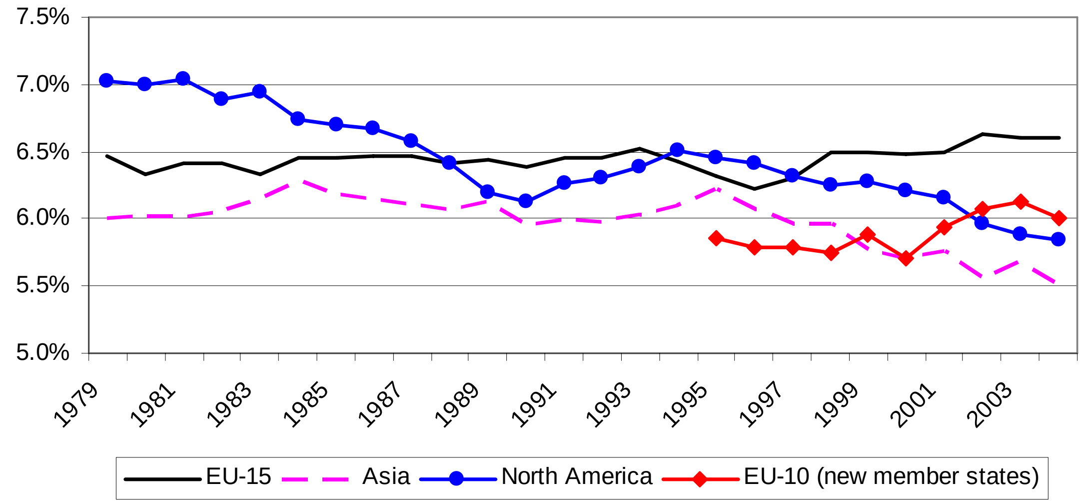
Next to the transport sector we also study the closely connected communication sector in this paper, which has been combined with transport in industrial classifications and in National Accounts. Communication is a sector that has undergone enormous changes since the rise of mobile telecommunication and the introduction of the internet. This paper is part of a set of studies in the ICOP-project (International Comparisons of Output and Productivity) to develop a new set of output PPPs for 1997, which cover all major industries in the economy (see Timmer, Ypma and van Ark, 2007)

In the next section we give a broad introduction of the transportation sector, with an emphasis on developments over time. The share of the transport sector in the total economy does not show much difference between countries, but the underlying composition of the sector forms an interesting starting point for understanding the difficulties in international comparisons. We will also discuss developments in the communication sector in more detail. In section three we develop a new methodology for constructing transportation and communication PPPs. The first part of the section focuses on the methodology, in the second part we calculate PPPs on an industry-by-industry basis. The PPP set constructed in section three is the main input for the productivity comparisons set out in chapter four. We will look at an industry level at the performances of regions and individual countries in this dataset. Finally, section five contains concluding remarks and describes issues for further research.

2. Overview of the transportation and communication sector

In this section we provide a broad picture of the transportation and communication sector, with a focus on the importance of these sectors for the total economy at national and international level. The developments over the past 25 years on total sector level do hardly show any change, but at industry level important shifts between transportation modes can be found. This section moreover gives an indication of the problems that arise when comparing these heterogeneous activities.

Figure 2.1 Share of Transport and Communication in Total GDP in current prices, 1979-2004

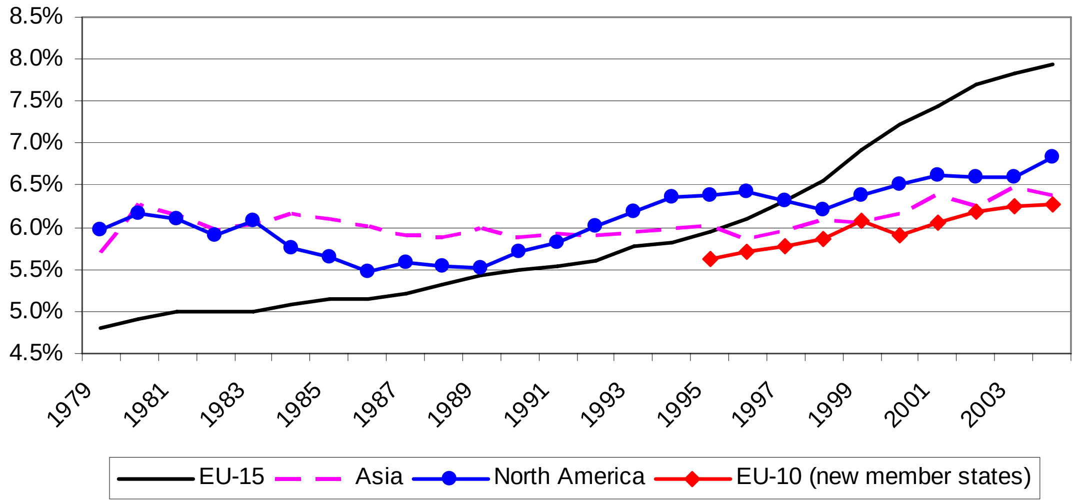


Source: EU KLEMS Database March 2007 and GGDC 60-industry database September 2006

Notes: Asia consists of Japan, South Korea and Taiwan, North America includes Canada and the United States, EU-15 includes Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden and the United Kingdom and the EU-10 consists of Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovak Republic and Slovenia.

Figure 2.1 shows that the share of transportation and communication in the total economy in current prices is rather stable over time, especially for the "old" EU-15. North America and Asia show a slight decrease in shares, while the value added shares of the new member states of the EU grew strongly, but seem to abandon this trend in the final years. The size of affiliated employment in the total economy is comparable, but shows even less variation with a steady 6% of total employment in the EU-15, Asia and the new EU member states and a slightly less than 5% in the United States and Canada. All regions except Asia (growth of 0.2 %) show a drop in the shares in employment between 1979 and 2004. The EU-15 lost 0.2% of its share in employment. North America has brought back its share with 0.8% over time, which is comparable with the annual drop the EU-10 shows for a shorter period.

Figure 2.2 Share of Transport and Communication in Total GDP in constant prices, 1979-2004

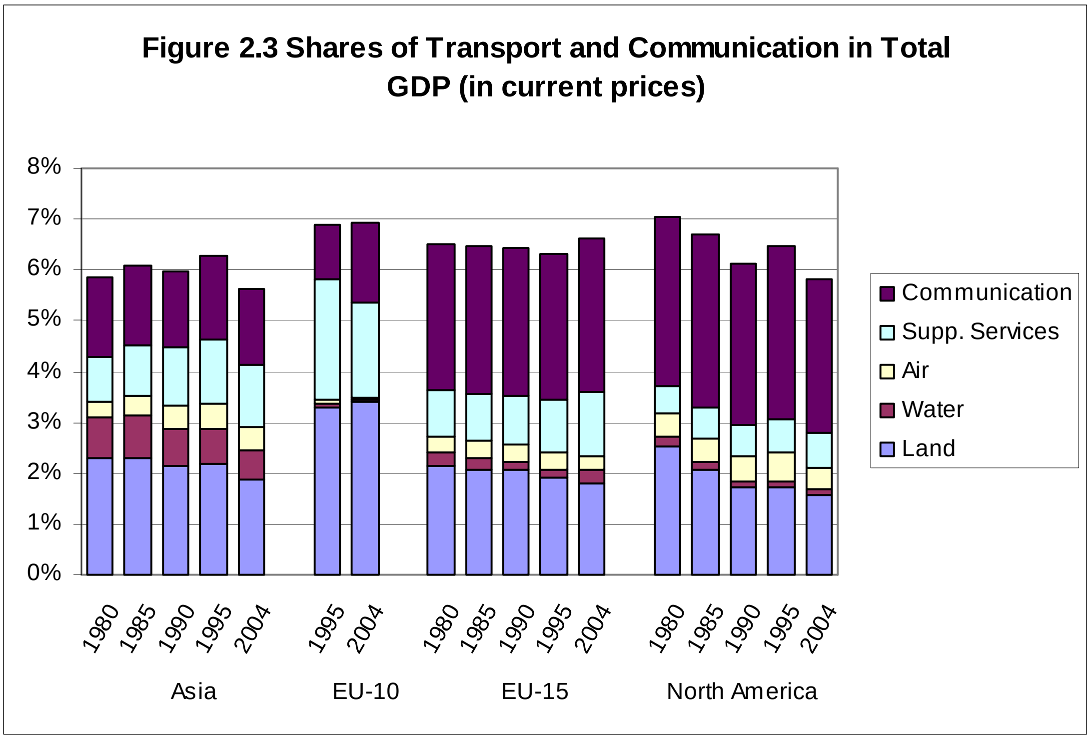


Source: EU KLEMS Database March 2007 and GGDC 60-industry database September 2006

We can distinguish two different stories in transport and communication. The story in current prices mainly describes a sector that is not showing major developments. Shares in GDP only change marginally over time. If we look however at the series in constant 1997 prices, as displayed above in Figure 2.2, a completely different picture appears. Adjusting for price changes leads to rising shares for all regions, with the EU-15 as the most striking example. To answer the question what is going on here, we have to look into the composition of the sector.

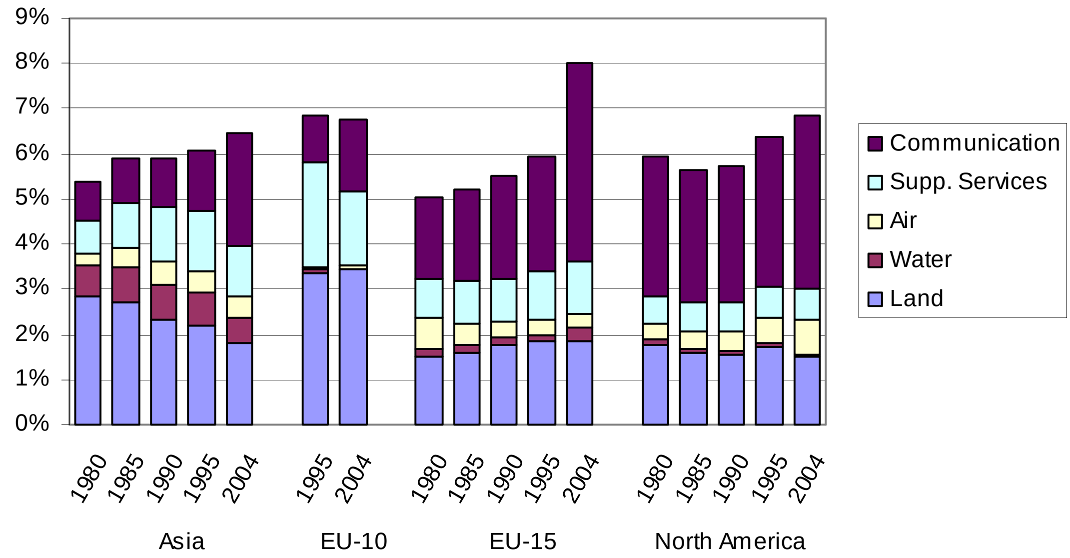
Figures 2.3 and 2.4 give more insight about the developments we discovered above. The distribution between transport modes, supporting services and communication in current prices is due to changing trends as figure 2.3 shows. For North America, EU-15 and Asia the same pattern takes place. In all three regions the share of land and water transport is falling, while the importance of supporting services grows. The EU-10 shows the opposite picture with growing market shares of land transport and a diminishing importance of supporting services. An important difference in the composition of the sector over regions is the small share of air and water transport in the EU-10 and the much lower shares of the communication sector in Asia and the EU-10, in comparison to the EU-15 and North America.

The figure in constant prices shows clearly where the differences in current and constant prices come from: now we can see a large increase in communication, as we would expect with the large growth of mobile phone traffic and internet use. Contrary to the transportation sector, where the price level has gone up, prices in this sector did not go up at all, and even decreased during the last decennium. This has led to the situation that growth in constant prices is almost completely absorbed by a decrease in prices. Air transport in North America and land transport in the EU-15 and Asia shows signs of the same phenomenon, although on a smaller scale.



Source: EU KLEMS Database March 2007 and GGDC 60-industry database September 2006

Figure 2.4 Share of Transport and Communication in Total GDP, in constant 1997 int. $



Source: EU KLEMS Database March 2007 and GGDC 60-industry database September 2006

If we go a step further and look at the country specific data, variation is getting larger. Transport and communication shows the highest shares in total GDP in the Baltic countries. Larger countries like the United States, Canada, France and Germany are all showing much smaller shares. The distribution between transport modes is dependent on geographical features of countries like the availability of coastal or inland water areas, road infrastructure and the size of the country. Table 2.1 (not surprisingly) shows that land-locked countries in Central and Eastern Europe are especially directed towards land transport, while countries with open access to the sea like Cyprus, Denmark, Greece, Norway, South Korea and Taiwan have a relatively high share in water transport. The highest shares of Air transport are in hands of small countries: Luxembourg and Ireland. The large share of air transport in Ireland can be explained by two factors: being an island is one of the reasons (leading to high shares for Australia, Cyprus, Malta, Taiwan and the United Kingdom as well), the success of low-cost carrier Ryanair is another one (see also Boyle and Evans, 2007). Especially after the European Commission deregulated the airline industry in 1997, value added in the airline market showed a large growth. Luxembourg thanks its high share especially to the large number of business flights to the country. The comparison of GDP and Employment shares in table 2.1 shows already a global view of productivity ratios in the transportation and communication sector. It is clear that Air transport and Communication are the most productive sectors, while employment is mostly higher than GDP in Land and Water transport.

The split up on NACE 2-digit level we have made so far distinguishes only three ways of transporting. This split-up hides a lot of detail, especially in land transport. This industry includes for instance pipeline transport, railway transport of passengers and road transport of freight. One can imagine that the transportation of a passenger is completely different from the transport of 80 kilos by pipeline. It would therefore be incorrect to look at land transport as a homogeneous category. Countries with an emphasis on freight transport will handle more tonnes, and appear as very productive, while countries that are mostly moving passengers end up at the bottom of productivity rankings. The Purchasing Power Parities we will calculate in the next sections therefore have to take into account the differences in the structure of industries and we have to make sure that we compare the prices of similar activities. That is why we make the distinction in as many transportation modes as possible in Chapter 3, with a clear split-up of passenger and freight transport.

The same holds for communication: postal deliveries and telephone calls are different activities, both in terms of costs and human input. To assess the relative performances we have to distinguish between different forms of communication. Even a relatively homogeneous activity like a phone call is incomparable if person A calls abroad for one hour, while person B makes a 5 minute local call. This example stresses the need to look at a detailed level at the comparability of activities. Unfortunately, the possibility to make a detailed comparison is always hampered by limited availability of data. Chapter 3 works out these examples in more detail and shows the compromise we made between detail and data availability.

Table 2.1 Shares of Transport and communication in total GDP and Employment, 2004

	GDP (in current prices)						Employment					
	Total Transport	of which: Land Transport	Water Transport	Air Transport	Supporting Services	Commu-nication	Total Transport	of which: Land Transport	Water Transport	Air Transport	Supporting Services	Commu-nication
	60-63	60	61	62	63	64	60-63	60	61	62	63	64
	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004	2004
Latvia	9.4%	56%	1%	3%	41%	5.3%	7.3%	71%	1%	1%	27%	1.6%
Lithuania	9.3%	63%	4%	3%	30%	3.3%	5.1%	63%	9%	3%	24%	1.4%
Estonia	8.8%	46%	7%	2%	45%	3.5%	6.4%	61%	4%	1%	33%	2.2%
Czech Republic	7.8%	59%	0%	4%	37%	3.1%	5.8%	80%	0%	2%	18%	1.4%
Finland	7.2%	50%	9%	8%	33%	3.6%	5.4%	66%	8%	4%	21%	1.9%
Malta	6.4%	28%	6%	19%	47%	3.7%	5.8%	25%	6%	21%	48%	1.8%
Slovak Republic	7.1%	83%	1%	0%	16%	2.9%	5.3%	83%	1%	1%	15%	1.4%
Greece	6.6%	30%	47%	3%	20%	3.3%	5.7%	66%	6%	3%	25%	1.3%
Luxembourg	5.6%	56%	1%	32%	12%	4.1%	6.2%	68%	0%	17%	15%	1.4%
Cyprus	5.2%	14%	25%	15%	46%	3.3%	5.5%	16%	23%	16%	45%	1.3%
Denmark	6.2%	42%	24%	7%	27%	2.3%	4.8%	55%	11%	9%	25%	1.8%
Norway	6.9%	39%	35%	6%	20%	1.5%	6.6%	38%	33%	8%	20%	1.8%
Belgium	5.4%	47%	2%	3%	47%	2.8%	5.1%	61%	2%	2%	35%	1.9%
Sweden	5.6%	48%	7%	6%	39%	2.6%	4.6%	57%	7%	4%	33%	1.9%
Hungary	4.6%	69%	0%	3%	28%	3.5%	5.9%	84%	1%	4%	12%	1.6%
Australia	4.9%	49%	2%	13%	36%	3.0%	4.5%	63%	3%	11%	24%	1.8%
Italy	5.3%	67%	4%	3%	26%	2.3%	3.9%	56%	3%	3%	38%	1.0%
Slovenia	5.0%	58%	5%	4%	33%	2.5%	4.7%	76%	2%	1%	21%	1.3%
U.K.	4.6%	43%	7%	12%	38%	2.8%	4.2%	59%	1%	7%	33%	1.7%
Netherlands	4.7%	51%	8%	10%	31%	2.7%	4.4%	58%	7%	9%	27%	1.4%
Poland	4.5%	76%	1%	2%	21%	2.9%	3.6%	81%	1%	1%	17%	1.1%
Spain	5.0%	54%	2%	8%	36%	2.2%	4.2%	72%	1%	5%	22%	1.2%
Austria	4.9%	65%	0%	6%	28%	2.3%	4.9%	76%	0%	4%	20%	1.3%
Portugal	3.8%	46%	3%	14%	38%	3.2%	2.8%	67%	1%	8%	24%	0.8%
Taiwan	4.3%	40%	18%	13%	28%	2.4%	4.2%	63%	2%	6%	29%	0.8%
South Korea	4.6%	64%	9%	7%	21%	2.1%	5.2%	81%	4%	3%	12%	1.0%
Canada	4.1%	67%	3%	10%	21%	2.6%	4.0%	67%	3%	12%	18%	2.1%
France	4.2%	53%	2%	7%	38%	2.1%	4.4%	62%	2%	6%	30%	1.8%
Germany	3.6%	39%	8%	8%	45%	2.2%	4.1%	57%	1%	3%	38%	1.3%
Japan	4.3%	69%	10%	8%	13%	1.5%	4.8%	80%	5%	3%	12%	0.9%
U.S.A.	2.7%	55%	3%	17%	26%	3.0%	2.9%	54%	1%	12%	32%	1.7%
Ireland	2.1%	34%	6%	31%	29%	3.3%	3.9%	48%	5%	17%	30%	2.2%
EU-15	3.6%	50%	7%	8%	35%	3.0%	4.2%	61%	2%	5%	32%	1.4%
Asia	4.0%	47%	14%	12%	30%	1.5%	4.8%	78%	4%	3%	14%	0.9%
North America	2.8%	56%	4%	16%	24%	3.0%	3.0%	56%	2%	12%	31%	1.7%
EU-10	4.4%	77%	0%	1%	42%	1.6%	4.7%	78%	2%	2%	18%	1.3%

Source: EU KLEMS Database March 2007 and GGDC 60-industry database September 2006

3. Calculating PPPs for transport and communication

Over the years, researchers have compared productivity in the transportation and communication sectors in several studies. First attempts to compare countries' performances do already stem from the late 40's (Rostas, 1948). The calculation of PPPs has always been an important part of productivity comparisons. In appendix A the main previous studies on this field have been described. We pay special attention to the way historical work handles two main problems in making comparisons in transport and communication: the treatment of terminal services and movement services in a consistent way, and dealing with quality differences of services across countries.

In the next subsection we will explain why a terminal adjustment is not needed anymore, given the current data availability. The methodology used for calculating PPPs is described in 3.2. In 3.3 we will point out the activities we were able to match between countries and give the reasoning behind the choice for those 'products'. Our set of products is wider than in previous research which leads to PPPs which are likely to be less prone to the quality problems of earlier work. On an industry-by-industry basis we describe the development of PPPs, including the sources we used, problems we coped with and discussions of the need for adjustments.

3.1 The need for terminal and quality adjustments

In previous work no data was available to deal with terminal services directly, and shortcuts had to be made. Quantity relatives, like a comparison of the amount of passenger (or ton) kilometres traveled by train, do not correct for differences in other services offered to the customer. One can assume that two persons travelling a given distance will require more terminal services than one person travelling twice that distance. This difference needs to be incorporated in comparative measures of productivity. In previous work researchers therefore corrected the quantity relatives for the amount of terminal services provided, based on the average distance traveled. If you only think about the costs of the 'extra' train stations, storage, loading and unloading, and ticketing, the unadjusted PPP is obviously unfavourable for countries with relatively short distances.

We can distinguish the following situations and classify the ways previous studies handle the terminal issue accordingly:

1. Average trip lengths are (assumed to be) equal

If the average trip length is equal, the proportionate amount of terminal work should be equal for each country, so freight ton km and passenger km would be acceptable proxies for transport output. Rostas (1948) and Girard (1958) made comparisons without terminal adjustments.

2. Hauls differ and no separate revenue and cost data is available for movement and terminal services

a) It is sometimes possible to derive the share of terminal services in the total implicitly. Higher relative prices often reflect the proportionally higher costs of transporting goods over shorter distances. See Smith, Hitchens and Davies (1982)

b) One can adjust the physical output measure to take account of terminal work. This can be done by using trip length ratios as variable (Mulder (1994, 1997), O'Mahony et al (1997), van Ark et al (1999), Monnikhof (2000))[2]. In van Ark et al (1999) population density serves as additional variable.

3. Hauls differ and separate revenues and cost data is available

When separate revenues are available for movement and terminal services (for example a split of air transport into flight and ground services), separate PPPs can be calculated for movement and terminal services. Paige and Bombach (1959) did already make a rough estimation of the part of revenues that could be attributed to loading and unloading. This study uses official data for terminal services.

Previous industrial classifications (ISIC rev. 2, NACE 70) did not provide a breakdown of terminal services and movement services. Revenues in both activities were reported together in a single transport industry, e.g. railways, or road transport. In the 1990s, there was a switch of the industrial classification systems to ISIC rev. 3/ NACE rev 1. In the revised industry classification operation of terminal facilities such as railway stations, bus stations and stations for the handling of goods has been classified in a separate industry: Supporting and auxiliary transport activities (63). This reclassification creates the possibility to split output of terminal and movement activities. Now we can calculate specific unit value ratios for movement services (in industries 60-62) and terminal services (in industry 63). Passenger and tonne kilometres can be used as quantity measure for the movement services whereas numbers of passengers and tons serve as output for terminal services.

The availability of more detailed data is another main improvement for the measurement of transportation performance. It creates the opportunity to match activities at lower levels, leading to better comparability. For air transport detailed information on passengers carried and performed passenger kilometers is available. This means that we can subdivide trip-lengths into various distance classes. This subdivision in trip length is an improvement over the domestic-international split-up which was used in earlier ICOP work.

[2] Mulder (1994, 1997), O'Mahony et al (1997), van Ark et al (1999), Monnikhof (2000) all use the ratio of average trip length in their formulas, although they all suppose a different relationship between trip length and the physical output measure. See Appendix A for a more extensive discussion.

More detailed data also provide a way to check if we are comparing similar activities. This can form a good basis to decide if we want to make quality adjustments to the data, like O'Mahony et al. did for the postal sector. Calculating average trip length is one of these checks, which provides information about the credibility of the data we use and it indirectly also shows if we can compare the services delivered as a homogeneous product.

Table 3.1 shows that comparability problems with the United States especially show up for railway and pipeline transport. Preferrably, we would like to create distance classes here like we did in air transport. This is however difficult because the number of firms operating on these market is often limited. This leads to confidentiality issues and makes it difficult to find data. Fortunately, we are able to split the metro and tram transport from other train transport, which is already more or less a trip length subdivision. For water transport we can make a similar trip length based split-up in inland water and coastal and ocean transport. This is of course far from perfect, but brings us already closer to the ultimate aim of perfect comparability.

Table 3.1 Average trip length in km

	Railway transport		Road transport		Pipeline	Inland water	Air
	Pass.	*Freight*	*Pass.*	*Freight*	*Freight*	*Freight*	*Pass.*
Australia	26	243	n.a.	92	n.a.	n.a.	2584
Austria	44	199	n.a.	61	22	1189	2457
Belgium	49	127	12	107	n.a.	55	1641
Canada	369	1056	16	586	n.a.	n.a.	2533
Cyprus	n.a.	n.a.	n.a.	32	n.a.	n.a.	2079
Czech Republic	38	201	n.a.	78	23	425	1686
Denmark	34	239	n.a.	107	22	n.a.	1097
Estonia	77	166	n.a.	245	n.a.	n.a.	629
Finland	68	244	n.a.	86	n.a.	301	1595
France	77	399	1	90	28	121	2210
Germany	44	245	7	82	150	266	1962
Greece	142	150	n.a.	n.a.	n.a.	n.a.	1312
Hungary	55	158	n.a.	n.a.	n.a.	n.a.	1472
Ireland	46	186	n.a.	n.a.	n.a.	n.a.	810
Italy	107	306	n.a.	140	n.a.	n.a.	1387
Japan	18	356	13	50	n.a.	n.a.	1611
Latvia	25	341	n.a.	133	275	n.a.	916
Lithuania	68	283	n.a.	88	121	33	1272
Luxembourg	25	35	10	n.a.	n.a.	n.a.	502
Malta	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	1594
Netherlands	44	149	n.a.	280	105	128	3833
Norway	67	365	11	49	107	n.a.	814
Poland	62	303	n.a.	57	44	100	2104
Portugal	26	242	n.a.	0	n.a.	n.a.	n.a.
Slovak Republic	43	209	n.a.	80	n.a.	1102	1271
Slovenia	45	202	20	49	n.a.	n.a.	1076
South Korea	11	236	6	45	n.a.	n.a.	n.a.
Spain	42	438	12	174	278	n.a.	n.a.
Sweden	60	337	n.a.	115	n.a.	n.a.	916
Taiwan	48	81	15	44	n.a.	n.a.	n.a.
U.K.	42	148	8	99	63	31	2704
U.S.	412	1401	8	208	614	430	1676
Average	**74**	**302**	**11**	**118**	**143**	**348**	**1634**
Standard deviation	**90**	**272**	**5**	**114**	**167**	**398**	**744**

Source: ICOP 1997 PPP set

3.2 Methods of calculating PPPs for transport and communication

As the PPP set we are calculating for the Transport and communication sector is part of a larger set for the whole economy, the basic set-up of the dataset is along the same lines. At the most detailed level, we derive binary PPPs for three digit industries. The basic 3-digit production PPPs are based on a mix of expenditure PPPs and industry-of-origin production PPPs. These binaries are multilateralised above the 3-digit level by using the EKS method. In section 3.2.2 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. The industry specific calculations are set out in more detail in section 3.2.1.

In industries like manufacturing we can choose either an adjusted expenditure PPP or a production PPP at the detailed industry level. The choice is based on the nature of the products (final consumption goods or intermediate inputs), the degree of international trade and practical assumptions like data availability. These criteria have been described in detail in Timmer, Ypma and van Ark (2007). In transport a large share of services is 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[3], and we relied exclusively on UVRs, following previous ICOP-research. Expenditure PPPs for the communications sector are available for postal services and telephone services and although the applicability is higher than for transport, usefulness is still limited. The data available in specific postal and telecommunication databases provides the opportunity to construct detailed PPPs, which will lead to better results. We should be aware however that the quality of PPPs in transport and communication will be less than in most goods producing industries.

3.2.1 The calculation of UVRs

Although the principle of calculation is the same, the nature of unit value ratios in manufacturing is different from the quantity relatives developed for transport and communication. The main problem is that we do not have harmonized services at our disposal, being sold like homogenous products. There is only information about the output of a branch or sector and the performances that have been delivered in terms of tonnes or kilometers. Contrary to manufacturing products, there is no direct link between the quantity and the output for each match. The possibility of biases due to unmeasured services is therefore larger, which diminishes the reliability of these price relatives.[4]

In the industry-of-origin approach industry-specific conversion factors are derived on the basis of relative product prices[5]. As a first step, unit values (uv) are derived by dividing output values (o) by produced quantities (q) for each product i in each country. For the transportation sector the quantity unit q can be passengers, tonnes, passenger kilometres and tonne kilometres. In communication we use mail pieces delivered, telephone calls, time of calls and mobile subscribers as quantity units:

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[3] On a scale of usefulness ranging from 1 to 5, expenditure PPPs for transport got a rating of 1 (very poor) in Timmer, Ypma and van Ark (2007). For Communication a usefulness grade of 2 (poor) has been assigned.

[4] See OECD, Measuring Productivity Levels- a Reader for a more elaborate discussion of the different forms of unit value ratios and their advantages and drawbacks.

[5] Although we are actually talking about "services" in transport and communication, we consider services as products in this method and stick in the terminology below to the word "products".

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

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

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

with *x* and *u* the countries being compared, *u* being the base country (in our case the United States). The product UVR indicates the relative producer price of the matched product in the two countries. Especially in industries with heterogeneous products or services, it is useful to make a subdivision in more homogeneous parts.

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

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

with i=1,.., I_j the matched products in industry *j*; $w_{ij} = o_{ij} / o_j$ the output share of the i[th] commodity in industry j; and $o_j = \sum_{i=1}^{I_j} o_{ij}$ the total matched value of output in industry j. In bilateral comparisons the weights of the base country (*B*) or the other country (*A*) can be used, which provide a Laspeyres and a Paasche type UVR respectively. To end up with a single currency conversion factor we take the geometric average (Fisher index) of the Laspeyres and Paasche indices. The industry UVR calculated here describes the 3-digit NACE industry level, which leads to 13 UVRs for transport and communication.

3.2.2 Construction of higher aggregates

In compiling this PPP dataset, we make a clear and consistent distinction between methodologies used above the 3 digit industry level and those below industry level. The methods below 3 digit level have been described above and can be used at the individual product or product group level. 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 ($F_{j\,k}$: j,k=1,..M) as the starting point. The computational form for the EKS index is given by:

$$EKS_{jk} = \prod_{l=1}^{M} \left[F_{jl} \cdot F_{lk} \right]^{1/M} \tag{4}$$

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 pairwise Fisher binary comparisons.

In specifying the aggregation weights, we take account of the reliability of the 3-digit industry PPPs. Reliability depends on the percentage of output covered by the PPPs. If the coverage ratio is below 20% we use matched output instead of gross output as weights in aggregating data to higher levels. For the manufacturing sector the coefficient of variation of the PPPs and/or the number of product matches within an industry has been used as reliability measures as well[6], but as the number of activities per 3-digit sector is usually limited in transport and communication we refrained from using those criteria.

The weights used in the industry aggregation are based on gross output.[7] As this PPP set is part of a PPP set for the Total Economy, we use the gross output dataset for 1997 that has been constructed at three digit level for the total economy. This dataset is based on gross output figures from National Accounts (mostly from the OECD STAN database), leading to a split-up of the total economy into 60 industries at most (NACE 2-digit level). To decompose this figures further to the 221 3-digit industries we needed for this work, gaps were filled with output shares obtained from Use tables (from Eurostat or from individual countries) and industry statistics, such as the OECD Industrial Structure Database (SSIS), the Eurostat Structural Business Statistics Database, national censuses and industry surveys, etc.. In all cases, however, the consistency with

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[6] These procedures have been used for other sectors as well, most notably in manufacturing. For a more detailed description of this methodology see Timmer, Ypma and van Ark (2007).

[7] 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. In a later stage of this research, value added PPPs will be derived by combining the gross output PPPs with a set of intermediate input PPPs.

National Accounts at a higher level was maintained.[8] Appendix B shows the shares of gross output by 3-digit industry in total transport and communication for all countries in this set.

Although we have calculated PPPs on a very detailed level, they will be published at a more aggregated level. Our impression is that PPPs below the 2-digit level should not be used for productivity comparisons. The reason for this is twofold: firstly, the PPPs have been based on a relatively small number of matches. Although the reliability is already higher than in earlier work, data should be used with great caution. A second reason is the lack of consistent value added and employment data on this level. A combination of weaknesses can lead to strange results.

3.3 Calculation of PPPs at industry level

The table below shows an overview of the industries we distinguish and subdivisions we make in the current set. The reasons to use these activities and the connected quantity measure will be set out below on an industry-by-industry basis.

Table 3.2 Industry classification by activity

NACE classification	*Industry name*	*Quantity measure*
60.1	**Transport via railways**	
60.1x	*Passenger transport by railway*	in mln pass.-km
60.1x	*Freight transport by railway*	in mln tonne-km
60.2	**Other land transport**	
60.21x	*Passenger transport by bus*	in mln pass.-km
60.21x	*Passenger transport by tram, light rail and metro*	in mln pass.-km
60.22	*Taxi Operation*	in mln pass.-km
60.24	*Freight transport by road*	in mln tonne-km
60.3	**Oil pipeline**	in mln short tons
61	**Water transport**	
61.1	**Sea and coastal water transport**	in mln short tons
61.2	**Inland water transport**	in mln tonne-km
62	**Air transport**	
62.1	**Scheduled transport**	
62.1x	*Scheduled passenger transport by air*	in mln pass.-km
62.1xx	Scheduled passenger transport by air (<750 km)	in mln pass.-km
62.1xx	Scheduled passenger transport by air (750-1500 km)	in mln pass.-km
62.1xx	Scheduled passenger transport by air (1500-2500 km)	in mln pass.-km
62.1xx	Scheduled passenger transport by air (>2500 km)	in mln pass.-km
62.1x	*Scheduled freight transport by air*	in mln tonne-km
62.2	**Non-scheduled transport**	
62.2x	*Non-scheduled passenger and freight transport*	in mln tonne-km
63	**Supporting and auxiliary transport activities; activities of travel agencies**	
63.1, 63.4	**Cargo handling and storage**	in mln short tons
63.2	**Other supporting transport activities**	

[8] In due time this gross output dataset will be linked to the EU KLEMS dataset and similar KLEMS estimates for non-EU countries.

63.21xRail transport services	in mln passengers
63.21xRail transport services	in mln short tons
63.21xRoad transport services	in mln passengers
63.21xRoad transport services	in mln short tons
63.22Water transport services	in mln tons handled
63.23xAir transport services	in mln passengers emplaned
63.23xAir transport services	in mln short tons
63.3Travel agencies	
60-63 Total transport	
64.1Postal service	
64.11Mail handled	in mln
64.2Telecommunication	
64.2xCellular communication	in mln subsribers
64.2xInternational communication	in mln minutes
64.2xLocal Calls	in mln calls
64.2xNational long distance comm.	in mln calls
64Total communication	

3.3.1 Land transport

The land transport sector in the NACE classification includes a broad spectrum of transport modes. All transport that not making use of the water or air is included here. The sector is subdivided in three 3-digit industries: transport by railways (60.1), other land transport (60.2) and pipeline transport (60.3). The first industry especially measures (interurban) transport by trains, urban rail transport like metros and trams are included in 60.2. Both for railway and pipeline transport there is no further subdivision. For railway transport we therefore make a subdivision ourselves in freight and passenger transport, because the composition of train transport can make a lot of differences in price. If we would only measure train transport in tons, irrespective of the kind of load (freight or persons), countries using the railway network especially for freight are performing much better than their counterparts with a focus on public transport. For pipelines this subdivision is for obvious reasons not needed.

Railway transport

Train transport is one of the most disputed issues in previous work. As the base country in a lot of studies, the United States, uses its railway network mainly for freight transport, their efficiency in terms of tonnes transported is relatively high.[9] In contrast, European and Asian countries have a comparative advantage in the transportation of passengers. When comparing the price of railway transport, it makes an enormous difference if you use the weights of the US (the Laspeyres

9 Please note the difference between **tons** and **tonnes**. Most sources describing transportation performances use tonnes as measure, also indicated as American short tons. One tonne is equal to 0.907185 metric tons.

index), or the other countries' shares (Paasche). The Fisher index takes the square root of the Paasche and Fisher index, so we end up in-between.

Railway data mostly stems from the World Bank *Railway Database*, which contains dataseries on quantities and revenues for freight and passengers separately for a large number of countries for the time period 1970-2002. To get a reliable UVR, we are keen to get quantity and revenue data from the same source. The World Bank database is a secondary source which relies on a lot of different sources, so caution and quality checks should be executed very carefully. The calculation of the average trip length and the revenue per passenger and tonne kilometer and comparing this across transport modes, gives a good indication of the reliability of the data. Gaps in the World Bank database are filled with data from the United Nations, *Annual Bulletin of Transport Statistics for Europe and North America 1999,* national transportation surveys and Statistical Yearbooks.

In previous work (O'Mahony et al, Mulder) adjustments for quality were made as well. They used the number of persons per train, reliability of trains and accuracy of departure and arrival times as measures of quality. We can have a look at the measures these authors used, to decide on the desirability of a quality adjustment.

Data on passenger kilometers, vehicle kilometers and rolling stock kilometers in table 3.3 comes from the World Bank *Railways Database*. As they make a split up here between vehicle kilometers of passengers and freight, we can calculate the average number of passengers per train, like Mulder did in his work. The current dataset also provides the vehicle kilometers of rolling stock, which makes it possible to calculate the average number of passenger coaches per train and subsequently we can also obtain the number of passengers by train wagon. This is even a better measure of comfort. The number of passengers per coach differs between 16 and 30 for countries from our set. Only the measures for Asia give strange results, which could be attributed to different sizes of coaches, but is probably due to mistakes in the database[10]. For Japan rolling stock kilometers are higher than vehicle kilometers, which practically means that they should travel with less than one coach per train. We did also include the results for some developing countries, to make sure that this indicator is a good measure of quality. This table shows the number of passengers is significantly higher in developing countries. Information on reliability and accuracy of railways is more difficult to obtain, so we cannot say anything about the need for quality adjustments in that respect. It is not likely however, that variations are very large within our country set.

[10] This is also the main reason that we use data from the Statistical Yearbooks for Japan and South Korea instead of the World Bank railway database for these countries.

Table 3.3 Number of passengers per train and per coach

Country	Year	Passenger km (in mln)	Vehicle km (in mln)	Rolling Stock km (in mln)	Average no. of pass. per train	Average no. of coaches per train	Average no. of pass. per coach
Austria	1995	9628	88	430	109	4.9	22
Belgium	1995	6757	70	326	96	4.6	21
Canada:ViaRail	1995	1341	10	58	128	5.6	23
Czech Republic	1995	8023	108	489	74	4.5	16
Denmark	1994	4784	52	n.a.	92		
Estonia	1995	421	5	32	85	6.4	13
Finland	1995	3184	25	148	127	5.9	22
France	1995	55311	308	2126	180	6.9	26
Germany	1995	60514	640	3261	94	5.1	19
Greece	1994	1599	15	54	105	3.5	29
Hungary	1995	8276	73	372	113	5.1	22
Ireland	1995	1291	9	63	145	7.1	20
Italy	1995	49700	256	1684	194	6.6	30
Japan	1995	248993	695	254	358	0.4	979
Latvia	1995	1373	12	79	114	6.6	17
Lithuania	1995	1130	10	61	110	5.9	18
Netherlands	1995	13977	108	535	129	5.0	26
Poland	1995	26600	174	n.a.	153		
Portugal	1995	4809	30	n.a.	161		
Slovak Republic	1994	4202	40	195	105	4.9	22
Slovenia	1995	590	12	39	51	3.4	15
South Korea	1995	29292	69	444	424	6.4	66
Spain	1995	15313	121	593	126	4.9	26
Sweden	1995	6219	61	266	102	4.3	23
United Kingdom	1993	30363	367	1826	83	5.0	17
USA:Amtrak	1996	8171	49	448	166	9.1	18
Brazil	1992	2098	9	25	247	2.9	85
Cote d'Ivoire	1992	189	1	5	195	5.0	39
Cuba	1986	2180	12	44	188	3.8	49
India	1995	326197	394	9259	827	23.5	35
Malawi	1988	112	1	2	154	2.3	66
Nigeria	1994	54	0.1	0.3	982	6.2	159
Russia	1990	274000	685	9133	400	13.3	30
South Africa	1995	9675	32	410	304	12.9	24
Thailand	1998	10947	30	273	370	9.2	40

Source: World Bank, Railway database

We can avoid the use of quality adjustments by matching at a detailed level. It would be useful if we could make the distinction between first and second class transport as differences in prices can be significant here. The current sources do not show transport by class, and complementary national sources sometimes provide information on quantity indicators (passengers and passenger-kms transported by class), but a split up of revenues by class has not been found up to now. Furthermore, as we handle 32 countries, it would be very difficult to compare the quality of classes over countries on a non-arbitrarily way. We do not have any clue if Class I travel in Taiwan is comparable with Class I travel in the US. A lot of further research is needed to satisfy the information need for thorough quality adjustments. For this dataset there is hence no basis or reason to make any (ad-hoc) adjustments.

Road Transport

In both the NACE and the ISIC Classification systems, industry 60.2 serves as a rest category for a lot of transport activities. It includes transport by buses, taxis and road freight transport, but for instance also transport by metro or tram. Even the exploitation of ski lifts and aerial cableways for sightseeing is included here. At 4-digit level NACE distinguishes four categories: Other scheduled passenger land transport (60.21), Taxi operation (60.22), Other land passenger transport (60.23) and Freight transport by road (60.24). The first branch includes all scheduled urban and interurban transport modes like buses, trams, undergrounds and elevated railways. Operation of school buses, as well as ski lifts and aerial cable-ways, also belongs to 60.21. Charter buses, excursions and other occasional coach services are included in other land passenger transport. We have tried to make matches for all transport modes and in all 4-digit industries. Unfortunately, we could not find data to make matches in 60.23 as the transport of unregulated bus transport is often included in other bus transport. The distinction between bus transport (including trolley buses) and tram-metro transport was easier to make, although a split-up of the revenues was often difficult as you need at least 5-digit industry level. In some cases we used the US price ratio between bus and tram-metro transport for other countries as well.

Table 3.1 shows no need to make an adjustment for trip length in bus, metro and taxi transport. For road transport the variation is larger, but again, data is hard to find to make such a split-up. Data about differences in quality of freight transport are even harder to obtain, if they exist at all.

For road transport we could mostly not obtain quantity and revenue data from the same source. Only for the United States, Norway and South Korea, we could find national sources including both quantities and revenues. For all other countries passenger kilometers and tonne kilometers stem from publications of the United Nations (*Annual Bulletin of Transport Statistics for Europe and North America 1999),* Eurostat *(Energy and Transport statistics 2003)* and the European Conference of Ministers of Transport (*Transportation database),* complemented with national sources. Revenue data mostly comes from OECD SSIS, the Eurostat Structural Business Statistics Database and national transportation and business surveys.

Pipeline transport

Transportation of goods per pipeline does not take place in all countries. Especially countries with natural oil and gas resources use pipelines. Transport of other goods by pipeline is negligible. The differences in pipeline infrastructure largely hamper the possibilities for comparing transportation performances in this respect. Especially because almost all costs are due to loading, pumping and unloading, this all happens within pump stations. One would expect that the operation of pump stations would be included in industry 63 as it includes supporting services, it is however included in land transport. In table 3.1 we can see that the average trip length differs enormously among countries. Especially the US is outstanding with an average trip length of almost 1000 km. Using tonne-kilometers as a quantity measures therefore results in large differences in UVRs. As most costs are involved in 'terminal' operation, we prefer to use tonnes transported as quantity indicator.

We do not expect quality differences in oil pipeline transport, so there is no reason to make quality adjustments. A split up in oil and gas transport would however improve the comparability, as the practices and costs of transport of gases will differ from liquids transport. The current sources do however not make this split possible.

The main sources for quantities transported are publications of the United Nations (*Annual Bulletin of Transport Statistics for Europe and North America 1999),* Eurostat *(Energy and Transport statistics 2003)* and the European Conference of Ministers of Transport (*Transportation database),* complemented with national sources. We only succeeded in making matches for Austria, Czech Republic, Denmark, France, Germany, Netherlands, Norway, Poland, Spain and the United Kingdom with the United States. Other countries did not have pipeline infrastructure or lacked reliable data.

Results

The table below shows the PPPs and relative prices for land transport. The Laspeyres, and Paasche PPPs have been calculated directly from the underlying UVRs, and the spread between the two measures gives an indication of the similarity in composition of the industry between the specific country and the US. The Fisher PPP has been calculated from the Paasche and Laspeyres PPPs, and has been added to show the difference between a binary and a multilateral approach. In the current set we do not use Fisher, Paasche or Laspeyres PPPs at 2-digit level. The EKS PPP aggregates 3-digit binary Fisher PPPs and converts these to transitive multilateral PPPs. The relative price is calculated by dividing the EKS PPP by the 1997 exchange rate with the US dollar and gives an indication of the price level in comparison with the United States.

What immediately stands out in the table below are the large differences between the Laspeyres and Paasche PPPs. This is due to the differences in the structure between the compared country and the US. One can see that these differences are mainly due to the size of the country, which has a lot of influences for the way of transporting goods. For the comparison with Canada and Australia the Paasche-Laspeyres spread is small, which indicates that these countries are similar in structure.

The relative prices show that countries can be classified in a few groups. Eastern and Central European countries (Baltic countries, Czech Republic, Hungary, Poland and Slovakia) all show low price levels, whereas Austria, Japan and Norway show really high price levels. The Netherlands show a low relative price level, which can be attributed to the large and competitive road freight transport branch. The flatness of the country and the availability of a good road network are other factors that have a positive influence.

Table 3.4 PPPs and relative prices in land transport, 1997

	PPPs					Relative price
	Laspeyres	Paasche	Fisher	EKS		US=1
Australia	1.41	1.40	1.41	1.40		1.0
Austria	33.10	15.54	22.68	25.33		2.1
Belgium	67.59	40.68	52.44	53.09		1.5
Canada	1.15	1.22	1.18	1.16		0.8
Cyprus	0.36	0.36	0.36	0.37		0.7
Czech Republic	25.12	15.83	19.94	18.48		0.6
Denmark	14.60	6.84	9.99	9.83		1.5
Estonia	11.16	7.57	9.19	8.99		0.6
Finland	7.92	6.10	6.95	6.76		1.3
France	9.13	6.58	7.75	7.93		1.4
Germany	2.94	2.29	2.60	2.60		1.5
Greece	553.09	323.94	423.28	385.99		1.4
Hungary	171.56	61.80	102.97	98.27		0.5
Ireland	1.64	0.63	1.01	0.86		1.3
Italy	3160.22	1431.16	2126.69	2293.89		1.3
Japan	373.81	167.13	249.95	277.95		2.3
Latvia	0.36	0.31	0.33	0.32		0.5
Lithuania	3.00	2.30	2.62	2.57		0.6
Luxembourg	77.39	35.65	52.53	43.16		1.2
Malta	0.25	0.33	0.29	0.29		0.8
Netherlands	1.81	1.15	1.44	1.32		0.7
New Zealand	2.54	1.85	2.17	2.02		1.3
Norway	20.75	12.91	16.37	18.24		2.6
Poland	1.80	1.15	1.44	1.40		0.4
Portugal	155.23	85.29	115.06	111.47		0.6
Slovak Republic	23.14	16.39	19.48	18.98		0.6
Slovenia	363.26	213.80	278.68	266.69		1.7
South Korea	2182.58	862.95	1372.39	1467.13		1.5
Spain	202.90	120.04	156.06	167.40		1.1
Sweden	13.69	12.09	12.86	12.79		1.7
Taiwan	84.54	33.74	53.41	55.72		1.7
U.K.	1.15	0.76	0.93	0.95		1.6
U.S.A.	1.00	1.00	1.00	1.00		1.0

3.3.2 Water transport

Water transport is only subdivided on NACE 3-digit level, with a subdivision in Sea and coastal water transport (61.1) and inland water transport (61.2). There is no subdivision into 4-digit industries for this industry. This makes it very difficult to make further split-ups. For example, we are not able to distinguish passenger transport by ferries and cruise ships from freight transport.

For most countries passenger transport is only marginal in comparison with freight, but for countries like Denmark and Greece, with high shares of passenger transport, very strange results appeared. That is why we refrained from making comparisons at all for those two countries, because we could not clearly distinguish revenues of passenger and freight movements.

Inland water transport consists of transport activities on lakes, rivers and within harbours. The structure of inland waterways can be rather different between countries, as some rivers are easier to navigate than others. It will take much more time and money if ships need to wait for bridges and locks. Another difference that influences productivity enormously is the direction of transport. Downstream transport can easily be three times faster than upstream transport. As data on issues like this is difficult to obtain, we cannot quantify the influence of such differences in infrastructure. All we can do is to assume that the upstream and downstream advantages and disadvantages will cancel out in the aggregate figures.

Tonne kilometers in inland transport are available in various publications. We heavily rely on the United Nations (*Annual Bulletin of Transport Statistics for Europe and North America 1999),* Eurostat *(Energy and Transport statistics 2003)* and the European Conference of Ministers of Transport (*Transportation database),* complemented with national sources. For Sea and Coastal transport limited information about tonne-kilometers is available. Although we would prefer to use this measure, data availability forces us to use an alternative measure: tonnes transported. This can introduce some bias as trip lengths may differ. Sources for quantities mostly stem from the United Nations (*Annual Bulletin of Transport Statistics for Europe and North America 1999).* For revenues we can rely on the 3-digit gross output data set.

As harbour operation and auxiliary services like pilotage, docking and vessel salvage are included in supporting services, there is no need to make adjustments for terminal services here. Quality adjustments in freight transport are hard to make and the choice of quality measures is subjective. One can think of subdividing freight by the nature of the products transported, distance classes or delivery time. For none of these reliable and comparable data is available however. We do therefore not make any quality adjustments to water transport.

Results

In table 3.5 the PPPs for the water transport sector have been displayed. As a number of countries only have data available for either inland water transport or coastal transport, the Laspeyres and Paasche indices are equal in a number of cases.

The relative prices show not only high prices in Japan and Norway (as for land transport), but also in New Zealand, Poland and Germany. For these countries this will be mainly due to the limited access to open sea. The price level for inland water transport is across the board higher than prices of open sea transport. At the other end Australia, South Korea and Canada have extremely low prices. This is mainly due to the high share of sea and coastal transport in these countries. The reason for the low price level in Austria (only inland water transport) is less obvious. In both cases it is a very small sector and therefore vulnerable to measurement errors.

Table 3.5 PPPs and relative prices in water transport, 1997

	PPPs					**Relative price**
	Laspeyres	Paasche	Fisher	EKS		US=1
Australia	0.32	0.32	0.32	0.34		0.3
Austria	7.16	7.16	7.16	4.15		0.3
Belgium	38.06	25.90	31.40	32.95		0.9
Canada	0.51	0.44	0.47	0.49		0.4
Cyprus	0.52	0.52	0.52	0.54		1.0
Czech Republic	59.41	59.41	59.41	34.45		1.1
Denmark	*11.75*	*11.40*	*11.58*	*12.49*		*1.9*
Estonia	8.13	8.13	8.13	8.32		0.6
Finland	8.08	5.55	6.70	7.22		1.4
France	7.51	4.25	5.65	5.77		1.0
Germany	3.80	3.79	3.79	3.80		2.2
Greece	*402.12*	*325.52*	*361.80*	*373.86*		*1.4*
Hungary	465.39	465.39	465.39	269.89		1.4
Ireland	0.51	0.51	0.51	0.52		0.8
Italy	2032.63	2032.63	2032.63	2081.07		1.2
Japan	166.11	275.68	213.99	156.86		1.3
Latvia	0.17	0.17	0.17	0.18		0.3
Lithuania	1.91	1.91	1.91	1.96		0.5
Luxembourg	65.90	37.94	50.00	51.49		1.4
Malta	0.50	0.50	0.50	0.51		1.3
Netherlands	1.44	1.16	1.29	1.26		0.6
New Zealand	3.90	3.90	3.90	3.99		2.6
Norway	15.10	17.44	16.23	12.14		1.7
Poland	4.90	4.29	4.58	4.96		1.5
Portugal	93.01	93.01	93.01	95.22		0.5
Slovak Republic	49.82	49.82	49.82	28.89		0.9
Slovenia	209.43	119.57	158.25	166.29		1.0
South Korea	406.54	406.54	406.54	416.23		0.4
Spain	118.25	58.47	83.15	82.01		0.6
Sweden	10.99	11.34	11.17	11.73		1.5
Taiwan	50.47	50.47	50.47	54.46		1.7
U.K.	0.99	0.59	0.77	0.81		1.3
U.S.A.	1.00	1.00	1.00	1.00		1.0

Note: PPPs for Greece and Denmark are for total transport

3.3.3 Air transport

Unlike land transport, the air transport industry classification is rather straightforward. NACE distinguishes between scheduled (62.1), non-scheduled air transport (62.2) and space transport (62.3). The latest category is for obvious reasons difficult to match and will not considered here. Unfortunately, no subdivision in passengers and freight has been made in the NACE classification. This problem will be less pressing than for land and water transport, because of the higher amount of data available about air transport. In particular we make use of airline company data to distinguish between trips of various lengths. The Statistical Yearbook of the International Civil Aviation Organization provides data on transport performances by company, with indicators on passengers and freight transported, passenger kilometers and tonne kilometers, and revenues for freight transport, passenger transport and non-scheduled transport. With this information we are able to calculate the average trip length of passenger flights, and classify airlines accordingly. We decided to make a sub-division in four distance categories, namely short distance flights (less than 750 km), medium distance flights (750-1500 km), long distance flights (1500-2500 km) and intercontinental flights (more than 2500 km). In previous work researchers distinguished between domestic and international transport. This was troublesome when comparing large and small countries. For example, a domestic flight in the United States is most of the times just as long as an international flight from the Netherlands, so a subdivision in domestic and international was not so useful. The use of distance categories is a good solution to take care of differences in country size.

For freight and non-scheduled transport we did not use distance groups. As the number of countries transporting freight is much smaller than in passenger transport, it was difficult to find enough companies for each category. Furthermore a lot of passenger flights also take some freight, as additional source of income. Freight transport has therefore been matched in one category, with the number of freight tonne-kilometers as quantity measure. For non-scheduled transport further subdivisions were also not possible, due to the problem that non-scheduled revenues do not show which part is due to freight and which part is due to passenger transport. This leads to the question which quantity measure should be used here. As the ICAO publication shows a tonne-kilometer measure that includes passengers[11], this seems to be the best measure we can get.

Almost all data stems from the ICAO, *Civil Aviation statistics of the World 1997, ICAO Statistical Yearbook.* As this publication did not show data for all airline companies especially for some (smaller) countries, we collected annual reports of firms not included in the ICAO report. Appendix table C shows the classification of air companies by distance category. For companies displayed in italics we based the data on their annual reports. Although annual reports do not always contain sufficient information, we managed to include the major airlines for each country.

The assignment of companies to countries leads to problems when air companies, like SAS, are owned by more than one country. What we did here was to consider domestic flights as the 'own' output of the country and distribute the international output equally among Norway, Denmark and Sweden. We do indirectly assume that the international performances are equal.

[11] They make the implicit assumption that each passenger, including luggage weighs 90 kilos.

We could further improve our PPPs if we would have information about first class, business class and economy class. This information is however often not freely available, so we stick to the aggregate data at firm level. Matching by distance category does already classify the firms operating on the same market, and the quality of the service on board is normally dependent on the length of the flight. Furthermore we distinguish between scheduled and non-scheduled flights. The detailed matching procedure already removes a lot of quality differences. For this reason we do not see a ground to apply any (other) quality adjustments.

Results

Compared to the land and water transport this industry shows much less differences between the Laspeyres and Paasche PPPs. This implicitly implies that the air transport market is more equal in structure than the other transport markets. Relative prices are especially low for Canada, South Korea and Taiwan. It is remarkable that the Central and Eastern European countries are not among the lower price countries here, like in other transport modes. UVRs are high for airlines in Belgium and Luxembourg, but this can be due to the fact that there are only a few national companies operating on the airline market (for both countries we have only included one firm in our comparison). In the Belgian case the numbers describe the performances of SABENA, which went bankrupt a few years later. For Luxembourg the high share of relatively expensive business flights can be an important reason. Relative prices for all other countries are between 0.8 and 1.7.

Table 3.6 PPPs and relative prices in Air transport, 1997

	PPPs				Relative price
	Laspeyres	Paasche	Fisher	EKS	US=1
Australia	1.08	1.42	1.24	1.26	0.9
Austria	14.39	14.49	14.44	14.41	1.2
Belgium	97.74	97.92	97.83	99.25	2.8
Canada	0.85	0.82	0.83	0.83	0.6
Cyprus	0.60	0.60	0.60	0.60	1.2
Czech Republic	37.69	38.07	37.88	37.88	1.2
Denmark	8.95	9.57	9.26	9.39	1.4
Estonia	37.69	9.75	19.17	19.34	1.4
Finland	6.05	6.10	6.08	6.11	1.2
France	6.92	6.56	6.74	6.67	1.1
Germany	2.27	2.15	2.21	2.19	1.3
Greece	307.15	258.72	281.90	283.83	1.0
Hungary	159.17	165.42	162.26	162.48	0.9
Ireland	1.08	1.08	1.08	1.10	1.7
Italy	2610.54	2344.59	2473.99	2433.71	1.4
Japan	209.06	149.98	177.07	175.98	1.5
Latvia	0.86	1.04	0.95	0.95	1.6
Lithuania	8.08	6.30	7.13	7.13	1.8
Luxembourg	81.26	81.26	81.26	82.45	2.3
Malta	0.62	0.60	0.61	0.60	1.6
Netherlands	2.21	2.08	2.15	1.74	0.9
New Zealand	1.25	1.25	1.25	1.27	0.8
Norway	9.81	8.55	9.16	9.29	1.3
Poland	3.73	3.83	3.78	3.74	1.1
Portugal	209.15	203.91	206.52	208.58	1.2
Slovak Republic	74.34	40.98	55.20	50.50	1.5
Slovenia	198.74	185.38	191.94	189.31	1.2
South Korea	498.15	450.67	473.82	478.05	0.5
Spain	155.16	140.60	147.70	146.16	1.0
Sweden	10.39	9.09	9.72	9.58	1.3
Taiwan	15.59	18.16	16.83	17.07	0.5
U.K.	0.83	0.81	0.82	0.80	1.3
U.S.A.	1.00	1.00	1.00	1.00	1.0

3.3.4 Supporting and auxiliary transport activities

This study is the first attempt to calculate PPPs for supporting services. Previous work always used the PPP for total transport as a proxy. The extended detail in the NACE rev. 1 classification and the shift of terminal services from 60-62 to industry 63 is the main reason that we are able to calculate specific PPPs for supporting services. Industry 63 has been split up in four 3-digit industries, of which especially 63.1, 63.2 and 63.4 will be described.

Cargo handling and storage

Industry 63.1 consists of cargo handling, storage and warehousing. This includes the loading and unloading of goods and passengers' luggage, stevedoring (shipment from ships to rampart) and the operation of storage and warehouse facilities. As these activities are mainly related to the handling of goods, its performance can best be quantified in tons. However, it is difficult to find data concerning the amount of goods stored. If we assume that most goods in storage are stored for a short time, waiting for further transportation, the tonnes of goods transported may be a good estimate. We have already collected this data by transport mode for industries 60 to 62. Although this number will most likely overestimate the actual amount in storage, it seems to be a justified proxy. Due to the lack of alternative data we add the tonnes transported by rail, road, water and air and use this quantity measure. For this data we rely on the World Bank *Railways Database,* the *ICAO Statistical Yearbook,* United Nations *Annual Bulletin of Transport Statistics for Europe and North America 1999,* Eurostat *Energy and Transport statistics 2003,* Institute of Shipping Economics and Logistics *Shipping Statistics Yearbook 1999* and the European Conference of Ministers of Transport *Transportation database,* complemented with national sources. Values have been calculated in the 3-digit gross output dataset, and mostly stem from OECD Structural Statistics on Industry and Services and the Eurostat Structural Business Statistics.

Other supporting transport activities

Industry 63.2 describes a broad range of activities and is further subdivided in supporting services to land transport (63.21), supporting services to water transport (63.22) and supporting services to air transport (63.23). It is not clear however, which services can be attributed to passenger transport and which activities belong to freight transport. In this case we assume that the ratio between the revenues of passenger and freight transport serves as a good approximation for the split-up in terminal services. Auxiliary services to land transport are split up in road and railway services in a similar way. We use the tonnes and passengers transported as performance indicator for supporting services to land transport. By far the largest part of transport is after all executed by domestic firms, and the use of terminal facilities like car parks, train and bus stations can mostly be attributed to these firms. The fact that foreign firms also use roads and bridges, but are not counted in this respect will not cause a severe bias. This is different in water and air transport. Harbours usually load and unload goods from ships operating under various flags. We do therefore need the actual number of handled goods, as this exactly describes the activities of the harbour. Activities like towing, pilotage and operation of locks and lighthouses are included here as well, but only make up small parts. The *Shipping Statistics Yearbook 1999* of the Institute of Shipping Economics and Logistics contains data on the handling of goods for all major ports. This source exactly provides the data we need. The supporting services of passenger transport will be small compared to this, and are assumed to be non-existing in this report. For auxiliary services to air transport, we can of course not neglect the services that can be attributed to passengers. So we use the ratio of the transportation output of freight and passengers to split up supporting services for passenger and freight transport. The number of passengers and freight handled by all major airports are also described in the *ICAO Statistical Yearbook*.

Activities of travel agencies and tour operators

Industry 63.3 is the odd man out in the supporting services. It describes the activities of travel agencies, tour operators and tourist guides. This includes arranging of tours, accommodation and transportation for tourists, but also advice and distribution of travel information. After a thorough search for a reliable quantity indicator, we decided to omit this industry. The problem is that the tourist industries for the countries in this data set are difficult to compare. One can argue that the number of foreigners coming in or the number of overnight stays forms a good quantity index of the activities carried out by firms in this branch. But this means that you would 'forget' the people enjoying trips and holidays in their own country, which is especially for larger countries a significant group. Another problem is the composition of this sector. For some countries tour operators (for which the number of persons that booked a trip would be a good quantity indicator) form the major part, while for other countries the tourist offices selling trips of other organizations (which should be compared on margins[12]) make up the biggest part. Taking into account all problems in this sector we decided to refrain from calculating a PPP.

Activities of other transport agencies

Forwarding of freight, activities of customs agents, issue and procurement of transport documents and other goods-handling operations are included in industry 63.4. As all activities in this industry are related to the handling of goods, they can be measured by the same indicator as industry 63.1. Because these industries are difficult to separate as the statistics of several countries do already include 63.4 in 63.1, we combine both industries and calculate one PPP.

Results

Differences in relative prices are large in supporting services, with low relative prices in less developed countries (Central and Eastern Europe, Portugal, Korea and Taiwan) and Luxembourg (probably due to the fact that transportation firms in Luxembourg often use foreign terminals). For Belgium, Ireland, Sweden and France prices are relatively high. For all these countries this is mainly due to high UVRs for data storage and warehousing. It is remarkable that the population density of the countries and the average length of trips do not show any correlation. This suggests

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[12] The method of calculating margin based PPPs has been described in more detail in Timmer and Ypma (2006).

that the assumption that population density and terminal services which has been used in previous studies is not valid.

Table 3.6 PPPs and relative prices in Supporting and auxiliary transport activities, 1997

	PPPs					Relative price
	Laspeyres	Paasche	Fisher	EKS		US=1
Australia	1.34	1.36	1.35	1.34		1.0
Austria	18.76	12.92	15.57	16.29		1.3
Belgium	78.07	64.70	71.07	71.75		2.0
Canada	1.70	1.46	1.57	1.56		1.1
Cyprus	0.29	0.33	0.31	0.31		0.6
Czech Republic	12.69	9.07	10.73	10.68		0.3
Denmark	10.69	6.24	8.17	8.56		1.3
Estonia	20.75	17.27	18.93	18.52		1.3
Finland	7.07	6.53	6.80	6.79		1.3
France	10.73	9.28	9.98	10.10		1.7
Germany	3.03	2.50	2.75	2.65		1.5
Greece	237.58	192.05	213.61	218.24		0.8
Hungary	85.77	77.76	81.67	81.49		0.4
Ireland	1.47	1.10	1.27	1.33		2.0
Italy	3147.26	2091.81	2565.83	2740.85		1.6
Japan	226.23	62.54	118.95	123.08		1.0
Latvia	0.47	0.28	0.36	0.37		0.6
Lithuania	5.68	1.26	2.67	1.92		0.5
Luxembourg	10.27	7.27	8.64	7.70		0.2
Malta	0.26	0.26	0.26	0.26		0.7
Netherlands	1.79	1.36	1.56	1.59		0.8
New Zealand	2.21	2.06	2.13	2.13		1.4
Norway	12.34	9.46	10.81	10.67		1.5
Poland	1.47	0.89	1.14	1.09		0.3
Portugal	83.44	56.30	68.54	72.98		0.4
Slovak Republic	10.80	9.07	9.90	10.01		0.3
Slovenia	126.90	108.82	117.51	116.56		0.7
South Korea	647.41	214.35	372.52	473.87		0.5
Spain	204.83	150.23	175.42	181.73		1.2
Sweden	14.26	13.26	13.75	13.67		1.8
Taiwan	15.17	14.83	15.00	15.94		0.5
U.K.	0.86	0.74	0.80	0.80		1.3
U.S.A.	1.00	1.00	1.00	1.00		1.0

3.3.5 Total Transport

For comparisons on a more aggregated level we also look at the combined PPP for industries 60-63. This also gives the possibility to compare our PPPs with the results from previous studies.

Aggregation of industry PPPs to the level of the total sector is done by weighting the two-digit PPPs with the gross output figures for the United States (Laspeyres) and the compared country (Paasche). The Fisher PPP is calculated as their square root. Like the aggregation from three to two digit PPPs, the weights stem from the 3-digit gross output data set for 1997. This means that the gross output figures are consistent with national accounts (see Appendix 1 for the shares of gross output of 3-digit industries in Transport and communication). The EKS results are based on multilateralised Fisher PPPs at 3-digit level, weighted with the three digit output weights. This leads to slightly different results than if you aggregate the 2-digit PPPs with the corresponding weights.

Results

At the level of the total transport sector we can distinguish a number of groups in relative prices. Most Central and Eastern European countries and Portugal have low relative prices (less than 0.7). The middle group is formed by the North American countries, Oceania, Asia (except Japan), Southern Europe (except Italy and Portugal), Estonia, Slovenia, Luxembourg and the Netherlands (especially due to low relative prices in land transport). The other European countries, Norway and Japan make up the high relative price group (more than 1.3).

Table 3.7 PPPs and relative prices in Total Transport, 1997

	PPPs					Relative price
	Laspeyres	Paasche	Fisher	EKS		US=1
Australia	1.27	1.22	1.24	1.26		0.9
Austria	24.49	14.37	18.76	20.62		1.7
Belgium	75.21	50.22	61.45	62.07		1.7
Canada	1.17	1.09	1.13	1.10		0.8
Cyprus	0.41	0.43	0.42	0.43		0.8
Czech Republic	24.05	13.20	17.82	18.28		0.6
Denmark	11.75	11.40	11.58	10.32		1.6
Estonia	19.09	10.59	14.22	13.23		1.0
Finland	6.92	7.10	7.01	6.78		1.3
France	8.90	7.29	8.05	8.21		1.4
Germany	2.66	2.51	2.58	2.65		1.5
Greece	402.12	325.52	361.80	326.44		1.2
Hungary	164.93	69.56	107.11	103.83		0.6
Ireland	1.42	0.84	1.09	1.03		1.6
Italy	2930.21	1566.75	2142.64	2443.65		1.4
Japan	294.46	118.38	186.70	209.35		1.7
Latvia	0.49	0.31	0.39	0.40		0.7
Lithuania	4.67	1.90	2.98	2.77		0.7
Luxembourg	77.78	47.82	60.99	40.14		1.1
Malta	0.35	0.37	0.36	0.38		1.0
Netherlands	1.88	1.32	1.58	1.43		0.7
New Zealand	2.25	1.69	1.95	1.95		1.3
Norway	16.18	12.58	14.27	15.22		2.2
Poland	2.32	1.13	1.62	1.71		0.5
Portugal	148.95	83.29	111.38	114.55		0.7
Slovak Republic	33.43	14.13	21.73	19.47		0.6
Slovenia	267.57	152.94	202.30	201.85		1.3
South Korea	1382.89	483.86	818.00	902.41		0.9
Spain	188.28	123.93	152.76	159.33		1.1
Sweden	12.93	11.97	12.44	12.65		1.7
Taiwan	52.32	24.97	36.14	33.63		1.0
U.K.	1.01	0.75	0.87	0.87		1.4
U.S.A.	1.00	1.00	1.00	1.00		1.0

Reliability

Some of the UVRs calculated for this project are based on a large number of matches and cover a large part of the output. There are however also PPPs which are based on only one or two matches. In the calculation of aggregate PPPs we take account of this, by using different weights for high quality and lower quality PPPs. In the manufacturing sector we use the number of matches, coverage ratio and covariance as quality measure of PPPs. As the number of matches is normally limited in transport we only use the coverage ratio as criterion in the decision process. If coverage of output at 3-digit level is lower than 20%, we use the matched output as weight. Otherwise we use gross output of the whole 3-digit industry as weight. As coverage ratios are generally high in our comparison, there are only a few cases where we switch to matched output (especially in Non-scheduled air transport and telecommunications). Table 3.9 shows the coverage and number of matches at 2-digit level.

In comparison with previous studies, where the maximum number of matches was 8 in total transportation, the current PPP set matches on a more detailed level. Coverage ratios are somewhat smaller compared to previous ICOP studies, as more detailed matches also exclude some activities that cannot be matched across countries. In previous work revenues of activities like taxi transport were included in bus transport, although the quantity measure did not include passenger transport by taxis. In the current set the revenues from taxi transport are excluded from bus transport even if we were not able to make a specific match for taxi transport. High coverage ratios do therefore not always mean that the reliability of the PPP should be higher. It can also be that the possibility to match activities at a detailed level was not possible. The combination of coverage and the number of matches gives a better indication.

Table 3.9 Reliability indicators in Transport

	60		61		62		63		**60-63**	
	Coverage (in %)	Number of Matches	Coverage (in %)	Number of Matches	Coverage (in %)	Number of Matches	Coverage (in %)	Number of Matches	**Coverage (in %)**	**Number of Matches**
Australia	88%	3	100%	2	59%	3	84%	7	**82%**	**15**
Austria	86%	6	56%	1	53%	4	68%	7	**76%**	**18**
Belgium	70%	5	100%	2	67%	2	75%	8	**74%**	**17**
Canada	74%	4	100%	2	42%	4	77%	8	**70%**	**18**
Cyprus	53%	1	100%	1	81%	2	69%	5	**76%**	**9**
Czech Republic	87%	5	18%	1	51%	3	63%	8	**76%**	**17**
Denmark	76%	5	0%	-	44%	3	68%	7	**42%**	**15**
Estonia	99%	4	100%	1	75%	3	95%	7	**97%**	**15**
Finland	98%	5	100%	2	69%	3	87%	7	**91%**	**17**
France	87%	6	100%	2	70%	4	80%	8	**83%**	**20**
Germany	100%	7	100%	2	61%	4	78%	8	**87%**	**21**
Greece	85%	5	0%	-	94%	3	65%	7	**69%**	**15**
Hungary	80%	5	92%	1	72%	3	66%	7	**76%**	**16**
Ireland	73%	4	99%	1	59%	2	76%	7	**73%**	**14**
Italy	58%	5	91%	1	52%	4	66%	7	**64%**	**17**
Japan	88%	4	45%	2	90%	5	100%	8	**88%**	**19**
Latvia	100%	4	99%	1	30%	3	68%	7	**76%**	**15**
Lithuania	97%	4	100%	1	63%	3	67%	7	**87%**	**15**
Luxembourg	84%	4	100%	2	27%	1	60%	6	**62%**	**13**
Malta	100%	2	100%	1	98%	3	53%	4	**82%**	**10**
Netherlands	97%	7	100%	2	58%	3	65%	7	**81%**	**19**
New Zealand	77%	3	100%	1	70%	2	85%	7	**78%**	**13**
Norway	100%	7	100%	2	56%	3	61%	8	**88%**	**20**
Poland	73%	5	82%	2	72%	3	77%	8	**75%**	**18**
Portugal	91%	5	95%	1	72%	4	58%	7	**78%**	**17**
Slovak Republic	57%	4	85%	1	71%	4	76%	7	**61%**	**16**
Slovenia	100%	4	100%	2	98%	3	65%	8	**86%**	**17**
South Korea	64%	6	99%	1	89%	4	73%	8	**70%**	**19**
Spain	83%	6	100%	2	75%	5	77%	8	**81%**	**21**
Sweden	86%	5	100%	2	55%	4	72%	8	**80%**	**19**
Taiwan	67%	4	0%	1	66%	3	59%	8	**50%**	**16**
U.K.	71%	6	100%	2	78%	5	51%	8	**66%**	**21**
U.S.A.	97%	7	100%	2	55%	5	77%	8	**83%**	**22**
Average	**83%**	**5**	**84%**	**1**	**66%**	**3**	**72%**	**7**	76%	17

3.3.6 Communication

The communication sector consists of two main activities: Postal deliveries (64.1) and Telecommunications (64.2).

Post and courier activities

This industry consists of two 4-digit industries, national post activities (64.11) and courier activities other than national post activities (64.12). Like in previous work on communication PPPs we measure the performance of the postal firms by the number of postal deliveries. We can subdivide this by the form of goods delivered, like packages, letters, newspapers and other products. All this information is collected in the *Postal database 2004* of the Universal Postal Union. Unfortunately revenue figures are not that detailed: there is only a figure for total postal revenues. To benefit at least partially from the huge detail in deliveries, we match all non-zero measures of quantities delivered between country x and the United States. This means that if there is information for letters, newspapers and insured letters, we add the same categories for the United States. If only the deliveries of letters is available (which is available for all countries we consider), we make a match at that level. We use the total postal revenue as output figure in all cases. [13]

The detailed matching procedure described in O'Mahony et al. would be very helpful here as well. However, we do compare 32 countries here and cannot really judge the quality of deliveries in all countries. We can however look at quality indicators from the postal database like the number of post offices per inhabitant and the average area covered by a post office. Table 3.10 shows a number of possible quality indicators, all deducted from the Postal database. There is no reason to correct for the percentage of inhabitants receiving mail at home or without postal service, because differences between countries are negligible. The area covered by a post office and the average number of inhabitants show more differences, but it is questionable if this is a right quality measure. Most people do not go to the post office to use the postal system. The number of letter boxes is a better measure then. A lower number of boxes per 1000 inhabitants means lower quality of postal services and this should be reflected in lower prices. We have checked if there is any correlation between the number of letter boxes per inhabitant and relative prices, but this is not the case. Therefore we do not adjust for quality.

[13] Total postal revenue was expressed in Special Drawing Rights (SDRs), and has been converted to national currency with exchange rates from the IMF International Financial Statistics.

Table 3.10 Quality indices postal activities

	Average number of inhabitants served by one post office	Average area covered by a post office (km²)	Population having mail delivered at home (in %)	Population without postal service (in %)	Number of letter boxes per 1000 inhabitants
Australia	4,647	1,956	99	0	0.7
Austria	3,135	33	99	0	3.0
Belgium	n.a.	n.a.	100	0	1.9
Canada	n.a.	n.a.	n.a.	0	n.a.
Cyprus	966	12	98	0	0.5
Czech Republic	2,992	23	99.95	0.01	2.4
Denmark	4,297	35	100	0	1.9
Estonia	2,431	78	82	0	2.6
Finland	3,329	219	n.a.	0	1.9
France	3,421	32	100	0	2.5
Germany	3,991	17	100	0	1.7
Greece	8,657	106	100	0	1.4
Hungary	3,184	29	97.6	0	1.7
Ireland	1,914	37	100	0	1.2
Italy	4,116	22	n.a.	n.a.	1.3
Japan	5,111	15	99.95	0	1.4
Latvia	2,454	65	96	0	1.1
Lithuania	3,655	67	100	0	1.5
Luxembourg	3,936	24	100	0	2.7
Malta	7,679	6	100	0	1.4
Netherlands	6,520	17	100	0	1.2
Norway	2,879	251	90	0	6.8
Poland	4,968	42	n.a.	0	1.5
Portugal	2,743	25	98	0	1.8
Slovakia	3,115	28	n.a.	n.a.	1.4
Slovenia	3,692	38	100	0	1.4
South Korea	12,779	28	95	0	0.9
Spain	n.a.	n.a.	99.5	0	0.9
Sweden	n.a.	n.a.	n.a.	n.a.	n.a.
Taiwan	n.a.	n.a.	n.a.	n.a.	n.a.
United Kingdom	3,057	13	100	0	1.9
United States of America	6,173	216	98.5	0	1.2
Average	**4,290**	**127**	**98.1**	**0**	**1.8**

Source: Universal Postal Union, Postal Database 2004

Telecommunications

The telecommunications industry includes all activities related to the transmission of sound, images, data or other information via cables, broadcasting, relay or satellite. Call-centers (74.83) and the production of radio and television programs (92.2) are not part of this industry. For telecommunications we can use the *OECD Telecommunications database*, which provides revenue and performance data on local calls, national calls, international calls and mobile telephony. As the number of minutes called gives the most detailed description, we prefer this measure. Unfortunately, this is only available for international calls. Local and national calls are expressed in the number of calls and for mobile traffic only the number of subscribers is available. But the split up in four forms of telephone traffic is already a large improvement in comparison with earlier work. The database also contains a few cost categories connected to connection or subscriber cost (revenue from installation charges, revenue from leased lines and revenue from line rental charges). In some of the countries the costs of being connected to the telephone network are significant, so we have tried to produce a UVR ratio for connection costs as well, with the number of lines as quantity measure. There seem to be data problems here, because differences among countries are enormous. As using this figures will highly bias the PPP measures, we have refrained from using this UVR.

Concerning the quality of telecommunications we can assume that for the countries in our dataset differences are small. In earlier times one could take the chance of making a connection as a quality indicator (see Mulder 1994), but this indicator will be almost 100% for each country now. Therefore we see no reason for making a quality adjustment here.

Results

Table 3.11 shows the results of the UVR calculations in the communication sector. Relative prices are high in Japan, New Zealand, Malta and Greece, which is mainly due to high UVRs for the postal industry. At the lower end the relative prices for Hungary, Slovakia, Sweden and the UK are remarkable. A closer look at these figures shows that the PPP for Canada has only been based on the telecommunication sector. For UK, Hungary and Sweden the prices for long distance calls are relatively cheap. Slovakia offers low prices for cellular communication.

The reliability indicators of the communication PPPs are displayed in table 3.12. It shows that the number of matches is often not very high, which is due to the fact that it was difficult to find detailed data for all countries. In previous work the maximum number of matches was 3, so we made some progress in terms of detail. It would however be useful if we could match even more activities in the communication sector. Expressing all calls in the number of minutes instead of the number of calls would be another major improvement. As both coverage ratios and the number of matches are not very high for communication, these PPPs should be handled with care.

Table 3.11 PPPs and relative prices in Communication, 1997

	PPPs					Relative price
	Laspeyres	Paasche	Fisher	EKS		US=1
Australia	2.07	1.74	1.89	1.54		1.1
Austria	14.90	13.36	14.11	14.01		1.1
Belgium	48.51	30.79	38.65	34.21		1.0
Canada	0.85	0.77	0.81	0.95		0.7
Cyprus	0.39	0.31	0.34	0.36		0.7
Czech Republic	37.76	33.76	35.70	35.34		1.1
Denmark	11.53	6.68	8.78	7.15		1.1
Estonia	15.50	15.97	15.73	16.28		1.2
Finland	7.04	5.46	6.20	6.21		1.2
France	6.02	4.58	5.25	5.20		0.9
Germany	2.30	0.97	1.49	1.68		1.0
Greece	506.30	371.67	433.79	390.33		1.4
Hungary	124.03	107.43	115.43	119.78		0.6
Ireland	1.41	0.71	1.00	0.81		1.2
Italy	2171.77	1259.21	1653.70	1589.40		0.9
Japan	218.80	191.05	204.46	212.60		1.8
Latvia	0.51	0.48	0.49	0.53		0.9
Lithuania	5.22	4.70	4.96	5.28		1.3
Luxembourg	52.90	24.91	36.30	26.87		0.8
Malta	0.98	0.45	0.66	0.67		1.7
Netherlands	3.15	2.35	2.72	2.46		1.2
New Zealand	2.24	2.57	2.40	2.42		1.6
Norway	10.46	7.75	9.01	6.29		0.9
Poland	5.43	3.88	4.59	3.92		1.2
Portugal	248.17	211.31	229.00	225.90		1.3
Slovak Republic	20.39	19.87	20.13	20.76		0.6
Slovenia	121.10	113.52	117.25	117.65		0.7
South Korea	1118.08	973.30	1043.18	1115.00		1.2
Spain	147.65	155.85	151.69	153.48		1.0
Sweden	5.94	1.71	3.19	3.29		0.4
Taiwan	28.74	28.93	28.83	30.23		0.9
U.K.	0.40	0.26	0.32	0.35		0.6
U.S.A.	1.00	1.00	1.00	1.00		1.0

Table 3.12 Reliability indicators in Communication

	64 Coverage (in %)	Number of Matches		64 Coverage (in %)	Number of Matches
Australia	82%	3	Lithuania	87%	3
Austria	76%	5	Luxembourg	62%	3
Belgium	74%	3	Malta	82%	3
Canada	70%	3	Netherlands	81%	3
Cyprus	76%	3	New Zealand	78%	4
Czech Republic	76%	3	Norway	88%	3
Denmark	42%	3	Poland	75%	3
Estonia	97%	2	Portugal	78%	3
Finland	91%	5	Slovak Republic	61%	5
France	83%	5	Slovenia	86%	4
Germany	87%	5	South Korea	70%	5
Greece	69%	3	Spain	81%	3
Hungary	76%	5	Sweden	80%	4
Ireland	73%	3	Taiwan	50%	3
Italy	64%	5	U.K.	66%	5
Japan	88%	4	U.S.A.	83%	5
Latvia	76%	3	**Average**	**76%**	**4**

4. Comparing productivity in transport and communication

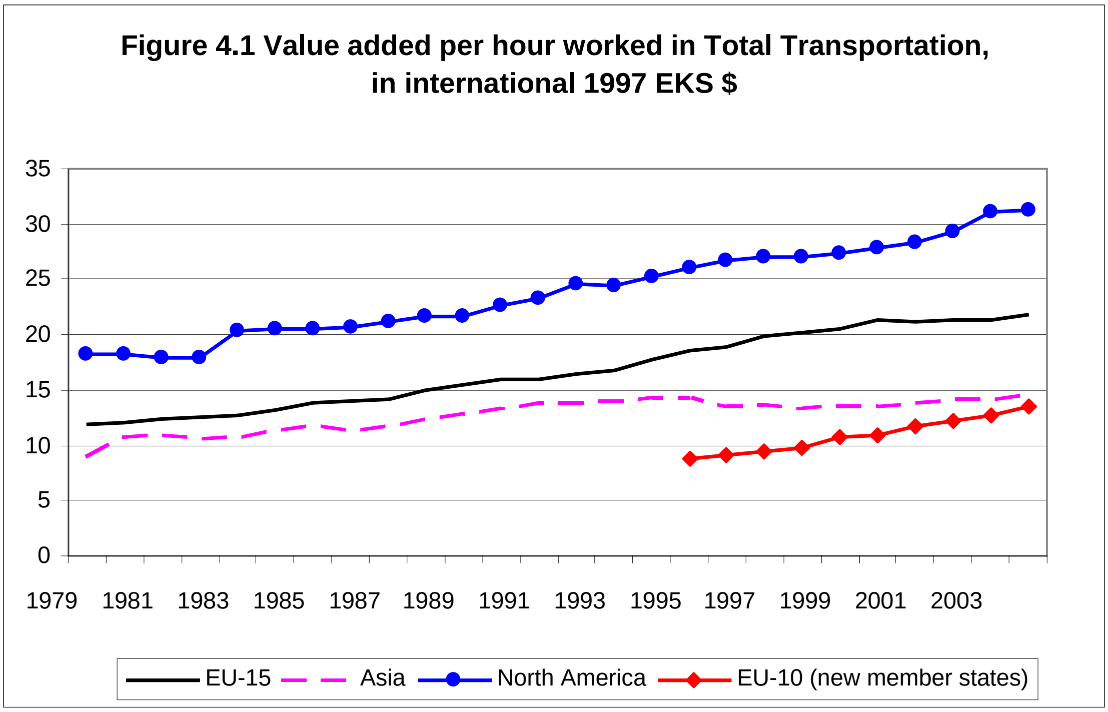
Over the years the productivity levels of Europe and the US have converged more and more if we look at previous studies (see Appendix table A.1). It is interesting to find out if this is due to changes in methodology, or if Europe is really catching up. Does the current methodology show a trend of convergence and has Europe already closed the gap in productivity? For New European Union members and Asian countries this working paper is one of the first attempts to quantify their levels, so we do not have a clear idea how they perform relatively to Europe and the US.

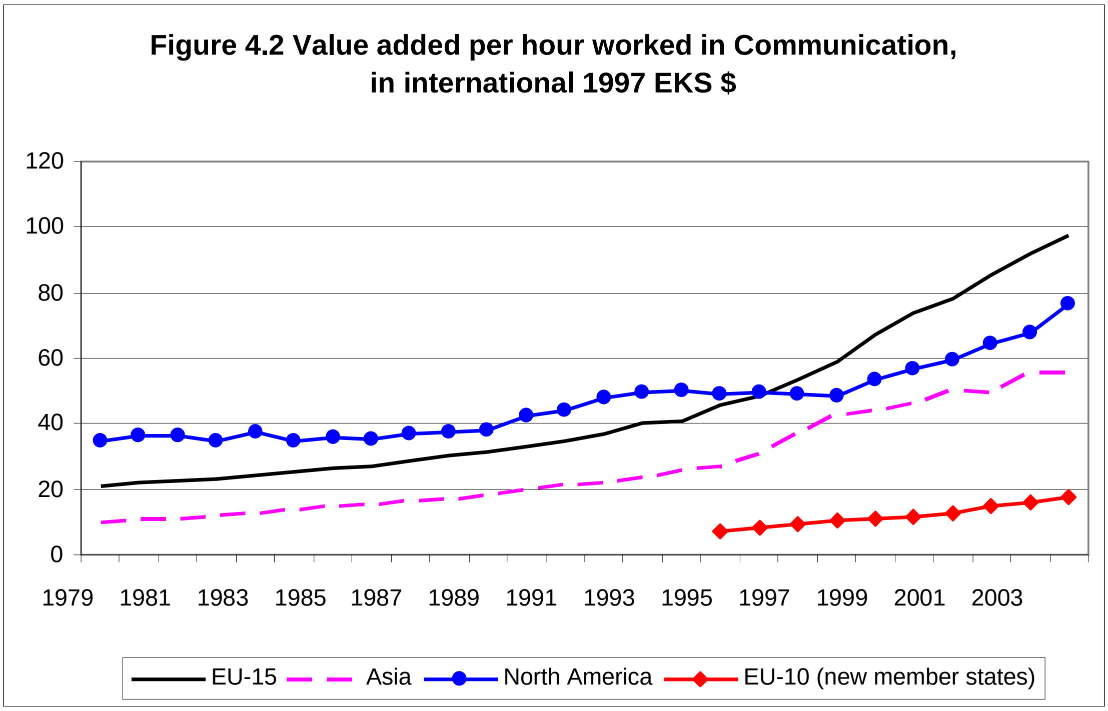
We start with confronting time series of value added, employment and hours worked from the EU KLEMS database of March 2007 with our new PPP set. For countries not covered in the EU KLEMS framework yet (Australia, Canada, Norway, South Korea and Taiwan) we use the GGDC 60-industry database (October 2005), updated with more recent data. For New Zealand we do not have enough information over time, so this country is not taken into account below. In 4.1 we will look at the trends and development of productivity for regions. Australia and Norway do not fit into the regions, so they have been omitted here. Their results are however available in section 4.2 where we describe the results of individual countries 4.2.

4.1 Regional productivity differences in transport and communication

To give an answer to the question if the gap in productivity in transport with the United States is converging, we can look at the development of the productivity over time. Figure 4.1 shows that productivity in North America is moving on a higher level than all other regions. In the EU-15 the productivity grows almost at the same rate, but the gap that already existed in the beginning of the 80s (EU productivity was about 60% of the North American productivity) only became a little smaller during the late 90s (76% in 2000) and is growing again in the most recent years. Asia even lost more ground during the last 25 years, while the EU-10 is starting at a much lower level (34% of the US) and is approaching the Asian levels, but needs to show high growth rates to catch-up with the productivity levels in the EU-15 and the United States.

In Communication the EU-15 has closed a large gap (40% in 1979) and overtaken North America in the mid nineties. Asia did also catch up on the United States and Canada, but not enough to close the gap in productivity. The EU-10 is the odd man out in this sector, as both productivity levels and growth rates are much lower. The mobile wave that has affected Western Europe, America and Asia apparently not penetrated into Eastern Europe yet.





If we look at the results on a more detailed industry level as displayed in table 4.1, a different picture appears. North America has a large productivity advantage in Land transport. This is largely due to the composition of this industry. Especially the United States has a large freight transportation sector (both by train and by truck), which makes up 83% of total land transport in

1997. For example in France (62%) and the UK (51%) this share is much smaller, and the share of passenger transport is much larger. Passenger transport is a much lower productive activity than freight transport (see section 4.3). This is the main reason for the gap between North America and the rest. The EU-10 countries are showing high productivity growth rates for land transport. They are already ahead of the Asian countries and but the productivity growth seems to stabilize in recent years so the gap with the old European Union will not be closed within a few years. The fear of especially Western European firms for competition from Eastern Europe is not exaggerated as the growth in output in the transport sector is large. The market share of the EU-10 in the European Union in land transport has risen from 27% in 1995 to 44% in 2004. The productivity levels are however not growing at the same speed. In productivity per person engaged the gap is a little smaller, but there is still a gap of 30% between the productivity level of EU-10 countries and the EU-15 level.

In water and air transport the new European Member states do not catch up yet. EU-15 is the most productive region in water transport now, although yearly variation in this sector is large and differences relatively minor. During the nineties the EU-15 also overtook North America in air transport and supporting services. Large productivity growth rates of the United States in industries in recent years (24% in air transport in 2003, 7% in supporting services in 2002) have restored the original situation. The growth in productivity in air transport in the U.S. is especially due to a large drop in employment. Between 2000 and 2004 16% of the jobs have disappeared. Asia is moving at the same level in air transport and is even more productive in supporting services. Asians make intensive use of public passenger transport and therefore also of terminals, which leads to relatively low UVRs and high productivity for especially Taiwan and Korea. The new member states are performing very well in supporting services. This is actually the only sector where these countries show higher productivity levels than North America and the EU-15, although the differences are very small. Unlike other transport industries, employment in supporting services is growing for the EU-10 leading to falling productivity rates.

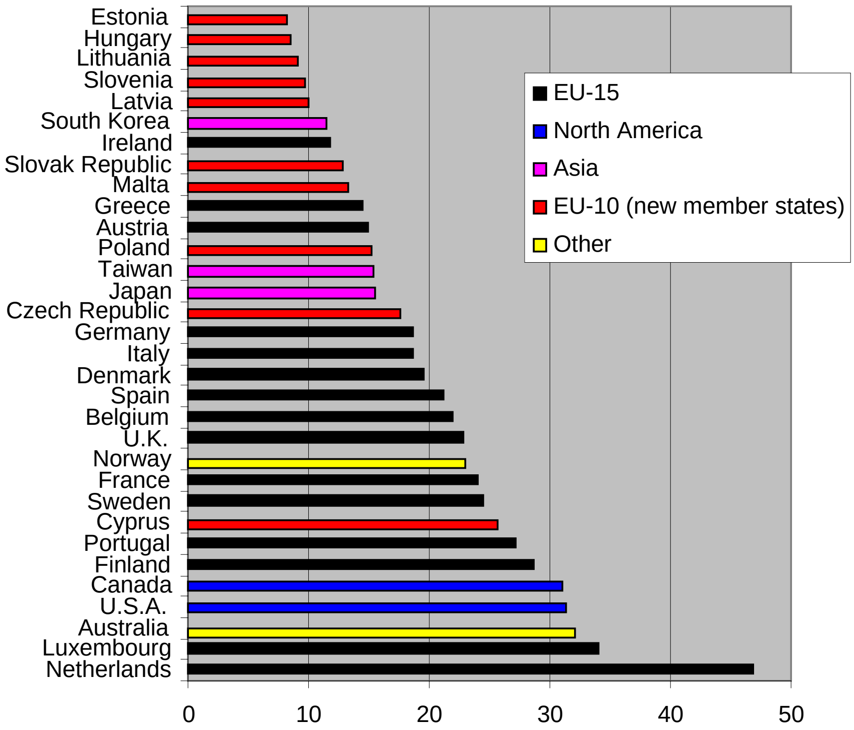
Table 4.1 Value added per hour as percentage of North America (in 1997 US$)

	1980	1990	1995	2000	2004
Land transport					
EU-15	48%	59%	60%	70%	71%
Asia	39%	35%	33%	28%	28%
EU-10 (new member states)			30%	38%	47%
Water transport					
EU-15	50%	56%	57%	81%	141%
Asia	72%	100%	81%	92%	113%
EU-10 (new member states)			10%	1%	1%
Air transport					
EU-15	182%	140%	114%	98%	63%
Asia	95%	181%	136%	126%	116%
EU-10 (new member states)			21%	21%	19%
Supporting services					
EU-15	111%	92%	106%	103%	86%
Asia	147%	143%	166%	164%	161%
EU-10 (new member states)			163%	130%	106%
Communication					
EU-15	60%	77%	93%	130%	128%
Asia	30%	47%	55%	82%	73%
EU-10 (new member states)			14%	20%	23%
Pro Memoria					
Total Transport					
EU-15	66%	71%	72%	76%	70%
Asia	59%	59%	55%	49%	48%
EU-10 (new member states)			34%	39%	43%

4.2 Productivity at country level

The figure below shows value added per hour for all countries in our data set in 1997 US$. It shows that the dominance of North America is not across the board. Two EU-15 countries perform better in transport than the US and Canada. The Asian and Eastern European countries are, as expected, the least productive countries. The high ranking of Portugal is remarkable and can be attributed to a combination of a low price level and good performances in especially water transport and supporting services. Another surprising feature is the low ranking of Ireland, which is one of the most productive economies in the world.

Figure 4.3 Value added per Hour in Total Transport, 2004 (in 1997 EKS$)



If we measure productivity per person engaged, differences get somewhat smaller. Workers in the EU-15 are generally working fewer hours than employees in the other regions. Especially in Asia (+18%) working hours are significantly higher, but the differences with the EU-10 (+3%) and North America (+6%) are relatively minor. Compared with the total economy, these differences are really small. In all other regions employees work 20% more than their EU-15 counterparts on the total economy level.

Figure 4.4 shows that North and Western Europe is performing well in the communication sector. Especially Luxembourg and Sweden are very productive, but Germany, the United Kingdom, Italy and France are also showing high productivity levels. Portugal, Spain, Austria and Greece are lagging behind but are still ahead of the Eastern European countries. Of the Asian countries especially Taiwan is performing well in communication.

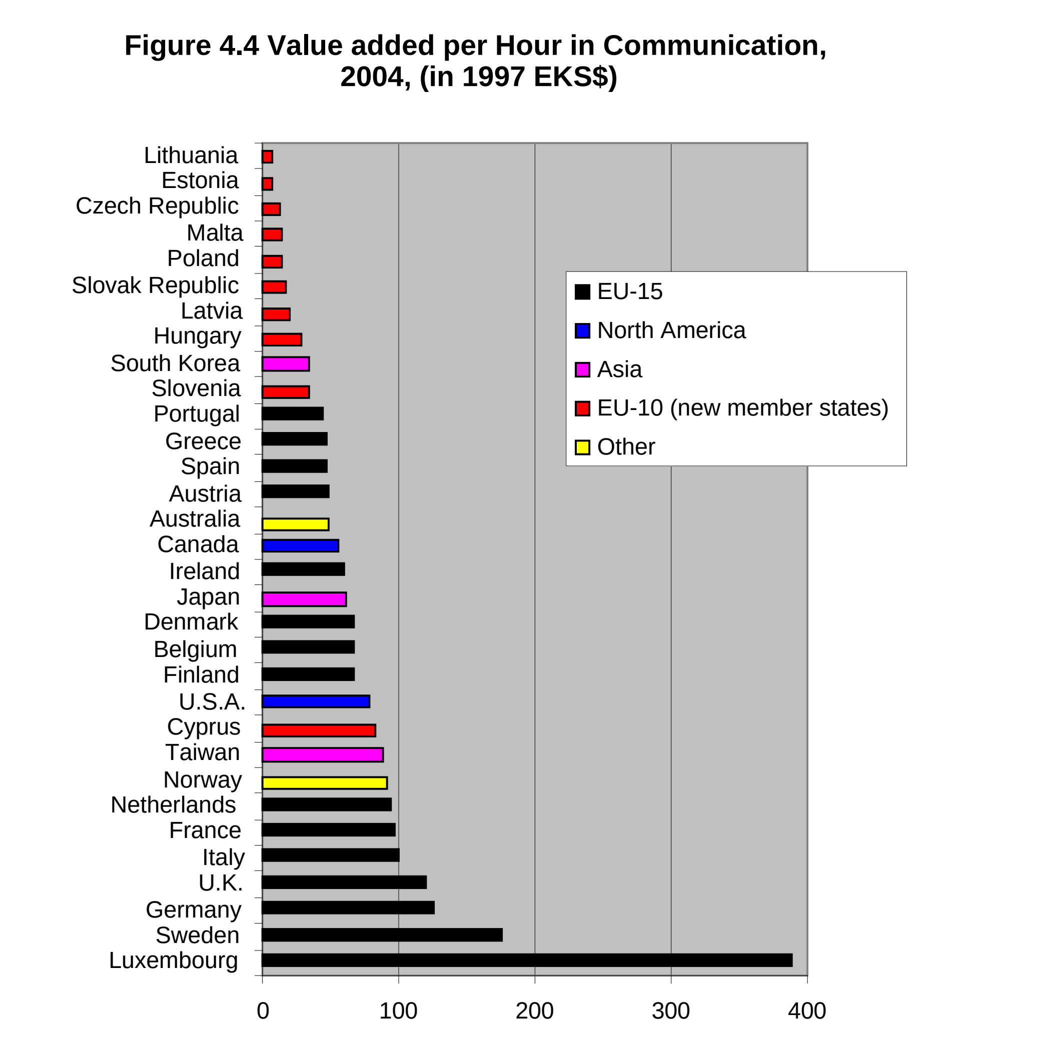


Table 4.2 shows the results for all sub sectors in comparison with the United States. No country is outperforming the United States in all industries. The Netherlands, Canada and Luxembourg are close with the air transport sector as only dissonant. Taiwan is also doing very well, but not in land transport. If we look at the large countries in the European Union and compare them with the US, Germany is only really lagging behind in land transport and supporting services. Unfortunately, these are the main industries within transport, which results in a serious productivity gap in total transport. The UK has the same problem in land transport. In Air transport both France, Italy and the UK are lagging behind seriously, although we should mention here that this sector is very volatile and the EU-15 and Northern America were still at the same level in 2000. The enormous productivity gain in the US in the latest years has a large influence on this table.

Differences in productivity between countries are especially large in Water transport, Supporting services and Communication. Countries with access to open sea are performing much better then land-locked countries with only rivers (with Austria as strange exception). Poland and Czech Republic are lagging behind in most sectors, but are doing quite well in supporting services. Cyprus is another surprise in the highest rows of this table, especially due to good performances in Land and supporting services. Ireland is the negative exception, with mediocre performances for almost all sectors. Even the relatively large air transport sector is not showing high productivity.

Table 4.2 Value added per hour worked in transport and communication, 2004 (in 1997 US$)

	Total transport	Land transport	Water transport	Air transport	Supporting services	**Commu-nication**
Netherlands	**150**	152	174	83	199	**119**
Luxembourg	**108**	106	118	37	503	**492**
Australia	**103**	74	239	75	196	**62**
U.S.A.	**100**	100	100	100	100	**100**
Canada	**99**	108	149	44	105	**71**
Finland	**91**	78	59	151	180	**86**
Portugal	**87**	72	148	35	270	**55**
Cyprus	**82**	93	54	23	148	**105**
Sweden	**78**	71	103	76	109	**223**
France	**77**	88	126	38	89	**123**
Norway	**73**	96	46	31	172	**116**
U.K.	**73**	55	261	68	120	**152**
Belgium	**70**	79	110	66	89	**85**
Spain	**68**	57	152	50	128	**60**
Denmark	**62**	69	151	45	155	**85**
Italy	**60**	91	102	18	38	**126**
Germany	**59**	62	184	143	61	**159**
Czech Republic	**56**	38	5	20	145	**16**
Japan	**50**	37	113	65	133	**78**
Taiwan	**49**	21	196	116	122	**113**
Poland	**48**	66	10	13	115	**19**
Austria	**48**	40	457	28	115	**62**
Greece	**46**	21	217	20	74	**59**
Malta	**42**	70	25	10	79	**17**
Slovak Republic	**41**	52	19	3	81	**22**
Ireland	**37**	37	69	27	35	**76**
South Korea	**36**	21	111	70	151	**43**
Latvia	**32**	37	89	14	68	**25**
Slovenia	**31**	22	63	39	103	**43**
Lithuania	**29**	36	12	4	67	**8**
Hungary	**27**	29	2	3	99	**36**
Estonia	**26**	34	47	17	32	**10**
EU-15	**70**	71	155	58	87	**124**
Asia	**46**	31	116	74	136	**71**
North America	**100**	101	110	92	100	**97**
EU-10	**43**	47	1	17	106	**22**

4.3 Shift share analysis

An interesting exercise would be to find out what the influence of the industry composition is on labour productivity. It might well be that the European Union cannot close the gap in productivity with the United States, because the current composition of the transportation sector does not make this possible. A comparison between a few lagging European countries and the United States can give us more information about this issue. Business censuses in France and the United Kingdom contain data at 4-digit level, which provides a good basis to make a detailed comparison.

For a shift share analysis we need the employment shares of different activities within a sector and the productivity of these activities. With this data we can breakdown the productivity gap into an intra effect and a shift effect.

$$LP_j^A - LP_j^B = \sum_{i=1}^{Ij}(LP_i^A - LP_i^B) * \frac{1}{2}(L_i^A + L_i^B) + \sum_{i=1}^{Ij}(L_i^A - L_i^B) * \frac{1}{2}(LP_i^A + LP_i^B) \quad (5)$$

with i=1,.., I_j the matched activities in industry *j*; *A* and *B* the countries being compared; LP the labour productivity and *L* the labour share in industry j. The first part of the formula calculates the intra-effect, while the second part indicates the shift or inter-industry effect. The shift effect shows the influence of the industry composition, while the intra effect points at productivity differences between similar activities. Our hypothesis that industry composition blocks the possibility to close the gap in productivity between the EU-15 and the US would be supported by high shift-effects.

In table 4.3 we start with an analysis at the level of total transport. The France-US comparison as well as the UK-US comparison shows that the shift-effect is much smaller than the intra-effect. We can conclude from this that the main difference between the productivity levels of these countries can be attributed to productivity variation between similar activities and the industry composition cannot be blamed for the difference.

Chapter 2 did already show that the differences within the 2-digit sectors are maybe even larger, so we went one step further in the bottom panel of table 4.3. We have now split up the 2-digit sectors into 3 and 4 digit activities. In Land transport we see relatively high productivity figures for pipeline transport and freight transport by road. For the US we can even say that freight transport is more productive across the board, taking into account the fact that railway transport also consists for 85% of freight transport. France shows the same phenomenon when we classify rail transport as a passenger activity, but the variation in productivity is much smaller. Large differences in the employment structure lead to almost equal contributions of intra and shift effects to the productivity gap with the US. For the UK freight and passenger transport do not differ much in productivity and the intra effect is the main driver of the gap. The intra effect is also dominant for Air transport and supporting services in both comparisons and for Water transport in France. Water transport in the UK-US comparison is the only transport industry in which the shift-effect exceeds the intra-effect. The UK turns the larger proportion of the more productive coastal and ocean transport to advantage.

In the Communication the composition of the sector is the main driver of the productivity gap. Productivity differences between postal services and telecommunication are large and the employment shares also differ across countries. Even though the UK has a less desirable industry structure, the productivity is already higher. The lower productivity in France can be attributed to the industry structure. The employment share of the postal sector is larger than in the US, leading to a lower overall productivity even though the productivity in telecommunications is higher.

Surprisingly, the United Kingdom does already perform better than the US in all sectors where the industry composition is an important driver of the productivity gap. This means that the productivity advantage relative to the US would be even larger if the United Kingdom would have the same industry composition in these sectors. If we take France and the United Kingdom as representative for the whole EU-15, we can conclude that the industry composition is important in some industries. It is however not the main obstacle for closing the productivity gap between the EU-15 and the US. The higher productivity of the US in most activities is the main reason.

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Table 4.3 Shift-share analysis of France, United Kingdom and the United States, 1997

		Productivity per person employed (in PPP converted EKS$)			Employment shares			France-US		UK-US	
		France	UK	US	France	UK	US	Intra-effect	Shift-effect	Intra-effect	Shift-effect
60-63	**Total Transport**	**37.08**	**39.45**	**54.24**	**100%**	**100%**	**100%**	**-14.61**	**-2.55**	**-12.23**	**-2.56**
60	Land transport; transport via pipelines	30.83	25.01	53.77	64%	66%	54%	-13.48	4.4	-17.20	4.9
61	Water transport	46.25	127.42	112.31	2%	2%	1%	-1.06	0.4	0.23	0.3
62	Air transport	75.91	71.00	87.08	6%	8%	13%	-1.03	-5.7	-1.68	-3.6
63	Supporting and auxiliary transport activities	42.75	62.35	39.56	28%	24%	32%	0.97	-1.6	6.43	-4.2
60	**Land transport; transport via pipelines**	**30.83**	**25.01**	**53.77**	**100%**	**100%**	**100%**	**-12.12**	**-10.82**	**-23.19**	**-5.57**
60.1	Transport via railways	12.67	33.76	46.96	33%	9%	2%	-5.93	9.4	-0.73	3.2
60.21	*Other scheduled passenger transport*	33.46	26.70	16.37	22%	24%	12%	2.88	2.6	1.82	2.6
60.22	*Taxi Operation*	36.62	17.07	26.70	2%	5%	3%	0.24	-0.6	-0.40	0.4
60.23	*Other passenger transport*	38.44	16.23	23.32	2%	4%	5%	0.54	-0.9	-0.33	-0.2
60.24	*Freight transport by road*	43.23	24.19	54.89	41%	58%	76%	-6.80	-17.0	-20.46	-7.1
60.3	Oil pipeline	66.00	53.34	264.02	0%	0%	3%	-3.05	-4.4	-3.09	-4.4
61	**Water transport**	**46.25**	**127.42**	**112.31**	**100%**	**100%**	**100%**	**-75.09**	**9.02**	**-14.78**	**29.88**
61.1	Sea and coastal water transport	43.96	133.28	145.61	89%	94%	62%	-76.97	25.3	-9.64	44.3
61.2	Inland water transport	64.87	33.50	57.10	11%	6%	38%	1.89	-16.3	-5.13	-14.4
62	**Air transport**	**75.91**	**71.00**	**87.08**	**100%**	**100%**	**100%**	**-14.75**	**3.58**	**-18.84**	**2.76**
62.1	Scheduled transport	77.00	73.33	87.78	93%	84%	49%	-7.67	35.7	-9.65	27.8
62.2	Non-scheduled transport	61.87	58.74	86.40	7%	16%	51%	-7.07	-32.1	-9.19	-25.1
63	**Supporting and auxiliary transport activities**	**42.75**	**62.35**	**39.56**	**100%**	**100%**	**100%**	**3.33**	**-0.14**	**24.55**	**-1.76**
63.11	*Cargo handling*	39.53	39.41	29.92	6%	3%	14%	0.99	-2.6	0.80	-3.9
63.12	*Storage and warehousing*	40.61	45.10	26.05	11%	15%	9%	1.48	0.7	2.29	2.1
63.21	*Other supporting land transport activities*	89.88	131.49	32.13	10%	9%	13%	6.61	-1.4	10.47	-3.3
63.22	*Other supporting water transport activities*	53.32	81.18	51.17	5%	6%	2%	0.08	1.2	1.29	2.4
63.23	*Other supporting air transport activities*	65.72	145.65	31.85	5%	8%	12%	2.94	-3.2	11.25	-3.7
63.3	Travel agencies	26.88	36.31	49.23	17%	37%	31%	-5.38	-5.3	-4.43	2.7
63.4	Activities of other transport agencies	35.00	59.70	45.69	45%	22%	19%	-3.39	10.5	2.88	2.0
64	**Total communication**	**71.02**	**118.50**	**94.28**	**100%**	**100%**	**100%**	**5.18**	**-28.43**	**55.70**	**-31.48**
64.1	Postal service	37.52	57.25	41.64	64%	58%	30%	-1.93	13.4	6.88	14.0
64.2	Telecommunication	130.07	204.00	116.71	36%	42%	70%	7.10	-41.9	48.82	-45.5

5. Conclusion and issues for further research

In the previous chapters we have developed a new PPP set for transport and communication. We have also applied this new set to the series of value added, employment and hours to calculate productivity on a detailed level. Both in terms of country coverage and on PPP detail, this is a unique set. These PPP set can furthermore be fitted neatly into the PPP framework for the total economy. We should however keep in mind that the activities in transport and communication are very heterogeneous, with higher chances of measurement failures and unmeasured activities. The PPPs for transport will therefore always be less reliable than the PPPs in goods manufacturing industries. We make the assumption that the quantity relationship for a matched activity can be applied to unmatched activities as well, which is significantly different from the calculation of representative unit value ratios. Furthermore the transportation sector differs from other sectors in the sense that the possibilities for an efficient transport sector are very dependent on infrastructure, geographical position and environmental possibilities and limitations. Therefore it is difficult to compare productivity in this sector, just because the situations can be incomparable among countries.

Although this PPP set contains several new features, we do not deviate very far from the old well-established ICOP methods. The main differences are the functional use of more detailed data and the final goodbye to the terminal adjustment. As chapter 4 shows, the first results are promising. There are a few outliers that cannot be explained yet. But the detail within this dataset also provides answers to relevant questions.

When looking at productivity trends in total transport the rise of the Eastern European countries does not look very impressive. When we compare the results in land transport the gap does already get smaller, but a gap in productivity levels remains. We can however conclude that the New European Members states are taking over a significant part of the land transport in Europe, even without reaching similar productivity levels as the old EU-15. Another issue is the productivity gap between the United States and EU-15. This gap has remained constant over time, especially in land transport. In all other sectors the EU-15 is or has been more productive for at least part of the period 1970 to 2004. The different composition of the land transport sector is not the main reason for the difference. On average the US outperforms the EU-15 countries in most activities within land transport. Especially in freight transportation the United States are performing much better than their European counterparts. Closing the productivity gap is therefore possible for the European Union and Asian countries, if they succeed in raising productivity levels.

This PPP set can be improved if the data availability and data detail gets better. Eurostat's Structural Business Statistics database does already provide data for road, inland water and rail transport by distance category and kind of goods, but mostly from the period 1999 onwards. Unfortunately, they do not (yet) connect this to revenue data, but this will perhaps be possible in future. They do also make a distinction in classes in passenger railway transport. For Railway and bus transport it might be possible to make a split up in distance categories. For the current comparison data sources were not reliable enough to make this subdivision, but for future work this should be looked at again. A subdivision in passenger and freight transport over water would be another main improvement for the current dataset. Especially for Denmark and Greece this can make a significant difference.

Extending the country set with other countries is also interesting and will happen from now onwards on an ad-hoc basis in GGDC work. We are thinking about adding the missing OECD countries (Iceland, Switzerland, Turkey) and important developing countries (Brazil, China, India, Indonesia, Russia). Other plans that will be carried out in the framework of the EU KLEMS project are the extrapolation of PPPs to other years and the calculation of input, labour and capital PPPs.

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Appendix A: Previous work on Transportation and Communication

Researchers have used a range of methodologies to calculate Purchasing Power Parities over the years. This Appendix describes these earlier attempts to produce reliable estimates and includes a discussion of the advantages and disadvantages of each method. In general, each method tries to deal with the two main problems in making comparisons in transport and communication: the treatment of terminal services and movement services in a consistent way, and dealing with quality differences of services across countries.

A.1 Historical work on productivity in transport and communication

Most work on productivity in transportation and communication only deals with one branch or country. As we are especially interested in the comparison of productivity among countries and the development of PPPs, we will not mention all these publications here[14]. The following publications provide a historical view on the development of transportation performance measurement over time. As our main focus is on the methodology applied, we restrict our description to the output measures used, adjustments and main results.

Rostas (1948)[15] and Girard (1958)[16]

One of the first attempts to make international comparisons of the transportation and communication sector was carried out by Rostas. He performed a calculation of labour productivity for several branches for UK and US based on physical quantity comparisons. It appeared that the measured performance was highly dependent on the output measure used. Measured in passenger journeys UK outperformed the US, but measured in passengers and tons, productivity in the UK was only a sixth of the US level for the period 1935-1939.

The US was also outperforming France, Germany and the UK in railway transport in 1949-1951. Girard finds a productivity difference of a factor 5. He used a weighted sum of passenger km and ton km per hour worked as estimate for productivity.

[14] For a more complete overview of previous work in transportation and communication see Mulder (1994), Transport and communications in Mexico and the United States: Value Added, Purchasing Power Parities and Labour Productivity, 1950-90, Appendix. (provide only full titles in reference list, not in text)

[15] Rostas, L. (1948), "Comparative Productivity in British and American Industries, NIESR Occasional Papers XIII, Cambridge University Press, Cambridge.

[16] Girard, J.M. (1958), "La Productivité du Travail dans les Chemins de Fer", Centre d'Etudes et de Mesures de Productivité, Paris.

Both studies show large differences in productivity between both sides of the Atlantic. This can partly be attributed to the period they are describing. The recovery from World War I and II will be one of the main reasons for lower productivity levels. This factor can however not explain the total gap. A large difference in the structure of the transport sector, in particular between passengers, freight and trip length, is another main factor that has not been taken into account in both studies.

Paige and Bombach (1959)

The split-up of terminal services and movement services was already proposed in 1959 by Paige and Bombach. They compared six branches of transport and communication between the UK and the US. Output in rail passenger transport was compared in terms of passenger km. For freight transport by train they estimated that the cost of loading and unloading accounted for 25 percent of the costs of rail goods transport in the UK. They did calculate different PPPs for terminal services (with tons transported as indicator) and for movement services (ton-km as indicator). For other branches they did not make an adjustment for terminal services. Output in postal services was estimated by the items of mail handled, while the weighted average of the number of telephones and the number of calls was used as indicator for the communication branch. Labour productivity in the UK was 29% of the US level in transport and 38% in communications.

Main improvement over previous work was the adjustment for terminal services, which has been followed by many other authors for more than 40 years afterwards. The way of adjusting was still rather ad-hoc, but did open a new field of research.

Smith, Hitchens and Davies (1982)

In their comparison of Britain, America and Germany, Smith et al. use different ad-hoc methods to adjust for terminal effects. They first look at the average trip length of the transport modes and countries they compare. Only if the differences are large, they make adjustments by relative costs of operating short and long distance. In road haulage for example they use the ratio of the British standardized cost per vehicle mile for long and short distances as adjustment. For railways they use another method: an indicator for the terminal work (tons carried) and an indicator for the transport element (ton-miles) have been aggregated by means of British handling cost per ton and transport cost per ton-mile. Unfortunately they do not show detailed calculations of their adjustments. It was found that US labour productivity in transport was 2.5 times the UK level and 2.1 times the German level. For communications US level outweighs the UK by factor 2.7 and Germany by 2.5.

Biggest problem of the method used for road haulage is the availability of data. For most countries you cannot find the standardized cost per vehicle for long and short distances. Moreover, the distinction between short and long is very doubtful. Is hundred kilometers for example a long or a short distance? The second adjustment (adding ton-kilometers and tons in some way) is less data demanding and has been applied in various ICOP formulas afterwards

O'Mahony, Oulton and Vass (1997)[17]

In this study a detailed comparison is made between the Transport and Communication sectors in the United States, the UK and Germany. The benchmark year is 1992 for Transport and 1993 for Communication. O'Mahony et al. followed the methodology from previous work with the use of weighted quantity ratios, adapted for terminal services. The main novelty was the regression method they used for the terminal adjustment. This regression method quantifies the effect of the length of trips and the passenger kilometre/freight tonne kilometre ratio on productivity, measured in freight tonne kilometres per employee. For this purpose they used data of the railway systems of 20 countries. They estimated the following regression for 1992:

$$\ln\left(\frac{Ton.km}{Employees}\right) = 3.4537 + 0.3438 * \ln(trip\_length) - 0.5771 * \ln\left(\frac{Pass.km}{Ton.km}\right)$$

Similar adjustments have been made for air transport and road haulage, where the elasticity of productivity with respect to stage length is respectively 0.43 and 0.4. The trip length adjustments lead to a decrease of the productivity gaps between Germany (from 45 to 60% of the US level) and the UK (from 38 to 52%) with the US.

For postal deliveries they distinguish different quality levels of mail delivery (the so-called classes of internal letter mail) for the UK and US. The use of unit value ratios from the matched classes significantly lowers the productivity gap between both countries compared to unadjusted quantity measures. For telecommunications they do also match on a detailed level and here the impact of international calls seems to be an important explanatory variable. Productivity levels move upwards with 25% for both UK (to 55% of US level) and Germany (to 50%) in comparison with the US.

Weak point of the terminal adjustment formulas in this paper is its economic justification. It's hard to justify that ton kilometers per employee are only dependent on trip length and the ratio passenger/ton kilometer. There are much more, and especially more important factors that

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17 Mary O'Mahony, Nicholas Oulton and Jennet Vass, Labour Productivity in Transport and Communications: International Comparisons, NIESR Discussion Paper no. 117, April 1997.

influence this measure. Another negative aspect is the dependence of the results on the countries included in the regression. The methodology they wield for communications is however a big leap forward in comparison with earlier work. They try to diminish quality problems as much as possible by matching activities on a very detailed level. Unfortunately, the information they have for US and UK is only available for a few countries. Even for Germany they could not find this level of detail.

A.2 Previous ICOP work

The Groningen Growth and Development Centre has a longstanding tradition in the comparison of productivity levels. From the beginning of the nineties various researchers have worked on performance estimates in transportation and communication. The methods used in the ICOP framework have been refined and improved over time.

Mulder (1991)

The first detailed ICOP comparison of performances in transportation and communication can be attributed to Mulder (1991). He compares labour productivity of six branches of France, the UK and the US for the period 1975-87. Output was measured in terms of passenger kilometres, ton kilometres and tons, weighted by the "prices" of the countries. No adjustment for terminal services has been applied. Main conclusions were that the French and British labour productivity was between 40 and 50 percent of the US level in 1975 and even worsening in the period up to 1987. Relative performances of France and the UK were high in Air transport performance and low in railways in comparison with the US.

Mulder (1994)[18]

In his subsequent comparison of the transportation, communication and distribution sectors of France and the United States, Mulder subdivides transport quantity into movement services and terminal services. In contrast to earlier work, where they assumed that the proportionate amount of terminal services was the same in each country, he introduces a terminal adjustment method. US relative output (Q_{US})was estimated by a composite index, in which French output (Q_X) was set to 100. M_{US} and M_X represent the US and the French movement services respectively. They are measured in passenger or freight kilometers, dependent on the kind of transport. Transported passengers (in numbers) and freight (in tons) are reflected by T_{US} and T_X and serve as measure

[18] Mulder, N. (1994) 'New Perspectives on Service Output and Productivity: a comparison of French and US Productivity in Transport, Communications, Wholesale and Retail Trade,' GGDC Research Memorandum 575 (GD-14), Groningen Growth and Development Centre

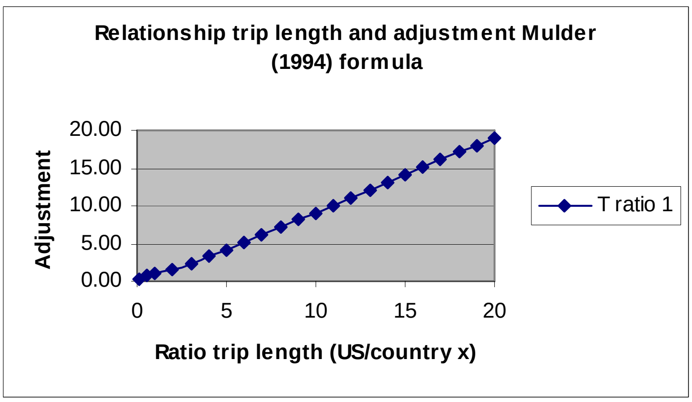
for terminal services. The ratio trip length between two countries (H_{US} / H_X or H_X / H_{US}) determines the weights (α) attributed to each type of service. Subsequently he adds the movement and the terminal part up to one quantity indicator again. Mulder uses the adjustment formula for all countries with large differences in trip length.

$$Q_{US} = \left[(1-\alpha)\frac{M_{US}}{M_X} + \alpha\frac{T_{US}}{T_X} \right] * 100 \qquad Q_X = 100$$

$$\text{with } \alpha = \left[\left(1 - \frac{H_{US}}{H_X} \right) \right] \text{ if } H_X > H_{US}$$

$$\text{or } \alpha = \left[\left(1 - \frac{H_X}{H_{US}} \right) \right] \qquad \text{if } H_X < H_{US}$$

A negative characteristic of this formula is that the adjustment rises almost proportional with the ratio of the trip length, which results in very large terminal adjustments when the variance is either extremely high or extremely low (see figure below).



Mulder considers two branches of communications: telephone and telegraph services, and postal services. Postal services output are measured by items of mail handled, for physical output of telephone services he uses a method developed by McKinsey. This method is based on a weighted average of the number of acces lines and calls, using employment shares as weights.

Mulder calculates Fisher UVRs for 9 branches[19] and aggregates these branch UVRs to sector level by weighting them with their gross value added.

Mulder (1999)*[20]*

In his comparison of Brazil, Mexico and the US, Mulder uses the 1994 method for adjusting for terminal effects. He does however introduce an interesting order for using different adjustments. He describes five ways to impute the varying proportionate importance of loading and unloading services.

Next to terminal adjustments, Mulder does also adjust for quality of services delivered (see table A1). The quality of transport in Mexico and Brazil is assumed to be inferior to those in the United States for some of the transport modes. Mexican rail passenger transport do for example have less comfort, are more crowded, are due to more delays and accidents and travel at a lower speed than American trains. The trains in Mexico carried on average two times the number of passengers in the U.S., supposing that the trains are similar in size. Therefore Mulder divides the number of passengers transported per train kilometre of both countries, which leads to the somewhat raw quality adjustment of -53%. This passenger density adjustment has also been applied to road passenger transport for both Brazil and Mexico. Road freight transport has been adjusted with the ratio of congestion per kilometre of road and for air transport Mulder assumes that the quality of service was 30% lower in Brazil and Mexico. For communication the quality adjustment is based on an arhythmic average of the percentages of completed calls, lines out of order, degree of digitalisation and the average repair time in days.

Table A.1 Terminal and quality adjustments for Brazil and Mexico

	Brazil		Mexico	
	Terminal adjustment	Quality adjustment	Terminal adjustment	Quality adjustment
Passenger transport				
Rail	0%	-39%	53%	-53%
Urban transport:				

[19] Transport of passenger and freight by rail, by road and by air, transportation of freight by water, postal services and telecommunications. For transportation services he uses the UVR for total transport as estimate.

[20] Mulder, N. (1999), "The Economic Performance of the Service Sector in Brazil, Mexico and the USA, A Comparative Historical Perspective", GGDC Monograph Series, No. 4.

-City Bus	*n.a.*	*n.a.*	*0%*	*-50%*
-Subway	*n.a.*	*n.a.*	*0%*	*-42%*
-Tramway/Trolley	*n.a.*	*n.a.*	*0%*	*-51%*
Bus transport	0%	-32%	0%	-42%
Air:				
-Domestic	*8%*	*-31%*	*n.a.*	*n.a.*
-International	*0%*	*-30%*	*n.a.*	*n.a.*
Freight transport				
Rail	9%	0%	20%	0%
Road	19%	-24%	16%	-24%
Water:				
-Rivers and lakes	*0%*	*0%*	*0%*	*0%*
-Ocean and Coast	*0%*	*0%*	*0%*	*0%*
Air:			0%	-29%
-Domestic	*0%*	*-30%*	*n.a.*	*n.a.*
-International	*0%*	*-30%*	*n.a.*	*n.a.*
Communication				
Postal services	*0%*	*-50%*	*0%*	*-60%*
Telecommunications	*0%*	*-40%*	*0%*	*-40%*

Source: Mulder (1999), tables 5.12 and 5.13

Van Ark, Monnikhof and Mulder (1999)

Van Ark, Monnikhof and Mulder[21] deal with productivity differentials in service industries for Canada, France, Germany, the Netherlands and the US. They have refined the procedures of Mulder (1994) for transport and communication.

$$UVR_{trcom}^{XU(X)} = \frac{\sum_{i=1}^{r}\left[GVO_i^{X(X)} / \frac{Q_i^X}{Q_i^U} \right]}{GVO_{trcom}^{U(U)}}$$

They use a terminal adjustment for railways, based on population density and average trip length. They adjust the comparative measures of passenger and ton kilometers for railways (*Qx/Qusa*) for the share of terminals in total output by combining it with an estimate of the total number of passengers or tons transported (*Tx/Tusa*):

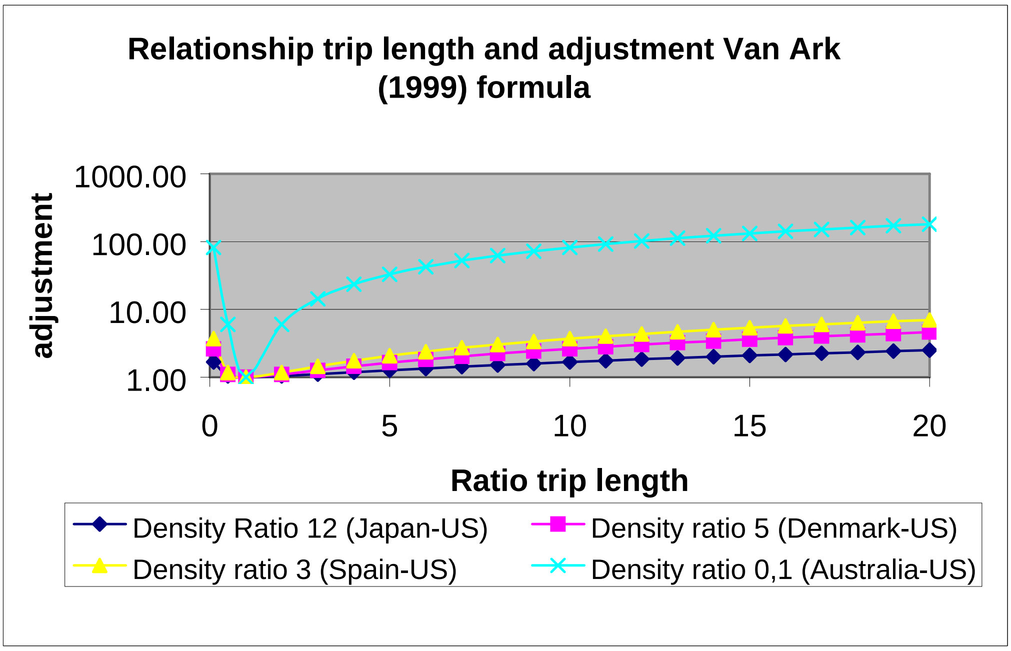
[21] Ark, B. van, E. Monnikhof and N. Mulder (1999), "Productivity in Services: an International Comparative Perspective", in *Canadian Journal of Economics, vol. 32 no. 2,* pp. 471-499

$$\frac{Qx^*}{Qusa^*} = \left[(1-S)\frac{Qx}{Qusa} + S\frac{Tx}{Tusa} \right]$$

The weighting factor S is obtained from the ratio of the average distance of a passenger or freight trip (*Hx/Husa*) and includes a correction for population density in both countries (*Dusa/Dx*):

$$S = \left[(1 - \frac{Hx}{Husa}) * \frac{Dusa}{Dx} \right]$$

Including density in the Mulder (1994) formula results in a diminishing slope. This formula cannot be used, however, for contexts in which density varies widely. The figure below shows the relationship between trip length and the magnitude of the adjustment. This chart also points out a disadvantage of this method: it yields very strange results for particular combinations of density. One advantage of this approach, however, is that data for the required variables are widely available.



Monnikhof (2000)

Monnikhof changes the methodology again in a (unpublished) working paper of December 2000. The van Ark, Monnikhof and Mulder adjustment described above gives too much weight to the terminal element. In fact, the adjustment factor in this function increases as a quadratic function of differences in the number of passengers transported, due to the inclusion of both the passenger ratio and the average distance traveled. Furthermore, this function also makes an adjustment for differences in relative population density, correcting in a rough way for infrastructural differences. It is based on the assumption that the population (and therefore the transport infrastructures) of less densely populated countries is often less evenly distributed over the land area. Monnikhof omits the inclusion of population density, partly due to the application of a terminal element adjustment to all transport sectors, whereas van Ark et al. originally made the correction only for railway transport.

This study corrects for the terminal element by multiplying the non-adapted ratio of transport services (Qx / Qus) by a factor based upon the relative average distances traveled $(Q/T)us /$ $(Q/T)x$.

$$\left[\frac{Qx\ *}{Qus\ *}\right] = \left[\frac{Qx}{Qus}\right] * \left[\frac{(Q\ /\ T\ )us}{(Q\ /\ T\ )x}\right]^{\left[\frac{1}{(Q\ /T\ )us\ /(Q\ /T\ )x}\right]}$$

This function has some attractive advantages over formulas used in earlier studies. It is asymptotic with increases in the terminal element, meaning that the adjustment for the terminal effect is in the right direction and magnitude, thus providing a realistic range of differences between average distances traveled[22] (see figure below). It is still a rough adjustment, since its magnitude will certainly differ across transport modes, within transport modes, between passenger and freight traffic, between countries and between time periods. Due to the limitations of the data, he uses the same simple adjustment factor in all comparisons in this study.

Next to the advantages above the previous formulas described above, this formula also has some drawbacks. Because the slope of the formula is hyperbolic, the adjustment gets smaller for larger trip length differences, which is hard to justify. Furthermore the formula doesn’t work when differences are not between one third and one and a half, which unfortunately happens quite often.

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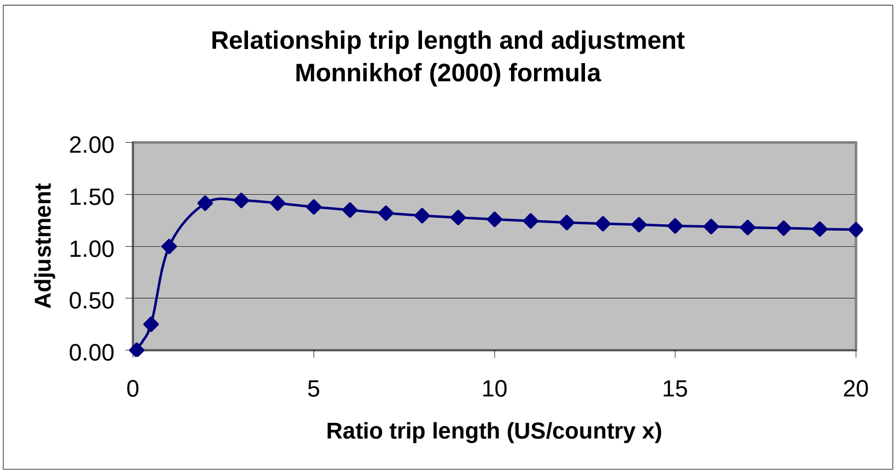
[22] The difference in average distance traveled or freight transported for countries in comparison to the United States in this study usually lies within the range of one-third to one-and-a-half the US distance.



All studies so far have relied on quantity comparisons, or unit value ratios to derive output PPPs for the transport and communication sectors. Expenditure PPPs have rarely been used. This is for good reason. 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 have to rely exclusively on quantity relatives, following previous ICOP-research (see van Ark, Timmer and Ypma (2007) for a more elaborate discussion). Another problem is that part of passenger transportation is heavily subsidized, which complicates adjustments from expenditure to output level.

Table A.2 Productivity levels in UK, France and Germany compared to the US in different studies

			Labour productivity per person engaged					
			UK		**France**		**Germany**	
			Transport US=100	Communication US=100	Transport US=100	Communication US=100	Transport US=100	Communication US=100
Author	*year(s)*							
Rostas (1948)	1937-39		17	37				
Girard (1958)	1949-51		<20		20		<20	
Paige & Bombach (1959)	1950	a	29	38				
Smith et al. (1982)	1968-77	a	40	37			48	41
Mulder (1991)	1975		40		50			
Mulder (1994)	1987	a			100	46		
Van Ark et al. (1999)	1992	a			71	79	66	63
			Value added per hour					
			UK		**France**		**Germany**	
			Transport US=100	Communication US=100	Transport US=100	Communication US=100	Transport US=100	Communication US=100
O'Mahony et al. (1997)	1993		38	44			45	41
-quality adjusted	1993	a	52	55			60	50
Mulder (1994)	1987	a			110	53		

a: adjusted for terminal services and/or quality

Sources: see references.

Appendix B: Share of Gross Output in Transport and communication by industry, 1997

		Australia	Austria	Belgium	Canada	Cyprus	Czech Republic	Denmark	Estonia	Finland	France	Germany
60	**Land transport**	**27%**	**41%**	**31%**	**40%**	**11%**	**43%**	**27%**	**26%**	**33%**	**32%**	**30%**
	of which:											
601	Transport via railways	18%	23%	19%	15%	0%	29%	25%	19%	13%	13%	21%
602	Other land transport	78%	76%	80%	75%	100%	65%	72%	81%	87%	87%	78%
603	Transport via pipelines	3%	1%	0%	10%	0%	7%	3%	0%	0%	0%	1%
61	**Water transport**	**3%**	**0%**	**5%**	**2%**	**11%**	**1%**	**31%**	**16%**	**9%**	**3%**	**4%**
	of which:											
611	Sea and coastal water transport	99%	44%	93%	82%	100%	15%	100%	100%	99%	93%	85%
612	Inland water transport	1%	56%	7%	18%	0%	85%	0%	0%	1%	7%	15%
62	**Air transport**	**13%**	**8%**	**9%**	**10%**	**28%**	**5%**	**8%**	**3%**	**8%**	**8%**	**8%**
	of which:											
621	Scheduled air transport	85%	94%	100%	96%	86%	95%	91%	95%	98%	91%	91%
622	Non-scheduled air transport	15%	6%	0%	4%	14%	5%	9%	5%	2%	9%	9%
63	**Supporting Services**	**26%**	**24%**	**34%**	**11%**	**27%**	**24%**	**14%**	**40%**	**27%**	**29%**	**29%**
	of which:											
631	Cargo handling and storage	19%	3%	10%	31%	12%	4%	8%	7%	6%	11%	6%
632	Other supporting transport activities	28%	37%	21%	29%	34%	14%	24%	21%	13%	22%	17%
633	Travel agencies	13%	21%	25%	23%	30%	37%	31%	4%	12%	22%	22%
634	Activities of other transport agencies	40%	38%	43%	18%	23%	45%	37%	68%	69%	45%	55%
64	**Communications**	**31%**	**26%**	**21%**	**36%**	**23%**	**28%**	**20%**	**15%**	**23%**	**28%**	**29%**
	of which:											
641	Post and courier activities	19%	30%	29%	26%	10%	18%	25%	10%	30%	30%	29%
642	Telecommunications	81%	70%	71%	74%	90%	82%	75%	90%	70%	70%	71%

Shares of Gross output in Transport and communication by industry, 1997 (continued)

	Greece	Hungary	Ireland	Italy	Japan	Latvia	Lithuania	Luxem-bourg	Malta	Nether-lands	Norway
60 Land transport	**33%**	**43%**	**21%**	**46%**	**43%**	**29%**	**43%**	**23%**	**10%**	**28%**	**25%**
of which:											
601 Transport via railways	17%	36%	17%	17%	27%	57%	21%	26%	0%	14%	25%
602 Other land transport	83%	64%	83%	83%	73%	43%	79%	74%	100%	84%	75%
603 Transport via pipelines	0%	0%	0%	0%	0%	0%	0%	0%	0%	2%	0%
61 Water transport	**10%**	**1%**	**4%**	**10%**	**6%**	**2%**	**9%**	**10%**	**6%**	**9%**	**3%**
of which:											
611 Sea and coastal water transport	91%	8%	99%	91%	63%	99%	93%	94%	100%	72%	97%
612 Inland water transport	9%	92%	1%	9%	37%	1%	7%	6%	0%	28%	3%
62 Air transport	**8%**	**5%**	**16%**	**6%**	**4%**	**8%**	**5%**	**26%**	**31%**	**14%**	**19%**
of which:											
621 Scheduled air transport	90%	96%	85%	90%	100%	95%	95%	96%	90%	91%	85%
622 Non-scheduled air transport	10%	4%	15%	10%	0%	5%	5%	4%	10%	9%	15%
63 Supporting Services	**11%**	**19%**	**28%**	**18%**	**19%**	**44%**	**21%**	**6%**	**28%**	**21%**	**17%**
of which:											
631 Cargo handling and storage	18%	4%	27%	18%	18%	5%	8%	20%	13%	25%	10%
632 Other supporting transport activities	25%	14%	29%	25%	45%	10%	24%	6%	18%	18%	34%
633 Travel agencies	23%	37%	13%	23%	13%	32%	32%	41%	45%	36%	35%
634 Activities of other transport agencies	34%	45%	31%	34%	24%	53%	36%	33%	24%	21%	22%
64 Communications	**39%**	**32%**	**31%**	**20%**	**28%**	**16%**	**23%**	**35%**	**25%**	**27%**	**36%**
of which:											
641 Post and courier activities	23%	17%	28%	23%	16%	9%	9%	37%	23%	29%	22%
642 Telecommunications	77%	83%	72%	77%	84%	91%	91%	63%	77%	71%	78%

Source: GGDC 1997 Gross Output set at 3-digit level

Shares of Gross output in Transport and communication by industry, 1997 (continued)

		New Zealand	Poland	Portugal	Slovak Republic	Slovenia	Korea	Spain	Sweden	Taiwan	U.K.	U.S.A.
60	**Land transport**	**23%**	**46%**	**27%**	**64%**	**43%**	**47%**	**41%**	**31%**	**29%**	**31%**	**27%**
	of which:											
601	Transport via railways	8%	21%	17%	58%	25%	11%	17%	13%	9%	18%	15%
602	Other land transport	66%	78%	83%	42%	75%	89%	83%	87%	91%	82%	75%
603	Transport via pipelines	26%	1%	0%	0%	0%	0%	0%	0%	0%	0%	10%
61	**Water transport**	**31%**	**4%**	**5%**	**1%**	**1%**	**6%**	**3%**	**10%**	**18%**	**4%**	**3%**
	of which:											
611	Sea and coastal water transport	100%	96%	95%	15%	99%	99%	91%	97%	100%	99%	82%
612	Inland water transport	0%	4%	5%	85%	1%	1%	9%	3%	0%	1%	18%
62	**Air transport**	**8%**	**3%**	**12%**	**1%**	**4%**	**5%**	**8%**	**7%**	**14%**	**10%**	**12%**
	of which:											
621	Scheduled air transport	88%	91%	99%	66%	94%	98%	90%	91%	100%	85%	96%
622	Non-scheduled air transport	12%	9%	1%	34%	6%	2%	10%	9%	0%	15%	4%
63	**Supporting Services**	**17%**	**24%**	**17%**	**17%**	**31%**	**15%**	**20%**	**27%**	**16%**	**26%**	**11%**
	of which:											
631	Cargo handling and storage	9%	31%	8%	6%	3%	37%	31%	5%	14%	6%	31%
632	Other supporting transport activities	23%	29%	15%	17%	31%	43%	29%	10%	65%	16%	29%
633	Travel agencies	42%	23%	40%	22%	35%	7%	23%	32%	9%	58%	23%
634	Activities of other transport agencies	27%	18%	36%	56%	31%	13%	18%	53%	12%	21%	18%
64	**Communications**	**22%**	**23%**	**39%**	**18%**	**20%**	**27%**	**28%**	**26%**	**23%**	**29%**	**47%**
	of which:											
641	Post and courier activities	21%	26%	14%	17%	27%	7%	26%	25%	14%	10%	26%
642	Telecommunications	79%	74%	86%	83%	73%	93%	74%	75%	86%	90%	74%

Source: GGDC 1997 Gross Output set at 3-digit level

Appendix C. Air Companies included in the PPP calculation

Classification of Air companies in distance classes					
	<750 km	*750-1500 km*	*1500-2500 km*	*>2500 km*	*Non-scheduled*
Australia		Ansett Australia		Quantas	
Austria			Austrian Airways	Lauda Air	Austria Airtransport
Belgium			*SABENA*		
Canada			Air Canada	Canadian Air	
Czech Republic			Czech Airlines		
Denmark	SAS Denmark	SAS International			
Finland			Finnair		
France			Air France	AOM -Minerve	Aeropostale, Corse Air
Germany	*Eurowings*		Lufthansa, Hapag Lloyd		Air Berlin GMBH, Condor, Donau-Air service, FAI Airservice AG, WDL Flugdienst
Greece		Olympic			
Hungary		MALEV			
Ireland		Aer Lingus			
Italy	Air Dolomiti, Azurra Air, Meridiana		Alitalia		Air Europe Spa, Eurofly Spa, Lauda Air Spa
Japan	Air Nippon	All Nippon, Japan Air System	JAL, Japan Asia Airways		
Luxembourg	Luxair				
Netherlands				KLM	
Norway	Coast Air K/S, Wideroe, SAS Norway	SAS International			Helicopter Service
Poland			Lot		
Portugal		Air Macau	Tap Air Portugal		
Slovakia	Tatra Air			Air Slovakia	Air Transport Europe, Cassovia air
South Korea		Asiana	Korean Air		
Spain	Air Nostrum, Aviaco, Binter Canarias	Air Europa, Spanair S.A., Viva Air	Futura, Iberia		Swiftair
Sweden	Malmo Aviation AB, Blue Scandinavia, SAS Sweden	SAS International			
Taiwan		*All Taiwanese companies*			
U.K.	British Midland, British Regional, Cityflyer Express, Gill Aviation, Jersey European Airways, Loganair		GB Airways, Manx Airlines	Air 2000 ltd, British Airways, Monarch Airways	
U.S.A.	*American Eagle,* Business Express, Challenge Air Cargo, Continental Express, DHL, Executive, Federal Express, Horizon Air, Polar Air, United Parcel	Alaska, America West, Hawaiian Air, Mid West Express, Midway Airlines, Reno Air, *Southwest*, USAIR	American, American Transair, Carnival Express, Continental, Delta, Northwest Airlines, TWA, United	Continental Micron., Tower Air	

Source: International Civil Aviation Organization (1999), Civil Aviation statistics of the World 1997, ICAO Statistical Yearbook

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