Measuring Global Value Chains with the WIOD (World Input-Output Database)

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Ways to measure GVCs

➢ Case study

➢ Firm-level survey data

➢ International trade data

➢ Input-output tables, various initiatives

    ➢ OECD

    ➢ IDE-JETRO

    ➢ GTAP

    ➢ WIOD (World Input-Output Database)

Documentation and info

- Dedicated website to WIOD project at www.wiod.org

- This presentation based on paper:

World Input-Output Database (WIOD):
Construction, Challenges and Applications

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Aim of WIOD

- Time-series of input-output tables with supply broken down by origin: domestically produced or imported (by partner country)

- Satellite accounts:

    - Socio-economic (labour and capital input by type)

    - Environmental (energy, emissions to air and water, natural resources)

- Period from 1995 to 2006:

    - 27 EU countries and 13 other major countries

    - 35 industries and 59 products

List of Countries

- **EU-27**

- **plus13 non-EU**:

- Canada	- China
- United States	- India
- Brazil	- Japan
- Mexico	- South Korea
- Turkey	- Taiwan
- Russia	- Indonesia
	- Australia

National Input-Output (IO) Table
(industry by industry type)

	Industry	Final use		Total
Industry	Intermediate use	Domestic Final use	Exports	Total Use
	Value added			
	Output			
Rest of World	Imports			
Total	Total supply			

World input-output table
(3 regions, industry-by-industry type)

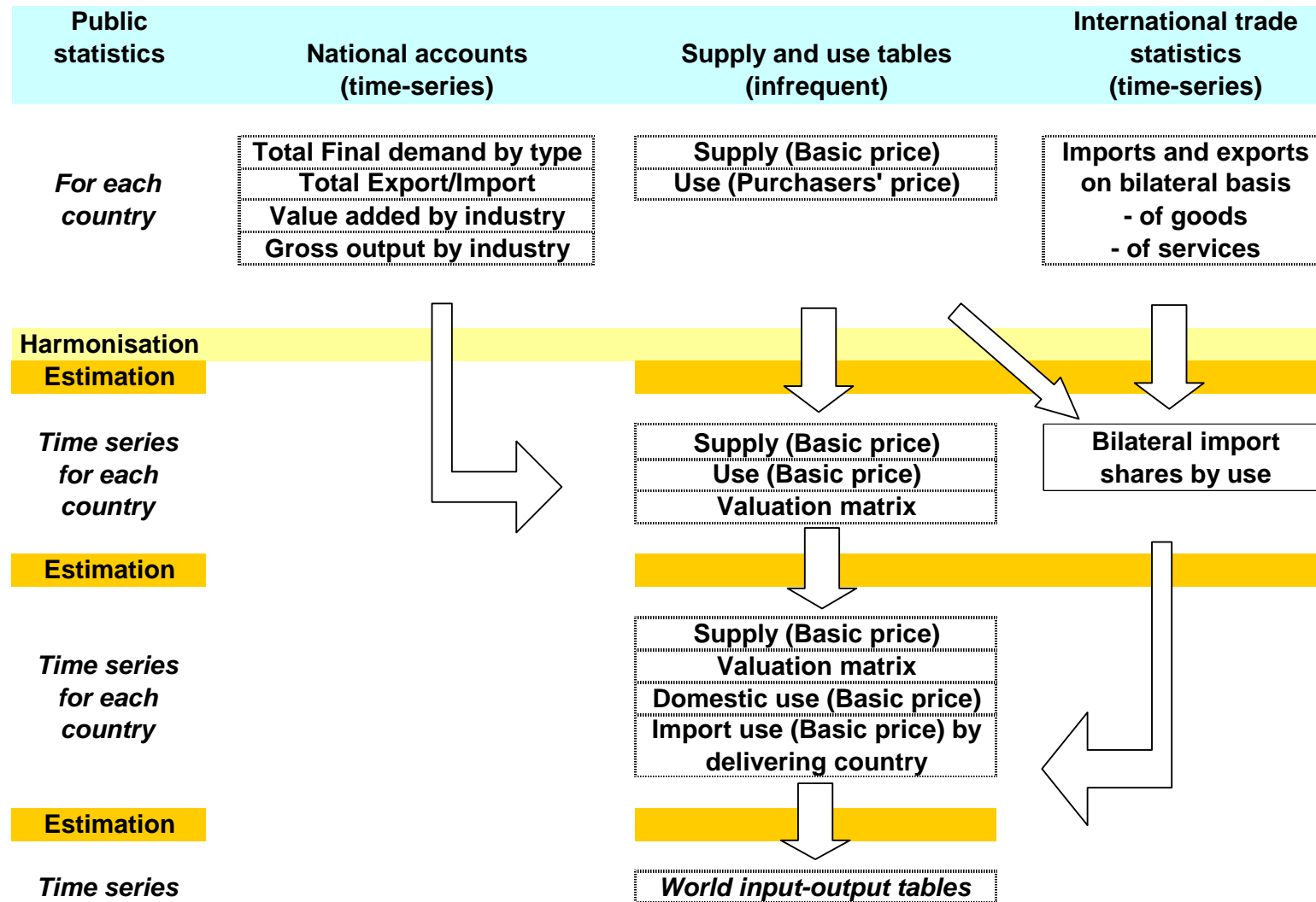|		Country A Intermediate use *Industry*	Country B Intermediate use *Industry*	Rest of World Intermediate use *Industry*	Country A Final domestic use	Country B Final domestic use	Rest of World Final domestic use	Total
Country A	*Industry*	Intermediate use of domestic output	Intermediate use by B of imports from A	Intermediate use by RoW of imports from A	Final use of domestic output	Final use by B of exports from A	Final use by RoW of exports from A	Output in A
Country B	*Industry*	Intermediate use by A of imports from B	Intermediate use of domestic output	Intermediate use by RoW of imports from B	Final use by A of exports from B	Final use of domestic output	Final use by RoW of exports from B	Output in B
Rest of World (RoW)	*Industry*	Intermediate use by A of imports from RoW	Intermediate use by B of imports from RoW	Intermediate use of domestic output	Final use by A of exports from RoW	Final use by B of exports from RoW	Final use of domestic output	Output in RoW
		Value added	Value added	Value added				
		Output in A	Output in B	Output in RoW				

WIOD: What's new?

- Time-series benchmarked on National Accounts data
- National supply and use tables as the basis
- Linked with bilateral international trade data
- Including trade in services
- Improved allocation of imports to use category (BEC-like)
- Socio-economic satellite accounts (labour by skill; capital by type)
- Constant price tables
- (Based on official statistics with maximum of transparency in calculations)

Dataflows and construction steps in WIOT

Public statistics	National accounts (time-series)	Supply and use tables (infrequent)	International trade statistics (time-series)
For each country	Total Final demand by type Total Export/Import Value added by industry Gross output by industry	Supply (Basic price) Use (Purchasers' price)	Imports and exports on bilateral basis - of goods - of services

Harmonisation

Estimation

Time series for each country		Supply (Basic price) Use (Basic price) Valuation matrix	Bilateral import shares by use

Estimation

Time series for each country		Supply (Basic price) Valuation matrix Domestic use (Basic price) Import use (Basic price) by delivering country	

Estimation

Time series		*World input-output tables*	

Methodologies

1. Time-series of SUTs at purchasers' prices

➢ Extrapolation and benchmarking of SUTs to National Accounts statistics, based on SUT-RAS method (Temurshoev and Timmer 2009)

2. From SUTs at purchasers' prices to basic prices

➢ Construction of net tax, trade and transport margin matrices

3. From national to inter-country SUTs

➢ Breakdown of Use table into domestic and imported (by delivering country)

➢ Relying on *imports* from international trade statistics

➢ Not simple proportional method, but distinction between intermediate, consumer and capital goods. This is based on a new classification of HS6-digit products to end-use

➢ (In later stage use import tables from NSIs if available)

Methodologies

4. From SUTs to inter-country input-output table

- ➢ Technology assumptions (on product sales or production)
- ➢ Rest of World: exports to RoW is calculated as residual and can become negative

5. From current price to constant price tables

- ➢ National deflators based on industry gross output deflators, and row wise deflation of SUT. At later stage add in more information from national accounts
- ➢ International deflators (PPPs): World Bank ICP expenditure PPPs adjusted and allocated to industries (for 2005)
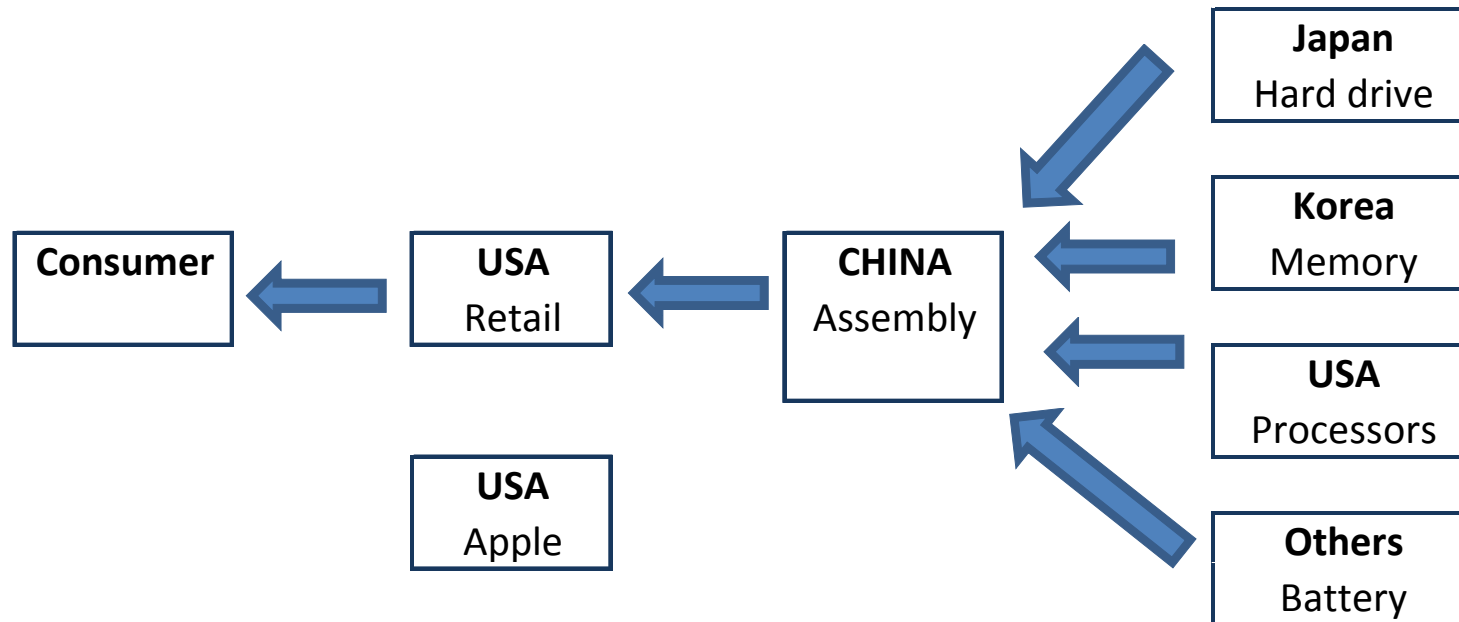
MADE IN CHINA

eaglecartoons.com

The iPod example
(Linden, Dedrick & Kraemer, 2009)

Stylised I-Pod value chain

I-Pod value chain (in $)
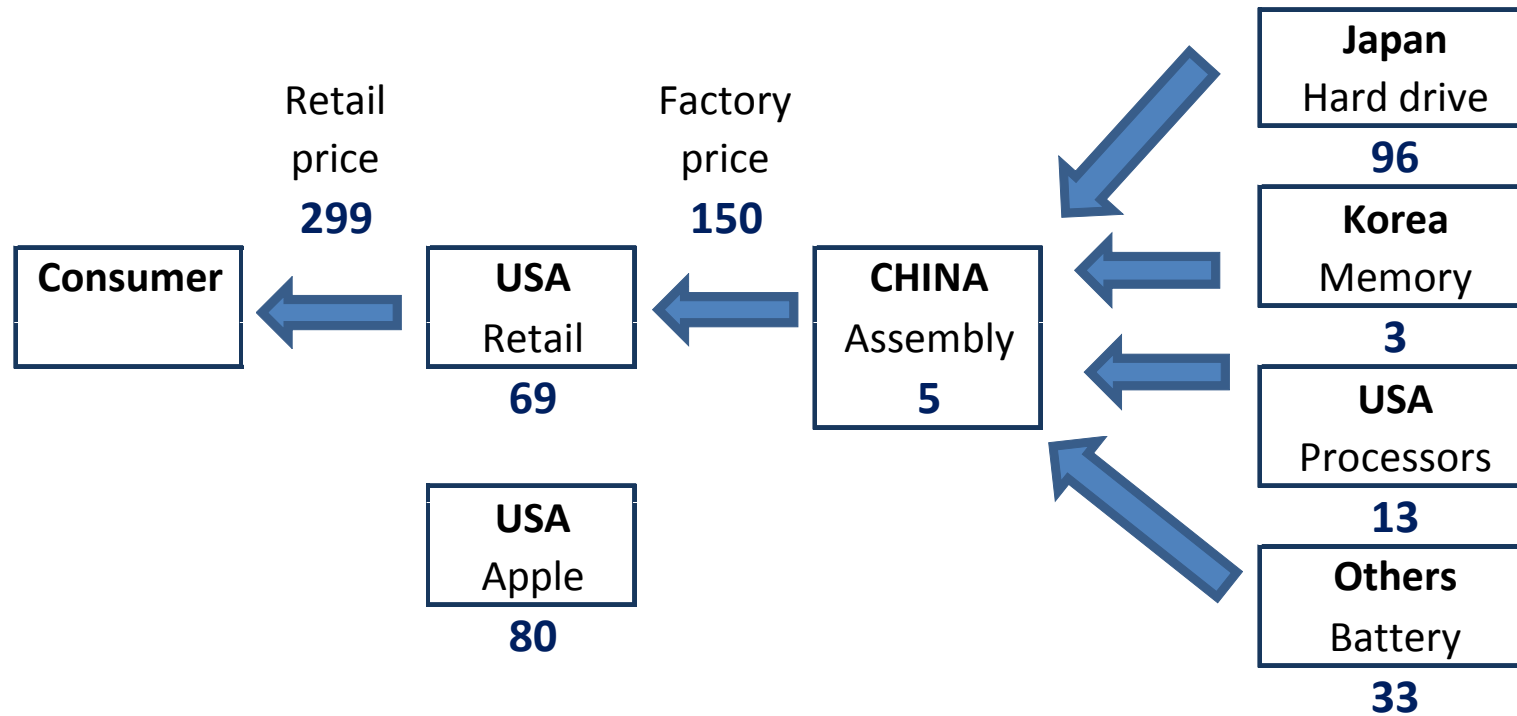
Breakdown of iPod $299 retail price

Japan, $96.00

Korea, $2.50

USA, $13.50

Other, $33.00

China, $5.00

Apple, $80.00

Distribution and reital, $69.00
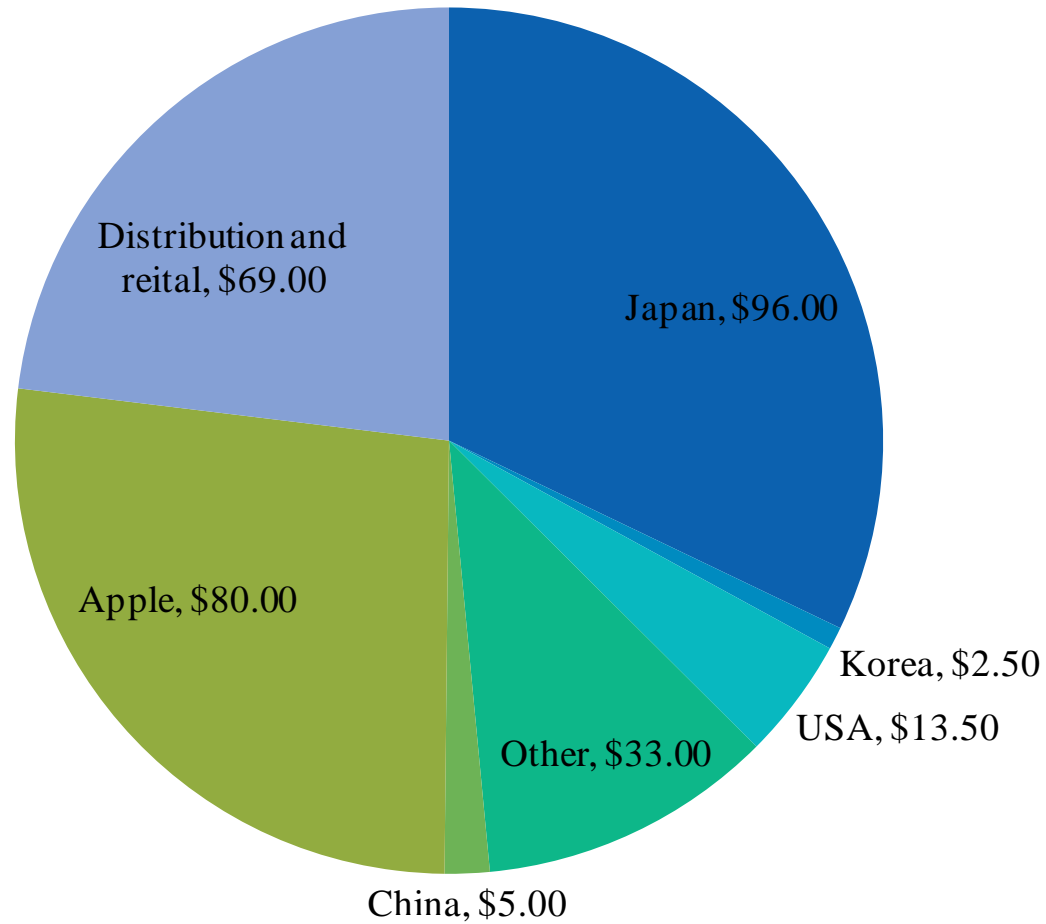
Some lessons

- I-pod is end-result of fragmented value chain
- Made in China does not mean that China captures most of the value. Japan and US do.
- Assembly taking place in China by low-skilled workers at low wages adds little value to the product
- Export statistics might be misleading ($150 from China to US). It is the value added content of trade that counts (only $5).

- BUT How to generalise this (and other) case-studies?
- Firm-level data with information where intermediate inputs are being sourced is scarce.
- Value chains are complex!

Value chain in value chain
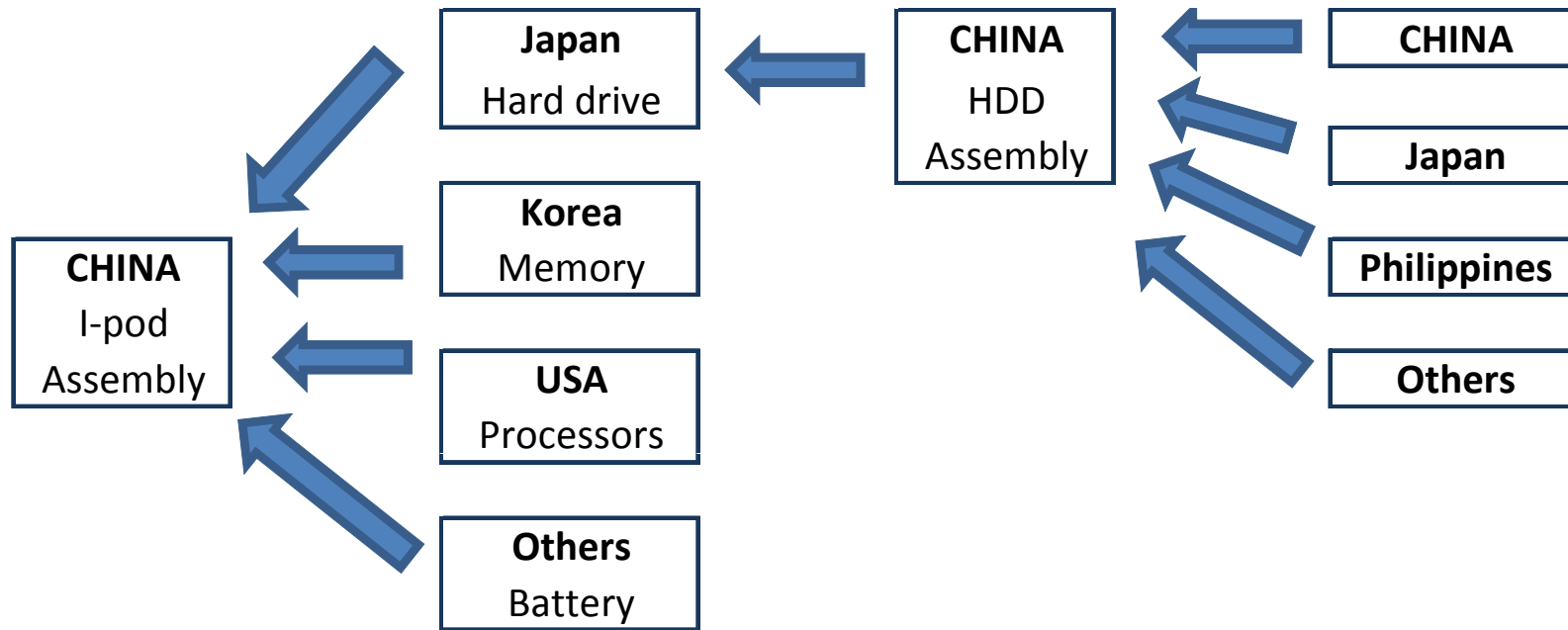
WIOD approach to global value chain analysis

➢ Using *industry data* from National Statistical Institutes (NSIs) that is collected and made consistent within the framework of the National Accounts

➢ Relying on *input-output techniques* to measure the direct and indirect inputs into production

➢ Decompose contribution of each country to value chains into value added by *factor inputs*:
  ➢ various types of labour (low-, medium-, and high-skilled)
  ➢ Physical capital.

➢ Provide trends over time

Factor content measurement

number of countries (C), industries (N) and factors (F)

B = (direct) factor inputs per unit of *gross output* (FC x NC)
$(I-A)^{-1}$ = Leontief inverse of world IO table (NC x NC)

The factor inputs required per unit of *final demand* (both direct and indirect):

$$B^* - B \; (I\text{-}A)^{-1}$$

B^* = factor inputs per unit of final demand (FC x NC)
B^* contains coefficients. The *amounts* of factor inputs that can be attributed to observed levels of final demand can be found by
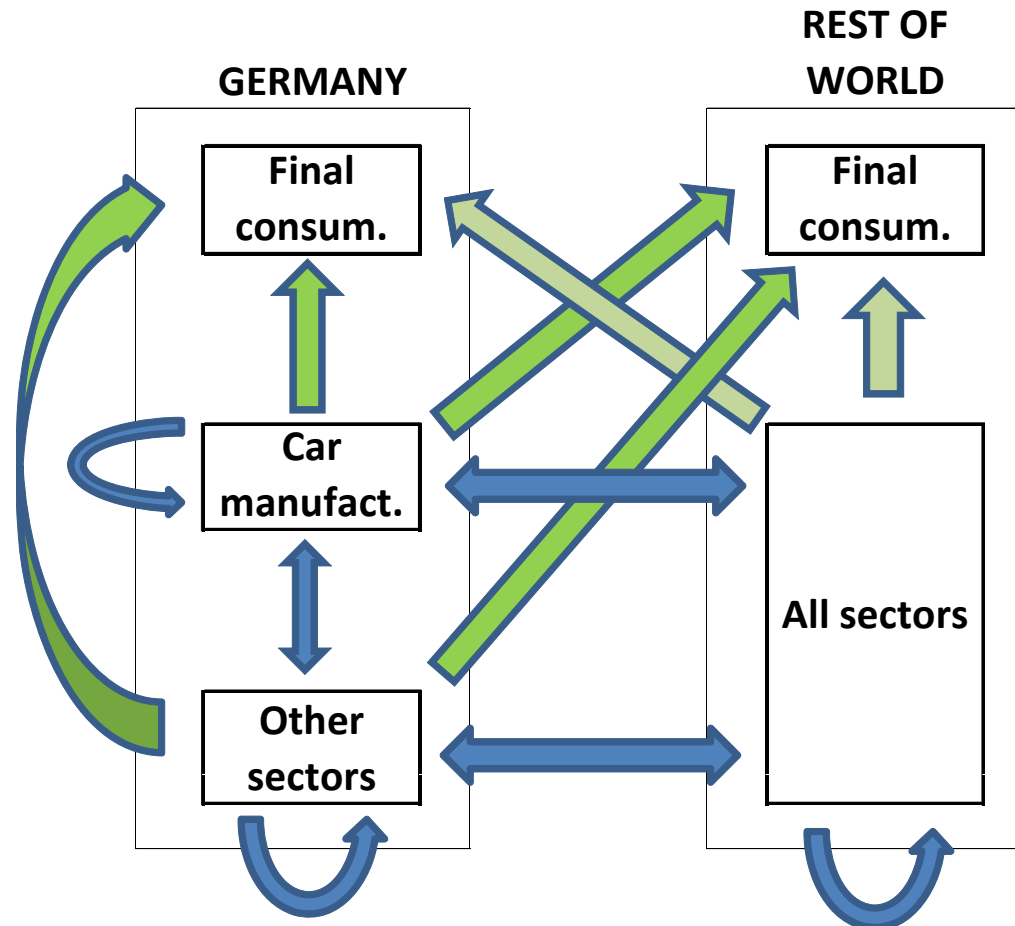
$$K = B^* D$$

in which D is an NC*NC diagonal matrix with final demand levels and K is the FC*NC matrix of amounts of factor inputs attributed to each of the NC final demand levels.
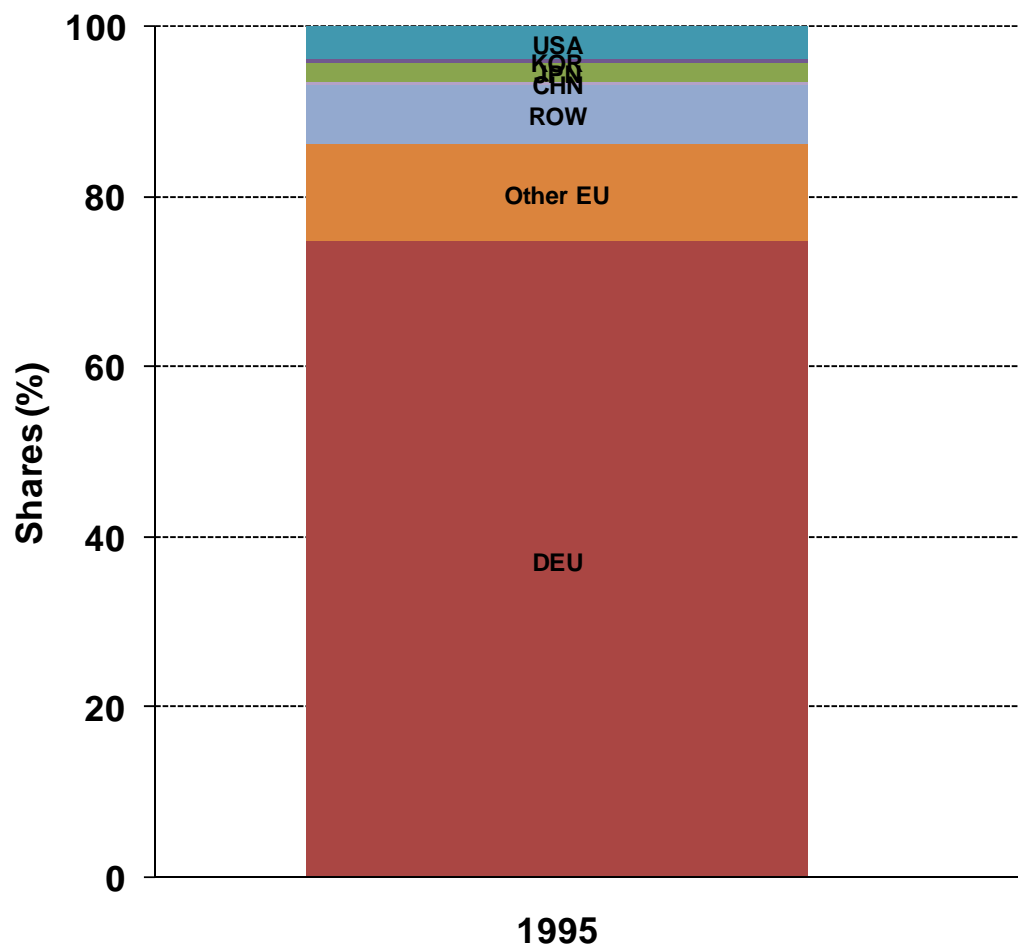
Example of Input-output relations

Global Value Chain of Final Output from German transport equipment manufacturing (1995)

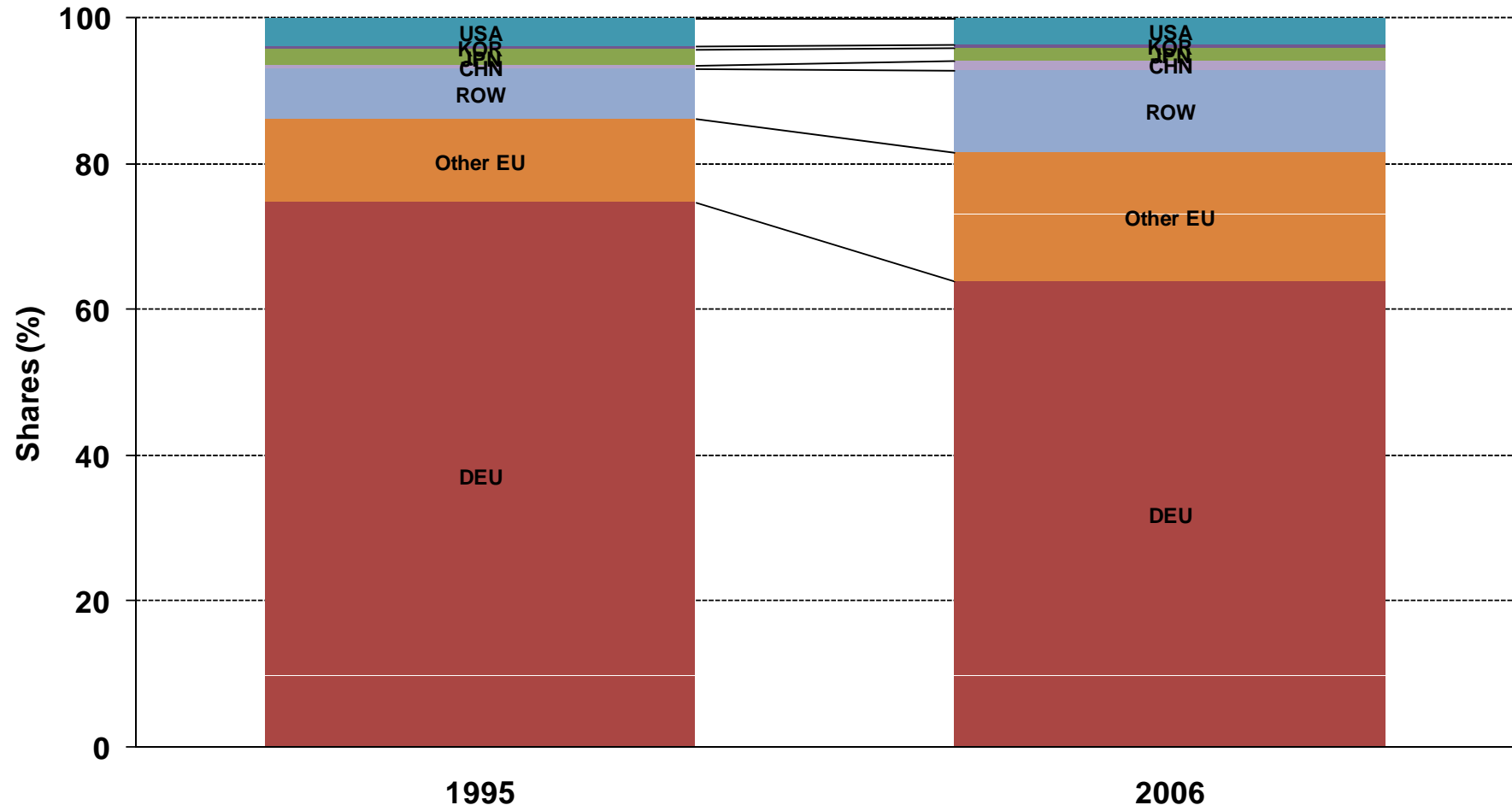> Total final expenditure (domestic and foreign) on output from German automotive industry (≤ sales)

> German share is partly due to factor inputs deployed in automotive industry

> But also in other German industries that deliver intermediate inputs to automotive industry

> Foreign countries capture share due to delivery of intermediate inputs (direct or indirect)

> Nationality is based on *location* of production factors, not ownership

Global Value Chain of Final Output from German transport equipment manufacturing (1995 and 2006)

Shares (%)

100

80

60

40

20

0

1995
- USA
- KOR
- JPN
- CHN
- ROW
- Other EU
- DEU
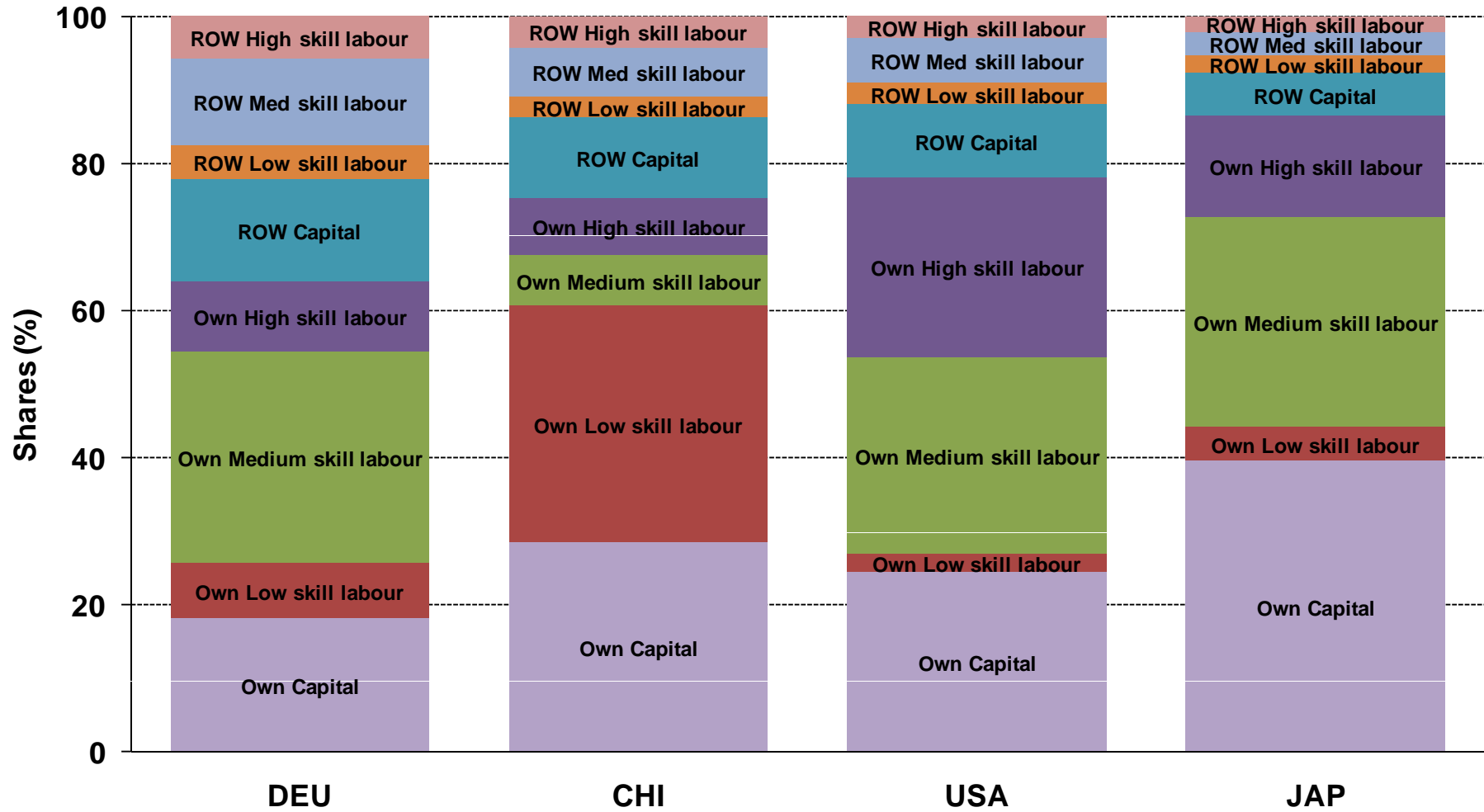
2006
- USA
- KOR
- JPN
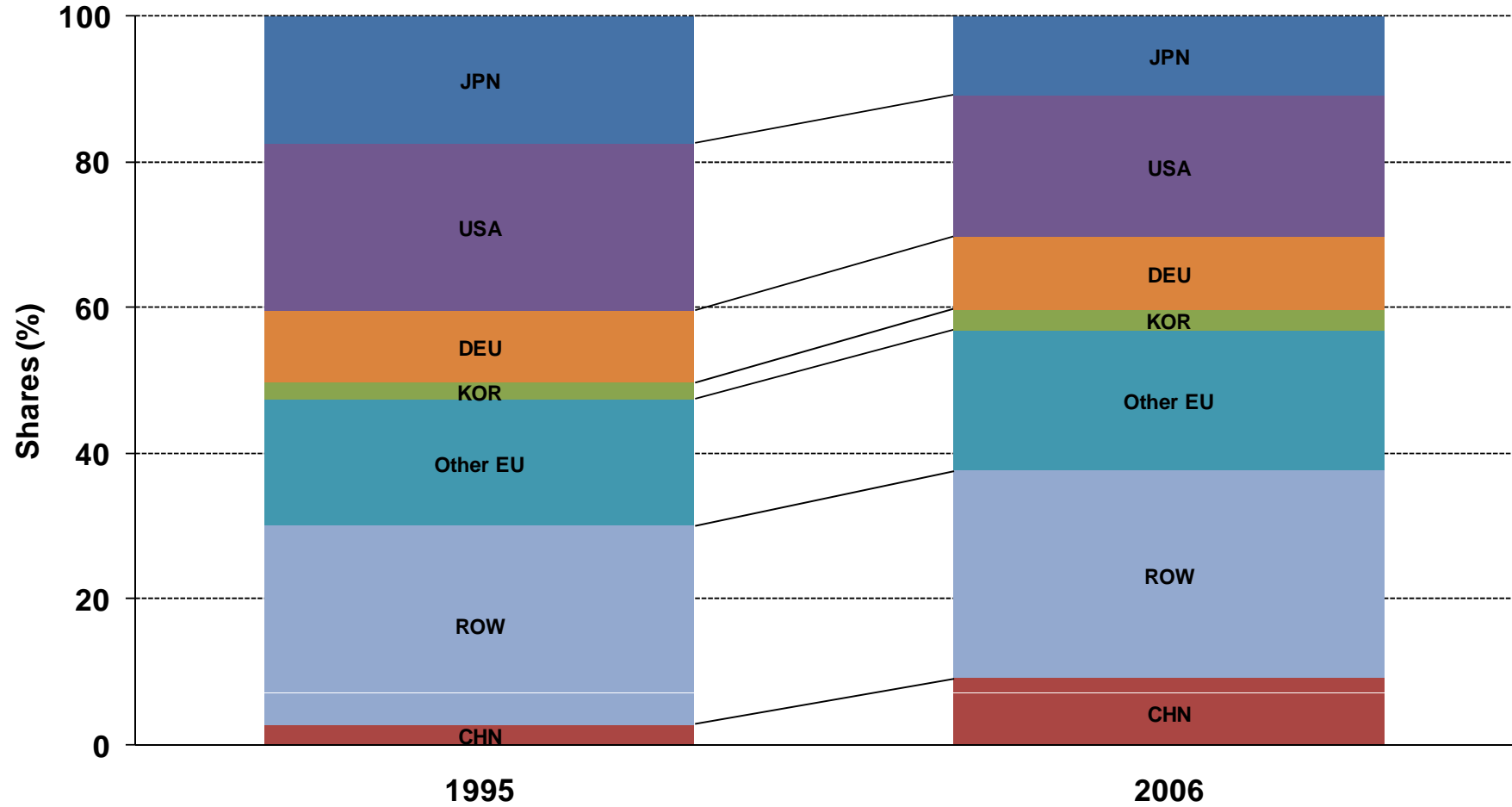- CHN
- ROW
- Other EU
- DEU

Global Value Chain of Final Output from German transport equipment manufacturing (1995 and 2006)
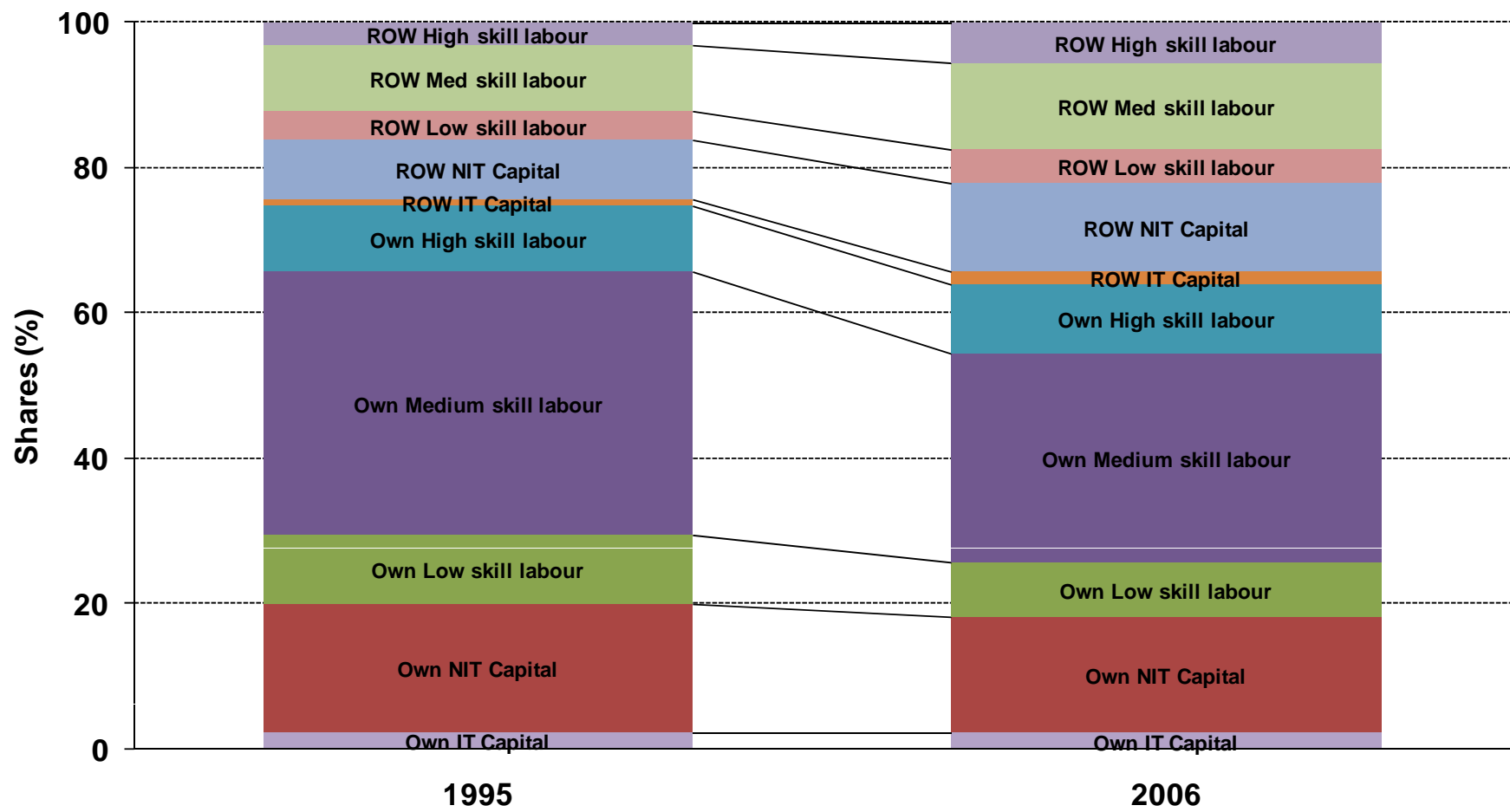
Global Value Chain of Final Output from transport equipment manufacturing (Germany, China, Japan and USA 2006)

Shares (%)

DEU
- ROW High skill labour
- ROW Med skill labour
- ROW Low skill labour
- ROW Capital
- Own High skill labour
- Own Medium skill labour
- Own Low skill labour
- Own Capital

CHI
- ROW High skill labour
- ROW Med skill labour
- ROW Low skill labour
- ROW Capital
- Own High skill labour
- Own Medium skill labour
- Own Low skill labour
- Own Capital

USA
- ROW High skill labour
- ROW Med skill labour
- ROW Low skill labour
- ROW Capital
- Own High skill labour
- Own Medium skill labour
- Own Low skill labour
- Own Capital

JAP
- ROW High skill labour
- ROW Med skill labour
- ROW Low skill labour
- ROW Capital
- Own High skill labour
- Own Medium skill labour
- Own Low skill labour
- Own Capital

Global Value Chain of Final Output from
Global transport equipment manufacturing (1995 and 2006)

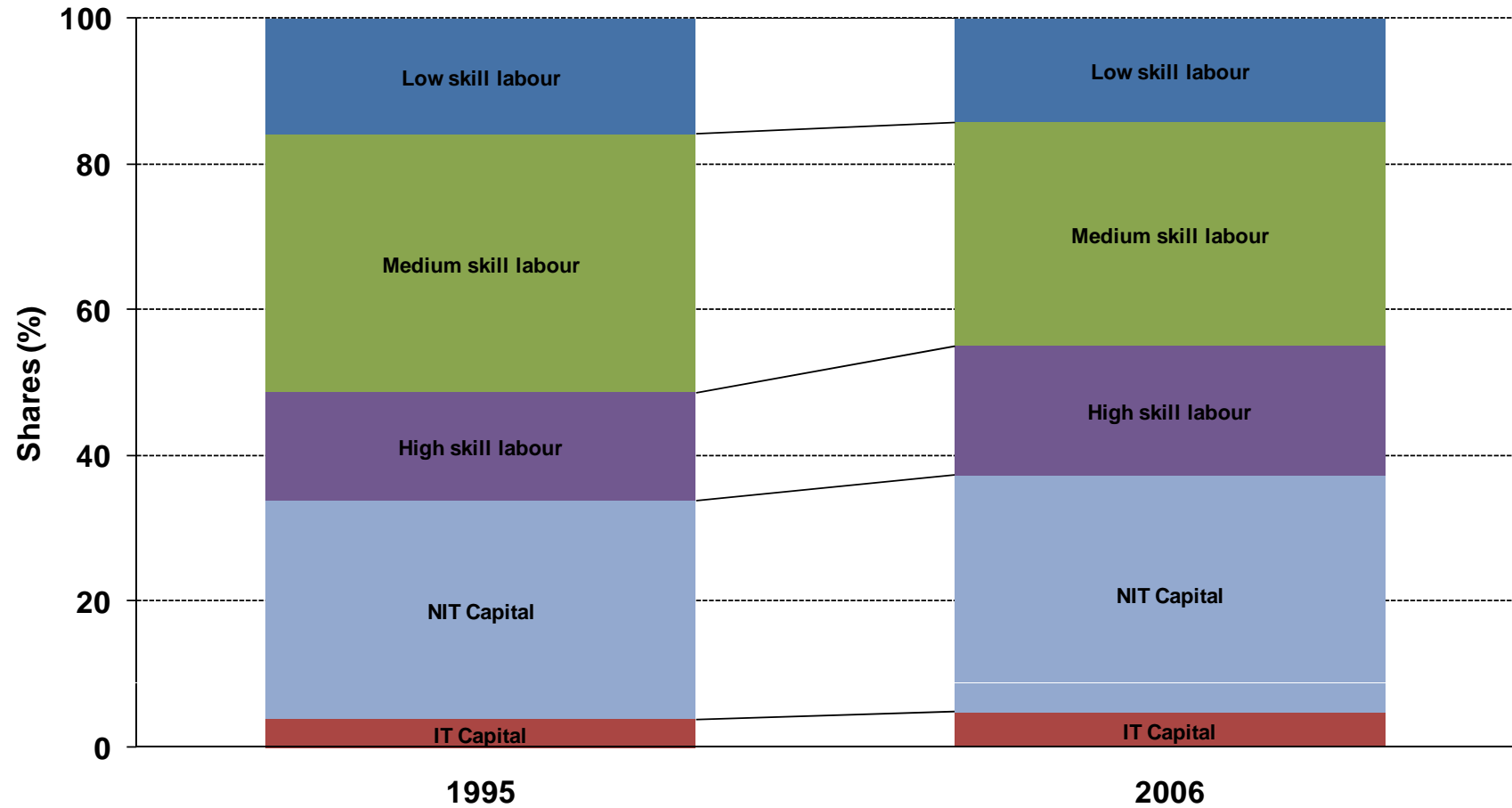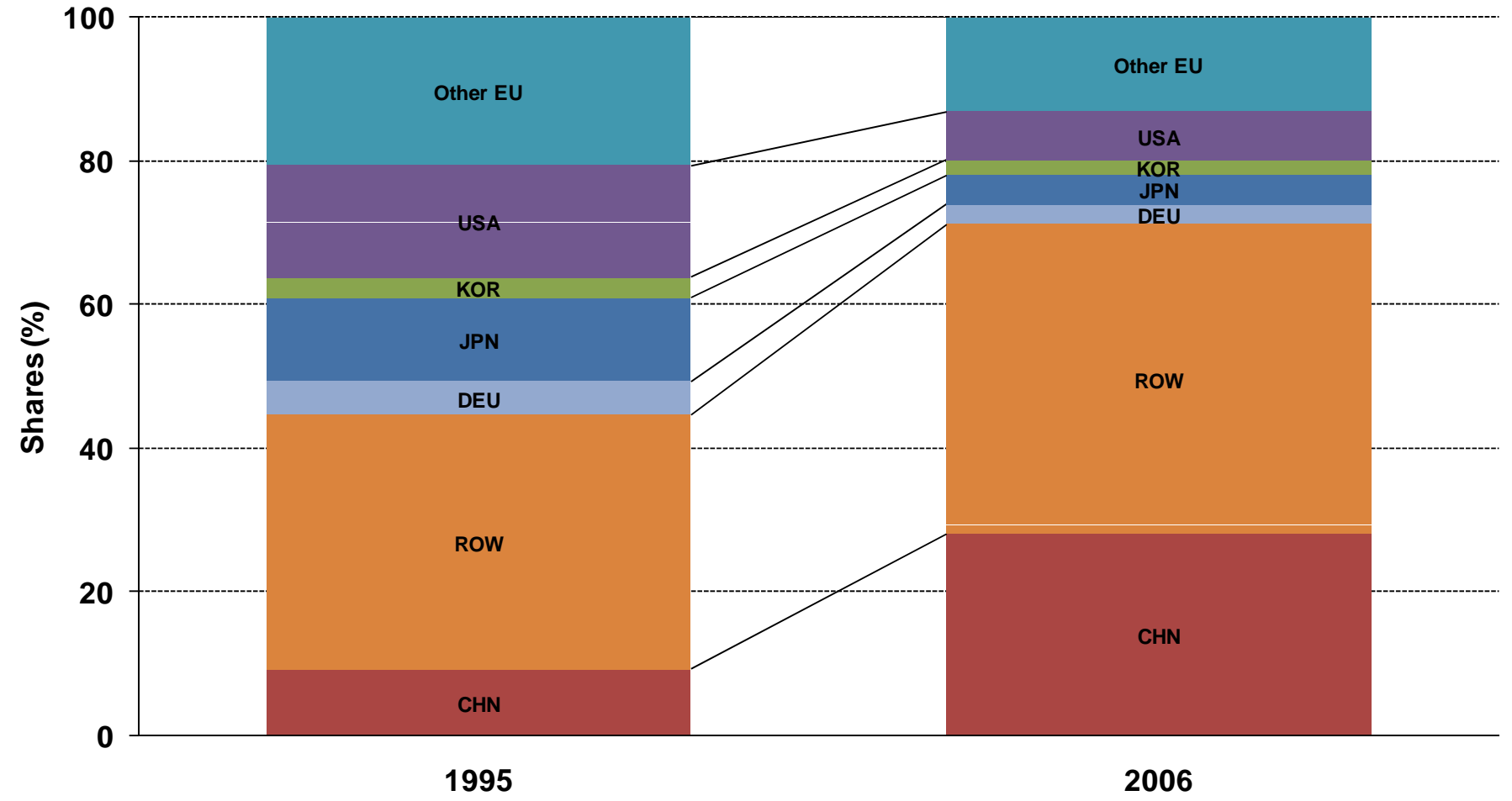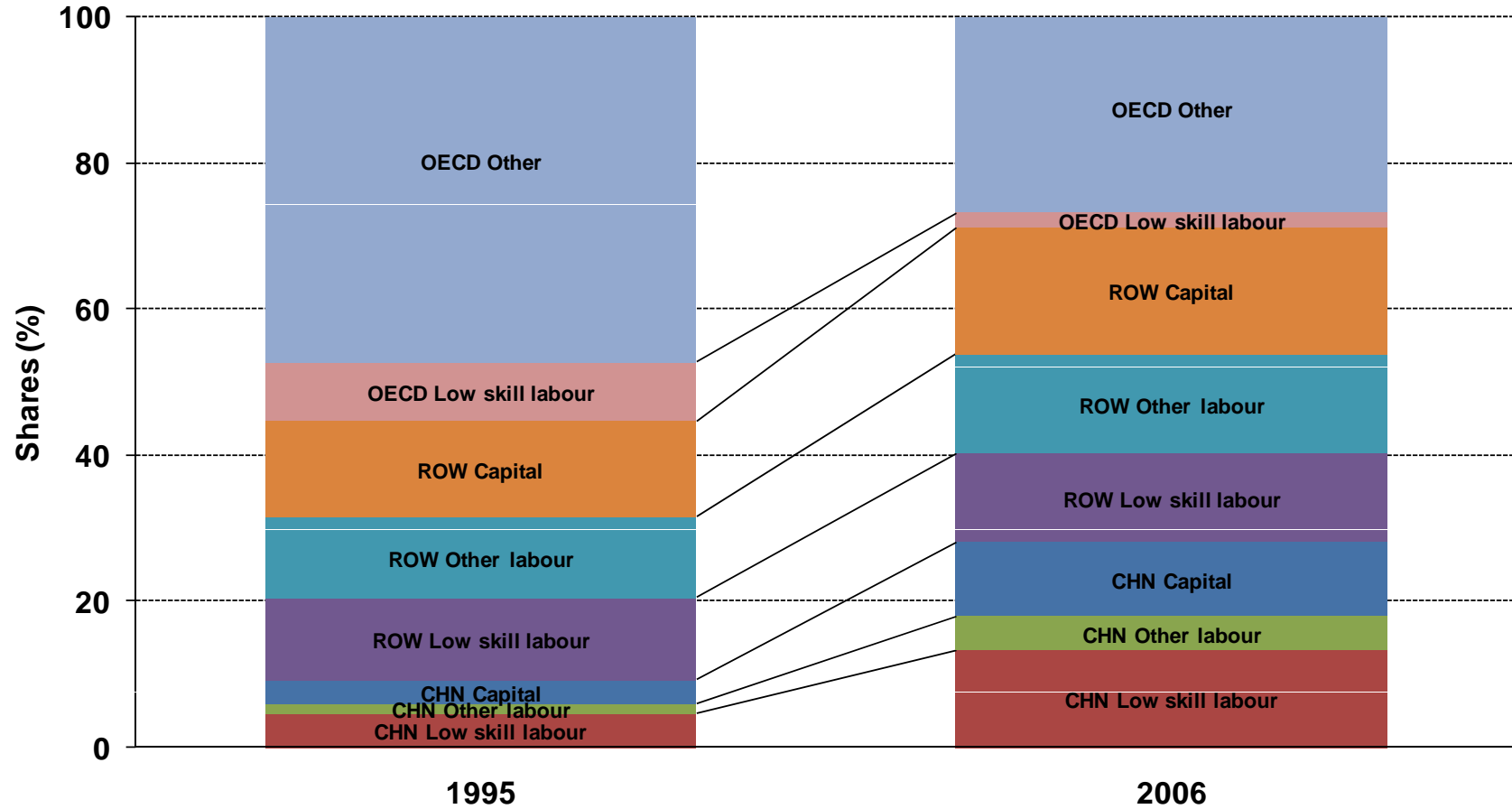# Global Value Chain of Final Output from Global transport equipment manufacturing (1995 and 2006)

Global Value Chain of Final Output from Global textile manufacturing (1995 and 2006)

Shares (%)

1995

2006

Other EU
USA
KOR
JPN
DEU
ROW
CHN

Global Value Chain of Final Output from
Global textile manufacturing (1995 and 2006)

Shares (%)

1995

- OECD Other
- OECD Low skill labour
- ROW Capital
- ROW Other labour
- ROW Low skill labour
- CHN Capital
- CHN Other labour
- CHN Low skill labour

2006

- OECD Other
- OECD Low skill labour
- ROW Capital
- ROW Other labour
- ROW Low skill labour
- CHN Capital
- CHN Other labour
- CHN Low skill labour

Issues on the table

➢ Global value chain is in nominal value ($). Changes can be due to changes in factor prices and changes in factor quantities. E.g. in German automotive case:
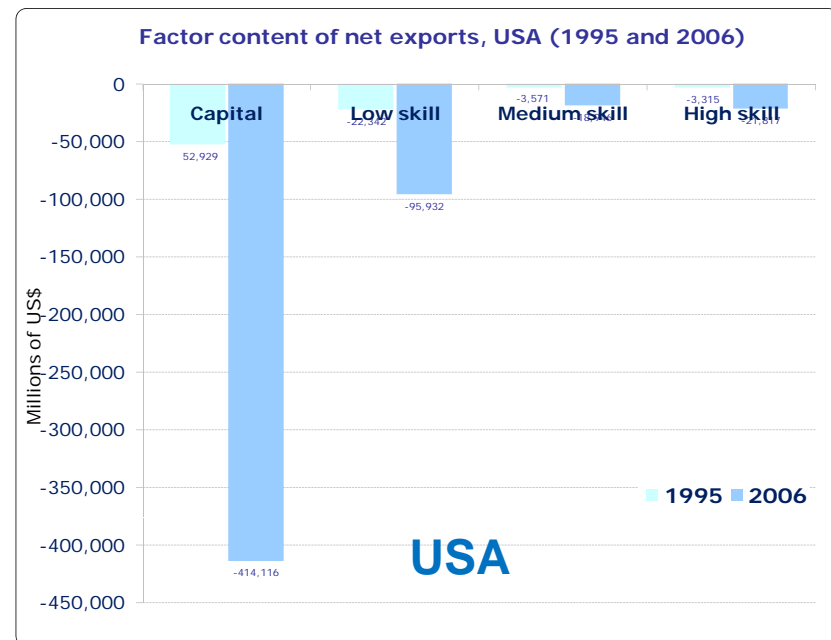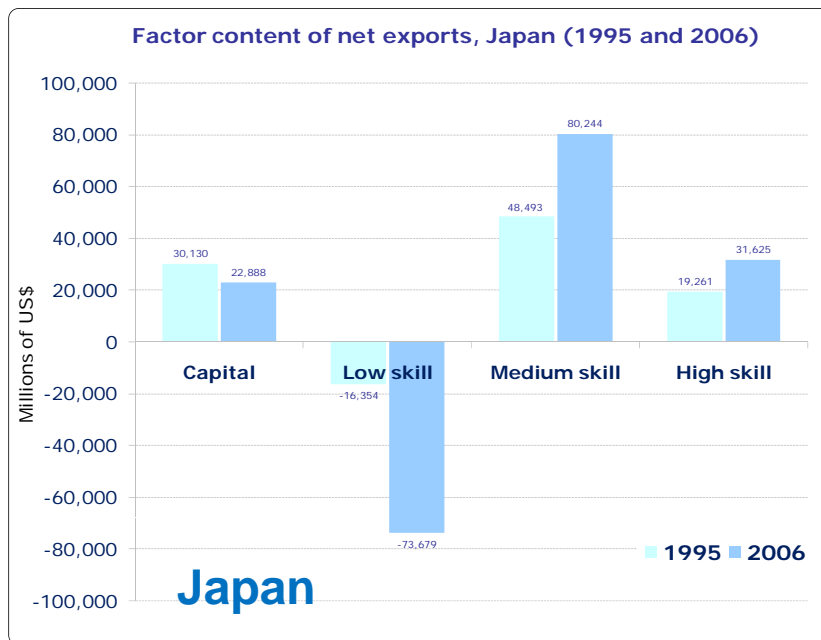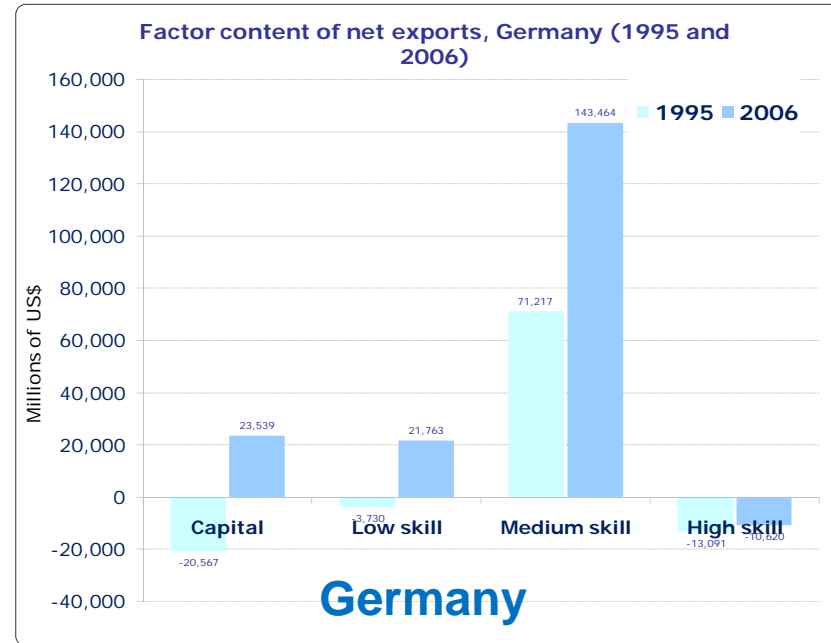
  ➢ Is the wage of German medium-skilled workers relative to other German (and foreign) workers squeezed?

  ➢ Or is their employment going down?

➢ We have the price data to make the breakdown

➢ Ownership versus location:

  ➢ Who owns the returns on capital? Disconnect in case of foreign ownership

  ➢ Less of an issue for labour compensation

➢ Capital compensation is partly payment for investment made in the past. E.g. Chinese textile makers buy Japanese machinery. In dynamic models we can trace this.

➢ Decomposition techniques are silent on causality

Factor content of net exports, China (1995 and 2006)
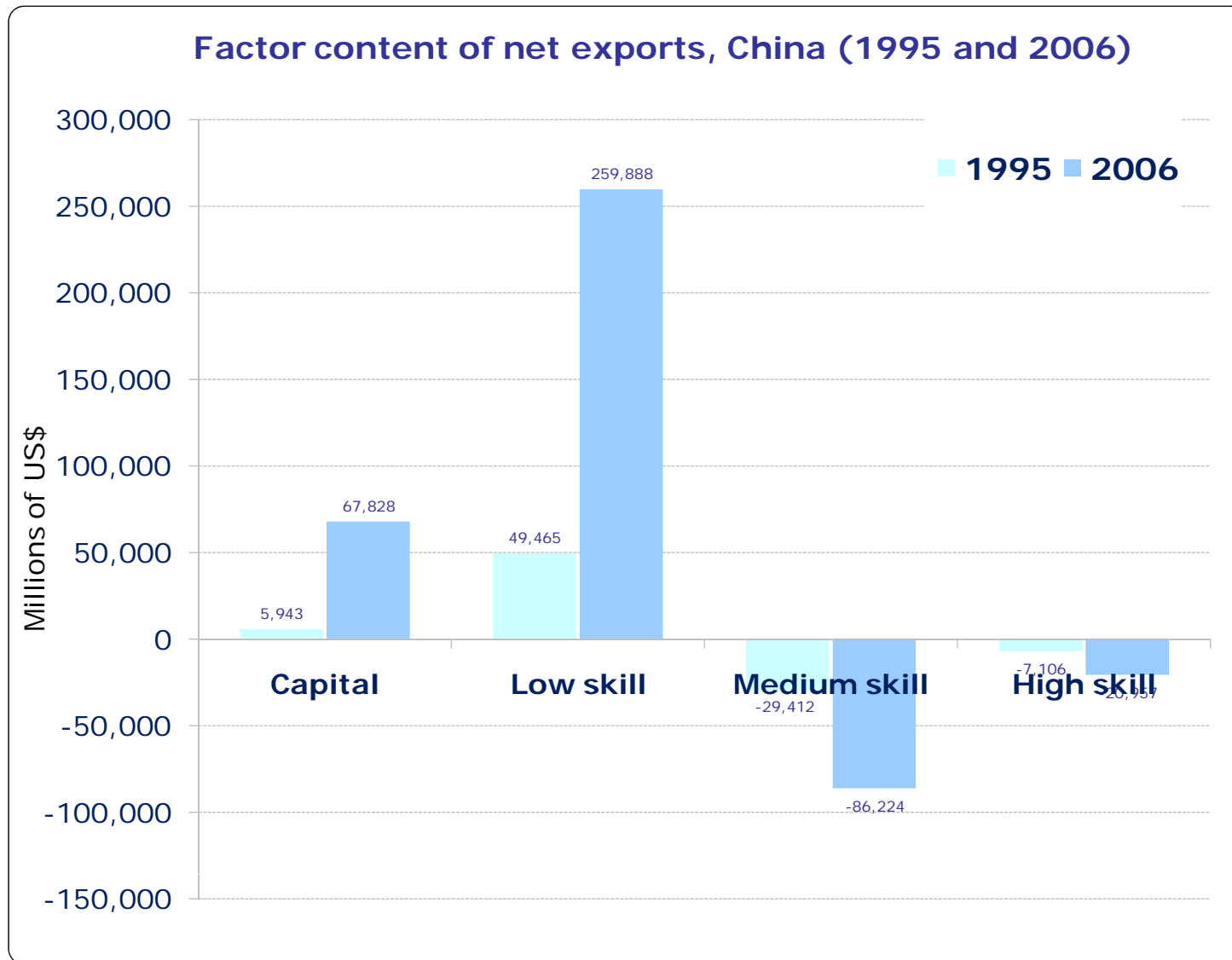
Factor content of net exports is defined as factors needed to satisfy domestic final demand minus available factors

Factor content of net exports, China (1995 and 2006)

Millions of US$

1995 | 2006

- Capital: 5,943 / 67,828
- Low skill: 49,465 / 259,888
- Medium skill: -29,412 / -86,224
- High skill: -7,106 / -26,464

China

Factor content of net exports, Germany (1995 and 2006)

Millions of US$

1995 | 2006

- Capital: -20,567 / 23,539
- Low skill: -3,730 / 21,763
- Medium skill: 71,217 / 143,464
- High skill: -13,091 / -10,620

Germany

Factor content of net exports, Japan (1995 and 2006)

Millions of US$

1995 | 2006

- Capital: 30,130 / 22,888
- Low skill: -16,354 / -73,679
- Medium skill: 48,493 / 80,244
- High skill: 19,261 / 31,625

Japan

Factor content of net exports, USA (1995 and 2006)

Millions of US$

1995 | 2006

- Capital: 52,929 / -414,116
- Low skill: -22,342 / -95,932
- Medium skill: -3,571 / -22,817
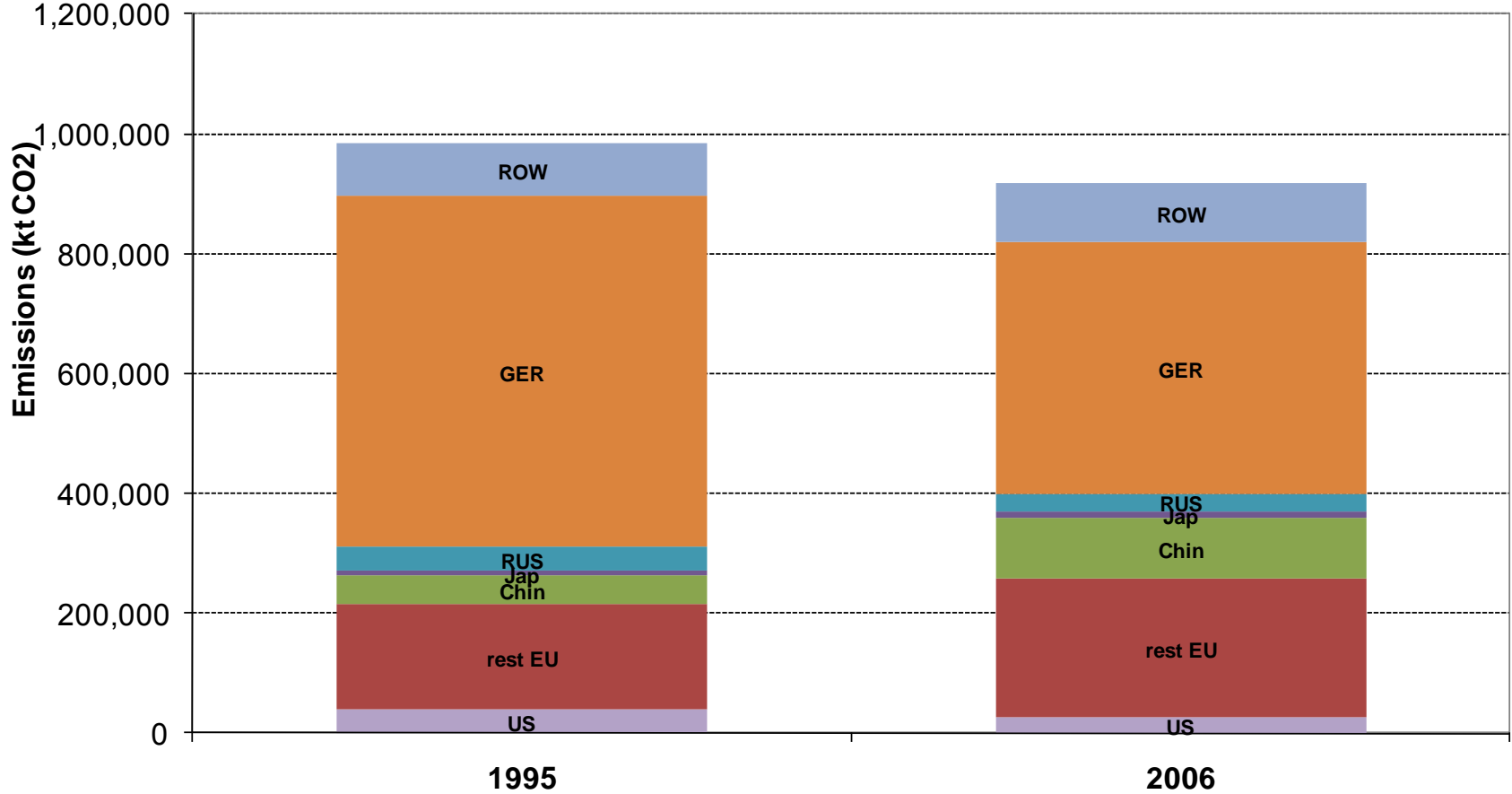- High skill: -3,315
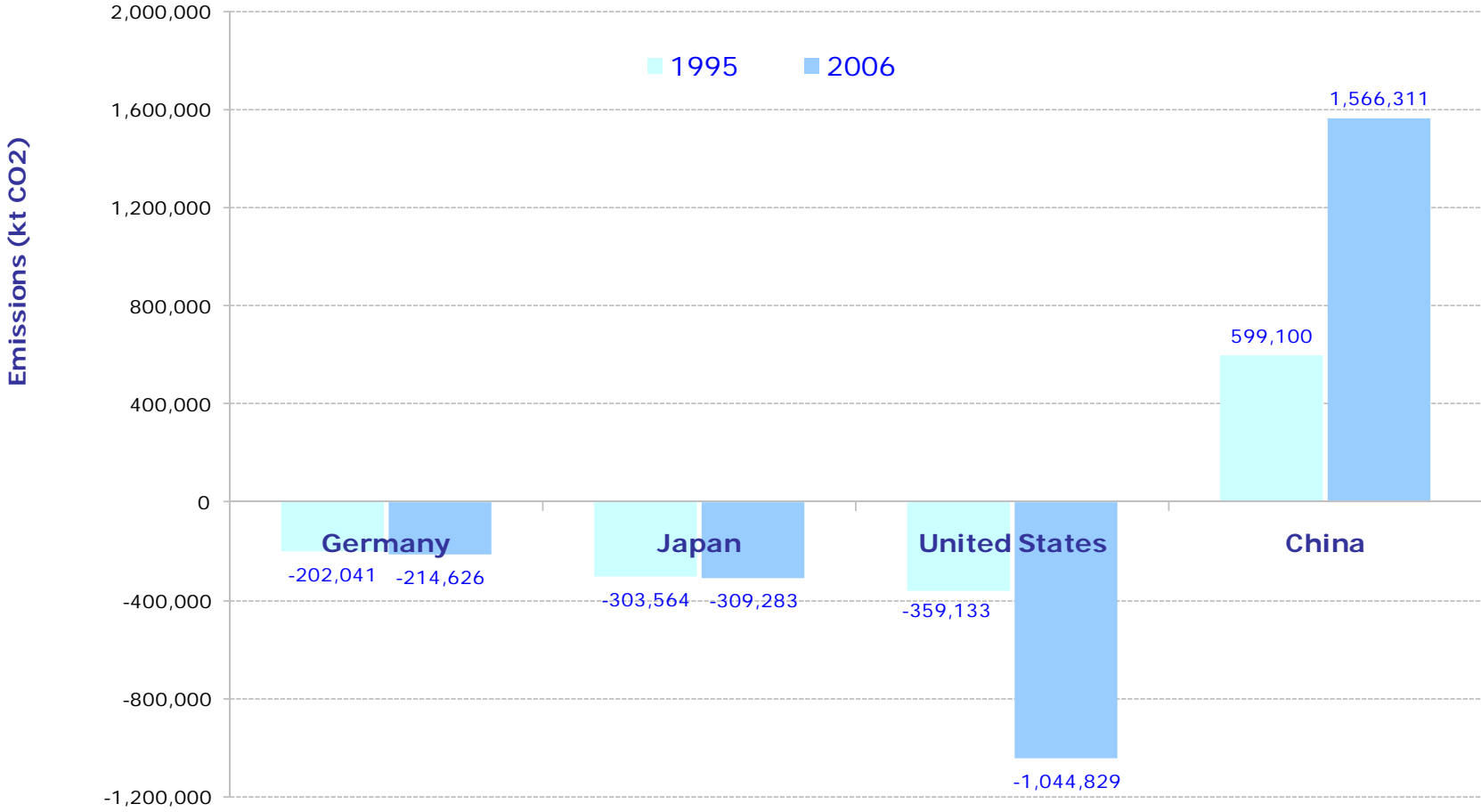
USA

Environmental applications

- Environmental satellite accounts:
  - Energy use
  - Greenhouse gases (CO_2 and others),
  - Ozone depleting gases
  - Acidifying emissions to air
- Same input-output technique as for global value chain analysis. Now e.g. emissions per unit of gross output is used.
- Carbon footprint of a country: CO_2 emitted *globally* in production to satisfy domestic final demand
- Carbon footprint minus available factors is emissions embodied in net trade

Embodied CO2 emissions of final German domestic demand (1995 and 2006)

Emissions embodied in net trade
(China, Germany, US and Japan in 1995 and 2006)

Emissions (kt CO2)

1995   2006

2,000,000

1,600,000

1,200,000

800,000

400,000

0

-400,000

-800,000

-1,200,000

Germany
-202,041   -214,626

Japan
-303,564   -309,283

United States
-359,133
-1,044,829

China
599,100   1,566,311

Future work

➢ Data improvements

➢ Testing by users (parts public autumn 2011; full May 2012)

➢ Provide further analysis
  ➢ Decomposition of changes in global value chains into changes in technology and changes in demand
  ➢ Similarly for pollution indicators (CO_2 plus other GHG)
  ➢ Link to timing of WTO ascension and Kyoto-protocol participation
  ➢ Bring in dynamic IO-models (investment)
  ➢ Testing Heckscher-Ohlin-Samuelson theory

Future work

➤ Data improvements
  ➤ Improving bilateral trade in services
  ➤ Constant price series
    ➤ National deflators
    ➤ Purchasing power parities for output and intermediate inputs
    ➤ Volume masures of labour and capital
  ➤ Improving factor input data for non-OECD countries (as part of work by World KLEMS consortium)
  ➤ Comparing our use-classification of trade flows with official import IO tables.
  ➤ Processing export trade tables for Mexico and China

➤ Testing by users (parts public autumn 2011; full May 2012)

➤ **Provide further analysis !**

Additional material

Who is in WIOD?

- University of Groningen (The Netherlands)
- Institute for Prospective Technological Studies (Spain)
- Wiener Institut für Internationale Wirtschaftsvergleiche (Austria)
- Zentrum für Europäische Wirtschaftsforschung (Germany)
- Österreichisches Institut für Wirtschaftsforschung (Austria)
- Konstanz University of Applied Sciences (Germany)
- The Conference Board Europe (Belgium)
- CPB Netherlands Bureau for Economic Policy Analysis
- Institute of Communication and Computer Systems (Greece)
- Central Recherche SA (France)
- OECD (France)

Columns in USE Table

Code	NACE	Description
1	AtB	Agriculture, Hunting, Forestry and Fishing
2	C	Mining and Quarrying
3	15t16	Food, Beverages and Tobacco
4	17t18	Textiles and Textile Products
5	19	Leather, Leather and Footwear
6	20	Wood and Products of Wood and Cork
7	21t22	Pulp, Paper, Paper , Printing and Publishing
8	23	Coke, Refined Petroleum and Nuclear Fuel
9	24	Chemicals and Chemical Products
10	25	Rubber and Plastics
11	26	Other Non-Metallic Mineral
12	27t28	Basic Metals and Fabricated Metal
13	29	Machinery, Nec
14	30t33	Electrical and Optical Equipment
15	34t35	Transport Equipment
16	36t37	Manufacturing, Nec; Recycling
17	E	Electricity, Gas and Water Supply
18	F	Construction
19	50	Sale, Maintenance and Repair of Motor Vehicles Retail Sale of Fuel
20	51	Wholesale Trade and Commission Trade, Except of Motor Vehicles
21	52	Retail Trade, Except of Motor Vehicles ; Repair of Household Goods
22	H	Hotels and Restaurants
23	60	Inland Transport
24	61	Water Transport
25	62	Air Transport
26	63	Other Supporting and Auxiliary Transport Activities; Activities of Travel Agencies
27	64	Post and Telecommunications
28	J	Financial Intermediation
29	70	Real Estate Activities
30	71t74	Renting of M&Eq and Other Business Activities
31	L	Public Admin and Defence; Compulsory Social Security
32	M	Education
33	N	Health and Social Work
34	O	Other Community, Social and Personal Services
35	P	Private Households with Employed Persons
36		Financial intermediation services indirectly measured (FISIM)
37		**Total**
38		Final consumption expenditure by households
39		Final consumption exp. by non-profit organisations serving households
40		Final consumption expenditure by government
41		**Final consumption expenditure**
42		Gross fixed capital formation
43		Changes in inventories and valuables
44		Gross capital formation
45		Exports
46		**Final uses at purchasers' prices**
47		**Total use at purchasers' prices**

Columns in Use table

Rows in Use table (part 1)

Code	CPA	Description
1	1	Products of agriculture, hunting and related services
2	2	Products of forestry, logging and related services
3	5	Fish and other fishing products; services incidental of fishing
4	10	Coal and lignite; peat
5	11	Crude petroleum and natural gas; services incidental to oil and gas extraction excluding s
6	12	Uranium and thorium ores
7	13	Metal ores
8	14	Other mining and quarrying products
9	15	Food products and beverages
10	16	Tobacco products
11	17	Textiles
12	18	Wearing apparel; furs
13	19	Leather and leather products
14	20	Wood and products of wood and cork (except furniture); articles of straw and plaiting mate
15	21	Pulp, paper and paper products
16	22	Printed matter and recorded media
17	23	Coke, refined petroleum products and nuclear fuels
18	24	Chemicals, chemical products and man-made fibres
19	25	Rubber and plastic products
20	26	Other non-metallic mineral products
21	27	Basic metals
22	28	Fabricated metal products, except machinery and equipment
23	29	Machinery and equipment n.e.c.
24	30	Office machinery and computers
25	31	Electrical machinery and apparatus n.e.c.
26	32	Radio, television and communication equipment and apparatus
27	33	Medical, precision and optical instruments, watches and clocks
28	34	Motor vehicles, trailers and semi-trailers
29	35	Other transport equipment
30	36	Furniture; other manufactured goods n.e.c.
31	37	Secondary raw materials
32	40	Electrical energy, gas, steam and hot water
33	41	Collected and purified water, distribution services of water
34	45	Construction work

35	50	Trade, maintenance and repair services of motor vehicles and motorcycles; retail sale of a
36	51	Wholesale trade and commission trade services, except of motor vehicles and motorcycle
37	52	Retail trade services, except of motor vehicles and motorcycles; repair services of person
38	55	Hotel and restaurant services
39	60	Land transport; transport via pipeline services
40	61	Water transport services
41	62	Air transport services
42	63	Supporting and auxiliary transport services; travel agency services
43	64	Post and telecommunication services
44	65	Financial intermediation services, except insurance and pension funding services
45	66	Insurance and pension funding services, except compulsory social security services
46	67	Services auxiliary to financial intermediation
47	70	Real estate services
48	71	Renting services of machinery and equipment without operator and of personal and house
49	72	Computer and related services
50	73	Research and development services
51	74	Other business services
52	75	Public administration and defence services; compulsory social security services
53	80	Education services
54	85	Health and social work services
55	90	Sewage and refuse disposal services, sanitation and similar services
56	91	Membership organisation services n.e.c.
57	92	Recreational, cultural and sporting services
58	93	Other services
59	95	Private households with employed persons
60		**Total**
61		Cif/ fob adjustments on exports
62		Direct purchases abroad by residents
63		Purchases on the domestic territory by non-residents
64		**Total intermediate consumption/final use at purchasers' prices**
65		Compensation of employees
66		Other net taxes on production
67		Operating surplus, gross
68		**Value added at basic prices**
69		**Output at basic prices**

Rows in Use table (part 2)