



International Conference on Innovation in Energy Technologies

**Mapping the Knowledge Base for Fuel Cells: A
Bibliometric Approach**

Washington D.C., 29-30 September 2003

E. HASSAN

Mapping the Knowledge Base for Fuel Cells

- Objectives
- Data & Method
- Main Results
- Discussion

Mapping the Knowledge Base for Fuel Cells

Objectives

- **Data & Method**
- **Main Results**
- **Discussion**



➤ **General:**

- Describing and analyzing both structural and relational features of the fuel cells innovation system with a comparative global perspective over the 1990s

➤ **Specific:**

- Identifying the actors (*i.e.* countries, institutional sectors, and institutions) engaged in the process of knowledge production and diffusion
- Examining the linkages between these different actors in terms of knowledge transfer and cooperation

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➤ ***Approach:***

- **The empirical case study is based on a quantitative approach, *i.e.* bibliometrics**
 - **Data on scientific publications and patents are used to create internationally comparable indicators that measure S&T output and provide insight into the structure of the innovation system**
- ⇒ ***Only S&T knowledge captured by data derived from published output is considered in this empirical case study.***

➤ ***The fuel cells customized database:***

- **A customized database on fuel cells publications and patents was constructed for the case study**
- **Scope: the database covers publications and patents related to the seven most common types of fuel cells technology, *i.e.***
 - Alkaline Fuel Cells (AFC);
 - Direct Methanol Fuel Cells (DMFC);
 - Molten Carbonate Fuel Cells (MCFC);
 - Phosphoric Acid Fuel Cells (PAFC);
 - Proton Exchange Membrane Fuel Cells (PEMFC);
 - Solid Oxide Fuel Cells (SOFC);
 - and Regenerative Fuel Cells (RFC).

⇒ ***Not all publications and patents dealing with fuel cells technology (or even related hydrogen technologies) are considered in this empirical case study.***

➤ ***The fuel cells customized database (cont'd):***

▪ **Information sources:** data on scientific publications and patents were extracted thanks to the use of keywords and/or indexing codes from large international bibliographic databases, *i.e.*

– ETDE's Energy database which contains the largest collection of energy literature with more than 3.8 million abstracted and indexed records (e.g. journal articles, technical reports, conference papers, books, thesis);

– Patent databases from the US Patent & Trademark Office and European Patent Office.

⇒ ***Neither publications from bibliographic databases specialized in the engineering sciences, physics, and chemistry nor patents applied for at minor national patent offices are considered in this empirical case study.***

➤ ***The fuel cells customized database (cont'd):***

- **Matching process:** bibliographic information on publications and patents were then respectively matched and linked to the corresponding records in the following databases:

- The Science Citation Expanded which covers more than 6,000 world's leading scholarly science and technical journals in more than 150 disciplines;
- The OECD patent database which covers all data on “triadic patent families”.

⇒ ***Only relevant peer-reviewed journal articles are considered in this empirical case study. This excludes all non-articles data (reports, conference proceedings, books) and data from non-SCI journals.***

⇒ ***Patent data from single patent offices have specific weaknesses (e.g. the “home” advantage bias) for bibliometric purpose. This is the reason why they are not used in this empirical case study.***

➤ ***The fuel cells customized database (cont'd):***

- **Data coverage:** The customized database covers all the main bibliographic information (e.g. author(s)/inventor(s), affiliation(s), sub-field(s), date of publication or priority, title, abstract) on:
 - 1191 peer-reviewed journal articles for the publication years 1990-2000 in various disciplines (mainly chemistry, engineering, physics, materials science);
 - 221 “triadic” patent families for the priority years 1990-1996.

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➤ ***Evolution and structure of the global fuel cells knowledge base:***

- Global trends in scientific publishing and patenting
- Scientific publishing and patenting by sub-field
- S&T cognitive linkages

➤ ***General overview of the S&T activities of OECD countries:***

- Regional and national performance
- S&T specialization
- Patterns of international scientific cooperation

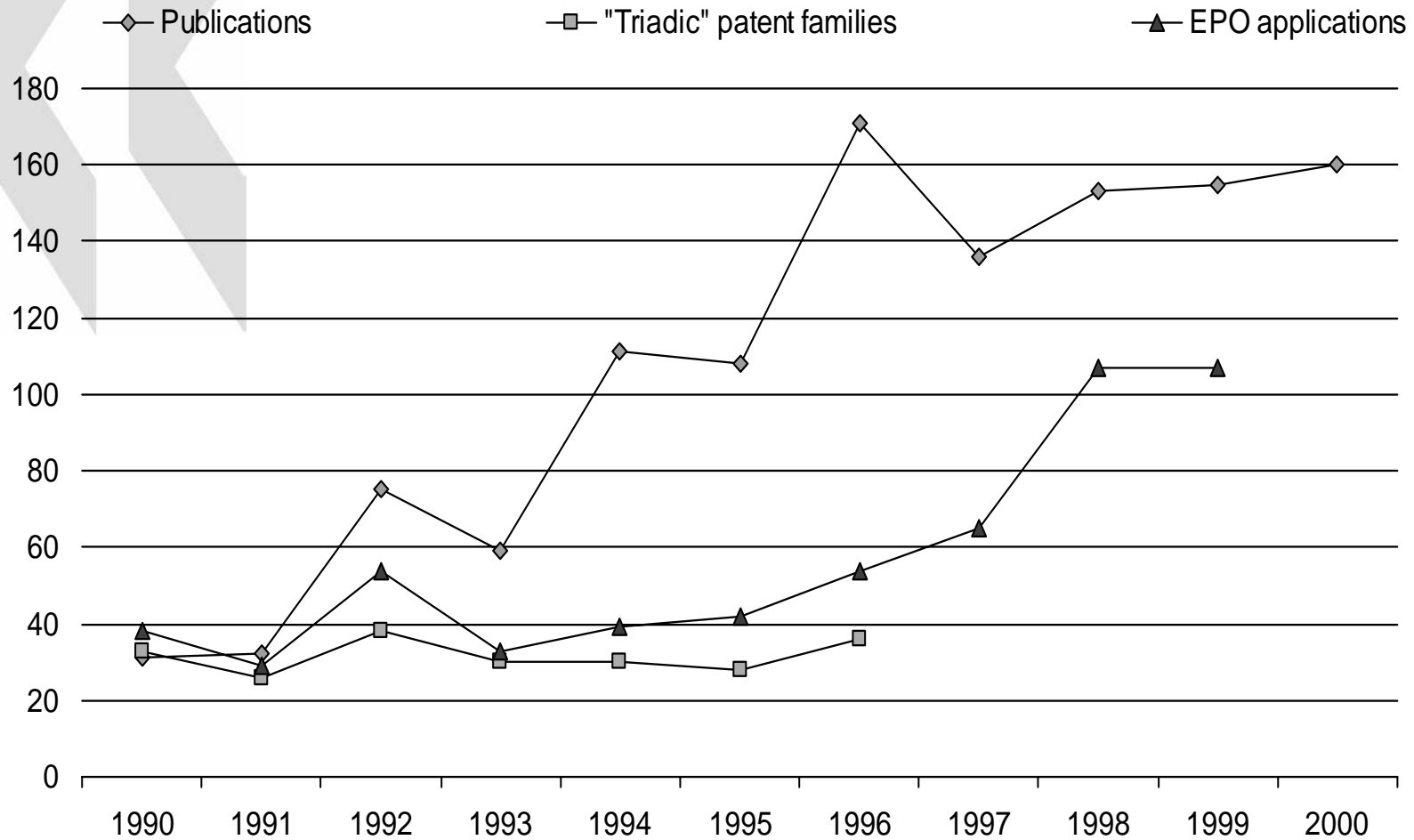
➤ ***Organization of S&T knowledge production and diffusion within the OECD countries:***

- The division of labor in the production of S&T knowledge
- Patterns of sectoral cooperation

➤ **Evolution and structure of the fuel cells knowledge base:**

▪ **Global trends in scientific publishing and patenting output**

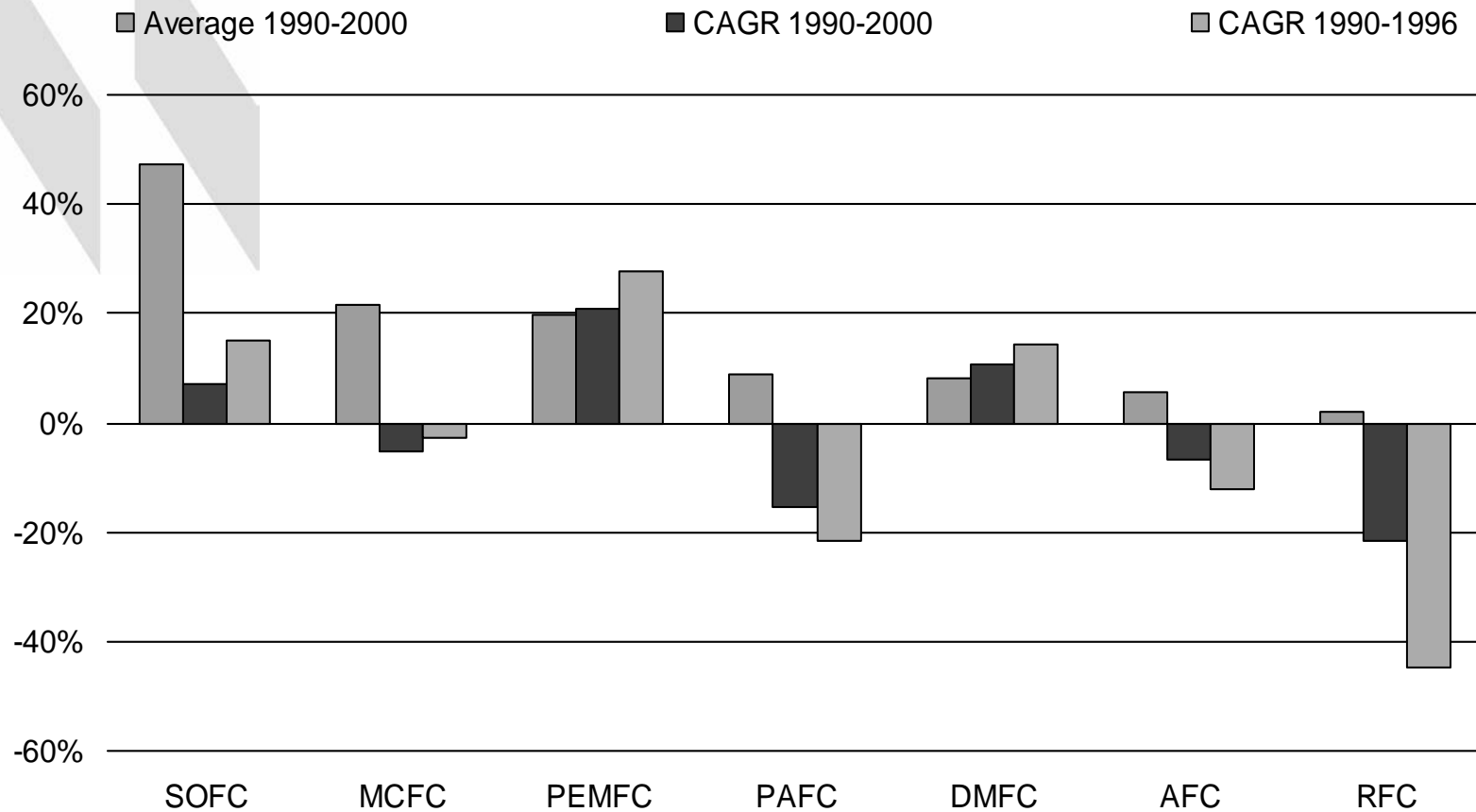
Publications, EPO applications, and “triadic” patent families, worldwide



➤ **Evolution and structure of the global fuel cells knowledge base (cont'd):**

▪ **Scientific publishing and patenting by sub-field**

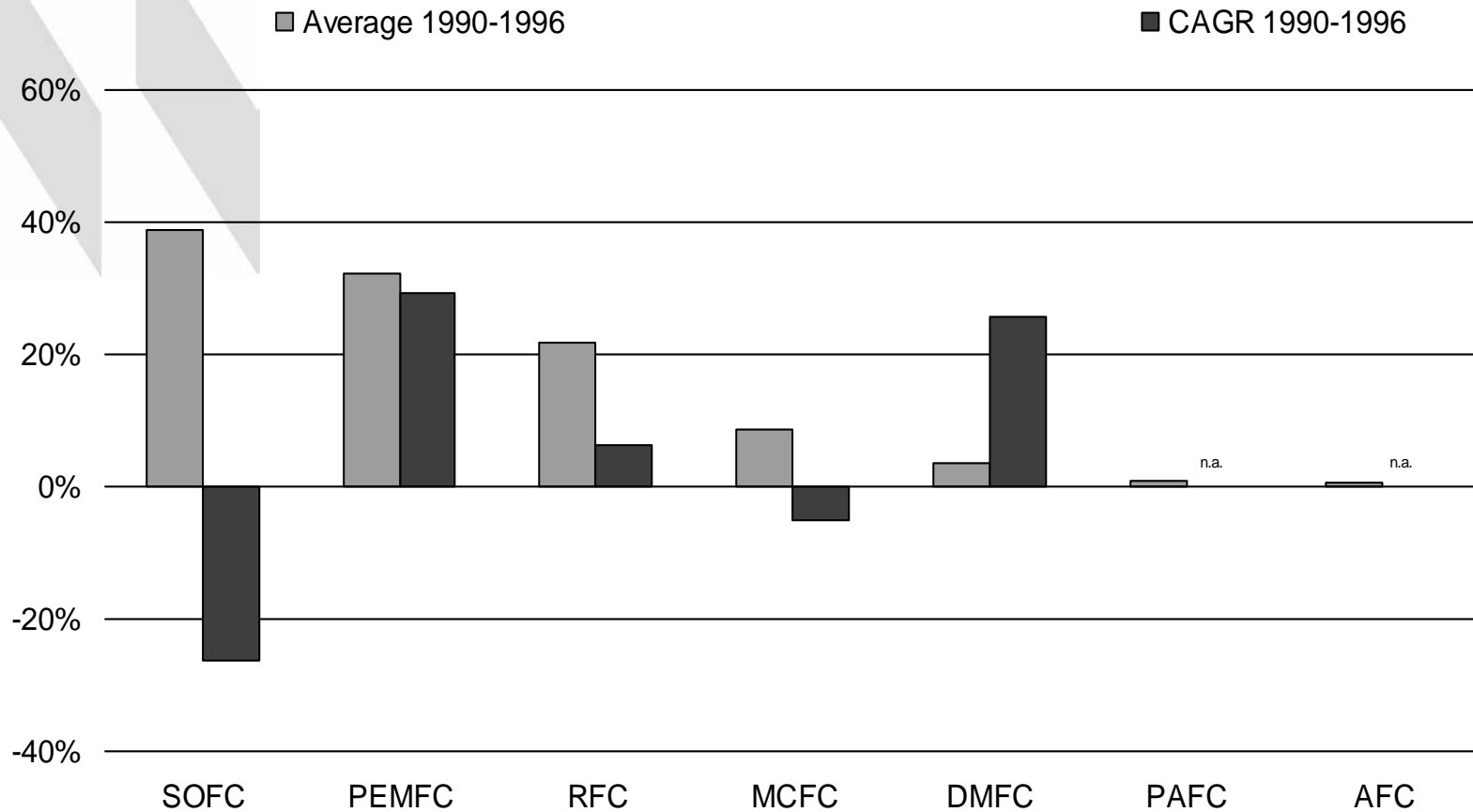
Average shares and growth of shares of publications by sub-field, 1990-2000



➤ **Evolution and structure of the global fuel cells knowledge base (cont'd):**

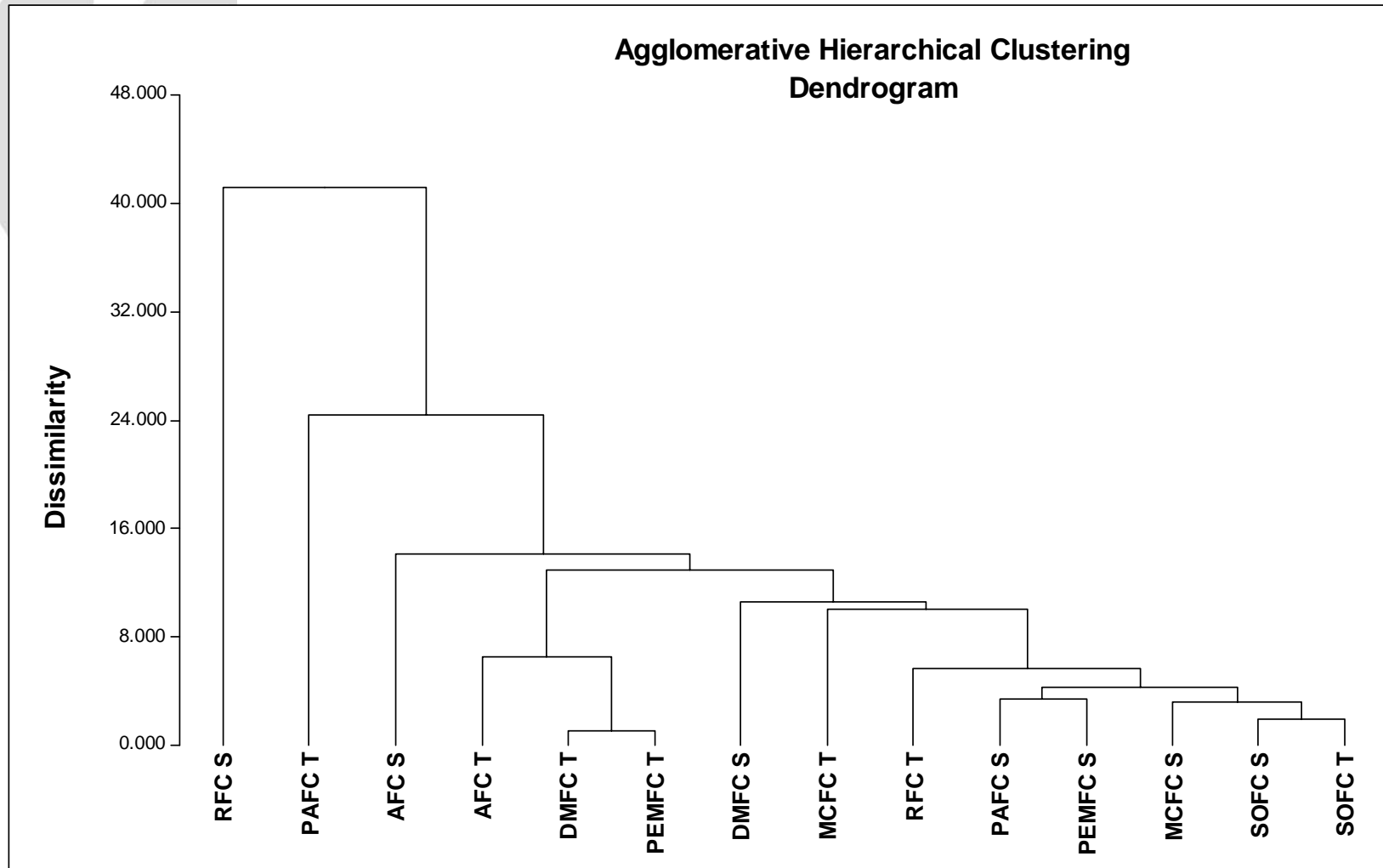
▪ **Scientific publishing and patenting by sub-field (cont'd)**

Average shares and growth of shares of “triadic” patent families by sub-field, 1990-1996



➤ **Evolution and structure of the global fuel cells knowledge base (cont'd):**

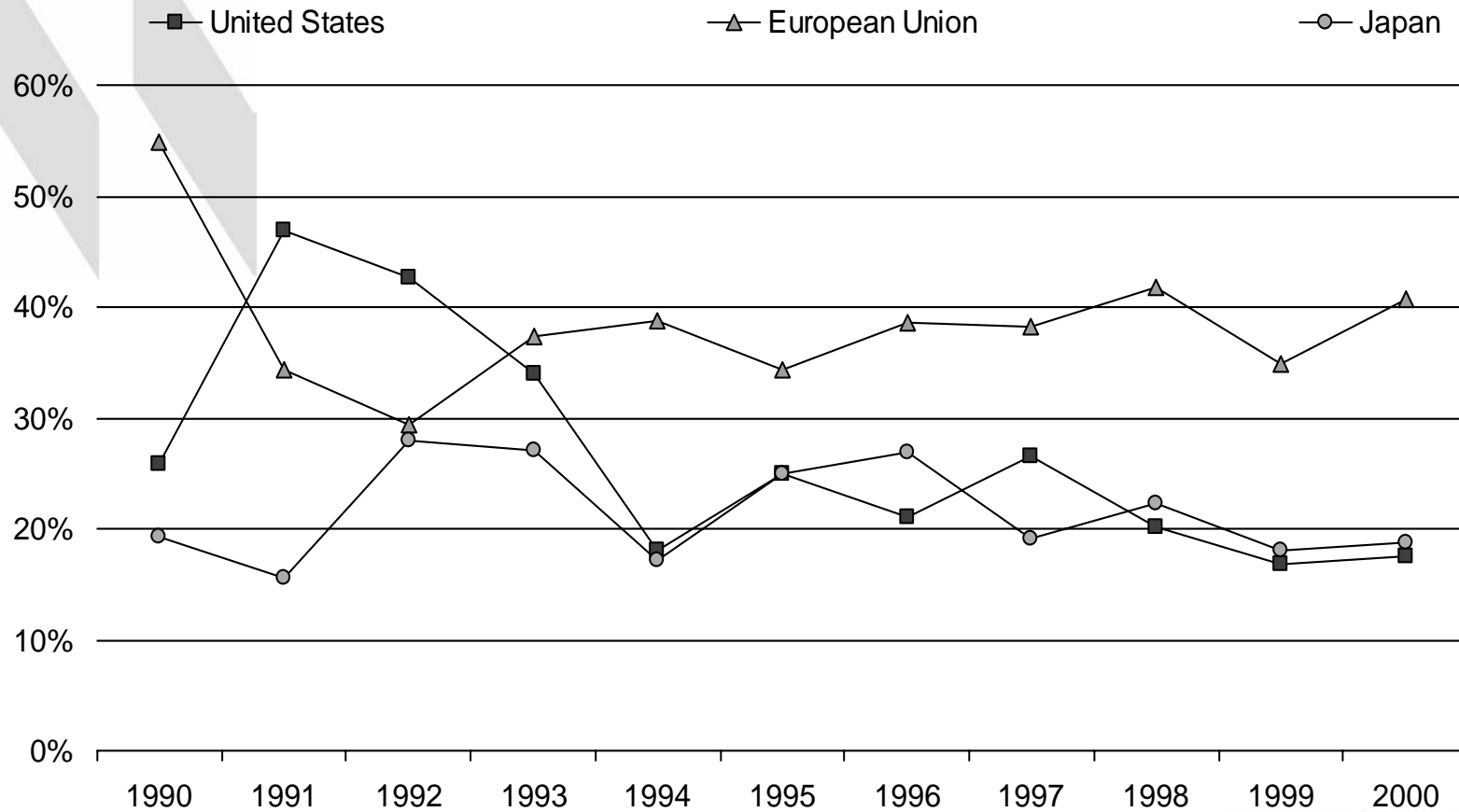
- **Science & technology cognitive linkages (1990-1996)**



➤ **General overview of the S&T activities of the OECD countries:**

▪ **Regional and national performance**

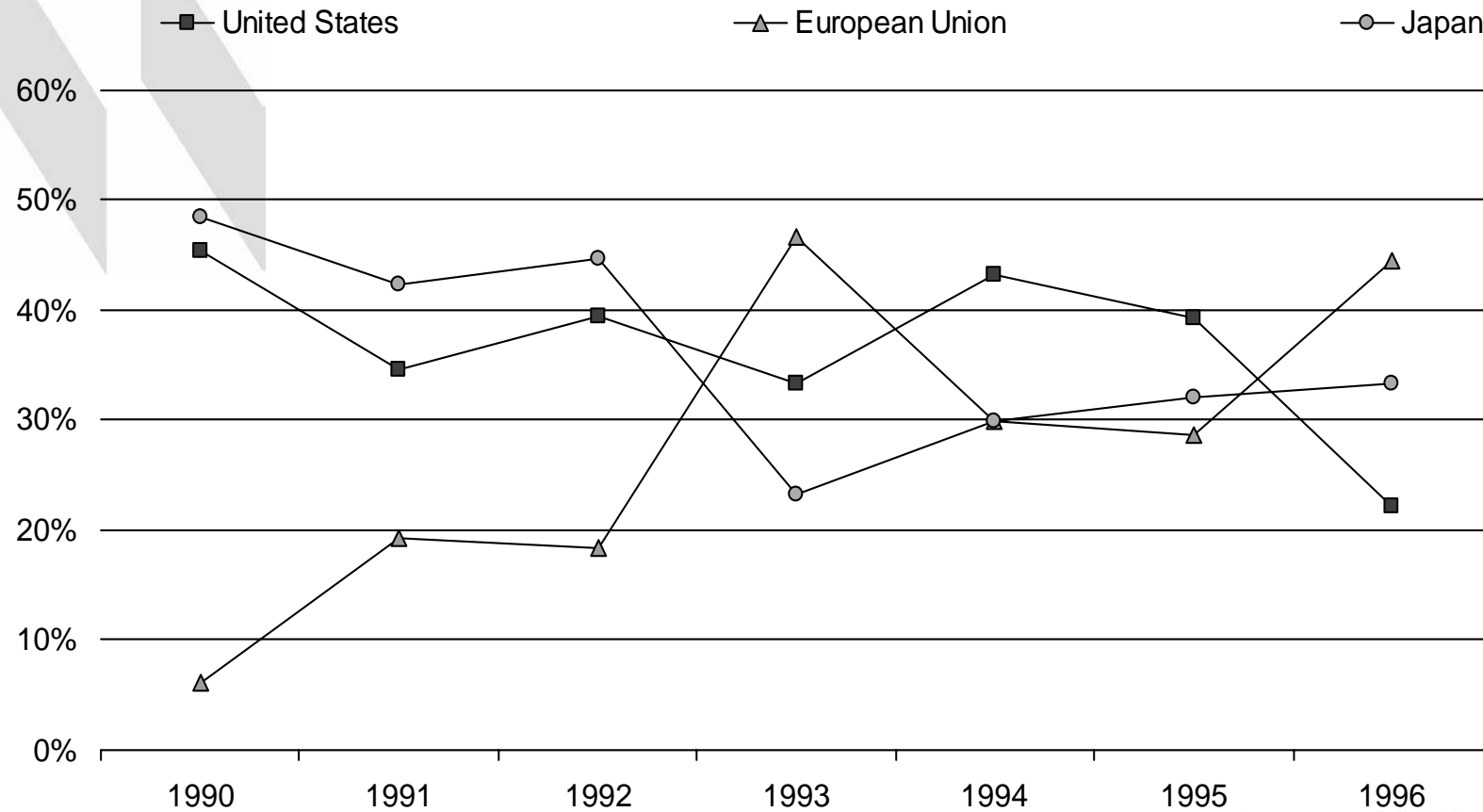
Average shares and growth of shares of publications by sub-field, 1990-2000



➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **Regional and national performance (cont'd)**

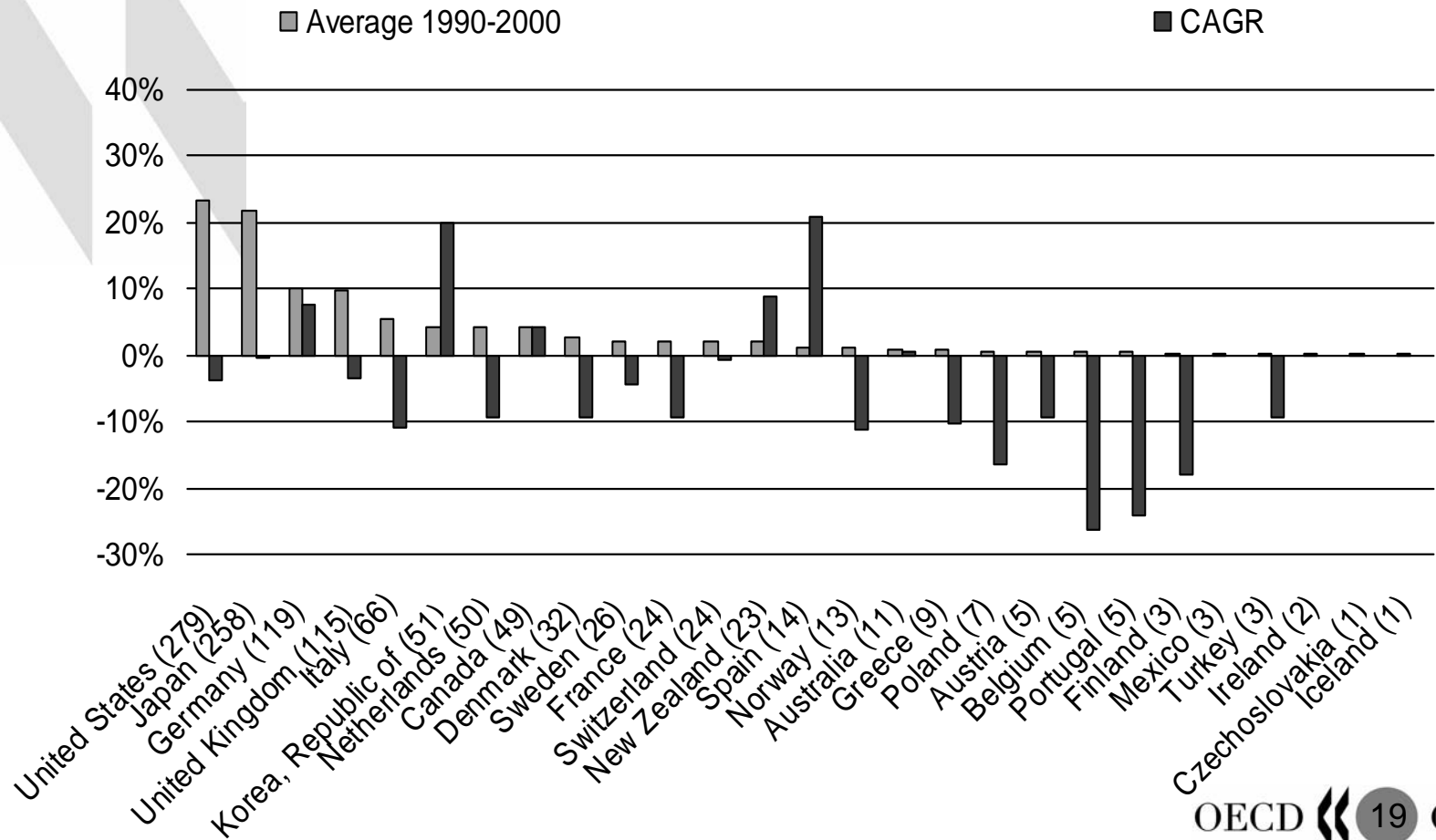
Average shares and growth of shares of “triadic” patent families by sub-field, 1990-1996



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▪ **Regional and national performance (cont'd)**

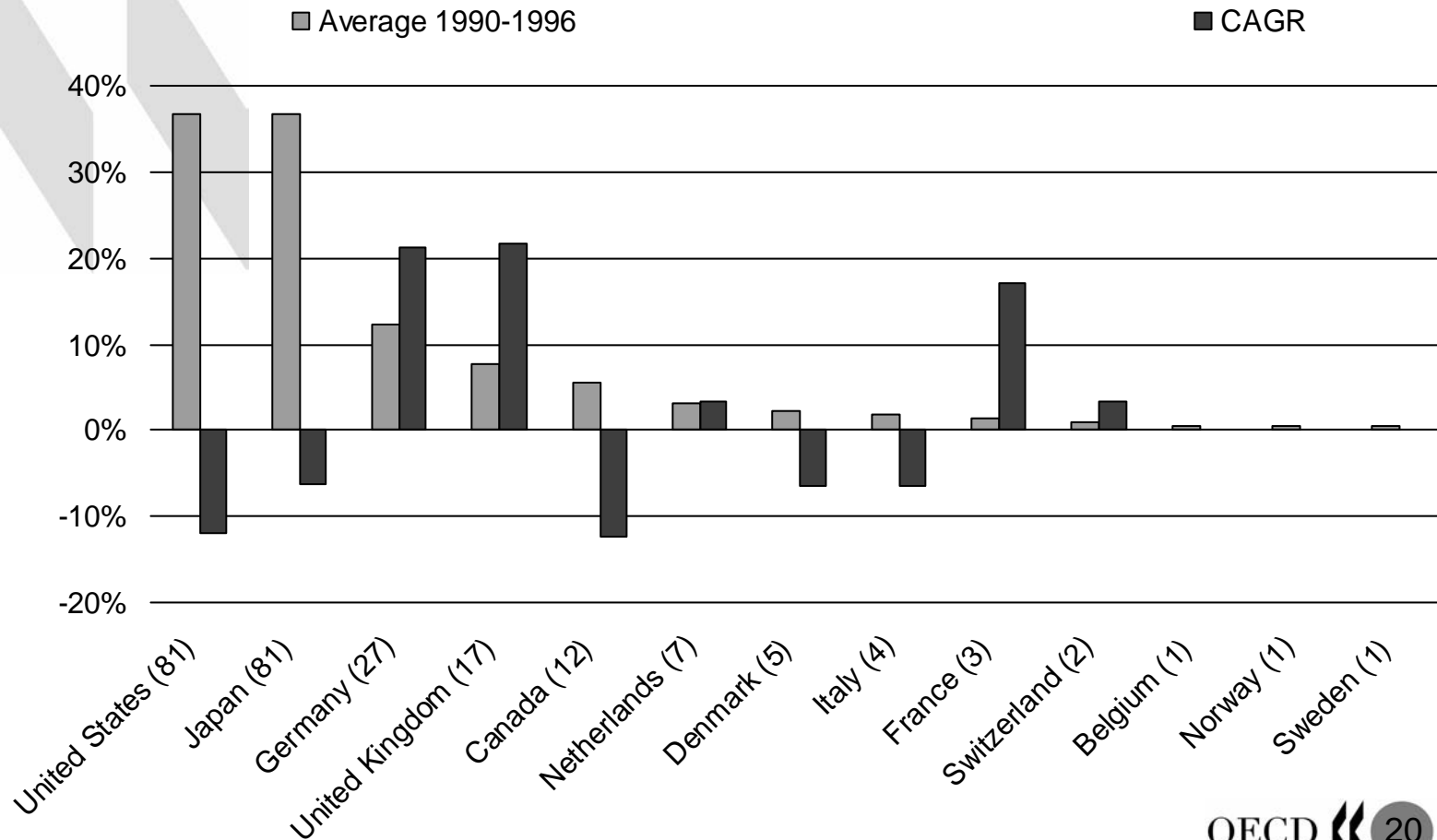
Average shares and growth of shares of OECD countries in publications, 1990-2000



➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **Regional and national performance (cont'd)**

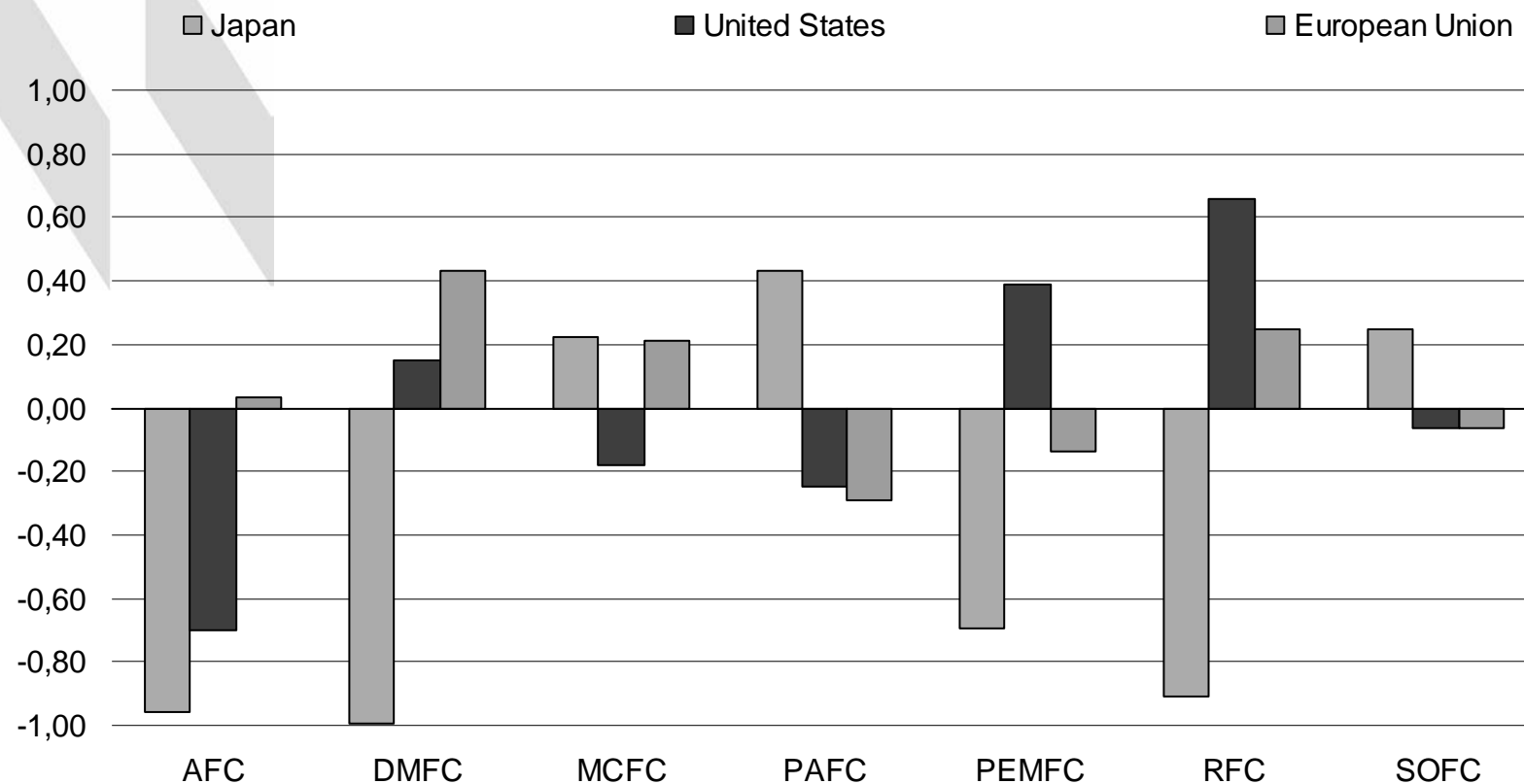
Average shares and growth of shares of OECD countries in “triadic” patent families, 1990-1996



➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **S&T specialization**

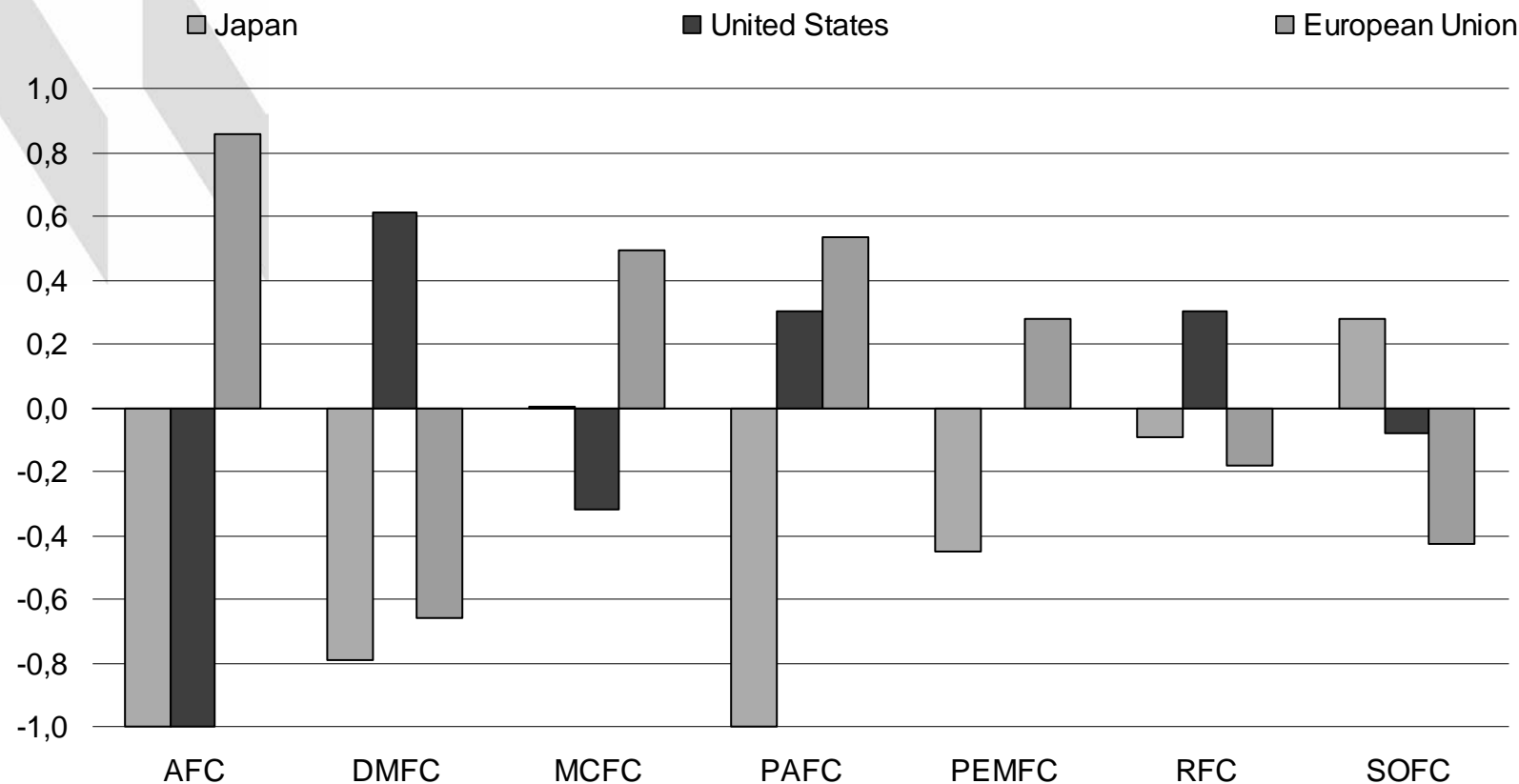
Scientific specialization profiles of the United States, the European Union, and Japan, 1990-2000



➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **S&T specialization (cont'd)**

Technological specialization profiles of the United States, the European Union, and Japan, 1990- 1996



➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **S&T specialization (cont'd)**

Scientific specialization profiles of most active OECD countries (>1% of world share),
1990-2000

	AFC	DMFC	MCFC	PAFC	PEMFC	RFC	SOFC
United States	-0,7	0,2	-0,2	-0,2	0,4	0,7	-0,1
Japan	-1,0	-1,0	0,2	0,4	-0,7	-0,9	0,2
Germany	-0,2	0,5	-0,6	-0,5	0,4	0,6	0,0
United Kingdom	-0,6	0,8	-0,5	-0,7	-0,5	0,0	0,3
Italy	-1,0	0,5	0,6	0,6	-0,4	-0,2	-0,7
Korea	0,6	0,1	0,4	0,6	0,2	-1,0	-0,8
Netherlands	-1,0	-1,0	0,9	-0,9	-1,0	-1,0	-0,4
Canada	0,7	-1,0	-1,0	0,2	0,8	-1,0	-0,9
Denmark	-1,0	-0,2	-0,6	0,4	-0,6	-1,0	0,4
Spain	0,9	0,0	0,3	-1,0	-0,7	-1,0	-0,2
France	-0,2	0,1	0,0	-1,0	0,4	0,7	-0,3
Switzerland	-0,2	-0,5	-1,0	-1,0	0,3	-1,0	0,4
New Zealand	0,7	-1,0	-1,0	-0,6	-1,0	-1,0	0,6
Sweden	0,9	-1,0	0,7	-0,6	-0,4	0,9	-1,0
Norway	-1,0	-1,0	-0,2	-1,0	-1,0	-1,0	0,6

➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **S&T specialization (cont'd)**

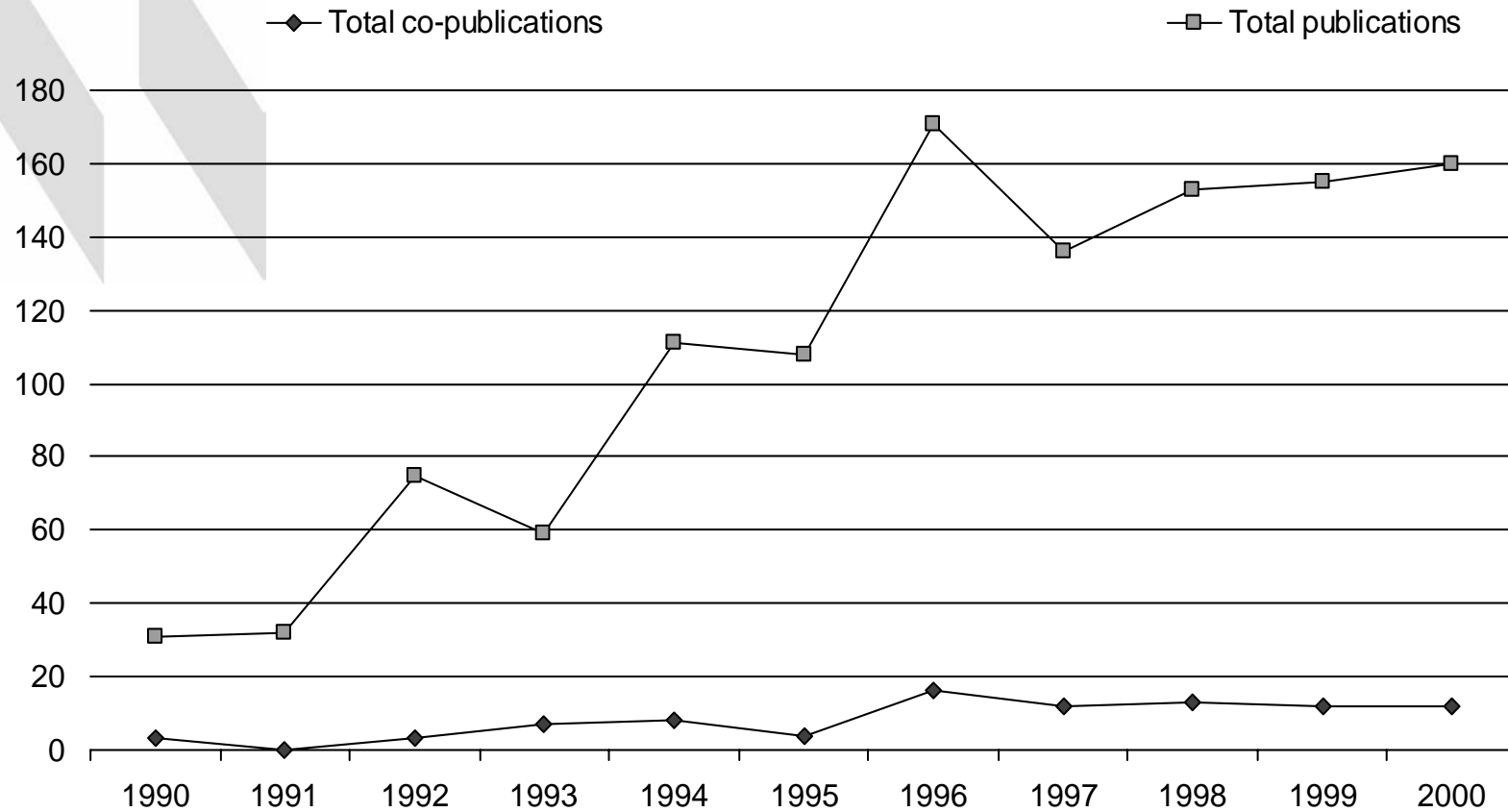
Technological specialization profiles of most active OECD countries (>1% of world share), 1990-1996

	AFC	DMFC	MCFC	PAFC	PEMFC	RFC	SOFC
United States	-1,0	0,6	-0,3	0,3	0,0	0,3	-0,1
Japan	-1,0	-0,8	0,0	-1,0	-0,5	-0,1	0,3
Germany	1,0	0,0	0,6	-1,0	0,6	-0,4	-0,9
United Kingdom	-1,0	-1,0	-0,4	-1,0	-0,3	0,5	-0,1
Canada	-1,0	0,9	-1,0	-1,0	0,8	-1,0	-1,0
Netherlands	-1,0	-1,0	0,8	-1,0	-1,0	0,6	-0,3
Denmark	-1,0	-1,0	-1,0	1,0	-0,4	-1,0	0,4
Italy	-1,0	-1,0	0,8	-1,0	0,4	-1,0	-0,4
France	-1,0	-1,0	-1,0	-1,0	0,0	0,4	-0,2

➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **Patterns of international scientific cooperation**

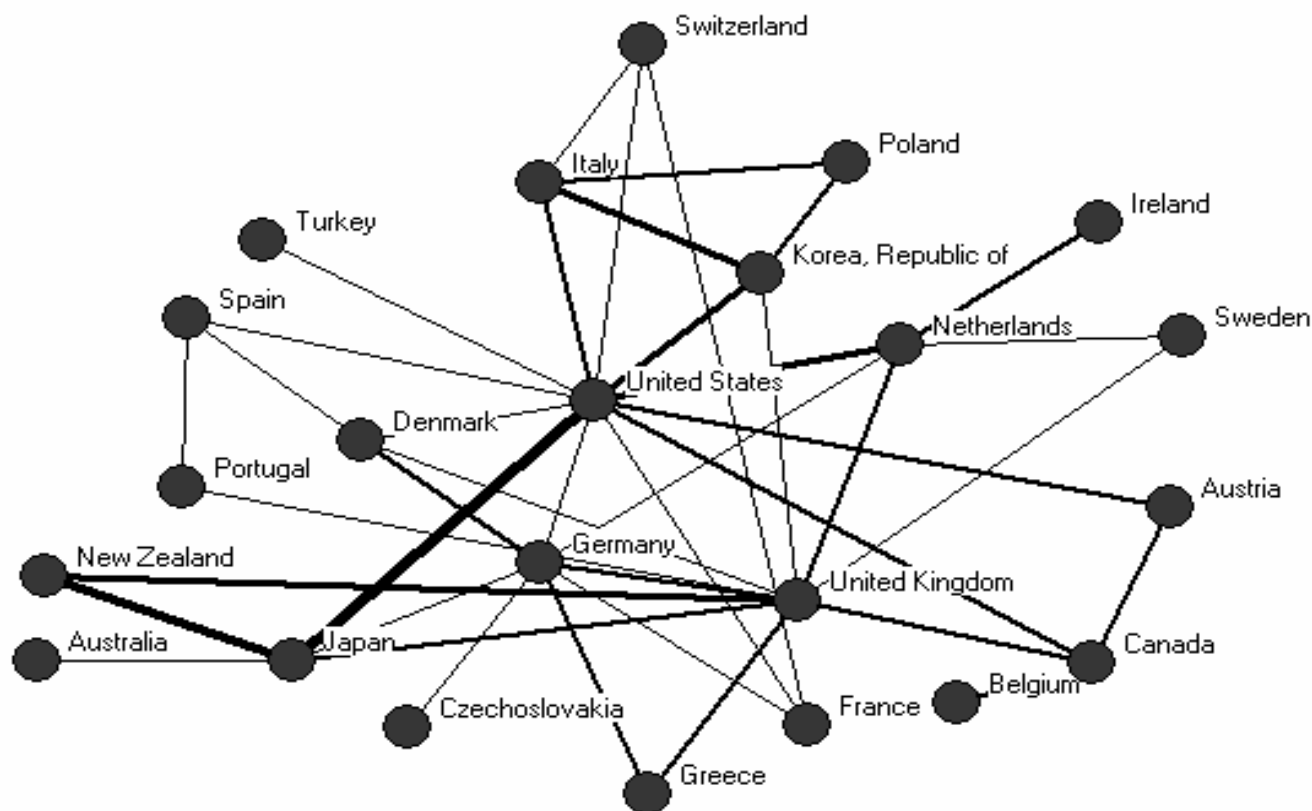
Publications and international co-publications, 1990-2000, worldwide



➤ **General overview of the S&T activities of the OECD countries (cont'd):**

▪ **Patterns of international scientific cooperation (cont'd)**

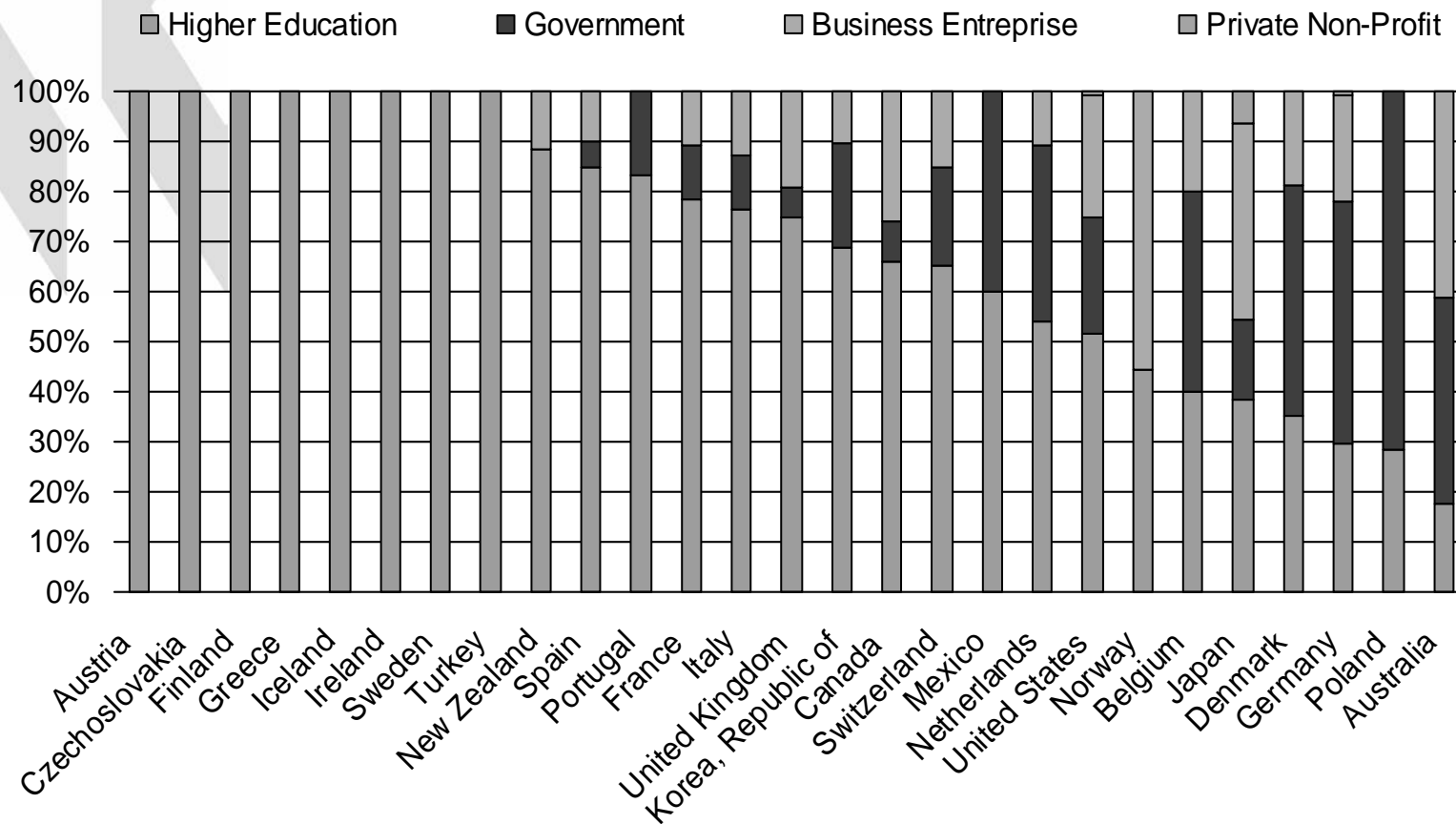
Structure of the “OECD network” of co-publications , 1990-2000



➤ **Organization of S&T knowledge production and diffusion within the OECD countries:**

- **The division of labor in the production of S&T knowledge**

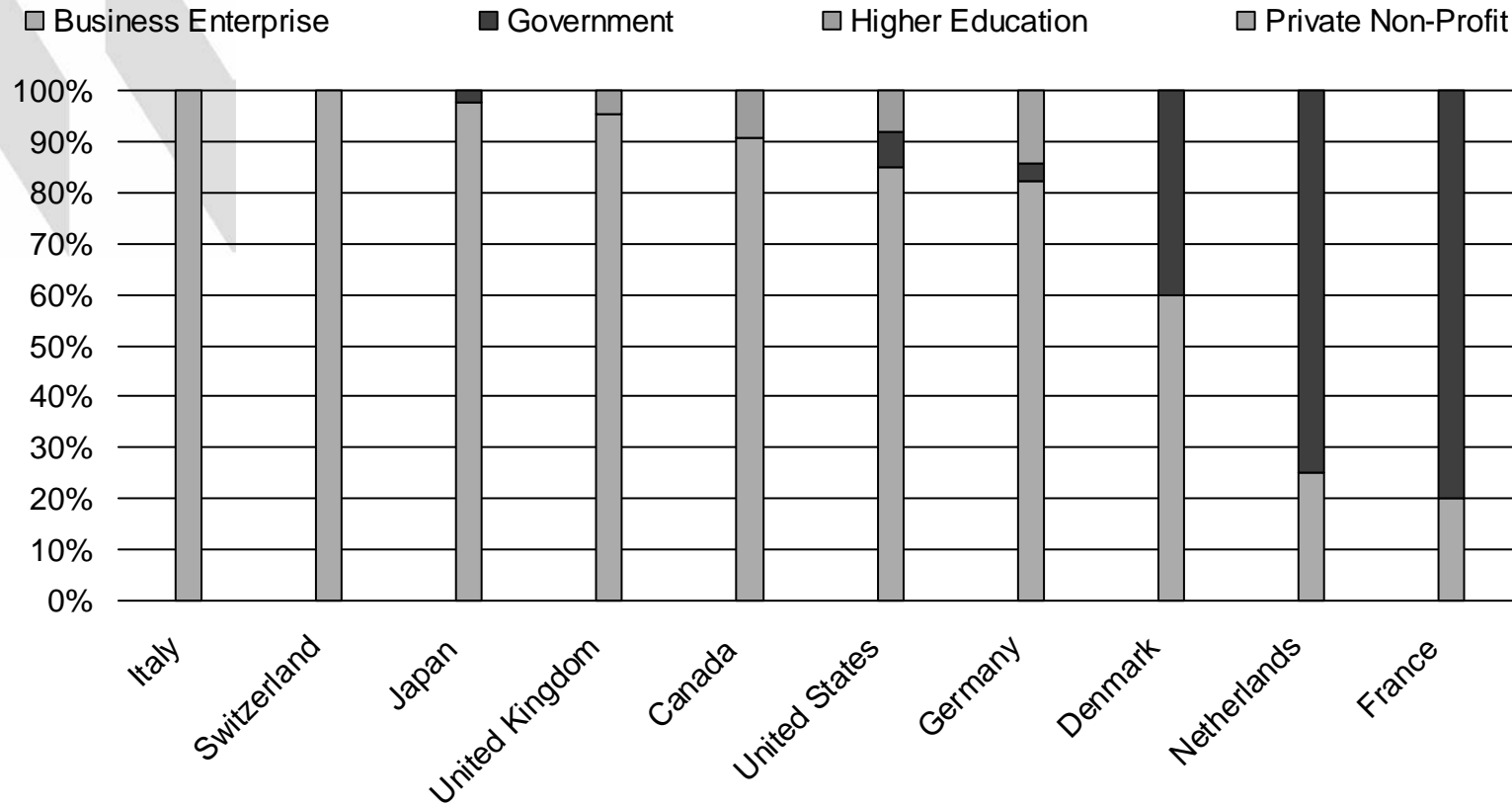
Distribution of publications among the main institutional sectors in OECD countries, 1990-2000



➤ **Organization of S&T knowledge production and diffusion within the OECD countries (cont'd):**

- **The division of labor in the production of S&T knowledge (cont'd)**

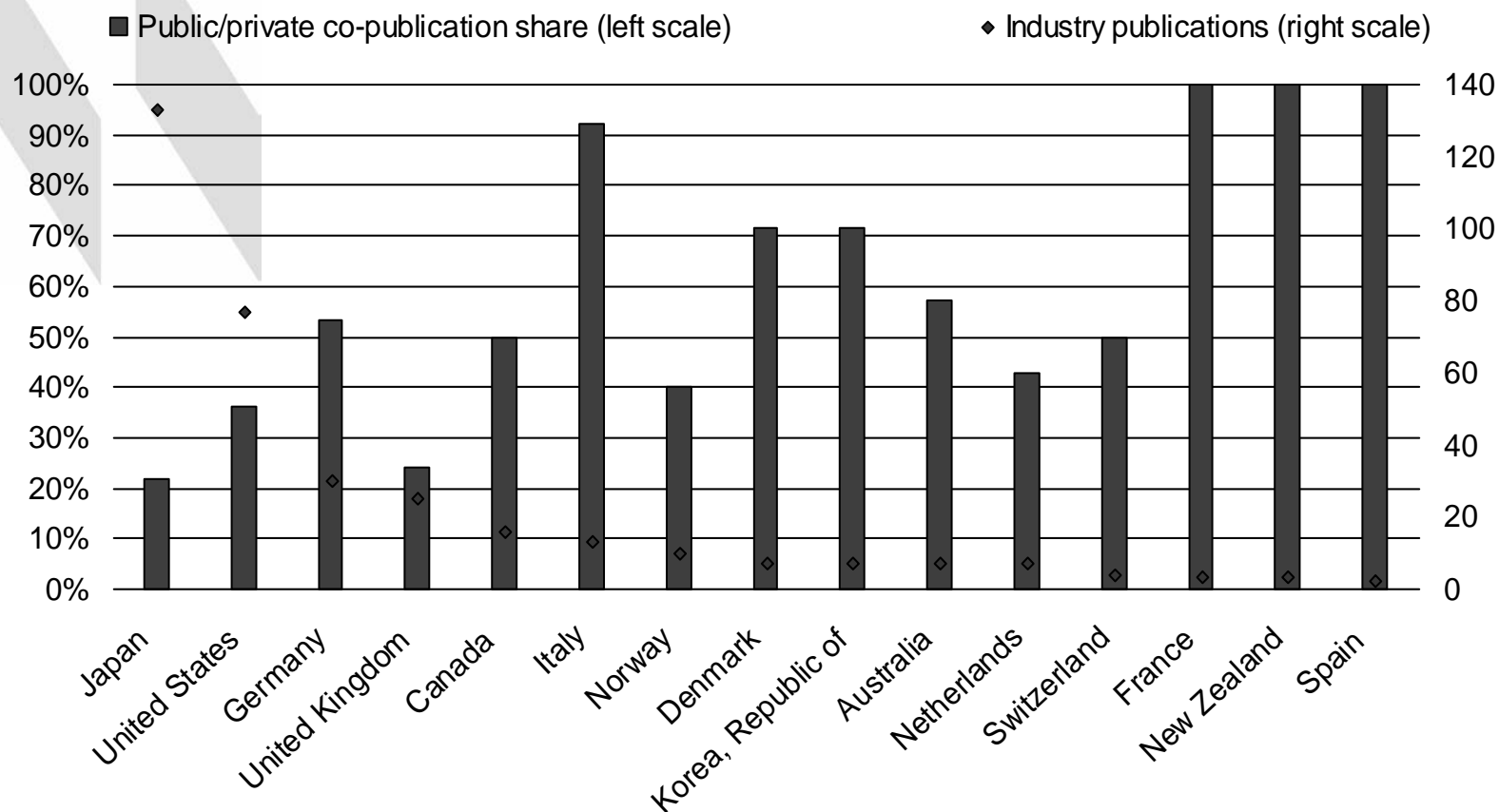
Distribution of publications among the main institutional sectors in OECD countries, 1990-2000



➤ **Organization of S&T knowledge production and diffusion within the OECD countries (cont'd):**

▪ **Patterns of sectoral cooperation (cont'd)**

Industry publications and public/private co-publication shares of OECD countries, 1990-2000



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