

ECONOMIC SURVEY OF THE NETHERLANDS 2005:

FACTOR ANALYSIS TO IDENTIFY INTER-RELATED EIS INNOVATION INDICATORS

*This is an excerpt of the OECD Economic Survey of the Netherlands, 2005,
from the section on factor analysis in chapter 5, annex 5.A1*

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Introduction

1. While the indicators included in the European Innovation Scoreboard (EIS) Summary Index (European Commission, 2004a) are all in some way *a priori* related to innovation activity, it will help to focus the analysis in Chapter 5 of the Economic Survey of the Netherlands 2005 by empirically determining which of these variables are in fact related to the same underlying phenomena and setting aside the other variables. The factor analysis that underpins the groups of inter-related variables selected for further analysis in chapter 5 is described in this excerpt.

Factor Analysis to identify inter-related variables and exclude others

2. Factor analysis¹ based on 20 EIS indicators (Table 1)² for the OECD 20 countries³ shows that 45% of the common variance shared by the 20 variables can be explained by the first factor (Table 2, “proportion” column). A further 21% of the common variance is explained by the second factor, bringing the cumulative proportion of the common variance explained to 66%. As subsequent factors add relatively little to explaining the common variance, they are set aside.

Table 1. Innovation Item Classification and Source of Data

Innovation Item	Source of Data
1. Human resources	
1.1 S&E graduates (% of 20 – 29 years age class)	EUROSTAT (Education statistics)
1.2 Population with tertiary education (% of 25 – 64 years age class)	EUROSTAT (LFS)
1.3 Participation in life-long learning (% of 25 – 64 years age class)	EUROSTAT (LFS)
1.4 Employment in medium-high and high-tech manufacturing (% of total workforce)	EUROSTAT (LFS)
1.5 Employment in high-tech services (% of total workforce)	EUROSTAT (LFS)
2. Knowledge creation	
2.1 Public R&D expenditures (% of GDP)	EUROSTAT (R&D statistics); OECD
2.2 Business expenditures on R&D (% of GDP)	EUROSTAT (R&D statistics); OECD
2.3.1 EPO high-tech patent applications (per million population)	EUROSTAT
2.3.2 USPTO high-tech patents granted (per million population)	EUROSTAT
2.4.1 EPO patent applications (per million population)	EUROSTAT
2.4.2 USPTO patents granted (per million population)	EUROSTAT
3. Transmission and application of knowledge	
3.1 SMEs innovating in-house (% of all SMEs)	EUROSTAT (CIS)
3.2 SMEs involved in innovation co-operation (% of all SMEs)	EUROSTAT (CIS)
3.3 Innovation expenditures (% of total turnover)	EUROSTAT (CIS)
3.4 SMEs using non-technological change (% of all SMEs)	EUROSTAT (CIS)
4. Innovation finance, output and markets	
4.1 Share of high-tech venture capital investment	EVCA
4.2 Share of early stage venture capital in GDP	EUROSTAT
4.3.1 Sales of 'new to market' products (% of total turnover)	EUROSTAT (CIS)
4.3.2 Sales of 'new to the firm but not new to the market' products (% of total turnover)	EUROSTAT (CIS)
4.4 Internet access	EUROSTAT
4.5 ICT expenditures (% of GDP)	EUROSTAT
4.6 Share of manufacturing value-added in high-tech sectors	EUROSTAT (SBS)

Source: Trend Chart Innovation Policy in Europe (<http://www.trendchart.org/scoreboards/scoreboard2004/indicators.cfm>). Detailed descriptions of the indicators can be found in Hollanders and Arundel (2004).

Table 2. Factor Analysis Results: 20 Items

Factor	Eigenvalue ¹	Difference ²	Proportion	Cumulative Proportion
1	8.94	4.72	0.45	0.45
2	4.22	2.13	0.21	0.66
3	2.09	0.42	0.10	0.76
4	1.68	0.52	0.08	0.85
5	1.16	0.25	0.06	0.90
6	0.91	0.48	0.05	0.95
7	0.44	0.13	0.02	0.97
8	0.31	0.06	0.02	0.99
9	0.25	0.25	0.01	1.00

1. Eigenvalue: An eigenvalue is the variance of the factor. In the initial factor solution, the first factor will account for the most variance, the second will account for the next highest amount of variance, and so on.
2. Difference: Gives the differences between the current and previous eigenvalues.

Source: European Commission (2004b), European Innovation Scoreboard 2004 Database; own calculations.

3. Ten of the innovation indicators load onto Factor 1 with a cut-off value for the correlation between the indicator and this factor of 0.7 (Table 3, variables identified with a * in the Factor 1 column). Considering the nature of these variables, they appear to reflect *'knowledge development'*. Four other innovation indicators load onto Factor 2 (see Table 3, variables identified with a * in the Factor 2 column). These indicators mostly appear to reflect *'knowledge application'*.

Table 3. Factor Loadings

Item	Loading	Factor 1	Loading	Factor 2
1.1 S&E graduates (% of 20 – 29 years age class)	0.53		0.06	
1.2 Population with tertiary education (% of 25 – 64 years age class)	0.78	*	-0.29	
1.3 Participation in life-long learning (% of 25 – 64 years age class)	0.73	*	-0.56	
1.4 Employment in medium-high and high-tech manufacturing (% of total workforce)	0.19		0.64	
1.5 Employment in high-tech services (% of total workforce)	0.88	*	-0.17	
2.1 Public R&D expenditures (% of GDP)	0.89	*	0.19	
2.2 Business expenditures on R&D (% of GDP)	0.90	*	0.29	
2.3.1 EPO high-tech patent applications (per million population)	0.85	*	0.19	
2.3.2 USPTO high-tech patents granted (per million population)	0.87	*	0.35	
3.1 SMEs innovating in-house (% of all SMEs)	-0.02		0.80	*
3.2 SMEs involved in innovation co-operation (% of all SMEs)	0.95	*	-0.04	
3.3 Innovation expenditures (% of total turnover)	-0.07		0.82	*
3.4 SMEs using non-technological change (% of all SMEs)	-0.33		0.74	*
4.1 Share of high-tech venture capital investment	0.35		0.25	
4.2 Share of early stage venture capital in GDP	0.89	*	-0.13	
4.3.1 Sales of 'new to market' products (% of total turnover)	0.12		0.57	
4.3.2 Sales of 'new to the firm but not new to the market' products (% of total turnover)	-0.07		0.86	*
4.4 Internet access	0.68		-0.21	
4.5 ICT expenditures (% of GDP)	0.63		0.08	
4.6 Share of manufacturing value-added in high-tech sectors	0.89	*	0.22	

Source: European Commission (2004b), European Innovation Scoreboard 2004 Database; own calculations.

4. On average the Netherlands ranks 9th out of the OECD 20 countries for the indicators of “knowledge development” (Table 4); lowest ranks for individual indicators range from 16-20 depending on available data. The Netherlands does particularly well on EPO high-tech patent applications (item 2.3.1) and public R&D expenditure as a share of GDP (item 2.1) but scores below average on the proportion of the population with tertiary education (item 1.2) and business expenditures on R&D as a percentage of GDP (item 2.2); the Netherlands ranks around the middle of the group for the other indicators. The Netherlands does not score very well on the “knowledge application” indicators, ranking 14th equal out of 17 high-income countries for which data are available (EU15 less Ireland plus Switzerland, Norway and Iceland) (Table 5). It scores relatively poorly on all four indicators loaded to this factor, with especially low rankings for the percentage of SMEs using non-technological change (item 3.4) and for total innovation expenditures as a share of turnover (item 3.3); the other two indicators with low rankings are the proportion of SMEs innovating in-house (item 3.1) and sales of products that are new to the firm but not the market as a percentage of total turnover (item 4.3.2).

Table 4. Rankings of OECD 20 countries for innovation items that load on "Knowledge Development"

Country	Rank Item 1.2	Rank Item 1.3	Rank Item 1.5	Rank Item 2.1	Rank Item 2.2	Rank Item 2.3.1	Rank Item 2.3.2	Rank Item 3.2	Rank Item 4.2	Rank Item 4.6	Factor 1 Item Average Rank
Finland	3	7	3	2	2	1	3	1	2	3	2.7
Sweden	8	1	1	3	1	3	4	3	1	8	3.3
USA	1	n.a.	n.a.	4	5	5	1	n.a.	4	4	3.4
Japan	2	n.a.	n.a.	7	3	9	2	n.a.	n.a.	7	5.0
Iceland	10	3	2	1	6	8	5	5	7	n.a.	5.2
Switzerland	9	2	7	11	4	4	6	6	5	1	5.5
Denmark	4	6	4	8	7	7	7	2	3	9	5.7
UK	6	5	5	13	12	10	10	12	6	5	8.4
Netherlands	12	8	11	6	14	2	9	8	11	11	9.2
France	15	12	6	5	11	11	11	9	9	6	9.5
Belgium	7	10	8	15	9	12	12	7	10	10	10.0
Norway	5	4	10	10	15	15	15	4	8	14	10.0
Germany	14	14	13	9	8	6	8	10	14	12	10.8
Ireland	11	9	9	19	16	13	13	n.a.	13	2	11.7
Austria	17	11	12	12	13	14	14	11	15	13	13.2
Luxembourg	18	13	14	20	10	16	18	n.a.	n.a.	19	16.0
Spain	13	15	16	17	17	18	17	16	16	16	16.1
Italy	20	16	15	16	18	17	16	15	18	15	16.6
Portugal	19	18	18	14	19	20	20	13	12	17	17.0
Greece	16	17	17	18	20	19	19	14	17	18	17.5

Source: European Commission (2004b), European Innovation Scoreboard 2004 Database; own calculations.

Table 5. Rankings of OECD 20 countries for innovation items that load on “Knowledge Application”

Country	Rank Item 3.1	Rank Item 3.3	Rank Item 3.4	Rank Item 4.3.2	Factor 2 Item Average Rank
Switzerland	1	1	n.a.	2	1.3
Germany	3	2	2	1	2.0
Belgium	5	3	7	8	5.8
Finland	6	6	9	3	6.0
Portugal	7	4	6	7	6.0
Austria	8	n.a.	4	10	7.3
Luxembourg	4	12	1	14	7.8
Italy	11	8	8	5	8.0
Iceland	2	10	5	16	8.3
Greece	16	7	3	13	9.8
Sweden	9	n.a.	11	n.a.	10.0
United Kingdom	15	9	n.a.	6	10.0
Spain	14	13	10	4	10.3
France	12	5	15	12	11.0
Netherlands	10	11	12	11	11.0
Denmark	17	15	14	9	13.8
Norway	13	14	13	15	13.8
Ireland	n.a.	n.a.	n.a.	n.a.	n.a.
Japan	n.a.	n.a.	n.a.	n.a.	n.a.
United States	n.a.	n.a.	n.a.	n.a.	n.a.

Source: European Commission (2004b), European Innovation Scoreboard 2004 Database; own calculations.

NOTES

- ¹ “Factor analysis aims to explain the most of the variability among a number of observable random variables in terms of a smaller number of unobservable random variables called factors. The observed random variables are modelled as linear combinations of the factors, plus “error” terms. The factor loadings (are) inferred from the data.” http://en.wikipedia.org/wiki/Factor_analysis
- ² Indicators 2.4.1 (EPO patent applications (per million population)) and 2.4.2 (USPTO patents granted (per million population)) have been excluded because they are highly related to indicators 2.3.1 (EPO high-tech patent applications (per million population)) and 2.3.2 (USPTO high-tech patents granted (per million population)), respectively.
- ³ As this procedure employs casewise deletion, meaning that information from countries with at least one missing value from the selected variables is excluded prior to performing the calculation, the EIS dataset is cut down to the OECD 20 group of countries: EU15, Iceland, Japan, Norway, Switzerland, and the United States.

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