

# **Intangible Capital and Productivity Growth in European countries**

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**INNODRIVE**

Intangible Capital and Innovations:  
Drivers of Growth and Location in EU



## **Descriptive analysis**

- Tangible and Intangible Investment across Europe
  - Dynamics and composition
  - Impact on measured labour productivity growth

## **Growth accounting analysis**

- Why including Intangible capital matters for growth?
- Changing nature of the global economy and the rising role of intangible capital

- ❑ The changing nature of the global economy has placed a novel attention on intangible capital as a new source of growth (Barnes and McClure, 2009).
- ❑ Since the publication of the seminal paper by Corrado Hulten and Sichel (2005), a number of country studies showed that intangible capital is an essential ingredient for economic growth (Marrano, Haskel and Wallis (2007), Jalava et al (2007), van Rooijen-Horsten et al. (2008), Fukao et al. (2008), van Ark, Corrado, Hao, Hulten (2009)).
- ❑ The **nature** of the impact of the inclusion of intangible capital in the growth accounting model is similar across countries: an **increase** in labour productivity growth and in the contribution of capital deepening and a **decrease** in TFP growth.

- But intangible expenditure is treated as **current expense** in the national accounts rather than as an investment.
  
- This determines an **understatement** of investment in the economy and an **incomplete** picture of the main sources of growth.
  - Serious concern for policy implications
  
- These are only some of the reasons **to measure** and **to investigate** intangible capital.

- ❑ Measure intangible investment for EU27 member countries and to provide an **internationally comparable** estimate of intangible assets.
- ❑ Analyze the **diffusion** of intangibles across European countries and their contribution to economic growth.
- ❑ Quantify the **bias** in the estimate of Labour and Total Factor Productivity when intangible assets are ignored.
- ❑ Investigate to what extent intangible capital accumulation might explain **differences in productivity** performance across countries.

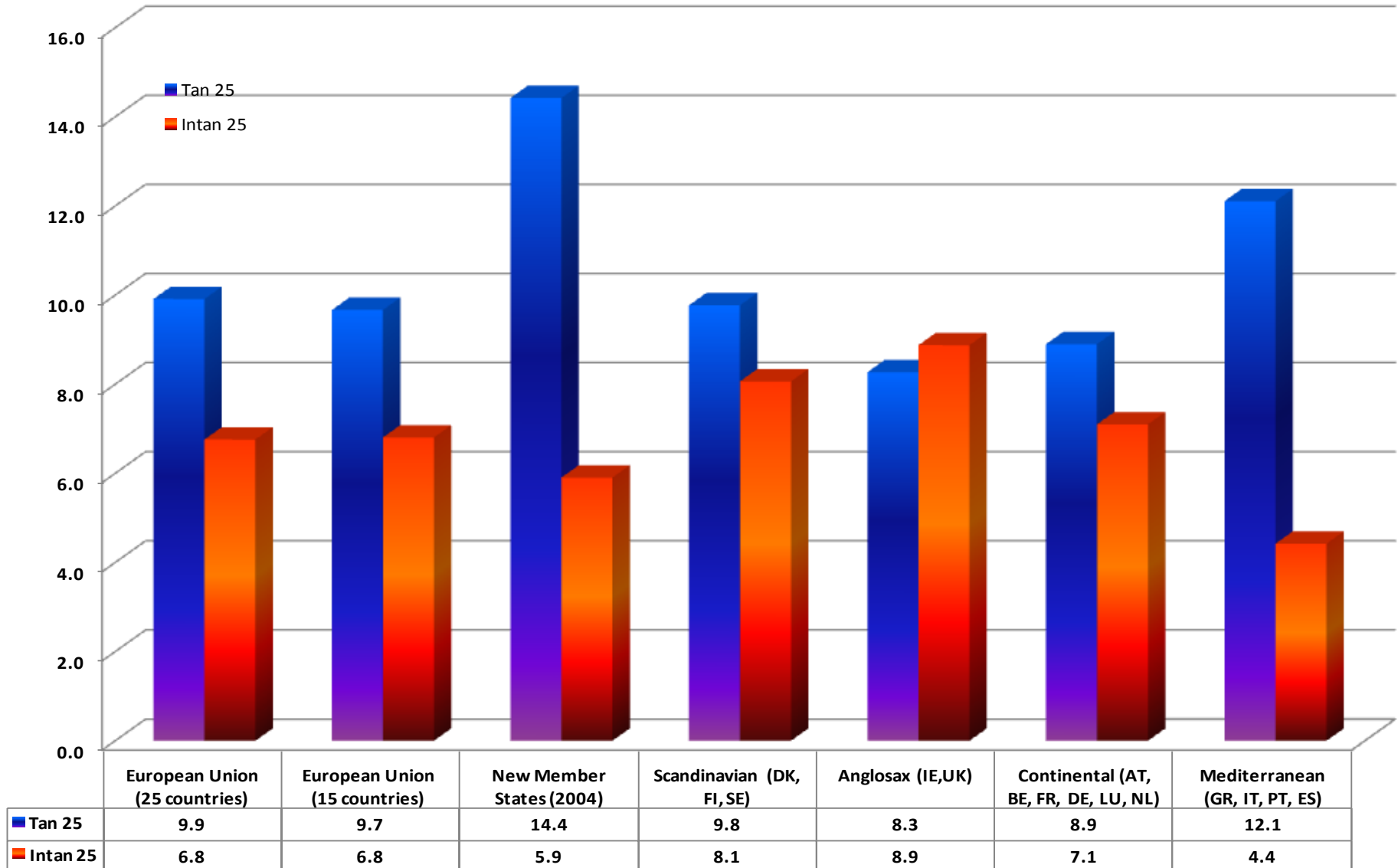
- ❑ Our estimates of intangibles refer to the Business sector
  - ❑ Sectoral coverage: non-agricultural business sector (defined as a grouping of all industries except agriculture, fishing, public administration, defence and compulsory social security, education, health, other community, private households)
- ❑ The Geographical and Time Coverage. Two levels of analysis:
  - ❑ Descriptive analysis (1995-2005) for EU27
  - ❑ Growth accounting analysis for selected EU countries
    - ❑ AUT, DNK, FIN, GER, FR, ITA, NDL, SP, PRT, SWE, UK

- We adopted an **expenditure based approach** so that we produce direct estimates of intangible gross fixed capital formation and capital, including both purchased and own-account components, based on expenditure data.
  - The proportion of intangible expenditure to be capitalized are as in CHS (2005)
- Our intangible measures (but the advertising estimate) are obtained by means of **official data sources** homogeneous across countries (mainly Eurostat surveys, national accounts data and supply and use tables, from National Statistical Institutes) to guarantee **reproducibility** and **international comparability**.

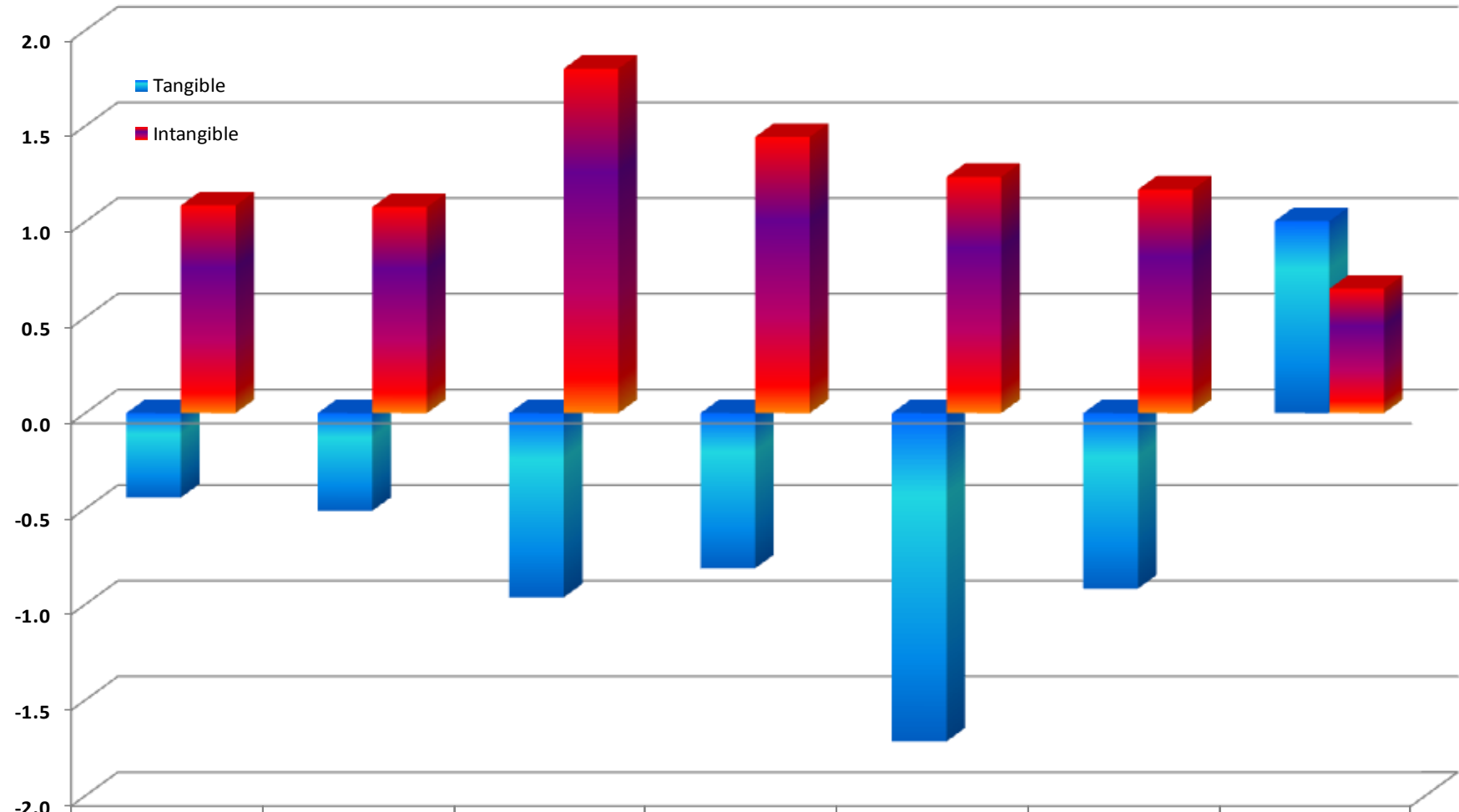


# Descriptive analysis

# Tangible and Intangible Shares of GDP: European Union - 2005



# Tangible and Intangible Shares of GDP: European Union – (1995 – 2005)



	European Union (25 countries)	European Union (15 countries)	New Member States (2004)	Scandinavian (DK, FI, SE)	Anglosax (IE, UK)	Continental (AT, BE, FR, DE, LU, NL)	Mediterranean (GR, IT, PT, ES)
<b>Tangible</b>	-0.4	-0.5	-1.0	-0.8	-1.7	-0.9	1.0
<b>Intangible</b>	1.1	1.1	1.8	1.4	1.2	1.2	0.6

# Composition of Intangible investment: EU Area 2005

	EU 27	EU 25	EU 15	NMS 2004	Scandinavian	Anglosax	Continental	Mediterranean
<b>Software</b>	<b>17.3</b>	<b>17.3</b>	<b>16.0</b>	<b>6.4</b>	<b>21.6</b>	<b>17.5</b>	<b>14.2</b>	<b>16.9</b>
<b>Innovative property</b>	<b>38.0</b>	<b>38.0</b>	<b>38.3</b>	<b>31.4</b>	<b>42.5</b>	<b>30.2</b>	<b>42.3</b>	<b>36.5</b>
R&D	15.6	15.7	16.1	5.9	25.5	10.1	19.4	10.8
Other national account	2.7	2.7	2.6	5.4	1.8	2.7	2.4	3.3
New financial product	7.3	7.3	7.3	6.4	3.6	6.4	8.5	6.9
Architectural and engineering design	12.4	12.4	12.3	13.7	11.8	11.0	12.0	15.5
<b>Economic Competencies</b>	<b>46.5</b>	<b>46.4</b>	<b>45.7</b>	<b>62.2</b>	<b>35.9</b>	<b>52.3</b>	<b>43.6</b>	<b>46.6</b>
Advertising	9.1	9.1	8.5	20.7	7.2	8.2	7.7	12.1
Market Research	4.9	4.8	4.7	6.1	2.2	4.3	4.7	6.8
Firm specific human capital	8.0	8.0	8.0	8.6	9.1	6.1	8.8	7.6
Organizational capital	24.5	24.6	24.4	26.8	17.5	33.7	22.4	20.2
<b>Total</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>	<b>100</b>

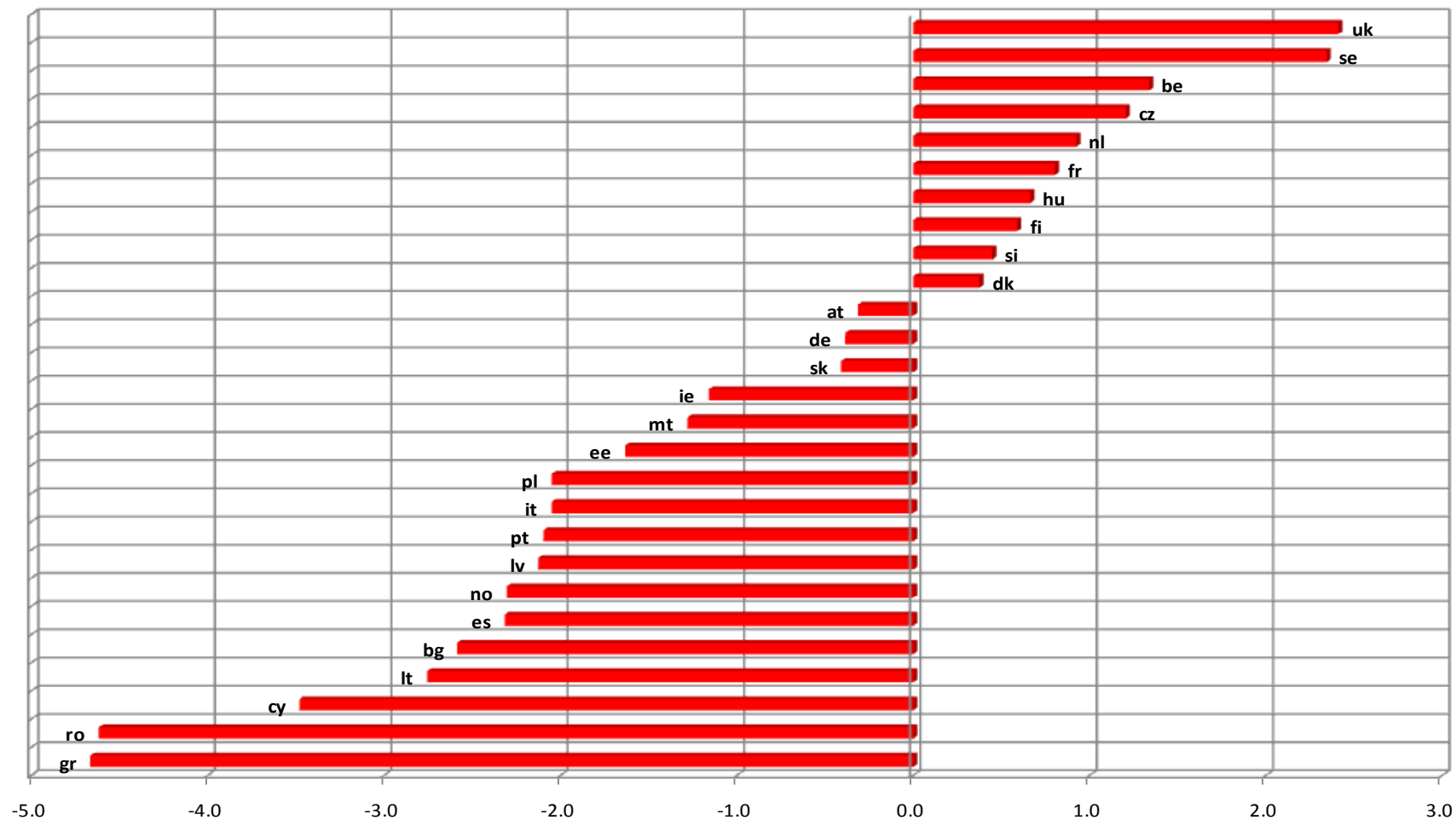
## Stylized facts (1):

- Intangible expenditure accounts for a significant share of GDP in the European countries even if with a different extent across them:  
**Scandinavian, Anglosax** and **Continental** regions play a leading role while **NMS** and **MED** areas lag behind;
- Intangible investment **increased** over the decade in all EU25 areas while tangible accumulation **decreased** everywhere but not in the MED economies;

## Stylized facts (1):

- Fast growing investors were: **NMS** (+1.8 pp), **Scandinavian** economies(+1.4 pp), **Anglosaxon** and **Continental Europe** (+1.2 pp);
- **R&D** and **Organizational capital** are the main components of intangible investment

# Distribution of Intangible Shares of GDP: Member Economies vs EU25

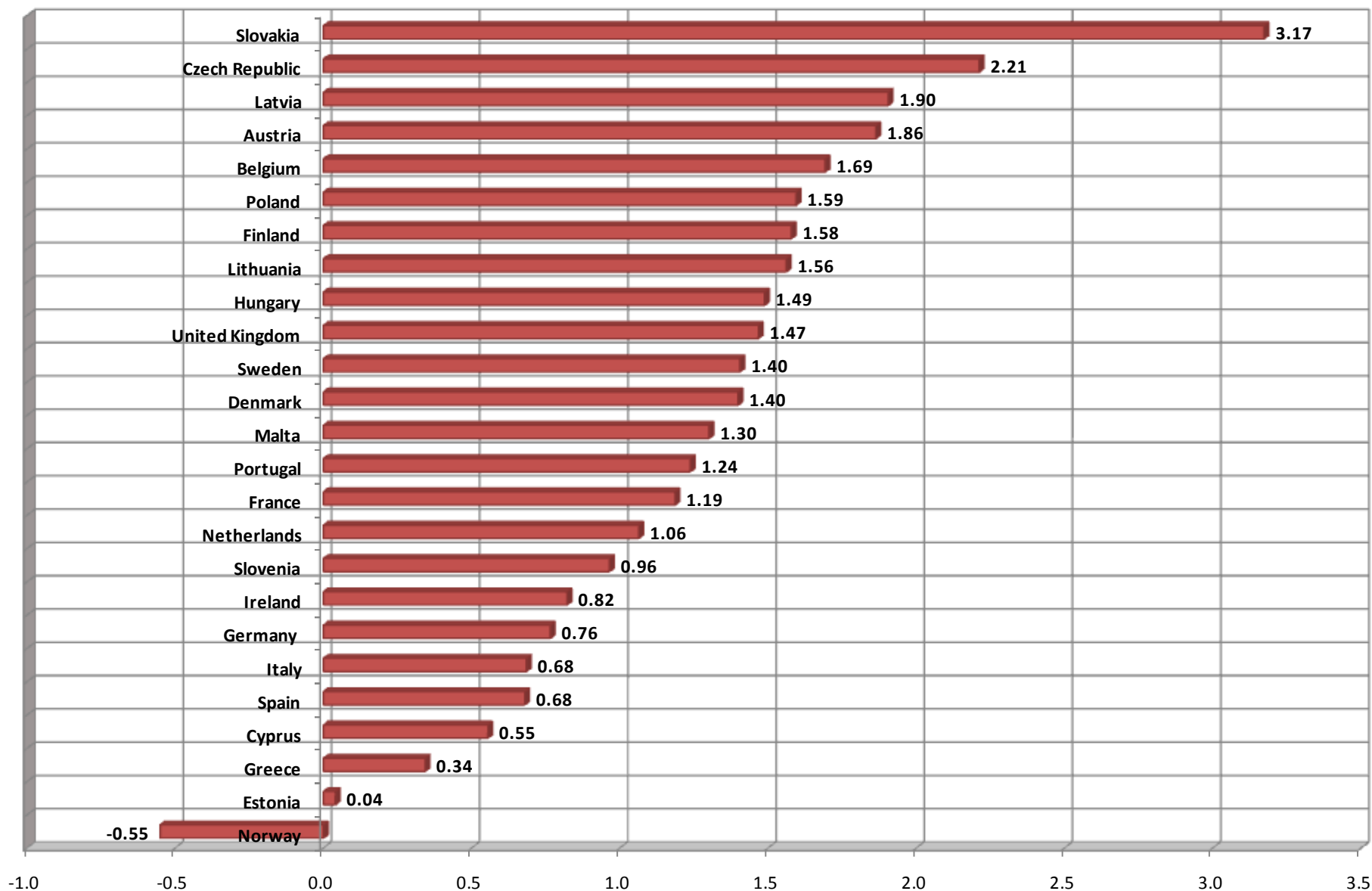


	gr	ro	cy	lt	bg	es	no	lv	pt	it	pl	ee	mt	ie	sk	de	at	dk	si	fi	hu	fr	nl	cz	be	se	uk
Series1	-4.7	-4.6	-3.5	-2.8	-2.6	-2.3	-2.3	-2.1	-2.1	-2.1	-2.0	-1.6	-1.3	-1.2	-0.4	-0.4	-0.3	0.4	0.4	0.6	0.7	0.8	0.9	1.2	1.3	2.3	2.4

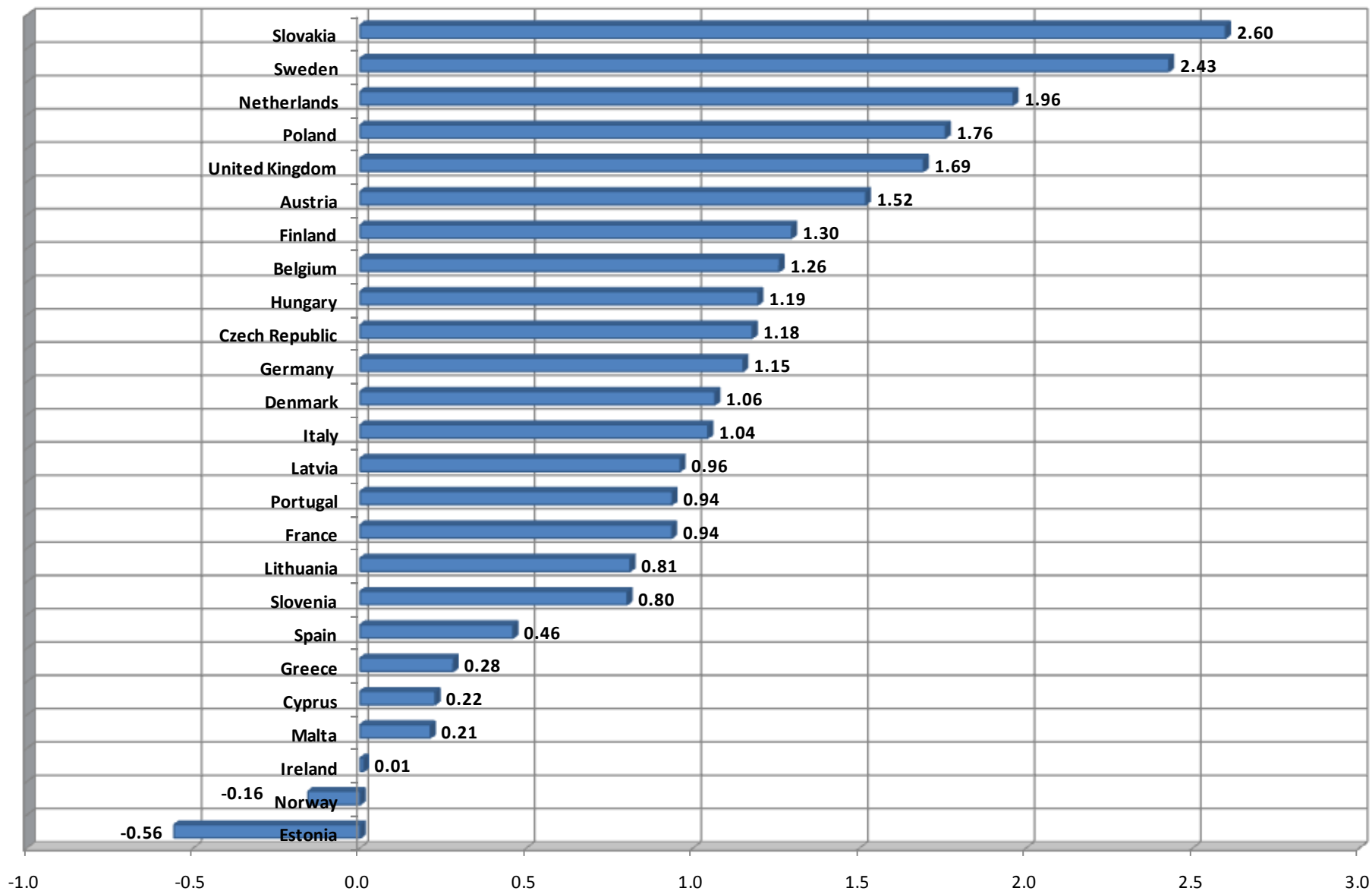
# Intangibles shares of gdp: EU27 Countries (1995-2005)

Eurostat name	1995	2000	2005
Austria	4.5	6.0	6.4
Belgium	6.4	7.6	8.1
Bulgaria	0.0	3.3	4.2
Cyprus	2.7	2.9	3.3
Czech Republic	5.4	6.6	7.6
Denmark	5.7	6.8	7.1
Estonia	5.1	4.6	5.2
Finland	5.7	7.0	7.3
France	6.4	7.3	7.6
Germany	5.4	6.6	6.2
Greece	1.7	2.0	2.0
Hungary	5.8	7.0	7.3
Ireland	4.6	4.6	5.4
Italy	4.1	5.2	4.8
Latvia	2.8	3.8	4.7
Lithuania	2.4	3.2	4.0
Malta	4.0	4.2	5.3
Netherlands	6.5	8.4	7.5
Poland	3.0	4.8	4.6
Portugal	3.3	4.2	4.5
Romania		2.0	2.2
Slovakia	3.2	5.8	6.4
Slovenia	6.0	6.8	7.0
Spain	3.6	4.0	4.3
Sweden	7.7	10.1	9.1
United Kingdom	7.5	9.2	8.9
Norway	5.0	4.8	4.4

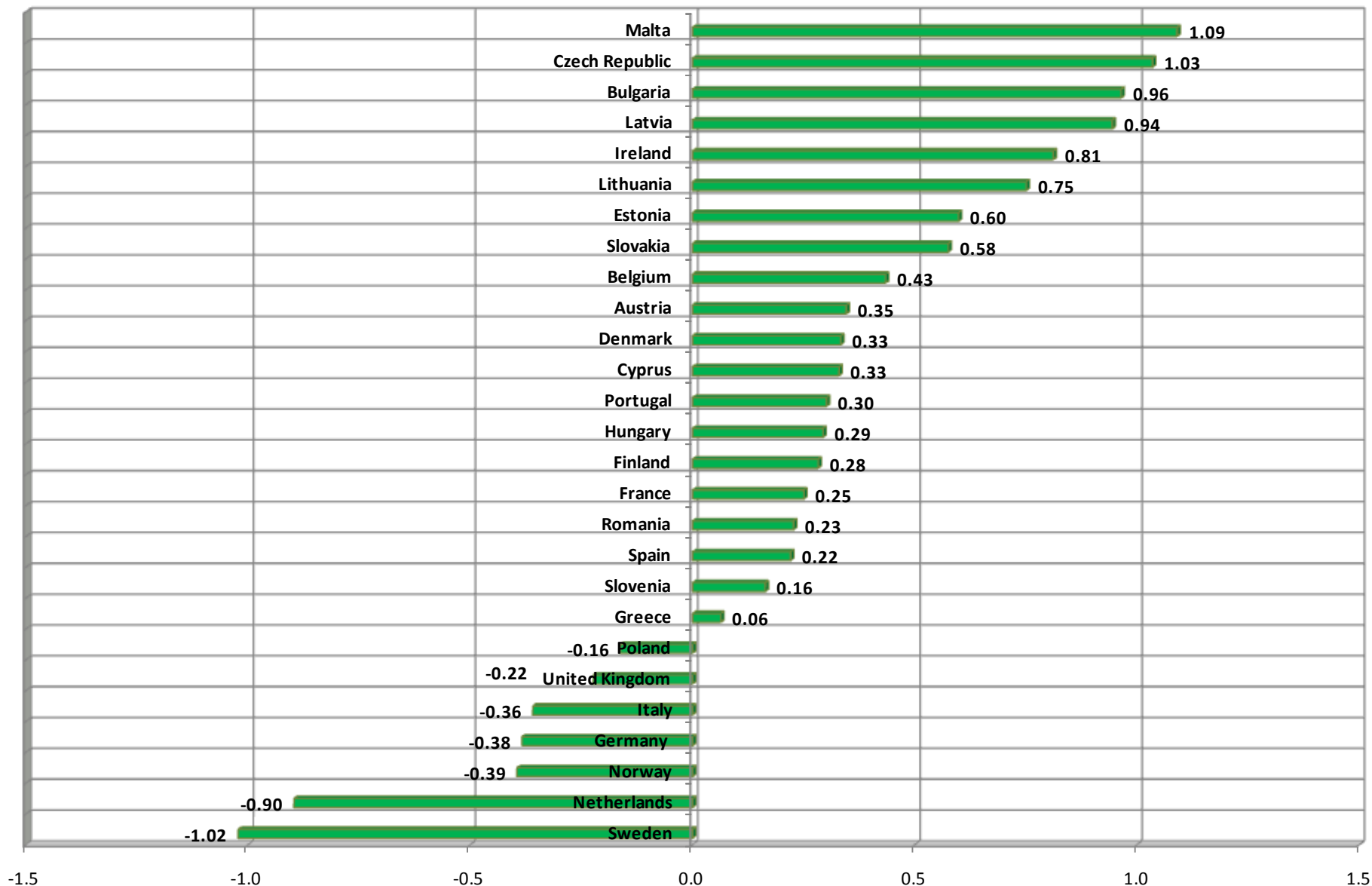
# Intangibles shares of gdp: European Countries change (2005-1995)



# New Intangibles shares of gdp: European Countries change (2000-1995)



# New Intangibles shares of gdp: European Countries change (2005-2000)

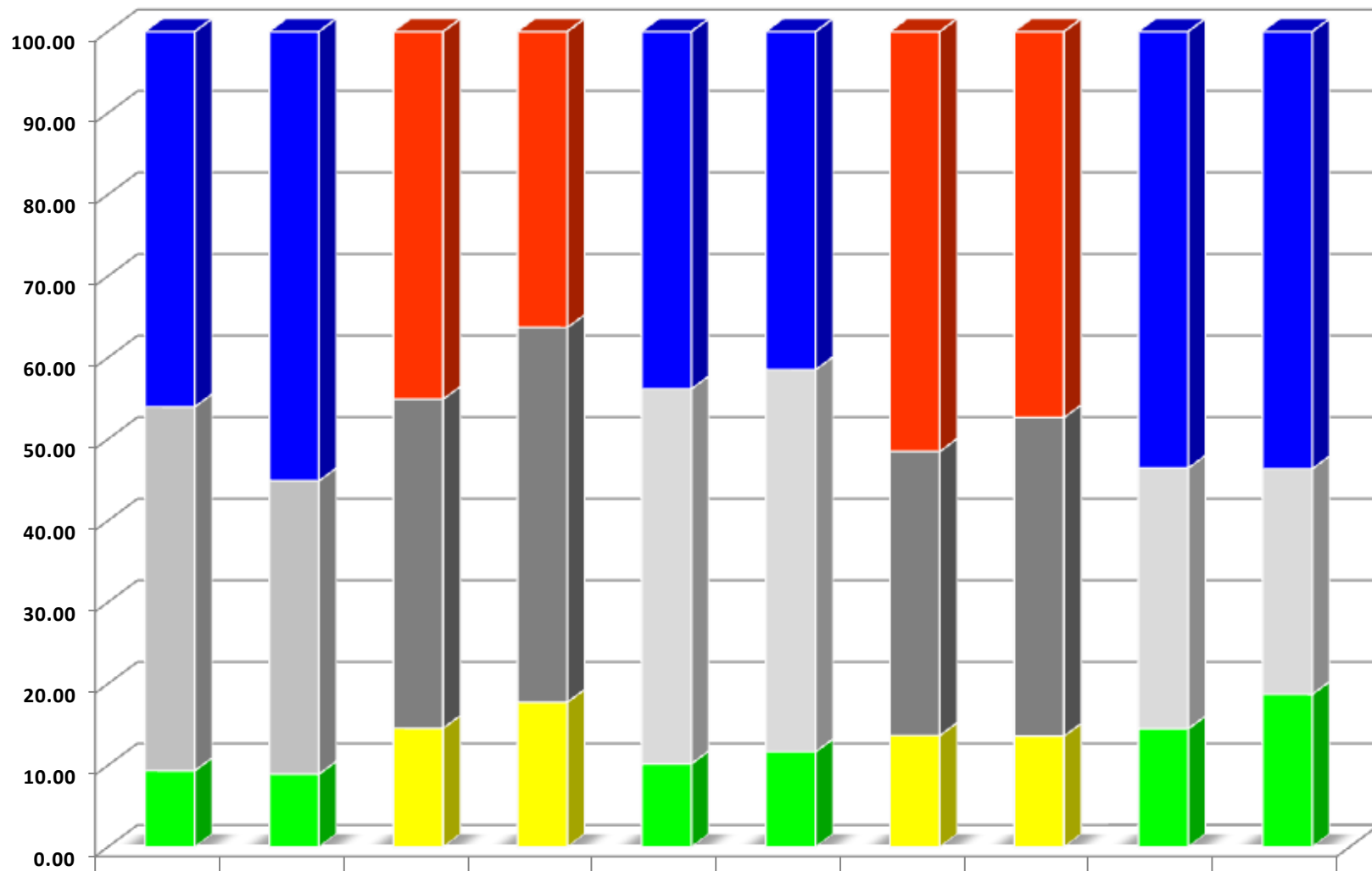


## How much the composition of intangibles varies across countries and over time?

Here we look at the composition of intangible investment, as defined by CHS, for one representative country of each EU25 area:

Czech Republic, Finland, UK, Germany and Italy.

# Composition of intangible GFCF: 1995-2005



	CZ95	CZ05	FI95	FI05	DE95	DE05	IT95	IT05	UK95	UK05
<b>Economic Competencies</b>	46.0	55.1	45.1	36.3	43.8	41.5	51.5	47.3	53.5	53.6
<b>Innovative property</b>	44.6	36.0	40.3	46.0	46.0	46.9	34.8	39.1	32.0	27.7
<b>Software</b>	9.4	8.9	14.6	17.8	10.2	11.7	13.7	13.6	14.5	18.7

# Composition of intangible GFCF

	Czech Republic			Finland			Germany			Italy			UK		
	1995	2005	D	1995	2005	D	1995	2005	D	1995	2005	D	1995	2005	D
<b>Software</b>	<b>9.4</b>	<b>8.9</b>	<b>-0.4</b>	<b>14.6</b>	<b>17.8</b>	<b>3.2</b>	<b>10.2</b>	<b>11.7</b>	<b>1.5</b>	<b>13.7</b>	<b>13.6</b>	<b>-0.1</b>	<b>14.5</b>	<b>18.7</b>	<b>4.2</b>
<b>Innovative property</b>	<b>44.6</b>	<b>36.0</b>	<b>-8.7</b>	<b>40.3</b>	<b>46.0</b>	<b>5.6</b>	<b>46.0</b>	<b>46.9</b>	<b>0.9</b>	<b>34.8</b>	<b>39.1</b>	<b>4.2</b>	<b>32.0</b>	<b>27.7</b>	<b>-4.3</b>
R&D	11.0	10.4	-0.6	22.4	29.6	7.2	26.4	26.4	0.0	12.1	10.6	-1.5	14.8	10.4	-4.4
Other national account	0.9	0.2	-0.7	3.8	2.4	-1.4	0.1	0.1	0.0	3.5	4.5	1.0	0.1	0.0	-0.1
New financial product	8.6	6.7	-1.9	4.7	2.8	-1.8	5.3	7.9	2.6	5.1	7.7	2.7	6.8	5.8	-1.0
Architectural & engineering design	24.1	18.6	-5.5	9.5	11.1	1.6	14.2	12.4	-1.7	14.2	16.2	2.0	10.2	11.5	1.2
<b>Economic Competencies</b>	<b>46.0</b>	<b>55.1</b>	<b>9.1</b>	<b>45.1</b>	<b>36.3</b>	<b>-8.8</b>	<b>43.8</b>	<b>41.5</b>	<b>-2.3</b>	<b>51.5</b>	<b>47.3</b>	<b>-4.1</b>	<b>53.5</b>	<b>53.6</b>	<b>0.1</b>
Advertising	8.1	15.5	7.4	10.6	8.4	-2.2	12.3	9.6	-2.8	9.2	9.9	0.7	9.7	8.2	-1.6
Market Research	2.2	6.8	4.6	1.3	1.7	0.4	2.9	3.7	0.8	9.2	8.1	-1.1	3.8	4.5	0.7
Firm specific human capital	10.5	8.0	-2.5	14.9	7.2	-7.7	9.9	8.0	-1.9	11.7	7.1	-4.6	6.2	6.0	-0.2
Organizational capital P	15.3	17.2	1.9	7.4	6.8	-0.7	8.6	12.5	3.9	11.7	13.7	2.0	8.1	12.0	3.9
Organizational capital O	10.0	7.7	-2.3	10.9	12.3	1.3	10.0	7.7	-2.4	9.7	8.4	-1.2	25.7	23.0	-2.7
<b>Total</b>	<b>100</b>	<b>100</b>		<b>100</b>	<b>100</b>		<b>100</b>	<b>100</b>		<b>100</b>	<b>100</b>		<b>100</b>	<b>100</b>	

**R&D and ORG C. are the main components but size and dynamics varies across countries**

## Stylized facts (2):

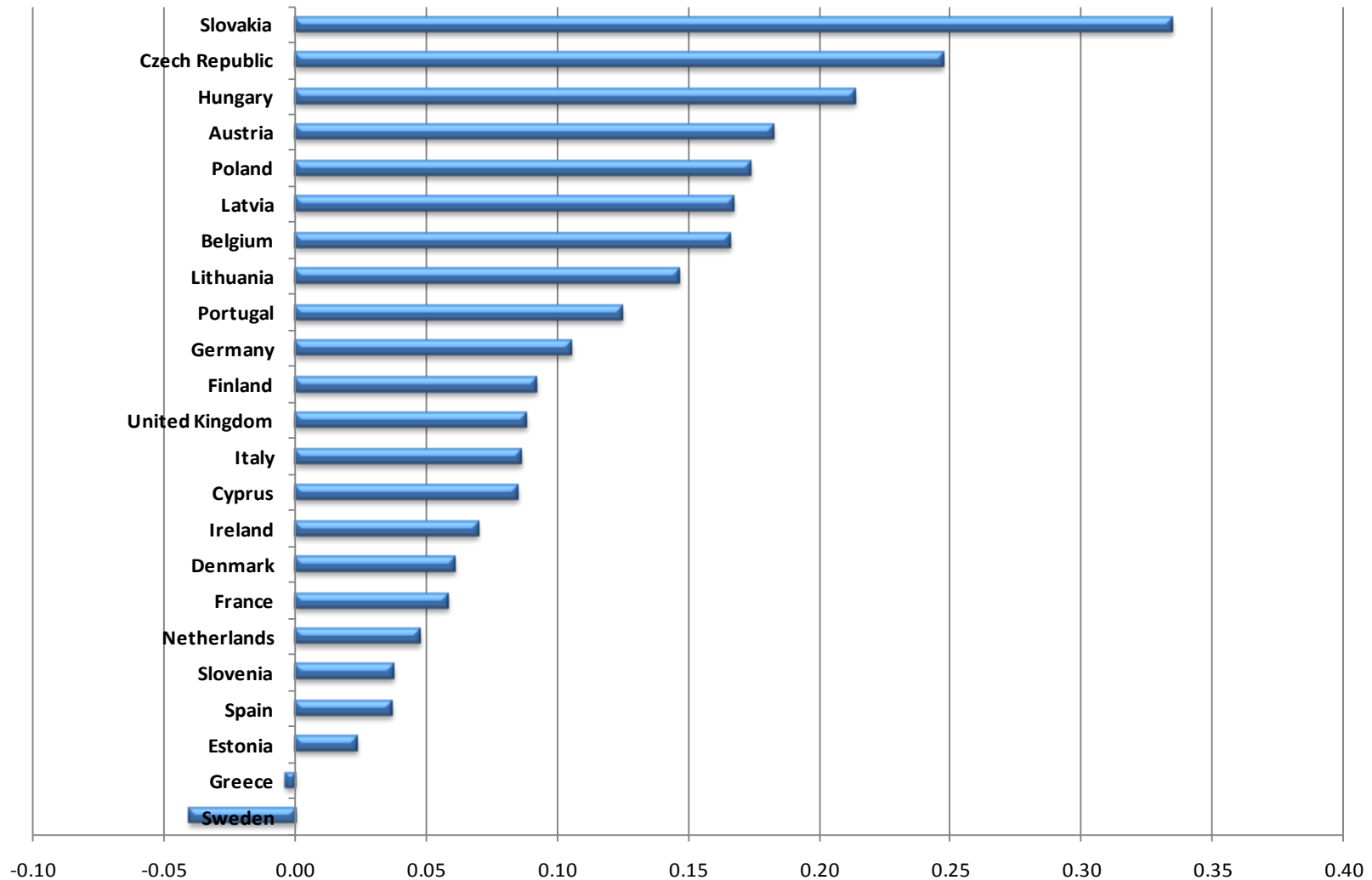
- Among **EU27** member countries there are sizable differences of intangible intensity: **UK** and **Sweden** are the top leaders while **Greece**, **Romania** and **Cyprus** are the laggards;
- The **most dynamic** countries are Slovakia, Czech Republic, Austria, Belgium and Finland.
- In 2000-2005, EU27 is divided in **two regions**: **fast** (UK, SWE, CZ) and **slow** adopter (IT, SP, GR) economies.



# Growth accounting

- What are the effects of the capitalization of intangibles on measured productivity growth?
- Tangibles vs intangibles: the changing nature of the sources of growth.
- Extended GA model as in CHS (2005).

# The effect of capitalizing intangibles on labor productivity growth: EU27 1995-2005



## Current versus extended asset boundary: Contributions to Labor Productivity Growth

	Current Asset Boundary			Extended Asset Boundary				Estimated Impact		
	Contributions to Labour Productivity Growth			Contributions to Labour Productivity Growth						
	(a)	(b)	(c)	(d)	(e)	(f)	(g)	(d-a)	((e+f)-b)	(g-c)
	LPG	CD	TFPG	LPG	NA CD	NI CD	TFPG	LPG	CD	TFPG
Austria	1.87	0.78	1.08	2.05	0.72	0.34	0.97	0.18	0.29	-0.11
Denmark	1.55	0.55	1.00	1.61	0.50	0.27	0.83	0.06	0.22	-0.16
Finland	2.98	0.28	2.69	3.07	0.25	0.37	2.43	0.09	0.34	-0.26
France	2.01	0.39	1.61	2.07	0.36	0.23	1.47	0.06	0.20	-0.14
Germany	1.59	0.80	0.78	1.69	0.74	0.27	0.68	0.11	0.21	-0.11
Italy	0.17	0.55	-0.37	0.26	0.51	0.09	-0.35	0.09	0.06	0.02
Netherlands	2.20	0.69	1.50	2.25	0.62	0.31	1.31	0.05	0.24	-0.20
Portugal	1.81	1.82	-0.01	1.94	1.72	0.24	-0.03	0.13	0.14	-0.02
Spain	0.21	0.53	-0.32	0.24	0.50	0.03	-0.29	0.04	0.01	0.03
Sweden	3.73	1.14	2.56	3.69	1.01	0.44	2.20	-0.04	0.32	-0.37
United Kingdom	2.62	1.06	1.55	2.71	0.95	0.34	1.39	0.09	0.24	-0.15

LPG stands for labour productivity growth

CD is capital deepening

TFP is total factor productivity

## Including New Intangible Assets: Contributions to Labour Productivity Growth

	LPG	TCD	ICD	SW	INN PROP	R&D	Arch_Des	NFP	Other_NA	Econ Comp	Advert+Mkt_Res	Org_Cap	FSHC	TFPG
Austria	2.05	0.62	0.47	0.10	0.22	0.13	0.05	0.03	0.00	0.15	0.06	0.07	0.02	0.95
Denmark	1.61	0.37	0.38	0.17	0.17	0.11	0.05	0.01	0.00	0.04	0.03	0.03	-0.01	0.84
Finland	3.07	0.18	0.40	0.09	0.27	0.23	0.06	-0.01	0.00	0.04	0.03	0.08	-0.08	2.48
France	2.07	0.25	0.43	0.14	0.13	0.03	0.07	0.02	0.01	0.16	0.02	0.10	0.04	1.38
Germany	1.69	0.60	0.38	0.05	0.18	0.08	0.05	0.05	0.01	0.14	0.03	0.08	0.04	0.71
Italy	0.26	0.46	0.13	0.03	0.06	-0.01	0.03	0.03	0.01	0.04	0.03	0.04	-0.03	-0.34
Netherlands	2.25	0.50	0.47	0.12	0.15	0.03	0.06	0.06	0.00	0.19	0.05	0.15	-0.01	1.27
Portugal	1.94	1.61	0.37	0.09	0.12	0.03	0.02	0.05	0.01	0.16	0.07	0.10	0.00	-0.05
Spain	0.24	0.43	0.10	0.06	0.04	0.02	0.02	-0.01	0.00	-0.01	0.00	0.01	-0.02	-0.29
Sweden	3.69	0.78	0.66	0.18	0.28	0.19	0.08	0.00	0.01	0.20	0.03	0.13	0.03	2.21
United Kingdom	2.71	0.74	0.57	0.15	0.11	0.01	0.08	0.04	-0.01	0.30	0.06	0.19	0.06	1.38

NI - CD = new intangible assets

NA – CD = national account intangible and tangible assets

- The capitalization of intangibles has the following effects:
  - On average, the rate of growth of labor productivity is **higher** when new intangible assets are included.
  - Capital deepening becomes the dominant source of labor productivity growth
  - TFP is substantially reduced

- The lower TFP growth shows that when intangibles are not capitalized their contribution to labour productivity growth is captured by TFP in line with its residual nature (Jorgenson and Griliches (1967))
- The **size** of the effects varies across countries and across time.
- The highest contribution of intangible capital deepening is in **fast growing** and **intangible intensive** economies (SWE,UK,FI)

- ❑ In the **slow growing** countries (Italy and Spain) intangible investment does not provide a significant contribution to labour productivity growth.
- ❑ **R&D** and **Organizational Capital** are the main drivers of growth among the intangible assets.

## Main Policy Issues:

- ❑ Improving measurement of intangibles promoting the development of common guidelines (harmonized and standardized system): **Measuring Intangible Capital** (Manual on Capital Stock & Measuring Productivity)
  - ❑ Necessary to draw robust policy conclusions
- ❑ Policies that promote the use of intangibles, such as:
  - ❑ Fiscal incentives for firms increasing Training, R&D and/or OC expenditures.

- ❑ Extend the growth accounting analysis to EU aggregates (according to data availability).
- ❑ Deeper investigate the influence of business cycle on our growth accounting results.
- ❑ Extending estimates beyond 2005 (to 2009?).
- ❑ For some selected country (depending on data availability) estimating expenditure and GFCF in intangible assets by industry.

- ❑ Estimate the own account component using detailed employment and labor cost data (e.g. microdata for Labor Force Survey and Structure of Earning Survey now available from Eurostat for many countries)
- ❑ Estimating the own account component consistently with the SNA including also the other components of the cost of production (besides labor cost)

- ❑ Try different deflators (e.g. Nace K74 gross output deflator for the purchased components and a wage index for the own accounts components)
- ❑ Revise the assumption about the share of total expenditure assumed to be GFCF
- ❑ Industry output vs product output
- ❑ Exports and Imports
- ❑ Industry level estimates



# Backup slides

## GA with intangible capital (Corrado, Hulten, Sichel (2006))

$$g_Q(t) = v_L(t)g_L(t) + v_T(t)g_T(t) + v_I(t)g_I(t) + g_A(t)$$

where  $g_X(t)$  denotes the logarithmic rate of growth of variable  $X$  and  $v_Y(t)$  denotes the share of input  $Y$  in total output (more precisely the average of the shares at time  $t$  and at time  $t-1$ ).  $L$ ,  $T$  and  $I$  are, respectively, the input of labour, tangible capital and intangible capital and  $g_A(t)$  denotes the growth rate of multifactor productivity

CHS show that the extended framework involves:

- 1) a different definition of final output
- 2) a restatement of input shares
- 3) the inclusion of the rate of growth of intangible capital input in the growth accounting equation.

## Capital input

$$g_K(t) = \sum_{i=1}^n 0.5(v_t^i + v_{t-1}^i) \ln \left( \frac{S_t^i}{S_{t-1}^i} \right)$$

where  $S_t^i$  is the productive stock of asset  $i$ , and

$$v_t^i = \frac{u_t^i S_t^i}{\sum_{i=1}^n u_t^i S_t^i}$$

is the cost-share of asset  $i$  in period  $t$ ,  $u_t^i$  is its user cost and  $n$  is the number of asset types (both tangibles and intangibles)

## Capital input

If there are  $z$  intangible-type assets, then the index of intangible capital services is

$$g_I(t) = \sum_{i=1}^z 0.5(v_t^i + v_{t-1}^i) \ln \left( \frac{SI_t^i}{SI_{t-1}^i} \right)$$

where

$$v_t^i = \frac{u_t^i SI_t^i}{\sum_{i=1}^z u_t^i SI_t^i}$$

is the share of intangible asset  $i$  in the value of total cost for intangible capital services and  $SI_t^i$  is the productive stock of intangible asset  $i$

## Implementation issues

- The first step to calculate the flow of capital services is the estimate of productive capital stock. In this respect we adopted the following simplifying assumptions:
  - geometric pattern  $S_t^i = (1 - d^i)S_{t-1}^i + I_t$   
(see Hulten, 1990; and Schreyer, Diewert, Harrison (2005))
  - constant depreciation rates through time
  - the depreciation rate for each type of asset is the same for all countries