

# National Innovation Systems in the EU

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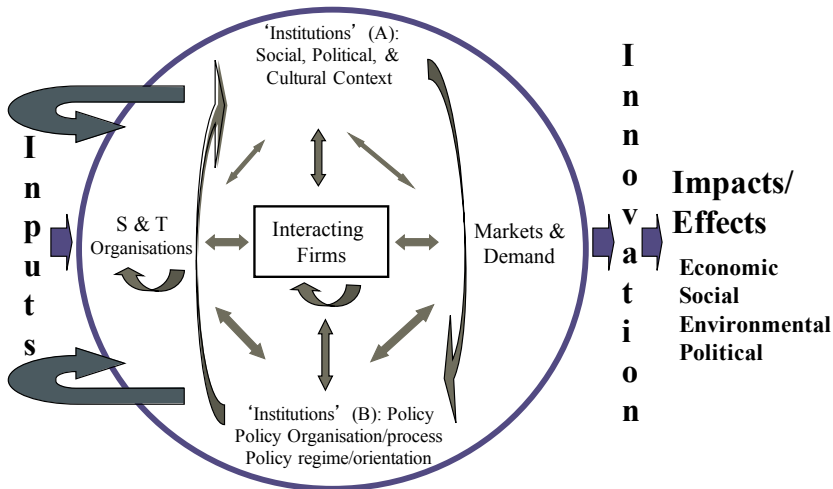
# Structure of the talk

- ▷ The appeal of the NIS framework and...
- ▷ ..the need for empirical grounding: what we do.
- ▷ Is there such a thing as a European Innovation System?
- ▷ No, there is not: A map of the European Technology Clubs and what's behind them.
- ▷ Industrial and Innovation Policy Challenges

# What is a NIS?

**‘Social’ technologies and innovation systems (Nelson, 2007)**

Performance, Inputs, Outputs and Outcomes/Impacts



# The influential concept of National Innovation System

- ▶ Highlights the complexity of national characteristics that explain economic performance (but no theoretical grounding)
- ▶ Each component of NIS might be a potential instrument for public policy (private sector, public-private links, local and national government, battery of instruments)
- ▶ The very notion of a successful pathway to catch up ('one size fits all') is nonsensical (but very few empirical grounding, (Castellacci and Archibugi, 2008; Castellacci and Natera, 2013; Fagerberg and Srholec, 2008))

# Is there such a thing as a European Innovation System?

- ▶ We empirically unravel the latent dimension of NIS, rank countries along these and ground the micro-level sources of countries' differences
- ▶ There are several European 'Technology Clubs'
- ▶ Some NIS clusters have interesting patterns that disprove the theory and challenge policy

# Empirically grounding a map of European Technology Clubs

- ▷ Starting from 2014 micro-aggregated Eurostat CIS data
- ▷ Actors: Private firms, government, public institutions - Activities: investments strategies, cooperation, innovation performance
- ▷ NIS Dimensions: Firm efforts and demand; cooperations (private, public, domestic, foreign); firm performance; Public support
- ▷ Country rankings in NIS dimensions
- ▷ Country clustering in NIS dimensions
- ▷ Map of the European NIS 'Clubs'

## 26 Countries included in the analysis

- Austria (AT), Belgium (BE), Bulgaria (BG), Cyprus (CY), Czech Republic (CZ), Germany (DE), Denmark (DK), Estonia (EE), Greece (EL), Spain (ES), Finland (FI), France (FR), Croatia (HR), Hungary (HU), Ireland (IE), Italy (IT), Lithuania (LT), Latvia (LV), Netherlands (NL), Norway (NO), Poland (PL), Portugal (PT), Romania (RO), Sweden (SE), Slovenia (SI) and Slovakia (SK).

# 33 Variables included in the analysis

Selected variables of/derived from the Community Innovation Survey 2014 Ed. (CIS-2014) used in the paper:

# Variable	Factor Analysis	Variable Label	Firm Type	Indicator Short Description	Unit	Indicator full description (derived from EUROSTAT)
1	Firm Innovation Inputs and Demand Sources	INNO_PPANPP_LARMAR_EU	Innovative firms all dimensions	Largest market: EU	%	Enterprises for which the largest market in terms of turnover is: EU/EFTA/EU-candidates
2		INNO_PPANPP_LARMAR_LREG	Innovative firms all dimensions	Largest market: Local/Regional	%	Enterprises for which the largest market in terms of turnover is the local/regional market
3		INNO_PPANPP_LARMAR_NAT	Innovative firms all dimensions	Largest market: National	%	Enterprises for which the largest market in terms of turnover is the national market
4		INNO_PPANPP_ENMRG_YES	Innovative firms all dimensions	Firm merged/took over	%	Enterprises that have merged with/take over another enterprise
5		INNO_PPANPP_GP_YES	Product/Process innovative firms	Firm part of enterprise group	%	Enterprises that are part of an enterprise group
6		INNOACT_EXPTOT14_ENT_POPU14	Product/Process innovative firms	R&D expenditure per firm	EUR/NR	Average total innovation expenditures in 2014 per firm
7		INNOACT_RRDEX14_PC	Product/Process innovative firms	Share of external R&D	% of TIE	Share of expenditures in external R&D in 2014 over total innovation expenditures
8		INNOACT_RRDIN14_PC	Product/Process innovative firms	Share of in-house R&D	% of TIE	Share of expenditures in in-house R&D in 2014 over total innovation expenditures
9		INNOACT_EXPTOT14_C	Product/Process innovative firms	Manufacturing/Aggregate R&D	% of TIE	Share of total innovation expenditures in 2014 in Manufacturing
10		INNOACT_ROEX14_PC	Product/Process innovative firms	Acquisition of external knowledge	% of TIE	Share of expenditures in acquisition of external knowledge in 2014
11	Cooperation Links	INNOACT_C01	Product/Process innovative firms	Cooperation within the enterprise group	%	Enterprises co-operating with other enterprises within the enterprise group
12		INNOACT_COEUR_YES	Product/Process innovative firms	Cooperation with EU partners	%	Enterprises engaged in innovation co-operation with a partner in EU/EFTA/EU-candidates
13		INNOACT_CONAT_YES	Product/Process innovative firms	Cooperation with National partners	%	Enterprises engaged in any type of innovation co-operation with a national partner
14		INNOACT_COCHIN_YES	Product/Process innovative firms	Cooperation with China/India	%	Enterprises engaged in any type of innovation co-operation with a partner in China or India
15		INNOACT_COUS_YES	Product/Process innovative firms	Cooperation with the US	%	Enterprises engaged in any type of innovation co-operation with a partner in United States
16		INNOACT_C02	Product/Process innovative firms	Cooperation with competitors, same sector	%	Enterprises co-operating with competitors or other enterprises of the same sector
17	INNOACT_C031	Product/Process innovative firms	Cooperation with private clients/customers	%	Enterprises co-operating with clients or customers from the private sector	
18	Government Role and Public Sector Policies	INNOACT_FUNGMT	Product/Process innovative firms	Funding from Central Government	%	Enterprises that received funding from central government
19		INNOACT_C032	Product/Process innovative firms	Coop. with public sector clients/customers	%	Enterprises co-operating with clients or customers from the public sector
20		INNOACT_C06	Product/Process innovative firms	Cooperation with universities/HEI	%	Enterprises co-operating with universities or other higher education institutions
21		INNOACT_C09	Product/Process innovative firms	Cooperation with Govt/Research Inst.	%	Enterprises co-operating with Government, public or private research institutes
22		INNOACT_FUNLOC	Product/Process innovative firms	Funding from Local/Regional Auth.	%	Enterprises that received funding from local or regional authorities
23		TOTAL_PUBDOM	Total firms	Domestic Procurement	%	Enterprises with procurement contract for domestic public sector
24		TOTAL_PUBFINRQ	Total firms	Foreign proc. req. innovation activities	%	Enterprises with procurement contract for foreign public sector/innovation activities required
25	TOTAL_PUBFOR	Total firms	Foreign Procurement	%	Enterprises with procurement contract for foreign public sector	
26	Firm Innovation Outputs	INNO_PROPAT	Innovative firms	Application for a patent	%	Enterprises that applied for a patent
27		INNO_PROTM	Innovative firms	Registration of a trademark	%	Enterprises that registered a trademark
28		INPDT_NEWFRM_YES	Product innovative firms	Turnover from products new to firm	%	Enterprises introduced new or significantly improved products that were only new to the firm
29		INPDT_NEWMAR_YES	Product innovative firms	Turnover from products new to market	%	Enterprises introduced new or significantly improved products that were new to the market
30		INPCS_INPSNM0	Process innovative firms	Process innovation new to firm	%	Enterprises that have introduced process innovation not new to the market
31		INPCS_INPSNM1	Process innovative firms	Process innovation new to market	%	Enterprises that have introduced process innovation new to the market
32		INONG_ENT_POPU14	Firms with ongoing innovation	Ongoing innovation activities	%	Enterprises with on-going innovation activities only
33		INNO_TURN_EMP	Innovative firms	Turnover per employee	EUR/EMP	Total turnover in 2014 per employee

## References:

% (percentages) are expressed in relation to the total of firms of the corresponding firm type

NR: number; EUR: euros at current prices; EMP: employees; % of TIE: percentage of Total Innovation Expenditure; % of Turnover: percentage of total firm turnover

Innovative firms all dimensions corresponds to firm type INNO\_PPANPP: Product and/or process innovative enterprises and organisation and/or marketing innovative enterprises

Source: Own elaboration based on EUROSTAT CIS 2014 Database



# Factor 1: Innovation Investments and Demand sources

## Panel (A) Firm innovation inputs & demand conditions

(factor loadings)

Code	Label	iMarket	iFirmStr	iRD
INNO_PPANPP_LARMAR_EU	Largest market: EU	<b>0.972</b>	-0.186	
INNO_PPANPP_LARMAR_LREG	Largest market: Local/Regional	<b>0.843</b>	0.255	
INNO_PPANPP_LARMAR_NAT	Largest market: National	<b>0.690</b>	0.224	0.104
INNO_PPANPP_ENMRG_YES	Firm merged/took over		<b>0.977</b>	
INNO_PPANPP_GP_YES	Firm part of enterprise group		<b>0.770</b>	0.168
INNOACT_EXPTOT14_ENT_POPU14	R&D expenditure per firm		0.446	<b>0.621</b>
INNOACT_RRDEX14_PC	Share of external R&D			<b>0.923</b>
INNOACT_RRDIN14_PC	Share of in-house R&D	0.120	0.264	<b>0.565</b>
INNOACT_EXPTOT14_C	Manufacturing/Aggregate R&D	-0.133		<b>0.555</b>
INNOACT_ROEK14_PC	Acquisition of external knowledge		0.158	
SS loadings		2.180	2.005	1.916
Proportion Var		0.218	0.201	0.192
Cumulative Var		0.218	0.418	<b>0.610</b>

## Factors dictionary

iMarket	Main source of demand
iFirmStr	Firm ownership structure
iRD	R&D intensity and composition

Test of the hypothesis that 3 factors are sufficient.

The chi square statistic is 11.58 on 18 degrees of freedom.

The p-value is 0.868

We do not reject the null hypothesis that 3 factors are sufficient to describe the correlation structure between manifest variables

## Country Ranking across factors:

	iMarket	iFirmStr	iRD	Mean	Rank
AT	5	3	12	6.5	7
BE	3	10	4	5.7	5
BG	21	25	18	21.5	23
CY	18	8	25	16.7	17
CZ	16	16	10	14.1	13
DE	4	4	7	4.9	3
DK	13	9	1	7.9	8
EE	22	19	17	19.4	22
EL	6	14	24	14.3	14
ES	17	20	6	14.6	15
FI	12	7	5	8.1	9
FR	7	6	3	5.4	4
HR	11	12	22	14.8	16
HU	23	21	8	17.7	18
IE	1	5	14	6.4	6
IT	8	11	16	11.5	10
LT	15	17	26	19.1	20
LV	25	24	23	24.0	25
NL	14	13	9	12.1	11
NO	2	2	11	4.8	2
PL	24	23	19	22.1	24
PT	19	18	20	19.0	19
RO	26	26	21	24.5	26
SE	10	1	2	4.4	1
SI	9	15	13	12.3	12
SK	20	22	15	19.1	21

# Factor 2: Geography and Type of Cooperation strategies

## Panel (B) Firm cooperation links

(factor loadings)

Code	Label	cEURNAT	cUSCNIN	cCCC
INNOACT_C01	Cooperation within the enterprise group	<b>0.876</b>	0.259	-0.146
INNOACT_COEUR_YES	Cooperation with EU partners	<b>0.836</b>		
INNOACT_CONAT_YES	Cooperation with National partners	<b>0.958</b>	-0.163	0.177
INNOACT_COCNIN_YES	Cooperation with China/India		<b>0.806</b>	0.138
INNOACT_COUS_YES	Cooperation with the US		<b>0.907</b>	
INNOACT_C02	Cooperation with competitors, same sector		0.152	<b>0.794</b>
INNOACT_C031	Cooperation with private clients/customers	0.271	0.338	<b>0.502</b>
SS loadings		2.469	1.712	0.961
Proportion Var		0.353	0.245	0.137
Cumulative Var		0.353	0.597	<b>0.735</b>

### Factors dictionary

cEURNAT	Links to EU and national partners
cUSCNIN	Links to China, India, US
cCCC	Links to competitors, clients, customers

Test of the hypothesis that 3 factors are sufficient.

The chi square statistic is 3.65 on 3 degrees of freedom.

The p-value is 0.302

We do not reject the null hypothesis that 3 factors are sufficient to describe the correlation structure between manifest variables

## Country Ranking across factors:

	cEURNAT	cUSCNIN	cCCC	Mean	Rank
AT	3	8	6	5.3	6
BE	1	5	7	3.6	2
BG	25	23	24	24.1	24
CY	16	11	10	13.0	13
CZ	14	14	18	14.9	16
DE	17	15	12	15.3	17
DK	9	3	9	7.0	7
EE	12	13	11	12.1	11
EL	13	18	2	12.3	12
ES	20	22	19	20.5	21
FI	4	2	1	2.7	1
FR	7	9	21	10.7	10
HR	19	17	14	17.3	18
HU	21	19	17	19.5	20
IE	8	4	20	9.2	8
IT	22	25	22	23.0	23
LT	11	16	16	13.8	14
LV	23	21	23	22.3	22
NL	5	7	3	5.3	5
NO	2	6	4	3.8	3
PL	24	24	26	24.4	25
PT	18	20	13	17.6	19
RO	26	26	25	25.8	26
SE	6	1	5	4.1	4
SI	10	10	8	9.6	9
SK	15	12	15	14.0	15

# Factor 3: Public Innovation policies

## Panel (C) Government innovation policies

### (factor loadings)

Code	Label	gGvtFCo	gLRFDPr	gForPr
INNOACT_FUNGMT	Funding from Central Government	<b>0.781</b>		
INNOACT_C032	Coop. with public sector clients/customers	<b>0.572</b>		0.261
INNOACT_C06	Cooperation with universities/HEI	<b>0.846</b>		0.137
INNOACT_C09	Cooperation with Gvt/Research Inst.	<b>0.957</b>		
INNOACT_FUNLOC	Funding from Local/Regional Auth.	0.202	<b>0.775</b>	-0.183
TOTAL_PUBDOM	Domestic Procurement		<b>0.932</b>	0.162
TOTAL_PUBFINRQ	Foreign proc. req. innovation activities	0.35		<b>0.625</b>
TOTAL_PUBFOR	Foreign Procurement		0.119	<b>0.886</b>
SS loadings		2.738	1.491	1.326
Proportion Var		0.342	0.186	0.166
Cumulative Var		0.342	0.529	<b>0.694</b>

### Factors dictionary

gGvtFCo	Fund. Gvt /Coop. HEI/Research Inst.
gLRFDPr	Local/Reg. Fund. / Dom. Procurement
gForPr	Foreign Procurement

Test of the hypothesis that 3 factors are sufficient.

The chi square statistic is 7.75 on 7 degrees of freedom.

The p-value is 0.355

We do not reject the null hypothesis that 3 factors are sufficient

to describe the correlation structure between manifest variables

## Country Ranking across factors:

	gGvtFCo	gLRFDPr	gForPr	Mean	Rank
AT	3	4	2	3.0	3
BE	2	2	1	1.7	1
BG	26	24	20	23.9	25
CY	20	14	11	16.1	18
CZ	13	16	17	14.8	15
DE	5	6	22	9.7	8
DK	11	11	10	10.7	10
EE	16	18	8	14.5	14
EL	12	10	18	13.0	13
ES	15	15	23	17.1	19
FI	1	3	3	2.0	2
FR	10	7	16	10.8	11
HR	21	8	14	15.8	17
HU	23	17	19	20.4	22
IE	9	1	12	7.7	6
IT	17	20	24	19.6	21
LT	18	12	4	12.8	12
LV	24	23	21	23.0	23
NL	6	21	9	10.7	9
NO	4	5	6	4.8	4
PL	22	25	26	23.8	24
PT	14	19	15	15.6	16
RO	25	26	25	25.3	26
SE	8	9	5	7.5	5
SI	7	13	7	8.6	7
SK	19	22	13	18.2	20

# Factor 4: Innovation Performance

## Panel (D) Firm innovation outputs

(factor loadings)

Code	Label	oRadPat	olncrPcs	oOng	oPtvtY
INNO_PROPAT	Application for a patent	<b>0.672</b>		0.243	
INNO_PROTM	Application for a trademark	<b>0.876</b>		0.133	
INPDT_NEWMAR_YES	Turnover from products new to market	<b>0.855</b>	0.113	-0.204	0.16
INPDT_NEWFRM_YES	Turnover from products new to firm		<b>0.923</b>	0.142	
INPCS_INPSNMD	Process innovation new to firm		<b>0.756</b>		
INPCS_INPSNM1	Process innovation new to market		<b>0.686</b>	-0.163	0.299
INONG_ENT_POPU14	Ongoing innovation activities			<b>0.924</b>	0.111
INNO_TURN_EMP	Turnover per employee			<b>0.118</b>	<b>0.886</b>
SS loadings		1.970	1.912	1.035	0.924
Proportion Var		0.246	0.239	0.129	0.116
Cumulative Var		0.246	0.485	0.615	<b>0.730</b>

### Factors dictionary

oRadPat	Radical Prod. Innov. / Patent App.
olncrPcs	Incr. Prod. / Rad. Proc. Innov.
oOng	Ongoing innovation
oPtvtY	Productivity

Test of the hypothesis that 4 factors are sufficient.

The chi square statistic is 3.73 on 2 degrees of freedom.

The p-value is 0.155

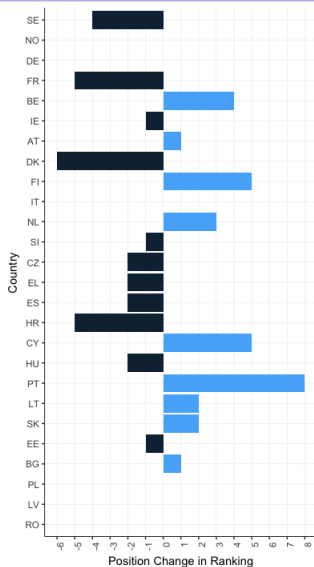
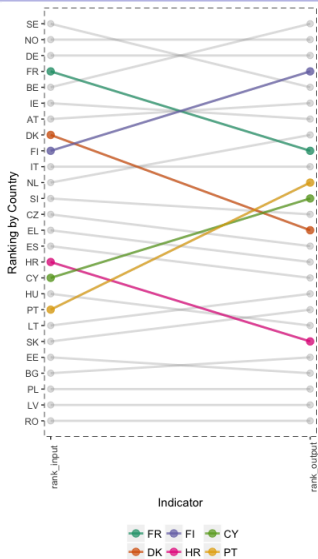
We do not reject the null hypothesis that 4 factors are sufficient to describe the correlation structure between manifest variables

## Country Ranking across factors:

	oRadPat	olncrPcs	oOng	oPtvtY	Mean	Rank
AT	2	6	17	10	7.2	6
BE	1	5	3	3	3.0	1
BG	22	19	15	26	20.5	22
CY	16	3	26	13	13.0	12
CZ	12	14	8	21	13.5	15
DE	8	2	1	12	5.6	3
DK	15	18	10	4	13.2	14
EE	25	26	12	20	22.3	23
EL	14	10	20	14	13.7	16
ES	21	20	7	11	16.6	17
FI	5	4	11	7	6.0	4
FR	7	12	9	6	8.8	9
HR	20	16	25	24	20.3	21
HU	19	21	14	17	18.4	20
IE	9	1	23	1	7.4	7
IT	11	17	5	9	11.6	10
LT	17	13	19	25	17.4	18
LV	23	22	24	22	22.7	25
NL	6	11	6	8	7.9	8
NO	4	7	4	2	4.6	2
PL	24	24	22	18	22.6	24
PT	13	8	16	15	12.3	11
RO	26	25	18	23	23.8	26
SE	3	15	2	5	7.0	5
SI	10	9	21	19	13.1	13
SK	18	23	13	16	18.4	19

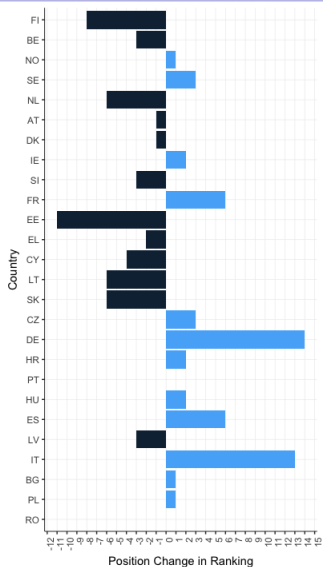
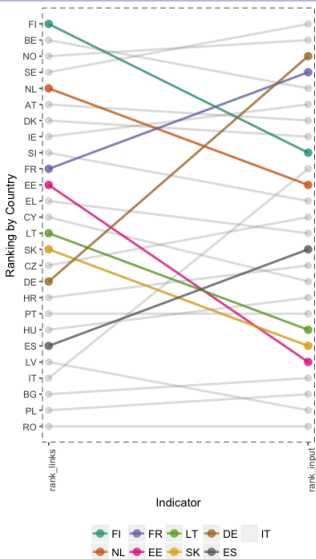
Country rankings in NIS Dimensions

# Ranking differences in pairs of dimensions: Innovation Inputs to Outputs



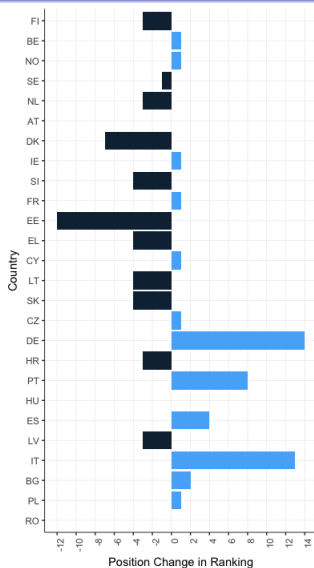
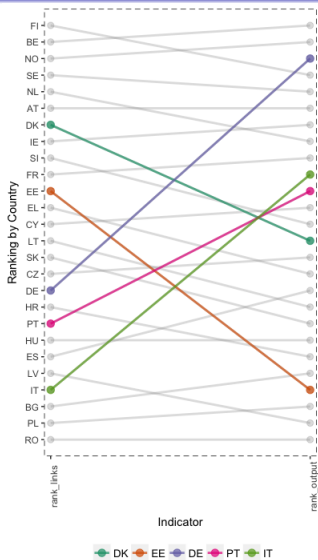
Country rankings in NIS Dimensions

# Ranking differences in pairs of dimensions: Cooperation to Inputs

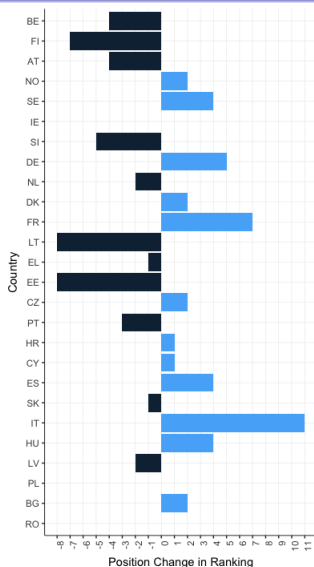
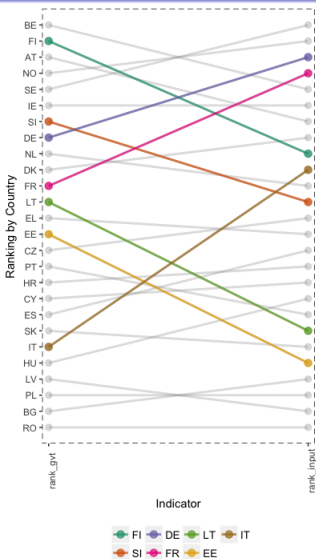


Country rankings in NIS Dimensions

# Ranking differences in pairs of dimensions: Cooperation to Outputs



# Ranking differences in pairs of dimensions: Public policy to Inputs

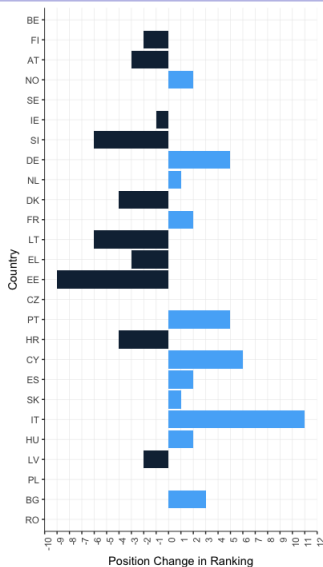
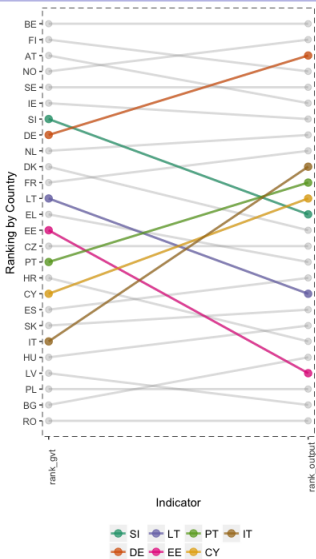




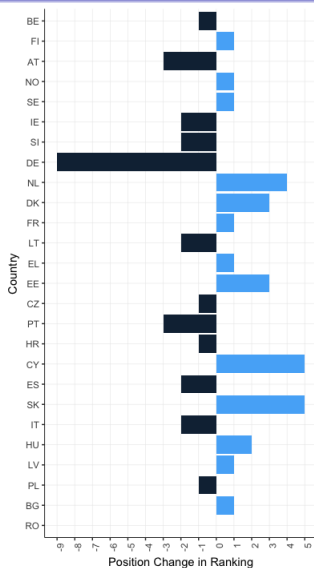
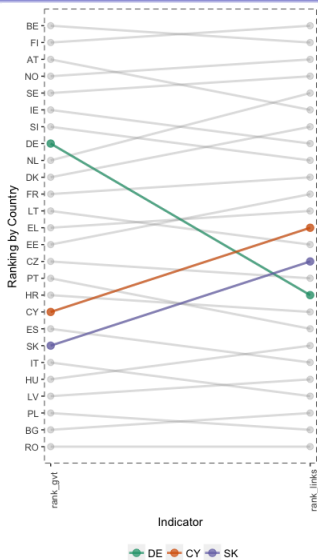
Country rankings in NIS Dimensions

# Ranking differences in pairs of dimensions:

## Public policy to Output



# Ranking differences in pairs of dimensions: Public policy to Cooperation





# What characterise NIS across countries?

- ▶ Little crowding out in public-private links and more additionality
- ▶ Close cooperation with firms, with public institutions and high domestic procurement associated with radical innovation (rather than internal R&D)
- ▶ International cooperation for innovation associated to high productivity performance

# Country clustering according to factor rankings

## Country clustering according to factor rankings

### Cluster means by factor

	iMarket	iFirmStr	iRD	cEURNAT	cUSCNIN	cCCC	gGvtFCo	gLRFDoPr	gForPr	oRadPat	oIncrPcs	oOng	oPtvtv	
Frontier	7	5.5	5.5	8.0	2.5	5.3	4.5	2.5	3.5	3.0	3.0	5.5	8.8	5.5
Nordic	2	12.3	7.7	4.0	6.7	3.7	5.7	8.3	13.7	8.0	8.0	14.7	6.0	5.7
G7_IE	3	4.0	5.0	8.0	10.7	9.3	17.7	8.0	4.7	16.7	8.0	5.0	11.0	6.3
LargeMed_CE	1	13.7	15.7	10.7	18.7	20.3	19.7	15.0	17.0	21.3	14.7	17.0	6.7	13.7
Med_Balkan	4	13.0	14.0	21.7	14.5	15.3	10.5	15.3	12.7	11.5	15.0	9.8	21.2	18.3
North_CE	5	21.7	20.7	13.3	16.0	14.7	14.3	19.3	19.0	13.3	20.7	23.3	13.0	17.7
CEE	6	24.0	24.5	20.3	24.5	23.5	24.5	24.3	24.5	23.0	23.8	22.5	19.8	22.3

Frontier	AT	7
	BE	7
	FI	7
	NO	7

Nordic	DK	2
	NL	2
	SE	2

G7_IE	DE	3
	FR	3
	IE	3

LargeMed _CE	CZ	1
	ES	1
	IT	1

Med_Bal kan	CY	4
	EL	4
	HR	4
	LT	4
	PT	4
	SI	4

North_CE	EE	5
	HU	5
	SK	5

CEE	BG	6
	LV	6
	PL	6
	RO	6

# Key findings: The European Technology Clubs

There is not such a thing as a European Innovation Systems. Clubs of NIS that are

- ▷ Top-Notch: Frontier Small (AT,BE,FI,NO). Highest rank in most factors, high public support complemented by high public private links; high innovation performance
- ▷ Demand-pulled: G7+IE (DE,FR,IE). Highly ranked in demand and in national public procurement and local public support
- ▷ Linear R&D-based: North Small (DK,NL,SE). High private investment in R&D, coupled with high (not the highest in NL) public support and outward cooperation
- ▷ Coping: Large Med + CZ (IT,ES,CZ). Above av inno inputs and outputs, relatively low public support, relatively less cooperative
- ▷ "Spoiled" Under-performing: Small Med + LT (HR,CY,EL,LT,PT,SI). Specular with the Coping, above av public support but low in inno outputs
- ▷ Embryonic: CEE and CE+EE (EE,HU,SK,BG,PO,RO). Rank low in all factors

# What to do? Challenges for policy

- ▶ Speeding up the process of moving away from unfavourable initial conditions
- ▶ Timing of public intervention with respect to the actual absorptive capacity of firms
- ▶ Identification of technological opportunities that fit with the (initial) industrial structure
- ▶ To be able to favour technological upgrading and structural change
- ▶ Coordination with macro economic policy: favourable demand conditions are a must for the achievement of the above

# Our research agenda

- ▷ From Technological Clubs to varieties of growth regimes looking at employment and distributional polarisation
- ▷ How are these countries facing the employment emergency posed by the fourth industrial revolution?
- ▷ An empirically grounded devised concerted vision of innovation, industrial policy and fiscal policies.
- ▷ European Technology clubs within Global Value Chains



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