Measuring product innovation and innovative capacity: new indicators to evaluate research programmes

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Evaluation of STI policies, instruments and organisations: New horizons and new challenges
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Agenda

1. Challenges evaluating R&D programmes: how to measure innovation?
2. Background: evaluation of the German Aviation Research Programme 2003-2014ff.
3. New indicators: using „Technology Readiness Levels“ to measure product innovation and measuring „Innovative Capacity“
4. Conclusions

Challenges evaluating R&D programmes

- Research projects are
  - risky
  - their outcome is uncertain
  - sometimes failures are necessary to find the right way
  - ways to exploitation are intricate
  - with very long time spans before exploitation begins

- Cause-effect relationships to economic success of an enterprise and to programmes are very difficult to establish

Types of innovation

Product innovation
Introduction of a good or service that is new or significantly improved with respect to its characteristics or intended uses

Process innovation
Implementation of a new or significantly improved production or delivery method

Marketing innovation
Implementation of a new marketing method involving significant changes in product design or packaging, product placement, product promotion or pricing

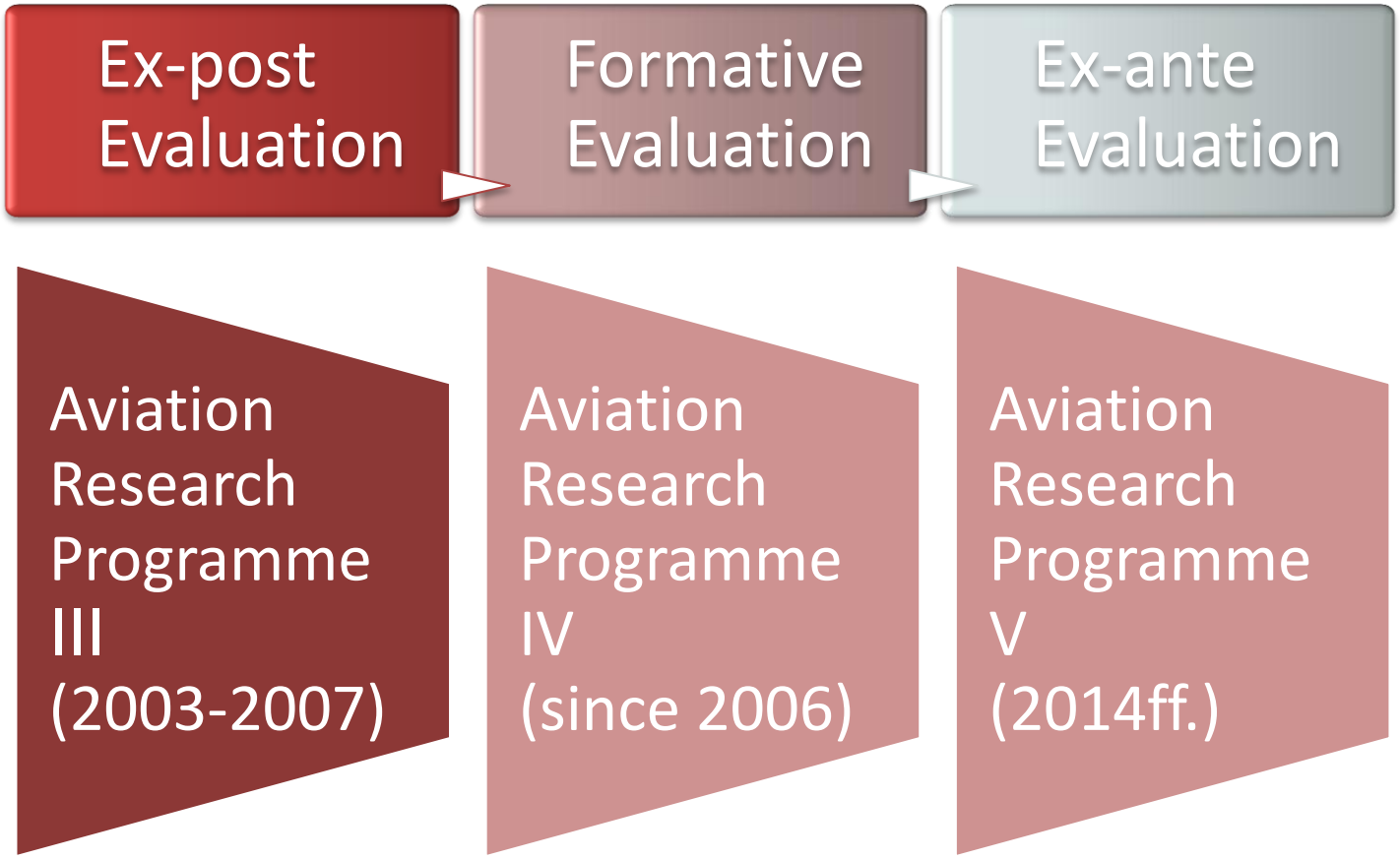
Organizational innovation
Implementation of a new organizational method in the firm's business practices, workplace organization or external relations

Tiwari 2008, Oslo Manual 2005

Focus of this presentation

- **Measuring steps of product innovation during R&D:**
  If there is a long time span between basic research, R&D and market-ready products, it becomes necessary to measure 'in-between' steps along this R&D&I process. The 'Technology Readiness Level (TRL)' approach is used as a metric for these intermediate steps.
- **Measuring innovative capacity:**
  Regarding these long time spans, it makes sense to measure not only impacts on innovations, but also on innovative capacity. Innovative capacity relates to companies´ ability to produce innovation. One core aspect of innovative capacity is the innovation-conduciveness of organisational structures within the companies. Thus, an analysis of innovative capacity will also shed some light on relations between organisational and product innovations.

Background: Evaluation of the German Aviation Research Programme 2003-2014ff.



Evaluation: January 2012 – March 2013

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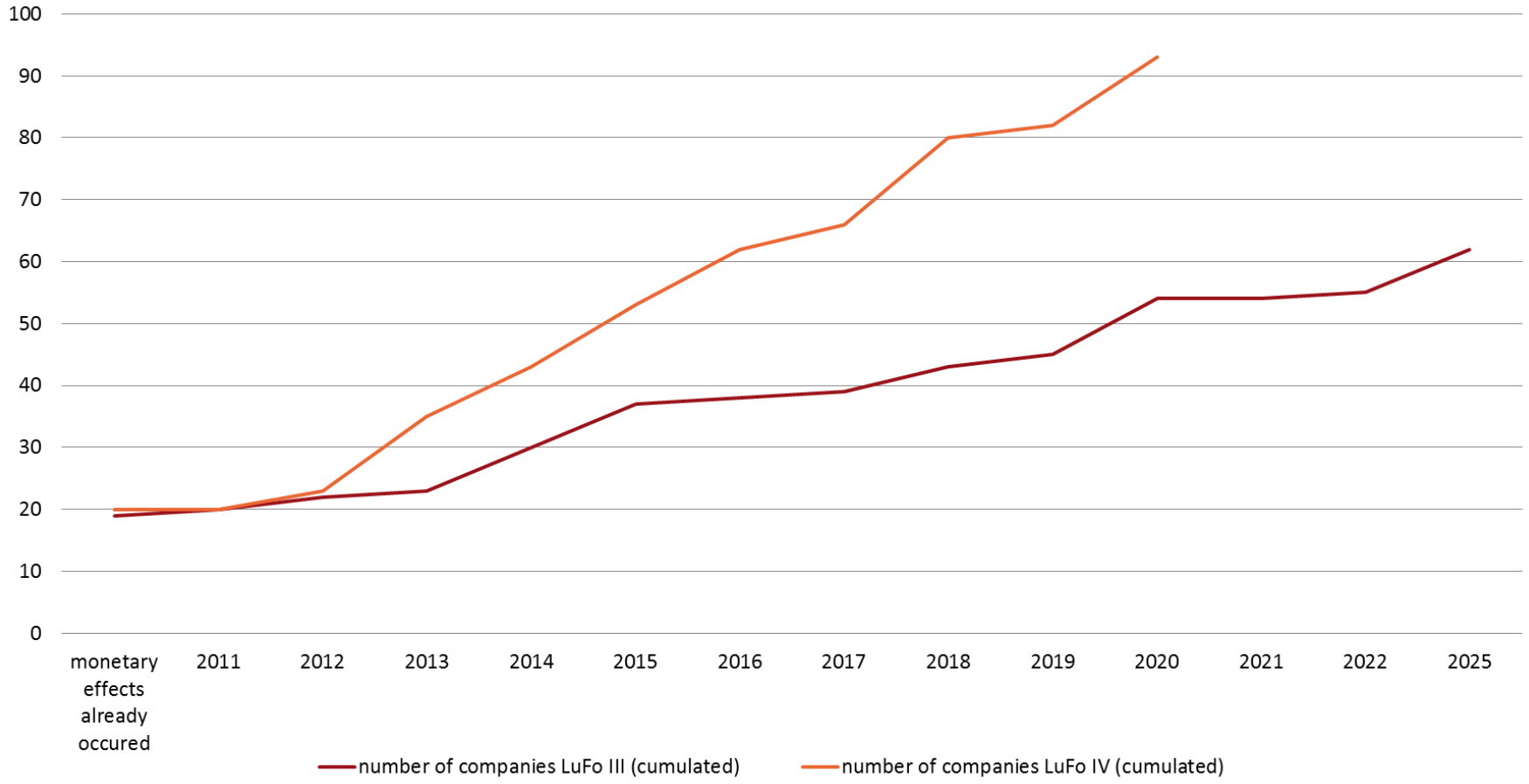
Very long time spans before exploitation



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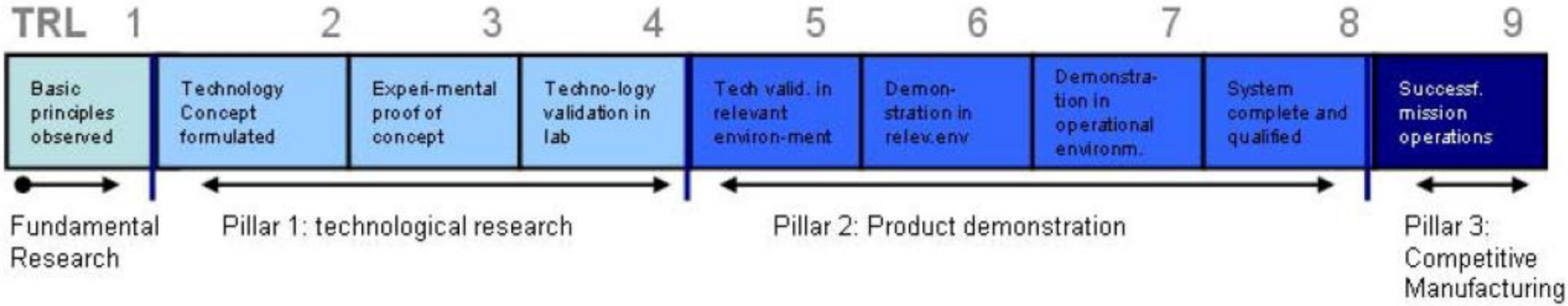
Technology Readiness Level



COM(2012) 341 final

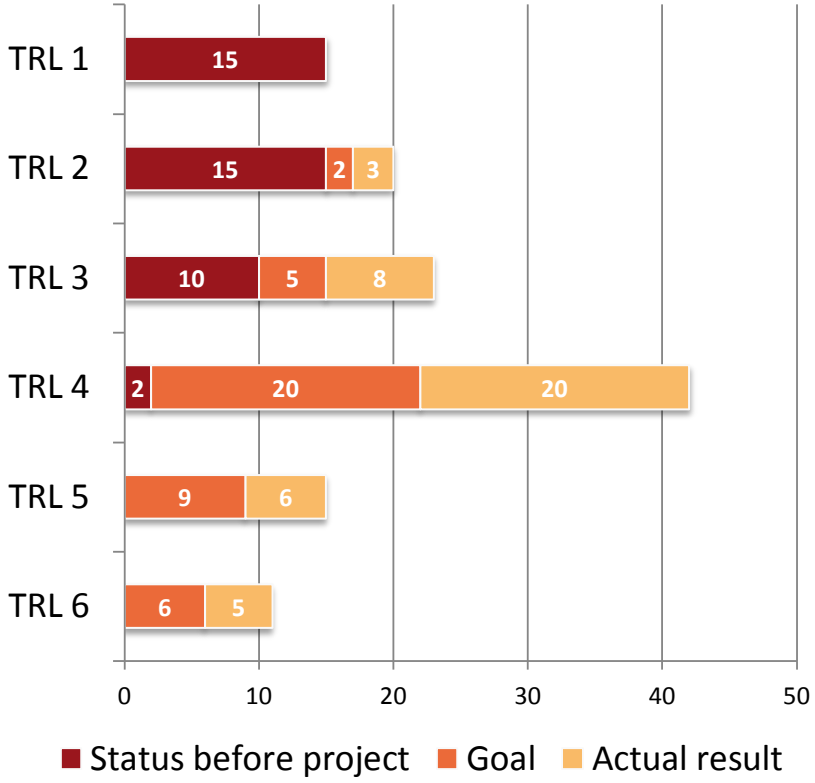
Technology Readiness Level	General description (US DOD Definition)
TRL 1	Basic principles observed and reported
TRL 2	Technology concept and/or application formulated
TRL 3	Analytical and experimental critical function and/or characteristic proof of concept
TRL 4	Component and/or breadboard validation in a laboratory environment
TRL 5	Component and/or breadboard validation in a relevant environment
TRL 6	System/subsystem model or prototype demonstration in a relevant environment
TRL 7	System prototype demonstration in an operational environment
TRL 8	Actual system completed and qualified through test and demonstration
TRL 9	Actual system proven through successful mission operations

Application within the evaluation

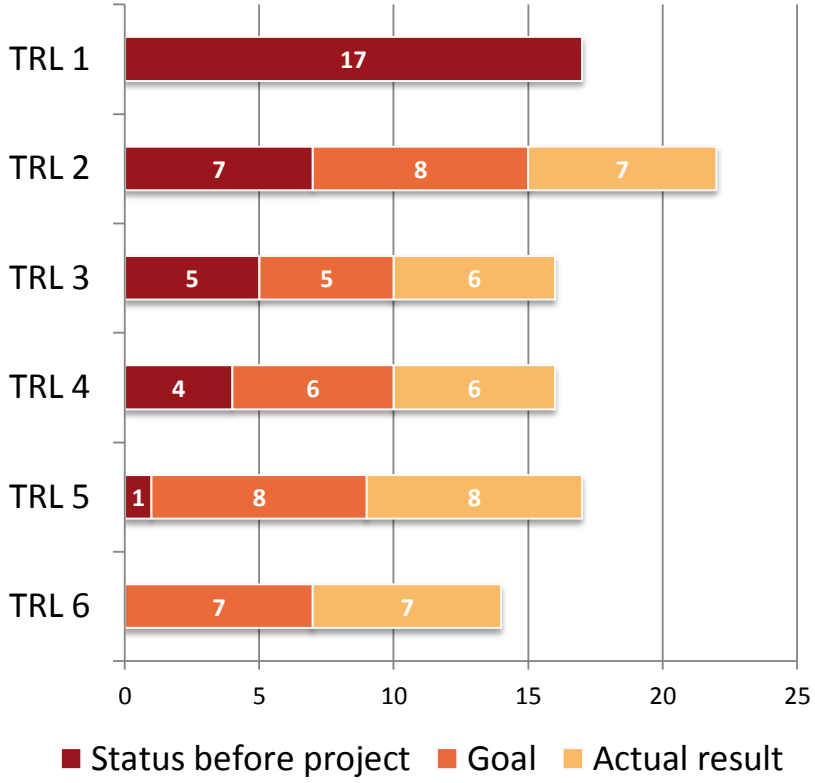
- Several questions in the survey sent out to project managers (companies, institutions)
- „What TRL was achieved before starting the project?“ – „What TRL did you want to achieve?“ – „What TRL did you achieve at the end of the project?“ – „What TRL did you achieve until now?“
- Using different definitions for hardware and software/production technologies

Results

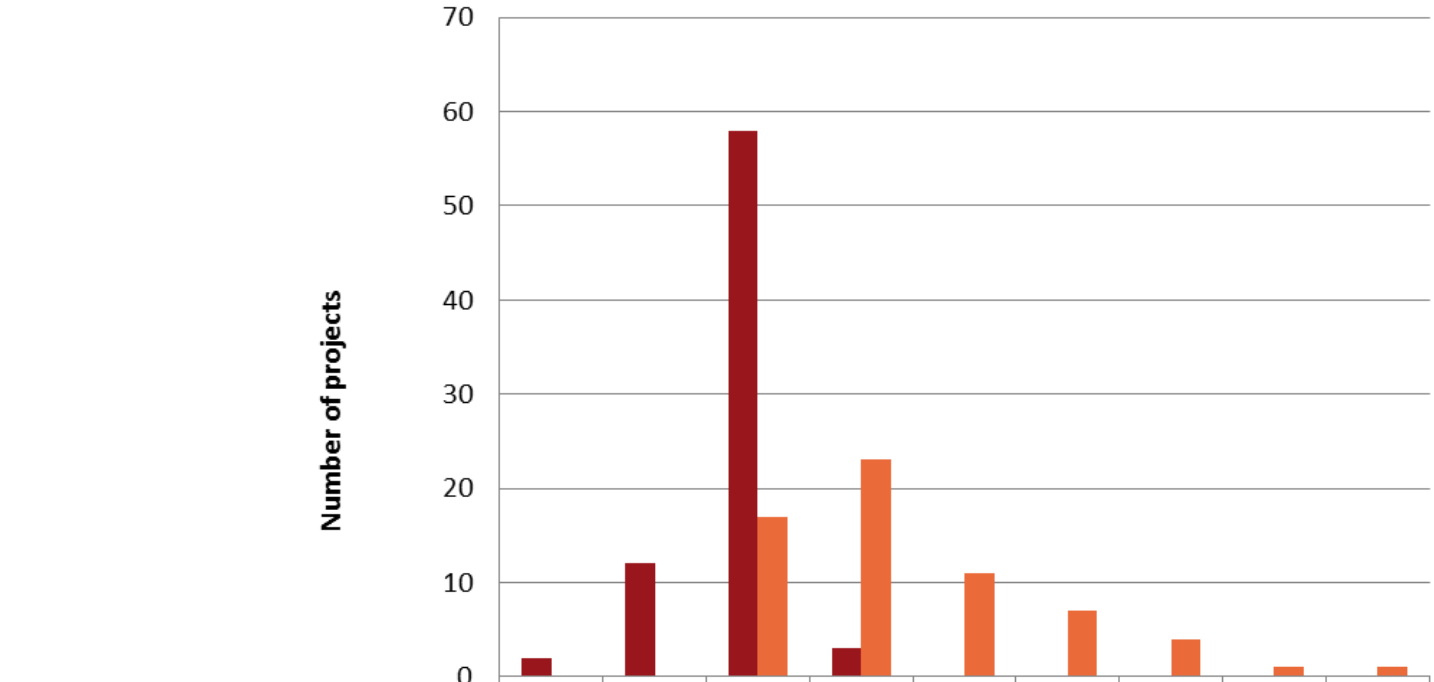
Hardware (aviation specific)



Software and hardware (non-aviation specific)



Difference
TRL reached/today – TRL planned



	-2	-1	0	1	2	3	4	5	6
Difference TRL reached - TRL planned	2	12	58	3	0	0	0	0	0
Difference TRL today - TRL planned	0	0	17	23	11	7	4	1	1

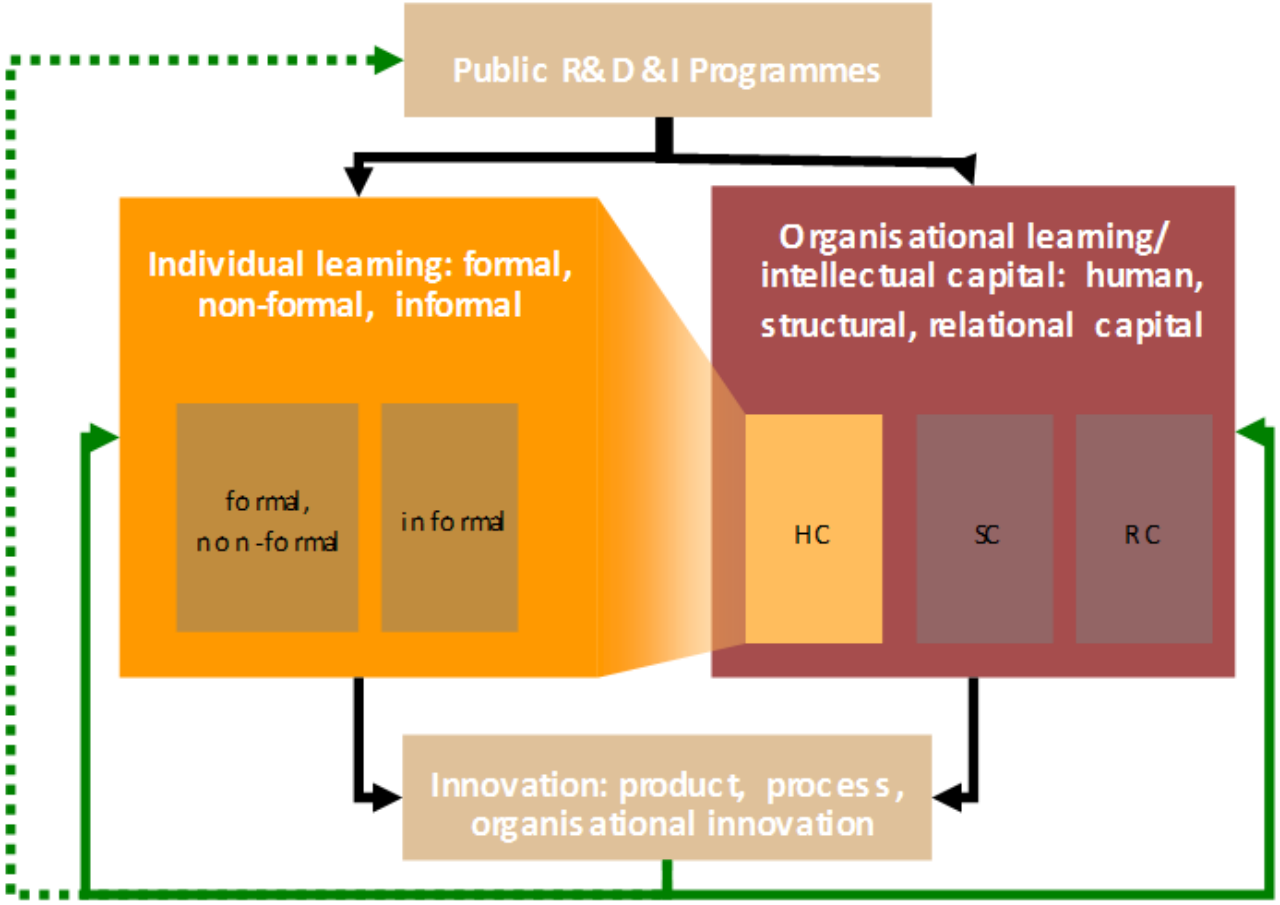
Results on TRL

- Concept was understood by participants
  - Evidence of technology development
  - Assessment of single project‘s results
- Progress of technologies can be shown at a stage where no monetary assessment is feasable
- Not all the projects fit into the logic

Innovative Capacity

- … relates to companies´ abilities to produce innovation
- … is an explicit objective of the Aviation Research Programme
- … is a core prerequisite for actual innovation
- … is attracting more and more awareness in discussions relating to innovation analysis and measurement
- … is an impact dimension which can be assessed earlier than other intended impacts of the Aviation Research Programme, as e.g. new aircraft or components being introduced into the market

Assumptions on causal relationships

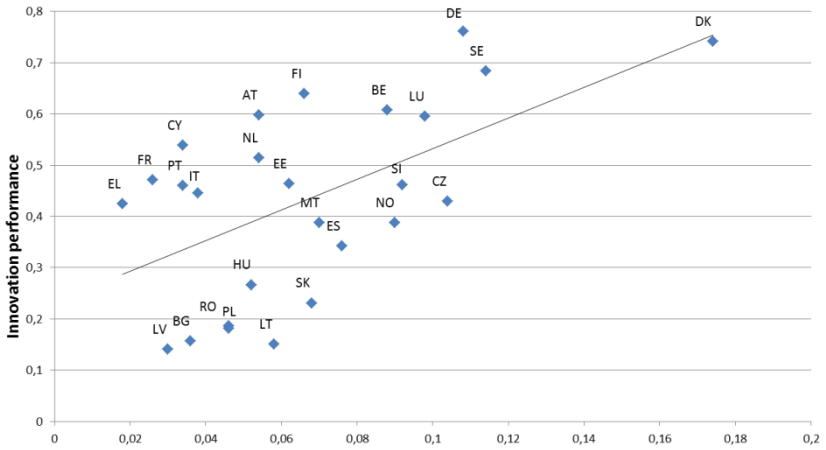


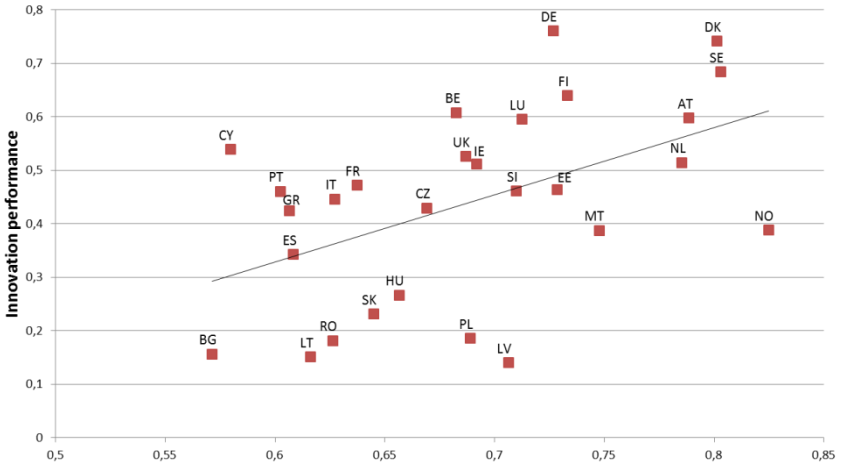
Three dimensions of of innovative capacity

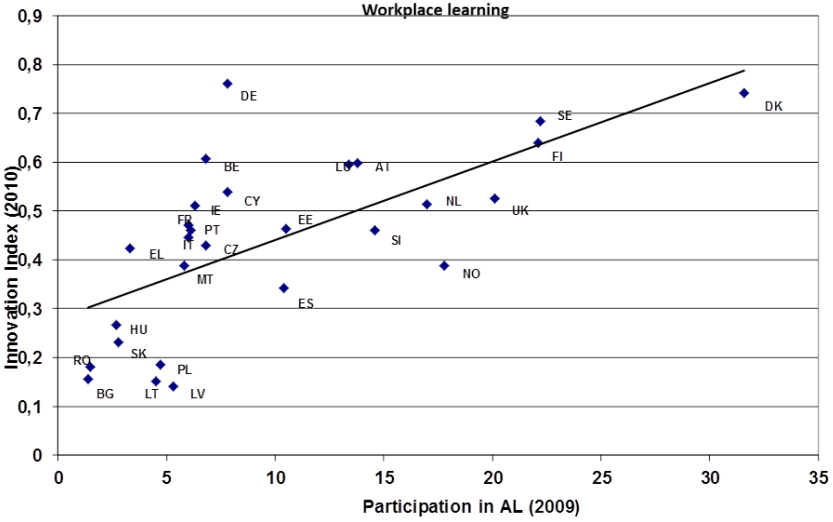
Human capital	Structural capital	Relational capital

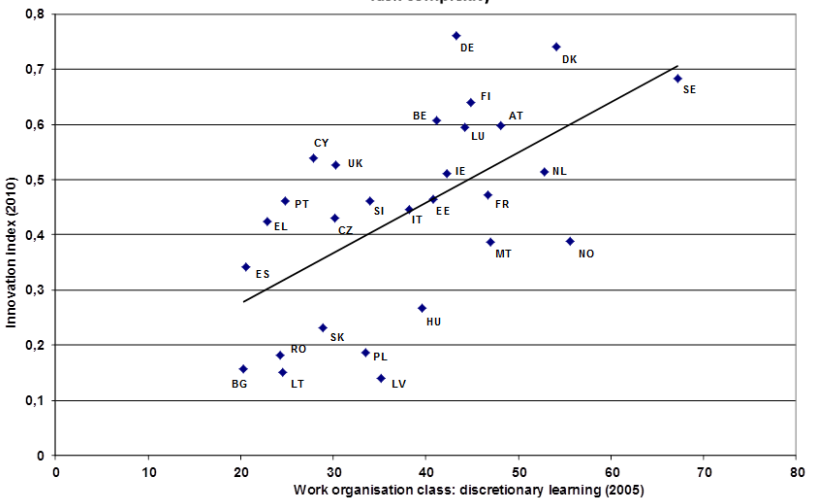
• Knowledge and skills of employees
  • Formal (degree)
  • Non-formal (further education without degree)
  • Informal (learning by doing)
• Human resources development, provision of continuing vocational education by employer
	• R&D structures
	  • departments
	  • Technological equipment
	• R&D processes
	  • Within R&D
	  • Communication and cooperations between R&D and production
	• Learning-intensive and innovation-conducive organisational structure
	• Learning and innovation-oriented corporation culture
		• Relations to
		  • customers
		  • suppliers
		  • Research institutions
		  • educational services
		  • General public
		• Image and brand

Relationships between aspects of innovative capacity and innovation









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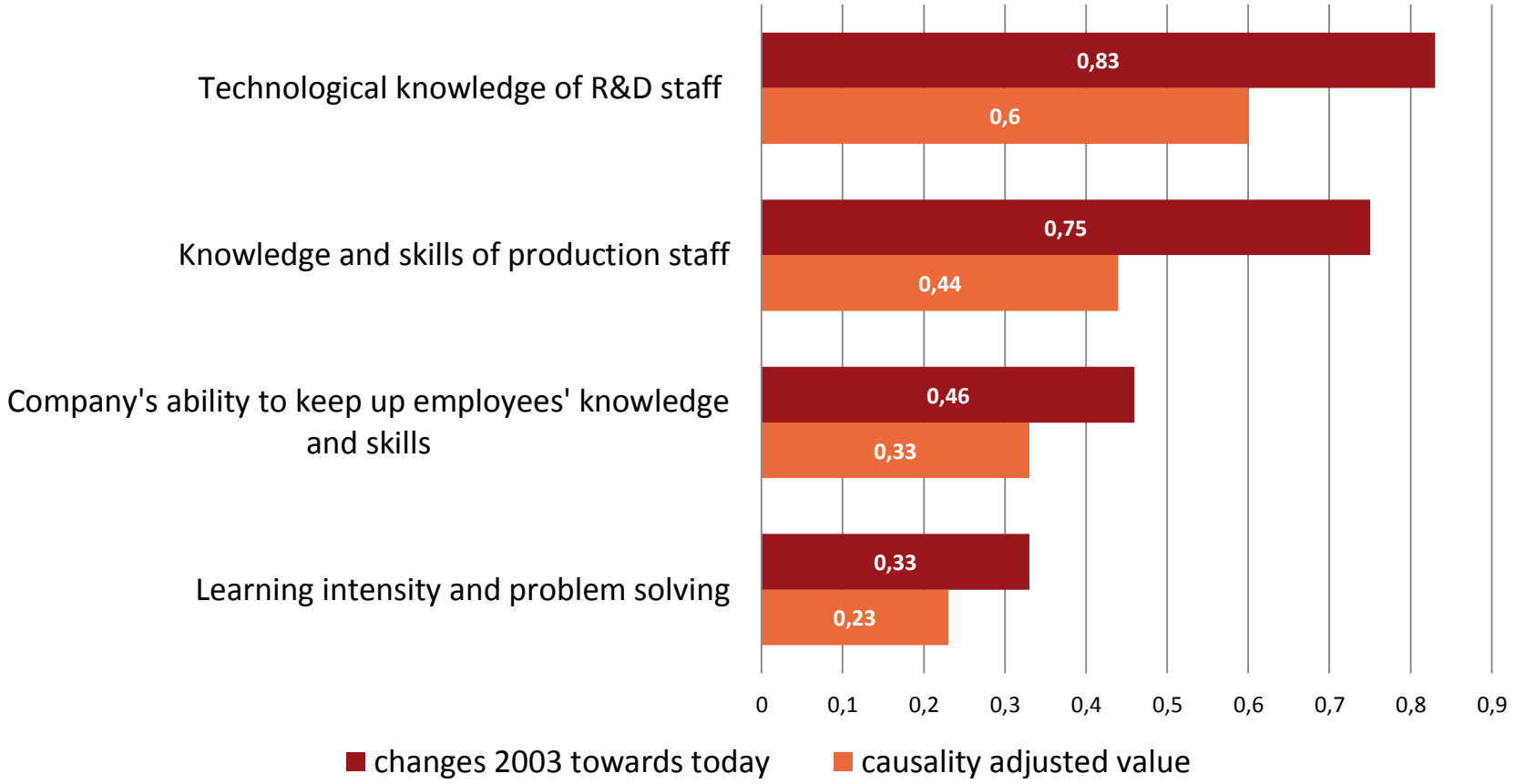
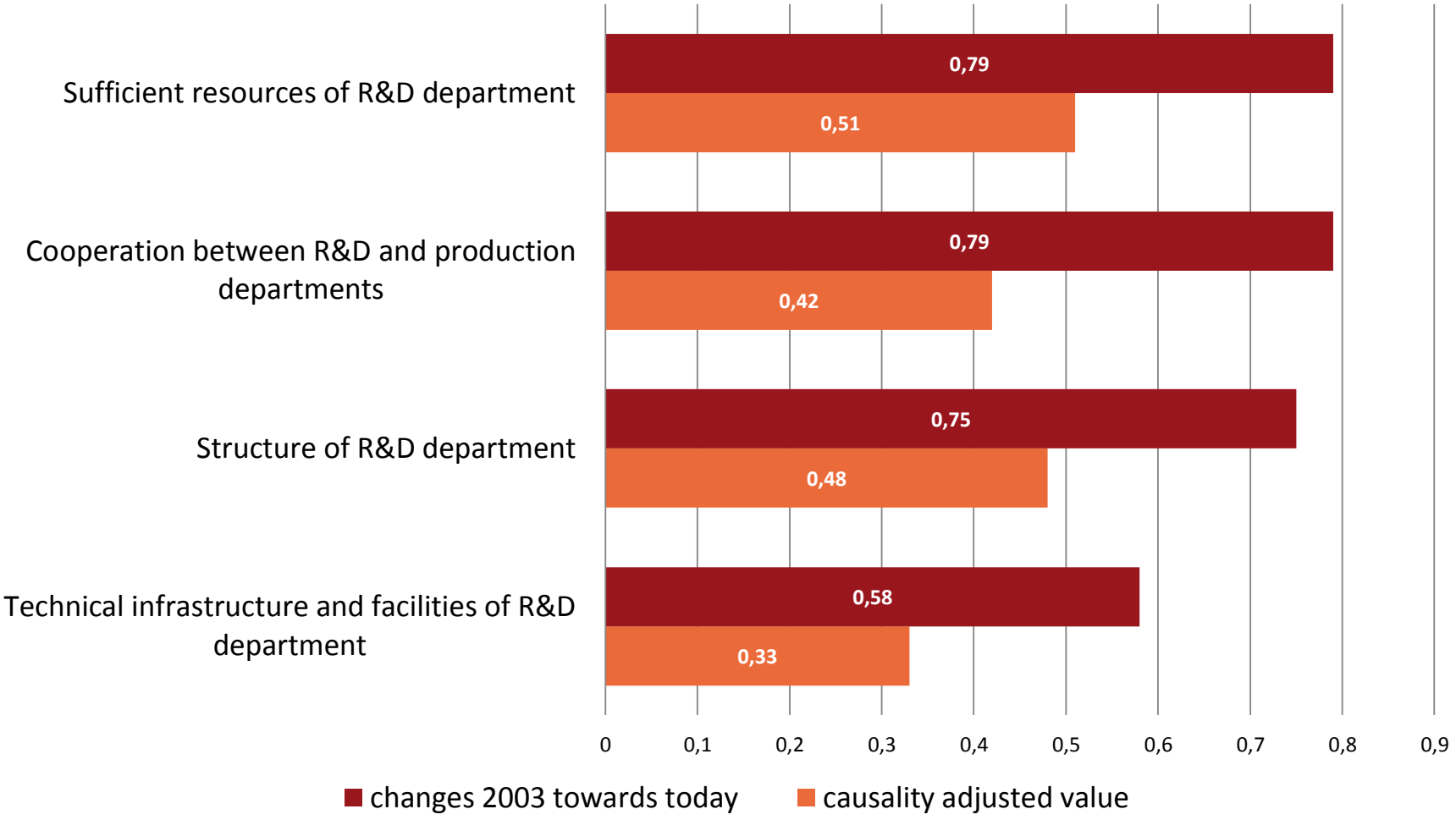
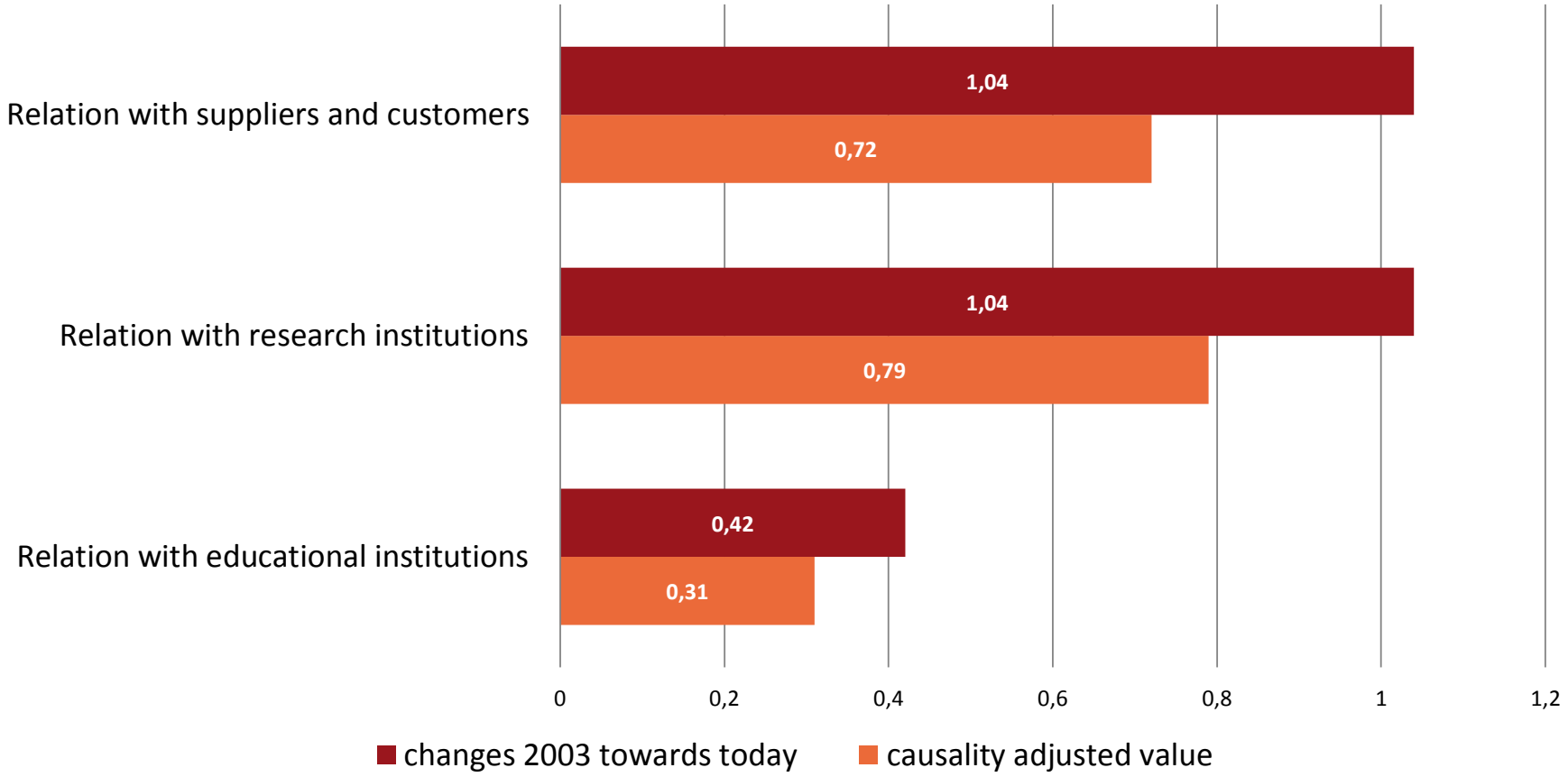
Results – Human Capital



Results – Structural Capital



Results – Relational Capital



Results on Innovative Capacity

- Effects can be shown which can be attributed to the programme
- Considering that innovative capacity is rather „sluggish“, these are surprisingly strong
- Effects on structural capital are higher than expected

Conclusions/Outlook

- We will use both concepts again in different areas
  - Will TRL be applicable to other industries?
  - Which categories can be used to capture those projects that do not fit into TRL definitions?
  - Instrument for innovative capacity will be further developed
  - Further establish link between innovative capacity and innovation performance
- iit indicator on innovative capacity will allow for regional, industry, and country comparisons