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Taking the Long Term View

Swedish and EU R&D Funding in Hindsight

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Vienna 18 October 2012

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Road map …

- Long term impacts
- The GSM Story
- The Framework Programme
- The Framework in Sweden
- What next?

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Long term impacts – back to the future?

- Some of the most interesting evidence about the long term impacts of research comes from the budget rivalry between the US National Science Foundation (NSF) and mission-orientated research in the 1960s
- The US Department of Defence commissioned the Hindsight study, which traced the research antecedents of a number of weapons systems back for twenty years or so and concluded that the underpinning research was largely mission-orientated in nature
- NSF retorted with the TRACES study, which traced backwards for up to fifty years from five important civil innovations and found critical connections to basic research
- The unsurprising implication is that both basic and mission-orientated research are at various times needed

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VINNOVA – taking the long view

- VINNOVA and its predecessors have played important roles in identifying, defining and growing new areas of needs-driven R&D in a process of dialogue with the research and industrial communities. This would not have been achieved had the funding been under the unique control of either the research or the industrial community
- This has been achieved through a combination of 'bottom-up', responsive mode funding and programming
- Programmes need both to be flexible – reflecting the uniqueness and adapting to the evolution of each field – and 'patient'
- Time constants are constantly under-estimated in R&D funding. It is not uncommon for 10-20 years to elapse before socio-economic effects of any size are visible

Elg, L. and Håkansson, S. (2011) När Staten Spelat Roll: Lärdomar av VINNOVAs Effekstudier. VINNOVA Analys, VA 2011:10, Stockholm: VINNOVA

VINNOVA – taking the long view (2)

- It is important to avoid the 'project fallacy'. Longer-term interactions allow beneficiaries to pursue their 'real projects' and strategies
- Key effects of funding have been the development of new clusters of human capital and organisational learning – system development, not just to underpinning individual innovations
- Effects are needed in both big and small firms – industrial renewal is a key ingredient
- Globalisation has meant that a key aim of R&D funding is not to 'support' wholly-Swedish companies but to make the Swedish innovation system attractive to companies irrespective of their 'nationality' or trans-nationality
- Where R&D programmes address societal needs, they have to connect with effective demand (ie users willing and able to pay)

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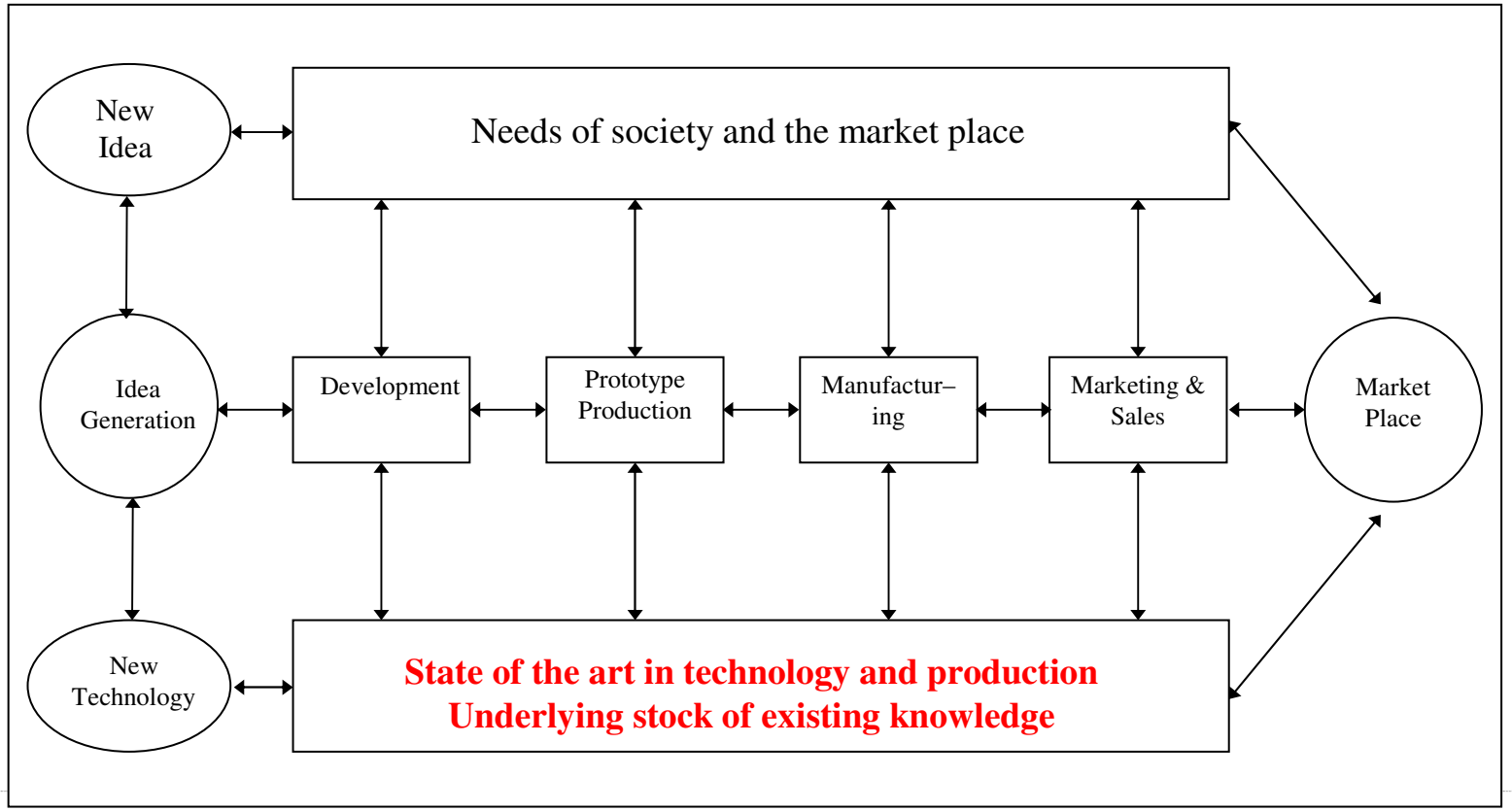
To understand this, we need a non-linear, systems understanding of the innovation process



Source: Mowery and Rosenberg, 1978

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Then we can see why there are so many links between research and industry

- Increase in the stock of useful knowledge
- Supply of skilled graduates and researchers
- Creation of new scientific instrumentation and methodologies
- Development of networks and stimulation of social interaction
- Enhancement of problem-solving capacity
- Creation of new firms
- Provision of social knowledge
- Shared access to unique facilities

Source: Ben Martin, Technopolis

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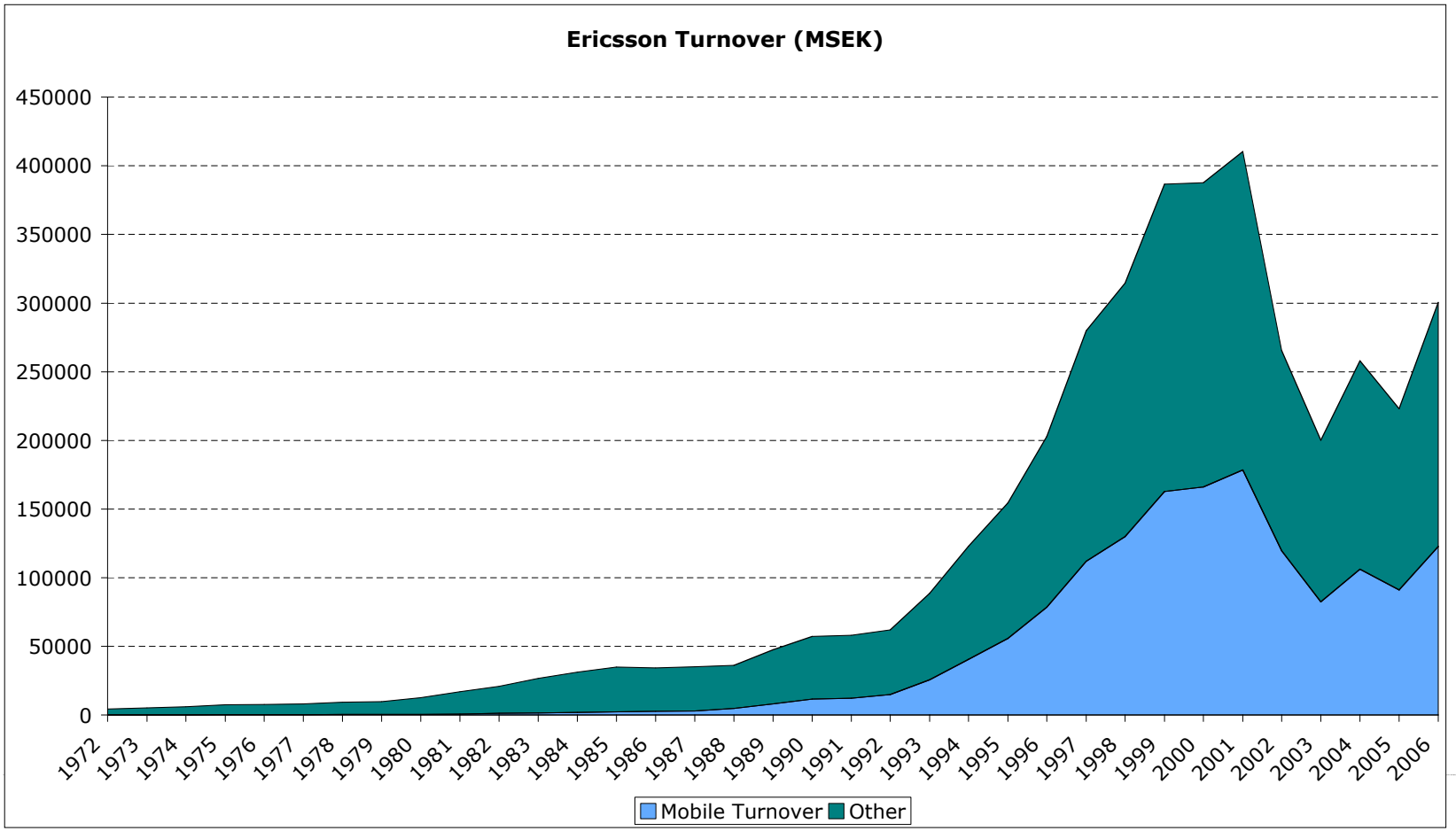
This is the story of Ericsson's transformation from bit-player to global dominance in digital mobile systems



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State action means the Nordic area was world leading in mobile telecoms from the outset

Generation	1G	2G	3G-	3G (2)	3G+ (4G)
System Examples	NMT AMPS TACS	GSM, PDC, D-AMPS, cdma One, DECT, PHS	GPRS EDGE	WCDMA TDCDMA MCCDMA	HIPERLAN/2 WLAN WATM
Maximum user data rate		9.6 kbps	384 kbps	2 Mbps	20 Mbpd
Dominant service	Analogue speech	Digital speech	Internet Data Speech	Multimedia Internet IP-telehony	High speed data using IP
Introduced	1982	1992	2000	2002	3G: 2002 (4G: 2012?)

Source: Sven-Olof Öhrvik

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The solutions were developed as part of a standardisation process

- 1G: PTT-dominated standards, coordinated via CEPT/ITU
  - *Nordic PTTs could define the NMT standard*
- 2G: Moving to the European level; growing industry involvement (from CEPT to ETSI)
  - *Ericsson and Swedish Telecom could influence the GSM standard, to their own advantage*
- 3G: Global management of de facto standards (from the telecoms to the computing model of standardisation)
  - *Global battles; states look on, helplessly*

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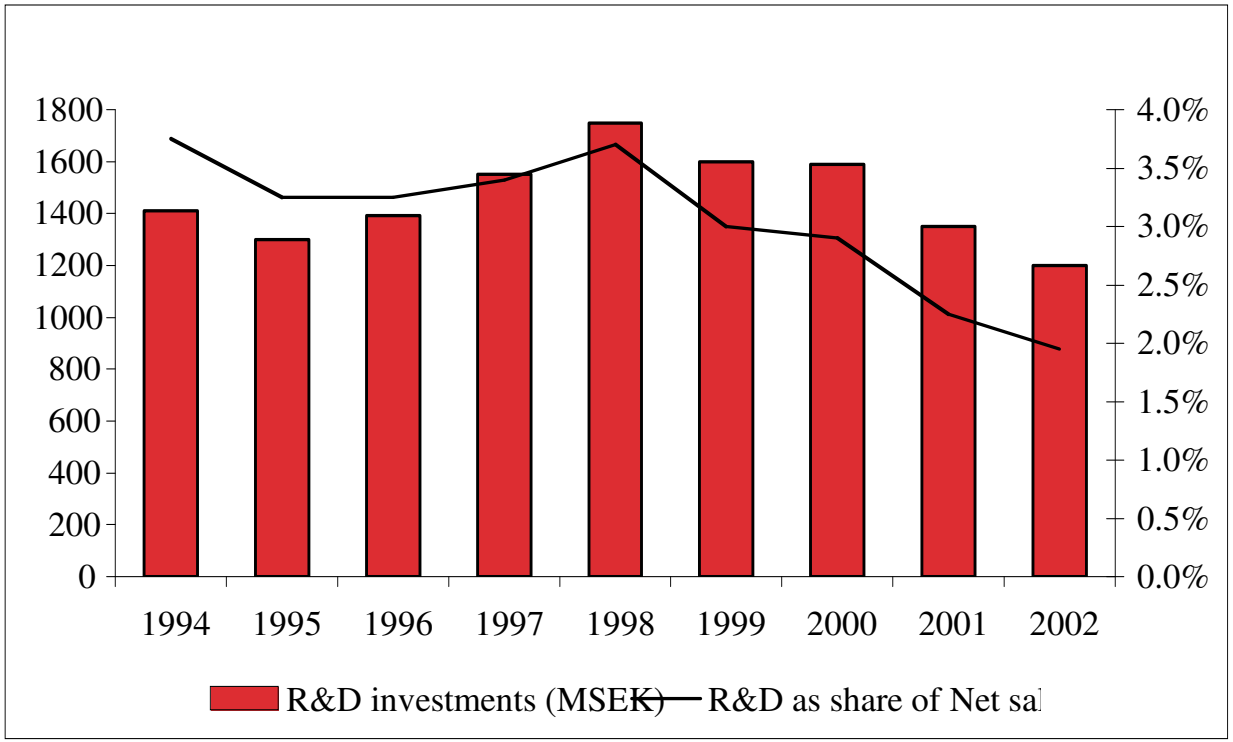
GSM was the last gasp of a 'development pair'. Swedish Telecom illustrates the decline of the PTTs as technology generators



Source: Lindmark, Andersson, Johansson and Bohlin,, 2004

Going digital depended on solving 6 problems in the radio access link

1. How to convert and code speech into digital form, using as little bandwidth as possible while maintaining acceptable speech quality
2. Coding multiple conversations into a single channel
3. How to protect the coded signal from fading and noise in the radio channel
4. How to modulate the resulting digital signal over radio waves while maintaining high bit rates
5. A particular problem was ‘inter-symbol interference’
6. How to implement the solutions to these problems in electronic components

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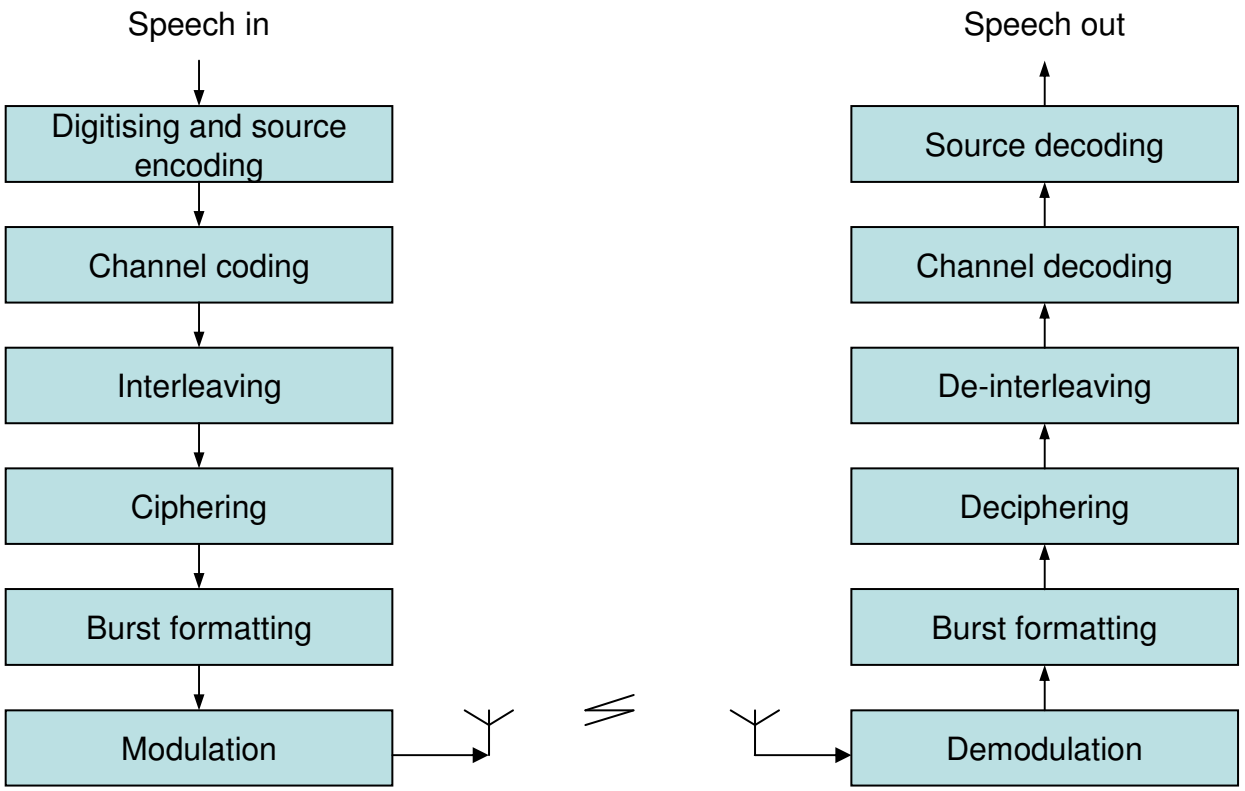
(By the way, this was the answer …)



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Mobilising research to help solve the problems at the 'radio club'

- Building on SRA capabilities developed to serve military needs
- Sven-Olof Öhrvik engages the research community through the 'radio club': Lund, Linköping, CTH, (KTH)
- STU supports the work via bottom-up project funding
- Universities launch new research agendas
- SRA runs internal problem-solving R&D projects that link with but do not wholly depend on university projects
- SRA moves Öhrvik to LTH; builds factories outside the university gates

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In the radio club period, the interaction involved only a handful of key university researchers

	Speech coding	Channel coding	Modulation	Propagation, equalisation	Components
Per Hedelin	X				
Lars Zetterberg	X	X			
Tomas Ericsson		X			
Rolf Johannesson		X			
S-O …hrvik		X			X
Jens Zander		X		X	
Lars Ahlin		X		X	
Bjšrn Gudmundsson				X	
Carl-Erik Sundberg			X		
Tor Aulin			X		
Arne Svensson			X		
Mats Torkelsson					X
Sven Mattisson					X
Claes Hammar					X
Lars Wanhammar					X

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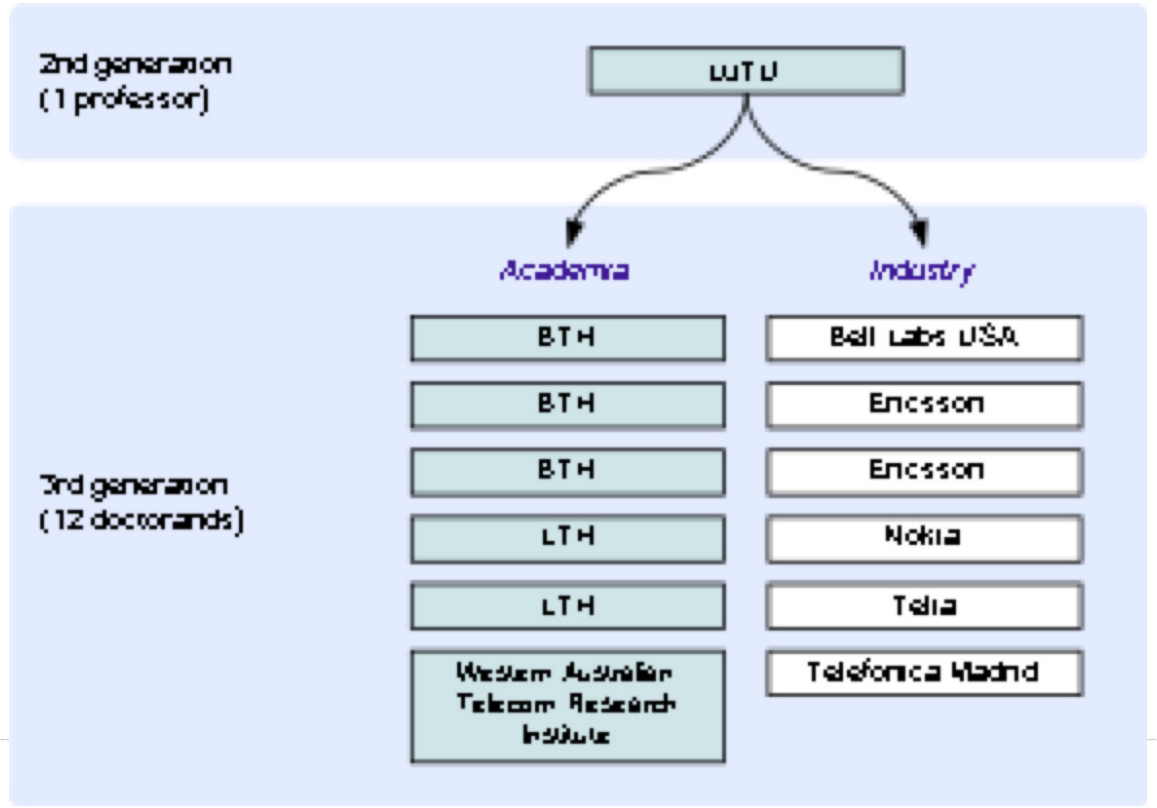
However, the 2G transition involved no fundamental research

- This study found not a single case of 'linear model' ideas transfer. The developments all depended on refining the stock of existing knowledge
- David Roessner has the same result for the 1G-> 2G transition in the USA: the NSF played no role at all

The development of human capital was key - but not just 'any old human capital' (eg Lund)



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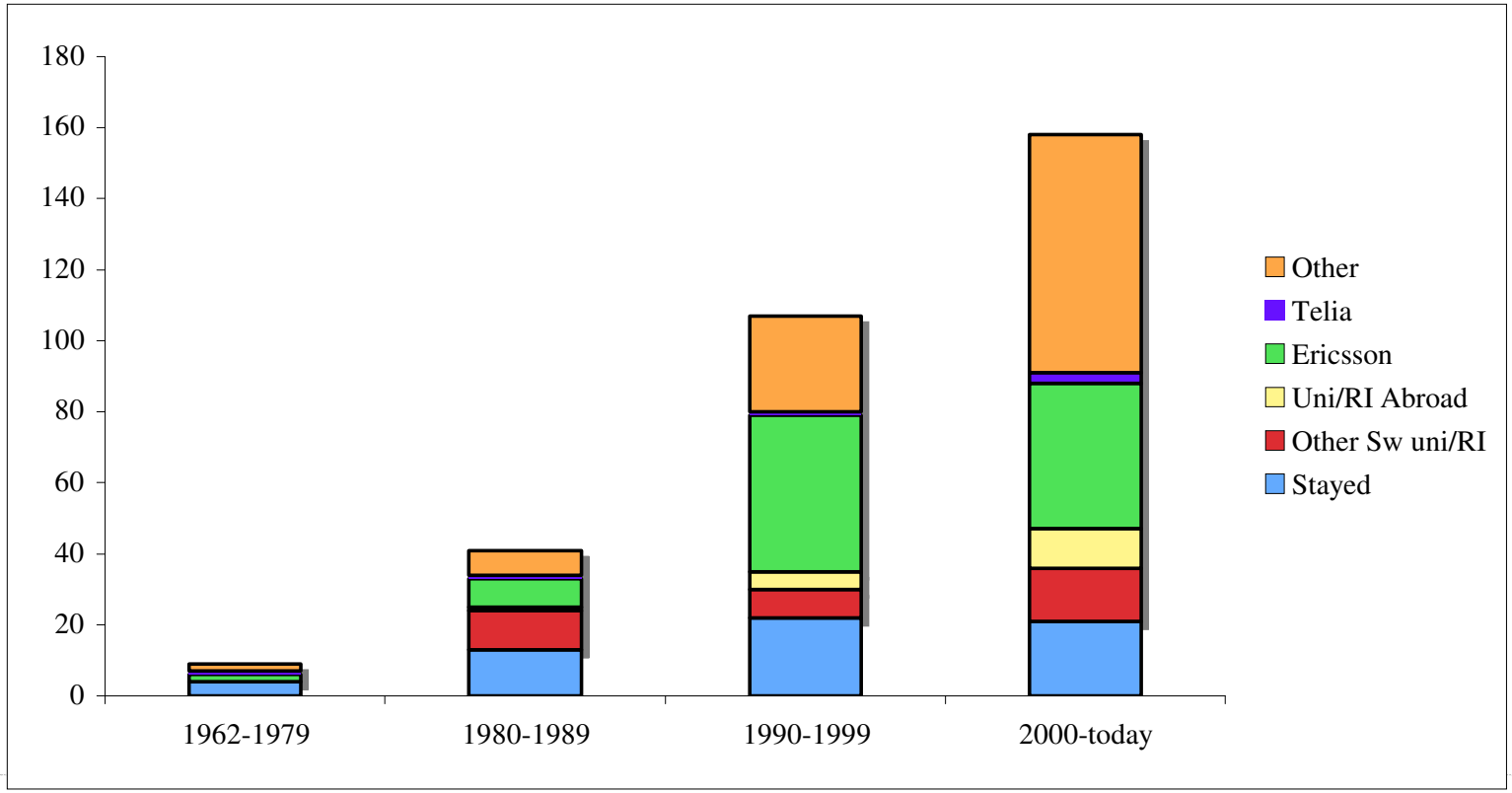
Scaling up human capital production to meet system needs underpinned Ericsson's success (PhD, lic)



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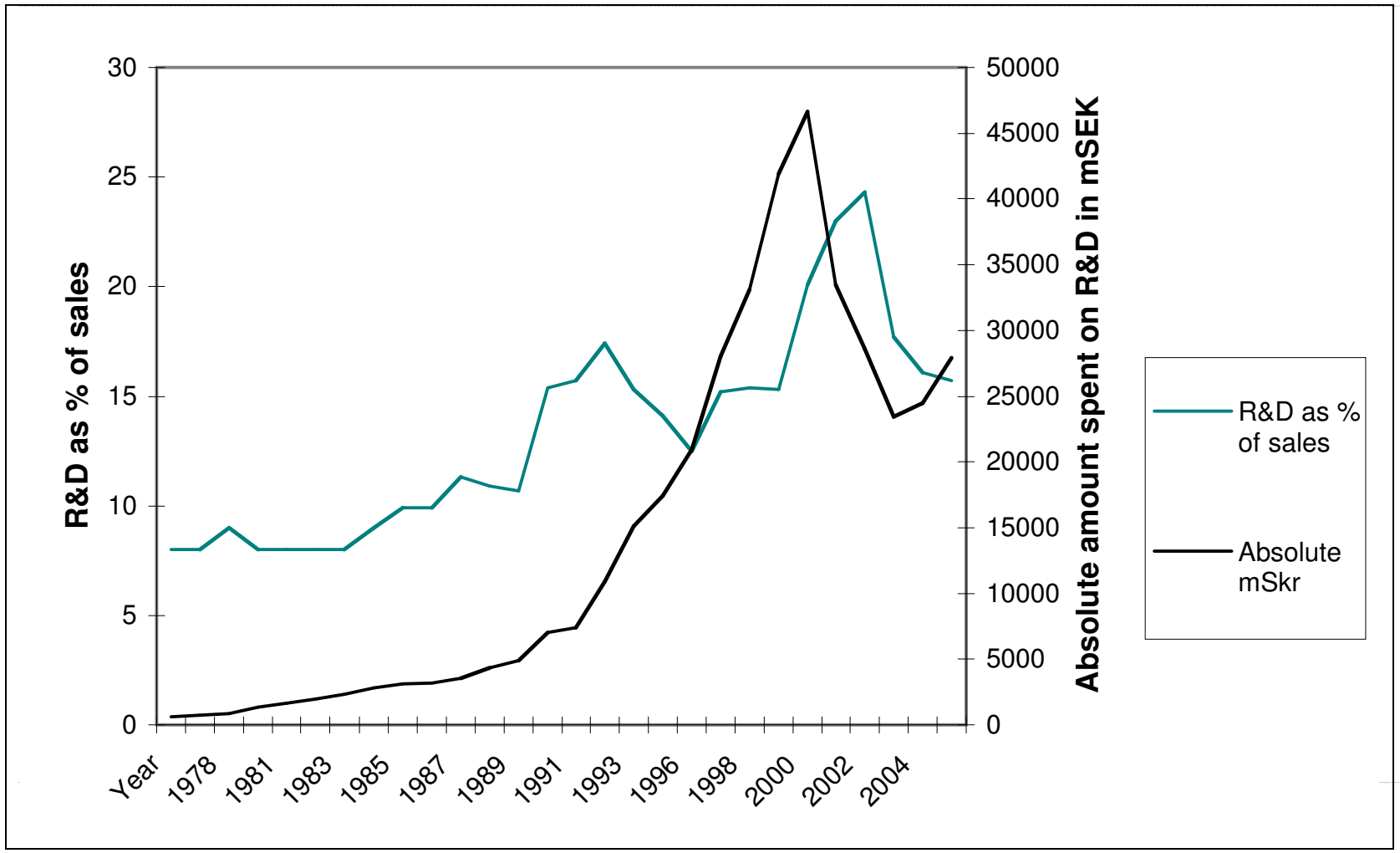
It enabled the transformation of Ericsson



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STU support followed the work of the radio club until the launch of the Digital Communications programme in 1987 - scaling up in earnest

	CTH	KTH	LTH	LiTH	Total
1978			50,000		**50,000**
1979		488,750	798,000	1,820,000	**3,106,750**
1980		729,910	2,485,000	307,808	**3,522,718**
1981		771,105	696,500	1,337,900	**2,805,505**
1982	605,980	1,111,292	283,560	2,354,340	**4,355,172**
1983		620,122	712,000	900,720	**2,232,842**
1984	1,050,200	1,542,000	1,024,300	1,150,100	**4,766,600**
1985	425,900	1,109,000	1,895,000	2,509,300	**5,939,200**
1986	706,000	1,198,300	2,480,000	741,000	**5,125,300**
Totals	**2,788,080**	**7,570,479**	**10,424,360**	**11,121,168**	**31,904,087**

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This role of STU was part of a much bigger picture

- Introduction of programming - using project funding as a search engine and relying on intense discussion with industry and the universities
- But set within a top-down strategy of bootstrapping Swedish ICT capabilities that led to the national IT programme
  - *NMP*
  - *ITx*
  - *IT Applications .....*

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This case suggests important things about the state's role in innovation systems

- Innovation is complex - the simple models mislead
- Both research council and use-oriented funding are needed
- Innovation funding should balance project-based search and programmatic intervention

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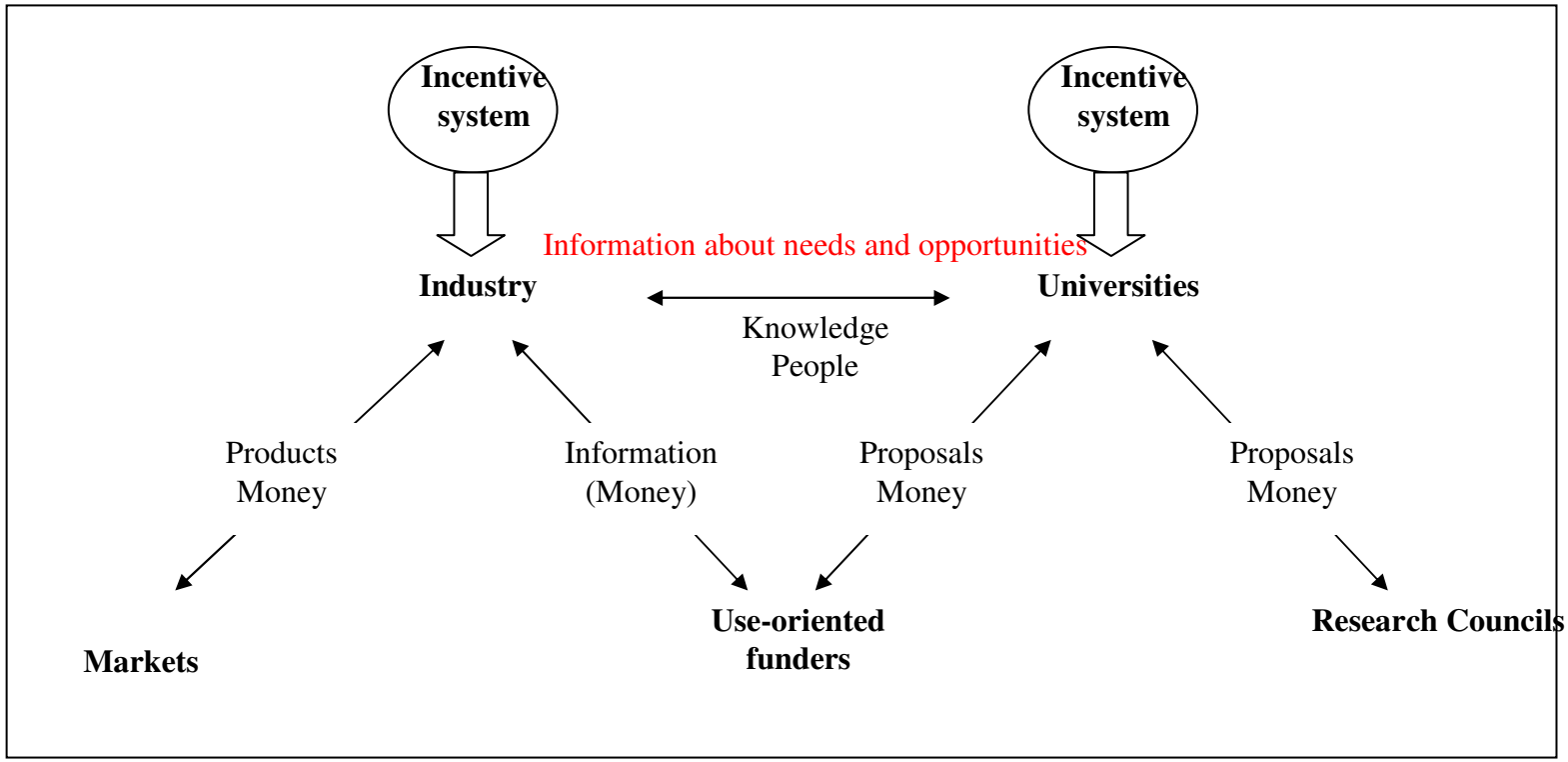
We need a funding system that 'walks on two legs'
(*Två pelare*, in the Nordic discussion)



Source: Mowery and Rosenberg, 1978

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How do we do more of this?

- SRA's absorptive capacity was crucial
- We need informal focusing devices like the radio club as well as formal programmes
- Large-scale change may need cross-system coordination, as in the national IT programmes
- The innovation agency needs technological capability and the right to take risks, especially at project level: "Lose small; win big"
- We need **change agency**, not just administration
- Large companies matter

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There are lessons for industry, too

- SRA transformed Ericsson and made it survive - despite its start as a ‘skunk works’ operation
- Selective, intelligent university interaction on a permanent basis, using own absorptive capacity
- University links are not only about knowledge but also about manpower
- Distinguish research from development and use research to reduce uncertainty
- Participate in focusing device efforts, such as test beds - the openness will be amply repaid

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What do we already know from meta-evaluation of the FP?

- The FP funds high-quality R&D: appraisal is tough; competition is fierce; participants perform better than non-participants in bibliometric terms; they include the scientific elite
- Growth in high-quality international co-publication within Europe has accompanied the growth of the FP
- Just as the FP attracts the more excellent researchers in their fields, so it engages the more research-intensive companies within their respective branches
- It is – by design – a pre-competitive, collaborative programme, primarily producing 'intermediate knowledge outputs' as well as technical and market network relationships that are re-used in other R&D and business processes
- Participants who enter projects with a deliberate product or process innovation objective are more likely to obtain short-term results than others

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More of what we know …

- With few exceptions, the FP is a place to exploit existing strength. Especially in established areas, it is too competitive to allow capacity building – that has to be done with national resources
- Most participants have only a fleeting relationship with the FP. However, new participants appear to learn the value of networked R&D and increasingly to participate in 'open innovation'
- There is a strong core of established players and networks whose composition slowly shifts over time. Just as with global 'scientific colleges', you have to 'earn your spurs' in order to join these networks and to carry on delivering value to your partners if you want to survive
- However, we know very little of the details of how networks work, how networking relates to strategy or how network shape relates to success

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Yet more …

- Despite the trend to larger instruments in recent Framework Programmes, bigger networks do not seem to be more productive than smaller ones – in fact, what evidence there is suggests the opposite
- The FP is often associated with pre-normalisation R&D and the development of technical standards
- Most participants believe that FP participation increases their competitivity but the indirect nature of the FP's effects (through 'intermediate knowledge outputs') makes them very hard to track
- Parts of the FP that focus on smaller firms and more direct results have been evaluated using a cash benefit-cost approach, which suggests high benefit-cost ratios. Smaller firms benefit less than larger ones (and are generally less satisfied with FP participation)

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In our long term study we see some impact mechanisms that are less visible in a short term perspective

Long-term impacts	QIPC	Brain Research	O_3	Solar PV	Auto-motive	Manu future
Discovery	X	X	X	X		
Creating new knowledge outputs, more generally, especially moving towards applications	X	X	X	X	X	
Discipline development	X					
Focusing device in relation to innovation				X	X	X
Agenda-setting	X	X	X	X	X	X
Promoting self-organisation of stakeholder communities	X	X	X	X	X	X
Influencing regulations or standards	X		X	X	X	
Coordinating or influencing policy		X	X	X	X	X
Networks, Knowledge Value Collectives; defragmenting the research community	X		X	X	X	X

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In the long term we see different impact mechanisms (2)

Long-term impacts	QIPC	Brain Research	O_3	Solar PV	Auto-motive	Manu - future
Changing research network shapes: putting Europe in the centre	**X**	**X**	**X**	**X**	**N.A.**	**N.A.**
Levering funding for R&D	X	X	X			X
Mobility and development of human capital	X	X	X	X	X	
Research infrastructure (Grids, test-beds, etc)						
Behavioural additionality: learning a 'new' innovation model		X			X	X
Speeding up industry entry into new technologies	X					
Tackling problems too big for an individual Member State	X	X	X			X
Addressing areas of major socio-economic importance for the EU	X	X	X	X	X	X

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Some of the more interesting dimensions of intervention

Positive

- Legitimating new fields
- Focusing devices
- Creating consensus: problem definitions, road maps, standards
- Empowerment and self-organisation of stakeholder groups
- Structuring the R&D fabric
- Knowledge Value Collectives

Problematic

- Lock-ins
- Absence of disequilibration, creative destruction?
- Inward-looking in an increasingly irrelevant continent?

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A new approach to understanding FP impacts

- Traditionally, EU- and national-level FP evaluations look at projects funded within the latest FP, missing the historical and learning dimensions, over-focusing on the views (and the field of vision) of the technologists involved
- This study asks what the FPs have done for Sweden in a 20-year perspective, in
  - *Sustainable energy; Life sciences and health; ICT; and Vehicles*
  - *The Universities of Lund, Gothenburg and Växjö, the Karolinska Institute and the Chalmers Institute of Technology*

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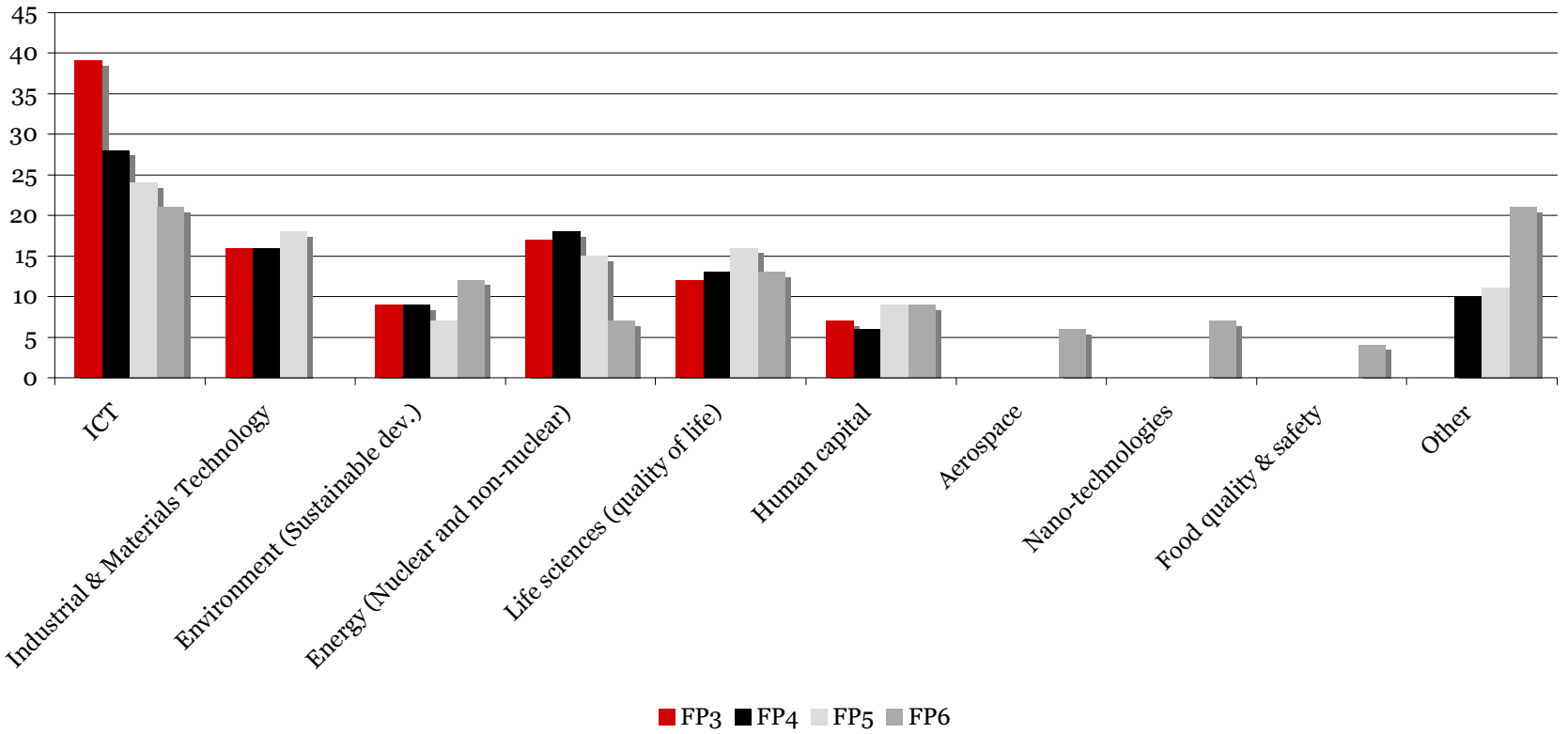
Changing thematic emphasis of FP3-6



Changing activities of the FPs

- Originally 'the Commission's industry policy', there is a long-term trend towards research
- Up to FP4, scale, networking and cohesion were key goals; collaboration and mobility the main instruments
- FP5 adds social benefits, in an ill-defined way
- FP6 is a reorientation, reflecting the new ERA research aims; adds bigger new instruments (NoEs, IPs) and more explicit 'structuring' and self-organising measures (ERANETS)
- FP7 builds on this: JTIs, Article 185*. European Research Council

*The article formerly known as 169

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Sweden in the FPs

- Involved at least since FP2 on the industry/institute side (IT4)
- The universities join in from FP3 and quickly dominate
- Five companies persistently participating at scale (Volvo, Ericsson, Saab, Vattenfall, Telia)
- A handful of industrial institutes - more state labs

- Shift from industrial to research policy
- Big role of the state and state-influenced organisations

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Swedish participation in the FPs

	FP3	FP4	FP5	FP6	Total
Non-Swedish participations	11,231	55,681	81,305	66,774	214,991
Swedish participations	730	2,694	3,115	2,493	9,032
Swedish participations as a %	6.1%	4,6%	3.7%	3.6%	4.0%
Total participations	**11,961**	**58,375**	**84,420**	**69,267**	**224,023**

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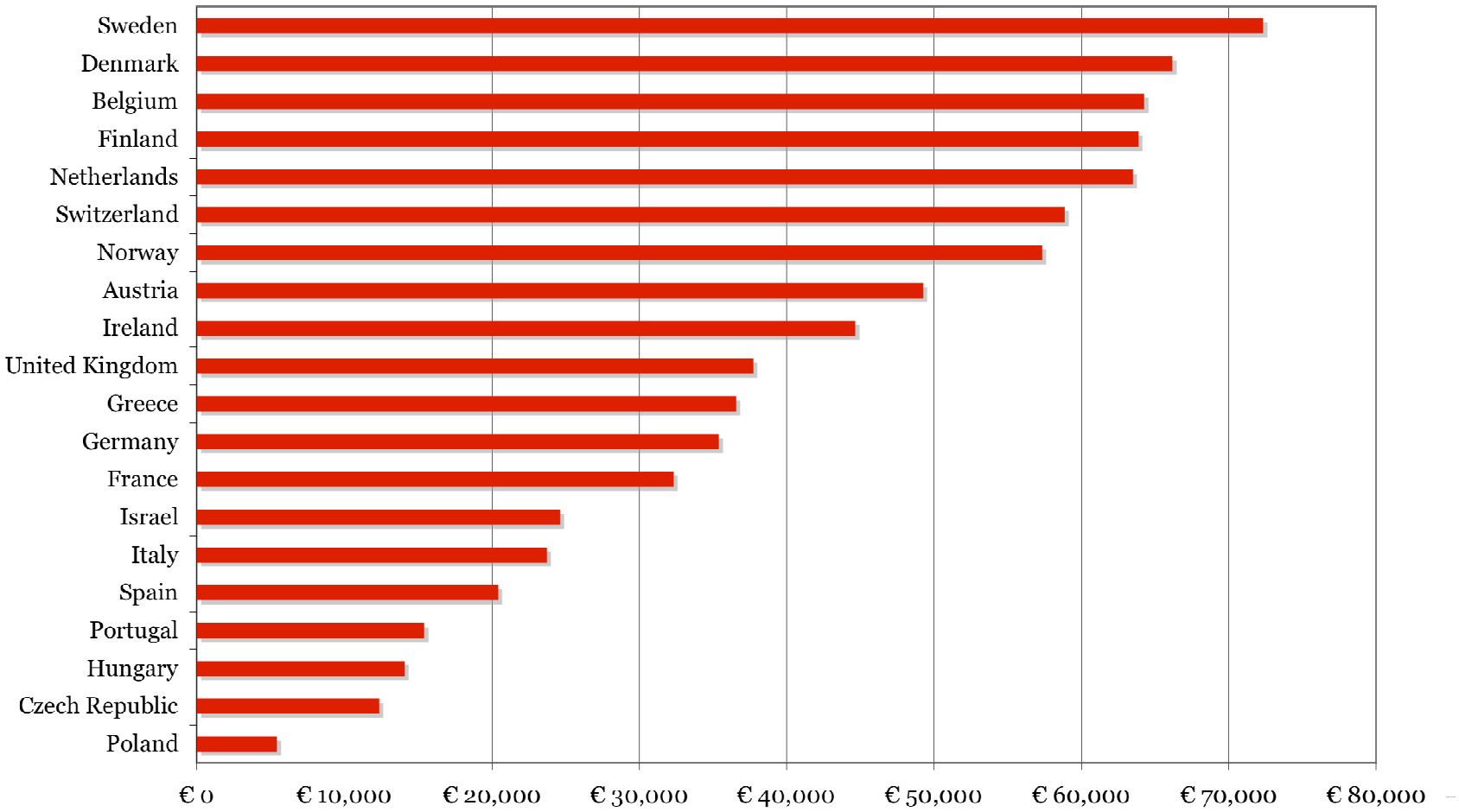
Sweden gets the best per capita returns (FP6)



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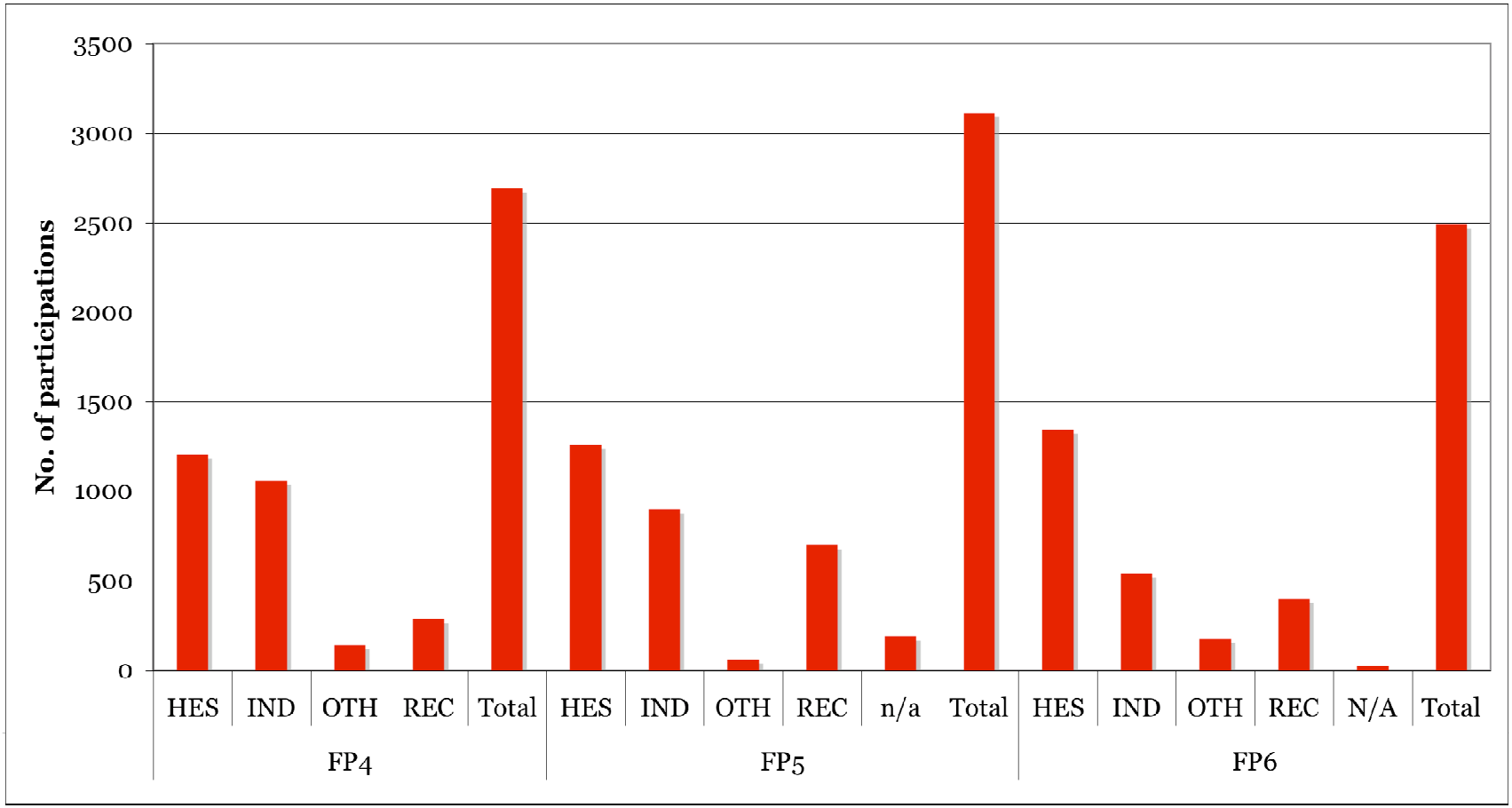
Slowly, the academics take over



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Industry: only a handful of usual suspects

FP3	
Company	**Participations**
Volvo	25
Ericsson	12
Saab Group	14
Telia	13
Vattenfall	3
ABB	2
AstraZeneca	2
Pharmacia	1
Celsius	1
Sandvik	1

FP4	
Company	**Participations**
Volvo	49
Ericsson	29
Vattenfall	25
Saab Group	23
ABB	20
Telia	19
AstraZeneca	8
Pharmacia	8
Sandvik	6
Celsius	4

FP5	
Company	**Participations**
Volvo AB	86
Ericsson	34
Saab AB	29
Vattenfall	17
SK*	17
Alstom Power	9
Tribon	8
Sydkaft	8
TPS	7
Astra Zeneca	7

FP6	
Company	**Participations**
Volvo AB	52
Ericsson	19
Teliasonera	13
Saab AB	12
Vattenfall	11
SK*	9
Arexis AB	6
Cellartis AB	5
Silex Microsystems AB	5
Biovitrium AB	4

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Institutes: weak participation; state-dominated

FP3		FP4		FP5		FP6	
RI	**Participations**	**RI**	**Participations**	**RI**	**Participations**	**RI**	**Participations**
FFA	12	IVF	24	SP	32	FOI	26
SICS	12	FFA	18	SMHI	29	VTI	19
KIMAB	10	VTI	17	FOA	21	IVL	19
SIK	10	SP	13	ACREO	20	SP	18
IVL	6	SMHI	9	SMI	19	IVF	16
STFI	6	IVL	9	SIK	15	SIK	15
VTI	4	SICOMP	8	VTI	15	SICS	15
ALI	4	SMI	8	SSI	13	ACREO	14
SP	4	ALI	8	SICS	12	SMHI	13
SMHI	4	SIK	7	ALI	11	SEI	12

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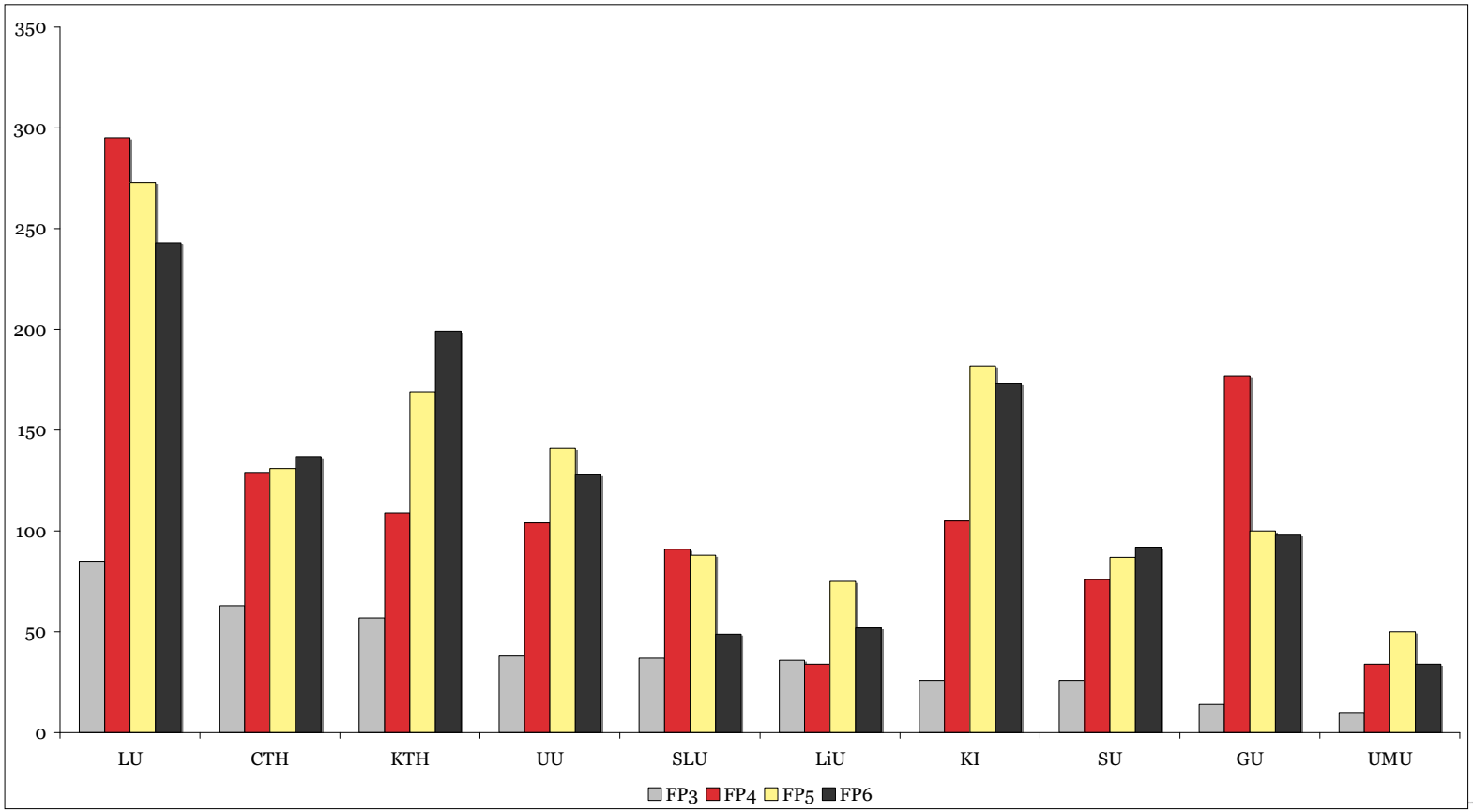
Top-10 Universities



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Past evaluations of impacts in Sweden

- Networking for technology and business
- 'Intermediate knowledge outputs' not products or processes
- Participation builds on domestic track record and funding portfolio
- Induced only minor changes in direction of researchers' trajectories
- Rather separate university and business networks - bridged by pre-existing industry-university relationships
- Quality equal to or better than Swedish nationally funded research

FPs are diverse and hence have diverse effects

- Fundamental research
- Industry-driven research and innovation
- Standardisation and pre-normalisation (in areas where this could not be done at the national level)
- Road mapping and other activities that help the vision of technological communities to converge on agreed trajectories
- Developing human capital and increasing its mobility

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Sustainable energy

- Increased volume of research, especially in universities
- Thematically, researchers do 'more of the same'
- Fragmentation of research community persists
- Major equipment manufacturers consolidate their positions but take no new risks
- Disappearance of development pairs means risks are transferred primarily to SMEs and the pace of change is dictated by the market (Very different to Statoil/Hydro, by the way …)
- Swedish failure to 'join up' research, industry, innovation and tax policies prevents more rapid change in technology or use
- Hence the FPs add money. But do they add value?

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Life sciences and health

- FPs add research resources to an already well-performing basic research system
- Small extension in strategic direction, taking on some of the EU disease priorities
- Big pharma stays away from the FP and other 'pre-competitve collaborative' programmes - they don't fit the business model
- Industrial participation is small - almost all SMEs (another case where risk is systematically shifted to the weak)
- Lack of explicit Swedish strategy prevents selective use of FPs or any influence by Sweden upon the FPs
- Question: How to protect Swedish interests in the JTI era?

ICT

- Participation here, too, is dominated by universities (and institutes to a degree)
- FP contributes resources to an essentially national strategy of expanding research and education in ICT
- Industrial participation is spotty: only Ericsson and (to a degree) Teliasonera persist
- FP performs key roles in generating consensus, road mapping and setting de facto standards for 3G
- Crucial contribution to the development of Ericsson's global mobile business - FP3 still producing innovations today
- FP a strong and positive influence on Swedish competitiveness

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Vehicles

- This industry exists in Sweden today largely on the basis of strong state support and inspired management, especially in Volvo TU / Vtec
- Participation is rather industry-dominated, with industry involving the 'usual suspects' among its Swedish university partners
- The industry largely tells the EC what to put in the FPs - and industry signs up to the technology agenda it has co-defined
- FP support strongly complements the closer-to-market support provided by the Swedish state
- FP/Eureka instrumental in technological trajectories including RTI, safety, combustion, catalysis, new drivelines
- A necessary but not sufficient condition for the survival of the Swedish industry

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Universities

- The best performers are best placed to participate, but everyone's working more internationally
- FPs have added quite a lot of **additional** money to the funding pot
- FPs add diversity to the funding portfolio, occasionally leading to research group survival
- Good for researcher networks and postgraduate education (but diminishing marginal returns)
- Little influence on thematic strategies because there is little strategy to influence
- Strategy gap in relation to renewed ERA critical mass aims

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Impacts in summary

Potential Impacts	Unis	Sus En	Life	ICT	Vehicles
Research strategy	X	X	?	X	?
Structuring research	X	X	X	X	X
Scale of research	¦	¦	¦	¦	¦
Quality	¦	¦	?	¦	¦
Addressing EU questions	?	X	¦	¦	¦
Convergence/visioning	X	X	X	¦	¦
Industrial innovation	¦	¦	¦	¦	¦

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Circularities

- FPs are open to strategic suggestion, especially from the powerful. But if you want influence, you also have to know what to suggest
- A bottom-up approach to the FPs leads only to self-reproduction
- FP is weak at tackling areas of high technological uncertainty and areas where there is not a clearly dominating set of players
- The FP is an R&D programme - sometimes you need more joined-up policy than that, eg sustainable energy

Some policy implications for Sweden

- An acute need to develop strategies for thematic and institutional concentration in the ERA
- A need to communicate about strategy and needs to the Commission, the research and industrial communities
- A requirement to support increased Swedish participation in the Technology Platforms and other new structures such as the JTIs. It is not clear that the FPs will continue in their present form
- A need to maintain a fully independent set of national strategies and programmes tuned to national needs but more deliberately to consider how to use the complementary resources available from the FPs. A slavish reproduction of the FP priorities is in the interests neither of Sweden nor of Europe

Some more policy implications

- A need to find policy mechanisms that can compensate or substitute for the Framework Programme's weakness as an instrument to tackle fragmented SME- and technology-based industries
- A need for new mechanisms that can go beyond R&D support to tackle some of the key innovation risks in radical technological change in areas like energy and climate change, where there is not necessarily time available to wait for a market solution to emerge but where risk-sharing between equipment supply and major users is a requirement for transition

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- The Framework in Sweden
- What next?

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What next in evaluation?

- More innovation in evaluation questions and methods. But this means
  - *Increased risks*
  - *Higher ratios of inputs to outputs*
  - *Accepting that not everything we try will work*
- Beware the newly-graduated PhD with a freshly-forged hammer …
- Micro work that engages more seriously with the science, technology and markets over long time periods
- Linking macro and micro explanations
  - *Not 'doing a Samuelson' …*
- Multi-factor explanations, especially extending from knowledge to human and institutional capital
- More attention to policy and market contexts
  - *Intervention + Context = Impact*

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Thank you

This PowerPoint is available at www.fteval.at

- *The GSM Story*
- *Understanding the Long Term Impacts of the Framework Programme*
- *Impacts of the Framework Programme in Sweden*

… are all available at from the downloads page at
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