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Technological Change and the challenges for development:

building on the experience of less favoured regions

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What is this talk about?...

To extend human capability through

innovation and competence building,

with

infrastructures, incentives and *institutions*

fostering social capabilities to comply with distributed knowledge bases and an acelerated rate of technical change

Which LFR´s? …Why?

- Low value, Low networking...but high rate of change
- Peculiar institutional framework...
- ...and social dynamics!

A specific issue:

- "With some notable exceptions, the regional developmment debate in LFRs has been dominated by **exogeneous models** to such an extent that development tends to be conceived **as something that is introduced to**, or visited upon, less favoured regions, from external doors…
- …this kind of regional policy did little or nothing to stimulate **localised learning**, innovation and indigeneous development within LFRs",

Henderson & Morgan (1999)

Structure of the Argument

1. **The perception today:** a diversified context
   - Technical Change: complexity and uncertainty
   - Distributed knowledge bases
   - Productivity growth accounts for most public actions!
   - increasing reliance on market-based mechanisms to promote innovation
2. **Infrastructures, Incentives and Institutions:** building evidence
   - Innovation and productivity: Discussing CIS data for Portugal
   - Innovation and the environment: how to foster sustainability?
   - Higher education: which incentives?
3. **Knowledge and Learning**: learning from case studies
   - Looking at 5 partnerships for advanced equipments
4. **The analysis**: social capabilities and a dynamic science base
5. **Policy implications:** innovation and competence building

The CONTEXT

Nathan Rosenberg (2001):

"**uncertainty** in the realms of both science and technology ... have enormously important consequences and a main concern is how organisations and incentives migth be modified to accommodate these uncertainties."

Fonte: OECD(2001), "Social Sciences and Innovation"

Chris Freeman (2001):

"There is an irreducible uncertainty about future political, economic and market developments ....,technological innovations may actually increase it, since they add to the dimensions of general business uncertainty, the dimension of **technological uncertainty**."

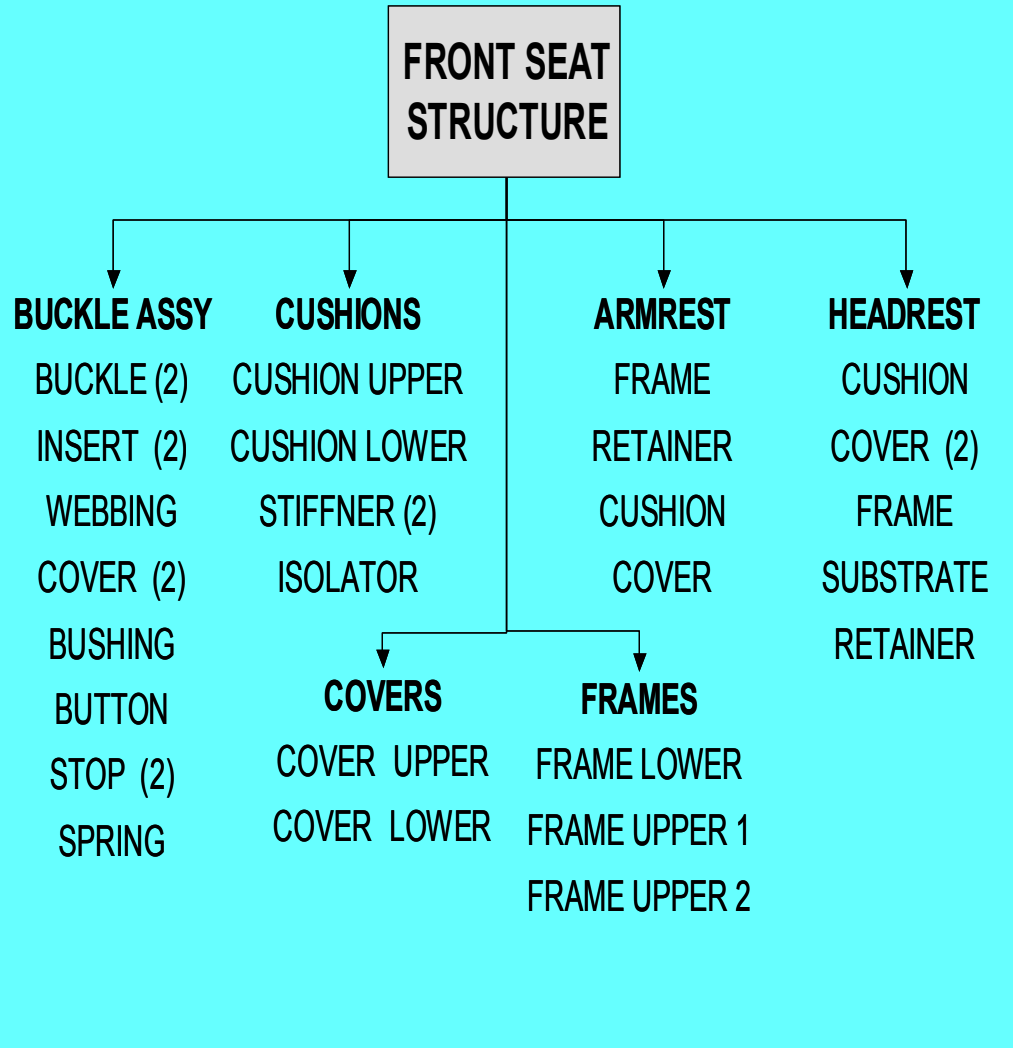
Fonte: SPRU (2001)

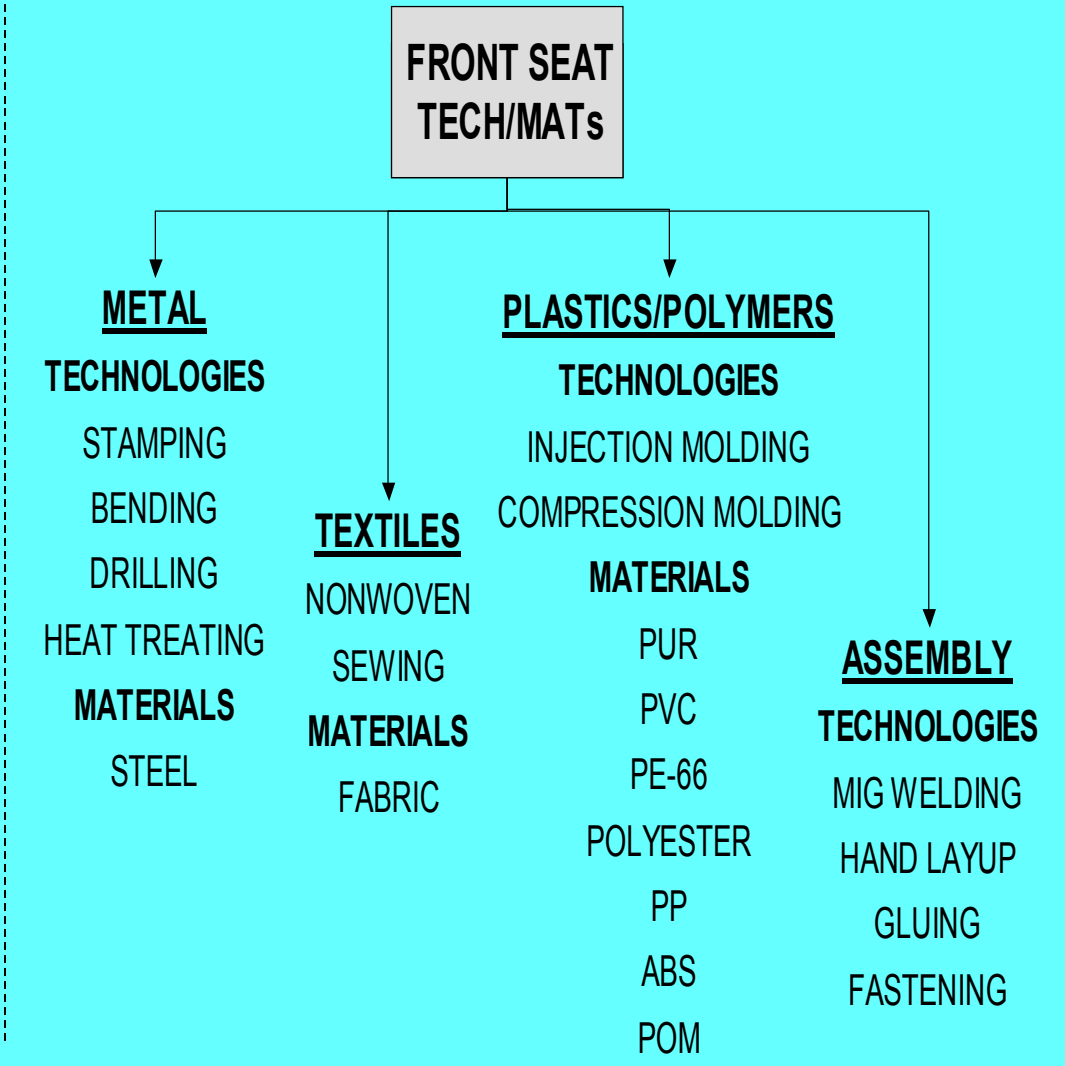
A case study :

Product innovation - Auto-interiores

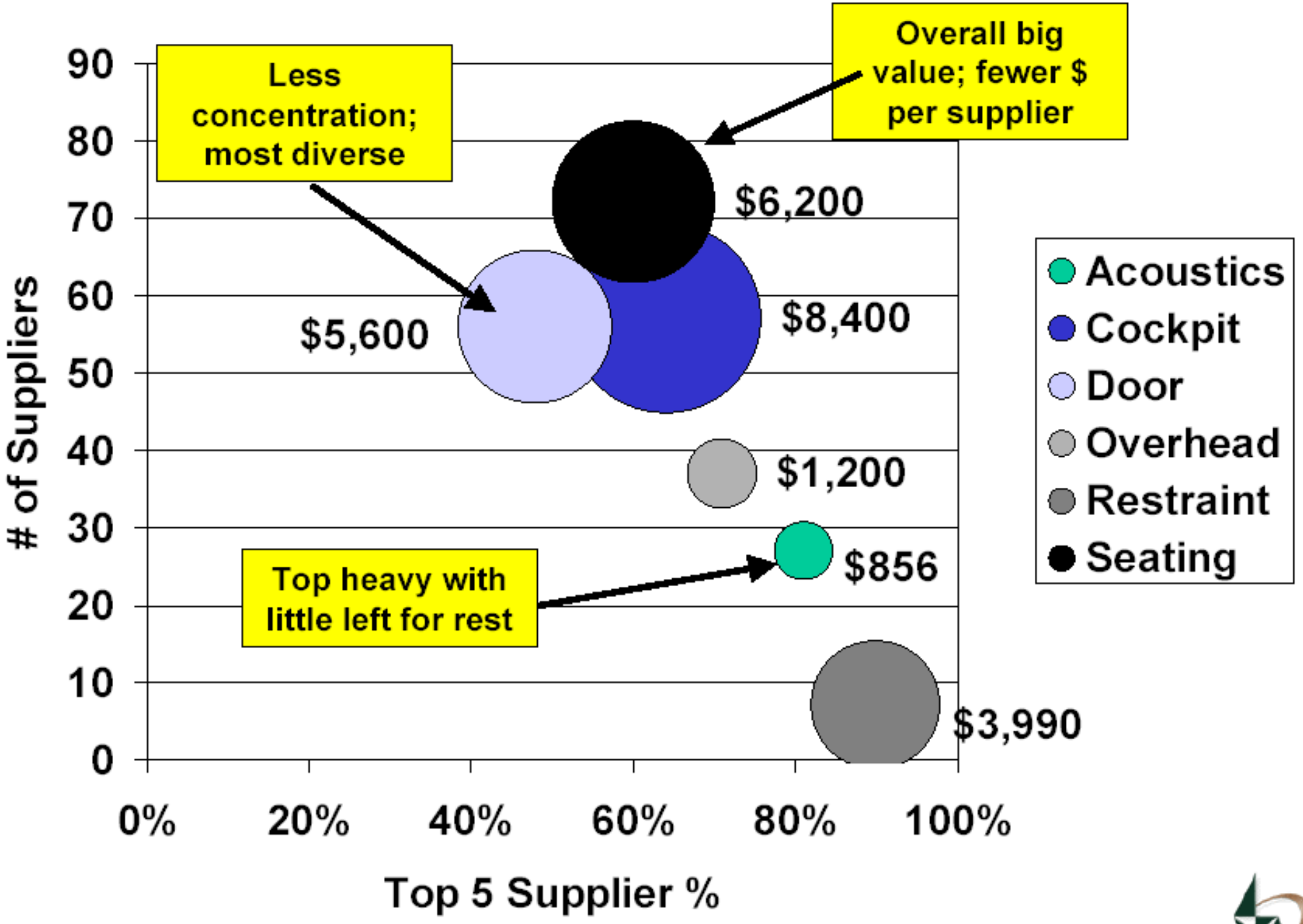
- Seat
- Instrument panel
- Door trims
- Panels
- Headliner

A case study: seat modules
Components, Materials & Technologies





P. Conceição, M. Heitor & F. Veloso (2002); see also K. Smith (2001)


Less concentration; most diverse
Overall big value; fewer $ per supplier
Top heavy with little left for rest
$6,200
$8,400
$5,600
$1,200
$856
$3,990
Acoustics
Cockpit
Door
Overhead
Restraint
Seating
# of Suppliers
90
80
70
60
50
40
30
20
10
0
0%
20%
40%
60%
80%
100%
Top 5 Supplier %

The perception today: a diversified context

The 'globalizing learning economy':

- a world characterized by accelerating technical change
- growing international interdependence

To compete in such a world it is important:

- to have **access to knowledge**,
- but, it is even more important, **to be able to learn** as old competences become obsolete.

The challenges:

- How to manage the **risks of being innovative**?
- Which Networks to access to **distributed knowledge bases ?**
- How to foster learning as moving along a given trajectory and capability to cope with the emergence of new trajectories (e.g. textiles)?
- How clusters can **remain open** to what is going on outside the cluster and how to stimulate **radical change** when this is necessary?

Infrastructures, Incentives and Institutions:

Why?...Which specific driving forces for development ?

1. Productivity growth
2. Sustainability
3. The knowledge base:
   Higher education

} the **time** frame

} the **spatial** dimension (local/regional/national)

The empirical evidence:
Case studies from Portuguese industry

Looking at 5 partnerships for advanced equipments

Case	Type	Main Partners	Sector	Scope	Duration
1	Large firm - University	Bombardier IST	Train	R&D	>20 yrs
2	Large firm - Interface structure	Vulcano INEGI	Non-electric equipment	Product development	> 8 yrs
3	Inter-firm vertical linkage	OGMA CASA	Aerospace	Manufacturing	1.5 yrs
4	Inter-firm consulting linkage	Salvador Caetano Almadesign	Automobile	Design	> 6yrs
5	SME network	Motoravia	Aerospace	Product development, manufacturing	> 4 yrs

Source: Ávila Martins (2003)

1. Productivity and Innovation: Why do we care?

- Aggregate productivity is ultimately a measure of economic development
  - And there is the discussion of the productivity slowdown!
- At firm level, it is an important measure of competitiveness
- Limited understanding of the relationship!

While much attention has been given to digital technologies, linking information technologies with increasing productivity remains to be explained, requiring processes of organizational change...

Disparities in Productivity and Income

	GDP Per Hour Worked As % of OECD Average		Effect of Working Hours		GDP Per Person Employed As % of OECD Average		Effect of Labor Force Participation		GDP Per Person As % of OECD Average
Austria	**102**		-4		**98**		2		**100**
Belgium	**128**		-5		**123**		-22		**101**
Denmark	**92**		0		**92**		11		**103**
Finland	**93**		0		**94**		-5		**88**
France	**123**		-9		**113**		-17		**97**
Germany	**105**		-5		**100**		-4		**96**
Greece	**75**	+	-4	=	**71**	+	-12	=	**58**
Ireland	**108**		5		**113**		-18		**95**
Italy	**106**		-11		**96**		-5		**91**
The Netherlands	**121**		-26		**95**		0		**96**
Norway	**126**		-17		**109**		12		**122**
Portugal	**56**		2		**58**		2		**60**
Spain	**84**		13		**97**		-26		**71**
Sweden	**93**		-3		**89**		-1		**88**
United Kingdom	**100**		-9		**91**		0		**92**
United States	**120**		-1		**118**		10		**128**
EU-14	**103**		-5		**98**		-8		**90**

Determinants of Productivity: What we know?

- **Firms entering a sector exhibit lower levels, but higher growth rates of productivity than existing firms**
- **Average level of human capital of the firm positively associated with productivity levels and growth rates**
  - Process may be mediated by technology (or innovation)
- **Increasing international exposure (measured by exports) associated with higher productivity levels and growth rates**
- **Management and ownership structure influences productivity**
  - Although not much has been widely accepted as a determinant

Innovation is a key correlate of productivity – so far positive…

Although they are probably jointly determined

Limited understanding of this relationship!

A *Research Hypothesis* for lagging regions

Firms make short-run decisions on resource allocation and tactical positioning that may be:

Devoted towards the "exploitation" of existing capacity to produce through full utilization and mobilization of resources

Including human and physical capital

- **Become, in the short-run, more productive**
  - **learning-by-doing dynamics that decrease unit costs as production increases.**
  - **Will not show evidence of innovation activities and outcomes**

Geared to "exploration" of new possibilities of production

Testing a new production layout based on recently acquired machinery, attempting to launch a new service or product, integrating a new person in research and development activities

- **Show less productivity gains**
  - **More innovative activities and more innovation**

Econometric estimation for Productivity and Innovation:
Novelties in the approach

Conceição & Veloso (2002); Conceição, Heitor & Veloso (2003);

- Look at **innovation in general**, not only at the adoption of a specific technological innovation (such as computers)
- Use information on **firms** that have attempted to innovate and on firms that have introduced innovations
- Consider **all innovations**, not only at radical innovations that have merited a patent (or at least an application for a patent).
  - Relevant for countries such as Portugal - behind those countries that lead the technological frontier
- Consider firms in both **manufacturing and services**

The data: Observations at the firm level performed in 1998 to a sample of Portuguese firms that result from the Portuguese participation in the European-wide survey known as **Community Innovation Survey (CIS)**

$$\text{Log(PrdG)}_i = \alpha_0 + \alpha_1 Inov_i + \alpha_2 Exp_i + \alpha_3 NF_i + \alpha_4 GP_i + \alpha_5 ED + \overline{\alpha S_i} + \varepsilon_i$$

Productivity and Innovation: **econometric estimation**

Conceição, Heitor & Veloso (2003);

Dependent:

Labor Productivity Growth (log form)

Independent

Inov: Innovation

Introduction of Innovation (0-1)

Investment in Innovation (0-1)

Share of sales associated with innovation (for manufacturing)

Exp: Share of Turnover devoted to Exports

NF: dummy indicating if firm created in the relevant period

GP: dummy indicating if firm is part of a larger group

S: Sector controls

Results: 2SLS Estimation

Conceição & Veloso (2002)

Variable	Complete C-2	
Innovation Introduced (0 or 1)	-0.687*** (0.269)	
Innovation Investment (0 or 1)		-1.018*** (0.396)
Share Sales Innovation		
Constant	0.139*** (0.037)	0.188*** (0.055)
Group Member	0.227*** (0.061)	0.254*** (0.07)
New Firm	0.118 (0.093)	0.174** (0.091)
Turnover Export Share	0.073* (0.046)	0.129** (0.059)
F. p value	(.000)	(.000)
Haus. p value	0.00	0.02
Observations	1834	

*** Sig. at 1%; ** 5%; * 10%

1. Productivity and Innovation: Research Conclusions and Policy Implications

After correcting for endogeneity:

- Firms that have introduced innovations in the last couple of years growth less in labor productivity than those that did not innovate
- Valid for both manufacturing and services
- investments in innovation are unproductive in the short run

Firms may feel the short-term loss in productivity as a powerful disincentive to invest in innovation

- Portugal is certainly a case where such effects could be observed
- If extreme can produce a "lock-in" of low innovation and low productivity growth

Lack of aggregate productivity growth performance can, thus, be seen as a "collective action" problem

- Individual decisions are rational, given the structure of incentives and the constraints faced by firms
- Collective outcomes are underperformant

The evidence: a vicious cycle of low innovation and low productivity growth

- How to break the cycle? How to suggest policies helping to do so?

1. The prevailing explanation: firms (Portuguese) are resource constrained and, in some cases, myopic.

Thus, the public policy should be aimed at breaking the resource constraint (giving subsidies for investment, R&D, and so forth) or reducing the information asymmetries that provoke the "myopia" (diffusion of information programs, helping firms to pay for consultants, to buy and access information, and so forth).

2. A different explanation: The incentives firms face may not provide them the signals to see innovation as a competitive edge – a cycle of innovation that is the **symmetric** of that described by Baumol (2002)

Thus, the low innovation/low productivity cycle (in Portugal) may not be a problem of resources not even of information: it may very well be purely a problem of incentives and institutions that do not provide the "right incentives" to innovate.

Why Can Technological Innovation Lead to Productivity Losses?

1. **learning lag** due to a new technology
2. **new technologies**, when they first appear, **are not as perfected** and developed as older ones
3. the **adjustment costs/liquidity constraints** associated with the introduction of innovation

The econometric estimation shows that 3 dominates!

See: Conceição, Heitor & Veloso (2003)

2. Environment and Innovation : Material Flow Analysis: Why does it matter?...

Material use leads to environmental damage

"One half to three quarters of annual resource inputs to industrial economies are returned to the environment as wastes within a year",

The weight of nations, WRI (2000)

International trend:

Increase material productivity by a factor of:

2 in global terms

4 in next 20 to 30 years (EUROSTAT, 2001)*

10 in next 30 to 50 years (Factor 10 Club, 1995)**

Considered in national policies (e.g. The Netherlands, Austria; Kuhndt and Liedtke, 1998)***

Supported by European Union (factors 4 and 10; Reijnders, 1998)****

* *Economy-wide Flow Accounts and Derived Indicators. A Methodological Guide*

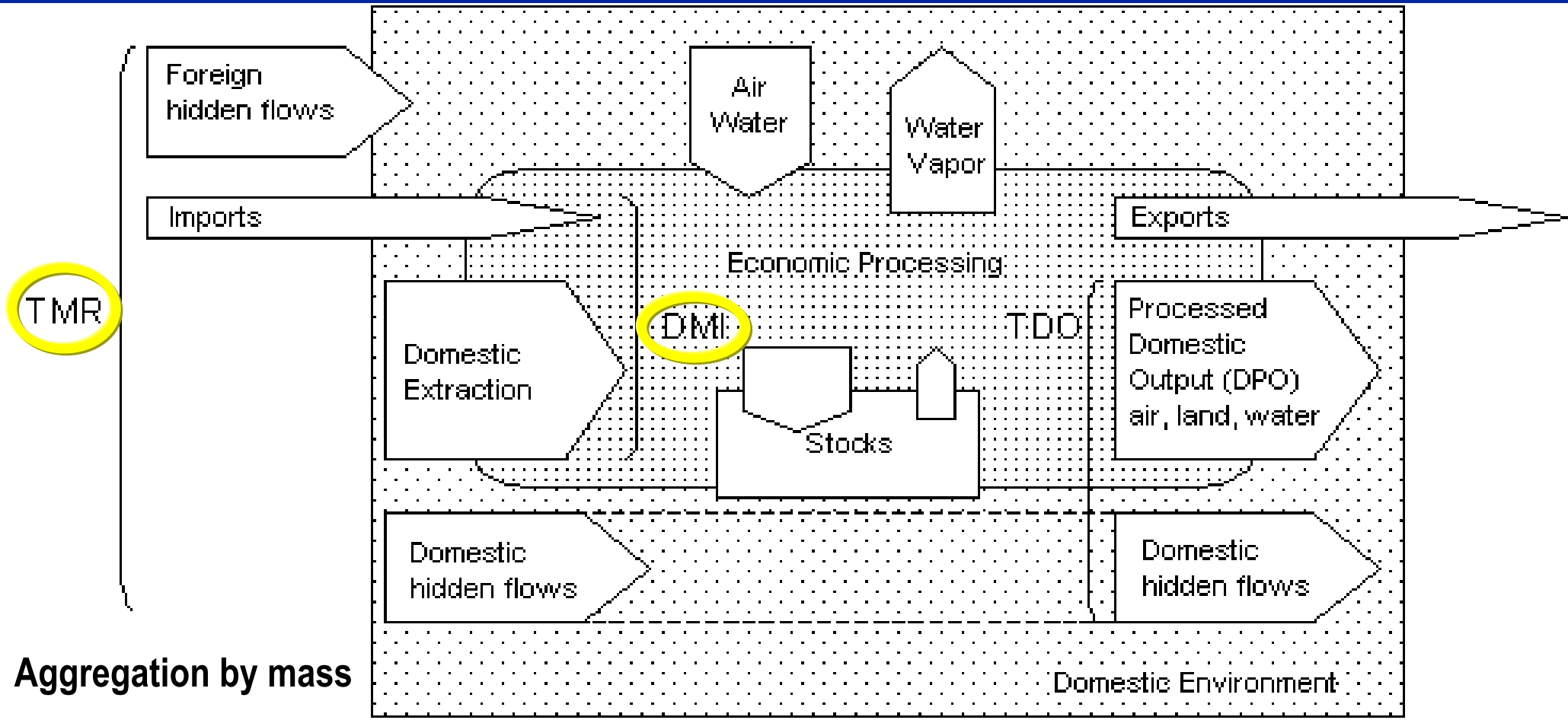
** *Carnoules Declaration*

*** "Translating a Factor X into Praxis", in *Third ConAccount Meeting: Ecologizing Societal Metabolism*

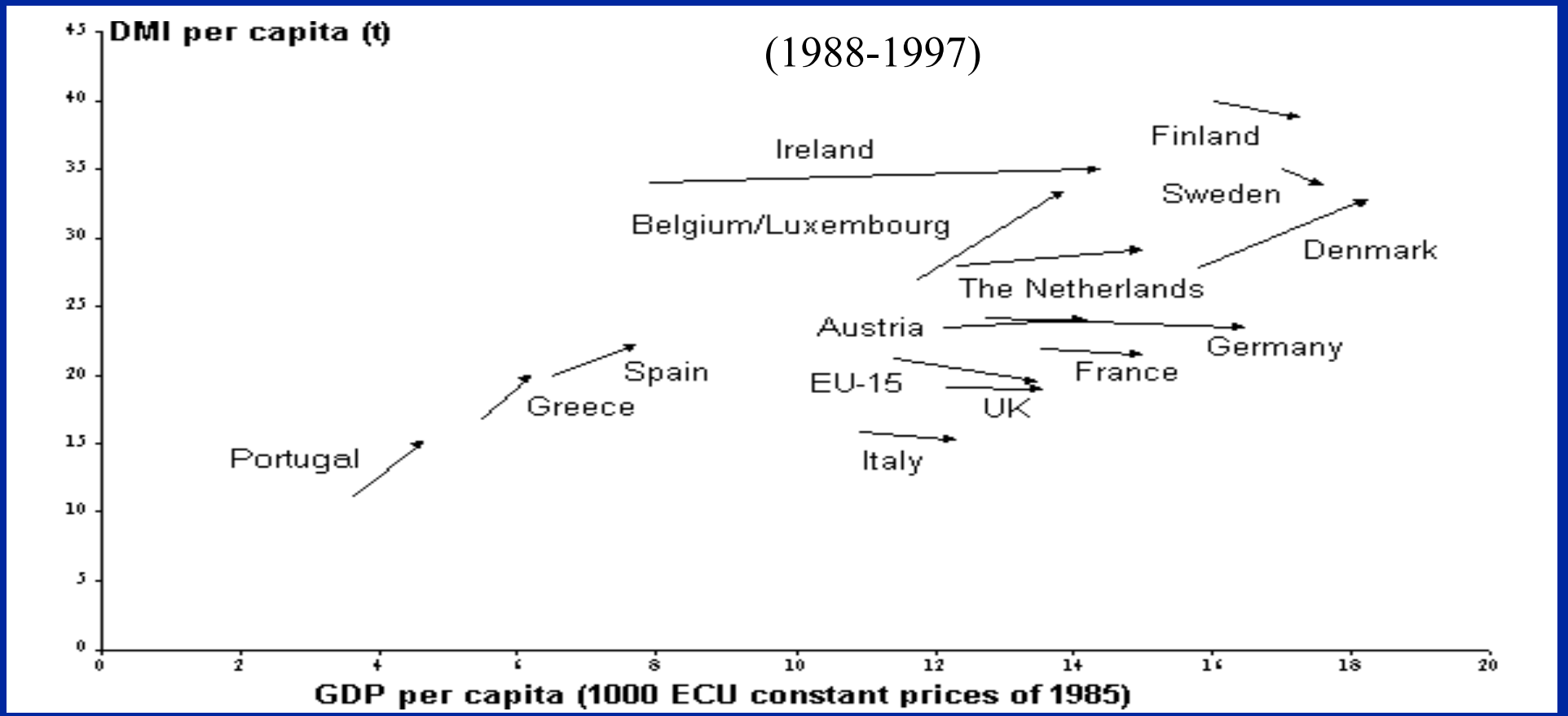
**** "The Factor X Debate: Setting Targets for Eco-Efficiency", *J. Industrial Ecology*, 2(1)

Material Flows accounting (MFA)

Adriaanse *et al.* (1997)*



DMI *vs* GDP: the International trend



Adapted from Bringezu and Schütz, 2000, *Total Material Requirement of the European Union*, European Environment Agency, Technical report No 55.

Sample Results: Portuguese DMI

Canas, Conceição and Ferrão(2002)

Domestic DMI	1960	1970	1980	1990	1998
Non-renewable (%)	19,6	38,6	63,3	65,2	75,4
Ores	6,2	3,8	1,9	2,4	1,0
Stone, clay, sand	12,4	34,2	61,1	62,7	74,3
Marine salt	1,0	0,5	0,3	0,1	0,1
Renewable (%)	80,4	61,4	36,7	34,8	24,6
Vegetal	79,0	60,5	36,3	34,4	24,4
Animal	1,3	1,0	0,4	0,4	0,2
Total (1000 t)	26999	38352	64231	77016	124835

Imported DMI: Mineral Products (includes fuels and ores)

Testing a relationship:
Innovation and the environment

What's the relevance of the technological innovation?

The technological innovation contributes to the economic growth **and allows the use of new processes and products that cause less environmental damage or use resources** more efficiently**.**

What's the relevance of this theme?

If the kuznets Hypothesis is valid, then the reduction in environmental damages **can be achieved** as a consequence of the natural economic development process**, that bases largely in the adoption of new production and consumption technologies. The result in terms of public policies is that the stimulus to the innovation can have positive consequences in the reduction of the environmental damages.**

2. Environment and Innovation : The approach...

Conceição, Heitor and Vieira(2002); Canas, Conceição and Ferrão(2003)

The Porter Hypothesis:

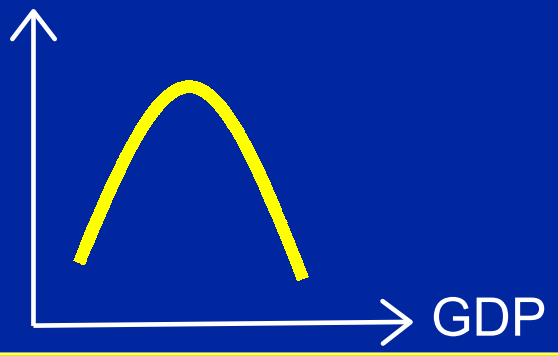
environmental regulation may lead, in the short term, to additional costs at the firm level, but will give rise, at the long term, to the adoption of new technologies and innovation, leading to growth

Static model → **Dynamic model**

The Environmental Kuznets Hypothesis:

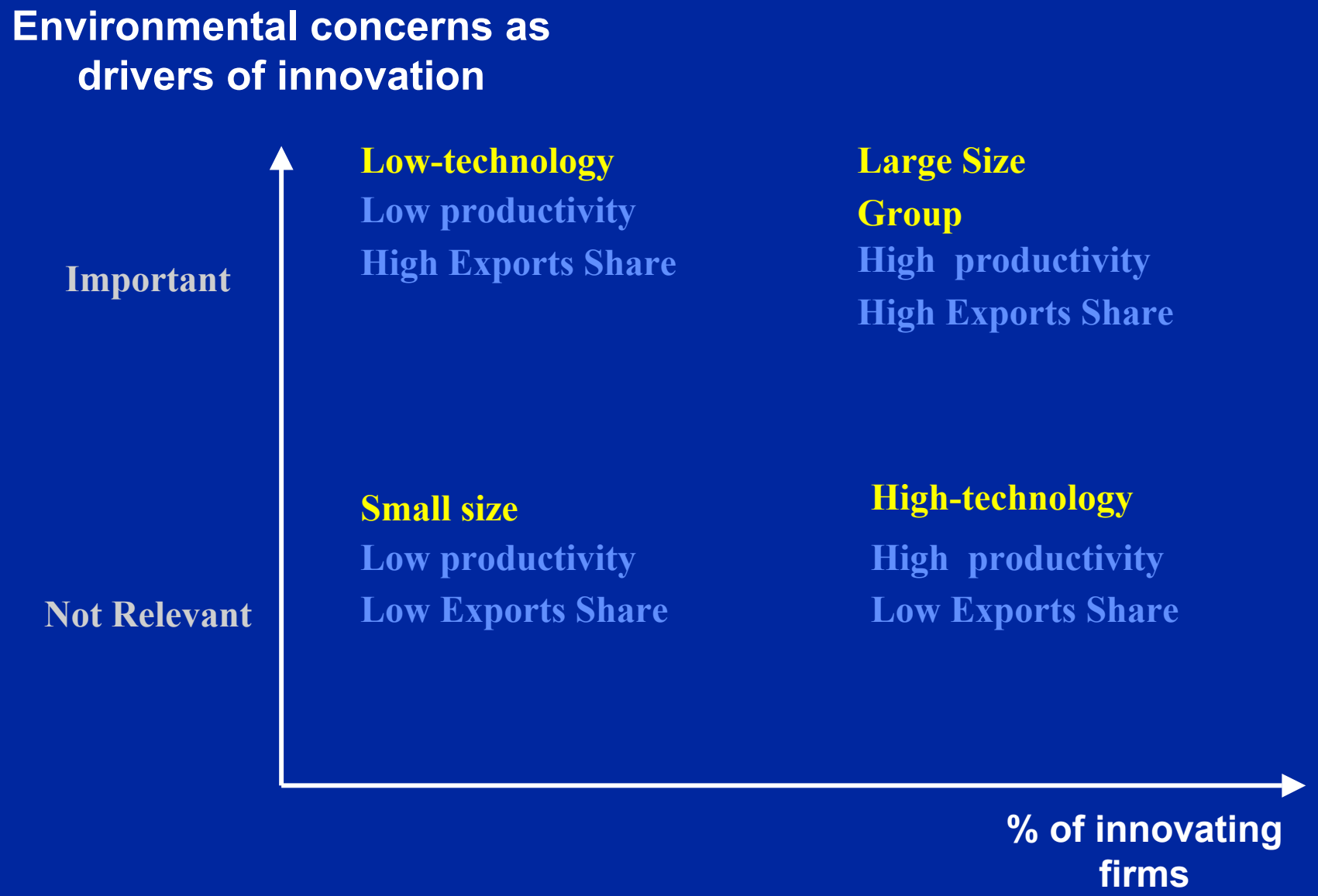
Economic growth and environmental degradation are related through an "U" inverted curve

- How far does this applies to Material Flows ?



Testing the "Porter Hypothesis"

Data from CIS II (1995-1997)- Portugal



Testing the "Porter Hypothesis"

Qualitative analysis:

- Environmental concerns stimulate technological innovation
- Relevant role of networking with Technological Centres and of the industrial associations
- Effectiveness of the innovation is guaranteed through the involvement of all the value-chain: the need for networking and supply chain management
- Consumer Pressure = Fundamental Factor to implement SD

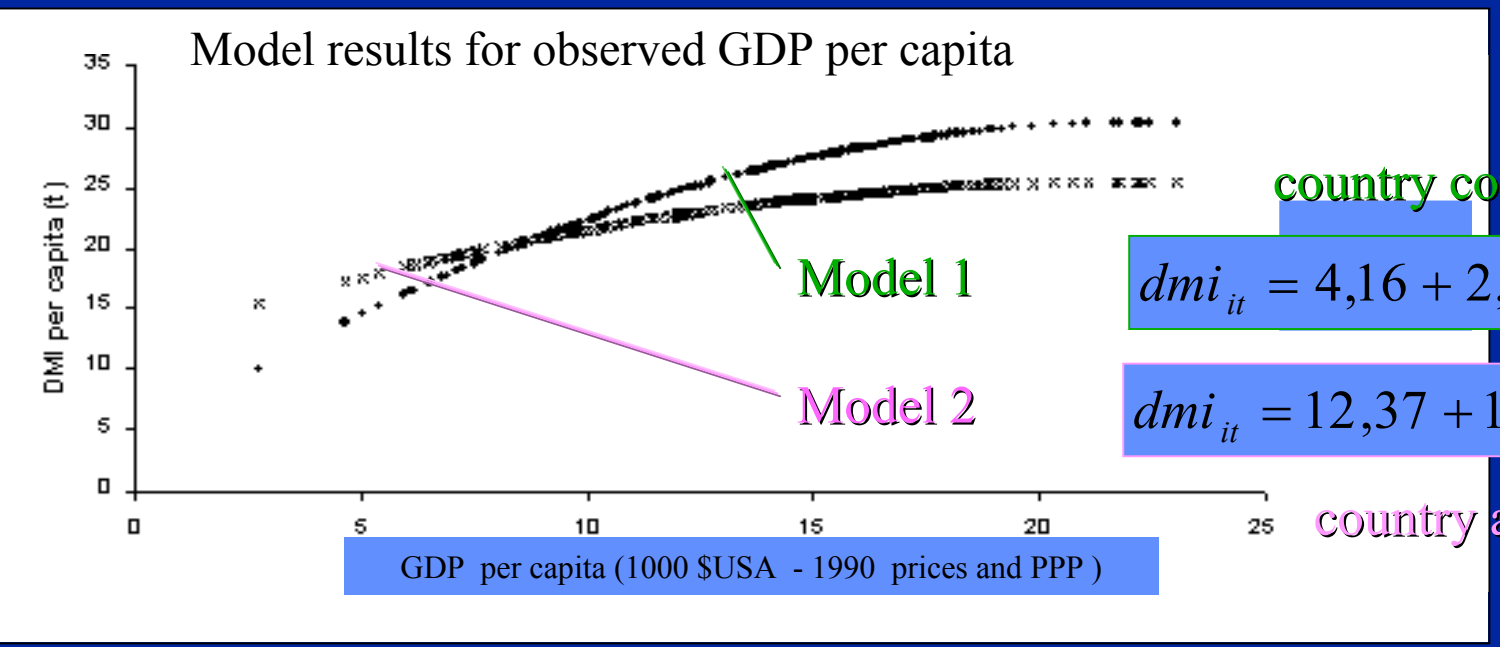
Quantitative analysis

	Industry	Services
Dimension	-	+
Productivity	+	-
Exportations	+	-

DMI modelling: Aggregated Data

Canas, Conceição and Ferrão(2002)

Support for inverted "U" EKC: ✓



country control

$$dmi_{it} = 4{,}16 + 2{,}33\, y_{it} - 0{,}05\, y_{it}^{2} \quad **$$

country and year control

$$dmi_{it} = 12{,}37 + 1{,}18\, y_{it} - 0{,}03\, y_{it}^{2} \quad **$$

Maximum DMI per capita:

21940 $USA e 22293 $USA

* Statistical significance at 1% level

* R^2=0,27 Random effects

* R^2=0,98 Fixed effects

2. Environment and Innovation
Research Conclusions and Policy Implications
Canas, Conceição and Ferrão(2002)

1. Industrialised Economies (1960-1998):

- **Aggregated data supports Environmental Kuznets Curve**
- **Evidence of GDP per capita relative dematerialization trend**

- Evolution driven by overcome of infrastructure needs
- External events dependence (e.g. energy crisis)
- Influence on economic structure of specific sectors

2. LFR´s: the case of the Portuguese Economy (1960-1998):

- **Increase in material use and intensity:**

  Growth since middle 80's can be due to infrastructure needs (highways, wastewater treatment facilities, Vasco da Gama Bridge)

- **Based in non renewable and building sector linked materials**

Knowledge for inclusive development…

Most development programmes stand on their ability to build use knowledge for inclusive development and lack a relational infrastructure for collective action

This requires a shift **:**

- *from* ***state-led*** or ***market-driven*** processes, regardless time, space or milieu
- *to* **institutional perspective,** looking at the **quality** of *institutional networks* and looking systematically to infrastructures, Incentives and Institutions

Which Public Policies?

- supporting existing clusters and relationships

  Keeping the trajectory...

- renewal of existing clusters and relationships

  …an important and somewhat more difficult role to play

- creating general framework conditions that support the emergence of new clusters and relationships

  o The need to combine protection with competition!
  o The integration of knowledge institutions vs reliable knowledge

- taking specific action to initiate new clusters

  …outside what policy makers can do ??

Policy Implications …

Fostering strategies which promote the integration of policies, but also the diversification of actions:

- **Funding the quality of supply:** *knowledge production*
- **Promoting new markets:** *knowledge diffusion*

requires:

- **time:** long-term perspectives
- **context:** specific sectorial *and/or* regional issues
- **value:** promoting new market strategies

but also:

- **people:** new competences and social capabilities
- **scope:** national *and/or* international

debate....

The empirical evidence:
Case studies from Portuguese industry

Looking at 5 partnerships for advanced equipments

Case	Type	Main Partners	Sector	Scope	Duration
1	Large firm - University	Bombardier IST	Train	R&D	>20 yrs
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5	SME network	Motoravia	Aerospace	Product development, manufacturing	> 4 yrs

Source: Ávila Martins (2003)

The evidence: sample conclusions

1. **cases 1 (Bombardier), 2 (Vulcano) and 5 (Motoravia):**
   - firms whose activities had a visible component of **product development** usually shown strong linkages to recognized **science or technology sources**
   - The main reason for these companies to refer to such partners is to **access state of the art complex knowledge**, creating new knowledge or transferring the existent one into applicable forms
2. **cases 1 (Bombardier) and 3 (OGMA):**
   - absorptive capacity and innovative capability is mostly constituted by tacit forms of knowledge (*know-how* and *know-who*)
3. **case 1 (Bombardier):**
   - experienced accumulation of *learning-by-research*

Networking for development: **What can we learn?**

• increases in productivity can only be considered in activities that do not suffer from “cost disease” (William Baumol, 2002)

• Partnerships reflect that:

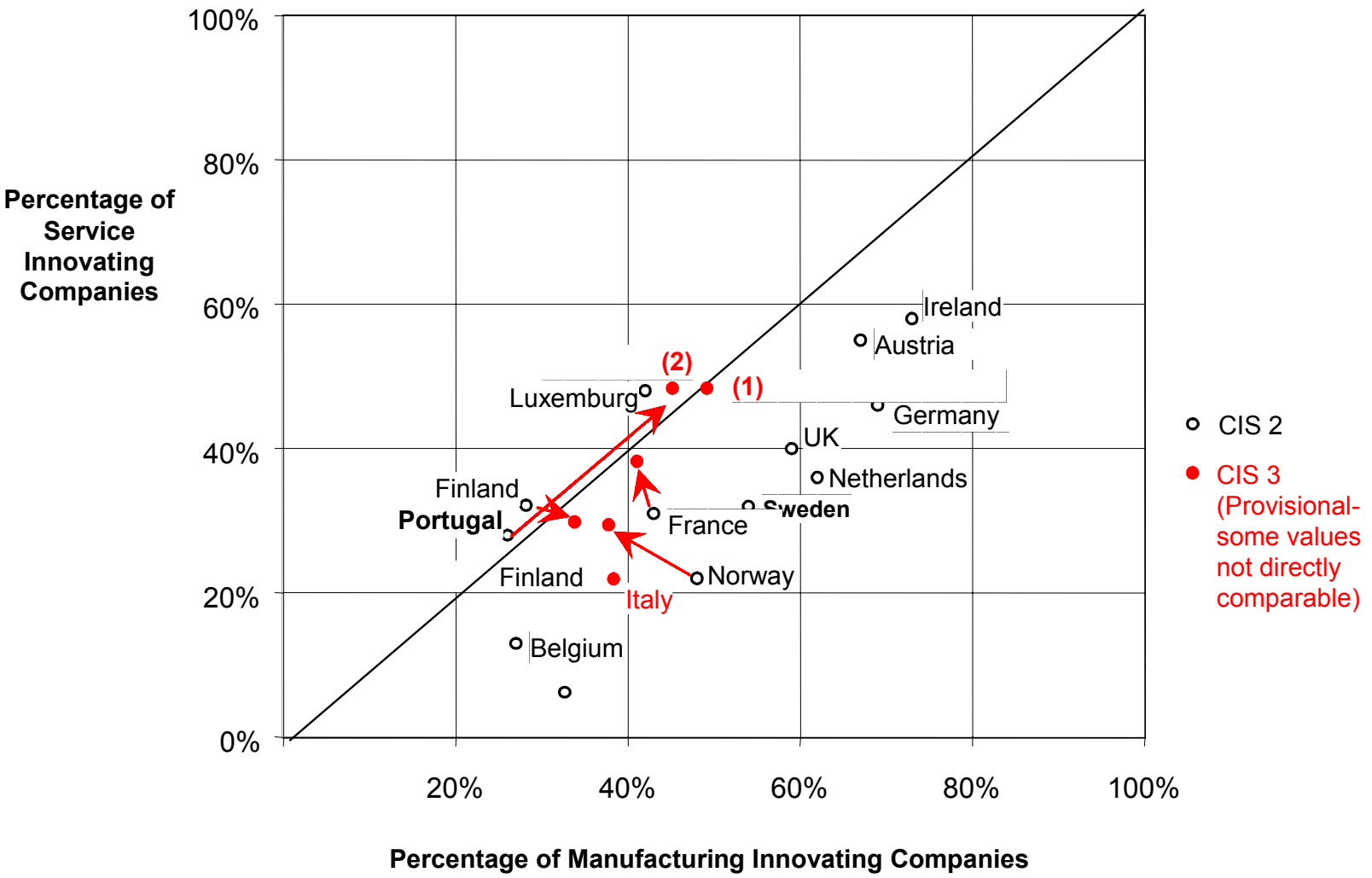
- *competence is built over time through interactive learning demanding proximity and there are increasing returns in the production and use of knowledge*
- *competence is localized – some of the knowledge is tacit and cannot easily be disentangled from the cluster - it is embodied in people, organizations and networks*
- *Competence building should be directed to open minds to new trajectories*

Networking for development: **What can we learn?**

- a national technological **infrastructure** that supports competence building in all kinds of firms
- a **social and legal system** that creates trust and interaction among people: good elements in the system is not enough. Focus needs to be on the interaction between the elements, but attention should be considered to avoid “negative social capital” (i.e., resistance to innovation).
- A set of **incentives** to foster new trajectories and attract new markets

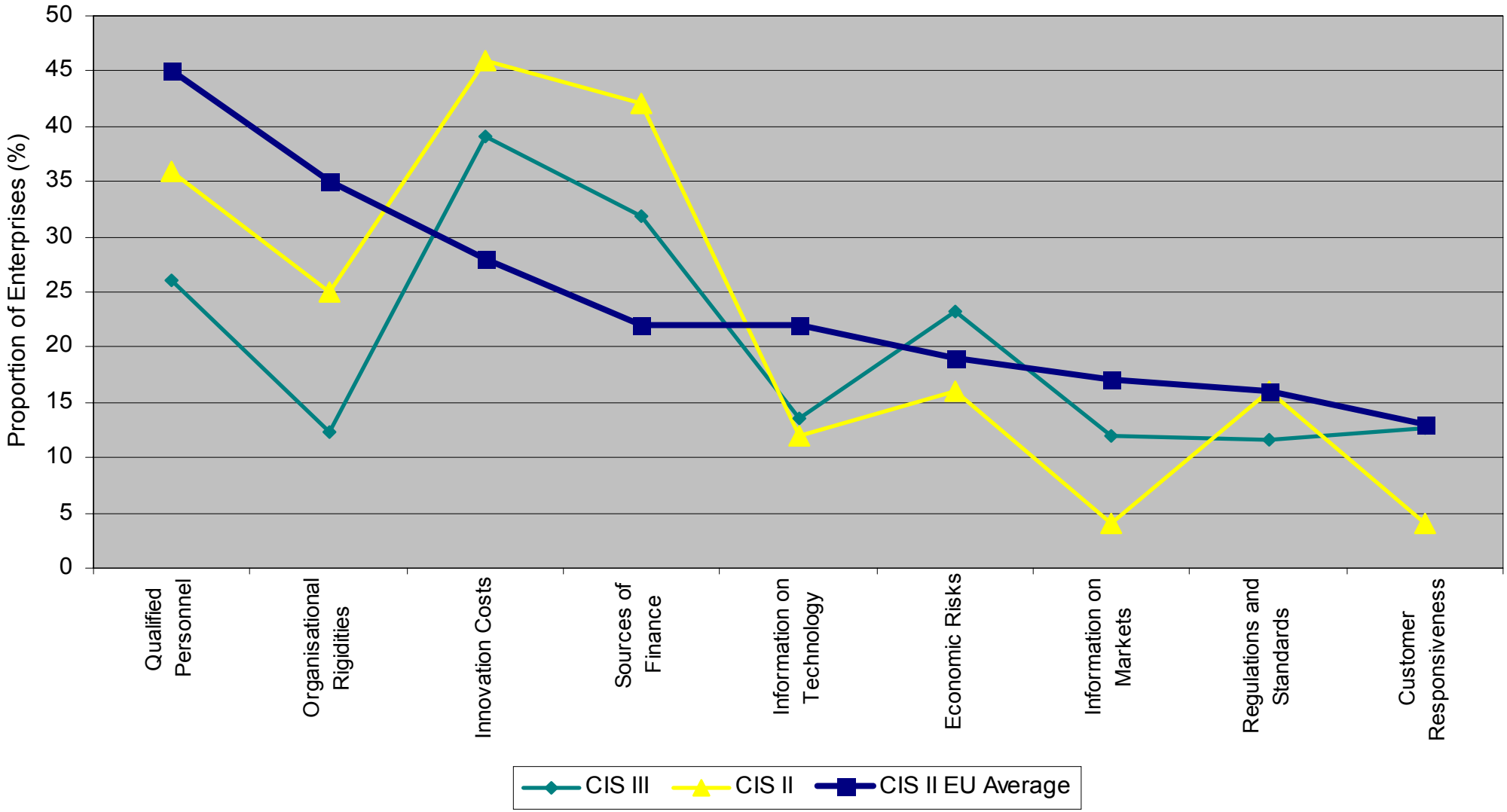
Innovation in EU

source: Community Innovation Survey



Evidence Supporting persistent structural weaknesses

As in CIS II, firms' perception of the obstacles hindering innovation contrasts with that of EU

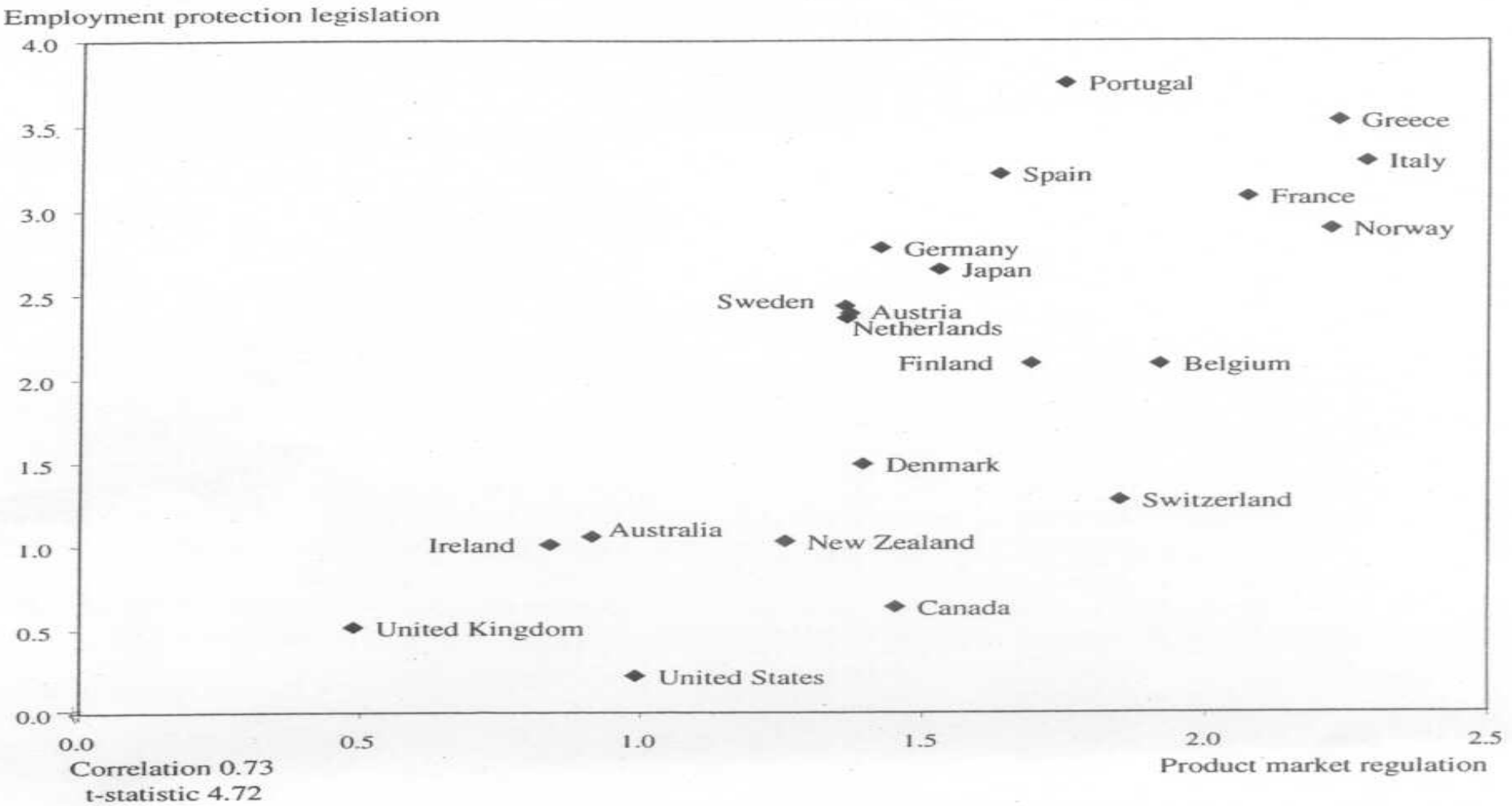


Which Institutional Framework?

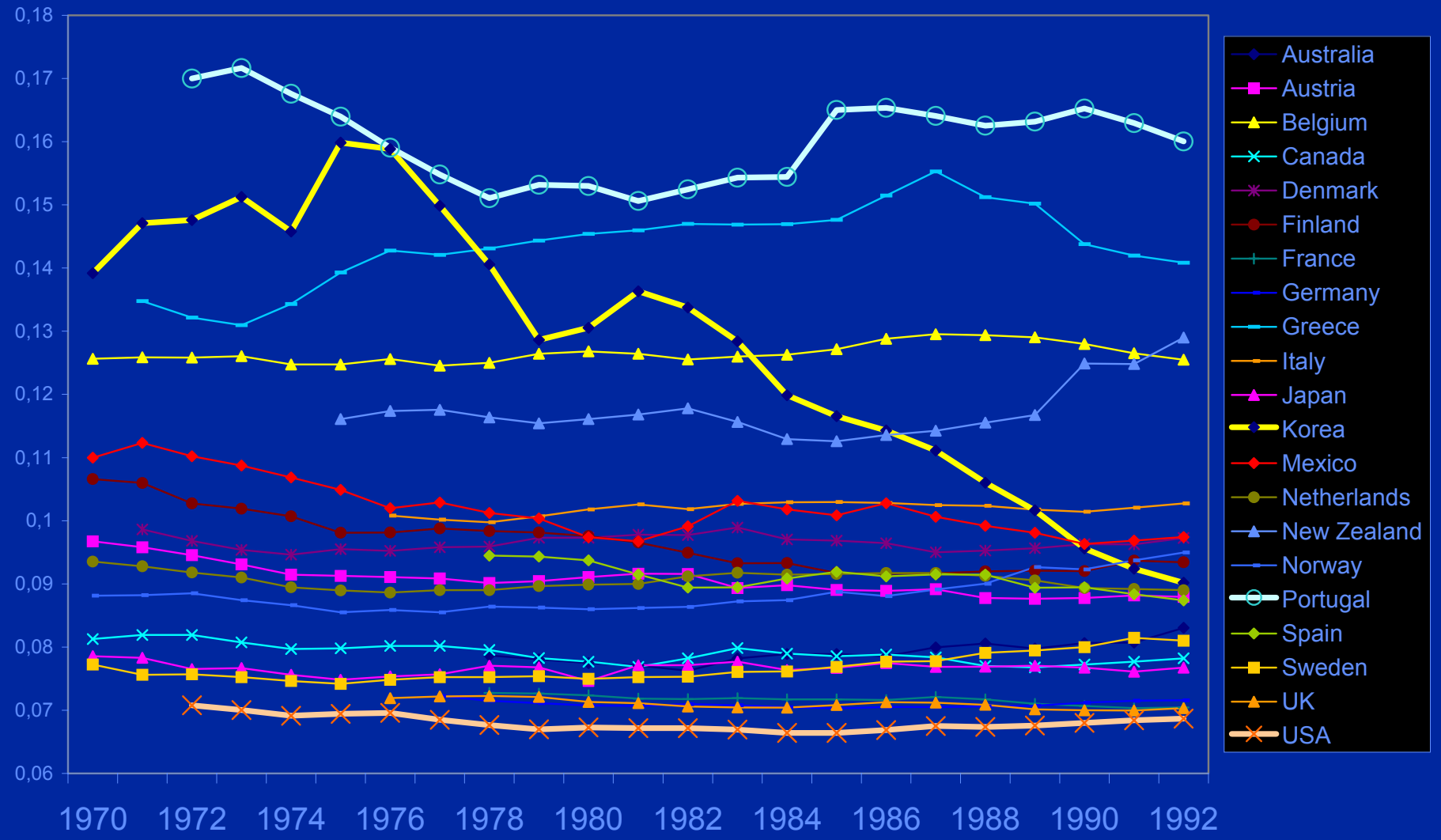
Market Regulation and Employment Protection

Nicoletti, Scarpetta & Boylaud; OECD (2000)

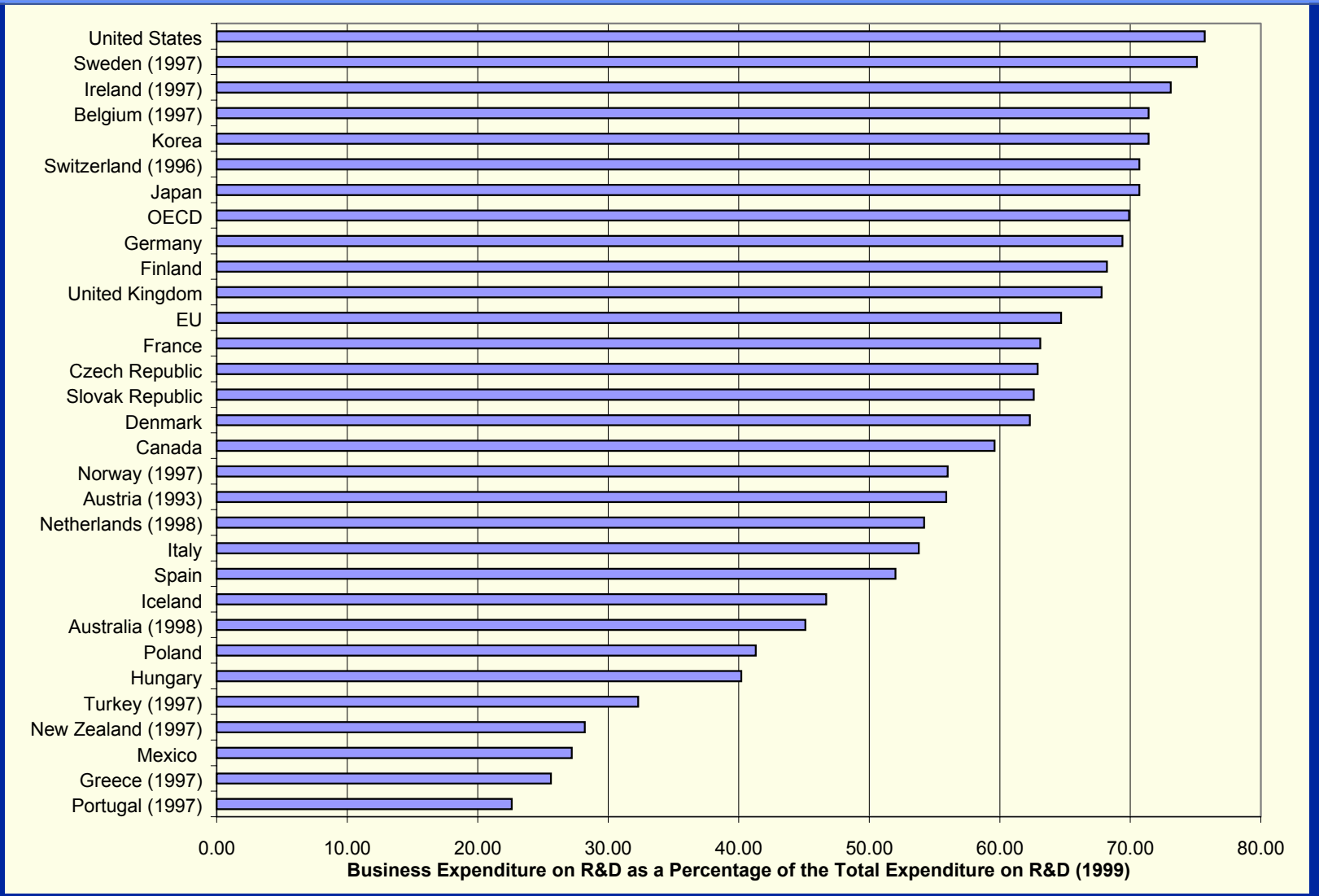
Figure 14. **Product market regulation and employment protection legislation**



How far Industrial structure affects innovation?

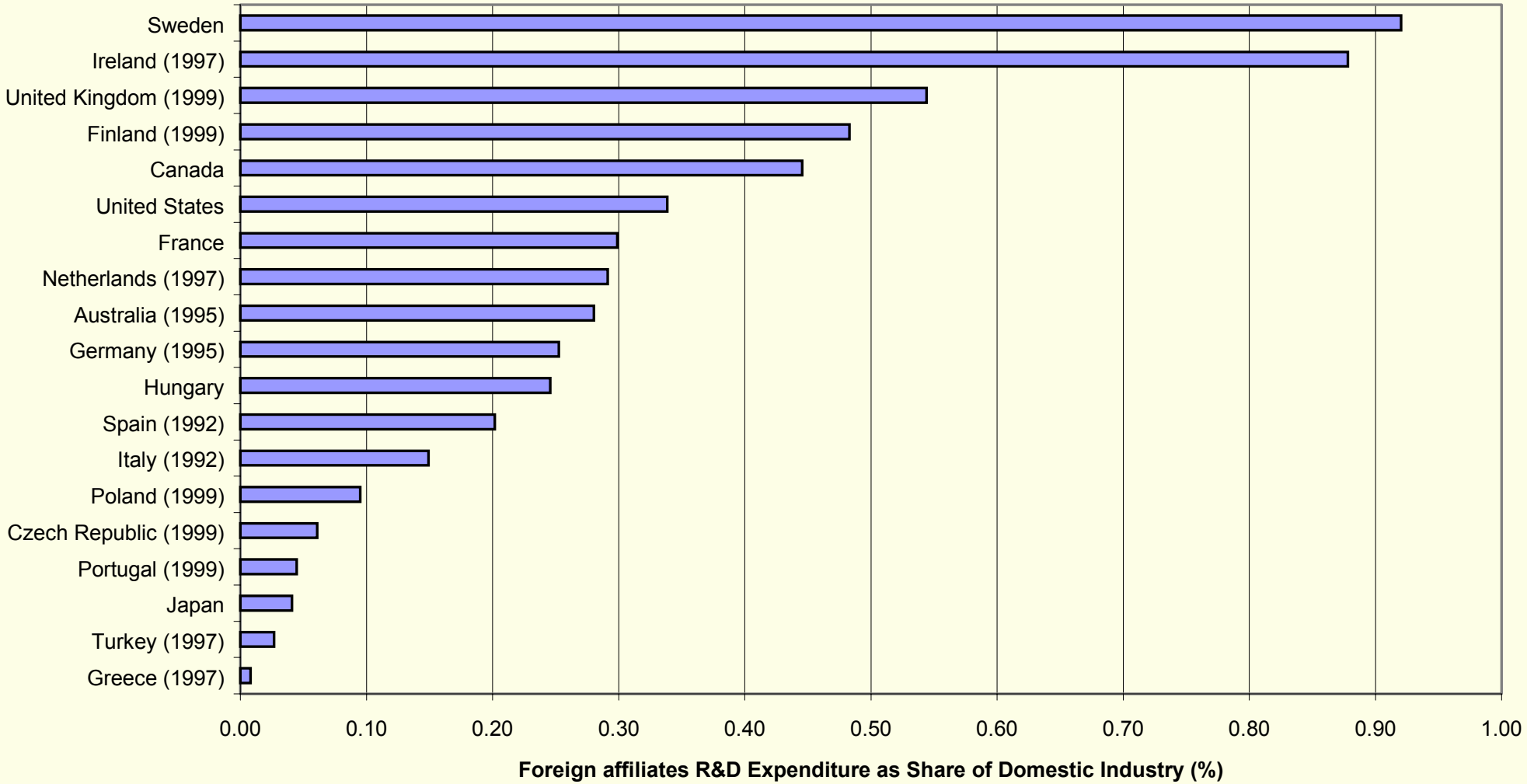


The Perception - 1: BERD / GERD



With the exception of the less developed OECD countries, business expenditure on R&D accounts for the majority of total expenditure, and has an overwhelming share (close or above ¾) in the most developed countries

The Perception – 2: **Foreign affiliates**



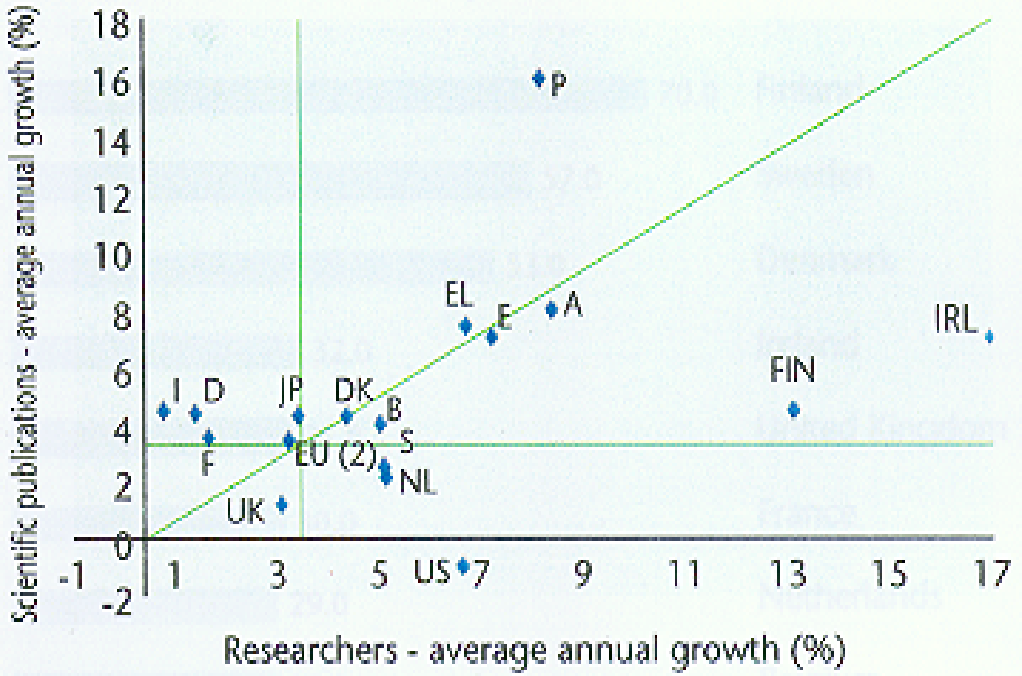
But, for some countries (Sweden, Ireland), the business expenditure is driven in large part by foreign affiliates, rather than domestic companies. In the US domestic firms are dominant.

...perspectives for "Change":

Scientific "Productivity" and inter-institutional cooperation

EC Benchmark of S&T Policies, September 2001

Figure 3.2.6: Number of scientific publications and number of researchers - average annual growth (%), 1995-98 (1)

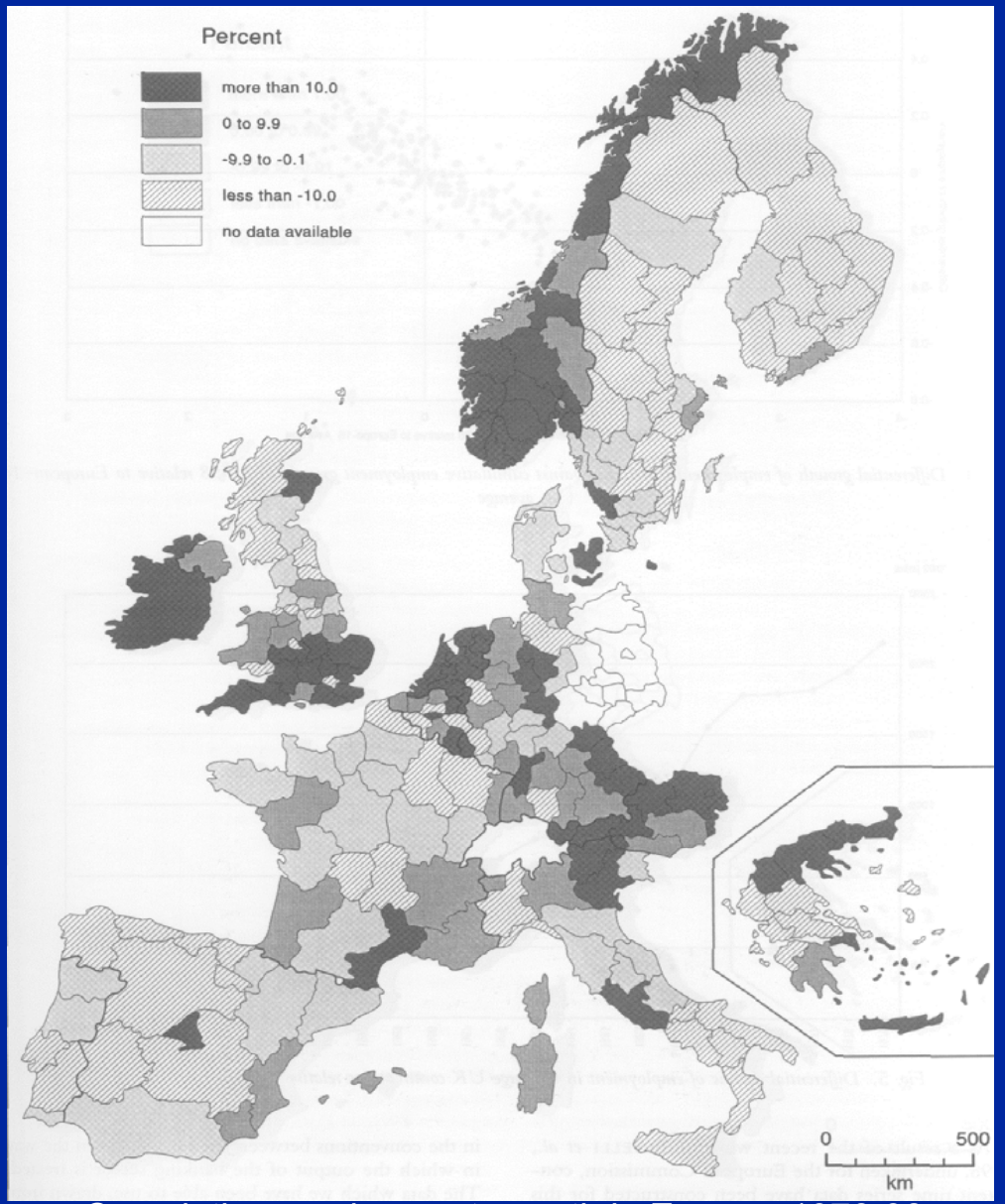


Source: DG Research
Data: ISI, CWTS
Notes: D,E,P: 1995-99; B,EL,IRL,I,FIN,S,US: 1995-97
(2) L data are not included in the EU average.

Figure 3.4.1. Percentage of innovating firms cooperating with other firms, universities or public research institutes (1996)

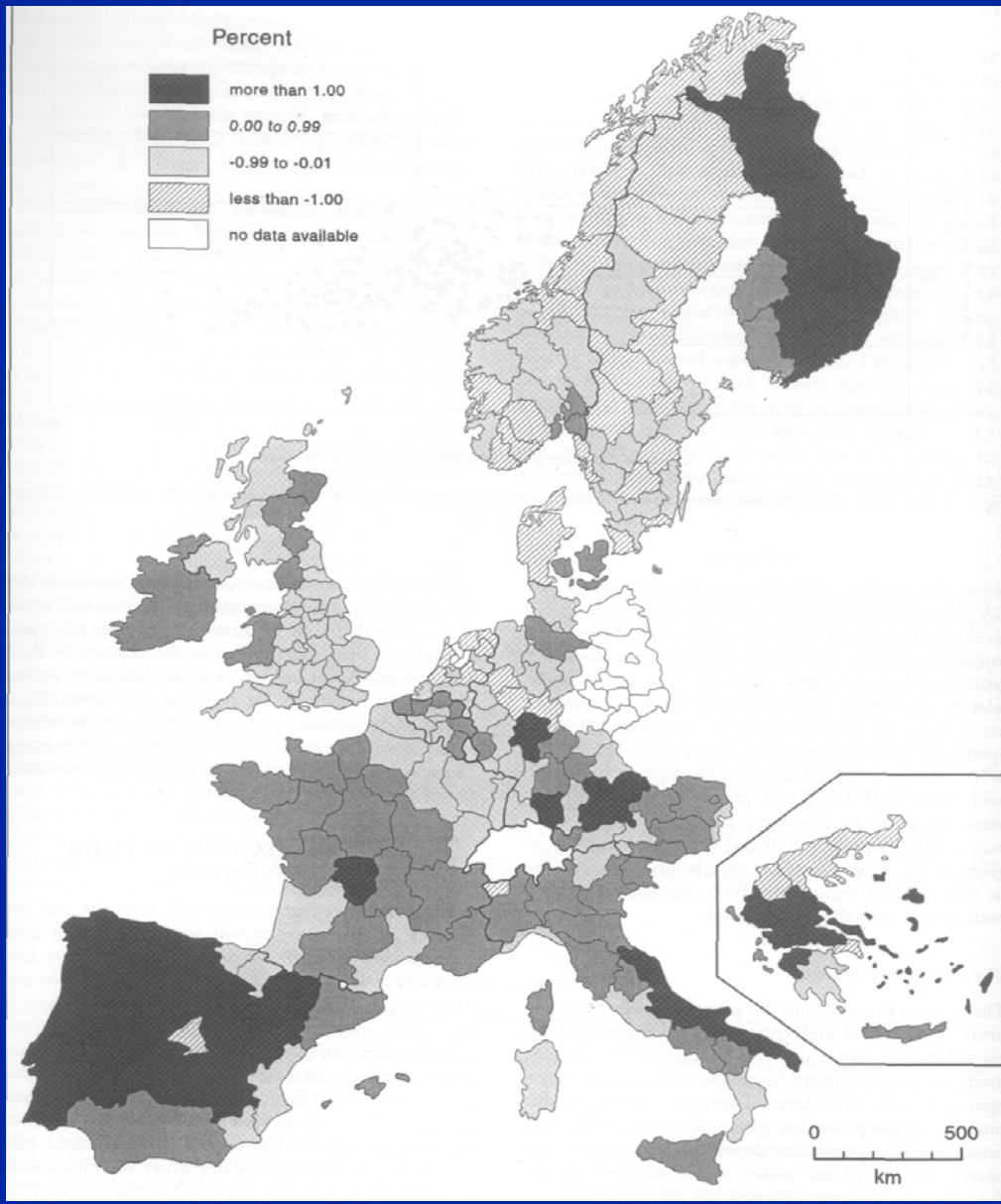
Source: DG Research
Data: CIS, Eurostat, DG Enterprise, Member States
Note: (1) see annex

Evidence and focus: diversity across Europe



Cumulative employment growth in Europe, 1976-98

Source: Martin & Taylor (2000):Reg Studies



Average annual growth in gross value added per employee relative to EU average, 1976-98

Looking at sustainability:
Decomposition of DMI variation

Canas, Conceição and Ferrão(2002)

Identity between Sustainability and Production (Malaska, 1998)*:

$$DMI = POP \cdot \left(\frac{GDP}{POP}\right) \cdot \left(\frac{DMI}{GDP}\right)$$

Sustainable development associated with decreasing material flow

Contributions calculation (Chung e Rhee, 2000)**: Logaritmic Mean Divisia Index (LMDI) Method

$$\Delta DMI = L(*)\ln\left(\frac{POP_t}{POP_0}\right) + L(*)\ln\left(\frac{GDP/POP_t}{GDP/POP_0}\right) + L(*)\ln\left(\frac{DMI/GDP_t}{DMI/GDP_0}\right)$$

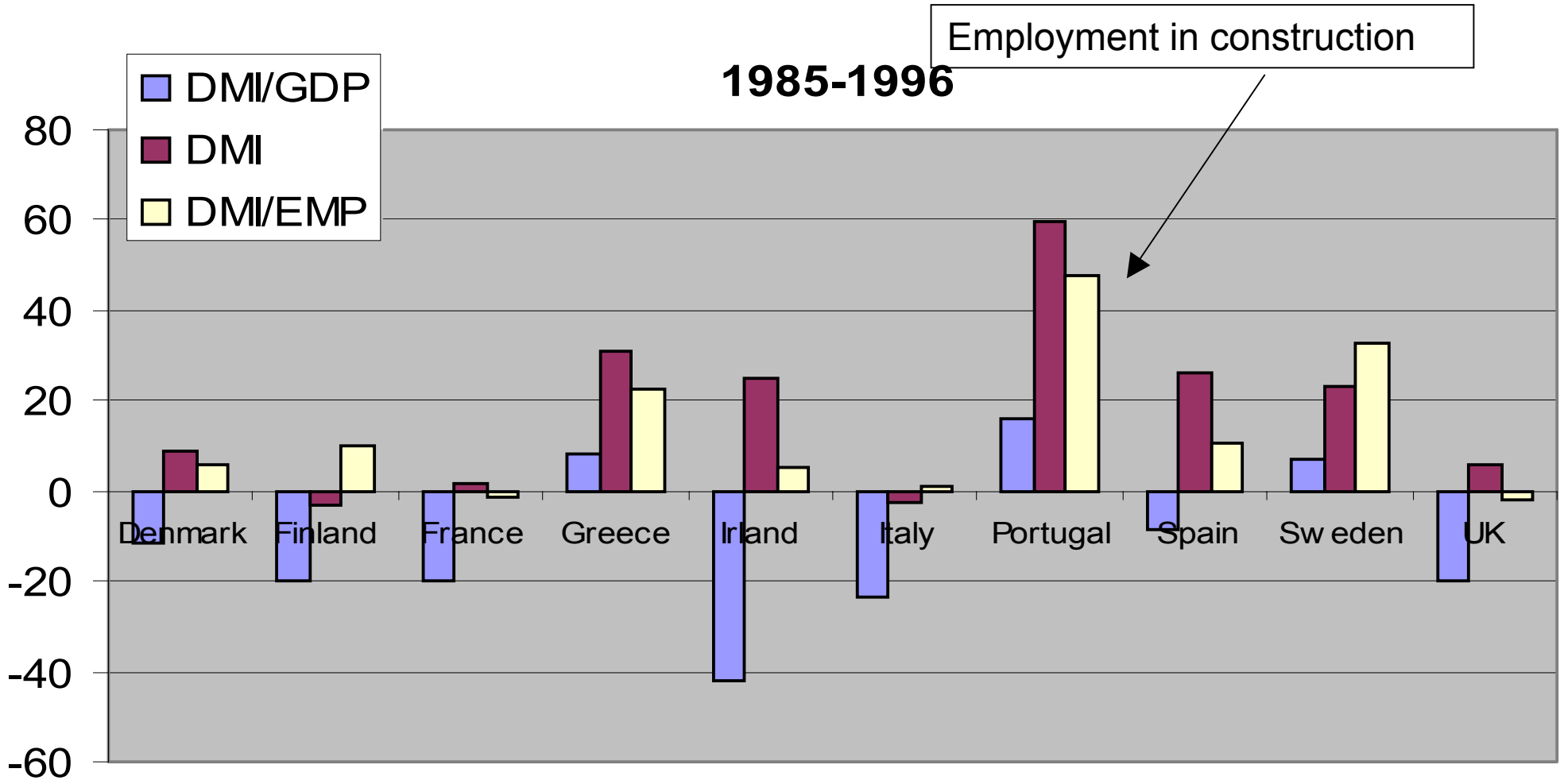
$$L(*) = \left(\frac{DMI_t - DMI_0}{\ln\left(DMI_t/DMI_0\right)}\right)$$

* Moll, 1999, *Reducing Societal Metabolism. A Sustainable Development Analysis*

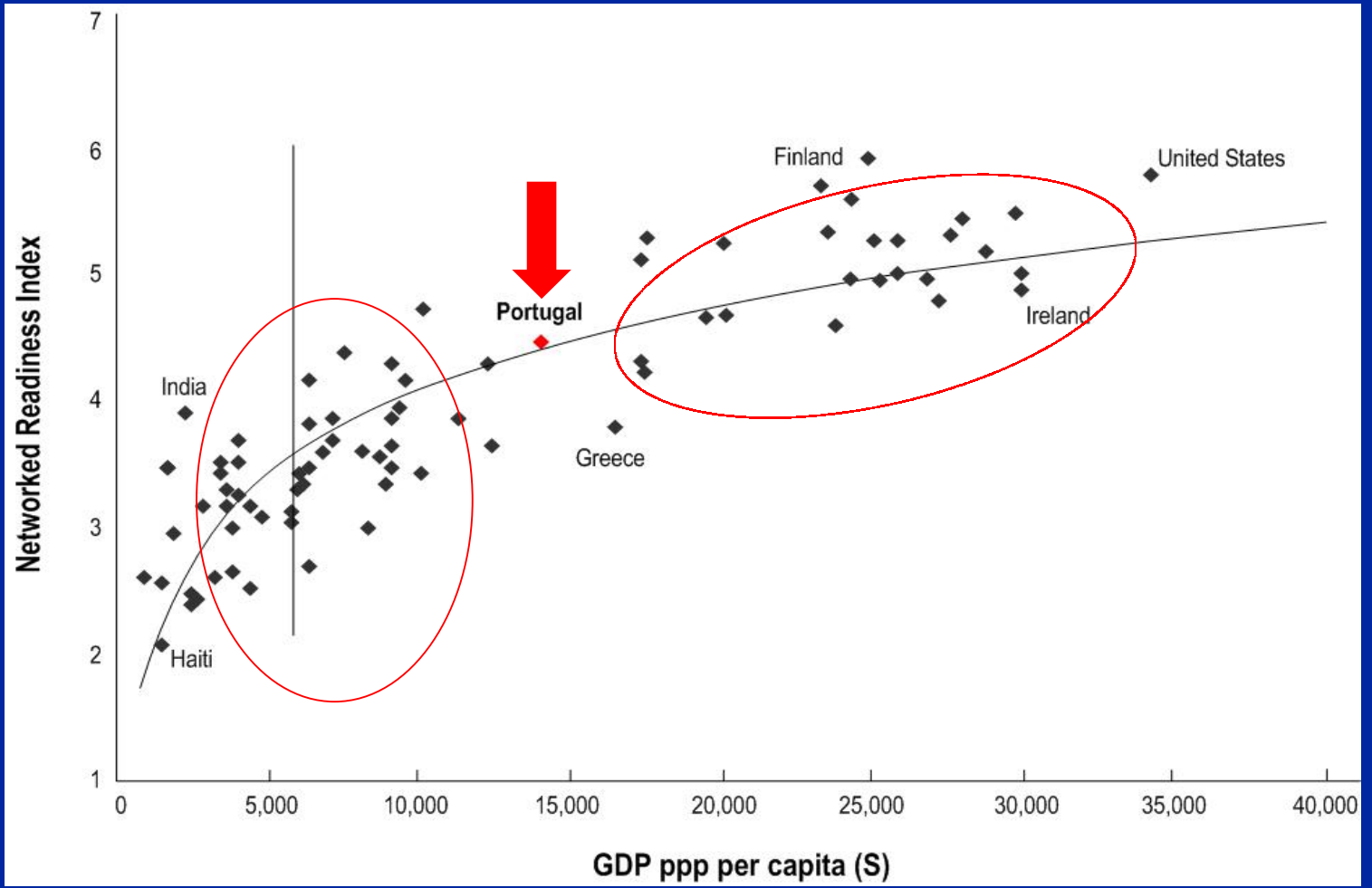
** *A Residual-free Decomposition of the Sources of Carbon Dioxide Emissions*

Decomposition of DMI variation

International disaggregation



Further evidence: network readiness



Source; The Global information Technology Report 2002-2003: Readiness for the Network Society, World Economic Forum

- LARGE growth rate of ICT expenditure (1992 to 1997)
- A cluster of countries where the effect of increasing GDP on network readiness is less pronounced and other factors, namely at institutional and contextual level, have been shown to particularly influence country's competitiveness