The Seminars of Ermoupolis, 2013: Η πρόκληση της εξόδου από την κρίση

The diffusion of energy innovations in times of prosperity and times of economic crisis

The case of Greece

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Outline

- Introduction to energy innovations
- The innovation cycle and its drivers
- Measuring the development and impact of energy innovations
- The interactive relation between energy innovations economic crisis
- Summary and concluding remarks

Definitions

- **Innovation: a new way of doing things that generates a value on the market**

- Energy innovation: a new way of….
  - ➔ Producing energy
  - ➔ Using energy
  - ➔ Meeting our energy needs

- …that generates a value on the market

  in any node of the energy value chain

The scope of energy innovations (EIs)

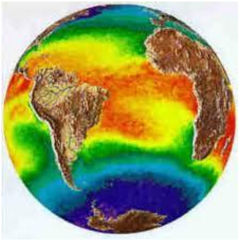
TIME ORDER

- To reduce the cost of energy

- To save depletable fuels

- To reduce atmospheric pollution

- To combat climate change



Taxonomy of technological changes

- **Incremental:** limited (linear) changes within a technological regime
  - ➔ Enhancement of existing technologies, not fundamentally altering their core characteristics

- **Disruptive:** new methods based on new knowledge bases
  - ➔ Functional changes in technical and economic structures (entrance and exit of firms, new financing mechanisms), not replacing the whole regime

- **Radical:** full-scale shifts of technological regimes
  - ➔ Changes in all components, including consumption patterns
  - ➔ Normally evolving in long time horizons

Examples
from the energy/climate sector

INCREMENTAL →

Energy efficiency in industry, buildings and transport

Combined-cycle technologies, district heating

→ **DISRUPTIVE**

New building materials, biofuels

Wind, solar & geothermal power technologies

→ **RADICAL**

Carbon sequestration and storage

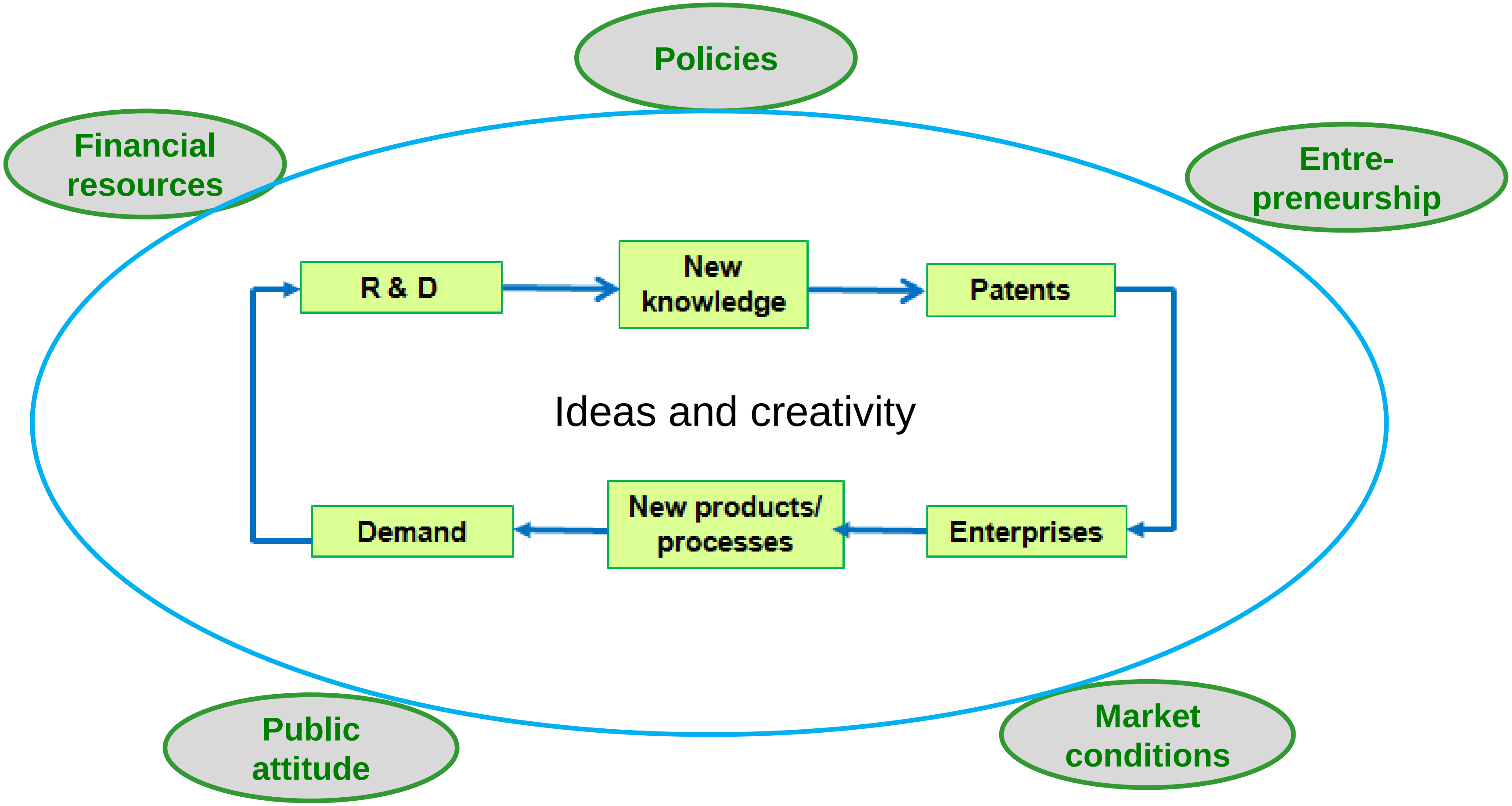
Hydrogen and fuel cells

Nuclear fusion

A different taxonomy

- **In the production of energy**
  - ➔ Changing the energy source, e.g. exploitation of renewables
  - ➔ Improving the process, e.g. increased efficiency
  - ➔ System restructuring, e.g. dispersed facilities, energy storage, micro units
- **In the use of energy**
  - ➔ Changing energy equipment , e.g. LED lamps, solar collectors
  - ➔ Changing fuels, e.g. biofuels,
- **In meeting energy needs**
  - ➔ Reducing losses, e.g. through insulation
  - ➔ Minimizing needs, e.g. through bioclimatic design
  - ➔ Reconsidering energy behaviour, e.g. through metering systems

Innovation cycle and drivers



The questions addressed

- How to measure the development and diffusion of EIs?
  - ➔ Inputs: R& D expenditure and Nº of patents
  - ➔ Outputs: Growth with less energy and carbon emissions
- How is economic crisis affecting EIs?
  - ➔ Less inputs? Worse outputs? Higher motivation for cost-effective solutions?...
- Do EIs help to recover from the crisis?
- Are there any differences between countries? What about Greece?

The approach followed

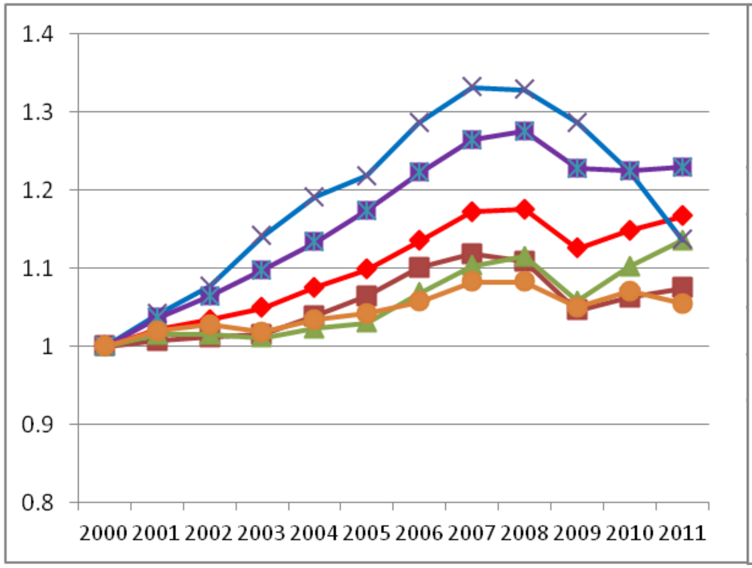
A quantitative macro-approach

- Statistical data (EU), indicators
- Decomposition analysis
  - ➔ Identifying the drivers behind changes in CO_2 emissions

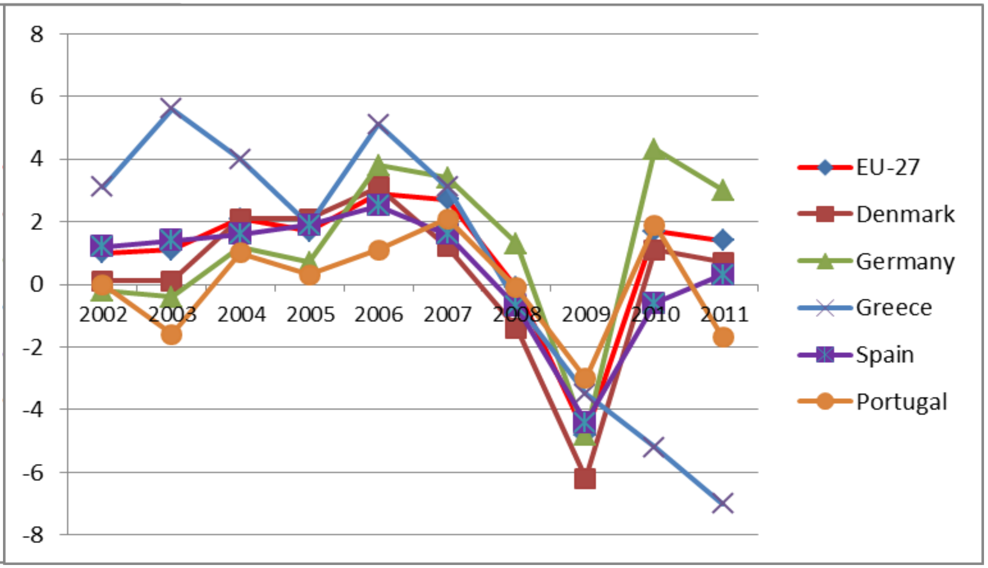
To generate insights for further elaboration at the micro-level and deeper understanding of driving forces

Evolution of GDP (in constant 2005 prices)

Relative growth



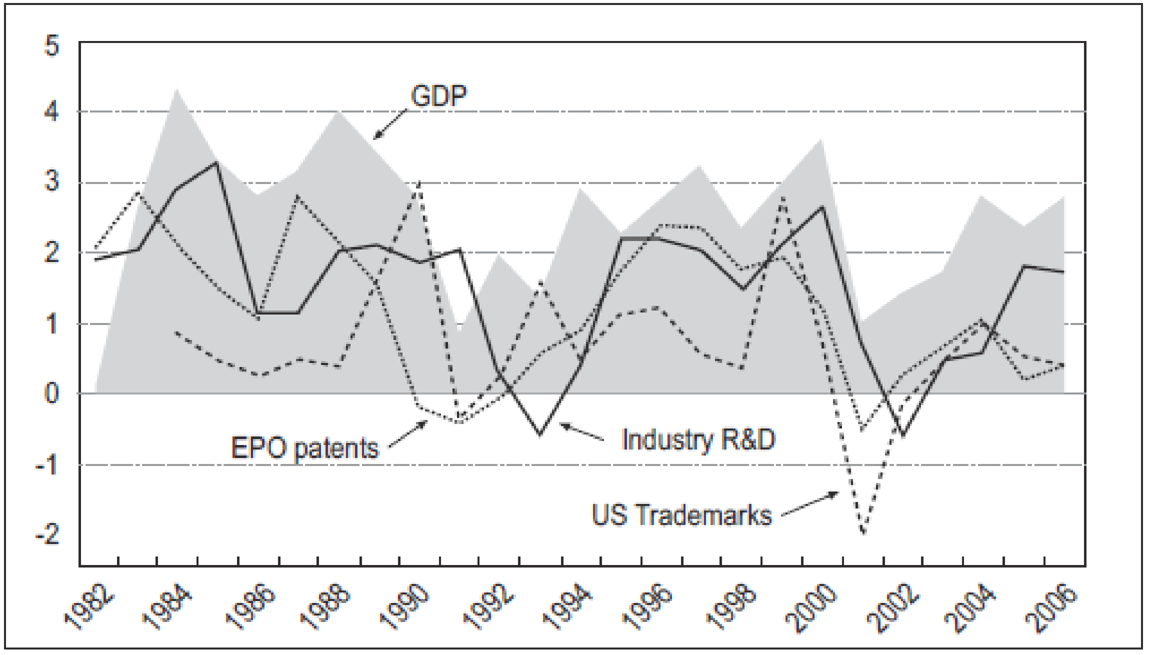
Annual growth rate



- The deep crisis of 2008-09 is followed by stagnation

…. except in Greece

The historical evidence

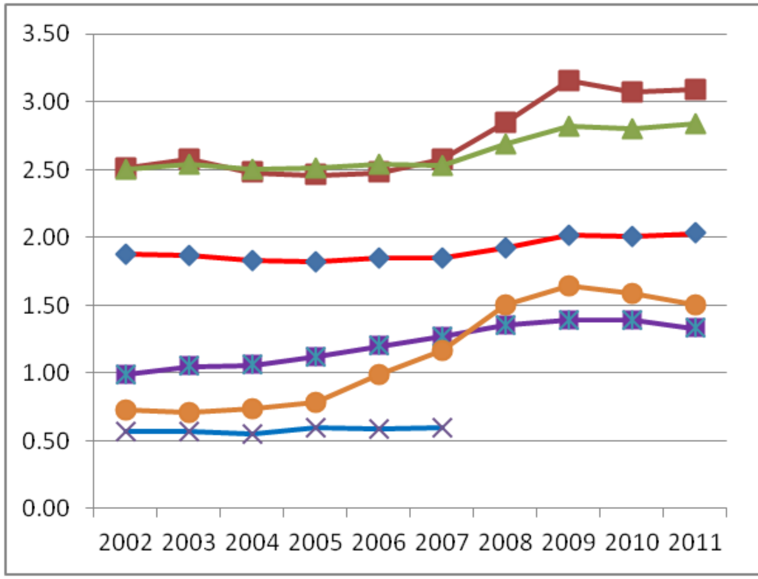


Source: OECD, MSTI and Patent database.

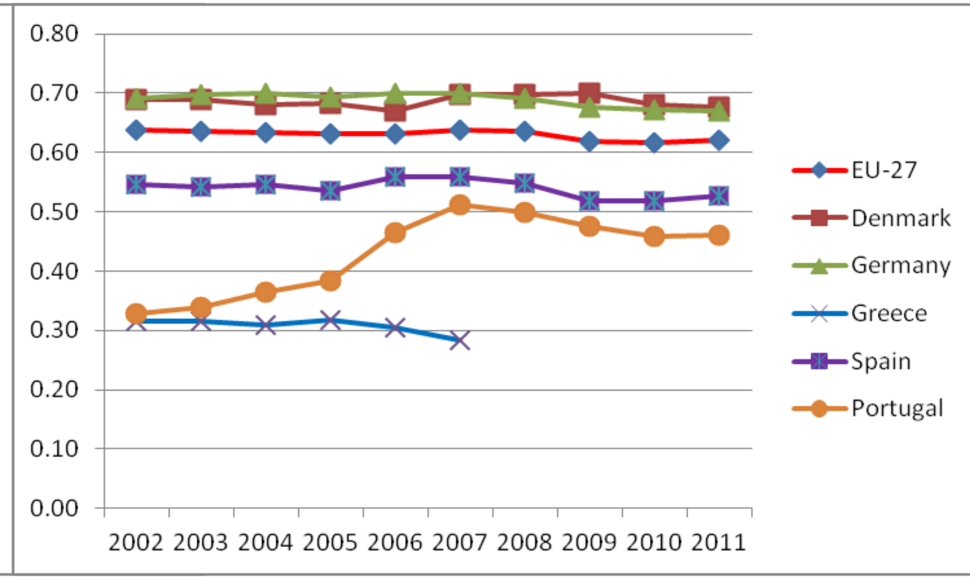
- Patents and R&D expenditures (especially from business) have followed the ups and downs of GDP

Evolution of R&D expenditures (% of GDP)

Total



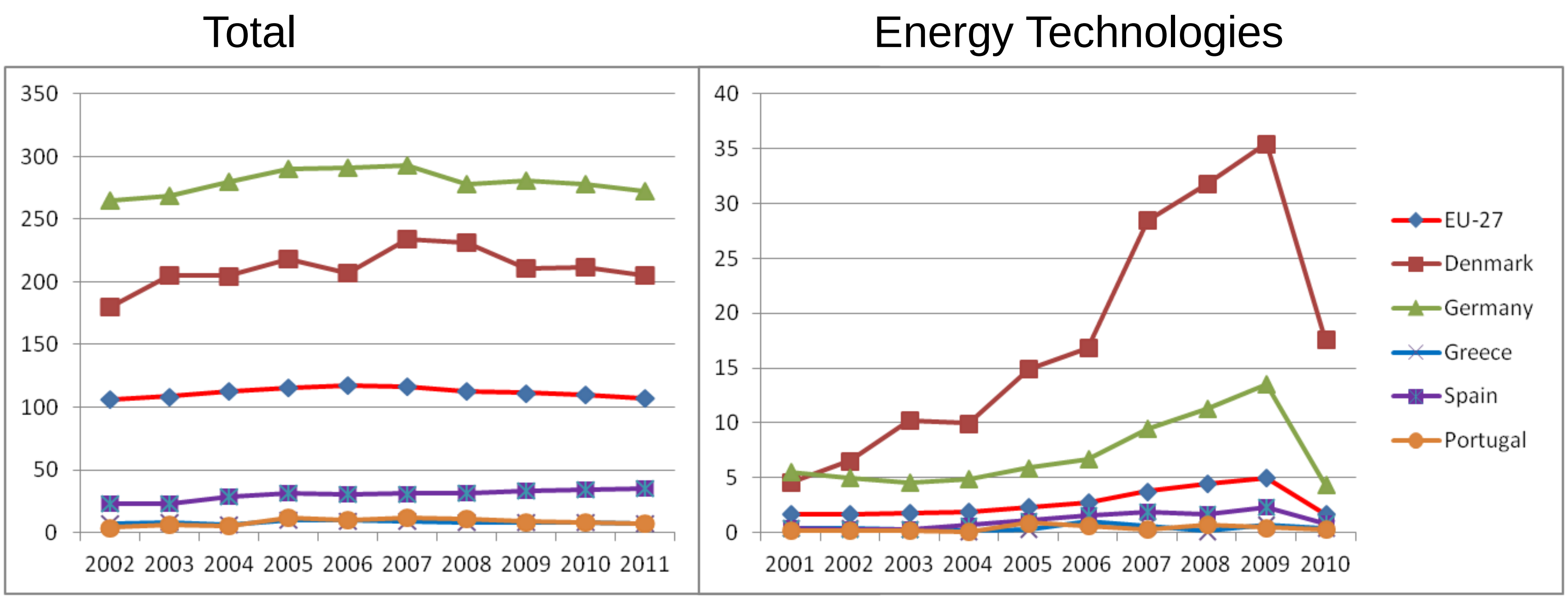
Private/Total



- Despite the crisis expenditures are not decreasing. Relatively stable share of the private sector

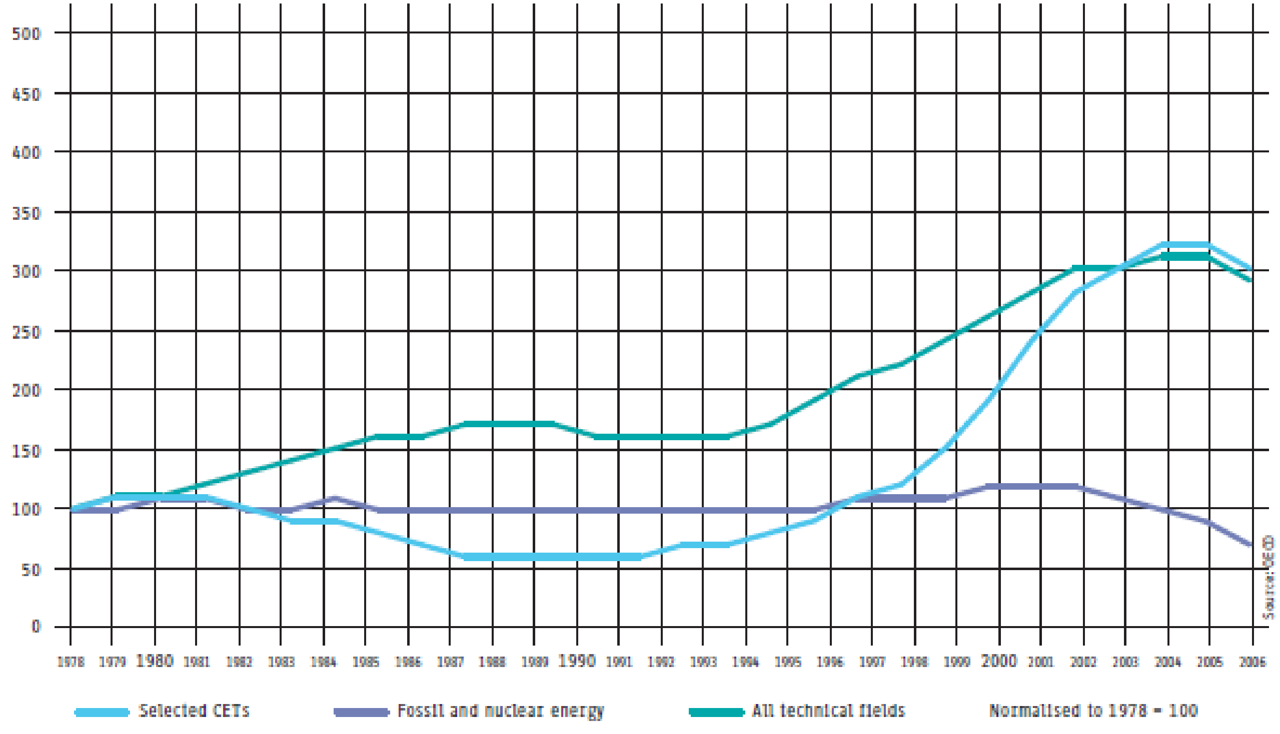
…. Greece vs Portugal

Patent applications to EPO (per million of inh.)



- Total No of patents remains relatively stable. At sector and country level mixed trends.
- Remarkable drop in Energy Technologies. Why?

Patent applications at the global level



- Patents in Clean Energy Technologies (CET) growing much faster compared to fossil and nuclear energy

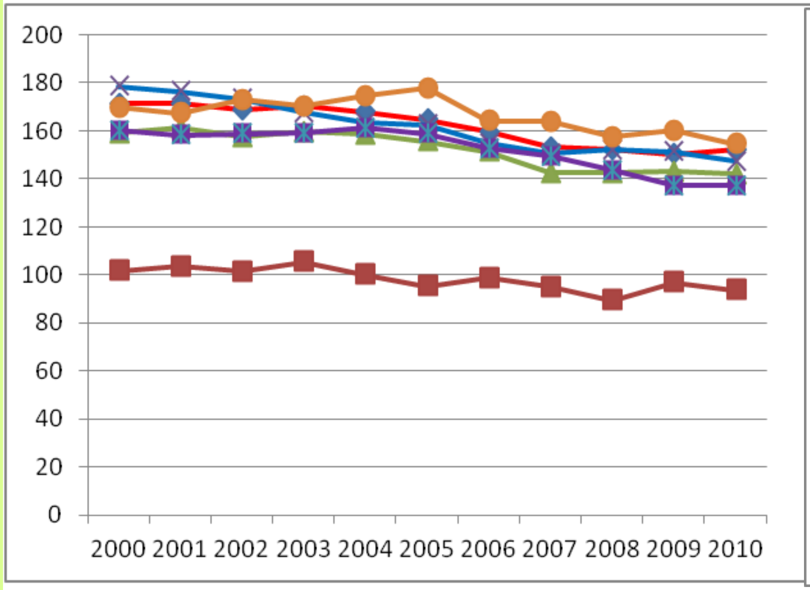
Leading countries in patents for selected CET

The wind sector	US, Germany, Denmark, Japan followed by the UK. Among the emerging developing economies, China was the top patentee;
Solar PV	US, Japan, Germany, the Republic of Korea and the UK. Again, among the emerging developing economies, China was the top patent holder;
Biomass	US, China, Germany, Japan and the Netherlands;
CSP	US, China, Germany, Japan and the Republic of Korea;
'Cleaner coal'	US followed by China, Japan, Germany and the Republic of Korea;
CCS	US, Canada, Japan, Germany and the Netherlands.

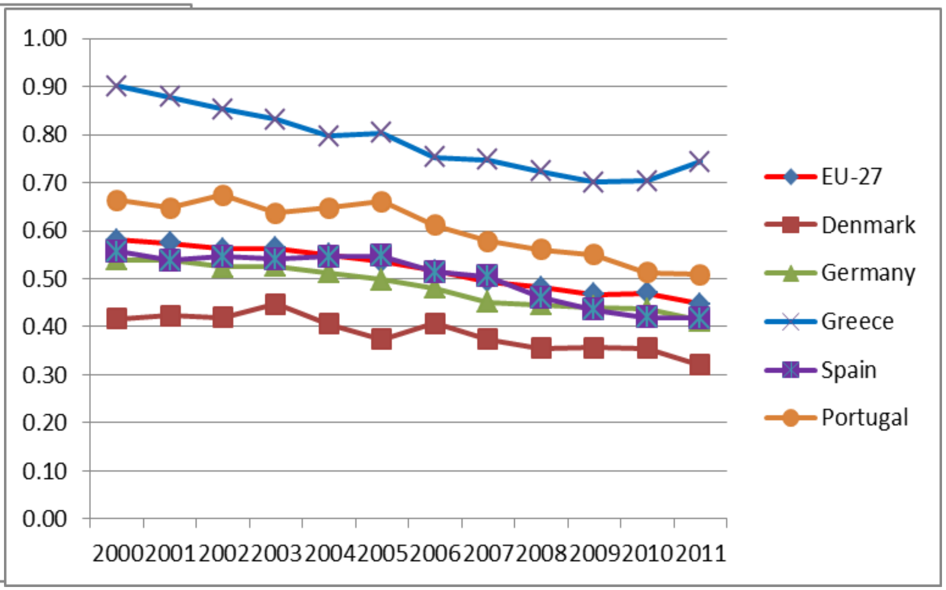
- A leading role for emerging economies
- Sometimes leading manufactiring countries have little patenting activity: Knowledge transfer

Intensities (per 1000 Euros)

Energy intensity (kg of oil eq.)



Carbon intensity (t CO_2)



- Gradual improvements in both intensities.
- Different initial position
- Converging trends, except for Greece's carbon intensity

Decomposition analysis

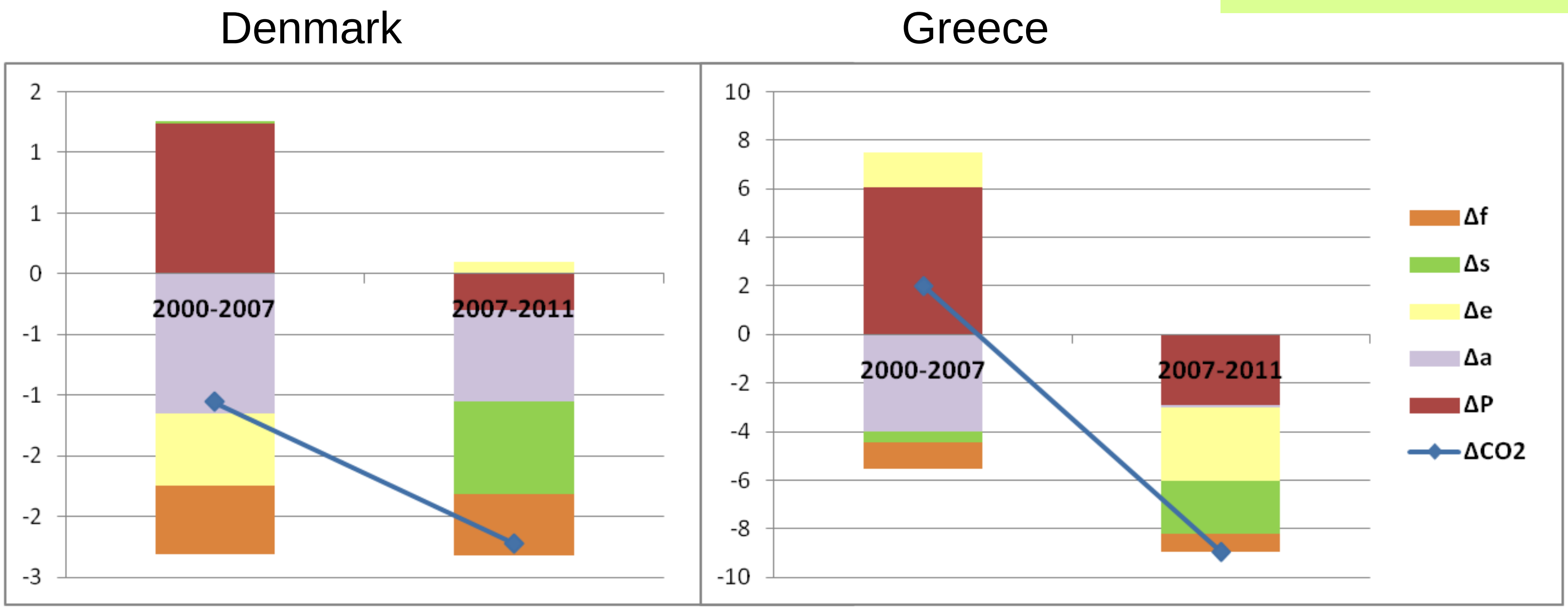
- An analytical approach to identify relative contribution of different driving factors to a perceived change.

- **The example of changes in CO_2 emissions:**
  - ΔP= Change in Production (GDP)
  - Δa= Change in the structure of the economy

  and reflecting the impact of EIs:

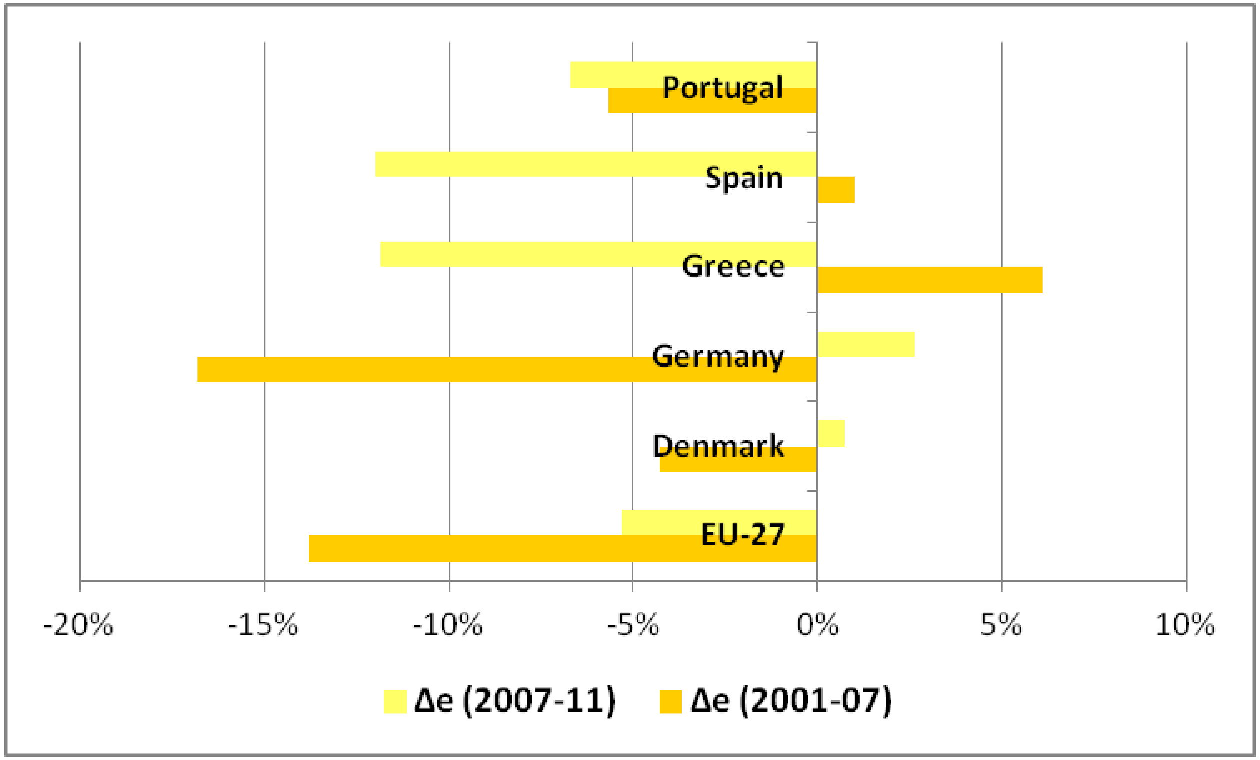
  - Δe= Change in energy intensity (energy/GDP)
  - Δs= Change in energy mix at the final demand
  - Δf = Change in electricity mix

Decomposition Analysis
Results from two countries



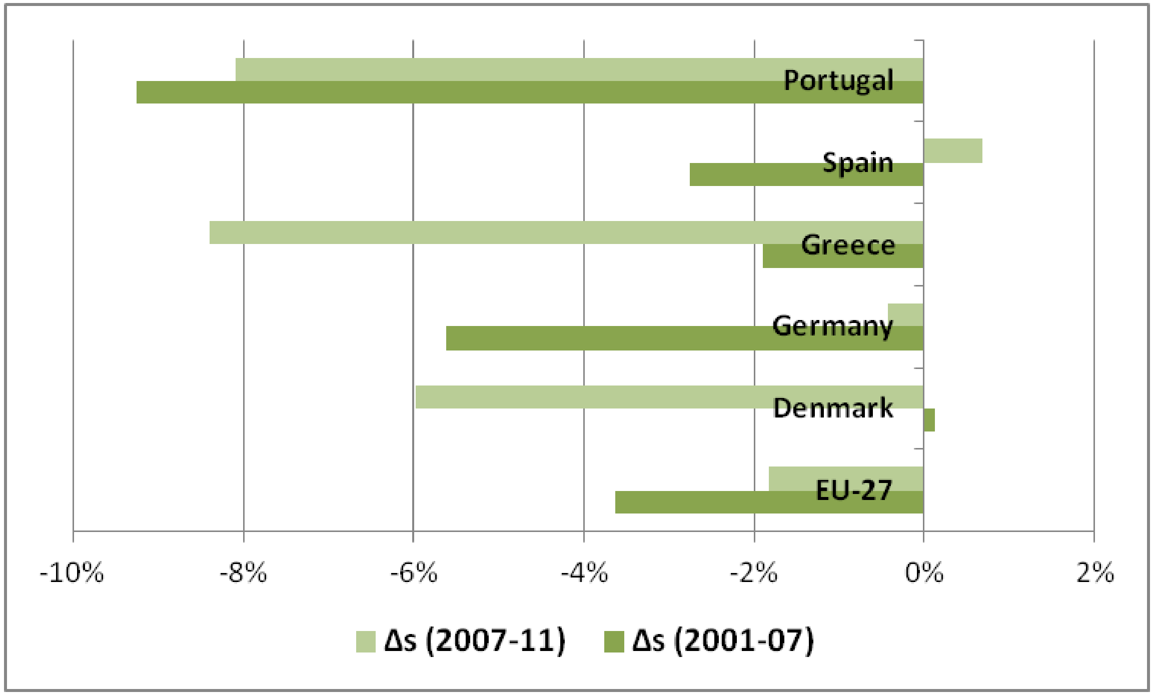
- After 2007, the falling GDP is dragging down emissions, together with all other factors
- High contribution of sectoral shifts, except for Greece after crisis
- Greece: delays in EIs related drivers

The contribution of Δe
(difference in energy intensity)



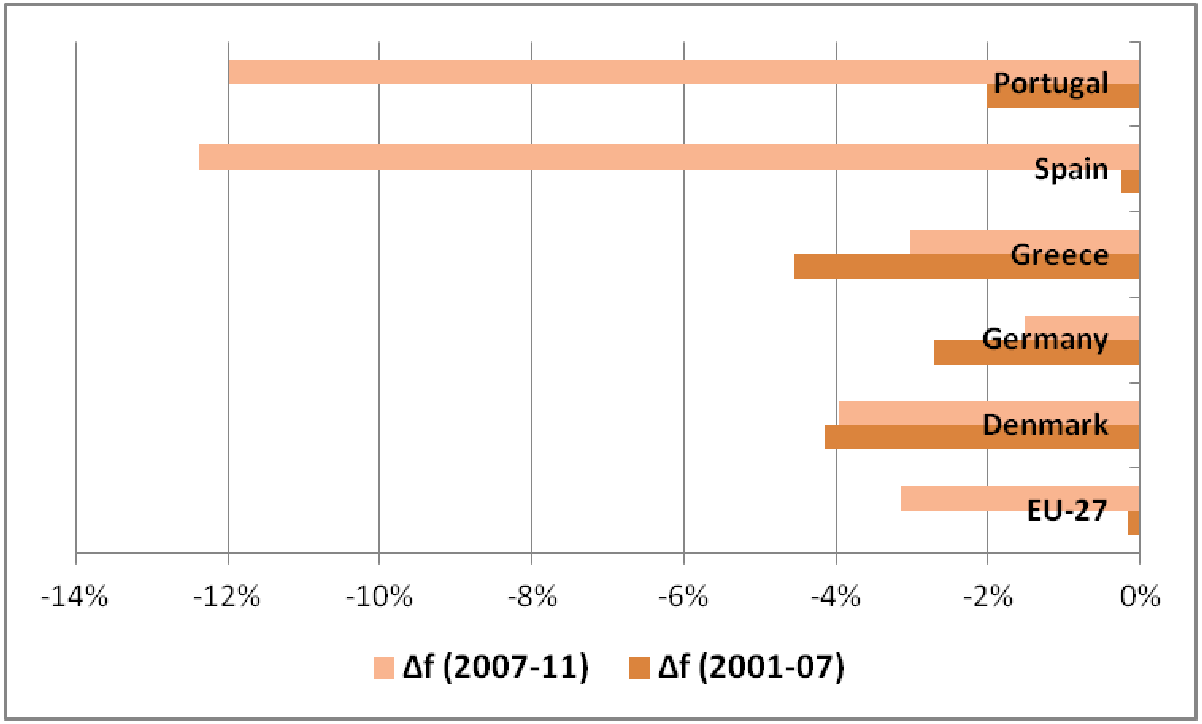
- Continuation but not acceleration of efforts to improve efficiency in energy use, especially in DE, DK

The contribution of Δs (difference in energy mix)



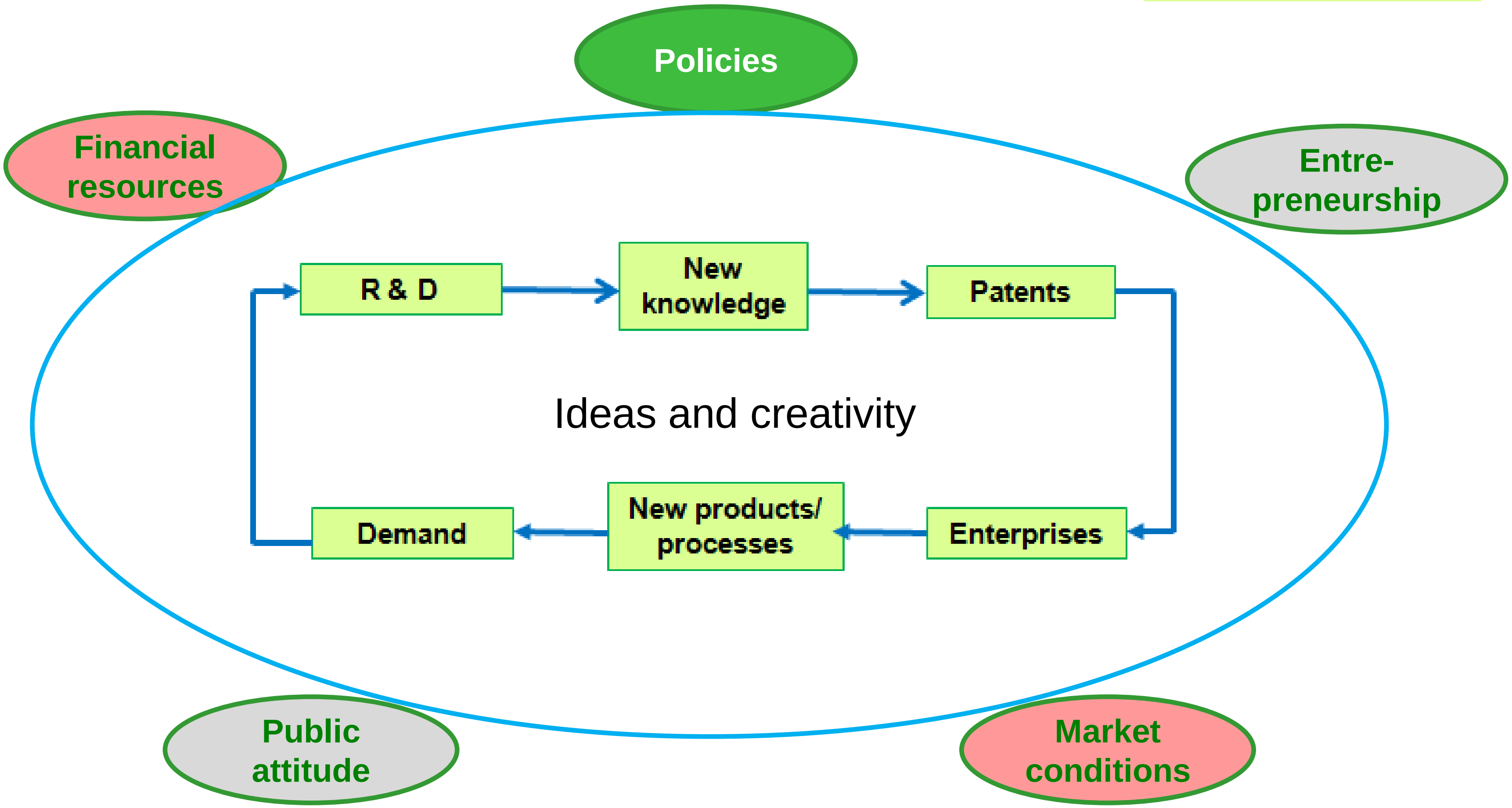
- Small contribution from the shift towards cleaner energy sources (CETs)
- in EU-27 <2% after 2007

The contribution of Δf (difference in electricity mix)



- High contribution from the shift towards cleaner energy sources in Portugal and Spain

The impact of economic crisis on EIs



Looking at the drivers

- Policy framework in EU is fostering energy innovations
  - ➔ The energy and climate targets for 2020
  - ➔ The roadmap to 2050 for moving to a low carbon economy
- Entrepreneurship
  - ➔ More incentives, higher motivation to create own firms
  - ➔ But also negative impact from market and financing
- Market conditions
  - ➔ Falling income, dropping demand, higher entrepreneurial risks
  - ➔ Lower energy prices reduce incentives to adopt CET
  - ➔ Dropping cost of some CET (e.g. PV) facilitate diffusion
- Financial resources
  - ➔ Decline in financing R&D
  - ➔ Decline in private funds and venture capital
  - ➔ Difficult access to loans

Summary and concluding remarks

1. Energy innovations are to a large extent policy-driven
2. The economic crisis has put additional barriers to the development and diffusion of EIs
   - ➔ Countries suffering the most do not react in the same way: Portugal invests in innovation, Greece continues to abstain
3. Inputs to EIs have shown a slight decrease
   - ➔ Not the same in all countries, for all CETs
   - ➔ The leading role of emerging economies
4. Diffusion of energy innovations is slowing down
   - ➔ Predominantly incremental improvements
   - ➔ Restricted to more mature technologies (wind, PVs, energy efficiency)
   - ➔ Uncertainty prevents from large, ambitious, risky investments

Summary and concluding remarks

5. EIs is more likely to help early movers than followers
   - ➔ The competition from strong manufacturing countries is reducing beneficial side effects for countries importing equipment and technology
   - ➔ The loss of human capital (brain-drain) makes the adoption of EIs more difficult
   - ➔ The prospect to remove financial support from mature CET (wind, PVs) discourages new entrants
6. Energy innovations is a necessary but not sufficient condition to recovery from the crisis.

Thank you

for your attention!