Integrating innovation impact into policy assessments: a case of energy-using products

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Bio Intelligence Service - Scaling sustainable development
Industrial Ecology - Nutritional Health

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Introduction

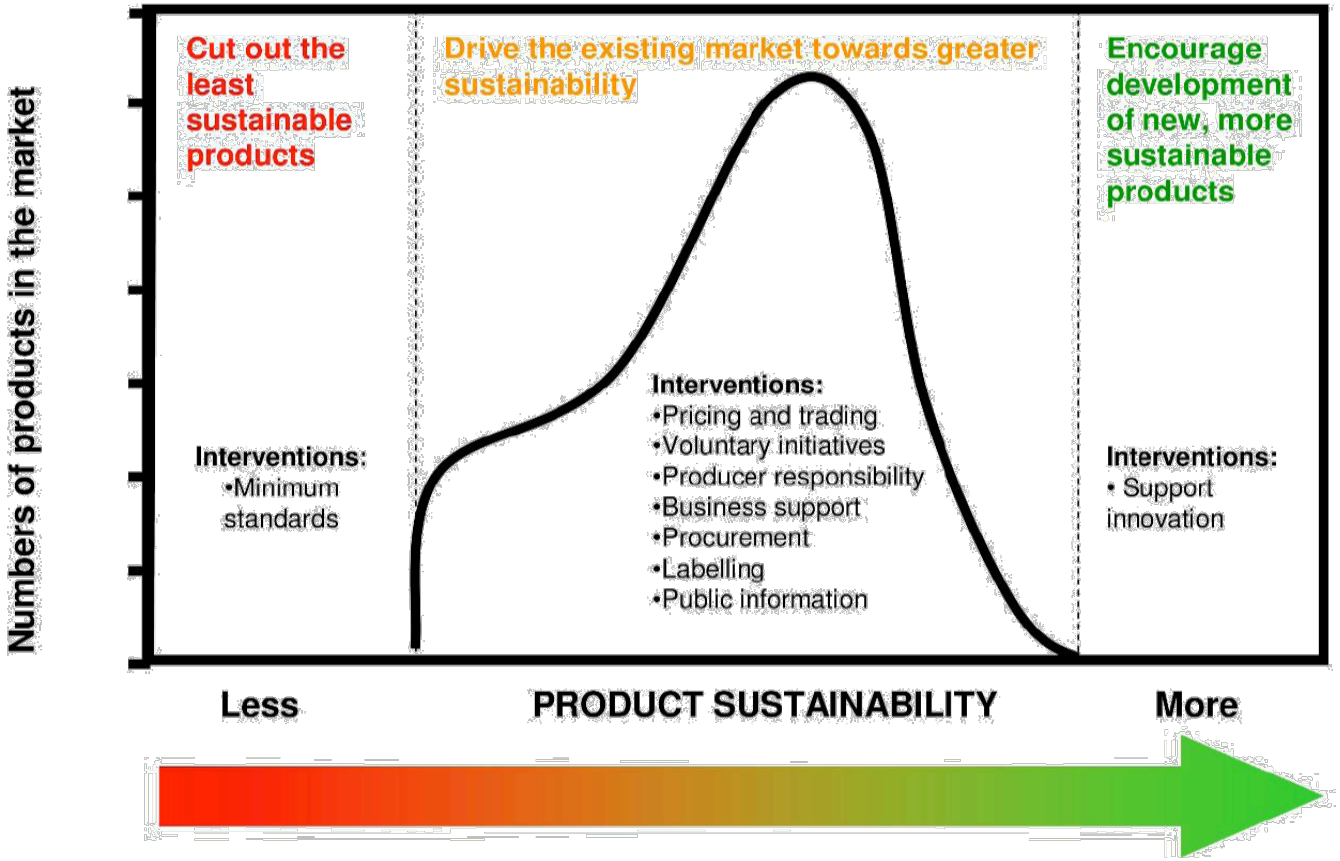
- Based on the results of a study commissioned and funded by the Department for Environment, Food and Rural Affairs (Defra), UK

- The views expressed reflect the authors' interpretation and do not necessarily reflect Defra policy or opinions

- **Project Team**

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Product policy approach

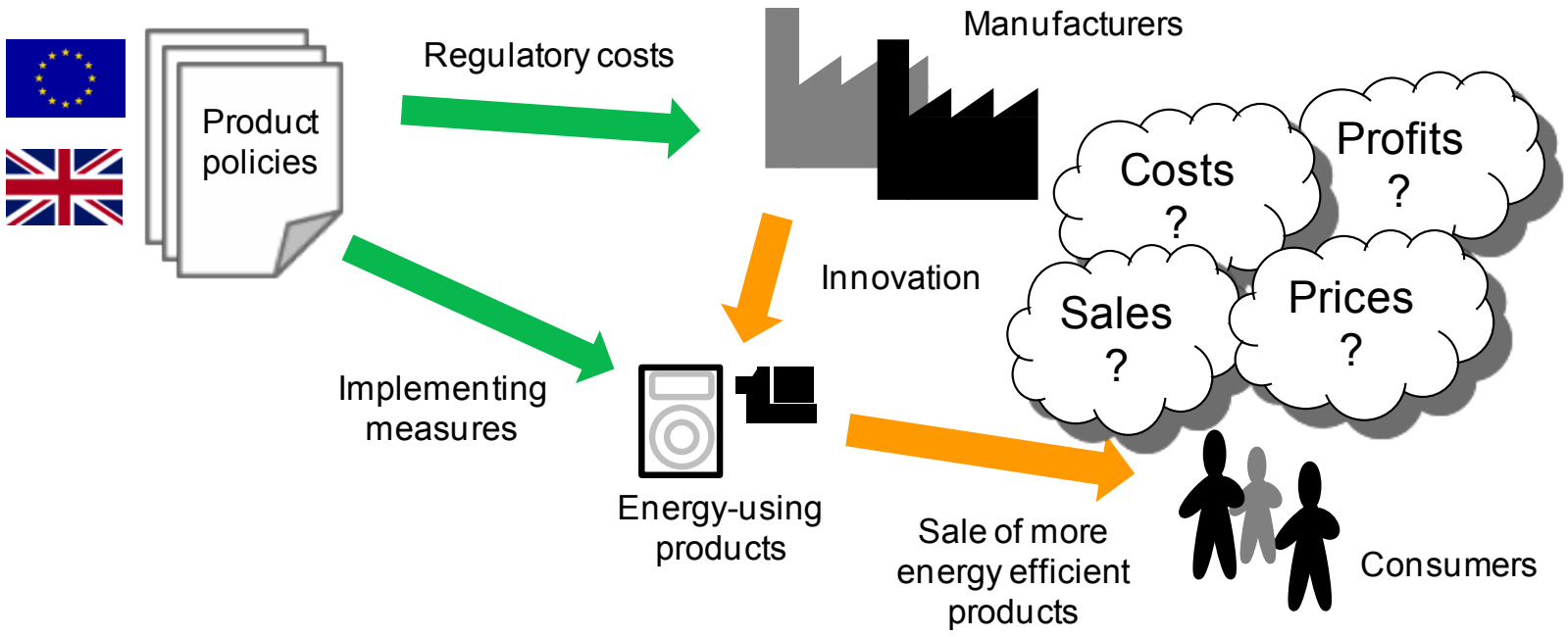


[Defra (2008) Progress Report on Sustainable Products and Materials, www.defra.gov.uk]

Impacts of innovation on the regulatory costs of EuP policy

Study objective

- Analyse the role of innovation in influencing the costs faced by product manufacturers in response to EuP policies
- Focus on EU Energy Labelling Directive



Regulatory costs

- *increased administration costs*, e.g. monitoring and reporting requirements, certification costs
- *decreased unit profitability of existing products* due to the inability to fully pass-on increased unit production costs to consumers in product prices;
- *additional investment costs* involved in the R&D and production of new products
- *changes in sales*, e.g. changes in the consumers' willingness-to-pay for products

- **Innovation induced by EuP policies**
  - *the introduction of new, more energy-efficient products*
  - *the accelerated diffusion of existing energy-efficient products*

Innovation has an impact on regulatory costs because it affects production costs, unit prices and sales

Methodology for accounting for innovation in policy impact assessments

- *Current Impact Assessments* take a 'engineering cost-driven' approach:
  - Product unit costs increase with introduction of policy interventions
  - Typically assumes full pass-through to consumers
  - Estimates based on expert opinion

COSTS:

Costs to manufacturers = £negligible

Costs to consumers of switching lamps = -£ 120,490,000 [i.e. a net saving to consumers]

Costs to consumers of replacing luminaires = £92,990,000

Increased CO_2 emissions from HRE = £ 83,700,000

Cost of additional air quality damage due to HRE = £18,690,000

Increased heating costs to consumers from HRE = £226,370,000

TOTAL COSTS: £301,260,000

BENEFITS:

Total Value Energy Savings = £1,010,120,000

Total Value EU ETS allowance savings (from CO_2 emissions savings) £195,970,000

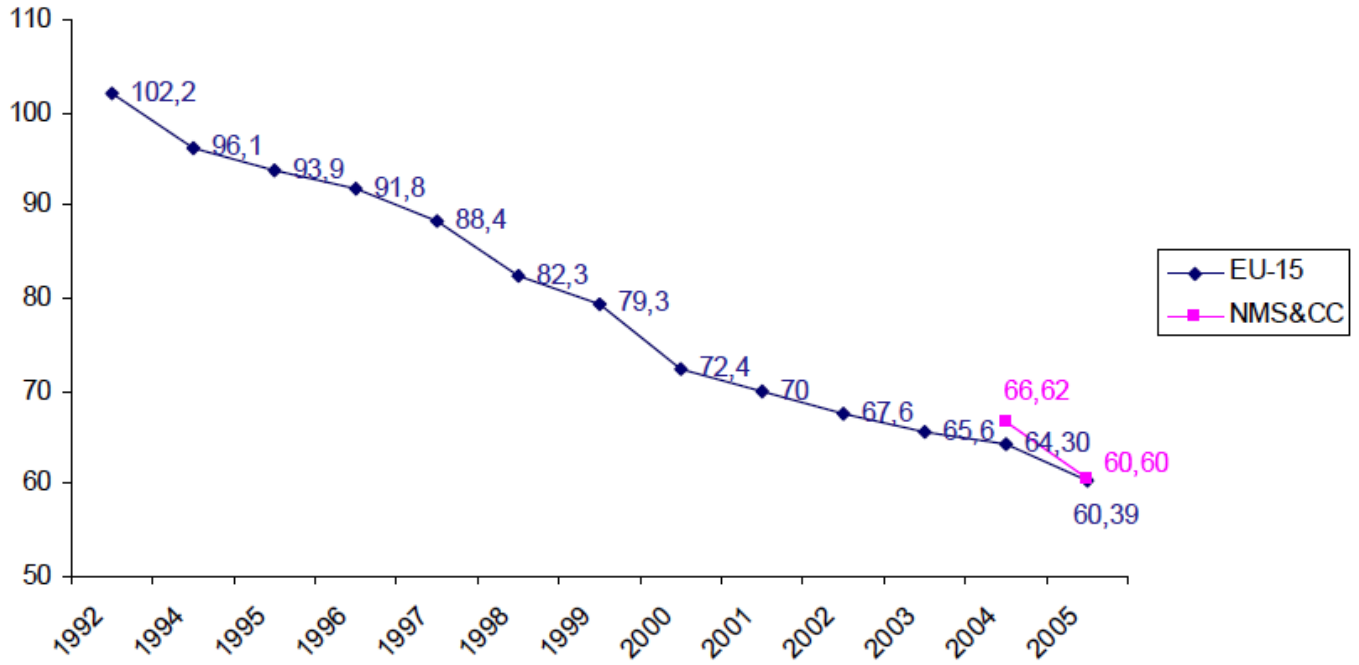
Total value air quality damages avoided = £ 26,730,000

Total value of absolute reduction in required delivery of renewable energy £297,680,000

TOTAL BENEFITS: £1,530,500,000

Evidence of innovation:

- *Energy efficiency of products on the market have increased*

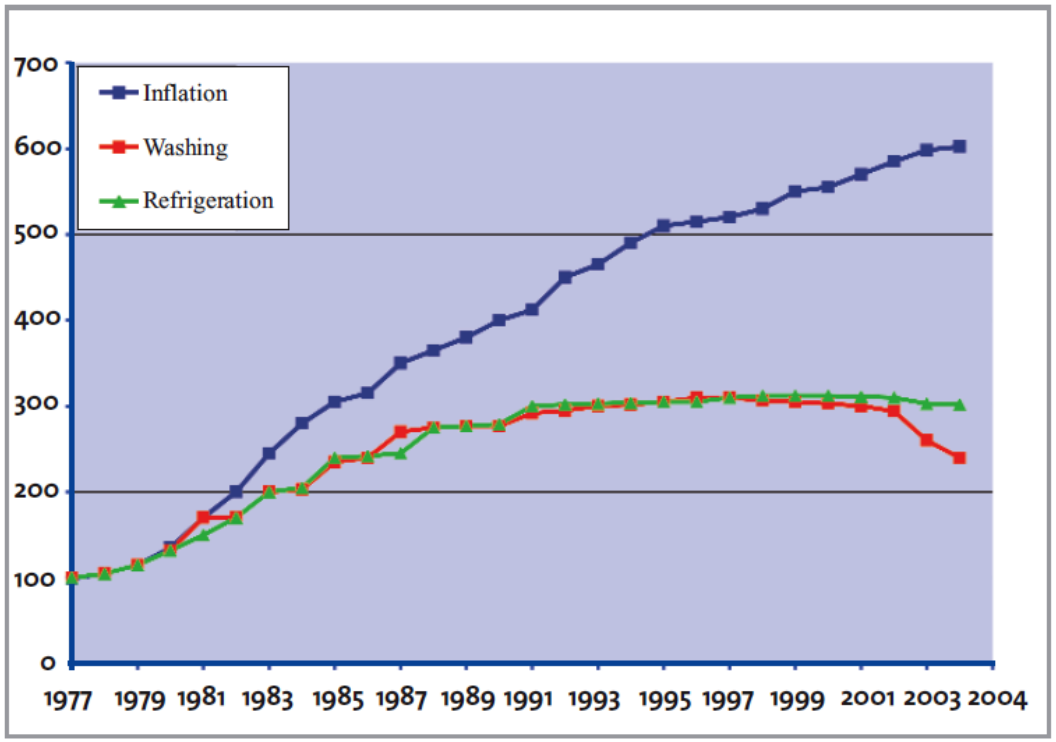


Energy efficiency improvement (new model sale weighted average) for cold appliances

[Bertoldi and Atanasiu, (2006) Electricity Consumption and Efficiency Trends in the Enlarges European Union, JRC - Institute for Environment and Sustainability]

Evidence of innovation:

- *At the same time the price of appliances have fallen in real terms*



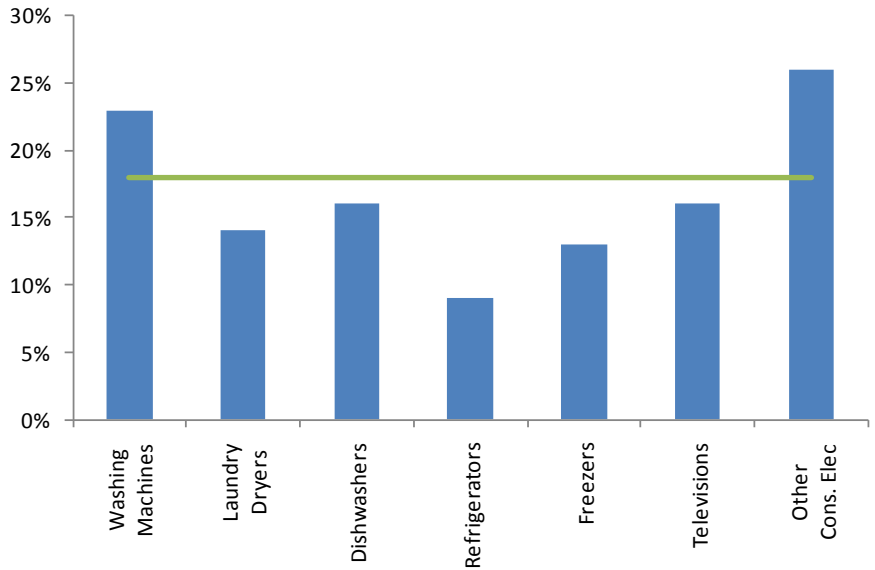
Price trends from 1977 to 2004 for washing machines and refrigerators

[CECED (2008) Energy-efficiency a shortcut to Kyoto targets - The vision of European home appliance manufacturers]

Evidence of innovation:

- Experience curves and learning rates
  - Learning rate (LR) is the % reduction in cost for a doubling of cumulative production
  - Learning rates for prices/costs of energy-using products range from 4% to 41%
  - Evidence of experience curve effects in relation to energy efficiency
    - LRs ranging from 13-35%
    - Indication of acceleration in LRs over time (due to policy interventions?)

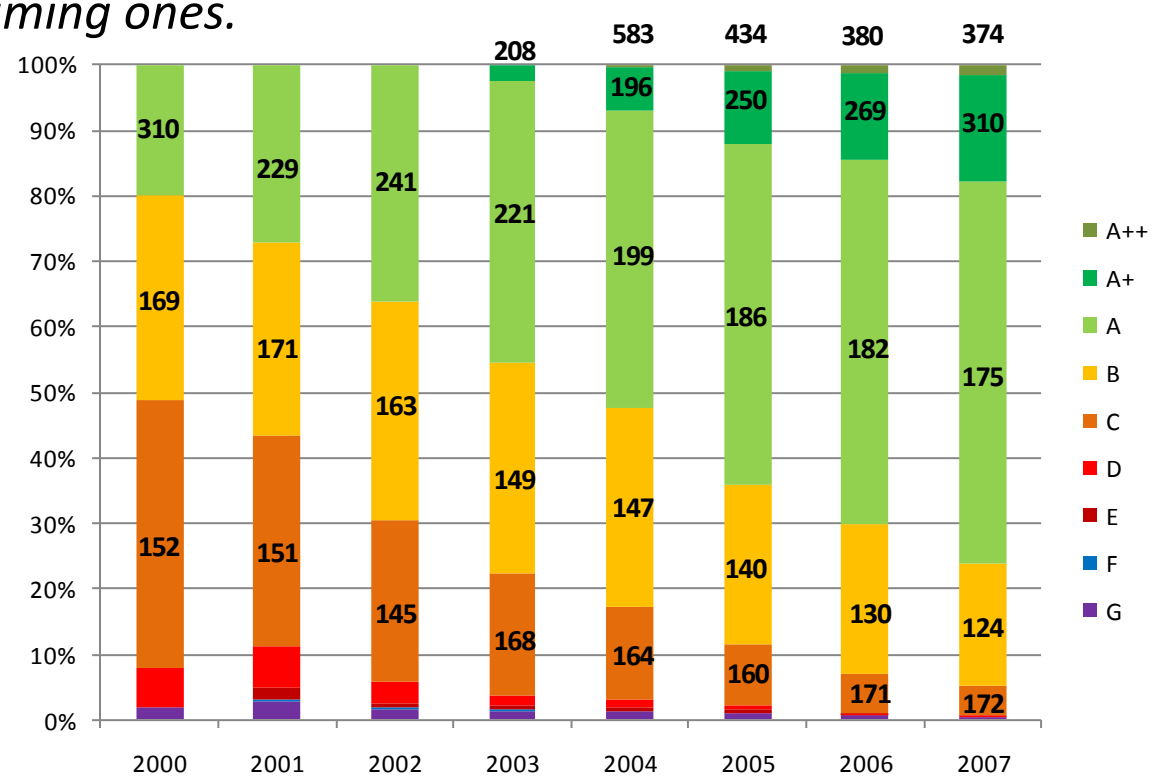
Average cost / price learning rates for selected EuP categories



[Weiss M, Junginger M, Patel MK, Blok K (2010) A review of experience curve analyses for energy demand technologies. Technological Forecasting & Social Change 77: 411–428]

Evidence of innovation:

- *When using energy efficiency classes as defined by the EU energy labelling Directive, one can see the progress of energy efficiency products with respect to energy consuming ones.*



The market share of energy labelled fridges and their average prices in GBP (GfK datasets)

Methodology

- ***Forecasting model*** *based on the analysis of the movement of prices and sales according to how products compare in terms of energy efficiency.*

  1. Prices: Hedonic pricing method (Regression analysis)

  With data on the price and product features of appliances, the shadow price premium associated with each product feature can be estimated. For this study, we wanted to estimate the price premium of relative energy efficiency.

  2. Sales: correlation between relative energy efficiency and sales at energy class level

  Use of a pattern of technology diffusion (appearance and disappearance of new products) to forecast sales levels by energy efficiency class (using information on EU labels).

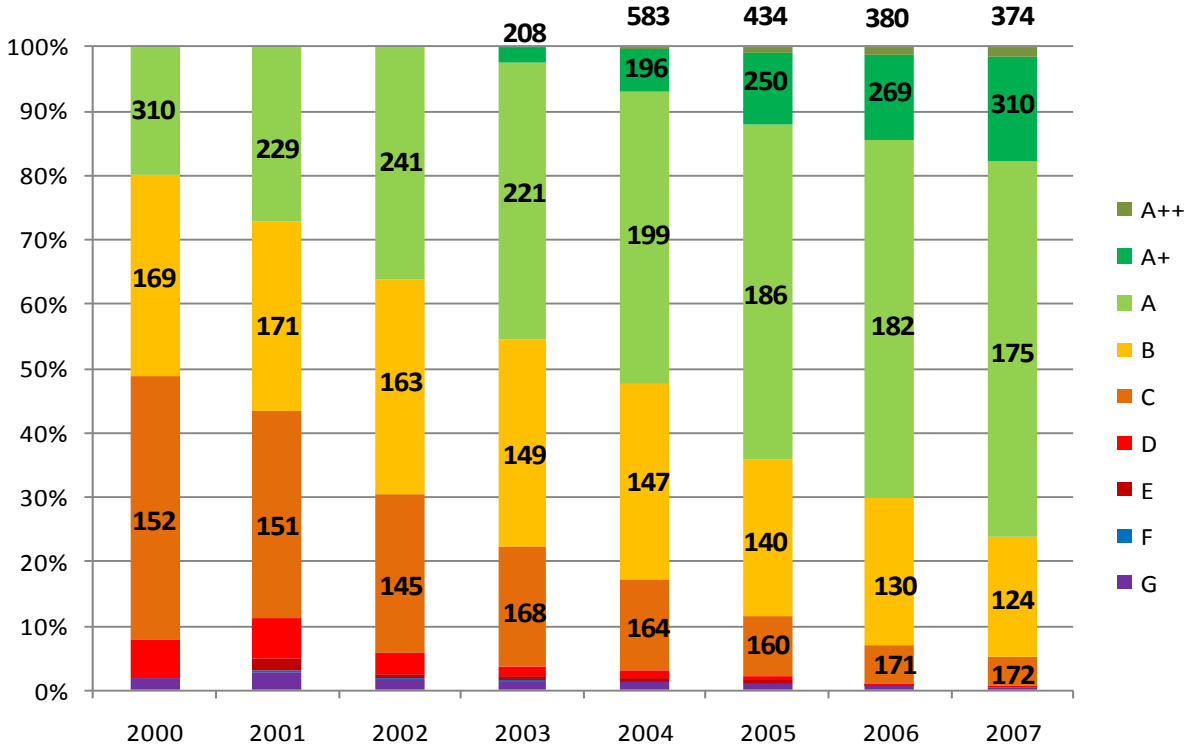
Data

- **Sales data at product level** including the price, sales level and other product features for a sample of models of appliances as collected from retailers by GfK Retail and Technology.

Appliance type	Years	Number of observations	Number of sold units in 2005	Energy efficiency parameter
Fridges	2000 – 2007	5,049	1,055,209	EU Mandatory Energy Labelling (A++ to G)
Fridge-freezers	2000 – 2007	7,667	1,533,690	EU Mandatory Energy Labelling (A++ to G)
Dishwashers	2005 – 2007	2,665	851,337	EU Mandatory Energy Labelling (A to G)
Washing machines	2003 – 2007	4,060	2,488,365	EU Mandatory Energy Labelling (AAA to GGG) CECED Voluntary Commitment (A+ and A++)
Ovens	2005 – 2007	3,044	567,417	EU Mandatory Energy Labelling (A to G) for electric ovens
Cookers	2005 – 2007	2,274	664,171	

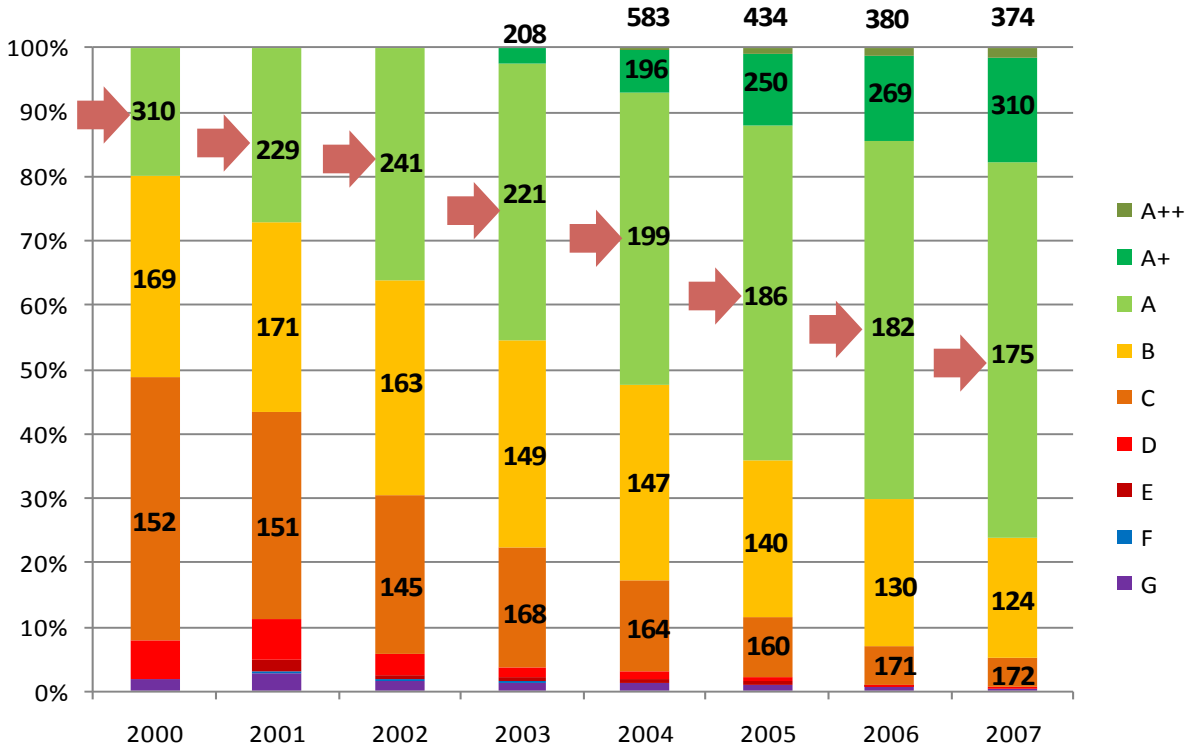
Intuition behind the forecasting model

- The rate of replacement and appearance of new models on the market is an indicator correlated with innovation



The market share of energy labelled fridges and their average prices in GBP (GfK datasets)

An indicator of relative energy efficiency: Efficiency Ranking Indicator (ERI)

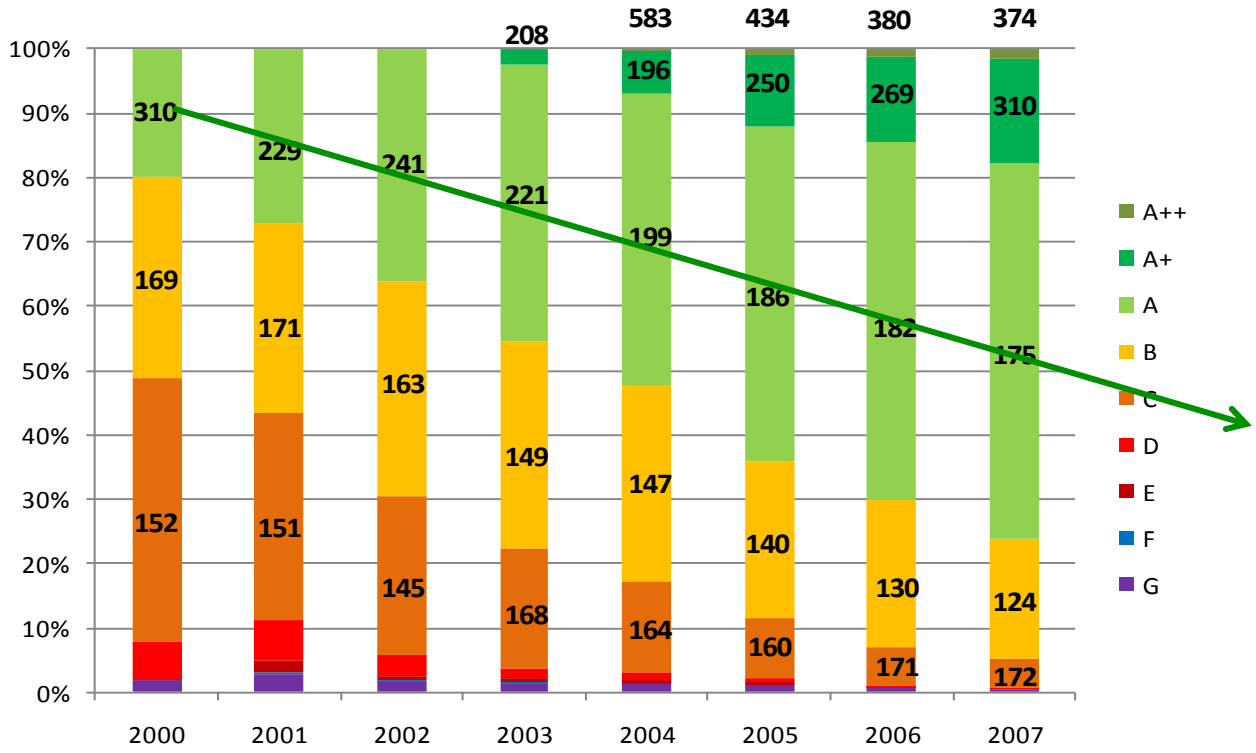


The market share of energy labelled fridges and their average prices in GBP (GfK datasets) and the ERI for A-labelled appliances

- *ERI is calculated as the median ranking of each energy efficiency label (ERI = 1 for the most efficient product ERI = 0 for the least efficient product)*
- *It therefore tracks the decline of the products or energy classes available on the market as new, more efficient product models and energy classes appear*
- *The product sales price is determined by its competitive position on the market*

Energy efficiency class life

- the time it takes a top energy class to become the least efficient class allowed on the market



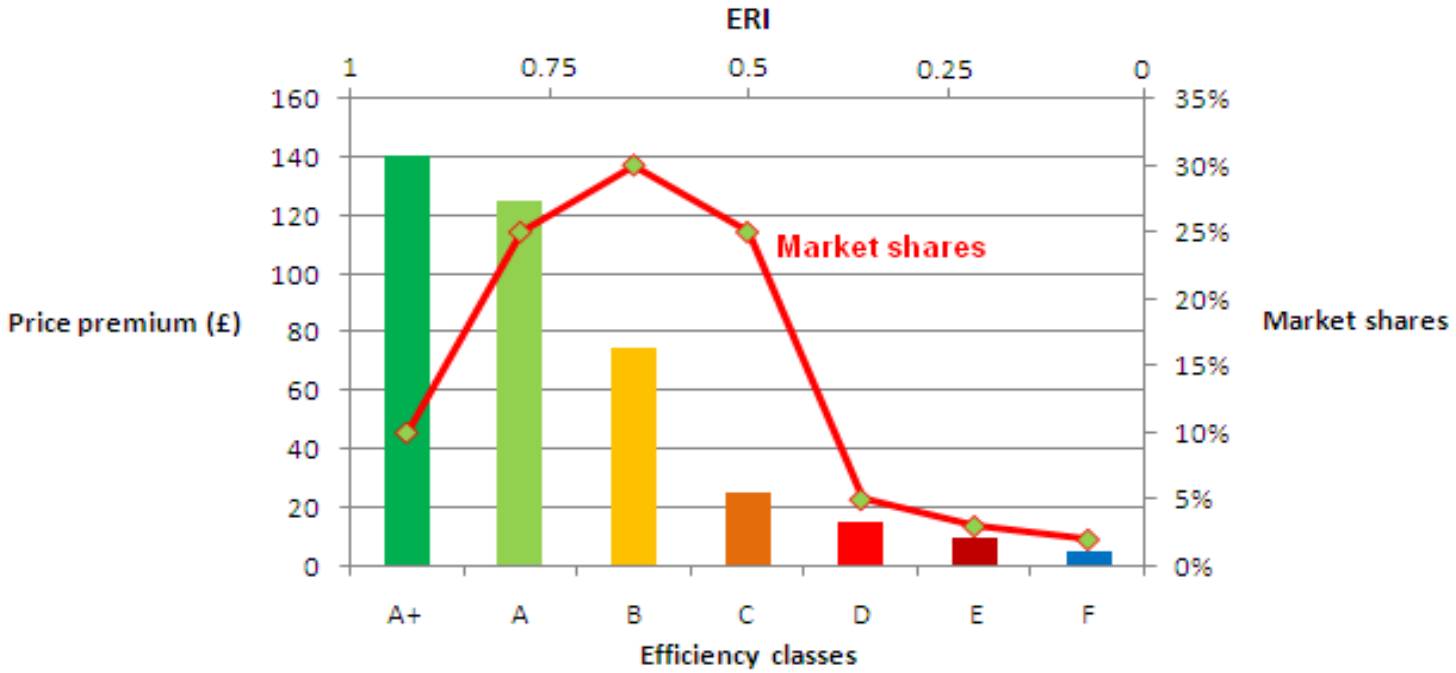
- *The average efficiency class life is calculated by the average time the ERI of an energy efficiency class drops from the highest to the lowest (i.e. from 1 to 0)*
- *It is an indicator of the rate of innovation*

A-labelled products sold for the first time

Energy efficiency class life

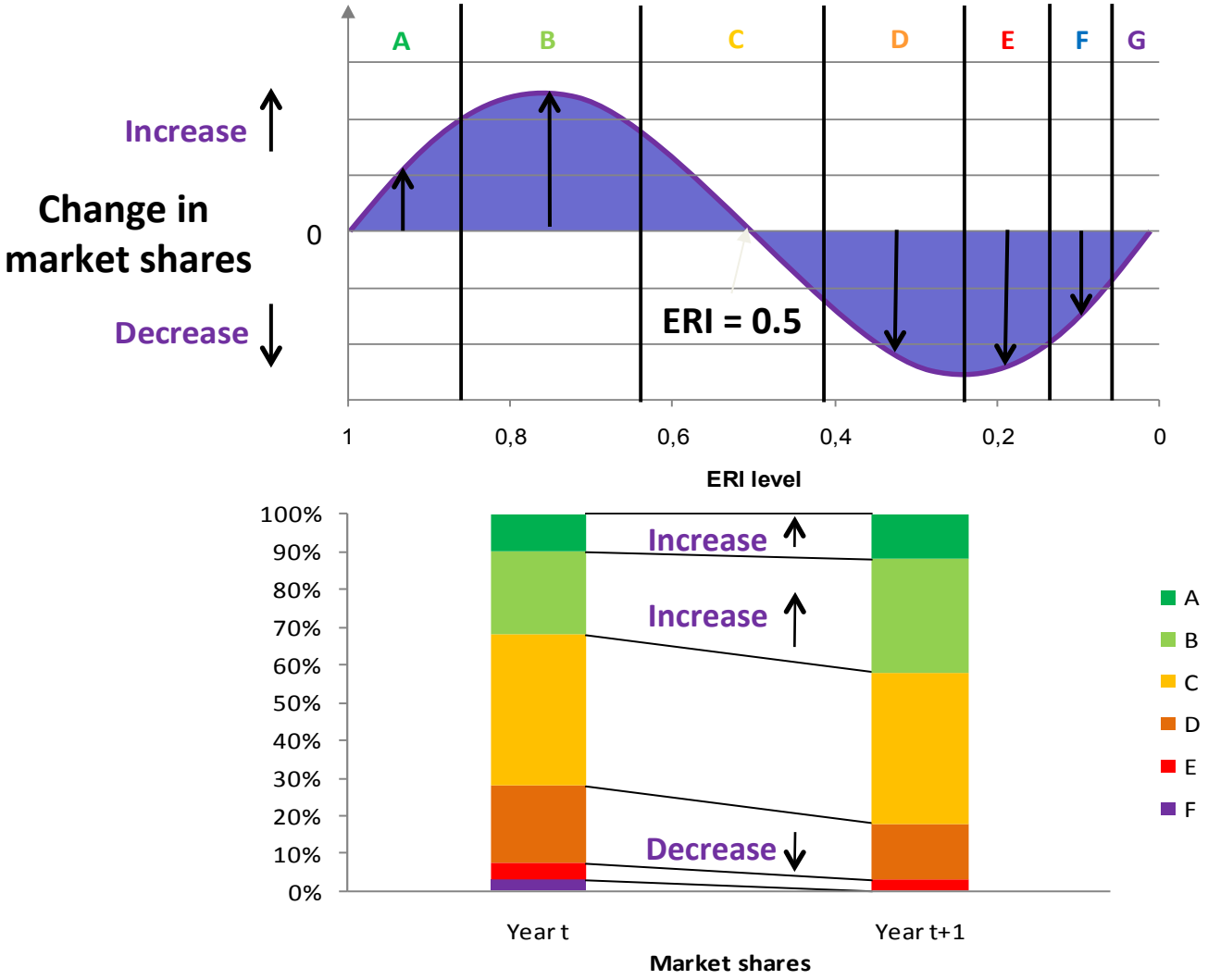
No more A-labelled products sold on the market

- **Innovation premium and innovation pattern**
- Innovation premium : the sales price difference between the most efficient and least efficient product on the market
- Innovation pattern : diffusion and disappearance of models is correlated with ERI



- *The innovation premium is the difference between sales price at ERI = 1 and ERI =0*
- *The innovation pattern is obtained by analysing how sales correlate with ERI for each efficiency class at each time period*

- **Projection of market shares: future market shares are estimated according to the assumed level of ERI at each time period, dependent of estimated energy efficiency class lifetime**



- *In the empirical analysis the highest efficiency products increased their market shares whilst the lowest efficiency products lost market shares as shown*
- *Market share projections assume that the increase in market shares of high efficiency classes (ERI > 0.5) are equivalent to a decrease in market shares of low efficiency classes (ERI < 0.5)*

- **Case studies**
  - Fridges
  - Domestic lighting
  - Televisions
  - Electric motors

Findings from case studies

- The simulator is applicable to most product categories thanks to optional tools
  - Non-linear trends in sales and prices
  - Complex scenario for minimum standards
- The simulator takes into account diverse policy scenarios
  - Different kinds of policies (supply or demand side)
  - Policies can be assessed separately or simultaneously
- The methodology can only be applied under certain conditions
  - The specificities of light bulbs could not be reproduced.
- A sensitivity analysis should be performed to take into account the eventual variability of the results
  - The estimation of the efficiency class life or the innovation premium can be imprecise, which has an effect on the final result.

- **Findings from the study**
  - Innovation is a 'natural phenomenon' that has resulted in:
    - improving product quality / features
    - improving energy efficiency
    - falling prices / costs
  - Policy interventions can accelerate the rate of innovation to promote faster improvements in energy efficiency
    - without any apparent impact on the long run decline in prices
    - any price / cost impacts are only short-run deviations from the long-run trend
  - The diffusion of new (more efficient) technologies is essentially a "market-driven" process
    - Policy impact should be modelled as such

Conclusions

- Current impact assessments do take into account some innovation effects
  - … but not on a consistent basis
  - … but without considering product heterogeneity

- The proposed 'market-based' methodology systematically controls for product heterogeneity and accounts for innovation
  - Only takes the costs of 'increase in energy efficiency' into account
  - Product prices are affected by market position
  - Policy intervention can accelerate the rate of energy efficiency improvement
  - Sales predictions are automatically estimated
  - Able to assess policy interventions separately and in combination
  - Provides a consistent / quick framework for assessing interventions

Conclusions

- A general framework with limitations when it comes to:
  - radical technology changes
  - different alternative technologies in the same product group,
  - market structure not driven by energy efficiency

- The effects of innovation should be taken into account more explicitly and consistently in impact assessments
- Only the costs of energy efficiency improvements should be taken into account

- Use both approaches: cost-based and market-based
- Expert consultation still important

Study available at:

http://randd.defra.gov.uk/

Explore the potential impact of technological progress (i.e. innovation) on the regulatory costs of Energy using Product policies - EV0703

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