

Engineering-Economic Analyses for Sustainable Energy and Transport Policies

Outline of Research Work and Outlook for the Future

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 - Transport, energy use and environmental impact
 - Energy-economy modelling
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Transport, energy & environmental impact

1. The Effect of Standards and Fuel Prices on Automobile Fuel Economy

(Clerides and Zachariadis, *Energy Economics* 30 (2008) 2657–2672)

- An attempt to disentangle forces driving vehicle fuel economy
- Econometric analysis of fuel economy evolution for OECD countries, 1975-2004 – individually and pooled together
- Standards effective in improving new car fuel economy; fuel prices have a modest impact
- If high oil prices (>120 \$/bbl) persist in the long term they might be sufficient for reducing new car CO₂ emissions as much as proposed EU regulations will

Transport, energy & environmental impact

2. Cars and Carbon – Automobiles and European Climate Policy in a Global Context

(collective volume published 2012 by Springer, ISBN 978-94-007-2122-7)

- 16 experts reported on the lessons learned from European & global policies since the 1990s – striking the balance between different policy instruments

3. Environmental and Economic Effects of CO₂-Based Vehicle Taxation

(Adamou, Clerides and Zachariadis, *Transp. Res. D* 17 (2012) 451–456;
Zachariadis, *Energy Policy* 54 (2013) 23–32;

Adamou, Clerides and Zachariadis, *Economic Journal* 10.1111/ecoj.12094)

- Deep transport CO₂ reductions required by 2050
- Main policies: CO₂ standards & fuel/carbon taxes
- CO₂-based vehicle taxes increasingly considered and implemented in Europe and around the world



Feebates – A promising vehicle tax type

- Cars emitting CO₂ above a threshold (e.g. 130 g/km) pay a fee; those emitting less than the threshold receive a rebate
- If tax rate is constant (for each g/km) then marginal compliance costs are equalized across all car models; probably the economically efficient outcome
- If threshold decreases over the years, feebates provide a credible long-term price signal
- Up to now, very limited *ex ante* analysis of carbon-based vehicle taxation in Europe; and little attention on overall economic impacts
 - real-world policies ‘too successful’ and too costly

Conclusions of Feebate Study

- It is possible to design a feebate program for new automobiles that curbs carbon emissions without reducing total welfare
- But needs careful design in order to account for trade-offs between environmental effectiveness, public finances and consumer/producer surplus
- Revenue-neutral tax schemes (politically most attractive) may not be welfare-improving *in the short run*; more stringent policies increasing public revenues can improve welfare

Energy – Economy Modelling for Cyprus

1. The Cost of Power Outages in a Modern Economy

(Zachariadis and Poulikkas, *Energy Policy* 51 (2012) 630–641)

- Explosion in July 2011 destroyed 60% of national power generating capacity
- Interruptions of electricity supply to consumers were implemented to cope with power shortage
- Emergency measures taken to eliminate shortages after summer 2011 (electricity imports, rental of generators)
- **Research questions:**
 - How much did these power supply disruptions cost to households and firms?
 - Were the supply-side emergency measures economically justified?

Energy – Economy Modelling for Cyprus

- Application of engineering & economic approaches:
 - Top-down economic analysis: Welfare losses due to power shortages (demand function approach)
 - Bottom-up engineering analysis: Costs of emergency measures to increase the available capacity
 - Economic assessment of the value of lost electricity (production function) using *i*) annual average values; *ii*) estimates by hour/day/season
- Conclusion: Extra costs due to emergency measures markedly lower than the low-end welfare loss estimates
- *But* optimal distribution of outages different depending on engineering or economic viewpoint
- Combination of economic and engineering approaches extremely useful for managing an energy crisis

Energy – Economy Modelling for Cyprus

2. Models Developed So Far at 3EP/CUT

(funded national and EU sources & collaboration with academic economists)

- Long-term energy & CO₂ emissions model
Zachariadis, *Energy Policy* 39 (2011) 6631–6635
- Econometric model of electricity demand
Zachariadis & Pashourtidou, *Energy Economics* 29 (2007) 183–198;
Zachariadis, *Energy Policy* 38 (2010) 744–750;
Zachariadis & Hadjinicolaou, *Energy* 76 (2014) 899–910
- Production model of the Cypriot economy
Ketteni, Mamuneas & Zachariadis, *Econ. Res. Working Paper*, 2013
- Household energy demand model
Pashardes, Pashourtidou & Zachariadis, *Energy Economics* 42 (2014) 58–66

Policy Support to National Authorities

- Long-term energy & CO₂ emissions model used for preparation of National Action Plans on Renewables & Energy Efficiency, 2010-11 & 2014; provided to environmental authorities for GHG emission forecasts as part of national report to the UNFCCC
- Econometric model of electricity demand used for cross-checking energy forecasts together with electricity authorities during March-April 2014
- Production model of the Cypriot economy informed economic authorities on the effect of EU energy and climate policies on competitiveness and employment
- Household energy demand model informed economic authorities on distributional impact of EU energy and climate policies

Funding

- International Renewable Energy Agency (IRENA), 2014
- EU LLP/Jean Monnet programme, 2013-2016
- Ministry of Energy, Commerce, Industry and Tourism, 2013
- Ministry of Education and Culture of Cyprus, 2012-2013
- EU Intelligent Energy Europe programme (2 grants – ‘Odyssee-Mure’ projects on energy efficiency indicators), 2011-2015
- Agricultural Research Institute of Cyprus, 2011
- Cyprus Research Promotion Foundation (3 grants), 2010-2015
- ‘Nicos Symeonidis’ National Research Prize, 2009
- University’s non-competitive start-up grant, 2009-2010
- FP7 Marie Curie Reintegration Grant, 2009-2011

Outlook

1. Further exploration of transport decarbonisation policies in Europe

➤ Economic analysis:

- Better simulation of car model substitution patterns
- Changes in vehicle use (with the aid of mobility data)
- Macroeconomic impact on vehicle demand
- Dynamic response of consumers (short vs. long term)

➤ Technological analysis:

- Supply-side response to environmental tax policy
- Long-term technical progress under increasingly stringent tax/regulation regimes

➤ **Aim: Make academic analyses (even) more useful to policy makers**

(EAERE Policy Session, Helsinki, 26 June 2015)

Outlook (continued)

2. Analysis & Promotion of Green Tax Reforms (Environmental Fiscal Reforms - EFR)

- Feebates is an EFR measure in the transport sector
- EFRs involve:
 - energy/carbon taxes, water/landfill/fertiliser charges, congestion charges, 'pay-as-you-throw' waste charges etc.
 - AND reductions in other (more distortive) taxes, e.g. income taxes, social security contributions etc.
- Energy models developed so far help analyse competitiveness & distributional impact of EFRs
- Collaboration with *Green Budget Europe* (Brussels-based NGO promoting EFR) and European academics supporting EFR

Outlook (continued)

3. Engineering-economic analysis of energy & environmental policies in Cyprus

- Further development of an energy & CO₂ emissions model for analysing cost-effective decarbonisation paths in Cyprus (collaboration with International Renewable Energy Agency & Royal University of Technology, Sweden)
- Reconciliation of top-down forecast model with bottom-up engineering estimates on end use energy demand
- Exploring the energy-water nexus in semi-arid regions
- Exploring the effect of economic recession in Europe on aggregate energy & electricity demand