Economy-wide CGE modelling of the 'multiple benefits' of increased energy efficiency

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Presentation at BEIS, 16th March 2017

ESRC grant ref: EP/M00760X/1

EPSRC EUED project 'Energy saving innovations and economy-wide rebound effects'
http://cied.ac.uk/research/impacts/energysavinginnovations

Project partners: EUED CIED centre at Sussex and Fraser of Allander Institute; external collaborators on different WP

Introduction

- **Real focus of project:** how does the wider economy respond to improvements in energy efficiency?
- Not just energy use across the economy (rebound question) but activity levels, incomes etc.
- 'Multiple benefits' (International Energy Agency, 2014) argument
- Considering both industrial energy efficiency – stimulus to competitiveness
- And household energy efficiency – demand-driven stimulus
- Efficiency in the delivery of energy-using services

Modelling rebound and multiple benefits using CGE models

- Multi-sector economy wide computable general equilibrium models are the most commonly adopted method for considering economy-wide rebound
  - *Ex ante – ex post* (historical) analyses often conducted using econometric methods
- Key benefit of CGE – focus on causal process, importance of interactions between sectors and markets
- Assess in context of wide range of economic and energy use impacts
- Distributional impacts where identifying different household income groups
- And also across different productive sectors/industries
- Useful for 'multiple benefits' context that may concern policy

A useful policy perspective?

- Primary aim of energy efficiency policy is to reduce energy use and emissions

- But wider policy environment and multiple objectives

- Impacts on economic and other variables may be key in gaining support for energy efficiency

CGE modelling

- Multiple sectors and markets
- 'General equilibrium'
- Options regarding specification and model 'closure'
- Aim of CGE modelling should be comprehension – not "black box"
- HM Treasury use of CGE modelling
- National 'tax model' may be developed for energy issues – and/or international trade model……use of latter dominant at present
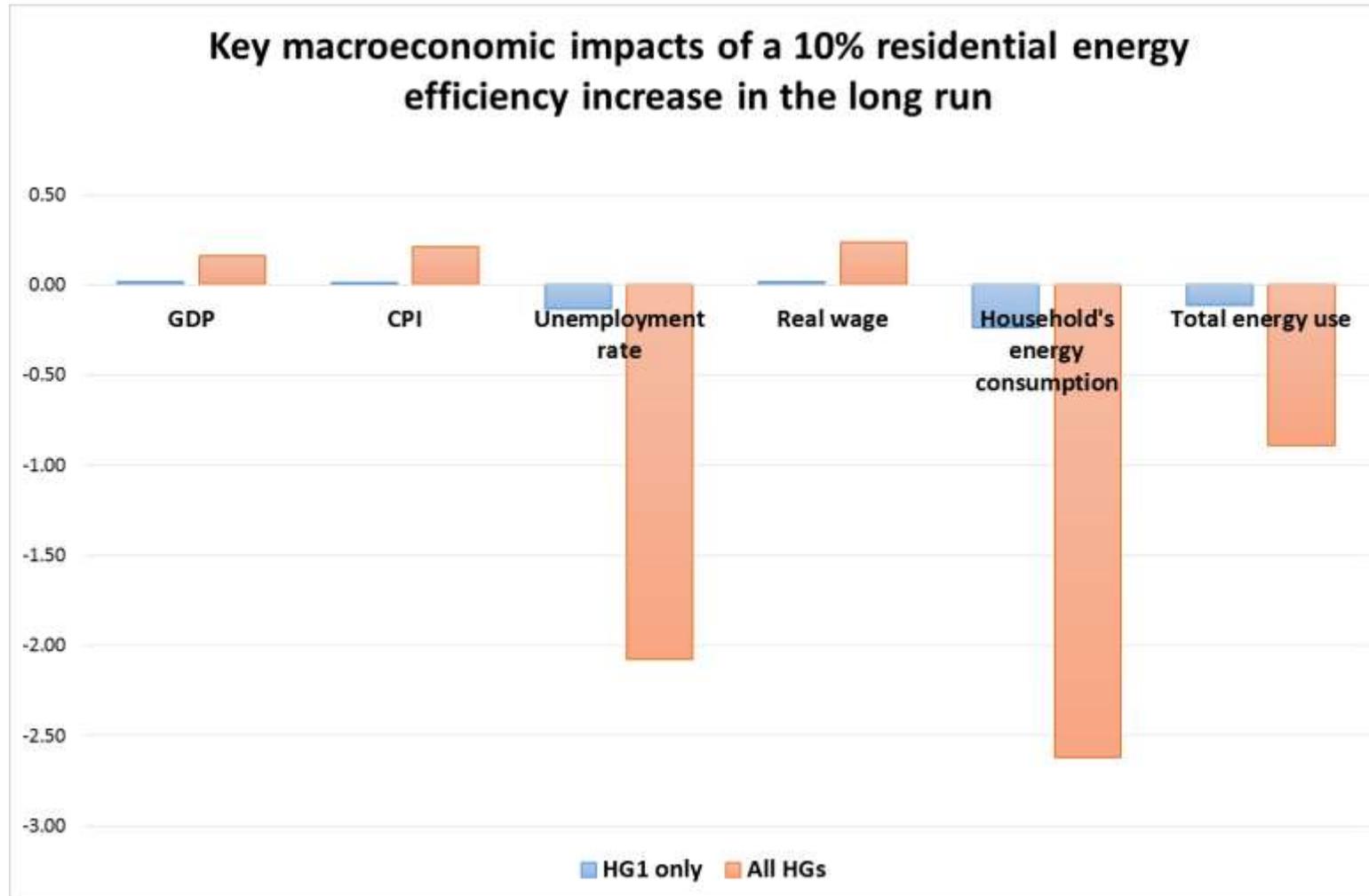
Our UK CGE model

- Multi-sector economy-wide CGE model of the UK national economy
- 2010 social accounting matrix
- Around 30 production sectors producing 30 outputs
- KLEM production functions – energy a distinct type of input (not HMT)
- Government budget can be constrained or not, expenditure/tax exogenous or endogenous
- Competitive goods markets
- Two exogenous regions – rest of the Europe (REU) and rest of world (ROW)
- UK and REU/ROW products imperfect substitutes (Armington assumption) and export demand responds to changes in prices
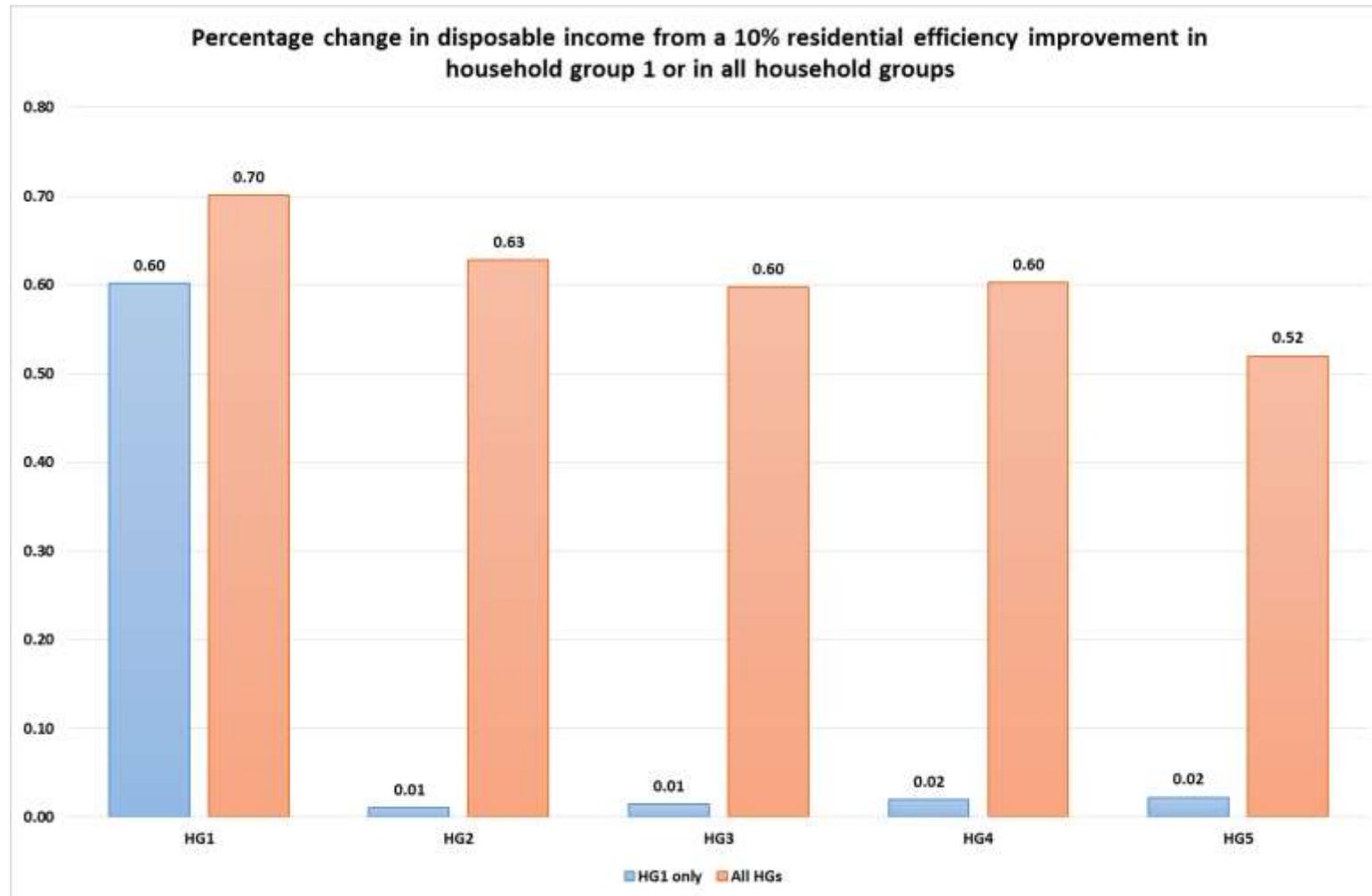
Anticipated impacts of increased efficiency in household energy use

- Household energy efficiency: lowers marginal cost of energy services
- Frees up income to spend on other things
- Shift in pattern of, and increase in level of demand
- Process of ***demand-driven economic expansion***

Improving household residential energy efficiency

Key macroeconomic impacts of a 10% residential energy efficiency increase in the long run

Improving household residential energy efficiency

Percentage change in disposable income from a 10% residential efficiency improvement in household group 1 or in all household groups

All household case – which industries win and lose?

Sector by sector gross output %change
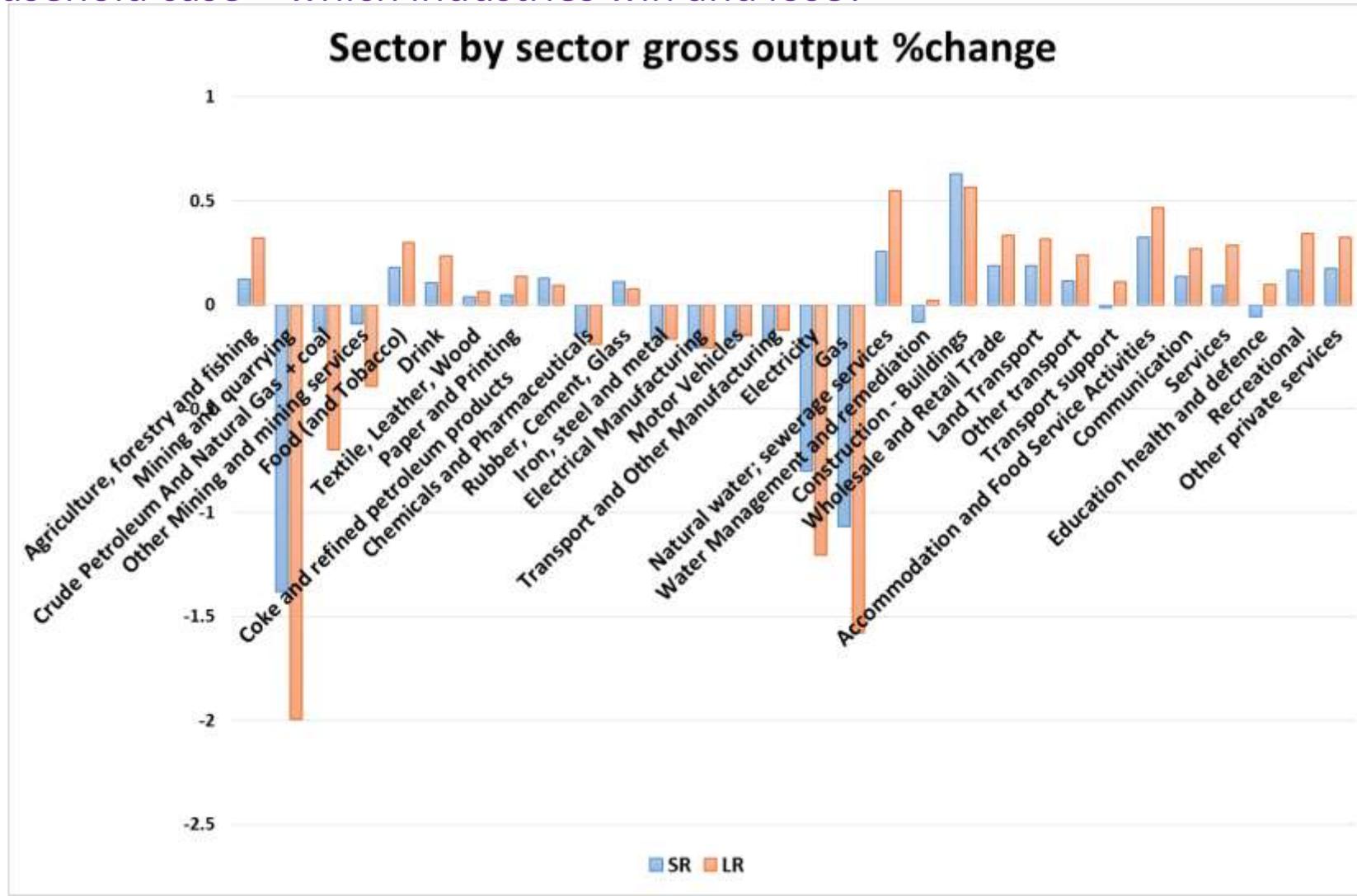
Time path of investment, replacement cost of capital and shadow price of capital
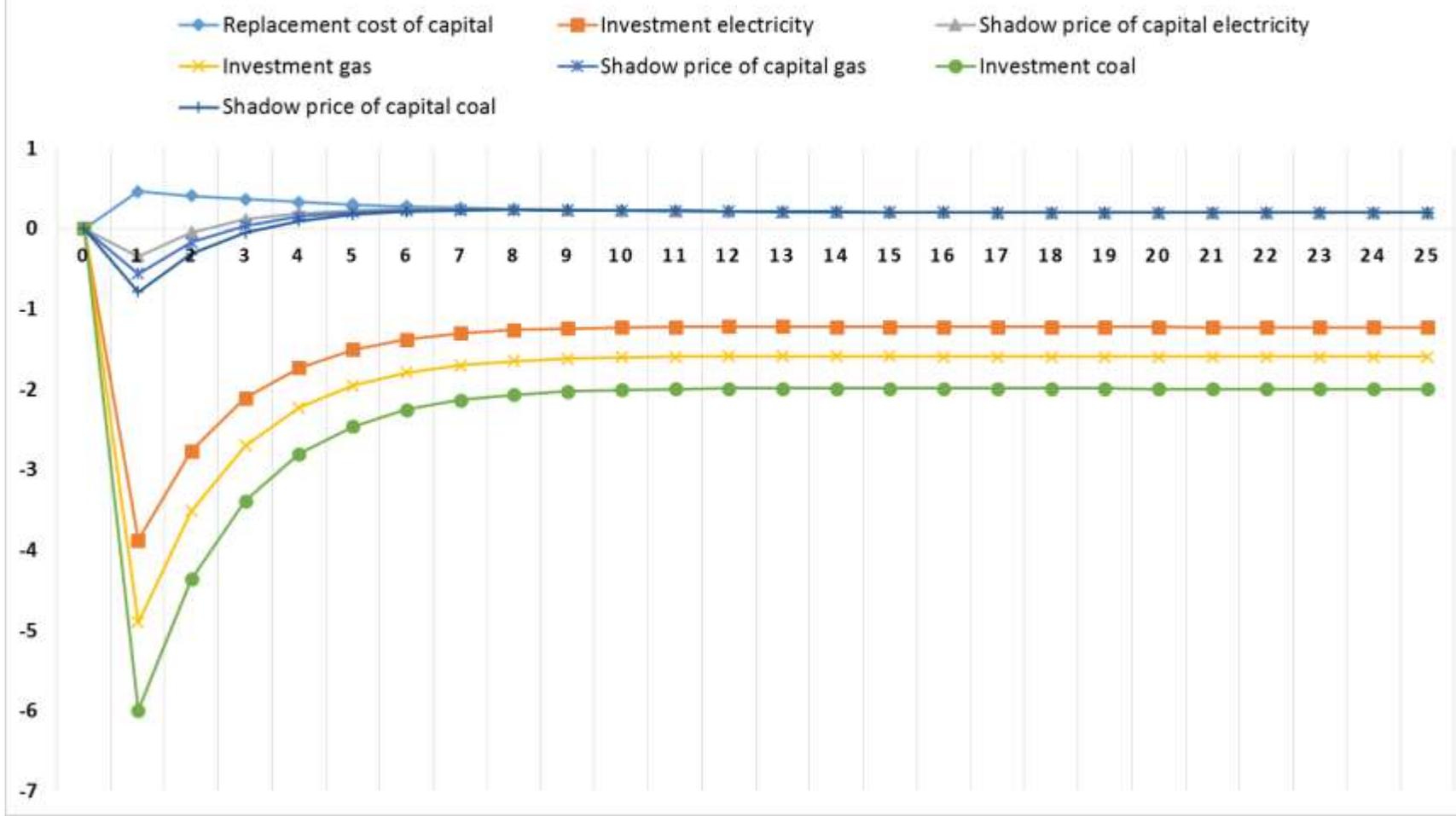
Anticipated impacts of increased efficiency in industrial energy use

- Industrial energy efficiency: lowers marginal cost of energy services
- Decreased cost of production: may reduce output price, boosting economic productivity and competitiveness
- Both in sector where efficiency improves and downstream
- Process of ***productivity-led or cost-push economic expansion***

5% Energy efficiency improvement: example of 2 energy-intensive sectors

	Rubber, Cement, Glass		Paper and Printing	
	Short-Run	Long-Run	Short-Run	Long-Run
GDP	0.014	0.022	0.008	0.014
Consumer Price Index	0.003	-0.005	0.001	-0.005
Unemployment Rate	-0.077	-0.164	-0.045	-0.108
Total Employment	0.005	0.010	0.003	0.007
Real Gross Wage	0.008	0.016	0.005	0.011
Investment	0.034	0.017	0.022	0.012
Government Deficit	-0.053	-0.101	-0.032	-0.067
Exports to EU	0.013	0.028	0.002	0.011
Exports to ROW	0.002	0.019	-0.001	0.010
Energy use in UK production sectors	-0.094	-0.101	-0.057	-0.061
Total energy use in the UK	-0.064	-0.070	-0.039	-0.042
Capital Stock of Coal Extraction sector	Fixed	-0.142	Fixed	-0.060
Capital Stock of Electricity sector	Fixed	-0.042	Fixed	-0.038
Capital Stock of Gas distribution sector	Fixed	-0.110	Fixed	-0.050

5% Energy efficiency improvement: example of 2 non energy-intensive sectors

	Manufacture of Motor Vehicles, Trailers and Semi Trailers		Construction - Buildings	
	Short-Run	Long-Run	Short-Run	Long-Run
GDP	0.003	0.004	0.006	0.008
Consumer Price Index	0.000	-0.001	-0.001	-0.003
Unemployment Rate	-0.017	-0.029	-0.023	-0.035
Total Employment	0.001	0.002	0.001	0.002
Real Gross Wage	0.002	0.003	0.002	0.004
Investment	0.005	0.002	0.011	0.003
Government Deficit	-0.009	-0.016	-0.017	-0.023
Exports to EU	0.007	0.010	0.003	0.006
Exports to ROW	0.003	0.006	0.002	0.005
Energy use in UK production sectors	-0.024	-0.028	-0.059	-0.072
Total energy use in the UK	-0.016	-0.020	-0.041	-0.052
Capital Stock of Coal Extraction sector	Fixed	-0.022	Fixed	-0.048
Capital Stock of Electricity sector	Fixed	-0.023	Fixed	-0.060
Capital Stock of Gas distribution sector	Fixed	-0.021	Fixed	-0.021

Conclusions

- Analysis needs to be done on case-by-case basis
- Economy-wide impacts depend on nature and focus of efficiency improvement, economic structure and conditions
- For comprehension, need to build up layers of complexity
- Simple examples presented here: project has involved, and ongoing work involving, developments in model specification and simulation strategies
- 'Learning by doing' – for modellers and audience
- Potential here for EPSRC Impact Accelerator with BEIS as partner