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Swiss Federal Institute of Technology Zurich

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SEEC Surrey Energy Economics Centre

3rd International Workshop on Empirical Methods in Energy Economics (EMEE2010)

Surrey Energy Economics Centre (SEEC)

University of Surrey, UK

24th – 25th June 2010

NOTE:

The following Presentation represents *Work in Progress* for discussion at the EMEE2010 workshop. It therefore must not be referred to without the consent of the author(s).

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BIEE British Institute of Energy Economics

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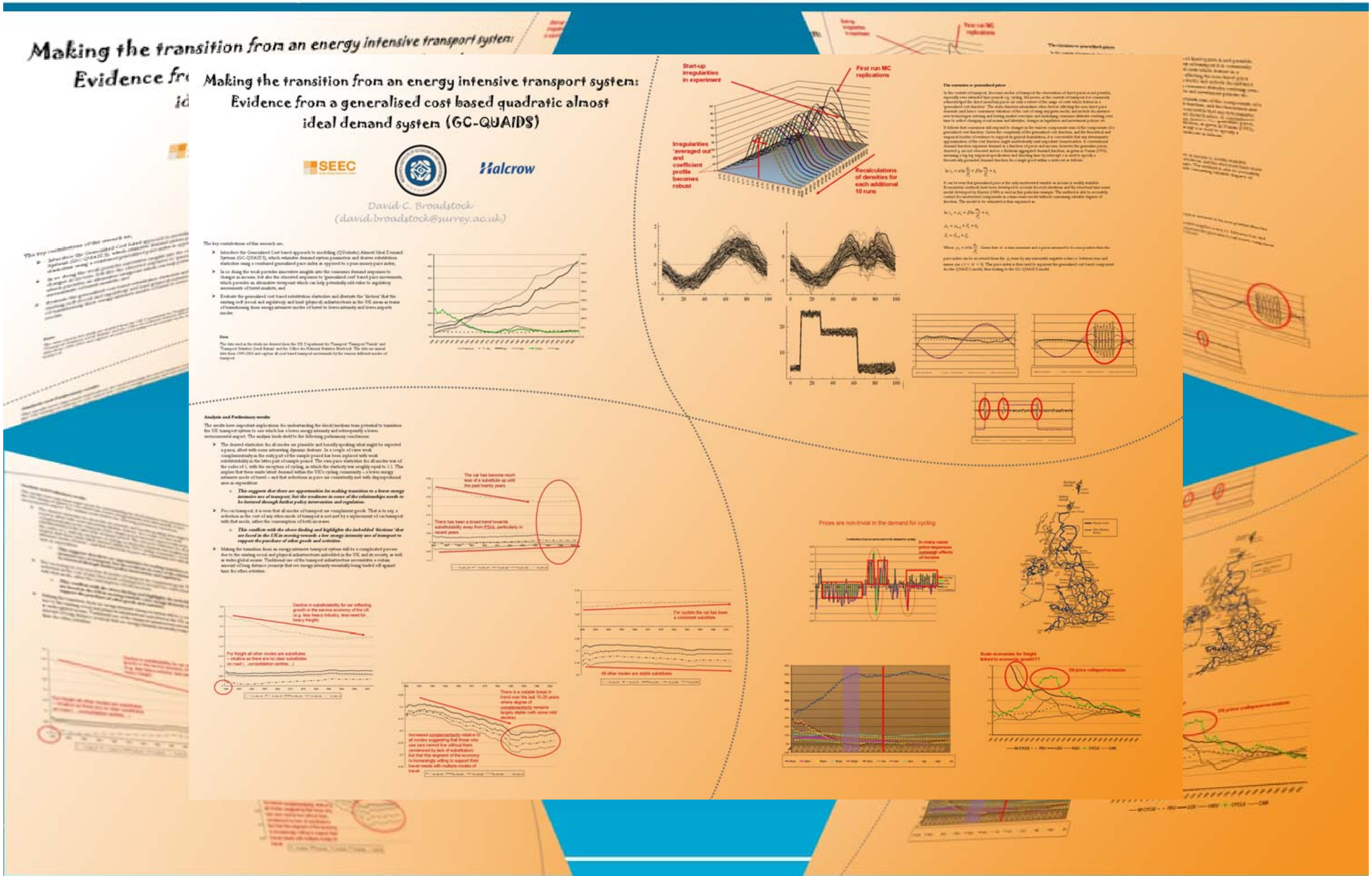
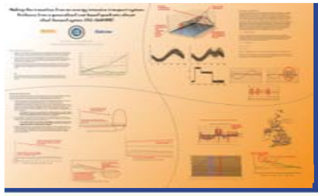
Halcrow

Making the transition from an energy intensive transport system:
Evidence from a GC-QUAIDS

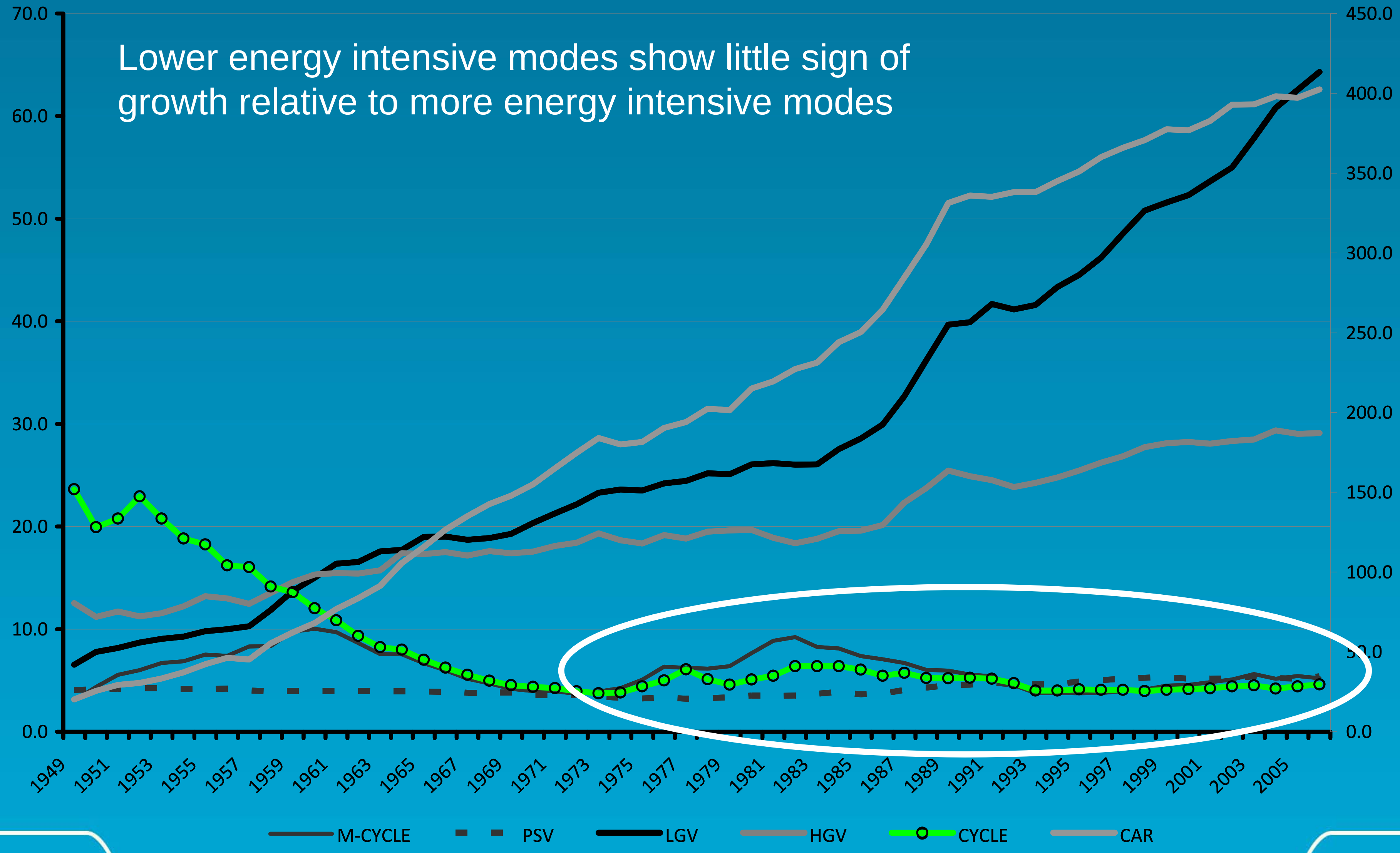
David C. Broadstock
Halcrow, Surrey Energy Economics Centre,
South Western University of Finance and Economics

Contents – the poster





Demand data


Lower energy intensive modes show little sign of growth relative to more energy intensive modes
70.0
60.0
50.0
40.0
30.0
20.0
10.0
0.0
450.0
400.0
350.0
300.0
250.0
200.0
150.0
100.0
50.0
0.0
1949
1951
1953
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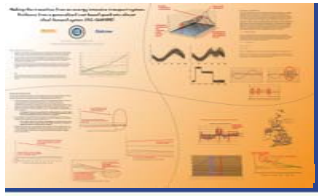
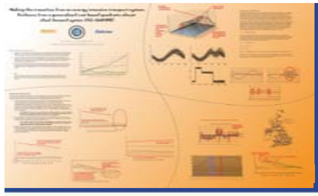


Basic structure of the QUAIDS model

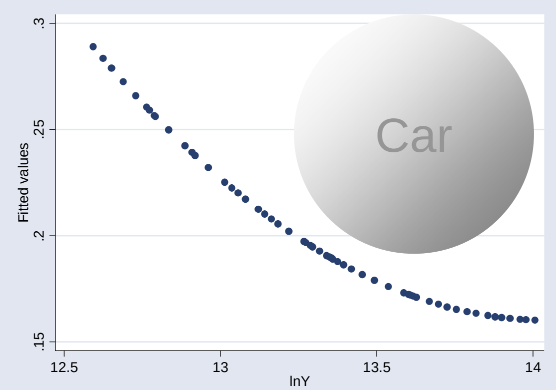
$$s_i = \alpha_i + \sum_{j=1}^{n} \gamma_{i,j} \ln\left(p_j\right) + \beta_i \ln \frac{M}{a(P)} + \frac{\lambda_i}{b(P)} \left[\ln \frac{M}{a(P)} \right]^2$$

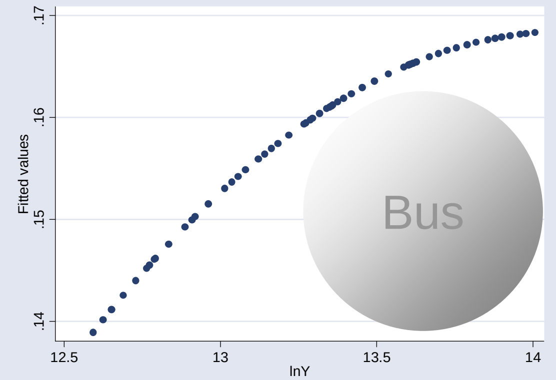
$$\sum_{i=1}^{n} \alpha_i = 1; \quad \sum_{i=1}^{n} \beta_i = 0; \quad \sum_{i=1}^{n} \gamma_{i,j} = 0; \quad \sum_{j=1}^{n} \gamma_{i,j} = 0; \quad \gamma_{i,j} = \gamma_{j,i} \quad \sum_{i=1}^{n} \lambda_i = 0$$

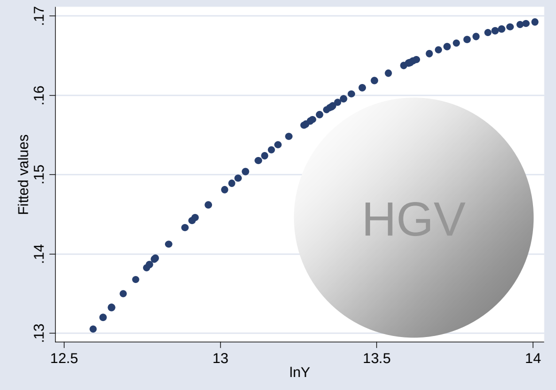
- **As with Banks et al (1997) and Lewbel and Ng (2005), deterministic time trends are added**
  - **Moosa and Baxter (2002) apply stochastic trends, but at the expense of symmetry**
- **Mixed AIDS-QUAIDS is possible, and AIDS is a testable restriction**



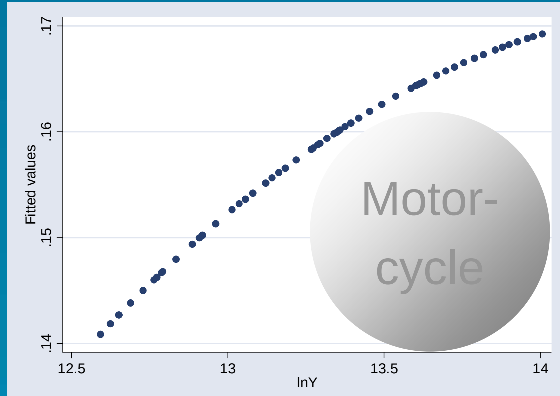
Non-linear Engel curves hence QUAIDS

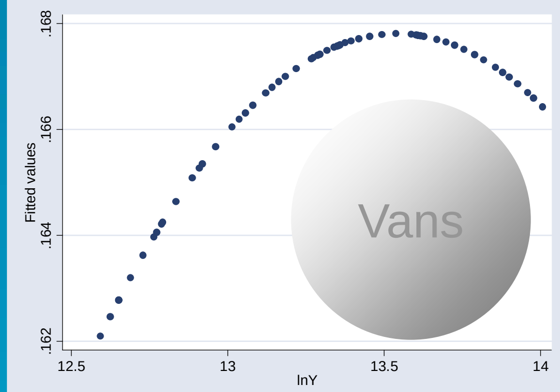


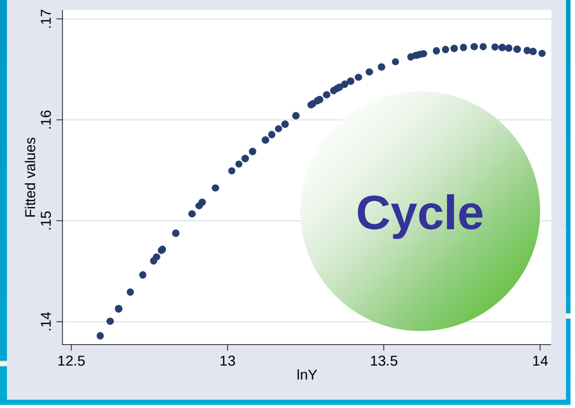


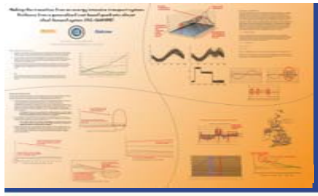


- **Estimate based on Lewbel, Blundell and Banks (1997) and Gahvari and Tsang (2009)**
- **Clearly give rise to non-linear income responses and use of QUAIDS model**









The econometric approach

- **Assuming a log-log empirical specification for the demand function and denoting time by subscript *t* it is possible to specify an estimable demand function as;**

$$\ln z_t = \alpha \ln \frac{q_t}{P_t} + \beta \ln \frac{m_t}{P_t} + \varepsilon_t$$

- **However the prices, *q*, are not observed and so given the above discussion of the theoretical model,**
- **Econometric methods have been developed to account for such situations and the structural time series model developed by Harvey (1989) is used in this particular example. The model is expressed as;**

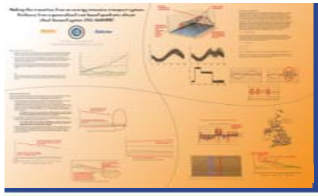
$$\ln z_t = \mu_t + \beta \ln \frac{m_t}{P_t} + \varepsilon_t$$

$$\mu_t = \mu_{t-1} + \delta_t + \eta_t$$

$$\delta_t = \delta_{t-1} + \xi_t$$

- **Where;**

$$\mu_t = \alpha \ln \frac{q_t}{P_t}$$

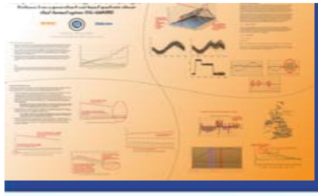


Some caveats

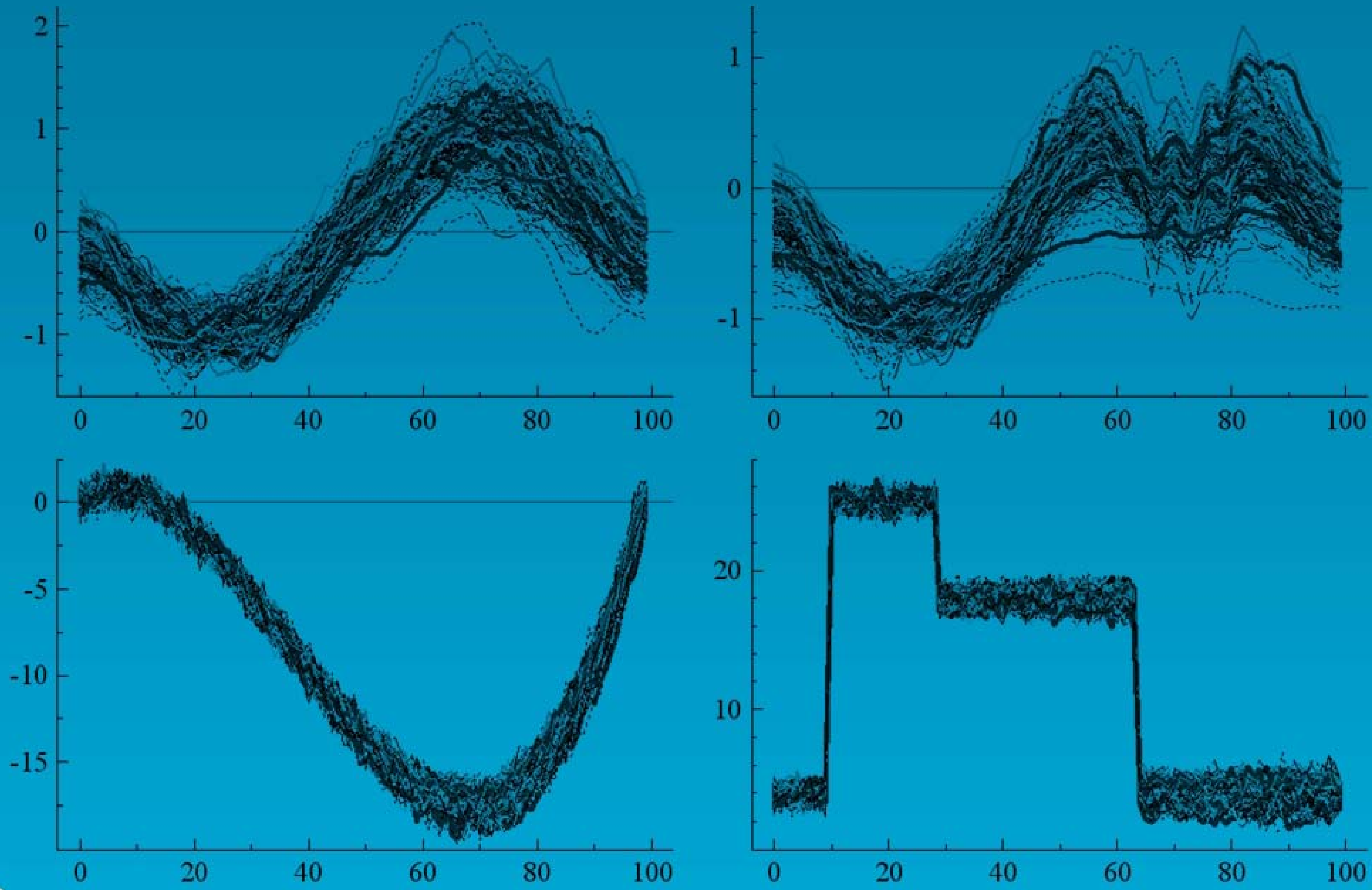
- **This is not a study of the components of generalised cost**
  - **It is an overview of the combined effects of the components**

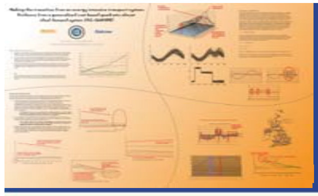
- **Therefore it is not attempting to place a specific value on the specific elements of the generalised cost function**

- **We do however acknowledge that generalised cost is constructed of a range of attributes, *<u>each of which are important</u>* in their own right but are not within the scope of the current piece of work**

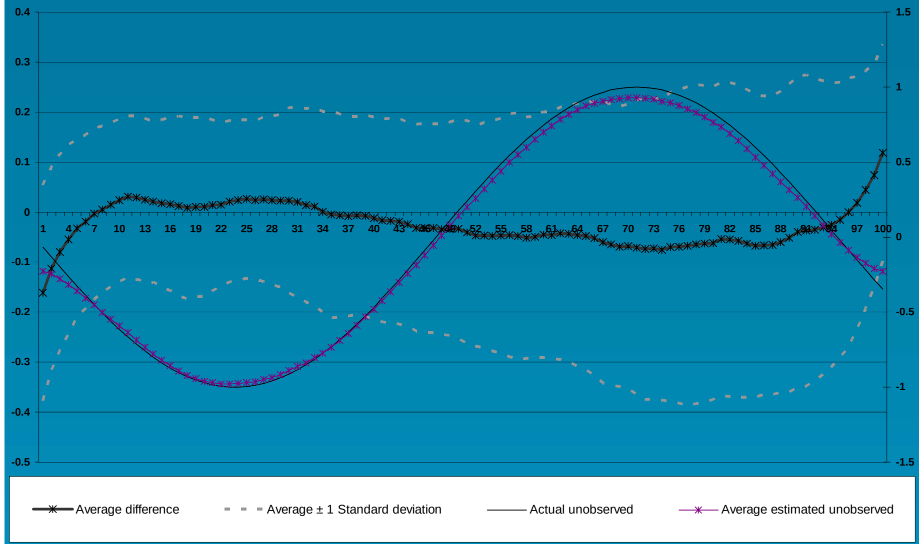


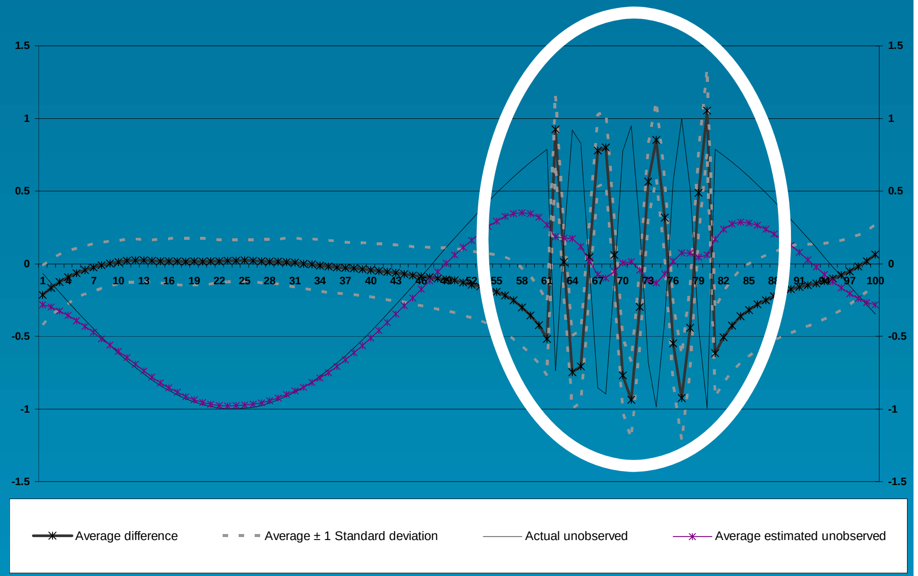
Observing the unobservable – does it work?

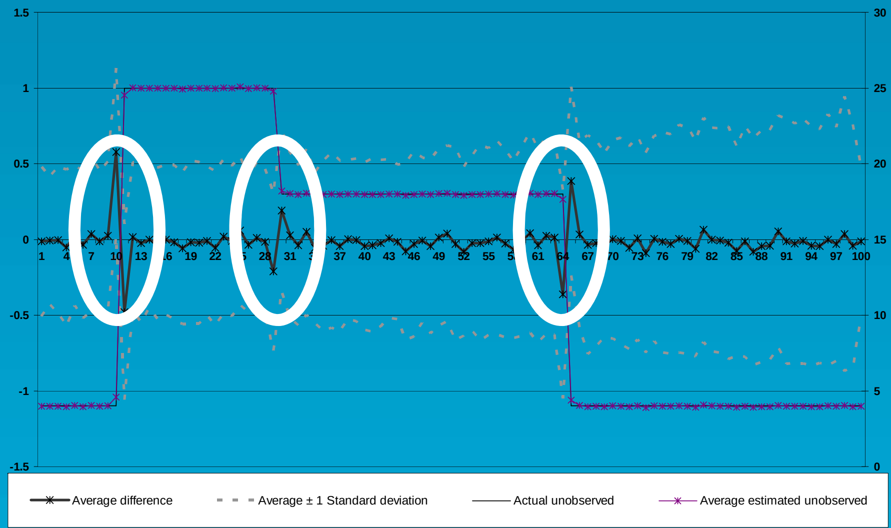


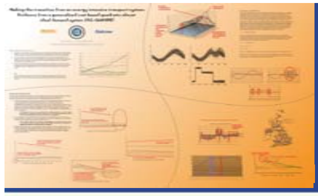


The results of the Monte Carlo analysis





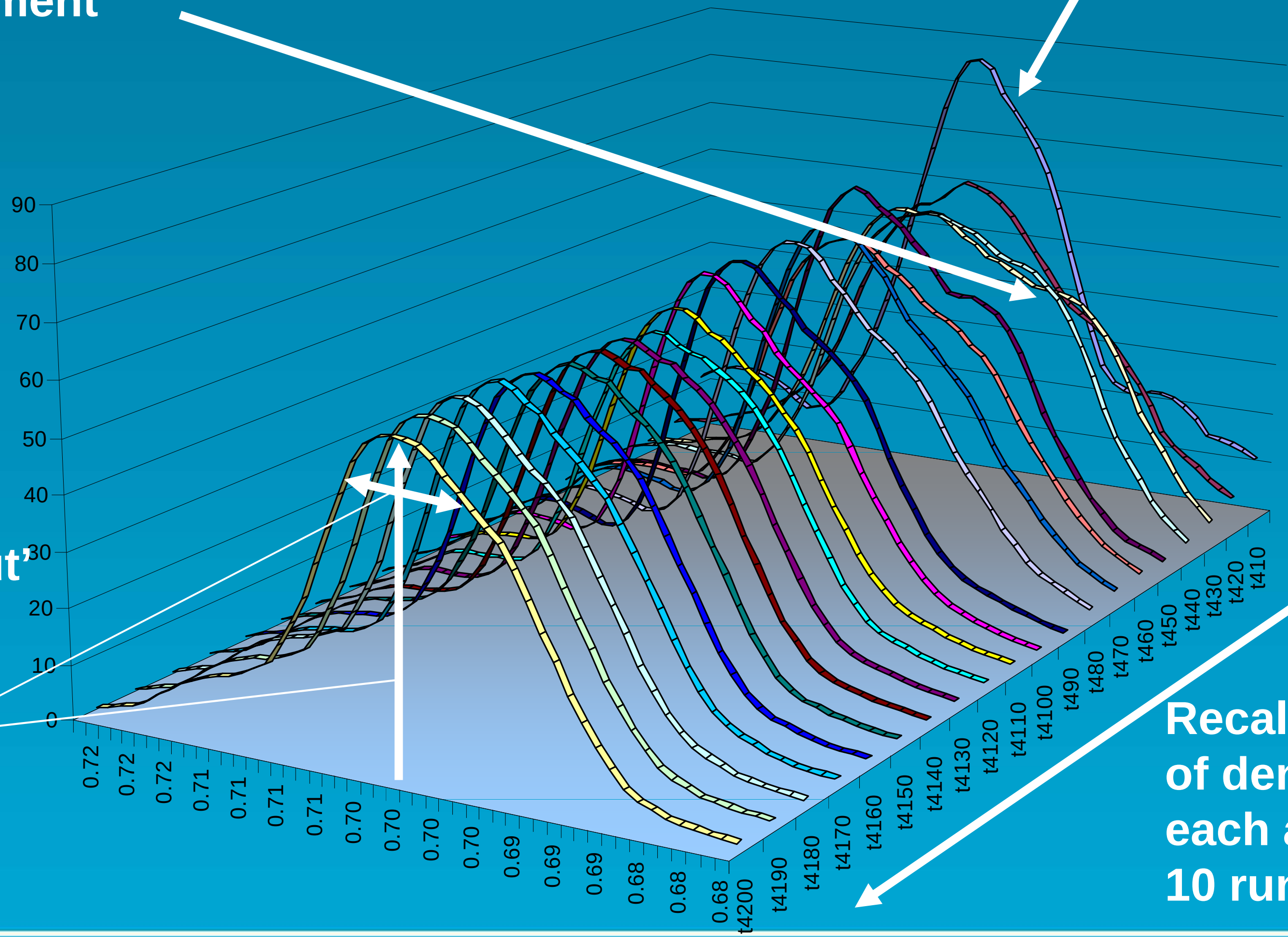




Kernel density estimates Trend IV

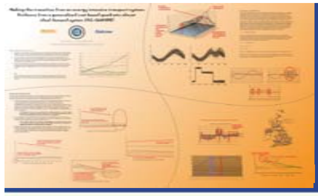
Start-up irregularities in experiment

First run MC replications

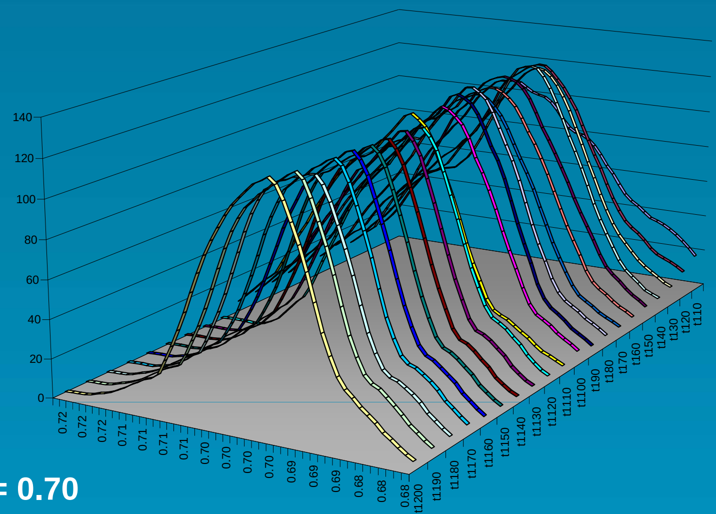


Irregularities 'averaged out' and coefficient profile becomes robust

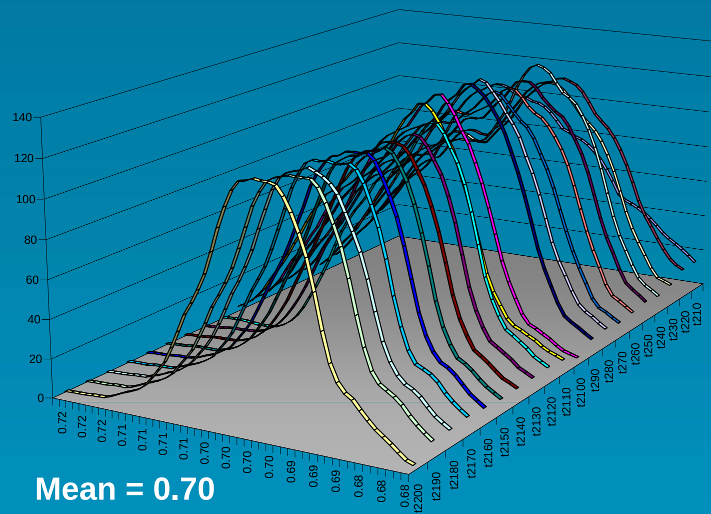
Recalculations of densities for each additional 10 runs



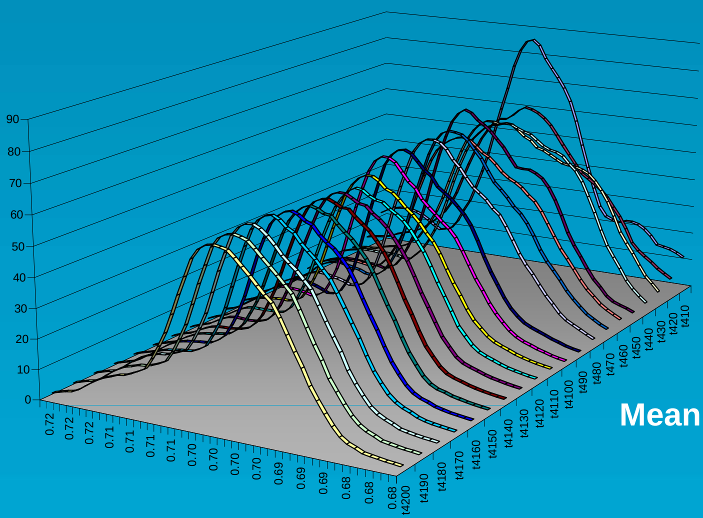
Distributions for all 4 trend types



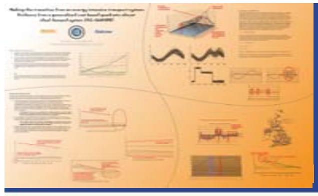
Mean = 0.70



Mean = 0.70



Mean = 0.70

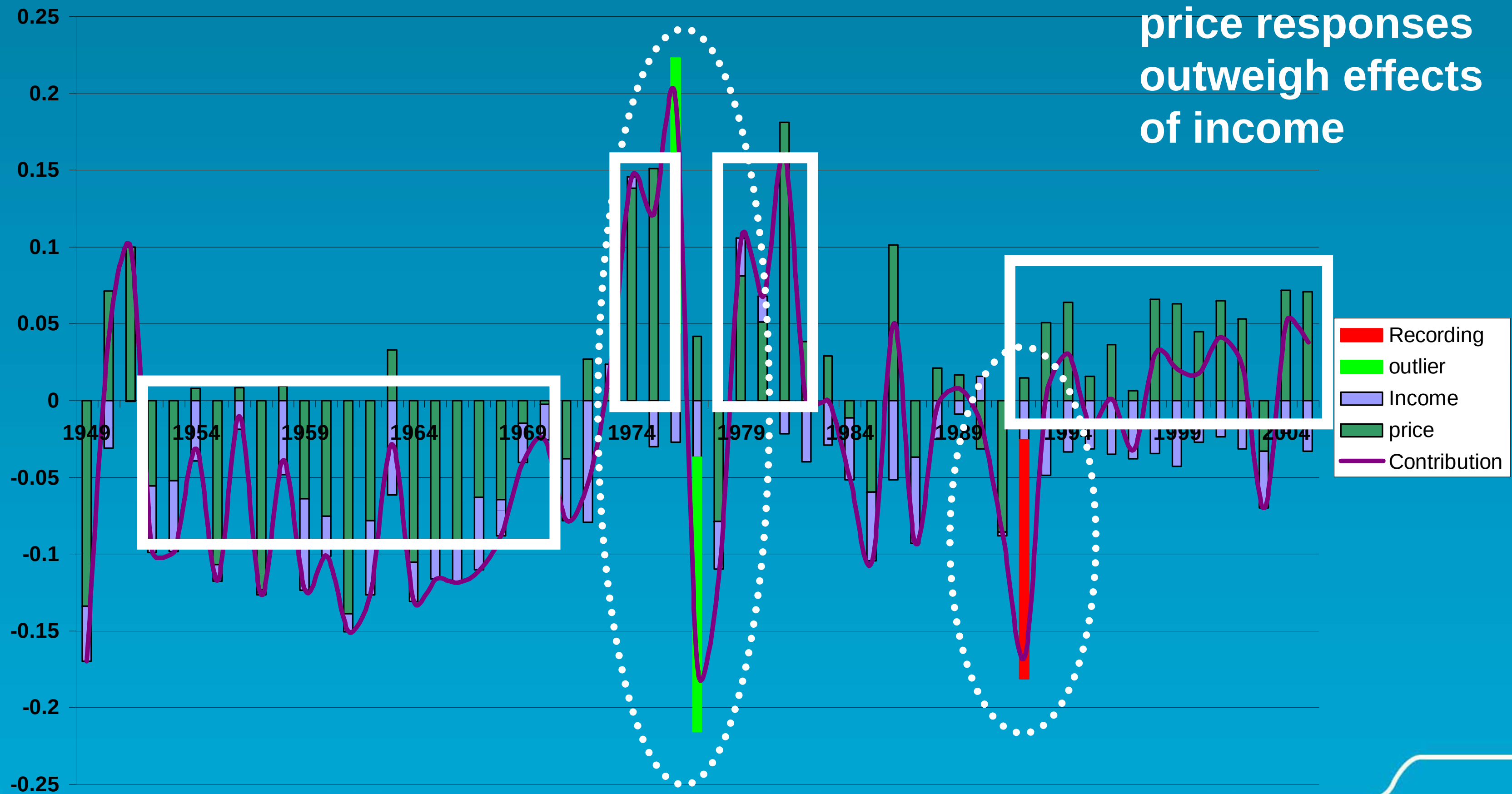


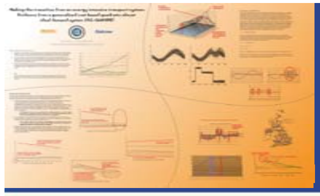
The contribution of the demand drivers

- Prices are non-trivial in the demand for cycling

Contribution of prices and income to the demand for cycling

In many cases price responses outweigh effects of income

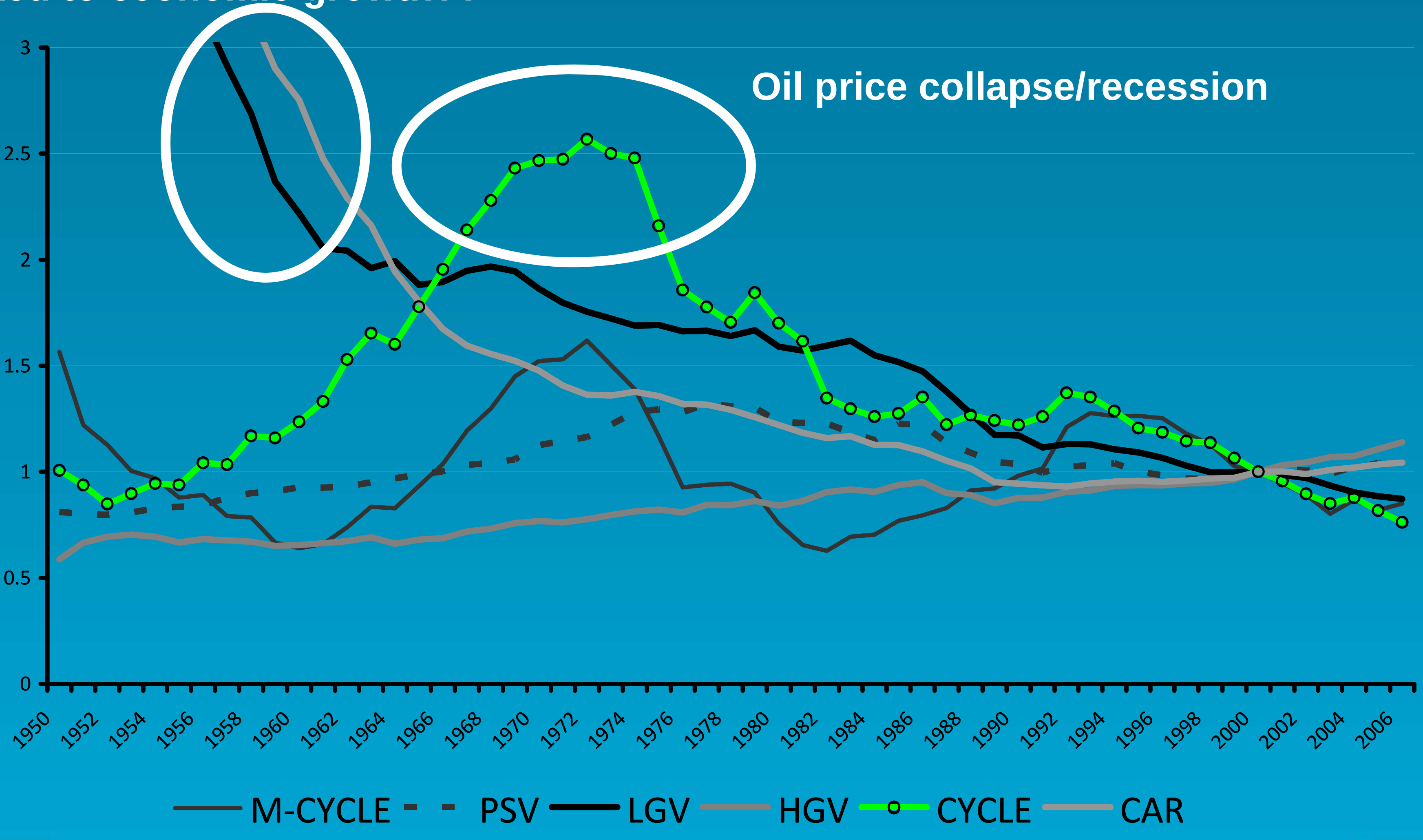


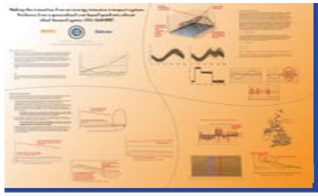


Estimated price series

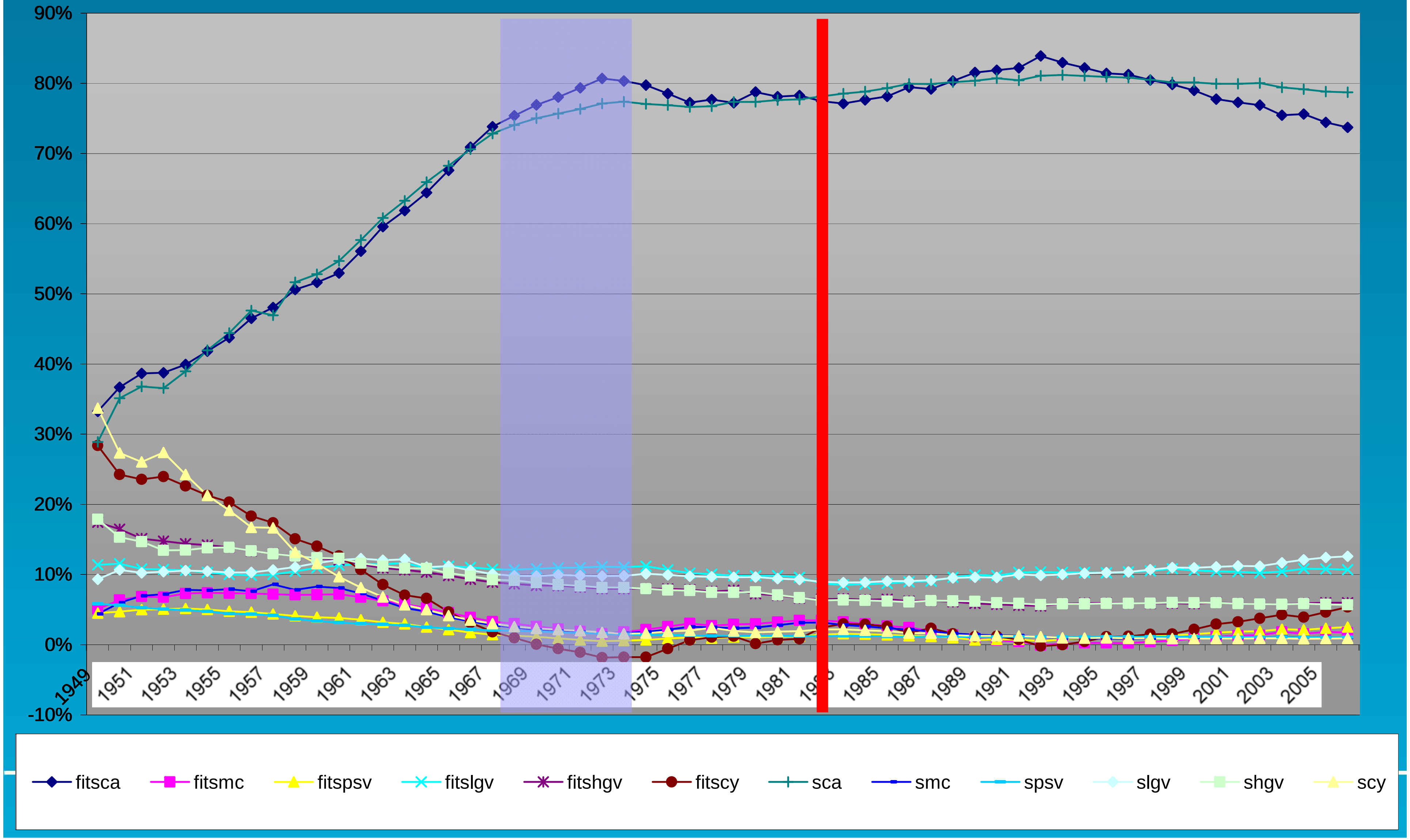
Scale economies for freight linked to economic growth??

Oil price collapse/recession

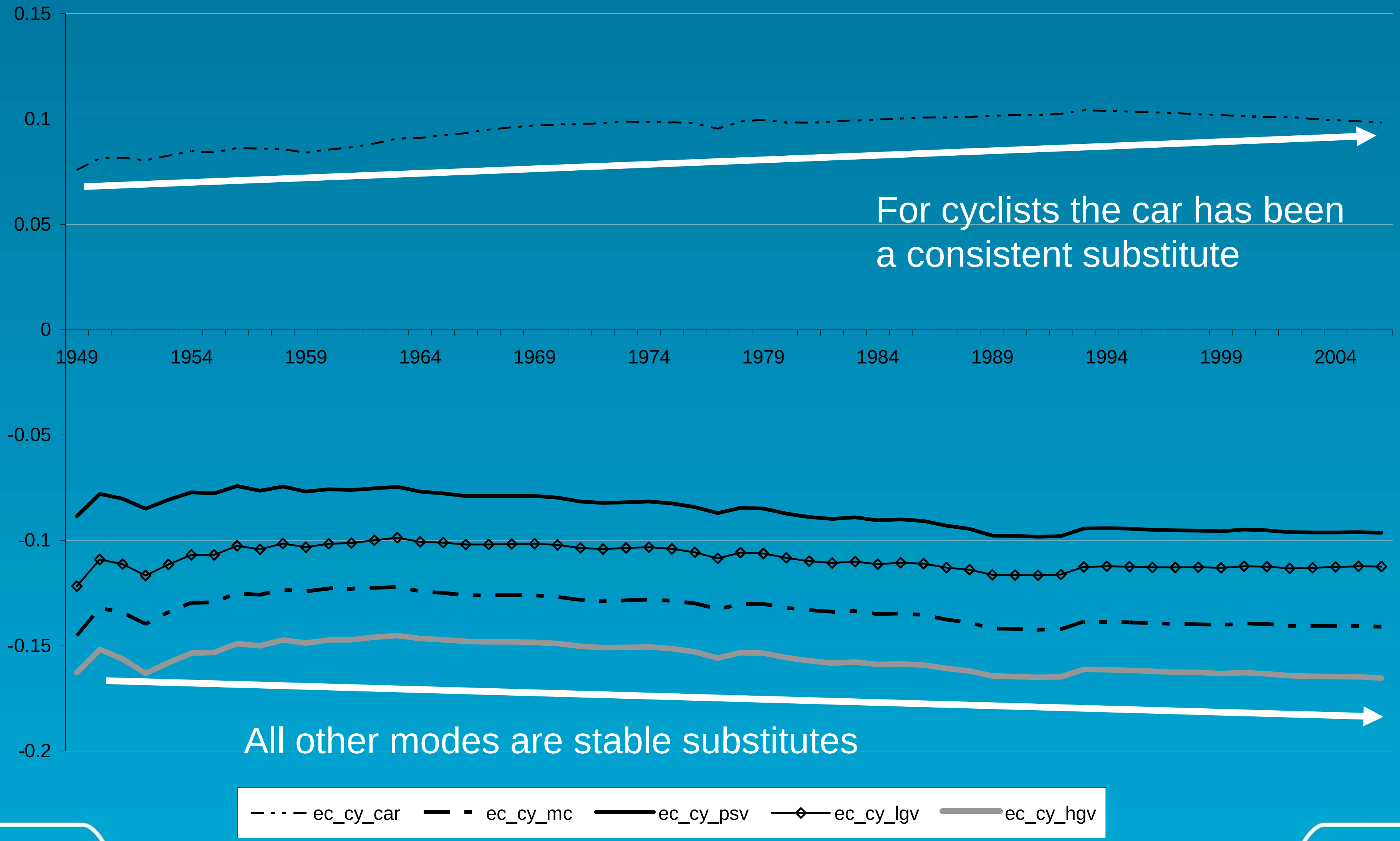




The fitted shares

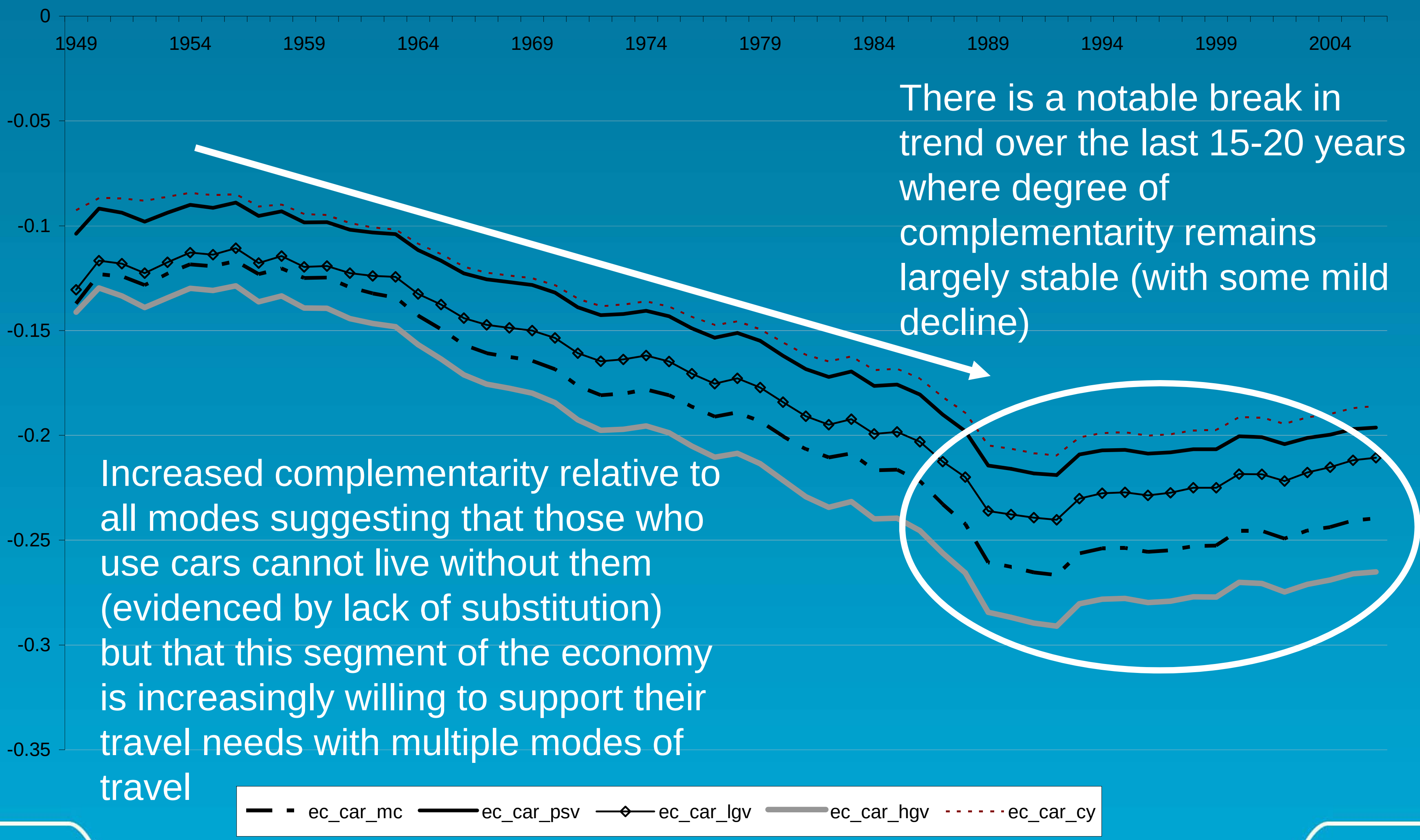


Cycle - CPE



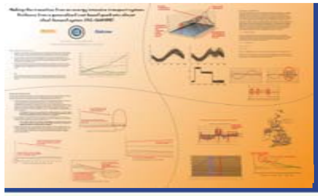
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
1949
1954
1959
1964
1969
1974
1979
1984
1989
1994
1999
2004
For cyclists the car has been a consistent substitute
All other modes are stable substitutes
ec_cy_car
ec_cy_mc
ec_cy_psv
ec_cy_lgv
ec_cy_hgv

Car - CPE

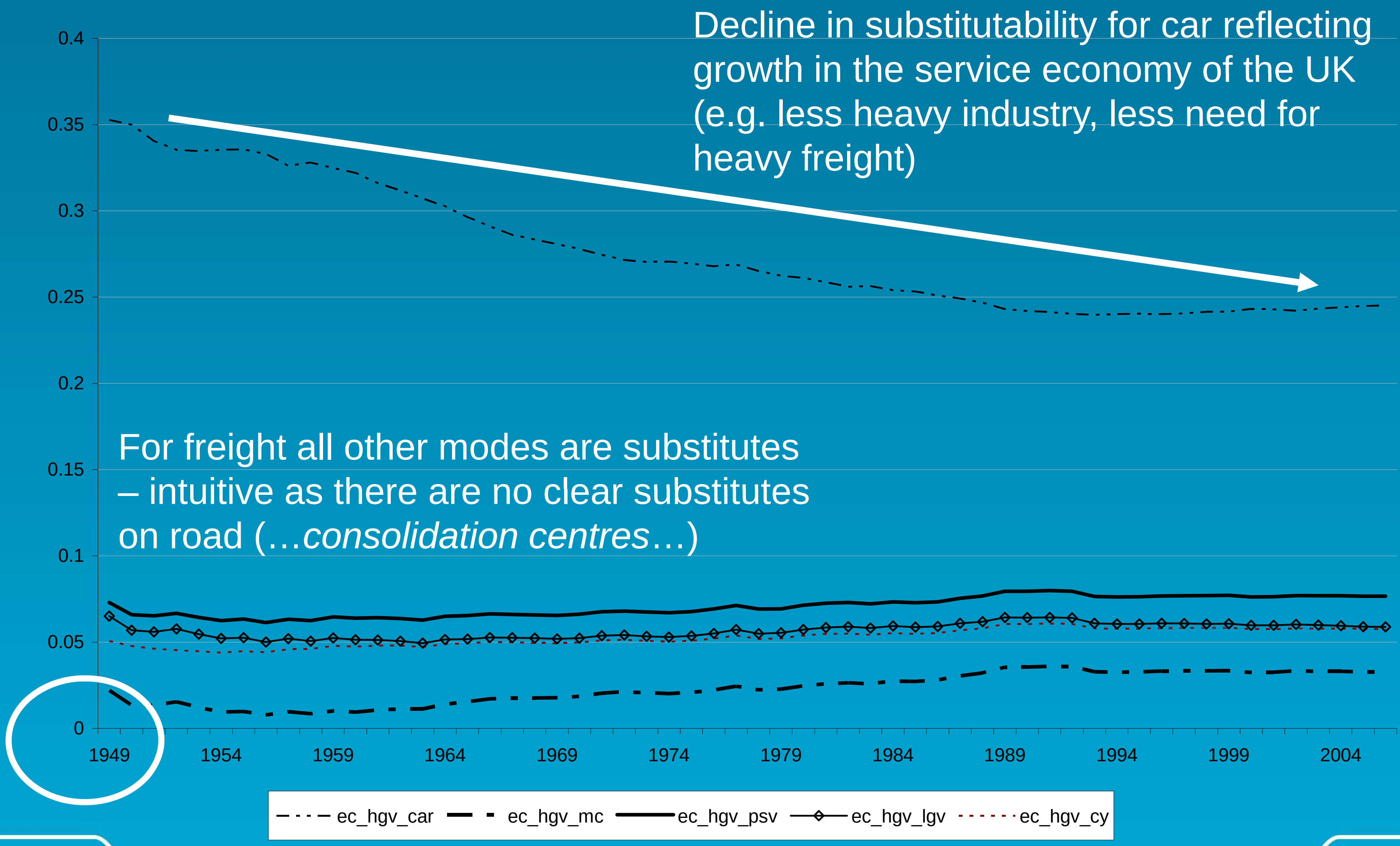


There is a notable break in trend over the last 15-20 years where degree of complementarity remains largely stable (with some mild decline)

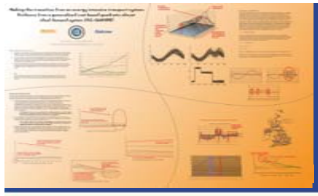
Increased complementarity relative to all modes suggesting that those who use cars cannot live without them (evidenced by lack of substitution) but that this segment of the economy is increasingly willing to support their travel needs with multiple modes of travel



HGV (freight) - CPE

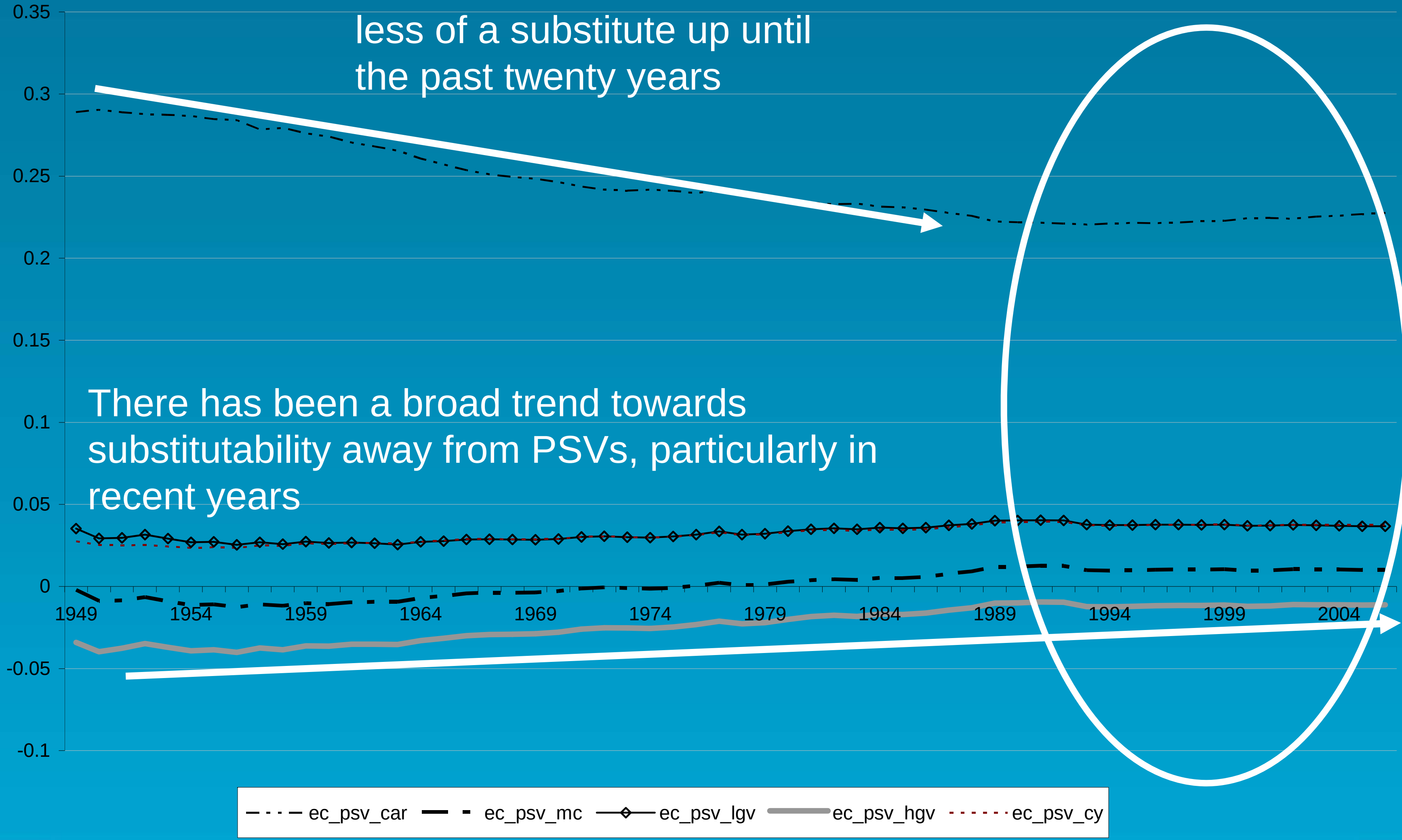


PSV - CPE



The car has become much less of a substitute up until the past twenty years

There has been a broad trend towards substitutability away from PSVs, particularly in recent years



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Implications for transport energy policy

- The results have important implications for understanding the short/medium term potential to transition the UK transport system to one which has a lower energy intensity and subsequently a lower environmental impact. The analysis lends itself to the following preliminary conclusions:

- Structural Time Series Models, also used in other areas of energy economics, appears to be very powerful at both accurately representing unobserved components and accurately reflecting elasticities on independent variables;

- The derived elasticities for all modes are plausible and broadly speaking what might be expected a-priori, albeit with some interesting dynamic features. In a couple of cases weak complementarity in the early part of the sample period has been replaced with weak substitutability in the latter part of sample period. The own price elasticities for all modes was of the order of 1, with the exception of cycling, in which the elasticity was roughly equal to 1.1. This implies that there exists latent demand within the UK's cycling community and that reductions in price are consistently met with disproportional rises in expenditure.
  - This suggest that there are opportunities for making transition, but the weakness in some of the relationships needs to be fostered through further policy intervention and regulation. The production of generalised price series in the first stage of empirical analysis also

- For car transport, it is seen that all modes of transport are compliment goods. That is to say, a reduction in the cost of any other mode of transport is not met by a replacement of car transport with that mode, rather the consumption of both increases.
  - This conflicts with the above finding and highlights the imbedded frictions that are faced in the UK in moving towards a low energy intensity use of transport to support the purchase of other goods and activities.

- Making the transition from an energy intensive transport system will be a complicated process due to the existing social and physical infrastructures imbedded in the UK and its society, as well as wider global norms. Traditional use of the transport infrastructure necessitates a certain amount of long distance journeys that see energy intensity essentially being traded off against time for other activities.