

Decomposing road freight energy use in the UK

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Why road freight?

Globally, freight transport accounts for:

- 30% of transport energy consumption
- 8% of energy-related CO₂ emissions

In the UK, Heavy Goods Vehicles (HGVs) account for:

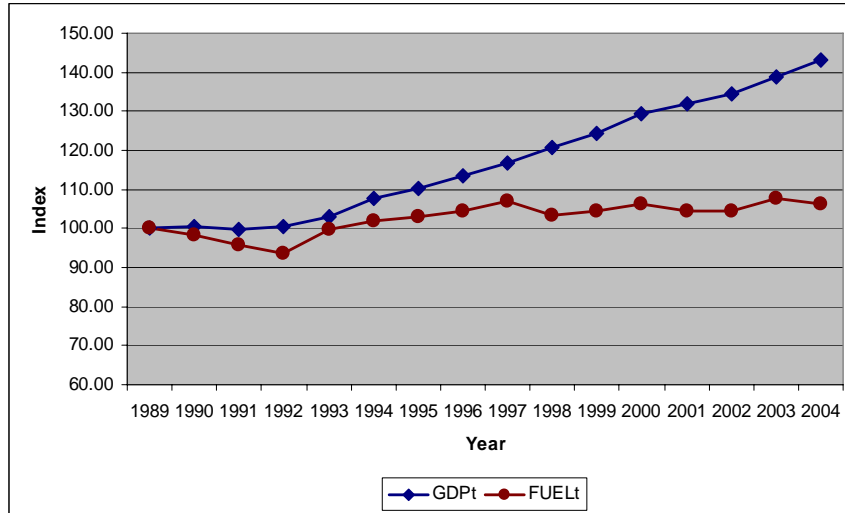
- 84% of goods lifted and 68% of goods moved (tonne km)
- 24% of road fuel use and 22% of transport CO₂ emissions
- 5% of total CO₂ emissions

Climate policy targets a subset of drivers and has limited effect

Freight has been neglected by climate policy research

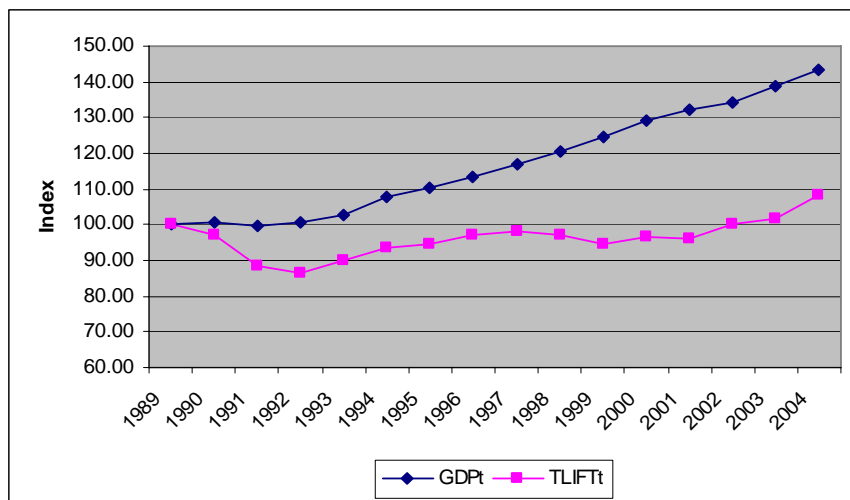
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Decoupling of UK road freight energy use



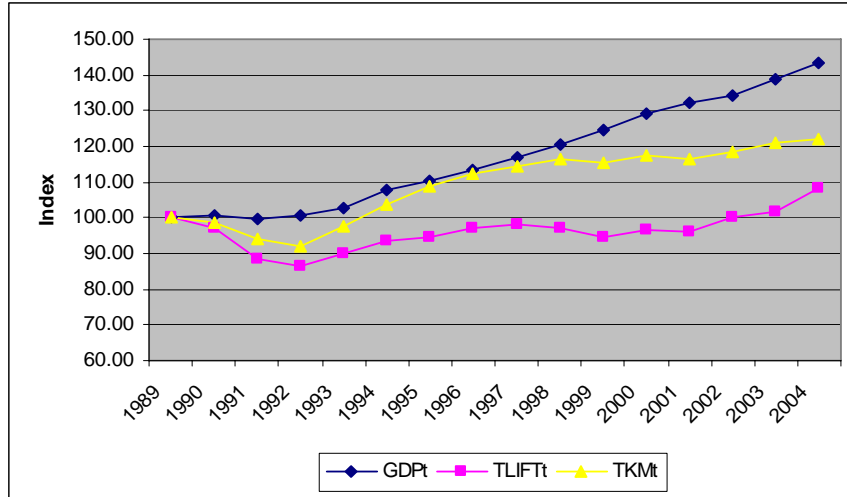
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Decoupling of road tonnes lifted



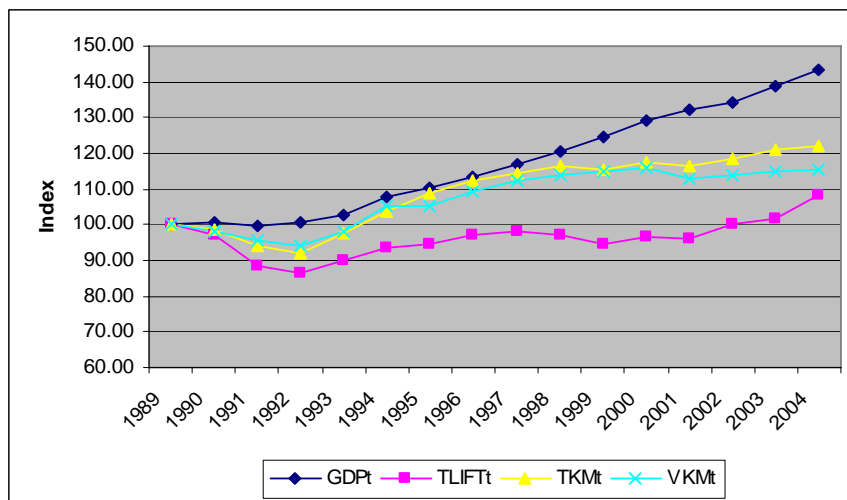
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Decoupling of road tonne kilometres



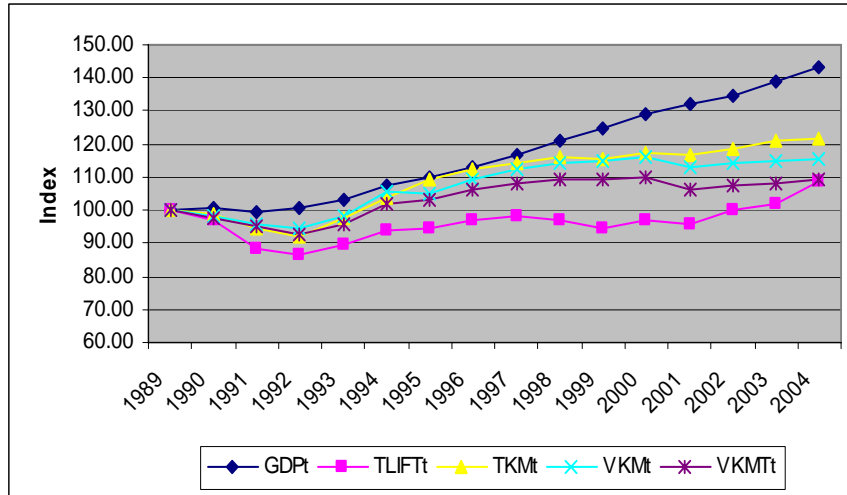
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Decoupling of loaded vehicle kilometres



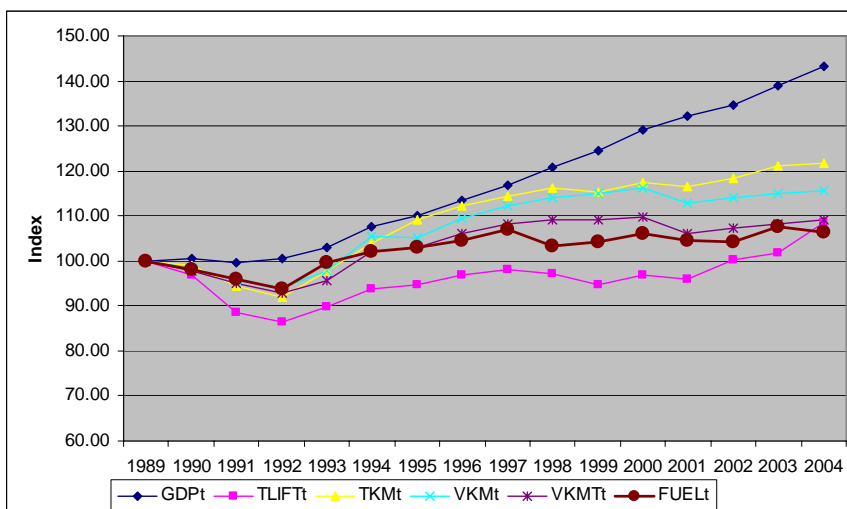
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Decoupling of total vehicle kilometres



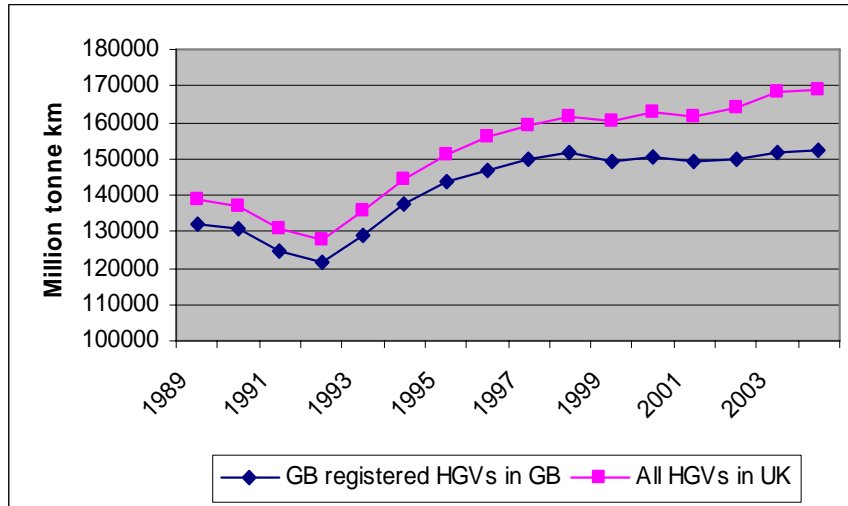
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Decoupling – all measures



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The importance of foreign-registered HGVs



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What is decomposition analysis?

- Express energy use as the product of a number of variables that can be expressed as ratios, e.g.
 - *Road share*: ratio of road tonnes lifted to total tonnes lifted
 - *Length of haul*: ratio of road tonne kilometres to road tonnes lifted
- Break these down by subcategory
 - e.g. commodity type and vehicle type
- Estimate the contribution of each key ratio to the overall change in energy consumption (*ceteris paribus interpretation*)
- Can decompose both overall change and the change for each subcategory

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Decomposition analysis of UK road freight



- Decompose UK road freight fuel consumption over the period 1989-2004 using ten key ratios (X) plus GDP
 - Three key ratios for the supply of goods
 - One key ratio for the freight intensity of goods (value to weight)
 - Six key ratios for the transport of goods
- Further broken down into:
 - 15 commodity types
 - 6 vehicle types
- Data intensive, but allows fine-grained analysis

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Supply key ratios



- ***Domestic manufacturing share***: ratio of value of UK manufacturing to GDP
- ***Commodity share***: ratio of value of UK production of a commodity to total value of UK manufacturing
- ***Import share***: ratio of supply of a commodity to UK production of that commodity

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Freight intensity key ratio



- **Freight intensity:** ratio of total tonnes lifted to value of UK supply
- Could be further decomposed into the product of:
 - **Value density:** ratio of value to weight
 - **Handling factor:** ratio of tonnes lifted to tonnes supplied (~number of links in the supply chain)
- Current data sources do not allow these variables to be accurately identified

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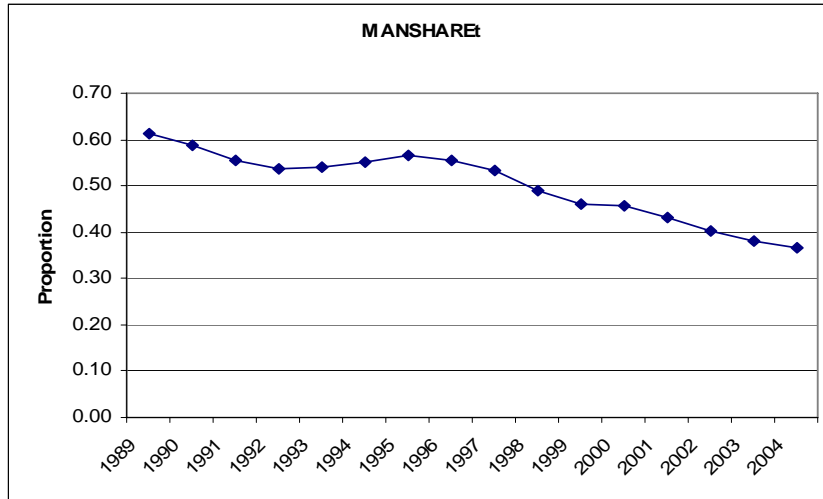
Transport key ratios



- **Road share:** ratio of road tonnes lifted to total tonnes lifted
- **Vehicle share:** ratio of tonnes lifted by each vehicle type to road tonnes lifted
- **Length of haul:** ratio of tonne kilometres to tonnes lifted
- **Payload weight:** ratio of tonne kilometres to vehicle kilometres
- **Empty running:** ratio of total vehicle kilometres to loaded vehicle kilometres
- **Energy intensity:** ratio of fuel consumption to total vehicle kilometres

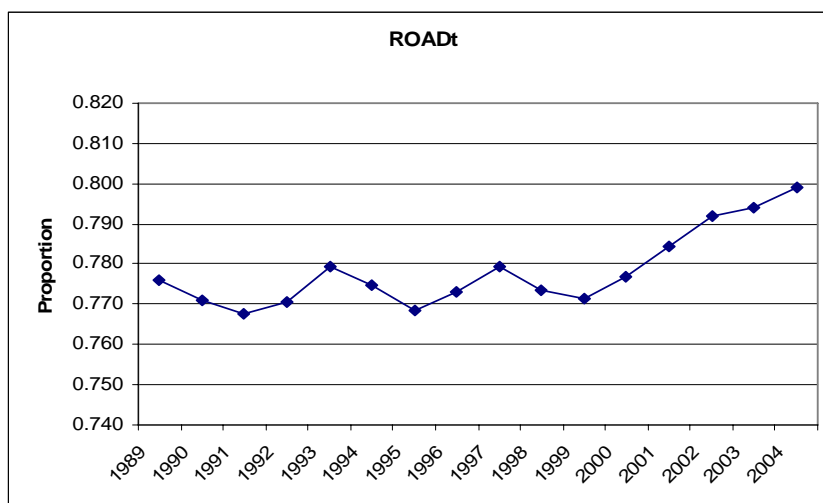
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Manufacturing share



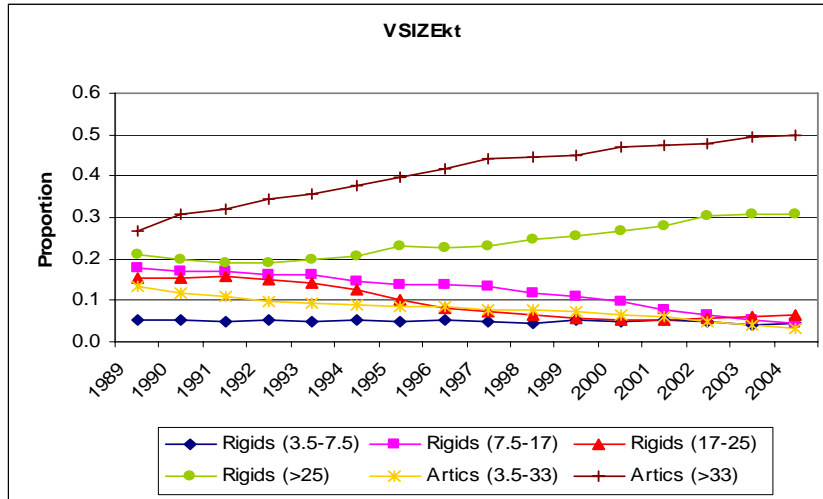
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Road share



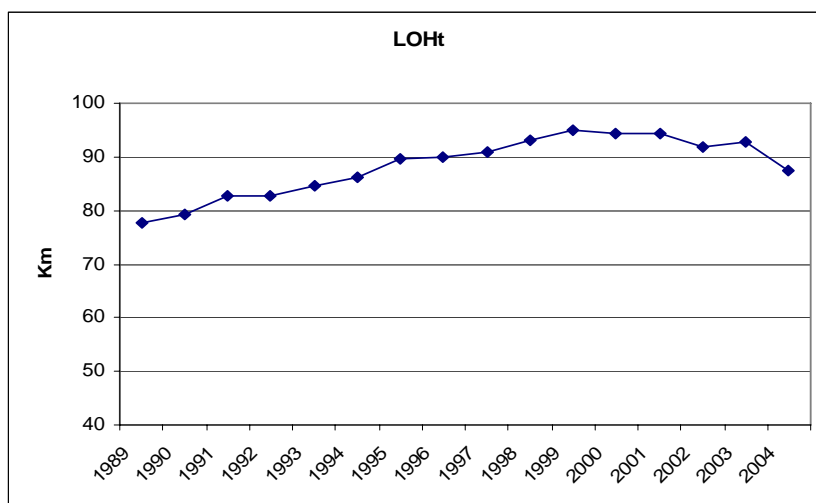
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Vehicle share



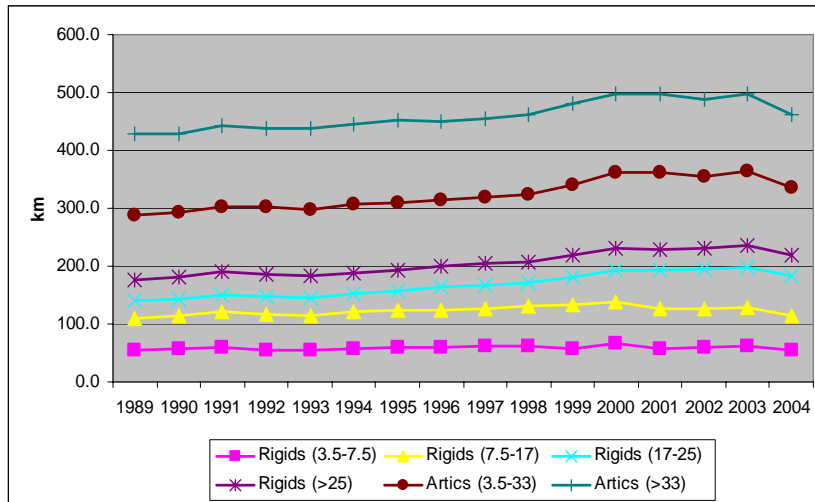
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Length of haul



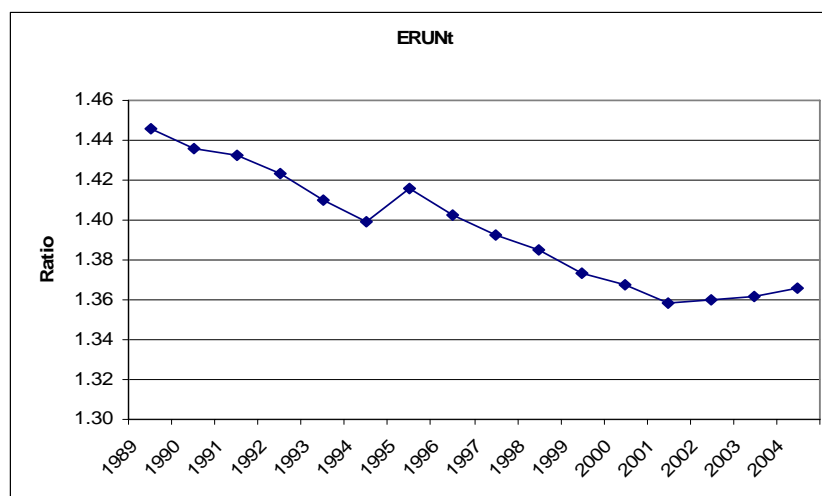
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Length of haul by vehicle type



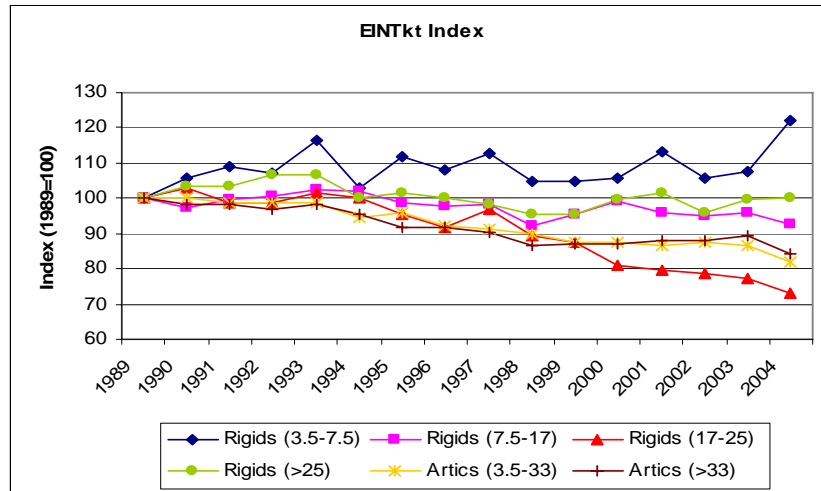
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Empty running



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Energy intensity by vehicle type



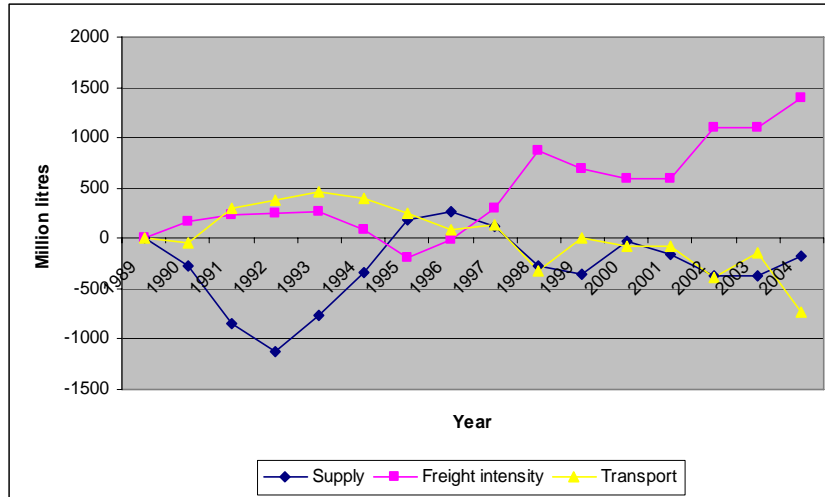
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Aggregate results – 1999-2004

- **Supply key ratios:** **-2.1%**
 - Substantial GDP growth offset by declining importance of manufacturing
- **Freight key ratios:** **+18.8%**
 - Increased handling factors and/or falling value densities
- **Transport key ratios:** **-8.6%**
 - Mix of factors contributing to net reduction in energy intensity
- **Net effect:** **+6.3%**
 - Overall increase in energy consumption

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Aggregate results – time series



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Key ratios increasing fuel consumption

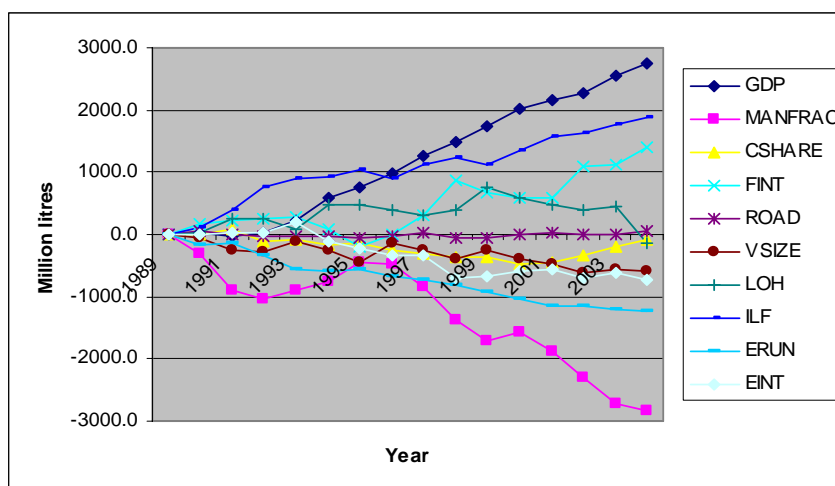
- **GDP:** +43.3%
 - Higher incomes increasing demand for goods
- **Payload weight:** +26.1%
 - Falling load factors for each category of vehicle
- **Freight intensity:** +18.8%
 - Increased handling factors and/or falling value densities
- **Import share:** +9.8%
 - More goods being imported
- **Commodity share:** +2.8%
 - shift towards producing commodities that use more energy in transport
- **Road share:** +0.8%
 - Modal shift towards road freight

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Key ratios reducing fuel consumption

- **Domestic manufacturing share:** **-38.1%**
 - manufacturing contributing less to UK GDP
- **Energy intensity:** **-8.6%**
 - Improvements in the fuel efficiency of vehicles
- **Empty running:** **-14.1%**
 - Greater use of backhauling
- **Vehicle share:** **-7.0%**
 - shift towards larger vehicles
- **Length of haul:** **-1.6%**
 - reductions in the average length of haul for energy intensive commodities/vehicles

Detailed results – time series



Concluding observations



- **Trends are unsustainable because:**
 - Only relative decoupling and less than official statistics suggest
 - Decline of domestic manufacturing displacing emissions overseas
- **Reduced empty running and trend towards larger trucks have significantly lowered energy intensity**
- **Reasons for increase in freight intensity are unclear**
 - Considerable variation between sectors (e.g. high in food and drink)
- **Decomposition analysis provides useful insights**
 - For example, key ratios that have increased in the aggregate have reduced energy consumption
 - But difficulties in accounting for endogenous variables and numerous gaps/inaccuracies in the data sources

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Policy issues



- **Potential for further improvements in empty running, fuel efficiency and (especially) vehicle load factors**
- **Limited opportunities for modal shifts**
- **Spatial concentration and supply chain extension may be reaching limits within UK, but**
 - continuing regional/global trend to longer supply chains
 - reversal requires restructuring of economic activity
- **Transport costs form small share of total costs for most products, so freight activity unresponsive to price incentives**

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Annex – Illustration of decomposition



E = Energy use A = value of goods L = goods lifted c = commodity
 S_{ct} = share of commodity c in total value of goods
 F_{ct} = 'freight intensity' of c I_{ct} = Energy intensity of commodity c

$$E = \sum_c E_c = \sum_c A \frac{A_c}{A} \frac{L_c}{A_c} \frac{E_c}{L_c} = \sum_c AS_c F_c I_c$$

$$D_E = \frac{E_t}{E_1} = D_A D_S D_F D_I$$

D_X = ratio of energy consumption in year t to that in year 1 that results from the change in the 'key ratio' X over this period (~ceteris paribus).

If $D_X < 1.0$, then X has reduced fuel consumption