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Data gathering and analysis to improve understanding of the impact of mileage on the cost-effectiveness of Light-Duty vehicles CO_2 Regulation

Passenger car and van CO_2 regulations – stakeholder meeting

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Background to project

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- European regulations have historically revolved around test cycle based metrics of CO_2 performance (i.e. grams CO_2 per kilometre travelled).
- These metrics illustrate the comparative emissions performance of different vehicles, however they do not capture lifetime emissions fully
- Distance travelled is an important element in determining the cost effectiveness of the Regulations
- It may be more cost effective to apply different targets to vehicles that are used more intensively (i.e those with high lifetime mileage) to those used less frequently.
- Adopting such a policy could redistribute the burden of effort of future CO_2 targets.
- The overall efficiency of the Regulations could be improved by applying this approach, thereby reducing the total costs incurred by the vehicle manufacturing sector and improve cost effectiveness from society's perspective.

Study aims and objectives

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1. **Obtain a detailed understanding of data availability on**
   - Vehicle mass
   - Vehicle footprint
   - Lifetime vehicle mileage
   - Mileage accumulation over time

2. **Gather real-world data for the above parameters and perform detailed analysis to examine linkages between mileage and mass/footprint**

3. **Using the results from this analysis, carry out analysis to investigate whether there are statistically significant relationships between:**
   - (a) vehicle mass and lifetime mileage; and
   - (b) vehicle footprint and lifetime mileage

4. **Carry out further analysis to investigate the potential cost implications of using lifetime mileage as a cost optimising method for target setting for different vehicle segments**

5. **In addition, mileage age profiles were also considered**

Findings from the literature review

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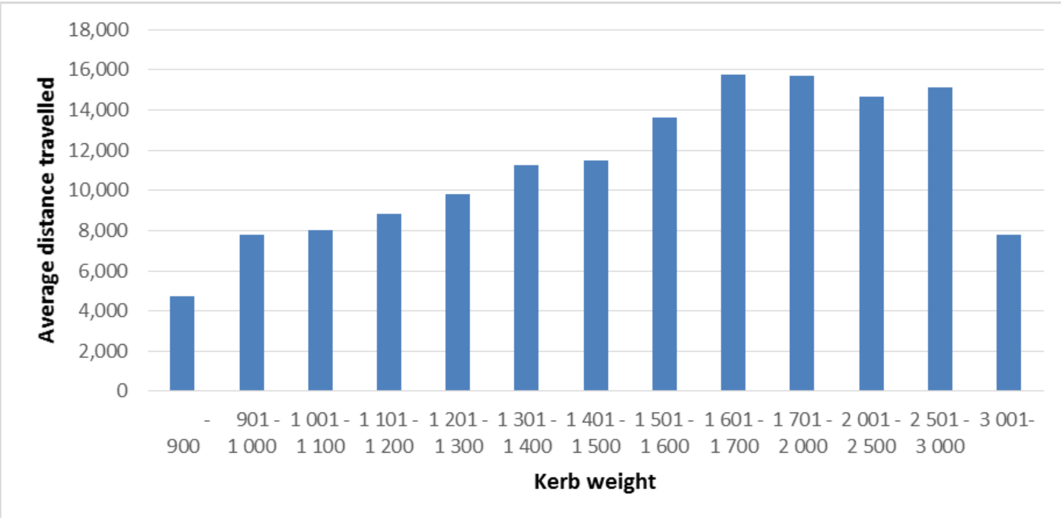
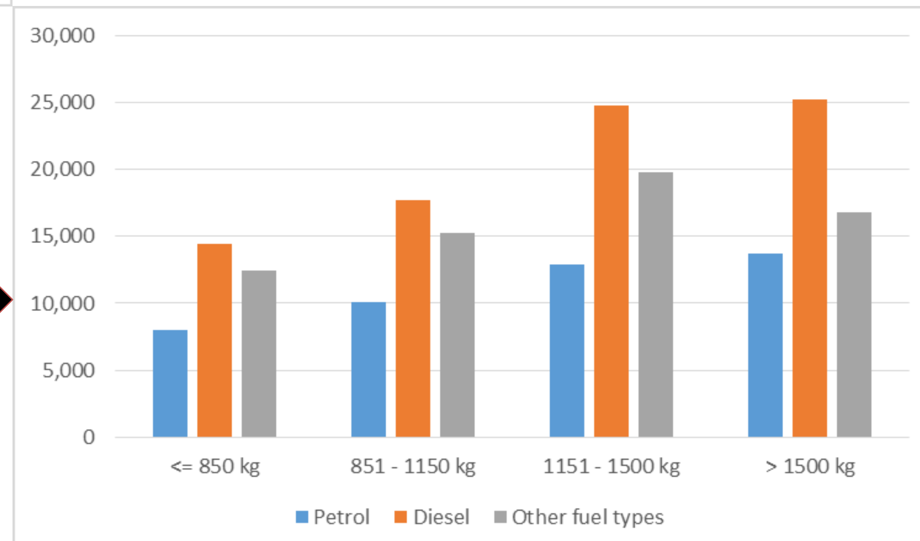
- Outcomes from the literature review support study findings



- Swedish travel survey data shows a linear upward trend of annual distance travelled versus mass up to a kerb weight of around 2000 kg.
- Trend less clear for heavy vehicles >2000kg

- "Statistics Netherlands" data shows a clear link between weight and annual mileage, with clear trends for each fuel type



Findings from the literature review

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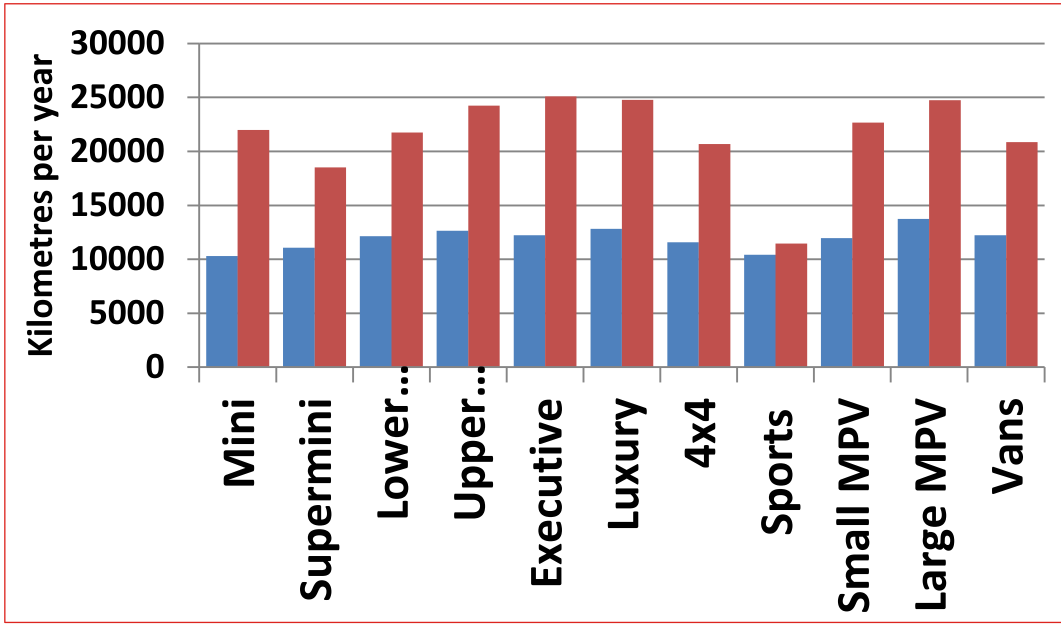
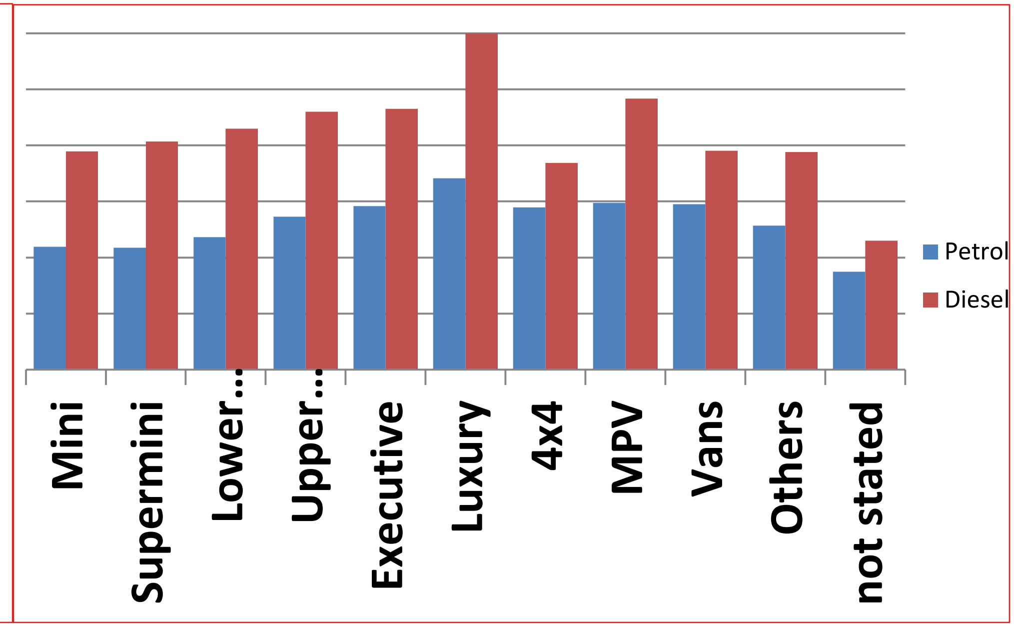
Mobilität in Deutschland, 2008



Fahrleistungserhebung, 2002



- These examples demonstrate that there is evidence that heavier cars and vans are driven further than lighter vehicles.
- This is turn underlines the potential benefit of identifying a more comprehensive dataset.

Data gathering

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- The project began with identifying possible sources for analysis. It was clear that these sources would need to be extremely large to enable the team to draw robust conclusions.

- Periodic Technical Inspection datasets, which often include annual mileage data, were gathered from a small selection of Member States

- Datasets were obtained from UK, France and Belgium with varying degrees of detail

  1. **UK:** The full 2013 publicly available MOT data was sourced however the sheer size of this database and a lack of mass and footprint data within it were obvious obstacles.

  2. **France:** 2010-2013 '*Contrôle Technique*' data was provided under the provision that only a sample of each year was given. This dataset therefore included all required data (mass, footprint and mileage) for over 3 million vehicles

  3. **Belgium:** Similar to France, 2013 '*contrôle technique*' data was obtained for over 500,000 vehicles. However this did not include footprint data data.

Review of data

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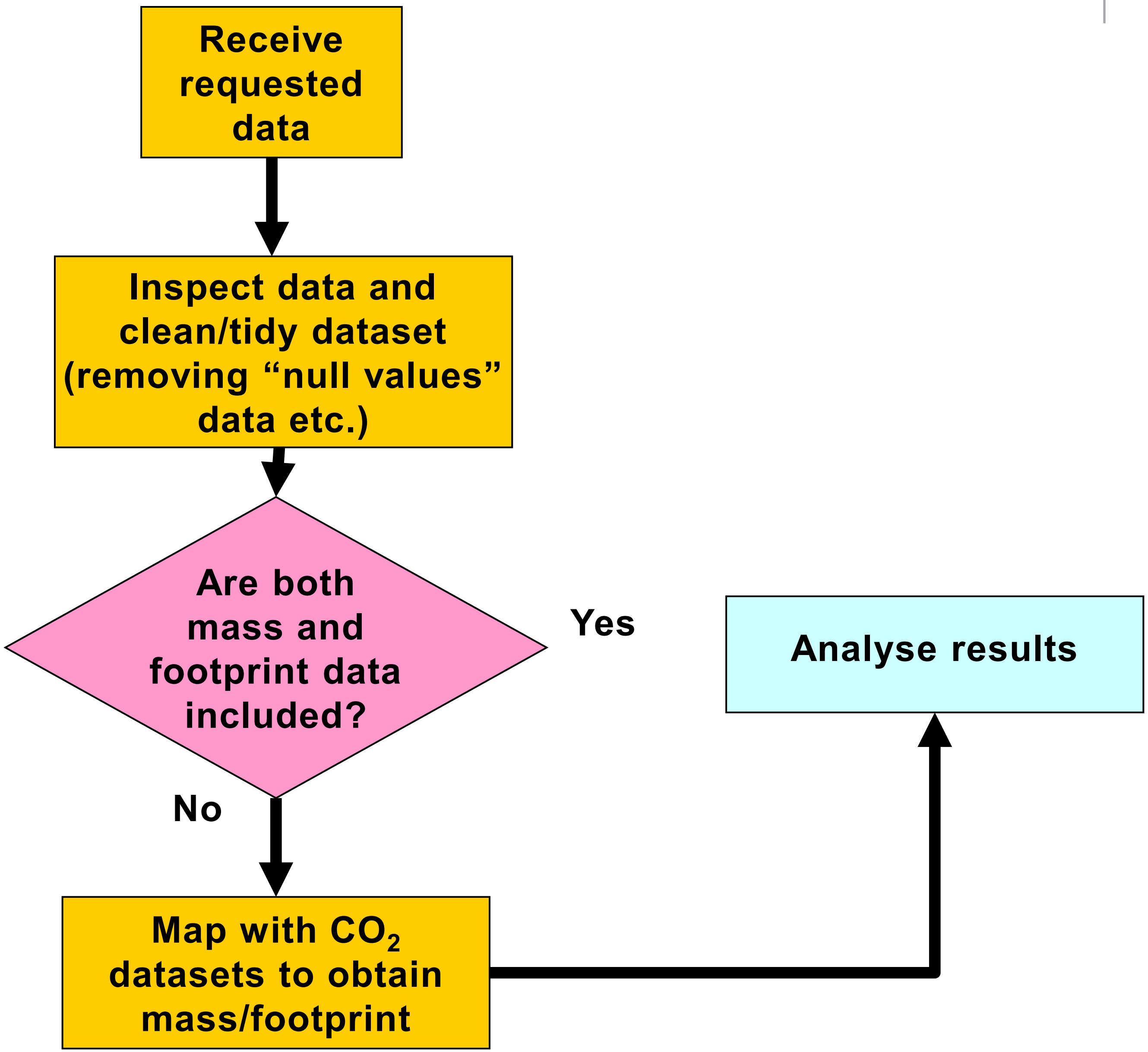

Review of data (cont.)

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- The UK dataset did not include mass or footprint data

- The make, model and year variations of this database were therefore matched to pre-existing CO_2 databases in order to obtain the required mass and footprint information.

- Important to note limitations of this process. For example:
  - In order the maximise the number of “matches”, the average mass and footprint data (where appropriate) of several unique variations of a common model were used.

Data analysis approach

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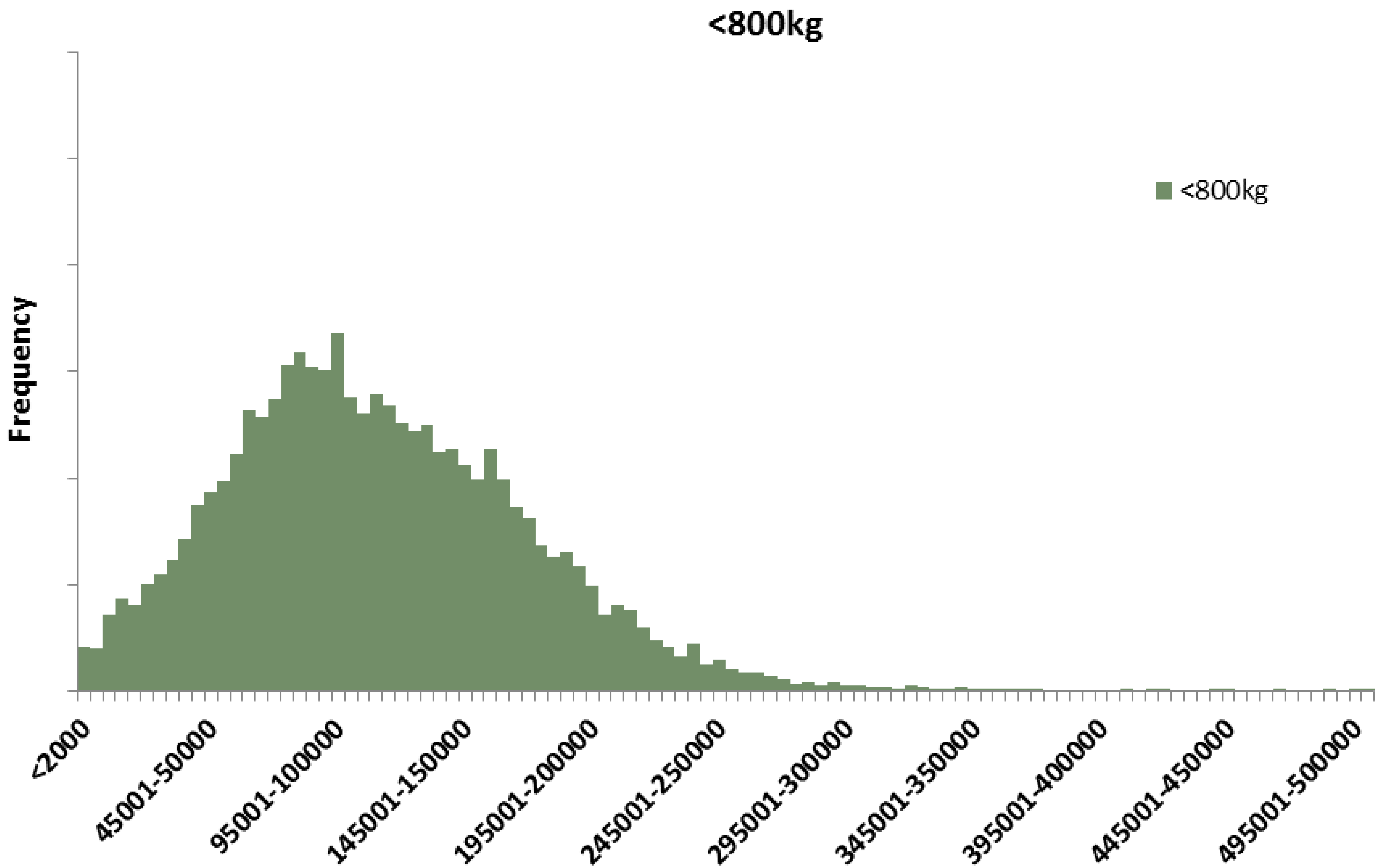
- Compiling the (cleaned up) data we have obtained it was first necessary to look at petrol and diesel vehicles separately since any correlation between mass/footprint and mileage would differ depending on fuel type.
- We also focused our attention on vehicles aged 15 years (for an indication of lifetime mileage) and aged 5 and 10 years (to try to develop a profile of mileage over time)
- The issue surrounding lifetime mileage is a complex one. Given the data we have there is no straightforward solution to obtaining information on when a vehicle is taken off the road and so this limitation required us to make an assumption on what age of vehicle we analyse.
- It was decided to use vehicles with an age of 15 years, as the majority of vehicles are scrapped before they reach this age
- Our approach allows us to analyse the likely lifetime mileage of different types of vehicles, taking into account variations in annual mileage as a vehicle ages

Establishing an appropriate relationship between mass/footprint and mileage

Mileage against	Cars		Vans	
	Diesel	Petrol	Diesel	Petrol
Mass	✔	✔	✔	✘
Footprint	✔	✔	✘	✘

- Based on the available datasets, five different possible correlations were investigate (see table above)
- The use of scatter plots was deemed too problematic due to the sheer size of the datasets and subsequent number of outliers to the expected trend.
- An approach using frequency distribution plots and normal distribution curves was taken to investigate the range of lifetime mileages for vehicles in different weight categories and footprint categories
- This was performed with a view to building up a series of data points on which correlation functions could be derived.

Results of analysis (example based on petrol cars)



Results of analysis (cont.)

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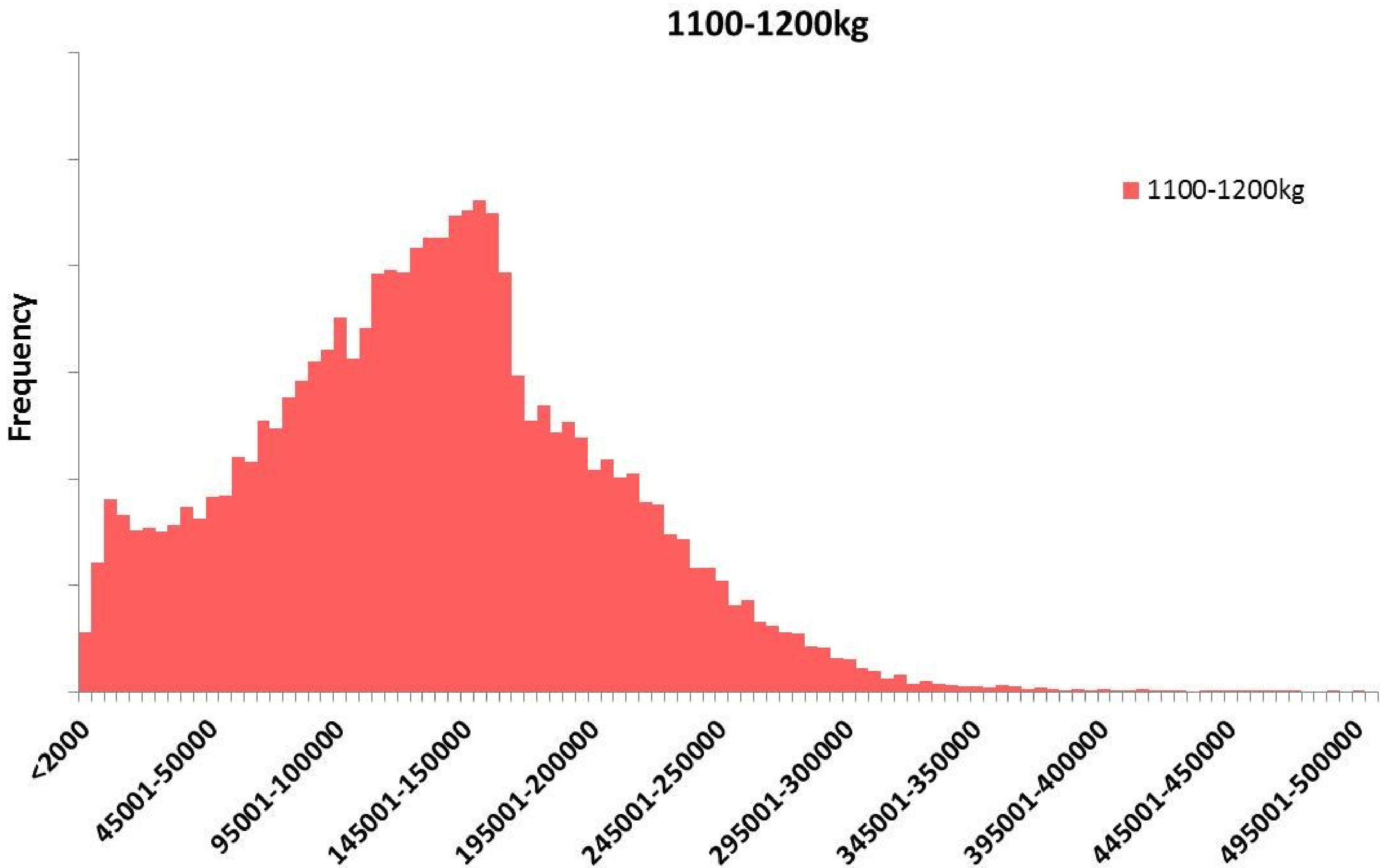
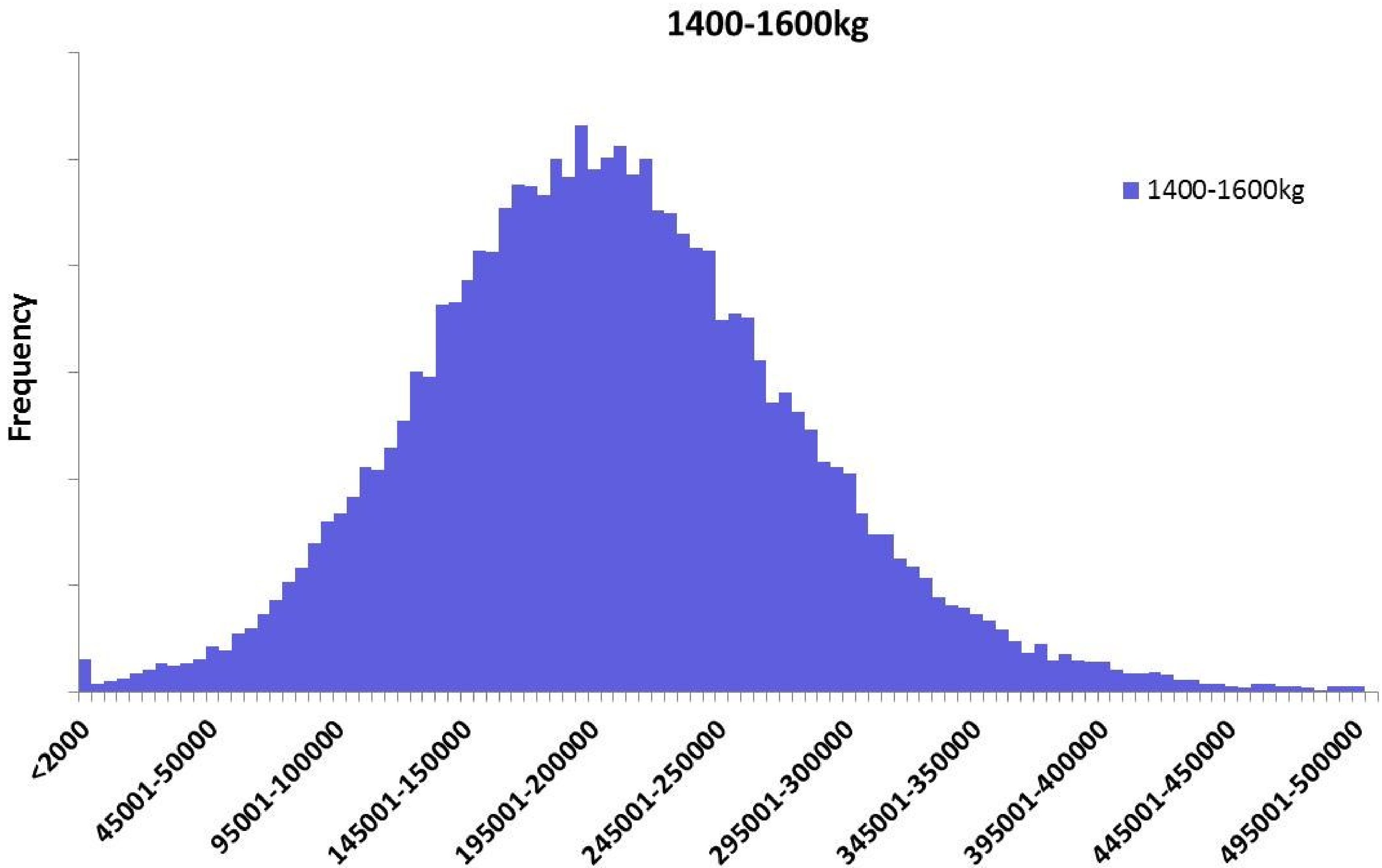


Results of analysis (cont.)



Results of analysis

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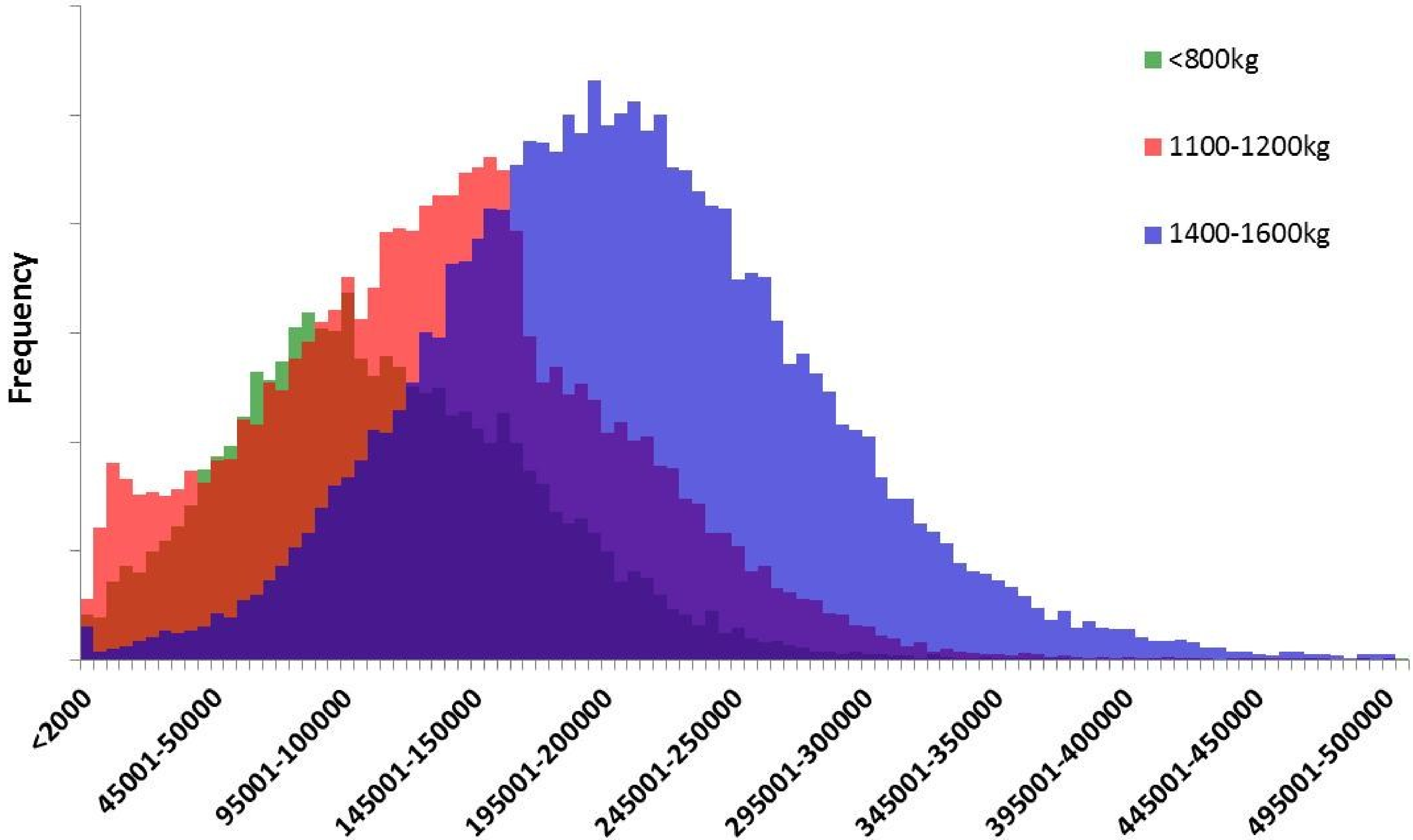

Results of analysis (cont.)

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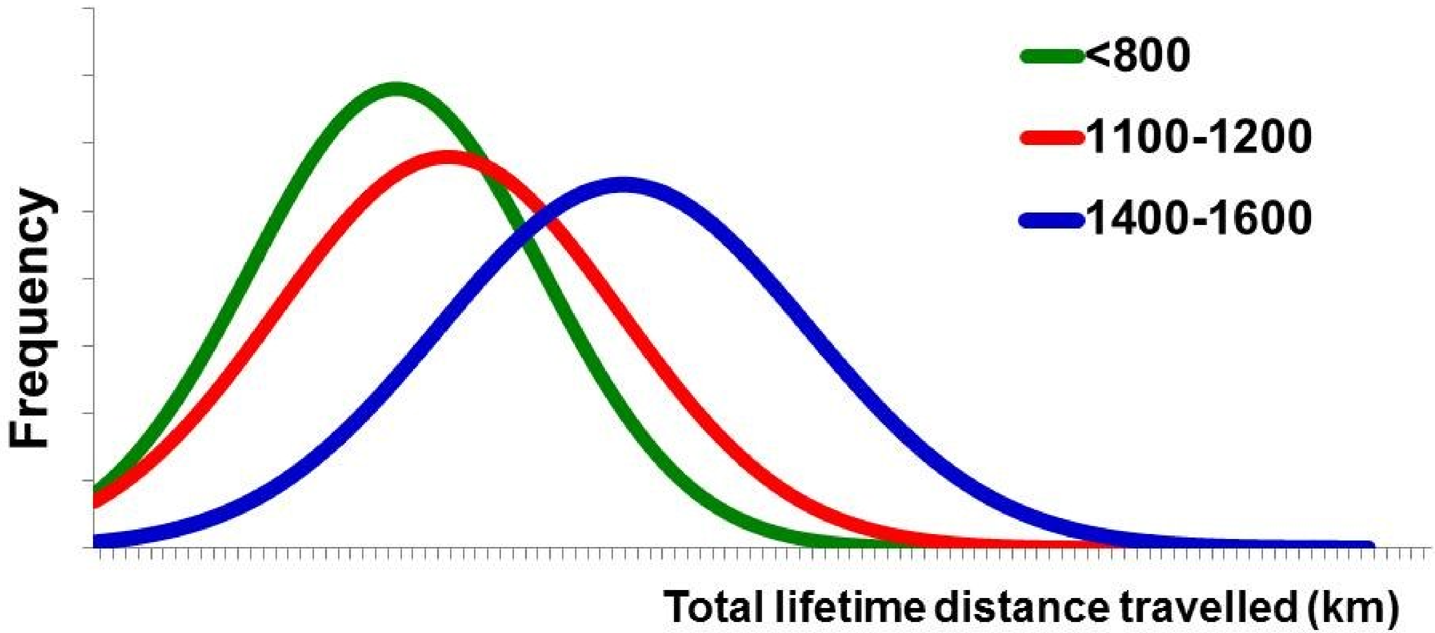
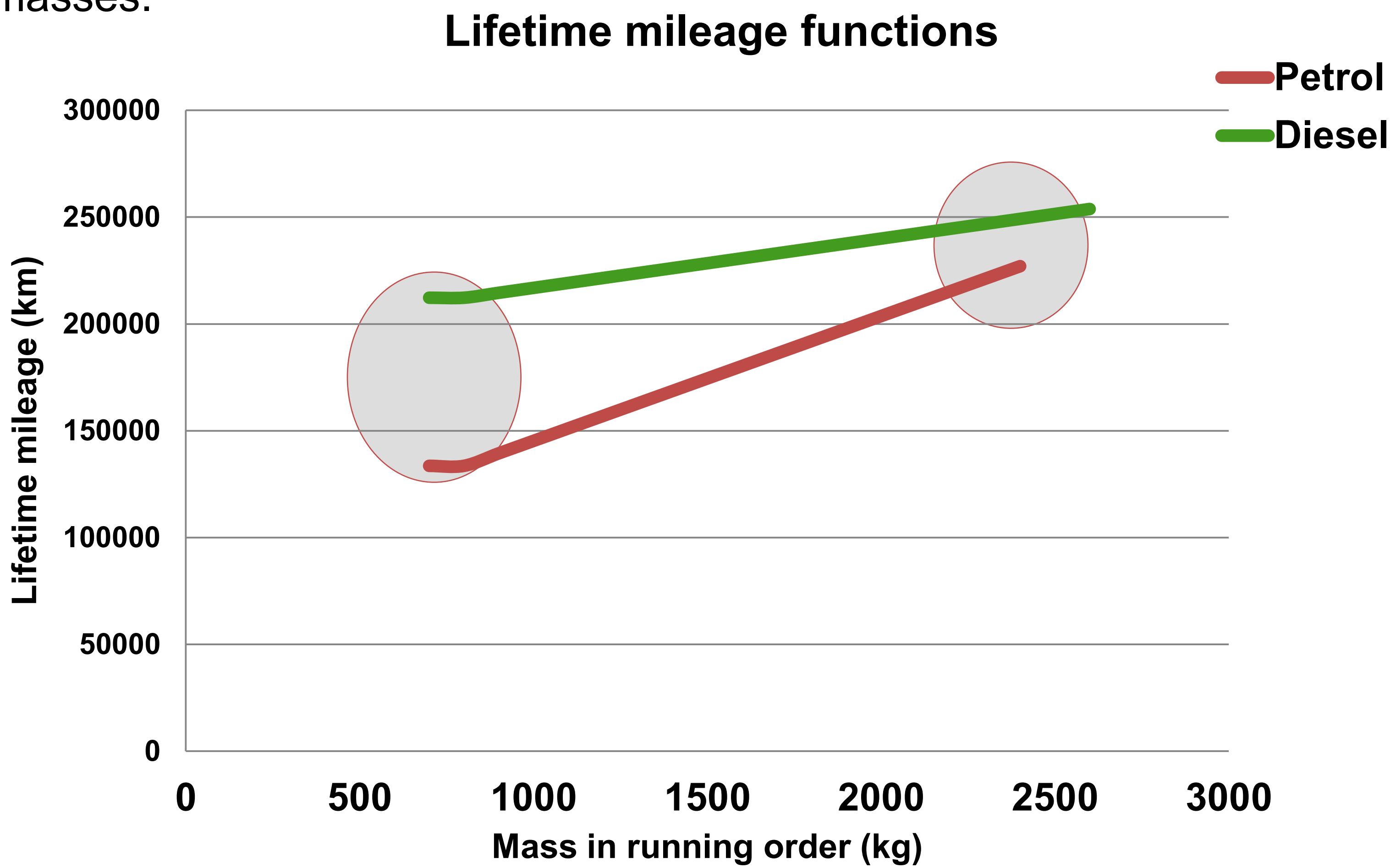


Most probable lifetime mileage range for petrol cars	
<800 kg	110 001 to 115 000 km
1101-1200 kg	130 001 to 135 000 km
1401-1600 kg	200 001 to 205 000 km

- Analysis indicates a clear linkage between kerb weight and lifetime vehicle mileage
- Data above presented for a small selection of mass bands – full analysis has more complete coverage

Results of analysis (cont.)

- Applying this analytical process over all vehicles mass categories allows us to plot a line of best fit through all data points.
- Shaded end point areas are "areas of uncertainty due to the sample size of vehicles at these masses.



Cumulative mileage as a function of vehicle age

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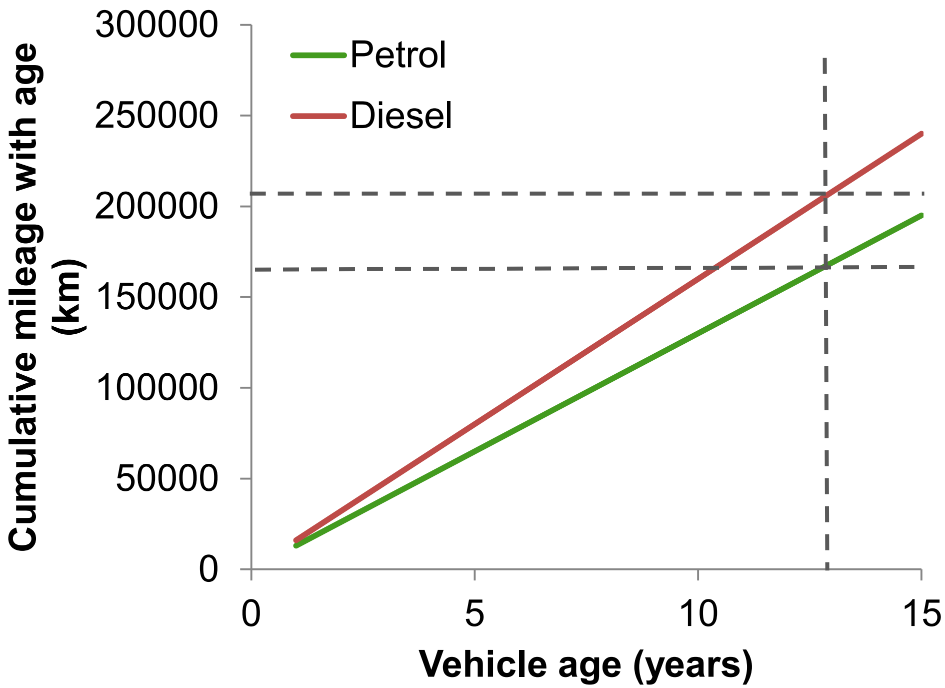
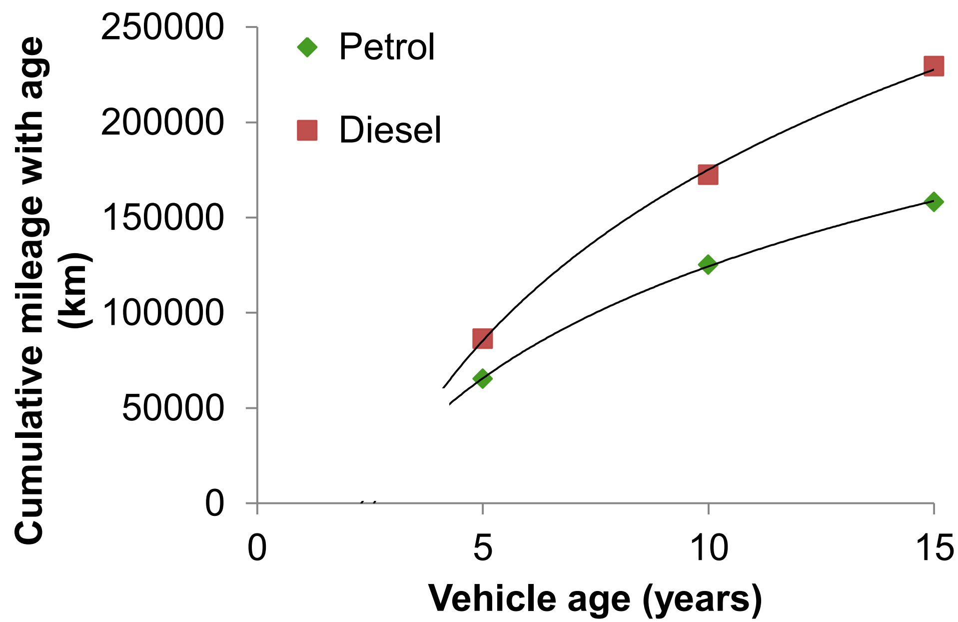
- Existing approach used for cost effectiveness analysis of the car and van CO_2 Regulations assumes that all **petrol vehicles** drive **13,000km per year (each year)** for 13 years and all **diesel vehicles** drive **18,000km per year (each year)** for 13 years
- PTI data indicates that this does not reflect real-world conditions – vehicles tend to be driven more intensively in earlier stage of life



Linear approach to cumulative mileage assumed for the purposes of regulatory analysis



Observations from Periodic Technical Inspection data

Light commercial vehicles

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- Work has also begun in looking at a relationship between LCV mileage and mass
- Vans analysis has not been sufficiently analysed prior to this event however it would appear that a link between mass and mileage might not be as strong.
- LCVs are used for a wide variety of different uses and unlike passenger cars are not purchased for the same reason.
- For example flat beds will travel short distances as they'll be mainly used for local work. By contrast vehicles used for delivery such as post or courier will probably travel very high distances. This would appear to be the case irrespective of size/mass.
- Another issue here has been the availability of a sufficient sample set of data with which to analyse

Assess impacts on vehicle costs associated with using mileage as a weighting parameter in the Regulations

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Four step process

1. Calculate cost and effort to target data per manufacturer under a non mileage weighting system using cost curve model and cost optimisation techniques

2. Use correlation function we have to assign every vehicle in the CO_2 database an average lifetime mileage value and therefore calculate a sales AND mileage weighted average for each manufacturer.

3. The calculated effort in a non mileage system and our lifetime mileage data results in a maximum amount of CO_2 emissions per manufacturer in grams per year to achieve their target.

4. Under a mileage-weighted target system, every manufacturer would be obliged to reduce a certain amount of total lifetime CO_2 emissions, the distribution of this reduction over the segments can be determined by the manufacturer in such a way that, in theory, the costs will be reduced in relation to a non-mileage weighted system.

Assess cost reduction of adopting mileage into the regulations (cont.)

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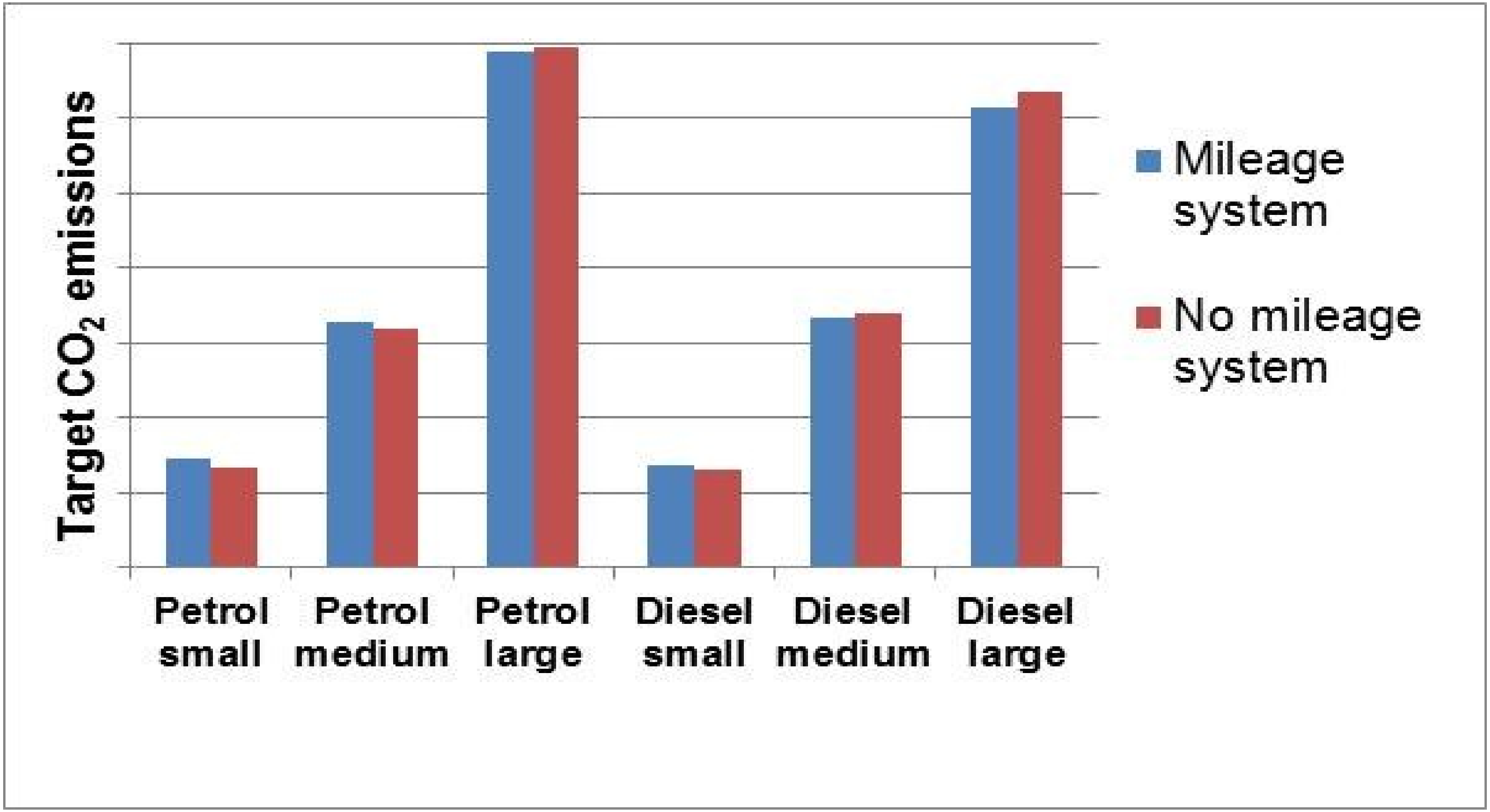
Emissions targets for different vehicle types under (a) mileage-weighted and (b) existing system



Effect on target slope

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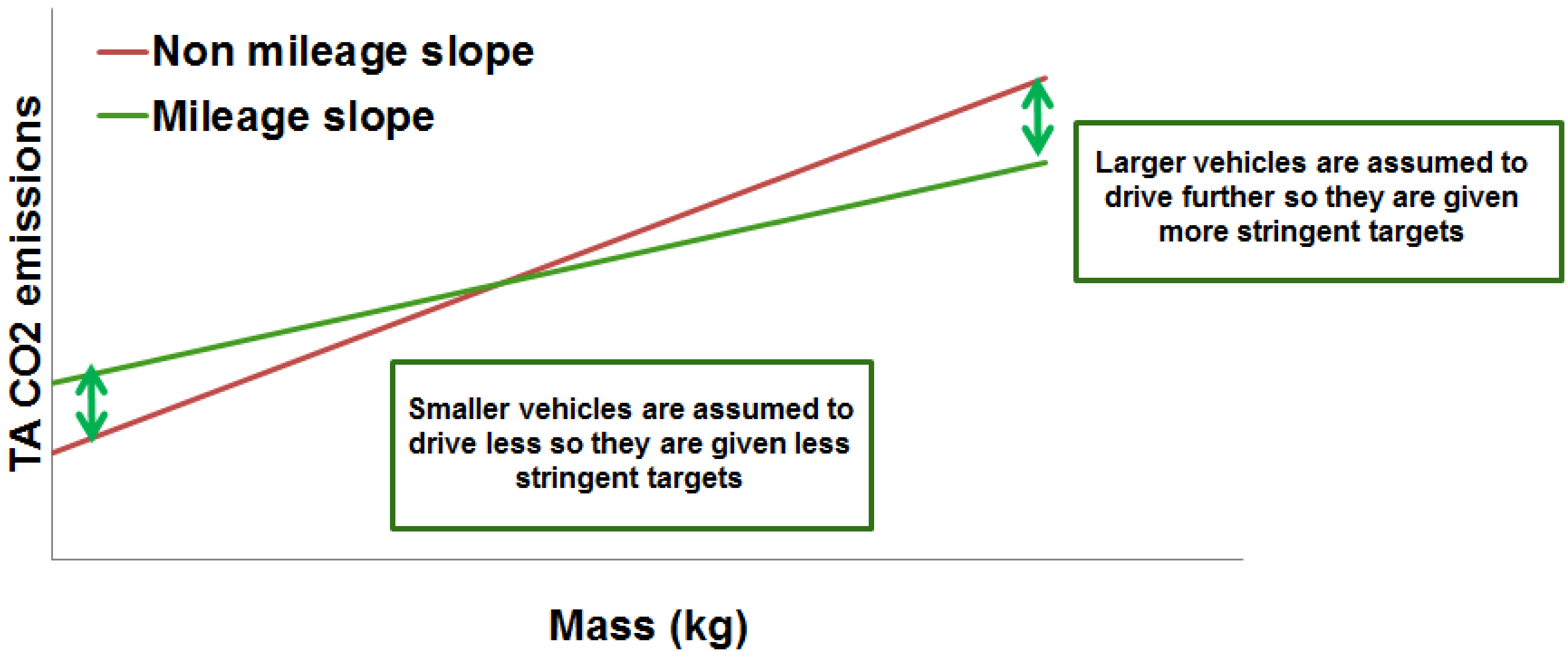
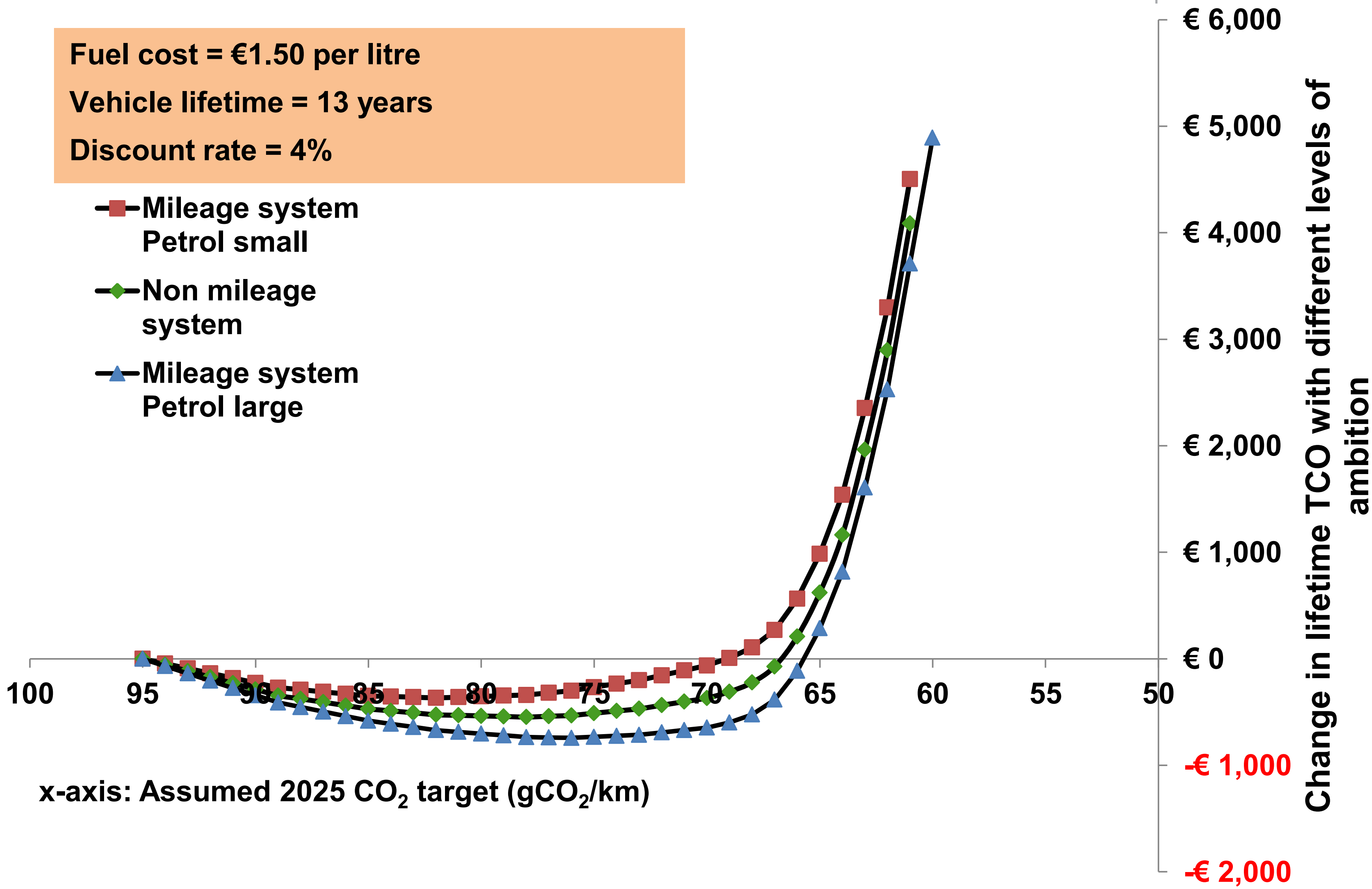
- Based on the initial findings from this study, mileage weighting would allow the slope of the target line to be altered
- Potential benefits in reducing the overall costs associated with meeting the fleet-weighted target

Illustrative example of effect on target slope (not to scale)



Effect of mileage weighting on total cost of ownership



Impacts of mileage-weighing on effort and costs to meet targets

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Mass system (with mileage)	Petrol, small	Petrol, medium	Petrol, large	Diesel, small	Diesel, Medium	Diesel, large
Impact on effort required to achieve emissions target	2.07% less effort	0.98% less effort	-0.59% more effort	0.88% less effort	-0.79% more effort	-1.95% more effort
Lifetime mileage assumed (km)	150,000	169,000	186,000	222,000	230,000	238,000
Mass in running order (kg)	1084	1422	1700	1242	1579	1898

- Under a mileage based system, manufacturers are able to re-focus their efforts to segments that are responsible for the most CO_2 emissions
- Overall this reduces the costs for compliance by more than 2% for vehicle manufacturers

Impacts of mileage-weighing on costs to meet targets

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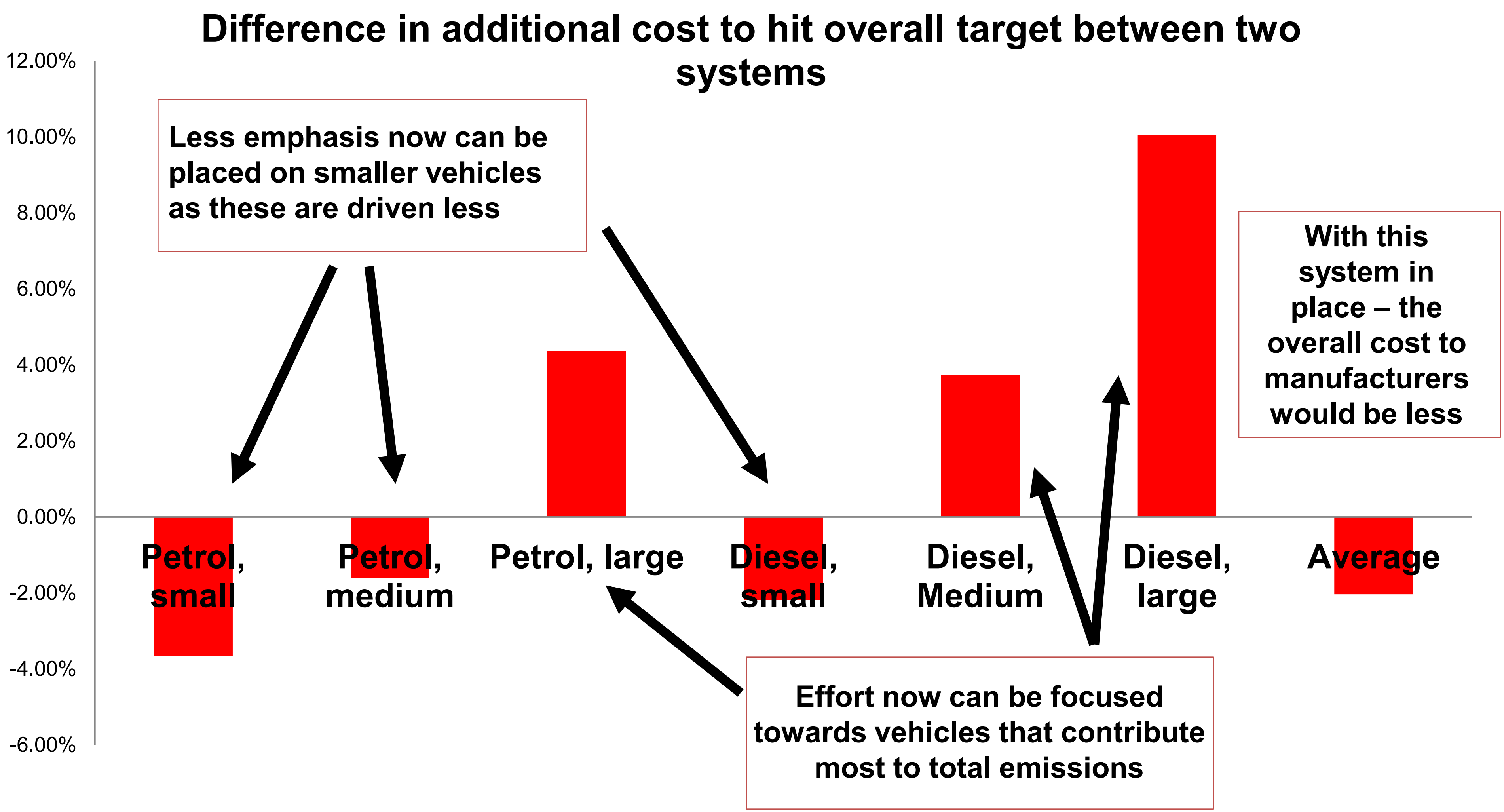

Further work

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Work on this study is currently on going – further work to be investigated includes;

- Analysis of any correlations between footprint and mileage
- Further investigation into a similar methodology for diesel vans (only using mass as the utility parameter)
- Quantitative analysis of the cost effectiveness of adopting such an approach from a social and consumer perspective.
    - Results from this study could affect previous cost effectiveness analysis performed on the regulations.
    - Previous analysis assumed constant annual mileages for petrol and diesel respectively and looked at the payback period of various targets over 5 years (to take into account "myopia") and over the lifetime.
    - Further analysis of this new mileage data is currently being performed to assess the societal and consumer benefits of such a policy.

QUESTIONS?

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