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What can fuel price increases tell us about the air pollution health co-benefits of a carbon price?

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ABSTRACT

Background: Despite their currency, there is little 'real-world' evidence for the health co-benefits of policies to reduce carbon dioxide emissions.
Objectives: To explore whether increases in market petrol and diesel price have a discernible impact on ambient air pollution.
Methods: A causal diagram informed the analysis. Linear regression was conducted on weekly air pollutant time-series (PM_{10}, NO_x, $PM_{2.5}$ and CO) for four air quality monitoring stations around New Zealand, and diesel and petrol pricing data, from 2001 to 2013. We explored the possible delayed effects of petrol and diesel price changes over 9 weeks. Flexible cubic splines were used to remove seasonal and long-term trends. Meta-analysis of results from the four stations was undertaken, as were sensitivity analyses.
Results: The unlagged adjusted models for each air quality station and the meta-analyses showed a modest, non-significant reduction in air pollutants (PM_{10}, NO_x, $PM_{2.5}$ and CO) associated with an increase in petrol price. For example, a 1% increase in petrol price was associated with a 0.32% (−1.21 to 0.58) reduction in NO_x. All confidence intervals included null. While the lagged adjusted models showed patterns suggestive of an initial drop in air pollutants after a fuel price rise, followed by a rebound increase over the nine-week period studied, the majority of estimates were non-significant.
Conclusions: The findings are suggestive of a short-term reduction in air pollutants associated with regular petrol or diesel fuel price rises, followed by a rebound increase. Further work could explore the specific pathways between fuel price and air pollution.

1. Introduction

The positive health impacts of policies to reduce carbon dioxide emissions (decarbonise) in the transport sector are the subject of considerable policy and research interest (Watts et al., 2015). Studies modelling potential policy scenarios consistently suggest that reducing reliance on fossil fuels for transport could have substantial positive health impacts. For example, a shift from private motor vehicles to active (e.g. cycling and walking) and public transport modes as a result of policies to reduce carbon dioxide emissions could lead to health co-benefits, including reduced injuries from road traffic crashes, and improved disease outcomes through reduced air pollution and increased population physical activity (Creutzig et al., 2012; Macmillan et al., 2014; Rojas-Rueda et al., 2012;

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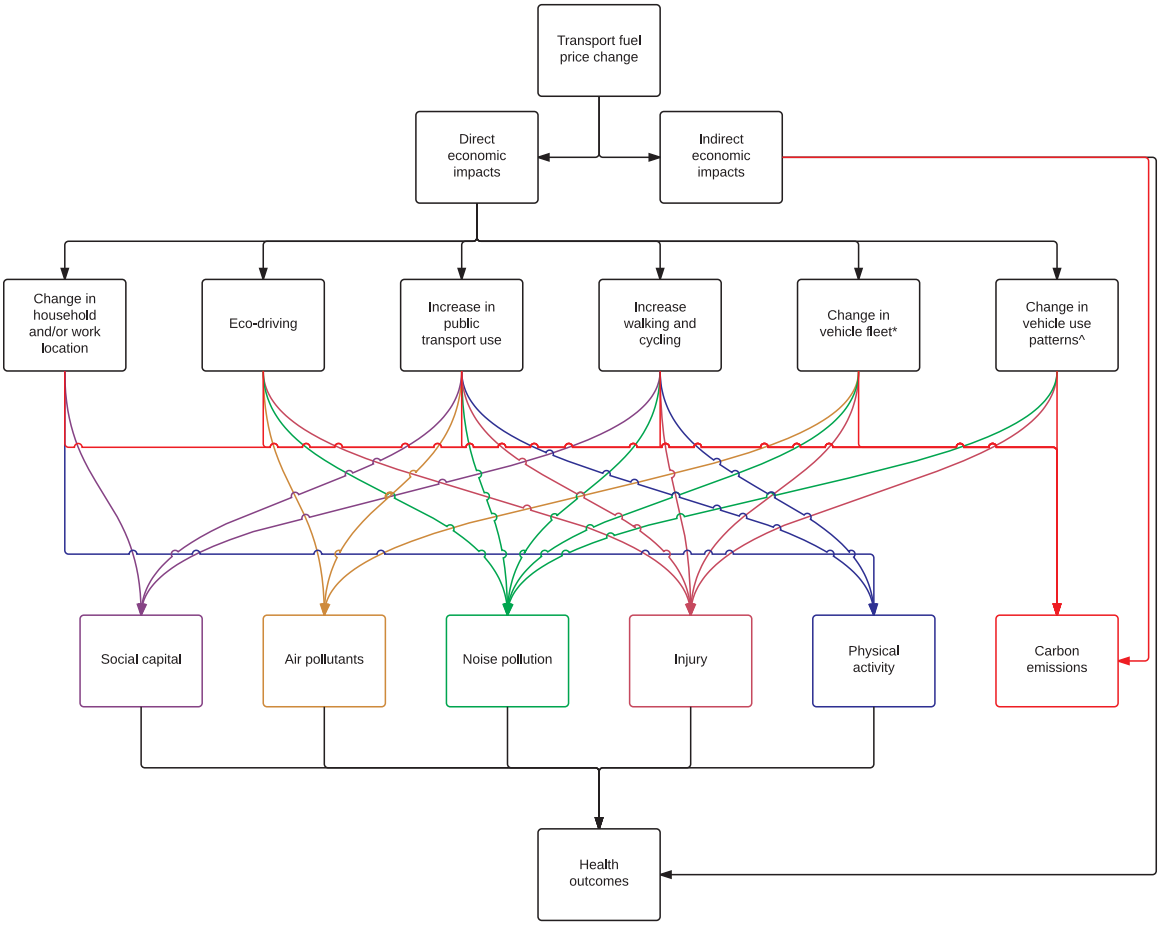

Fig. 1. Theoretical pathways between transport fuel price and health and carbon impacts. Figure footnote ^For example, trip reductions, trip chaining, carpooling *For example, fewer car purchases, retiring of older vehicles, conversion to more efficient vehicles such as hybrids, diesels, 2-wheelers, ethanol/biofuel vehicles.

Woodcock et al., 2009). Due to these positive health impacts, decarbonisation policies are thought to be highly cost-effective and sometimes cost-saving (Jarrett et al., 2012; Jensen et al., 2013; Macmillan et al., 2014).

There are two broad issues with using scenario modelling studies as a source of evidence for policy development. Firstly, there are considerable methodological limitations in some studies. For example, limited approaches to deal with stochastic and parametric uncertainty in the models (Remais et al., 2014). Secondly, scenario modelling studies are unable to deal with the reality of policy-making, where policies may not be implemented, be poorly implemented, fail to deliver the expected outcomes and/or have unanticipated effects.

Thus, evidence from modelling needs to be supported by real-world research, including trials or evaluations of decarbonisation policies and natural experiment evaluations. Currently empirical evidence in this area is limited and/or of poor quality (Shaw et al., 2014). Innovative approaches are needed to provide empirical evidence for policy-making and analysis.

As part of decarbonisation policy packages, multiple international institutions now recommend an effective price on carbon emissions (Aldy, 2015). Pricing policies are generally emissions trading schemes and/or taxes. Approximately 12% of the global carbon emitted is now part of a pricing scheme (World Bank, 2015). While use of carbon pricing in the transport sector has varied, it has had a large impact in British Columbia, Canada with a 19% per capita reduction in fuel use in the four years after implementation in 2008 (Ecofys and World Bank, 2014).

After reviewing the literature (Shaw, 2016), we created a diagram of the theoretical pathways between land transport fuel price and health and carbon emission outcomes (see Fig. 1). Potential pathways to health outcomes include changing travel modes and patterns of vehicle use, and relocating employment and housing.

To our knowledge, there has been no 'real-world' assessment of the health impacts of existing carbon pricing tools. It is extremely challenging to evaluate these health impacts: best-practice epidemiological methods such as randomised controlled trials are difficult, if not impossible, to apply in this setting. Other robust epidemiological methods may also be unsuitable to evaluate health impacts. A carbon tax in British Columbia, Canada was gradually implemented over a number of years (Rivers and Schaufele, 2014), for example, making interrupted time-series analysis difficult (Kontopantelis et al., 2015). Non-methodological issues can also make evaluation challenging: the poor design of the New Zealand emission trading scheme, for instance, resulted in an ineffective carbon