Summary:

Equity effects of automobile taxation

TØI Report 1463/2016
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Oslo 2016, 65 pages, English language

The commuter tax credit in effect in Norway helps equalize welfare between low and high income communities. Revoking it would be a strongly regressive tax reform, affecting people in low income areas much more than in affluent ones. Increasing the fuel tax would have similar, although not quite so strongly regressive effects. Higher toll rates and ferry fares also affect different population segments unequally, but this variation has little to do with income and more to do with geography per se. In choosing among these three policy measures, there is a clear conflict between equity and efficiency, in that the most cost efficient measure for greenhouse gas abatement is also the most regressive, while the least efficient measure is least regressive.

The Norwegian vehicle purchase tax, on the other hand, is an effective instrument for long-term greenhouse gas abatement, without having obvious regressive effects. The same is true of the value added and purchase tax exemptions for battery electric vehicles. These tax incentives have allowed Norwegian consumers a large new assortment of relatively affordable vehicles – cars that are also quite economical in use, since battery electric vehicles are three to four times more energy efficient than conventional cars.

Affecting travel behaviour – three policy options

State-of-the-art travel demand models for Norway have been run with the aim of revealing the equity effects of selected policy measures for greenhouse gas (GHG) abatement. The Oslo Intercity Regional Model, comprising roughly 43 per cent of Norway's five million population, was used to study trips shorter than 100 km one way in southeastern Norway, i. e. in and around the capital city of Oslo. The NTM6 model for domestic, long distance travel was used to analyze trips longer than 70 km one way. Both of these are network models of travel demand, predicting trip frequency, destination choice, mode choice and route choice under user specified input assumptions.

The following three policy options have been studied:

1. Tripled toll rates and ferry fares everywhere in Norway
2. A NOK 0.20 (= € 0.024)[1] per vehicle km road charge or higher fuel tax
3. Abolishment of the commuter tax credit

In 2014, the commuter tax credit applied to all workers travelling more than 10 000 km per annum between their home and their job, with a standard rate of NOK 1.50 per km, regardless of travel mode. Given a 28 per cent marginal income tax rate, the

[1] As of 1 July 2014, NOK 1 = SEK 1.09 = US$ 0.162 = € 0.119.

credit gave rise to a tax cut of NOK 0.42 per km travelled in excess of the annual 10 000 km threshold, enough to cover just about half the average motorist's fuel bill.

The three measures result in comparable CO_2 abatement effects, on short as well as long distance trips (Figs. E.1 and E.2).

For short distance trips, the only mode of interest in our policy context is the private car. For other modes the changes in CO_2 emissions are negligible. The three policy measures considered all result in emissions reductions between 80 000 and 120 000 tonnes of CO_2 (tCO_2) per annum within the area covered by the Oslo intercity model. The relative reduction is 2.8 to 4.2 per cent compared to the reference scenario emissions of 2.89 million tonnes of CO_2 on short-haul trips.

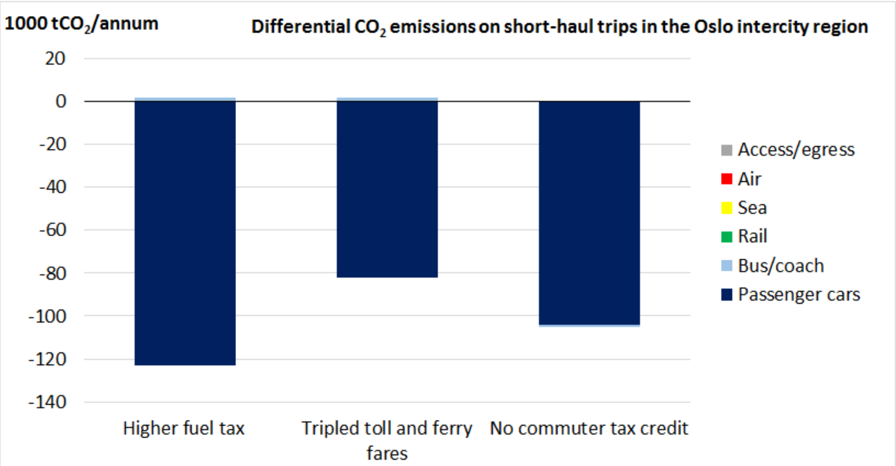

Fig. E.1. Policy impact on short-haul trips in Oslo intercity region. Absolute changes in annual CO_2 emissions, by policy measure and travel mode.

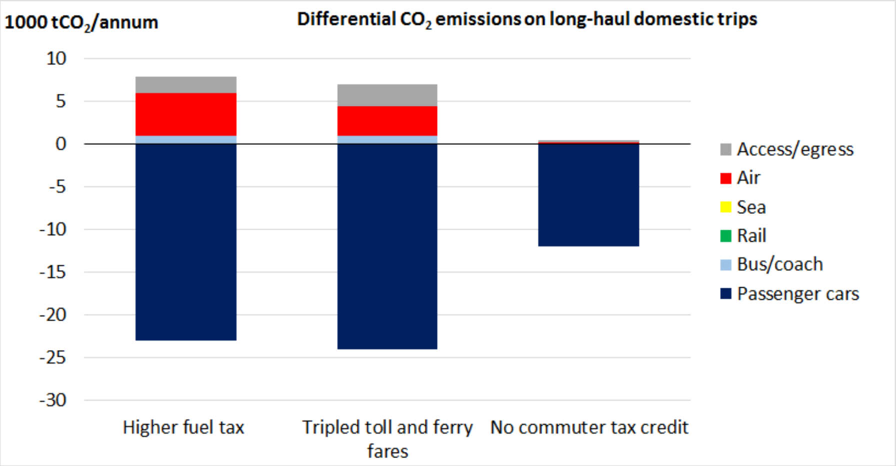

Fig. E.2. Policy impact on long-haul domestic trips. Absolute changes in annual CO_2 emissions, by policy measure and travel mode.

In the long distance travel market, the pattern is a bit more complex. Part of the emissions reductions from automobiles will be counteracted by increased emissions from air travellers, as the air mode becomes more competitive vis-à-vis private cars, also resulting in more airport access and egress trips. The net annual emissions

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reduction estimated is between 12 000 and 17 000 tCO_2 in all three cases, or between 0.5 and 0.7 per cent compared to the 2.55 million tonnes benchmark.

Each policy option inflicts costs on the travellers, in the form of higher cash expenditure, increased travel time and/or foregone trips. We calculate these losses by means of standard cost-benefit appraisal methods, more precisely by means of the well-known 'rule-of-the-half', which measures changes in aggregate consumer surplus as one moves up or down the demand curve.

To provide a full picture of the social welfare impact, changes in external costs and benefits must be taken into account. These externalities mean that private economic costs, as perceived by the individual household or person, may differ from the costs incurred by society at large.

The calculated cost efficiency of the respective three policy measures exhibits nothing like the relatively uniform pattern obtained for aggregate CO_2 emissions. While the tripled toll rate and ferry fares option inflicts large welfare costs on society, the fuel tax increase and the revocation of the commuter tax credit are shown to have negative net economic costs, when due account is taken of external effects, including the prescribed 20 per cent incremental value attributed to public funds (Fig. E.3).

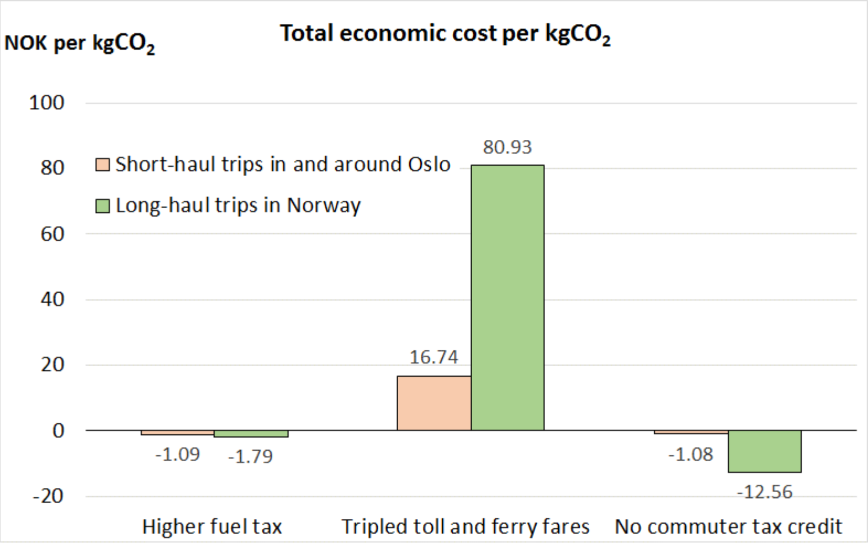

Fig. E.3. Calculated net economic cost per avoided kg CO_2 under three policy scenarios, according to the Oslo Intercity Regional Model for short-haul trips and the NTM6 model for long-haul trips.

These two measures are, in other words, socially profitable before GHG abatement benefits. According to the travel demand models, revoking the commuter tax credit results in a net social *gain* before GHG abatement benefits of € 100-120 per tonne CO_2 in the short-haul market around Oslo and € 1 200-1 500 in the long-haul domestic market. These estimates do not, however, take account of the possible productivity loss resulting from a contracted labour market, when the recruitment area of employers shrinks and workers no longer find it worthwhile to commute long distances for a better paid job.

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The NOK 0.20 per km increased fuel tax option results in very similar benefits in the short-haul market, but smaller benefits in the long distance market: € 180-220 per tonne CO_2.

The by far least efficient option is to raise the toll rates and ferry fares. Here, CO_2 abatement comes at a *cost* a € 1 700-2 000 and € 8 000-10 000 on short, resp. long distance trips. Note, however, that most Norwegian toll roads have nothing to do with congestion charging or marginal cost pricing. Their purpose being road financing, the toll rates are, with few exceptions, invariant across time and across all types of passenger cars.

In terms of equity rather than efficiency, the ranking of the three options is completely reversed.

As shown in Fig. E.4 for the commuter tax credit revocation, the extra tax burden inflicted on residents in the least affluent neighbourhoods, having less than NOK 175 000 per capita income in 2001, is roughly 4.5 times higher in absolute terms than in the top income communities.

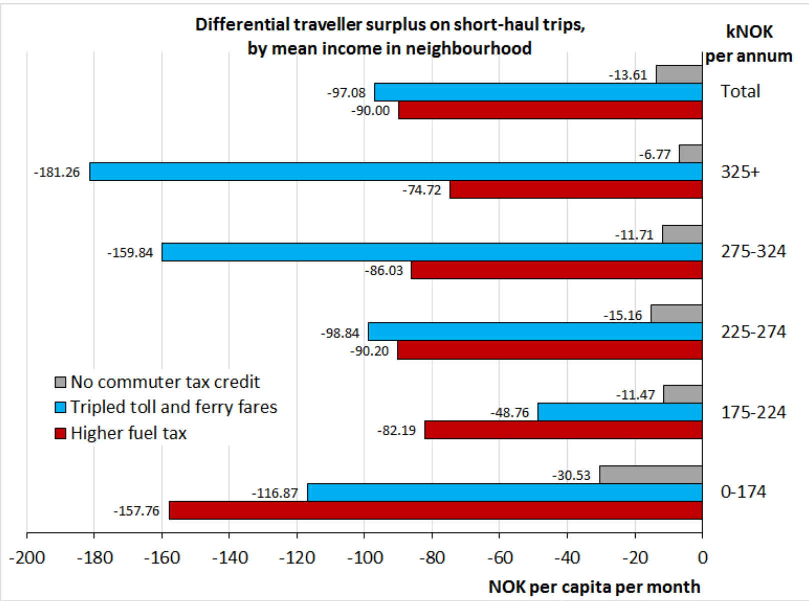

Fig. E.4. Calculated per capita changes in traveller surplus on short-haul trips in the Oslo intercity region, under three policy scenarios, by mean income in neighbourhood in 2001.

An increased fuel tax policy would be somewhat less regressive, with a ratio of roughly 2 between the bottom and top income neighbourhoods.

The tripled toll rate and ferry fares scenario has less distinct equity effects.

Traditionally, the distinction between progressive and regressive taxes is done, not on the basis of *absolute* changes in welfare, as shown in Fig. E.4, but from changes *relative* to the initial income level. A tax is progressive only if it withdraws a higher *percentage* of value from high income earners than from low income households. When we convert the absolute changes shown in Fig E.4 to percentages of mean income in each income bracket, the ratio of low to top income tax burden becomes 14.7 for the abolished commuter tax credit, 6.9 for the higher fuel tax option, and 2.1 for the tripled toll rates and ferry fares policy. All options are, according to this argument, regressive. Abolishing the commuter tax credit is the worst.

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It may seem surprising that the inhabitants of the low-income neighbourhoods have the highest fuel bill and the longest commute by car. But they do. This is no doubt a reflection of the well-known rent gradient phenomenon, by which housing rents and land values decrease gradually as one moves away from the city centre, as does also the wage and income levels. Inhabitants of low income areas incur long commutes, since most jobs are located in or near the city.

Fig. E.4 deals with short distance travel in and around Oslo. An analogous picture for long distance trips nationwide is given in Fig. E.5.

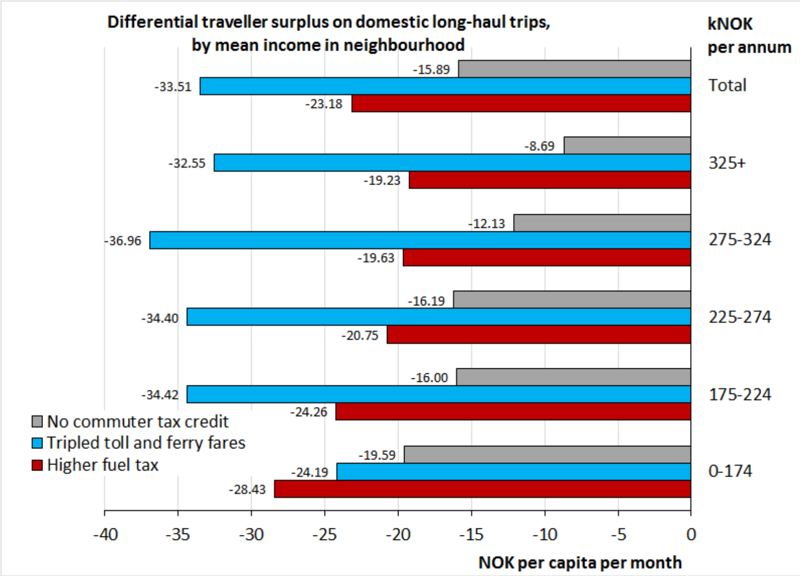

Fig. E.5. Calculated per capita changes in traveller surplus on long-haul domestic trips, under three policy scenarios, by mean income in neighbourhood in 2001.

Again the commuter tax credit revocation and the higher fuel tax policy are seen to be clearly regressive, even when judged by *absolute* changes in welfare. When correction is made for varying initial income, the *relative* burden ratio between low and high income areas comes out at 5.3 in the case of abolished commuter tax credit, at 3.5 in the case of more expensive fuel, and at 1.8 in the tripled toll rates and ferry fares case. All options are regressive, although less so than in the short-haul travel market.

Equity effects may be measured along a number of different dimensions other than income. In this study, effects have also been computed by age, gender, county of residence, household type, and household car ownership.

While the latter two dimensions are found to exhibit few interesting differences, certain clear patterns of inequality do emerge in terms of age, gender and geography.

Males are generally more seriously affected by increased fuel tax and reduced commuter tax credit. This is true in the short-haul as well as in the long-haul market (Figs. E.6 and E.7). Persons in the economically most active ages (25-59/66) are more seriously affected than the younger or older.

Geographic differences are shown in Figs. E.8 and E.9. The three CO_2 abatement policies will affect the population in different counties unequally. This is true in

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particular of the tripled toll and ferry fares scenario, since toll roads and ferry crossings are unevenly spread across the counties.

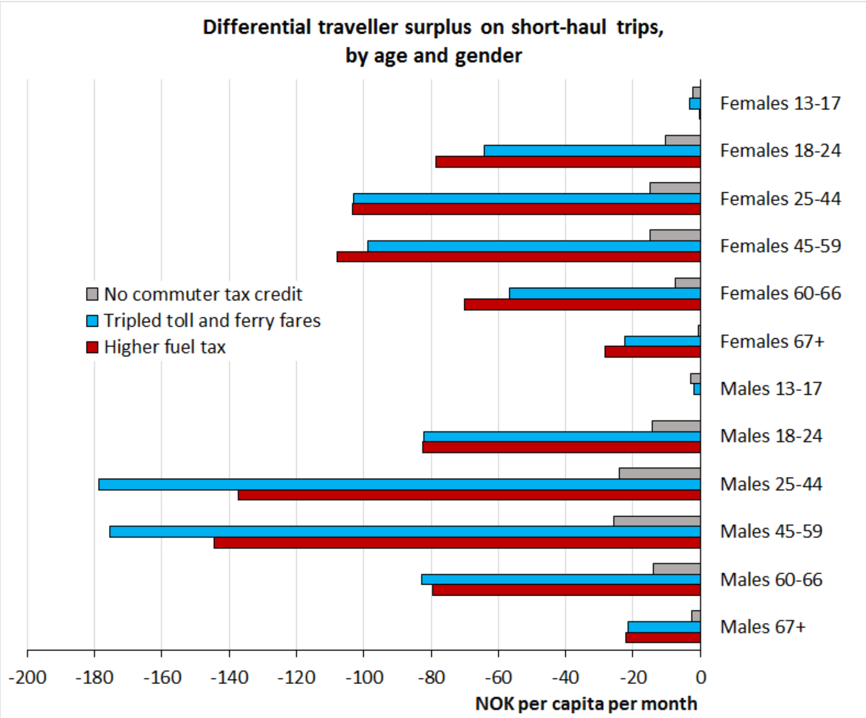

Fig. E.6. Calculated per capita changes in traveller surplus on short-haul trips in the Oslo intercity region, under three policy scenarios, by age and gender.

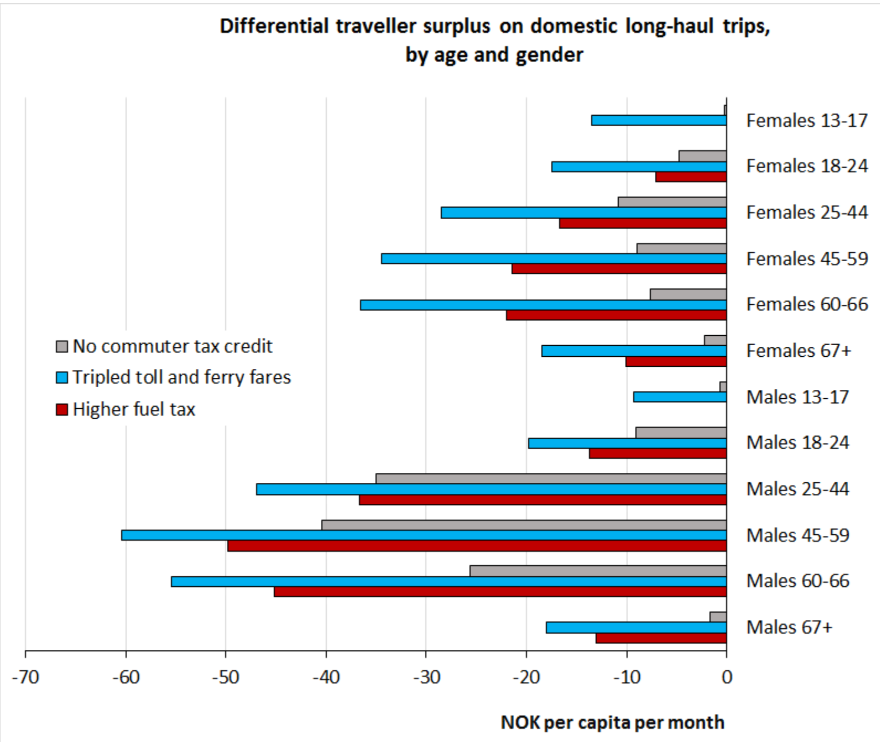

Fig. E.7. Calculated per capita changes in traveller surplus on long-haul domestic trips, under three policy scenarios, by age and gender.

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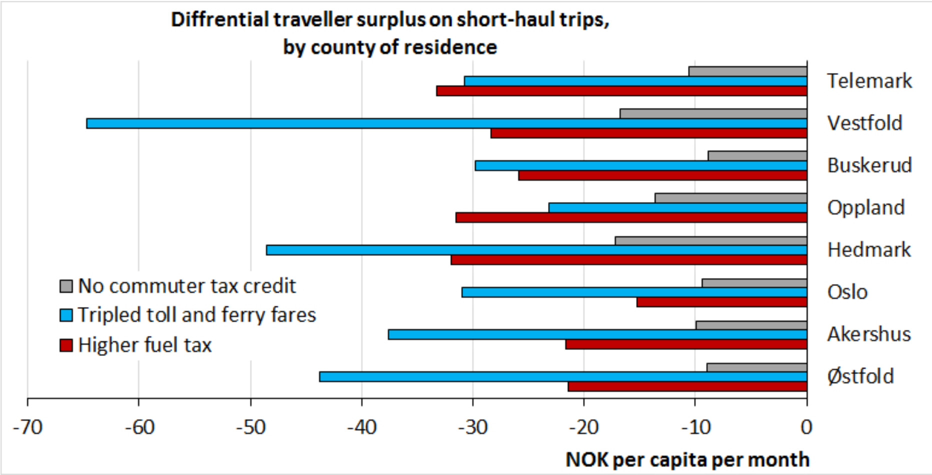

Fig. E.8. Calculated per capita changes in traveller surplus on short-haul trips in the Oslo intercity region, under three policy scenarios, by county of residence.

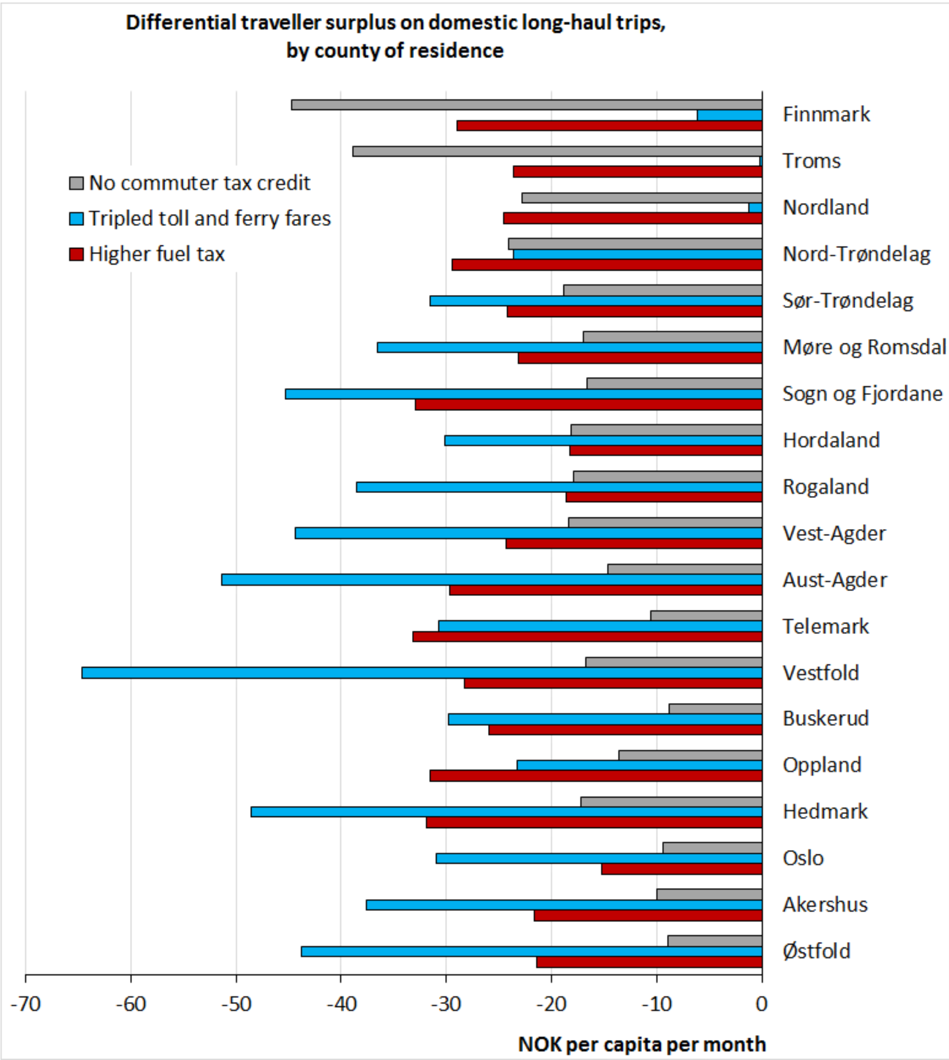

Fig. E.9. Calculated per capita changes in traveller surplus on long-haul domestic trips, under three policy scenarios, by county of residence.

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The small county of Vestfold, on the west side of the Oslo fjord, appears to be more severely hit by increased toll and ferry fares than any other county in south-eastern Norway. Residents of the three northernmost counties, on the other hand, are hardly affected at all by an increase in toll and ferry fares.

The fuel cost increase is seen to affect the highly urbanised county of Oslo least and the less densely populated counties most.

The commuter tax credit revocation also hits harder in the sparsely populated counties. In the northernmost county of Finnmark, the per capita traveller surplus loss on long-haul trips is nearly five times higher than in Oslo.

In summary, when policy makers are to choose among the above three options, the traditional contradiction between equity and efficiency is as present as ever. Abolishing the commuter tax credit would be the most profitable of the three policy options considered, but also the most regressive. The opposite – high cost and low regressivity – is true of tripled toll rates and ferry fares.

In principle, however, the final equity effect will depend crucially on how the public revenue from tax, toll or ferry fares is used. For some policy options, it might be possible to redistribute the increased public revenue in such a way that the final distributional effect would become progressive. At least this would be true of policies affecting travellers more or less in general, such as a fuel tax increase, where a reduced VAT on food would probably do the trick. It might be harder to design redistribution schemes to compensate the relatively few affected by an abolished commuter tax credit, or the relatively haphazard set of travellers hit by higher toll rates or ferry fares.

Affecting vehicle choice behaviour – six policy options

Automobiles are more heavily taxed in Norway than in almost any European country, with the possible exception of Denmark. Private cars meant for passenger transport are subject to purchase tax (‘engangsavgift’) upon their first registration.

The vehicle purchase tax for passenger cars is a sum of four independent components, calculated on the basis of curb weight, engine power, and type approval CO_2 and NO_X emissions, respectively. All but the small, linear NO_X component are distinctly convex curves, i. e. they bend upward and become gradually steeper.

For vehicles equipped with an internal combustion engine (ICE), the four purchase tax components taken together typically add 50 to 100 per cent on top of the import value – or even more for the largest and most powerful vehicles.

For plug-in hybrid vehicles (PHEVs), certain special rules apply. The electric motor is not considered part of the tax base for engine power. Also, so as to leave the standardized weight of the battery pack and the electric powertrain out of the tax calculation, the taxable curb weight of PHEVs is reduced, as of our base year 2014, by 15 per cent. In 2015, this deduction was raised to 26 per cent.

Since the CO_2 component is negative for cars emitting less than 105 g/km (as of 2014), light-weight PHEVs may come out with zero of near-zero purchase tax. The purchase tax cannot, however, become negative, as in the French feebate (bonus-malus) system.

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Battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs) are altogether exempt of purchase tax. Most of these vehicles would, however, be subject to zero purchase tax even if the exemption were lifted, as the engine power and NO_X components would be zero, while the negative CO_2 component would more than offset the positive weight component, except for the heaviest vehicle models.

BEVs and FCEVs are also exempt of value added tax (VAT). Other vehicles are subject to a 25 per cent VAT as calculated on the retail price exclusive of purchase tax.

By means of the BIG discrete choice model of automobile purchase we have simulated six different policy options bearing on the automobile purchase tax. These are

1. A 10 per cent increase in all purchase tax components.
2. A 10 per cent increase in the CO_2 component
3. A 10 per cent increase in the curb weight component
4. A 10 per cent increase in the engine power component
5. A revocation of the purchase tax exemption for BEVs
6. A revocation of the VAT and purchase tax exemptions for BEVs.

Results in terms of changes in the mean type approval CO_2 emission rate of new passenger cars are shown in Fig. E.10. The reference situation is the observed car sales and the tax regime in effect in 2014.

A uniformly 10 per cent higher purchase tax will reduce the mean type approval emission level by 2.4 gCO_2/km, or about 2.2 per cent. Increasing the CO_2 or weight component leads to a 1.1 gCO_2/km decrease in average emissions, while an increase in the power component will have very little effect on the CO_2 level.

Introducing a purchase tax for BEVs, identical to the one in effect for PHEVs, will lead to a moderate, 0.56 gCO_2/km increase in the average emission level of new cars.

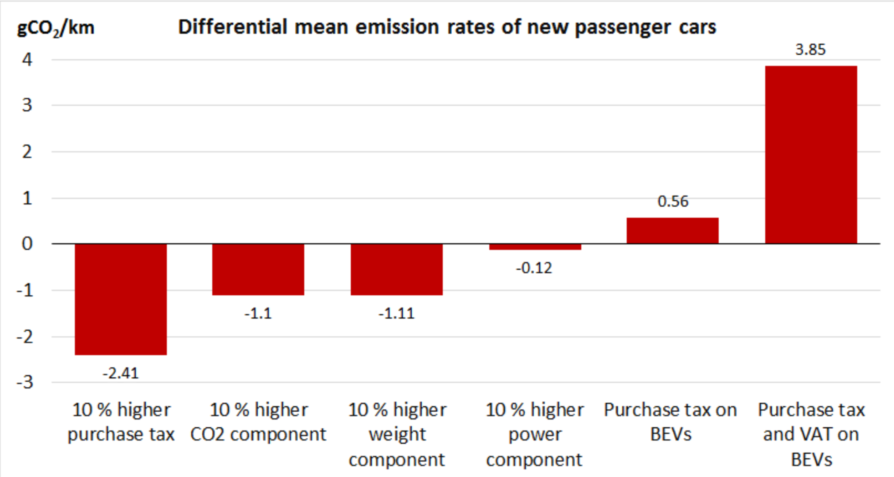

Fig. E.10. Absolute changes in mean type approval CO_2 emission rates of new passenger cars, compared to reference case, under six fiscal policy scenarios.

If, however, both the VAT and the purchase tax exemptions are lifted, the result will be an estimated 3.85 gCO_2/km higher level of emissions. The VAT effect alone can be calculated as 3.85 – 0.56 = 3.3 gCO_2/km.

The left-most and right-most policy options shown in Fig. E.10 differ by 6.3 gCO_2 per km. This difference corresponds to roughly 2.5-3 ml/km lesser fuel consumption

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by the type approval test. For a car running 200 000 km before scrapping, the total fuel savings are 7-800 litres over the vehicle's lifetime, when considering that the real-world, on-the-road fuel consumption of the 2014 cohort of cars is about 40 per cent higher than according to the EU type approval test. For the entire 2014 cohort of Norwegian registered cars, the lifetime CO_2 emissions difference is around 250 000 tonnes.

Public revenue impacts are shown in Fig. E.11. A 10 per cent overall increase in the purchase tax rates will generate an estimated NOK 742 million extra revenue for the public treasury, when behavioural changes on the part of car buyers are taken into account. VAT revenue goes slightly down, as more buyers choose VAT-exempt BEVs or FCEVs.

Increasing only the CO_2 component by 10 per cent will have comparatively small effects on the purchase tax revenue. The same is true of the engine power component. The weight component, however, is a potent one. Most of the revenue increase obtained by a uniform 10 per cent increase in all tax components is due to the weight factor.

Interestingly, the purchase tax exemption for BEVs reduces public revenue by only NOK 200 million – a small amount compared to large numbers featured in multiple media announcements on the 'cost' of the electric vehicle incentives. Note, however, that our point of reference is a tax regime in which low and zero emission vehicles already enjoy very much lower tax rates – especially if they are equipped with an electric motor – than do fuel guzzlers.

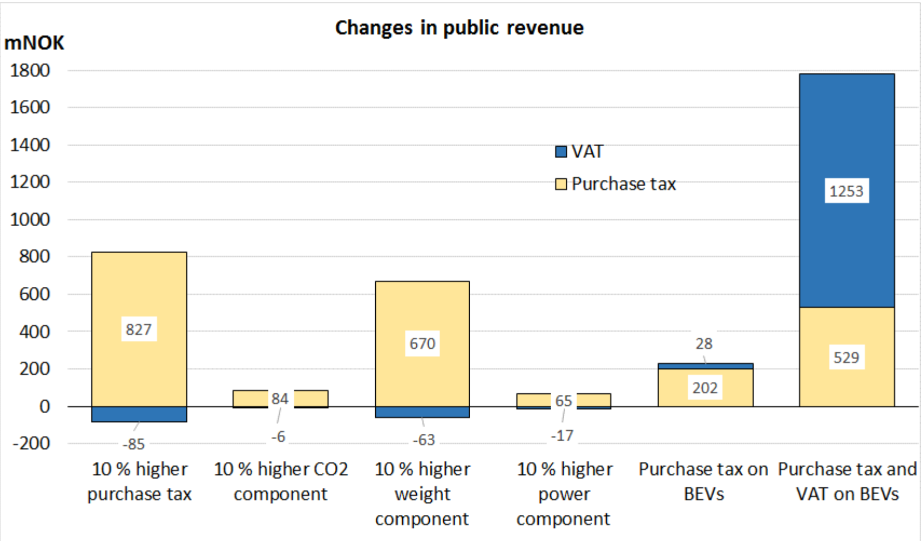

Fig. E.11. Differential annual VAT and purchase tax revenue under six fiscal policy scenarios.

A much larger increase in public revenue would take place if the VAT exemption were lifted as well. In such a case, some car buyers would shift from BEVs to ICE vehicles, whereby the purchase tax revenue would increase, not by NOK 200 million, but by more than NOK 500 million. An even larger revenue increase would come from the VAT system. The total public revenue increase is estimated at NOK 1.782 billion.

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In Figs. E.12 to E.15, we show, in somewhat greater detail, how the same two fiscal policy options would affect the market for cars in different fuel, weight, price and CO_2 emission categories. In all of these calculations, it has been assumed that tax increases are passed on 100 per cent to the buyers, translating into proportional retail price increases.

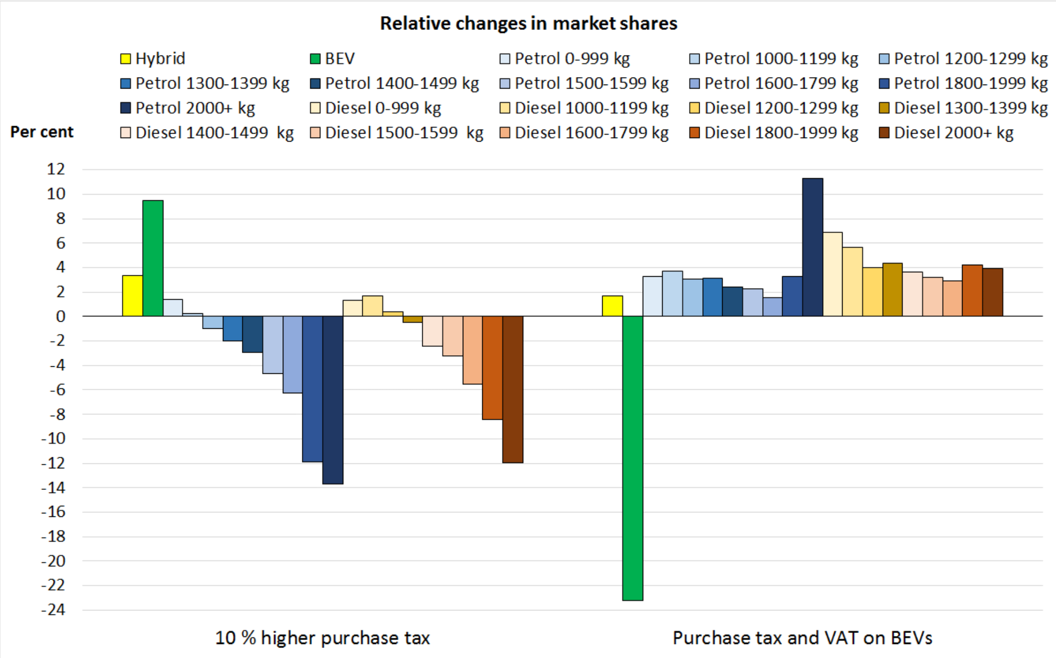

Fig. E.12. Relative changes in fuel and weight segments' market shares under two fiscal policy scenarios.

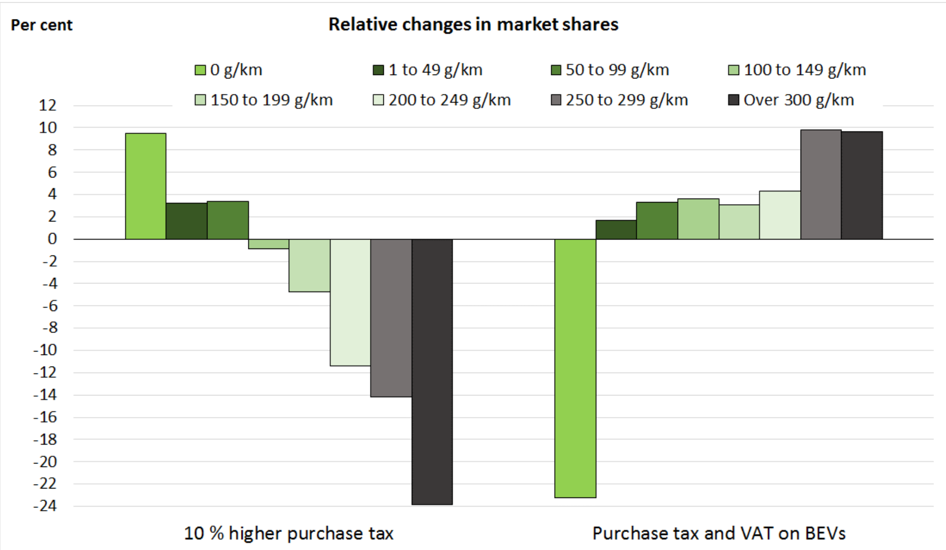

Fig. E.13. Relative changes in market shares under two fiscal policy scenarios, by type approval CO_2 emission interval.

A uniformly 10 per cent increased purchase tax would enhance the sales of hybrid and battery electric vehicles, and also of the smaller petrol and diesel driven cars (Fig. E.12). The largest ICE cars would, however, have their market drop by 12-14 per

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cent. Increasing sales would take place for cars with less than 100 gCO_2/km type approval emission rates, while the least climate friendly vehicles would sell about 24 per cent less (Fig. E.13). In terms of price segments, sales would increase only in the two most inexpensive categories, while the most expensive segments of models would have their sales reduced by about 10 per cent (Fig. E.14). The demand impact is more or less a mirror image of the respective changes in price (Fig. E.15), although in such a way that vehicle categories undergoing comparatively small price increases will have their market shares grow.

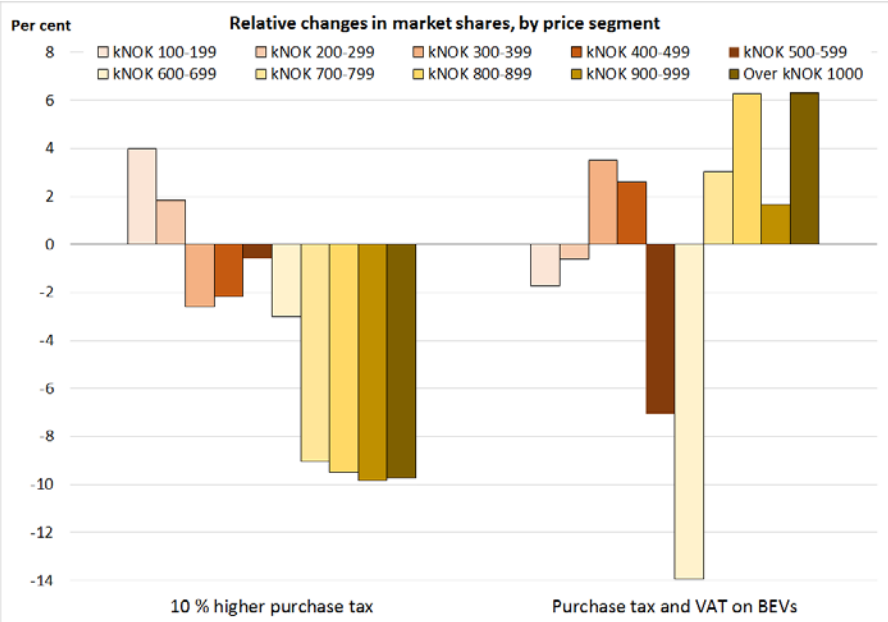

Fig. E.14. Relative changes in automobile market shares under two fiscal policy scenarios, by vehicle price bracket (kNOK 2010).

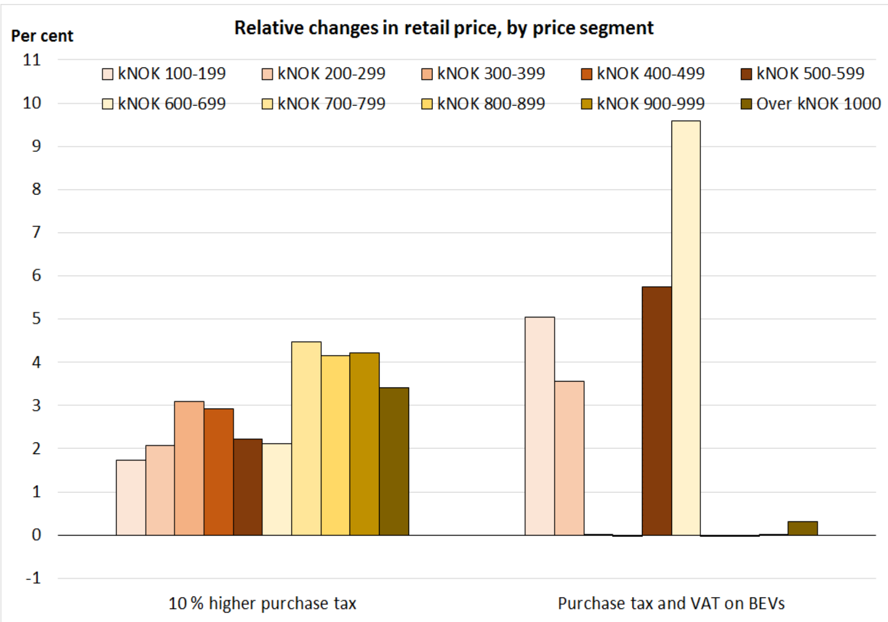

Fig. E.15. Relative changes in automobile prices under two fiscal policy scenarios, by vehicle price bracket (kNOK 2010).

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The revocation of the VAT and purchase tax exemptions for BEVs would, if implemented in 2014, have reduced the BEV sales by an estimated 23 per cent (Fig. E.12). All other vehicle classes would gain market shares. The demand for fuel guzzlers would go up by 10 per cent (Fig. E.13). Average prices would go up and aggregate sales would drop in the two most inexpensive price segments, where most BEVs are, and also in the upper-mid-price segment (kNOK 550-770 000 when adjusted for inflation until November 2015), where the Tesla models are (Figs. E.14 and E.15).

In terms of equity, the uniform 10 per cent increase in purchase tax rates is seen to affect the more expensive vehicle segments more strongly than the less costly. Relative price increases are, by and large, higher the higher is the initial price (Fig. E.15). The demand response is also stronger in the uppermost price segments. This is a clear sign that the vehicle purchase tax, and any proportional increase in it, is progressive. People buying the more expensive cars are, by and large, more affluent than those buying cheaper vehicles.

The revocation of the VAT and purchase tax exemptions for BEVs has more mixed distributional effects. The largest average price increase and the sharpest relative drop in demand will occur in the upper-mid-price segments, where Teslas hold a considerable market share. The second most important impact will take place within the two lowermost price segments. BEVs in this price range represent around 80 per cent of the BEVs sold in Norway in 2014. Hence, if and when VAT and purchase tax is reintroduced for BEVs, the numerically most dominant effect will be that consumers have a more limited choice in the low-price vehicle segments. A number of comparatively inexpensive cars will become generally less affordable. Although we cannot tell for sure who gain or lose by this, chances are that the less affluent car buyers will lose more, relatively to their income, than the wealthy.

The BEV tax exemptions are, in such a case, progressive rather than regressive, and their revocation could be a regressive fiscal measure. Here, there is no apparent contradiction between equity and GHG abatement, since the BEV exemptions are also quite effective in bringing down the mean CO_2 emission rate of new cars.

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