Institute of Transport Economics
Norwegian Centre for Transport Research

Summary

Decomposition of CO_2 emissions from passenger transport in Norway

TØI Report 1845/2021
Author: Andreas Kokkvoll Tveit
Oslo 2021 43 pages Norwegian

This report decomposes the CO_2 emissions from passenger transport in Norway between 2010 and 2018. A series of decomposition analyses demonstrate that population and mobility per capita (passenger kilometres divided by population) have strong emissions-increasing effects. In contrast, reduced carbon intensity and changes in transport modes' market shares helped reduce emissions. While the report's primary analyses assume that biofuels are carbon neutral, additional checks demonstrate that results are highly sensitive to that assumption. When assuming that biofuel emissions equal end-user emissions, I find that total passenger-transport emissions increase between 2010 and 2018, and the effect of carbon intensity is close to zero.

What affects CO_2 emissions from passenger transport?

This report assesses the effects of several drivers of CO_2 emissions from passenger transport in Norway between 2010 and 2018. Norway has commissioned a number of policies intended to reduce such emissions, including support schemes for electrification, measures to reduce overall mobility needs, and incentivizing public transport. Although my analyses do not constitute tests of each of these measures' effectiveness, I assess the relative impact of a number of structural factors, such as population, general mobility, and technology. Deepening our understanding of emissions drivers can help improve future emissions scenarios and inform policies.

I understand CO_2 emissions from passenger transport as a function of six factors. First, I include *population* in my model, because CO_2 emissions from passenger transport is likely dependent on the number of inhabitants in the geographical area under scrutiny (Norway). To capture the effects of changes in general mobility of the population, my second measure is *volume;* that is, the number of passenger kilometres (pkm) divided by population. Third, I expect that emissions are affected by what I label *structure* or *market share*, i.e. the distribution of mobility across transport modes: If emissions-free transport modes (walking, biking) are substituted for relatively emissions-intensive modes (i.e., cars running on diesel), total emissions will go down, everything else being equal,. Fourth, emissions are affected by changes in the ratio between vehicle kilometres (vkm) and pkm, i.e. *vehicle occupancy*. Fifth, my model should capture changes in *energy intensity*, here understood as energy consumed per vkm. Finally, total emissions are likely affected by *carbon intensity*, which I define as the amount of CO_2 emitted per energy consumed. The latter two components capture technological changes of interest, such as energy-saving technologies, and technologies that decouple emissions from energy use.

Hence, I understand CO_2 emissions from passenger transport as:

$$CO_2 \equiv \underbrace{population}_{(1)} * \underbrace{\frac{passenger\ km}{population}}_{(2)} * \underbrace{market\ share}_{(3)} * \underbrace{\frac{vehicle\ km}{passenger\ km}}_{(4)} * \underbrace{\frac{energy}{vehicle\ km}}_{(5)} * \underbrace{\frac{CO_2}{energy}}_{(6)}$$

Albeit a simplified version of the model I estimate, the equation above demonstrates logics underpinning my decomposition analyses.

Estimating the effects of factors 3-6 requires disaggregated data; that is, data on a number of transport modes. I collect data on emissions, energy use, pkm, and vkm for a number of such modes, including active transport (walking, biking), trams, trains, buses, passenger cars (disaggregated to a number of sub-categories such as diesel, battery, and hybrid cars), and planes.

Table S.1 shows my main results. Assuming that biofuels are carbon neutral, I find that emissions from passenger transport decrease by 5.19 percent between 2010 and 2018. Despite this overall decrease, two factors (components) have strong emissions-increasing effects: I find that population and volume (pkm/population) increase emissions by 8.37 and 11.07 percent, respectively. Hence, unless other factors had driven emissions down, total emissions would have increased considerably because of Norway's population growth and the fact that the average Norwegian travelled more in 2018 than in 2010. The strongest emissions-reducing factors are *structure* and *carbon intensity*. That structure reduces emissions implies that overall, Norwegians have switched from relatively emissions-intensive to lower-emissions transport modes. The effect found for carbon intensity implies that means of transport used in Norway in 2018 emitted less CO_2 per energy unit used than in 2010.

Table S.1: Decomposition analyses. All values are in percent, and show the component's effect on change in emissions from passenger transport in the given period of time. Biofuels are assumed climate neutral.

	2010-2015	2015-2018	2010-2018
Population	6,08	2,34	8,37
Volume (pkm/pop)	8,67	2,44	11,07
Structure	-4,08	-5,34	-9,13
Vkm/pkm	-1,37	-2,12	-3,49
Energy intensity (Energy/vkm)	-3,92	0,82	-3,32
Carbon intensity (CO_2/energy)	-1,01	-6,66	-7,10
Total	**3,73**	**-8,60**	**-5,19**

What lessons can be drawn from my findings? That population increases emissions is hardly surprising, but it is nonetheless noteworthy that population outweighs all emissions-reducing factors except from structure. That is even more true in the case of volume (the general mobility of the population), which has the strongest effect of all factors between 2010 and 2018. This means that the emissions-reducing effects of technological changes are outweighed by the fact that inhabitants of Norway travel more and more. Finally, my robustness checks reveal that my results are highly sensitive to assumptions regarding the emissions from biofuels. In my main results presented above, I assume that the emissions from biofuels equal zero. When I run analyses including CO_2 emissions from biofuels, overall emissions increase by more than 2 percent. Moreover, the emissions-reducing effect of carbon intensity is considerably weaker.