Transport and Carbon Emissions in the United States: The Long View

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Abstract

We trace US transport CO2 emissions by mode from 1960. We discuss changes in emissions into components related to overall population and economic growth, changes related to mode shift, changes in the ratio of fuel used to passenger or tonne-km of activity, and changes in the CO2 content of fuels. We also note where data permit how changes in vehicle utilization affected CO2 emissions. We comment on factors causing the changes in components of emissions. From an index decomposition we speculate on whether the factors associated with the increases in CO2 emissions since 1960 still could be important in the future, and what other factors could reduce emissions.

Since the first oil crises of 1973, there have been reductions in emissions per passenger-km or tonne-km of key modes, driven both by changes in technology and changes in the utilization and operation of vehicles. There was no significant change in the amount of CO2 per unit of fuel consumed. In the same time frame, overall transport activity rose and that of the most energy and carbon intensive modes, cars, trucks, and aircraft, rose the most quickly. Shifts to these modes offset some of the savings in fuel and carbon from improvements in each mode; indeed shifts to trucking almost offset the impacts of reduced CO2 emissions per tonne-km of each mode in freight. Indeed, an important surprise from this analysis is the continued rise in the importance of freight as a source of CO2 emissions compared to travel.

With population and per capita income still growing, both travel and freight activity are expected to continue to grow. Future reductions in emission from transport means some combination of deeper cuts in carbon intensity of individual modes, some shifts of traffic back to less carbon intensive modes for travel or freight, or simply slower growth in total travel or freight activity. The latter two changes would break with past trends, but if demographic and other factors such as transport-oriented development slow the growth in transport demand, while transport reforms lead to changes in the variable costs of using streets and highways, landing slots, etc change, transport activity itself may grow much more slowly in the future.

Data Sources

The data come from Bureau of Transport Statistics and various other FHWA and DOT sources, as well as the Oak Ridge Transport Energy Data Book. The division of light truck energy use in to travel and freight follows the Vehicle Inventory and Utilization Surveys and was done by the authors

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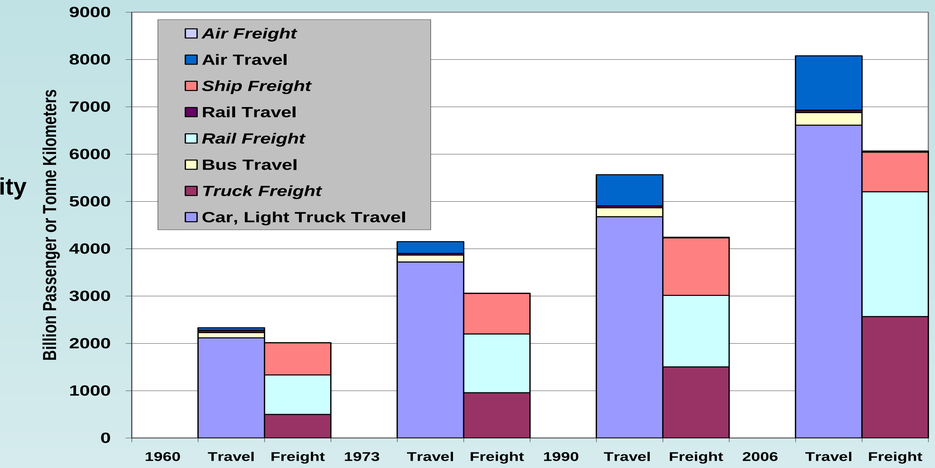
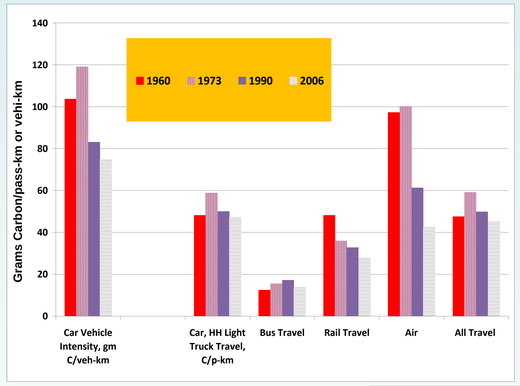
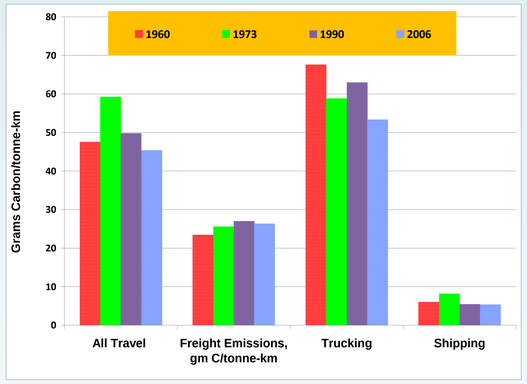
Bottom-Up analysis of travel an freight activity, CO2 intensities, and emissions by mode 1960-2006.

Figure 1. Travel and freight activity by mode



Carbon Intensities
(Emissions/activity)





CO2 by Mode

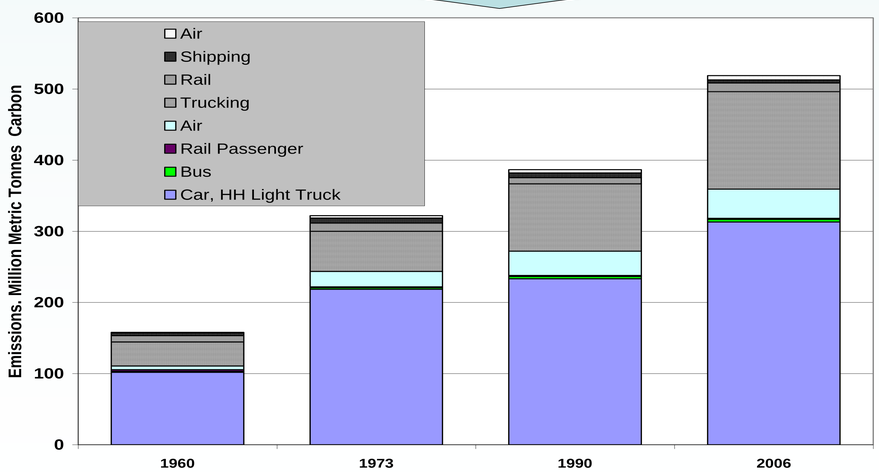
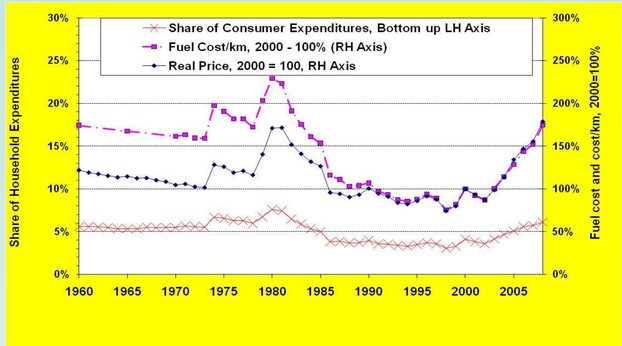


Figure 3. Carbon emissions from Travel and Freight, million metric tons of carbon.

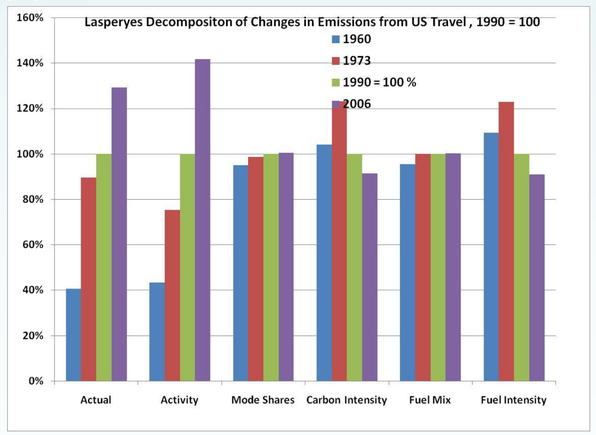
Drivers of Change

Higher oil prices and CAFÉ standards on light duty vehicles were the two major drivers of change, the former affecting both vehicle use and efficiency, the latter acting on light-duty vehicles only. Interestingly, real fuel prices attained their highs in the 1980-82 period, as did real vehicle use costs. Even in 2008, however vehicle use costs in cents per vehicle kilometer for driving remained below their 1980-82 values because of improved fuel economy while costs per tonne-km for shipping or per passenger-km for air travel were above their previous peaks.



Decomposition of Changes over Time

We used Laspeyres and Log- Mean Weighted Divisia Indices to decompose changes in emissions from 1960 to 2006. The activity term contributed the largest change (increase), while the intensities terms for both travel (cars and even more, air travel), and freight (trucking and rail) cause the most important changes. Mode shifts had a small impact on travel, but a large impact on freight emissions. The graphs below show change caused by each mode acting alone, holding the other factors constant.



Conclusions. Greater transport activity, bolstered strongly by mode shift to trucking raised CO2 emissions from transport more than lower intensities reduced emissions. Fuel switching had almost no impact.. Without a true low-carbon energy source, a combination of strong fuel economy improvements and shifts away from light study vehicles, air travel and to some extent trucking will be required if the US is to reduce direct CO2 emissions from transport in the future.