Estimating the Rebound Effect of the US Road Freight Transport

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Background

- The United States (US) road freight sector **has continued to expand over the past decades.**
- Road freight activities have resulted in **increased energy consumption and greenhouse gases (GHG)** emissions as byproduct.
- Policies i.e., the **Energy Independence and Security Act in 2007** and the **Clean Air Act in 2012** are implemented.
- However, the effects of **the efforts to lower energy consumption and GHG emissions are unclear** due to the Rebound Effect.
- Improvement in technology and efficiency for energy service may lowers its effective price, which will attract greater use, known as **the Rebound Effect (RE)** (*Figure 1*).
- US road freight sector has generally overlooked the **asymmetric nature of carriers' responses to price changes**, which could lead to a biased estimate of the rebound effect.

Objectives

- To identify the rebound effect for US road freight transport given government policies that aimed at reducing energy consumption and GHGs emissions.
- To complement the related literature by considering the asymmetric energy price responses in the estimate of the rebound effects.

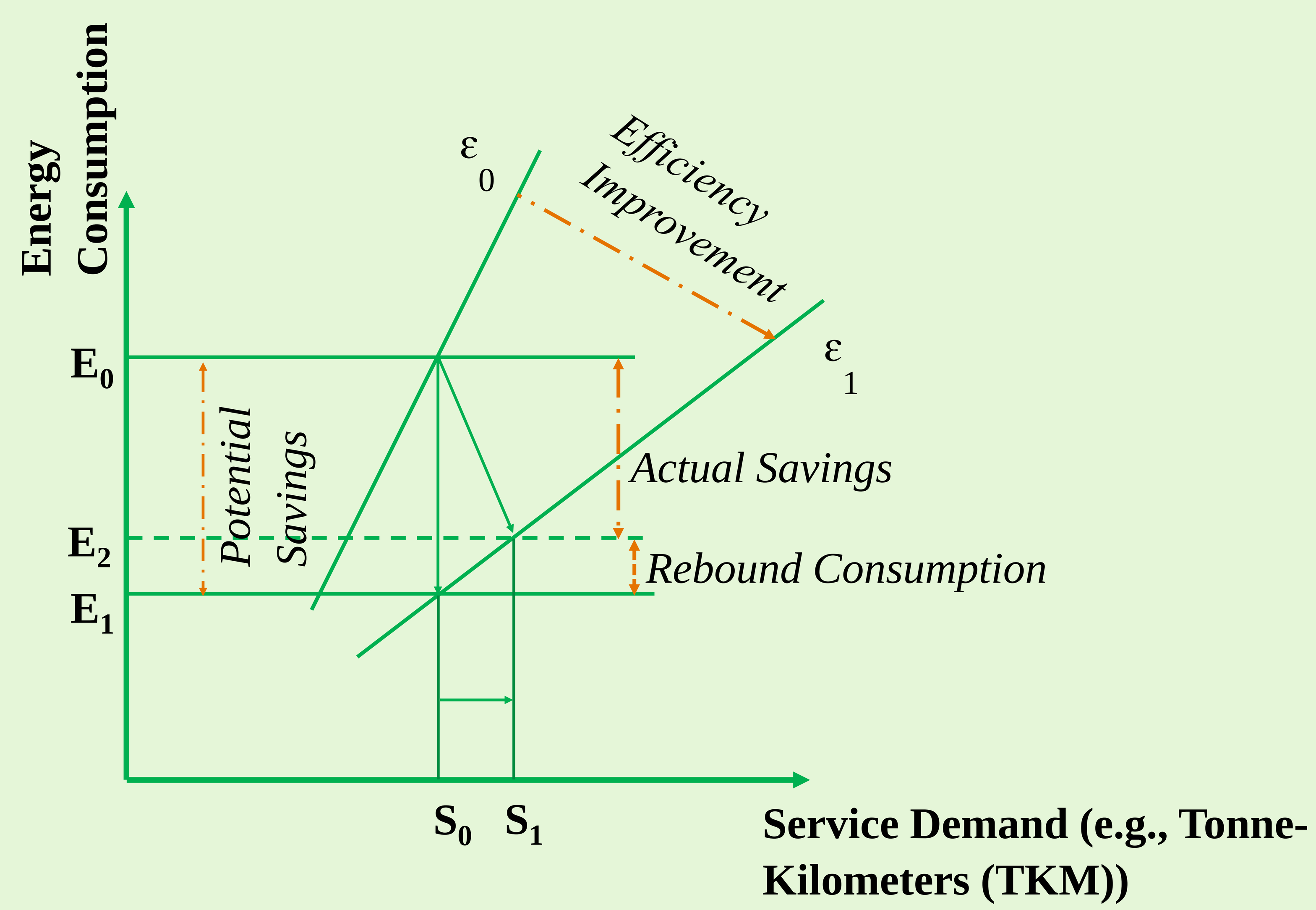
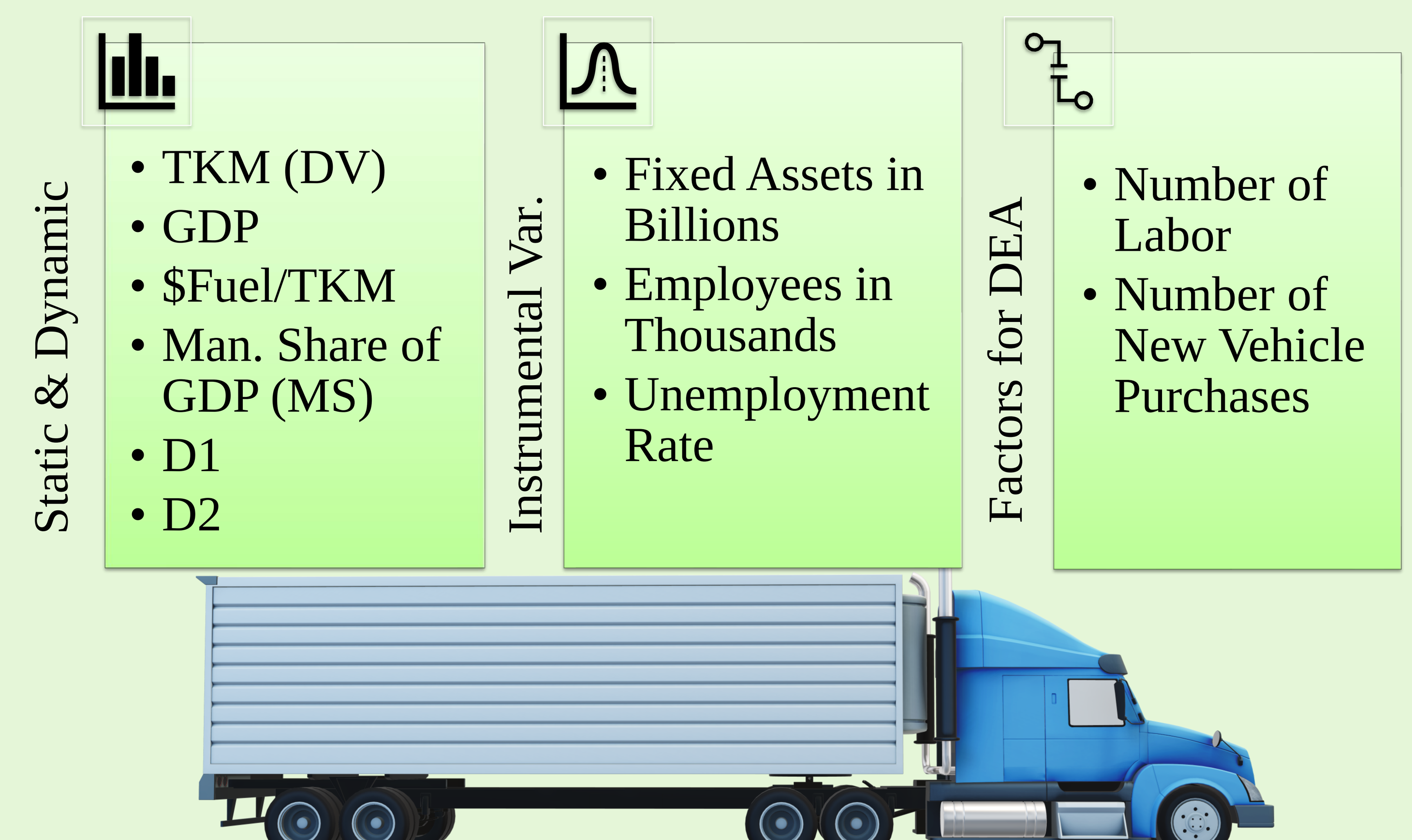


Figure 1: Graphical Representation of the Rebound Effect

Method and Data

- **Eight fuel cost models** are used considering their static and dynamic versions with different combinations of some selected variables.
- Two-stage least squares (**2SLS**) log-log regressions with heteroskedastic and autocorrelation consistent (HAC) robust corrections are adopted.
- **Asymmetric energy price responses** (Prec: Price Recovery, Pdec: Price Decrease) are decomposed following Gately & Huntington (2002).
- Robust **Data envelopment analysis (DEA)** is applied to determine the annual rebound effect in the US road freight sector.
- The **1980-2016 time series data** used for analysis are generated from a variety of public domain resources.
- D1 dummy variable captures the potential influence of **the Clean Air Act 2012**, and D2 accounts for the impact of **ultra-low sulfur diesel (ULSD)** imposition in freight transport since 2006.
- **Manufacturing share of GDP** is considered to account for the potential decoupling of freight from GDP.



Result and Discussion

- *Table 1* shows the avg. rebound effect for the **static models is 8.8%, whereas for dynamic models is 6.6%.**
- A 1% increase in fuel efficiency decreases fuel consumption by 0.88% and 0.66% in short-run and long-run, respectively.
- The asymmetric rebound effects: **price recovery = 17% and 27.5% decrease**, **price decrease = 8% and 2.9% increase** in short-run and long-run.
- The overall results also suggest that **reliance upon only static models could lead to larger price elasticities.**

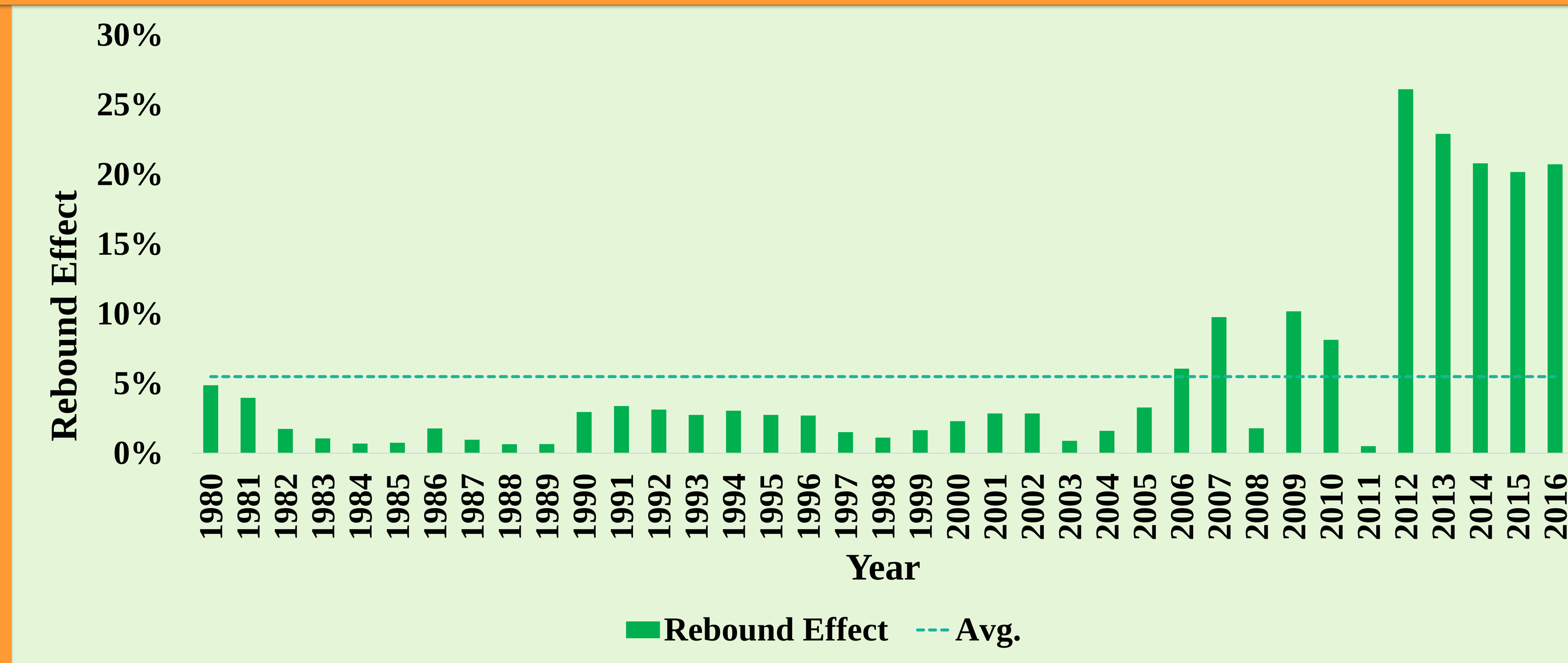


Figure 2: Annual Rebound Effect of the US Road Freight Transport from 1980 to 2016

- The estimated annual rebound effect is presented in *Figure 2*. It shows **high variability with a boost in the later years (21% - 26% range).**
- It **could be potentially related to the Clean Air Act 2012** that requires higher fuel efficiency vehicles for freight.
- The variability in the rebound effect over time could also be linked to several factors such as **commodity types, shipping distance, and modal share**.

TABLE 1 Overall Estimated Results

Models	ln (GDP)	ln ($Fuel/ TKM)	ln (Lag Term)	ln (MS)	D_1	D_2	Avg. RE	Avg. RE (Prec)	Avg. RE (Pdec)
Static 1	0.52***	-0.14***	--	--	--	--			
Static 2	0.58***	-0.06***	--	--	-0.23***	--			
Static 3	0.78***	-0.12***	--	0.37***	-0.22***	--	**8.8%**	**7.30%** (17% decrease)	**9.5%** (8% increase)
Static 4	0.75***	-0.08**	--	0.31***	-0.22***	-0.03			
Dyna. 1	0.12	-0.06	0.74***	--	--	--			
Dyna. 2	0.43***	-0.05***	0.27*	--	-0.18***	--			
Dyna. 3	0.62***	-0.08***	0.22	0.31***	-0.18***	--	**6.6%**	**5%** (27.5% decrease)	**7.10%** (2.9% increase)
Dyna. 4	0.65***	-0.05**	0.18**	0.28***	-0.19***	-0.04			

Conclusion

- Our estimated rebound effects imply that a proportion of the potential energy and carbon savings from the improved efficiency in **US road freight has been partially offset by increased freight activity (more TKM)**.
- Rebound effects from asymmetric price responses suggest that **freight carriers use less energy with a price increase, and vice-versa.**
- **Rebound effect proves to be a deterrent to the energy efficiency policies' goals**.
- **A systematic cap-and-trade scheme, a sector-specific energy or environmental tax, e.g., carbon tax,** could serve as an alternative strategy in mitigating the rebound effect.

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