Unintended Consequences Of Nested State & Federal Regulations: The Case of the Pavley Greenhouse-Gas-per-Mile Limits

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14 States Pledged to Adopt "Pavley" Limits on Greenhouse Gases (GHGs) Per Mile

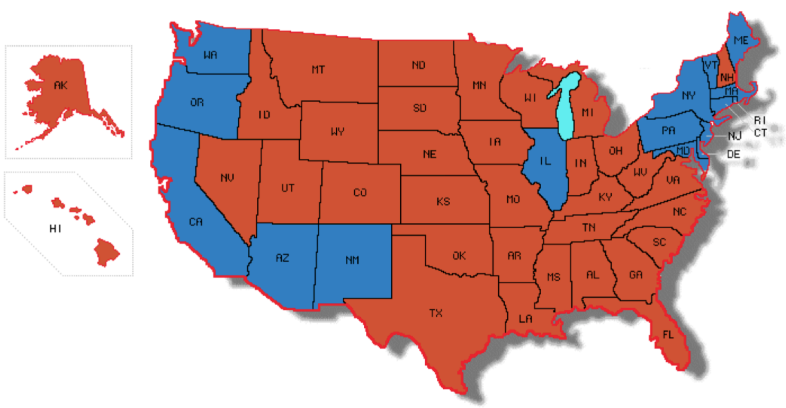
These are equivalent to limits on gallons per mile

(GHG/mile = GHG/gallon * gallons/mile)

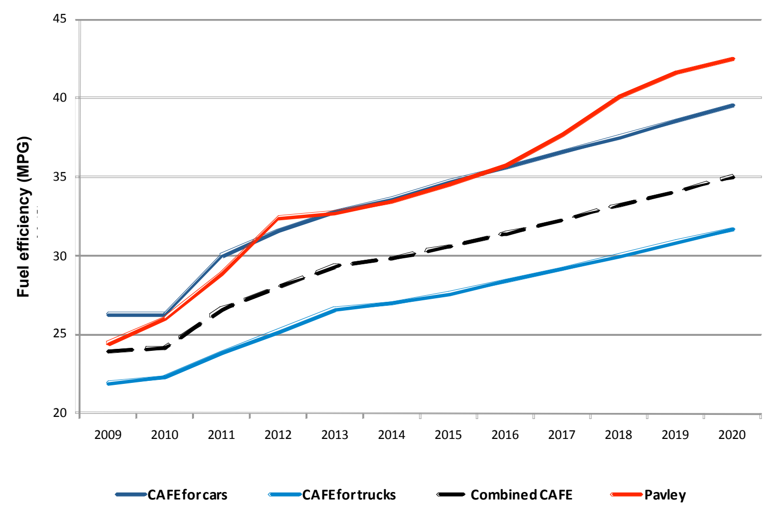
or floors on miles per gallon

Effectively, these states were committing to their own, stronger, fuel-economy standards

14 States (Shown in Blue) Planned to Adopt the Rule



CAFE vs. Pavley Standards



The 14 states claimed this would significantly reduce GHG emissions and gasoline consumption.

e.g., California estimated the Pavley limits would achieve reductions of 32 million metric tons of GHGs (CO_2 equivalents) in 2020 -- 22 percent of required reductions under AB 32

But earlier studies ignored potential for leakage. Two channels:

- from adopting to non-adopting states in new car market
- from new cars to used cars

On the other hand, the 14-state initiative could stimulate cost-reducing technological progress that spills over to non-adopting states, thus offsetting the leakage.

This paper considers these and other channels in assessing Pavley's impact on emissions and gasoline consumption, and its economic cost

The New-Car Market Leakage Reflects "Nested Regulations"

Not leakage from manufacturer exodus

Not leakage from consumers changing the location of car demands

Instead, it's leakage from interaction with the federal CAFE standard

example:

-- adopting state --	-- other state --
substitute S for L	substitute L for S

Other cases of potential leakage from nested regulations:

- Cap and trade: tighter CA cap in presence of federal cap
- Renewable fuel standards: tighter state standards in presence of federal standard
- CA tax/subsidy program: fines/rewards based on GHG/mile

The Model

cars distinguished by **class** (car vs. truck), **size** (large and small), **age** (new -> 18 years old), **manufacturer** (7 categories), and **region of registration** (adopting state and non-adopting state)

supply side:

new car market: producers engage in Bertrand competition

-- set car prices and fuel-economy levels to maximize profits

used (or retained) car market: $S_{v,t+1} = S_{v,t} - scrap_{v,t}$

demand side:

one aggregate automobile demand function calibrated to mimic US aggregate automobile choices

equilibrium:

supply = demand for all new and used cars

simple dynamics: sequence of static equilibria (no intertemporal optimizing)

Vehicle Dimensions

Types	Ages	Manufacturers	
small car	new	Ford	*Initially constrained by Fedl. CAFE stnds.*
large car	1 year old	GM	
small truck	2 years old	Chrysler	
large truck	.	Toyota	*Not initially constrained by Fedl. CAFE stnds.*
	.	Honda	
	.	Other Asian	
	18 years old	European	

New Vehicle Supply

Producers choose prices and fuel-economy levels to maximize profit:

$$\max_{\{p_{rj}, e_{rj}, z_j\}} \sum_j \left(\sum_r \left(\left(p_{rj} - c_j(e_{rj}, z_j) \right) \cdot q_{rj}(\bar{p}_r, \bar{e}_r) \right) - h_j(z_j) \right)$$

$r \in \{1,2\}$ (adopting, non-adopting regions)
$j \in \{1,2,3,4\}$ (small car, large car, small truck, large truck)
p, *c*, *q*, and *e* are price, cost, quantity, and fuel economy, respectively
z is investment in innovation common across regions

Underlying choices that determine fuel-economy improvements:
static: choice of model features (horsepower, transmission type, etc.)
dynamic: level of R&D toward invention of fuel-saving technologies

New Vehicle Supply (continued)

Profits are maximized subject to the CAFE requirements

$$\frac{\sum_r \sum_{j \in \{1,2\}} q_{rj}}{\sum_r \sum_{j \in \{1,2\}} \left(\frac{1}{e_{rj}} q_{rj} \right)} \geq \bar{e}_C \qquad \frac{\sum_r \sum_{j \in \{3,4\}} q_{rj}}{\sum_r \sum_{j \in \{3,4\}} \left(\frac{1}{e_{rj}} q_{rj} \right)} \geq \bar{e}_T$$

and the Pavley rules

$$\frac{\sum_j q_{1j}}{\sum_j \left(\frac{1}{e_{1j}} q_{1j} \right)} \geq \bar{e}_P$$

Data and Policy Experiments

- Aggregates calibrated to 2009 projections, current gas price
- Average own and cross price elasticities for individual models derived from Kleit (2004)
- Cost of fuel economy technologies from National Research Council (2002)

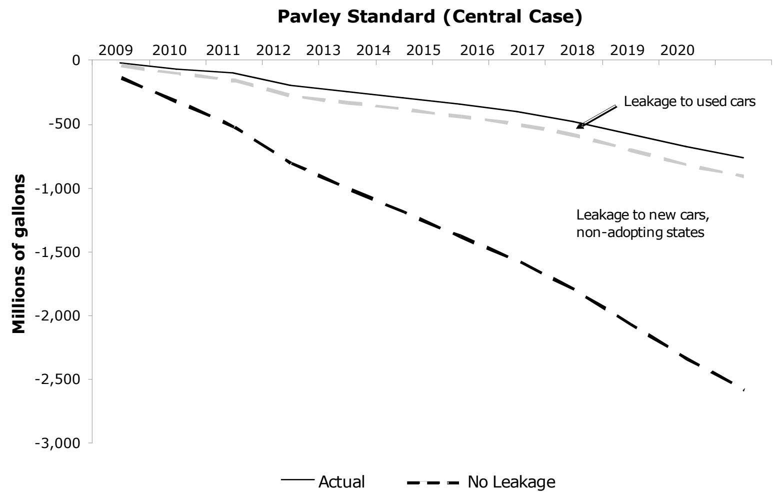
- Central policy experiment simulates projected path of CAFE and Pavley rules
- Focus on sensitivity of results to:
  - Technological spillovers
  - Size of the adopting region

Impacts of Pavley Requirements on Gasoline Consumption in Year 1

	New Cars		Used Cars	Total
	Adopting States	*Other States*		
Baseline *(millions of gallons)*	1,484	2,227	33,526	37,237
Pavley Standards (Central Case)				
Change	-126.9 *-8.55%*	90.5 *4.07%*	10.9 *0.03%*	-25.5 *-0.07%*
Leakage		*71.31%*	*8.60%*	*79.91%*

Gasoline consumption in millions of gallons.

Impacts on Gasoline Consumption Over Time



Decomposition of Sources of Changes in Gasoline Consumption (Year 1)

Pavley Standards (Central Case)	***New Cars*** *Adopting States*	*Other States*	***Used Cars***	***Total***
Overall gasoline use change	-126.9	90.5	10.9	**-25.5**
Change due to:				
change in fleet composition	-13.7	1.9	0.5	**-11.3**
change in individual models' mpg	-85.9	76.7	0.0	**-9.2**
change in total fleet size	-27.3	12.0	10.4	**-5.0**

Gasoline consumption in millions of gallons.

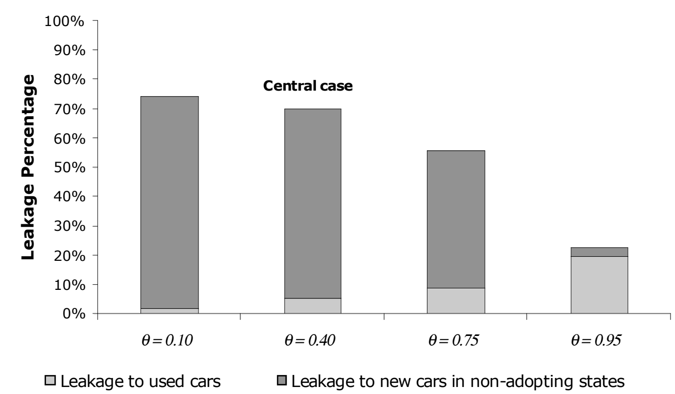
Varying the Importance of Spillovers

Vary the Extent to Which New Technologies Are:

a) Static - altering the mix of components (involving existing technologies)
b) Dynamic - investing in research toward invention of new fuel saving technologies

Static	Leakage via technology: Cars outside receive worse-than-baseline improvements in fuel economy
Dynamic	Spillovers can occur: Cars in the outside region improve relative to baseline

Varying the Importance of Spillovers

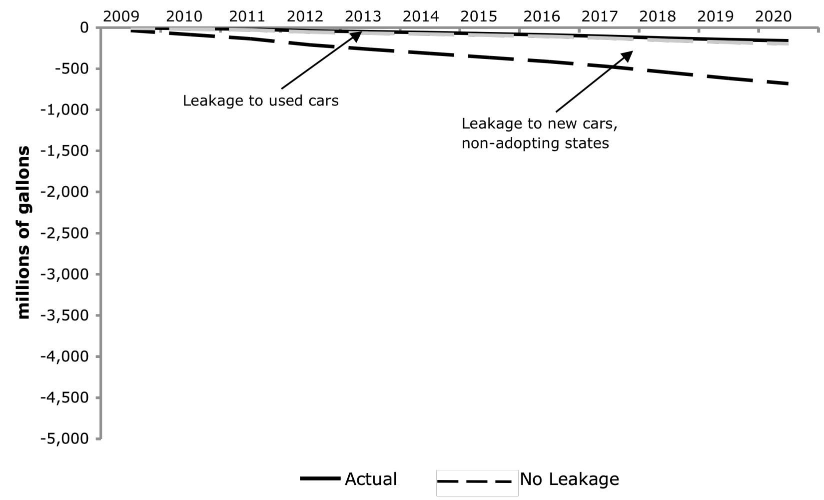


θ is the fraction of fuel-economy improvement (at the margin) coming from technological advances that can spill over

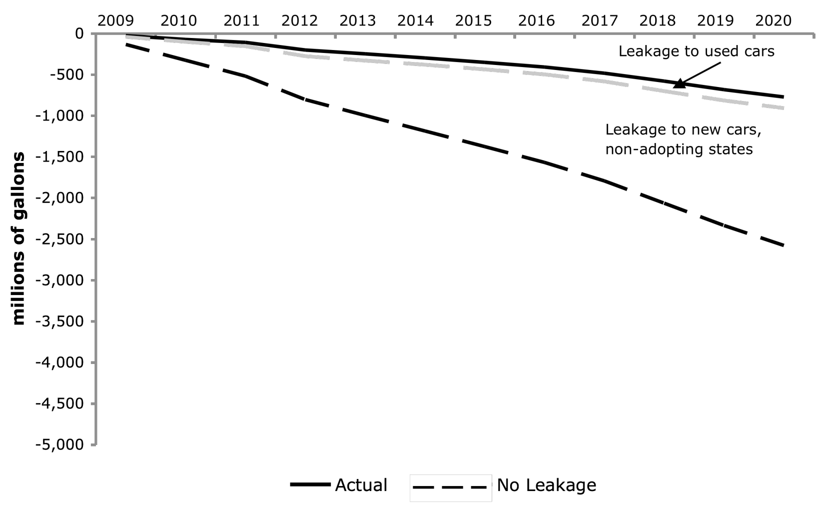
Implications of Breadth of the Pavley Initiative

- Broader adoption reduces the pool of new cars in the outside region, eventually limiting leakage
- As new car leakage falls, pressures increase for distortion in the used car market

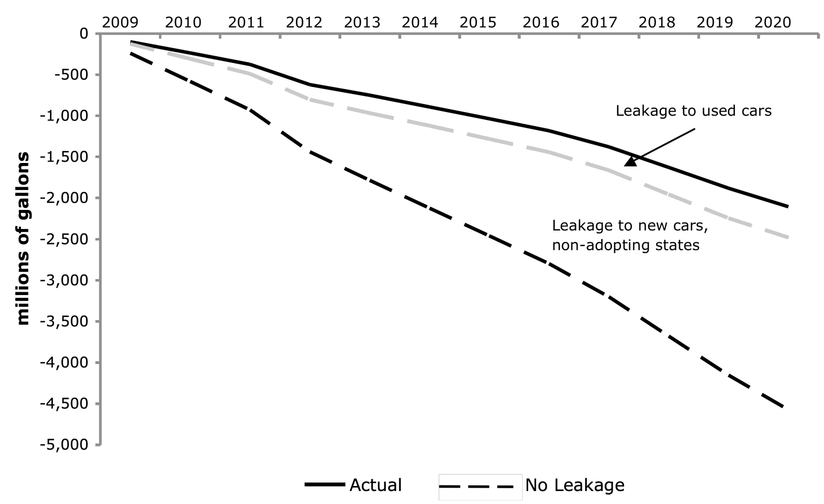
California Only (11%)



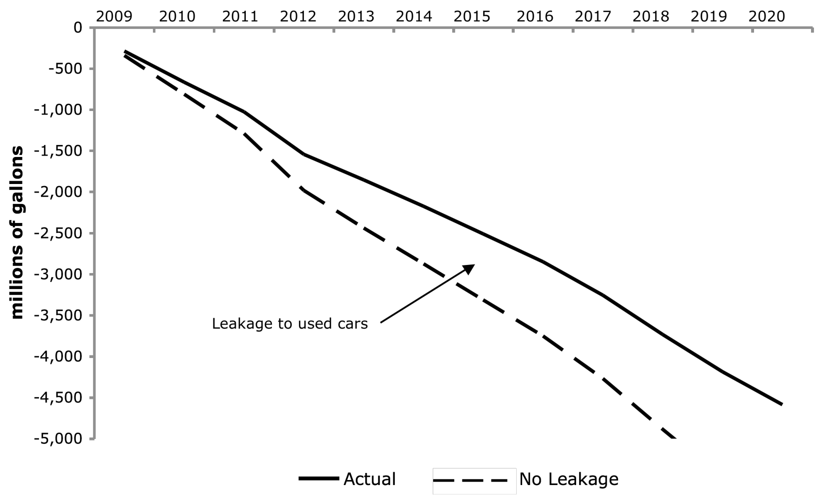
Central Case (42%)



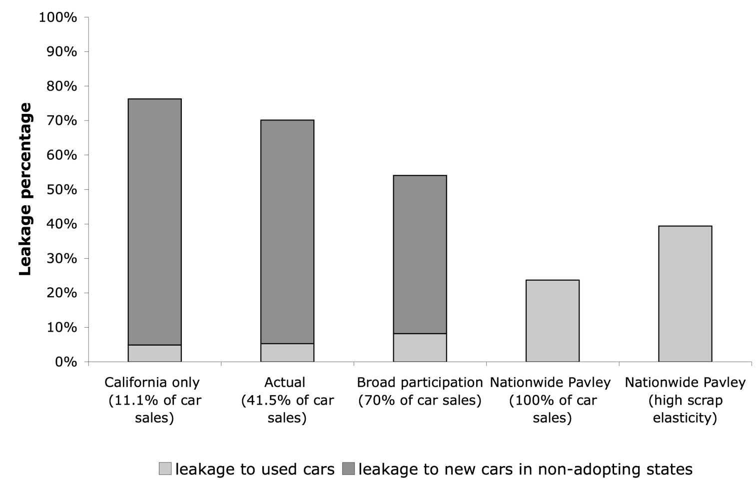
Wider Adoption (70%)



All States (100%)



Total Leakage under Different Adopting Region Sizes



Cost and Cost per Gallon under Different Adopting Regions Sizes And under an Equivalent Increment to Federal CAFE Standard

	Cost			*Gallons Saved*			*Cost per Gallon Saved*
Pavley Regulation: Percent of National Market:	**Adopting States**	**Other States**	**Total**	**Adopting States**	**Other States**	**Total**	**(All States)**
11.1 Percent (California Only)	4.8	3.4	8.2	-2.6	1.8	-0.8	9.67
41.5 Percent (Actual Pavley)	27.8	3.5	31.3	-9.6	5.5	-4.0	7.77
70 Percent	61.5	-4.9	56.6	-17.4	5.8	-11.7	4.86
100 Percent	81.9		81.9	-27.4		-27.4	2.99
Equivalent Federal CAFE Standard:							
Equivalent Gasoline Savings to Actual Pavley	7.2	10.8	18.1	-1.6	-2.4	-4.0	4.52
Equivalent Gasoline Savings to Pavley with 100% Adoption	56.8	85.3	142.1	-11.0	-16.5	-27.4	5.18
CAFE Standard with Pavley Increment	47.1	70.6	117.6	-7.9	-11.9	-19.8	5.95

[1] Costs in billions of discounted dollars; gallons in billions of gallons saved over the period 2009-2020.

Conclusions and Policy Implications

Nested fuel economy regulation creates substantial leakage

Complementary switching of small and large vehicles in new car market produces approximately 65% leakage

Importance of used car leakage for nationwide policies

Shifts in the used car market (scale and composition effects) create 24-39% leakage

Continued separation of car and truck fleets limits efficiency

Was the Pavley effort misguided?

Risk of leakage if implemented in a small region vs. the potential to accelerate federal policy

Broader Perspectives

Similar issues of nested regulation occur with the:

- overlap of California Low Carbon Fuel Standard and proposed Federal Renewable Fuels Standard
- overlap of state-level cap-and-trade policies and potential Federal cap-and-trade system
- implementation of a “feebate” system for fuel economy in California

These problems are symptoms of the success of state or regional environmental efforts.

They underscore the importance of efforts to rationalize state and federal environmental initiatives