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ARTICLE

Don't TREAD on Anyone? The Political Economy and Effectiveness of Tire Pressure Monitoring Systems

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Abstract

In response to tire failures and vehicle rollover accidents, most notably those experienced by Ford Explorers with Firestone Tires, the 106th Congress and President Clinton enacted the Transportation Recall Enhancement, Accountability, and Documentation (TREAD) Act of 2000. Section 13 of the TREAD Act requires vehicle manufacturers to install tire pressure monitoring systems (TPMS) that alert drivers when a tire is significantly under-inflated. This paper first discusses the political economy that ultimately led to the final TREAD Act TPMS regulation. Then, relying on the variation of model-year TPMS introduction, I investigate whether and to what extent TPMS reduces all vehicle fatalities and those associated with tire failure and improper inflation. I find that the introduction of TPMS is associated with just over 11 fewer tire failure-related deaths per year, resulting in a net benefit of −\$752 million to −\$1,876 million (in \$2001) per year. I find no change in the number of tire inflation-related fatalities with the introduction of TPMS.

1. Introduction

In the summer of 1998, State Farm employee Sam Boyden began investigating sudden tire tread separation after an inquiry from a claims adjuster (Spurgeon, 2000). Boyden recognized that sudden tread separation was not a result of everyday wear. All 21 tread separation cases he investigated involved Bridgestone Corporation's Firestone ATX tires, and 14 of these incidents affected Ford Explorers. Boyden submitted his findings to the National Highway Traffic Safety Administration (NHTSA) in 1999.

Although the NHTSA failed to act on Boyden's reports, his early warnings were a sample of what would come. By May 2000, after accumulating 90 complaints involving four deaths, the NHTSA opened a formal investigation (Pinedo *et al.*, 2002). On August 9, 2000, Bridgestone-Firestone announced a recall of 6.5 million Firestone Wilderness, AT, ATX, and ATX II P235/75R15 tires (15″ tires). These tires were often, though not exclusively, standard equipment on many Ford Motor Company vehicles, including the Ford Explorer from 1991 through 2000. "By September 2000, there were 2,200 complaints involving 103 deaths and more than 400 injuries" (Pinedo *et al.*, 2002, 1).

In September, Congress held hearings on the Firestone Recall and Ford Explorer. Although the hearings provided evidence that BF Goodrich tires experienced more failures than others, much of the Congressional discussion surrounded proper tire inflation and rollover risk. In October and November, respectively, Congress passed, and President Clinton signed the TREAD ACT of 2000 that ultimately required tire pressure monitoring systems on all new passenger vehicles after 2007 (H.R. 5164). In 2002, the NHTSA issued its first Regulatory Impact Assessment (RIA) of tire pressure monitoring systems (TPMS). Assuming $3.5 ($2001) million per statistical life, the NHTSA found TPMS resulted in a net benefit to society of between $441.6 and $480 million. After numerous comments and updates, the NHTSA reversed its positive net benefit finding from its 2002 RIA and, in 2005, estimated a net benefit of $-226 to −$915 million in its 2005 RIA.

This paper seeks to determine whether, ex-post, TPMS results in a net benefit. To do so, I first report the NHTSA's final estimated costs. Then, I discuss Mulholland's (2020) estimated ex-posts costs that utilize teardown costs found by Simons (2017) on behalf of the NHTSA. Simons (2017) finds that the price of TPMS required by rule FMVSS 138 is $162.13 ($2012) for passenger vehicles or $125.25 ($2001). This cost is $59.17 ($2001) higher than the $66.08 ($2001) used in the Final 2005 RIA. Combining these installation costs from Simons (2017) and maintenance costs from tirerack.com (2018) of $59.76 per wheel with an assumed 17 million vehicles sold annually results in ex-post estimated costs of $2,813 million ($2001; Mulholland, 2020). This estimate is $1,334 million more or almost double the annual cost of $1,479 million ($2001) reported in the NHTSA's Final RIA in 2005. Including the cost of an additional set of wheels and sensors needed for those owning winter tires and wheels results in $1,915 to $2,987 million in costs (Mulholland, 2020). Although Mulholland (2020) notes that these ex-post costs are higher than the ex-ante benefits estimated by the NHTSA, Mulholland fails to investigate whether the ex-post benefits through fewer tire-related fatalities have resulted in a net loss or benefit to society.

To estimate the potential benefits, I use a difference-in-difference approach that relies on the variation of model-year TPMS introduction to determine whether and to what extent TPMS is associated with changes in fatalities. Analyzing the first 5 years a model-year is on the road, TPMS is associated with 663 fewer deaths per year. However, other safety-enhancing tire and vehicle characteristics are often introduced along with TPMS. Therefore, I also investigate the number of deaths due to tire failures and tire under- or over-inflation. I find that the introduction of TPMS is associated with 11 fewer tire failure-related deaths per year. Using $3.5 million for statistical life (in $2001) from the NHTSA's Final Rule in 2005, I estimate that the net benefit ranges from −$752 million to −$1,876 million (in $2001) per year. Thus, these findings show that the TPMS mandate resulted in a net loss to society. I find no change in the number of tire inflation-related fatalities. Therefore, in terms of tire inflation-related deaths, the net loss is equal to the total cost of TPMS. These results suggest that regulatory agencies should be more cautious when mandating specific technologies.

To provide background on how the TREAD Act of 2000 came to be, I offer a short history of vehicle safety regulation in the United States in Section 2. Section 3 uses Yandle's (1983) Bootlegger and Baptist Theory of Regulation to explain how specific technological regulations, such as TPMS, become law. Drawing on Mulholland (2020), Section 4 discusses the

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introduction of TPMS. Section 5 updates the NHTSA's final 2005 RIA by using ex-ante costs of producing, installing, and replacing TPMS components, and Section 6 looks at the ex-ante benefits of the NHTSA versus ex-post costs. To find the ex-post benefits, Section 7 describes the diff-in-diff method used to estimate the reduction in fatal crashes associated with the introduction of TPMS, and Section 8 describes the data. Section 9 reports the estimated ex-post benefits and net benefits of TPMS. Section 10 presents robustness checks on the preferred specifications, and Section 11 concludes.

2. Automotive safety

As vehicle injuries and death became more prevalent with ever-increasing power and speed in the early and mid-1900s, automakers introduced many safety items, including emergency brakes, safety glasses, and padded dashboards. However, the focus on vehicle safety became a hot issue when Ralph Nader published his 1965 critique of the Corvair and automobile safety: *Unsafe at Any Speed* (Nader, 1965). Unlike most domestic cars at the time, which had engines in the front and solid beam axles in the rear, the Corvair's motor is in the back which requires an independent rear suspension. Due to its rear suspension design, the Corvair had a greater tendency to lose outside rear grip when negotiating a turn. The faster the cornering speed, the greater the propensity to lose control. The Corvair's manufacturer, General Motors, recommended low tire pressure for the front tires and high tire pressures for the rear tires to counteract this tendency. Critiques, including Nader, noted under-inflation causes additional stress, uneven wear, and, after repeated use while under-inflated, an increase in the likelihood of tread separation and sudden failure.

Nader and others sought to require new safety equipment, including tire pressure monitors, to reduce accidents, injuries, and fatalities (Williams, 2015). His testimony persuaded Congress to regulate passenger vehicle safety and design and establish the National High Traffic Safety Administration (NHTSA). Many of Nader's safety equipment demands, such as two-piece steering columns (Standard No. 204, 1968), safety belts (Standard No. 208, 1968), and door bars (Standard No. 214, 1973) became required by law. However, others, like Nader's demand for tire pressure monitoring systems, did not.

3. What is needed to become a regulation?

To investigate why tire pressure monitoring systems were not required by the early 1970s, while other safety measures were mandatory, requires a theory of regulatory action. Luckily, Bruce Yandle's (1983) "Bootlegger's and Baptist's" Theory of regulation provides such insight. Building on earlier theories of regulation, most notably the "Public Interest Theory" and Stigler's (1971) "Economic Theory of Regulation," Yandle (1983) notes that regulatory bodies have several ways to generate a preferred outcome. These methods can be categorized into two broad categories:

1. Command and Control Standards
2. Performance Standards

Under command and control standards, government agencies require the use of a specific technology or process. Failure to use the specific technology or process results in fine or other punishment. Under performance standards, government agencies create a minimum

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standard that must be met or exceeded. Any legal methods that meet the standard are acceptable; however, failure to comply with the standard results in a fine or punishment.

Yandle (1983) then explores why agencies regularly choose command and control methods when performance standards provide more incentive to innovate and are often less costly.

To answer his question, Yandle recounts a story of living in a county where alcohol sales are illegal. He notes that Baptists seek to restrict or prohibit alcohol consumption for moral reasons. At the same time, Bootleggers benefit when such alcohol restrictions are in place. Command and control prohibitions are often successful because moral (Baptist) and economic (bootleggers) interest groups support the policy (Smith & Yandle, 2014; Yandle, 1983). The result: bootleggers gain the market share, and Baptists have met their moral responsibility.

Yandle's Bootlegger and Baptist Theory has been used to explain many unlikely pairings: Archer Daniels Midland and environmentalists seeking biofuel subsidies (Vanderkam, 2007), anti-smoking organizations and cigarette makers finding ways to limit the use of electronic cigarettes (Adler et al., 2016), and the promotion of Accountable Care Organizations as part of the Affordable Care Act by physicians, hospitals, and other medical providers, along with health rights advocates (Smith, 2019). And, yes, even the combined efforts of religious organizations and liquor store owners in wet Arkansas counties to keep neighboring counties dry (Horpedahl, 2021).

However, in the late 1960s, no bootleggers were present to support the Baptists' desire to require TPMS. That is, in the late 1960s, bootleggers could profit from requiring seat belts and two-piece steering columns, but TPMS had not yet been invented, and thus, no TPMS bootleggers were present.

4. Introduction of the TPMS

In 1978, the Society of Automotive Engineers investigated real-world tire inflation and discovered that 27 % of the vehicles they analyzed had tires under-inflated by 4–16 pounds (Viergutz *et al.*, 1978) and submitted their findings to the NHTSA. The NHTSA initially said it would require low-pressure warning systems, but ultimately nixed the idea (House of Representatives, 2000a).[1]

In the early 1980s, Brookstone began producing warning systems that could be placed on the end of each tire's valve stem so that drivers could quickly and easily see if a tire was under-inflated before entering their vehicle. By the mid-1980s, TPMS that alerted drivers via dash lights were ready for retail customers. Porsche was the first to include factory-installed TPMS on their 1986 959 models. In 1991, Corvettes became the first U.S. vehicle equipped with TPMS. In 1998, Bartec began selling tools that enabled tire shops to read and test TPMS systems (Bartec, 2018). In 2000, Renault launched the first high-volume passenger vehicle to include TPMS: the Laguna II.

Over time, two systems became the most prevalent: the direct system and the in-direct systems. Direct systems, initially developed by Schrader Electronics, require a pressure sensor inside the wheel at the base of the valve stem. The sensor periodically measures the tire pressure and sends a wireless signal to the vehicle's electronic control unit (ECU). If the

[1] Much of this section and the next comes from Mulholland (2020)

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tire pressure falls below a prescribed amount, the sensor alerts the vehicle's ECU, which triggers a light on the dash. Indirect systems do not directly measure tire pressure. Instead, they measure the speed of tire rotation. An under-inflated tire has a smaller circumference than a properly inflated tire. Therefore, the tire must rotate faster than when properly inflated. The indirect system uses the vehicle's stability control system to recognize when one tire spins more quickly than another. If this takes place, the TPMS alerts the driver.

By 2000, evidence began to mount that tread on BF Goodrich tires on Ford Explorers were abruptly failing and causing rollovers and fatalities. In February of 2000, numerous complaints were submitted to regulators after Houston's KHOU TV station aired a segment on sudden tread separation (Tompkins, 2002). In May 2000, after accumulating 90 complaints involving four deaths, the NHTSA opened a formal investigation (Pinedo *et al.*, 2002). On August 9, 2000, Bridgestone-Firestone announced a recall of 6.5 million Firestone Wilderness, AT, ATX, and ATX II P235/75R15 tires (15″ tires). These tires were often, though not exclusively, standard equipment on many Ford Motor Company vehicles, including the Ford Explorer from 1991–2000. "By September 2000, there were 2,200 complaints involving 103 deaths and more than 400 injuries." (Pinedo *et al.*, 2002, 1). A vast number of articles were published decrying low tire pressure risks (Bradsher, 2000a, 2000b; CNN Money, 2000; Simison et al., 2000; Spurgeon, 2000).

In September, Congress held hearings on the Firestone Recall and Ford Explorer. The hearings provided evidence that BF Goodrich tires experienced more failures than others. "For example, the 23575R15 tire, which amounted to only 6 % of Firestone production of these tires, nevertheless were 36 % of the total separations in 1 year alone in 1999" (House of Representatives 2000b, 3). They also discovered that the Decatur plant, which produced 17–18 % of the tires in question and experienced contentious labor disputes, accounted for 57 % of the total separations in 1999 (House of Representatives, 2000b; Krueger & Mas, 2004).

Much of the Congressional discussion surrounded proper tire inflation and rollover risk. BF Goodrich had tested their tires at 32 pounds per square inch (psi), while Ford recommended 26 psi for its Explorer. Ford recommended lower tire pressure to lower the vehicle's ride height and the probability of rollover. However, the lower tire pressure increased tire stress and the risk of sudden failure.

In November, the U.S. Federal government enacted legislation that ultimately required tire pressure monitoring systems on all new passenger vehicles (H.R. 5164). Explicitly, Section 13 of the 2000 TREAD Act states,

> Not later than 1 year after the date of the enactment of this Act, the Secretary of Transportation shall complete a rulemaking for a regulation to require a warning system in new motor vehicles to indicate to the operator when a tire is significantly under-inflated (H. R. 5164).

Shortly after the NHTSA filed its notice of proposed rulemaking in July of 2001, Bootleggers and Baptists filed comments in support of the direct tire pressure sensor system. Direct tire pressure sensor producers, such as Schrader Electronics, suggested the NHTSA rule should require TPMS to "provide [a] warning when any number of tires, from one to four tires, is significantly under-inflated" (McClelland, 2001, p.1). Though this suggestion appears reasonable on its face, it also effectively precludes systems that use indirect, differential tire rotation speed methods, because two similarly under-inflated tires will not trigger a warning. Therefore, Schrader was supporting a rule that required automobile manufacturers to buy sensors they produced for all wheels mounted to the vehicle, unlike an indirect system that uses the anti-lock braking system already available on many vehicles and the indirect/direct combination that uses sensors on two wheels in combination with the anti-lock braking system.

Baptists, including Public Citizen, Consumer Federation of America, Trauma Foundation, Consumers Union, and Advocates for Highway and Auto Safety, also objected to the NHTSA's decision to allow automobile manufacturers to use existing antilock brake technology to design indirect TPMS (Claybrook, 2001). These objections became more intense when, in February of 2002, John D. Graham of the Office of Information and Regulatory Affairs (OIRA) returned the proposed rule to the NHTSA due to cost concerns. Graham suggested the NHTSA allow automobile manufacturers to install less expensive, less accurate, and less informative types of indirect TPMS. In response to this return letter, Public Citizen President Joan Claybrook chastised Graham for blocking "an overdue, lifesaving rule required by Congress in the wake of the nation's most publicized tire safety disaster because, in your view, NHTSA must permit industry to install a marginally cheaper, but far less accurate and beneficial, type of tire pressure monitoring system" (Claybrook, 2002, p. 1).

Ultimately, Public Citizen, the New York Public Interest Research Group, and the Center for Auto Safety petitioned for a review of the Final Rule on Tire Pressure Monitoring Systems (Public Citizen, Inc. v. Mineta 2003). In their petition, they noted that initial indirect systems assess tire inflation by comparing the wheel speeds in diagonally opposed tires. Therefore, this indirect method is unable to detect incorrect inflation if it occurs simultaneously in all four of the vehicle's tires, two tires on the same side of the vehicle, or two tires on the same axle of the vehicle. Moreover, indirect systems require a vehicle in motion, whereas direct systems can warn of incorrect inflation before a vehicle is moving. The court sided with the plaintiffs and the final command and control type rule required a specific technology: direct sensors. The alternatives included either two direct sensors along with an indirect method or four direct sensors, much to the delight of direct sensor manufacturers, such as Schrader Electronics and others.

5. Estimated ex-ante costs by the NHTSA versus ex-post costs

In 2002 the NHTSA issued an estimate of the costs and benefits of installing TPMS in passenger vehicles. They investigated two tire pressure options: Alternative 1 alerted drivers when tire pressure fell 20 % below the recommended psi. Alternative 2 was a 25 % decline. (US NHTSA, 2002). However, the NHTSA noted that it did not include the maintenance costs most direct systems, and some indirect systems, require (NHTSA 2001, VI-9). After public comments, the OMB returned the rule to NHTSA for reconsideration. Ultimately, after two court cases brought by Public Citizen and others, the NHTSA issued the final rule and regulatory impact assessment (RIA) in March of 2005. The updated 2005 RIA assumed 17 million vehicles sold annually, added a measure of maintenance costs, the cost of refilling tires, the benefits of less property damage, and reduced travel time from fewer accidents (US NHTSA, 2005).

The NHTSA's 2005 RIA investigated three compliance options: a direct system that supplies a continuous readout of tire pressures, a direct system that alerts the driver with a warning light if one or more tires are under-inflated, and a hybrid system that includes two

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direct sensors and an indirect system with a warning light for the driver. The 2005 assessment estimates that a direct system (option 2) is $66.08 per vehicle ($2001). The RIA also notes that direct systems require batteries that will likely need replacement after 8 years. Therefore, the maintenance costs are estimated to be as high as $40.40 per vehicle. Table 1, row 1, replicates row 2 of Table VII-4 (b) of the 2005 RIA to show the total annual cost for 17 million cars and trucks (in millions $2001 at a 7 % discount rate). Notably, the 2005 assessment finds that the yearly cost of a direct system (option 2), including the cost of sensor/battery maintenance and tire inflation minus the benefits of improved fuel mileage, less tire wear, less time in traffic, and less property damage is $1,479 million.

Mulholland (2020) noted that NHTSA's 2005 ex-ante RIA was overly optimistic about the cost of installing and maintaining a direct TPMS. First, the installation value of $66.08 is much lower than the teardown cost found by Simons (2017), on behalf of the NHTSA. Simons (2017) finds that the price of TPMS required by rule FMVSS 138 is $162.13 ($2012) for passenger vehicles or $125.25 ($2001). This finding is $59.17 ($2001) higher than the $66.08 ($2001) used in the Final 2005 RIA.

Second, the NHTSA assumes that each replacement sensor, excluding installation costs, will cost the owner $22.50 ($2001). However, Mulholland (2020) uses the 2018 retail prices of the 159 sensors listed for sale on tirerack.com to show that the median price of a sensor is $49 each (Mulholland 2020). Following the NHTSA 2005 methodology but updating their estimated price of a sensor and the updated installation cost from Simons (2017), Mulholland (2020) reports an annual loss of up to $2,813 million ($2001). This value is shown in row 2 of Table 1. Mulholland also adds the additional costs faced by those in northern states who use a dedicated set of wheels and winter tires. Including winter tires and wheels for northern states, the result is $1,915 to $2,987 ($2001) million in losses.

6. Estimated ex-ante benefits by the NHTSA versus ex-post costs

Combining both fatalities and injuries by estimated severity, the NHTSA's initial 2002 RIA conducted for the proposed rule estimated the number of equivalent fatalities to be reduced by 300 per year under Alternative 1 (a 20 % decline in psi) and 184 per year under Alternative 2 (a 25 % decline in psi; US NHTSA, 2002). Adjusting for improved fuel mileage and reduced tread wear, the NHTSA estimates $369 million ($2001) annually for Alternative 1, or $1.9 million ($2001) per equivalent life saved (at a 7 % discount rate), and $138 million ($2001) annually, or $1.1 million ($2001) per equivalent life saved, for Alternative 2 vehicle (US NHTSA, 2002). Assuming $3.5 million per statistical life, this results in a net benefit to society of $480 million (300*$1.6 million) under Alternative 1 and $441.6 (184*$2.4 million) under Alternative 2. However, in the NHTSA's revised 2005 estimates, the agency estimated that 161 equivalent lives would be saved using Option 2. Table 2, row 1, shows that this resulted in a cost-per-adjusted life saved between $4.90 and $9.20 million ($2001). Mulholland (2020) finds a cost of anywhere from $11.16 to 18.56 million per adjusted life saved. Table 3 shows the range of estimated net benefits assuming a statistical life is valued at $3.5 million ($2001), In the 2005 RIA, the NHTSA reversed its positive net benefit finding from its 2002 RIA and estimated a net benefit of −$226 to −$915 million. Mulholland (2020) compares the expected benefits in the NHTSA's 2005 RIA and finds a net cost to society of $1,233 to $2,249 million. Including dedicated winter tire and wheel costs, results

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Table 1. *Total annual costs for 17 million vehicles at 7%*

(Millions of 2001 dollars)

Option	Source/construction	Vehicle costs	Present value of maintenance costs* (range)	Present value of opportunity costs of refilling tires	Present value of fuel savings	Present value of tread wear savings	Present value of property damage and travel delay savings	Net costs range
2	NHTSA (2005) Table VII–4 (b)	$1,123	$0–$689	$114	$257	$85	$105	$791–$1,479
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018)	$2,129	$0–$1,016	$114	$257	$85	$105	$1,797–$2,813
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018) adjusted for winter tire use	$2,248	$0–$1,072	$114	$257	$85	$105	$1,915–$2,987

Table 2. *Net cost per equivalent life saved*

(Millions of 2001 dollars)		
Option	Source/construction	7% discount rate
2	NHTSA (2005) Table VII–4 (b)	\$4.90–\$9.20
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and Maintenance Costs from tirerack.com (2018)	\$11.16–\$17.47
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and Maintenance costs from tirerack.com (2018) adjusted for winter tire use	\$11.89–\$18.56

Table 3. *Net benefits with a value of \$3.5 million per statistical life*

(Millions of 2001 dollars)		
Option	Source/construction	7% discount rate
2	NHTSA (2005) Table VII–4 (b)	−\$226 to −\$915
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and Maintenance costs from tirerack.com (2018)	−\$1,233 to −\$2,249
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018) adjusted for winter tire use	−\$1,352 to −\$2,424

in a net loss to society of \$1,352 to −\$2,424 million (\$2001) or a loss that is 2.5 higher than those estimated by the Final Rule's 2005 RIA (Mulholland, 2020).

7. Estimated ex-post benefits versus ex-post costs

However, the estimates above are *ex-ante* benefits versus *ex-post* costs. Because it has been 15 years since the final rule became law, we can now determine whether TPMS is associated with a decline in fatalities, ex-post. Although the TREAD Act required all post-2007 models to have TPMS, the initial year of availability of TPMS varies by model. Figure 1 shows the fraction of models with factory-installed TPMS by model year. When the TREAD Act was signed into law in 2000, only about 3 % of models came with TPMS. By 2005 this had increased to 21.4 %. By 2007, this had risen to just under 42 %.

Taking advantage of this variation in the model-year rollout, I perform a difference-in-difference estimation to determine whether the introduction of TPMS is associated with declines in fatalities. The estimating equation,

$$y_{\text{model, model-year}} = \begin{array}{l} \alpha_0 + \alpha_1 \text{tpms}_{\text{model,model-year}} + \alpha_2 \text{sales}_{\text{model, model-year}} \\ + \gamma_{1\text{model-year}} + \gamma_{2\text{model}} + \gamma_3 * \text{trend}_{\text{model}} + \varepsilon_{\text{model, model-year}}, \end{array} \quad (1)$$

investigates whether fewer fatalities from vehicle crashes, $y_{\text{model, model-year}}$, are associated with

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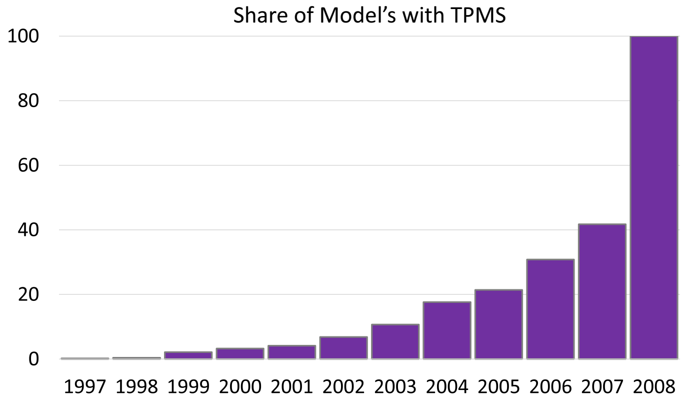

Figure 1. *Share of models with TPMS by year.*

the introduction of TPMS, $tpms_{model,\ model\text{-}year}$, by model-year. Because the number of passengers potentially exposed to fatal crashes is a function of the number of vehicles sold, I also include the number of units sold for each model for each year, $sales_{model,\ model\text{-}year}$ (carsalesbase.com). The estimation also includes model-year fixed effects, model-specific fixed effects, and, for some specifications, model-specific trends. All errors are clustered by model.

The number of deaths is measured in three ways. First, I investigate the total number of vehicle fatalities. However, because the TREAD Act calls for several vehicle and tire safety regulations, in addition to TPMS, looking at the overall number of deaths will likely overestimate the association between the introduction of TPMS and fatalities. Moreover, because the addition of TPMS was often part of safety updates and, at times, complete model redesigns with new, safety-enhancing features, the coefficient α_1 will also capture declines in fatalities associated with other safety features introduced simultaneously and will therefore be negatively biased.[2] To partially address this bias, I focus on the number of vehicle deaths due to tire failure and the number of vehicle deaths due to tire misinflation. Although this alternative measure will also be negatively biased because of tire wear and longevity improvements, using these more precise measures of tire-related fatalities enables me to focus more directly on TPMS's role in possibly reducing deaths.[3]

8. Data

To estimate Equation 1, I combine the NHTSA's Fatal Analysis Reporting System (FARS) data with TPMS model-year introduction data from BARTEC, a producer of tire pressure sensor readers, and vehicle sales data from CarSalesBase.com. Vehicle fatalities come from

[2] For example, the inaugural year of TPMS for the Ford Explorer was the completely redesigned 2002 model. Instead of relying on the Ford Ranger Truck frame for its chassis as it had in the past, the new, unibody Explorer design was lower to the ground, had four-wheel independent suspension, and a longer wheelbase than previous models. All of these features enhanced handling, reduced rollover risk, and, ultimately, death. TPMS was often introduced as part of mid-generation updates. TPMS arrived on the 2005 Honda Pilot along with electronic stability control and an upgraded airbag system. The Chevrolet Suburban first included TPMS in 2004, along with an improved braking system.

[3] Section 10 of the TREAD Act requires improved tire construction and more thorough tire wear and longevity testing. These new construction and testing rules reduced tire-related failures and fatalities as well.

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Table 4. *Summary statistics*

Pre-TPMS					
	Observations	Mean	Standard deviation	Minimum	Maximum
Model year	2,718	1996	7	1970	2007
Fatalities	2,718	124.16	198.16	0.00	1,929.00
Tire failure fatalities	2,718	0.516	2.532	0.000	67.000
Tire inflation fatalities	2,718	0.003	0.064	0.000	2.000
TPMS	2,718	0	0	0	0
Sales	2,718	64,044	108,373	0	939,511
Pre-TPMS					
	Observations	Mean	Standard deviation	Minimum	Maximum
Model year	2,634	2010	4	1997	2017
Fatalities	2,634	27.65	63.34	0.00	874.00
Tire failure fatalities	2,634	0.019	0.241	0.000	7.000
Tire inflation fatalities	2,634	0.000	0.000	0.000	0.000
TPMS	2,634	1	0	1	1
Sales	2,634	53,750	83,608	0	820,799

the NHTSA's Fatality Analysis Reporting System (FARS) (NHTSA, 2019). The FARS data includes information on the model (or models) involved, the model year of the vehicle(s), the date of the accident, the number of fatalities, and what law enforcement reports as the reason or reasons for the fatal crash. BARTEC provides information on the model-years when tire pressure monitoring systems are standard equipment (BARTEC, 2018). Because the number of fatalities is a function of the number of vehicles sold for a particular model-year, I include the number of model-year units sold provided by CarSalesBase.com.

Table 4 shows the summary statistics for the model years before and after the introduction of TPMS. For pre-TPMS model-years, the average number of vehicle fatalities for a model year is 124 with a maximum of 1929. The mean number of tire failure-related deaths is 0.5 with a maximum of 67. The mean number of tire inflation deaths is 0.003, with a maximum of 2. For model-years after the introduction of TPMS, the mean number of fatalities for a model-year is just under 28, with a maximum of 874. Tire failure-related fatalities have a mean just under 0.02 with a maximum of seven. There are no post-TPMS reported tire inflation deaths.

9. Estimations and ex-post net-benefits

Table 5 shows the estimated coefficients from Equation 1 when looking at total deaths, tire failure-related deaths, and misinflation-related deaths separately. The first three columns do not include model-specific trends; columns 4–6 do. Focusing on the model-specific trends specifications, the introduction of TPMS is associated with 47 to 95 fewer vehicle fatalities

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Table 5. *Change in deaths by model with introduction in TPMS*

Variables	Fatalities	Tire-related fatalities	Tire inflation fatalities	Fatalities	Tire-related fatalities	Tire inflation fatalities
TPMS	−94.71*** (13.45)	−0.621*** (0.234)	−0.00393* (0.00201)	−46.78*** (11.55)	−0.266* (0.148)	0.000899 (0.00187)
Sales	0.00122*** (0.000130)	8.12e−06** (3.97e−06)	1.77e−08 (1.11e−08)	0.00181*** (0.000170)	137e−05* (7.07e−06)	−9.22e−09 (1.89e−08)
Constant	51.51*** (7.390)	0.0956 (0.139)	0.00257** (0.00104)	−7.443 (8.653)	−0.406 (0.363)	0.00180* (0.00104)
Includes model fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Includes model year trend	No	No	No	Yes	Yes	Yes
Observations	5,320	5,320	5,320	5,320	5,320	5,320
R-squared	0.732	0.345	0.061	0.835	0.481	0.144

Standard errors in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

per model-year. For tire-failure deaths, TPMS is associated with 0.27 to 0.62 fewer deaths. For tire inflation deaths, the estimate without a model-specific trend reports 0.004 fewer deaths. The specification with model-specific trends is 0.0009, but it is imprecisely estimated. These estimates suggest that the introduction of TPMS was associated with a reduction in fatalities overall and tire failure related fatalities.

This method compares old versus new, but it also compares older pre-TPMS vehicles that have been on the road for many more years, with more modern, TPMS vehicles that have been on the road for fewer years. Because these new vehicles have been on the road fewer years, the estimated coefficient on TPMS is likely negatively biased. Therefore, to compare apples to apples, I truncate the sample to only include fatalities in vehicles that have been on the road for 5 or fewer years. This approach enables me to focus on the first 5 years of ownership when vehicles less likely to experience potential mechanical failures. It also allows me to address the concerns that newer vehicles are often driven by more prudent and healthier drivers (Blows et al., 2003; Farmer & Lund, 2006; Martin & Lenguerrand, 2008; Sheehan-Connor, 2022).[4] Most importantly, with this methodology, I can estimate the change in the number of fatal crashes across 5 years so that I can calculate the change in the average annual number of fatalities.

Table 6 shows the estimates from the five-year sub-sample. The introduction of TPMS is associated with 7.1 to 21.9 fewer deaths for the first 5 years of operation per model-year. Using the model-year specific trends specification coefficient of 7.1 and recognizing that this is a reduction in fatalities over 5 years, the estimate suggests an average of 1.42 fewer deaths per year per model-year. The sample includes 467 different models. Therefore, assuming all types of fatalities forgone are a result of TPMS, the introduction of TPMS is associated with about 663 fewer deaths per year (or 1.42*467).

Table 7 then reports the net benefit of these 663 fewer deaths by assuming 17 million cars are purchased each year, as was the case in 2016, $3.5 ($2001) million per statistical life, and using the costs estimates from the NHTSA and Mulholland (2020). Table 7 shows that the net benefit of 663 fewer deaths per year ranges from $405 million ($2001) to $1,530 million if we assume that the entire reduction in vehicle deaths is due to the introduction of TPMS alone and there are no maintenance costs. If the maximum maintenance costs are included, the net benefit ranges from −$667 to $841 million.

However, as noted above, some of this decline in fatalities is likely due to other new features introduced along with TPMS in updated models. Therefore, I re-perform the analysis above using the reduction in deaths associated with only tire failures. Taking the results from Table 6 that shows that each post-TPMS model year witnesses 0.12 fewer tire-related fatalities and again given the 467 models included, this is a reduction of 56 deaths over 5 years or just over 11 fewer deaths per year.

Table 8 reports the three possible estimated net benefits of TPMS by using the same cost estimates in Table 7 combined with the benefit of 11 fewer tire failure-related fatalities witnessed after the introduction of TPMS. As shown in Table 8, the net benefit ranges from −$752 million to −$1,876 million without maintenance costs included. The net benefit

[4] One additional difficulty, noted by Blows et al. (2003); Farmer and Lund (2006), Martin and Lenguerrand (2008), and Sheehan-Connor (2022), in measuring the safety of vehicles that vary by age is that newer vehicles may also be driven by more prudent or healthier drivers than older vehicles. This vehicle age effect is a problem because vehicle age is based on the calendar year, which is included, and vehicle model year, which is the variable of interest. Looking at similarly aged vehicles, as I do in later in this section, reduces this concern.

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Table 6. *Change in deaths by model with introduction of TPMS (with first 5 years of operation)*

Variables	Fatalities	Tire-related fatalities	Tire inflation fatalities	Fatalities	Tire-related fatalities	Tire inflation fatalities
TPMS	−21.88*** (3.070)	−0.186*** (0.0688)	−0.00225 (0.00182)	−7.097*** (2.111)	−0.120* (0.0632)	0.000814 (0.00124)
Sales	0.000454*** (5.42e−05)	4.55e−06** (2.09e−06)	−2.31e−09 (6.91e−09)	0.000606*** (7.32e−05)	4.90e−06*** (1.83e−06)	−1.57e−08 (1.33e−08)
Constant	51.51*** (7.390)	0.0956 (0.139)	0.00257** (0.00104)	−7.443 (8.653)	−0.406 (0.363)	0.00180* (0.00104)
Includes model fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Includes model year trend	No	No	No	Yes	Yes	Yes
Observations	4,476	4,476	4,476	4,476	4,476	4,476
R-squared	0.770	0.215	0.042	0.851	0.324	0.103

Standard errors in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

Table 7. *Total annual costs for 17 million vehicles (assuming present year benefits and $3.5 million per statistical life; millions of 2001 dollars)*

Option	Source/construction	Vehicle costs	Present value of maintenance costs* (range)	Present value of opportunity costs of refilling tires	Present value of fuel savings	Present value of trend wear savings	Present value of property damage and travel delay savings	Net costs range	Ex-post benefits	Ex-post net benefits range
2	NHTSA (2005) Table VII–4 (b)	$1,123	$0–$689	$114	$257	$85	$105	$791–$1,479	$2,321	$1,530 to $841
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018)	$2,129	$0–$1,016	$114	$257	$85	$105	$1,797–$2,813	$2,321	$524 to −$492
2	NHTSA (2005) Table VII–4 9b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018) adjusted for winter tire use	$2,248	$0–$1,072	$114	$257	$85	$105	$1,915–$2,987	$2,321	$405 to −$667

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Table 8. *Total annual costs for 17 million vehicles (assuming present year benefits and $3.5 million per statistical life): tire failures (millions of 2001 dollars)*

Option	Source/construction	Vehicle costs	Present value of maintenance costs* (range)	Present value of opportunity costs of refilling tires	Present value of fuel savings	Present value of tread wear savings	Present value of property damage and travel delay savings	Net costs range	Ex-post benefits	Ex-post net benefits range
2	NHTSA (2005) Table VII–4 (b)	$1,123	$0–$689	$114	$257	$85	$105	$791–$1,479	$39	−$752 to −$1,440
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018)	$2,129	$0–$1,016	$114	$257	$85	$105	$1,797–$2,813	$39	−$1,758 to −$2,774
2	NHTSA (2005) Table VII–4 (b) with vehicle costs from Simons (2017) and maintenance costs from tirerack.com (2018) adjusted for winter tire use	$2,248	$0–$1,072	$114	$257	$85	$105	$1,915–$2,987	$39	−$1,876 to −$2,949

declines further from −$1,440 to −$2,949 million when the maximum maintenance costs are included. Thus, I find a net loss with the introduction of TPMS.[5]

10. Alternate ex-post benefits: Varying the number of years on the road

The use of a five-year window is somewhat arbitrary. To determine whether the 5-year window affects the results, I repeat the estimation above using vehicles that have been on the road for (a) 3 years or less and (b) 10 years or less. Table 9 shows the summary statistics for both samples. As was the case in the full sample, the number of vehicle fatalities is much larger pre-TPMS than post-TPMS. For the three-year sample, the mean number of deaths is almost three times greater before TPMS; for the 10-year sample, deaths are 3.4 times greater before TPMS. For the three-year sample, tire failure fatalities are 10 times greater in the pre-TPMS period; for the 10-year sample, tire failure fatalities are almost 22 times higher before the introduction of TPMS.

Table 10 shows the results from the 3-year estimation. Over 3 years, the introduction of TPMS is associated with 4.5 fewer fatalities overall. Fatalities from tire failures and tire inflation are not precisely estimated, suggesting that the introduction of TPMS did not alter the number of tire failure and tire inflation-related fatalities. Using the model-year specific trends specification coefficient of 4.5 and recognizing that this is a reduction in deaths over 3 years, suggests 1.5 fewer deaths per year per the 449 models included in the 3-year sample. Therefore, assuming the TPMS reduces all types of vehicle fatalities, the introduction of TPMS is associated with about 651 fewer deaths per year (or 1.45*449). This estimate is similar to the 663 deaths estimated when using the five-year window.

Table 11 repeats the exercise above with the 10 years or less sample. When including a model year-specific time trend, I find 23 fewer fatalities overall per model and 0.26 fewer tire failure-related fatalities per model. Given the 10-year time frame, this results in 2.3 fewer deaths per year and model and 0.026 fewer tire failure-related fatalities per year and model. Because there are 494 models, TPMS is associated with 1136 fewer vehicle fatalities of all types per year. This estimate is almost twice the size of the 663 fewer deaths found when using the 5-year window. If TPMS is responsible for reducing all types of fatalities, then the net benefit to society would be between $2.1 and 43.2 trillion ($2001) per year (without maintenance costs). However, if we focus on tire failure-related fatalities alone, the 12.8 fewer deaths per year would result in a net loss of $746 million to $1.9 trillion (2001$) per year (without maintenance costs). This loss is similar to the loss of $752 million to $1.9 trillion (2001$) per year found when using the five-year time frame.

11. Conclusion

The TPMS saga follows the Bootleggers and Baptists theory of regulation. In the 1960s, many were calling for tire pressure warning systems for moral reasons, but no bootleggers were present. By the 1980s and 1990s, bootleggers like the Society of Engineers, Schrader Electronics, and others were producing TPMS, but few Baptists were pushing to require TPMS. Only with the Firestone-Explorer rollover controversy in 2000 did Baptists,

[5] This negative net benefit is present despite the required improvements in tire construction and testing dictated by the TREAD Act.

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Table 9. *Summary statistics for 3- and 10-year estimations*

	Three-year estimations					Ten-year estimations				
	Pre-TPMS					Pre-TPMS				
	Observations	Mean	Standard deviation	Minimum	Maximum	Observations	Mean	Standard deviation	Minimum	Maximum
Model year	1,824	2000	4	1993	2007	2,403	1998	6	1986	2007
Fatalities	1,824	27.37	40.25	0.00	371.00	2,403	83.91	127.76	0.00	1254.00
Tire failure fatalities	1,824	0.094	0.740	0.000	17.000	2,403	0.432	2.304	0.000	62.000
Tire inflation fatalities	1,824	0.001	0.023	0.000	1.000	2,403	0.002	0.050	0.000	2.000
TPMS	1,824	0.000	0.000	0.000	0.000	2,403	0.000	0.000	0.000	0.000
Sales	1,824	72,910	112,642	0	939,511	2,403	67,899	111,976	0	939,511
	Three-year estimations					Ten-year estimations				
	Post-TPMS					Post-TPMS				
	Observations	Mean	Standard deviation	Minimum	Maximum	Observations	Mean	Standard deviation	Minimum	Maximum
Model year	2,414	2010	4	1997	2016	2,559	2010	4	1997	2016
Fatalities	2,414	9.91	17.23	0.00	215.00	2,559	24.51	52.07	0.00	661.00
Tire failure fatalities	2,414	0.010	0.127	0.000	3.000	2,559	0.019	0.244	0.000	7.000
Tire inflation fatalities	2,414	0.000	0.000	0.000	0.000	2,559	0.000	0.000	0.000	0.000
TPS	2,414	1.000	0.000	1.000	1.000	2,559	1.000	0.000	1.000	1.000
Sales	2,414	56,481	84,847	0	820,799	2,559	53,555	83,267	0	820,799

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Table 10. *Change in deaths by model with introduction of TPMS (with first 3 years of operation)*

Variables	Fatalities	Tire-related fatalities	Tire inflation fatalities	Fatalities	Tire-related fatalities	Tire inflation fatalities
TPMS	−12.61*** (1.821)	−0.0766** (0.0310)	−0.000506 (0.000504)	−4.469*** (1.266)	−0.0538 (0.0397)	0.00120 (0.00126)
Sales	0.000262*** (3.00e−05)	2.12e−06** (9.91e−07)	3.76e−09 (3.84e−09)	0.000304*** (3.41e−05)	2.05e−06** (8.07e−07)	−3.26e−09 (3.65e−09)
Constant	7.979*** (1.743)	−0.0465 (0.0489)	0.000285*** (6.80e−05)	0.649 (2.211)	−0.0546 (0.0364)	−0.000234 (0.000502)
Includes model fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Includes model year trend	No	No	No	Yes	Yes	Yes
Observations	4,191	4,191	4,191	4,191	4,191	4,191
R-squared	0.783	0.166	0.053	0.864	0.271	0.165

Standard errors in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

Table 11. *Change in deaths by model with introduction of TPMS (with first 10 years of operation)*

tire_inflation_deaths	Fatalities	Tire-related fatalities	Tire inflation fatalities	Fatalities	Tire-related fatalities	Tire inflation fatalities
TPMS	−48.84*** (6,145)	−0.455*** (0.162)	−0.00250 (0.00155)	−23.07*** (6.406)	−0.260** (0.127)	−0.000223 (0.00162)
Sales	0.000865*** (0.000107)	9.20e−06** (4.58e−06)	1.10e−08 (7.52e−09)	0.00217*** (0.000121)	1.40e−05* (7.45e−06)	9.31e−09 (9.44e−09)
Constant	26.14*** (5.619)	−0.105 (0.205)	0.00143** (0.000669)	−11.60* (6.526)	−0.500 (0.405)	0.000360 (0.000492)
Includes model fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Includes model year trend	No	No	No	Yes	Yes	Yes
Observations	4,191	4,191	0	0	0	0
R-squared	0.271	0.165	0	0	0	0

Standard errors in parentheses.
***$p < 0.01$.
**$p < 0.05$.
*$p < 0.1$.

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including Public Citizen, Consumer Federation of America, Trauma Foundation, Consumers Union, and Advocates for Highway and Auto Safety, return and, along with profit-seeking producers of TPMS, successfully enact the TREAD Act of 2000 requiring TPMS. Moreover, as Yandle's theory of regulation suggests, these Baptists successfully petitioned the NHTSA to impose a command-and-control type rule that requires the use of a specific technology, direct sensors, even though anti-lock braking systems already present on many vehicles could be used and potentially modified to also provide drivers with information about tire inflation.

Assuming the TPMS reduces all types of vehicle fatalities, the introduction of TPMS is associated with about 663 fewer deaths per year for the first 5 years TPMS models are on the road. However, because other safety-enhancing tire and vehicle features are introduced along with TPMS, I focus on the number of vehicle deaths due to tire failures and vehicle deaths due to tire under- or over-inflation. I find that the introduction of TPMS is associated with 11 fewer tire failure deaths per year. Using \$3.5 million for statistical life (in \$2001) from the NHTSA's Final Rule in 2005, combined with 11 fewer tire failure-related fatalities witnessed after the introduction of TPMS, the net benefit ranges from −\$752 million to −\$1,876 million (in \$2001) per year. Thus, the TPMS mandate likely resulted in a net loss to society. Moreover, I find no change in the number of tire inflation-related fatalities. Therefore, in terms of tire inflation-related deaths, the net loss is equal to the total cost of TPMS. Although bootleggers and Baptists were successful at requiring TPMS, and the regulation is associated with fewer tire failure fatalities, the net effect on society appears to be negative. These results suggest that regulatory agencies should be more cautious when mandating specific technologies.

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References

Adler, Jonathan H., Roger E. Meiners, Andrew P. Morriss, Bruce Yandle. 2016. "Baptists, Bootleggers and Electronic Cigarettes." *Yale Journal on Regulation*, Summer. *33*: 2, 313–361.

Bartec. 2018. TPMS Legislation. Viewed July 7, 2018. https://www.bartecusa.com/tpms-legislation.

Blows, Stephanie, Rebecca Q. Ivers, Mark Woodward, Jennie Connor, Shanthi Ameratunga, and Robyn Norton. 2003. "Vehicle Year and the Risk of Car Crash Injury." *Injury Prevention*, *9*, 353–356.

Bradsher, Keith. 2000a. "Tire Deaths Are Linked to Rollovers." *The New York Times.* August 16, 2000.

Bradsher, Keith. 2000b. "Explorer Tires Had to Carry A Heavy Load." *The New York Times.* August 23, 2000.

Claybrook, Joan. 2001. Re: Tire Pressure Monitoring Systems: Notice of Proposed Rulemaking 66 FR 38982 et seq., July 26, 2001. Docket No. NHTSA-2000-8572 U.S. DOT Dockets, Room PL-401 U.S. Department of Transportation.

Claybrook, Joan. 2002. New Tire Pressure Monitoring Rule: A Fraud on Consumers. March 11, 2002, Letter Sent to OMB's Office of Information and Regulatory Affairs about the Tire Pressure Monitoring Rule. https://www.regulations.gov/document/NHTSA-2000-8572-0199

CNN Money. Ford Explorer Scrutinized. September 20, 2000. Viewed July 15, 2018. https://money.cnn.com/2000/09/20/companies/ford/index.htm.

Farmer, Charles M. and Adrian K. Lund. 2006. "Trends Over Time in the Risk of Driver Death: What If Vehicle Designs Had Not Improved?" *Traffic Injury Prevention*, *7*, 335–342.

Horpedahl, Jeremy. 2021. "Bootleggers, Baptists and Ballots: Coalitions in Arkansas' Alcohol-Legalization Elections." *Public Choice. 188* (1–2), 203–219. https://doi.org/10.1007/s11127-020-00822-5.

House of Representatives. 2000a. The TREAD Act. 5164.

House of Representatives. 2000b. *The recent Firestone Tire Recall Action, Focusing on the Action as It Pertains to Relevant Ford Vehicles: Hearings Before the Subcommittee on Telecommunications, Trade, and Consumer Protection and the Subcommittee on Oversight and Investigations of the Committee on Commerce.* 106. (September 6 and 21). Serial No. 106–165. 1–1416.

Krueger, Alan B. and Alexandre Mas. 2004. "Strikes, Scabs, and Tread Separations: Labor Strife and the Production of Defective Bridgestone/Firestone Tires," *Journal of Political Economy 112*, no. 2: 253–289.

Martin, Jean-Louis and Erik Lenguerrand. 2008. A Population Based Estimation of the Driver Protection Provided by Passenger Cars: France 1996-2005, *Accident Analysis and Prevention*, *40*, 1811–1821.

McClelland, Stephan. 2001. RE: NHTSA Docket 2000–8572- Tire Pressure Monitoring Systems. September 5, 2001. Docket No. NHTSA-2000-8572 U.S. DOT Dockets, Room PL-401 U.S. Department of Transportation

Mulholland, Sean E. 2020. "Moralists, Moonshiners, and Monitors." In Meiners, Roger and Stefanie Haeffele (Ed.) *Celebrating Bruce Yandle*. The Mercatus Center at George Mason University. Arlington, Virginia. 121–138.

Nader, Ralph. 1965. *Unsafe at Any Speed*. New York: Grossman Publishers.

NHTSA. 2019. National Highway Traffic and Safety Administration's Fatality Analysis Reporting System. https://www.nhtsa.gov/research-data/fatality-analysis-reporting-system-fars.

NHTSA. 2001. Tire Pressure Monitoring System: FMVSS No. 138. Office of Regulatory Analysis and Evaluation Plans and Policy. July 2001.

Pinedo, Michael, Sridhar Seshadri, and Eitan Zemel. 2002. The Ford-Firestone Case. New York: Department of Information, Operations, and Management Sciences, Leonard N. Stern School of Business, New York University.

Public Citizen, Inc. v. Mineta, 340 F.3d 39 (2d Cir. 2003)

Sheehan-Connor, D. (2022). Reducing informational asymmetry impacts choices and improves safety: An evaluation of automobile crash tests. *Journal of Risk and Insurance*, *89*(3), 697–723. Portico. https://doi.org/10.1111/jori.12375.

Simison, Robert L., Karen Lundegaard, Norihiko Shirouzu, and Jenny Heller. August 10, 2000. "How a Tire Problem Became A Crisis for Firestone, Ford." *The Wall Street Journal*. Viewed July 15, 2018. https://www.wsj.com/articles/SB965870212891028108.

Simons, James F. November 2017. *Cost and Weight Added by the Federal Motor Vehicle Safety Standards for MY 1968-2012 Passenger Cars and LTVs* (Report No. DOT HS 812 354). Washington: National Highway Traffic Safety Administration.

Smith, Adam. 2019. Bootleggers and Baptists Reconsidered: With Application to ACA and ACO's. (this book).

Smith, Adam and Bruce Yandle. 2014. *Bootleggers and Baptists: How Economic Forces and Moral Persuasion Interact to Shape Regulatory Politics*. Washington.: Cato Institute.

Spurgeon, Devon. September 2000. "State Farm Researcher's Sleuthing Helped Prompt Firestone Recall." *The Wall Street Journal.* Viewed July 15, 2018. (https://www.wsj.com/articles/SB967764514906874559).

Stigler, George J., 1971. "The Theory of Economic Regulation," *Bell Journal of Economics and Management Science*, *2* (Spring), 3–21.

Tirerack.com. 2018. All Tire Pressure Sensors Listed for Sale. Viewed July 20, 2018. https://www.tirerack.com/tpms/category.jsp?category=Sensor.

Tompkins, Al. 2002. Breaking the Big One. *Poynter.* Viewed July 15, 2018. https://www.poynter.org/news/breaking-big-one.

US NHTSA. 2002. Tire Pressure Monitoring System FMVSS No. 138. Preliminary Economic Assessment.

US NHTSA. 2005. Tire Pressure Monitoring System FMVSS No. 138. Final Regulatory Impact Analysis.

Vanderkam, Laura. May/June 2007. "Biofuels or Bio-fools?" *American.com.* Viewed July 20, 2018. http://www.aei.org/publication/biofuels-or-bio-fools/.

Viergutz, O., Wakeley, H. and Dowers, L. February 1978. *Automobile In-Use Tire Inflation Survey.* Number 780256. Warrendale: Society of Automotive Engineers.

Williams, Casey. July 3, 2015. "Nader talks car safety on 50th anniversary of 'Unsafe at Any Speed'." *The Chicago Tribune.* Viewed July 10, 2008. https://www.chicagotribune.com/classified/automotive/sc-cons-0702-autocover-unsafe-nader-50-20150626-story.html

YandleYandle, Bruce. 1983. "Bootleggers and Baptists: The Education of a Regulatory Economist." *Regulation. 7*: 12–16.

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