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To LDT or Not to LDT:
An Assessment of the Principal Impacts of Light-Duty Trucks

by

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Abstract

Light-duty truck classification allows manufacturers and owners to avoid a host of passenger-car regulations, including gas-guzzler taxes, safety standards, and more stringent emissions and fuel-economy standards. This paper describes the distinct policies that govern light duty trucks and passenger cars, evaluates the emissions, safety, and fuel economy differences that have resulted, and investigates the household use differences across such vehicles. The result is that when comparing the average new pickup truck or sports utility vehicle to a passenger car, there appears to be an implicit subsidy of roughly $4,400, favoring the light-duty truck. When comparing minivans to passenger cars, this subsidy is estimated to be around $2,800. With more equitable vehicle regulations, it is likely that prices would more accurately reflect the true cost differences resulting from the use of these vehicles, causing light-duty trucks to lose some of their popularity and/or clean up their act.

Key Words:
light duty truck, automobile regulations, sport utility vehicles

Introduction

The U.S. government has taken an active regulatory stance toward the emissions, safety, and fuel economy of vehicles. A particularly interesting policy for evaluation is the distinct regulation of two classes of personal passenger vehicles: light-duty trucks (LDTs)[1] – which include pickups, vans, and sport utility vehicles – are regulated very differently from passenger cars, though for many owners they serve identical purposes. It can be argued that the regulatory differences have not been optimal and have led to some unfortunate consequences in terms of consumer behavior and industry production decisions.

The light-duty truck classification allows LDT manufacturers and owners to avoid a host of passenger-car regulations, including gas-guzzler taxes, safety standards, and more stringent emissions and fuel-economy standards. There are also concerns of LDT impact aggressivity in collisions (*e.g.*, Gabler and Hollowell 1998), visibility restrictions due to LDT size and headlamp glare (*e.g.*, Bradsher 1998), off-road erosion (U.S. PIRG and the Sierra Club 1998), among others. Light-duty trucks have been held to different standards than passenger cars for several reasons. During the early 1970s, when CAFE standards were first being considered, there were concerns regarding the preservation of domestic truck-manufacturing jobs. Moreover, significant differences in size, weight, and, sometimes, use between passenger cars and light-duty trucks suggest that a single standard for all manufacturers is an inefficient control, since manufacturers specializing in certain vehicle types (*e.g.*, heavier, less fuel-efficient vehicles used for hauling cargo) are more constrained than others. More demanding restrictions can cut profitability and cause a business or product line to fail. In fact, imposition of CAFE standards on passenger cars probably provoked the emergence of luxury imports from Japan and economy vehicles in the U.S.; at the time these were highly rational responses – given the Japanese manufacturers' ability to diversify their product line (unfettered by the fuel-economy standard) and domestic manufacturers' need to produce more fuel-efficient vehicles (in order to meet the average standard). (Thorpe 1997)

Though they may rarely be used for purposes other than passenger transport, pickups are classified as LDTs because they permit cargo hauling. Minivans are considered to be derivatives[2] of cargo vans and thus gain entrée into this protected class, though they are designed and used for the purpose of passenger transport. Sport utility vehicles (SUVs) are classified as LDTs because they satisfy design definitions for off-road use[3] – though many are not used this way. (Harpers 1998, USDOC 1999)

LDTs are popular for a variety of reasons, including greater engine power, lower real gas prices, and a strong perception that bigger vehicles are safer in crashes. And expanding real incomes also have allowed more households to puchase relatively expensive vehicles; SUVs, for example, cost 35% more than new passenger cars, on average. Surprisingly, LDT sales appear to be growing at the expense of car sales in this country. Between 1980 and 1996 the U.S. vehicle fleet grew at a rate of two percent, compounded annually; the LDT fleet grew at a 7.8 percent rate. Car sales actually fell slightly in 1996, while new-LDT sales rose eight percent – and SUV sales rose a whopping 22%. Presently, the Ford F-series of pickups has a sales volume almost double that of the most popular car sold in the U.S. (the Toyota Camry). (Automotive News 1998) Figure 1 illustrates the rise of LDT sales as a fraction of the total sales fleet.

Regulatory policies and personal preferences distinguishing between LDTs and passenger cars have had myriad effects, and many researchers have looked at *pieces* of this puzzle. For example, Goldberg (1998) and Crandall *et al.* (1986) have econometrically studied the effects of the Corporate Average Fuel Economy standards on gasoline consumption by *cars*, Gabler and Hollowell (1998) and Joksch (1998) have examined the relative fatality rates associated with different vehicle types, Palmer (1998) has examined the profitability issues for manufacturers, and Thorpe (1997) has considered the likely fleet-production effects of the distinct CAFE standards. With the recent and dramatic rise in sales of sport utility vehicles (SUVs), the popular media has reported on several of the differences in cars and SUVs (see, *e.g.*, Bradsher 1997 & 1998, Sacramento Bee 1997 & 1998, Newsweek 1999). However, no work has comprehensively examined and compared the different impacts or the use patterns of cars and light duty trucks until now.

Presently, LDTs are 44% of new passenger vehicle sales – more than double their 20% share in 1972, before most regulations. This shift is marked by a reduction in fleetwide fuel economy – in contrast to the gains of the 1970s and 1980s, along with increasing difficulties in meeting the National Ambient Air Quality Standards (NAAQS) and the Kyoto Accord (which governs greenhouse gas emissions). The following discussion describes a bit of the legislative history that led us to our lop-sided regulatory environment which has in turn promoted these trends.

Legislative History:

Safety and emissions regulation of automobiles began in the late 1960s. Primarily in response to the serious consequences of the 1973 oil embargo, Congress adopted the Energy Policy Conservation Act (EPCA) in 1974. EPCA's Corporate Average Fuel Economy (CAFE) standards were first imposed on passenger cars in the 1978 model year, at a rate of 18.0 mpg; this standard was to increase to 27.5 mpg[4] in 1985 (49CFR531). CAFE requirements were imposed on LDTs in model year 1979. Initially set at rates of 17.2 mpg and 15.8 mpg for two- and four-wheel-drive vehicles, these were permitted to fall to 16.0 and 14.0 mpg the following year. They have increased to a combined standard of 20.7 mpg today – 25 percent below the passenger car standard (49CFR533.5).

Remarkably, the long-term passenger-car standard – at 27.5 mpg – has maintained its level since the inception of CAFE regulations in 1978 – over two decades ago. In 1980 a NHTSA report recommending CAFE increases to 40 to 50 mpg by 1995 was produced – but not released to the public (Washington Post 1981). The 1990-1991 Persian Gulf War provoked a new debate on this issue at the national level, but proposals for CAFE increases by senators like Barbara Boxer and Richard Bryan were defeated. In 1995 the National Research Council went on record suggesting that increasing the CAFE standards to 44 mpg for subcompact cars, 30 for large cars, 32 for small LDTs, and 23 for large LDTs would be fiscally reasonable and technically very feasible. (NRC 1995) However, Congress has prevented the USDOT from updating the CAFE standards by attaching legislative riders to annual transportation appropriations bills.

At least one significant legislative change has occurred: the gas guzzler tax levels were doubled in 1991. Strangely, these have never applied to LDTs; if a new car were to just meet the LDT fuel-economy standard, it would have to pay $1700 (40CFR600.513-91). If a new car had the Ford Expedition's fuel economy, it would be required to pay $2,600; a Toyota Land Cruiser would have to pay $3,700. These seem like clear biases in the legislation; but oil prices have been low, and political pressure to address such legislation is not great.

Special interests have made a major difference on auto regulation in this country. For example, in 1964 the United Auto Workers union successfully lobbied then President Johnson to place a very stiff 25-percent tax on imports of pickups; this tax has remained through today – in contrast to zero to three-percent taxes on virtually all other imports (with the exception of clothing and textiles) – and has significantly restricted competition in this market (Bradsher 1997). Moreover, unlike cars, light-duty trucks are not subject to luxury-goods taxes, which total eight percent of price over $36,000. In 1997 the average retail price of a Range Rover was $60,000 while a Lexus LX450 was $49,000; yet, according to U.S. legislation, these are not luxuries.

Other examples of special protection also exist. For example, in 1975 Congress was persuaded by unions to separate domestically produced from imported cars for enforcement of the CAFE standards. In 1985, recognizing that their car sales would not meet the CAFE requirements, U.S. auto manufacturers petitioned the Department of Transportation for a relaxation of the standard to 26 mpg. This request was granted (50 Federal Register 40528, 1985) and even extended to include the 1987 and 1988 model years and then remain relaxed at 26.5 mpg, for 1989 model-year cars (51 FR 35594, 1986). A year earlier, a similar deal was granted LDT manufacturers – even while many recognized the rising popularity of these vehicles for purely personal use. (Washington Post 1984)

Use Similarities:

Of total light-duty vehicle[5] sales in 1997, 44 percent were light duty trucks. (Automotive News 1998) Of new vehicle registrations by households, this figure is about 50 percent. (Bradsher 1997) Thus it is not surprising to learn that, of all trucks with gross vehicle weight ratings (GVWR) up to a hefty 10,000 pounds – which is 18% heavier than the LDT class definition permits, the latest U.S. Vehicle Inventory and Use Survey shows that 76% are used primarily for personal transportation. (USDOC 1999) Many would agree with the NRC's statement that "light trucks are being used as a substitute for the passenger car." (NRC 1992, p. 58) As mentioned, SUVs are only classified as LDTs because they satisfy federal design definitions for off-road use; yet, almost 90 percent of Ford Explorers are never taken off road (Harper's 1998).

If one believes that light-duty trucks are used as work vehicles, one might expect LDTs to carry fewer persons (but more cargo) and make fewer recreational trips. Regression analysis of the 1995 National Personal Transportation Survey (NPTS) data set – which covers over 40,000 households and their 75,000 personal vehicles – is shown in Tables 1 and 2. These results indicate that LDTs carry 7.25% more occupants per trip, on average, than passenger cars and make 15.4% more recreational person trips[6] – even after controlling for vehicle age, home neighborhood population density, income per household member, day of week (weekend vs. weekday) and vehicles per person in the household. Such findings suggest that one cannot argue that LDTs deserve regulatory protection as work vehicles; instead, they appear to be "play vehicles" – for the entire family's use. The data also indicate that households use their LDTs for longer trips than they do their passenger cars. While controlling for the same factors as in the previously described models, least-squares regression of annual mileage suggest that LDTs rack up 870 more miles per year than passenger cars – an 8.2% increase over the sample's average annual passenger-car mileage of 10,600. While LDTs tend to serve more passenger trips, they make essentially the same number of vehicle trips (Table 2). And even though LDTs average 7.25% more occupants than passenger cars (after controlling for the other variables described), 80% of the deaths in car-LDT collisions are car occupants. This brings us to a discussion of LDT safety.

Safety Differences:

The popularity of light-duty trucks for personal use has created a fierce debate around safety impacts. For example, a letter to the Editor of the New York Times comments that "Many drivers buy sport utilities in self-defense. This is tantamount to an automotive arms race." (Holzman 1999)

While LDTs are often perceived as providing greater safety to their occupants, research does not support this perception. In fact, results indicate that LDTs not only pose a significantly higher danger to other road users but often to their own occupants. (See, *e.g.*, NRC 1992, O'Donnell and Connor 1996, NHTSA 1998, Digges and Malliaris 1999.) For example, sport utility vehicles (SUVs) and pickups are more prone to rollovers; vehicle rollover is a factor in over 60 percent of all crash deaths involving late-model SUVs and almost 50 percent involving late-model pickups – versus just 25 percent involving late-model cars and minivans.[7] In fact, 50 percent of SUV occupant deaths come from single-vehicle incidents involving rollovers, versus 34 percent for trucks, 28 percent for minivans, and just 18 percent for cars. (FARS 1997) A recent study commissioned by Ford Motor Company – a company with a clear stake in the research results – concludes that SUV occupants do not fare any better than passenger car occupants. (Digges and Malliaris, 1999)

Overall, the total number of deaths associated with different light-duty vehicles is highest for pickups and SUVs – in any weight class comparison. In a study of model year 1991-1994 vehicles using crash data through 1996, the Insurance Institute for Highway Safety (IIHS) found 525 fatalities are associated with every one million registered light SUVs[8] – in contrast to just 280 fatalities associated with cars and minivans in this weight category. In the heaviest category for all vehicle types considered (4000^{+} lbs. GVWR), passenger cars and minivans are connected to 200 deaths per million registrations – in contrast to 330 for pickups (which is rather stable across all pickup weight classes) and 220 for SUVs.

Gabler and Hollowell (1998) normalize the ratios of driver fatalities in other vehicles to the number of crashes of the subject vehicle and call these "aggressivity indices". They estimate these for full-size pickups to be 2.31, SUVs to be 1.91, small pickups to be 1.53, and minivans to be 1.46. In contrast, passenger car indices ranged from just 0.45 for subcompacts to 1.15 for large cars. Pickups and SUVs are clearly linked to a significantly higher death level of other drivers.

Consider, for example, side collisions: the risk of death to the driver of a passenger car, when struck on the left side by an LDT, is estimated to be 30 times that of the LDT driver. If the striking LDT were replaced by a passenger car, the driver fatality ratio is 6.6. (NHTSA 1998) What is it about these vehicles that makes them more deadly? Size, weight, design, and use differences all play a role. LDTs are relatively big: new minivans and pickups[9] are an average of eight and 16 percent longer and nine and twelve percent wider – respectively – than a new passenger car. New SUVs, minivans, and pickups also are 24%, 31%, and 29% higher than new cars, respectively, on average. And their dimensions imply frontal areas that are 27, 44, and 46 percent larger than that of a passenger car, and side areas that are 25, 43, and 39 percent larger, respectively. Such dimensions are likely to hinder other drivers' vision of roadway conditions, inducing more collisions. These dimensions may also add to congestion by increasing inter-vehicle spacings and reducing speeds (behaviors that drivers may undertake to maintain a stable margin of safety). It already is well accepted that larger vehicles may be equivalent to many passenger cars; research indicates this (*e.g.*, Kockelman 1998) and standard roadway capacity calculations take this into account (TRB 1996).

Heavy LDTs can compel strong decelerations of smaller vehicles in multi-vehicle crashes. SUVs, minivans, and pickups weigh 41%, 48%, and 52% more than cars, on average; in an elastic collision, this difference would imply 41, 48, and 52 percent higher deceleration rates undergone by cars during impact with these vehicles. Moreover, LDT design renders them rather "aggressive" in crashes. In contrast to the stress-absorbing unibody car construction, most LDTs are built on rigid frames which are not designed to absorb impact forces and tend to transfer all energy when impacting a yielding surface. This body-on-frame construction can turn deadly for the LDT occupants when impacting an immovable object (such as the wall or ground).

LDTs also ride considerably higher. Gabler and Hollowell (1998) found that average "ride heights" (as measured to rocker panels) of pickups, SUVs, and minivans are 0.36, 0.35, and 0.26 meters, respectively – versus just 0.20 meters for passenger cars, over the 1990-1994 model years. They write that such differences produce a "mismatch in the structural load paths" that result from collisions with lower-centered objects and raise the center of gravity, which contributes to rollover instability (Consumer Reports 1997). Heavier vehicles also tend to require longer braking distances. Federal minimum braking distance requirements on light-duty trucks up to 8000 GVWR are roughly 20 percent higher than those for passenger cars.[10] (49CFR571.135) The higher eye height of an LDT driver can compensate for some of this under certain scenarios (such as obstructions on the other side of a crest curve); but in situations where sight distance is not the issue, LDTs will tend to crash with higher speeds, rendering them more dangerous to their occupants and to others.

Considering 1996 vehicle crashes, Joksch (1998) estimates that households' choices of LDTs rather than passenger cars of the same weight were responsible for a five percent increase in the vehicle-crash fatality rate; as the purchase and use of such vehicles rises, this figure is likely to increase. O'Donnell and Connor (1996) estimate that one's being an occupant of an LDT – rather than a passenger car – contributes in a statistically significant way toward the likelihood of severe injury and death in an accident. And Gabler and Hollowell (1998) point out that while light trucks and vans account for one-third of all registered light vehicles (up from just 20 percent in 1980), crashes between these and any other light vehicle characterize the majority of multi-vehicle collisions.

To be fair, the situation is more complex than many statistics allow. As described in the section on use similarities, LDTs are driven about eight percent further than passenger cars – making them eight percent more exposed to accidents, *ceteris paribus*. LDTs also drive with about seven percent more occupants, suggesting seven-percent higher occupant death rates. LDTs may also be driven – on average – less safely or in more dangerous environments. (NHTSA 1998, IIHS 1998) For example, pickup truck owners in Riverside, California, tend to be male, between the ages of 30 and 39, married, and less likely to use their seat belts (Anderson *et al.* 1999) – and passengers riding in the cargo area of a pickup are essentially unprotected and at significant risk of injury in a collision. As a proxy for driving environment, the vehicle-use regressions used here do control for population density (the only reasonably continuous environmental variable readily available in the NPTS data set) – but this is far from a perfect control.

Additionally, a heavier car is generally safer for its occupants than a lighter car – everything else constant. After controlling for gas-price increases in the 1970s and early 1980s, Crandall and Graham (1989) estimate that CAFE standards led to a roughly fourteen percent reduction in vehicle weight. Such vehicle weight reductions are associated with higher *occupant* death rates (Evans 1994) – but also *lower* death rates among occupants of other vehicles (who may collide with these new, lighter vehicles). It should be noted, however, that when two heavy vehicles collide relative to a collision of two light vehicles, research suggests there is a somewhat lower risk to occupants. (Evans and Frick 1991) Even so, vehicle design and mismatch are very important; heavy *cars* are generally substantially safer than LDTs of the same weight. Cars also tend to be more fuel efficient (due, for example, to reduced drag resistance) and are held to higher emissions and miscellaneous safety standards – making them a better choice for society at large. Research suggests that reductions in the *variation* of vehicle mass – for example, by reducing the number of heavy LDTs on the road – would be very beneficial in reducing fatalities and injuries (*e.g.*, Buzeman *et al.* 1998, Broughton 1995).

Little if any investigation has been conducted into the crash protection that LDTs offer their occupants over passenger cars in collisions with *heavy* duty trucks (HDTs). It is likely that the heaviest vehicles enhance survivability in these circumstances; however, such collisions are not very common: heavy-duty trucks account for less than four percent of vehicles in all fatal accidents (NSC 1998) – and survivability is very low, regardless, thanks to the great weight differences that cannot be overcome unless Americans wish to begin driving HDTs to work and play. Even if there were evidence that LDTs are safer for their occupants than passenger cars, the National Resource Council aptly remarks that our nation's "concern for safety should not be allowed to paralyze the debate on the desirability of enhancing the fuel economy of the light-duty fleet." (NRC 1992, p. 7) In addition to fuel economy and safety, of course, there are the issues of emissions, visibility, roadway space usage, and others.

Emissions:

Federal and California tailpipe emissions requirements are based on vehicle curb weight and payload. Under federal requirements, most LDTs fall into the heavier, $LDT2^+$ categories, permitting them to be 28%, 30%, and 75% more emitting of hydrocarbons, carbon monoxide, and oxides of nitrogen (NO_x) after five years. In fact, roughly two-thirds of all pickups sold in 1997 qualify for LDT4 classification, permitting them 160% higher oxides of nitrogen at the end of their "useful life" (120,000 miles). In 1997, only about 15 percent of new SUVs qualified as LDT4's, but this percentage is expected to increase with the introduction of the Ford Excursion and continuing popularity of other full-size SUVs.

The U.S. EPA and the California Air Resources Board (CARB) are trying to address the emissions issue to some extent by adopting regulations that hold cars and LDTs to the "same" emissions standards. These plans still classify vehicles by weight – allowing medium-duty trucks (*e.g.*, the Ford Excursion) much higher emissions levels, and the new accounting system focuses on the *average* emissions across a manufacturer's fleet of light vehicles. (CARB 1998, Federal Register 1999b) The federal Tier 2 plan also allows for a later phase-in of the "heavy" LDT standards (at 2009, versus 2007 for cars). (EPA 1999) Thus, it is highly likely that the average LDT will remain higher polluting than the average car. However, due to emissions averaging, the more compliant cars are likely to be favored in a manufacturer's pricing decisions (in order to ensure that the average emissions target is met from sales).

Presently, the federal emissions for gasoline-powered cars and LDTs are as shown in Table 3. (40CFR86.094) The National Low Emissions Vehicle program's more restrictive standards are expected to take effect in 2001, requiring oxides of nitrogen emissions to fall to 0.30 gpm (for cars) and 0.50 (for light LDTs) at the end of their useful life (*i.e.*, at 10 and 12 years, respectively). This program only applies to light LDTs – *i.e.*, those with a GVWR under 6000 pounds. The recently proposed Tier 2 standards would take this much further, to a 0.07 gpm *average* (over each manufacturer's sales fleet) by 2009 for all light-duty trucks. Non-methane organic gases (NMOG) would have standards associated with the chosen NO_x level met by each model and would average close to 0.09 mpg; carbon monoxide and particulate matter emissions would be set similarly, averaging about 4.0 gpm and 0.01 gpm, respectively. Tier 2 sulfur-content restrictions on gasoline would assist on-board vehicle technology in achieving the lower emissions levels, and reductions in vehicle test weights for LDTs will aid these vehicles in meeting the standard. The more constraining the new emissions restrictions are for heavy, high-engine-displacement vehicles, such as LDT3s and LDT4s, the more of a price effect and implicit subsidy one will expect to see between cars and LDTs. This transfer will render buyers of LDTs more responsible – price-wise – for their vehicles' higher impacts and is likely to make the choice between owning a car and a truck more consistent with a social optimum.

Fuel Economy:

Fuel economy is directly linked to carbon dioxide emissions, natural resource depletion, and import dependence. Global warming, while not a scientific certainty, seems a rather likely result of our high energy use. Small and Kazimi (1995) suggest that as the CARB and EPA tighten emissions standards, global warming could be come the "dominant" air pollution issue associated with cars. Moreover, our trade deficit is setting records (NYT 1999a), and the Persian Gulf War of the early 1990s is an example of the extremes to which gasoline dependence can take us.

As illustrated in Figure 1, average fuel efficiency for personal vehicles has actually been declining over the last ten to fifteen years; it went from 26.2 mpg in 1987 to 24.4 in 1997. (Federal Register 1999) This trend occurred after CAFE standards largely leveled out and while serious oil-price shocks have not transpired; it is due to consumption changes. In 1992, an NRC committee designed to address CAFE issues concluded that there has been a "major shift in consumer demand toward light trucks, most of which are used in the same way as automobiles. ... Moreover, there has been increasing consumer demand for options that negatively affect fuel economy." (NRC 1992, p. 9)

Thorpe's (1997) research finds that because LDTs are less constrained by CAFE requirements, price changes have arisen across the two vehicle classes that induce consumers to purchase more LDTs. His results cause him to conclude that "CAFE standards – the very policy designed to improve automotive fuel efficiency – might have contributed to the observed decrease in the average fuel efficiency of new automobiles in the United States since 1987." (1997, p. 322).

Presently, the CAFE standards are set to stand indefinitely at 27.5 mpg for cars and 20.7 mpg for LDTs. Several manufacturers have been exempted[11], but most are expected to meet this on the basis of their yearly sales-fleet average. Credits and debits can be accumulated for up to three years, after which a civil penalty is imposed of $55 for every one mile per gallon per vehicle sold that their average falls below the standard. In terms of rationalizing the current CAFE structure, the NRC committee that studied these issues "believes that there may be some merit in allowing the manufacturers to trade CAFE credits" ... "because it enhances economic efficiency." (NRC 1992, p. 184) Thorpe (1997) also suggests this. Moreover, the NRC committee felt that "the... penalty for noncompliance should be adjusted so that it better reflects the social cost of departure from the requirements. These changes would increase the flexibility for manufacturers to respond to the law in an economically efficient way." (NRC 1992, p. 11) Some have suggested raising gas prices, so that all vehicles are affected at once and the tax is clearer, but, following, an econometrically sophisticated analysis of supply and demand models of vehicle choice, Goldberg concludes that "CAFE seems to function as a set of internal taxes (on fuel inefficient) and subsidies (on fuel efficient vehicles) within each firm. This suggests that CAFE may not fare that badly from a welfare point of view." (1998, p. 31)

There are no signs that the U.S. DOT plans to bring car and truck fuel economy standards into concurrence, though this policy seems very reasonable if set as a fleet average with credit trading permitted across manufacturers. In fact, the NRC committee formed to address such issues concluded that "If the basic CAFE system is retained, Congress should consider several modifications. In light of the increasing interest in and use of light trucks, the fuel economy requirements for such vehicles should be brought into conformance with those for automobiles." (NRC 1992, p. 11)

In addition to CAFE, gas guzzler taxes play a role in vehicle efficiency. As mentioned earlier, these are not presently applied to LDTs – and there is no sign that they ever will be. Essentially then, these are a substantial tax that favors LDT purchases; the thousands of dollars of difference that these represent per vehicle is likely to significantly bias pricing and purchases. Thus, the unintended consequence that Thorpe (1997) has noted with CAFE standards is compounded by gas guzzler taxes, prompting pricing coupled with preferences to induce a switch away from cars to LDTs – causing Americans to consume more fuel than they might had no tax at all been applied.

This taxation imbalance certainly does not hurt truck manufacturers' bottom lines. Currently, there is a profitability margin of roughly $12,000 per full-size SUV (Bradsher 1999, Palmer 1998).[12] If gas guzzler taxes were applied to the 16 mpg Navigator or Suburban, they would be $3,700 per vehicle; given such a tax, it is highly unlikely that Detroit could continue this level of profitability and our roads would contain so many of these "humongous" (Palmer 1998) and "prodigiously thirsty" (Consumer Reports 1997) "monsters" (Newsweek 1999). The present regulations act as a set of implicit taxes significantly biased toward LDTs; the following section attempts a comprehensive examination of extra costs associated with their use.

Comprehensive Cost Estimates:

On average, how favored are LDTs? How much more should we be paying when we buy such vehicles? Valuations of this nature require estimates of damages and implicit tax biases. While one can be quite certain of taxes, damage estimates are notoriously uncertain: air pollution impacts are highly localized, death and injury involve pain and suffering whose values are highly subjective, and global warming is not yet a proven phenomenon. The following estimates of gas guzzler taxes, carbon or greenhouse-gas costs, emissions costs, and fatality cost are intended to provide an order of impact and have been chosen well within reported results, rather than at any extreme.

According to the CAFE method of deducing fuel economy, the average economy of LDTs sold in 1997 was 20.9 mpg (Federal Register 1999a). This level of fuel economy corresponds to a gas guzzler tax level of $1,300. Additionally, if LDTs were subject to the same CAFE standard that passenger cars are, they would have to pay a fine of $5.50 for every 0.1 mpg they fall below 27.5 mpg, making this fine equivalent to $330 per LDT (on average). This level of taxation has hardly changed since 1978 (when it was $5.0), and it is not consistent with present valuations of carbon removal from the atmosphere (or perhaps even the costs of dependence on foreign oil supplies – which make up half of our record trade deficits [NYT 1999a]). Manne and Richels (1992) estimate that the minimum carbon removal cost is $250 per ton of carbon (1999$); Nordhaus's work (1991) puts this value closer to $50. Assuming a carbon-removal cost of $70 per ton, a 20.9 mpg vehicle that travels 12,000 miles per year for ten years can be expected to impose an extra global warming cost – relative to a 27.5 mpg vehicle – of $1,020[13] (which includes a discount rate of four percent[14]).

Emissions costs come from actual, in-use emissions and do not correspond in magnitude to the standards based on the Federal Test Procedure of vehicles. However, the ratios of differences are not too distinct when comparing actual emissions with test standards. Looking at in-use emissions, the average LDT emits about 45 percent more organic gases and carbon monoxide and 28 percent more NO_x[15] than the average passenger car. Considering only human health effects, Small and Kazimi's (1995) work[16] – often cited as the standard for emissions cost valuations – suggests that such differences amount to roughly one-half cent per LDT mile traveled. Over the life of the typical LDT[17], this is likely to amount to $600 – without discounting, or $487 with a discount rate of four percent.

Like emissions, safety valuations are subject to substantial uncertainty. LDT owners – like all travelers – put their own lives at risk; this source of damage is not included here because it is largely internalized by the LDT owner (whether she is aware of it or not). However, if LDTs take more non-occupant lives than passenger cars, this is a cost imposed upon society for which they should be held accountable explicitly. Ideally, insurance rates should account for risk differences, but much of the insurance cost is a fixed cost associated with insurance administration and many drivers and their vehicles are uninsured. Moreover, fatality rates and vehicle type do not figure very significantly into liability premiums (NHTSA 1999) – and many costs borne by society are not paid out by insurers. Using the IIHS (1998) results of two-vehicle collisions for 1990-1995 model-year vehicles during calendar years 1991-1996, one finds that the sample's pickups are associated with about 110 deaths of nonoccupants for every million pickups each year. For SUVs, this number is roughly 90; for passenger cars and minivans, it is about 50. Assuming that driving behaviors and situations are similar across vehicle types, we estimate that ten-year use of the average SUV or pickup results in .0005 more deaths than use of a passenger car or minivan for the same period. At a present value of $4 million per life lost[18] with a discount rate of four percent, this amounts to $1,622 in added fatality damages imposed on others that one could attach to an LDT.

The total estimate of average unpaid difference between pickups or SUVs and cars is thus estimated to be over $4,400 (Table 4). Though they are as fuel inefficient as their partners in the LDT class, minivans are not associated with such high deaths among non-occupants, so their different impact value is estimated to lie closer to an average of $2,800. These results represent very high implicit subsidies essentially "paid" by society to owners of LDTs. Such a difference is certainly sufficient to make LDTs more popular than they should be – relative to passenger cars; Mannering and Winston's work (1985) suggests that own-price elasticities generally are about –2.5 for one-vehicle households and –1.6 for two-vehicle households. A $4,400 price increase in an LDT represents about one-quarter of present average-LDT sales value, suggesting – very roughly – a 45 percent fall in demand for such vehicles. Of course, LDT manufacturers who are making significant profits on various LDT models can afford to increase their prices less than the full amount of this presently-unpaid impact – and thus avoid such a dramatic fall in demand. And, if all LDT prices rise together, the shift out of the LDT market and into the car market is likely to be less severe than the individual-model elasticity estimates that come out of

Mannering and Winston's vehicle-model-focused work. But even a ten to thirty percent reduction in LDT sales would make a big difference on our roads and on the environment.

Conclusions:

This work strongly suggests that current regulations are far from optimal. Analysis of vehicle use patterns demonstrates that light-duty trucks and passenger cars are used in very similar ways; yet a comparison of federal regulations and the negative externalities of light-duty trucks and passenger cars indicates that pickups and SUVs enjoy a hidden average subsidy of about $4,400, while minivans benefit from an average subsidy closer to $2,800. Perhaps not too surprisingly, manufacturing-plan predictions are that light-duty truck production and use will increase, relative to passenger cars (Meredith 1999).

Equity in the CAFE, gas-guzzler, emissions, and safety regulations across these two vehicle classes, along with stiffer non-compliance fines for inefficient vehicles and permission of credit trading across vehicle classes and across manufacturers, promise to go a long way toward a much more optimal set of national policies. As a letter to the editor of the New York Times aptly puts it, the present situation "may be a good deal for Detroit, but the rest of the country is paying the bill." (Sanford 1998)

Endnotes:

[1] The Code of Federal Regulations (CFR) defines a light-duty truck to be any motor vehicle having a gross vehicle weight rating (curb weight plus payload) of no more than 8,500 pounds which is "(1) Designed primarily for purposes of transportation of property or is a derivation of such a vehicle, or (2) Designed primarily for transportation of persons and has a capacity of more than 12 persons, or (3) Available with special features enabling off-street or off-highway operation and use." (40CFR86.082-2)

[2] The first minivans were cargo vans with holes cut out for windows and seats added by way of floor bolts.

[3] The "special features" enabling off-road use are defined by the EPA to be four-wheel drive and at least four of five clearance characteristics: an approach angle of not less than 28 degrees, a breakover angle of not less than 14 degrees; a departure angle of not less than 20 degrees, a running clearance of not less than 8 inches, and front and rear axle clearances of not less than 7 inches each. (CFR 40CFR86.084-2) The approach angle is that grade angle at which a vehicle on flat ground rolling forward into the grade would strike the grade with tire and most forward point simultaneously. Departure angle is the same idea, but occurs at the vehicle's rear end. The breakover angle is for a sharp change in grade hitting the vehicle's underside midway between rear and front tire axles – and both pairs of tires simultaneously.

[4] New-car labeled mileage is about 15% less than the CAFE values, because the standardized tests performed for CAFE computation are not perfectly reflective of actual driving conditions and behaviors. (EPA 1991)

[5] Light-duty vehicles are defined here as LDTs plus passenger cars.

[6] Recreational trips include the NPTS trip-purpose categories of vacation (on the survey day, by light-duty vehicle) and other social/recreation. This definition does not include eating out or shopping.

[7] Death rates are computed per registered vehicle in 1997. "Late-model vehicles" are composed of model years 1994, 1995, and 1996.

[8] Light is defined as GVWRs under 2500 pounds.

[9] All size and weight averages come from sales-weighted averages of new vehicles sold in 1997, using data from *Ward's Automotive Yearbook*, 1997, and *Automotive News*, 1998.

[10] In September of 1997 NHTSA amended FMVSS 135 to require that LDTs up to 7,700 pounds meet the same stopping sight distance requirements as passenger cars, but this will not take effect until September of 2002.

[11] For example, Avanti Motor Co., Rolls-Royce Motors, Inc., Checkers Motor Co. are subject to much lower standards. (49CFR531.5)

[12] Palmer (1998) cites "outsiders" as suggesting that the Ford Explorer carries as much as a $15,000 profit margin. However, as leases on new SUVs expire and used ones enter the market, such margins are expected to fall.

[13] About 26 pounds of carbon dioxide are emitted for every gallon of gasoline refined and then burned in an internal combustion engine. The difference in gallons of gas consumed for every mile traveled in a 20.9 mpg LDT versus a 27.5 mpg car is the difference of their inverse values or 0.01148 gallons per mile. 12,000 miles a year and 2000 pounds per ton produce the result shown here.

[14] This rate is based on Blincoe (1994), whose review of market rates and social rates of time preference prompted his use of a four-percent discount rate in assessing the costs of vehicle crashes.

[15] These results are based on the Mobile5a results shown for cars and LDTs in an NCHRP report on emissions estimation (Chatterjee *et al.* 1997).

[16] Small and Kazimi's (1995) cost estimates neglect property and vegetation damage as well as the costs of CO, SO_2, and global warming – since these are less certain and/or of lesser magnitude. The value of life they assume is $4.87 million (in 1992 dollars), and exposure is for the Los Angeles, California, air basin, which claims a relatively high population density and a topography and climate conducive to higher exposure levels. They predict 3.18¢ per existing fleet-average passenger-car mile in 1992 dollars. To account for cleaner new vehicles and lessened exposure situations, only a one-half-cent-per-mile cost is assumed for the present comparison. The order of magnitude of this estimate should be valid for our purposes.

[17] A "typical" LDT is assumed here to be driven 12,000 miles per year for 10 years – which is comparable to the average car.

[18] Substantial research has been conducted into assessing the value of life. Small and Kazimi's (1995) work led them choose a value of $4.87 million in 1992 dollars, which would be about $5.6 million in current, 1999 dollars. Dreyfus and Viscusi (1995) use a market study of employment choices to estimate a value between $2.6 and $3.7 million in 1988 dollars, or $3.6 to $5.1 million today. Fisher *et al.* (1989) review a large body of work in this area for adults, finding reasonable results between $1.5 and $8 million in 1986 dollars (or $2.2 to $12 million in current

dollars), with the most “reliable” results lying in the lower range; they note, however, that people appear to be willing to spend even more to avoid uncontrollable risks – such as traffic accidents. Given the literature on this subject, a $4 million assumption in 1999 dollars appears realistic.

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Figures & Tables:

FIGURE 1: Plot of Average Fuel Economies and LDT Fraction

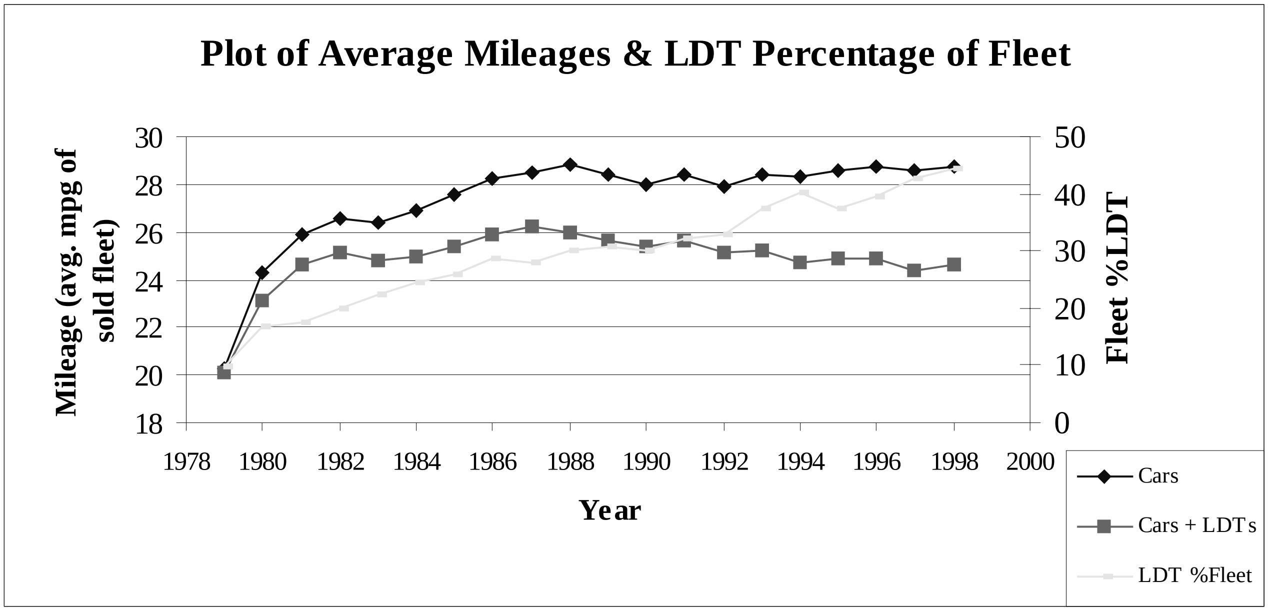

TABLE 1: Weighted Least Squares Regression of Average Trip Occupancy on Vehicle Type and Household Characteristics

Dependent Variable: Vehicle's Average Trip Occupancy (all trip purposes)

Variable	Beta	SE	T-Stat.	P-Value
Intercept	1.149	0.0112	102.8	0.000
Persons per Vehicle	0.251	0.0039	64.3	0.000
Income per Person	-3.81E-06	2.59E-07	-14.7	0.000
Population Density	-3.06E-06	6.02E-07	-5.1	0.000
Vehicle Age	-0.00903	6.54E-04	-13.8	0.000
LDT Indicator	0.103	0.0070	14.6	0.000
Weekend Day Indicator	0.295	0.0075	39.2	0.000
Adjusted R2	0.165			
#Observations	41538			
Weight = #Trips by Vehicle				

TABLE 2: Poisson Regression Results of Log-Linear Equations for Number of Persons Trips (for all purposes & for recreation purposes) and Number of Vehicle Trips (for all purposes)

Dependent Variable: #Person Trips (all purposes)

Variable	**Beta**	**SE**	**T-Stat.**	**P-Value**
Intercept	1.509	0.0064	236.1	0.000
Persons per Vehicle	0.306	0.0019	159.5	0.000
Income per Person	-4.37E-06	1.64E-07	-26.6	0.000
Population Density	-8.31E-06	3.50E-07	-23.8	0.000
Vehicle Age	-0.0390	4.11E-04	-95.0	0.000
LDT Indicator	0.0152	0.0042	3.7	0.000
Pseudo-R2	0.111			
#Observations	59952			

Dependent Variable: #Person Trips (recreational purposes)

Variable	**Beta**	**SE**	**T-Stat.**	**P-Value**
Intercept	-1.575	0.0277	-57.0	0.000
Persons per Vehicle	0.342	0.0081	42.1	0.000
Income per Person	4.95E-07	6.83E-07	0.7	0.469
Population Density	-1.18E-05	1.57E-06	-7.6	0.000
Vehicle Age	-0.0466	0.0019	-25.0	0.000
LDT Indicator	0.142	0.0178	8.0	0.000
Pseudo-R2	0.036			
#Observations	59952			

Dependent Variable: #Vehicle Trips (all purposes)

Variable	**Beta**	**SE**	**T-Stat.**	**P-Value**
Intercept	1.493	0.0083581	178.6	0.000
Persons per Vehicle	0.112	0.0028702	38.9	0.000
Income per Person	-6.57E-07	1.93E-07	-3.4	0.001
Population Density	-2.81E-06	4.43E-07	-6.4	0.000
Vehicle Age	-0.00897	5.16E-04	-17.4	0.000
LDT Indicator	-0.006	0.0052	-1.2	0.228
Weekend Day Indicator	-0.084	0.0056875	-14.8	0.000
Pseudo-R2	0.038			
#Observations	41538			

Vehicle Type	Weight (lbs.)	NMHC	CO	NOx	PM10	NMHC	CO	NOx	PM10
		5 years/50,000 miles				10 years/100,000 miles			
PC	--	0.25	3.4	0.4	0.08	0.31	4.2	0.60	0.10
		5 years/50,000 miles				11 years/120,000 miles			
LDT1	0-3750 LVW	0.25	3.4	0.4	0.08	0.31	4.2	0.60	0.10
LDT2	3751-5750 LVW	0.32	4.4	0.7	0.08	0.4	5.5	0.97	0.10
LDT3	<= 5750 TW	0.32	4.4	0.7	--	0.67	6.4	0.98	0.10
LDT4	<~8000 TW	0.39	5.0	1.1	--	0.56	7.3	1.53	0.12

Emissions Levels are in grams per mile (gpm).
LVW = Loaded Vehicle Weight = Curb Weight + 300 lbs.
TW = Test Weight = (Curb Weight + GVWR)/2 = Curb Weight + ½ Payload

TABLE 3. Federal Tailpipe Emissions Standards for Different Light-Duty Vehicles

Gas Guzzler Tax	$ 1,300
Global Warming	$ 1,020
Emissions Damages	$ 487
Deaths among Non-Occupants*	$ 1,622
TOTAL:	$ 4,429

Note: Shown impacts do not include differences in injury costs, induced non-fatal accidents due to reduced, visibility of other drivers, congestion costs, resource depletion, or other possible costs.
* Deaths among Non-Occupants is computed using the average induced fatality rate due to pickups and SUVs; this does not apply to minivans.

TABLE 4. Estimate of Present Value of Unpaid Difference from LDT Impacts, relative to Passenger Car Payments and Impacts