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Bringing Transportation into a Cap-and-Trade Regime

A. Denny Ellerman, Henry D. Jacoby and Martin B. Zimmerman

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Abstract

The U.S. may at some point adopt a national cap-and-trade system for greenhouse gases, and if and when that happens the system of CAFE regulation of vehicle design very likely could still be in place. Imposed independently these two systems can lead to economic waste. One way to avoid the inefficiency is to integrate the two systems by allowing emissions trading between them. Two possible approaches to potential linkage are explored here, along with a discussion of ways to guard against violation under such a trading regime of vehicle standards that may be justified by non-climate objectives. At a minimum, implementation of a U.S. cap-and-trade system is several years in the future, so we also suggest intermediate measures that would gain some of the advantages of an integrated system and smooth the way to ultimate interconnection.

Contents

1. ISSUES OF SYSTEM DESIGN

The European Union has adopted a cap-and-trade system as a component of its program of greenhouse gas (GHG) mitigation, and the United States is considering similar proposals. A key question in the design of these systems is if and how to incorporate the transport sector which accounts for around one-third of U.S. CO_2 emissions and is a fast growing segment elsewhere. In the United States, the main component of transport—the light-duty vehicle (LDV) comprised of automobiles and light trucks—is a particular concern and it is subject to a comprehensive set of controls aimed at improving fuel efficiency, the Corporate Average Fuel Economy (CAFE) program. Because of the scale and economic importance of the transport sector mitigation efforts need to consider the costs required to alter the characteristics of the vehicle fleet and to influence the decision to drive. Here we assess various ways that the transportation sector with its pre-existing regulatory controls might be integrated in a GHG cap-and-trade structure and assess the implications of this choice for the economic efficiency of an overall mitigation effort. Our central conclusion is that there are important efficiency gains to be realized by including transport emissions under the cap and by integrating pre-existing programs, such as CAFE, and cap-and-trade systems.

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The integration of the transport sector within a nationwide program of GHG emissions control faces two special challenges. First, transport emission sources are individually small, highly dispersed and mobile, so in-use emissions are prohibitively costly to monitor. Proxies for greenhouse gas emissions must be used, such as the fuel that contains the potential carbon emissions or (even more distant from the substance of interest) the fuel economy of the vehicle. Emissions regulations based on these proxies can lead to wide variation in the costs of emissions reduction between sectors and among different auto manufacturers and across the various categories of vehicle users. Second, in many countries transport vehicles are already subject to various forms of regulation and taxation for reasons unrelated to climate. These measures are expected to remain in place in one form or another, and a cap-and-trade system that is implemented without coordination can yield high costs for some sectors and particular emissions sources while low-cost opportunities remain underutilized. Without coordination unnecessary burdens will be imposed on the economy for the environmental benefits gained. Also, control costs may differ among vehicle manufacturers, both within the domestic industry and between U.S. and foreign firms.

The difficulties in integrating the transport sector can be seen in existing and proposed GHG cap-and-trade systems. For example, the European Emissions Trading System (EU ETS) now undergoing a trial period omits motor fuel, which is already subject to substantial fuel taxes country by country. In addition, the European Commission reached agreement with European and foreign automobile manufacturers (the ACEA Agreement) in 1998 to attain an all-fleet, new LDV CO_2 emissions standard of 140 gm CO_2 per kilometer by 2008 (roughly 40 miles per gallon in U.S. terms). The Commission's ultimate goal is 120gm by 2012. How these national and EU-level policies might be more effectively coordinated is an open question for subsequent stages in the design of the EU ETS.

Here we focus on how transport fuel might be brought into a U.S. cap-and-trade regime and ways that the pre-existing federal system of regulation of vehicle design by control of Corporate Average Fuel Economy (CAFÉ) might be integrated with the resulting system. Our concern with integrating CAFE leads to a focus on CO_2 emissions. The auto sector also emits non-CO_2 greenhouse gases (mainly from air conditioning) that could also be integrated into the systems explored below, but these details are outside the scope of this study.

We begin the discussion in Section 2 with a summary of the different designs of cap-and-trade proposal.[1] If CAFE is to be integrated with one or another of these emissions trading systems then some form of tradable instrument related to vehicle characteristics is needed. Section 3 proposes such a definition based on an estimate of the total carbon emissions of the vehicle over its lifetime. Given that the U.S. CAFE system may well remain in place even after the implementation of a cap-and-trade system, in Section 4 we explore the implications of maintaining two independent systems of emissions regulation, and the gains to be had from integration. The details of such a linkage depend on the design of the cap-and-trade system and on possible modification of the regulation now imposed on fleet average fuel consumption.

[1] It can be argued that other instruments such as a fuel tax would be preferred for mitigating greenhouse gas emissions (Newell and Pizer, 2003), but here we focus on cap-and-trade as the approach most likely to prove politically acceptable in the U.S.

U.S. CAFE Regulation

Corporate Average Fuel Economy (CAFE) regulation was instituted in 1975 in the wake of the mid-1970s oil crisis with a goal of reducing oil consumption in order to reduce the macroeconomic effects of oil price shocks and lessen the security concerns associated with oil imports. CAFE applies to any manufacturer selling over 10,000 light-duty vehicles in the U.S. and limits the fleet average fuel efficiency of the vehicles that can be sold in any year. A distinction is made between two different types of vehicles: cars with a current standard of 27.5 miles per gallon (mpg) and light trucks with standard of 20.7 mpg scheduled to rise to 22.2 mpg in 2007. NHTSA recently issued post 2007 regulations that require different standards for various size classes ("footprints") of light trucks. NHTSA estimates that the light truck average under the new system will reach 24 mpg by 2011. In addition, the car fleet is subdivided into domestic and import components, each separately subject to the standards. If a fleet average is beneath the CAFE standard in any year the difference can be banked, and firms can without penalty exceed the standard in any year provided the difference is made up within three years. In effect, therefore, compliance is calculated on a multi-year average. Exchange of CAFE credits among firms is not allowed, and both the domestic and imported components of a manufacturer's car fleet must meet the standard, accounted separately. For trucks domestically produced and imported vehicles are a combined fleet for the purposes of CAFE calculations.

The CAFE regulations specify a penalty of $55 on each vehicle sold in a year for each mile-per-gallon deficiency in the fleet average. Although importers have paid fines, domestic firms believe that paying fines as a compliance strategy would subject their directors to legal jeopardy. As a result of this legal interpretation and possible public relations costs associated with paying fines, domestic manufacturers have treated the standard as an absolute constraint.

In Section 5 we explore the effects of two possible paths to integration that differ according to whether or not motor fuels are included under the cap. The discussion in Sections 4 and 5 assumes that the main concern of CAFE regulation and, in particular, of any tightening of the CAFE standard, is greenhouse gas control. The discussion of Section 6 then considers non-carbon-related objectives that the CAFE system may address, such as oil import dependence and national security, and explores ways that these considerations could be taken into account if CAFE were integrated with a cap-and-trade system.

Although various national cap-and-trade systems are now incorporated into legislation before the U.S. Congress, it is unlikely that any such system will be put in place for a number of years. It is therefore useful to explore actions applied to the transport sector alone that might help alleviate problems in the CAFE system while preserving and perhaps easing the integration at a later date with multi-sector cap-and-trade. Three such prospects are considered in Section 7. Section 8 attempts a summary of insights from the analysis.

Several criteria underlie our assessment of the various ways of handling automotive transport in the context of a national cap-and-trade system. The key one is economic efficiency. To achieve a given environmental objective at least cost the penalty imposed on emissions should be the same across all emitting activities, both within a sector and among sectors (e.g., transport and electric power).[2] There is no reason to penalize consumers more severely for the emissions from

[2] This familiar principle would not necessarily hold if there were differences among sectors in the potential for price induced technical change over time and technology spillovers (Otto, Löschel and Reilly, 2006). However, we have seen no evidence that such an argument based on these multi-period dynamics applies to the transport sector.

their trip to visit relatives than for the heating of their houses or the running of the clothes dryer. Transparency is another desirable characteristic. Measures that obscure policy cost may facilitate political acceptance, but at the same time lead to lost opportunities for cost-saving coordination of penalties across sources and sectors. Also, emissions control measures will have distributional consequences and two are particularly relevant to this discussion: the differential impact of policy measures among automotive firms, particularly domestic makers and importers, and the distribution of burdens among different groups of consumers. Finally, the cost and intrusiveness of administration is important—not only that of the required monitoring and enforcement but also of the allocation of rights and burdens among the regulated entities.

2. POSSIBLE U.S. CAP-AND-TRADE SYSTEMS

The steps involved in designing and implementing a national cap-and-trade system can be summarized as follows:

- Determine which sectors of the economy are to be covered—in particular whether to include motor fuel or limit the system to stationary emissions sources.
- Determine the level of the cap in total national tons per year and its expected evolution over time, and other details such as the possible provision of a safety valve.[3]
- Decide where emissions accounting takes place and the obligation is imposed to supply allowances equal to these emissions. This point may be "upstream" in the energy system (e.g., refinery, port, gas pipeline, coal mine) or "downstream" (e.g., the emitter, government agency, household). The choice has important implications for the transactions cost of the system (***see Box***).
- Allocate permits in total amount equal to or less than the cap. These allocations frequently are "grandfathered" to pre-existing emitters but this need not be the case. Permits may be auctioned or they may be given to any agents in the economy.
- Allow and/or facilitate emissions trading and provide mechanisms for enforcement.

Upstream vs. Downstream Systems

Upstream and downstream systems are distinguished by the point of obligation for the accounting of carbon emissions and the corresponding surrender of allowances. In the upstream option the obligation is at the refinery gate or product import terminal. Refiners and product importers would report product sales by carbon content and surrender allowances in the appropriate amount. The carbon charge would be passed down the distribution chain and eventually paid by the end-user.

The downstream alternative would place the regulatory obligation at the point of final sale. Households would receive an allotment of tradable allowances to be surrendered at the pump. Consumers needing more than their allotted number would need to purchase additional allowances and those not being used could be turned into cash. Being required to surrender allowances at the pump could be inconvenient for both consumers and gasoline retailers but it is not hard to see how they would get around it. Retailers could purchase allowances from intermediaries and incorporate the cost into the pump price for those not desiring to go through the hassle of producing allowances. Similarly, households could sell their endowments to

[3] Under a safety valve the government agrees to offer allowances at a fixed price thereby placing an upper limit on the market price.

intermediaries and use the extra cash to purchase gasoline bundled with allowances. In the end, the consumer would face an increased price at the pump and the only difference would be that the consumer had received an endowment of allowances that could be turned into cash to help defray the added cost.

The same distributional effect could be achieved by auctioning the allowances and distributing the auction proceeds to households. The price of transportation fuel would be higher and consumers would respond accordingly. The only difference is that consumers would have received a payment, or dividend, from the government equal to a pro rata share of auction proceeds that can be used to offset the increased price at the pump. Indeed, the arrangement could be used for either an upstream or a downstream point of regulatory obligation and the preference for an upstream point lies in the smaller number of entities that would have to bear the regulatory burden of reporting and managing allowances. The transaction costs would be lower and enforcement easier at the relatively high volume refinery and import terminal outlets than at service stations and other points of final sale.

Cap-and-trade systems have gained acceptance in recent years as the result of successful experience in the United States. Prominent applications include a national system of SO_2 control in electric power plants, RECLAIM trading system for SO_2 and NO_x in the Los Angeles Basin the NO_x Budget Program in the eastern U.S., and the management of the phase-down of lead in gasoline in the period 1982-82 whereby refineries with different costs were allowed to trade allocations with one another (Ellerman, 2003; Ellerman *et al*., 2003; Burtraw and Palmer, 2004). The current EU ETS trial is the most ambitious application of all. The advantage of these systems (in contrast to a tax) is that they guarantee that the target is met while (in contrast to command-and-control regulation) they ensure that reductions are realized at the least-cost emissions sources. In addition, the cap-and-trade approach avoids the close government involvement in private decision-making that is characteristic of traditional regulatory methods.

The types of cap-and-trade systems proposed in the U.S. Congress fall into two categories: systems that include transport fuel under the cap and those that are limited to stationary sources with transport fuel outside the cap. An example of a proposal that includes transport fuel under the cap is the Climate Stewardship Act sponsored by Senators McCain and Lieberman, first introduced in 2003 (U.S. Senate, 2003a) and reintroduced in 2005. It is a hybrid in that the point of obligation for motor fuel is upstream whereas other sectors included under the cap are regulated downstream, at the level of the emitter. A close alternative is a proposal by Senator Bingaman, based largely on recommendations by the National Commission on Energy Policy (NCEP, 2004), that would implement a pure upstream system. The other category of proposals would impose the cap-and-trade system on stationary sources only and resort to other regulation to influence carbon emissions from the transportation sector. These latter approaches share the characteristic that LDV carbon emissions are to be influenced indirectly by restriction of fuel economy of vehicles with no direct effect through a price penalty on fuel either by volume or according to its carbon content. Examples are the Jeffords bill (U.S. Senate 2003b) and the Carper bill (U.S. Senate, 2003c).

None of these measures would require a change in CAFE regulation. The lack of a connection between a cap-and-trade measure and CAFE regulation very likely would lead to differences in the marginal cost of CO_2 abatement between stationary and mobile sources and thus to inefficiencies and loss of welfare for the economy as a whole. We explore this possibility below, but first we turn to the question of how integration might work.

Most of these cap-and-trade proposals are based on an assumption that the emissions price will be modest at the outset (to avoid premature abandonment of capital stock) and that it will rise over time. For example, in the version of the McCain-Lieberman proposal voted by the U.S. Senate in 2003 two commitment periods were specified with the same overall cap in each. The price would be expected to rise over time because of economic growth. Analysis by Paltsev *et al.* (2003) of the original McCain-Lieberman proposal contains a case very close to the version that received a Senate vote in 2003 and the carbon price in this instance was $29 per metric ton of carbon (mt-C) in 2010 rising to $48 in 2030.[4] The NCEP (2004) report, which is the basis of a similar proposal by Senator Bingaman, recommends an initial price of $7 per mt-$CO_2$ or $25 per ton C, with this price rising at a rate of 5% per year (which if started in 2010 would yield a price of $41 per mt-C in 2020).

3. WHAT TO TRADE IF SYSTEMS ARE INTEGRATED

If CAFE regulation of vehicle design is likely to be a continuing feature of transport policy then integration with a cap-and-trade system will require a measure of emissions as a unit of exchange—for use in transactions both among vehicle manufacturers and with other covered sectors. For the light-duty vehicle an appropriate measure is an estimate of the total CO_2 to be emitted by a vehicle, its Lifetime Carbon Burden or LCB. On average, light-duty vehicles are driven about 150,000 miles before they are scrapped, and this assumption can be used along with the carbon content of a gallon of gasoline to convert the test mileage of a particular vehicle into its LCB expressed as metric tons per vehicle, as in Equation 1:

$$LCB = \frac{150{,}000\, miles}{X} \times \frac{5.27\ (lbs\, C\ \ per\ \ gallon\ gasoline)}{2200\ (lbs\ /\ metric\ ton)} = \frac{359}{X} \tag{1}$$

where X is the test mileage (miles per gallon or mpg) corrected to represent experience on the road.[5]

Several questions may be raised about the adequacy of this approximation. Is the emissions estimate accurate enough? And is this the proper measure from the standpoint of climate effect? And what about changes in the carbon content of motor fuel? On the first point, it is the case that fuel economy declines with vehicle age and use and some models are on average driven more or less than others. Were this a concern a further correction could be made to the value of X as measured in the new-vehicle test, akin to that for other variation from test to road performance (see footnote 5). Taking these details into account would not add significant administrative cost.

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[4] The original version of the McCain Lieberman bill proposed tightening the restriction in the second period, which, because of the effect of borrowing, led to higher prices in the first period. Analysis of this version by the U.S. Department of Energy (U.S. DOE, 2003) found prices of $79 and $178 in the two periods respectively; the closest case studied by Paltsev *et al*. (2003) yielded prices of $73 and $125. Apparently the prices foreseen in these early periods were higher than the sponsors of the legislation thought appropriate because the bill’s provisions for the second period were subsequently relaxed.

[5] The statistic determining compliance with CAFE is a weighted average of ideal rural and city driving conditions. Since in practice driving conditions are not ideal the realized fuel efficiency, mpg in Equation 1, is approximately 85% of the fuel efficiency as measured in the test (U.S. EPA, 2005).

A second question concerns the fact that emissions from an electric power plant in a particular year would be traded for emissions from a vehicle, defined as its LCB, which would occur over the next 14 years (centered around the seventh year). For a short-lived gas this would be an inappropriate trade. But the lifetime of CO_2 in the atmosphere is 80 to 120 years, so a shift in timing of seven years introduces only a small difference so far as the effect on the Earth's radiation balance is concerned.

Finally, the approximation above assumes the fuel is gasoline. A similar relation would hold for a Diesel vehicle, with different emissions parameters. More complexity is created by the introduction of bio-fuels into the motor-fuel mix, and the design of vehicles to handle various fuel blends. For example cars are being manufactured in the U.S. that can run on a mix of 85% ethanol and 15% gasoline (so called E-85). However, the fact that they can do so does not mean that they will, either by consumer choice or because the blend is not widely available. Furthermore, ethanol must be credited with the CO_2 emissions from growing and processing the biological feedstock. Considering the fossil fuel used in fertilizer manufacture, tillage and processing, only a fraction of the gallon of ethanol burned represents a reduction in CO_2 emissions.

Correction for the net emissions of the ethanol or bio-Diesel component of fuel should not be a serious problem for the design of a trading system. Estimates can be made and established for trading purposes by administrative decision. The handling of the LCB of multi-fuel vehicle designs is more problematic. While the number of these vehicles is small, and the fuel supply limited, assuming a consistent percentage for use of the ethanol blend would lead to only a small error in the estimated emissions at a national level.[6] With the growth of this segment, however, additional administrative rulings would likely be needed to establish a credit close to the actual emissions contribution.

4. POTENTIAL GAINS FROM INTEGRATION

The primary reason for integrating CAFE with a cap-and-trade system is the gain in economic efficiency. As noted above, most cap-and-trade-systems that have been proposed in the United States would lead to a carbon price of \$25 to \$30 per mt-C in 2010 rising to \$40 to \$50 in 2020. Without economic analysis that is beyond the scope of this study it is not possible to estimate the cost of CO_2 emissions control via a CAFE restriction with confidence, or to obtain a per-ton cost that might be compared with the emissions prices anticipated for a U.S. cap-and-trade system. However, the \$55 penalty per mpg deviation from the CAFE standard does provide an estimate of the minimum cost for some manufacturers of the current level of restriction. If a firm's fleet achieves 26.5 mpg on average while the standard is 27.5 mpg it owes a fine for that year of \$55 times the number of vehicles it produced. If the CAFE limit is seen as justified by greenhouse gas concerns the penalty level translates into an implicit carbon price of about \$90 per mt-C.[7] Some firms do pay that fine—European importers like BMW or Mercedes for example—rather than

[6] Indeed, a credit is provided for these vehicles under the current CAFE system, which assumes E-85 is burned for 50% of the vehicle use. No account is taken of the net emissions involved in the manufacture of ethanol, effectively assuming them to be zero, since the original purpose of the law was to reduce oil consumption and was not focused on greenhouse gasses.

[7] The fact that the CAFE constraint may also reflect non-climate concerns associated with fuel consumption itself is addressed in Section 6.

"mix shift" [8] or modify the design characteristics of their vehicles (which would reduce profits) or spend more on technology (which also would lower profits). Thus for these manufacturers, the marginal cost of carbon emission reduction can be safely assumed to be $90 per mt-C or above.

Domestic manufacturers do not pay fines but treat the CAFE standard as an absolute constraint (*see Box on page 3*). Instead they do mix shift and install fuel-saving design and technology changes to meet the CAFE standard while trying to sustain the combination of vehicle attributes that their customers want. Since the European manufacturers and U.S. firms have the same technologies and mix-shifting options it is reasonable to expect that domestic manufacturers are operating at an implicit emissions penalty of at least $90 per mt-C as well.[9]

An alternative cost estimate relies on engineering data: this approach has been used by the U.S. National Research Council (NRC, 2002), the National Highway Transport and Safety Administration (NHTSA, 2005)**,** and the California Air Resources Board (CARB, 2004**)** to look at the costs of increasing fuel economy. In this method a list of technologies that can improve the fuel economy of the vehicle is compiled. Then the cost of each technology is estimated and the present value of the fuel saved by utilization of the technology is subtracted to yield a net cost. Often in this approach some of the technologies appear to be "free" in the sense that the technology costs less than the value of the fuel saved.

Such engineering analyses are subject to controversy over their estimates of expected fuel economy gains, the cost of equipping vehicles with technical advances such as variable valve timing, or the appropriate markup to allow for capital costs. But even more problematic is the assumption that the only attribute of a vehicle that is assumed to have value to the purchaser is fuel economy. Clearly people value other features, and when fuel prices are low, they value these other features quite a bit more than saving another gallon of gasoline. The true cost of CAFE includes the loss in consumer utility by forcing greater fuel economy on a consumer who wants, for example, safety features like multiple airbags that add weight and reduce fuel economy, traction control, more interior room, towing capability or better 0 to 60 performance. (After all, if consumers only valued fuel economy, what is the explanation for the increase over time in the average square footage of the American home?)

Some European manufacturers have decided that it is worth paying the fine, rather than further altering their vehicles. In the case of the domestic manufacturers, the fuel saving technology has been adopted to hold fuel economy at the constrained level while improving performance and offering more features in a vehicle. As an illustration of this process, a 1992 National Research Council fuel economy study listed technologies that were available and could be adopted over the next ten years to improve fuel economy (NRC, 1992). Many of these technologies were, in fact, adopted in the subsequent years, but fleet fuel economy remained roughly constant while vehicle performance improved.[10]

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[8] Mix shifting refers to the adjustment of the relative prices of larger and smaller vehicles away from what would be the profit maximizing levels in order to attain a combination or "mix" that will meet the standard for the fleet as a whole.

[9] In fact, there is reason to believe that domestic producers may face higher marginal costs as we will explain shortly.

[10] The list of fuel economy technologies appears in Table 2-2 of the NAS (1992) report. Using available technologies, the NAS estimated that by 2006 the new car fleet could average between 34 and 37 mpg. They estimated that the new truck fleet could average between 26 and 28 mpg (Table 8-2, p. 153). These estimates were done holding vehicle performance constant and using the size mix of cars and trucks at the 1990 level. In fact, the MY2005 fleet averages reported by NHTSA were 30 mpg for cars (import plus domestic) and 21.8 mpg for light trucks.

The Congressional Budget Office recently conducted a study that modeled the demand for different types of vehicles and the cost of the CAFE constraint (CBO, 2003; Austin and Dinan, 2005). They assumed, consistent with the experience of the last 15 years that, unconstrained, the "free" fuel economy technology would be used to improve performance and other vehicle characteristics and not fuel economy. Increasing CAFE standards forces the use of technology to improve fuel performance. The cost of reducing fuel consumption by 10%, on their measure of lost consumer and producer surplus was the equivalent of $117 per ton of carbon.[11] What the CBO analysts estimated was in fact an average cost, so the marginal cost is higher. Even this cost ignores the additional costs associated with rebound (NRC, 2002; Kleit, 2004).

The Rebound Effect

Part of the fuel saving attributable to an increase in vehicle fuel economy is lost in the so-called rebound effect. Better fuel economy lowers the cost per mile of vehicle use and encourages driving. Estimates of the magnitude of this effect suggest an elasticity of vehicle use to fuel cost 0.1 to 0.2—a response that would decline somewhat with rising incomes over time. That is, a 10 percent increase in economy will result in a 1% to 2% increase in miles driven. Not only does this feedback raise fuel consumption but it also increases other costs associated with total miles driven such as the costs of congestion and of property loss, injury and death from accidents.

All of these implicit cost estimates of $90 to $100 per mt-C are substantially higher than the $30 to $40 per mt-C costs that the McCain-Lieberman or the Bingaman bills would have imposed. (A U.S. Guzzler Tax applied to high mile-per-gallon vehicles (***see Box)*** is even higher but is paid only on a small number of vehicles.) So, if a cap and trade system along these lines were implemented in the U.S., there are gains to be had by allowing trading between the auto sector and the rest of the economy.[12]

The Guzzler Tax

Separate from the CAFE regulations is a tax on individual cars (not light trucks) that have very low mileage performance. The fraction of the fleet subject to this tax is small and includes high performance cars, limousines, hearses, etc. The schedule of payments begins with a charge of $1000 for a vehicle with a test performance below 22.5 mpg and escalates at lower mileage to a maximum of $7,700 per vehicle for cars getting less than 12.5 mpg. Though it was imposed for other reasons, it is possible to evaluate this tax as if it were a carbon charge. As a tax on the LCB of the vehicle the charge ranges from $50 per metric ton of carbon (mt-C) for cars just below 21.5 mpg to over $200 per mt-C at the low end of the efficiency range. Alternatively, it could be seen as premium on the lifetime carbon burden, allowed at the CAFE standard for autos of 27.5 mpg. Under that assumption the range of the carbon charge is $252 to $375 per mt-C.

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[11] The Austin and Dinan (2005) study assumed a gasoline price of $1.50 per gallon. At higher prices some of these technical improvements would be expected to be diverted to fuel economy, lowering the implicit carbon cost somewhat.

[12] As a crude illustration, applying Equation 1 a new car fleet of 10 million vehicles with an average fuel economy of 25 mpg would have a total LCB of 14.4 million mt-C. A 10% reduction at the Austin and Dinan level of $117 per mt-C would cost $1.63 billion. If national policy were imposing only a McCain-Lieberman level penalty, estimated at $29 per mt-C, the excess cost imposed would be $1.26 billion for each model year when this spread is maintained.

5. POSSIBLE PATHS TO INTEGRATION

We now turn to consideration of how the CAFE system could be integrated with the overall CO_2 cap. The mechanism for integration is trading in differences between actual emissions, measured as lifetime carbon burden, and the emissions level that would obtain from meeting the CAFE standard. We term this mechanism debit-credit trading. The effects of integration through trading depend importantly on whether or not motor fuel is included within the overall cap on CO_2 emissions.

5.1 Debit-Credit Trading with Motor Fuel Under the Cap

Features. If the transport sector is under the cap then allowances must be surrendered either upstream or downstream (*see Box on page 4*) equal to the carbon content of the motor fuel consumed by LDVs. Debit-credit trading between the cap-and-trade and CAFE systems would give credit to companies with a new fleet fuel economy that exceeds the CAFE standard. Unless a company expects to produce a fleet that fails to meet the standard over the next three years, such over-compliance has no value under the existing CAFE program. Indeed, such slack creates an incentive for these manufacturers to produce less fuel-efficient models to compete with domestic producers in the higher weight and performance segment of the market. Allowing companies to sell emissions savings from CAFE over-compliance to the capped sector would remove this perverse incentive, and perhaps encourage other manufacturers to do better than the standard.

By the same token, manufacturers who were deficient under CAFE would be allowed to purchase allowances from the capped sector and submit an amount equal to the excess LCB corresponding to the shortfall. Take as an example Daimler Chrysler's 2003 import fleet with an average of 26.3 mpg. Correcting for the average 15% difference between the federal test and realistic driving conditions the manufacturer in this example would have an on-the-road fleet performance of mpg = 0.85x26.3 = 22.4. The similar measure of a fleet that just exactly met the 27.5 mile per gallon standard under the federal test would have mpg = 0.85x27.5 = 23.4. When these mpg figures are applied in Equation 1 the result is an excess LCB of 0.7 mt-C per vehicle. At a carbon price of, say, $50 per mt-C, compliance could be maintained by paying $35 per vehicle for emissions permits.[13] Such a linking of systems would at once effectively allow inter-firm trading, thus removing many of the unequal costs and perverse incentives now embedded in the CAFE design, and a single emissions price would emerge which would help to equalize the marginal costs of reducing carbon emissions across stationary sector components and the design attributes of LDVs.

Since tightening the CAFE standard is often proposed as a component of climate policy along with a cap-and-trade system, it is important to understand that the effects of such a policy would depend upon the extent of integration between the two instruments. With motor fuel under the cap, tightening the CAFE standard will have different effects depending on whether trading is allowed between the CAFE and cap-and-trade systems. If trading is not allowed, tightening the CAFE standard will not change total emissions, which are determined by the national cap. Tightening will produce a distributional effect, however, shifting cost from stationary sectors to the

[13] At higher carbon prices manufacturers might choose to pay the fine as a compliance strategy.

purchasers of new LDVs. The mechanism is as follows. The more stringent CAFE standard will reduce motor fuel demand (even corrected for the rebound effect) as more efficient automobiles are introduced into the LDV fleet, lowering the demand for permits from this sector and relaxing the overall pressure on the emissions cap. Emissions prices will fall somewhat as a result, leading stationary sources to reduce less than they would without the constraint on LDV design. Thus with inter-system trading any intent to reduce emissions by tightening CAFE will be frustrated, and the only result will be to shift some of the cost of the emissions reduction from one sector to another. Unfortunately, in the process greater inefficiency would likely be introduced into the economy in that the cost of reducing CO_2 emissions through changes in vehicle fuel economy (perhaps at $90 to $100 per mt-C level discussed above) will be greater than the cost being imposed on stationary emissions sources, particularly in the early stages of any cap-and-trade regime when prices only a fraction of these levels are expected, as discussed above.

If trading is allowed between the two systems, tightening the CAFE component would reduce overall national emissions somewhat, and have similar but attenuated distributional effects, while eliminating the inefficiency of differential emissions penalties among sectors. In this case, automobile manufacturers would respond to the tightened CAFE limit by some combination of improved vehicle fuel economy and allowance purchases within the cap-and-trade system. Under the assumptions above about costs of economy improvement *vs*. likely cap-and-trade permit price, the main accommodation will likely be in the permit market. Automobile manufacturers would buy emissions permits to the extent of the LCB difference between the realized fuel economy of the new car fleet and the CAFE standard, and these costs (plus those of any fuel economy improvement) will show up in new LDV prices. By their emissions permit purchase the auto manufacturers would withdraw allowances from circulation,[14] and these purchases will increase the carbon price and elicit greater reductions from the capped sector in the same manner as if the cap had been reduced by the amount of the purchases by auto manufacturers. In effect, automobile manufacturers will pay stationary sources to reduce more than they would without the CAFE tightening. Vehicle owners will also drive less because of the effect of the higher permit price on fuel cost. Thus with trading among systems a tightened CAFE standard is largely transformed into a tightened cap with the emissions trading serving to insure that marginal costs of reduction are equalized across sectors—so that main difference between a lower cap and a more demanding CAFE standard is distributional. Under tightened CAFE the increased cost would be imposed mainly on the purchasers of new LDVs, whereas with a lowered cap (achieving the same emissions result) the burden would fall more evenly across sources.

In sum, this analysis suggests that CAFE is a poor choice of policy instrument for mitigating CO_2 emissions in the context of a cap-and-trade regime that includes motor fuel in the cap. Tightening CAFE has no effect on total emissions when there is no trading between systems. If trading is allowed, the same reduction in emissions can be achieved by leaving CAFE unchanged and lowering the cap—with the latter approach distributing costs more broadly across the economy.

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[14] The effect would be very similar to that produced if permits were purchased by a non-governmental organization and retired from the system.

Advantages. With motor fuel under the cap the linking of systems through trade would have several advantages—most of which originate in the economy-wide design of the cap-and-trade system itself. Most importantly, trading would promote least cost emissions reduction in that the penalty imposed on emissions should be the same across all activities, both within each sector and among sectors (e.g., transport and electric power). If this equal-cost condition does not hold, control activities can be relaxed in one place and increased elsewhere while maintaining the same total emissions constraint, reducing the stress on the national economy in the process. In particular, the higher fuel price reflecting the cost of carbon will affect both the choice of vehicle type (with its relative fuel economy) and the decision of how much to drive given the available vehicle stock.

Trade linkage would penalize guzzlers and benefit efficient models. Additional units of a model whose LCB is greater than the standard would increase the fleet average fuel consumption and thus bear a cost in required permits, whereas more sales of a model better than the standard would lower the fleet average and thus yield permits to transfer elsewhere. The resulting differences in the cost of sales would cause the consumer prices of different models to reflect their levels of LCB. The effect is equivalent to a fee-bate system whereby taxes on low economy vehicles are used to subsidize high economy ones (Greene *et al.*, 2005), only in this case with the fee and rebate tied directly to the emissions price set in the cap-and-trade system.[15]

Finally, because a single national price of CO_2 emissions will emerge, applying across components of the LDV sector and between the LDV and other sectors under the national emissions cap, transparency will be provided in the cost of GHG mitigation instruments—another desirable characteristic of environmental control policy.

Complexities. Two complications may arise in such a linking of CAFE with a fuel-inclusive cap-and-trade system, each of which could be managed through the design of the trading rules. One concerns the appropriate baseline for calculating credits based on performance relative to the CAFE standard. The increase in the price of motor fuel resulting from the cap-and-trade-determined charge on its carbon content would, through the consumer purchase of more fuel efficient vehicles, lead over time to an increase in the average fuel economy of new vehicles. If the baseline were calculated from an unchanged CAFE standard, this response would create credits for a reduction in emissions that would occur anyway. A possible fix for this phenomenon would be to set the baseline for credits and debits at a level higher than the CAFE standard, based on an estimate of the consumer price elasticity of demand for fuel economy.[16] A related concern arises with manufacturers not bound by the CAFE constraint because they serve only the small car component of the vehicle market. Integration of the CAFE system with the cap-and-

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[15] Cross subsidy of vehicles occurs under the current CAFE system where there is no trading among firms. In effect, a firm subsidizes small cars and taxes large cars by adjusting relative prices (and margins) in order to sell a mix of vehicles that meets the standard. However, there is no connection in this procedure to any particular value of a fuel or emissions penalty.

[16] The CBO (2003) estimates a fuel economy elasticity of +0.22. That is, a 10% increase in fuel price would, in long-term equilibrium, yield a 2.2% increase in fuel economy. At a gasoline price of $2.00 per gallon and a carbon price of $50 mt-C, the increase in gasoline price would be about $0.10/gallon, or 5% of the price at the pump. Using this estimate of elasticity and these assumptions, the baseline for trading would be 1.1% higher, or 27.8 mpg for the current standard.

trade system could lead to these firms having saleable credits that would lead to more emissions from the capped sectors. As noted above, these firms now have an incentive to enter the less fuel-efficient segment of the LDV market. Nevertheless, if this form of no-reduction transfer were a problem, it might be limited by restrictions, defined by firm or market segment, built into the trading system design.

The second complexity derives from concerns other than greenhouse emissions. If the price of allowances were less than the carbon-equivalent cost of achieving the existing CAFE requirement, manufacturers' use of purchased allowances to make up any deficiency could allow fleet average economy to fall below a level justified by non-climate concerns, such as national security. Again, the design of the debit/credit trading regime could include features to manage this issue—including constraints on trading or, as explored in Section 6, the imposition of a premium on trades between the CAFE and cap-and-trade systems to account for the non-climate factors.

5.2 Debit-Credit Trading with Motor Fuel Outside the Cap

Features. If the cap-and-trade program applies only to large stationary sources, the only regulatory constraint on greenhouse gases from LDVs will be the CAFE standards. Without debit-credit trading, the marginal penalties applying to stationary sources and to vehicle design and use will be very different, leading to potentially large inefficiencies. If linked through credit-debit trading, the inefficiency associated with the difference in marginal penalty between vehicle design and stationary sources would be eliminated, but vehicle use would remain unaffected, as in the existing CAFE system. This remaining inefficiency is the inevitable result of applying the constraint to vehicle design only and not including the cost of carbon in the price of motor fuels as would be done when they are under the cap.

When motor fuels are outside the cap a tightening of the CAFE standard would have emissions and distributional effects somewhat different from those when motor fuels are included. If there is no trading between the CAFE and capped systems, tightening CAFE will reduce CO_2 emissions, in contrast to the case where motor fuels are included in the cap and tightening would have no effect on total emissions. However, this reduction comes at significantly greater cost than necessary because new car purchasers would be paying a much higher cost for the emission reductions obtained through improved fuel economy than the consumers of electricity, for instance, would pay for the reductions obtained from stationary sources. Since both new cars and electricity are purchased by households, although perhaps in different proportions in different households, the question arises why consumers should be forced to bear an extra burden for a given environmental goal by paying more for carbon emission reductions obtained by vehicle design than by lower emissions from generation of electricity or the production of the products of other stationary sources.

When the CAFE is linked through trading with a capped system that excludes motor fuels, system inefficiency is reduced if not eliminated. Total emissions from LDVs and the capped sector will decline as CAFE is tightened. The costs of the additional reduction in emissions will be paid by the purchasers of new vehicles, but those costs will be less than they would be without linkage since the standard can be met by purchasing lower cost credits in the capped sector. To the extent that the increased CAFE standard is met by buying credits from the capped sector, transport emissions will not decline but capped sources will be paid to reduce more than would have done otherwise.

A variation on this approach, where the entire CAFE system is transformed into a tradable carbon efficiency program, and which we call a Corporate Average Carbon Efficiency (CACE) standard, is sketched out in the ***Box*** below. Since it too excludes motor fuels from the cap, its effect is similar to that of debit-credit trading under the same circumstances.

Shift of Basis to Corporate Average Carbon Emissions

An alternative to the credit/debit approach if motor fuel is outside the emissions cap is a Corporate Average Carbon Emission (CACE) system. Vehicle manufacturers would be required annually to surrender allowances equal to the LCB of the vehicles they sell. The entire LCB of the new vehicle fleet would be included in the annual national cap and these allowances would be tradable with stationary sources. Trading flows would appear very much as they would with the credit-and-debit approach with one important difference. Under the debit-credit systems a manufacturer would receive an implicit allocation as if its fleet were exactly at the CAFE standard (LCB_{CAFE}). It would trade only in the departures from this quantity. Trading may affect the relative prices of new vehicles with different emissions characteristics through the fee-bate effect, but the marginal cost (and therefore the sales prices) of the new fleet as a whole would not include the cost of the implicit allocation of LCB_{CAFE}. With a CACE system the full price of the lifetime carbon burden of the vehicle would be included in the vehicle price. The difference in price between the two approaches would be the value of the allowed or target LCB. In the credit/debit approach, the value is implicitly but effectively granted to the purchasers of new vehicles, while in the CACE approach purchasers must pay for the right to emit those potential tons.

Like the credit/debit approach, the CACE alternative would equalize marginal costs between the stationary source sector and the cost of reducing the lifetime carbon burden associated with new vehicle sales. Similarly, by excluding fuel price, it would have no effect upon emissions from the existing car fleet and it would have no effect on the utilization of new cars.

Advantages. Provision of credit-debit trading in the LCB of new vehicles would ensure that the cost of greenhouse gas emissions is taken into account in manufacturers' vehicle design and sales decisions and that this cost would be the same as that incurred in other sectors of the economy. Vehicle manufacturers who over-comply with the CAFE standard would receive allowances equal to the difference between the CAFE level and their fleet LCB, and those in a deficit position could satisfy the CAFE obligation by surrendering allowances in amount of their excess LCB purchased from the capped sector. The marginal cost of emission reductions would tend to equalize across auto makers and between LDV manufacture and emissions from electric generation and other activities included under the national emissions cap. As a result the inter-system trading would reduce the total cost of any emission target. Further, the resulting emissions price would provide transparency as to the marginal cost of the overall emissions restriction.

Complexities. The complexities of this system are similar to those when fuel is included in the cap. Again, they could be managed through the design of the trading rules in ways to those discussed for the earlier case. Since the price of fuel does not change, the problem of a changing baseline does not arise. The problem of issuing credits to manufacturers already exceeding the

CAFE standard, however, would be the same as when fuel is included in the cap. The potential for exceeding a CAFE target justified by non-climate concerns is more serious than in the case with motor fuel under the cap because there is no feedback of excess permit demand onto the fuel price and driving response. Finally, without the effect on vehicle use in reducing emissions, CAFE trading raises the price of emissions in the capped sector somewhat more than would be the case with similar linkage and tightening when motor fuels are included in the cap.

6. NATIONAL SECURITY CONSIDERATIONS

Until now we have considered the advantages from integrating CAFE into a future cap and trade system only from the perspective of limiting carbon emissions consistent with a climate change policy. One argument against such integration is that oil consumption costs include disruption to the economy because of oil price volatility, the potential effects of U.S. monopsony power in oil markets (reducing consumption of such a large market participant might lower oil prices), national security costs involved with military expenditures necessary to protect oil and shipping lanes, and difficulties caused by revenues going to unstable political regimes. Buying and selling CAFE credits in an integrated system creates the possibility that trading might result in a level of fuel economy lower than the current standard (or some higher standard motivated by oil import objectives). While the trading in carbon is to be desired, the nature of the trade could be such that coal or natural gas use is reduced instead of oil use. There would be no assurance therefore, that CAFE limit would lead to the intended reduction in oil consumption.

Several studies have estimated the magnitude of the national externality costs associated with oil consumption, explicitly including risks of disruption and exercise of monopsony power. Citing these studies, the NRC (2002) in its CAFE analysis, and NHTSA (2005) in its recent preliminary regulatory impact assessment, put the combined costs in the range of 10-12 cents per gallon of gasoline. One could argue that these costs are already incorporated in the price of gasoline, given the average tax imposed on gasoline in the U.S. of about 40 cents per gallon. Moreover, including oil in the cap-and-trade system will increase oil prices and have the ancillary benefit, from these aspects of national interest, of reducing oil imports.

It is also argued, however, that these estimates do not take full account of the U.S. military costs that are borne only for the protection of our oil imports. And, more recently, it is claimed that U.S. oil imports provide financial resources to terrorist-supporting regimes.[17] There is a lack of serious analysis of the effect on the U.S. military posture of a decrease in U.S. oil imports, particularly considering the U.S. position as a dominant world power and the U.S. national interest in the stability of oil supplies worldwide. Similarly, the influence of U.S. volumes in world oil trade (as distinct from that of volumes purchased by Europe, Japan or China for instance) on the motivation and financing of terrorist groups has not been the focus of quantitative analysis, at least not in the public domain.

[17] See, for example, “Who’s afraid of Big, Bad Woolsey? An interview with geo-green James Woolsey, former head of the CIA”, *Grist Magazine* (online), June 7, 2005; or “The New ‘Sputnik’ Challenges: They All Run on Oil” by Thomas Friedman, *New York Times*, January 20, 2006.

The lack of analytical justification does not argue that these issues of national security are insignificant, however, and these concerns contribute to the view implicit in much policy discussion that, among the myriad energy using and emissions producing activities in the economy, automobile travel deserves to be singled-out for special treatment. Under the economic efficiency criterion suggested earlier it is important to know how special that treatment should be, and whether a higher marginal cost imposed in the LDV sector is commensurate with the some notion of the national security costs of oil imports. To this end, if policymakers choose to reflect an additional security premium, a way to preserve the efficiency gains of integration would be to adjust the trading ratio of permits for transactions between the CAFE and the cap-and-trade systems. For example, to offset one ton of carbon emissions expressed as LCB, the auto sector might have to buy 1.2 tons or allowances from the capped sector.[18]

The correct ratio would depend on the valuation of oil dependence externalities not already covered by existing fuel taxes. Importantly, such a trading penalty would not only impose this externality penalty on vehicle design in an efficient way but would also provide transparency as to what the penalty is—a characteristic missing in the use of the CAFE level itself for this purpose. Debate over the proper level of such a trading ratio would stimulate needed research and analysis of the import premium, and foster greater transparency in this important area of public policy.

7. INTERMEDIATE STEPS IN ANTICIPATION OF INTEGRATION

Although some form of cap-and-trade system seems likely to be adopted in the U.S., none of the current proposals has yet received the support of either house of Congress or of the Administration. In anticipation of such a system, several intermediate steps could improve the efficiency of the CAFE system in ways that are consistent with possible system integration using the trading mechanisms discussed above. Three such measures are of interest: opening up LDV trading only among the auto manufacturers, changing the nature of the compliance penalty under the current CAFE system, and allowing auto manufacturers to meet their CAFE requirements in part by earning or purchasing early action credits under potential voluntary emissions mitigation programs.

7.1 Permit Trading Among Manufacturers

An initial step in the direction of a linked trading system would be to allow trading of CAFE credits among vehicle manufacturers. As shown by the study by the Congressional Budget Office (CBO, 2003; Austin and Dinan, 2005) allowing trading only among manufacturers would allow emissions reductions within the auto sector to be achieved in at lower cost, yielding cost savings of around 17%. This change would also allow a price signal to emerge providing transparency about the cost of policy to consumers and legislators. Finally, if and when a cap-and trade system

[18] The correction of policy inefficiency in the regulation of this sector would not be complete, of course. Under the trading differential the security premium would apply to vehicle manufacture and choice but not to the decision to drive, which would require an equivalent impact on motor fuel price. This option raises a long debated question of the imposition of auto-related externality costs in fuel taxes, a topic studied most recently (with a heavy focus on congestion cost) by Parry and Small (2006).

emerges, the experience gained would facilitate integration with the transport sector. This intra-sectoral trading has been endorsed by the NAS (2003) and, most recently, by the National Commission on Energy Policy (2004). Trading would not lead to a departure by the industry as a whole from the current CAFE standard since underachievement by one manufacturer would have to be offset by overachieving by others. As noted above, in today's system overachievement has been the signal to enter less fuel-efficient segments of the market and drive the individual firm average back to the standard. Inter-firm trading would lower this incentive.

7.2 Create a Safety Valve

Another step toward an explicit carbon price in the LDV sector would be to introduce a "safety valve" as proposed by the NAS (2002) and endorsed by the National Commission on Energy Policy (2004). Under a safety valve the U.S. government would stand ready to sell CAFE credits at a pre-determined price. Manufacturers could then choose to buy credits if the cost of adding technology or mix-shifting exceeded the pre-determined upper limit to the price of carbon.

The present CAFE fine is, in effect, a safety valve at about an equivalent of $90 per ton of carbon. As discussed earlier, however, domestic firms fear that a strategy that utilized fines would put them at legal jeopardy. As a result, based on the analysis above, the costs of CAFE likely exceed the legislatively established fine. One way to introduce the safety valve would be to provide clear language in the statute that paying fines would be an alternative compliance strategy.

Introduction of an explicit fine would also enhance the transparency of the policy and provide a measure of the cost of the regulation. As increases in the standard are contemplated, explicit measures of the upper limit on the cost would help in evaluating policy changes.

7.3 Consider Early Action Credits

While helpful in correcting some current inefficiencies and distortions, the two intermediate approaches above still would not take advantage of the lower-cost GHG emissions reductions that may be available in other sectors of the economy. To accomplish that end, trading between the LDV manufacturers and other sectors is necessary. One possibility for introducing this feature, even in the absence of an economy-wide cap-and-trade system, is to allow automobile manufacturers to purchase credits generated voluntarily in other sectors as a means of complying with CAFE regulation.

The Administration has proposed regulations for documenting carbon baselines under section 1605b of the Energy Policy Act of 1992. The intent of the proposed regulations is to establish documented CO_2 emissions baselines to allow measurement and "early action" credit for CO_2 reductions undertaken by firms. The idea of early action is to allow firms to gain credits from actions taken before a mandatory trading regime is instituted. Allowing these credits to be used instead for satisfying the CAFE requirements placed on automobile manufacturers would allow a closing of the gap between the cost of CO_2 reductions through CAFE and the expected cost in other sectors of the economy. In addition, allowing the purchase of credits voluntarily earned would encourage participation in the program of voluntary reduction since the reward would be more certain than what would be offered by potential early action credit provisions. If oil consumption issues are the source of independent concern, again, the proper ratio of permits could be applied.

Another argument against allowing this sort of inter-sectoral trading is that it will be difficult to certify real reductions. But, achieving this improvement is precisely the goal in the attempts to strengthen the 1605b program. Furthermore, the Chicago Climate Exchange seems to have had some success in establishing rules and procedures for measuring voluntary reductions from baselines, and international organizations, including the World Bank, are sponsoring trading in certified emission reductions. Thus it should be possible to piggy-back on the Administration's and other voluntary reduction programs to begin to approach an integrated system.

These intermediate steps would progressively introduce transparency, explicit carbon prices, and greater efficiency. Of course they fall short of the efficiency obtainable by an economy-wide cap-and-trade system including motor fuels and linked to the transport sector.

8. CONCLUSIONS

Two central conclusions emerge from this analysis. First, in the presence of an overall carbon cap CAFE is a poor regulatory policy for dealing with carbon emissions whether integrated with the cap-and-trade system or not. It is at best an inefficient means of obtaining any given emission reduction, and at worst completely ineffective in achieving any end other than shifting more of the cost of any future CO_2 emission reduction onto new car purchasers. Second, integrating CAFE regulation with a future cap-and-trade system likely would improve the efficiency and reduce the total cost of the intended CO_2 emission reduction.

Whether transport emissions are included within the cap or not, the main mechanism for integration of CAFE with a cap-and trade system would be trading of credits and deficiencies where the unit of exchange would be the lifetime carbon burden of the new vehicle. If underachievement of CAFE were still a concern because of national security issues raised by oil imports, a differential trading price as suggested above could be applied.

Integrating the light-duty vehicle sector into an economy-wide cap-and-trade system yields a single price of carbon and the cost of mitigation is equalized at the margin between automobile manufacturers and across sectors of the economy, producing an efficient pattern of carbon mitigation. In addition, a known and public carbon price fosters policy transparency, informing legislators, consumers, and the public in general about the costs of policies. The U.S. CAFE system, under current levels but more significantly if tightened in the support of climate policy, implicitly imposes a cost of carbon mitigation in excess of what most observers believe would be the price of carbon reduction in the early years of a domestic cap-and-trade regime. This difference in cost suggests that there are gains to be realized for the national economy by integrating transportation regulation with any economy-wide system for controlling CO_2 emissions.

Of the possible combined linked systems the most efficient would be one based on a cap-and-trade regime where motor fuel is under the cap and therefore the price of fuel reflects the carbon externality. With oil under the cap, tightening CAFE has the same effect on emissions as tightening the overall cap. The significant difference, however, is that tightening CAFE places more of the regulatory burden on the auto sector, whereas tightening the cap distributes the burden over all sectors subject to the cap. In essence, CAFE becomes a distribution policy and redundant from the standpoint of carbon emissions. If motor fuel is not under the cap, tightening CAFE will have some effect on emissions but at very high cost.

Finally, there are intermediate approaches that could begin to equalize carbon mitigation costs among vehicle manufacturers and sectors in anticipation of an economy-wide cap-and-trade system. The most obvious change would be to allow the trading of credits only among vehicle manufacturers, which would equalize marginal compliance costs and develop experience with such trading systems. Another potential step would be to clarify the statutory language so that vehicle manufactures could choose to pay the legislated CAFE fines as a compliance strategy. Allowing fines as an alternative would set an upper limit on the costs of CAFE, which are already high relative to carbon mitigation costs contemplated for other sectors. Lastly, any increased CAFE standard could be coupled with trading of LCB credits with other sectors that voluntarily reduce emissions. Many firms have made voluntary reduction commitments, and allowing trading between vehicle manufacturers and those firms would encourage more firms to make similar commitments. Experimentation in this domain would also be consistent with efforts to encourage voluntary action and develop sound inventories of firm-level CO_2 emissions. This policy innovation would be a step along the way toward equalizing marginal mitigation costs across sectors, and would help develop baselines and a market for carbon mitigation.

Given these observations, what is the best way to control CO_2 emissions from the automobile sector? Our view is that the best approach is an upstream, all-sector cap-and-trade system. Under such a system, CAFE would not be a good climate policy tool for the reasons described above. Nevertheless, linking CAFE by a credit-debit approach—with appropriate adjustment for non-climate objectives—would ensure least cost carbon reduction if there are mandated increases in CAFE and remove an existing inefficiency as well. Integrating the systems very likely cannot be achieved piecemeal. If an un-linked cap-and-trade system is created, then any attempt later to integrate the transport sector may be very difficult. If this political judgment is correct, then the desired path is legislation with cap-and-trade and the CAFE link bundled. Such an approach would add some complexity to the already difficult task of cap-and-trade design, but the likely alternative would appear to be independent systems, continuing struggle over CAFE, and a potentially wasteful system for greenhouse gas control that asks consumers to pay more for GHG control when driving to visit relatives than when using electricity at home.

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