Proposed Changes in Motor Carrier Hours of Service Regulations: An Assessment

DRAFT REPORT

FOR
task under
Contract No. DTFH61-96-C-00038
Engineering, Analytic and Research Support for Motor Carrier Safety Activities
Prime Contractor University of Michigan
Transportation Research Institute

Cost-benefit analysis provided by
University of Michigan
Institute of Labor and Industrial Relations
University of Michigan Trucking Industry Program

March 6, 2002

Project Director: Michael H. Belzer, Ph.D.
Contributing Researchers:
George A. Fulton, Ph.D.
Donald R. Grimes
Gregory M. Saltzman , Ph.D.
Stanley Sedo, Ph.D.
Lucie G. Schmidt

ABSTRACT:

This report consists of two parts. Section I is a critique of the FMCSA's analysis for the Proposed Rulemaking, analysis of existing research in this area, analysis of applicable law, and a general weighing of costs and benefits. Benefit-cost analyses require analysts to determine both costs and benefits to determine whether the benefits of regulation outweigh the costs. Time and funding limited this analysis, as research generally is lacking on occupational health and safety issues involved in long and irregular work hours.

Section II is a macroeconomic analysis of the cost involved in regulating truck driver hours-of-work. This analysis uses a macroeconomic model to estimate effects based on existing data on truck driving. This analysis is based on the UMTIP truck driver survey, with which we were able to estimate the labor supply curve (the individual driver's tradeoff of labor and leisure, at each given wage level in the gradient found in the current labor market). Based on that analysis, researchers employed a REMI model of the economy and provide estimated employment effects throughout the economy.

The May 2000 proposal by the U.S. government to change hours of service (HOS) regulations for motor carriers generated considerable controversy. This study, however, finds that an HOS proposal that effectively reduced work hours and stabilized schedules could increase economic efficiency by addressing important market failures in the market for driver labor. The government's preliminary economic analysis of the HOS proposal misclassified redistribution from motor carriers to drivers as a social cost, omitted important benefits to driver health from working shorter and more regular hours, and arguably misclassified the costs of achieving compliance with current HOS regulations (adopted in 1937) as a cost of the May 2000 revisions.

This study also assesses the cost of implementing a simplified but enforced HOS regime. Assuming only compliance with the 60 hour per week work limit in the current regulations, and based on the FMCSA's expectation that at least 49,000 new drivers would be needed under this regime, we find that the cost to the economy of the additional work force is $2.3 billion. We assume, for purposes of this analysis, a full-employment economy, so these workers will shift from other sectors of the economy (mainly services) and the impact will be uneven on a state-by-state basis. Because of unexpected funding limitations we were unable to test alternative proposed regulatory regimes so this analysis is limited to the cost (not the benefits) of getting truck drivers who are covered by the regulations into compliance with current law, assuming most conservatively that all drivers who work in excess of 60 hours per week reduce their hours to 60 hours and all drivers working less than 60 hours are able to increase their hours to the legal limit. While obviously unrealistic, this assumption allows us to develop the most conservative cost baseline.

In short, we find that the expected benefits from shorter work hours likely include lower crash costs, lower injury cost, and lower cost of occupational disease due to long and irregular hours. Research suggests that greater hourly labor productivity results from less total hours spent working and such working conditions likely will attract more qualified, safer, and more efficient workers. Further research will be necessary to determine the precise measures of such benefits. This analysis does not include a balancing of costs and benefits because of the lack of current research available on which to base such analysis and because funding was terminated mid-project.

U.S. HOS standards lag behind the standards set by other major democracies. Although clearly there are many operational difficulties, the case in favor of strengthening HOS regulations is stronger than the many critics allege.

Part I
General Assessment
Introduction

On May 2, 2000, the Federal Motor Carrier Safety Administration (FMCSA) of the U.S. Department of Transportation (DOT) proposed modifications in hours of service (HOS) regulations governing work hours of interstate truck and bus drivers. This proposal generated considerable controversy. In October 2000, Congress included language in the DOT appropriations bill prohibiting FMCSA from taking final action on the proposed rule during fiscal year 2001 (October 2000 through September 2001).[1]

This section of the report assesses the HOS proposal and the economic analysis of the proposal in the Notice of Proposed Rulemaking (NPRM).[2] We show that the preliminary cost/benefit analysis in the NPRM substantially overstated some costs and substantially understated the benefits of the HOS proposal.[3] The specific topics addressed include:

- Current HOS regulations and how the May 2000 proposal would amend them.
- Market failures that may justify HOS regulations.
- The political economy of HOS regulations and reasons why there might be opposition to them even if they passed the cost/benefit test.
- The distinction between the costs of compliance with existing regulations and the incremental costs imposed by the proposed new regulations. Most of the costs attributed to the May 2000 HOS proposal actually represent costs of ending violations of HOS regulations that have been in effect since 1938.
- The social cost of labor needed to implement the HOS proposal and why the NPRM may greatly overestimate this social cost.
- DOT's obligation to consider driver health when assessing the benefits of the proposed HOS regulations.
- The potential impact of the proposed HOS regulations on driver health. The driver health benefits are substantial; thus, adding them to the benefits considered in the NPRM greatly strengthens the case for regulations reducing actual work hours.
- Other potential benefits of the proposed HOS regulations that did not receive sufficient attention in the NPRM.
- HOS regulations in the European Union—how the U.S. lags far behind other industrialized democracies in addressing long work hours among truck and bus drivers and in using modern technology to record work hours.

---

[1] Bill Ghent, "Conferees OK Transportation Appropriations; Mandate New Alcohol Laws," National Journal News Service, 106 Markup H.R. 4475, October 3, 2000, available online June 27, 2001 through Lexis-Nexis Congressional Universe.

[2] Federal Motor Carrier Safety Administration, U.S. Department of Transportation, "Hours of Service of Drivers; Driver Rest and Sleep for Safe Operations," *Federal Register*, May 2, 2000, pp. 25540-25611 (hereafter, NPRM).

[3] For another analysis of the HOS proposal, see Paul F. Rothberg, "Hours-of-Service Regulations For Commercial Drivers—Federal Motor Carrier Safety Administration's Proposal," (Washington, DC: Congressional Research Service Report for Congress), December 18, 2000. The lack of evidence for some of the assumptions in the NPRM analysis is noted in U.S. General Accounting Office, "Commercial Motor Vehicles: Effectiveness of Actions Being Taken to Improve Motor Carrier Safety Is Unknown," (Washington, DC: Report number GAO/RCED-00-189), July 2000.

We conclude that the case in favor of the proposed modifications in HOS regulations is considerably stronger than its many critics allege.

Current HOS Regulations and How the May 2000 HOS Proposal Would Amend Them

Current HOS regulations limit motor carrier drivers to no more than 60 hours of on-duty time in any 7 consecutive days or 70 hours in any 8 consecutive days. These weekly limits were established by the original HOS regulations, adopted in 1937, and they have not been changed since then.[4]

The 1937 regulations also limited drivers to 12 hours per day of work, including "loading, unloading, driving, handling freight, preparing reports, preparing vehicles for service, or performing any other duty pertaining to the transportation of passengers or property."[5] But a 1938 amendment replaced this with a limit of 10 hours of driving in any 24-hour period and a requirement that drivers have at least 8 consecutive off-duty hours per day. The remaining 6 hours per day could be used for work activities other than driving, such as loading, inspecting the vehicle, and completing paperwork, or for meals and breaks.[6]

A 1962 amendment led to work schedules potentially inconsistent with humans' natural 24-hour circadian rhythm. This amendment replaced the limit of 10 hours of driving per 24-hour period with a requirement that drivers have at least 8 consecutive off-duty hours after having completed no more than 10 hours of driving. After this off duty period, the driver could resume driving.[7] A driver in a hurry—or a carrier dispatching a driver for maximum production—thus could legally use an 18-hour cycle: 10 hours of driving, 8 hours off duty, 10 hours of driving, 8 hours off duty, etc. A driver on this cycle would be driving 16 hours on some days, rather than the maximum of 10 per day allowed from 1938 to 1962.

The HOS amendments proposed in May 2000 would be the first major amendments to HOS regulations since 1962. The May 2000 proposal establishes five categories of drivers: long-haul, regional, local split shift, local, and "work vehicle" drivers (such as repair technicians) whose work mainly consists of tasks other than driving. HOS rules would be slightly different for each category. The major features of the May 2000 proposal are that:

- It restores the 24-hour daily cycle in HOS regulations.
- It limits most drivers to a maximum of 12 hours on-duty within a 24-hour cycle, with no distinction between driving and other work. (Work vehicle drivers may work 13 hours per day.)
- It increases the minimum off-duty period from 8 consecutive hours each day to 10 for long haul, regional, and local drivers; and from 8 to 9 for local split shift and work vehicle drivers.

[4] NPRM, pp. 25547-25548.
[5] Quoted in NPRM, p. 25547.
[6] NPRM, p. 25548.
[7] NPRM, p. 25548.

- It requires a weekly recovery period of at least 32 consecutive hours off duty per week (including at least two consecutive midnight to 6:00 AM periods).
- It permits long-haul and regional drivers to use a two-week cycle in which they can work up to 72 hours one week if they work no more than 48 in the other.
- The option that FMCSA recommends also requires long haul and regional drivers to use electronic on-board recorders (EOBRs) to keep track of work hours automatically.[8]

The proposed EOBR requirement is an attempt to prevent the widespread falsification of work logs that occurs under the current record of duty status (RODS) system, in which drivers write down their hours in work logs.[9]

One option mentioned in the NPRM would also prohibit drivers from driving more than 18 hours per week between midnight and 6:00 AM. This prohibition, however, was not included in the option that FMCSA recommends and therefore seems unlikely to be adopted.

Market Failures That May Justify HOS Regulations

An assessment of the HOS proposal must consider a key theorem in economics: perfectly competitive markets result in economic efficiency. If the benefits from reduced driver hours exceed the costs, then market forces will reduce driver hours. For example, if long work hours have an adverse effect on drivers' health, family life, and sense of well being, then they will demand compensating wage differentials (that is, higher hourly pay) for jobs that entail long hours. In this idealized economic model, trucking companies and shippers will be willing to pay the cost of these compensating differentials only if the benefit to them of having drivers work long hours is large enough to justify the cost.

Under what circumstances, then, are new government regulations appropriate? In 1996, the Office of Management and Budget (OMB) published "best practice" guidelines for economic analysis of federal regulations, prepared by a working group chaired by Joe Stiglitz of the President's Council of Economic Advisors and DOT General Counsel Steve Kaplan.[10] These guidelines state:

> In order to establish the need for the proposed action, the analysis should discuss whether the problem constitutes a significant market failure. If the problem does not constitute a market failure, the analysis should provide an alternative demonstration of compelling public need, such as improving governmental processes or addressing distributional concerns. If the proposed action is a result of a statutory or judicial directive, that should be so stated.

[8] NPRM, p. 25568, 25581, 25604.
[9] This falsification of work logs has been documented by research surveys of drivers. See Michael H. Belzer, *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation* (New York: Oxford University Press, 2000), pp. 37-38.
[10] "Economic Analysis of Federal Regulations Under Executive Order 12866," U.S. Office of Management and Budget, January 11, 1996, available online on May 1, 2001 at http://www.whitehouse.gov/omb/inforeg/riaguide.html

This statement echoes the argument of noted economist Arthur Okun that decision makers should consider both economic efficiency and fair treatment for the less advantaged when setting policy.[11]

This moral argument about fairness has some relevance to a debate about legal limits on work hours. For example, the portion of the May 2000 HOS proposal requiring a weekly recovery period of at least 32 consecutive off duty hours has roots in the Ten Commandments, which require people to refrain from work every seventh day in order to get adequate rest. According to the Bible, divine commandment requires people to provide this day of rest even to their slaves and to their farm animals such as oxen and donkeys.[12] A compelling distributional argument could be made for treating American truck drivers at least as well as the Bible required people to treat their donkeys.

Another equity issue is that drivers earn relatively low hourly wages but face relatively high risks of occupational injury or death. A 1997 survey found that nonunion truckload drivers earned an average of $9.88 per hour at straight time, or the equivalent of $8.17 per hour in most other jobs, where the Fair Labor Standards Act requirement of premium pay for overtime would apply.[13] Only a few other occupations such as commercial fishing and logging, however, have higher rates of occupational fatalities than that for truck drivers.[14] A fairness argument could therefore be made for regulations to improve working conditions for drivers.

The rest of this section, however, will focus on economic efficiency. The OMB guidelines list four cases of market failure: externalities, natural monopoly, market power, and inadequate or asymmetric information. Psychologists might add another case: cognitive failures in processing data. Where there is a market failure, government regulation could enhance rather than reduce economic efficiency. Motor carriers have little or no market power, and none have a natural monopoly. There are, however, other market failures that might justify the proposed HOS regulations, as explained below.

First, there is an important externality: the benefit to other drivers and pedestrians from improved highway safety. Work hours affect safety. Numerous research studies published in refereed journals have established that long and irregular work hours for drivers lead to fatigue, reduced alertness, and impaired coordination.[15,16,17] Driver fatigue and reduced driver alertness

---

[11] Arthur Okun, *Equality and Efficiency: The Big Tradeoff* (Washington, DC: Brookings Institution, 1975).
[12] See, for example, *Exodus* 23:12.
[13] Belzer, *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation, ibid.*, p. 47.
[14] Occupational Safety and Health Administration, U.S. Department of Labor, "Occupations With Highest Rates of Fatal Industries" (1993 data), available on line, November 16, 2001, at http://www.osha.gov/oshinfo/priorities/appendixA/table6.html
[15] For a review of research studies on this topic and other topics related to the NPRM, see Deborah M. Freund, *An Annotated Literature Review Relating to Proposed Revisions to the Hours-of-Service Regulation for Commercial Motor Vehicle Drivers*, Office of Motor Carrier Safety, U.S. Department of Transportation, November 1999, DOT-MC-99-129.
[16] The following studies relate specifically to truck or bus drivers:
Merrill M. Mitler, James C. Miller, Jeffrey J. Lipsitz, *et al.*, "The Sleep of Long-Haul Truck Drivers," *New England Journal of* Medicine, Vol. 337, No. 11, 11 September 1997, pp. 755-761.
Goran Kecklund and Torbjorn Akersted, "Sleepiness in long distance truck driving: an ambulatory EEG study of night driving," *Ergonomics*, September 1993, Vol. 36, No. 9, pp. 1007-1017.

cause highway collisions and near misses.[18] The rate of fatigue-related truck accidents increases significantly after drivers have been driving for more than 9.5 hours.[19] Restriction of sleep to 4-5 hours per night (a common experience for truckers[20]) causes significant deterioration in reaction time performance within three nights; and after a week of partial sleep deprivation, it takes two full nights of sleep for reaction time performance to recover.[21] In addition, six days of partial sleep deprivation (sleep limited to four hours per day) significantly increases sleep-disordered

---

Elisa R. Braver, Carol W. Preusser, David F. Preusser, *et al.*, "Long Hours and Fatigue: A Survey of Tractor-Trailer Drivers," *Journal of Public Health Policy*, Vol.13, No. 3, Autumn 1992, pp. 341-366.

Judith K. Sluiter, Allard J. van der Beek, and Monique H.W. Frings-Dresen, "The Influence of Work Characteristics on the Need for Recovery and Experienced Health: A Study on Coach Drivers," *Ergonomics*, Vol. 42, No. 4, 1999, pp. 573-583.

A.M. Williamson and Anne-Marie Feyer, "Moderate Sleep Deprivation Produces Impairments in Cognitive and Motor Performance Equivalent to Legally Prescribed Levels of Alcohol Intoxication," *Occupational and Environmental Medicine*, Vol. 57, No. 10, 1 October 2000, pp. 649-655.

M.T. Mello, M. G. Santana, L. M. Souza, *et al.*, "Sleep Patterns and Sleep-Related Complaints of Brazilian Interstate Bus Drivers," *Brazilian Journal of Medical and Biological Research*, Vol. 33, No. 1, January 2000, pp. 71-77.

[17] The following studies (of railroad engineers, experimental subjects, and car drivers, respectively) also seem relevant to truck or bus drivers:

June J. Pilcher and Michael K. Coplen, "Work/Rest Cycles in Railroad Operations: Effects of Shorter Than 24-H Shift Work Schedules and On-Call Schedules on Sleep," *Ergonomics*, Vol. 43, No. 5, 2000, pp. 573-588.

Drew Dawson and Kathryn Reid, "Fatigue, Alcohol and Performance Impairment," *Nature*, Vol. 388, No. 6639, 17 July 1997, p. 235.

Heikki Summala, Helina Hakkanen, Timo Mikkola, and Janne Sinkkonen, "Task Effects on Fatigue Symptoms in Overnight Driving," *Ergonomics*, Vol. 42, No. 6, June 1999, pp. 798-806.

[18] See, for example:

James M. Lyznicki, Theodore C. Doege, Ronald M. David, and Michael A. Williams, "Sleepiness, Driving, and Motor Vehicle Crashes," *JAMA*, Vol. 279, No. 23, 17 June 1998, pp. 1908-1913.

William C. Dement, "The Perils of Drowsy Driving," *New England Journal of Medicine*, Vol. 337, No. 11, 11 September 1997, pp. 783-785.

Paul Barach, Gerry Ben David, and Elihu Richter, "The Sleep of Long-Haul Truck Drivers (Correspondence)," *New England Journal of Medicine,* Vol. 338, No. 6, 5 February 1998*,* pp. 389-391.

Heikki Summala and Timo Mikkola, "Fatal Accidents among Car and Truck Drivers: Effects of Fatigue, Age, and Alcohol Consumption," *Human Factors*, Vol. 36, No. 2, June 1994, pp. 315-326.

Helina Hakkanen and Heikki Summala, "Sleepiness at Work Among Commercial Truck Drivers," *Sleep*, Vol. 23, No. 1, 2000, pp. 49-57.

P. Philip, F. Vervialle, P. Le Breton, *et al.*, "Fatigue, Alcohol, and Serious Road Crashes in France: Factorial Study of National Data," *British Medical Journal*, Vol. 322, No. 7290, 7 April 2001, pp. 829-830.

Anne-Marie Feyer, "Fatigue: Time to Recognize and Deal with an Old Problem: It's Time to Stop Treating Lack of Sleep as a Badge of Honor," *British Medical Journal*, Vol. 322, No. 7290, 7 April 2001, pp. 808-809.

Jim A. Horne and Louise A. Reyner, "Vehicle Accidents Related to Sleep: A Review," *Occupational and Environmental Medicine*, Vol. 56, No. 5, May 1999, pp. 289-294.

Jim A. Horne and Louise A. Reyner, "Sleep Related Vehicle Accidents," *British Medical Journal*, Vol. 310, No. 6979, 4 March 1995, pp. 565-567.

[19] F. F. Saccomanno, M. Yu, and J. H. Shortreed, "Effect of Driver Fatigue on Truck Accident Rates," in L. J. Sucharov (ed.), *Urban Transport and the Environment for the 21st Century* (Southampton, United Kingdom: Computational Mechanics Publications, 1995), pp. 439-446.

[20] Mitler, Miller, Lipsitz, *et al.*, "The Sleep of Long-Haul Truck Drivers," *op. cit.*

[21] David F. Dinges, Frances Pack, Katherine Williams, *et al.*, "Cumulative Sleepiness, Mood Disturbance, and Psychomotor Vigilance Performance Decrements During a Week of Sleep Restricted to 4-5 Hours per Night," *Sleep*, Vol. 20, No. 4, April 1997, pp. 267-277.

breathing.[22] A common problem among long-haul truck drivers,[23] sleep disordered breathing doubles the accident rate among this group.[24]

The externality arises because these collisions often affect third parties (parties other than bus or truck companies, shippers, and commercial motor vehicle drivers), and motor carriers may not fully consider costs borne by third parties when making decisions about driver hours.[25] Admittedly, bus or trucking companies may have to provide compensation to third parties who have suffered losses. But compensation actually paid often does not fully compensate for the losses. Moreover, many trucking companies are small firms whose liability insurance is not fully experience rated, so that much of the compensation may come out of the pockets of other trucking companies or even companies in other industries. (This helps to explain why the Insurance Institute for Highway Safety supported a minimum of 12 to 14 hours off duty per day.[26]) Because part of the damage to third parties caused by driver fatigue is an external cost, an unregulated free market provides less than the economically efficient level of highway safety.

Inadequate or asymmetric information often prevents labor markets from providing the economically efficient level of occupational safety and health. Many cite the experience of shipyard workers during World War II, who incurred dangerous exposures to asbestos because major asbestos producers concealed information about the harmful effects of this material.[27] Because the shipyard workers were ignorant of the risks they were taking, they did not demand proper ventilation in the ship hulls in which they worked, and they did not receive compensating wage differentials. The social benefits of reducing occupational exposure to asbestos would have exceeded the social costs (that is, reducing asbestos exposure would have been economically efficient); but the free market failed to effect this reduction because of imperfect information. Subsequent government asbestos regulations have been criticized for going too far in the other direction, setting exposure limits that were excessively strict and disregarding costs. Still, had the government adopted narrowly tailored asbestos regulations that focused on the highest risk cases (cigarette smokers with massive exposures to loose asbestos fibers), regulation could have been highly cost-effective compared to the alternative of an unregulated free market.

---

[22] Riccardo A. Stoohs and William C. Dement, "Snoring and Sleep-Related Breathing Abnormality During Partial Sleep Deprivation (Correspondence)," *New England Journal of Medicine*, Vol. 328, No. 17, 29 April 1993, p. 1279.

[23] Riccardo A. Stoohs, L'Ann Bingham, Anna Itoi, Christian Guilleminault, and William C. Dement, "Sleep and Sleep-Disordered Breathing in Commercial Long-Haul Truck Drivers," *Chest*, Vol. 107, No. 7, May 1995, pp. 1275-1282.

[24] Riccardo A. Stoohs, Christian Guilleminault, Anna Ito, and William C. Dement, "Traffic Accidents in Commercial Long-Haul Truck Drivers: The Influence of Sleep-Disordered Breathing and Obesity," *Sleep*, Vol. 17, No. 7, October 1994, pp. 619-623.

[25] A study of Germany, the United Kingdom, Switzerland, and Scandinavia found that "passenger cars and motorcycles primarily pose a hazard to the occupants of those vehicles, whereas buses and lorries primarily pose a hazard to the non-occupants, … for example, pedestrians, cyclists and occupants of those motor vehicles lighter than lorries or buses." Ulf Persson and Knut Odegaard, "External Cost Estimates of Road Traffic Accidents: An International Comparison," *Journal of Transport Economics and Policy*, Vol. 29, No. 3, September 1995, pp. 291-304 at 299-300. See also Rune Elvik, "The External Costs of Traffic Injury: Definition, Estimation, and Possibilities for Internalization," *Accident Analysis and Prevention*, Vol. 26, No. 6, December 1994, pp. 719-732.

[26] NPRM, p. 25550.

[27] Paul Brodeur, *Outrageous Misconduct: The Asbestos Industry on Trial* (New York: Pantheon Books, 1985), pp. 109-121.

As a later section will demonstrate, long and irregular work hours have adverse health effects on drivers. Some of these adverse effects do not become apparent until years after the drivers have had occupational exposure to bad working conditions. In other cases, drivers are unaware of the linkage between occupational conditions and these adverse effects. Whenever the onset of adverse effects is delayed or only experts know that occupational conditions contribute to these effects, an unregulated free market provides less than the economically efficient level of occupational health to drivers.

Cognitive psychologists such as Daniel Kahneman and Amos Tversky would add to economists' traditional list of market failures, noting that decisions of individual workers or managers may be distorted by cognitive failures in processing data, and preferences may be endogenous.[28] Many prominent economists, such as Daniel McFadden, have recognized the importance of these deviations from economists' assumptions about rationality.[29] Government regulation may also increase economic welfare over the outcome from an unregulated free market if cognitive failures or endogenous preferences are important.

McFadden's colleagues at the University of California-Berkeley, George Akerlof and William Dickens, argued that cognitive dissonance causes workers to underestimate systematically the health risks that they face in the workplace, as allowing themselves to recognize these risks would be too stressful.[30] Such a phenomenon might cause drivers to underestimate the adverse effects on their health and family life of long and irregular work hours, with the result that they do not demand sufficiently large compensating wage differentials to counter these adverse effects. HOS regulations are needed, in part, because cognitive dissonance distorts the driver labor market.

Decisions by managers may be distorted when some costs are not explicit. Psychologists have shown that implicit opportunity costs are less salient to decision makers than are explicit costs.[31] Because long haul and regional drivers typically are paid only by the mile, with no separate pay for nondriving work (unless they are among the shrinking number of drivers covered by union contracts, who generally receive hourly pay for nondriving work), trucking companies and shippers perceive time that drivers spend waiting for loads or supervising loading and unloading as having a price of zero. This zero price gives shippers and trucking companies little incentive to minimize the waiting or loading time. Furthermore, drivers have no incentive to record waiting or loading time in their RODS; recording an extra hour of waiting or loading time does not yield them any extra pay, but it does reduce the number of hours they have available under the HOS regulations for paid driving time. The social cost of nonunion drivers' time clearly exceeds zero, however, so that the false perception that waiting or loading time has a

[28] See, for example, Daniel Kahneman and Amos Tversky, "Prospect Theory: An Analysis of Decisions Under Risk," *Econometrica*, Vol. 47, No. , 1979, pp. 263-291; or Daniel Kahneman, Jack L. Knetsch, and Richard Thaler, "Experimental Tests of the Endowment Effect and the Coase Theorem," *Journal of Political Economy*, Vol. 98, No.6, 1990, pp. 1325-1348.
[29] Daniel McFadden, "Rationality for Economists?" *Journal of Risk and Uncertainty*, Vol. 19, No. 1, 1999, pp. 73-105.
[30] George A. Akerlof and William T. Dickens, "The Economic Consequences of Cognitive Dissonance," *American Economic Review*, Vol. 72, No. 3, June 1982, pp. 307-319.
[31] Gregory B. Northcraft and Margaret A. Neale, "Opportunity Costs and the Framing of Resource Allocation Decisions," *Organizational Behavior and Human Decision Processes*, Vol. 37, No. 3, June 1986, pp. 348-356.

zero price leads to an inefficient allocation of resources. Strict enforcement of HOS regulations would make the opportunity costs of loading and waiting time more salient to trucking companies and shippers, thereby prodding them to re-engineer inefficient aspects of their operations.

The economically efficient level of driver work hours depends in part on the strength of driver preferences for time off work. Economists normally assume that preferences are exogenous (determined outside the economic system). This and other standard economic assumptions result in the Coase theorem, which states that the use of resources does not depend on the initial allocation of property rights.[32] But Coase's colleague at the University of Chicago, Cass Sunstein, argued that this aspect of the Coase theorem is not valid when preferences are endogenous (determined within the economic system).[33] Sunstein cited one example of endogenous preferences: the "endowment effect," whereby people place a greater subjective value on something that they already own than on something that they do not already own.[34] Because of the endowment effect, "the entitlement will tend to stay where it has initially been allocated. People to whom the entitlement has initially been allocated will value it most, and precisely because of the initial allocation."[35]

The implication of this for HOS regulation is that the "economically efficient" level of driver hours is a moving target. If the government cannot prevent systematic violations of HOS regulations, then drivers will place a lower value on something that they do not have (adequate rest), and long work hours will be economically efficient. But if the government enforces a policy that drivers have a right to adequate rest, then the endowment effect will cause drivers to place a higher subjective value on rest, and shorter work hours will be economically efficient.

Another consideration is that the HOS proposals do not apply to a previously unregulated market. Rather, they revise existing regulations. While economic theory asserts that perfectly competitive markets maximize economic efficiency, there is no theoretical reason to assume the efficiency of existing regulations. Older regulations that were adopted before government used careful cost/benefit analysis and when knowledge about adverse health effects was less extensive than it is today could have very unfavorable cost/benefit ratios. Furthermore, regulations that were efficient under market conditions existing at the time of adoption (e.g., a regulated industry with strong union protection for workers, or high production costs for EOBR's) might no longer be efficient if those conditions have changed substantially.

The May 2000 proposals may contribute to economic efficiency by revising two previously adopted regulations. First, they effectively reverse the 1962 HOS amendment that allowed many drivers to move to an 18-hour daily work/rest cycle. Scientific experts on sleep and circadian rhythm have emphasized the biological need for a 24-hour daily work/rest cycle, which the May 2000 proposals would help restore (although cycles longer than 24 hours would still be permitted). Second, the May 2000 proposal for EOBRs represents an efficiency gain

[32] Ronald H. Coase, "The Problem of Social Cost," *Journal of Law and Economics*, Vol. 3, No. 1, October 1960, pp. 1-44.
[33] Cass R. Sunstein, *Free Markets and Social Justice* (New York: Oxford University Press, 1997), pp. 248-252.
[34] Richard H. Thaler, "Toward a Positive Theory of Consumer Choice," in *Quasi-Rational Economics* (New York: Russell Sage Foundation, 1991), pp. 3-24 (previously published 1980).
[35] Sunstein, *op. cit.,* p. 252

when compared to the previous regulatory system, which required drivers to spend time keeping written logs of their work hours (the record of duty status, or RODS). The preliminary cost/benefit analysis in the NPRM found substantial benefits from the associated reduction in truckers' paperwork burden.[36]

A final efficiency issue concerns whether there are other ways of achieving the same objectives at lower cost. Rather than regulating driver hours directly, the government could indirectly affect driver hours by changing the driver compensation system. One method would be to adopt the European Union regulation effectively banning per-mile pay. Alternatively, the U.S. Department of Labor (DOL) could change the way that it administers the minimum wage law to ensure that no on-duty hours are viewed as having a price of zero. Either method would parallel the approach for environmental regulation of putting a price on pollution, which noted economists have argued is more efficient than directly regulating the quantity of pollution.[37]

By administering the minimum wage provisions of the Fair Labor Standards Act (FLSA) somewhat differently, DOL could change the incentives for shippers, trucking companies, and drivers. In 1940, DOL made an administrative decision to require that the average hourly wage rate over the week at least equal the minimum wage, rather than that the wage rate for each hour at least equal the minimum wage. U.S. Circuit Court judge Ruth Bader Ginsburg declined in 1985 to overturn this DOL decision,[38] deferring to the precedent set 25 years earlier in the Klinghoffer case.[39] Nevertheless, Ginsburg ruled that "the minimum wage laws logically could be construed as requiring hour-by-hour compliance."[40] If DOL chose to exercise its statutory authority to require hour-by-hour compliance, it could end the common practice of treating waiting, loading, and unloading time as unpaid time.

Once shippers and trucking companies stopped perceiving drivers' time as free, they would be more careful not to waste it. Shippers could, for example, arrange for pickups only when the load is ready, and consignees could arrange for deliveries only when they are ready to receive the goods. Similarly, shippers, consignees, and trucking companies could make greater use of the "drop and hook" technique, in which the driver detaches the truck tractor from one trailer and immediately attaches it to another trailer, without waiting for the original trailer to be loaded or unloaded. Although drop and hook entails a capital cost from buying additional trailers, savings in driver waiting time in many cases would justify this capital investment if driver waiting time were not improperly assigned a value of zero.

The impact of requiring hour-by-hour compliance with the minimum wage would be strengthened if Congress also made motor carrier employees subject to the overtime provisions of the FLSA, which require time-and-one-half pay for work in excess of 40 hours per week.

---

[36] Federal Motor Carrier Safety Administration, "Preliminary Regulatory Evaluation and Regulatory Flexibility Act Analysis Hours of Service NPRM," April 2000.
[37] William J. Baumol and Wallace E. Oates, "The Use of Standards and Prices for Protection of the Environment," *Swedish Journal of Economics*, Vol. 73, No. 1, March 1971, pp. 42-54.
[38] *Dove v. Coupe,* 759 F.2 167(DC Cir. 1985).
[39] *United States v. Klinghoffer Bros. Realty Corp.*, 285 F.2d 487 (2d Cir. 1960). We are grateful to Pat Michael, an Oregon truck driver, for calling our attention to the *Klinghoffer* case and for noting its impact on nondriving work hours.
[40] *Dove v. Coupe* at 171,

This requirement for premium pay would give motor carriers an incentive to re-engineer their operations to avoid long work weeks. Currently, Section 13(b)(1) of the FLSA exempts motor carrier employees who are subject to HOS regulations from the overtime provisions of the FLSA. In March 2000, Representative Gerald Kleczka introduced a bill to repeal Section 13(b)(1),[41] but this bill never came to a vote.

Besides changes in the driver compensation system, other alternatives to direct regulation of HOS include: (a) subsidizing construction of rest areas for truck drivers, and (b) repealing the ban on secondary boycotts in the Taft-Hartley Act and the ban on "hot cargo" clauses in the Landrum-Griffin Act.[42] The former would directly address the problem of driver fatigue. The latter would enable the Teamsters to extend union contract coverage to more drivers, and Teamster contracts generally provide hourly pay for waiting and loading time.

It is unclear whether requiring hour-by-hour compliance with the FLSA or any of the other alternatives would address problems associated with driver fatigue at lower cost than the proposed HOS regulations.

Why HOS Proposals Face Opposition Regardless of Economic Efficiency

The proposed HOS regulations face considerable opposition from the trucking industry, as indicated by public comments on the NPRM. In large part, this opposition reflects a fight over the distribution of income and the concentration of compliance costs in a small group—issues not addressed in conventional cost/benefit analysis. Even if it could be decisively demonstrated that the proposed HOS regulations pass the test of cost-benefit analysis, these distributional concerns would remain.

These issues arise because of the way that cost/benefit analysis is conventionally practiced. One could avoid many fights over distribution by assessing proposed regulations with the Pareto criterion: a regulation must make at least one person better off without making anyone worse off. A regulation would be Pareto superior to the pre-regulation status quo if those who gained from the regulation provided full compensation to the losers and still had some net gains left over. But most cost/benefit analyses do not require Pareto superior outcomes.

In practice, cost/benefit analyses assess proposed regulations with the Kaldor-Hicks criterion: the benefits of a regulation must exceed the costs. The Kaldor-Hicks criterion requires only that it be possible, in theory, for the winners to provide full compensation to the losers and still have some net gains left over; the winners need not actually compensate losers. In essence, the Kaldor-Hicks criterion ignores distributional issues and just asks: does the proposed regulation increase adjusted gross domestic product (with the adjustments accounting for goods and services not traded in markets, such as leisure time)?

---

[41] 200 H.R. 4062.

[42] A secondary boycott is when a union goes on strike against one employer to induce that employer to stop doing business with another employer with whom the union has a dispute. Hot cargo clauses are provisions in union contracts allowing union workers at a trucking company or at a warehouse to refuse to handle cargo from another trucking company whose workers are on strike. Both strategies significantly increase union bargaining power and enhance organizing leverage.

Even if the total gains to society exceed the total losses, those who lose will oppose a proposed regulation when compensation is not actually paid. No compensation for losses is provided by the HOS proposal. This lack of compensation accounts for much of the opposition.

Objections to proposed HOS regulations are intensified because the costs of these regulations are concentrated in a small group, each member of which has a lot at stake; but benefits are spread among a very large group, each member of which has little at stake. In such a situation, the small group has a greater incentive to mobilize politically to try to influence governmental decision makers.[43]

The costs of the strengthening HOS regulations fall disproportionately on those trucking companies—generally nonunion companies in the truckload sector—whose drivers now operate their trucks for extremely long hours without breaks. Although these work hours may violate existing HOS regulations, the government usually cannot detect the violations. But the proposed EOBRs, while ineffective in monitoring loading and waiting time, could readily identify companies whose drivers do not have 10 continuous hours per day and 32 continuous hours per week free from driving duties. To avoid penalties for regulatory violations, these companies would have to hire more drivers (possibly driving up market wage rates for drivers) and buy additional truck tractors and trailers. Their costs would rise substantially if the May 2000 HOS proposal were implemented. Because they compete with trucking companies that already comply with existing HOS regulations (who may not have to incur the costs of hiring more drivers or buying additional tractors and trailers merely to maintain their present level of shipping services), the trucking companies that significantly violate existing HOS regulations could not pass on all of their increased costs to shippers. Many of the firms whose competitive advantage was their willingness to violate the law will be forced out of business.

It is also important to note that some trucking executives would like to comply with existing HOS regulations but feel unable to do so because of competition from other trucking firms that violate the existing regulations. Effective enforcement procedures would allow these executives to obey the law without fear of losing their customers to law-breaking rivals.

Effective enforcement of the weekly hours limit also would make it harder for some nonunion trucking companies to undermine the labor standards in Teamster contracts. Nonunion firms often treat loading and waiting time as off-duty hours in order to evade the weekly hours limit, whereas union firms typically treat it as on-duty time for which the drivers receive hourly pay. Enforcement measures to reduce this evasion would level the playing field, seemingly to the advantage of the Teamsters and motor carriers with Teamster contracts.

The California Teamsters have supported state legislation to let drivers sue for damages if trucking companies violate HOS regulations.[44] Similarly, a Congressman testified at a June 22,

---

[43] Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge, MA: Harvard University Press, 1965).

[44] The California Teamsters Public Affairs Council supported a state bill allowing drivers to sue their employers for $250 per day in damages for each day that their employer requires or authorizes them to violate HOS regulations [http://www.teamster.org/01news/hn%5F010321%5F3.htm available online June 25, 2001]. The bill, 2001 CA S.B. 278, was passed by the California Senate on April 19, 2001 and approved by the Assembly Committee on Labor and

2000 Congressional hearing in favor of the proposed EOBR requirement, noting that "hours-of-service rules are widely flouted, with many drivers still referring to their hours-of-service logs as 'comic books.'"[45]

The International Brotherhood of Teamsters (IBT), however, has opposed the May 2000 HOS proposal, using two seemingly contradictory arguments. At a June 22, 2000 Congressional hearing, the Assistant Director of the Safety and Health Department of the IBT objected to the proposed reduction in maximum daily work hours from 16 to 12, noting that drivers would have less time with their families if they performed 60 hours of work per week over a five-day period rather than over a four-day period.[46] Less than six months later, however, the Director of that IBT department expressed concern that long daily hours were unsafe. In his December 15, 2000 docket comments on the HOS proposal, the IBT safety and health director noted—correctly—that EOBRs would be ineffective in monitoring time spent on non-driving duties. He then added the following statement: "Because non-driving duties can account for several hours per day, and because as little as an hour or two of extra on-duty time can have serious implications for safety, the use of EOBRs does nothing to prevent manipulation of records sufficient to allow a driver illegally to extend his or her workday to the point of becoming unsafe."[47] The IBT safety director also objected to the HOS proposal because it would increase the maximum permissible consecutive driving hours from 10 to 12, asserting that this increase would harm highway safety.[48] The concluding clause in the Teamsters union's docket comments was, "the IBT urges the FMCSA to take no action rather than to proceed with the rules in their proposed form."[49] The perhaps surprising lack of support from the international Teamsters union for the May 2000 HOS proposal diminishes the prospects that the proposal will be adopted.

Those truck drivers who are prevented by HOS regulations from working as many hours as they would like incur costs from the May 2000 proposal, although losses from reduced work hours will be partially offset by gains from higher hourly wages and increased leisure. Indeed, it is plausible that the gains to truck drivers will outweigh the losses, at least for the median truck driver. After all, unionized truck drivers have voluntarily chosen a package of higher hourly wages but shorter work hours, suggesting that this package increases the welfare of the median voter in Teamsters union elections. Nonunion drivers don't have this option because of a collective action problem: no one nonunion driver can force the market wage rate to rise by cutting back his work hours. The increase in the market wage rate (the key to making drivers better off) only comes about if many thousands of drivers cut back their work hours. This collective action problem prevents nonunion truck drivers from maximizing their utility in an unregulated free market.

Employment on June 20, 2001. As amended, it applies to violations of either state or federal HOS rules [Lexis-Nexis State Capital Universe, Statenet information on 2001 CA S.B. 278, available online June 25, 2001].

[45] Statement of Representative James L. Oberstar (D-Minnesota), presented at the Ground Transportation subcommittee hearings on FMCSA Proposed Hours of Service Regulations, June 22, 2000, available online on June 27, 2001 at http://www.house.gov/transportation_democrats/Of_Interest/000622_JLOHoursStmt.htm

[46] Jim Abrams, "Little Support for Effort to Change Trucking Hours of Operation," Associated Press State & Local Wire, June 22, 2000.

[47] "Comments of the International Brotherhood of Teamsters," FMCSA Docket No. 97-2350-23019 (Hours of Service of Drivers), December 15, 2000, p. 5.

[48] *Ibid.*, p. 3.

[49] *Ibid.*, p. 6.

Persons whose lives are saved because of the new HOS regulations have a great deal to gain from the new regulations. But nobody knows in advance which individuals would die in the absence of the new regulations. Although there are millions of drivers and pedestrians, only a very small fraction of them would die in the absence of new HOS regulations. The expected value of the benefit that each individual receives from improved traffic safety thus is quite small, even though the aggregate total benefit may be large. Groups such as the American Automobile Association represent the interests of potential victims of collisions with fatigued truckers; and the AAA made comments supportive of the proposed revisions in HOS regulations.[50] But because of the collective action problem, car drivers and pedestrians do not mobilize to the extent needed to maximize their utility. Their voices are drowned out by the voices of a smaller number of individuals and firms, each of whom has a lot at stake.

Costs of Achieving Compliance with Existing Regulations vs. Incremental Costs of New Regulations

The OMB guidelines for "Economic Analysis of Federal Regulations" specify that "All costs calculated should be incremental, that is, they should represent changes in costs that would occur if the regulatory option is chosen compared to costs in the base case (ordinarily no regulation or the existing regulation)."[51] A crucial question is, which of the costs attributed to the May 2000 HOS proposal should be considered incremental costs?

Three costs are unquestionably incremental: (1) costs of reducing maximum daily hours from 16 to 12, (2) costs of providing drivers with an off-duty weekly recovery period of at least 32 continuous hours, and (3) costs of installing and operating EOBR's. None of these are required by existing regulations, but all would be required under the May 2000 proposal.

Public comments on the HOS proposal, however, emphasized costs associated with drivers working fewer hours per week. Drivers would lose income and would find it more difficult to make it home for the weekend. Trucking companies would have to hire more drivers, but lower weekly earnings for drivers would make hiring difficult. Trucking companies would also have to buy more truck tractors and trailers, as each tractor and trailer would be used fewer hours per week. Should these costs be considered incremental?

Some truly are incremental because the new 12-hour daily maximum or the new weekly recovery period could reduce a driver's weekly hours below 60. A driver could legally work 12 hours per day for five consecutive days. But scheduling a driver to work 60 hours per week could be difficult if a driver works relatively short hours on some days or in weeks with a 56-hour weekly recovery period.

---

[50] For example, on July 6, 2000, the AAA Managing Director of Traffic Safety told an FMCSA hearing that the May 2000 revisions "provide a workable framework that takes into account sound science and the best judgments of experts in the areas of sleep research and traffic safety." Quoted in "AAA Response to Federal Motor Carrier Safety Administration Proposed Rules on Hours-of-Service," FMCSA Docket No. 97-2350-22672 (Hours of Service of Drivers), December 15, 2000, p. 1.

[51] "Economic Analysis of Federal Regulations Under Executive Order 12866," *op cit.*, section III.C.1.

Most of the costs of reduced weekly hours, however, are costs of reducing weekly hours to 60 (rather than below 60). The May 2000 HOS proposal does not in any way change the 60 hour per week limit for drivers set by the Interstate Commerce Commission in December 1937, which took effect July 1, 1938. Rather, the May 2000 proposal makes the longstanding 60-hour limit easier to enforce, as the new EOBR requirement makes it harder for trucking companies and drivers to conceal noncompliance.

From the perspective of chronic violators of existing regulations, the cost of reducing weekly hours to 60 is an incremental cost of the May 2000 proposal, as they would continue to violate the 60-hour limit if there were no EOBRs to provide evidence of their violations. But if existing regulations are the base case against which incremental costs should be measured, then the cost of reducing drivers' weekly hours to achieve compliance with the 60-hour limit imposed by the December 1937 HOS regulations should not be considered an incremental cost of the May 2000 HOS proposal. FMCSA could consider both perspectives by conducting the economic analysis using two different baselines: first, the existing HOS regulations as written; and second, the current practice, which includes substantial noncompliance with existing regulations. Regardless of which baseline FMCSA finds more convincing, however, it seems clear that most of the costs attributed to the May 2000 HOS proposal properly should be attributed to bringing firms into compliance with existing regulations.

A pending court ruling may affect the procedural requirements for federal agencies wishing to begin strict enforcement of existing regulations that had previously been violated. In May 2001, the Federal Aviation Administration announced its intent to begin strict enforcement of regulations limiting work hours of airplane pilots.[52] The airlines sued, alleging that the new enforcement policy constituted a rule change that the FAA could not implement without first soliciting comments from them. In September 2001, the U.S. Court of Appeals for the District of Columbia granted the airlines' request for a temporary stay of the FAA proposal, pending a hearing in January 2002.[53] Any procedural requirements imposed on the FAA may apply to FMCSA as well.

Overstatement of the Social Cost of Labor in NPRM Preliminary Cost/Benefit Analysis

In the NPRM preliminary cost/benefit analysis, FMCSA noted, "The largest cost for motor carriers [of the proposed changes in HOS regulations] will be hiring new drivers."[54] FMCSA estimated that the proposed HOS changes would require approximately 40% of long haul drivers to reduce their work hours, and that motor carriers would have to hire approximately 49,000 new drivers (almost all in the truckload sector) to make up for the resulting loss in labor time.[55] The reduction in work hours for individual drivers now working in excess of 60 hours per week would save motor carriers money, but these savings would be outweighed by the wages paid to new drivers, for a net payroll increase of approximately $210 million per year. In addition, hiring 49,000 new drivers would increase the market wage rate for drivers, and existing

[52] Federal Aviation Administration, U.S. Department of Transportation, "Flight Crewmember Flight Time Limitations and Rest Requirements; Final Rule," *Federal Register*, May 17, 2001, pp. 27548-27550.
[53] Matthew L. Wald, "National Briefing Washington: Airlines Block Rules on Pilots' Hours," *The New York Times*, September 11, 2001, p. A18.
[54] NPRM, p. 25573.
[55] NPRM, p. 25572-25573.

drivers also would receive the higher wage rate, entailing an increase in the wage bill of $175 million per year. Combining these elements, FMCSA estimated the net increase in wage costs for motor carriers to be $384 million per year.[56] This substantially exceeds, for example, the estimated cost of installing and maintaining EOBR's ($492 million over ten years[57]).

The large magnitude of the increase in wages thus strongly influences the outcome of the cost/benefit analysis. FMCSA's efforts to be sensitive to concerns of trucking companies, however, led FMCSA to use the wrong measure of labor costs associated with the HOS proposal. The analysis in the NPRM expressly states that it presents "the cost *to motor carriers*" (emphasis added) of additional wages.[58] Taking the perspective of motor carriers makes increases in payroll costs a reasonable measure of labor costs of the new regulations. But OMB guidelines require economic analyses of federal regulations to take a broader perspective, considering *social* costs and *social* benefits (those for all persons in society), and not just *private* costs and *private* benefits (those for motor carriers alone).[59] The proposed HOS regulations only raise social costs to the extent that diversion of factors of production (labor, capital, and land) to the motor carrier industry causes society to forego the production of other goods and services. Wages paid should be considered as a social cost only if they measure the value of production foregone as a result of the diversion of labor.

Consider first the $175 million per year from higher hourly wage rates for existing drivers. Paying the existing drivers more for the same work does not cause the motor carrier industry to employ a greater quantity of factors of production, and it therefore does not divert any factors of production from alternative uses. Because an increase in the hourly wage rate for existing drivers does not cause society to sacrifice the production of other goods or services, the opportunity cost to society of this wage increase is zero. From a social perspective, this $175 million per year is not a cost.[60] It is purely a redistribution of income from motor carriers and (to the extent that carriers can raise prices) shippers to drivers. The dollars lost by motor carriers and shippers are gained by existing drivers.

Whether the wages and benefits paid to 49,000 additional drivers entail an opportunity cost depends on labor market conditions. If the economy is at full employment and no foreign labor is available, then employing these 49,000 workers as drivers forces society to forego what they would have produced had they worked in other jobs. This is the standard microeconomic model, which FMCSA adopted in the NPRM. But one must also consider a macroeconomic question: can employers meet staffing needs by hiring workers who would otherwise be unemployed or underemployed?

---

[56] NPRM, p. 25573.
[57] NPRM, p. 25575.
[58] NPRM, page 25573.
[59] The analysis should allow decision makers to determine whether "The proposed action will maximize net benefits to society (including potential economic, environmental, public health and safety, and other advantages; distributional impacts; and equity)" ["Economic Analysis of Federal Regulations Under Executive Order 11286," Introduction].
[60] "Transfer payments are not social costs but rather are payments that reflect a redistribution of wealth. While transfers should not be included in the EA's estimates of the benefits and costs of a regulation, they may be important for describing the distributional effects of a regulation." "Economic Analysis of Federal Regulations Under Executive Order 12866," *op cit.*, Section III.C.2.

Because of a highly controversial decision made after FMCSA's preliminary economic analysis was completed, Mexico may provide many of the drivers needed to implement new HOS rules. In February 2001, an arbitration panel established under the provisions of the North American Free Trade Agreement (NAFTA) ordered the U.S. to allow Mexican trucks to operate throughout the U.S., and not just in a 20-mile-wide strip along the border. The Bush administration quickly decided to implement the policy ordered by the arbitrators, rather than exercise the option provided by NAFTA to keep Mexican trucks out and provide Mexico with compensation.[61] The Teamsters, asserting that Mexican trucks were unsafe, lobbied Congress to restrict the entry of Mexican trucks.[62] Both the House and the Senate approved such restrictions, but President Bush threatened a veto.[63] If the Bush administration prevails, then Mexican drivers will be able to deliver loads between Mexico and any point in the U.S. beginning in January 2002.

The Mexican labor market chronically has high levels of unemployment and underemployment, consistent with W. Arthur Lewis' model of developing countries as essentially having horizontal labor supply curves.[64] Furthermore, Mexican labor that is available to drive trucks in the U.S. under the NAFTA provision cannot legally be employed for other purposes in the U.S. From a macroeconomic perspective, then, the opportunity cost (in terms of foregone production) of tapping the Mexican labor market to meet the demand for drivers in the U.S. is zero or close to zero.

Mexican labor is unlikely to meet *all* of the additional demand for drivers created by new HOS regulations. U.S. Immigration and Naturalization Service cabotage rules prohibit Canadian drivers from transporting goods or passengers from one U.S. location to another U.S. location,[65] and Mexican drivers presumably would face the same prohibition. Even under the NAFTA provision, the maximum extent to which Mexican drivers can operate in the U.S. is limited to the portion of international shipments between the 20-mile-wide border zone and origins or destinations farther north in the U.S. or Canada. The number of incoming truck crossings along the U.S.-Mexican border grew from 2.9 million in 1995 to 4.5 million in 2000,[66] and this number is likely to grow further as trade between the U.S. and Mexico increases; but shipments between Mexico and U.S. or Canadian origins or destinations are likely to remain a relatively small fraction of total shipments in the U.S.

---

[61] Steven Greenhouse, "Bush to Open Country to Mexican Truckers," *The New York Times*, February 7, 2001, p. A12.
[62] Philip Shenon, "Teamsters May Stall Bush Goals for Mexican Trucks and Trade," *The New York Times*, July 30, 2001, p. A1.
[63] Philip Shenon, "Senate Approves Limits on Mexican Truckers," *The New York Times*, August 2, 2001, p. A8.
[64] W. Arthur Lewis, "Economic Development with Unlimited Supplies of Labour," in Rajani Kanth, ed., *Paradigms in Economic Development: Classic Perspectives, Critiques, and Reflections* (Armonk, NY: Sharpe, 1994), pp. 59-97. Previously published 1954.
[65] *Greyhound Lines v. Immigration and Naturalization Service*, 1995 U.S. Dist. LEXIS 16594 (U.S. District Court for the District of Columbia, 1995).
[66] U.S. Bureau of Transportation Statistics, U.S. Department of Transportation (based on data from U.S. Customs Service), "Incoming Truck Crossings, US-Mexican Border, 1994-2000," personal communication from BTS to one of the authors, October 9, 2001.

Nevertheless, in the absence of Congressional action to overturn the Bush administration decision, low-wage Mexican drivers could displace American drivers for hundreds of millions of miles of trucking shipments per year. Regardless of one's position on the NAFTA provision, one must recognize that this displacement will at least partially offset increased demand for drivers created by the new HOS regulations.

In short, FMCSA's focus on private costs to motor carriers rather than on social costs caused FMCSA to overestimate substantially the costs of implementing the proposed HOS regulations. Redistribution associated with wage increases is not a social cost; and increased employment of Mexican drivers in the U.S. entails little or no opportunity cost in terms of foregone production. Correctly measuring the labor costs of implementing the proposed changes to HOS regulations would make the cost/benefit analysis much more favorable to adoption of these changes.

One still can debate whether particular instances of redistribution are socially desirable. Economist Milton Friedman, for example, criticized large subsidies by the state of California for elite universities such as Berkeley and UCLA, on the grounds that the students at these elite universities disproportionately came from high-income families who did not merit a subsidy from average-income taxpayers.[67] But long-haul truck drivers—the beneficiaries of the additional employment and any wage increase that would stem from HOS regulations—fall below the median for society in terms of hourly wage rates and many other measures of privilege. Redistribution in favor of long-haul truck drivers may be easier to justify than redistribution in favor of students at elite universities.

FMCSA Needs to Consider Beneficial Effects on Driver Health in the Cost/Benefit Analysis of HOS Regulations

The NPRM preliminary cost/benefit analysis explicitly considered two potential benefits of the proposed revisions to HOS regulations. One was the improvement in highway safety from reducing fatigue-related crashes, and the other was the reduction in paperwork burdens from eliminating the RODS logs. It is fully appropriate that FMCSA considered these potential benefits. The preliminary cost/benefit analysis was distorted, however, by the incorrect exclusion from the analysis of a potentially large benefit from the proposed revisions: improvements in driver health.

Because occupational safety and health falls primarily under the jurisdiction of the Department of Labor rather than of FMCSA, some might argue that FMCSA need not consider driver health in the HOS cost/benefit analysis. This argument does not seem to take into consideration important judicial precedents and Office of Management and Budget (OMB) guidelines. More importantly, federal statutes specifically require the U.S. Department of Transportation to protect the health and safety of transportation workers.

[67] Milton and Rose Friedman, *Free to Choose: A Personal Statement* (New York, Harcourt Brace Jovanovich, 1980), pp. 182-183.

a) *Court Precedents Regarding Work Hours, Worker Health, and Motor Carrier Regulation*

The U.S. Supreme Court has recognized the importance of improvements in worker health as a justification for limits on work hours. In 1908, the Court upheld the constitutionality of an Oregon statute limiting women's work hours to 10 hours per day, citing the argument in Louis Brandeis' brief that longer work hours could injure the health of women workers.[68]

The U.S. Court of Appeals stated that driver safety and health was a valid justification for motor carrier regulations. The court made the following statement in a ruling about safety regulations promulgated by the Interstate Commerce Commission under the Motor Carrier Act of 1935: "And while the provisions of the Act or of valid regulations promulgated under it with respect to safety of operation of motor vehicles on the highway may be intended primarily for the protection of employees engaged in transportation in interstate commerce for hire, the duties imposed by such provisions or such regulations are secondarily for the protection of others on the highways with right."[69]

b) *OMB Guidelines for Cost/Benefit Analysis of Proposed Regulations*

The 1996 OMB guidelines for economic analysis of proposed regulations mention the importance of including in the analysis even those benefits that cannot be expressed in monetary terms: "An attempt should be made to quantify all potential real incremental benefits to society in monetary terms to the maximum extent possible. . . Any benefits that cannot be monetized, such as an increase in the rate of introducing more productive new technology or a decrease in the risk of extinction of endangered species, should also be presented and explained."[70] OMB guidelines thus require FMCSA to consider even difficult-to-quantify benefits, such as improvements in driver health.

c) *Statutory Requirements That DOT Protect Driver Health and Physical Condition*

Most important of all, statutory language specifically directs the U.S. Department of Transportation to protect the health of drivers. Consider the following language from Title 49, Subtitle VI, Part B, Chapter 311, Subchapter III (which deals with safety regulation of commercial motor vehicles by the U.S. Department of Transportation):

- 49 USCS §31131 states that one of the purposes of that subchapter is "to minimize dangers to the health of operators of commercial motor vehicles and other employees whose employment directly affects motor carrier safety." It further states that Congress finds "enhanced protection of the health of commercial motor vehicle operators is in the public interest."
- 49 USCS §31136(a) states that "the Secretary of Transportation shall prescribe regulations on commercial motor vehicle safety. . . At a minimum, the regulations shall insure that. . . (3) the physical condition of operators of commercial motor vehicles is adequate to enable them to operate the vehicles safely; and (4) the operation of

[68] *Muller v. Oregon*, 208 US 412 (1908). Subsequent court rulings rejected the sex-based distinctions in *Muller*, but they did not challenge the validity of worker health as a justification for governmental limits on work hours.
[69] *Interstate Motor Lines v. Great Western Railway Company*, 161 F.2d 968 (Tenth Circuit, 1947).
[70] "Economic Analysis of Federal Regulations Under Executive Order 12866," *op. cit.*, Section III B.

commercial motor vehicles does not have a deleterious effect on the physical condition of the operators."

The inclusion in §31136(a) of both item (3) and item (4) makes it clear that protecting the physical condition of the operators is a statutory requirement for its own sake, even beyond the extent to which this protection enables them to operate the vehicles safely.

On the basis of the above court rulings, OMB guidelines, and statutory language, it seems that FMCSA is not only permitted but required to consider the impact of HOS regulations on driver health in the cost/benefit analysis of the HOS proposals.

The Potential Impact of HOS Regulations on Driver Health

Some of the harmful effects of long work hours and extended periods away from home (both common in some segments of trucking and long-distance bus transportation) are readily apparent to drivers. To the extent that drivers perceive long work hours and extended exposure to harmful substances or conditions as distasteful, an unregulated labor market should, in theory, provide compensating differentials to address the problems. Among these problems are that drivers report feeling lonely,[71] tired, and irritable.[72] They experience anxiety, depression, and musculoskeletal symptoms.[73] They are often cut off from friends and family; and even on days home from work, they may be too tired to help their children with their homework or nourish their marriages. They may enjoy their off-duty hours less if they are spent in the sleeper berth of a truck rather than at home. Many drivers perceive stress during long work shifts—a perception confirmed by physiological measures of heart rate, blood pressure, catecholamines, and cortisol among long-distance bus drivers.[74] This stress response may be aggravated if drivers do not have adequate resting times during trips and a duty-free recovery period between trips.[75] Those who drive gasoline tanker trucks often experience acute headaches, dizziness, or nausea after exposure to gasoline vapors during loading and unloading.[76]

---

[71] A study of 88 professional drivers in Sweden, for example, found that the drivers rated their loneliness on average at about 4.3 on a scale of 1 to 5. See Gudrun E. Hedberg, Lisbeth Wikstrom-Frisen, and Urban Janlert, "Comparison between Two Programs for Reducing the Levels of Risk Indicators of Heart Diseases among Male Professional Drivers," *Occupational and Environmental Medicine,* Vol. 55, No. 8, August 1998, pp. 554-561.

[72] S. Milosevic, "Drivers' Fatigue Studies," *Ergonomics*, Vol. 40, No. 3, March 1997, pp. 381-389.

[73] P. T. Raggatt, "Work Stress among Long Distance Coach Drivers: A Survey and Correlational Study," *Journal of Organizational Behavior,* Vol. 12, No. 7, December 1991, pp. 565-579.

[74] P. T. Raggatt and S. A. Morrissey, "A Field Study of Stress and Fatigue in Long-Distance Bus Drivers," *Behavioral Medicine*, Vol. 23, No. 3, Fall 1997, pp. 122-129.

[75] Judith K. Sluiter, Allard J. van der Beek, and Monique H. Frings-Dresen, "Work Stress and Recovery Measured by Urinary Catecholamines and Cortisol Excretion in Long Distance Coach Drivers," *Occupational and Environmental Medicine*, Vol. 55, No. 6, June 1998, pp. 407-413.

[76] M. Hakkola, M. L. Honkasalo, and P. Pulkkinen, "Changes in Neuropsychological Symptoms and Moods among Tanker Drivers Exposed to Gasoline during a Work Week," *Occupational Medicine* (London), Vol. 47, No. 6, August 1997, pp. 344-348. The extent of this exposure was reported in Sinikka Vainiotalo and Anne Ruonakangas, "Tank Truck Driver Exposure to Vapors from Oxygenated or Reformulated Gasolines during Loading and Unloading," *American Industrial Hygiene Association Journal*, Vol. 60, No. 4, July/August 1999, pp. 518-525. See also B. Javelaud, L. Vian, R. Molle, *et al.*, "Benzene Exposure in Car Mechanics and Road Tanker Drivers," *International Archives of Occupational and Environmental Health*, Vol. 71, No. 4, June 1998, pp. 277-283.

But drivers do not recognize many harmful health effects of their long and irregular work hours until years later, either because they have imperfect information or because cognitive dissonance distorts their perceptions. The market mechanism does not adequately address occupational health problems with long latent periods.

Clearly, drivers disproportionately suffer from certain health problems, many with delayed onset. An epidemiological study of over 450,000 Canadian men found that truck drivers faced higher risk of death than other men did from colon cancer, laryngeal cancer, lung cancer, diabetes, ischemic heart disease, non-alcohol cirrhosis, and motor vehicle accidents.[77] A Danish study found that a group of 14,225 truck drivers had higher mortality over a ten-year period from lung cancer and multiple myeloma than did a group of 43,024 unskilled male laborers in other occupations.[78] An analysis of virtually all admissions to Danish hospitals over several years found that, compared to the male working age population, both truck and bus drivers had especially high age-standardized hospital admission ratios for lung cancer, ischemic heart disease, cerebrovascular disease, chronic obstructive pulmonary disease, and prolapsed cervical or lumbar discs; and truck but not bus drivers had especially high admission ratios for back injuries.[79] A study of package truck drivers in the U.S. found that their mean score on a standard scale of psychological stress was at the 91st percentile for the general adult population.[80] The proposed HOS regulations may help improve driver health to the extent that these health problems arise because of chronic partial sleep deprivation; work schedules that are irregular, entail long hours, or include work/rest cycles shorter than 24 hours; and long periods of exposure to harmful substances or conditions.

Many long-haul drivers face chronic partial sleep deprivation. A study of eighty long-haul drivers over a five-day period found that their electrophysiologically verified sleep averaged 4.78 hours per day (and only 3.83 hours of sleep per day for those drivers on a steady night schedule).[81] There are serious adverse health effects of this sleep deprivation that may not be immediately obvious to drivers. A 1999 study in *The Lancet*, for example, found that restricting sleep in healthy young men to four hours per night for a mere six nights "is associated with striking alterations in metabolic and endocrine function." Specifically, sleep debt reduced glucose tolerance and thyrotropin concentrations, and it increased evening cortisol concentrations and activity of the sympathetic nervous system. "The effects are similar to those seen in normal ageing and, therefore, sleep debt may increase the severity of age-related chronic disorders" such as diabetes and hypertension.[82] This hypertension may account for the high risk of stroke found among both truck and bus drivers in Denmark.[83]

---

[77] Kristan J. Aronson, Geoffrey R. Howe, Maureen Carpenter, and Martha E. Fair, "Surveillance of Potential Associations between Occupations and Causes of Death in Canada, 1965-91," *Occupational and Environmental Medicine*, Vol. 56, No. 4, April 1999, pp. 265-269.

[78] Eva S. Hansen, "A Follow-Up Study on the Mortality of Truck Drivers," *American Journal of Industrial Medicine*, Vol. 23, No. 5, May 1993, pp. 811-821.

[79] Harald Hannerz and Finn Tuchsen, "Hospital Admissions among Male Drivers in Denmark," *Occupational and Environmental Medicine,* Vol. 58, No. 4, 1 April 2001, pp. 253-260.

[80] Peter Orris, David E. Hartman, Pamela Strauss, *et al.*, "Stress among Package Truck Drivers," *American Journal of Industrial Medicine*, Vol. 31, No. 2, February 1997, pp. 202-210.

[81] Merrill M. Mitler, James C. Miller, Jeffrey J. Lipsitz, *et al*., "The Sleep of Long-Haul Truck Drivers," *New England Journal of Medicine*, Vol. 337, No. 11, 11 September 1997, pp. 755-761.

[82] Karine Spiegel, Rachel Leproult, and Eve Van Cauter, "Impact of Sleep Debt on Metabolic and Endocrine Function," *The Lancet*, Vol. 354, No. 9188, 23 October 1999, pp. 1435-1439. See also Rachel Leproult, Georges

Other researchers have confirmed the harmful effects of partial sleep deprivation on healthy, working-age men. One study assessed the impact on blood pressure of overtime work that limited sleep. Blood pressure was significantly higher following a day with overtime work and between 3 and 4 hours of sleep than it was following an eight-hour workday and approximately 8 hours of sleep.[84] Another study compared immune function after a normal night of sleep to that after a night when subjects were not allowed to sleep between 10 PM and 3 AM. The researchers found that "even a modest disturbance of sleep produces a reduction in natural immune responses," resulting in increased vulnerability to infection.[85] A third study measured sympathetic nervous system activity, both on nights when subjects were allowed to sleep and on nights when subjects were awakened at 3 AM and kept awake until 6 AM. They found that partial sleep deprivation raised nocturnal catecholamine levels, which can contribute to cardiovascular disease.[86] This laboratory finding was supported by epidemiological evidence: middle aged men who suffered sleep loss as a result of rotating shifts had higher risks of coronary heart disease than men working only during the day.[87]

Working long or irregular hours may have other harmful effects on health in addition to those related to partial sleep deprivation.[88] An epidemiological study in Sweden examined the impact of long work hours on mortality between 1973 and 1996 among approximately 11,000 men and 9,500 women born 1926-1958. Even controlling for age and for behavioral factors such as smoking, drinking, and use of tranquilizers, regular overtime work of more than five hours a week was associated with higher mortality rates for five years following the overtime. [89]

Copinschi, Orfeu Buxton, and Eve Van Cauter, "Sleep Loss Results in Elevation of Cortisol Levels the Next Evening," *Sleep*, Vol. 20, No. 10, October 1997, pp. 865-870.

[83] Finn Tuchsen, "Stroke Morbidity in Professional Drivers in Denmark 1981-1990," *International Journal of Epidemiology,* Vol. 26, No. 5, October 1997, pp. 989-994.

[84] Osamu Tochikubo, Akihiko Ikeda, Eiji Miyajima, and Masao Ishii, "Effects of Insufficient Sleep on Blood Pressure Monitored by a New Multibiomedical Recorder," *Hypertension*, Vol. 27, No. 6, June 1996, pp. 1318-1324.

[85] Michael Irwin, John McClintick, Carolyn Costlow, *et al.*, "Partial Night Sleep Deprivation Reduces Natural Killer and Cellular Immune Responses in Humans," *FASEB Journal*, Vol. 10, No. 5, April 1996, pp. 643-653 at 643.

[86] Michael Irwin, John Thompson, Claudine Miller, *et al.*, "Effects of Sleep and Sleep Deprivation on Catecholamine and Interleukin-2 Levels in Humans: Clinical Implications," *The Journal of Endocrinology and Metabolism*, Vol. 84, No. 6, June 1999, pp. 1979-1985.

[87] Leena Tenkanen, Tom Sjoblom, and Mikko Harma, "Joint Effect of Shift Work and Adverse Life-Style Factors on the Risk of Coronary Heart Disease," *Scandinavian Journal of Work, Environment, and Health,* Vol. 24, No. 5, October 1998, pp. 351-357.

[88] For reviews of the literature, see:

Susan Michie and Anne Cockcroft, "Overwork Can Kill: Especially If Combined with High Demand, Low Control, and Poor Social Support," *British Medical Journal*, Vol. 312, No. 7036, 13 April 1996, pp. 921-922.

Anne Spurgeon, J. Malcolm Harrington, and Cary L. Cooper, "Health and Safety Problems Associated with Long Working Hours: A Review of the Current Position," *Occupational and Environmental Medicine*, Vol. 54, No. 6, June 1997, pp. 367-375.

J. Malcolm Harrington, "Health Effects of Shift Work and Extended Hours of Work," *Occupational and Environmental Medicine*, Vol. 58, No. 1, January 2001, pp. 68-72.

Kate Sparks, Cary L. Cooper, Yitzhak Fried, and Arie Shirom, "The Effects of Hours of Work on Health: A Meta-Analytic Review," *Journal of Occupational and Organizational Psychology*, Vol. 70, No.4, December 1997, pp. 391-408.

[89] L. Nylen, M. Voss, B. Floderus, "Mortality among Women and Men Relative to Unemployment, Part-Time Work, Overtime Work, and Extra Work: A Study Based on Data from the Swedish Twin Registry," *Occupational and Environmental Medicine*, Vol. 58, No. 1, January 2001, pp. 52-57.

Other studies have examined the impact of long or irregular work hours on specific health problems:

- Extended working periods desynchronize the internal circadian rhythms of long-haul drivers who work many hours per day and have work/rest cycles less than 24 hours.[90]
- Irregular hours and night work raise the risk of being hospitalized for ischemic heart disease (IHD).[91] Professional drivers are at greater risk of IHD if they work long hours.[92] This cardiac risk may increase partly because professional drivers who spend long hours behind the wheel tend to have a higher body mass index.[93]
- Working over 40 hours per week doubled the risk of acute Helicobacter pylori infection (associated with peptic ulcers), even controlling for age, sex, and marital status.[94]
- A group of Dutch truck drivers working an average of 11.4 hours per day had insufficient recovery after work from sympathoadrenal activation. Their elevated catecholamine levels were associated with increased psychosomatic health complaints.[95]

Long hours also intensify problems of truckers' exposure to harmful substances or conditions, particularly since "occupational exposure limits are almost invariably calculated on the basis of an 8 hour day, 5 day week."[96] Drivers are exposed to diesel emissions—found to raise the risk of lung cancer among trucking workers in the U.S.;[97] among truck, bus, and taxi drivers in West Germany;[98] and among truck, bus, and taxi drivers in Denmark.[99] A meta-

[90] A. G. Stoynev and N. K. Minkova, "Circadian Rhythms of Arterial Pressure, Heart Rate and Oral Temperature in Truck Drivers," *Occupational Medicine* (London), Vol. 47, No. 3, April 1997, pp. 151-154.
[91] Finn Tuchsen, "Working Hours and Ischaemic Heart Disease in Danish Men: A 4-Year Cohort Study of Hospitalization," *International Journal of Epidemiology*, Vol. 22, No. 2, April 1993, pp. 215-221.
[92] Reza Emdad, Karen Belkic, Tores Theorell, *et al.*, "Work Environment, Neurophysiologic and Psychophysiologic Models among Professional Drivers with and without Cardiovascular Disease: Seeking an Integrative Neurocardiologic Approach," *Stress Medicine*, Vol. 13, No. 1, January 1997, pp. 7-21.
[93] Reza Emdad, Karen Belkic, Tores Theorell, and S. Cizinsky, "What Prevents Professional Drivers from Following Physicians' Cardiologic Advice?" *Psychotherapy & Psychosomatics*, Vol. 67, No. 4-5, July-Oct. 1998, pp. 226-240.
[94] Steffen J. Rosenstock, Lief P. Andersen, Charlotte V. Rosenstock, *et al.*, "Socioeconomic Factors in Helicobacter pylori Infection among Danish Adults," *American Journal of Public Health*, Vol. 86, No. 11, November 1996, pp. 1539-1544.
[95] Judith I. Kuiper, Allard J. van der Beek, and Theo F. Meijman, "Psychosomatic Complaints and Unwinding of Sympathoadrenal Activation after Work," *Stress Medicine*, Vol. 14, No. 1, January 1998, pp. 7-12. See also Allard J. van der Beek, Theo F. Meijman, Monique H. Frings-Dresen, *et al*., "Lorry Drivers' Work Stress Evaluated by Catecholamines Excreted in Urine," *Occupational and Environmental Medicine*, Vol. 52, No. 7, July 1995, pp. 464-469.
[96] J. Malcolm Harrington, "Health Effects of Shift Work and Extended Hours of Work," *op cit.*, p. 71.
[97] K. Steenland, J. Deddens, L. Stayner, "Diesel Exhaust and Lung Cancer in the Trucking Industry: Exposure-Response Analyses and Risk Assessment," *American Journal of Industrial Medicine*, Vol. 34, No. 3, September 1998, pp. 220-228.
[98] I. Brüske-Hohlfeld, M. Möhner, W. Ahrens, *et al.*, "Lung Cancer Risk in Male Workers Occupationally Exposed to Diesel Motor Emissions in Germany," *American Journal of Industrial Medicine*, Vol. 36, No. 4, October 1999, pp. 405-414.

analysis of 30 epidemiological studies in North America and Europe (including 10 of truck drivers, 2 of bus drivers, and 4 of all professional drivers) similarly concluded that occupational exposure to diesel exhaust raised the risk of lung cancer.[100] Another meta-analysis of 15 studies of truck drivers and 10 studies of bus drivers found that exposure to diesel exhaust may also raise the risk of bladder cancer.[101]

Drivers also face extended exposure to highway noise (which can lead to hearing loss[102]—a problem exacerbated when drivers sleep in their trucks while their partners drive and thus lack recovery time between exposures[103]) and whole body vibration[104] (which can lead to low back pain[105]). In addition, some drivers do heavy lifting immediately after spending long hours sitting in a single body posture, which contributes to injuries to the spine and ligaments.[106]

As in the case of asbestos in shipyards, these unrecognized hazards persist at inefficiently high levels in an unregulated free market. Government regulation to reduce these hazards could increase economic efficiency. This important benefit of the proposed changes in the HOS regulations was not included in the cost/benefit analysis in the NPRM. Recognizing this benefit would make the cost/benefit analysis more favorable to adoption of the proposed changes.

Impact of Excessive Driving Speeds on Highway Safety

The FMCSA cost/benefit analysis notes that some highway deaths are due to truck driver fatigue and finds that the HOS proposal will reduce the number of these deaths. FMSCA did not include, however, another possible contribution to highway safety from the HOS proposal: the impact of EOBR's on truck and bus driving speeds. Truck or bus drivers in Germany sometimes

---

[99] Johnni Hansen, Ole Raaschou-Nielsen, and Jorgen H. Olsen, "Increased Risk of Lung Cancer among Different Types of Professional Drivers in Denmark," *Occupational and Environmental Medicine*, Vol. 55, No. 2, February 1998, pp. 115-118.

[100] Michael Lipsett and Sharan Campleman, "Occupational Exposure to Diesel Exhaust and Lung Cancer: A Meta-Analysis," *American Journal of Public Health*, Vol. 89, No. 7, July 1999, pp. 1009-1017. Similar findings were reported earlier in another meta-analysis: Rajiv Bhatia, Peggy Lopipero, and Allan H. Smith, "Diesel Exhaust Exposure and Lung Cancer," *Epidemiology*, Vol. 9, No. 1, January 1998, pp. 84-91.

[101] P. Boffetta and Debra T. Silverman, "A Meta-Analysis of Bladder Cancer and Diesel Exhaust Exposure," *Epidemiology*, Vol. 12, No. 1, January 2001, pp. 125-130.

[102] D. J. van den Heever and F. J. Roets, "Noise Exposure of Truck Drivers: A Comparative Study," *American Industrial Hygiene Journal*, Vol. 57, No. 6, June 1996, pp. 564-566.

[103] Baily Seshagiri, "Occupational Noise Exposure of Operators of Heavy Trucks," *American Industrial Hygiene Association Journal*, Vol. 59, No. 3, March 1998, pp. 205-213.

[104] Keith T. Palmer, Michael J. Griffin, Holly Bendall, *et al.*, "Prevalence and Pattern of Occupational Exposure to Whole Body Vibration in Great Britain: Findings from a National Survey," *Occupational and Environmental Medicine,* Vol. 57, No. 4, April 2000, pp. 229-236.

[105] M. H. Pope, M. Magnusson, and D. G. Wilder, "Kappa Delta Award. Low Back Pain and Whole Body Vibration," *Clinical Orthopaedics and Related Research*, No. 354, September 1998, pp. 241-248. See also F. Pietri, A. Leclerk, L. Boitel, *et al.,* "Low-Back Pain in Commercial Drivers," *Scandinavian Journal of Work, Environment, and Health*, Vol. 18, No. , 1992, pp. 52-58; and M. V. Jensen, Finn Tuchsen, and E. Orhede, "Prolapsed Cervical Intervertebral Disc in Male Professional Drivers in Denmark, 1981-1990: A Longitudinal Study of Hospitalizations," *Spine*, Vol. 21, No. 20, 15 October 1996, pp. 2352-2355.

[106] Harald Hannerz and Finn Tuchsen, "Hospital Admissions among Male Drivers in Denmark," *op cit.*; and Marianne V. Jensen, Finn Tuchsen, and Elsa Orhede, "Prolapsed Cervical Intervertebral Disc in Male Professional Drivers in Denmark, 1981-1990: A Longitudinal Study of Hospitalizations," *Spine*, Vol. 21, No. 20, 15 October 1996, pp. 2352-2355.

receive speeding tickets in cases where no police officer observed them at the time the speeding occurred because the EOBR's kept a record of their driving speeds. The European Union requirement of EOBR's in trucks and buses[107] has probably led to increased compliance with speed limits, at least on expressways. (Drivers still could exceed the posted speed limit on roads with lower speed limits than expressways unless the EOBR's were sophisticated enough to link information on the precise location of the vehicle with the speed of the vehicle at the time it was at this location.) Because high driving speeds substantially increase the risk of highway fatalities, greater compliance with speed limits reduces highway deaths.

A comprehensive account of the benefits of EOBR's requires estimates of the following:

(1) The extent to which truck or bus drivers now exceed posted speed limits on expressways
(2) The number of highway fatalities caused by this speeding
(3) The extent to which EOBR's could increase compliance with posted speed limits on expressways
(4) The reduction in the number of highway fatalities stemming from this increased compliance with speed limits

We know that speed kills. The dollar value of the reduction in highway fatalities due to increased compliance with speed limits should therefore be included as a benefit of the proposed HOS regulations when doing the cost/benefit analysis.

Respect for the Rule of Law

Many long haul drivers in the truckload sector drive more hours than existing HOS regulations permit.[108] Even a report that was harshly critical of the FMCSA cost/benefit analysis reported without any critical comment the FMCSA assertion that many drivers falsify their RODS logbook.[109] Because of the large number of truck drivers, high violation rates suggest that over 500,000 people are routinely and repeatedly violating federal HOS rules—both by working more than the legal limit and by falsifying RODS.

Criminologist James Q. Wilson explained how acquiescence in seemingly minor violations of the law can have serious social consequences:

> [O]ne unrepaired broken window is a signal that no one cares, and so breaking more windows costs nothing.[110] … Arresting a single drunk or a single vagrant who has harmed no identifiable person seems unjust, and in a sense it is. But failing to do anything about a score of drunks or a hundred vagrants may destroy an entire community…[Turning a blind eye to a drunk or a vagrant] makes no

[107] Council Regulation (EEC) No. 3821/85 of 20 December 1985 requires first-generation automatic recording devices on trucks. Council Regulation (EC) No. 2135/98 of 24 September 1998 requires second-generation automatic recording devices (which are harder to falsify) on trucks.
[108] Belzer, *Sweatshops on Wheels: Winners and Losers in Trucking Deregulation, ibid.*, pp. 37-38.
[109] Mark Berkman and Jesse David, "A Review of the Federal Motor Carrier Safety Administration's Economic Analysis for Its Proposed Hours of Service Standard," (San Francisco: National Economic Research Associates), August 3, 2000, p. 7.
[110] James Q. Wilson, *Thinking about Crime*, Revised edition (New York: Basic Books, 1983), p. 78.

sense because it fails to take into account the connection between one broken window left untended and a thousand broken windows.[111]

Wilson's theory of contagion effects has gained acceptance from many criminal justice experts. Although past acquiescence in widespread HOS violations has not been a major cause of crime, it may have diminished respect for the rule of law. This diminished respect may have fostered violations of laws and regulations other than HOS standards.

The key effect of the proposed EOBR requirement would be to increase compliance with the existing regulations. Reinforcing respect for the rule of law is a very real benefit of the HOS proposal, even if the dollar value of this benefit is hard to quantify.

Comparisons to the European Union: America Lags Behind

America's regulations concerning truck drivers' hours of work do not meet the norms established by many of our peers among wealthy democracies. In particular, the European Union (EU) has set stricter standards than does the U.S. for hours of service, and the EU has made greater use of modern technology to ensure that records of work hours are not falsified.

The EU has issued a number of regulations related to drivers' work hours. Among them are the following:

- Council Regulation (EEC) No. 3820/85 of 20 December 1985.[112] This requires that drivers have a daily rest period of at least 11 consecutive hours in each 24-hour period (although it allows this to be reduced to a minimum of nine consecutive hours not more than three times in any one week if an equivalent period of rest is granted as compensation before the end of the following week). It requires a weekly rest period of a minimum of 24 consecutive hours. Article 10 of this regulation provides that "Payments to wage-earning drivers, even in the form of bonuses or wage supplements, related to distances traveled and/or the amount of goods carried shall be prohibited, unless these payments are of such a kind as not to endanger road safety."

- Council Regulation (EEC) No. 3821/85 of 20 December 1985 requires first-generation automatic recording devices on trucks to enforce the restrictions in work hours of Regulation 3820.85.[113] The paper record sheets produced by these devices must separately measure four different periods of time: driving time, other work time, other periods of availability (such as waiting time, time spent beside the driver while the vehicle is in motion, and time spent on a bunk while the vehicle is in motion), and breaks in work. The record sheets also must show the vehicle's speed and distance traveled.

- Council Regulation (EC) No. 2135/98 of 24 September 1998 requires second-generation automatic recording devices on trucks in order to prevent evasion of work hours rules.[114]

[111] *Ibid.*, p. 84.
[112] Available online on March 28, 2001 at http://europa.eu.int/eur-lex/en/lif/dat/1985/en_385R3820.html
[113] Available online on March 28, 2001 at http://europe.eu/eur-lex/en/lif/dat/1985/en_385R3821.html
[114] Available online on March 28, 2001 at http://europe.eu/eur-lex/en/lif/dat/1998/en_398R2135.html

It also requires each driver to have a personal driver card, which the driver inserts into the recording device on the truck. Each driver is allowed only one valid card. The regulation sets detailed specifications for the second-generation recording devices. They must record electronically, and also be able to display or print, additional information beyond what was required of first-generation devices. For example, the device on the truck must record the times and dates of insertion and removal of each driver card, and each driver card must record the registration number of the vehicle driven as well as the driver's driving time and break time.

The requirement that new trucks be equipped with second-generation recording devices is now expected to take effect by 2003.[115] If FMCSA adopted EOBR specifications very similar to those that the EU requires, then American trucking companies will be able to use off-the-shelf technology that has already had extensive field testing in Europe. One major German producer of recorders stated the cost to the truck manufacturers of the second-generation automatic recording devices is $300 per truck.[116]

Eastern Europe is the EU's counterpart to Mexico. Economic crises in some of the formerly Communist nations of Eastern Europe have many people desperate; in the extreme case of Moldova, poverty has induced some people to sell one of their kidneys for transplants in Turkey.[117] In these circumstances, Eastern European truck drivers may be willing to work extremely long hours at low wages—even on trips where they are taking loads to or from the much more prosperous nations of the EU. The EU can limit how many hours Eastern Europeans drive per day or per week after entering EU territory, but the EU cannot limit how many hours they have driven immediately before crossing the border.

Despite the potential for competition from Eastern Europeans to undermine EU standards, the EU is preparing new legislation that would raise EU standards even higher. Commission proposal 598PC0662(02) of 24 November 1998 would restrict work hours of drivers to 48 hours per week, averaged over a four-month period, although it allows drivers to work up to 60 hours in any one week.[118] The EU limits expressly state that work hours include loading and unloading time.

EU member states differed sharply on whether to include self-employed drivers within the scope of this new legislation, and these differences delayed its approval.[119] The 1998 EU proposal was amended in 2000 by Commission proposal 500PC0754, which provides that self-employed drivers will not be covered by the 48-hour rule until three years after the regulation

[115] Communication from the Commission to the European Parliament and Council, "Towards a safer and more competitive high-quality road transport system in the Community," (COM (2000) 364 final), 21 June 2000, p. 5. Available online on April 12, 2001 at http://europa.eu.int/eur-lex/en/com/cnc/2000/com2000_0364en01.pdf
[116] Personal communication to one of the authors on May 18, 2001 from Dr. Dieter Plehwe, Social Science Center Berlin.
[117] Mark Franchetti, "Interpol Hunts Queen of the Kidney Trade," *Sunday Times* (London), May 28, 2000.
[118] Available online on April 12, 2001 at http://europa.eu.int/eur-lex/en/com/dat/1998/en_598PC0662.html
[119] Communication from the Commission to the European Parliament and Council, "Towards a safer and more competitive high-quality road transport system in the Community," *op. cit.*, p. 3.

takes effect.[120] On March 23, 2001, the European Council formally adopted this compromise proposal.[121]

When the 48-hour regulation takes effect, the maximum workweek for drivers in the EU will be substantially less than the 60 hours allowed in the U.S. This is consistent with the general pattern of stricter regulation in the EU than in the U.S. The EU requires a longer minimum daily rest period (9 to 11 consecutive hours, vs. 8 in the U.S.), a longer minimum weekly recovery period (24 consecutive hours, vs. none in the U.S.), and harder-to-falsify records of work hours (automatic recording devices, vs. hand-written logs in the U.S.). The EU, unlike the U.S., also prohibits per-mile driver compensation systems, which give drivers an incentive to omit waiting and loading time from their work logs.

Three decades ago, Derek Bok noted that American labor law differed substantially from that in other industrial democracies. Bok asserted that the American system of law "permits great flexibility… and provides abundant opportunities for initiative." But the American system, Bok contended, also "is uniquely hard on the weak, the uneducated, the unorganized and the unlucky."[122] The stark contrast between the EU and the U.S. in regulation of truck drivers' work hours suggests that Bok's claim remains valid today.

Conclusion

Important market failures affect the market for driver labor. Among these are external costs of traffic accidents, drivers' imperfect information about the costs to them of long and irregular work hours, and cognitive failures among drivers in recognizing health risks and among motor carriers and shippers in recognizing the opportunity cost of driver time. The existence of these market failures and flaws in the 1962 amendments in HOS regulations suggest that revisions in HOS regulations have the potential to raise economic efficiency.

The preliminary cost/benefit analysis in the NPRM substantially overstated social costs of the proposed HOS revisions by mislabeling redistribution from motor carriers to existing drivers as a social cost and, arguably, by classifying the cost of achieving compliance with 1937 HOS regulations as a cost of the May 2000 proposal. The NAFTA ruling on Mexican trucks (after the NPRM was completed) may further reduce the social cost of implementing the HOS proposal. The preliminary economic analysis also omitted important benefits from improvements in driver health that would occur if the HOS proposal were implemented. Furthermore, U.S. HOS standards lag behind the standards set by other major industrialized democracies.

Vocal opposition to the May 2000 HOS proposal stems in part from the lack of compensation for losers and the contrast between concentrated losses and diffuse gains. Nevertheless, given the inherent complexity of regulating a diverse industry such as trucking, it

[120] Available online on April 12, 2001 at http://europa.eu.int/eur-lex/en/com/dat/2000/en_500PC0754.html
[121] Commission proposal 501PC0584S, available online on May 24, 2001 at http://europa.eu.int/eur-lex/en/com/dat/2001/en_501PC0584S.html
[122] Derek C. Bok, "Reflections on the Distinctive Character of American Labor Laws," *Harvard Law Review*, Vol. 84, No. 6, April 1971, p. 1460.

may be wise for federal regulators to proceed in small steps. Although the proposed weekly recovery period and the proposed 12-hour daily on-duty limit have some merit, they also create operational problems for some carriers and drivers. We suggest that the federal government drop those elements of the May 2000 HOS proposal and focus regulatory efforts on the following two issues.

First, FMCSA should address the problems created by the 1962 HOS amendments that permitted 18-hour work/rest cycles. A 24-hour cycle is more consistent with humans' natural circadian rhythm and less likely than an 18-hour cycle to induce fatigue-related highway safety or driver health problems.

Second, the federal government needs to adopt some mechanism to increase driver compliance with longstanding rules limiting overall work hours to 60 per week, driving hours to 10 per work shift, and total driving and non-driving hours to 15 per work shift. There are a variety of possible mechanisms, all with strengths and drawbacks.

- For single-driver operations, EOBRs could enforce limits on driving time, though overall limits on work time might still be exceeded because it will not record waiting time or other non-driving work time. The effectiveness of the EOBR also is compromised in team operations, where one driver operates the vehicle and another driver sleeps. Even with a coded and password-protected electronic card, two drivers may collude to use each others' card and password to split the driving however they wish.
- Congress could extend the time-and-one-half provision of the FLSA to truck drivers, raising the cost to the firm of overtime work and reducing incentives to assign drivers extended work schedules.
- The Department of Labor could require hour-by-hour compliance with the minimum wage law, at least within the motor carrier industry. This would give drivers an incentive to keep accurate logs of their non-driving time. Explicit pay for every hour worked would also reduce operational inefficiencies arising from the incorrect perception that drivers' non-driving work time has an opportunity cost of zero.
- Congress could require that all shipping contracts contain detention clauses that require additional compensation to carriers in the event of undue delays at the location of the shipper or consignee or delays in when the truck is permitted to enter the shipper's or consignee's premises. Detention clauses would give carriers the resources to provide drivers with additional pay when there are such delays. Enforcement could be difficult, however; if shippers and consignees have more power than carriers and drivers, then carriers and drivers could be pressured to wait outside the customer's premises and not record any detention liability.
- Congress could repeal the Taft-Hartley Act ban on secondary boycotts and the Landrum-Griffin Act ban on hot cargo contracts to enable the Teamsters to extend union coverage to more drivers, giving them hourly pay for waiting and loading time. Union bargaining power would lead to higher driver wages, helping the motor carrier industry retain well qualified drivers; and the union presence would make it harder for those systematically violating federal regulations to escape detection. Non-union carriers, however, would oppose this labor law change most actively.

The federal government should consider industry views when choosing among these mechanisms, including the views of motor carriers, union and non-union drivers, and owner-drivers and their associations. They should also consider the views of other public groups, including those representing other highway users. Continued acceptance of widespread violations of hours of service regulations, however, would be inconsistent with the government's obligation to protect public safety and health.

Part II:

Macroeconomic Effects in a Full-Employment Economy of Compliance with Existing Hours-of-Service Rules for the Trucking Industry

Issue

The purpose of this report is to provide predictions of the macroeconomic effects on the nation and each of its fifty states (as well as the District of Columbia) of compliance with existing hours-of-service (HOS) rules for the trucking industry. Specifically, the predictions focus on the cost aspects of successfully enforcing the existing rule of a 60-hour maximum workweek in a full-employment economy.

Method

To generate the predictions, we use a state-of-the-art macroeconomic model constructed by Regional Economic Models, Inc. (REMI) of Amherst, Massachusetts, and adapted for this analysis by our research team. The REMI model has been fully documented and peer-reviewed in the professional literature (3, 4). The model has been designed particularly for carrying out simulations of the type generated for this study (see appendix B) and has been used extensively for such studies over the past two decades, including studies by the authors of this report (2, 5, 6, 7).

The model is used in this study to predict the total effects by sector and by state of the enforcement of the existing HOS rules in a full-employment environment. The structure of the model is sufficiently sophisticated to capture the interstate trade flows of effective enforcement of policy, and to derive both the regional and national impacts of such enforcement.

The total effect of the changes includes the direct effect of adding truck drivers and the associated spin-off effects. These spin-off activities include indirect effects, or purchases from domestic suppliers, and expenditure-induced effects, or spending by people who receive income attributable to trucking activity.

The results reflect the long-run equilibrium position of the economy after adjusting over time to the need for additional truck drivers in a full-employment economy. We consider the long-run equilibrium implications, both sectorally and geographically, of workers shifting out of other sectors of the economy and into the trucking industry.

Estimates from a previous study suggest that about 49,000 additional truck drivers would be required to meet labor force needs associated with effective enforcement of existing HOS rules (1, pp. 25572-3), and we use this estimate (precisely, 48,777 new drivers) to derive the results in this study. Additional experimentation indicated that the results are roughly (but not exactly) linear for different estimates of the number of drivers required.

Estimates on Wage Elasticity of Supply for Trucking

The wage change required to induce sufficient numbers of workers into the trucking industry if the HOS regulations were enforced is derived from estimates on wage elasticity of supply for the industry. In summary, the macroeconomic estimates provided in this study were based on an elasticity of 1.5, that is, a 1.5 percent increase in wages associated with a one percent increase in industry employment, evaluated at 60 hours a week. In the macroeconomic analysis, the elasticity estimate did not affect the number of workers assumed to transfer from other industries. It only affects costs in the trucking industry, and therefore rates of inflation.

The primary purpose of this section is to estimate the determinants of the number of weekly hours worked by drivers. Of particular interest is the relationship between mileage rates and hours of work. However, since it is reasonable to assume that hours might be determined in part by some of the same random components that influence mileage rates, it is not possible to estimate this relationship directly. It is therefore necessary to use a two-step procedure, first estimating the mileage rate for each driver, and then using the fitted values of the mileage rate to estimate the hours equation.

Each equation was estimated using ordinary least squares (OLS). The general form of the model can be written as:

$$Rate_i = \beta_1 + \beta_2 X_{i2} + \beta_3 X_{i3} + \quad \ldots \quad \beta_K X_{iK} + \varepsilon_i$$

where $Rate_i$ is the mileage rate for the i^{th} driver, the X's represent characteristics of the driver and job that are relevant to determining the mileage rate, and the β's are the parameters to be estimated. The term ε summarizes the random components and unobserved characteristics of the individual driver.

The variables used to estimate the mileage rate equation can be divided broadly into two groups. The first group of variables represents the human capital characteristics of the individual driver. These include experience, tenure, race and union status. The squares of experience and tenure are included to allow for a non-linear relationship between these variables and the mileage rate. In addition, the interaction of race and union status is included which would allow the union premium to differ by race. Finally, education and the previous driving record of the driver are also included as measures of the skill and performance levels of the individual drivers.

It would be expected that the mileage rate would be positively associated with experience and tenure, but a negative second order term would indicate that this premium is decreasing. Unionized and white workers might be expected to earn more. However, the interaction would be expected to be negative, since unions tend to equalize the wages of workers who otherwise

might be expected to earn less. In this case, it would be expected that unions would raise the mileage rate of black drivers by more than that of white drivers. While in most occupations, a high school degree would be expected to raise the wage rate, this may not be true among truck drivers, since the skill requirement of most jobs is rather low. Finally, those drivers with a previous moving violation might be expected to receive a lower mileage rate.

The second group of variables captures characteristics of the firm and job. It has been documented in other cases that large firms pay higher wages. Private carriage firms (versus for-hire firms) and firms that haul primarily dryboxes (versus refrigerator and tanker firms), might be expected to pay different mileage rates, but the direction of these differences cannot be predicted in advance. Drivers with longer dispatches might be expected to earn a lower mileage rate since they are able to spend a greater percentage of their time driving. Finally, the amount of unpaid time and paid time off are also included. However, the direction of these influences cannot be determined in advance. Firms that require large amounts of unpaid time for loading, waiting or other activities may or may not be compelled to compensate their drivers by paying a higher mileage rate depending on other characteristics of the job. Similarly, it might be the case that more paid holidays and longer vacations are compensation for a lower mileage rate, or they could be complementary aspects of 'good' jobs that offer better compensation in all areas.

The data used in the study are summarized in Table 1. The sample consists of all full time drivers who are employees and paid by the mile. Owner operators and those drivers who are paid hourly are not included since it is difficult to make a valid comparison of their wages. The estimation is based on a sample of 233 drivers for whom complete information was available.

The average hours worked is 64.49 with a minimum of 25 and a maximum of 126. They are paid an average of .286 per mile with a range from .13 to .485. The average experience is 13.66 years and the average tenure is 3.46 years, and 83% of the drivers have a high school degree. A number of the variables in the study are categorical. Union members account for 8% of the sample, 86% are white, 25% have had a moving violation in the past year, while 33% work in a 'medium' sized firm, (between 100-500 workers) and 34% work in 'large' firms with over 500 workers. Other firm characteristics include 14% of the drivers working in the private carriage segment of the market, while 65% haul dryboxes.

The average miles per dispatch is 858 with a standard deviation of 619.75. Two variables of particular importance is compensation for time spent in activities other than driving. The variable, 'Unpaid Time' measures the number of minutes of unpaid time per mile driven. The average driver spend about .23 minutes in uncompensated activities per mile driven. Given the average of 858 miles per dispatch, this means that the typical run includes about 197 minutes of uncompensated time. At the other end of the spectrum, the typical driver receives 13.7 paid holiday, vacation and sick days per year, with a minimum of zero and a maximum of 35 days.

The last group of characteristics includes age, with an average of 42.18 years, and marital status, with 69^% of the drivers married. The variable other income is the measure of total family income less the income earned from driving. This can include income earned by other family members, or by the driver in other occupations. The mean value is $31,978 with a

standard deviation of $18,878. The final variables used in the study indicate that 22% of driving occurs at night (between the hours of midnight and 6:00 a.m.), and that 19% of the typical drivers' time is spent in non-driving activities. Finally, the typical driver last slept at home 8.46 days prior to the interview.

The results of the mileage rate equation are reported in Table 2. These show that the returns to tenure are statistically significant at the 5% level of significance, and the returns to experience are significant at the 10% level. However, the point estimates indicate that an additional year of tenure (and experience) increases the mileage rate by less than .005 per year. However, union members can be expected to earn almost .10 per mile more than non-union drivers, and this estimate is significant at a 1% level of significance. The returns to education and racial differences in compensation are not significant. Neither is the interaction of race and union status, which indicates that the union premium is similar for all drivers, regardless of race.

The firm level characteristics offer a great deal of insight into differences in driver compensation. Workers in large firms are paid significantly more than those in smaller firms, while workers in private carriage firms earn less. In addition, workers with more paid time off also receive higher mileage rates, indicating that 'good jobs' reward workers not just by paying higher wages, but with other forms of compensation as well. Finally, drivers with longer dispatches are paid less per mile than those with shorter dispatches.

In order to estimate the weekly hours equation, it is necessary to include variables in the mileage rate equation that do not determine hours of work. In this case, it is hypothesized that experience and tenure will influence wages, but not hours. In addition, education, race, and firm size are also included in the wage equation, but not used to determine hours worked. Finally, the size of the firm and the type of trailer, are not included in the hours equation. The weekly hours equation can be written as:

$$Hours_i = \gamma_1 + \gamma_2 * W_i + \gamma_3 W_i^2 + \gamma_4 Z_{i4} + \ldots \gamma_K Z_{iK} + \varepsilon_i$$

where $Hours_i$ are the weekly hours of the i^{th} driver, and W_i is the fitted wage of the i^{th} driver from the regression estimates described above. The Z's represent characteristics of the driver and job that influence the number of hours worked, while ε_i captures the random components of the hours worked not .included in the explanatory variables.

Both the fitted wage and its square are included in the regression. This allows the influence of the wage rate to decrease, and even allows for the possibility of a 'backward bending' supply curve where higher wages actually cause a decrease in hours worked. The other variables included in the regression are age (and it's square), marital status and other income. Characteristics of the firm and job that might influence hours worked are also considered. These include the percentage of driving done at night, the percentage of time spent in non-driving activities, the amount of unpaid time, and paid days off. Union status, length of dispatch, private carriage and tenure are also included. Finally, the variable 'last home' is a measure of how long it has been since the driver has slept at home.

The results of the hours equation are reported in Table 3. The first thing to note is that weekly hours are not estimated as precisely as the mileage rate. One obvious reason for this is that the reported hours may be measured with error, relative to the explanatory variables. The weekly hours are reported for the most recent week. However, it is possible that the hours worked in any given week may over or under estimate the hours worked in a typical week. As long as these differences are not systematic, they do not bias the parameter estimates, but do make them less precise, which is reflected in the results.

Some results of note are that weekly hours tend to increase with age, until the driver is about 44.8 years old, at which point they decline. Married workers tend to work fewer hours, but this result is significant only at the 10% level of significance. Finally, it is necessary to interpret the results on non-driving time. The variable 'Unpaid Time' measures the amount of unpaid time per mile driven. The estimate indicates that if a driver is not paid for his non-driving time, he tends to compensate by working longer hours. The variable non-driving time measures the percentage of time that a driver spends in activities other than driving. While the negative coefficient may seem surprising, in conjunction with unpaid time, the interpretation of this variable to measure the effect of non-driving time that is compensated, at least in part. Therefore, it is not surprising that drivers with more non-driving time that is paid may work fewer hours, while those who have more unpaid non-driving time may work more.

The results on mileage rate can be interpreted as follows. The fitted value of the mileage rate and its square show an overall positive influence of wages on hours, for most drivers. However, these estimates are only significant at the 10% level of significance. The positive relationship between mileage rates and hours continues until the mileage rate reaches about .313 per mile, at which point it is estimated that further increases in the mileage rate lead to a decrease in hours. This relationship is described in Figure 1. Of particular note are the predictions of hours worked relative to the current hours of service regulations, which generally limit drivers to 60 hours per week. For low mileage rates, increasing the mileage rate leads to an increase in hours worked. The mean rate of .286 provides an estimate of about 62.5 hours worked per week, with an increase to almost 65 hours. However, after this point, further increases in the mileage rate lead to a decrease in hours. This can be explained by the idea that once drivers are paid a high enough rate and are already working long hours, further increases in the mileage rate are used to 'buy' more time off rather than purchase more goods and services. The point estimates indicate that if the mileage rate were to increase to .37 per mile, drivers would have reduced their weekly hours to be in compliance with the current regulations. At this rate, drivers are being compensated at a rate sufficient for them to be able to satisfy their income requirements without being induced to work in excess of those mandated by law.

Table 1.
Summary Statistics
N = 233

Variable	Mean	Standard Deviation	Minimum	Maximum
Weekly Hours	64.49	18.11	25	126
Mileage Rate	.286	.055	.130	.485
Experience	13.66	10.12	1.00	43.00
Tenure	3.46	4.58	.083	30.00
HS Degree	.83	.37	0	1
Union	.08	.27	0	1
White	.86	.35	0	1
Moving Violation	.25	.43	0	1
Medium Firm Size	.33	.47	0	1
Large Firm Size	.34	.48	0	1
Private Carriage	.14	.34	0	1
Drybox	.65	.48	0	1
Miles Per Dispatch	858.01	619.75	144.14	3500.00
Unpaid Time per Mile	.23	.40	0	3.00
Paid Days Off	13.70	8.40	0	35.00
Age	42.18	9.51	22.00	64.00
Married	.69	.46	0	1
Other Income	31,978	18,878	0	5,000
% Night Driving	.22	.21	0	.75
% Non-Driving	.19	.17	0	.89
Last Home	8.46	12.74	0	90.00

Table 2.

Mileage Rate Equation

Valid cases:	233	Dependent variable:	Mileage Rate
R-squared:	0.385	Rbar-squared:	0.340
Residual SS:	0.431	Std error of est:	0.045
F(16,216):	8.457	Probability of F:	0.000

Variable	Estimate	Standard Error	t-value
CONSTANT	0.241	0.016	14.727***
Experience	0.002	0.001	1.939*
Experience^2	-0.000041	0.000031	-1.338
Tenure	0.003	0.001	2.057**
Tenure^2	-0.000106	0.000069	-1.529
HS Degree	0.000574	0.008	0.067
Union	0.097	0.027	3.531***
White	0.015	0.008	1.749*
Union**x**White	-0.040	0.030	-1.332
Prev Moving Violation	0.006	0.007	0.988
Medium Firm	0.013	0.007	1.698*
Large Firm	0.026	0.008	3.324***
Private Carriage	-0.019	0.009	-2.024**
Drybox	-0.008	0.006	-1.261
Miles per Dispatch	-0.00002	0.000005	-4.056***
Unpaid Time	-0.009	0.008	-1.194
Paid Days Off	0.001	0.0004	2.080**

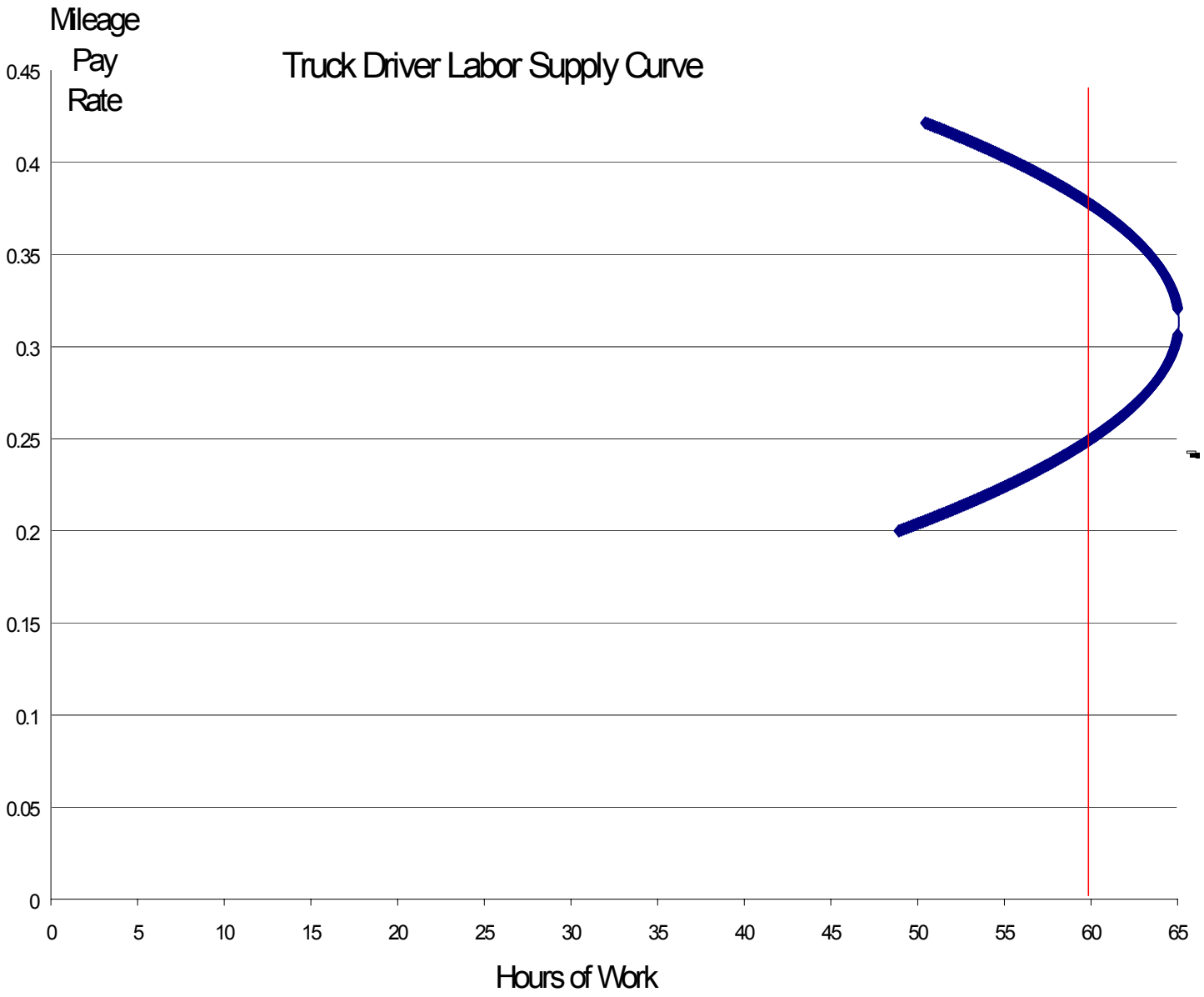
Table 3.
Weekly Hours Equation

Valid cases:	233	Dependent variable:	Hours Per Week
R-squared:	0.165	Rbar-squared:	0.107
Residual SS:	63580.403	Std error of est:	17.117
F(15,217):	2.852	Probability of F:	0.000

Variable	Estimate	Standard Error	t-value
CONSTANT	-119.328	65.559	-1.820*
Fitted Rate	785.677	446.722	1.758*
Fitted Rate^2	-1252.969	756.186073	-1.656*
Age	3.124	0.992	3.147***
Age^2	-0.035	0.011	-3.056***
Married	-4.827	2.672	-1.806*
Other Income ($1000)	0.023	0.067	0.336
% Night Driving	9.377	5.666	1.654*
% Non-Driving Time	-21.803	8.913	-2.446**
Unpaid Time	11.066	3.864	2.86***
Paid Days Off	-0.064	0.196	-0.327
Union	9.759	9.207	1.059
Miles Per Dispatch	0.001	0.002	0.386
Private Carriage	-3.487	4.256	-0.819
Tenure	-0.362	0.300	-1.207
Last Home	-0.008	0.094	-0.090

Labor Supply Curve

Based on this analysis we fit a classic backward-bending labor supply curve. This shows that given empirical evidence of wages, from the UMTIP driver survey, drivers will prefer to work more hours (trade labor for leisure) up to a rate of pay of approximately 31.4 cents per mile (slightly more than 65 hours per week) and above that rate of pay they will prefer to work fewer hours. We recognize that apparent driver preferences may be affected endogenously by the firm preferences (firms that pay a higher rate may prefer to work drivers fewer hours or firms that pay at a higher rate may be limited in their ability to require drivers to work more than the legal limit, either because of legal or ethical reasons or for reasons of firm strategy, or because of the inhibiting influence of unionization) but regardless of the reason, the higher the wages the lower the number of hours worked. This result, though relatively rarely demonstrated empirically, is consistent with standard economic theory.


Mileage Pay Rate
Truck Driver Labor Supply Curve
0.45
0.4
0.35
0.3
0.25
0.2
0.15
0.1
0.05
0
0
5
10
15
20
25
30
35
40
45
50
55
60
65
Hours of Work

Assumptions

The results reported in the study reflect the cost to the economy of enforcing the existing HOS rules in a full-employment economy, under the restrictions imposed by the assumptions described in this section. Future research directions would include experimenting with relaxing several of these assumptions to obtain a full profile of potential costs. The research agenda would also include, where possible, predicting the benefit impacts of successful enforcement, such as those related to health and safety.[123] The key assumptions of the current study are:

- We are operating in a full-employment economy. There will be periods of economic slowdown with greater numbers of unemployed workers, but these episodes will be temporary. With the accelerated aging of the population and the slowing of labor force growth after 2010, tight labor markets will be the norm for the foreseeable future unless there is a considerable increase in the rate of immigration.
- We consider only those truck drivers who are classified in the formal industry category (Standard Industrial Classification code 42), and not those drivers who are categorized in other industries such as retail trade or construction (for example, drivers who work for large grocery chains or who drive gravel trucks). Data from the Current Population Survey indicate that the noncompliance rate is low for drivers outside of the trucking industry.
- Output in the industry remains unchanged from production levels that would be realized with current enforcement policies.
- The additional truck drivers required are not supplied by increased immigration or increased labor force participation rates. Also, these additional workers are replacing the excess hours of existing drivers.
- Drivers working less than 60 hours a week can be induced to raise their workload to 60 hours. This was chosen as a benchmark assumption; alternate assumptions of worker responsiveness would require an estimate of the proportion of workers willing to increase their hours and the number of hours they are currently working. Such estimates were not available, but assuming the proportion of drivers willing to increase their hours to be anything less than the entire pool would change the scenario such that there would be greater transfers of workers and thus higher costs to the economy, including reduced output and higher inflation.
- If new trucks are purchased, the cost is balanced by lower depreciation rates for the existing fleet.

[123] A primary benefit from a macroeconomic perspective would be, for instance, that fewer drivers would have to leave the labor force due to injury. In addition, if the money spent on vehicle repair were to be invested instead on productivity-enhancing activities, the macroeconomy would be affected positively.

Results for the U.S. Economy

The following table shows our estimates of the long-run effect in a full-employment U.S. economy of adding 48,777 truck drivers to meet labor force needs associated with effective enforcement of existing HOS rules.

The results are presented in terms of the change in employment and the change in inflation-adjusted Gross Domestic Product, both by major industry divisions in the private nonfarm economy.

By the nature of the experiment, jobs in the full-employment economy are redistributed to the trucking industry from the other sectors of the economy, so that there is no net change in employment for the United States as a whole compared with a scenario of no intervention. Thus, the economy grows (or shrinks) at a predicted rate, but the rate of change in total employment is the same with or without the policy intervention. This result reflects the assumption that we are enforcing the HOS rules during a full-employment economy, and that there is no change in the labor force due to either international migration or an increase in the labor force participation rate.

The gain of 48,777 jobs in the trucking industry means that there will be an equivalent decline among the rest of the industries in the private nonfarm economy. About 15 percent of these workers (7,244) are transfers from manufacturing, with the remaining 85 percent (41,533 workers) coming from the private nonmanufacturing sector excluding trucking. The largest shifts within the rest of nonmanufacturing to trucking are from retail trade (18,109 workers) and services (12,957 workers).

The policy intervention results in a reduction of $2.3 billion in real Gross Domestic Product (1992 dollars), or 0.03 percent of total real GDP.[124] Since we are assuming that the additional truck drivers are replacing the excess hours of existing drivers, real GDP for the trucking industry is unchanged. All other sectors suffer production losses, with one-third of these losses occurring in manufacturing and another third in the combination of retail trade and services.

The price level (measured by the deflator for consumer expenditures) increases by 0.07 percent in response to the policy intervention.[125]

[124] In a previous Department of Transportation study (1), an estimate was made of the higher wage costs necessary to attract new workers. Higher wage costs have also been incorporated into our estimates, which reflect the total *output costs* associated with transferring workers to the trucking industry. It should also be noted that the DOT estimates of the labor costs for trucking firms were far too low because in the calculation they assumed that the labor supply elasticity was 10, contrary to the reference in the text of 0.1. In this study, we estimate the labor supply elasticity to be 1.5.

[125] The change in industry costs in our estimates were the result of higher wage rates. These higher wage rates add to the cost of trucking services, which result in higher inflation. The higher wage costs do not affect real output, but they do permanently raise the price level.

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

United States

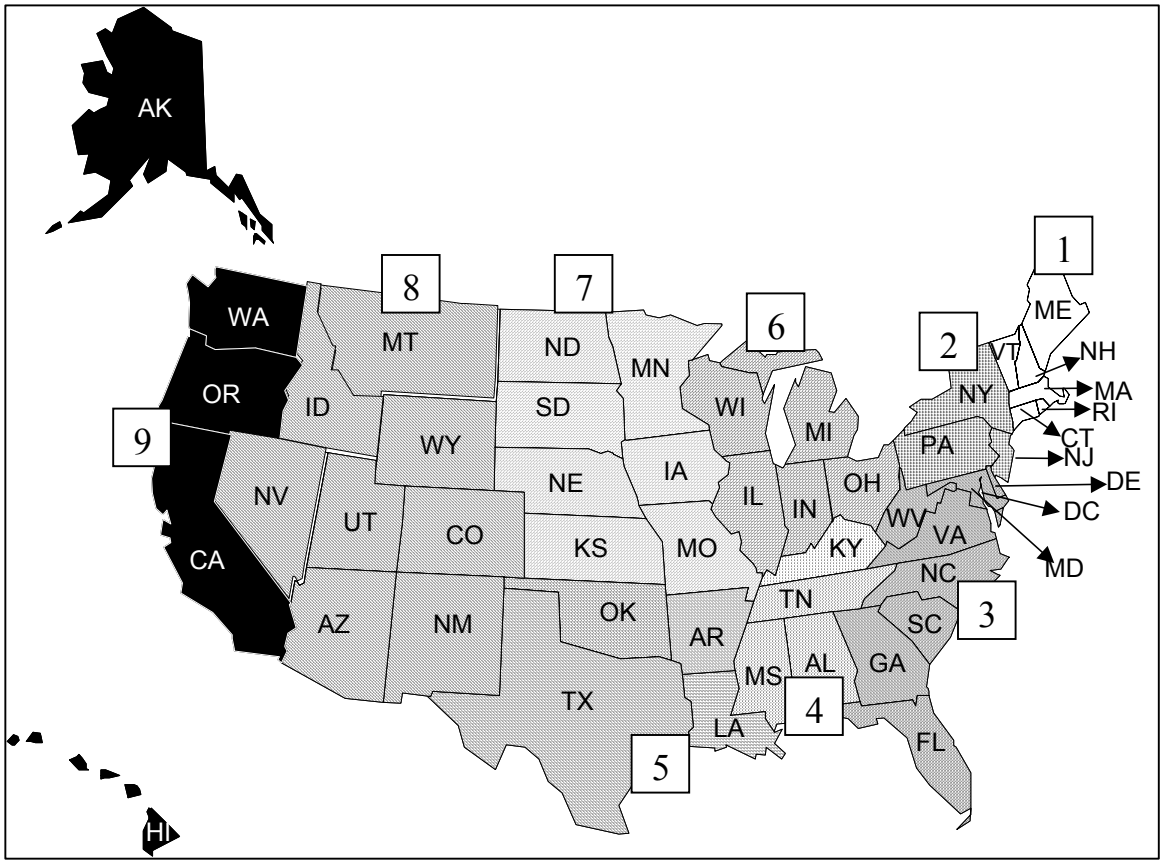
Area/Industry	**Change in employment**	Change in Gross Domestic Product (Millions, '92 $)	Change in GDP as a % of nation	Price level (% change)
Total private nonfarm	0	-2,327.5	-0.030	0.072
Manufacturing	-7,244	-709.3		
Mining	-166	-32.5		
Construction	-4,116	-175.3		
Trucking	48,777	0.0		
Other transportation, communication, utilities	-2,019	-304.5		
Finance, insurance, and real estate	-1,176	-33.1		
Wholesale trade	-2,467	-231.1		
Retail trade	-18,109	-494.8		
Services	-12,957	-341.2		
Agricultural services, forestry, and fishing	-522	-5.6		

Source: Institute of Labor and Industrial Relations, University of Michigan

Census Regions of the United States

A major objective of this study was to break out the impact of successful rules enforcement into sub-regions of the country. We have generated predictions consistent with the national results for all fifty states and the District of Columbia.

To provide an initial and broader summary of these results, we have also combined our state estimates into the nine official census regions of the United States. The composition of the regions by state is shown in the map and table which follows.


AK
HI
1
ME
2
VT
NH
NY
MA
RI
CT
NJ
PA
DE
DC
MD
WV
VA
NC
3
SC
GA
4
AL
MS
LA
5
TX
6
WI
MI
IL
IN
OH
KY
TN
7
ND
MN
SD
IA
NE
KS
MO
OK
AR
8
MT
WY
CO
NM
AZ
UT
9
WA
OR
CA
NV
ID

Census Regions of the United States

1	New England	Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, Vermont
2	Middle Atlantic	New Jersey, New York, Pennsylvania
3	South Atlantic	Delaware, District of Columbia, Florida, Georgia, Maryland, North Carolina, South Carolina, Virginia, West Virginia
4	East South Central	Alabama, Kentucky, Mississippi, Tennessee
5	West South Central	Arkansas, Louisiana, Oklahoma, Texas
6	East North Central	Illinois, Indiana, Michigan, Ohio, Wisconsin
7	West North Central	Iowa, Kansas, Minnesota, Missouri, Nebraska, North Dakota, South Dakota
8	Mountain	Arizona, Colorado, Idaho, Montana, Nevada, New Mexico, Utah, Wyoming
9	Pacific	Alaska, California, Hawaii, Oregon, Washington

Results for the Economies of the U.S. Census Regions

The table which follows shows our estimates of the distribution of the national results across the economies of the nine U.S. census regions.

The results are presented in terms of the change in employment and the change in inflation-adjusted Gross Regional Product (GRP), both by three sectoral divisions: manufacturing, trucking, and private nonmanufacturing except trucking. The rankings among the nine census regions are also presented for the change in private nonfarm employment, the change in real GRP, and the change in real GRP as a percentage of total real GRP. We view the last statistic as the most meaningful for regional comparisons of economic impact.

Three regions, all in the central part of the country (West South Central, West North Central, and East South Central) show an increase in total private nonfarm employment. The gains occur because the addition of truck drivers more than offsets the employment losses in other industries. Migrants from other regions fill these net additional jobs. The other six census regions see a net loss in jobs.

All of the regions realize a net loss in real output (GRP in 1992 dollars) as workers shift out of the non-trucking industries. The smallest losses as a percent of total regional output are in the same central regions that see an increase in employment. The largest percentage losses occur in the regions on the east coast and around the Great Lakes.

Sectorally, in every region the employment and output losses are concentrated in the private nonmanufacturing sector excluding trucking.

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

U.S. Census Regions

(Number in parentheses is each region's ranking among all regions in the nation.)

Area/Industry	Change in **employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of region
New England	(8)	(3)	(7)
Total private nonfarm	-1,249	-143.0	-0.032
Manufacturing	-415	-48.2	
Trucking	1,731	0.0	
Other nonmanufacturing	-2,565	-94.8	
Middle Atlantic	(9)	(8)	(8)
Total private nonfarm	-2,209	-401.8	-0.035
Manufacturing	-1,097	-123.5	
Trucking	5,530	0.0	
Other nonmanufacturing	-6,643	-278.3	
South Atlantic	(6)	(7)	(6)
Total private nonfarm	-649	-379.4	-0.030
Manufacturing	-1,012	-85.0	
Trucking	8,006	0.0	
Other nonmanufacturing	-7,643	-294.5	
East South Central	(3)	(1)	(2)
Total private nonfarm	1,531	-105.1	-0.026
Manufacturing	-518	-38.1	
Trucking	3,816	0.0	
Other nonmanufacturing	-1,766	-67.0	
West South Central	(1)	(5)	(1)
Total private nonfarm	2,469	-178.5	-0.021
Manufacturing	-407	-37.7	
Trucking	6,173	0.0	
Other nonmanufacturing	-3,297	-140.8	
East North Central	(4)	(9)	(9)
Total private nonfarm	-29	-459.9	-0.036
Manufacturing	-2,004	-203.8	
Trucking	9,074	0.0	
Other nonmanufacturing	-7,100	-256.4	
West North Central	(2)	(4)	(3)
Total private nonfarm	1,571	-152.2	-0.028
Manufacturing	-603	-55.2	
Trucking	4,837	0.0	
Other nonmanufacturing	-2,661	-96.8	
Mountain	(5)	(2)	(5)
Total private nonfarm	-379	-133.2	-0.029
Manufacturing	-252	-22.2	
Trucking	2,810	0.0	
Other nonmanufacturing	-2,932	-111.0	

Area/Industry	Change in **employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of region
Pacific	(7)	(6)	(4)
Total private nonfarm	-1,057	-374.2	-0.028
Manufacturing	-933	-95.7	
Trucking	6,802	0.0	
Other nonmanufacturing	-6,925	-278.6	

Results for the Fifty States and the District of Columbia

The following tables show our estimates of the distribution of the national results across the economies for each of the fifty states and the District of Columbia, organized by census region. An equivalent table organized in alphabetical order by state is provided in appendix A.

The results are presented in terms of the change in employment and the change in inflation-adjusted Gross Regional Product (GRP), both by three sectoral divisions: manufacturing, trucking, and private nonmanufacturing except trucking. The rankings among the fifty states and the District of Columbia are also presented for the change in private nonfarm employment and the change in real GRP. We view the latter statistic as the more meaningful for regional comparisons of economic impact.

Twenty-eight states show an increase in total private nonfarm employment, but the gains are small, ranging from six jobs in Wyoming to 1,558 in Texas. The gains occur because the addition of truck drivers more than offsets the employment losses in other industries. Migrants from other states fill these net additional jobs. The other thirty-three states see a small net loss in jobs, ranging from five jobs in South Carolina to 1,201 in Michigan.

More significant, every state sees a net loss in real output (real GRP) as workers shift out of the non-trucking industries. These losses range from $3.6 million (1992 dollars) in North Dakota to $293.7 million in California. The smallest loss as a percent of total state output is in Texas (0.020 percent), and the largest percentage loss is in Michigan (0.050 percent).

Sectorally, in every state except Arkansas, Indiana, and Wisconsin, the output losses are greater in the private nonmanufacturing sector excluding trucking than they are in manufacturing.

Every state sees a small increase in the price level (measured by the deflator for consumer expenditures), ranging from 0.052 percent in the District of Columbia to 0.082 percent in Arkansas.

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

New England Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Connecticut	(46)	(37)		
Total private nonfarm	-448	-46.9	-0.041	0.068
Manufacturing	-130	-17.3		
Trucking	373	0.0		
Other nonmanufacturing	-691	-29.6		
Maine	(25)	(9)		
Total private nonfarm	23	-7.1	-0.023	0.075
Manufacturing	-20	-1.0		
Trucking	249	0.0		
Other nonmanufacturing	-206	-6.1		
Massachusetts	(47)	(42)		
Total private nonfarm	-648	-64.9	-0.031	0.069
Manufacturing	-182	-21.9		
Trucking	716	0.0		
Other nonmanufacturing	-1,182	-43.0		
New Hampshire	(32)	(12)		
Total private nonfarm	-40	-9.9	-0.024	0.069
Manufacturing	-27	-3.8		
Trucking	174	0.0		
Other nonmanufacturing	-187	-6.1		
Rhode Island	(38)	(10)		
Total private nonfarm	-100	-8.4	-0.032	0.072
Manufacturing	-38	-2.8		
Trucking	108	0.0		
Other nonmanufacturing	-170	-5.6		
Vermont	(31)	(6)		
Total private nonfarm	-36	-5.8	-0.034	0.074
Manufacturing	-18	-1.4		
Trucking	111	0.0		
Other nonmanufacturing	-129	-4.4		

Source: Institute of Labor and Industrial Relations, University of Michigan

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

Middle Atlantic Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
New Jersey	(27)	(43)		
Total private nonfarm	10	-87.2	-0.034	0.072
Manufacturing	-295	-35.9		
Trucking	1,584	0.0		
Other nonmanufacturing	-1,280	-51.3		
New York	(51)	(50)		
Total private nonfarm	-1,977	-203.0	-0.037	0.067
Manufacturing	-425	-49.6		
Trucking	1,858	0.0		
Other nonmanufacturing	-3,410	-153.4		
Pennsylvania	(44)	(45)		
Total private nonfarm	-242	-111.6	-0.032	0.074
Manufacturing	-377	-38.0		
Trucking	2,088	0.0		
Other nonmanufacturing	-1,953	-73.6		

Source: Institute of Labor and Industrial Relations, University of Michigan

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

South Atlantic Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	Change in **employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Delaware	(33)	(11)		
Total private nonfarm	-69	-9.0	-0.036	0.071
Manufacturing	-30	-3.6		
Trucking	111	0.0		
Other nonmanufacturing	-150	-5.4		
District of Columbia	(37)	(3)		
Total private nonfarm	-97	-5.3	-0.022	0.052
Manufacturing	-3	-0.2		
Trucking	30	0.0		
Other nonmanufacturing	-124	-5.1		
Florida	(48)	(47)		
Total private nonfarm	-837	-115.9	-0.032	0.070
Manufacturing	-164	-14.2		
Trucking	1,947	0.0		
Other nonmanufacturing	-2,620	-101.8		
Georgia	(10)	(41)		
Total private nonfarm	291	-60.6	-0.028	0.075
Manufacturing	-201	-17.9		
Trucking	1,505	0.0		
Other nonmanufacturing	-1,013	-42.7		
Maryland	(43)	(33)		
Total private nonfarm	-211	-41.4	-0.032	0.070
Manufacturing	-67	-6.7		
Trucking	753	0.0		
Other nonmanufacturing	-897	-34.6		
North Carolina	(6)	(40)		
Total private nonfarm	391	-54.2	-0.026	0.076
Manufacturing	-269	-20.2		
Trucking	1,587	0.0		
Other nonmanufacturing	-927	-34.0		
South Carolina	(29)	(28)		
Total private nonfarm	-5	-28.9	-0.031	0.075
Manufacturing	-113	-9.1		
Trucking	674	0.0		
Other nonmanufacturing	-566	-19.9		
Virginia	(41)	(39)		
Total private nonfarm	-174	-53.9	-0.029	0.072
Manufacturing	-144	-13.0		
Trucking	1,072	0.0		
Other nonmanufacturing	-1,102	-40.9		

Area/Industry	Change in **employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of region	
West Virginia	(23)	(13)		
Total private nonfarm	62	-10.2	-0.027	0.073
Manufacturing	-21	-0.1		
Trucking	327	0.0		
Other nonmanufacturing	-244	-10.1		

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

East South Central Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Alabama	(13)	(26)		
Total private nonfarm	258	-27.4	-0.028	0.076
Manufacturing	-153	-8.2		
Trucking	910	0.0		
Other nonmanufacturing	-499	-19.2		
Kentucky	(11)	(25)		
Total private nonfarm	275	-26.0	-0.026	0.077
Manufacturing	-80	-8.6		
Trucking	817	0.0		
Other nonmanufacturing	-462	-17.4		
Mississippi	(16)	(19)		
Total private nonfarm	179	-17.4	-0.029	0.077
Manufacturing	-109	-5.9		
Trucking	572	0.0		
Other nonmanufacturing	-284	-11.5		
Tennessee	(2)	(30)		
Total private nonfarm	819	-34.3	-0.024	0.079
Manufacturing	-176	-15.4		
Trucking	1,517	0.0		
Other nonmanufacturing	-521	-18.9		

Source: Institute of Labor and Industrial Relations, University of Michigan

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

West South Central Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Arkansas	(5)	(17)		
Total private nonfarm	554	-13.9	-0.023	0.082
Manufacturing	-121	-7.3		
Trucking	843	0.0		
Other nonmanufacturing	-167	-6.6		
Louisiana	(19)	(27)		
Total private nonfarm	97	-28.1	-0.024	0.074
Manufacturing	-37	-3.5		
Trucking	730	0.0		
Other nonmanufacturing	-596	-24.6		
Oklahoma	(12)	(22)		
Total private nonfarm	260	-20.7	-0.025	0.078
Manufacturing	-44	-4.1		
Trucking	729	0.0		
Other nonmanufacturing	-425	-16.6		
Texas	(1)	(46)		
Total private nonfarm	1,558	-115.8	-0.020	0.075
Manufacturing	-205	-22.8		
Trucking	3,871	0.0		
Other nonmanufacturing	-2,109	-93.0		

Source: Institute of Labor and Industrial Relations, University of Michigan

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

East North Central Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Illinois	(30)	(48)		
Total private nonfarm	-11	-126.4	-0.034	0.073
Manufacturing	-458	-50.9		
Trucking	2,416	0.0		
Other nonmanufacturing	-1,969	-75.6		
Indiana	(4)	(38)		
Total private nonfarm	563	-51.9	-0.030	0.078
Manufacturing	-291	-26.5		
Trucking	1,643	0.0		
Other nonmanufacturing	-789	-25.4		
Michigan	(50)	(49)		
Total private nonfarm	-1,201	-131.4	-0.050	0.071
Manufacturing	-568	-57.5		
Trucking	1,340	0.0		
Other nonmanufacturing	-1,973	-73.9		
Ohio	(14)	(44)		
Total private nonfarm	240	-106.3	-0.033	0.074
Manufacturing	-440	-46.2		
Trucking	2,357	0.0		
Other nonmanufacturing	-1,677	-60.2		
Wisconsin	(7)	(35)		
Total private nonfarm	380	-43.9	-0.029	0.076
Manufacturing	-247	-22.7		
Trucking	1,318	0.0		
Other nonmanufacturing	-692	-21.3		

Source: Institute of Labor and Industrial Relations, University of Michigan

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

West North Central Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Iowa	(8)	(23)		
Total private nonfarm	357	-21.7	-0.026	0.076
Manufacturing	-92	-8.8		
Trucking	837	0.0		
Other nonmanufacturing	-387	-12.9		
Kansas	(18)	(24)		
Total private nonfarm	119	-22.4	-0.031	0.077
Manufacturing	-83	-6.8		
Trucking	597	0.0		
Other nonmanufacturing	-395	-15.6		
Minnesota	(26)	(36)		
Total private nonfarm	18	-45.7	-0.032	0.071
Manufacturing	-182	-17.7		
Trucking	973	0.0		
Other nonmanufacturing	-772	-28.0		
Missouri	(3)	(32)		
Total private nonfarm	599	-41.2	-0.027	0.075
Manufacturing	-146	-14.9		
Trucking	1,453	0.0		
Other nonmanufacturing	-708	-26.2		
Nebraska	(9)	(15)		
Total private nonfarm	309	-11.9	-0.025	0.079
Manufacturing	-69	-5.1		
Trucking	574	0.0		
Other nonmanufacturing	-195	-6.8		
North Dakota	(22)	(1)		
Total private nonfarm	82	-3.6	-0.022	0.076
Manufacturing	-9	-0.4		
Trucking	185	0.0		
Other nonmanufacturing	-95	-3.1		

South Dakota	(20)	(5)		
Total private nonfarm	87	-5.7	-0.025	0.076
Manufacturing	-22	-1.5		
Trucking	218	0.0		
Other nonmanufacturing	-109	-4.2		

Source: Institute of Labor and Industrial Relations, University of Michigan

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

Mountain Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Arizona	(40)	(29)		
Total private nonfarm	-145	-32.3	-0.026	0.071
Manufacturing	-54	-5.9		
Trucking	639	0.0		
Other nonmanufacturing	-730	-26.5		
Colorado	(39)	(31)		
Total private nonfarm	-121	-36.6	-0.030	0.070
Manufacturing	-76	-7.8		
Trucking	696	0.0		
Other nonmanufacturing	-740	-28.8		
Idaho	(17)	(7)		
Total private nonfarm	127	-6.4	-0.021	0.076
Manufacturing	-20	-1.6		
Trucking	297	0.0		
Other nonmanufacturing	-149	-4.8		
Montana	(24)	(4)		
Total private nonfarm	37	-5.6	-0.028	0.075
Manufacturing	-7	-0.4		
Trucking	198	0.0		
Other nonmanufacturing	-153	-5.2		
Nevada	(45)	(20)		
Total private nonfarm	-285	-20.4	-0.041	0.068
Manufacturing	-18	-1.3		
Trucking	190	0.0		
Other nonmanufacturing	-457	-19.0		
New Mexico	(36)	(16)		
Total private nonfarm	-81	-12.2	-0.031	0.073
Manufacturing	-19	-1.5		
Trucking	232	0.0		
Other nonmanufacturing	-293	-10.7		
Utah	(21)	(18)		
Total private nonfarm	83	-15.0	-0.028	0.076
Manufacturing	-55	-3.9		
Trucking	447	0.0		
Other nonmanufacturing	-309	-11.1		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Wyoming	(28)	(2)		
Total private nonfarm	6	-4.7	-0.031	0.075
Manufacturing	-3	0.0		
Trucking	111	0.0		
Other nonmanufacturing	-101	-4.7		

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

Pacific Region

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Alaska	(35)	(8)		
Total private nonfarm	-81	-6.6	-0.041	0.069
Manufacturing	-30	-1.5		
Trucking	92	0.0		
Other nonmanufacturing	-143	-5.1		
California	(49)	(51)		
Total private nonfarm	-886	-293.7	-0.029	0.068
Manufacturing	-659	-74.5		
Trucking	5,041	0.0		
Other nonmanufacturing	-5,268	-219.2		
Hawaii	(42)	(14)		
Total private nonfarm	-201	-11.4	-0.035	0.069
Manufacturing	-12	-0.8		
Trucking	85	0.0		
Other nonmanufacturing	-274	-10.7		
Oregon	(15)	(21)		
Total private nonfarm	189	-20.6	-0.023	0.075
Manufacturing	-90	-7.6		
Trucking	720	0.0		
Other nonmanufacturing	-440	-13.0		
Washington	(34)	(34)		
Total private nonfarm	-78	-41.9	-0.028	0.071
Manufacturing	-142	-11.3		
Trucking	864	0.0		
Other nonmanufacturing	-800	-30.6		

Source: Institute of Labor and Industrial Relations, University of Michigan

Conclusion to Part II

In this study, we provide predictions of the total macroeconomic effects, by sector and by state, of enforcement of the existing HOS rules in a full-employment environment. The predictions focus on the cost aspects of successfully enforcing the existing rule of a 60-hour maximum workweek.

To generate the predictions, we use the REMI model, a state-of-the-art macroeconomic model that has been fully documented and peer-reviewed in the professional literature.

A previous study suggests that effective enforcement of the rule would create a need for approximately 49,000 additional truck drivers. We predict the long-run economic consequences of workers shifting out of other sectors to accommodate this need. We assume that the additional drivers are not supplied by increased immigration or increased labor force participation rates.

We predict that, with a full-employment economy, a gain of 48,777 jobs in the national trucking industry would be realized by a shift of 7,244 workers (15 percent of the total) out of manufacturing and 41,533 workers (85 percent) out of the private nonmanufacturing sector. The workers in the latter sector are concentrated in retail trade and services.

The transfer of workers results in a reduction of $2.3 billion in real Gross Domestic Product (1992 dollars), or 0.03 percent of total real GDP. One-third of these losses occur in manufacturing and another third occur in retail trade and services.

Three of the nine official census regions of the United States, all in the central part of the country, show an increase in private nonfarm employment as the addition of truck drivers there more than offsets employment losses in other industries.

All of the census regions see a net loss in real Gross Regional Product as workers shift out of the non-trucking industries. The largest percentage effect occurs in the regions on the east coast and around the Great Lakes.

Among the fifty states and the District of Columbia, there is a mixture of small gains and losses in private nonfarm employment. More significant, every state realizes a net loss in real Gross Regional Product as workers shift out of the non-trucking industries. The smallest percentage effect is in Texas, and the largest is in Michigan.

Future research directions include freeing up some of the assumptions to obtain a full profile of potential costs, and predicting (to the extent possible) the benefits of successful enforcement. Also, the effects of alternative rules could be evaluated.

Appendix A

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

Alphabetical by State

Long-Run Effect of Adding 49,000 Truck Drivers in 2000 to Meet Labor Force Needs Associated with Effective Enforcement of Existing HOS Rules

Alphabetical by State

(Number in parentheses is each state's ranking among all states and D.C.)

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Alabama	(13)	(26)		
Total private nonfarm	258	-27.4	-0.028	0.076
Manufacturing	-153	-8.2		
Trucking	910	0.0		
Other nonmanufacturing	-499	-19.2		
Alaska	(35)	(8)		
Total private nonfarm	-81	-6.6	-0.041	0.069
Manufacturing	-30	-1.5		
Trucking	92	0.0		
Other nonmanufacturing	-143	-5.1		
Arizona	(40)	(29)		
Total private nonfarm	-145	-32.3	-0.026	0.071
Manufacturing	-54	-5.9		
Trucking	639	0.0		
Other nonmanufacturing	-730	-26.5		
Arkansas	(5)	(17)		
Total private nonfarm	554	-13.9	-0.023	0.082
Manufacturing	-121	-7.3		
Trucking	843	0.0		
Other nonmanufacturing	-167	-6.6		
California	(49)	(51)		
Total private nonfarm	-886	-293.7	-0.029	0.068
Manufacturing	-659	-74.5		
Trucking	5,041	0.0		
Other nonmanufacturing	-5,268	-219.2		
Colorado	(39)	(31)		
Total private nonfarm	-121	-36.6	-0.030	0.070
Manufacturing	-76	-7.8		
Trucking	696	0.0		
Other nonmanufacturing	-740	-28.8		
Connecticut	(46)	(37)		
Total private nonfarm	-448	-46.9	-0.041	0.068
Manufacturing	-130	-17.3		
Trucking	373	0.0		
Other nonmanufacturing	-691	-29.6		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Delaware	(33)	(11)		
Total private nonfarm	-69	-9.0	-0.036	0.071
Manufacturing	-30	-3.6		
Trucking	111	0.0		
Other nonmanufacturing	-150	-5.4		
District of Columbia	(37)	(3)		
Total private nonfarm	-97	-5.3	-0.022	0.052
Manufacturing	-3	-0.2		
Trucking	30	0.0		
Other nonmanufacturing	-124	-5.1		
Florida	(48)	(47)		
Total private nonfarm	-837	-115.9	-0.032	0.070
Manufacturing	-164	-14.2		
Trucking	1,947	0.0		
Other nonmanufacturing	-2,620	-101.8		
Georgia	(10)	(41)		
Total private nonfarm	291	-60.6	-0.028	0.075
Manufacturing	-201	-17.9		
Trucking	1,505	0.0		
Other nonmanufacturing	-1,013	-42.7		
Hawaii	(42)	(14)		
Total private nonfarm	-201	-11.4	-0.035	0.069
Manufacturing	-12	-0.8		
Trucking	85	0.0		
Other nonmanufacturing	-274	-10.7		
Idaho	(17)	(7)		
Total private nonfarm	127	-6.4	-0.021	0.076
Manufacturing	-20	-1.6		
Trucking	297	0.0		
Other nonmanufacturing	-149	-4.8		
Illinois	(30)	(48)		
Total private nonfarm	-11	-126.4	-0.034	0.073
Manufacturing	-458	-50.9		
Trucking	2,416	0.0		
Other nonmanufacturing	-1,969	-75.6		
Indiana	(4)	(38)		
Total private nonfarm	563	-51.9	-0.030	0.078
Manufacturing	-291	-26.5		
Trucking	1,643	0.0		
Other nonmanufacturing	-789	-25.4		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Iowa	(8)	(23)		
Total private nonfarm	357	-21.7	-0.026	0.076
Manufacturing	-92	-8.8		
Trucking	837	0.0		
Other nonmanufacturing	-387	-12.9		
Kansas	(18)	(24)		
Total private nonfarm	119	-22.4	-0.031	0.077
Manufacturing	-83	-6.8		
Trucking	597	0.0		
Other nonmanufacturing	-395	-15.6		
Kentucky	(11)	(25)		
Total private nonfarm	275	-26.0	-0.026	0.077
Manufacturing	-80	-8.6		
Trucking	817	0.0		
Other nonmanufacturing	-462	-17.4		
Louisiana	(19)	(27)		
Total private nonfarm	97	-28.1	-0.024	0.074
Manufacturing	-37	-3.5		
Trucking	730	0.0		
Other nonmanufacturing	-596	-24.6		
Maine	(25)	(9)		
Total private nonfarm	23	-7.1	-0.023	0.075
Manufacturing	-20	-1.0		
Trucking	249	0.0		
Other nonmanufacturing	-206	-6.1		
Maryland	(43)	(33)		
Total private nonfarm	-211	-41.4	-0.032	0.070
Manufacturing	-67	-6.7		
Trucking	753	0.0		
Other nonmanufacturing	-897	-34.6		
Massachusetts	(47)	(42)		
Total private nonfarm	-648	-64.9	-0.031	0.069
Manufacturing	-182	-21.9		
Trucking	716	0.0		
Other nonmanufacturing	-1,182	-43.0		
Michigan	(50)	(49)		
Total private nonfarm	-1,201	-131.4	-0.050	0.071
Manufacturing	-568	-57.5		
Trucking	1,340	0.0		
Other nonmanufacturing	-1,973	-73.9		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Minnesota	(26)	(36)		
Total private nonfarm	18	-45.7	-0.032	0.071
Manufacturing	-182	-17.7		
Trucking	973	0.0		
Other nonmanufacturing	-772	-28.0		
Mississippi	(16)	(19)		
Total private nonfarm	179	-17.4	-0.029	0.077
Manufacturing	-109	-5.9		
Trucking	572	0.0		
Other nonmanufacturing	-284	-11.5		
Missouri	(3)	(32)		
Total private nonfarm	599	-41.2	-0.027	0.075
Manufacturing	-146	-14.9		
Trucking	1,453	0.0		
Other nonmanufacturing	-708	-26.2		
Montana	(24)	(4)		
Total private nonfarm	37	-5.6	-0.028	0.075
Manufacturing	-7	-0.4		
Trucking	198	0.0		
Other nonmanufacturing	-153	-5.2		
Nebraska	(9)	(15)		
Total private nonfarm	309	-11.9	-0.025	0.079
Manufacturing	-69	-5.1		
Trucking	574	0.0		
Other nonmanufacturing	-195	-6.8		
Nevada	(45)	(20)		
Total private nonfarm	-285	-20.4	-0.041	0.068
Manufacturing	-18	-1.3		
Trucking	190	0.0		
Other nonmanufacturing	-457	-19.0		
New Hampshire	(32)	(12)		
Total private nonfarm	-40	-9.9	-0.024	0.069
Manufacturing	-27	-3.8		
Trucking	174	0.0		
Other nonmanufacturing	-187	-6.1		
New Jersey	(27)	(43)		
Total private nonfarm	10	-87.2	-0.034	0.072
Manufacturing	-295	-35.9		
Trucking	1,584	0.0		
Other nonmanufacturing	-1,280	-51.3		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
New Mexico	(36)	(16)		
Total private nonfarm	-81	-12.2	-0.031	0.073
Manufacturing	-19	-1.5		
Trucking	232	0.0		
Other nonmanufacturing	-293	-10.7		
New York	(51)	(50)		
Total private nonfarm	-1,977	-203.0	-0.037	0.067
Manufacturing	-425	-49.6		
Trucking	1,858	0.0		
Other nonmanufacturing	-3,410	-153.4		
North Carolina	(6)	(40)		
Total private nonfarm	391	-54.2	-0.026	0.076
Manufacturing	-269	-20.2		
Trucking	1,587	0.0		
Other nonmanufacturing	-927	-34.0		
North Dakota	(22)	(1)		
Total private nonfarm	82	-3.6	-0.022	0.076
Manufacturing	-9	-0.4		
Trucking	185	0.0		
Other nonmanufacturing	-95	-3.1		
Ohio	(14)	(44)		
Total private nonfarm	240	-106.3	-0.033	0.074
Manufacturing	-440	-46.2		
Trucking	2,357	0.0		
Other nonmanufacturing	-1,677	-60.2		
Oklahoma	(12)	(22)		
Total private nonfarm	260	-20.7	-0.025	0.078
Manufacturing	-44	-4.1		
Trucking	729	0.0		
Other nonmanufacturing	-425	-16.6		
Oregon	(15)	(21)		
Total private nonfarm	189	-20.6	-0.023	0.075
Manufacturing	-90	-7.6		
Trucking	720	0.0		
Other nonmanufacturing	-440	-13.0		
Pennsylvania	(44)	(45)		
Total private nonfarm	-242	-111.6	-0.032	0.074
Manufacturing	-377	-38.0		
Trucking	2,088	0.0		
Other nonmanufacturing	-1,953	-73.6		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Rhode Island	(38)	(10)		
Total private nonfarm	-100	-8.4	-0.032	0.072
Manufacturing	-38	-2.8		
Trucking	108	0.0		
Other nonmanufacturing	-170	-5.6		
South Carolina	(29)	(28)		
Total private nonfarm	-5	-28.9	-0.031	0.075
Manufacturing	-113	-9.1		
Trucking	674	0.0		
Other nonmanufacturing	-566	-19.9		
South Dakota	(20)	(5)		
Total private nonfarm	87	-5.7	-0.025	0.076
Manufacturing	-22	-1.5		
Trucking	218	0.0		
Other nonmanufacturing	-109	-4.2		
Tennessee	(2)	(30)		
Total private nonfarm	819	-34.3	-0.024	0.079
Manufacturing	-176	-15.4		
Trucking	1,517	0.0		
Other nonmanufacturing	-521	-18.9		
Texas	(1)	(46)		
Total private nonfarm	1,558	-115.8	-0.020	0.075
Manufacturing	-205	-22.8		
Trucking	3,871	0.0		
Other nonmanufacturing	-2,109	-93.0		
Utah	(21)	(18)		
Total private nonfarm	83	-15.0	-0.028	0.076
Manufacturing	-55	-3.9		
Trucking	447	0.0		
Other nonmanufacturing	-309	-11.1		
Vermont	(31)	(6)		
Total private nonfarm	-36	-5.8	-0.034	0.074
Manufacturing	-18	-1.4		
Trucking	111	0.0		
Other nonmanufacturing	-129	-4.4		
Virginia	(41)	(39)		
Total private nonfarm	-174	-53.9	-0.029	0.072
Manufacturing	-144	-13.0		
Trucking	1,072	0.0		
Other nonmanufacturing	-1,102	-40.9		

Area/Industry	**Change in employment**	Change in Gross Regional Product (Millions, '92 $)	Change in GRP as a % of state	Price level (% change)
Washington	(34)	(34)		
Total private nonfarm	-78	-41.9	-0.028	0.071
Manufacturing	-142	-11.3		
Trucking	864	0.0		
Other nonmanufacturing	-800	-30.6		
West Virginia	(23)	(13)		
Total private nonfarm	62	-10.2	-0.027	0.073
Manufacturing	-21	-0.1		
Trucking	327	0.0		
Other nonmanufacturing	-244	-10.1		
Wisconsin	(7)	(35)		
Total private nonfarm	380	-43.9	-0.029	0.076
Manufacturing	-247	-22.7		
Trucking	1,318	0.0		
Other nonmanufacturing	-692	-21.3		
Wyoming	(28)	(2)		
Total private nonfarm	6	-4.7	-0.031	0.075
Manufacturing	-3	0.0		
Trucking	111	0.0		
Other nonmanufacturing	-101	-4.7		

Source: Institute of Labor and Industrial Relations, University of Michigan

Appendix B

Overview of the REMI EDFS-53 Model

Overview of the REMI EDFS-53 Model

Regional Economic Models, Inc. (REMI) was established in 1980 to respond to the demand for regional forecasting and simulation models. The REMI methodology was first initiated in the mid-1970s as the TFS methodology, named after its original authors, Treyz, Friedlander, and Stevens. The Massachusetts Economic Policy Analysis model, developed in 1977, was the first implementation of this methodology. A core version of the model was then developed for the National Academy of Sciences. Now available for any county/state or combination of counties/states in the United States, the standard REMI model is the Economic and Demographic Forecasting and Simulation 53-sector (EDFS-53) model.

Policymakers and analysts can use the EDFS-53 model to forecast and simulate policy changes in a regional economy. The baseline forecast (also called a control forecast) does not include any policy variable changes. A forecast that does include one or more policy variable changes is called an alternative forecast or a simulation. The difference between the control and alternative forecasts shows the effects of the policy change. Examples of such policy changes include decisions relating to tourism, the environment, transportation, energy, taxation, utility rates, and a wide variety of regional development projects.

Interindustry relationships are included in the REMI model, as well as behavioral equations from economic theory. This creates a model that will respond in a logical way to changes in an area's economy. The coupling of proven economic theory with customized data ensures state-of-the-art accuracy of the REMI EDFS-53 forecast and simulation. The result of the REMI modeling technique is a representation of a regional economy that predicts demand and supply conditions across 53 sectors, 94 occupations, 25 final-demand sectors, and 202 age/sex cohorts.

In contrast to traditional regional econometric models, REMI models are estimated using data from all regions and then calibrated to the specific region. This method ensures that estimated model parameters produce more econometrically consistent results than would be possible using data from only a single area. The model embodies a consistent internal structure that is widely documented in academic publications. Users benefit from the ongoing model research and development program at REMI.

References for Part II

1. *Federal Register*, May 2, 2000:25540-611.

2. Fulton, George A., Donald R. Grimes, Lucie G. Schmidt, Sean P. McAlinden, and Barbara C. Richardson. "Contribution of the Automotive Industry to the U.S. Economy in 1998: The Nation and Its Fifty States." Study prepared for the Alliance of Automobile Manufacturers, Inc., and the Association of International Automobile Manufacturers, Inc. Ann Arbor: Institute of Labor and Industrial Relations, University of Michigan; Office for the Study of Automotive Transportation, University of Michigan Transportation Research Institute; Center for Automotive Research, Environmental Research Institute of Michigan, Winter 2001.

3. Treyz, George I. *Regional Economic Modeling: A Systematic Approach to Economic Forecasting and Policy Analysis*. Boston: Kluwer Academic Publishers, 1993.

4. Treyz, George I., Dan S. Rickman, and Gang Shao. "The REMI Economic-Demographic Forecasting and Simulation Model." *International Regional Science Review* 14, no. 3 (1992):221-53.

5. Warner, Kenneth E., George A. Fulton, Peter Nicolas, and Donald R. Grimes. "Employment Implications of Declining Tobacco Product Sales for the Regional Economies of the United States." *Journal of the American Medical Association* 275, no. 16 (April 24, 1996):1241-6.

6. Warner, Kenneth E., and George A. Fulton. "The Economic Implications of Tobacco Sales in a Nontobacco State." *Journal of the American Medical Association* 271, no. 10 (March 9, 1994):771-6.

7. Warner, Kenneth E., and George A. Fulton. "Importance of Tobacco to a Country's Economy: An Appraisal of the Tobacco Industry's Economic Argument." *Tobacco Control* 4, no. 2 (Summer 1995):180-3.