

# A Long Way to Go and a Short Time to Get There: The Effect of the ELD Mandate on Truck Driver Hours

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# Disclaimer

*This work is presented with the hope that its content may be of interest to the general statistical community. The views expressed here are those of the authors, and do not necessarily represent those of the Census Bureau.*

# Overview

- Trucking is central to the U.S supply chain
  - ▶ 2017 *CFS*: 8.8B tons worth \$10.4T moved by truck
  - ▶ GDP \$19.4T (*BEA*)
- Highly regulated (environment and safety, trucks and drivers)
- US *DOT* changed the way drivers comply with safety regs (HOS)
- Examine whether the policy change had any effect
- Find evidence of a modest effect consistent with market incentives

# Outline

- Hours of Service (HOS) regulations
- Monitoring and compliance (RODS)
- ELD mandate
- Research question
- Methodology
- Data
- Results
- Summary
- Discussion

# Hours of Service (HOS): Allocating a Driver's Time

- 1 OFF DUTY
- 2 SLEEPER BERTH
- 3 DRIVING
- 4 ON DUTY (NOT DRIVING)

# HOS: Daily and Weekly Limits

- 14 hours of total duty time
- 11 hours of driving
- 8 hours continuous driving without  $\geq 30$ -min break
- 60/70 weekly hours in 7/8 consecutive days
  - ▶ 34-hour “restart”
- Special allowances for inclement weather and emergencies

# Truck Driver Incentives

- Paid by the mile
- Statutorial exempt from overtime provisions of *FLSA* of 1938
- Incentive to cheat:
  - ▶ Truck is only making money when it is moving between nodes
  - ▶ “Tweener” routes

# HOS: Monitoring and Compliance

- Record of Duty Status (RODS)
- Log book maintained by *drivers*
- Regulators can inspect on demand (weigh stations, traffic stops)



# Example RODS Template

**U.S. DEPARTMENT OF TRANSPORTATION**

**DRIVER'S DAILY LOG**  
(FOR CARRIER USE ONLY)

ORIGINAL - TO BE FILED WITH LOGS  
DUPLICATE - TO BE FILED WITH LOGS

**Total miles driving today**

**Truck or tractor and trailer number**

**Date** (MONTH) (DAY) (YEAR)

**Name of carrier**

**Main office address**

**24-hour period starting time**

**Driver's signature/certification**

**Name of co-driver**

**Total hours**

**Shipping document number(s), or name of shipper and commodity**

**Remarks**

**1: OFF DUTY**

**2: SLEEPER BERTH**

**3: DRIVING**

**4: ON DUTY (NOT DRIVING)**

**REMARKS**

**Pro or Shipping No.**

**Shipping document number(s), or name of shipper and commodity**

**Remarks**

**1: OFF DUTY**

**2: SLEEPER BERTH**

**3: DRIVING**

**4: ON DUTY (NOT DRIVING)**

**REMARKS**

**Pro or Shipping No.**

# Driver Completing RODS by Hand



# Completed RODS Example

U.S. DEPARTMENT OF TRANSPORTATION		DRIVER'S DAILY LOG (ONE CALENDAR DAY - 24 HOURS)		ORIGINAL - Submit to carrier within 13 days DUPLICATE - Driver retains possession for eight days																					
<u>04</u> <u>09</u> <u>08</u> <small>(MONTH) (DAY) (YEAR)</small>		<u>350</u> <small>(TOTAL MILES DRIVING TODAY)</small>		<u>123, 20544</u> <small>VEHICLE NUMBERS - (SHOW EACH UNIT)</small>																					
I certify these entries are true and correct:																									
<u>John Doe's Transportation</u> <small>(NAME OF CARRIER OR CARRIERS)</small> <u>Washington, D.C.</u> <small>(MAIN OFFICE ADDRESS)</small>			<u>John E. Doe</u> <small>(DRIVER'S SIGNATURE IN FULL)</small> <hr/> <small>(NAME OF CO-DRIVER)</small>																						
	MID- NIGHT	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	TOTAL HOURS
1: OFF DUTY																								10	
2: SLEEPER BERTH																								1.75	
3: DRIVING																								7.75	
4: ON DUTY (NOT DRIVING)																								4.5	
REMARKS	MID- NIGHT	1	2	3	4	5	6	7	8	9	10	11	NOON	1	2	3	4	5	6	7	8	9	10	11	TOTAL HOURS
<u>24</u>																									
Pro or Shipping No. <u>101601</u>																									
<div style="display: flex; justify-content: space-around; align-items: center;"> <div style="text-align: center;"> <p>Richmond, VA</p> </div> <div style="text-align: center;"> <p>Fredericksburg, VA</p> </div> <div style="text-align: center;"> <p>Baltimore, MD</p> </div> <div style="text-align: center;"> <p>Philadelphia, PA</p> </div> <div style="text-align: center;"> <p>Cherry Hill, NJ</p> </div> <div style="text-align: center;"> <p>Newark, NJ</p> </div> </div>																									

# Compliance Monitoring is a Cat-and-Mouse Game

- Log books can be inspected on demand (weigh stations, traffic stops)
- Drivers must maintain a 7-day history
- Submit to carrier after 7-days
- Store for 6 months (subject to audit)



# Problem: Paper Logs are Inefficient

- Management and storage
- Difficult to audit
- Costs increase with fleet size
  - ▶ Frito Lay (1985) first to seek exemption
  - ▶ Filed for and received exemption to use EOBRs for HOS compliance

# Problem: Paper Logs are Easily Falsifiable

- Cheating on HOS is “common”:
  - ▶ 1,265 drivers surveyed in 2010: 37% violate HOS and 10% do so “often” (Chen et al. 2015)
  - ▶ Study on a single route between Minn. and Wash. state: 50-90% drivers violate HOS by at least one hour (Hertz 1991)
- Creates competitive disadvantages

# ELD Mandate

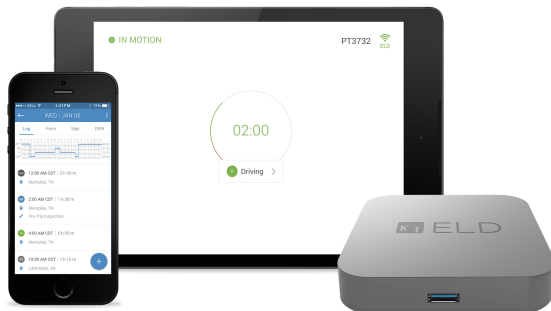
- RODS must be replaced with *Electronic Logging Devices* (ELDs)
- Limited exceptions:
  - ▶ 100-mi air radius same day origin-destination (now 150)–“short-haul”
  - ▶ Vehicles weighing less than 10,000 lbs
  - ▶ Trucks (power units) built before year 2000
  - ▶ Drive fewer than eight days per month where RODS required
  - ▶ Drive-away/tow-away operations
- Cost:
  - ▶ ~\$500 to buy/install
  - ▶ Subscription \$15/mo

# Example ELD





# Example ELD



The image shows a Motorola smartphone screen displaying the P.O.V. (Police Officer's View) application. The app interface is as follows:

- Top Bar:** Motorola logo on the left, Verizon logo on the right.
- Search Bar:** A Google search bar with a microphone icon.
- Navigation Bar:** A series of tabs: Summary, Log Book, Event History, Reports, Jobs, Maintenance, Alarms, Alarms Config, Comments, Information.
- Left Sidebar:**
  - Profile:** A placeholder image of a person's head and shoulders.
  - Current Alarms:** A section with a "VIEW HISTORY" link.
  - Current Events:** A section with a "VIEW HISTORY" link.
  - Recent Comments:** A section with a "VIEW HISTORY" link.
- Main Content Area:**
  - Header:** "Insert New Record" button, date "02/25/2013", and navigation arrows.
  - Timeline:** A horizontal timeline showing events for the day. The timeline is divided into two sections: "OFF DUTY" (top) and "ON DUTY (NOT DRIVING)" (bottom). The timeline is marked with hours from 1 to 11, and then "ROOM 1" to "ROOM 11". The timeline shows various status changes and location updates.
    - OFF DUTY:** Includes "SLEEPER BERTH" and "DRIVING".
    - ON DUTY (NOT DRIVING):** Includes "ON I-75/290", "ON I-75/290", "ON I-75/290", "ON I-75/290", and "ON I-75/290".
  - Legend:** A legend at the bottom of the timeline shows three types of markers: "Un-annotated" (blue circle), "Annotated" (blue circle with a dot), and "Original" (blue circle with a dot).
  - Total Mileage:** "TOTAL MILEAGE TODAY: 244.4"

# Research Question

Did the ELD mandate have any effect on the hours driven by truck drivers?

# ELD Mandate Implementation Timeline



# Methodology

- Exploit timing of ELD mandate enforcement to identify the mandate effect
- Compare average hours of drivers before and after the mandate
  - ▶ Most drivers work for large fleets (*control*)
  - ▶ Use independent owner-operators as the *treatment*
- $H_0$ : ELD had no effect on hours
- Sensitivity analysis

## Estimation 1: Difference-in-Difference Estimator

$$\Delta^2 = (Y_O^{T=1} - Y_O^{T=0}) - (Y_E^{T=1} - Y_E^{T=0}),$$

where:

- $Y$  = average hours worked in the previous week,
- $T = \begin{cases} 1 & \text{if observation in an ELD enforcement month,} \\ 0 & \text{otherwise} \end{cases}$
- $O$  and  $E$  index owner-operators and employee-operators, respectively

Test:

$$H_0 : \Delta^2 = 0$$

$$H_1 : \Delta^2 \neq 0$$

## Estimation 2: Diff-in-Diff by Regression

$$Y_i = \alpha + \beta_1 T_i + \beta_2 O_i + \beta_3 T_i O_i + \mathbf{X}_i' \delta + \epsilon_i,$$

where:

- $Y$ ,  $T$ , and  $O$  retain their previous definitions,
- $\mathbf{X}_i$  is a matrix of exogenous variables (e.g., driver characteristics, time dummies),
- $\epsilon$  is the idiosyncratic error, and
- $i$  indexes the individual driver

Coefficient  $\beta_3$  is the diff-in-diff estimator; use  $t$ -stat to test:

$$H_0 : \hat{\beta}_3 = 0$$

$$H_1 : \hat{\beta}_3 \neq 0$$

# Household Survey Data on Individual Truckers

- *Current Population Survey* (CPS)
  - ▶ Monthly rotating sample of 60,000 U.S. households
  - ▶ 4-8-4 design
- Hours worked (previous week), industry/occupation, class of worker
- Month of survey indicates ELD treatment period
- Independent cross-sections
  - ▶ Pool months into a single file
  - ▶ Longitudinal effects (ORG)



# Data: Sample Restrictions

- Period 2011–2019
- Driving occupations in the trucking industry
  - ▶ *SOC*
  - ▶ *NAICS*
- Age 21+
- Full-time employed at a single job (35+ hours)
- No missing data: industry/occupation, hours\*
- Exclude Hawai'i and Alaska

# Period of Declining Unemployment

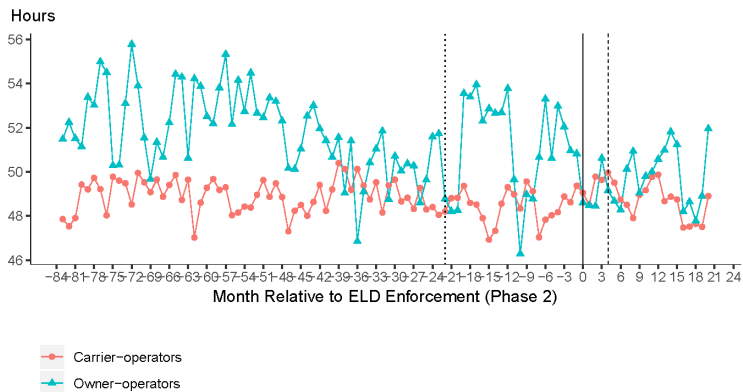


# Select Driver Summary Statistics by Operator Type

Variable	Carriers	Owners	<i>p</i>
Hours worked in the previous week	48.8	51.1	***
Proxy response	0.582	0.536	***
Spouse proxy	0.366	0.388	***
Age (years)	46.8	47.8	***
Female	0.038	0.044	***
White alone	0.768	0.794	***
Black alone	0.183	0.140	***
Hispanic	0.194	0.229	***
Married	0.654	0.733	***
Never married	0.162	0.108	***
Less than high school	0.144	0.160	***
High school or GED	0.541	0.487	***
College degree	0.062	0.109	***
Obs.	36,518	9,978	

\*\*\*  $p \leq 0.01$ , \*\*  $p \leq 0.05$ , \*  $p \leq 0.1$

# Average Work Hours by Operator Type, 2011–2019



## Diff-in-Diff Estimates by ELD Phase: $\Delta^2$

	Pooled		ORG	
	Owners	Carriers	Owners	Carriers
<i>Phase 2: Enforcement</i>				
(1) Pre-ELD	51.5	48.8	51.2	48.1
(2) Phase 2 Enforcement	49.8	48.7	49.0	48.3
(3) Row (2) – Row (1)	–1.7	–0.1	–2.2	0.2
(4) Owners (3) – Carriers (3)	–1.7 (0.32)		–2.4 (0.63)	

## Diff-in-Diff Estimates by ELD Phase: $\Delta^2$

	Pooled		ORG	
	Owners	Carriers	Owners	Carriers
<i>Phase 2: Enforcement</i>				
(1) Pre-ELD	51.5	48.8	51.2	48.1
(2) Phase 2 Enforcement	49.8	48.7	49.0	48.3
(3) Row (2) – Row (1)	–1.7	–0.1	–2.2	0.2
(4) Owners (3) – Carriers (3)	–1.7 (0.32)		–2.4 (0.63)	
<i>Phase 1: Announcement</i>				
(5) Pre-Ruling	52.1	49.0	52.1	48.5
(6) Phase 1	51.0	48.6	50.1	47.7
(7) Row (6) – Row (5)	–1.1	–0.4	–2.0	–0.8
(8) Owners (7) – Carriers (7)	–0.7 (0.32)		–1.2 (0.64)	

## Diff-in-Diff Estimates by ELD Phase: $\Delta^2$

	Pooled		ORG	
	Owners	Carriers	Owners	Carriers
<i>Phase 2: Strict Enforcement</i>				
(9) Light Enforcement	49.0	49.2	48.1	49.2
(10) Strict Enforcement	49.9	48.6	49.1	48.1
(11) Row (10) – Row (9)	0.9	–0.6	1.0	–1.1
(12) Owners (11) – Carriers (11)	1.5 (0.74)		2.0 (1.42)	

# Diff-in-Diff: Pooled Regression Estimates

	(1)	(2)	(3)	(4)	(5)
Constant	48.8 (0.076)	48.9 (0.280)	48.7 (0.497)	40.6 (1.3)	40.3 (1.4)
Owner	2.7 (0.174)	2.8 (0.174)	2.8 (0.172)	2.8 (0.170)	2.8 (0.171)
Owner $\times$ ELD	-1.7 (0.341)	-1.7 (0.339)	-1.4 (0.334)	-1.4 (0.329)	-1.4 (0.334)
Time Controls	No	Yes	Yes	Yes	Yes
State Controls	No	No	Yes	Yes	Yes
Driver Controls	No	No	No	Yes	Yes
$\mathbf{X}_i \times T_i$	No	No	No	No	Yes
Adj. $R^2$	0.007	0.007	0.045	0.076	0.078
$K$	4	22	70	92	113
$N$	38,055	38,055	38,055	38,055	38,055



# Diff-in-Diff: ORG Regression Estimates

	(1)	(2)	(3)	(4)	(5)
Constant	48.1 (0.149)	49.1 (0.558)	48.9 (0.973)	39.0 (2.6)	38.8 (2.7)
Owner	3.1 (0.344)	3.1 (0.344)	3.2 (0.339)	3.2 (0.339)	3.2 (0.341)
Owner $\times$ ELD	-2.4 (0.675)	-2.5 (0.670)	-2.1 (0.660)	-2.2 (0.650)	-2.3 (0.670)
Time Controls	No	Yes	Yes	Yes	Yes
State Controls	No	No	Yes	Yes	Yes
Driver Controls	No	No	No	Yes	Yes
$\mathbf{X}_i \times T_i$	No	No	No	No	Yes
Adj. $R^2$	0.008	0.010	0.049	0.079	0.080
$K$	4	22	70	92	113
$N$	9,305	9,305	9,305	9,305	9,305

# Summary

- ELD mandate made HOS monitoring easier to enforce
- Diff-in-Diff to examine if it had effect on work hours
  - ▶ Owner-operators (treatment), carrier-operators (control)
  - ▶ Treatment occurs at ELD Phase 2 (enforcement)
- Pooled estimates:  $\downarrow$  1.2 hours average (95% CI  $[-2.1, -0.77]$ )
- ORG estimates:  $\downarrow$  2.3 hours average (95% CI  $[-3.6, -0.97]$ )
- Owners were more likely to be out of compliance

# Discussion

- Diff-in-Diff depends on constant trends assumption
- Is hours non-response related to the mandate?
- Measurement error from public data: who is exempt?
  - ▶ Long vs. short haul
  - ▶ Routes
  - ▶ Truck characteristics (age, chassis)

# Disribution of Driving Occupations by Industry

SOC Code	Description	All Industries		Trucking	
		(1) Emp.	(2) Share	(3) Emp.	(4) Share
53-3030	Driver/sales workers and truck drivers	3,089,370	100%	933,150	100%
53-3031	Driver/sales workers	414,320	13.4%	4,360	0.5%
53-3032	Heavy and tractor-trailer truck drivers	1,771,770	57.4%	880,710	94.4%
53-3033	Light truck or delivery services drivers	903,280	29.2%	48,080	5.2%

Source: Bureau of Labor Statistics OES, May 2018

# Employment by Long-Distance and Local Trucking, 2011–2018



Source: Bureau of Labor Statistics *Industry Productivity* series

## Next Steps: Implications for Trucking Industry

- Industrial organization
- Loss of competitive advantage for owners (relative earnings to carriers)
- Does it worsen the truck driver shortage?
- Unintended consequences: more speeding (Scott et al. 2019)

# Thank you!

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