Pay Rates and Motor Carrier Safety:
Testing Intrastate Trucking Companies Using MCMIS

Transportation Research Board
ACS60 (former ANB70)
Truck and Bus Safety Committee

January 15, 2020
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Workplace Safety and Motor Carrier Safety Requires Economic Analysis

- Competition drives carriers to lowest price
- Lowest price drives carriers to lowest cost
- Lowest cost drives rates down and squeezes drivers
  - Unqualified, dangerous drivers
  - Dangerous workplace pressure
  - Dangerous hours of work
- Safety cost pushed to public because carrier legal liability is limited
  - Since 1982, trucking firms need to carry only $750,000 in liability insurance
  - That's $2,046,000 in todays dollars
 - Victims bear this cost of risk

FACT: Truckers Work Long Hours

- UMTIP 1997 survey:
  - Median non-union driver worked 65 hr/wk
  - 55% of CMV drivers not paid for loading/unloading
  - 70% not paid for waiting or other on-the-job time.
- NIOSH 2010 survey
  - Median employee driver works 60 hr/wk
  - 20% exceed 75 hours/week
  - On average, 10.5 hours of work/week (22%) are unpaid
  - On average, 27% of employee drivers' work week is unpaid labor
- FMCSA 2014 and OIG 2018 "Detention Time" studies
  - 10% of all stops experienced 2+ hours detention time
  - Mean detention time 1.4 hours (3.4 hours total)
  - First 15-minute delay beyond 2 hours increases the average expected crash rate by 6.2%
- That is why surveys show long-haul drivers regularly work an impossible (illegal) number of hours.

Drivers in Black Work Excessive Hours

Number of drivers
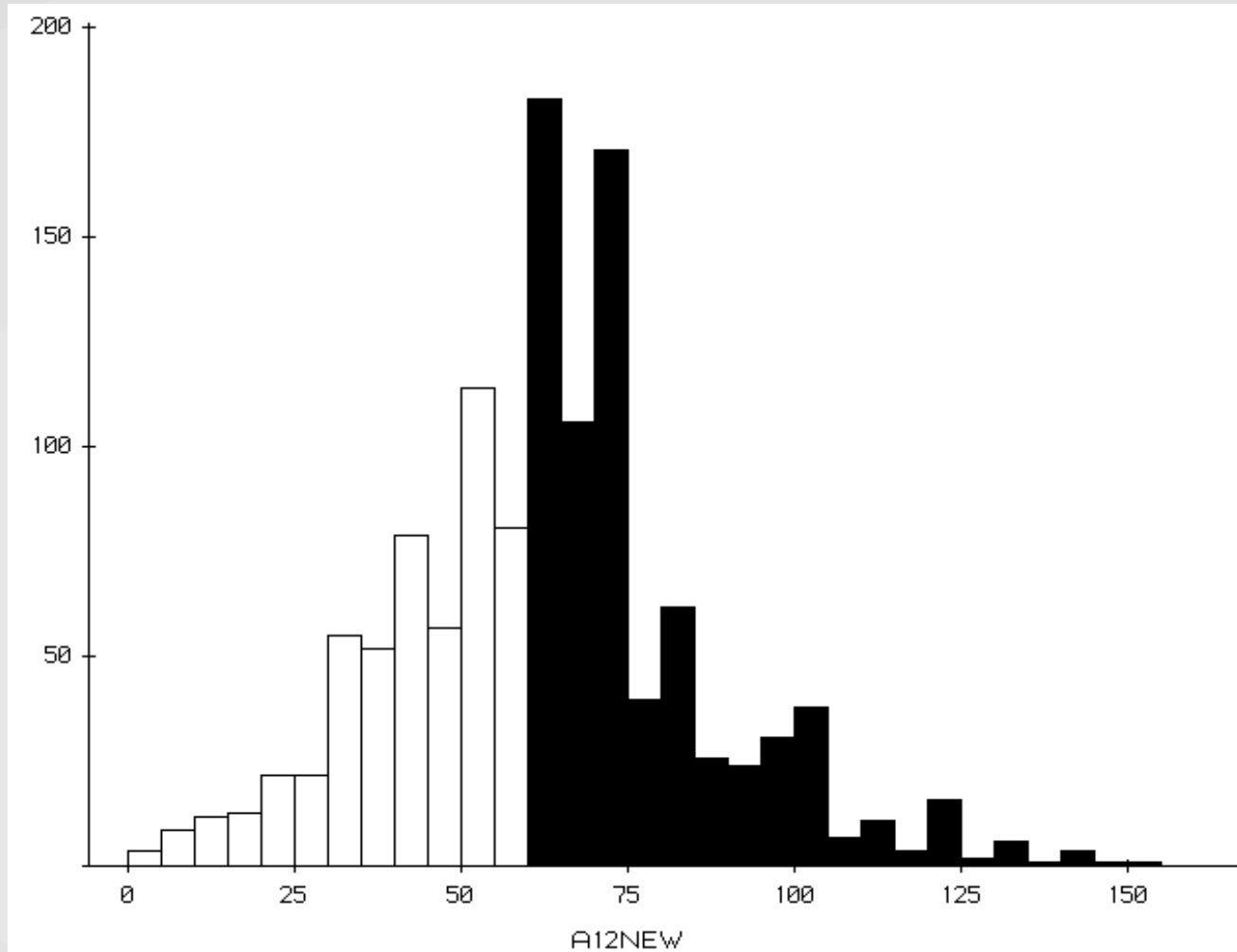
Hours worked/week

- Median: 60 hours
- Average: 61.5 hours
- n = 1,254 long haul truck drivers

Part One: Cross Sectional

Literature

- Research shows that motor carrier safety is greater in firms that pay more money
  K. Monaco and Williams (2000); Belzer et al. (2002); Rodriguez et al. (2006)

- Drivers see target earnings and will work until they achieve them, leading to long hours.
  - Drivers reduce hours as pay rate increases
    Belzer and Sedo (2018)

- Higher pay rates also reduce turnover and increase productivity
  Faulkiner and Belzer (2019)

- Extended bibliography at the end of the presentation

Higher Wages and HOS Violations

- Wages and earnings unavailable in MCMIS

- We therefore use intrastate carriers in MCMIS
  - This allows us to get median wages at a state level using 2018 Current Employment Statistics
  - Truck transportation industry (NAICS 484000)
  - Heavy and Tractor-Trailer Truck Drivers (OCC 53-3032)

- Dependent variable is HOS violations from Crash File

- Independent variables include all other BASICS and other controls.

- Recall the fundamental bias in violations:
 - Inspections are not a random sample

Descriptive Statistics

Summary statistics						
Variable	**N**	**Mean**	**Std Dev**	**Minimum**	**Maximum**	**Label**
CRASHES	14957	0.20	1.39	0	107	Number of crashes
HOS	14957	0.07	0.62	0	38	Number of HOS compliance violations
UNSAFE	14957	0.11	0.58	0	13	Number of unsafe driving violations
DR_FIT	14957	0.12	0.68	0	26	Numebr of driver fitness violations
SUBT	14957	0.00	0.07	0	5	Number of controlled subtances violations
VM	14957	2.01	6.09	0	131	Number of vehicle maintenance violations
WAGE	14957	20.14	1.50	17.14	25.67	Median hourly wage in the carrier's state
Pop_density_m2	14957	224.68	290.72	1	11011	Population density in 2015
VMT	14957	316,005	18,263,635	1,000	2,174,200,000	Reported VMT
HM_FLAG2	14957	0.02	0.13	0	1	Hazmart flag

Distribution of Truck Crashes: 2018

Distribution of Crashes in 2018
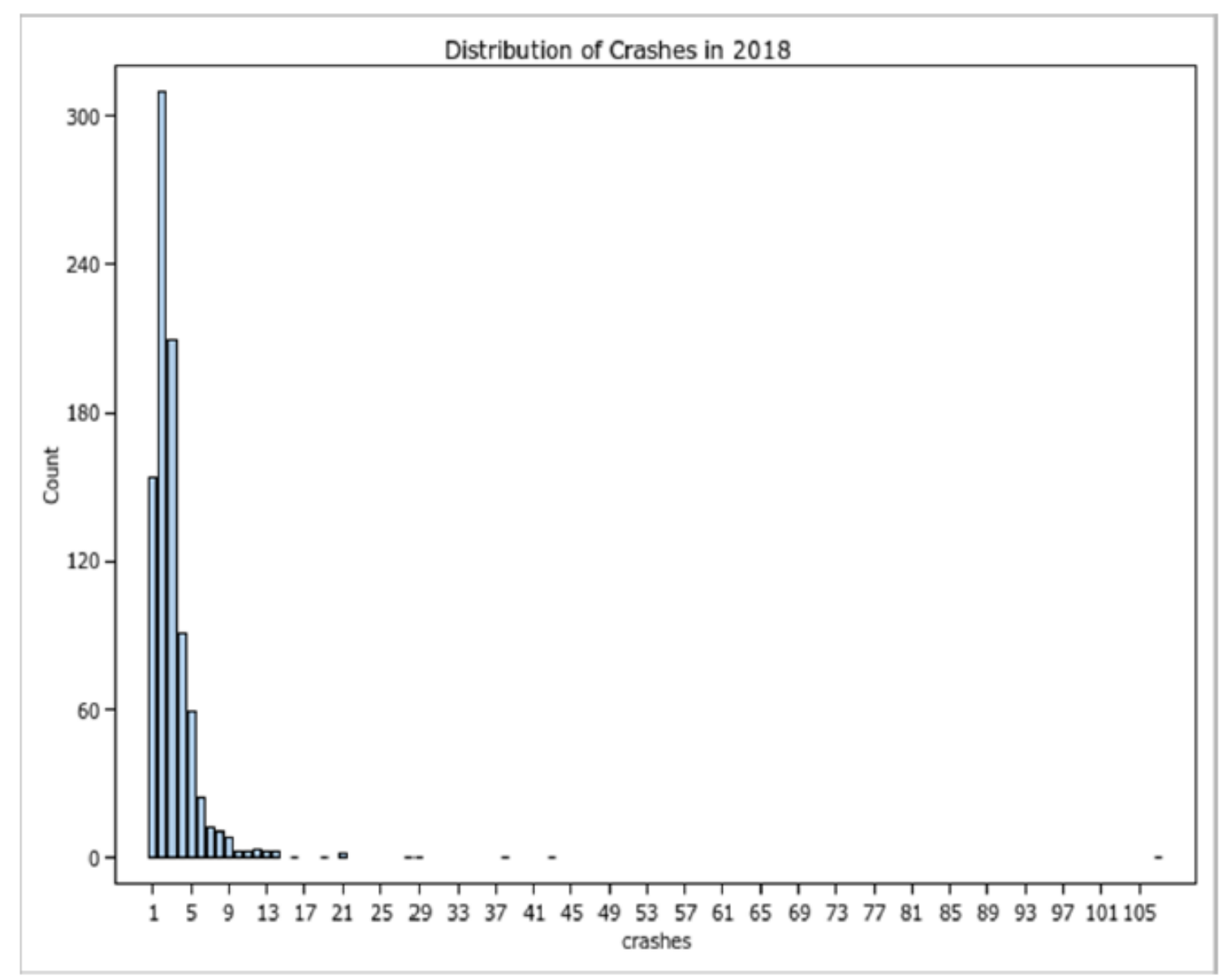
Left-Censored and Biased Distribution of Crashes Requires Poisson and Negative Binomial Models

$Log(Crashes)$

$$= \beta_0 + \beta_1 \, HOS \, Viol + \beta_2 \, Unsafe \, driving \, Viol$$

$$+ \beta_3 \, Driver \, fitness \, Viol + \beta_4 \, Substance \, alcohol \, Viol$$

$$+ \beta_5 \, Vehicle \, maintenance \, Viol + \beta_6 \, Log(Hourly \, wage$$

$$+ \beta_7 \, Log \, (Population \, density) + \beta_8 \, Hazmat \, Flag$$

$$+ \beta_9 \, Log \, (VMT)$$

Estimated Results

| Variable	Poisson Parameter Estimate	Pr > |t|	NB - preferred Parameter Estimate	Pr > |t|
Intercept	-0.02	0.98	0.30	0.88
HOS	**0.09**	<.0001	**0.25**	**0.01**
UNSAFE	0.04	0.11	0.22	0.01
DR_FIT	0.03	0.18	0.02	0.75
SUBT	0.12	0.26	0.33	0.63
VM	0.01	<.0001	0.04	<.0001
lwage	**-3.09**	<.0001	**-3.16**	<.0001
lPop_density_m2	0.13	<.0001	0.19	<.0001
LVMT	0.61	<.0001	0.56	<.0001
HM_FLAG2	0.97	<.0001	0.77	0.01
Dispersion	1		17.37	
Log Likelihood	-5199.2		-2088.4	
Full Log Likelihood	-8115.6		-5004.9	
AIC (smaller is better)	16251.2		10031.8	

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What does this mean?

- HOS matters
  - 1 count increase adds 1.28 more crashes
  - Remember that work hours are inversely related to pay rates
  - Hours of work is one half of the compensation equation
- Vehicle maintenance matters
  - Effect is small but significant
- The effect of hourly wages is **huge**
  - 1% higher hour wages correspond to 3.16% fewer crashes
  - This is 3:1 ratio, by far the biggest effect in this model
  - Consistent with all prior research, the effect of economic factors far outweighs all others
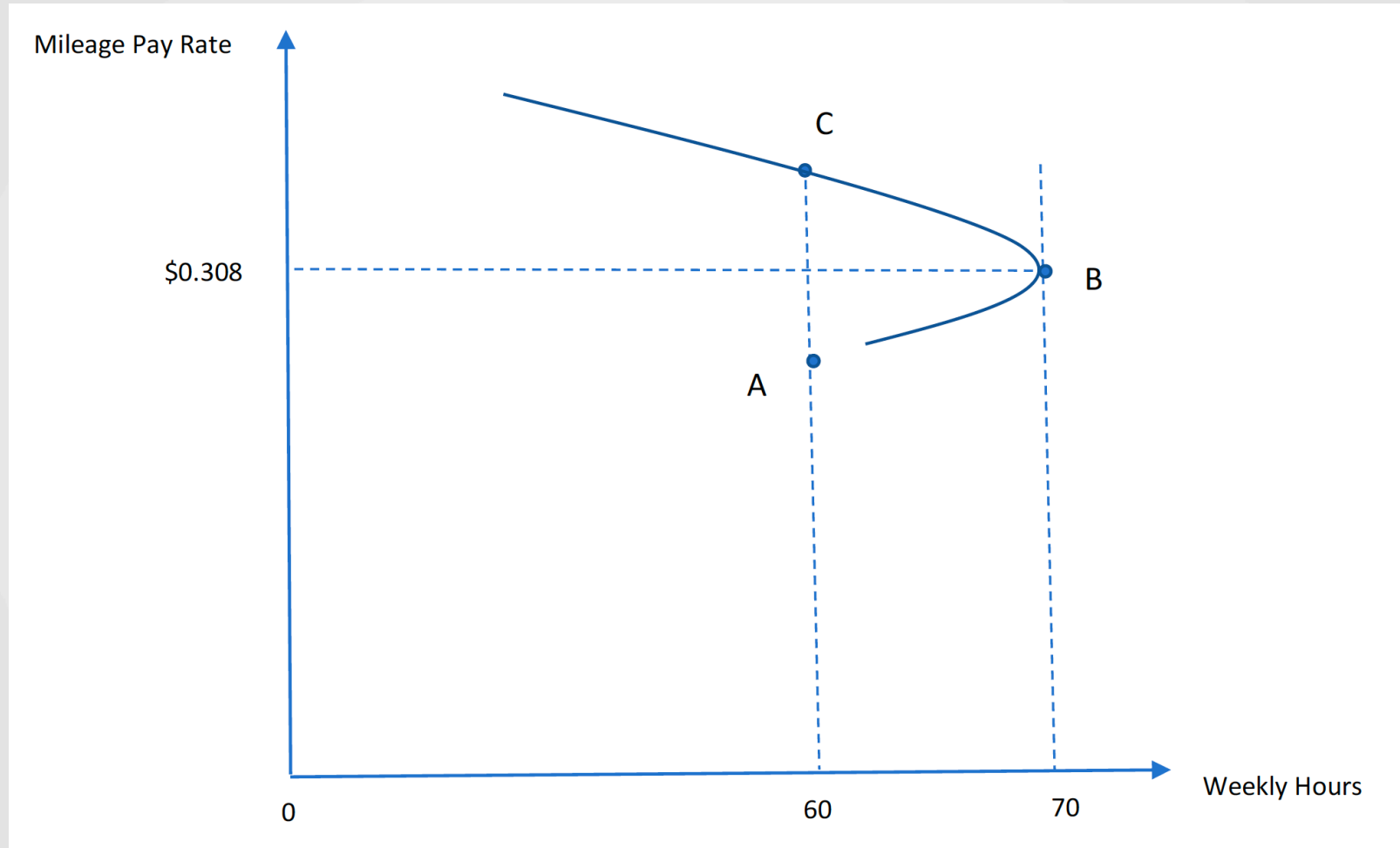
Labor-Leisure Tradeoff
(Belzer and Sedo 2018)
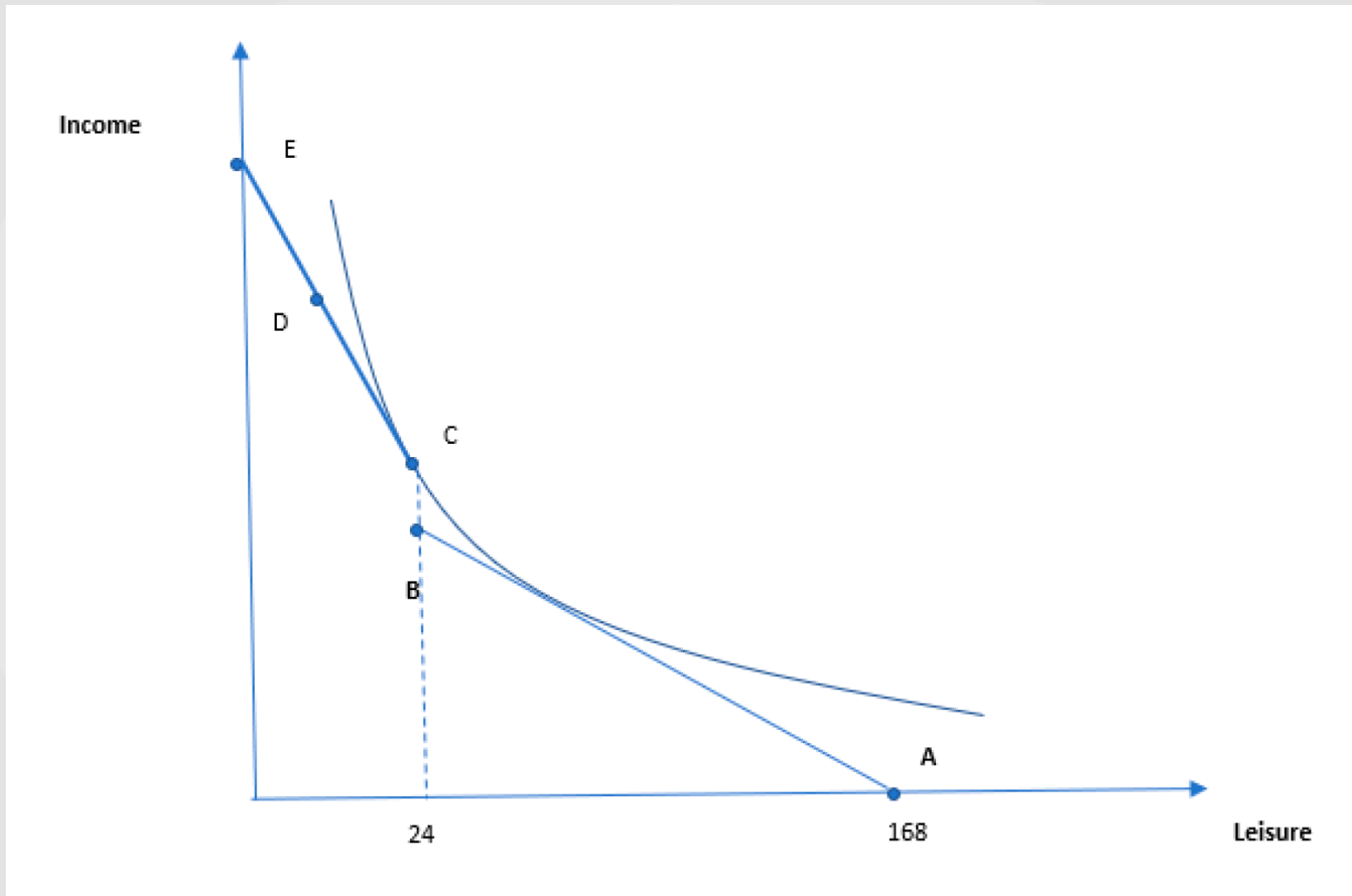
Labor Supply Curve Bends Back as Driver Pay Rate Increases

(Belzer and Sedo 2018)

Data

- MCMIS data from 2015-2018, inclusive
  - Census, Inspection, Violation, & Crash
  - 1,000,000+ carrier observations nationally
  - 220,302 intrastate carrier observations used
- Occupational Employment Statistics (OES) Survey by state and occupation
- Truck transportation industry (NAICS 484000)
- Heavy and Tractor-Trailer Truck Drivers (OCC 53-3032)
- Population data from the U.S. Census Bureau.

Summary Statistics 2015-2018

Variable	N	Mean	Std Dev	Minimum	Maximum	Label
CRASHES	43606	0.24	1.49	0	107	Number of crashes
HOS	43606	0.11	0.88	0	38	Number of HOS compliance violations
UNSAFE	43606	0.15	0.73	0	28	Number of unsafe driving violations
DR_FIT	43606	0.15	0.80	0	26	Numebr of driver fitness violations
SUBT	43606	0.00	0.08	0	6	Number of controlled subtances violations
VM	43606	2.64	8.15	0	221	Number of vehicle maintenance violations
WAGE	43606	19.93	1.53	17	26	Median hourly wage in the carrier's state
LPop_density_m2	43606	4.86	1.19	0	9	Population density in 2015
LVMT	43606	10.42	1.62	7	22	Reported VMT
HM_FLAG2	43606	0.02	0.13	0	1	Hazmart flag

Table title: Summary statistics

Poisson Random Effects Model

$\log(Crashes_{i,t})$

$$= \beta_0 + \beta_{1,t} \times HOS\ Viol + \beta_{2,t} \times Unsafe\ driving\ Viol$$

$$+ \beta_{3,t} \times Driver\ fitness\ Viol + \beta_{4,t} \times Substance\ alcohol\ Viol$$

$$+ \beta_{5,t} \times Vehicle\ maintenance\ Viol + \beta_{6,t} \times Log(Hourly\ wage)$$

$$+ \beta_{7,t} \times Log\ (Population\ density) + \beta_{8,t} \times Log\ (VMT)$$

$$+ \beta_{9,t} \times Hazmat\ flag + \mu_i + \varepsilon_{i,t}$$

Where

μ_i is the between-carrier error, capturing carrier i's unique characteristics

$\varepsilon_{i,t}$ is the within-carrier error

Estimated Results:
Dependent Variable Log (Crashes)

Column	A		B		C		D	
	NB - 2018		Poisson pooled 2015-18		NB pooled 2015-2018		Poisson RE 2015-2018	
Variable	Parameter Estimate	Pr > |t|	Parameter Estimate	Pr > |t|	Parameter Estimate	Pr > |t|	Parameter Estimate	Pr > |t|
Intercept	0.30	0.88	-0.02	0.98	-2.57	0.04	-2.42	0.06
HOS	0.25	0.01	0.09	<.0001	0.06	0.11	0.09	0.01
UNSAFE	0.22	0.01	0.04	0.11	0.34	<.0001	0.26	<.0001
DR_FIT	0.02	0.75	0.03	0.18	0.01	0.75	0.04	0.28
SUBT	0.33	0.63	0.12	0.26	0.46	0.31	0.83	0.03
VM	0.04	<.0001	0.01	<.0001	0.04	<.0001	0.03	<.0001
lwage	**-3.16**	**<.0001**	**-3.09**	**<.0001**	**-1.83**	**<.0001**	**-1.80**	**<.0001**
lPop_density_m2	0.19	<.0001	0.13	<.0001	0.21	<.0001	0.20	<.0001
LVMT	0.56	<.0001	0.61	<.0001	0.47	<.0001	0.45	<.0001
HM_FLAG2	0.77	0.01	0.97	<.0001	0.92	<.0001	0.96	<.0001
Dispersion	17.37		1.00		26.52		0.33	
Full Log Likelihood	-2088		-29538		-15064		-15480	

Our preferred model is Poisson Random Effects model (D) because it allows for firm unique characteristics over time.

Conclusions

- FMCSA cannot do more that work around the edges as long as compensation is low

- Low compensation means drivers substitute [lack of safety, or risk] for greater earnings
  - They will take more risk.

- If carriers paid higher wages, the income effect would overcome the substitution effect, and drivers would trade higher earnings for greater safety
  - They will take less risk.

- 1% higher wages is associated with 1.8% lower crash rates

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