Selection on Risk: Traffic Officers and the Value of Nonfatal Injury

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Motivation

- Public safety/law enforcement officers consistently rank among the top occupations in terms of nonfatal (and fatal) injury rates.
- Public safety occupations also have a reputation for working enormous amounts of overtime, which is paid at premium rates.
- Individuals have **private information** about personal injury risk on a given day, and depending on whether **disutility from injury** outweighs **utility from additional income** this can cause selection on risk.

This Paper

Explore the previous ideas in the context of Los Angeles Traffic Officers, using over 200,000 detailed daily pay and workers compensation records from a 1.5 year period.

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- ⋆ Using the structural model, what is the implied average value of injury risk (VIR)? How does this depend on changes in expected workers' compensation benefits?

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    - **In progress.**

Road Map

1. Literature
2. Context and Data
3. Empirical Strategy
4. Results

Literature

1. Value of Health Risks: Big focus on risk preferences.
   - VSL strand: Ashenfelter and Greenstone (2004),
   - Compensating wage differential: Viscusi and Aldy (2003)
   - Transport choice: Leon and Miguel (2017)
   - Value of Non-Fatal Injury: **Cameron and DeShazo (2013)**
2. Associations Between Overtime and Injury: **Dembe et al. (2005)**, many studies on specific populations in epidemiology (reviews by Caruso (2006))
   - Extended work generally positively associated with injury, but results vary by sub-population and definition of overtime. No identification strategies.
3. Workers' Compensation: Butler, Durbin and Helvacian (1996), Bronchetti and McInerney (2012), **Cabral and Dillender (2020).**
   - Earlier papers found connection between claims and benefit levels.
   - Later work with better identification reveals little connection with number of claims, more with duration of claims.

Los Angeles Traffic Officers

- Employed by LADOT. Main tasks include issuing citations and directing traffic.
- Union employs covered by overtime laws, paid hourly.
- Covered by a workers' compensation system.
- Analysis population limited to full-time (defined as having less than 60 leave and work hours in a 4 week period three or more times) in the period Jan. 2015 to Sept. 2016

Overtime Assignment

- Main idea from MOU: overtime must be **equitably assigned** within location and classification (position).
- Probably implemented using **list mechanism:**
  1. Everyday officers ranked by seniority, past overtime worked in period, other factors.
  2. When overtime shift arises, officers presented with option to take the shift based on rank on list.
  3. If an officers declines the offer goes down the list.
  4. If everyone declines, there is a similar risk for forcing.
- PlanIt Schedule and Telestaff provide software implementations.
- Still trying to get confirmation of precise assignment mechanism used. The above is a common practice - used by Culver FD, LAFD, Culver PD, LAPD.

Data Structure

- Workers' compensation claims used to identify workplace injuries.
- Daily pay records used to identify hours/days worked and pay rates.
- Result is panel data set of daily records for 537 officers.

Number of Injuries

Total Injuries	Officers	Pct.	Cum. Pct.
0	358	66.67	66.67
1	129	24.02	90.69
2	38	7.08	97.77
3	10	1.86	99.63
4	1	0.19	99.81
5	1	0.19	100.00
Total	537	100.00	

Among estimation sample: Full-time officers between Jan. 2015 and Sept. 2016.

Age/Tenure Types of Injury

Weekly Pay Statistics

	mean	sd	p10	p25	p50	p75	p90
Hourly Wage	30.11	2.32	26.64	30.54	30.54	30.54	32.22
Regular Pay	1233.58	705.25	0.00	976.00	1220.00	1564.00	2104.00
Overtime Pay	290.07	486.10	0.00	0.00	0.00	447.00	961.00
Proportion OT	0.12	0.14	0.00	0.00	0.00	0.25	0.33
Observations	42628						

Wage is maximum observed in week.

Overtime and straight time is classified based on Variation Description.

Daily Hours Worked (Intensive Margin)

	mean	sd	p5	p10	p25	p50	p75	p90	p95
Not Injured	9.01	2.70	7.00	8.00	8.00	8.00	8.00	13.00	15.00
Injured	8.96	2.66	8.00	8.00	8.00	8.00	8.00	13.00	15.00
Total	8.99	2.69	8.00	8.00	8.00	8.00	8.00	13.00	15.00
N	181233								

Restricted to days with positive hours worked.

Clustered t-test of null $|HoursWork_{INJ} - HoursWork_{Not}| = 0$:
$t(536) = -0.39,\ p = 0.70$

Days Worked in 4 Week Periods (Extensive Margin)

	mean	sd	p10	p25	p50	p75	p90
Not Injured	18.28	4.17	13.00	16.00	19.00	21.00	23.00
Injured	17.17	4.77	11.00	15.00	18.00	20.00	22.00
Total	17.90	4.42	13.00	16.00	19.00	20.00	22.00
N	10127						

Restricted to 4 week periods with at least one day with positive hours worked.

Clustered t-test of null $|DaysWork_{INJ} - DaysWork_{Not}| = 0$:
$t(536) = -4.35$, $p = 0.000$

Motivating Observations:

1. Injured employees generally work **less** than non-injured.
2. The relevant margin is the **extensive**.

Model

Officers decide to work if (normalized utility of not working to 0):

$$E[U_i(Z_{it}, Y_{it})|w_{it} = 1] = Z_{it}\alpha + c_{i1} + u_{it1} \geq 0$$

Injury is determined by:

$$y_{it} = \begin{cases} 1 \text{ if } X_{it}'\beta + c_{i2} + u_{it2} \geq 0 \\ 0 \qquad \text{otherwise} \end{cases}$$

But only observed if $w_{it} = 1$ (Heckman-style selection). Dis-utility from injury enters work decision through shared covariates X_{it} <u>and</u> correlation between $c_{i1} + u_{it1}, c_{i2} + u_{it2}$.

Model

Use this form of person-specific heterogeneity:

$$c_{i1} = \zeta_1 + \bar{z}_i' \gamma_1 + a_{i1} \tag{1}$$

$$c_{i2} = \zeta_2 + \bar{z}_i' \gamma_2 + a_{i2} \tag{2}$$

This yields the below final set of equations:

$$y_{it} = \begin{cases} 1 \text{ if } \zeta_2 + X_{it}' \beta + \bar{z}_i' \gamma_2 + a_{i2} + u_{it2} \geq 0 \\ 0 \qquad \text{otherwise} \end{cases}$$

$$w_{it} = \begin{cases} 1 \text{ if } Z_{it}' \alpha + \zeta_1 + \bar{z}_i' \gamma_1 + a_{i1} + u_{it1} \geq 0 \\ 0 \qquad \text{otherwise} \end{cases}$$

Finally, assume joint normality of $v_{it1} = a_{i1} + u_{it1}$ and $v_{it2} = a_{i2} + u_{it2}$ with correlation coefficient ρ.

Estimation and Identification

Given prior assumptions and:

- (Independence) $(v_{it1}, v_{it2}) \perp\!\!\!\perp z_i$
- (Exclusion) $dim(z_{it}) > dim(x_{it})$
- (Normalization) (v_{it1}, v_{it2}) assumed to have unit variances.

Semykina and Woolridge (2018) show identification. Can estimate using MLE (Heckman-style bivariate probit augmented with time means of instruments).

Additional Controls in Both Equations (x_{it}):

- Month and Day of Week Fixed Effects
- Division Fixed Effects
- Time specific controls: maximum temperature, rain, holiday indicator.

Economic Intuition

Two Types of Selection:

1. **Type Correlation:** Manifests as correlation between a_{i1} and a_{i2}, coefficients on $\bar{z}_i$.
2. **Knowledge effect:** Manifest as correlation between u_{it1} and u_{it2} as well as shared coefficients on z_{it}.

Generally, these are entangled. They cannot be separately identified without additional assumptions.

Instruments

For identification *not based on functional form* need instruments satisfying **Relevance** and **Independence/Exclusion**.

Candidates:

1. *Number of Other Employees on Leave in Division*
2. *Wage Rate on Date*
3. *Seniority Rank*

Identifying Variation: Summary of Leave Measures

	mean	sd	p10	p25	p50	p75	p90
CENTRAL PRKG							
Officers with Positive Leave	11.18	7.43	1.00	3.00	12.00	17.00	20.00
Officers with Positive Sick	3.56	2.66	0.00	1.00	3.00	5.00	7.00
Total Leave Hours	84.40	56.82	4.00	24.00	95.50	129.00	154.00
WESTERN PRKG							
Officers with Positive Leave	16.72	10.10	1.00	5.00	21.00	25.00	28.00
Officers with Positive Sick	5.63	3.61	1.00	2.00	6.00	8.00	10.00
Total Leave Hours	126.98	77.43	8.00	32.50	154.50	187.00	210.00
VALLEY PRKG							
Officers with Positive Leave	9.32	5.79	0.00	3.00	11.00	14.00	16.00
Officers with Positive Sick	2.38	1.80	0.00	1.00	2.00	4.00	5.00
Total Leave Hours	71.64	45.08	0.00	24.00	84.00	108.00	123.00
SOUTHERN PRKG							
Officers with Positive Leave	4.72	3.29	0.00	1.00	5.00	7.00	9.00
Officers with Positive Sick	1.52	1.32	0.00	0.00	1.00	2.00	3.00
Total Leave Hours	35.80	24.97	0.00	8.00	40.00	55.00	68.00
HOLLYWOOD PRKG							
Officers with Positive Leave	16.95	10.39	1.00	4.00	21.00	24.00	28.00
Officers with Positive Sick	5.80	3.66	1.00	2.50	6.00	8.00	10.00
Total Leave Hours	128.17	79.62	8.00	32.00	152.00	186.00	220.00
OVERALL							
Officers with Positive Leave	8.42	8.59	0.00	2.00	5.00	14.00	22.00
Officers with Positive Sick	2.72	3.00	0.00	0.00	2.00	4.00	7.00
Total Leave Hours	64.33	65.14	0.00	10.00	40.00	108.00	171.00
Observations	4864						

Graphical Depiction of Relevance of Leave

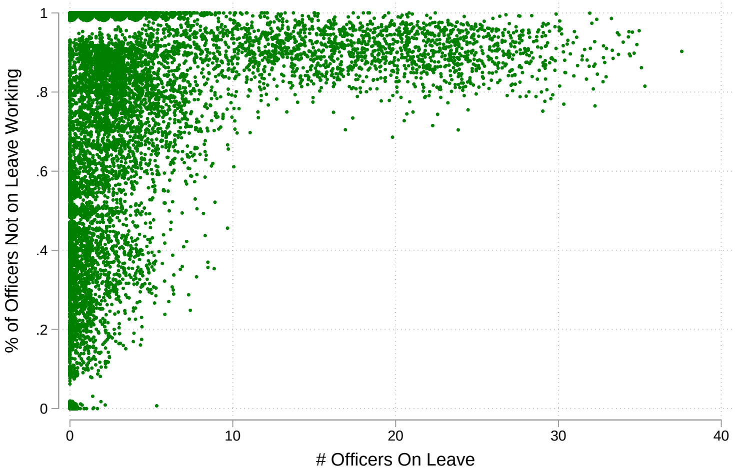


Figure: Relationship Between Leave of Others and Work

LPM Estimates of Work Decision (Statistical Check of Relevance)

	(1)	(2)	(3)	(4)
Leave of Others (Count)	0.0267***	0.0282***	0.00370***	0.00612***
	(0.000459)	(0.000482)	(0.000657)	(0.000740)
Seniority Rank	-0.000312	0.000276	0.000353	0.000320
	(0.000233)	(0.000199)	(0.000194)	(0.000187)
Wage	0.0716***	0.0536***	0.0396***	0.0397***
	(0.00438)	(0.00479)	(0.00318)	(0.00315)
Age	0.000521	-0.00752*	-0.00534*	-0.0935**
	(0.00388)	(0.00353)	(0.00262)	(0.0327)
Avg. Leave of Others (Count)	-0.0251***	0.00490*	0.00569**	0.00548**
	(0.00110)	(0.00195)	(0.00176)	(0.00173)
Avg. Wage	-0.0741***	-0.0547***	-0.0404***	-0.0392***
	(0.00471)	(0.00505)	(0.00368)	(0.00371)
Avg. Age	-0.000795	0.00789*	0.00583*	0.0940**
	(0.00387)	(0.00348)	(0.00260)	(0.0328)
Observations	255613	255613	255613	255613
F-Stat.	615.6	181.2	221.7	.
Division FE	No	Yes	Yes	Yes
Day of Week/Month FE	No	No	Yes	No
Date FE	No	No	No	Yes

Standard errors in parentheses

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Model Parameter Estimates: Work Decision and Injury Outcome

	Injury	Work
Avg. Div. Leave	-0.0524***	0.0224**
	(0.00981)	(0.00684)
Avg. Wage	0.00784	-0.155***
	(0.0101)	(0.0157)
Avg. Age	-0.00504	0.0209*
	(0.0361)	(0.0105)
Age	0.00772	-0.0188
	(0.0358)	(0.0106)
Holiday	-0.836***	1.802***
	(0.223)	(0.148)
Amount Rain (in.)	-0.130	-0.0214
	(0.118)	(0.0225)
Max. Daily Temp.	-0.00122	-0.000145
	(0.00281)	(0.000457)
Division Leave (count)		0.0194***
		(0.00247)
Seniority Rank		0.00141
		(0.000806)
Wage		0.153***
		(0.0135)
Observations	255613	
Rho	-0.676	
Rho 95% CI	(-0.33, -0.860)	

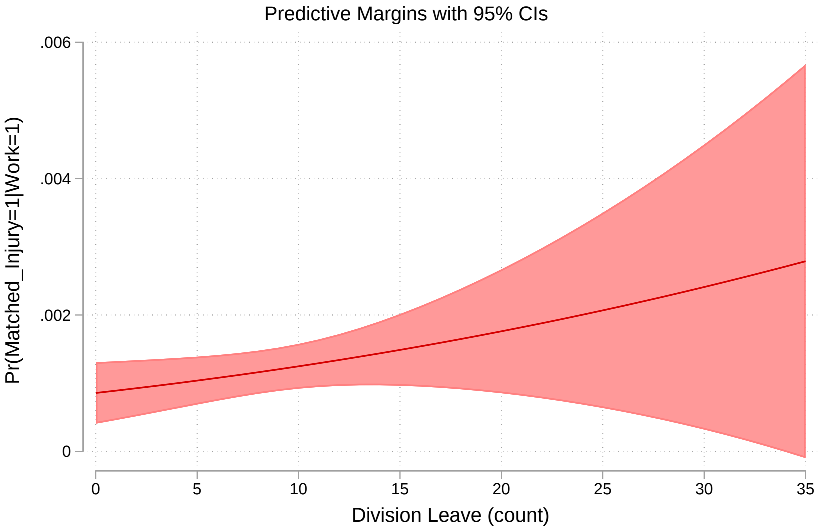
Average Conditional Injury Probabilities

Conditional On	Analytical Representation	Model Estimate	Observed
Work	$E_{v,z_{it}}[Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)]$	0.0012 (0.0001)	0.0013
Not Work	$E_{v,z_{it}}[Pr(y_{it}=1 \mid w_{it}=0, z_{it}, v)]$	0.0512 (0.0421)	–
Unconditional (API)	$E_{v,z_{it}}[Pr(y_{it}=1 \mid z_{it}, v)]$	0.0163 (0.0142)	–

[1] Delta-method cluster robust standard errors.

[2] Averaged over all covariates and officer-days.

Graph of Selection Against Risk



Average Conditional Probability Elasticities

Effect	Analytical Representation	Model Estimate
Wage	$E_{v,z_{it}}\left[\frac{wage_{it}}{Pr(y_{it}=1 \vert w_{it}=1,z_{it},v)}\frac{\partial Pr(y_{it}=1 \vert w_{it}=1,z_{it},v)}{\partial wage_{it}}\right]$	9.066 (3.813)
Leave in Div.	$E_{v,z_{it}}\left[\frac{leave_{it}}{Pr(y_{it}=1 \vert w_{it}=1,z_{it},v)}\frac{\partial Pr(y_{it}=1 \vert w_{it}=1,z_{it},v)}{\partial leave_{it}}\right]$	.3009 (.1233)
Seniority	$E_{v,z_{it}}\left[\frac{senior_{it}}{Pr(y_{it}=1 \vert w_{it}=1,z_{it},v)}\frac{\partial Pr(y_{it}=1 \vert w_{it}=1,z_{it},v)}{\partial senior_{it}}\right]$	.0826 (.0585)

[1] Delta-method cluster robust standard errors.

[2] Averaged over all covariates and officer-days.

The Value of Nonfatal Injury Risk

1. Consider an increase in injury risk.
2. z_{it} includes wage, so find $\Delta wage_{it}$ such that expected utility remains constant.
3. Average this over time, people, and observables.
4. Result is something like VSL: value of a statistical non-fatal injury.

Simple idea, hard calculation because utility is:

$$U_{it}(z_{it}) = E[\max\{z_{it}\alpha + \bar{z}_i'\gamma_1 + v_{it1}, 0\}]$$

It matters if increase in injury probability comes through observables x_{it} (which is a subset of z_{it}) or unobservables v_{it2} (correlated with v_{it1}).

Next Steps

1. Consider mechanisms to allocate overtime to minimize injury social cost.
2. Perform more robustness checks.
3. Nonparametric identification with only one exclusion restriction.
4. Are dynamics important?

The End

Officer Age, Tenure, Division Changes

	mean	sd	p5	p10	p25	p50	p75	p90	p95
Not Injured									
Age	44.43	9.91	28.24	30.11	37.30	44.06	52.05	58.43	60.16
Tenure (years)	13.09	8.52	1.95	2.86	7.20	12.41	17.79	26.49	28.20
Divisions Worked In	1.26	0.46	1.00	1.00	1.00	1.00	1.00	2.00	2.00
Injured									
Age	46.63	8.72	34.30	35.19	40.39	47.75	52.82	58.31	62.38
Tenure (years)	14.27	8.21	3.42	3.75	8.19	11.99	20.21	26.49	27.76
Divisions Worked In	1.23	0.45	1.00	1.00	1.00	1.00	1.00	2.00	2.00
Total									
Age	45.16	9.58	28.72	32.03	38.83	44.75	52.22	58.31	60.23
Tenure (years)	13.48	8.43	2.57	3.42	8.19	12.00	18.18	26.49	27.76
Divisions Worked In	1.25	0.46	1.00	1.00	1.00	1.00	1.00	2.00	2.00
Observations	537								

Age as of Jan. 1, 2015. Tenure as of first day observed.

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Top Claim Cause of Injuries

Claim Cause	freq	pct
Strain or Injury By, NOC	53	21.90
Collision or Sideswipe w	40	16.53
Repetitive Motion - Other	24	9.92
Fall, Slip, Trip, NOC	17	7.02
Motor Vehicle, NOC	15	6.20
Other-Miscellaneous, NOC	12	4.96
Animal or Insect	10	4.13
Object Being Lifted or	8	3.31
Fellow Worker, Patient, or	7	2.89
Other Than Physical Cause	6	2.48

Among estimation sample: Full-time officers between Jan. 2015 and Sept. 2016.

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