Selection Against Injury Risk: Daily Labor Supply Decisions of Los Angeles Traffic Officers

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Motivation

- Occupational injury had an estimated cost of \$250 billion in 2007, the majority of this comes through lost productivity (Leigh 2011).

A Puzzle

- Consider LA Traffic Officers.
- Literature shows a positive association between excessive hours worked and injury.
- For LA traffic officers, the median injured employee worked 1 day less than the uninjured in a 4 week period.
- This remains true even if we exclude the 4 weeks after injury and the 4 weeks including injury.

Research Questions, Results Preview

1. How does officer selection into work impact the observed injury rate?
   - ⋆ Officers select against injury risk, lowering the observed injury rate.
2. How do officers trade-off injury risk for additional wages?
   - ⋆ Officers are willing to trade injury risk for additional wages.
3. What is the implied value of non-fatal injury?
   - ⋆ A 1 percentage point increase in injury risk is worth on average \$ 31- \$67 in daily earnings.
4. Given 1-3, how can internal overtime markets be designed to minimize injury rates?
   - ⋆ K-price shift auctions, where shifts are awarded to the officers who are willing to work for the lowest wage, this leverages selection in a way that reduces injury rates.

Literature

1. **Value of Health Risks:** Ashenfelter and Greenstone (2004), Kniesner, et. al. (2010), Cameron and DeShazo (2013)
2. **Daily Labor Supply:** Farber (2015), Langley et. al. (2010), Hanna and Oliva (2015), Aragon et. al. (2016), Heath (2017), Fernandez et. al. (2013), Schimdt (2019)
3. **Overtime and Injury Associations:** Dembe et. al. (2005), Wooden et. al. (2009); Stimpfel (2015), Weaver (2015)

Contribution

We use:

- Detailed, administrative data within a single occupation.
- Variation in the leave of others as an instrument.
- Labor supply framework.

in order to estimate:

- ⋆ The causal impact of an additional shift on injury.
- ⋆ The value of non-fatal injury in terms of wages.

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 does not include part-time (defined as having less than 60 leave and work hours in a 4 week period three or more times).
- Period is 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 of the list mechanism.

Data Structure

- **Workers' compensation claims:** workplace injuries.
- **Daily pay records:** days worked, pay rates, location worked.
- Together the data yield a panel data set of daily work and injury records for 537 officers.

Intuitive Empirical Strategy

- Core identification issue: individuals select into work, probably non-randomly.
- Workplace injury never happens if an officer does not work!
- Key strategy: as others go on leave in my location, I am more likely to be offered the chance to work (or forced to work).
- Variation in leave across divisions traces out selection effects.

Simple 2SLS Baseline

We can see the intuition of the result by just comparing OLS of injury on work dummy and 2SLS with work instrumented by leave of others:

OLS	**2SLS**
.00135	.00163
(.00009)	(.00017)

- OLS represents the "observed" injury rate, 2SLS is adjusted for selection.
- 2SLS is nearly 21% higher, suggesting the observed injury rate is much lower than the population average injury rate due to selection on unobservables.

Panel Model

Work if expected utility of work exceeds that of not working:

$$w_{it} = \begin{cases} 1 \text{ if } E[U_i(Z_{it}, Y_{it})|w_{it} = 1] = Z_{it}'\alpha + \bar{Z}_i'\gamma_1 + v_{it1} \geq 0 \\ 0 \text{ else} \end{cases}$$

Injury is determined according to:

$$y_{it} = \begin{cases} 1 \text{ if } X_{it}'\beta + \bar{Z}_i'\gamma_2 + v_{2it} \geq 0 \\ 0 \qquad \text{otherwise} \end{cases}$$

- y_{it} is only unobserved if the officers works.
- Contemporaneous selection: v_{it1}, v_{it1} allowed to be correlated.
- Permanent selection: $\{v_{1it}, v_{2it}\}_{t=1}^{T}$ may be correlated across time.
- Inclusion of time means of instruments $(\bar{Z}_i)$ allows for weaker identifying assumptions.

Identification

Nonparametric identification comes through two assumptions:

1. (Independence) $(v_{it1}, v_{it2})|\bar{Z}_i \perp\!\!\!\perp Z_i$
2. (Exclusion/Relevance) One continuous element of Z_{it} is not in X_{it}.

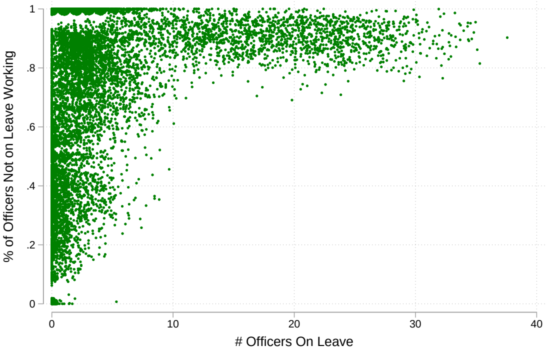
For estimation, we also impose normality:

$$\begin{bmatrix} v_{1it} \\ v_{2it} \end{bmatrix} \sim N\left(\begin{bmatrix} 0 \\ 0 \end{bmatrix}, \begin{bmatrix} 1 & \rho \\ \rho & 1 \end{bmatrix} \right)$$

- Semykina and Wooldridge (2018) show constructive identification.
- Estimation is by maximum likelihood.

Relevance

Instrument Validity



1. Instruments pass weak instrument, underidentification and overidentification tests. Table
2. There is balance with respect to medical expenses of the injury. Table

Model Results

	Injury	Work
Avg. Div. Leave	-0.0543***	0.0228***
	(0.00991)	(0.00676)
Avg. Wage	-0.0437	-0.154***
	(0.0656)	(0.0158)
Avg. Age	0.00200	0.0211*
	(0.0425)	(0.0105)
Age	0.00113	-0.0193
	(0.0422)	(0.0106)
Holiday	-0.697**	1.804***
	(0.260)	(0.148)
Wage	0.0519	0.152***
	(0.0659)	(0.0136)
Division Leave (count)		0.0194***
		(0.00247)
Seniority Rank		0.00142
		(0.000807)
Observations	256287	
Rho	-0.559	
Rho 95% CI	(-0.01, -0.848)	

Standard errors in parentheses

Specification includes division, month and day of the week fixed effects in both the work and injury equations.

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

Adjusted Injury Probabilities

Statistic	Analytical Representation	Model Estimate	Observed
All Work	$E_{v,z_{it}}[Pr(y_{it=1} \| w_{it} = 1 \,\&\, z_{it} \& v)]$	.0012 (.0001)	0.0013
All Not	$E_{v,z_{it}}[Pr(y_{it=1} \| w_{it} = 0 \,\&\, z_{it} \,\&\, v)]$	.0289 (.0342)	–
Conditional on Observed	Varies	.0142 (.0190)	–
Unconditional	$E_{v,z_{it}}[Pr(y_{it=1} \| z_{it} \,\&\, v)]$	.0089 (.0108)	–

[1] Standard errors account for sampling of covariates.

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

[3] Probability of injury conditional on working.

Injury Probability Elasticities

Conditional on working, how did different covariates impact injury?

Effect	Analytical Representation	Model Estimate
Wage	$E_{v,z_{it}}[\frac{wage_{it}}{Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)} \frac{\partial Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)}{\partial wage_{it}}]$	12.42 (6.073)
Leave in Div.	$E_{v,z_{it}}[\frac{leave_{it}}{Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)} \frac{\partial Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)}{\partial leave_{it}}]$	.2223 (.1407)
Seniority	$E_{v,z_{it}}[\frac{senior_{it}}{Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)} \frac{\partial Pr(y_{it}=1 \mid w_{it}=1, z_{it}, v)}{\partial senior_{it}}]$	.0618 (.0544)

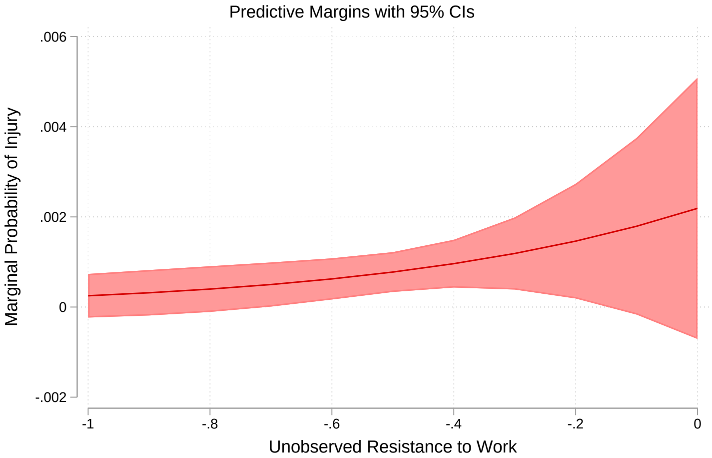
[1] Standard errors account for sampling of covariates.

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

[3] Probability of injury conditional on working.

Visualizing Selection

Marginal probability of injury is the value of work resistance v_{1it} at which the officer is indifferent (analogy: marginal treatment effect)



Marginal Value of Injury Risk

1. **Idea:** Using coefficient on wages, derive the revealed preference value of risk.
2. Define *marginal value of injury risk* as the value of an increase in risk to an employee who is at first indifferent between working and not working.

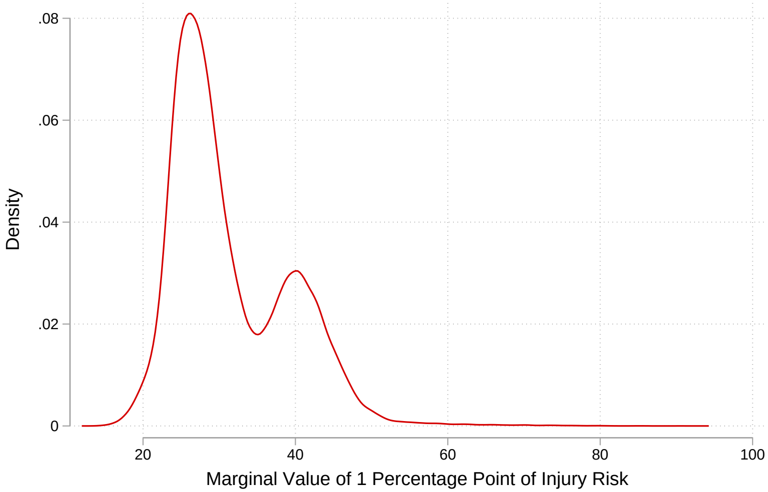
Table: Marginal Value of Injury Risk for Two Multipliers

Multiplier of 1			Multiplier of 1.5		
+1%	+5%	+10%	+1%	+5%	+10%
31.42	51.97	66.65	47.13	77.96	99.97
(12.47)	(20.86)	(27.78)	(18.71)	(31.29)	(41.67)

Standard errors in parentheses

Averaged over realized covariate values.

The Distribution of the Value of Injury Risk



Summary of Results

- Officers select against injury in a way that drives down the observed injury rate.
- Wages allow for a revealed preference computation of the implied marginal value of injury risk.
- Combining these results: officers prefer higher wages and dislike injury risk. These can be combined to *leverage selection* to further reduce injury.

Shift Assignment

- LADOT probably assigns shifts using a *random list* mechanism.
  1. Order officers (either randomly or based on seniority).
  2. Offer an extra shift to the first person on the list.
  3. If they reject, go to the next person. Repeat until acceptance or we reach the end of the list.
  4. If no one accepts force the first person on the list to take the shift.
- In our model: give the shift randomly to someone whose value exceeds 0, and if there is no such person forcing someone randomly.
- This mechanism is what identifies our parameters.
- It induces selection/risk reduction because $v_{1it} > Z_{it}'\alpha + \bar{Z}_i'\gamma_1$ and $corr(v_{it1}, v_{it2}) < 0$
- But we can do **better**: Choose the people who value the shift the highest.
- These people should also tend to have the lowest ex-ante *lowest* injury risk.

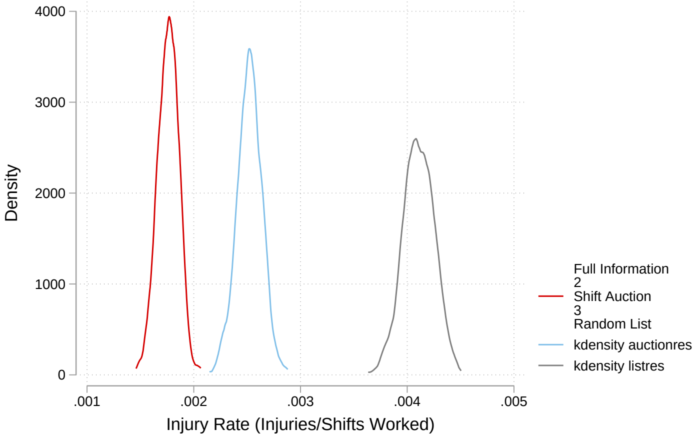
Shift Auctions

How do we implement this? Answer: **Shift Auctions**

1. Suppose LADOT has k shifts to fill (due to special city events or people out due to vacation/sick.
2. Consider *k+1-price shift auctions*, where officers bid the wage they want to receive for the shift and the shift is given to the lowest k bidders.
3. The officers who win are paid the highest wage bid by a non-winner.

- Equilibrium is to *bid your value*.
- This is built into many commercial scheduling software packages.

Simulating Shift Auctions



Uses Epanechnikov kernel, with STATA's default bandwith optimizer.

Key Result: Shift auctions reduce the number of injuries by 38.5 percent.

Future Work

- With richer demographic data, we could separate how much of selection is due to idiosyncratic factors as opposed to officer types.
- How does this generalize to other populations?
- How does this interact with intensive margin (hours per day) labor supply choices?
- Are there dynamic effects? Do officers consider long term impacts of working today (lost opportunity to work in the future, more tired tomorrow, etc).

Instrument Validity Tests

Table: Instrument Validity Tests: FE-2SLS (instrumenting for work)

	(1)	(2)	(3)	(4)
work	0.00260***	0.00231***	0.00829*	0.00287
	(0.000333)	(0.000293)	(0.00349)	(0.00219)
N	256287	256287	256287	256287
Underid K-P F-stat	334.9	339.7	32.07	58.86
Weak id. K-P F-stat	1702.6	1717.3	17.14	35.44
Hansen J	1.890	1.042	0.298	.
Hansen J p	0.169	0.307	0.585	
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

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

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Instrument Balance: Medical Expenses

Table: Regression of Medical Expenses on Instruments

	(1)	(2)	(3)	(4)
Division Leave (count)	-8.949	32.83	79.34	98.18
	(27.33)	(36.60)	(55.23)	(61.88)
Seniority Rank	-6.811	0.604	-1.828	-1.542
	(9.682)	(9.863)	(10.35)	(10.44)
Observations	245	245	245	245
F.	0.364	.	.	.
Division FE	No	Yes	Yes	Yes
Day of Week FE	No	No	Yes	Yes
Month FE	No	No	No	Yes

Standard errors in parentheses

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

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