

Estimating Compensating Wage Differentials with Endogenous Job Mobility

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- ▶ **Theory:** Sewage Testers should get paid more than Ice Cream Testers

- ▶ **Why Do We Care:**
 - 1. Compensating Wage Differential (CWD):
How much more are Sewage Tester paid, ceteris paribus
 - 2. Willingness to Pay (WTP):
Is Sewage Worker indifferent to becoming an Ice Cream Tester

- ▶ **Problem:** “Wage Regressions” approach flawed by not taking model seriously enough
 - 1. *Ability bias*
 - 2. *Compensation bias*
 - 3. *Endogenous mobility bias*

[Solon (1988); Gibbons and Katz (1992)]

What we do

- ▶ Estimate compensating differentials for fatal injury risk

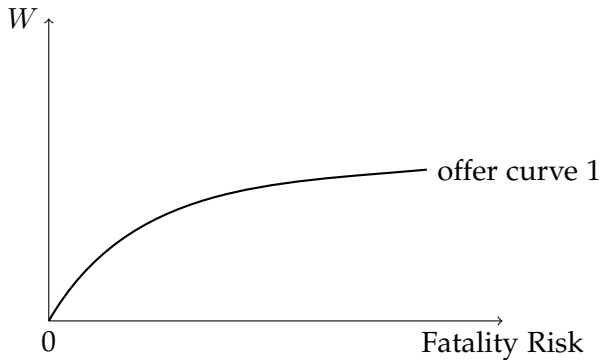
Data: Employer-employee matched data from Brazil

- ▶ **Results:**

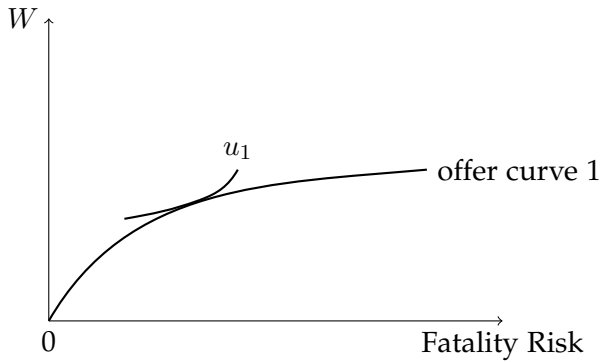
- Basic reduced-form model strikingly consistent with predictions of hedonic search
 - Simple AKM-style models can identify
 - Compensating Wage Differential (CWD)
 - Willingness-to-Pay (WTP/VSL)
- ... under the right circumstances

Conceptual Framework

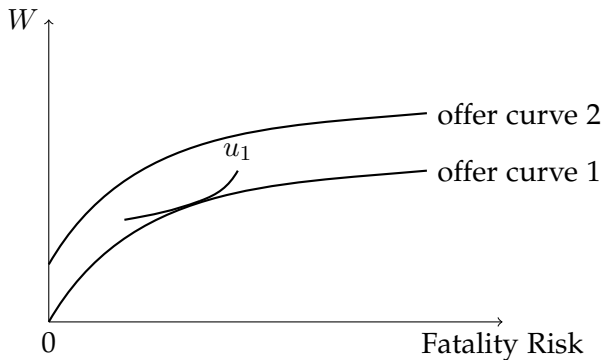
Conceptual Framework



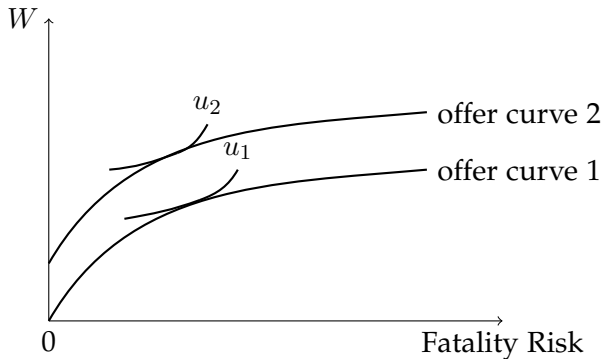
Conceptual Framework



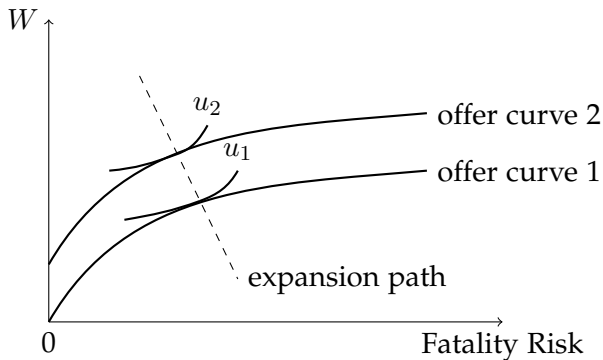
Conceptual Framework



Conceptual Framework



Conceptual Framework



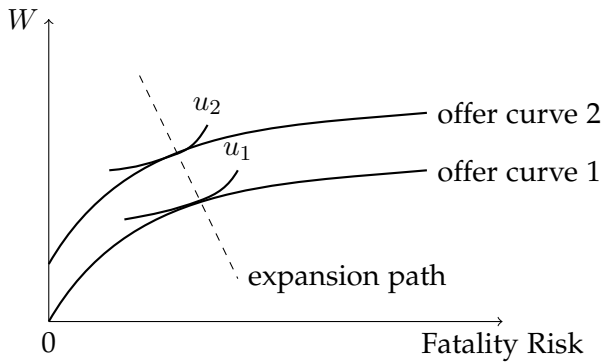
Background: Bias from Unobserved Ability

$$\ln w_{it} = x_{it}\beta + \gamma R_{c(i,t),t} + \theta_i + \nu_{it}.$$

- ▶ **Intuition:** Ability, θ , negatively correlated with disamenity, R
- ▶ **Solutions:**
 1. Correct cross-sectional estimates [Hwang, Hubbard, Reed (1992 *JPE*)]
 2. Panel data (within-worker) estimates [Brown (1980) ; Garen (1988); Kniesner, Viscusi, Woock, Ziliak (2012)]
- ▶ **Puzzle:** Panel estimates indicate cross-section estimates are biased *upward*.

Why do workers move?

1. Find jobs with better pay and conditions
[Hwang, Mortensen, Reed (1998); Lang and Majumdar (2004)]
2. Get good/bad news about ability
[Gibbons and Katz (1992)]
3. Workers get good/bad news about match quality
[Abowd, McKinney, Schmutte (2015)]



$$\ln w_{it} = x_{it}\beta + \gamma R_{c(i,t),t} + \theta_i + \Psi_{J(i,t)} + \varepsilon_{it}$$

- ▶ Separate literature has demonstrated the relevance of firm effects on wages

[Abowd, Karamarz, Margolis (1999); Woodcock (2004); Card, Heining, Kline (2013)]

- ▶ **Key Assumptions**

- Additive separability of θ_i and $\psi_{J(i,t)}$
- Exogenous mobility (again)

- ▶ Within-worker estimates suffer endogenous mobility bias
- ▶ Controlling for employer-specific heterogeneity
 - increases estimated CWD
 - no evidence against exogeneity
- ▶ Modeling Framework [Card, Cardoso, Heining, Kline (2017); Hwang, Mortensen, Reed (1998)]
 - search with differentiated firms
 - multiple jobs per firm
 - focal point for identifying assumptions
 - identification of CWD and WTP

- ▶ Specification diagnostics
 - Exogeneity [Caetano (2015)]
 - Separability / Event history diagnostics
- ▶ Remaining sources of endogeneity:
 - Learning over time: Mass displacement sample
 - Omitted match characteristics: IV strategy

▶ **Panel Data and CWD**

- Brown (1980); Kniesner et al. (2012)

▶ **Structural Partial Equilibrium Approaches**

- Gronberg and Reed (1994)
- Bonhomme and Jolivet (2009); Dey and Flinn (2008)
- Sullivan and To (2013;2015)

▶ **Matched Data and CWD**

- Lalive (2003) [Austria]
- Dale-Olsen (2006) [Norway]
- Tsai (2011) [Taiwan]
- Lavetti (2015) [Alaska]

▶ **Matched Data and the role of Employers**

- Taber and Vejlín (2016); Sorkin (2017)
- Abowd, Kramarz, Margolis (1999); Card, Heining, Kline (2013); Song, Price, Guvenen, Bloom, von Wachter (2015); Card, Cardoso, Heining, Kline (2016); Abowd, McKinney, Zhao (2018); Abowd, McKinney, Schmutte (2015)

Data

Longitudinal employer-employee data for Brazil: 2003-2010

- ▶ *Relação Anual de Informações Sociais (RAIS)*

data items

- ▶ **job characteristics:**
 - wage, hours, occupation, date of hire
 - **CAUSE OF SEPARATION**, including
 - *Death on the job*
- ▶ **plant characteristics:** industry, size, location ...
- ▶ **worker characteristics:** age, education, race, sex ...

$$a_c = \frac{F_c}{(H_c/2,000)} \times (1,000). \quad (1)$$

- ▶ F_c is the number of fatal injuries in cell c
- ▶ H_c is the total number of contracted hours worked over the year.
- ▶ Preferred measure: three-year moving average within 2-digit industry by 3-digit occupation cell
- ▶ Scaled to deaths per 1,000 full-time equivalent job-years

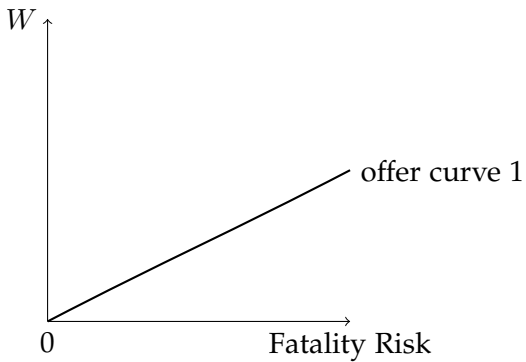
- ▶ Men age 23–60, employed full-time
- ▶ Dominant jobs only
- ▶ Exclude government and temporary contracts
- ▶ Populations
 - 83 million job-year observations
 - 30 million workers
 - 1 million plants

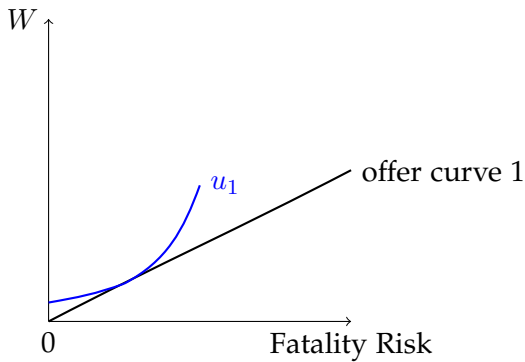
Summary Statistics

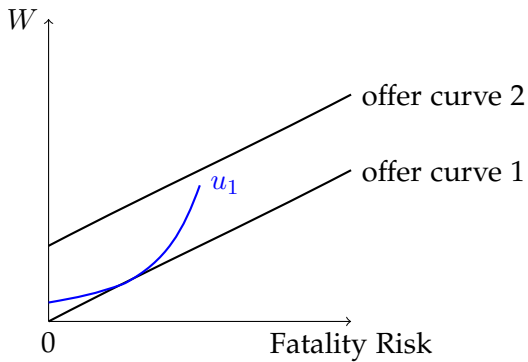
	Population	Analysis Sample
Age	36.98	36.23
Race <i>branco</i> (White)	0.56	0.58
Elementary or Less	0.40	0.40
Some High School	0.09	0.10
High School	0.36	0.39
Some College	0.04	0.04
College or More	0.11	0.07
Contracted Weekly Hours	42.19	43.34
Hourly Wage	6.10	5.10
Log Hourly Wage	1.47	1.37
Total Experience (Years)	20.58	19.86
Job Tenure (Months)	58.70	44.28
Fatality Rate (per 1,000)	0.071	0.083
Zero Fatality Rate (Percent)	0.14	0.09
Number of Observations	158,254,802	83,418,032

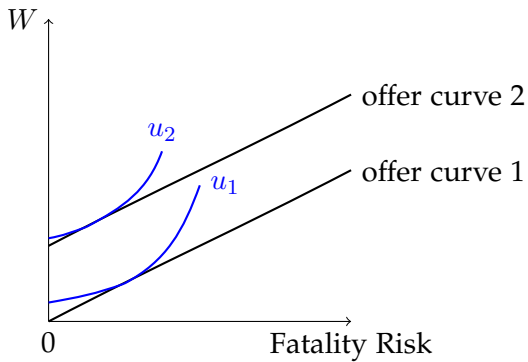
Intuition Underlying Exogeneity Tests

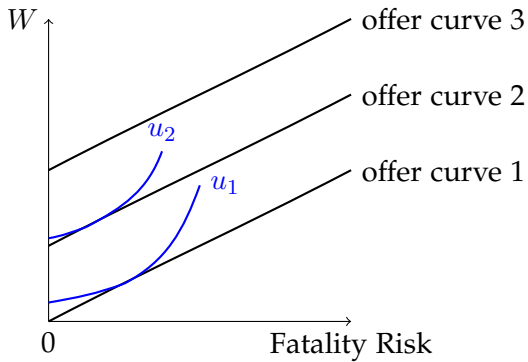
- ▶ Caetano (2015): Misspecification diagnosed by discontinuous response at threshold points.
- ▶ In our context: $\text{Risk} \approx 0$

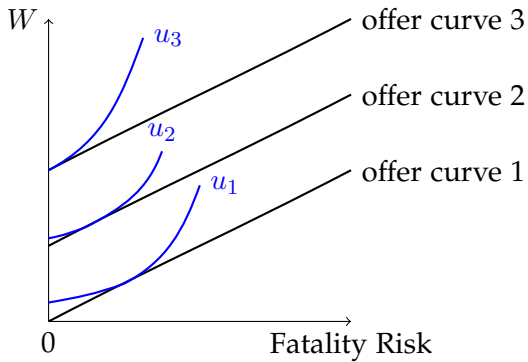




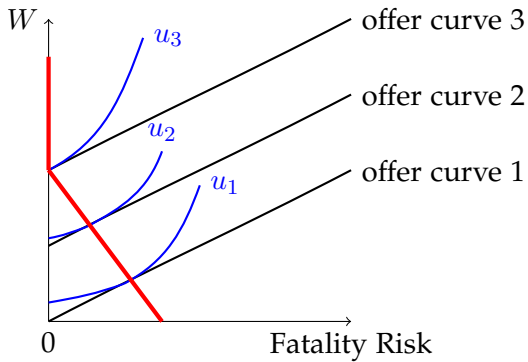




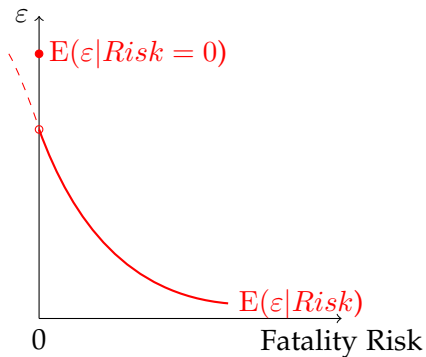


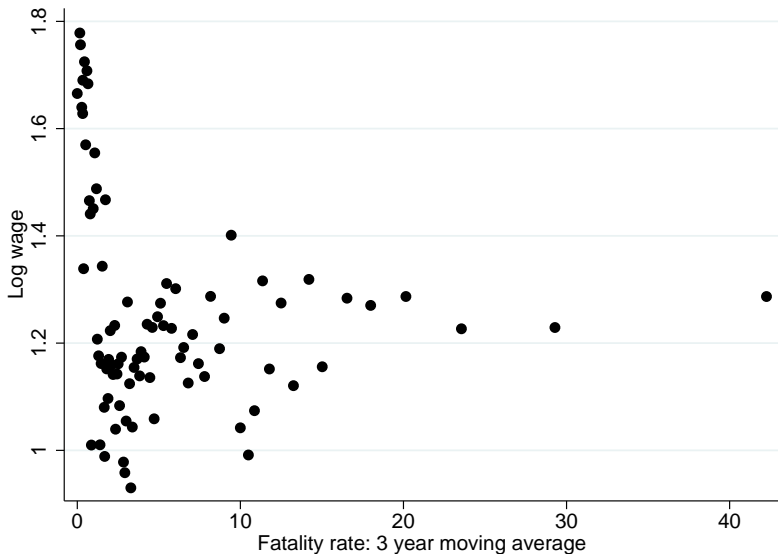


Corner Solutions



Implications of Misspecification



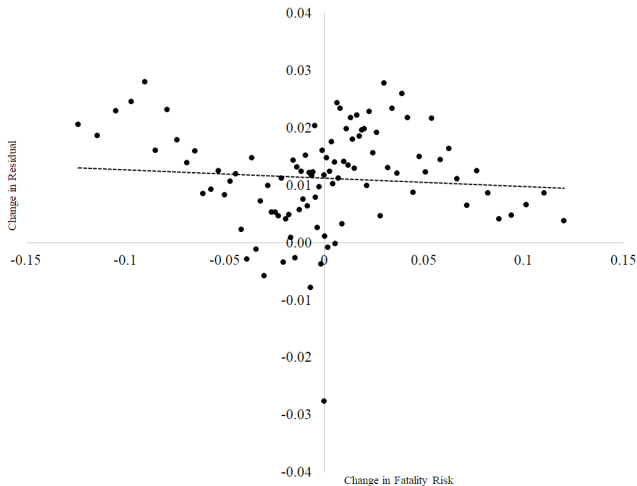
Fatality Rate versus Log Wage: Binned Scatterplot [▶ Tests](#)

Baseline Estimates

CWD for Full-Time Prime-Age Men

	(1) Pooled	(2) Worker Effects	(3) Match Effects	(4) OME
Fatality Rate (3-Yr MA)	0.279* (0.001)	0.037* (0.001)	-0.006* (0.001)	0.170* (0.001)
Zero Fatality Rate	0.073* (0.000)	0.008* (0.000)	-0.006* (0.000)	0.014* (0.000)
N	83,411,371	83,418,032	83,418,032	83,418,032
R-Sq	0.458	0.913	0.978	0.930
VSL (millions of reais)	2.84	0.37	-0.06	1.73
95% CI	[2.83, 2.86]	[0.35, 0.39]	[-0.09, -0.03]	[1.72, 1.75]

Figure: Average Change in Residual by Change in Fatality Rate



Residual Diagnostics: OME Model

► Worker Effect

Figure: Average Change in Residual by Change in Fatality Rate

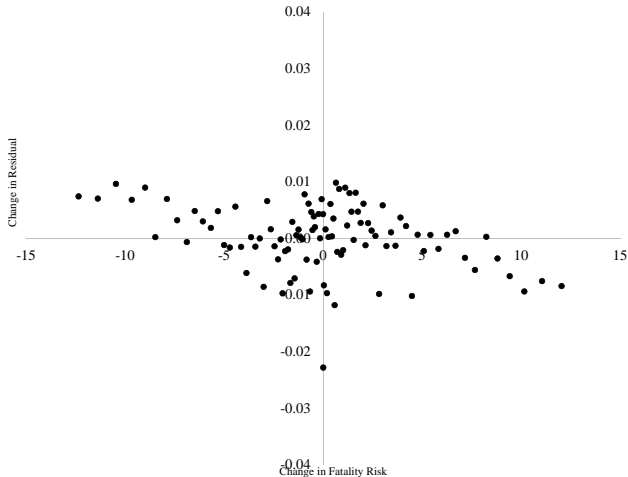


Figure: Average Worker Wage Effect by Percentile of the Fatality Rate

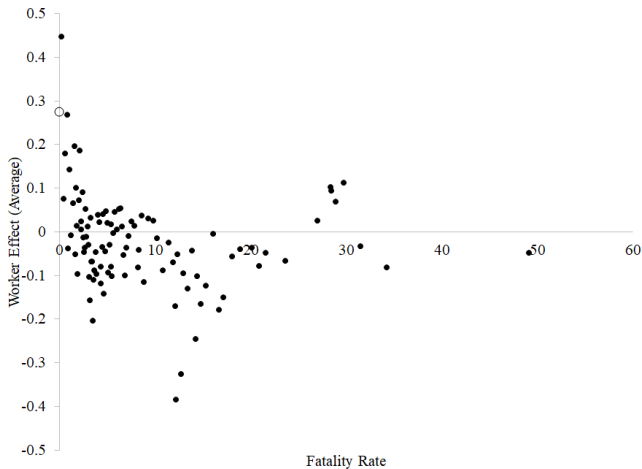
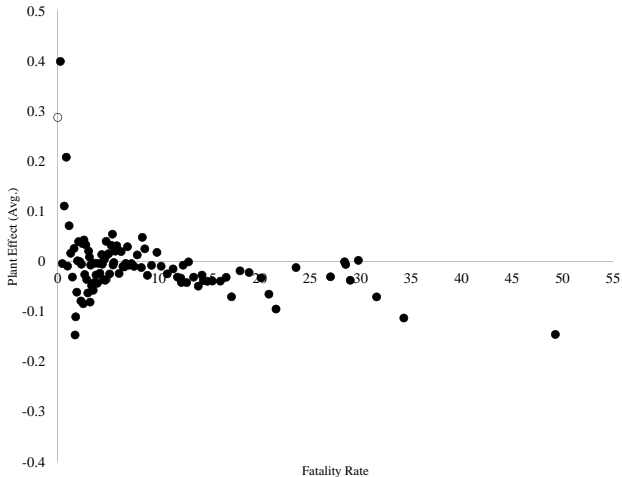


Figure: Average Establishment Wage Effect by Percentile of the Fatality Rate



Variance Decomposition

	Component
Std. Dev. of Log Wage w_{it}	0.650
Std. Dev. of P_{it}	0.648
Std. Dev. of θ_i (Worker Effect)	0.456
Std. Dev. of $\Psi_{J(i,t)}$ (Estab. Effect)	0.298
Std. Dev. of $\gamma R_{c(i,t)}$	0.014
Std. Dev. of Residual	0.172
Correlation between $(\theta_i, \Psi_{J(i,t)})$	0.280
Correlation between $(R_{c(i,t)}, \theta_i)$	-0.091
Correlation between $(R_{c(i,t)}, \Psi_{J(i,t)})$	-0.108
Std. Dev. of $\Phi_{i,J(i,t)}$ (Match Effect)	0.133

Figure: Worker Effects Model

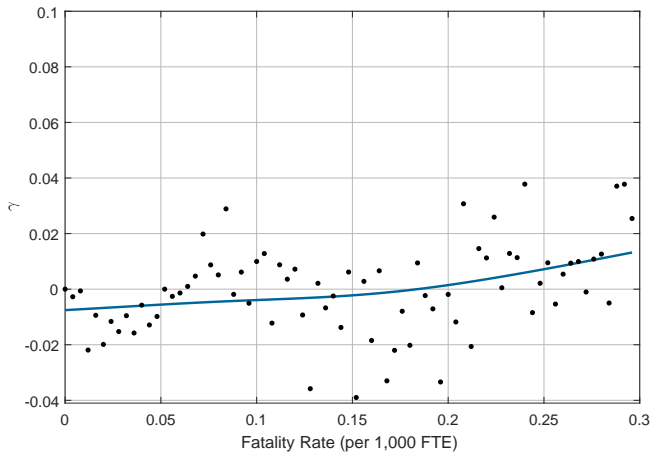
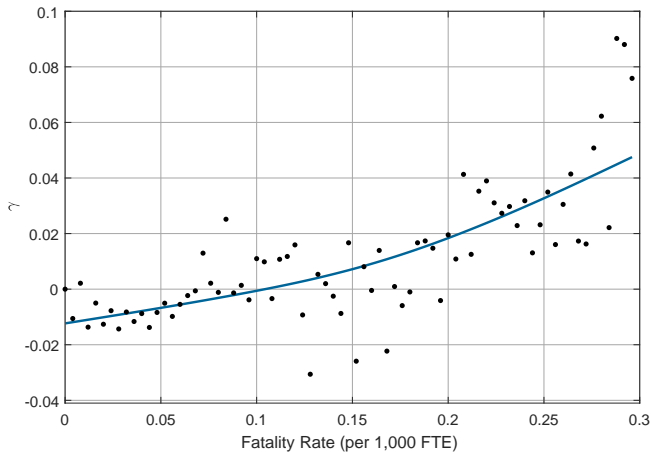


Figure: OME Model



- ▶ **Purpose:** establish sufficient conditions for identification
- ▶ partial equilibrium search model with differentiated firms
- ▶ Firms offer jobs across a range of occupations
- ▶ Jobs differ in
 - exogenous amenities
 - fatality risk
- ▶ Combines features of
 - Card, Cardoso, Heining, Kline (2016)
 - Hwang, Mortensen, Reed (1998); Lang and Majumdar (2004)

- ▶ Firms: $j \in \{1, \dots, J\}$
- ▶ industry: $b(j) \in \{1, \dots, B\}$
- ▶ exogenous amenity: a_j
- ▶ productivity: T_j

- ▶ occupations: $k \in \{1, \dots, K\}$
- ▶ exogenous amenity: d_k
- ▶ endogenous amenity: R_{jkt}

- ▶ time is discrete, and workers and firms live forever
- ▶ workers $i \in \{1, \dots, N\}$ supply labor
- ▶ skill: $s(i) \in \{1, \dots, S\}$
- ▶ utility: $u_{ijkt} = \bar{u}_{s(i)jkt} + \epsilon_{ijkt}$
- ▶

$$\bar{u}_{s(i)jkt} = f(w_{sjkt}, R_{jkt}) + g_s(a_j, d_k)$$

- ▶ ϵ_{ijkt} is distributed Type 1 Extreme Value

In each period four events take place:

1. firms choose wage and amenity offers (w_{sjkt}, R_{jkt})
2. firms make offers
 - with certainty to all of their current (inside) workers
 - with probability λ to each outside worker
3. workers draw new idiosyncratic preference ϵ
4. workers accept highest utility offer

The profits of firm j in period t are

$$L_{sjkt} [Q_{sjkt} - C_{b(j)k}(w_{sjkt}, R_{jkt})] \quad (2)$$

- ▶ L_{sjkt} is total employment of type s labor
- ▶ Q_{sjkt} is revenue per worker
- ▶ $C_{bk}(w_{sjkt}, R_{jkt})$ is unit cost of labor

The probability that a firm's offer is accepted can be expressed by:

$$p_{sjkt} = K_s \exp(\bar{u}_{sjkt}),$$

where K_s is a normalizing constant. **this is an approximation**

based on assumptions:

- ▶ each firm employs a negligible share of each type of worker
- ▶ the number of firms is large J
- ▶ sufficient outside offers

$$L_{t+1} = pL_t + \lambda p(N - L_t)$$

steady-state employment as a function of the utility offer is:

$$H(\bar{u}) = \frac{\lambda K \exp(\bar{u}) N}{\Omega(\bar{u})}$$

where $\Omega(\bar{u}) \equiv [1 - (1 - \lambda)K \exp(\bar{u})]$

$$\Omega(\bar{u}) \equiv [1 - (1 - \lambda)K \exp(\bar{u})]$$

- ▶ $\Omega(\bar{u})$ is the *incumbency advantage*
- ▶ $\lambda < 1$, the incumbent advantage is larger for jobs with particularly attractive exogenous characteristics, reducing the marginal cost of recruiting.
- ▶ $\lambda = 1$, every period is repeat of static model

At an optimum:

$$\frac{f_w(w, R)}{f_R(w, R)} = \frac{C_w(w, R)}{C_R(w, R)}.$$

- ▶ Yields implicit relationship between w and R
- ▶ When (reducing) R is normal, can induce negative expansion path (Lang and Majumdar 2004)

Functional Form Assumptions

- ▶ indirect utility over wages and risk

$$f(w, R) = \ln w - h(R)$$

- ▶ logarithm of unit labor costs

$$\ln C(w, R) = w - y_{bk}(R)$$

- ▶ unit revenue

$$Q_{sjk} = T_j \theta_s \pi_k$$

Risk

$$y'_{bk}(R) = h'(R)$$

Log wage

$$\ln w = \ln T_j + \ln \theta_s + \ln \pi_k + y_{bk}(R) + \ln \left(\frac{1}{1 + \Omega(\bar{u})} \right).$$

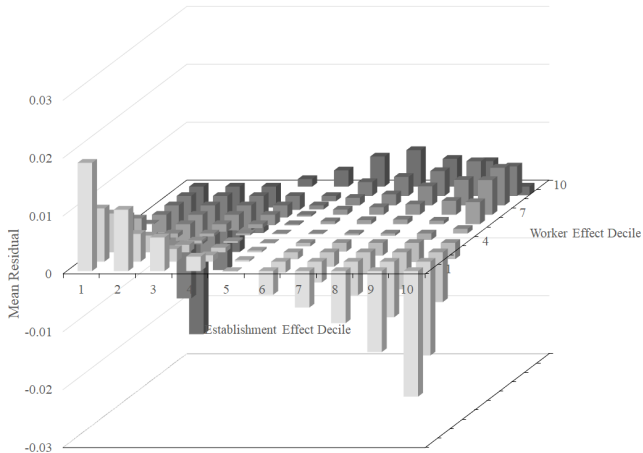
Implying

$$\frac{d \ln w}{dR} = h'(R) \left[1 - \left(\frac{1 - \Omega(\bar{u})}{1 + \Omega(\bar{u})} \right) \right].$$

- ▶ **Bias** from *incumbency advantage*
 - Match effect
 - Heterogeneous response
- ▶ **Does it matter?**
 - Separability of worker and employer effects
 - Event study
 - Control for tenure
 - Instrumental Variables

Specification Diagnostics: OME Model

Figure: Average Wage Residual By Deciles of Worker and Establishment Effects

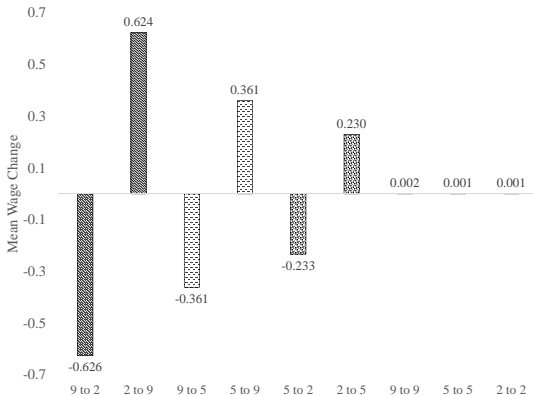


Sensitivity to Tails of Worker and Employer Effect Distribution

Sample	Pooled	Worker Effects	OME
5th to 95th Percentiles	0.308* (0.001)	0.037* (0.001)	0.170* (0.001)
10th to 90th Percentiles	0.282* (0.001)	0.035* (0.001)	0.170* (0.001)
15th to 85th Percentiles	0.261* (0.001)	0.035* (0.001)	0.171* (0.001)
20th to 80th Percentiles	0.244* (0.001)	0.039* (0.001)	0.174* (0.001)
25th to 75th Percentiles	0.223* (0.001)	0.043* (0.001)	0.180* (0.001)
30th to 70th Percentiles	0.201* (0.001)	0.048* (0.001)	0.187* (0.001)
35th to 65th Percentiles	0.175* (0.001)	0.051* (0.001)	0.196* (0.001)
40th to 60th Percentiles	0.154* (0.001)	0.054* (0.001)	0.204* (0.001)
45th to 55th Percentiles	0.138* (0.001)	0.053* (0.001)	0.207* (0.002)

Specification Diagnostics: OME Model

Figure: Average Wage Change By Deciles of Origin and Destination Establishment Effect



- ▶ **Intuition:** Search implies prob. of separation...
 1. increases with risk
 2. decreases with wage and with employer-specific pay
- [Gronberg and Reed (1994)]

Separation Models

	Dependent Variable: Separation			
	(1)	(2)	(3)	(4)
Log Wage	-0.050* (0.000)	-0.025* (0.000)	-0.016* (0.000)	-0.001* (0.000)
Fatality Rate	0.087* (0.001)	0.054* (0.001)	0.038* (0.001)	-0.042* (0.001)
Zero Fatality Rate	0.002* (0.000)	0.002* (0.000)	0.001* (0.000)	-0.001* (0.000)
Tenure (Years)		-0.010* (0.000)	-0.009* (0.000)	-0.006* (0.000)
Establishment Size			Y	
Establishment Effects				Y
N	83,418,032	83,418,032	83,418,032	83,418,032
R-Sq	0.050	0.059	0.061	0.142

Sensitivity to Controlling for Tenure

	Pooled		Worker Effects		OME	
	(1)	(2)	(3)	(4)	(5)	(6)
Fatality Rate (3-Yr MA)	0.373* (0.001)	0.407* (0.001)	0.037* (0.002)	0.043* (0.002)	0.199* (0.002)	0.200* (0.002)
Zero Fatality Rate	0.064* (0.000)	0.061* (0.000)	0.009* (0.000)	0.010* (0.000)	0.018* (0.000)	0.018* (0.000)
Completed Job Tenure		0.003* (0.000)		0.001* (0.000)		0.001* (0.000)
N	23,518,979	23,518,979	23,520,871	23,520,871	23,520,871	23,520,871
R-Sq	0.441	0.464	0.902	0.903	0.924	0.924
VSL (millions of reais)	3.61	3.95	0.36	0.42	1.93	1.94
95% CI	[3.58, 3.64]	[3.92, 3.97]	[0.32, 0.40]	[0.38, 0.46]	[1.89, 1.97]	[1.90, 1.98]

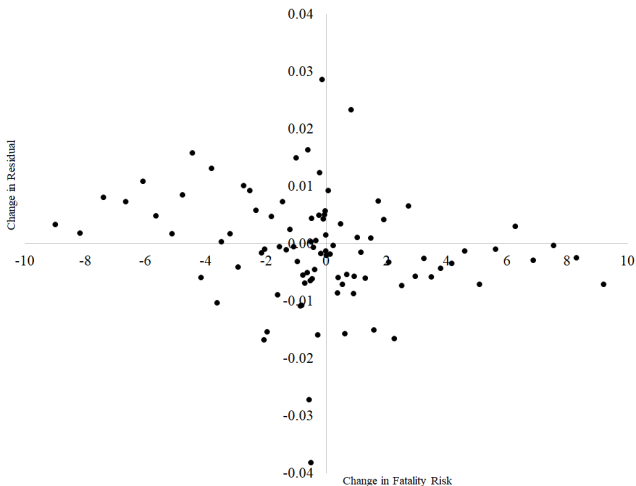
- ▶ **Problem:** Endogenous mobility in OME model
- ▶ **Solution:** Instrument change in risk with coworkers past changes
- ▶ **Intuition:**
 1. Workers in the same job sample from the same distribution of outside offers
 2. Past coworkers choices uncorrelated with idiosyncratic component of own offer

	(1) First- Differenced	(2) Establishment Effects	(3) IV First Stage	(4) IV	(5) OME on IV Sample
Δ Fatality Rate	-0.048 (0.003)	0.236* (0.000)		0.210* (0.011)	
Avg. Δ Fat. Rate in $N(i.t)$ Fatality Rate			0.338* (0.001)		0.203* (0.009)
N	5,653,428	5,403,738	5,403,738	5,403,738	5,403,738
VSL (million reais)	-0.39	1.94		1.72	1.68
95% CI	[-0.44, -0.35]	[1.89, 1.99]		[1.55, 1.90]	[1.53, 1.82]

IV Residual Diagnostics

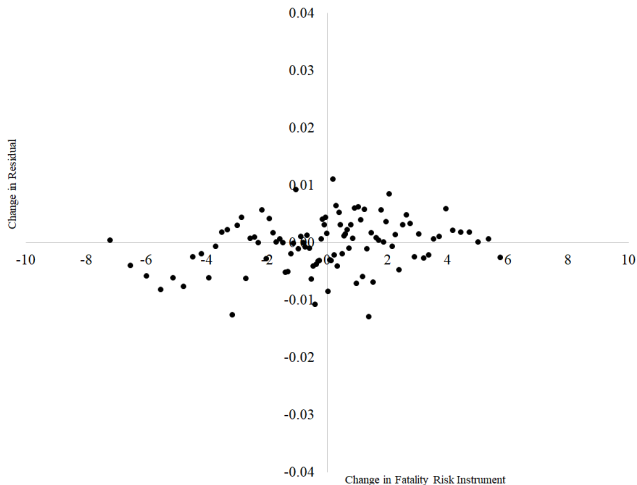
► OME Model

Figure: Average Change in Residual by Change in Fatality Rate



IV Residual Diagnostics

Figure: Average Change in Residual by Change in Instrument



- ▶ Statistical AKM decomposition matches predictions of hedonic search theory quite well
- ▶ The empirical features that motivate this study hold in U.S. data as well
 - Within-worker estimates of VSL attenuated
 - evidence that 'firms matter' for setting wages
- ▶ Likewise, endogenous mobility bias probably affects estimates of CWD for other amenities
- ▶ **Future:**
 - Structural estimation of hedonic search models with matched data
 - Modeling risk and risk perception differently

Thank You.

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Bonus Slides

Causes of Job Separation

Value	Label Portuguese	Label English
0	nao desl ano	no separation this year
10	dem com jc	terminated with just cause
11	dem sem jc	terminated without just cause
12	term contr	end of contract
20	desl com jc	resigned with just cause
21	desl sem jc	resigned without just cause
30	trans c/onus	xfer with cost to firm
31	trans s/onus	xfer with cost to worker
40	mud. regime	Change of labor regime
50	reforma	military reform - paid reserves
60	falecimento	demise, death
62	falec ac trb	death - at work accident
63	falec ac tip	death - at work accident corp
64	falec d prof	death - work related illness
70	apos ts cres	retirement - length of service with contract termination
71	apos ts sres	retirement - length of service without contract termination
72	apos id cres	retirement - age with contract termination
73	apos in acid	retirement - disability from work accident
74	apos in doen	retirement - disability from work illness
75	apos compuls	retirement - mandatory
76	apos in outr	retirement - other disability
78	apos id sres	retirement - age without contract termination
79	apos esp cre	retirement - special with contract termination
80	apos esp sre	retirement - special without contract termination

Average Fatality Rates

Industry	Average Fatality Rate	Number of Job-Years
Agriculture and Fishing	10.25	22,762,420
Mining	10.48	1,814,957
Manufacturing	5.24	76,712,576
Utilities	4.19	2,023,931
Construction	13.77	26,098,278
Trade and Repair	6.04	82,004,063
Food, Lodging, and Hospitality	4.99	15,589,304
Transportation, Storage, and Communication	14.53	20,941,098
Financial and Intermediary Services	1.01	6,947,728
Real Estate, Renting, and Services	4.59	57,447,503
Public Administration, Defense, and Public Security	0.84	72,055,976
Education	1.58	12,418,485
Health and Social Services	1.67	14,089,834
Other Social and Personal Services	3.98	15,469,519
Domestic Services	5.76	116,086
Occupation		
Public Administration and Management	2.63	18,035,409
Professionals, Artists, and Scientists	1.09	39,178,629
Mid-Level Technicians	2.50	40,972,375
Administrative Workers	1.87	78,792,943
Service Workers and Vendors	4.40	98,796,568
Agriculture Workers, Fishermen, Forestry Workers	9.26	25,417,204
Production and Manufacturing I	11.65	94,955,794
Production and Manufacturing II	5.28	15,947,072
Repair and Maintenance Workers	7.39	13,871,753

Sensitivity to Type of Job Change

	(1)	(2)
Fatality Rate	0.157* (0.001)	0.157* (0.001)
Fatality Rate*Change Occupation	0.007* (0.001)	0.001 (0.001)
Fatality Rate*Change Establishment	0.009* (0.001)	-0.014* (0.001)
Fatality Rate*Change Industry		0.041* (0.001)
N	83,418,032	83,418,032
R-Sq	0.930	0.930

- ▶ **Problem:** Selection bias from job movers
[Solon (1988); Gruetter and Lalive (2009)]
- ▶ **Solution:** Attenuated for involuntary job changes
[Gibbons and Katz (1992)]
- ▶ **Implementation:**
 - Identify *mass displacement events*
 - Firm-year where FTE declines by at least 30%
[Jacobson, Lalonde Sullivan (1993); Couch and Placzek (2009)]
 - Restrict sample to observations within 2 years of J2J transition
 - 6% from mass displacement

Mass Displacement

	(1)	(2)	(3)	(4)	(5)
	Pooled	Worker Effects	Match Effects	OME	TWFE
Fatality Rate (3-Yr MA)	0.475* (0.001)	0.079* (0.002)	-0.011* (0.002)	0.205* (0.001)	0.193* (0.001)
Fatality Rate \times Mass Disp.	0.209* (0.002)	0.003 (0.002)		-0.014* (0.002)	-0.012* (0.002)
Zero Fatality Rate	0.089* (0.000)	0.013* (0.000)	-0.004* (0.000)	0.016* (0.000)	0.016* (0.000)
Zero Fatality Rate \times Mass Disp.	-0.006* (0.001)	0.004* (0.001)		0.005* (0.000)	0.004* (0.000)
Mass Disp. Origin	-0.023* (0.000)	0.016* (0.000)		0.009* (0.000)	0.009* (0.000)
Mass Disp. Destination	-0.031* (0.000)	0.002* (0.000)		0.001 (0.000)	-0.000 (0.000)
N	44,220,194	44,224,540	44,224,540	44,224,540	44,224,540
R-Sq	0.448	0.914	0.976	0.925	0.925
VSL (millions of reais)	5.12	0.86	-0.12	2.21	2.08
95% CI	[5.09, 5.14]	[0.82, 0.89]	[-0.17, -0.07]	[2.18, 2.24]	[2.05, 2.11]