Equalizing wage differentials

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Equalizing differences

Rosen (1986) *Handbook* chapter a useful overview

- Motivation: what explains the distribution of labor earnings?
- Chapter X of *The Wealth of Nations*: *"The whole of the advantages and disadvantages of the different employments of labour and stock must, in the same neighbourhood, be either perfectly equal or continually tending to equality."*

Equalizing differences

Why is this an important model?

- Rosen (1986): has a legitimate claim to be *the* fundamental (long-run) market equilibrium construct in labor economics
- Also a central model in urban economics
- Empirically, the model has been extremely useful in:
  1. Understanding and interpreting the structure of wages
  2. Drawing inferences about preferences, technology from wages
- Policy: often want to know the value of non-market goods
  - By definition: not priced!
  - Value of mortality risks $\Rightarrow$ value of a statistical life (directly applicable in a variety of policy settings)

Friedman-Kuznets (1954)

- *Income from Independent Professional Practice*
  - Friedman's dissertation, published with advisor Kuznets
- Investigation of income in five professions: medicine, dentistry, law, certified public accountancy, consulting engineering
  - Equalizing differences
  - Temporary adjustments
  - "Persistent hinderances to the free choice of occupation"
- Controversy: argued American Medical Association artificially limits # of licensed physicians in order to increase doctors' earnings
  - Compare medicine and dentistry: $\sim 32\%$ income gap
  - Four times as many medical school applicants
  - Examine training, variability of income, demand, ...
  - Argue innate differences in ability do not explain the gap
- Very controversial at the time: 5-year publication delay due to objections of an AMA-proponent NBER board member
  - Debates over occupational licensing continue to be contentious
  - Difficult to draw firm conclusions from F/K tabulations, but these data were very influential in spurring subsequent research

1. Preliminaries
2. Theory of equalizing differences: Rosen (1974)
3. Estimating equalizing wage differentials
    - Version 1.0: Cross-section
    - Version 2.0: Panel
    - Version 3.0: Policy variation
    - Version 4.0: Job offers
4. Application: Spatial equilibrium (Roback 1982)
5. Looking ahead

Overview of Rosen model

- Classic reference: Rosen (1974)
- Focus here: simplified version in Rosen (1986)

- As in 'standard' models, prices adjust to achieve equilibrium
- But: here "which workers work for which firms" matters
  - Equilibrium serves a matching or sorting function
  - Specific workers are allocated to specific firms
- Labor market transactions are viewed as tied sales:
  - Worker sells (rents) her labor and buys job attributes
  - Employers buy labor and sell job attributes
  - Wage paid in equilibrium is the sum of two transactions:
    1. Labor services
    2. Job attributes
- Implicit market in job and worker attributes
- Assumes perfect information on both sides of the market

Binary case

- Two types of jobs:
  1. “Clean” jobs ($D = 0$, no airborne particulates)
  2. “Dirty” jobs ($D = 1$, some airborne particulates)
- Wages w_0, w_1 paid to workers in each type of job
- Workers productively homogenous, differ in preference for D

Preferences, opportunities, and worker choices

- Workers have preferences over two consumption goods:
  1. Market consumption C (purchased with money)
  2. Job type D
- Worker preferences represented by $U = U(C, D)$
  - $U_C > 0$
  - $U_D \leq 0$
- $U(C, 0) \geq U(C, 1) \Rightarrow D = 1$ not preferred to $D = 0$
- C_0: market consumption when $D = 0$
- C^*: consumption level such that $U(C^*, 1) = U(C_0, 0)$
  - Achieves same utility with $D = 1$ as C_0 guarantees with $D = 0$
  - Given that $D = 1$ is not preferred to $D = 0$, $C^* \geq C_0$
- $Z = C^* - C_0$: compensating differential (consumption units)
  - Compensating differential for $D = 1$ compared to $D = 0$
  - Add'l consumption needed to be indifferent between two types of jobs

Preferences, opportunities, and worker choices

- x-axis: disamenity D
- y-axis: consumption C
- Clean jobs offer $(w_0, 0)$
- Dirty jobs offer $(w_1, 1)$
- y: unearned income
- $cb = Z$
- Drawn for an inframarginal worker: $cb > ab$

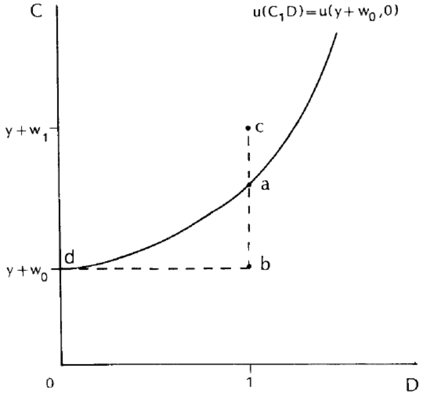

Figure 12.1

Preferences, opportunities, and worker choices

- $\Delta w = w_1 - w_0$: market equalizing wage differential
- Workers choose job type to maximize utility:
  - Choose $D = 1$ if $\Delta w > Z$
  - Choose $D = 0$ if $\Delta w < Z$
  - Indifferent if $\Delta w = Z$ (coin flip)

Market supply

- Fix size of overall labor force
- Relative market supply characterized by # workers $\Delta w \lesseqgtr Z$
  - Δw is the same for all workers, Z (taste) varies across individuals
  - Workers maximize utility given Δw and their Z
- $Z \sim G(Z)$ with density function $g(Z)$
- L_1^s: fraction of workers applying to $D = 1$ jobs
  - Fraction of workers with $\Delta w > Z$
- L_0^s: fraction of workers applying to $D = 0$ jobs
  - Fraction of workers with $\Delta w < Z$

$$L_1^s = \int_0^{\Delta w} g(Z) dZ = G(\Delta w)$$

$$L_0^s = \int_{\Delta w}^{\infty} g(Z) dZ = 1 - G(\Delta w)$$

Preferences, opportunities, and worker choices

- L_1^s, L_0^s for given Δw
- Left of Δw, workers choose $D = 1$ jobs
- Right of Δw, workers choose $D = 0$ jobs

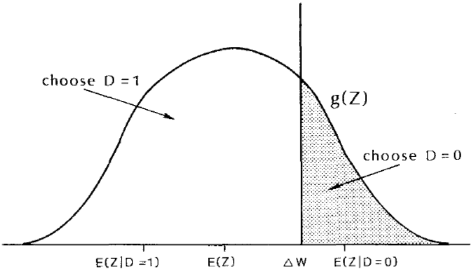

Figure 12.2

Technology, opportunities, and firm choices

- Firms sell a good x (output) to the market
  - Normalize the price of x to be 1
- D is produced as a by-product of the production of x
  - Example: production of steel x involves smoke D
- Firms can use resources to reduce D
  - Example: purchasing cleaner capital equipment
  - Note: D must be productive for it to be observed in the market

Technology, opportunities, and firm choices

Let the production technology have the following form:

$$x = a_1 L \text{ if } D = 1$$

$$x = a_0 L \text{ if } D = 0$$

- $B = a_1 - a_0$
  - Marginal cost per worker of producing clean worksites
  - Denominated in terms of forgone output
- Restricting $B > 0$ requires D be productive
  - Efficiency of labor in x production larger when resources are not used to clean up the work environment
- Marginal labor cost per worker of providing clean jobs is Δw
- In choosing production technology, firms compare B with Δw

Market demand

- Fix firm size
- Firms differ in B
- $B \sim F(B)$ with density function $f(B)$
- Firms choose $D = 1$ if $B > \Delta w$ and choose $D = 0$ if $B < \Delta w$
- L_1^d: fraction of firms demanding workers in $D = 1$ jobs
  - Fraction of firms with $B > \Delta w$
- L_0^d: fraction of firms demanding workers in $D = 0$ jobs
  - Fraction of firms with $B < \Delta w$

$$L_1^d = \int_{\Delta w}^{\infty} f(B)dB \quad = \quad 1 - F(\Delta w)$$
$$L_0^d = \int_{0}^{\Delta w} f(B)dB \quad = \quad F(\Delta w)$$

Market demand

- L_1^d, L_0^d for given Δw
- Left of Δw, firms choose $D = 0$ jobs
- Right of Δw, firms choose $D = 1$ jobs

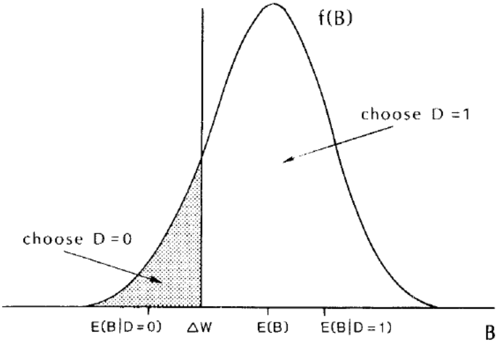

Figure 12.3

Market equilibrium

- Equilibrium equates supply, demand for workers in each job
  - Wages w_0 and w_1 adjust so # of workers seeking positions in each type of job equals # of positions to be filled
  - $\Rightarrow \Delta w$ adjusts so that $L_1^s = L_1^d$, $L_0^s = L_0^d$
- Equilibrium Δw^* solves $G(\Delta w^*) = 1 - F(\Delta w^*)$

Selection

- Workers and firms are systematically matched in equilibrium
  - Workers in $D = 1$ jobs have the smallest distaste for D
  - Firms offering $D = 1$ jobs have largest clean-up costs
- $\Rightarrow$ negative assortative matching in equilibrium: workers with larger Z systematically found in firms with smaller B, and vice versa

$$
\begin{aligned}
E(Z|D=0) &> E(Z) \\
E(Z|D=1) &< E(Z) \\
E(B|D=0) &< E(B) \\
E(B|D=1) &> E(B)
\end{aligned}
$$

Marginal vs. inframarginal workers

Market wage differential Δw gives preferences of marginal worker

- Rent: difference between reservation wage and actual wage
- Market allocation may generate significant "rents": excess return relative to what is required to change an individual's decision
- Average person choosing $D = 1$ is far from indifferent
  - Would keep same job choice even if Δw changed substantially
- Using the definition of rent, we can derive that for average individual choosing $D = 1$: $\Delta w - E(Z|D = 1)$

Normal distribution of worker preferences

- Example: Z is normally distributed across workers
- Lecture notes work through this example
- As variance in preferences $\sigma^2 \to 0$, $R_1 \to 0$:
  no heterogeneity $\Rightarrow$ no inframarginal workers $\Rightarrow$ no rents
- More generally: rents depend on distribution of preferences.

Rosen (1974): Continuous case

- Binary case illustrates key issues
- Rosen (1974) presents more general model incorporating a continuous measure D of disamenity - say, parts per million of particulates as a continuous measure of pollution
- Language: bid and offer functions (widely used)
- Theoretical framework has been extremely influential, but identification approach in Rosen (1974) has been heavily criticized

Estimating equalizing wage differentials

Tremendous interest in estimating equalizing wage differentials:
Testing theory, understanding wage structure, linking to policy

How have people tried to estimate equalizing wage differentials?

1. Version 1.0: Cross-section estimates
2. Version 2.0: Panel estimates
3. Version 3.0: Policy variation
4. Version 4.0: Job offers

Cross-section estimates

Data source that subsequently became central to this literature:
Dictionary of Occupational Titles

- As best I know, Lucas (1977) first to use this data
- Still heavily used: http://www.occupationalinfo.org/
- Attributes for $> 10,000$ jobs: toxic conditions, extreme temperatures, repetitiveness, physical strength...

Lucas (1977)

- Opening anecdote: Adam Smith's observation that public hangmen received higher wages for their "obnoxious task"
- Primary contribution is new data: *"...the discovery of an unusually rich and hitherto unexplored source of data renders possible a 'new approach' to the topic in this paper."*
- Framework: Model similar to Rosen's "kissing equilibrium" model
- Data: *Survey of Economic Opportunity* matched to *DOT* data
- Empirics: relate log wages to job characteristics
  - RHS variables: piecewise linear function for age, indicator for union status, series of job characteristics

Lucas (1977): Table 1

TABLE 1—ESTIMATED HEDONIC WAGE EQUATIONS

	White Males			Black Males			White Females			Black Females		
Schooling	0–8	9–11	12	0–8	9–11	12	0–8	9–11	12	0–8	9–11	12
Constant	.470	.765	.819	−.111	.427	.284	.350	.603	.413	.353	.245	.287
	(.106)	(.086)	(.076)	(.176)	(.149)	(.115)	(.160)	(.119)	(.070)	(.278)	(.129)	(.095)
Age 14	−.570	−.819	−.690	−.469	−.573	−.390	−.183	−.380	−.310	−.380	−.237	−.343
	(.057)	(.042)	(.050)	(.067)	(.054)	(.079)	(.097)	(.070)	(.047)	(.123)	(.063)	(.072)
25	−.101	−.136	−.127	−.123	−.186	−.064	−.064	−.048	−.037	−.032	−.077	−.168
	(.038)	(.035)	(.026)	(.042)	(.048)	(.052)	(.076)	(.073)	(.035)	(.061)	(.054)	(.053)
99	−.687	−1.162	−.772	−.754	−1.143	−1.474	−.979	−1.371	−.423	−.208	−.257	−.700
	(.118)	(.191)	(.170)	(.162)	(.411)	(.573)	(.209)	(.359)	(.216)	(.180)	(.357)	(.475)
Union member	.299	.239	.160	.447	.268	.253	.262	.218	.208	.324	.235	.125
	(.022)	(.021)	(.017)	(.027)	(.029)	(.030)	(.051)	(.055)	(.032)	(.060)	(.050)	(.042)
SVP	.344	.228	.335	.336	.197	.335	.246	.020	.166	.201	.322	.433
	(.059)	(.057)	(.065)	(.056)	(.062)	(.062)	(.071)	(.077)	(.053)	(.071)	(.056)	(.052)
GED	.423	.245	.241	.444	.325	.139	.382	.285	.315	.128	.150	.319
	(.050)	(.046)	(.039)	(.067)	(.070)	(.068)	(.132)	(.103)	(.047)	(.148)	(.097)	(.075)
Supervise	.151	.227	.152	.184	.159	−.128	−.440	−.185	−.067	.019	−.348	.045
	(.086)	(.068)	(.053)	(.162)	(.154)	(.208)	(.342)	(.245)	(.194)	(.344)	(.257)	(.201)
Nonsedentary	−.260	−.138	−.170	.055	−.055	.275	−.504	−.398	−.188	−.610	−.217	−.282
	(.092)	(.068)	(.038)	(.172)	(.135)	(.080)	(.139)	(.089)	(.031)	(.272)	(.111)	(.064)
Repetitive	.296	.119	.103	.450	.264	.077	.400	.274	.223	.152	.110	.256
	(.045)	(.045)	(.043)	(.046)	(.056)	(.059)	(.082)	(.080)	(.049)	(.069)	(.065)	(.071)
Physical conditions	.133	.100	.068	.109	.128	−.077	.149	.198	.033	.377	.121	.195
	(.039)	(.035)	(.028)	(.047)	(.048)	(.051)	(.075)	(.079)	(.054)	(.070)	(.061)	(.066)
Degrees of freedom	1602	1758	2699	1625	956	757	735	990	2020	1038	809	826
Sum squared residuals	264.9	258.4	392.2	326.6	143.1	101.1	203.9	337.9	351.2	246.9	134.6	125.4
Residual variance	.165	.147	.145	.201	.150	.134	.278	.341	.174	.238	.166	.152
R^2	.374	.461	.199	.330	.319	.165	.233	.149	.144	.146	.152	.230

Some coefficients of expected sign ("Repetitive"), others not ("Nonsedentary")

Lucas (1977): Interpretation

- Interpretation of "wrong-signed" coefficients: *"The nonsedentary jobs are those requiring more lifting and physical exertion. The undertaking of such tasks, if distasteful, is not rewarded...but rather the converse, which suggests the omission of some skill associated with sedentary job holders."*

Cross-section estimates: Consensus as of 1980

Brown (1980): reviewed cross-sectional evidence, concluded there was surprisingly limited support for the theory: *"The overall pattern that emerges...is one of mixed results: some clear support for the theory but an uncomfortable number of exceptions. Among the studies that fail to find equalizing differences, the most common explanation is the omission of important worker abilities, biasing the coefficients of job characteristics."*

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4. Application: Spatial equilibrium (Roback 1982)

5. Looking ahead

Brown (1980)

- Goal: move beyond cross-sectional estimates to develop "a more appropriate test of the theory"
- Notes that focus of Rosen model is on choices made by individuals with given personal characteristics (X) among jobs with different wages (w) and non-wage attributes (Z)
- In order to attract labor of a given quality, an employer offering jobs that are undesirable must pay higher wages
- Individuals face jobs differing in w and Z and choose among these jobs to maximize utility

Ability bias

$$ln(w_i) = \alpha + \beta X_i + \gamma Z_i + \delta A_i + u_i$$

- w: wages
- X: observable individual-level characteristics
- Z: non-wage job attributes (higher $Z \Rightarrow$ less desirable)
- A: unmeasured ability ($\delta > 0$)

Rosen framework: expect $\gamma > 0$

- If workers with higher A_i use some of their higher earnings capacity to "purchase" better Z, then $cov(Z_i, A_i) < 0$
- Then expect γ to be biased downwards
- Consistent with empirics: "wrong-signed" (negative)

Addressing ability bias: Brown (1980)

- Brown (1980) insight: some progress can be made if "most" omitted characteristics are fixed within individuals over time
  - Longitudinal data: individual fixed effects
  - Data: NLS Young Men's survey matched to *DOT* data

- Brown's question: how do log earnings change when job attributes change, conditional on individual fixed effects?
  - Important paper
  - Bottom line: individual fixed effects don't seem to help much
  - Still many "wrong-signed" estimates (relative to theory)
  - Key results in Table II: Columns 1-4 differ in job characteristics
  - Columns 5-8 add individual fixed effects
  - *"The hypothesis that the inconsistent support for the theory of equalizing differences that characterized previous studies was due to the omission of important dimensions of worker quality was not supported by the data."*

Brown (1980): Table IIa

TABLE II

ESTIMATES OF EQUATION (1)

Variable	Mean (st. dev.)	1	2	3	4	5	6	7	8
Constant	1.00	5.71.	5.66	5.71	5.68				
	(0.00)	(0.127)	(0.126)	(0.126)	(0.125)				
Year = 1967	0.143	−0.013	−0.015	−0.007	−0.009	0.003	0.003	0.004	0.004
	(0.350)	(0.023)	(0.022)	(0.022)	(0.022)	(0.013)	(0.013)	(0.013)	(0.013)
Year = 1968	0.143	0.012	0.009	0.026	0.023	0.035*	0.035*	0.036*	0.036*
	(0.350)	(0.033)	(0.032)	(0.032)	(0.032)	(0.018)	(0.018)	(0.018)	(0.018)
Year = 1969	0.143	0.013	0.006	0.031	0.025	0.035	0.034	0.035	0.035
	(0.350)	(0.045)	(0.045)	(0.044)	(0.044)	(0.024)	(0.024)	(0.024)	(0.024)
Year = 1970	0.143	−0.011	−0.022	0.014	0.005	0.018	0.017	0.019	0.018
	(0.350)	(0.058)	(0.057)	(0.057)	(0.057)	(0.031)	(0.031)	(0.031)	(0.031)
Year = 1971	0.143	−0.049	−0.061	−0.019	−0.029	−0.020	−0.021	−0.020	−0.021
	(0.350)	(0.071)	(0.070)	(0.070)	(0.070)	(0.038)	(0.038)	(0.038)	(0.038)
Year = 1973	0.143	−0.071	−0.090	−0.027	−0.043	−0.042	−0.043	−0.041	−0.043
	(0.350)	(0.098)	(0.097)	(0.097)	(0.097)	(0.053)	(0.053)	(0.053)	(0.053)
Cum company train school	0.078	−0.003	−0.003	−0.005	−0.006	−0.001	−0.001	0.000	−0.001
	(0.467)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Cum part-time school	0.100	0.035*	0.036*	0.033*	0.034*	0.026	0.026	0.026	0.026
	(0.368)	(0.014)	(0.014)	(0.014)	(0.014)	(0.016)	(0.016)	(0.016)	(0.016)
Cum other school	0.096	0.049*	0.047*	0.043*	0.042*	−0.007	−0.008	−0.008	−0.009
	(0.459)	(0.011)	(0.011)	(0.011)	(0.011)	(0.013)	(0.013)	(0.013)	(0.013)
Cum work exper. since 1965	3.91	0.103*	0.105*	0.096*	0.097*	0.101*	0.102*	0.102*	0.102*
	(2.17)	(0.014)	(0.014)	(0.014)	(0.014)	(0.008)	(0.008)	(0.008)	(0.008)
Years tenure current job	3.06	0.000	0.001	0.001	0.002	0.006*	0.006*	0.006*	0.006*
	(2.85)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)

(*continued*)

Brown (1980): Table IIb

TABLE II

(cont'd.)

Variable	Mean (st. dev.)	1	2	3	4	5	6	7	8
Prob resp covered by union	0.378	0.130*	0.126*	0.134*	0.132*	0.081*	0.080*	0.080*	0.080*
	(0.448)	(0.013)	(0.013)	(0.013)	(0.013)	(0.016)	(0.016)	(0.016)	(0.016)
Union coverage, office	0.015	0.274*	0.332	0.233*	0.271*	0.178*	0.201*	0.176*	0.210*
	(0.073)	(0.074)	(0.073)	(0.074)	(0.073)	(0.076)	(0.074)	(0.076)	(0.074)
Union coverage, nonoffice	0.396	0.223*	0.178*	0.207*	0.172*	0.200*	0.190*	0.203*	0.190*
	(0.326)	(0.023)	(0.022)	(0.023)	(0.021)	(0.027)	(0.026)	(0.027)	(0.026)
Currently married	0.750	0.132*	0.133*	0.129*	0.130*	0.065*	0.065*	0.064*	0.064*
	(0.433)	(0.012)	(0.012)	(0.012)	(0.012)	(0.013)	(0.013)	(0.013)	(0.013)
Job in SMSA	0.678	0.135*	0.135*	0.135*	0.135*	0.105*	0.105*	0.104*	0.104*
	(0.467)	(0.011)	(0.011)	(0.011)	(0.011)	(0.020)	(0.020)	(0.020)	(0.020)
Residence in South	0.440	−0.016*	−0.107*	−0.107*	−0.109*	−0.003	−0.002	−0.004	−0.002
	(0.496)	(0.012)	(0.012)	(0.012)	(0.012)	(0.045)	(0.045)	(0.045)	(0.045)
Residence in West	0.095	0.034	0.031	0.040*	0.038*	0.135*	0.138*	0.133*	0.137*
	(0.293)	(0.018)	(0.018)	(0.018)	(0.018)	(0.064)	(0.064)	(0.064)	(0.064)
Cum layoff + discharge	0.439	0.001	0.000	0.002	0.002	0.013	0.013	0.011	0.012
	(0.888)	(0.006)	(0.006)	(0.006)	(0.006)	(0.007)	(0.007)	(0.007)	(0.007)
Health limits work	0.069	−0.021	−0.022	−0.020	−0.022	−0.009	−0.010	−0.007	−0.009
	(0.253)	(0.020)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)	(0.019)
Race = White	0.760	0.125*	0.128*	0.110*	0.111*				
	(0.427)	(0.014)	(0.014)	(0.014)	(0.014)				
Knowledge of World of Work	33.9	0.0053*	0.0055*	0.0051*	0.0053*				
	(8.50)	(0.0008)	(0.0008)	(0.0008)	(0.0008)				
SES Index	91.3	0.0016*	0.0017*	0.0016*	0.0016*				
	(20.9)	(0.0003)	(0.0003)	(0.0003)	(0.0003)				
Cum experience in 1965	3.07	0.012*	0.011*	0.012*	0.011*				
	(2.34)	(0.002)	(0.002)	(0.002)	(0.002)				
Years schooling completed	11.0	0.031*	0.032*	0.031*	0.031*				
	(2.00)	(0.004)	(0.004)	(0.004)	(0.004)				
Cum military training	0.150	0.005	0.006	0.005	0.006				
	(0.635)	(0.008)	(0.008)	(0.008)	(0.008)				

Brown (1980): Table IIc

Government worker	0.091	−0.074*	−0.091*	−0.060*	−0.071*	−0.076*	−0.080*	−0.074*	−0.079*
	(0.287)	(0.019)	(0.019)	(0.019)	(0.019)	(0.024)	(0.024)	(0.024)	(0.024)
Sup/wages in industry	0.110	0.010	0.185	0.050	0.178	0.170	0.223	0.161	0.217
	(0.051)	(0.119)	(0.117)	(0.118)	(0.116)	(0.163)	(0.161)	(0.163)	(0.161)
Time now in company train	0.008	−0.009	0.003	0.003	0.012	−0.036	−0.033	−0.032	−0.029
	(0.067)	(0.079)	(0.079)	(0.078)	(0.078)	(0.061)	(0.061)	(0.061)	(0.061)
Time now in part-time sch	0.008	−0.357*	−0.360*	−0.361*	−0.360*	−0.200*	−0.204*	−0.205*	−0.209*
	(0.058)	(0.088)	(0.088)	(0.087)	(0.087)	(0.071)	(0.071)	(0.071)	(0.071)
Time now in other training	0.008	−0.193*	−0.181*	−0.191*	−0.182*	−0.116	−0.112	−0.117	−0.113
	(0.063)	(0.082)	(0.082)	(0.082)	(0.081)	(0.065)	(0.065)	(0.065)	(0.065)
Occupation = apprentice	0.018	−0.007	−0.005	−0.028	−0.030	−0.098*	−0.097*	−0.098*	−0.098*
	(0.132)	(0.039)	(0.039)	(0.039)	(0.039)	(0.034)	(0.034)	(0.034)	(0.034)
Repetitive work	0.395	−0.137*	−0.143*	−0.036	−0.029	−0.049*	−0.050*	−0.056*	−0.048*
	(0.361)	(0.015)	(0.016)	(0.024)	(0.023)	(0.016)	(0.017)	(0.025)	(0.025)
Work under stress	0.067	0.041	−0.005	−0.012	−0.043	0.028	0.027	−0.019	−0.017
	(0.176)	(0.031)	(0.032)	(0.033)	(0.034)	(0.040)	(0.040)	(0.043)	(0.043)
Physical strength required	0.188	−0.006	−0.036	0.030	0.011	−0.028	−0.036	−0.009	−0.018
	(0.252)	(0.023)	(0.022)	(0.023)	(0.022)	(0.025)	(0.024)	(0.026)	(0.025)
Bad working conditions	0.561	−0.067*		−0.044*		−0.031		−0.037	
	(0.353)	(0.018)		(0.019)		(0.020)		(0.021)	
Deaths/1,000 manyears	0.225		0.060*		0.057*		0.009		0.007
	(0.448)		(0.012)		(0.012)		(0.012)		(0.012)
Ln (usual hours)	3.77	−0.375*	−0.381*	−0.368*	−0.369*	−0.254*	−0.255*	−0.254*	−0.255*
	(0.198)	(0.031)	(0.030)	(0.030)	(0.030)	(0.028)	(0.028)	(0.028)	(0.028)
Part-time worker	0.028	−0.095*	−0.105*	−0.087*	−0.089*	−0.052	−0.053	−0.053	−0.053
	(0.164)	(0.037)	(0.037)	(0.037)	(0.036)	(0.032)	(0.032)	(0.032)	(0.032)
Low GED requirement	0.584			−0.044	−0.067*			0.044	0.033
	(0.387)			(0.024)	(0.022)			(0.024)	(0.024)
Low SVP requirement	0.158			−0.212*	−0.204*			−0.075*	−0.075*
	(0.222)			(0.030)	(0.030)			(0.030)	(0.030)
Standard error of estimate		0.277	0.276	0.274	0.274	0.202	0.202	0.202	0.202
R-squared		0.635	0.636	0.641	0.643	0.833	0.833	0.834	0.834
Number of observations		3,290	3,290	3,290	3,290	3,290	3,290	3,290	3,290

* = Statistically significant at the 0.05 level.

Brown (1980): Interpretation

"The impacts of the intercepts on the coefficients of job characteristics vary considerably, and there is no marked improvement in the correspondence between these coefficients and a priori predictions."

Brown discusses several potential explanations for his results:

1. Labor markets not as competitive as theory assumes.
2. Marginal workers' tastes may differ from those assumed. Brown argues plausible for physical strength, less so for others.
3. Job characteristics are not well-measured. Likely a huge issue: workers assigned mean job characteristics for their occupation/industry. Classical measurement error $\Rightarrow \gamma$ biased towards zero; likely exacerbated in fixed effects models (problem set Q).
4. Omitted variables may be biasing the estimates.

Take-aways

Individual fixed effects solve some problems, but introduce others:

1. Why do some individuals switch jobs but not others?
2. Could job switches be driven by changes in unobserved (time-varying) individual-level productivity (A_{it} vs. A_i)?
3. Are job switches due to poor "matches"? (Gibbons and Katz 1992)

Motivation

Cross-section and panel methods for estimating compensating differentials often produce non-sensical/"wrong signed" estimates of how workers value non-wage job characteristics

- Previous focus: risks (e.g. death on the job)
- Alternative non-wage characteristic: benefit (e.g. health insurance)
  - Do workers value health insurance one-for-one with wages?
  - What about other types of benefits?
  - Again, hard to estimate in a cross-section/panel
  - Quasi-experimental variation: mandated benefits

Mandates for employer-provided benefits

Variety of government policies take form of mandated employer provided benefits: health insurance, workers' compensation

- Famous 1989 *American Economic Review P&P* article by Larry Summers laid out a framework clarifying how to think about incidence, welfare costs of employer-mandated benefits
- Showed mandated benefits and taxes may have different effects on equilibrium wages, employment: equilibrium depends on workers' value of benefits

Summers (1989) in one slide

- Labor demand $L_d = f_d(W + C)$ and supply $L_s = f_s(W + \alpha C)$
  - W: wage
  - C: cost of mandated health insurance
  - αC: monetary value employees place on health insurance
- In equilibrium, $L_s = L_d$
- Can show (totally differentiating equilibrium conditions) that if $\alpha = 1$ then wages fall by the full cost of the mandated benefit, while there is no change in employment (problem set)
  - $\alpha = 1 \Rightarrow$ employees value benefits same as wages
  - Public finance: "tax-benefit linkage" (DWL could be 0)

Subsequent empirical literature ("Jon Gruber literature")

Summers framework spurred empirical literature analyzing how wages and employment respond to changes in mandated employer-provided benefits

- Workers' compensation insurance
  - Gruber and Krueger (1991)
  - Fishback and Kantor (1995)
- Gruber (1994) on mandated maternity benefits
  - Wage offsets among "relevant" workers
- Gruber (1997) on payroll tax changes
  - Tax-benefit linkage: payroll tax revenues often used to finance programs that benefit only workers (Social Security)
  - Results consistent with full employee valuation of benefit
  - Doesn't formally test against competing explanations

Workers' compensation: Fishback and Kantor (1995)

Another excellent example of economic history as a good laboratory for labor economics research topics

- State-level WC introduced in the 1910s
- Widely touted as "bonuses to workers"
- Collect pre-/post-wage data from three (relatively dangerous) industries: coal mining, lumber milling, and unionized building trades

Variation: Staggered adoption + cross-state variation

TABLE II
EXPECTED BENEFITS UNDER WORKERS' COMPENSATION AS A PERCENTAGE OF ANNUAL EARNINGS BY STATE, 1910–1923

State	1910	1911	1912	1913	1914	1915	1916	1917	1918	1919	1920	1921	1922	1923
AK	.	.	.	.	.	2.02	1.85	1.67	1.44	1.30	1.13	1.20	1.24	1.54
AL	.	.	.	.	.	.	.	.	.	.	1.05	1.15	1.20	1.12
AR	.	.	.	.	.	.	.	.	.	.	.	.	.	.
AZ	.	.	.	1.67	1.67	1.68	1.63	1.58	1.42	1.30	1.16	2.18	2.24	2.12
CA	.	1.71	1.71	1.69	1.51	1.51	1.53	1.53	1.62	1.68	1.56	1.65	1.65	1.65
CO	.	.	.	.	.	0.96	0.88	0.87	0.72	0.83	0.68	0.74	0.78	0.90
CT	.	.	.	.	1.20	1.26	1.26	1.26	1.25	1.42	1.31	1.36	1.39	1.35
DE	.	.	.	.	.	.	.	.	0.97	1.31	1.18	1.30	1.33	1.26
FL	.	.	.	.	.	.	.	.	.	.	.	.	.	.
GA	.	.	.	.	.	.	.	.	.	.	.	0.84	1.20	1.15
HI	.	.	.	.	.	1.42	1.42	1.55	1.55	1.48	1.35	1.46	1.49	1.46
IA	.	.	.	.	1.17	1.17	1.17	1.17	0.97	1.25	1.03	1.13	1.18	1.10
ID	.	.	.	.	.	.	.	.	1.41	1.23	1.00	1.41	1.47	1.37
IL	.	.	1.48	1.42	1.42	1.42	1.42	1.54	1.42	1.40	1.14	1.29	1.35	1.25
IN	.	.	.	.	.	1.28	1.28	1.40	1.40	1.30	1.06	1.17	1.22	1.14
KS	.	.	1.23	1.23	1.23	1.23	1.23	1.40	1.40	1.24	1.02	1.12	1.17	1.09
KY	.	.	.	.	.	.	1.57	1.45	1.32	1.14	1.07	1.17	1.23	1.14
LA	.	.	.	.	.	1.17	1.28	1.28	1.40	1.40	1.35	1.43	1.53	1.45
MA	.	.	1.65	1.64	2.16	2.17	2.04	1.96	1.67	1.53	1.26	1.38	1.63	1.57
MD	.	.	1.27	1.27	1.32	1.32	1.32	1.32	1.23	1.08	1.42	1.56	1.63	1.52
ME	.	.	.	.	.	.	1.25	1.25	1.06	1.33	1.12	1.38	1.44	1.35
MI	.	.	1.14	1.14	1.14	1.14	1.14	1.14	0.95	1.27	1.04	1.17	1.23	1.14
MN	.	.	.	1.17	1.17	1.22	1.22	1.48	1.23	1.38	1.13	1.54	1.61	1.74
MO	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MS	.	.	.	.	.	.	.	.	.	.	.	.	.	.
MT	.	.	.	.	.	1.30	1.30	1.30	1.08	1.17	0.96	1.06	1.11	1.03
NC	.	.	.	.	.	.	.	.	.	.	.	.	.	.
ND	.	.	.	.	.	.	.	.	.	2.82	2.57	2.76	2.81	2.71
NE	.	.	.	1.28	1.28	1.28	1.28	1.68	1.39	1.51	1.24	1.36	1.42	1.32
NH	.	.	1.21	1.21	1.21	1.21	1.21	1.21	1.05	0.95	0.82	0.88	0.91	1.20
NJ	.	1.14	1.14	1.14	1.14	1.14	1.14	1.14	0.99	1.08	0.89	0.97	1.02	1.26
NM	.	.	.	.	.	.	.	0.99	0.91	1.03	0.88	1.01	1.05	0.99
NV	.	.	.	1.43	1.54	1.66	1.65	1.65	2.19	2.48	2.14	2.29	2.37	2.25
NY	1.73	1.73	1.71	1.80	2.33	2.33	2.32	2.32	2.26	2.12	1.86	2.00	2.32	2.27
OH	.	.	1.61	1.70	1.77	1.77	1.77	1.61	1.50	1.40	1.15	1.32	1.38	1.28
OK	.	.	.	.	.	0.72	0.72	0.72	0.60	0.95	0.95	0.95	0.95	0.99
OR	.	.	.	.	2.40	2.40	2.23	1.99	1.65	1.50	1.23	1.60	1.64	1.57
PA	.	.	.	.	.	.	1.21	1.21	1.01	0.87	0.84	0.92	0.97	0.90
RI	.	.	1.24	1.24	1.24	1.24	1.24	1.47	1.27	1.13	1.12	1.26	1.28	1.25
SC	.	.	.	.	.	.	.	.	.	.	.	.	.	.
SD	.	.	.	.	.	.	.	1.17	1.10	1.01	0.84	1.06	1.10	1.03
TN	.	.	.	.	.	.	.	.	.	1.03	0.85	0.93	0.97	1.20
TX	.	.	.	1.84	1.84	1.84	1.82	1.61	1.61	1.46	1.19	1.31	1.37	1.61
UT	.	.	.	.	.	.	.	1.38	1.30	1.57	1.29	1.41	1.48	1.38
VA	.	.	.	.	.	.	.	.	.	0.84	0.82	0.90	0.95	0.88

Estimation

For each of their three industries, they estimate regressions of the following form for occupation i in state j in year t:

$$w_{ijt} = \beta_0 + D_{ijt}\beta_1 + B_{ijt}\beta_2 + WT_{ijt}\beta_3 + A_{ijt}\beta_4 + U_{ijt}\beta_5 + o_i + s_j + y_t + e_{ijt}$$

- w_{ijt}: real hourly wage
- D_{ijt}: measures of product market fluctuations and worker productivity
- B_{ijt}: postaccident benefits
- WT_{ijt}: working time restrictions
- A_{ijt}: accident rate
- U_{ijt}: measures of strikes and union strength
- s_j: state fixed effects
- y_t: year fixed effects
- o_i: occupation fixed effects

Notes: controls, timing/event studies around the time of the policy change

Estimates

0/1 and continuous measure: contrast of union vs. non-union

Coefficient of -1 $\Rightarrow$ workers fully paid for increases in expected benefit

Similar in magnitude to Gruber and Krueger (1991)

TABLE III
FIXED-EFFECTS WEIGHTED LEAST SQUARES WAGE REGRESSIONS
(DEPENDENT VARIABLE IS HOURLY WAGE IN 1890–1899 CENTS)

Variable	Coal mining hourly wage workers		Lumber mill workers		Unionized building trades	
Workers' compensation dummy	−0.603 (3.67)		−0.335 (2.62)		−0.124 (0.604)	
Expected present value of accident compensation[a]		−1.72 (4.14)		−1.04 (2.11)		0.020 (0.031)
Limits on working time[b]	0.053 (0.138)	0.264 (0.704)	−0.359 (18.5)	−0.362 (18.6)	−0.843 (22.7)	−0.843 (22.7)
Product price or other product demand index[c]	8.46 (17.7)	8.35 (17.5)	0.277 (6.68)	0.286 (6.95)	0.044 (5.02)	0.044 (5.01)
Productivity measure[d]	6.43 (3.46)	7.66 (4.12)	0.387 (2.44)	0.386 (2.43)		
Fatal accidents per million man-hours	−0.029 (0.505)	−0.005 (0.086)				
Paid-up membership in the United Mine Workers of America as a percentage of employment	0.111 (0.161)	0.317 (0.469)				
Strike days per employee	0.010 (2.56)	0.012 (3.16)				
Strike days per employee lagged one year	−0.006 (2.28)	−0.005 (2.20)				
Strike days per employee in states other than state *j*	0.072 (4.00)	0.079 (4.42)				
Intercept	3.40 (2.52)	2.57 (1.91)	37.4 (30.5)	37.6 (29.5)	77.1 (45.7)	77.0 (45.5)
Occupation dummies	9 of 10	9 of 10	9 of 10	9 of 10	12 of 13	12 of 13
Geography dummies	22 of 23 states	22 of 23 states	22 of 23 states	22 of 23 states	76 of 77 cities	76 of 77 cities

Job offers

Version of individual fixed effects approach that makes progress on holding unobserved individual productivity fixed: Stern (2004)

- Will discuss this paper in detail in an upcoming lecture

How are urban attributes implicitly priced?

- Long literature: Intercity and regional wage differences among "similarly productive" workers (education, experience)
- Well-cited analytical treatment is Fuchs (1967) *Differentials in Hourly Earnings by Region and City Size, 1959*
  - Open-access: `http://www.nber.org/books/fuch67-1`

Fuchs (1967): Regional wage differences

TABLE 4

Ratio of Actual to "Expected" Hourly Earnings, by Region, 1959

	South	Non-South	North-east	North Central	West
			(Ratio)		
White males	.90	1.03	1.02	1.03	1.05
White females	.89	1.04	1.07	1.00	1.07
Nonwhite males	.80	1.16	1.09	1.20	1.21
Nonwhite females	.79	1.21	1.30	1.16	1.19
Total	.89	1.04	1.04	1.03	1.06
		(Index of Ratio, South = 100)			
White males	100	114	113	114	117
White females	100	117	120	112	120
Nonwhite males	100	145	136	150	151
Nonwhite females	100	153	165	147	151
Total	100	117	117	116	119

Source: Tables 2 and 3.

Regional wage differences: surprising?

- Why is this surprising?
  - Surely amenities differ across areas
  - Expect utilities (not earnings) to be equalized across areas
  - My sense is that this was not what people were thinking at the time: regional wage differences seen as a "puzzle"
- (Side note: may feel this way in 10 years about health literature)

Fuchs (1967): City size wage differences

TABLE 8

Ratio of Actual to "Expected" Hourly Earnings, by City Size, 1959

		Urban Places		Standard Metropolitan Statistical Areas			
	Rural	Under 10,000	10,000-99,999	Under 250,000	250,000-499,999	500,000-999,999	1,000,000 and More
South	.76	.76	.83	.89	.94	.96	1.06
Non-South	.88	.88	.94	1.00	.99	1.05	1.13
Northeast	.91	.92	.95	.96	.96	.99	1.10
North Central	.85	.85	.93	1.03	1.03	1.11	1.16
West	.91	.89	.95	1.01	1.00	1.05	1.14

Pre-Roback view

- Prior to Roback's analysis, investigations of regional and city-size wage differentials focused solely on consumer side without thinking about firm behavior
- In contrast, Roback's contribution was to conceptualize the equilibrium decisions of both firms and workers
- Motivating example: if workers require compensating wage to live in a polluted city, firms in that city must have a productivity advantage that allows them to pay higher wages
- Applies Rosen's key insight: implicit prices represent both marginal valuation to consumers and marginal cost to firms

Roback's contribution

1. Spatial equilibrium: both land and labor markets must clear
2. Decomposition of implicit prices of attributes into wage gradients vs. rent gradients
   - Spatial equilibrium: wages must be lower or costs of living must be higher in more amenable locations
   - Without a model, not clear whether utility equalization across locations should show up as wage differences, or as differences in site-specific costs of land or housing, or both
   - Roback model is designed to guide thinking on this question: GE model incorporating both mobile factors (labor, capital) and site-specific factors (land)

Rosen vs. Roback

In Roback, both land and labor markets must clear

- Rosen: if firms and workers are homogeneous, one wage-amenity bundle is offered in equilibrium
- Roback: people cannot all occupy the same space; scarcity of land gives rise to an additional constraint

Model set-up

- s: vector of amenities (climate, pollution, crime)
  - Differ across cities, constant (and fixed) within cities
  - Indexed such that higher s is preferred by workers
- Each city has a wage w and price of land r
- Workers are identical and firms are identical
- Workers and firms are mobile, but must live/work in same city
  - Assumes no cost of moving capital or labor
  - Land is fixed (can be relaxed to a rising supply price of land due to *e.g.* within-city transportation costs)

Worker decision problem

- Leisure is ignored
- Workers supply a single unit of labor (independent of w)
- Conditional on location (given s), workers maximize: $\max_{x,l^c} U(x, l^c; s)$ subject to $w + I = x + l^c r$
    - x: composite commodity
    - l^c: residential land
    - I: non-labor income
- Re-write as indirect utility function $V(w, r; s) = k$
    - k: constant
    - Intuition: wages and rents must adjust to equalize utility in all locations - otherwise individuals have an incentive to move
- Higher s preferred by workers: $\frac{\partial V}{\partial s} > 0$

Firm decision problem

- CRS production function: $x = f(l^p, N; s)$
  - l^p: land used in production
  - N: total number of workers in the city
  - Note: assumes production requires physical space (could look at firms where workers work remotely/offsite)
- Firms minimize costs subject to the production function
- Firms sell x on world market at a fixed price, normalized to 1
- Unit costs at each location must equal the price: $C(w, r; s) = 1 = p$
  - Cost function is increasing in both factor prices
  - For unproductive amenities: $C_s > 0$ (note: typo in paper)

Amenities

- Example of an unproductive amenity: clean air (preferred by workers, costly to firms)
- Example of a productive amenity: severe snow storms (costly to both workers and firms)

Severe snow storms

"...blizzards may be as costly to the firm in inconvenience and lost production as they are unpleasant to consumers"

(definitely true based on my former life as a North Dakotan, and winter 2015 in Boston)

Equilibrium

The indirect utility function and unit cost condition generate equilibrium wages $w(s)$ and rents $r(s)$ for a given level of k, where k is determined by aggregate labor demand and supply.

Roback illustrates the equilibrium in Figure 1.

Equilibrium: Graph

- s: unproductive amenity (for $s_2 > s_1$, factor prices must adjust to equalize utility across locations)
- Firm cost curves: downward-sloping curves; equalize unit costs at a given s
- Worker indirect utility curves: upward-sloping curves; equalize indirect utility at a given s

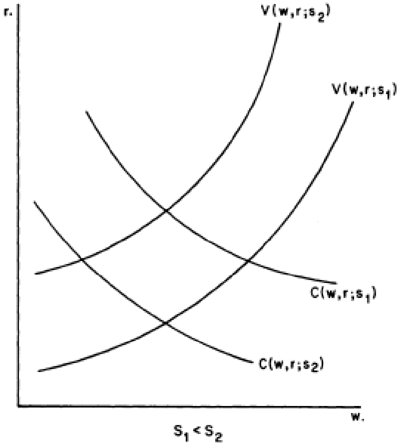

FIG. 1

Equilibrium

Derive expressions for $\frac{dw}{ds}$ and $\frac{dr}{ds}$

- Totally differentiate indirect utility function and cost function
- Combining these equations, can sign $\frac{dw}{ds}$ and $\frac{dr}{ds}$

Summary: in locations with higher levels of unproductive amenities, wages should be lower, but the change in rents is uncertain

- s is unproductive: firms prefer low s, workers prefer high s
- Low wages discourage workers and attract firms
- High rents discourage both firms and workers from locating:
  - Worker equilibrium: high $s \Rightarrow$ high rents (discourage moving)
  - Firm equilibrium: high $s \Rightarrow$ low rents (induce firm location)
- Factor prices equalize to strike a balance between the conflicting locational preferences of firms and workers

If s were productive instead of unproductive, rents would rise whereas the change in wages would be ambiguous.

Data

- 1973 May CPS data for the 98 largest US cities
  - Sample: men over the age of 18 who reported earnings
- *FHA Homes* data for residential site prices
  - Average site prices per square foot
  - Only available for 83 of 98 cities
  - Over-samples lower income households (FHA-eligible)

Table 1: log(earnings) on city attributes

- No guidance on choice of covariates
- Little guidance on productive vs. unproductive

TABLE 1

COEFFICIENTS OF CITY CHARACTERISTICS FROM LOG EARNINGS REGRESSIONS IN 98 CITIES

	1	2	3	4
TCRIME 73	$.94 \times 10^{-5}$ (2.58)	$.44 \times 10^{-5}$ (1.17)	$.74 \times 10^{-5}$ (1.93)	$.86 \times 10^{-5}$ (2.21)
UR 73	$.36 \times 10^{-2}$ (1.29)	$.12 \times 10^{-2}$ (.43)	$.32 \times 10^{-2}$ (1.14)	$.27 \times 10^{-2}$ (.97)
PART 73	$.24 \times 10^{-3}$ (1.55)	$.13 \times 10^{-3}$ (.86)	$.37 \times 10^{-3}$ (2.33)	$.34 \times 10^{-3}$ (2.15)
POP 73	$.16 \times 10^{-7}$ (7.97)	$.15 \times 10^{-7}$ (7.74)	$.16 \times 10^{-7}$ (8.04)	$.16 \times 10^{-7}$ (8.11)
DENSSMSA	$.81 \times 10^{-6}$ (.29)	$.24 \times 10^{-5}$ (.86)	$.20 \times 10^{-5}$ (.73)	$.38 \times 10^{-5}$ (1.40)
GROW 6070	$.21 \times 10^{-2}$ (7.84)	$.14 \times 10^{-2}$ (5.66)	$.15 \times 10^{-2}$ (6.06)	$.17 \times 10^{-2}$ (6.47)
HDD	$.20 \times 10^{-4}$ (8.48)			
TOTSNOW		$.72 \times 10^{-3}$ (3.54)		
CLEAR			$-.64 \times 10^{-2}$ (-4.80)	
CLOUDY				$.72 \times 10^{-2}$ (5.21)
R^2	.4980	.4955	.4960	.4962
F-ratio	424.2	420.0	420.8	421.1
N = 12,001				

NOTE.—Regressions include all personal characteristics. Sample includes 98 cities; t-statistics are in parentheses (see App. for variable definitions).

Table 2: city attributes and regional earnings differences

- Regional wage differences "go away" once condition on city X's
- Exception: West

TABLE 2

COEFFICIENTS OF REGION DUMMIES AND CITY CHARACTERISTICS

NORTHEAST	−.0218	−.0095
	(−2.25)	(−.74)
SOUTH	−.0669	−.0138
	(−6.51)	(−.87)
WEST	−.0354	−.0579
	(−3.46)	(−3.41)
TCRIME 73		$.13 \times 10^{-4}$
		(2.82)
UR 73		$.92 \times 10^{-2}$
		(2.60)
PART 73		$.29 \times 10^{-3}$
		(1.87)
POP 73		$.16 \times 10^{-7}$
		(7.77)
DENSSMSA		$-.13 \times 10^{-5}$
		(−.42)
GROW 6070		$.23 \times 10^{-2}$
		(8.41)
HDD		$.16 \times 10^{-4}$
		(4.86)
R^2	.4900	.4986
F-ratio	479.4	384.0

NOTE.—Regressions include all personal characteristics. Sample includes all 98 cities; t-statistics are in parentheses.

Table 3: log(price per sq foot) on city attributes

- Again, no guidance on choice of covariates
- Little guidance on productive vs. unproductive

TABLE 3

REGRESSIONS OF THE LOG OF AVERAGE RESIDENTIAL SITE PRICE PER SQUARE FOOT ON CITY CHARACTERISTICS

	1	2	3	4
TCRIME 73	2.5×10^{-5} (.65)	1.5×10^{-5} (.38)	-4.5×10^{-7} (−.01)	7.0×10^{-6} (.16)
UR 73	8.9×10^{-2} (3.45)	8.8×10^{-2} (3.35)	9.2×10^{-2} (3.53)	9.1×10^{-2} (3.52)
PART 73	2.2×10^{-4} (.15)	1.1×10^{-4} (.08)	-3.8×10^{-5} (−.02)	1.4×10^{-4} (.09)
POP 73	6.8×10^{-8} (1.80)	6.9×10^{-8} (1.78)	6.8×10^{-8} (1.76)	6.8×10^{-8} (1.76)
DENSSMSA	1.9×10^{-4} (3.02)	2.0×10^{-4} (3.12)	2.0×10^{-4} (3.17)	2.0×10^{-4} (3.18)
GROW 6070	1.1×10^{-2} (4.34)	1.0×10^{-2} (4.11)	9.9×10^{-3} (4.03)	1.0×10^{-2} (4.00)
HDD	3.5×10^{-5} (1.44)			
TOTSNOW		1.3×10^{-3} (.69)		
CLEAR			1.2×10^{-4} (.09)	
CLOUDY				3.2×10^{-4} (.21)
INTERCEPT	−1.73 (−5.92)	−1.54 (−5.99)	−1.44 (−6.51)	−1.53 (−3.32)
R^2	.5741	.5650	.5623	.5625
F-ratio	14.44	13.92	13.77	13.78

SOURCE.—Data are from U.S. Department of Housing and Urban Development 1973. $N = 83$.

Table 4: implied implicit prices at average earnings

- Combines coefficients from Tables 1 and 3 + budget share of land to compute implicit price for each attribute in percentage terms
- Average person willing to pay \$69.55 per year for add'l clear day

TABLE 4

IMPLICIT PRICES OF AMENITIES COMPUTED FROM TABLES 1 AND 3

	1	2	3	4
TCRIME 73 (crimes/100 population)	\$−9.25	\$ .90	\$ −8.05	\$ −9.15
UR 73 (fraction unemployed)	−5.55	20.65	−.70	5.00
PART 73 (micrograms/cubic meter)	−2.50	−1.40	−4.00	−3.70
POP 73 (10,000 persons)	−1.50	−1.40	−1.50	−1.50
DENSSMSA (100 persons/square mile)	6.30	4.90	5.35	3.35
GROW 6070 (percentage change in population)	−1.85	−11.95	−13.05	−15.2
HDD (1° F colder for one day	−.20			
TOTSNOW (inches)		−7.30		
CLEAR (days)			69.55	
CLOUDY (days)				−78.25

NOTE.—Measurement units of amenities shown under variable name. Each entry is computed using eq. (5) in the text and evaluated at mean annual earnings. $p_i^* = [k_i(d \log r/ds) - (d \log w/ds)]w$. Average annual earnings = \$10,868. Average budget share of land = .035. Negative numbers indicate disamenities, while positive numbers indicate amenities.

Take-aways

- *Extremely* influential framework: should be in your toolkit
- Empirics not the main focus of the paper
- Basis of lots of recent interesting research in urban economics on city size wage differentials, quality of life measures...

Looking ahead

- Wednesday: Applying the Roy model and equalizing wage differentials to female labor supply
- Next Monday: Applying the Roy model and equalizing wage differentials to the scientific workforce

Thanks for your comments on the assigned reading (Goldin-Katz forthcoming JOLE); no new reading assignment

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