

Wage and Housing Cost Gradients across the Urban Hierarchy

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Motivation & Literature

- Factor price gradients relative to the CBD (Lucas and Rossi-Hansberg, 2002)
 - Mono-centric model
- City Size and wages (Glaeser and Maré, 2001)
 - Usually assumes agglomeration economies end at city border and does not extend further in space.
 - Rosenthal and Strange (2004) note agglomeration economies can attenuate over longer distances and is understudied.
- New Economic Geography (NEG), role of market potential (Head and Mayer, 2004, 2006)
 - Smooth effect of market potential

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Roback 1982—joint hhld firm decisions re wages and rent

Motivation--continued

- Urban Hierarchy (Eaton and Eckstein, 1997)
 - Polycentric model over a large geographical space
- Joint household-firm decisions and urban system are often ignored in (NEG) empirical work (Roback, 1982; Gabriel and Rosenthal, 2004).

New Economic Geography

- Non-pecuniary effects cause agglomeration economies—through input-output links and greater product mkt variety.
 - Better access to customers and/or suppliers underlies agglomeration economies.
- NEG usually empirically tested through ‘market potential’ (Head and Mayer, 2004; 2006).
- Factor returns should be higher when there is more access to market potential.
 - Consequently, because market potential is continuous, then factor prices should be affected continuously across space (Brülhart and Koenig, 2006).

Urban Hierarchy

- Multiple tiers of the urban hierarchy (CPT)
 - Christaller (1933); Partridge et al. (2007; forthcoming)
- Each tier offers different levels of services from basic (gas station) to highest order (patent attorney)
 - Incremental costs to successively reach each tier
 - Because each tier has different industry compositions, there are different marginal costs to reach each tier: farming vs. services.
 - One implication is that there are agglomeration effects over the 360° spectrum from potentially multiple sources
 - Discontinuous effects on factor prices because small geographic changes alter proximity to different size tiers.

Explain hierarchy

NEG vs. Urban Hierarchy

- NEG considers population within a given distance, but does not consider whether it is concentrated in cities
 - Urban Hierarchy approach.
 - Does it matter whether pop spread across ten 100,000 cities or concentrated in one 1million population city?
 - NEG typically says no, urban hierarchy approach says yes.

Theoretical Model

Roback (1982) model (Gabriel and Rosenthal, 2004)

2. Firms $\Pi^k(w^k, r^k, s^k, d^k) = \Pi^u$,

$\Pi^k_w < 0$; $\Pi^k_r < 0$; $\Pi^k_s > 0$; $\Pi^k_d \leq 0$

W=wages, r=rents, s=site attributes, d=distance from agglomerations including market potential.

Indirect profits equalized across space

3. Households $V^k(w^k, r^k, s^k, d^k) = V^u$,

$V^k_w > 0$; $V^k_r < 0$; $V^k_s > 0$; and $V^k_d \leq 0$.

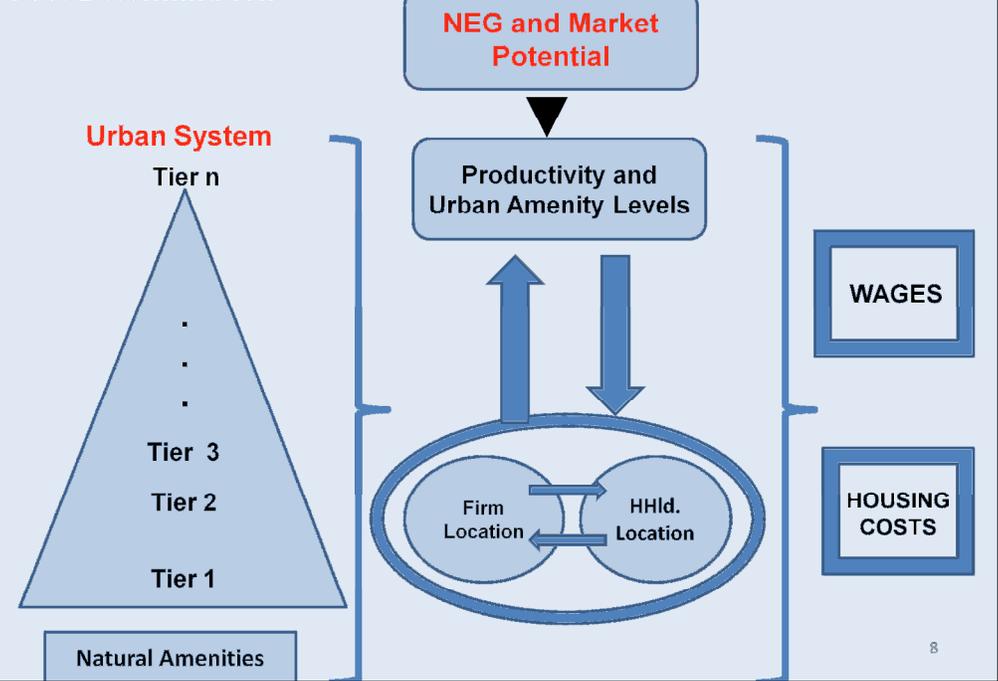
Indirect utility equalized across space

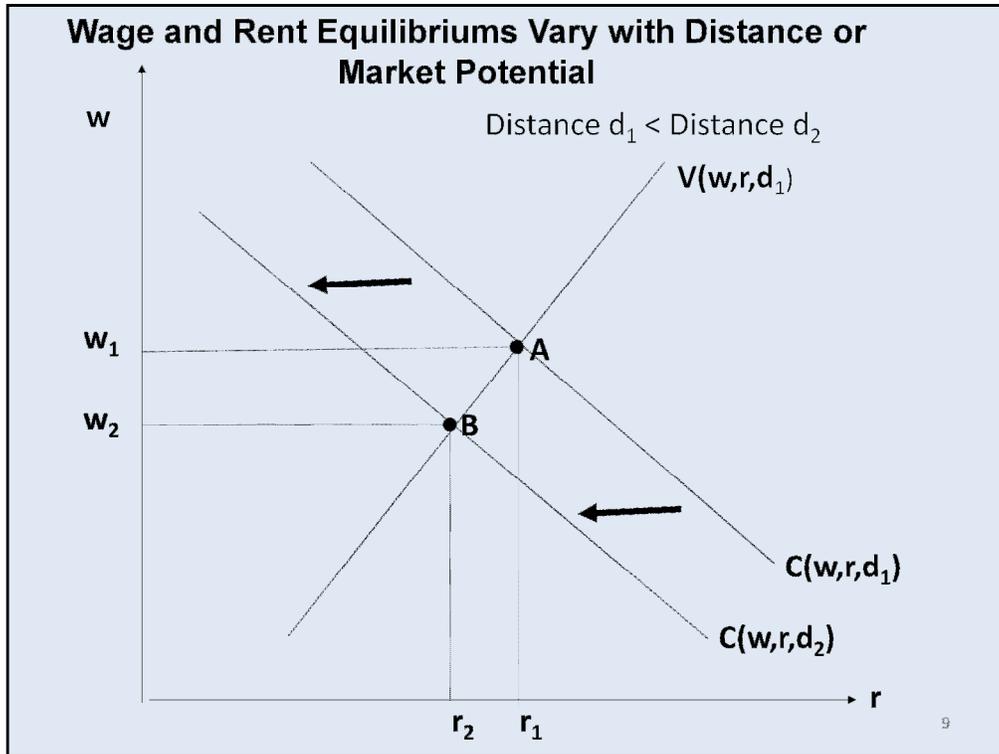
Reduced form model that solves for W and R.

Equilibrium wages and rent will vary by d and Market Potential

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Market Potential and Urban Hierarchy Context for Wage and Housing Cost Determination





What happens to the Iso-costs if another otherwise equal town is a greater distance d away.

Empirical Model

$$EARN_{ist} = \alpha^W + \varphi^W GEOG_{ist-l} + \gamma^W AMENITY_{is} + \sigma_s^W + \varepsilon_{ist}^W$$

$$HCOST_{ist} = \alpha^H + \varphi^H GEOG_{ist-l} + \gamma^H AMENITY_{is} + \sigma_s^H + \varepsilon_{ist}^H$$

N=3,029 counties

Four samples:

Rural; Nonmetro; Metro <250k; Metro >250k—differ transport technologies and industry structures.

Hierarchy:

Micro; any metro; metro >250k; >500k; >1.5m

Amenities: 4 climate; 1 to 24 topography scale; % water area; 3 vars proximity to Ocean/Lakes

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State fixed effects, error term

Key Variables in **GEOG**

- Market Potential (Hanson, 2005)
 - Personal Income within concentric rings
 - Market Potential 100-200km; 200-300km, 300-400km, 400-500km
 - Do not have to worry about specific distance weight (i.e., $1/d^2$ or $1/d^3$, etc)
 - Do not include market potential <100km because it is potentially endogenous—analysis suggests this doesn't affect our results.

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Urban Distance Variables

- Consider multiple agglomeration sources:
 - Nearest/own urban Area
 - Rural counties: distance in kms to nearest urban area defined as at least micropolitan area, pop>10,000
 - Micro/MA counties: distance in kms to center of urban core if multi-county, 0 for single-county urban area;
 - Population-weighted centroids
 - Incrementally proximate higher-tiered areas
 - the incremental distances to reach nearest MA, MA> 250k, MA> 500k, and MA> 1.5m. pop. (for all counties)
 - **We considered a 'highest' tier of NY, LA, & Chicago.**
 - **Could be zero if nearest urban area already that size.**
 - Population of county/urban area, but not statistically important.

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Estimation

- Staged model estimation—limit possibility of multicollinearity and endogeneity effects
 - Distance variables only
 - Distance plus market effects
 - Long lags and predetermined variables.
 - Large-scale sensitivity analysis.
- County residual assumed to be correlated with neighboring counties—GMM to produce robust t-statistics to spatial autocorrelation

Measuring Distance Effects

1. Urban Hierarchy Distance Effects:

$$Penalty_{ij} = \sum_t d_t \phi_t$$

Where:

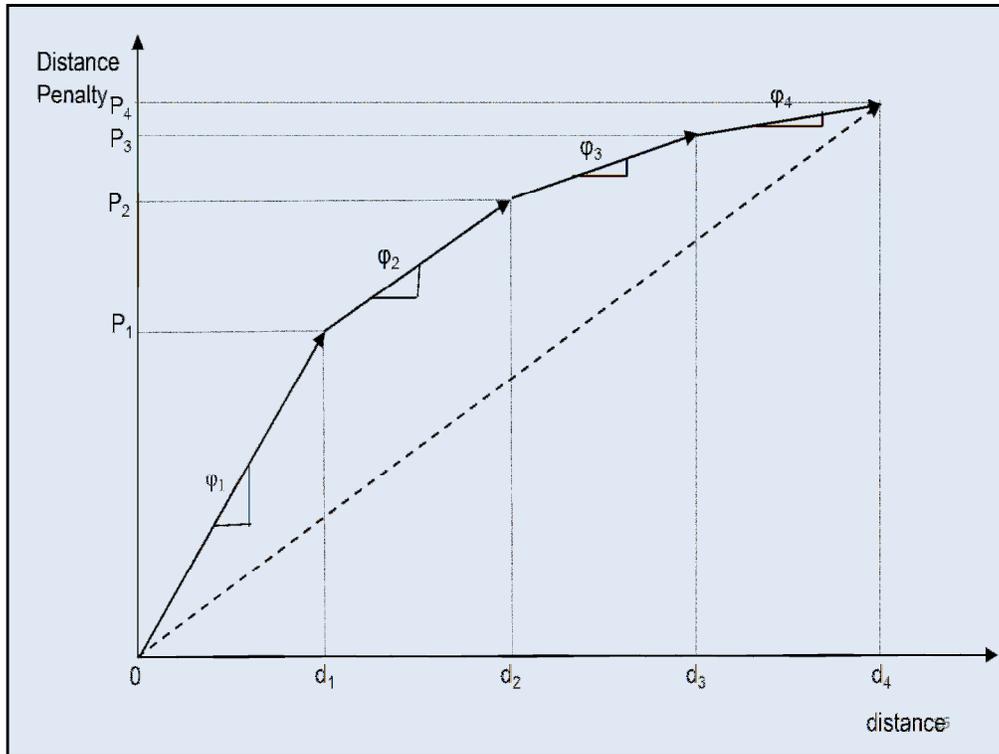
d is the incremental distance to each higher tier,
 ϕ marginal effect on earnings or housing costs by tier

Summation equals the total distance effects over all tiers of the urban hierarchy

Penalty reflects the total disadvantage a resident/business in area i (in tier j) faces to access progressively higher-order goods/services and urban amenities up the hierarchy.

Market Potential effects are derived through a corresponding summing of market potential β x MKT Pot.

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We consider other non-linearities such as quadratic and cubic models.

Results

- Only non-metro and small MA<250K are presented
- Distance-only variables: Strong Distance penalty effects for earnings and housing costs.
 - Housing response is larger
- Adding Market Potential effects: Distance variables remain highly significant and about same size.
- Market Potential has a much smaller effect.
 - **Correlation between MP and Distance is low \approx .25**
- Urban Hierarchy has much larger effect than NEG
 - Location wrt to cities matters, not just people/suppliers

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Selected Results Dependent variable: log(median earnings 1999\$)

Variables	Base = Distance + Market Potential			
	Non-metro	(t-stat)	Small MA < 250k	(t-stat)
Dist to nearest/own urban center	-6.8E-04***	(-5.46)	4.3E-04	(1.22)
Inc dist to a MA	-2.1E-04*	(-1.94)	N	N
Inc dist to MA > 250k	-1.8E-04***	(-2.85)	-4.8E-04***	(-3.77)
Inc dist to MA > 500k	-6.1E-05	(-0.87)	-3.8E-04***	(-3.46)
Inc dist to MA > 1500k	-2.1E-05	(-0.43)	-3.8E-04***	(-3.91)
Market pot. 100-200 km 1989	4.6E-07***	(4.59)	6.9E-08	(0.41)
Market pot. 200-300 km 1989	7.2E-09	(0.12)	1.3E-07	(0.97)
Market pot. 300-400 km 1989	1.6E-07**	(2.20)	-4.6E-08	(-0.24)
Market pot. 400-500 km 1989	1.1E-07	(1.26)	-4.9E-08	(-0.35)
County population 1990	7.2E-07***	(3.69)	1.2E-07	(1.39)
Pop of nearest urban center 1990	7.2E-08*	(1.76)	7.0E-08	(0.38)
County area (sq miles)	-7.3E-06**	(-2.16)	-1.4E-05*	(-1.80)
Amenities/Ocean	Y		Y	
Adj. R ²	0.37		0.30	
Sample size	1972		416	
F-stats All distance vars = 0	10.68***		8.04***	
Incremental dist = 0	4.67***		7.52***	
Market potentials = 0	7.78***		0.28	18

Selected Results Dependent variable: log(weighted average median house rent 2000 \$/month)

Variables	Base = Distance + Market Potential			
	Non-metro		Small MA <250k	
Dist to nearest/own urban center	-2.2E-03***	(-8.50)	-2.7E-03***	(-3.42)
Inc dist to a MA	-4.5E-04**	(-2.16)	N	N
Inc dist to MA>250k	-5.5E-04***	(-4.15)	-1.1E-03***	(-5.16)
Inc dist to MA>500k	-4.0E-04***	(-3.00)	-5.3E-04***	(-2.46)
Inc dist to MA>1500k	-1.2E-04	(-1.35)	-5.2E-04***	(-3.27)
Market pot. 100-200 km 1989	6.8E-07***	(3.68)	-1.9E-08	(-0.08)
Market pot. 200-300 km 1989	2.1E-07	(1.42)	5.5E-08	(0.18)
Market pot.300-400 km 1989	3.7E-07***	(2.55)	5.8E-08	(0.19)
Market pot. 400-500 km 1989	-1.6E-08	(-0.11)	-2.8E-07	(-1.07)
County population 990	2.8E-06***	(6.03)	7.6E-07***	(3.20)
Pop of nearest urban center 1990	2.0E-07**	(2.23)	-1.6E-07	(-0.84)
County area (sq miles)	-3.4E-06	(-0.53)	-4.7E-06	(-0.44)
Amenities/Ocean	Y		Y	
Adj. R ²	0.64		0.61	
Sample size	1,972		416	
F-stats All distance vars = 0	36.67***		10.26***	
Incremental dist = 0	12.67***		12.09***	
Market potentials = 0	8.36***		0.56***	19

Distance Penalties (%), Median Earnings (mean)*

Updated in latest version Models	Non-metro	Small MA<250k
(1) Dist	-7.58	-8.85
(2) Base=(1)+mktpot.	-5.04	-8.51
(3) Base – pop	-5.96	-8.80
(4) Base + sq distance	-9.52	-15.20
(5) Full90 = (2) + 1990 vars	-7.43	-6.22
(6) Full90 – market potential	-7.73	-6.31
(7) Full90 – distance	n.a.	n.a.
(8) Full00 = (2) + 2000 vars	-6.94	-4.77
(9) Full00 – market potential	-7.17	-5.09
(10) Full00 – distance	n.a.	n.a.
(11) Base + inc MA pop	-4.58	-8.63
(12) Base 1980 X variables	-5.07	-8.44
Only based on coefs sign. at 10% level*		

Evaluated at the mean distance

Median Earnings models description:

(1) Dist: includes 5 distance variables, plus 1990 county pop, 1990 pop in the nearest urban center, January sun hours, January temp, July humidity, July temp, typography score, % water area, proximity to Great Lakes, Pacific Ocean, and Atlantic Ocean, county area and state fixed effects.

(2) Base: (1) + 4 market potential variables defined as 1989 aggregate household income within 100-200 km, 200-300 km, 300-400 km, and 400-500 km rings from the county centroid.

(3) = (2) – two pop variables: own county population and total population in the nearest or own urban area.

(4) = (2) + 5 quadratic distance terms. Because of the nonlinearity, the impact of a one standard deviation change is evaluated as the change after a one-standard deviation *increase* in distances evaluated at the mean distances.

(5) Full90: (2) plus 5 ethnicity vars, 6 age-distribution vars, 4 education vars, % female, % married, and % with a work disability, all measured in 1990

(6) = (5) – market potential variables defined in (2); (7) = (5) – 5 distance variables; (8) Full00: (2) plus same set of additional variables in (5) measured in 2000

(9) = (8) – market potential variables defined in (2); (10) = (8) – 5 distance variables

(11) = (2) + 4 incremental MA pop 1990: inc pop of the nearest MA, inc pop of MA>250,000, inc pop of MA>500,000, and inc pop of MA>1.5 mill. See footnote 20.

(12) = similar to (2) but pop variables are measured in 1980 and 1989 agg hh inc variables are replaced with 1979 BEA personal incomes within corresponding rings.

Housing Cost models: Same set of variables as above except Full90 and Full00, which are explained below:

Full90: (2) plus age of housing units, shares of 1-5 bedrooms out of total rooms, share of mobile units, share of complete plumbing and share of complete kitchen facilities, all measured in 1990.

Full00: (2) plus median number of rooms, age of housing units, shares of 1-5 bedrooms out of total rooms, share of mobile units, share of complete plumbing and share of complete kitchen facilities, all measured in 2000.

Market Potential (%), Median Earnings (mean)*		
Models	Non-metro	Small MA<250k
(1) Dist	na	na
(2) Base=(1)+mktpot.	3.24	0.00
(3) Base – pop	3.43	0.00
(4) Base + sq distance	3.21	0.00
(5) Full90 = (2) + 1990 vars	0.59	0.00
(6) Full90 – market potential	n.a.	n.a.
(7) Full90 – distance	3.19	1.27
(8) Full00 = (2) + 2000 vars	0.87	-1.76
(9) Full00 – market potential	n.a.	n.a.
(10) Full00 – distance	3.26	-0.09
(11) Base + inc MA pop	2.89	0.00
(12) Base 1980 X variables	3.64	1.92
Only based on coefs sign. at 10% level*		

Evaluated at the mean distance

Median Earnings models description:

(1) Dist: includes 5 distance variables, plus 1990 county pop, 1990 pop in the nearest urban center, January sun hours, January temp, July humidity, July temp, typography score, % water area, proximity to Great Lakes, Pacific Ocean, and Atlantic Ocean, county area and state fixed effects.

(2) Base: (1) + 4 market potential variables defined as 1989 aggregate household income within 100-200 km, 200-300 km, 300-400 km, and 400-500 km rings from the county centroid.

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Distance Penalties (%), Housing Costs*

Models	Non-metro	Small MA<250k
(1) Dist	-19.81	-14.41
(2) Base = (1)+mkt pot.	-15.53	-14.65
(3) Base – pop	-5.96	-16.58
(4) Base + sq distance	-27.58	-24.73
(5) Full90 = (2) + 1990 vars	-14.03	-12.00
(6) Full90 – market potential	-18.01	-11.47
(7) Full90 – distance	n.a.	n.a.
(8) Full00 = (2) + 2000 vars	-8.27	-6.36
(9) Full00 – market potential	-11.59	-5.87
(10) Full00 – distance	n.a.	n.a.
(11) Base + inc MA pop	-14.67	-11.86
(12) Base 1980 X variables	-16.38	-15.46
Only based on coefs sign at 10% level*		

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Median Earnings models description:

(1) Dist: includes 5 distance variables, plus 1990 county pop, 1990 pop in the nearest urban center, January sun hours, January temp, July humidity, July temp, typography score, % water area, proximity to Great Lakes, Pacific Ocean, and Atlantic Ocean, county area and state fixed effects.

(2) Base: (1) + 4 market potential variables defined as 1989 aggregate household income within 100-200 km, 200-300 km, 300-400 km, and 400-500 km rings from the county centroid.

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Full00: (2) plus median number of rooms, age of housing units, shares of 1-5 bedrooms out of total rooms, share of mobile units, share of complete plumbing and share of complete kitchen facilities, all measured in 2000.

Market Potential (%), Housing Costs*

Models	Non-metro	Small MA<250k
(1) Dist	na	na
(2) Base = (1)+mkt pot.	6.03	0.0
(3) Base – pop	3.43	0.00
(4) Base + sq distance	6.44	0.00
(5) Full90 = (2) + 1990 vars	7.43	0.00
(6) Full90 – market potential	n.a.	n.a.
(7) Full90 – distance	14.78	0.00
(8) Full00 = (2) + 2000 vars	4.47	-2.60
(9) Full00 – market potential	n.a.	n.a.
(10) Full00 – distance	9.64	0.00
(11) Base + inc MA pop	5.59	0.00
(12) Base 1980 X variables	8.50	0.00
Only based on coefs sign at 10% level*		

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Median Earnings models description:

(1) Dist: includes 5 distance variables, plus 1990 county pop, 1990 pop in the nearest urban center, January sun hours, January temp, July humidity, July temp, typography score, % water area, proximity to Great Lakes, Pacific Ocean, and Atlantic Ocean, county area and state fixed effects.

(2) Base: (1) + 4 market potential variables defined as 1989 aggregate household income within 100-200 km, 200-300 km, 300-400 km, and 400-500 km rings from the county centroid.

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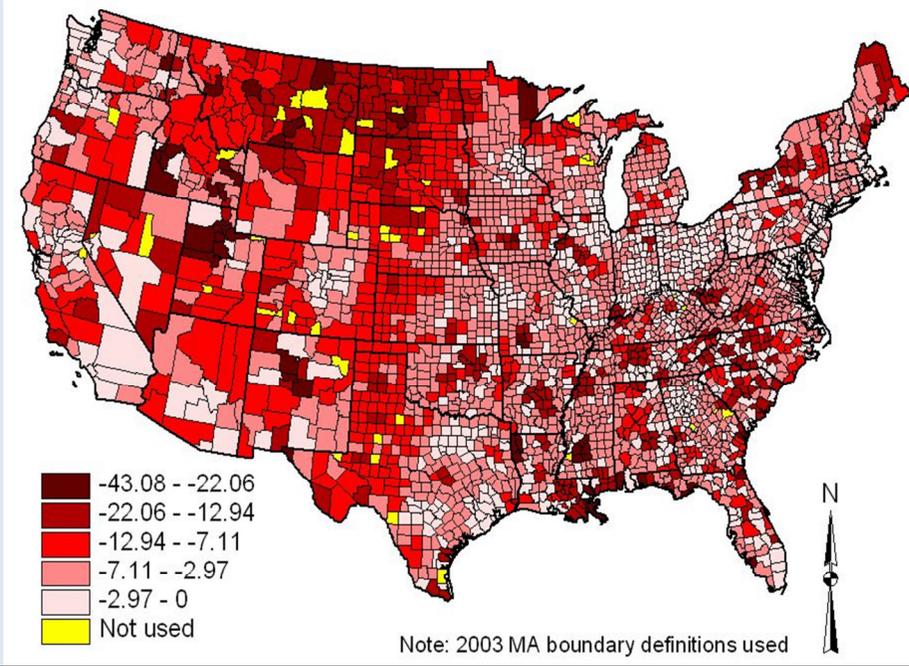
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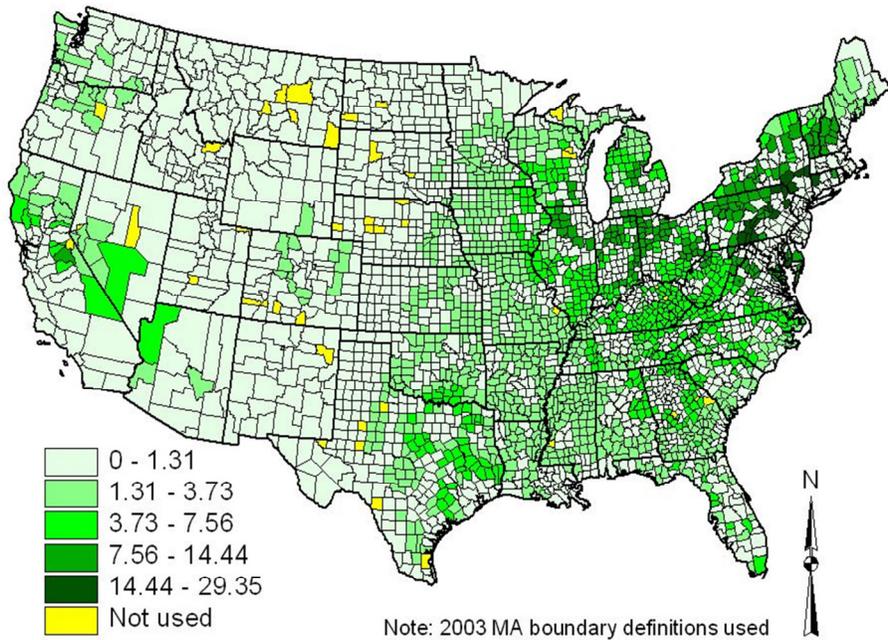
Full00: (2) plus median number of rooms, age of housing units, shares of 1-5 bedrooms out of total rooms, share of mobile units, share of complete plumbing and share of complete kitchen facilities, all measured in 2000.

Figure 3: Distance Penalties (%) for Median Earnings 1999



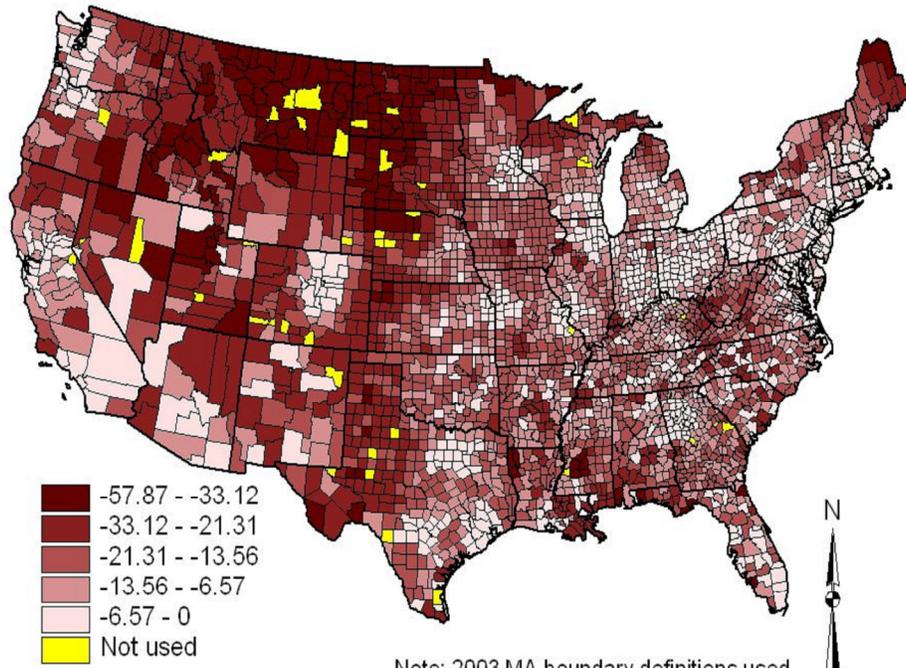
Distance penalty strongest in West

Figure 5: Market Potential (%) for Median Earnings 1999



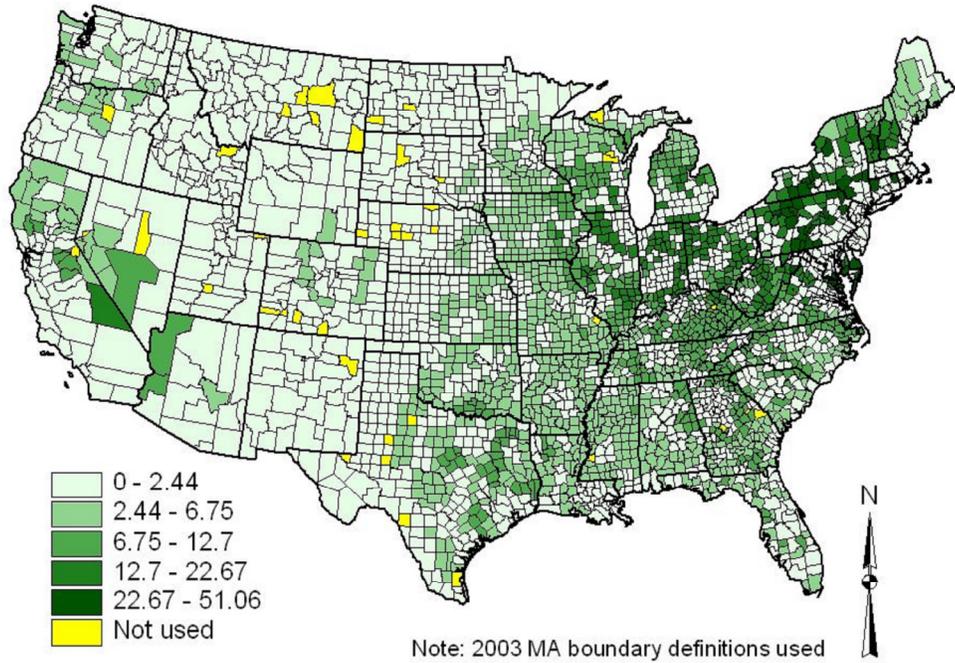
Market Potential strongest in Northeast through Chicago

Figure 4: Distance Penalties (%) for Housing Costs 2000



Distance penalty strongest in West

Figure 6: Market Potential (%) for Housing Costs 2000



Market Potential strongest in East

Summary

- Proximity to urban centers plays an important role in explaining wage and housing cost gradients over space
 - There is an incremental penalty for remoteness from successively higher level centers, multiple agglomeration sources, throughout the 360° spectrum.
 - Urban system has richer effects than typically imagined
- Market Potential and NEG smaller effect
- Maps indicate that NEG best works in densely populated regions such as Northeastern U.S.
- Urban system works best in lightly populated Western U.S. with clearly defined urban hierarchy.

Thank-you!

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