Quick Review

- Construction of HPIs (Average/Median, Average/Median with subsamples, and Hedonic)
- Discussions on the evaluations of housing market conditions based on different HPI being used



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Spatial Equilibrium Across Cities: The Rosen-Roback model

RE420: URBAN AND REGIONAL ECONOMICS



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Introduction

- In the basic monocentric city model, everyone earned the same income in the same city and housing price differences served to compensate for location disadvantages (commuting cost)
- But actually, consumers can move to another city that gives higher income
- Moreover, firms can also relocate to another city that offers maximum profit





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Rosen-Roback model studies movement across circles. ٠

Introduction

- Why it is important to consider migrations to other cities
- A classic question in urban economics
 - How do households (firms) choose one city over the other?
 - 1. Why some people decide to live in a city with higher housing cost?







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Introduction

- Why it is important to consider migrations to other cities
- A classic question in urban economics
 - How do households (firms) choose one city over the other?
 - 1. Why some people decide to live in a city with higher housing cost?
 - 2. Why some people decide to live in a city with lower wage?



Median Household Income by County (2021)





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Introduction

- Why it is important to consider migrations to other cities
- A classic question in urban economics
 - How do households (firms) choose one city over the other?
 - 1. Why some people decide to live in a city with higher housing cost?
 - 2. Why some people decide to live in a city with lower wage?
- An answer: "In the world with **spatial equilibrium**, *housing costs* and *wages* can vary to compensate consumers for intercity differences in *amenity*, or *quality of life*"



Spatial Equilibrium Revisited

- Assumption:
 - Free to move: workers can freely migrate across cities
 - Optimal location choice: all workers migrate to their most preferred locations
- Equilibrium Dynamics
 - If City A offers lower housing costs, higher wages, and better amenity (quality of life) compared to City B, residents of City B will move to City A
 - As migration from City B to City A increases, the dynamics adjust:
 - Housing costs in City A will rise due to increased demand
 - Wages in City A may decrease as the labor supply increases
 - Migration from City B to City A will cease when the advantages of City A (higher amenities) are balanced by its disadvantages (higher housing costs and lower wages)
- In a spatial equilibrium, households are indifferent across space

Spatial Equilibrium Revisited

- Assumption:
 - Free to move: firms can freely relocate across cities
 - Optimal location choice: firms relocate to their most preferred locations
- Equilibrium Dynamics
 - If City A offers lower housing (land) costs, lower wages, and better amenity (i.e., productivity) compared to City B, firms of City B will move to City A
 - As relocation of firms from City B to City A increases, the dynamics adjust:
 - Housing (land) costs in City A will rise due to increased demand
 - Wages in City A *may* increase as the labor demand increases
 - Firm relocation from City B to City A will cease when the benefits of City A (higher amenities) are balanced by its disadvantages (higher housing costs and higher wages)
- In a spatial equilibrium, firms are indifferent across space



The Rosen-Roback Model of Urban Housing Markets

- Jennifer Roback (1982). "Wages, Rents, and the Quality of Life," *Journal of Political Economy*, 90(2) 1257-1278.
 - The Rosen-Roback model assumes that firms and households move across cities to maximize profit (for firms) and utility (for households).
 - In equilibrium, neither profits nor utility levels will vary across urban areas.
 - Thus, if a city has amenities that make it a good place to live, it will attract households until some combination of higher house prices and lower wages eliminates the incentive to move there.
 - Similarly, a good business environment will lead to a combination of higher land rents and increased wages for firms.



Basic assumptions

- 1. There is no cost of moving to another city
- 2. Intercity commuting is prohibited: a person living in one city cannot work in another
- 3. Intracity commuting costs are ignored in what follows to focus attention on the across-city allocation of workers and firms
- 4. Housing or real estate supply is fixed within cities



Amenities

- In the Monocentric City Model, consumer utility depended on their disposable income (y) and housing cost (p)
- In Rosen-Roback Model, consumer utility is also derived from city amenities, which vary across different cities
 - E.g. pleasant climate, nature, clean air, low crime
- Each city's amenity level can be summarized with a single **quality**of-life index value, *a*.



Amenities

Rank	City ^	Quality of Life Index	Purchasing Power Index	Safety Index	Health Care ^ Index	Cost of Living ^ Index	Property Price to Income A Ratio	Traffic Commute Time ^ Index	Pollution Index	Climate Index
1	Raleigh, NC, United States	207.78	144.12	65.53	75.64	68.20	3.05	32.79	21.88	83.88
2	Columbus, OH, United States	201.40	151.29	56.58	73.95	69.70	4.00	24.94	25.96	71.29
3	Madison, WI, United States	199.18	132.13	66.00	77.78	67.32	3.52	24.18	18.98	51.64
4	Austin, TX, United States	198.91	158.21	62.94	71.04	66.50	3.53	34.21	36.50	82.08
5	Charlotte, NC, United States	197.34	144.88	54.70	74.63	70.06	2.51	34.73	28.44	84.05
6	Oklahoma City, OK, United States	196.15	127.95	50.69	75.78	64.94	2.88	25.00	22.02	77.61
7	Richmond, VA, United States	193.09	130.94	53.50	73.86	67.75	4.15	21.96	31.14	81.27
8	Dallas, TX, United States	192.67	170.66	49.71	66.20	67.85	2.12	35.16	41.61	81.85
9	Buffalo, NY, United States	191.01	124.36	55.50	76.92	74.29	1.52	23.80	27.82	66.43
10	Seattle, WA, United States	189.58	145.39	49.54	74.01	88.52	4.52	41.85	28.84	91.73



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Consumer Utility

- The utility level of consumers will depend on income y, housing prices p, and city amenity level a.
- This can be summarized using a utility function V(y, p, a):
 - $-V\uparrow as v\uparrow$
 - $-V \downarrow as p \uparrow$
 - $-V\uparrow as a\uparrow$

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Household indifference curves with different amenity levels



- An indifference curve illustrates the various combinations of *p* and *y* that provide the same level of utility for a given level of amenity, *a*₀:
 - $V(y, p, a_0) = \bar{u}$
- Why upward sloping?
 - Consider point **A**, (y', p', a_0) .
 - If income increases from y' to y", utility will rise because utility increases with y.
 - To keep utility constant, an increase in housing price is necessary, as utility decreases with p.
 - Consequently, point *B*, which offers the same utility as *A*, will be located in the northeast direction of *A*.

Household indifference curves with different amenity levels



- The indifference curve with higher amenity a_1 lie above the curve with lower amenity a_0
- Why?
 - Suppose that amenity increases from a_0 to a_1
 - This change would raise utility: $V(y', p', a_0) < V(y, 'p', a_1)$
 - To keep utility at the same level (*ū*),
 an increase in housing price, a drop in wage, or both is necessary

Firm Profit

- Firms incur costs from labor (wage y) and from real estate (price p)
- Firm cost may also depend on the amenity level *a*
 - Better road network, for instance, may allow firms to produce the same amount of output at a lower cost
- The production cost of firms can be expressed by the unit cost function C(y, p, a):
 - $C \uparrow as y \uparrow$
 - *C* ↑ as p ↑
 - C ↓ as a ↑

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Firm iso-profit curves with different amenity levels



- The iso-profit curve $C(y, p, a_0)$ shows the different combinations of p and y that incur the same unit production cost, 1, for a given level of amenity, a_0
- Why downward sloping?
 - Consider point C, (y', p', a_0) .
 - If wage increases from y' to y", the cost of firms will rise.
 - To keep the unit production cost constant, a decrease in housing price is necessary.
 - Consequently, point *D*, which incurs the same production cost as *C*, will be located in the southeast direction.



Firm iso-profit curves with different amenity levels

Graph of $C(y, p, a_1) = 1$ when costs р are decreasing (increasing) in amenities p $C(y, p, a_0) = 1$ Π v''

- If amenity is productive, the iso-profit curve with higher amenity a_1 lie above the curve with lower amenity a_0
- Why?
 - Suppose that amenity increases from a_0 to a_1
 - This change would reduce the production cost: $C(y', p', a_0) > C(y', p', a_1)$
 - To keep cost at the same level, an increase in housing price, an increase in wage, or both is necessary



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- Let's compare two cities: City 0 vs. City 1
- In City 0 with lower amenity, housing price and the income level are given by the intersection point of the *a*₀ indifference curve and the *a*₀ isoprofit curve: (*y*₀, *p*₀)
- In City 1 with higher amenity, housing price and the income level are given by the intersection point of the *a*₁ indifference curve and the *a*₁ isoprofit curve: (*y*₁, *p*₁)
 - The a_1 indifference curve lies above the the a_0 indifference curve;
 - The *a*₁ iso-profit curve lies above the the *a*₀ iso-profit curve





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- The figure predicts that house prices will be higher in city 1 with higher amenity
- How about the prediction for wage?



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- The figure predicts that house prices will be higher in city 1 with higher amenity
- How about the prediction for wage?
- What happens to wages is ambiguous: they can go either way.
- Why?



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- The figure predicts that house prices will be higher in city 1 with higher amenity
- How about the prediction for wage?
- What happens to wages is ambiguous: they can go either way.
- Why?
- The direction of wage depends on the magnitude of indifference curve shift relative to the shift of iso-profit curve.



Extension: Equilibrium with Unproductive Amenities



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- Firm cost may increase with the amenity level of a city
 - Pleasant weather may make workers too relaxed, so the firms produce the same amount of output at a higher cost
 - In this case, the a_1 iso-profit curve lies below the the a_0 iso-profit curve
- As a result, household wage will decrease
- However, the impact on housing price is ambiguous; they could either increase or decrease, depending on the relative magnitude of the responses

Practice Question

The City of Gotham was once known for its high crime rate. However, with the recent intervention of Batman, the crime rate has decreased dramatically. It is well understood that people prefer living in areas with low crime rates. A lower crime rate is also known to lead to higher productivity of firms.

Q1. Using the Rosen-Roback model framework, draw the firm's isoprofit curve and the household's indifference curve before and after Batman.

Q2. How does the Rosen-Roback model predict the direction of changes in house prices and wages?



Practice Question

Q1. Using the Rosen-Roback model framework, draw the firm's isoprofit curve and the household's indifference curve before and after Batman.





Practice Question

Q2. How does the Rosen-Roback model predict the direction of changes in house prices and wages?

House prices will certainly increase. However, the direction of wage change is ambiguous; it depends on the relative magnitude of the shift in the household indifference curve compared to the shift in the firm iso-profit curve.



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Further Applications of Rosen-Roback Model



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Best Places to Live for Quality of Life in the U.S. US News & World Report (2024-2025)

View All 43 Photos	Ann Arbor, MI #1 in Best Places to Live for Quality of Life Ann Arbor is a city of contrasts. It is at once rural and urban, sporty and smart, outdoorsy and high-tech Read More »	Overall Score 6.6 Quality Of Life 7.7 Value 5.8	View All 22 Photos	Honolulu, HI #4 in Best Places to Live for Quality of Life Honolulu continues to entice visitors to make their vacation a permanent one. Honolulu is regularly identified as one of Read More »	Overall Score 6.5 Quality Of Life 7.4 Value 4.4
View All 53 Photos	Boulder, CO #2 in Best Places to Live for Quality of Life Snug against the foothills where the Great Plains give rise to the Rocky Mountains, Boulder is nothing if not a looker Read More »	Overall Score 6.7 Quality Of Life 7.4 Value 5.5	View All 13 Photos	Raleigh, NC #5 in Best Places to Live for Quality of Life Raleigh, along with neighboring Durham and Chapel Hill, is known for research/technology roots and collegiate rivalries Read More »	Overall Score 6.8 Quality Of Life 7.2 Value 6.9



1.11	Boise, ID #3 in Best Places to Live for Quality of Life	Overall Score 7.0
N. Y	Boise is a recreationalist's paradise. If you value the outdoors and time spent among rivers, mountains, canyons Read More »	Quality Of Life 7.4
A LOW TO A L		Value 7.6

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Madison, WI	Overall Score
= #6 in Best Places to Live for Quality of Life	6.7
Against a backdrop of high-tech businesses and acclaimed academic	Quality Of Life
institutions, Madison, Wisconsin, exudes the casual Read More »	7.2
	Value 6.5



Top 10 Ranked Cities in Northern America by the Quality-of-Life Index 2022 (NUMBEO)

Rank	City ^	Quality of Life Index	Purchasing Power Index	Safety Index	Health Care A Index	Cost of Living ^ Index	Property Price to Income Ratio	Traffic Commute Time ^ Index	Pollution Index	Climate Index
1	Raleigh, NC, United States	207.78	144.12	65.53	75.64	68.20	3.05	32.79	21.88	83.88
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10	Seattle, WA, United States	189.58	145.39	49.54	74.01	88.52	4.52	41.85	28.84	91.73



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Bottom 15 Ranked Cities in Northern America by the Quality-of-Life Index 2022 (NUMBEO)

Rank	City ^	Quality of	Purchasing	Safety	Health Care	Cost of Living	Property Price to Income	Traffic Commute Time A	Pollution	Climate
		Life index	Power Index	Index	Index	Index	Ratio	Index	Index	Index
1	Detroit, MI, United States	132.98	110.05	25.19	62.39	70.68	1.39	45.09	59.40	66.03
2	New York, NY, United States	137.97	100.00	52.93	62.38	100.00	9.94	42.77	58.02	79.66
3	Hamilton, Canada	141.68	86.35	45.84	80.64	66.95	8.67	33.03	54.77	61.06
4	Los Angeles, CA, United States	142.04	126.12	50.25	61.43	79.19	6.43	61.07	67.59	95.50
5	Winnipeg, Canada	146.93	101.59	42.18	69.16	70.33	3.54	31.46	36.57	24.67
6	Regina, Canada	150.35	104.02	46.67	66.91	69.44	4.00	17.20	39.86	14.28
7	Philadelphia, PA, United States	151.12	115.61	37.62	69.38	79.19	3.96	40.26	53.49	77.98
8	Miami, FL, United States	154.14	93.71	47.19	63.54	78.00	5.32	43.02	39.43	85.69
9	Chicago, IL, United States	154.23	135.26	34.05	65.41	77.06	3.60	41.91	49.26	66.11
10	Las Vegas, NV, United States	154.66	124.83	44.88	56.10	68.34	3.47	27.39	52.93	57.40
11	Kelowna, Canada	156.24	77.45	41.74	74.93	69.73	6.29	28.93	26.59	59.65
12	Toronto, Canada	156.34	101.29	58.86	75.94	74.29	10.58	45.10	37.81	65.35
13	San Francisco, CA, United States	156.93	133.16	41.41	64.56	93.91	7.12	51.23	49.74	97.26
14	Montreal, Canada	157.00	89.93	69.64	64.19	70.60	7.93	39.48	33.29	52.37
15	Phoenix, AZ, United States	158.95	135.94	48.27	67.15	69.37	3.77	32.62	55.98	53.76



1. Measuring Implied Amenity Value

- Unlike house prices or wage, measuring amenity value (quality-of-life) of a location is not obvious
- The existing quality-of-life index, such as NUMBEO, utilizes survey information of safety, pollution, commuting time, and health care system



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1. Measuring Implied Amenity Value

- An alternative approach is to measure the implied amenity value from the observed housing and income information
 - Suppose City A has higher rent cost and lower wage than City B. Then, why would people live in city A? Because city A provides better quality-of-life!
- E.g., Madison, WI vs. Minneapolis, MN

	Madison, WI		Minneapolis, MN
2022 Home Value (Zillow)	\$368,791	>	\$365,323
2022 Per Capita Income (Census)	\$71,516	<	\$75,164

- Madisonians pay more for housing and earn less
- Why do they still live in Madison? Quality-of-life should be higher, compensating the two disadvantages



1. Measuring Implied Amenity Value

Oswald, A. J., Wu, S., 2010, "Objective Confirmation of Subjective Measures of Human Well-Being: Evidence from the U.S.A." *Science*

- Compares two different city-level quality-of-life measures
 - 1. Results from a survey question "How happy do you feel on a scale from 1 to 4?" (i.e., Behavioral Risk Factor Surveillance System by CDC)
 - 2. Implied quality-of-life from the Rosen-Roback spatial equilibrium model



The downward sloping trend line suggests a positive correlation b/w two measures.

2. Impact of Work-From-Home Economy

- Brueckner, J., Kahn, M., Lin, G. C., 2023, "A New Spatial Hedonic Equilibrium in the Emerging Work-from-Home Economy?", *AEJ: Applied Economics* 15(2), 285-319.
- The Rosen-Roback model assumes income levels vary based on the location in which individuals reside
 - High amenities often correspond to high rents, but result in lower wages
- What happens if a person's location no longer affects their income levels due to the rise of work-from-home (WFH) options?
- Findings of Brueckner, Kahn, and Lin (2023):
 - "WFH puts downward pressure on housing/rent prices in high-wage counties, as workers can relocate to more affordable areas with better amenities without sacrificing their jobs"



Key Takeaways

- Review the spatial equilibrium concept
- Understand the Rosen-Roback model and the model's implication on housing prices and wages caused by the location choice of firms and individuals
- Understand the economic intuitions of the (ambiguous) predictions for wages/rents in Rosen-Roback model
- Understand how the city-level implied quality-of-life can be measured by the Rosen-Roback model
- Understand how the prediction of the Rosen-Roback model changes after work-from-home options became available



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Key Takeaways

- Reading
 - Roback, J., 1982. "Wages, Rents, and the Quality of Life," *Journal of Political Economy* 90(2) 1257-1278.
 - Oswald, A. J., Wu, S., 2010, "Objective Confirmation of Subjective Measures of Human Well-Being: Evidence from the U.S.A." *Science* 327(5965), 576-579.
 - Brueckner, J., Kahn, M., Lin, G. C., 2023, "A New Spatial Hedonic Equilibrium in the Emerging Work-from-Home Economy?", *AEJ: Applied Economics* 15(2), 285-319.



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