Measuring the Returns to Highway Investments

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Overview of the Talk

• Discuss evidence on causal impacts of highways on the spatial structures of US cities 1960-2000

  • Population decentralization (by industry)
  • Job decentralization (by industry)

• Provide some interpretation of these estimated impacts

  • Decompose into various mechanisms for treatment effects of highways on urban population decentralization
  • Discuss components of welfare consequences

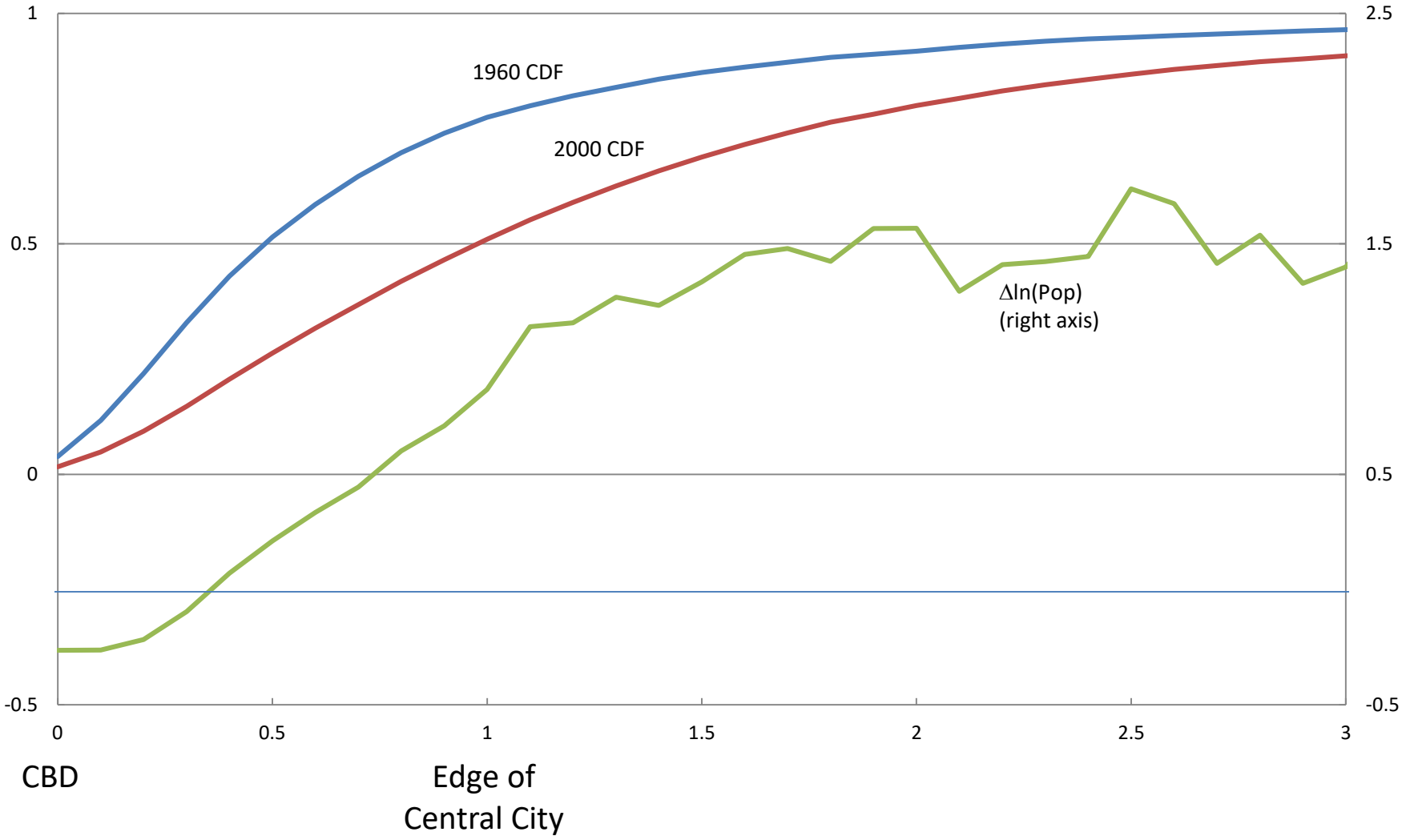
• Draw some general conclusions about the opportunities and challenges for cities associated with installing new highways

Based on the following paper:
"Urban Transport Expansions and Changes in the Spatial Structure of US Cities: Implications for Productivity and Welfare" (*Review of Economics and Statistics*)

Decentralization Patterns in Worker Residential Location

CDFs For 78 Large US Metro Areas (SMSAs), 1960 & 2000

CBD at Location 0, Edge of Primary Central City at Location 1



Changes in Commuting Patterns, Large U.S. Metro Areas

		Millions (Fraction of Total) 1960	2000	Change
Live in CC	Work in CC	16.5 (0.43)	12.0 (0.16)	-27% -0.27
Live in CC	Work in Ring	1.8 (0.05)	4.9 (0.07)	173% 0.02
Live in CC	Work Outside SMSA	0.4 (0.01)	0.9 (0.01)	125% 0.00
Live in Ring	Work in CC	5.9 (0.15)	10.5 (0.14)	79% -0.01
Live in Ring	Work in Ring	10.8 (0.28)	32.4 (0.43)	200% 0.15
Live in Ring	Work Outside SMSA	0.9 (0.02)	4.4 (0.06)	381% 0.04
Live Outside SMSA	Work in CC	1.0 (0.03)	3.0 (0.04)	206% 0.01
Live Outside SMSA	Work in Ring	0.9 (0.02)	6.5 (0.09)	633% 0.06
	Total	38.1	74.6	96%

millions
(share)

Empirical Model

- Goal is to estimate causal impacts of each highway on the allocation of industry-specific employment and working residents between central cities (CC) and suburbs, while holding the industry mix constant

- Estimate parameters ρ_{1k} and r_{1k} in the following regression equations:

$$\Delta \ln(emp_{ki}^{CC}) = \rho_{0k} + \rho_{1k}\Delta hwy_i + \rho_{2k}\Delta \ln(emp_{ki}^{SMSA}) + \sum_{j \neq k} \rho_{2k}^{\,j} \Delta \ln(emp_{ji}^{SMSA}) + X_i \Psi_k + \upsilon_{ik}$$

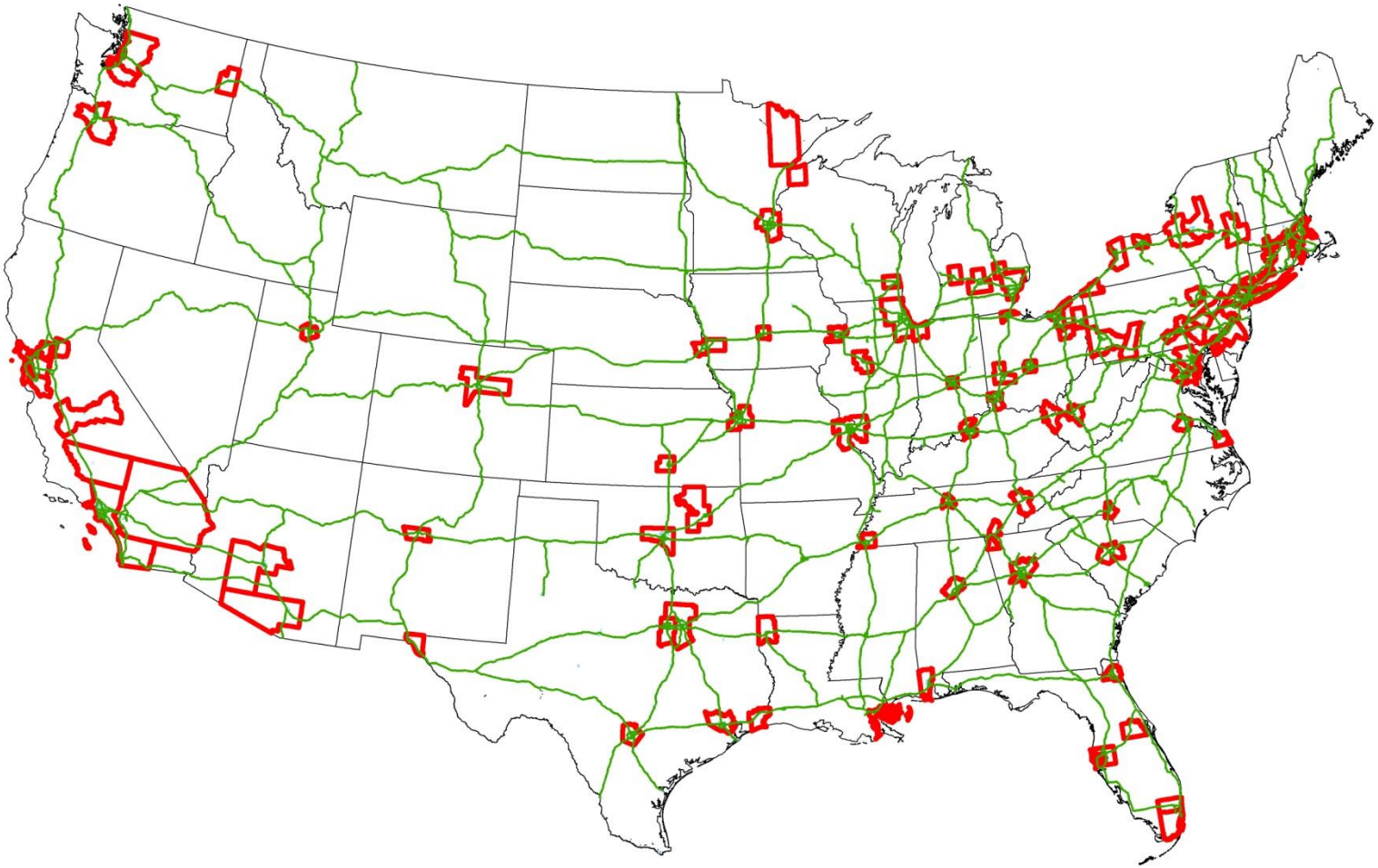
$$\Delta \ln(pop_{ki}^{CC}) = r_{0k} + r_{1k}\Delta hwy_i + r_{2k}\Delta \ln(pop_{ki}^{SMSA}) + \sum_{j \neq k} r_{2k}^{\,j} \Delta \ln(pop_{ji}^{SMSA}) + X_i R_k + \nu_{ik}$$

emp is # of jobs
pop is # of resident workers
in industry k and metro area i

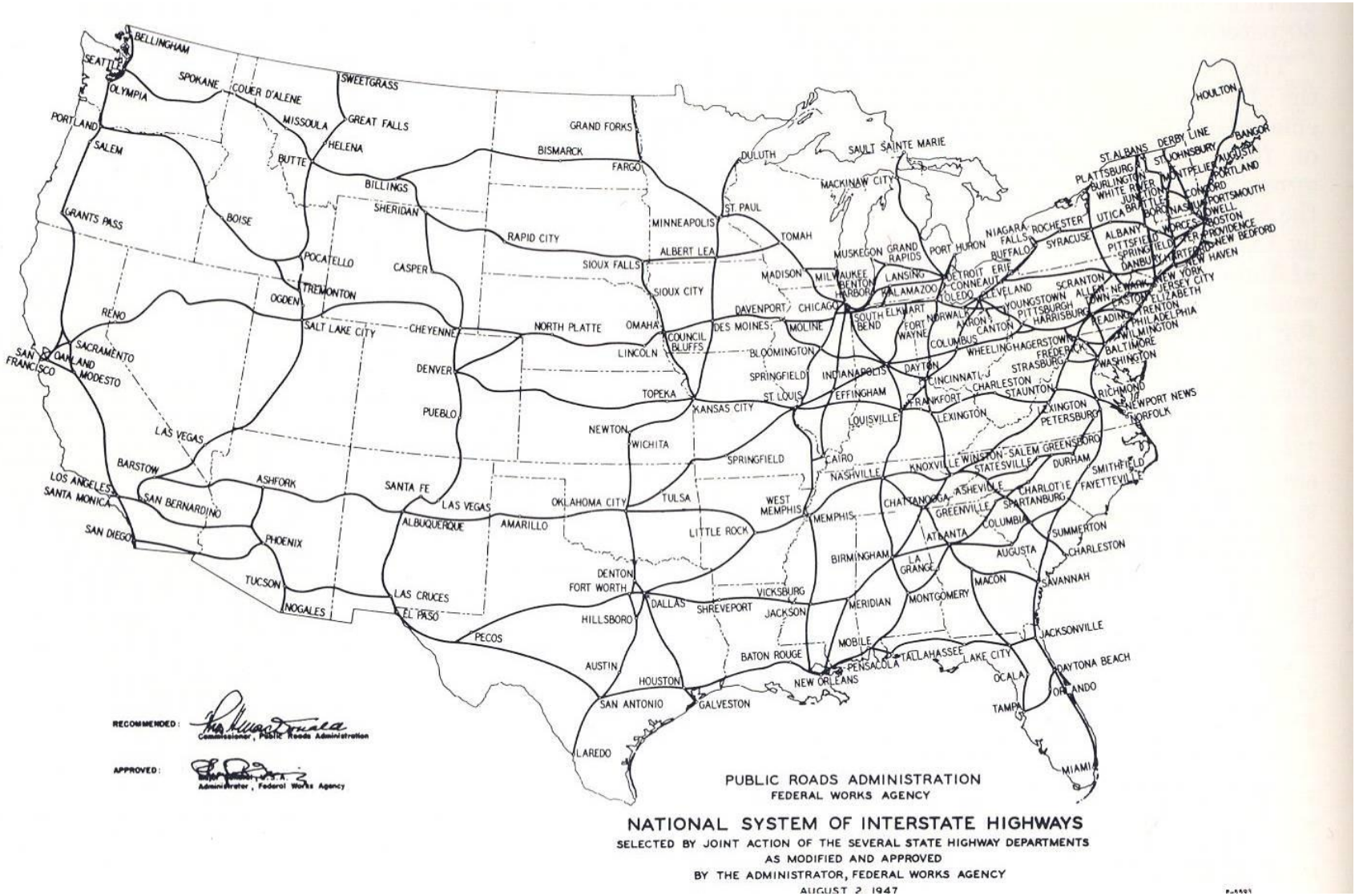
- Need to find some pseudo-randomization in highway construction for identification

  - Use planned radial highways from a 1947 map serving each metro area as an instrumental variable, which generates this pseudo-randomization

Metro Areas Used in the Analysis and the Interstate Highway System in 2000



The Projected System of Interstate Highways in 1947



Implied Effects of Each Radial Highway on Decentralization by Industry

	Employment	Working Residents	Difference
All	-0.06*	-0.16**	0.10**
	(0.04)	(0.07)	(0.04)
Manufacturing	-0.08	-0.15***	0.07
	(0.05)	(0.05)	(0.06)
Services	-0.07**	-0.15***	0.08**
	(0.03)	(0.05)	(0.03)
Retail and Wholesale Trade	-0.14**	-0.19***	0.05
	(0.05)	(0.05)	(0.04)
TCPU	-0.07*	-0.13***	0.06
	(0.04)	(0.05)	(0.05)
Construction	-0.08**	-0.21***	0.14***
	(0.04)	(0.06)	(0.05)
Public Administration	0.01	-0.13***	0.14**
	(0.03)	(0.05)	(0.06)
FIRE	-0.04	-0.12***	0.07
	(0.05)	(0.05)	(0.05)

Using The Estimated Treatment Effects

- Specify a simple model for quantification

- Focus mainly on the observation that each radial highway decentralized about 6% of employment and 16% of working residents from cities to suburbs

    - But recognize that smaller impacts reflect stronger agglomeration forces which incentivize firms to stay centralized

- The main idea is that because they reduce commuting costs, highways increase the amount of space available for urban uses in a metro area (within a given commute time from the center)

Outline of the Model

- Setting
    - "Closed city" with central city and suburban regions
    - Traded goods produced with land, labor and capital, subject to agglomeration economies and location-specific productivity
    - Housing produced with land, labor and capital
    - Consumers spend income net of commute cost on housing and consumption and care about local amenities
        - Commuting exists from the suburbs to the city and within each region
- Equilibrium
    - Land and labor market clearing in each region
    - Consumer and firm indifference across regions

Mechanisms through Which Highways Caused Urban Residential Decentralization (Total Impact: 16%)

- Holding firm locations constant

  - Commuting and housing costs fall, leading to greater real incomes, boosting housing demand (9%-17% of total) holding the land share in housing and goods production constant

  - The decline in the price of space leads to more intensive use of land in housing and goods production, crowding out residential density
    - Housing component (21%-43% of total)
    - Central city firms also demand more space, crowding out space used for residential housing (14%-27% of total)

  - Additional income effect from wage increases further boosts demand for housing but also increases cost of housing production (negligible % of total)

- Additional impacts of changes in firm relocation decisions to suburbs (negative 10%-15% of total)

Welfare Consequences

- Income net of commuting costs (probably positive)
    - Decline in the price of space lead to more space per worker (+)
    - More dispersed employment throughout the metro area (?)
    - Commute time (+)
    - Based on calibrations, these forces add up to 1.1 to 2.4 percent increase per additional highway of initial income net of commuting costs
- Housing cost impacts
    - Decline in the price of space (+)
    - Increase in wages in the construction sector (-)
    - Based on calibrations, results in declines of 0.6 to 1.3 percent of initial housing cost
- Capital losses in central city land value of 4.3 to 8.5 percent

Summary of Welfare

- Renter Welfare
    - Calibrations indicate 1.2% to 2.6% increase in real income per radial highway
- Homeowner Welfare
    - Calibrations indicate 1.0% to 2.2% increase in real income per radial highway (incorporating capital losses)
- Typical construction cost per mile is about $100 million or about $1 billion per radial highway in a medium sized city
    - The majority of radial highways that were built thus easily pass a cost-benefit test based on this analysis

Caveats to Welfare Analysis

- Trade (impacts on the consumption price index)
- Changes in local amenities
    - Neighborhoods near highways may experience reductions in their amenity values (Brinkman & Lin, 2019)
- Environmental costs
- Incidence
    - Wage impacts may be greater for higher income residents
    - Income segregation may increase

Conclusions

- Highways caused a movement of jobs, people and commutes from cities to suburbs
    - Estimated job decentralization in response to highways is smaller than estimated population decentralization responses in absolute and percentage terms
- Through the lens of a simple model, we can conclude from these estimated impacts that US urban highways promoted welfare gains that exceeded their construction costs
    - Most of these welfare gains came because the highways opened up additional space for urban uses

Thank You