Urban Growth and Transportation

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and

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Objective

- Assess the effects of transportation infrastructure, roads and public transit in particular, on the growth of cities.

Transportation is important #1

- Claims about the importance of of transportation to growth are common:

> The development and implementation of transportation infrastructure projects ... is essential to the well-being of the American people and a strong American economy.
>
> President G. Bush, September 18th, 2002

Transportation is important #2

- Transportation and transportation infrastructure consume a large share of a developed economy's resources:
  - In 2002 the US spent 135.9 billion dollars on federal highways (or 1.3% of GDP).
  - American households devote about 20% of their expenditures to road transport.
- Are these resources allocated wisely and well?

Transportation is important #3

- Transportation costs are among the most fundamental quantities in theoretical models of cities:
  - The Alonso-Muth-Mill monocentric framework (Brueckner, 1987; Fujita, 1989).
  - Multicentric extensions of AMM (Anas, Arnott, and Small, 1998).
- However, only a few papers provide empirical evidence for the role transportation costs in shaping cities, e.g., (Glaeser and Kahn, 2004; Baum-Snow, 2007).

Related literature

- Literature on urban growth:
  - A large literature investigates the role of agglomeration effects (Glaeser, Kallal, Scheinkman, and Schleifer, 1992; Henderson, Kuncoro, and Turner, 1995), human capital (Glaeser, Scheinkman, and Schleifer, 1995; Glaeser and Saiz, 2004), and climate (Glaeser, Kolko, and Saiz, 2001; Rappaport, 2007).
  - The role of transportation in growth is little studied.
- Literature on the determinants of country growth:
  - Very large cross-country literature following Barro (1991).
  - Cities are natural places in which to study economic growth (Lucas, 1988).

- Empirical literature on monocentric and multicentric model:
  - Much research examines land use and land prices within cities.
  - Few papers examine the relationship between transportation infrastructure/costs and population size (Brueckner, 1990; Baum-Snow and Kahn, 2000; Kopecky and Suen, 2006; Baum-Snow, 2007)
  - Fewer still examine the relationship between urban growth and transportation (Baum-Snow, 2007; Burchfield, Overman, Puga, and Turner, 2006)

- Literature on the effects of infrastructure investment:
  - Estimation of local production with public capital following Aschauer (1989) (see also Gramlich, 1994; Fernald, 1999; Haughwout, 2002).
  - Nascent literature modelling infrastructure supply (Haughwout and Inman, 2001; Cadot, Roller, and Stephan, 2006).

The road ahead

- Theory
- Estimation
- Data
- Main results for roads
- Results for transit

A simple static model of city population and transportation costs #1

- Consider a linear, open, monocentric city with absentee landowners and fixed lot sizes (normalized to unity)
- Homogenous workers receive a wage w at the CBD
- Net income of worker located in x:

$$w - 2\tau x - R(x)$$

- Agricultural rent normalized to zero and reservation wage for labour outside the city $\underline{w}$

A simple static model of city population and transportation costs #2

The city is in equilibrium when worker locations and land rents adjust so that workers are indifferent between any location in the city and $\underline{w}$:

$$w - 2\tau x - R(x) = \underline{w}.$$

$\Longrightarrow$ Land rent at the city fringe is zero, i.e., $R(N/2) = 0$.

$\Longrightarrow$ Population in equilibrium: $N = (w - \underline{w})\tau^{-1}$.

That is, lower commuting costs must lead to larger equilibrium city populations.

Changes in commuting costs are not reflected in wages but are reflected in population

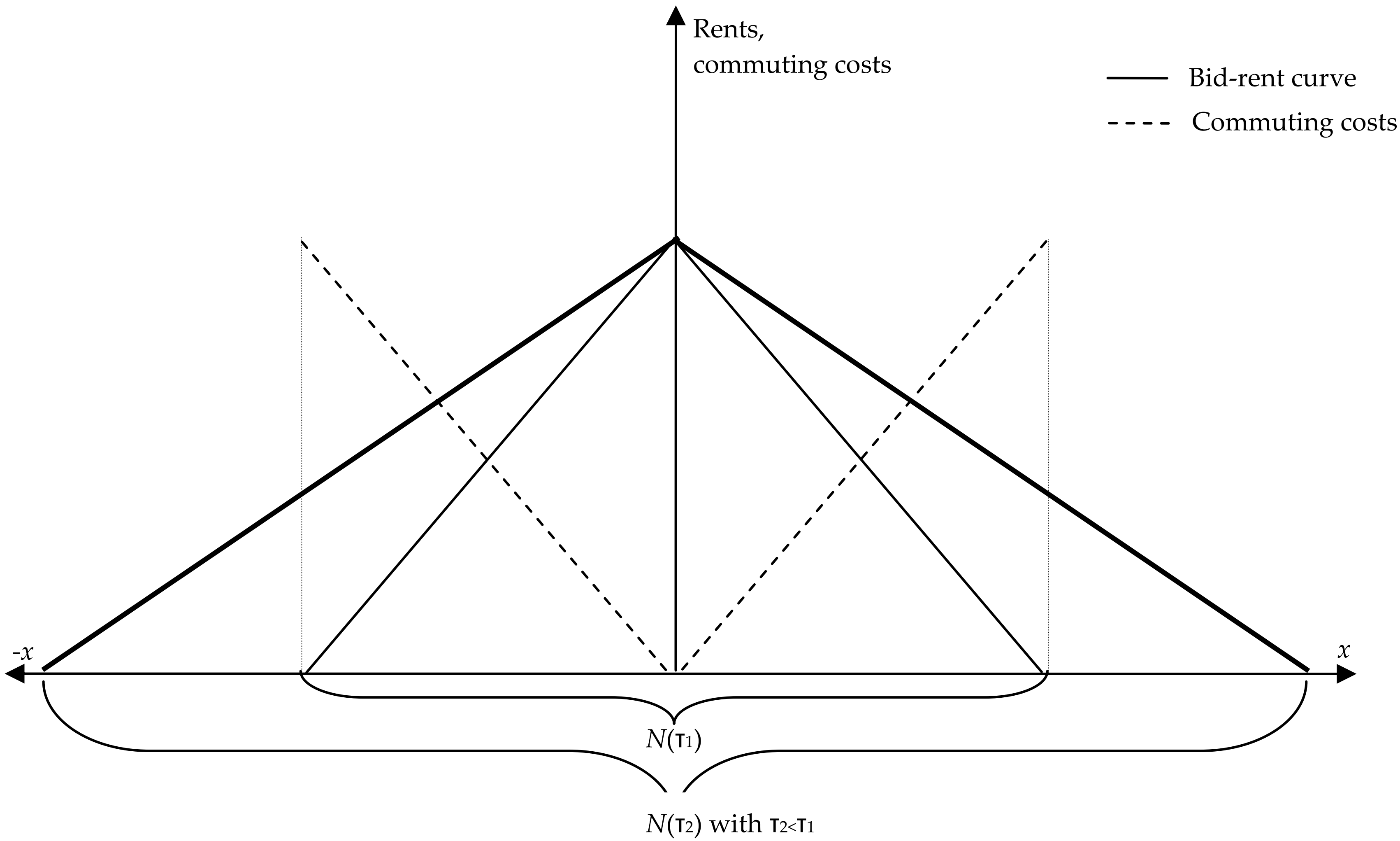


Figure 1. A monocentric city with linear commuting costs

A simple dynamic model of city population growth and transportation costs

- Given technological progress, population growth and shocks, cities will not attain a static equilibrium in a world where migration is not instantaneous.
- Instead, we expect the rate of migration to a city proportional to cross-city differences in disposable income. This leads us to predict slow convergence to a steady-state equilibrium.
- This is analogous to the approach of the empirical growth literature (Barro and Sala-i-Martin, 1992; Durlauf, Johnson, and Temple, 2005), and leads us to,

$$\Delta_{t+1,t} \ln(\text{Pop}) = A_0 + A_1 \ln(\tau) + A_2 \ln(\text{Pop}_t) + \epsilon$$

An experiment

- Consider two statistically identical cities (MSA's) in 1980 one with marginally more roads/commuter rail/bus infrastructure than the other.
- Observe growth in population and employment between 1980-2000.
- Attribute differences in growth to initial differences in transportation infrastructure.

Required data

Our unit of observation will be a 1999 MSA/CMSA. We use:

- Population data from the US census since 1920.
- Roads 1980 – 1980 USGS digital line graphs.
- Roads 1994-7 – US National transportation atlas.
- Count of light rail cars and buses — Section 15 data.

In addition to instruments described below, we also use:

- Employment data from the County Business Patterns (CBP).
- Physical geography: availability of ground water, topography, climate, census divisions.
- Per capita 1902 streetcar ridership.
- Share of democratic vote in 1972 presidential election.

Naive regression #1

$$\Delta_{00,80} \ln(\text{POP}) = A_0 + A_1 \ln(\text{Transport}_{80}) + A_2 X + \epsilon$$

where X and ϵ and are observed and unobserved city characteristics, and $\Delta_{00,80} \ln(\text{POP}) = ln(\text{POP}_{00}) - ln(\text{POP}_{80})$.

- Shouldn't it be transportation infrastructure per person that matters?
- What if transportation infrastructure is not assigned to cities at random?

Naive regression #2

Transportation infrastructure may be assigned to cities in response to past population shocks.

To formalize this, let

$$\begin{aligned} \Delta_{00,80} \ln(\text{POP}) &= A_0 + A_1 \ln(\text{Transport}_{80}) + A_2 X + \epsilon \\ \ln(\text{Transport}_{80}) &= B_0 + B_{80} \ln(\text{POP}_{80}) + B_{70} \ln(\text{POP}_{70}) + \\ &\quad \cdots + B_{20} \ln(\text{POP}_{20}) + \mu \end{aligned}$$

If $E(\mu\epsilon) = 0$ then including historical population as controls in an OLS regression of the first equation gives an unbiased estimate of A_1.

However transportation infrastructure may also be assigned to cities in anticipation of increased travel demand, or in response to contemporaneous employment shocks.

In which case Transport_{80} is endogenous, $E(\mu\epsilon) \neq 0$, and OLS is biased.

Naive regression #3

Consider an augmented naive regression

$$\Delta_{00,90} \ln(\text{POP}) = A_{90} + A_1 \ln(\text{Transport}_{90}) + A_2 X + \delta + \epsilon_{90}$$

where δ is a city fixed effect.
For the previous decade

$$\Delta_{90,80} \ln(\text{POP}) = A_{80} + A_1 \ln(\text{Transport}_{80}) + A_2 X + \delta + \epsilon_{80}$$

Differencing yields:

$$\Delta_{00,80} \ln(\text{POP}) = A_0 + A_1 \Delta_{90,80} \ln(\text{Transport}) + \epsilon$$

- Allows to control for permanent city characteristics that affect their growth.
- Makes measurement problems worse.
- Does not solve for endogeneity and harder to instrument.

Instrumental variables estimation

If we estimate

$$\begin{aligned}\ln(\text{Transport}_{80}) &= B_0 + B_{80}\ln(\text{POP}_{80}) + B_{70}\ln(\text{POP}_{70}) + \\ &\cdots + B_{20}\ln(\text{POP}_{20}) + B_1 X + B_2 Z + \mu \\ \Delta_{00,80}\ln(\text{POP}) &= A_0 + A_1 \ln(\widehat{\text{Transport}}_{80}) + A_2 X + \\ &A_{80}\ln(\text{POP}_{80}) + A_{70}\ln(\text{POP}_{70}) + \\ &\cdots + A_{20}\ln(\text{POP}_{20}) + \epsilon,\end{aligned}$$

then to get unbiased estimates when $E(\mu\epsilon) \neq 0$ we need Z to satisfy two conditions:

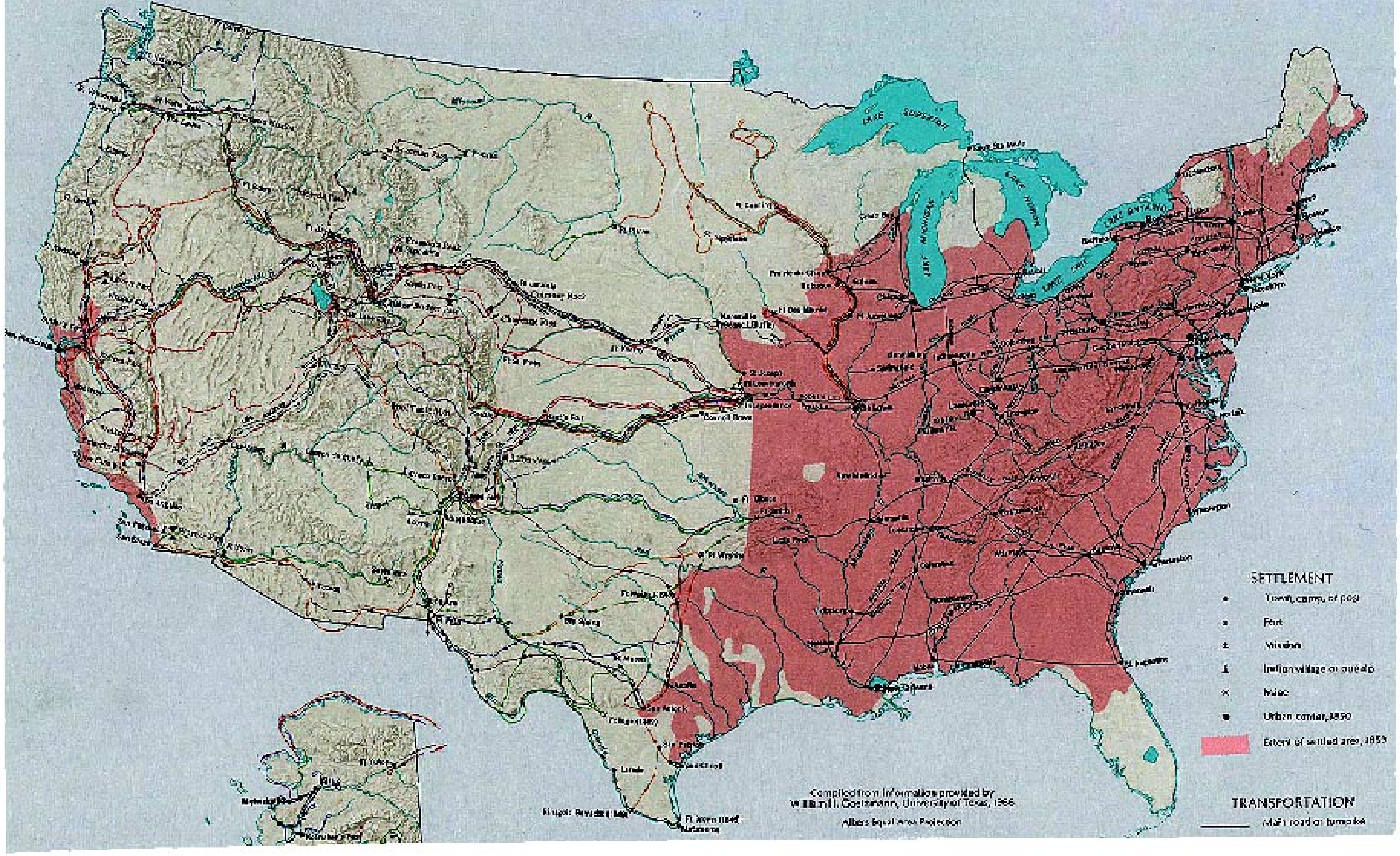
- Exogeneity: $E(Z\epsilon) = 0$.
- Relevance: $E(Z\text{Transport}_{80}|\cdot) \neq 0$.

The trick is finding Z.

Z^1 – 1835-1850 exploration routes and highways

Z^1 =*kilometers of exploration routes or main highways c.1850 contained within each 1999* MSA (Nat. Atlas of the US, Map of exploration and settlement between 1835 and 1850, USGS 1970)

- Relevance: Explorers were looking for good places to put transportation infrastructure.
- Exogeneity: (1) Explorers conducted reconnaissance and looked for routes to California and Oregon; (2) In 1850, 943,000 of 23 million were employed in manufacturing. *Explorers could not anticipate, and would not have cared about economic growth between 1980 and 2000.*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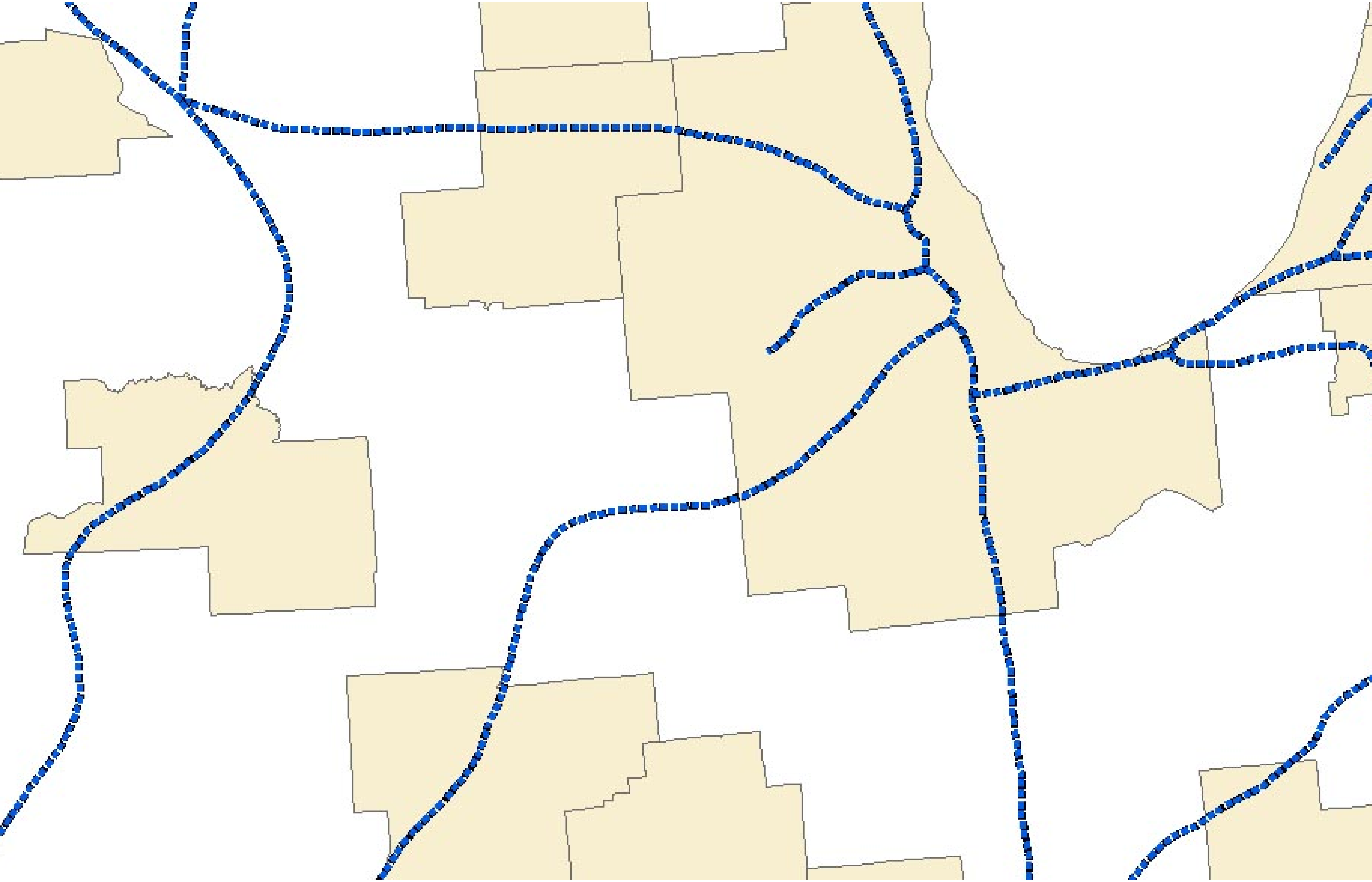
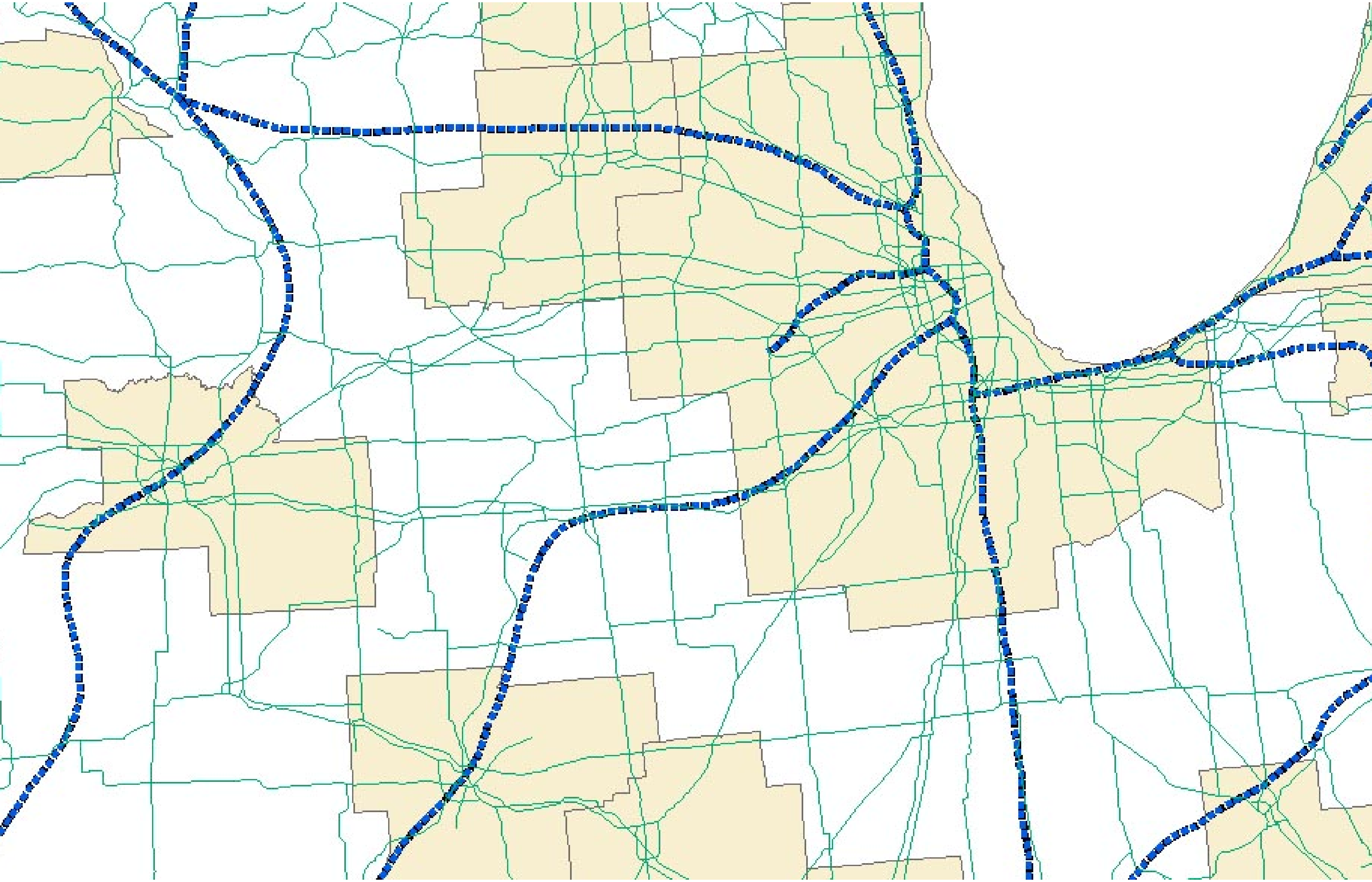
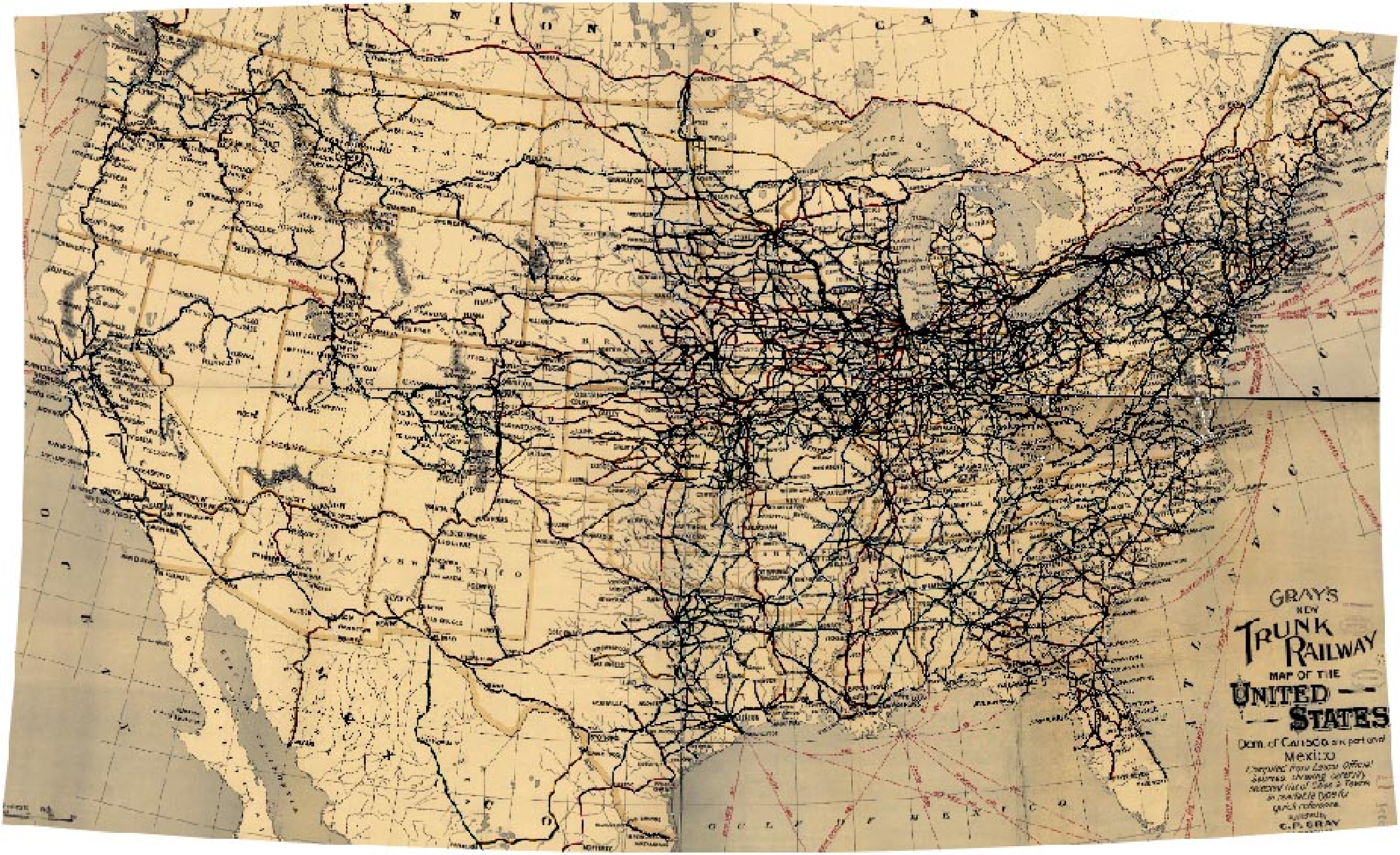




Z^2 – 1898 railroad routes

Z^2 = *kilometers of railroad routes c.1898 contained within each 1999* MSA (Gray's new trunk railway map of the United States, Dom. of Canada and portion of Mexico, Charles P. Gray, Library of congress).

- Relevance: Railroad beds are good road beds.
- Exogeneity: (1) A very different economy; (2) Railroads were built for profit with no interest in population growth a hundred years later.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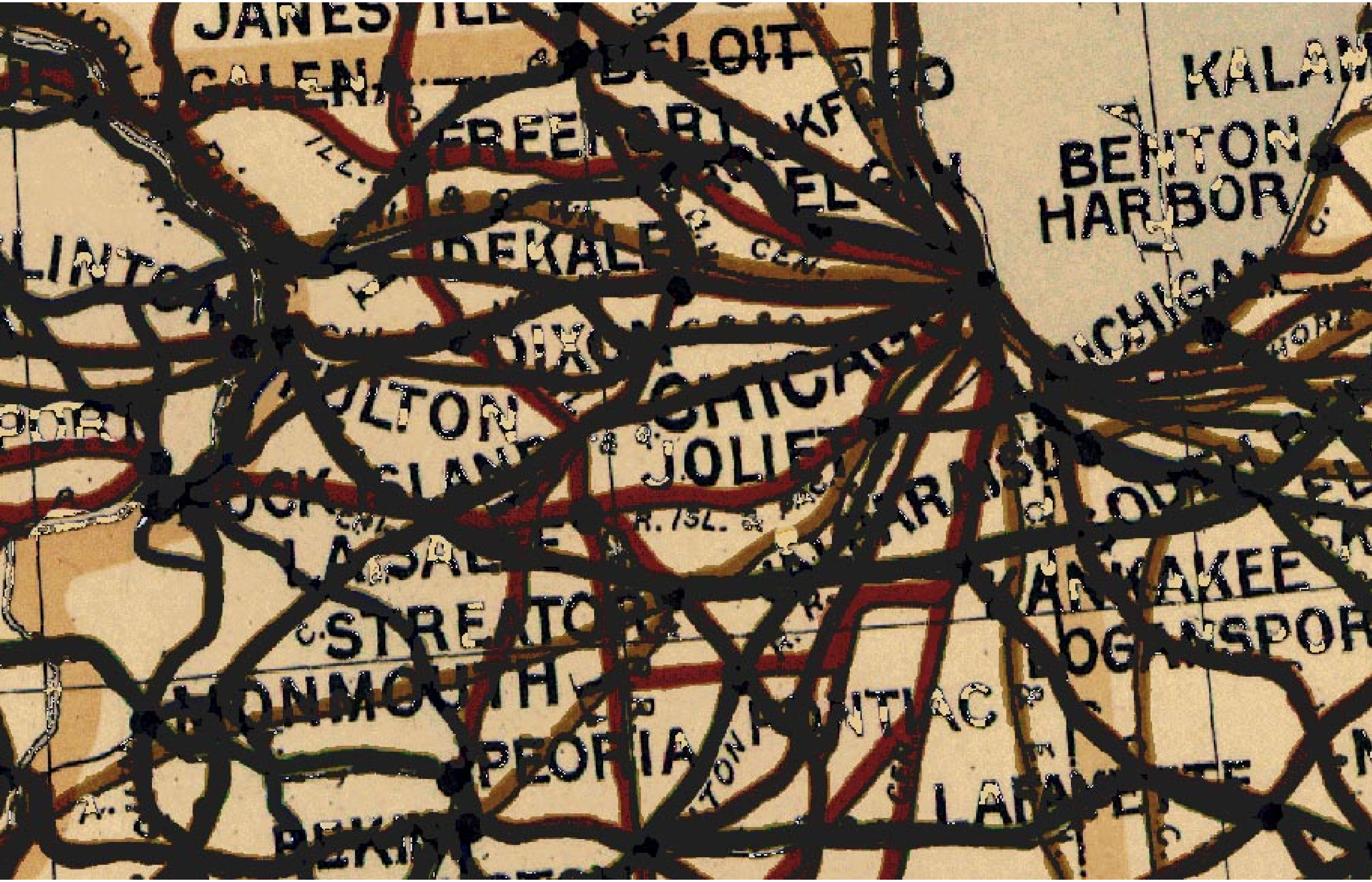
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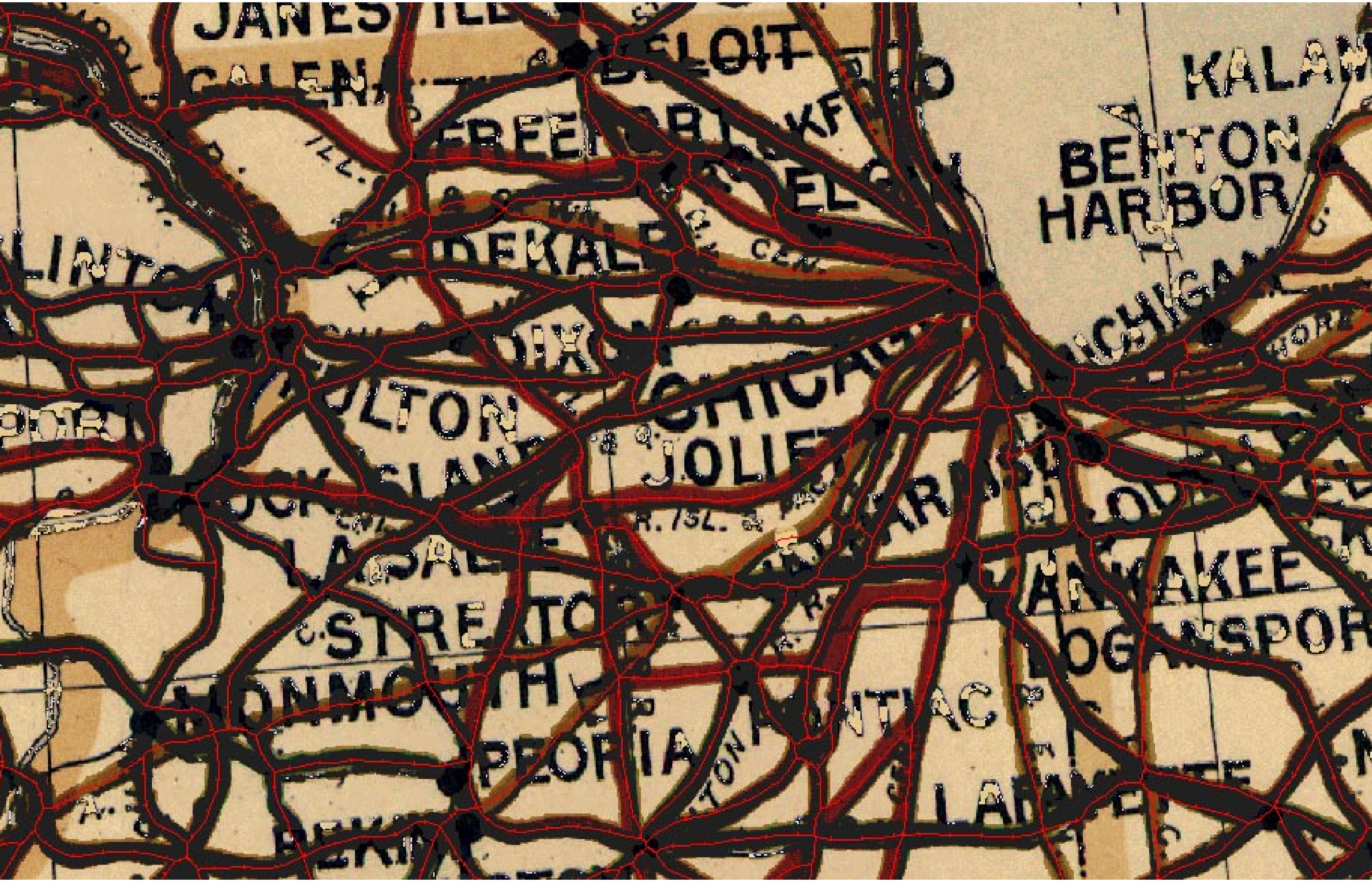
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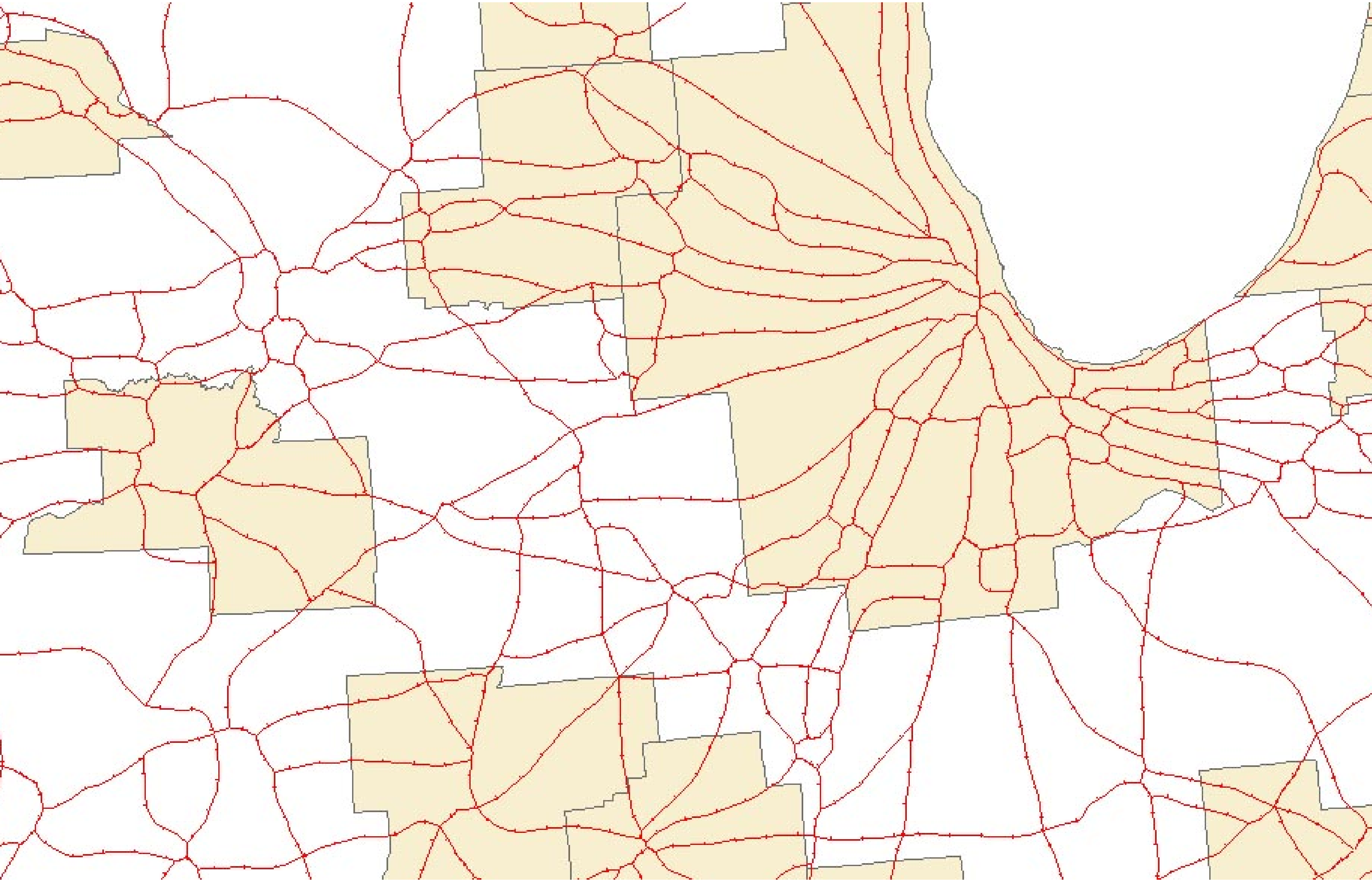
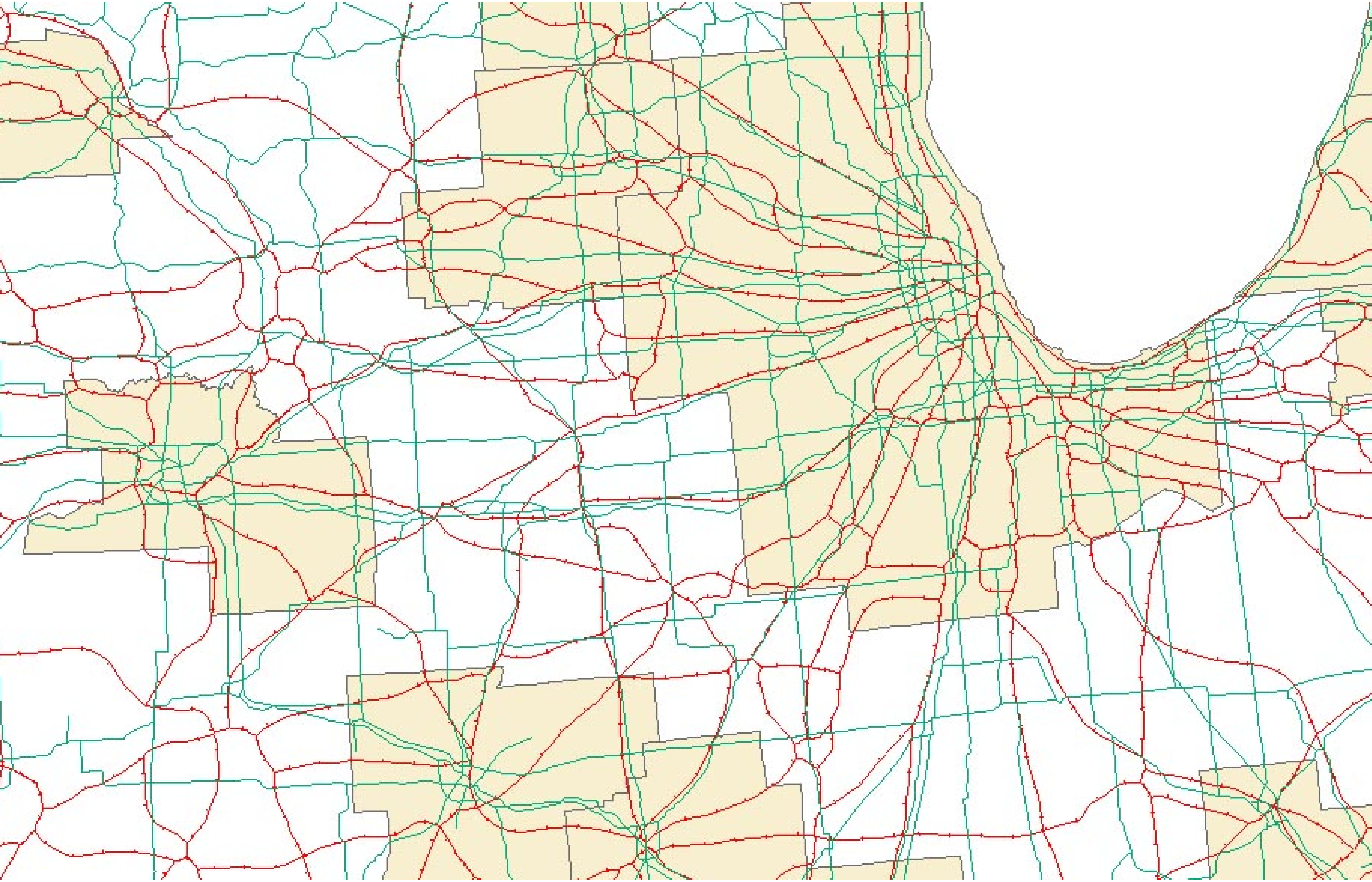
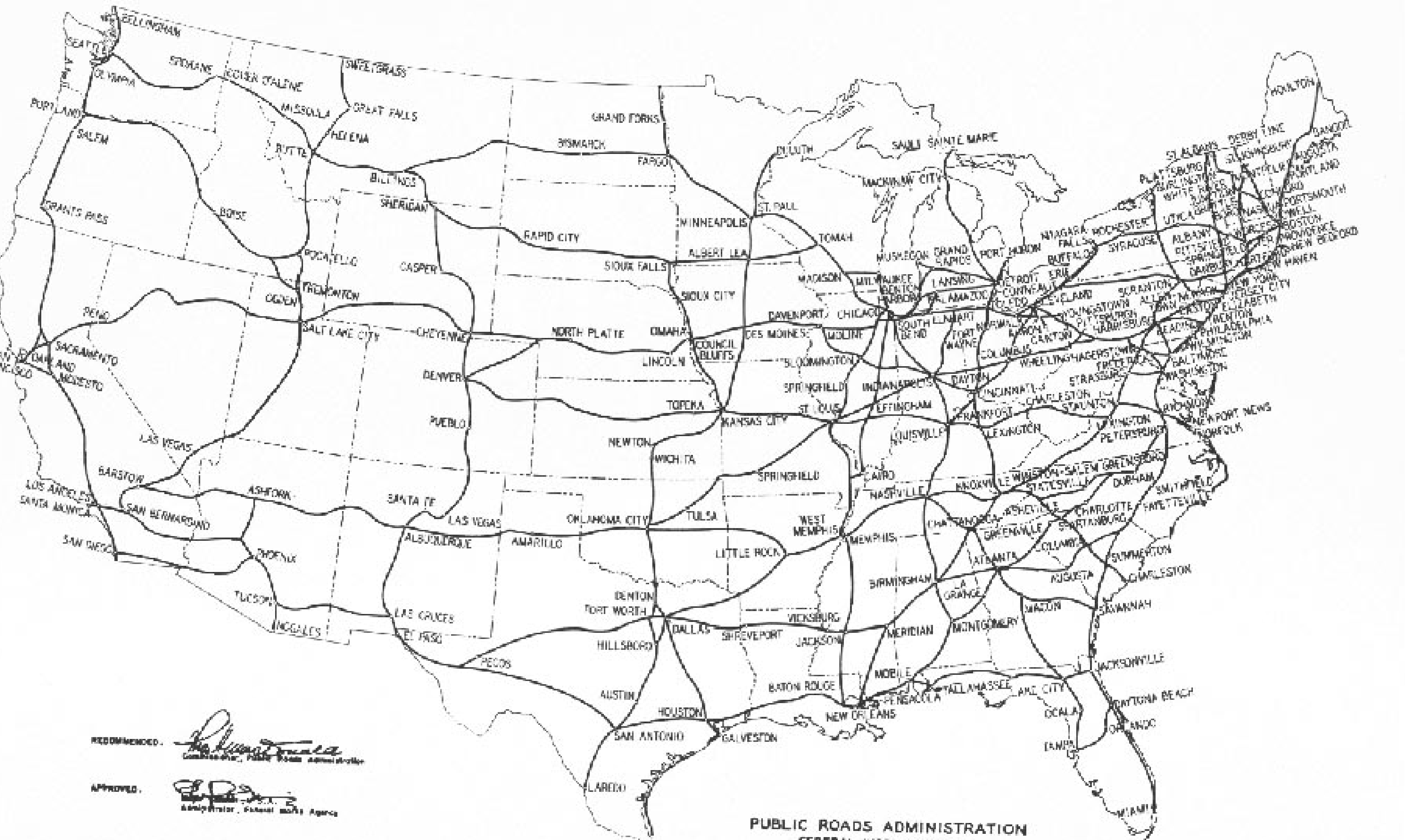




Z^3 – 1947 Highway Plan

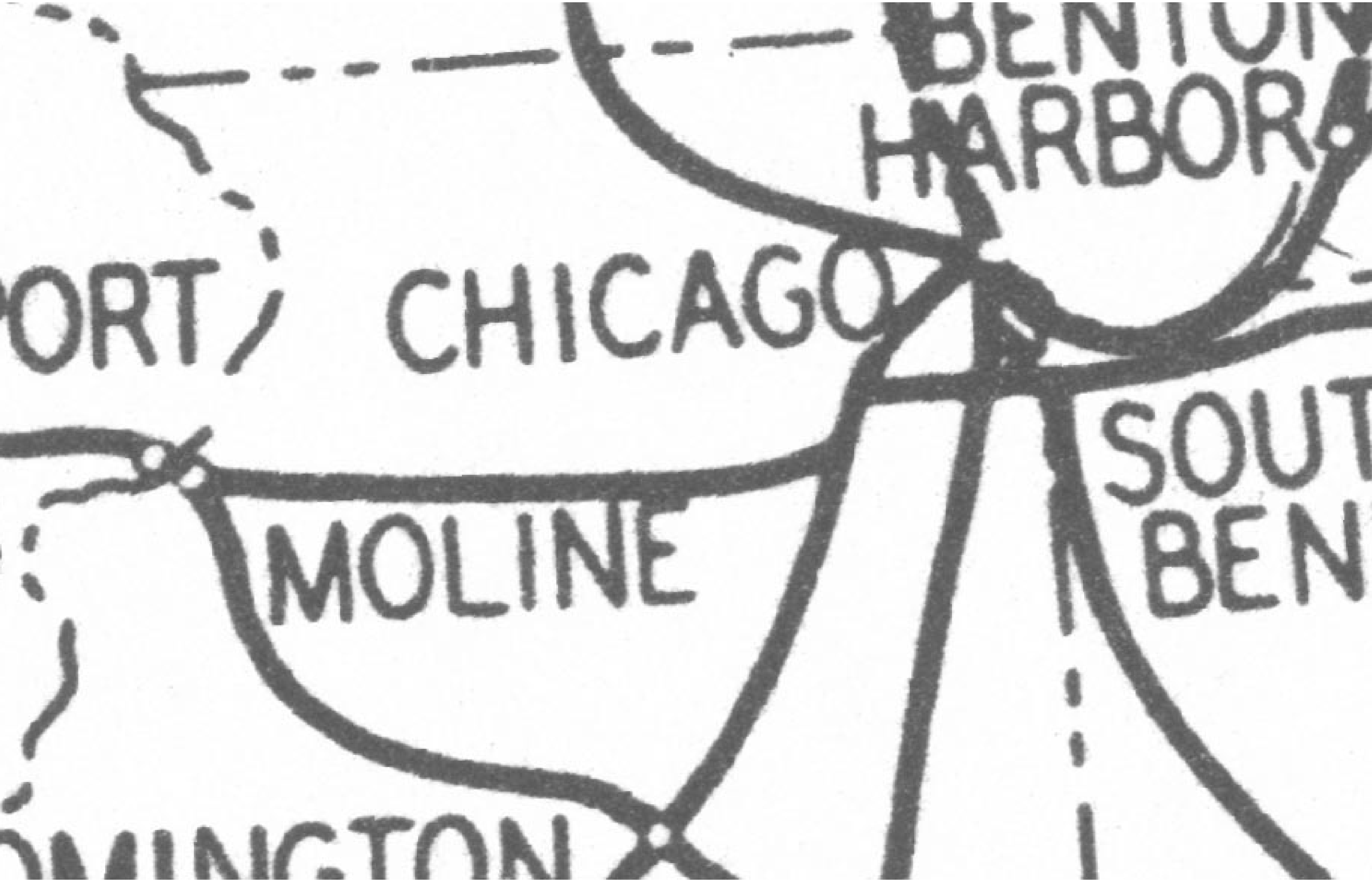
Z^3 = *kilometers of planned interstate highway routes contained within each 1999* MSA (1947 plan of the interstate highway system).

- Relevance: The 1947 plan was by-and-large implemented after the 1956 Federal-Aid Highway Act.
- Exogeneity: The 1947 map was drawn by the military with an eye to serving the needs of National Defense, not to facilitate commuting within existing cities.



PUBLIC ROADS ADMINISTRATION
FEDERAL WORKS AGENCY

NATIONAL SYSTEM OF INTERSTATE HIGHWAYS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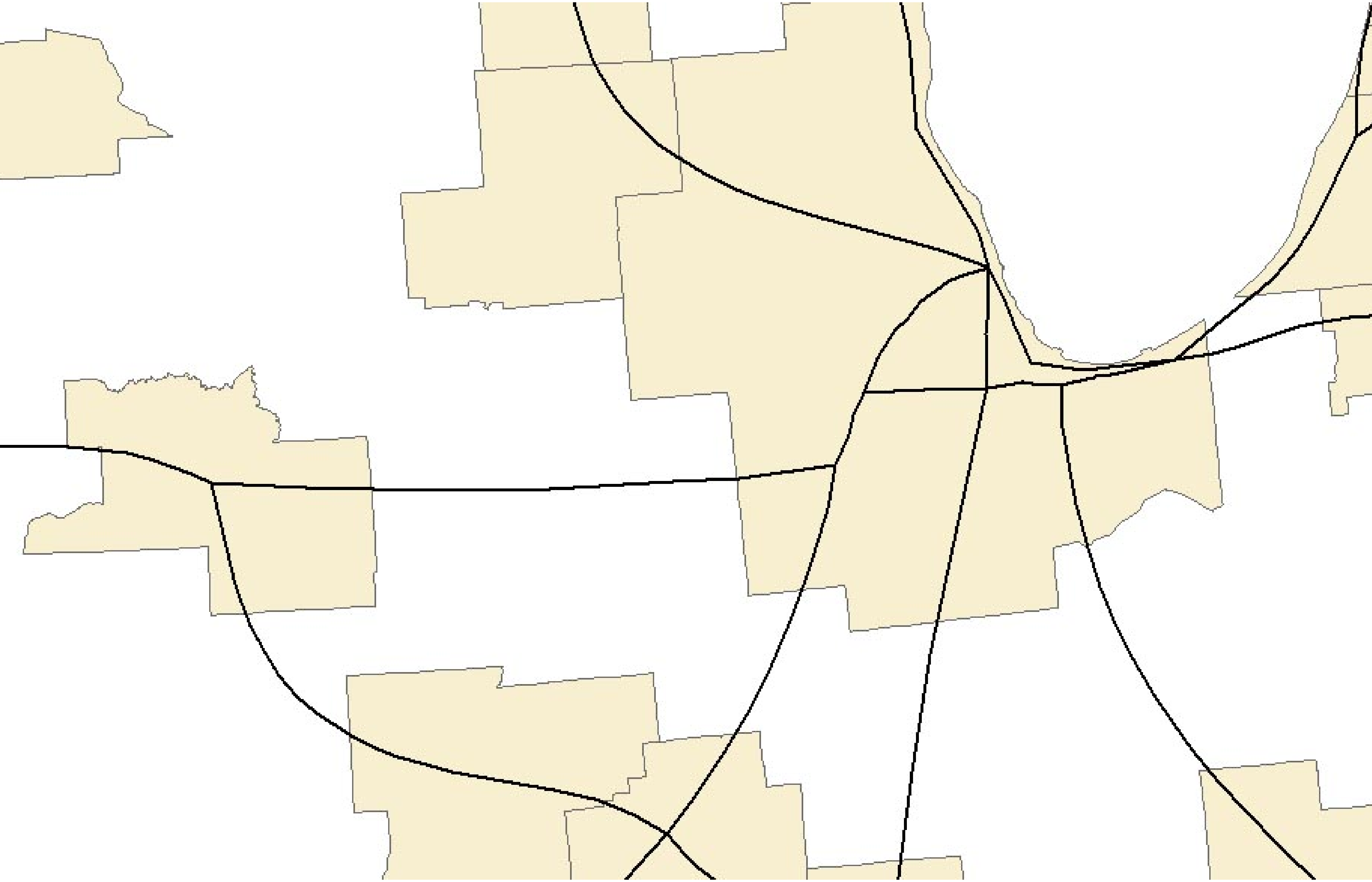

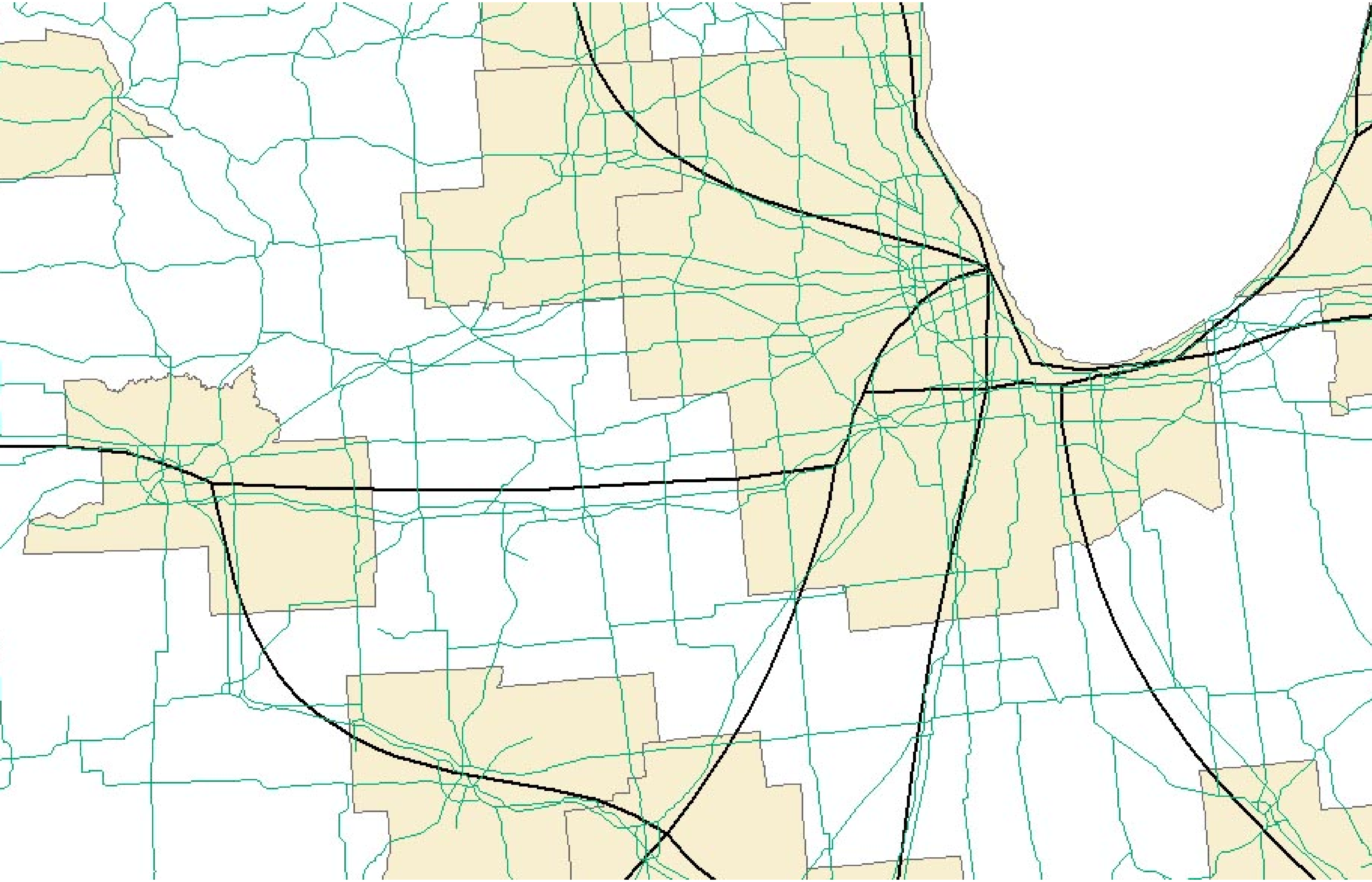

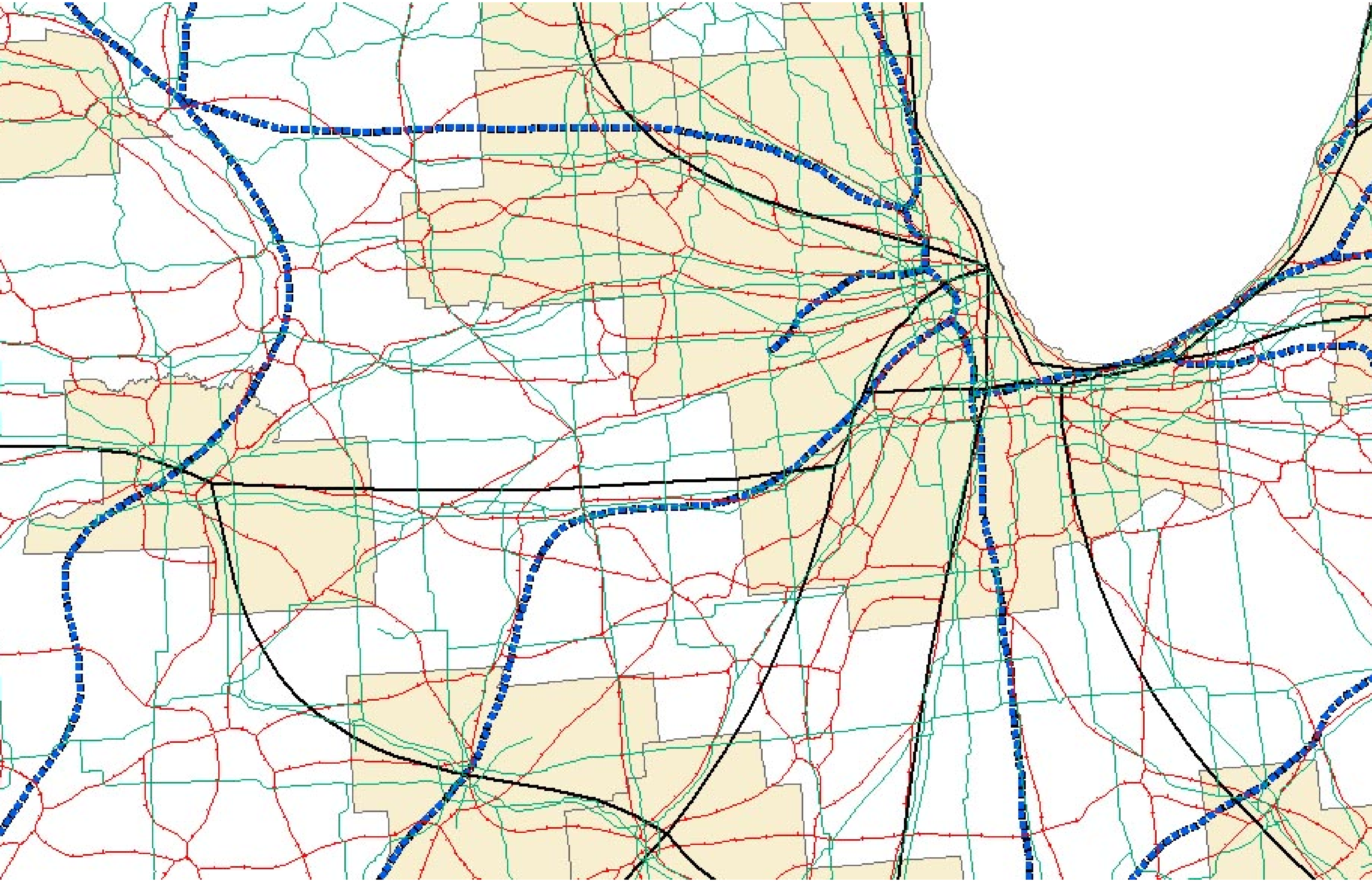

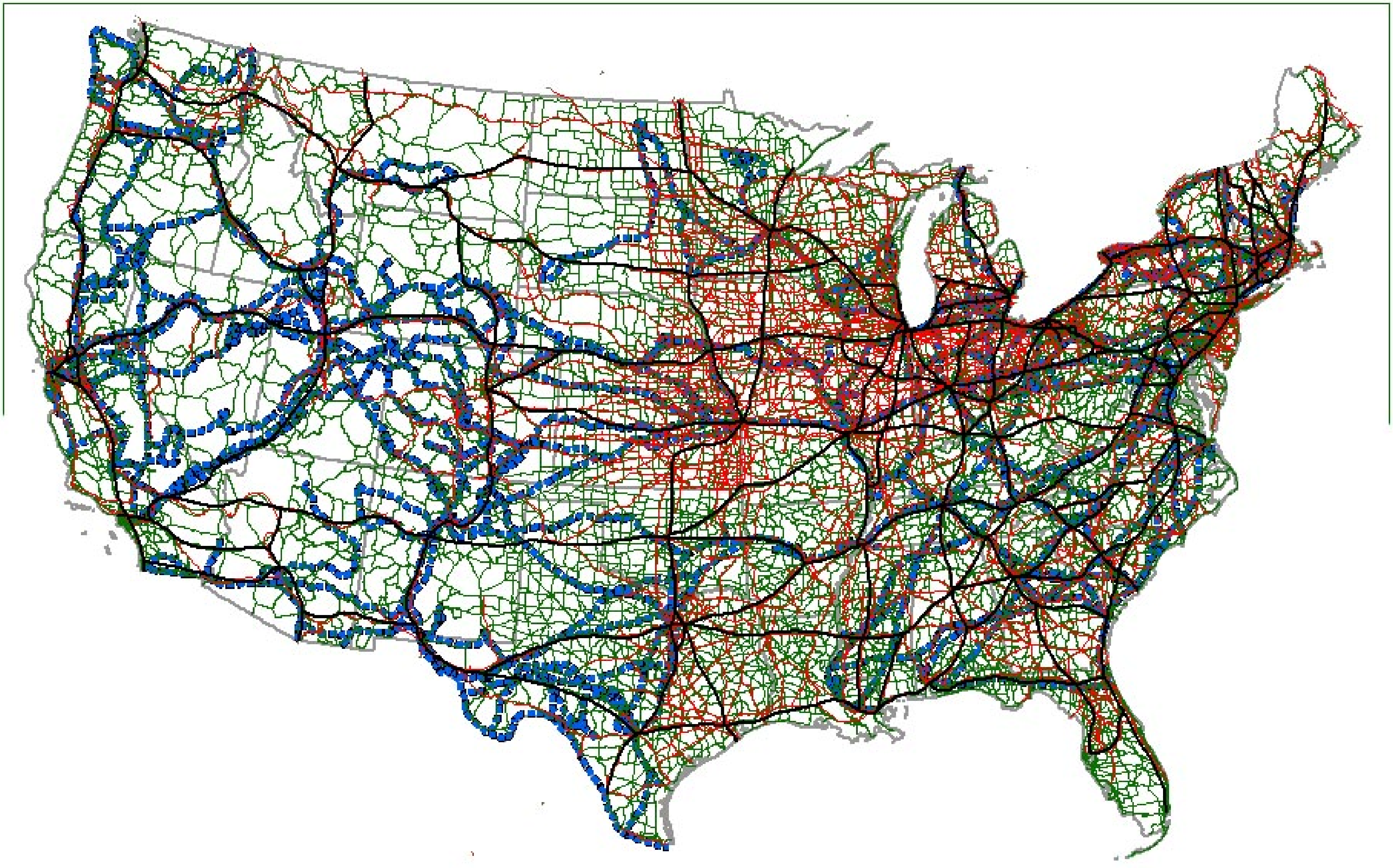

Summary of IV estimation strategy

$$\begin{aligned}
\ln(\text{Transport}_{80}) &= B_0 + B_{80}\ln(\text{POP}_{80}) + B_{70}\ln(\text{POP}_{70}) + \\
&\cdots + B_{20}\ln(\text{POP}_{20}) + B_1 X + B_2 Z + \mu \\
\Delta_{00,80}\ln(\text{POP}) &= A_0 + A_1 \ln(\widehat{\text{Transport}_{80}}) + A_2 X + \\
&A_{80}\ln(\text{POP}_{80}) + A_{70}\ln(\text{POP}_{70}) + \\
&\cdots + A_{20}\ln(\text{POP}_{20}) + \epsilon,
\end{aligned}$$

- Three instruments: Exploration routes, Historical Railroads, Planned Interstate Highways.
- Only planned highways used before but for different purposes (Baum-Snow, 2007; Michaels, 2006).
- Relevance: Pairwise correlation with 1980 roads: 0.85 (Rail); 0.75 (Wagon); 0.89 (Interstate).

- Exogeneity can be argued a priori but can also be tested.
- Since MSA growth is serially correlated and we expect our instruments to affect growth for other periods, population controls are important.
- Similarly geography and location are important.

Table 1. Population growth rate 1980-2000 as a function of 1980 roads

Variable	[ols1]	[ols2]	[ols3]	[iv1]	[iv2]	[iv3]	[iv4]
ln(1980 road km.)	0.178	0.03	0.035	0.208	0.197	0.025	0.184
	(0.040)[a]	(0.019)	(0.021)[c]	(0.079)[a]	(0.079)[b]	(0.134)	(0.075)[b]
$\ln(\text{Pop}_{80})$	-0.101	0.902	0.873	0.617	0.635	-0.013	0.637
	(0.028)[a]	(0.106)[a]	(0.118)[a]	(0.194)[a]	(0.193)[a]	(0.077)	(0.186)[a]
$\{\ln(\text{Pop}_t)\}_{t\in\{10,20,...70\}}$	N	Y	Y	Y	Y	N	Y
Physical Geography	N	Y	Y	Y	Y	N	Y
Census Divisions	N	N	Y	N	N	N	Y
Instruments used:							
ln(Exploration routes)	-	-	-	Y	N	N	N
ln(Railroad routes)	-	-	-	Y	Y	Y	Y
ln(Planned Interstate Hwy.)	-	-	-	Y	Y	Y	Y
First stage F-test	-	-	-	8.06	12.17	11.67	12.45
(H_0 − All instruments zero)							
Over-id test p-value	-	-	-	0.11	0.31	0.01	0.34
R-squared	0.10	0.74	0.77	-	-	-	-
Observations	275	275	275	275	275	275	275

Robust standard errors in parentheses. All regressions include a constant term.
a, b, c: significant at 1%, 5%, 10%.

Dependent variable$\Delta_{00,80}$Pop.

Table 2. Population growth rate 1980-2000 as a function of 1980 roads: Robustness to change of instruments

Variable	[1]	[2]	[3]	[4]	[5]	[6]
ln(1980 road km.)	0.968	0.274	0.158	0.316	0.178	0.197
	(1.079)	(0.092)[a]	(0.095)[c]	(0.094)[a]	(0.097)[c]	(0.079)[b]
$ln(\text{Pop}_{80})$	0.603	0.511	0.698	0.443	0.665	0.635
	(1.690)	(0.223)[b]	(0.203)[a]	(0.225)[b]	(0.206)[a]	(0.193)[a]
Instruments used:						
ln(Exploration routes 1835-50)	Y	N	N	Y	Y	N
ln(Railroad routes c. 1898)	N	Y	N	Y	N	Y
ln(Planned Interstate Highway 1947)	N	N	Y	N	Y	Y
First stage F-test (H_0 − All instruments zero)	0.84	12.81	17.42	6.50	8.70	12.17
Over-id test p-value	-	-	-	0.17	0.05	0.31
Observations	275	275	275	275	275	275

All regressions include a constant and control for physical geography and $\{\ln(\text{Pop}_t)\}_{t\in\{10,20,...70\}}$.
Robust standard errors in parentheses.
a, *b*, *c*: significant at 1%, 5%, 10%.

Dependent variable $\Delta_{00,80}$Pop.

Table 3. Population growth rate 1980-2000 as a function of 1980 roads: Robustness to change of specification

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]	[11]
ln(1980 road km.)	0.249	0.150	0.099		0.197	0.123	0.074		0.275	0.258	0.183
	(0.101)[b]	(0.079)[c]	(0.058)[c]		(0.079)[b]	(0.057)[b]	(0.035)[b]		(0.082)[a]	(0.134)[c]	(0.083)[b]
ln(1990 road km.)				0.125				0.097			
				(0.067)[c]				(0.042)[b]			
F-test	12.17	12.17	12.17	10.40	12.17	12.17	12.17	10.40	4.43	5.58	13.50
Over-id test p-value	0.58	0.41	0.79	0.96	0.31	0.37	0.40	0.58	0.02	0.83	0.26
Observations	275	275	275	275	275	275	275	275	141	131	253

All regressions: include a constant; control for physical geography and $\{\ln(\text{Pop}_t)\}_{t\in\{10,20,...80\}}$; use ln(Railroad routes c. 1898) and ln(Planned Interstate Highway 1947) as instruments.
Robust standard errors in parentheses.
a: significant at 1%, *b*: significant at 5%, *c*: significant at 10%.

Dependent variable by column:
1-$\Delta_{03,83}$Emp; 2-$\Delta_{93,83}$Emp; 3-$\Delta_{03,93}$Emp; 4-$\Delta_{03,93}$Emp;
5-$\Delta_{00,80}$Pop; 6-$\Delta_{90,80}$Pop; 7-$\Delta_{00,90}$Pop; 8-$\Delta_{00,90}$Pop;
9-$\Delta_{00,80}$Pop for $\text{Pop}_{00} > 250{,}000$; 10-$\Delta_{00,80}$Pop for $\text{Pop}_{00} \leq 250{,}000$; 11-$\Delta_{00,80}\text{Pop}_{00} < 2{,}000{,}000$.

Table 4. First stage regressions

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]
ln(Exploration routes)	0.001 (0.005)		0.004 (0.005)					
ln(Railroad routes)	0.028 (0.012)[b]	0.028 (0.012)[b]		0.041 (0.011)[a]		0.01 (0.014)	0.031 (0.012)[a]	0.027 (0.011)[b]
ln(Planned Interstate Hwy)	0.017 (0.005)[a]	0.017 (0.005)[a]			0.020 (0.005)[a]	0.026 (0.006)[a]	0.016 (0.005)[a]	0.012 (0.004)[a]
Physical Geography	Y	Y	Y	Y	Y	N	Y	Y
Census Divisions	N	N	Y	N	N	N	Y	N
$\{\ln(\text{Pop}_t)\}_{t\in\{10,20,\ldots 70\}}$	Y	Y	Y	Y	Y	N	Y	Y
$\ln(\text{Pop}_{80})$	Y	Y	Y	Y	Y	Y	Y	Y
Observations	275	275	275	275	275	275	275	275
R-squared	0.8	0.8	0.79	0.79	0.8	0.74	0.82	0.88
F-test (H_0 − All instruments zero)	8.06	12.17	0.84	12.81	17.42	11.67	12.45	10.40
Partial R-squared	0.08	0.08	0.00	0.04	0.06	0.09	0.08	0.07

All regressions include a constant. Robust standard errors in parentheses.
a, *b*, *c*: significant at 1%, 5%, 10%.

Dependent variable: 1-7, ln(1980 road km.); 8, ln(1990 road km.).

Table 5. Population growth rate 1980-2000 and network effects

Variable	[1]	[2]	[3]	[4]
ln(1980 road km.)	0.206 (0.083)[b]	0.209 (0.084)[b]		
ln(Neighbor 1980 road km.)	0.01 (0.018)			
ln(Neighbor 1980 gravity.)		0.004 (0.007)		
ln(1990 road km.)			0.080 (0.042)[c]	0.076 (0.042)[c]
ln(1990 road km.)				-0.006 (0.003)[b]
ln(Neighbor 1990 gravity)			-0.013 (0.007)[c]	
F-test	12.11	11.67	11.21	10.27
Over-id test *p*-value	0.34	0.36	0.40	0.35
Observations	275	275	275	275

All regressions: include a constant; control for physical geography and $\{\ln(\text{Pop}_t)\}_{t\in\{10,20,...80\}}$; use ln(Railroad routes c. 1898) and ln(Planned Interstate Highway 1947) as instruments for own roads. Robust standard errors in parentheses.
a, *b*, *c*: significant at 1%, 5%, 10%.

$$\text{Neighbor gravity}_t \equiv \frac{\text{Neighbor Pop}_t \times \text{Neighbor road km}_t}{\text{Distance to Neighbor}}.$$

Table 6. Further evidence for road construction as make-work.

Variable	[1]	[2]	[3]	[4]	[5]	[6]	[7]
$\Delta_{00,80}$Pop	-0.005	-0.005	-0.008	-0.009			
	(0.003)^c	(0.002)^b	(0.003)^b	(0.003)^a			
$\Delta_{80,70}$Pop					-0.318	-0.255	-0.194
					(0.07)^a	(0.092)^a	(0.113)^c
Share of Employment in non-road construction				0.293			
				(0.147)^b			
Physical Geography	N	Y	Y	Y	N	N	Y
Census Divisions	N	Y	Y	Y	N	Y	Y
$\{\ln(\text{Pop}_t)\}_{t\in\{10,20,...70\}}$	N	N	Y	Y	N	N	N
Observations	275	275	275	275	275	275	275
R-squared	0.19	0.3	0.34	0.39	0.06	0.2	0.26

All regressions are OLS and include a constant. Robust standard errors in parentheses.
a, *b*, *c*: significant at 1%, 5%, 10%.

Dependent variable in columns 1-4 is employment share in road construction.

Dependent variable in columns 5-7 is: 1990 road km − 1980 road km.

Econometric model and motivation for long run effects

Transportation is a strong determinant of urban growth between 1980 and 2000. Does it have long run effects?

With our data we can estimate

$$\Delta_{00,20} \ln(\text{POP}) = A_0 + A_1 \ln(\text{Rail}_{1898}) + A_2 X + \epsilon$$

- We can use $\ln(\text{POP}_{20})$, geography and census divisions as controls.
- We can instrument railroads in 1898 by exploration routes.

Table 7. Long run effects of rail on population growth

Variable	[ols.1]	[ols.2]	[ols.3]	[iv.4]	[iv.5]
ln(Railroad routes)	0.587 (0.135)[a]	0.325 (0.085)[a]	0.297 (0.104)[a]	0.513 (0.253)[b]	0.586 (0.262)[b]
Physical Geography	Y	Y	Y	Y	Y
Census Divisions	N	N	Y	Y	N
ln(Pop_{20})	N	Y	Y	Y	Y
Observations	117	117	117	117	117
R-squared	0.16	0.64	0.72		
F-test (H_0 − All instruments zero)				10.72	10.28
Over-id test p value				0.61	0.76

All regressions include a constant. Robust standard errors in parentheses.
a, *b*, *c*: significant at 1%, 5%, 10%.

Dependent variable $\Delta_{00,20}$Pop

Sample is restricted to MSA's with 1920 population of more than 100,000. For iv1 and iv2, instruments are ln(Exploration routes) and an indicator that is 1 if Exploration routes $\neq 0$.

Table 8. Population growth rate 1980-2000 as a function of 1980 roads and 1984 buses

Variable	[ols1]	[ols2]	[ols3]	[iv1]	[iv2]	[iv3]	[iv4]
ln(1980 road km.)	0.173	0.030	0.035	0.183	0.207	0.044	0.191
	(0.040)[a]	(0.019)	(0.021)[c]	(0.090)[b]	(0.095)[b]	(0.128)	(0.084)[b]
ln(1984 buses)	-0.032	0.006	0.003	0.069	0.066	0.056	0.042
	(0.011)[a]	(0.007)	(0.007)	(0.033)[b]	(0.035)[c]	(0.026)[b]	(0.035)
$\ln(\text{Pop}_{80})$	-0.047	0.903	0.874	0.659	0.621	0.067	0.644
	(0.032)	(0.107)[a]	(0.120)[a]	(0.227)[a]	(0.237)[a]	(0.066)	(0.211)[a]
$\{\ln(\text{Pop}_t)\}_{t\in\{10,20,...70\}}$	N	Y	Y	Y	Y	N	Y
Physical Geography	N	Y	Y	Y	Y	N	Y
Census Divisions	N	N	Y	N	N	N	Y
Instruments used:							
ln(Railroad routes)	-	-	-	Y	Y	Y	Y
ln(Planned Interstate Hwy.)	-	-	-	Y	Y	Y	Y
ln(Share DemVote72)	-	-	-	Y	Y	Y	Y
ln(Streetcar 1902)	-	-	-	Y	N	N	N
First Stage Cragg-Donald F-Stat	-	-	-	4.21	5.63	8.86	4.50
Over-id test *p*-value	-	-	-	0.53	0.46	0.01	0.37
R-squared	0.12	0.74	0.77	-	-	-	-
Observations	275	275	275	275	275	275	275

Robust standard errors in parentheses. All regressions include a constant term.
a, *b*, *c*: significant at 1%, 5%, 10%.

Dependent variable$\Delta_{00,80}$Pop.

Table 9. Population growth rate 1980-2000 as a function of 1980 roads and 1984 buses: Robustness

Variable	[iv1]	[iv2]	[iv3]	[iv4]	[iv5]	[iv6]	[iv7]	[iv8]
ln(1980 road km.)	0.151	0.229	0.207	0.173	-	-	-	-
	(0.103)	(0.108)[b]	(0.096)[b]	(0.115)				
ln(1984 buses)	0.072	0.073	0.066	0.070	0.067	0.056	0.067	0.068
	(0.033)[b]	(0.037)[b]	(0.035)[c]	(0.034)[b]	(0.028)[b]	(0.026)[b]	(0.028)[b]	(0.029)[b]
Instruments used:								
ln(Railroad routes)	N	Y	Y	N	N	Y	N	N
ln(Planned Interstate Hwy.)	Y	N	Y	Y	Y	N	N	N
ln(Share DemVote72)	Y	Y	Y	Y	Y	Y	Y	Y
ln(Streetcar 1902)	Y	Y	N	N	Y	Y	Y	N
First Stage Cragg-Donald F-Stat	5.61	3.62	5.63	8.29	5.95	6.10	8.96	17.27
Over-id test p-value	0.55	0.33	0.46	-	0.26	0.06	0.91	-
Observations	275	275	275	275	275	275	275	275

All regressions include a constant and control for physical geography, $\ln(\text{Pop}_{80})$, and $\{\ln(\text{Pop}_t)\}_{t\in\{10,20,\ldots70\}}$. Robust standard errors in parentheses.
a, b, c: significant at 1%, 5%, 10%.

Dependent variable$\Delta_{00,80}$Pop.

TO BE DONE

- Can we compare effect of roads with effect of education/institutions?
- Can we calculate costs/benefits of roads?
- Can we say anything about the efficiency of roads supply?

Conclusion

- Roads have large effects on urban growth.
- Transportation infrastructure has very persistent effects.
- The supply of roads appear to be driven by short-term considerations.
- Buses also have a measurable effect on urban growth.

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