# “Trade Integration, Market Size, and Industrialization” Discussion of Faber, ReStud 2014

Nathan Schiff
Shanghai University of Finance and Economics

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# Administration

Final referee report: choose a recent working paper related to your research project (confirm with me first)

Schedule:

- 5/24, Today: Faber paper
- 5/31: Consumer Cities; discuss Couture and Handbury
- 6/7: Website-based data; discussion of my paper on monopolistic competiion in restaurant industry
- 6/14: NO CLASS; I'm away at a conference
- 6/21: student presentations, concluding discussion

You need to submit a write-up of your final proposal, due at end of semester. This should be as detailed as possible and include: introduction and discussion of question, thorough literature review, discussion of data and empirical methodology, and any early results you have.

# Faber ReStud 2014: Main Question

What is the main question?

Main question: what is effect of being connected (new highways) to large cities on small city industrial output?

Two possible effects: 1) production is shifted from large city to connected small city 2) production further concentrates in large city

Additional questions and issues:

1. What happens to population of small city?
2. How are neighboring, unconnected cities affected?

# Innovations and Contributions

Novel “engineering IV”: cleverly used geography as a source of exogenous variation in road placement

Big question with no theoretical prediction: effect of trade could increase or decrease concentration depending on parameters (Krugman papers) and context (urbanization)

Quite thorough: results are robust to many specifications, falsification tests, and seem to tell a consistent story

Note: Appendix is a nicely written description of exactly how the estimation was done (data issues, necessary choices, etc..); well worth reading if interested in doing Trade-style projects on China

# Why study this question in China?

China's National Trunk Highway System was built recently and rapidly

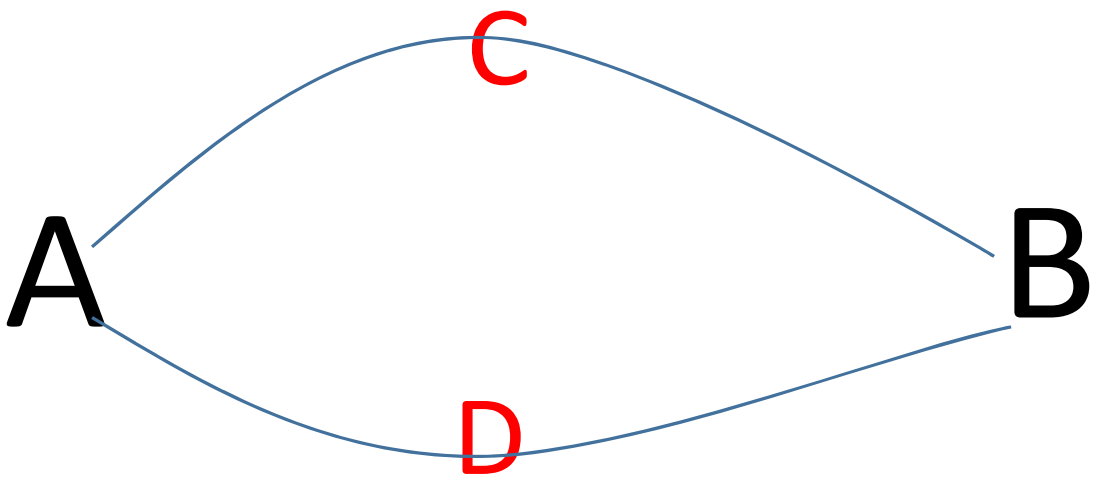
China has many cities and high industrial output, makes identification strategy feasible

Data on city/region output available, geocoded roads, high precision land cover data

General importance of China as a large country

Krugman 2010: "...approaches of the new economic geography aren't backward-looking after all. They're utterly relevant to understanding developments in the world's fastest-growing economies. Localization in America has become a subtle affair, but in China and other emerging economies, it's anything but subtle, and there's wide scope for the use of [first principles] models to make sense of what we see."

# Basic Setup




New road policy is to connect large cities A and B

Road could go through peripheral county (city) C or D

What is effect on peripheral economy of new road?

# Review of Krugman Models

Let $A$ be the big metropolitan area and $C$ be the small peripheral county that will be connected; assume they are identical in all ways except $A$ has more workers (larger)

Krugman set-up: CES consumers, IRS manufacturing, iceberg transport cost

Autarky: firms in $A$ and $B$ have same equilibrium output, same mark-up $p/w$, but more firms in $A$, utility higher in $A$

Allow trade but no mobile workers, what happens?

Workers in $A$ will still be better off because of more goods ($n_A > n_C$), but *also* will have higher wages

This is the home-market effect

# Home Market Effect

With trade (but no mobile factors) wages are higher in the bigger region, but the mark-up $p/w$ is the same (implies prices are also higher)

How to think about this: assume wages were the same in both regions:

- Larger region ($A$) has more firms
- When connect the regions, region $C$ consumers now want to buy all the products from $A$
- This implies that payments from consumers in $C$ on imports would be larger than payments from consumers in $A$ on imports, or uneven balance of trade
- This uneven balance of trade would imply positive profits for firms in $A$
- But, there can't be additional entry because all workers are already employed; therefore this puts upward pressure on wages (otherwise another firm could enter and steal workers away)

# Theory for Faber 2014

Faber uses the ideas of Krugman (1980), and a similar model in Krugman and Helpman (1985) to motivate his paper

In his appendix he discusses a similar model but allows for three regions and mobile capital

The key is that this home-market effect can end up hurting the connected peripheral region even without worker mobility

He also discusses some related implications about how the pre-connected size distribution affects how a new connection would impact each region

# National Trunk Highway System

Faber writes that policy aim was “to connect all provincial capitals and cities with an urban registered population above 500,000 on a single expressway network, and to construct routes between targeted centres and the border in border provinces as part of the Asian Highway Network.”

- Policy approved in 1992: “7-5” network, 7 horizontal axes, 5 vertical axes
- Constructed between 1992 and 2007 at cost of US$ 120 bn
- 10% open by 1997, additional 81% by 2003,l final 9% after 2003

Note: no official list of targeted cities, Faber uses stated aim to classify these, finding 54 cities

# National Trunk Highway System map

FIGURE 1

China's National Trunk Highway System. The figure shows Chinese county boundaries in 1999 in combination with the targeted city nodes and the completed expressway routes of the NTHS in the year 2007.

# Endogeneity

$$ln(y_{ip}^{2006}) - ln(y_{ip}^{1997}) = \gamma_p + \beta * Connect_{ip} + \eta * X_{ip} + \epsilon_{ip} \quad (1)$$

County $i$, province $p$, $Connect_{ip}$ indicates linked to NTHS between 1992 and 2003, cluster $\epsilon_{ip}$ by province

What is the endogeneity issue here?

What is his identification strategy?

Creates two IV road plans:

1. Least cost path spanning network: minimize total network cost given cost of building along different land cover types (slope/elevation, developed land, wetland, water)
2. Euclidean path network: minimize total network cost using straight line connections

# Connected vs Non-Connected Regions

TABLE 1
*Descriptive statistics for 1997*

| | Targeted city centres | Connected periphery | Non-connected periphery | National share of targeted city centres |
|---|---|---|---|---|
| Population (10,000) | 233.24 | 56.96 | 38.48 | 0.17 |
| Urban population (10,000) | 179.69 | 10.77 | 5.83 | 0.5 |
| GDP (100 Million Yuan) | 517.86 | 32.58 | 15.09 | 0.5 |
| GDP per capita (Yuan) | 21435.06 | 5142.16 | 3637.09 | – |
| Local government revenue (100 Million Yuan) | 38.23 | 1.23 | 0.57 | 0.67 |
| Industrial gross value added (100 Million Yuan) | 194.61 | 14.93 | 5.58 | 0.48 |
| Nonagricultural gross value added (100 Million Yuan) | 505.75 | 24.42 | 9.74 | 0.59 |
| Agricultural output share | 0.04 | 0.34 | 0.42 | – |
| Land area ($km^2$) | 1543.09 | 3057.47 | 4513.4 | 0.015 |
| Number of counties | 54 | 424 | 943 | 54 |

*Notes*: The first three columns present mean 1997 levels, and the fourth column presents national shares by county groups. Targeted city centres refer to the central city county units (shixiaqu) of targeted metropolitan regions. Peripheral counties are counties outside a 50 km commuting buffer around the targeted city centres.

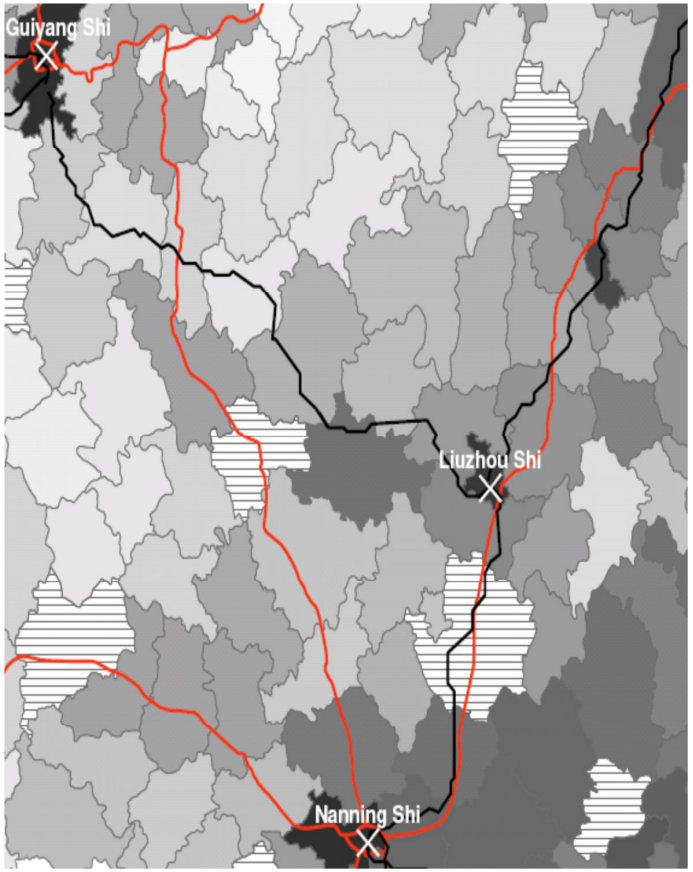
Connected peripheral regions look larger and richer.

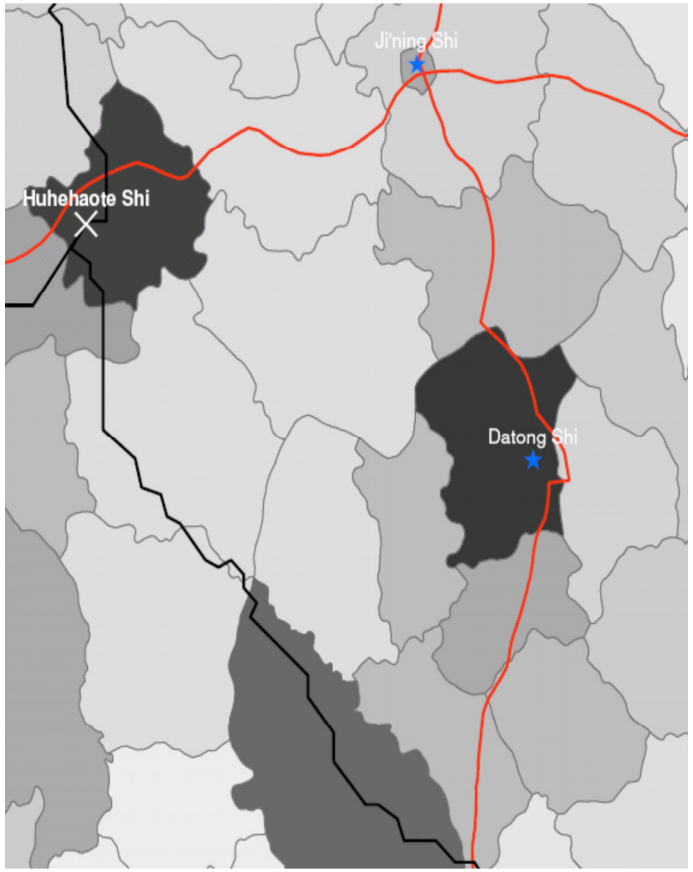
# Creating Least Cost Path Spanning IV

How does he do this?

- Uses US and Chinese government data on characteristics of land parcels (GIS raster data is basically a grid of cells with values)
- Uses ArcGIS to run algorithms that minimize construction cost of entire road network based on requirement of connecting 54 cities and given costs of land types
- Output of process is a network of bi-lateral curves between 54 cities

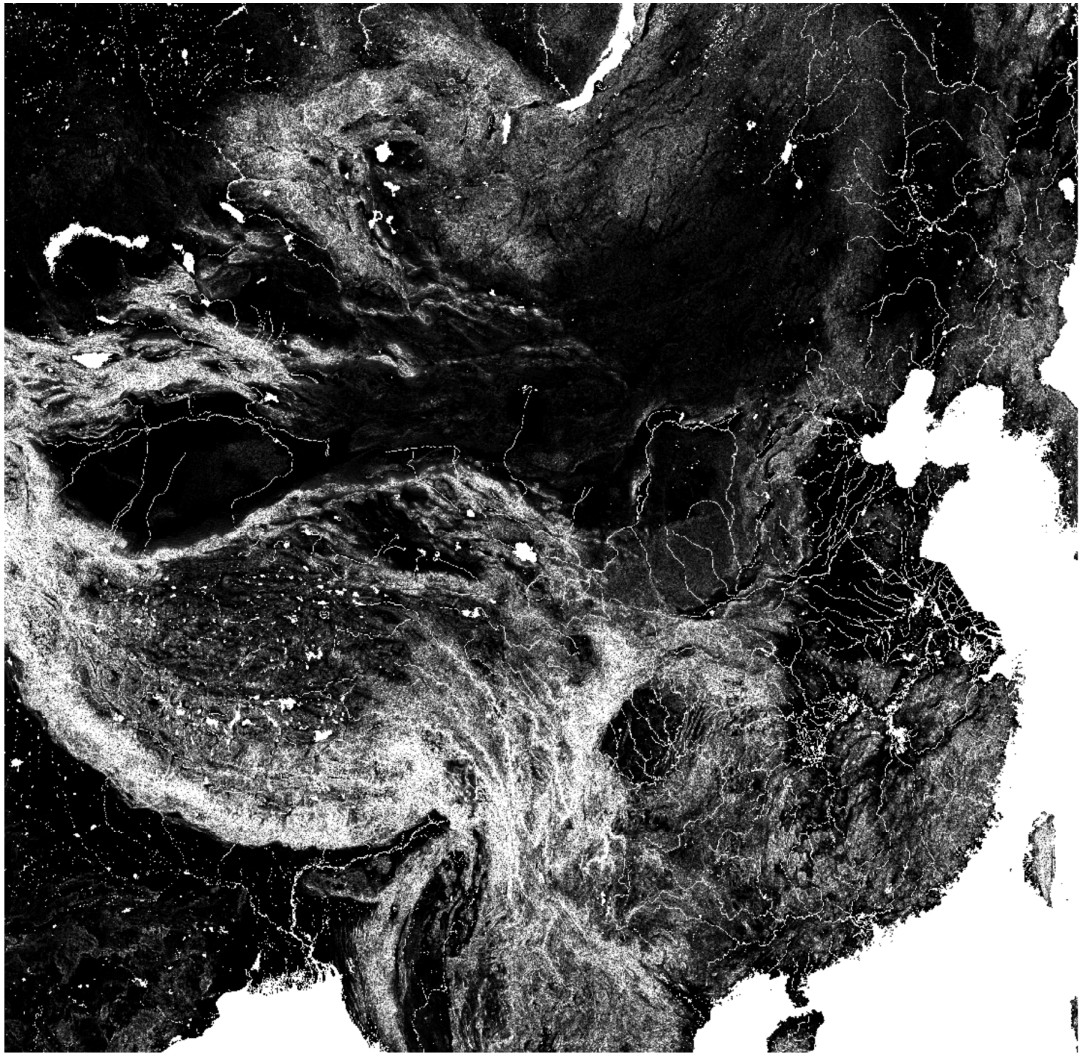
# Least Cost Path Spanning IV Example




The network in red color depicts actual NTHS expressway routes. The network in black color depicts the least cost path spanning tree network. Crosses indicate targeted metropolitan nodes. Counties are color coded according to their nominal levels of GDP in 1997, where darker colors represent higher values. Striped areas indicate missing 1997 GDP data.

# Construction Cost Map



The figure depicts the construction cost raster used as input into the least cost path algorithm. The color scale ranges from white (very high cost of crossing a parcel of land) to black (very low cost of crossing a square km parcel of land). The cost assignment is based on land gradient (slope) as well as land cover (water, wetlands, and developed land), and described in more detail in the text.

# Least Cost Path Spanning IV Map

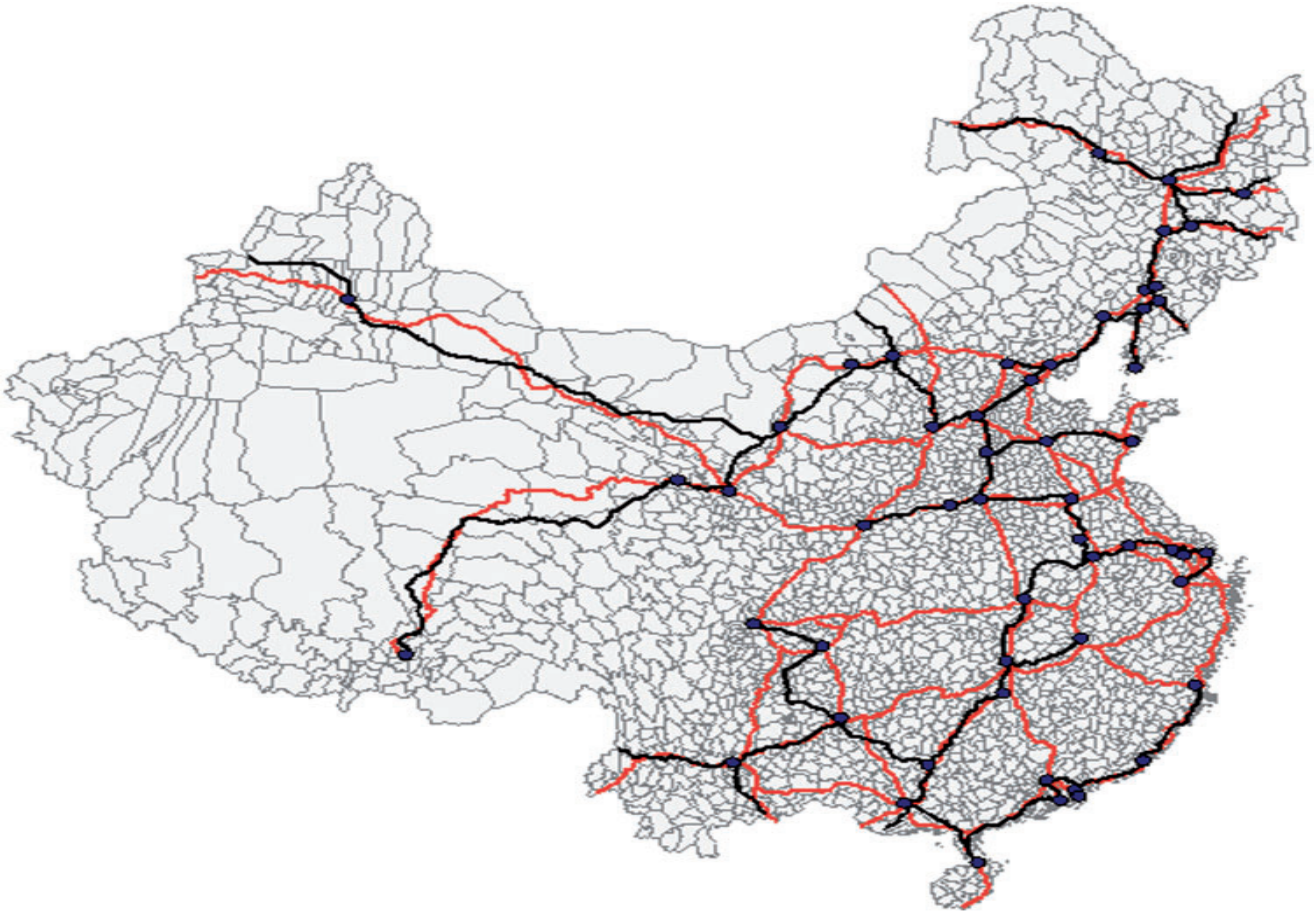


FIGURE 2

Least cost path spanning tree network. The network in red colour depicts the completed NTHS network in 2007. The network in black colour depicts the least cost path spanning tree network. The black routes are the result of a combination of least cost path and minimum spanning tree algorithms. In the first step Dijkstra's (1959) optimal route algorithm is applied to land cover and elevation data in order to construct least costly paths between each bilateral pair of the targeted destination. In the second step, these bilateral cost parameters are fed into Kruskal's (1956) minimum spanning tree algorithm. This algorithm identifies the subset of routes that connect all targeted nodes on a single continuous network subject to global construction cost minimization.

# Euclidean IV

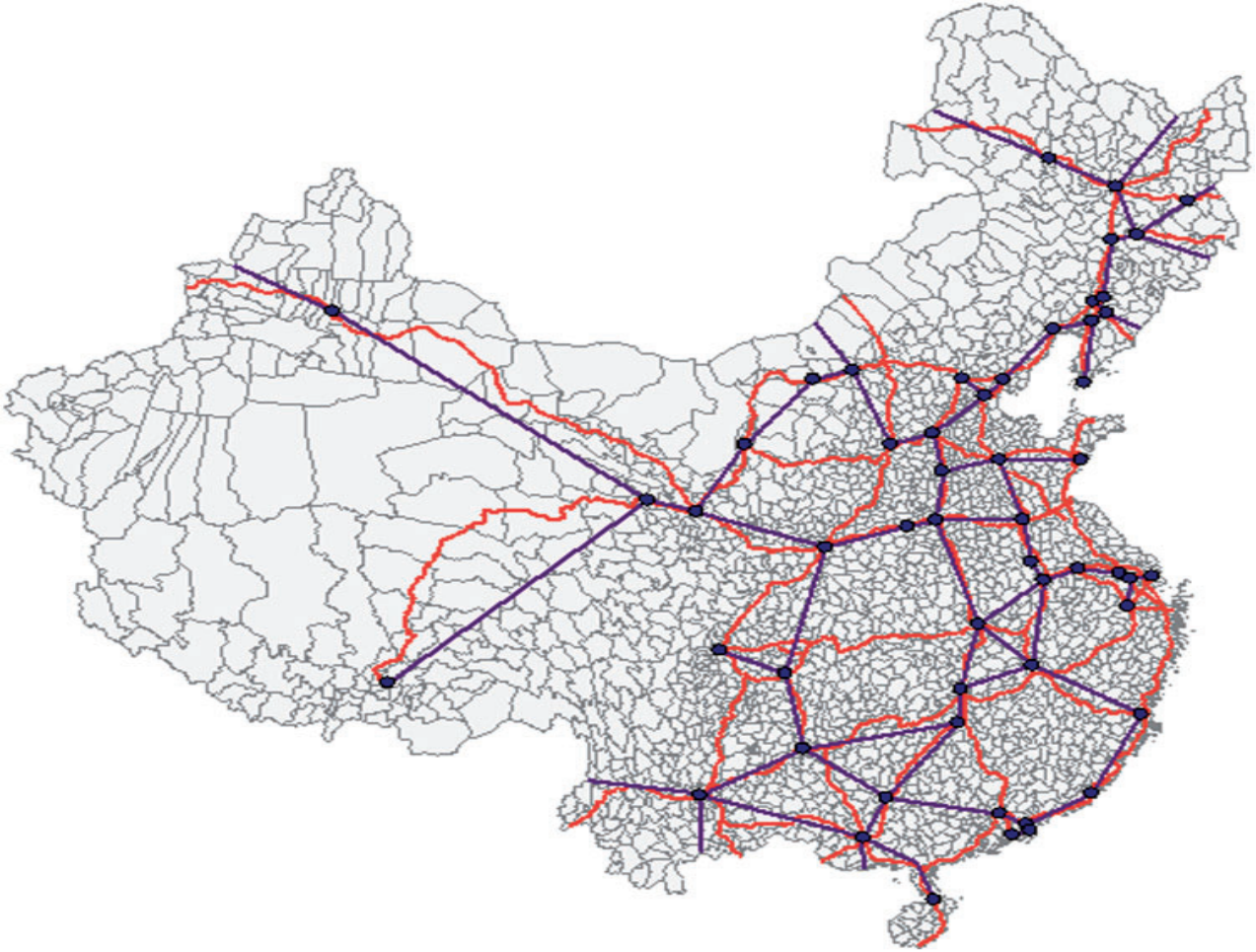


FIGURE 3

Euclidean spanning tree network. The network in red colour depicts the completed NTHS network in 2007. The network in darker colour depicts the Euclidean spanning tree network. The routes are the result of applying Kruskal's (1956) minimum spanning tree algorithm to bilateral Euclidean distances between targeted destinations. This algorithm is first run for the all-China network, and then repeated within North-Centre-South and East-Centre-West divisions of China. These regional repetitions add 9 routes to the original minimum spanning tree.

# Discussion of IV

What is the relevance requirement and exclusion restriction for this IV?

Relevance: must be able to predict placement of road network, *controlling* for other variables (distance to node cities, capital status, urban status, demographics)

Exclusion restriction: instrument must be uncorrelated with error term; any problems in this context?

Controls are important; author notes:

- peripheral counties closer to targeted cities are "mechanically more likely to lie on a least cost [path]"
- least cost paths could also be correlated with "political and economic county characteristics due to historical trade routes"
- includes controls for pre-existing political status and 1990 economic conditions, including schooling and agricultural employment

# Evaluation of IV

Author is very careful and pre-empts readers concerns by directly stating and address possible identification issues

Online appendix: discusses testing for whether land cover features could be endogenous (also includes as controls)

Additional discussion of LATE vs population average: argues should be no difference here

Thoughts?

# Main Results

What does he find?

Output of connected peripheral counties grows more slowly than non-connected counties

*Note*: it's a little unclear how he defines peripheral counties; he excludes counties within 50km of targeted cities (worried about commuting) but does not explain remaining selection criteria

Effects are stronger when including additional controls, suggesting correlation of IV roads and controls

NTHS connections reduced GDP growth by 9% to 18% from 1997-2006; this comes from decrease in industrial output growth (no effect on agriculture)

No effect on county population growth

# Table 2: First Stage

TABLE 2
*First stage regressions*

| Dependent variable: | (1) Connect | (2) Connect | (3) Connect | (4) lnDistHwy | (5) lnDistHwy | (6) lnDistHwy |
|---|---|---|---|---|---|---|
| Least cost path IV | 0.323*** | | 0.254*** | 0.317*** | | 0.245*** |
| | (0.0574) | | (0.0635) | (0.0645) | | (0.0635) |
| Euclidean IV | | 0.243*** | 0.144** | | 0.280*** | 0.193*** |
| | | (0.0529) | (0.0560) | | (0.0599) | (0.0657) |
| lnDistNode | −0.130*** | −0.127*** | −0.104*** | 0.588*** | 0.635*** | 0.426*** |
| | (0.0376) | (0.0295) | (0.0323) | (0.130) | (0.112) | (0.122) |
| Prefect capital | −0.124* | −0.129* | −0.120* | 0.437** | 0.429* | 0.413* |
| | (0.0648) | (0.0736) | (0.0658) | (0.209) | (0.229) | (0.215) |
| City Status | 0.0891** | 0.0929** | 0.0847** | −0.297*** | −0.296*** | −0.270*** |
| | (0.0403) | (0.0437) | (0.0399) | (0.0946) | (0.103) | (0.0951) |
| lnUrbPop90 | 0.106*** | 0.115*** | 0.107*** | −0.228*** | −0.244*** | −0.227*** |
| | (0.0225) | (0.0217) | (0.0209) | (0.0691) | (0.0640) | (0.0636) |
| Educ90 | −0.273 | −0.303 | −0.302 | −1.671 | −1.747 | −1.626 |
| | (0.598) | (0.656) | (0.601) | (1.697) | (1.804) | (1.666) |
| AgShare90 | −0.170 | −0.216 | −0.167 | 0.0238 | −0.00173 | −0.0160 |
| | (0.182) | (0.189) | (0.179) | (0.537) | (0.555) | (0.533) |
| Obs | 1342 | 1342 | 1342 | 1342 | 1342 | 1342 |
| $R^2$ | 0.222 | 0.204 | 0.233 | 0.401 | 0.394 | 0.414 |
| First stage F-Stat | 31.61 | 21.07 | 20.31 | 24.09 | 21.82 | 15 |

*Notes*: All regressions include province fixed effects. Columns 1–3 report results for binary NTHS connection indicators among peripheral counties. Columns 4–6 report results for the log distance to the nearest NTHS segment among peripheral counties. lnDistNode is log county distance to the nearest targeted city node. Prefect Capital and City Status are binary indicators for respective county status in 1990. lnUrbPop90 is log 1990 county urban population. Educ90 is the 1990 county share of above compulsory schooling in 20+ population. AgShare90 is the 1990 county share of agricultural employment. Standard errors are clustered at the province level and stated in parentheses below point estimates. ***1%, **5%, and *10% significance levels.

# Table 3: Main Specification

TABLE 3

*Network connection effects among peripheral counties*

| Dependent variables | | (1) OLS No controls | (2) OLS With controls | (3) LCP IV No controls | (4) LCP IV With controls | (5) Euclid IV No controls | (6) Euclid IV With controls | (7) Both IVs No controls | (8) Both IVs With controls | (9) Both IVs With controls |
|---|---|---|---|---|---|---|---|---|---|---|
| Change ln(IndGVA) 1997–2006 | Connect | −0.0529 | −0.0356 | −0.284** | −0.304** | −0.246* | −0.287* | −0.272*** | −0.297*** | −0.297** |
| | | (0.0418) | (0.0499) | (0.118) | (0.145) | (0.148) | (0.154) | (0.0965) | (0.108) | (0.121) |
| | Obs | 1302 | 1280 | 1302 | 1280 | 1302 | 1280 | 1302 | 1280 | 1280 |
| | $R^2$ | 0.242 | 0.255 | | | | | | | |
| Change ln(NonAgGVA) 1997–2006 | Connect | −0.0411 | −0.0266 | −0.243** | −0.252** | −0.270** | −0.296** | −0.251*** | −0.268*** | −0.268*** |
| | | (0.0335) | (0.0375) | (0.0983) | (0.117) | (0.122) | (0.131) | (0.0877) | (0.0969) | (0.0946) |
| | Obs | 1285 | 1262 | 1285 | 1262 | 1285 | 1262 | 1285 | 1262 | 1262 |
| | $R^2$ | 0.27 | 0.284 | | | | | | | |
| Change ln(GovRevenue) 1997–2006 | Connect | −0.0497* | −0.0914*** | −0.0542 | −0.223* | −0.175 | −0.315** | −0.0926 | −0.257*** | −0.257*** |
| | | (0.0285) | (0.0295) | (0.109) | (0.120) | (0.117) | (0.132) | (0.0893) | (0.0996) | (0.100) |
| | Obs | 1290 | 1285 | 1290 | 1285 | 1290 | 1285 | 1290 | 1285 | 1285 |
| | $R^2$ | 0.275 | 0.334 | | | | | | | |
| Change ln(GDP) 1997–2006 | Connect | −0.00204 | −0.0144 | −0.106 | −0.177* | −0.178 | −0.254** | −0.127 | −0.203** | −0.203** |
| | | (0.0245) | (0.0276) | (0.0830) | (0.0942) | (0.112) | (0.116) | (0.0824) | (0.0886) | (0.080) |
| | Obs | 1297 | 1272 | 1297 | 1272 | 1297 | 1272 | 1297 | 1272 | 1272 |
| | $R^2$ | 0.228 | 0.264 | | | | | | | |
| Change ln(AgGVA) 1997–2006 | Connect | −0.00344 | −0.00790 | 0.000194 | −0.0252 | −0.0305 | −0.0597 | −0.00865 | −0.0371 | −0.0371 |
| | | (0.0210) | (0.0220) | (0.0631) | (0.0789) | (0.0672) | (0.0728) | (0.0545) | (0.0630) | (0.0654) |
| | Obs | 1335 | 1313 | 1335 | 1313 | 1335 | 1313 | 1335 | 1313 | 1313 |
| | $R^2$ | 0.202 | 0.208 | | | | | | | |
| Change ln(Population) 1997–2006 | Connect | 0.00488 | −0.00217 | 0.0395** | 0.0264 | 0.0183 | 0.0104 | 0.0333* | 0.0207 | 0.0207 |
| | | (0.00456) | (0.00568) | (0.0188) | (0.0234) | (0.0242) | (0.0262) | (0.0183) | (0.0215) | (0.0225) |
| | Obs | 1337 | 1314 | 1337 | 1314 | 1337 | 1314 | 1337 | 1314 | 1314 |
| | $R^2$ | 0.234 | 0.271 | | | | | | | |

# Table 4: Falsification Test

TABLE 4

*Falsification test before and after the network was built*

| Dependent variable: Change ln(LocGovRev) | (1) OLS 1990–97 | (2) OLS 1997–06 | (3) LCP IV 1990–97 | (4) LCP IV 1997–06 | (5) Euclid IV 1990–97 | (6) Euclid IV 1997–06 | (7) Both IVs 1990–97 | (8) Both IVs 1997–06 |
|---|---|---|---|---|---|---|---|---|
| *Panel A: Binary* | | | | | | | | |
| Connect | 0.0154 | −0.0848** | 0.0143 | −0.151 | 0.117 | −0.282** | 0.0563 | −0.204*** |
| | (0.0410) | (0.0360) | (0.0853) | (0.0974) | (0.107) | (0.129) | (0.0647) | (0.0467) |
| Obs | 894 | 894 | 894 | 894 | 894 | 894 | 894 | 894 |
| $R^2$ | 0.274 | 0.339 | | | | | | |
| First stage F-Stat | | | 19.635 | 19.635 | 19.091 | 19.091 | 14.93 | 14.93 |
| *Panel B: log Distance* | | | | | | | | |
| ln(DistHwy) | −0.0114 | 0.0160 | −0.0409 | 0.0854* | −0.00442 | 0.185** | −0.0274 | 0.122*** |
| | (0.0142) | (0.0190) | (0.0350) | (0.0470) | (0.0573) | (0.0783) | (0.0329) | (0.0430) |
| Obs | 894 | 894 | 894 | 894 | 894 | 894 | 894 | 894 |
| $R^2$ | 0.275 | 0.336 | | | | | | |
| First stage F-Stat | | | 18.696 | 18.696 | 17.306 | 17.306 | 11.259 | 11.259 |

*Notes*: Each point estimate stems from a separate regression. All regressions include province fixed effects and a full set of county controls. LCP IV stands for the least cost path spanning tree instrument. Euclid IV stands for the straight line spanning tree instrument. Panel A presents results for binary NTHS connection indicators (for both OLS and instruments) and Panel B presents results for log distance to the nearest NTHS segment (again for both OLS and instruments). Standard errors are clustered at the province level and stated in parentheses below point estimates. ***1%, **5%, and *10% significance levels.

# Two Possible Explanations

What are the two explanations for his results that he tests?

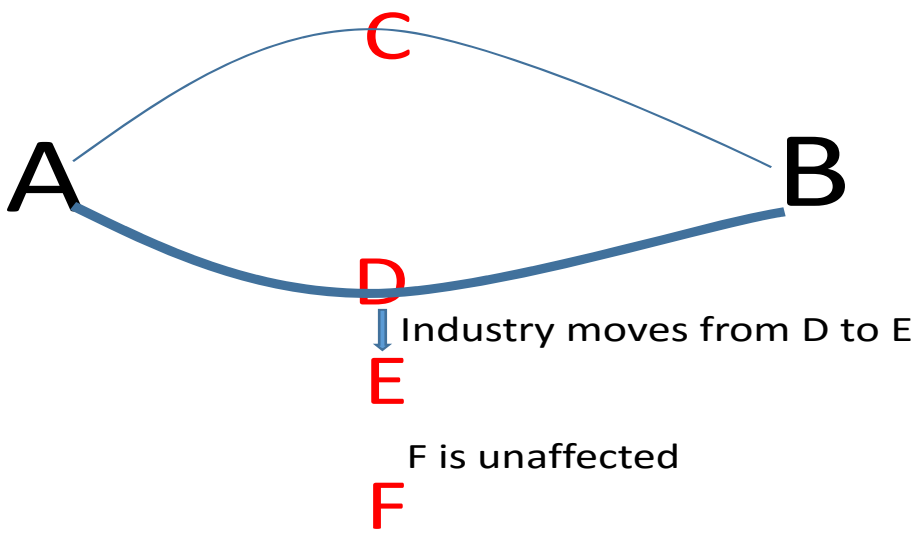
1) Trade effect: bigger market with IRS production leads to concentration of production in core, periphery loses (home market effect)

This effect can be reinforced when workers move to core area (last class)

2) Urbanization effect: connected counties lose industry to nearby unconnected counties (decentralization)

Also implies population growth should differ in connected counties compared to nearby unconnected (but how exactly? not a good fit for monocentric city model)

# Effect of Distance to NTHS Road




Decentralization implies non-monotonic effect of distance to road on output; trade implies effect decreases with distance

D should be negatively affected, E positive, F unchanged

To test this estimates effect of distance using high-order polynomial (effect can vary greatly with distance)

# Urbanization vs Trade

TABLE 5

*Are NTHS connections associated to urbanization and industrial decentralization among peripheral counties?*

| Dependent variable: | Change ln(UrbPop) 1997–06 | Change ln(Urb/Pop) 1997–06 | Change ln(IndGVA) 1997–06 | | | Change ln(GDP) 1997–06 | | | Change ln(GovRevenue) 1997–06 | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) |
| Connect | 0.0350 | 0.0137 | −0.297*** | −0.262** | | −0.203** | −0.193** | | −0.257*** | −0.253*** | |
| | (0.0953) | (0.0925) | (0.108) | (0.113) | | (0.0886) | (0.0919) | | (0.0996) | (0.0961) | |
| Neighbour | | | | 0.153 | | | 0.0907 | | | 0.0535 | |
| | | | | (0.214) | | | (0.132) | | | (0.195) | |
| lnDistHwy | | | | | 0.113* | | | 0.0845* | | | 0.177*** |
| | | | | | (0.0615) | | | (0.0480) | | | (0.0667) |
| First Stage F-Stat | 13.374 | 13.374 | 18.886 | 5.016 | 13.852 | 17.425 | 4.84 | 12.989 | 19.055 | 5.383 | 13.879 |
| Obs | 1,072 | 1,072 | 1,280 | 1,280 | 1,280 | 1,272 | 1,272 | 1,272 | 1,285 | 1,285 | 1,285 |

*Notes*: All regressions include province fixed effects and a full set of county controls. Reported results are 2nd stage estimates using the least cost path and the Euclidean spanning tree networks to instrument for NTHS connections, neighbouring peripheral counties, or distance to the nearest NTHS segment. Columns 1 and 2 report connection effects on peripheral county changes in log urban population and urbanization, respectively. Neighbour indicates peripheral counties neighbouring a connected peripheral county. Standard errors are clustered at the province level and stated in parentheses below point estimates. ***1%, **5%, and *10% significance levels.

# Fitted Effect of Distance

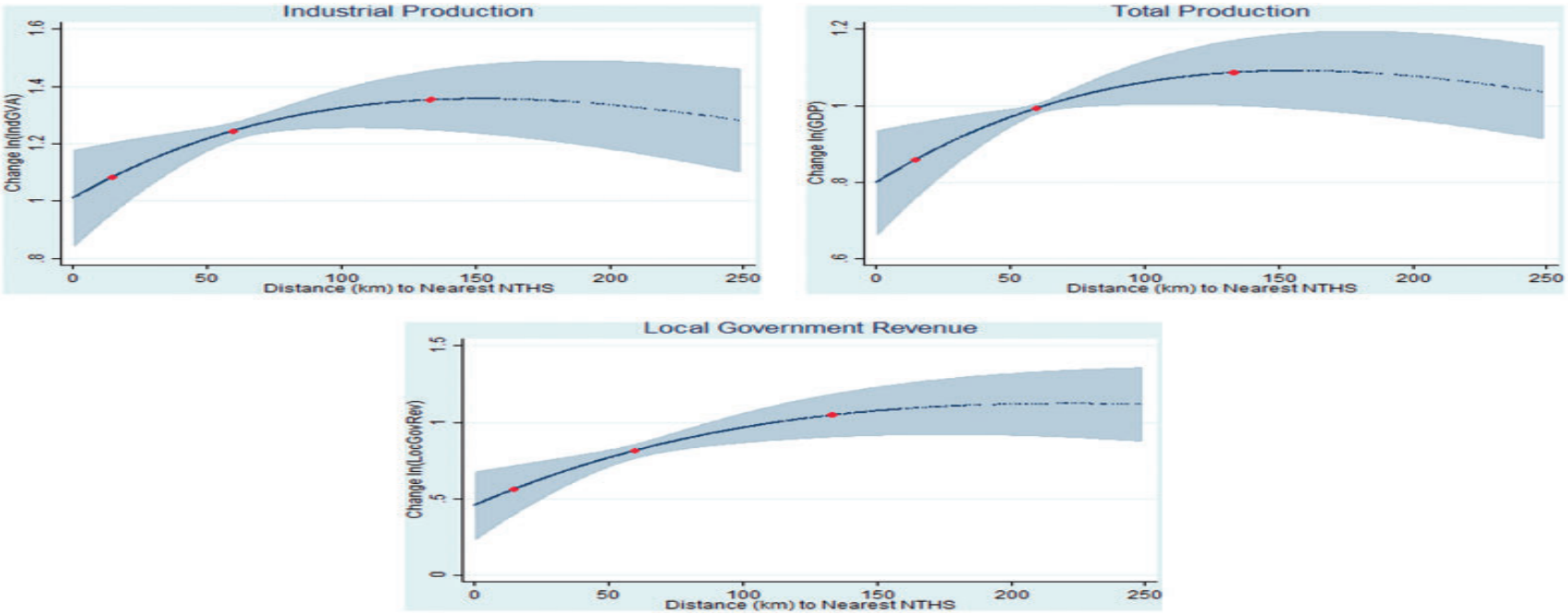



FIGURE 4

Estimated effect of peripheral connections over distance to the nearest NTHS route. The graphs depict the flexibly estimated relationships between distance to the nearest NTHS route and peripheral county growth in industrial value added, total GDP, and local government revenue. The plots correspond to the best fitting polynomial functional form according to the Akaike Information Criterion (AIC). The functions and confidence intervals are based on IV estimates holding covariates at their mean. County distance to the NTHS and its polynomial terms are instrumented with distances to the LCP and Euclidean spanning trees and their polynomials. The red dots indicate median county distances to the nearest NTHS route among connected peripheral counties (left), peripheral counties neighbouring a connected county (centre), and the remaining peripheral counties farther away (right). The shaded areas indicate 90% confidence intervals. Standard errors are clustered at the province level.

# Discussion

Do you find results convincing? Surprising?

Are you satisfied with the instruments?

Anything you would do differently?

Any important details of Chinese context ignored?