Distributive economic impacts of the Bipartisan Infrastructure Law: A case study of Texas applying the computable general equilibrium (CGE) model

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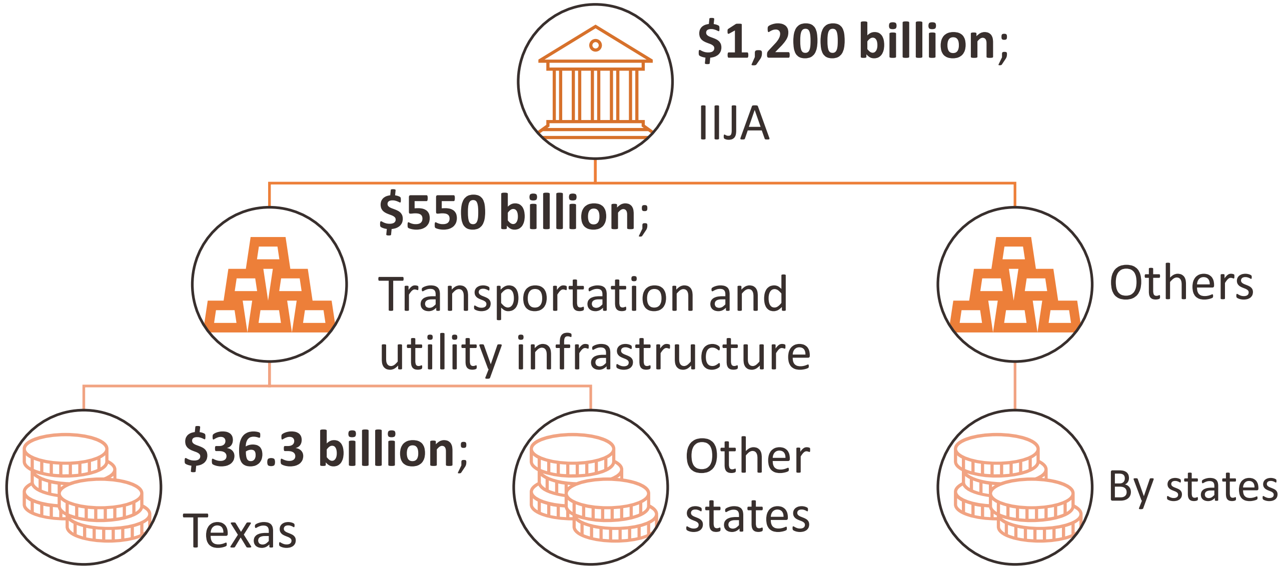
Background of BIL

https://tmacog.org/news/bipartisan-infrastructure-law-update



Introduction

- This study aims to understand the potential distributive economic impacts of the BIL with a focus on the State of Texas.
- The study takes an ex-ante approach applying the TERM-USA model, a customized general equilibrium model for inter-county economic dynamics.
- By estimating the investment impacts across different types of communities and population groups, the study draws policy implications for advancing spatial and social equity.

Framework and methods of transportation impact analysis

Economic impact analysis methods:

CBA **Cost-benefit analysis**

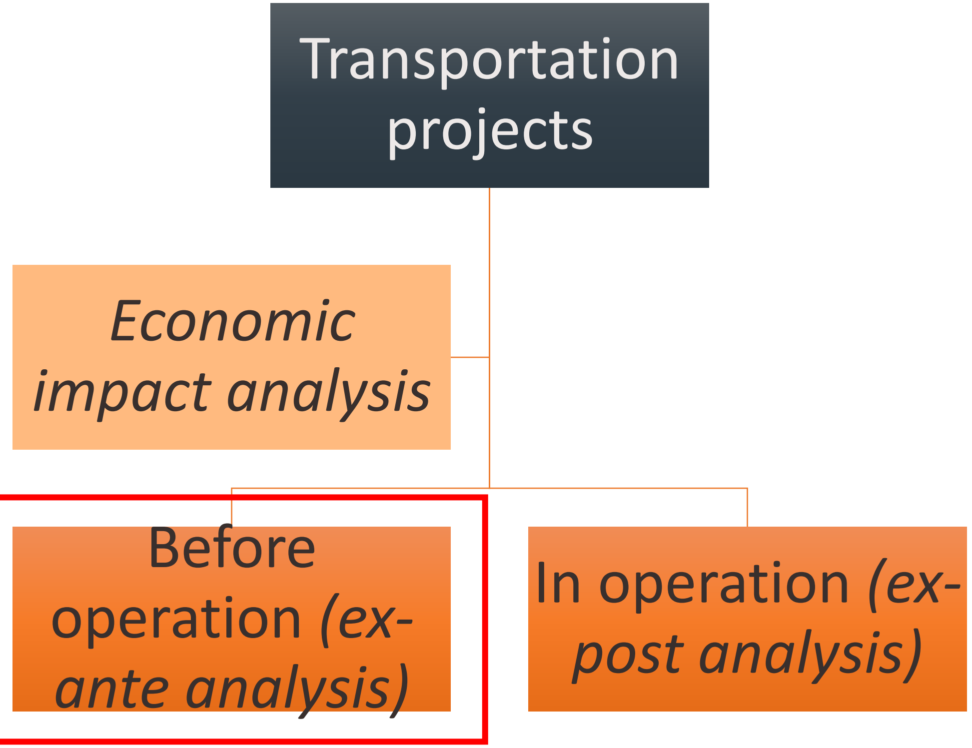
- It measures the efficiency of spending from the viewpoint of benefits and costs to society.

IO **Input-output (IO) model**

- It evaluates the sectoral outputs through intermediate transactions with multiplier.

GE **General equilibrium model**

- It estimates the regional and sectoral outputs through multiple equilibriums.



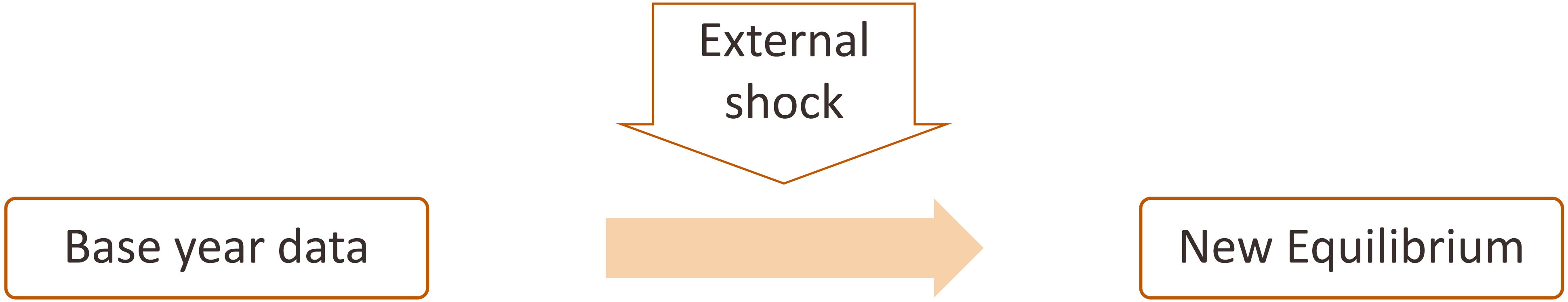
Applications with CGE model for transportation projects

- **Disaster impact evaluation**
  - Seaport disruptions (Wei et al., 2020)
  - COVID-19 effect on transportation loss (Cui et al., 2021)
- **Investment scenario comparison**
  - Cross-border transport improvement (Shahrokhi Shahraki & Bachmann, 2019)
  - Regional transport investment (Rokicki, et al., 2021)
- **Output specification from social aspects**
  - HSR investment on land use (Chen et al., 2016)
  - BIL investment for skilled and unskilled workers (Suarez-Cuesta & Latorre, 2022)

Research gap

- Most existing CGE modeling applications operate at rather large spatial units of analysis.
  - For example, the study by Suarez-Cuesta & Latorre (2022) with the TERM-USA model divided the US economy into 11 regions and combined states.
  - In European applications, CGE models are calibrated typically at the NUT2 level, equivalent to provinces or states.
- Most CGE analyses focus on interpreting the industrial output, while few studies the distributional social impacts and spatial inequality.

Computable General Equilibrium(CGE) Model



- The CGE model can capture the response of agents (firms, households, government) due to the policies or shocks in the economy.
- TERM (the enormous regional model)-USA applied disaggregated economic data in the USA. The base model contains 512 sectors and 70 regions, which gives a master database of 512*512*70 matrix layers.

Matrix in The Enormous Regional Model (TERM)-USA (cont.)

USE(i,o,d) + **TAX** (i, d) + FACTORS = **VTOT** (i, d) = **STOCKS** (i, d) + **MAKE** (c, i, d)

Delivered value of demand

Commodity taxes

Industry output

Inventories

Output of goods

Primary factors

LAB(i,o,d) + **CAP** (i, d) + **LND** (i, d) + **PRODTAX** (i, d) = FACTORS

Wages

Capital rentals

Land rentals

Production tax

Matrix in The Enormous Regional Model (TERM)-USA

USE(i,o,d) + **TAX** (i,d) + FACTORS = **VTOT** (i,d) = **STOCKS** (i,d) + **MAKE** (c,i,d)

Delivered value of demand

Commodity taxes

Industry output

Inventories

Output of goods

Equilibrium

USE_U= **TRADE** (c,i,d) + (**TRADEMAR** (c,s,m,r,d)= **SUPPMAR** (m,r,d,p))=**MAKE_I**

The Enormous Regional Model (TERM) -USA model

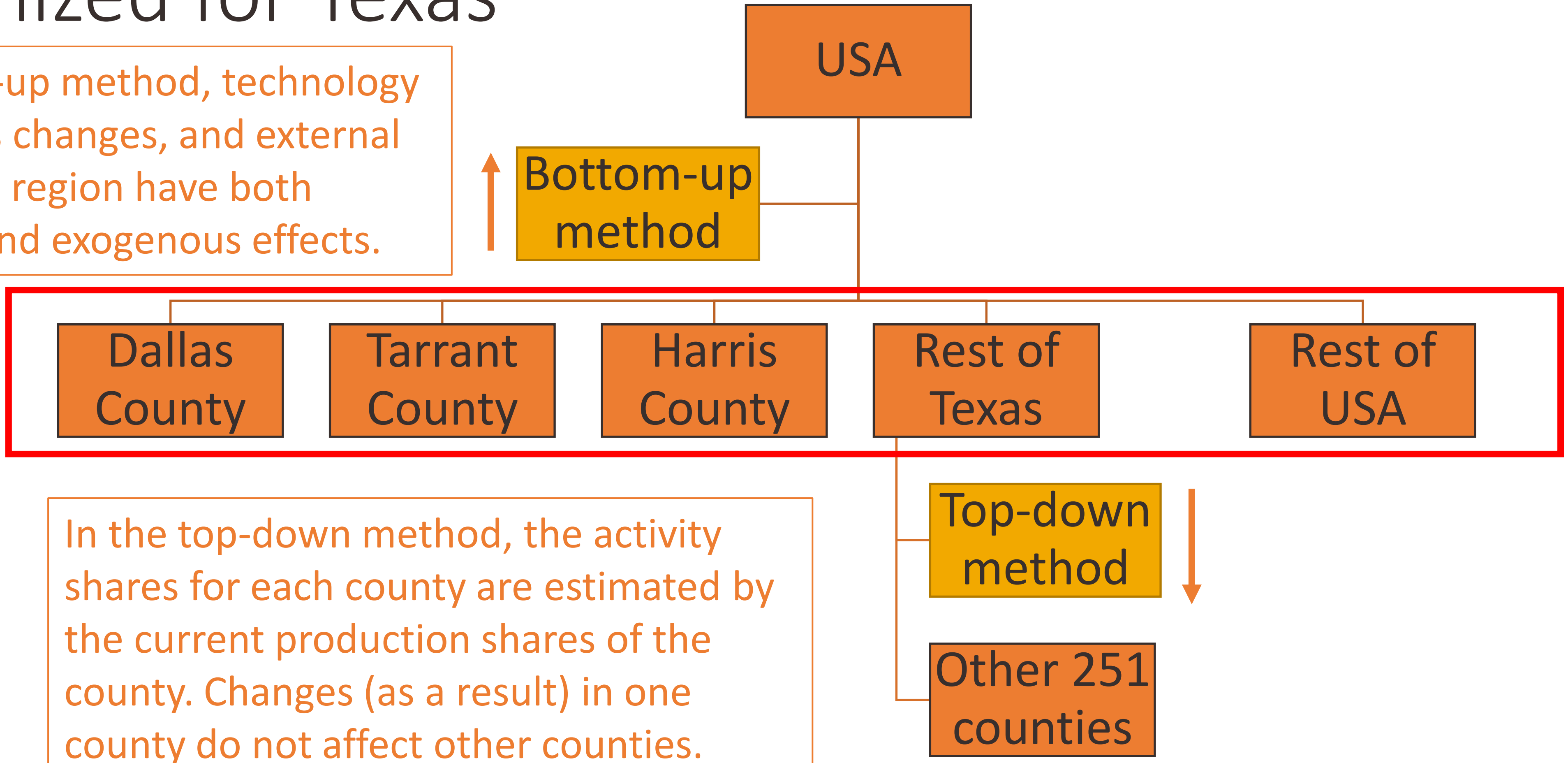
- TERM (the enormous regional model)-USA is a US version CGE model developed by the CoPS at Victoria University, Australia (Horridge, et al., 2008).
- It applied disaggregated economic data in the USA. The base model contains 512 sectors and 70 regions, which gives a master database of 512*512*70 matrix layers.
- Large-scale TERM models (e.g., NUTS2 in European countries, combined states in the USA) apply the bottom-up framework, where each region has its own CGE model linked by inter-regional trade.
- With specific regional interests, the top-down method is applied to break down the impacts by finer geographic scales.

Economic theories in the TERM-USA model

- Neoclassical assumptions
  - Profit optimization and perfect information
- Single CGE model
  - It applies the Leontief model where production = consumption;
  - Constant Elasticity of Substitution (CES) is used for both production and consumption function
- Inter-regional trade
  - It applies the Armington model where goods from different origins have different values and are imperfect substitutes;
  - Gravity assumption

Spatial decomposition of the TERM-USA model customized for Texas

In the bottom-up method, technology changes, taxes changes, and external shocks in each region have both endogenous and exogenous effects.



In the top-down method, the activity shares for each county are estimated by the current production shares of the county. Changes (as a result) in one county do not affect other counties.

Top-down and Bottom-up frameworks

- Bottom-up method
  - Demands, supplies, prices, and quantities are computed for each region separately.
  - Industries minimize the costs of producing outputs.
  - Levels of output satisfy demands and reflect prices and incomes.
- Top-down method
  - Demand for a region can be shifted among counties based on production share and trade distance.
  - Within the same region, changes in a county do not affect other counties.

Industrial sectors involved in BIL funding

	Construction (23)	Manufacturing (33)	Transportation (48)
	Heavy and civil engineering construction (237)	Transportation equipment manufacturing (336)	-
air	Other heavy and civil engineering construction (2379)	Aerospace Product and Parts Manufacturing (3364)	Air transportation (481)
rail	Other heavy and civil engineering construction (2379)	Railroad rolling stock manufacturing (3365)	Rail transportation (482)
water	Other heavy and civil engineering construction (2379)	Ship and boat manufacturing (3366)	water transportation (483)
ground transportation	Land subdivision (2372) Highway, street, and bridge construction (2373)	motor vehicle/motor vehicle body/motor vehicle part manufacturing (3361/3362/3363)	Truck transportation (484) Transit and ground passenger transportation (485)
others	Other heavy and civil engineering construction (2379)	Other transportation equipment manufacturing (3369)	-

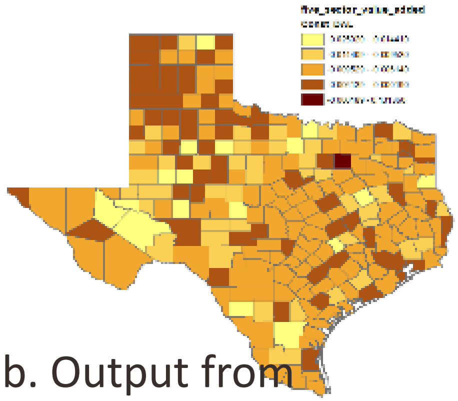
Estimation on funding allocation

INVEST(million)	Construction	AirTrans	RailTrans	WaterTrans	GrdPassTrans
USA Total	109,948.12	53,870.32	17,005.07	31,357.23	2,261.60
Rest of US	100,726.76	48,121.24	15,731.97	29,322.39	2,174.06
Rest of Texas	6,291.05	554.62	866.36	387.18	47.75
Tarrant	577.60	2,076.97	79.57	6.29	7.14
Dallas	940.45	949.41	125.52	61.32	17.44
Harris	1,412.28	2,168.09	201.64	1,580.06	15.21
Texas total	9,221.37	5,749.09	1,273.10	2,034.84	87.54
external investment(5y)	30,337.00	1,200.00	1,237.30	1,977.62	85.08
external investment(1y)	6,067.40	240.00	247.46	395.52	17.02
external shock(1y)	65.80%	4.17%	19.44%	19.44%	19.44%

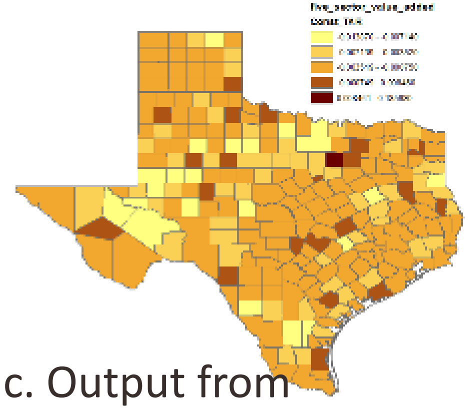
The estimated investment amount is calculated based on the funding categories released by the white house.
The shock percentage is normalized using the TERM model's PUR (purchase price) matrix.

Source:
https://www.texastribune.org/2021/11/09/biden-infrastructure-bill-texas/
https://www.whitehouse.gov/wp-content/uploads/2021/08/TEXAS_Infrastructure-Investment-and-Jobs-Act-State-Fact-Sheet.pdf
https://www.texastribune.org/2021/11/09/biden-infrastructure-bill-texas/

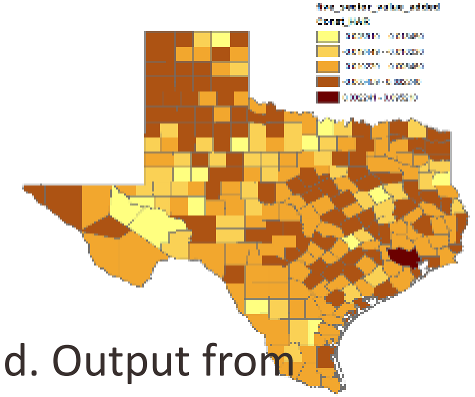
Results – value added changes after shock



b. Output from Dallas county

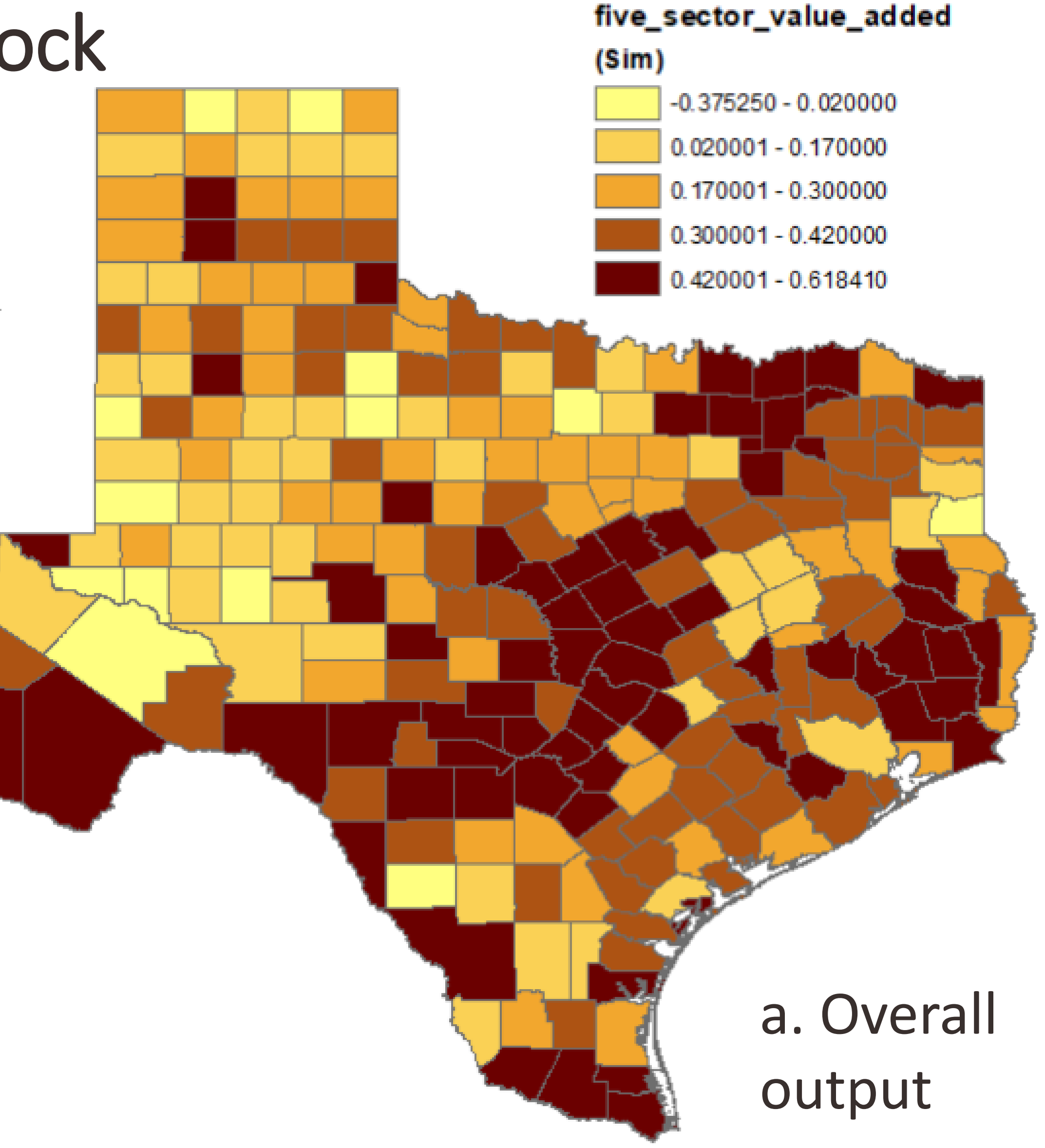


c. Output from Tarrant county



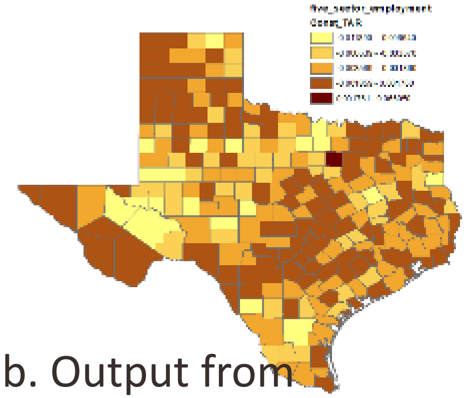
d. Output from Harris county

- Large benefit in the central Texas metropolitan area along I35.
- Some gains in regional economic hubs, e.g., Amarillo, and Rio Grande Valley.
- Value-added loss in 10 rural counties.

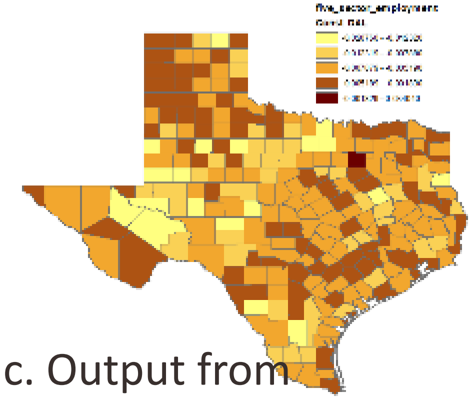


a. Overall output

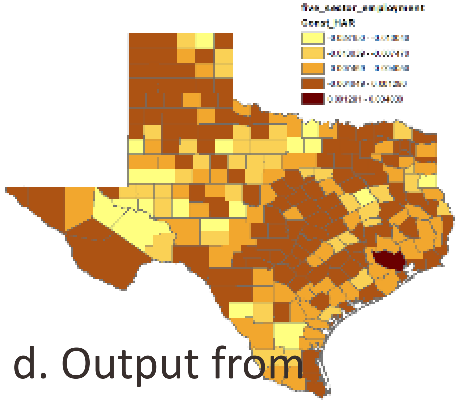
Results – employment changes after shock



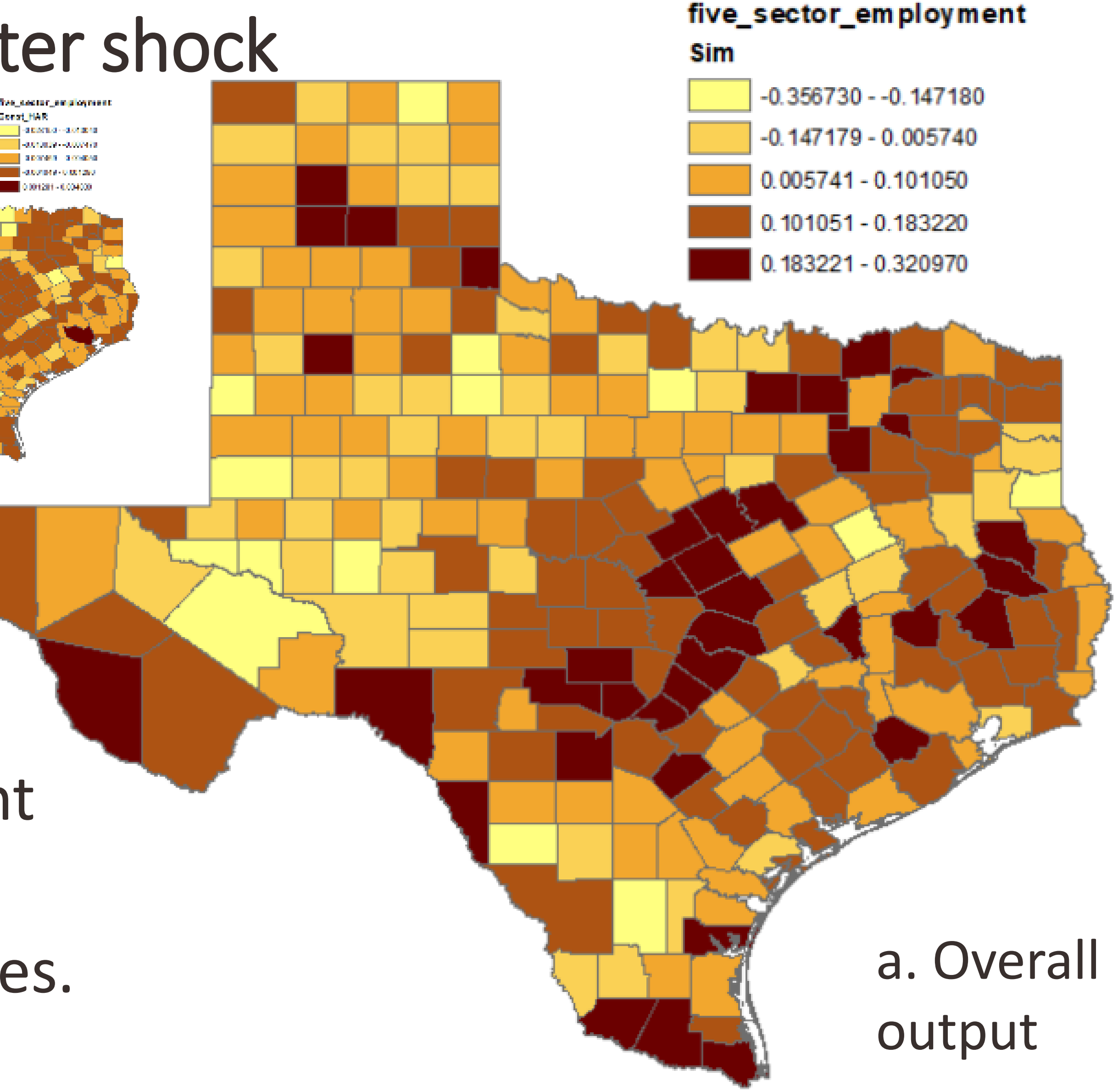
b. Output from Dallas county



c. Output from Tarrant county



d. Output from Harris county

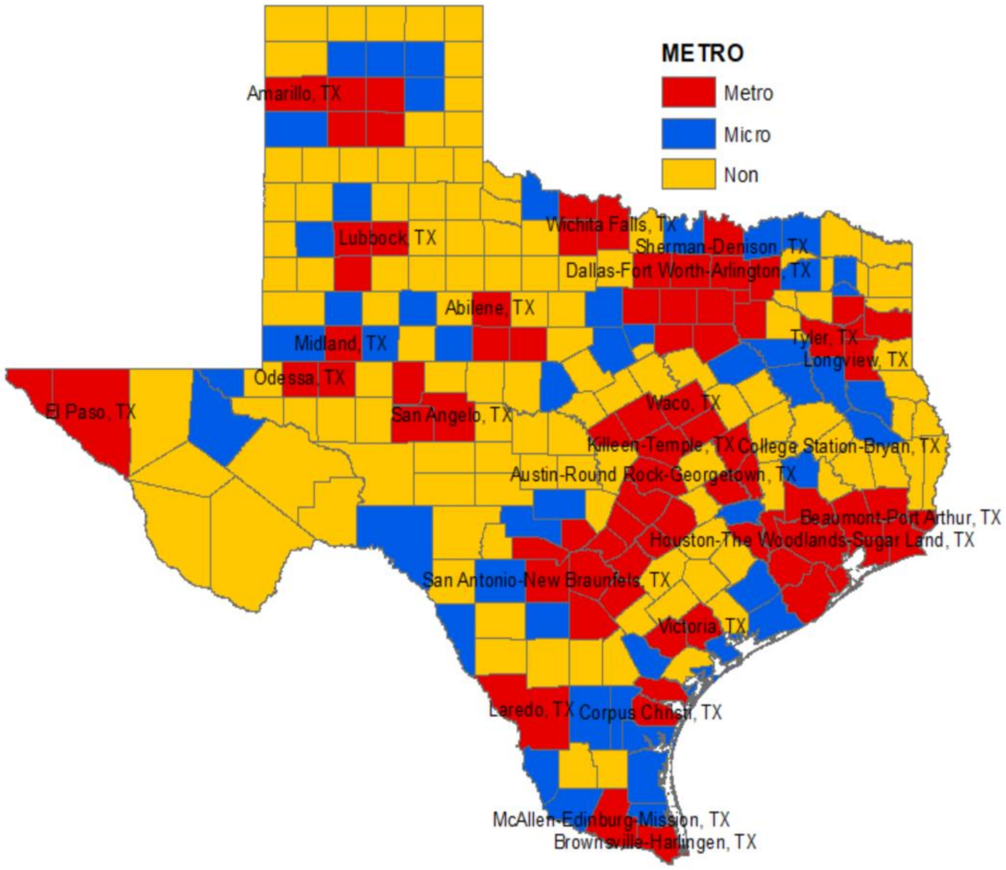


a. Overall output

- Less overall increase in employment compared to the industry output.
- Employment loss in 54 rural counties.

Results – impact distribution by metro/micro/rural areas

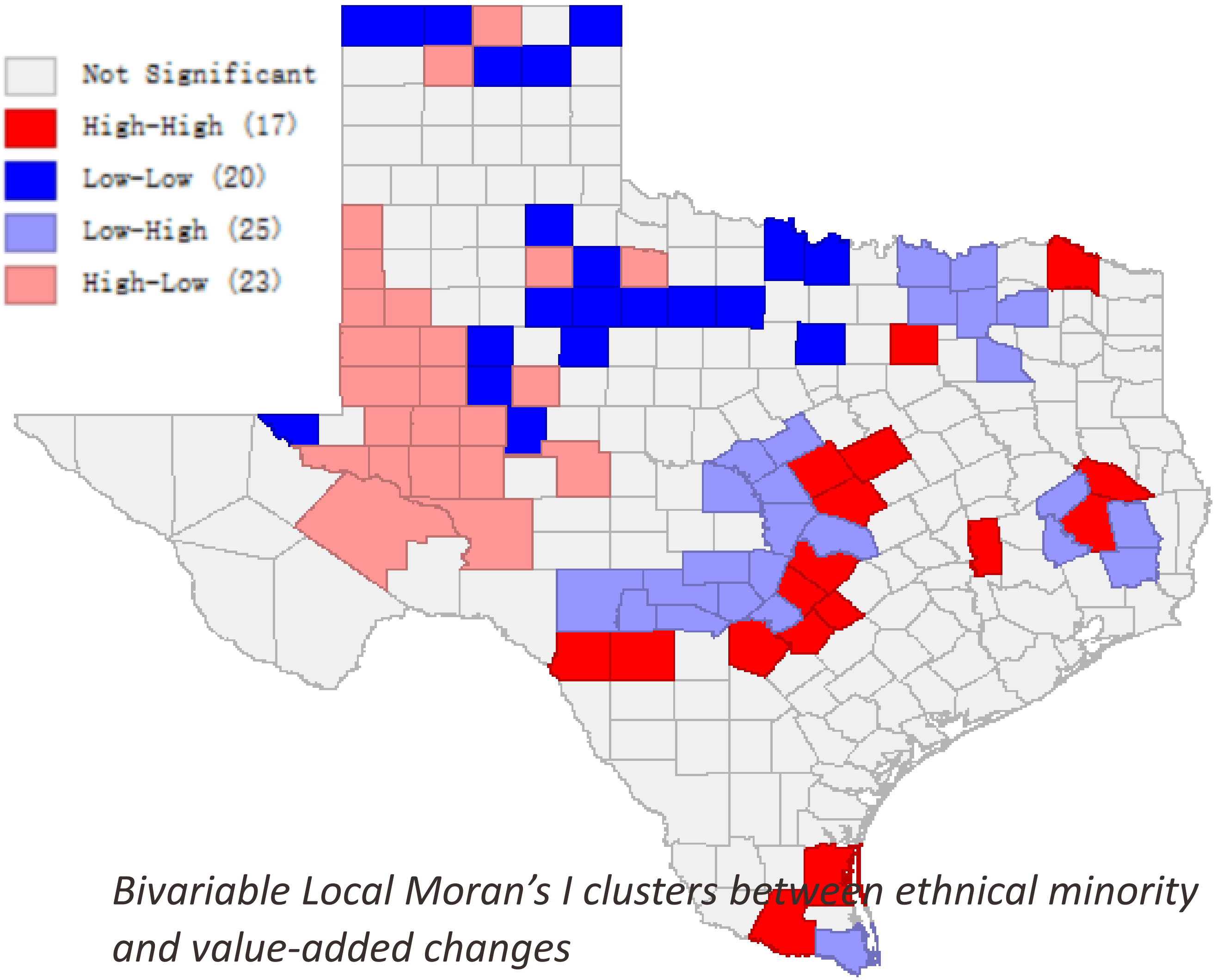
		Metropolitan areas	Micropolitan areas	Rural areas	Texas State
Total value-added (billion)	Before investment	1,488,436	108,314	133,399	1,730,149
	After investment	1,492,813	108,604	133,662	1,735,079
	Percentage change	0.294%	0.268%	0.197%	0.285%
Total employment	Before investment	16,056,219	889,272	761,171	17,706,662
	After investment	16,074,687	890,268	761,765	17,726,719
	Percentage change	0.115%	0.112%	0.078%	0.113%



Micropolitan, Metropolitan, and non-urban areas in Texas

Results – cluster analysis on value-added changes and ethnic minority

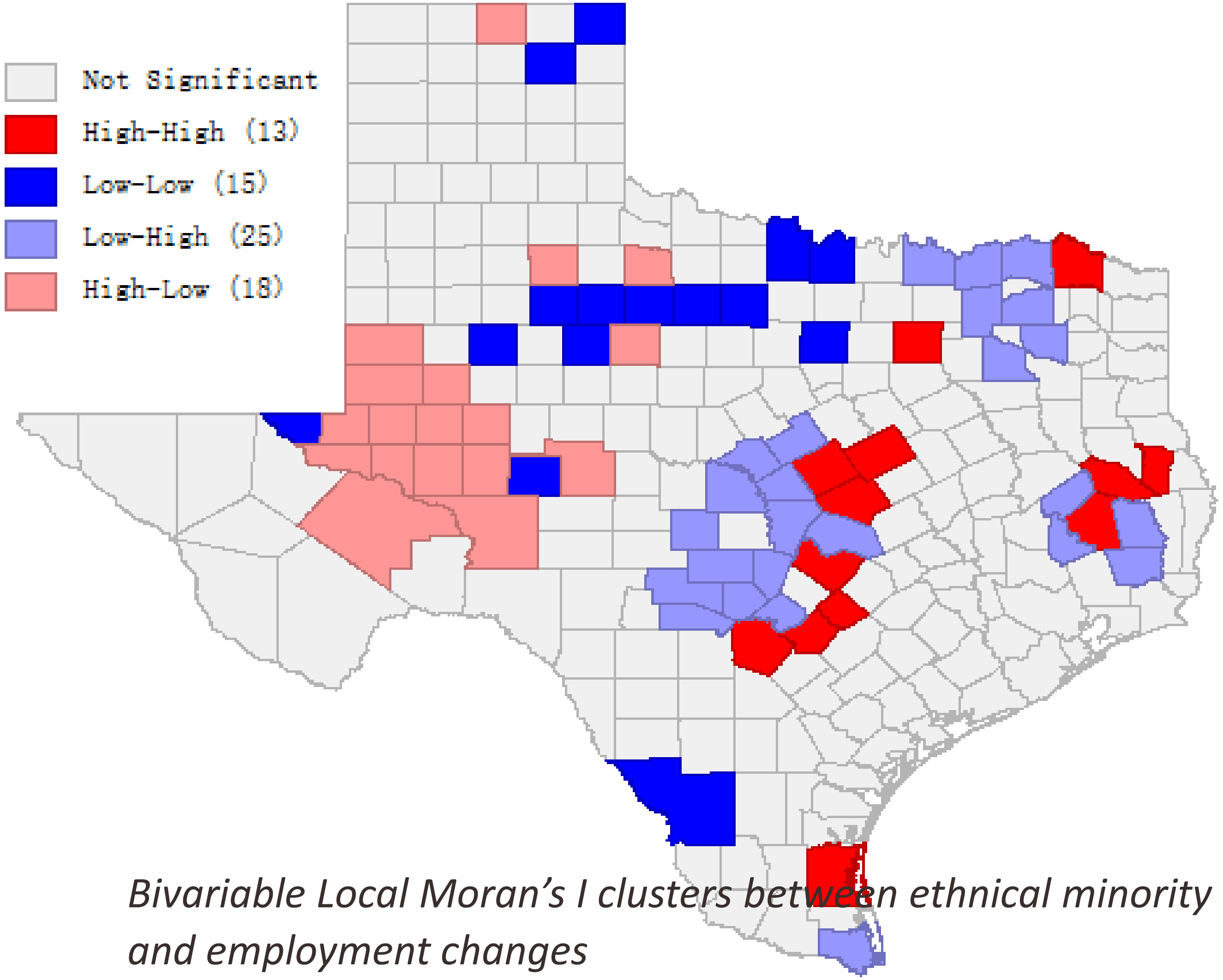
- The high-high clusters in red indicated those clusters had both high ethnic minority groups and a high increase in value added by transportation investment.
- The low-low cluster indicates those counties have low ethnic minority groups yet didn't benefit much from transportation investment.
- The low-high cluster in light blue indicates that those counties have low ethnic minority groups but high economic groups with BIL investment.
- The high-low cluster in light red are the places worse off in this game, indicating those counties have high-ethnic minority groups but low economic growth.



Bivariable Local Moran's I clusters between ethnical minority and value-added changes

Results – cluster analysis on employment changes and ethnic minority

- The employment change is less dramatic for ethnic minority groups in general compared to value-added changes.
- Both high-high and low-low clusters appear at the same place for employment changes and value-added changes.
- Smaller high-low clusters exist in the west of Texas for employment changes, indicating fewer counties are worse off in the employment changes from BIL.
- Smaller low-high clusters exist in the west suburb of San Antonio, indicating fewer counties benefit from the employment changes from BIIL.



Bivariable Local Moran's I clusters between ethnical minority and employment changes

Results – social impact by occupation

		before	after	increase	Percentage change
Dallas County	Skilled	1,108,120	1,109,889	1,769	0.160%
	Unskilled	1,999,740	2,004,181	4,441	0.222%
	Total	3,107,859	3,114,070	6,211	0.200%
Harris County	Skilled	1,018,837	1,019,685	848	0.083%
	Unskilled	2,669,849	2,672,180	2,331	0.087%
	Total	3,688,686	3,691,865	3,179	0.086%
Tarrant County	Skilled	265,055	265,618	563	0.212%
	Unskilled	956,432	958,624	2,192	0.229%
	Total	1,221,487	1,224,242	2,755	0.226%
Rest of Texas	Skilled	1,849,007	1,856,510	7,503	0.406%
	Unskilled	6,092,026	6,118,609	26,583	0.436%
	Total	7,941,033	7,975,119	34,086	0.429%
Texas total	Skilled	4,241,018	4,251,702	10,684	0.252%
	Unskilled	11,718,047	11,753,595	35,547	0.303%
	Total	15,959,065	16,005,296	46,231	0.290%

- The labor increase ratio between unskilled and skilled workers is three to two statewide, indicating that BIL funding will create more unskilled job opportunities in Texas.
- Compared to the proportion of occupational employment statewide, Dallas County has a high concentration of skilled employment. In contrast, Tarrant County and the rest of Texas have comparatively a high concentration of unskilled employment.

Conclusion

- With the 36.3 billion investments in Texas from BIL funding over five years, the model shows that most counties have around 0.1 to 0.3 percent of increase in employment and 0.1 to 0.6 percent of increase in the value added.
- When specifying changes in the Texas rural areas to each county, there are negative changes in some counties due to the market competitiveness.

Conclusion

- Secondly, the results show the county-level connections in Texas between metropolitans and the remote regions. The current regional trade was calculated based on travel distance and the regional productivity. With the major investment in transportation related sectors, it seems counter-intuitive to find that investment in the Dallas County and Harris County has the most significant impact in the remote Texas Panhandle area, rather than the metropolitan suburbs and outskirts. Moreover, compared to the Dallas County and Harris County, Tarrant County with Fort Worth metro had significant less inter-regional trade with the rest of Texas.

Conclusion

- Thirdly, BIL investment may bring uneven social impacts to Texas across locales and occupations. In general, BIL funding will trigger more unskilled job opportunities, especially in non-metropolitan areas. Metro counties where Dallas, Austin, and Houston locate likely have greater BIL-investment-induced increases in GDP and employment than the rural counties in west Texas.

Limitation

- One limitation of this model is the scenario design. Currently, the external shock from BIL funding is roughly distributed based on the location of current transportation infrastructure, meaning that where there is a higher share of transportation productivity, there will be more investment from BIL.
- Secondly, Limited by the calculation capacity, the bottom-up framework with the Leontief method was only applied to five regions. At the same time, the rest of the counties in Texas still utilized regional purchase coefficients for calculating employment and GDP changes. This may lead to impreciseness in estimating rural counties without considering the competitiveness among adjacent counties.

Thanks for your attention and comments!