

ECONOMIC IMPACT OF TRANSPORTATION INNOVATION, TRANSIGHT 4.0

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what does **REMI** say? sm

Transportation and the Economy

- Transportation and economic development are linked
- Networks enable the flow of workers, goods and services within regions and between regions



Technological Revolution



Cutting edge technologies and disruptive business models are changing transportation

- **Ride-hailing apps**
 - Uber, Lyft
- Hybrid and electric vehicles
 - Electric trucks from Cummins, Tesla; hybrid from Volvo
- Driverless vehicles
 - Tesla, Google, Daimler, Volvo, etc.

Driverless Vehicles



Recent Legislation

- House passed "Self Drive Act" for driverless cars
 - Preempt states from passing certain restrictions
 - Allow some driverless cars that don't meet normal safety standards
- Senate Commerce Committee to examine driverless trucks
 - Increase trucking productivity
 - Reduce fuel costs (MIT drafting study)
- Several impacts of driverless vehicles
 - Trucking productivity
 - Commuters and the structure of metro areas

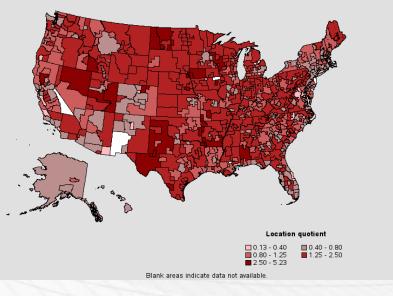
Trucking



- Most common occupation in over half of U.S. states (2014)
- About 3.5 million truck drivers in U.S. (2015)
- \$726.4 billion in U.S. gross freight revenues (2015)

Location quotient of heavy and tractor-trailer truck drivers, by area, May 2016

Regional distribution:



Sources: BLS, NPR, American Trucking Association

Transportation and Economic Development



Driverless vehicles

Labor Accessibility



Commuting; Labor productivity

Intermediates Accessibility

Materials to factories

Final Goods Accessibility

what does **REMI** say? sm

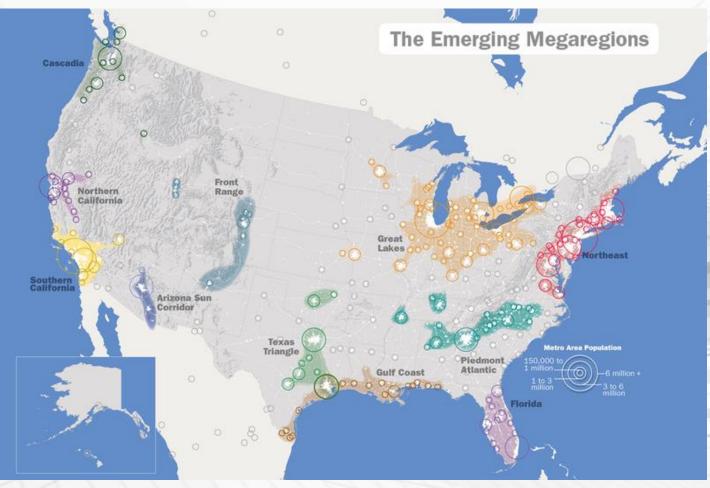
Goods and services to consumers





Emerging Megaregions





what does **REMI** say? sm

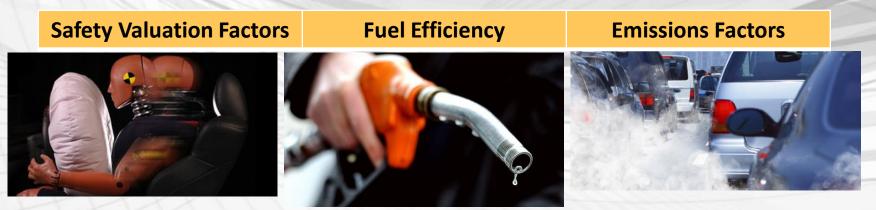
Graphic: Regional Plan Association

What is TranSight 4.0?



TranSight – the next generation platform for estimating the total economic effects of changes to transportation systems. TranSight allows users to understand how transportation networks increase economic competitiveness.

TranSight is also constructed with extensive data on:



TranSight Process



- VMT (by mode)VHT (by mode)
 - Trip Counts (by mode)

Inputs: TDM Indicators

TranSight Calculations

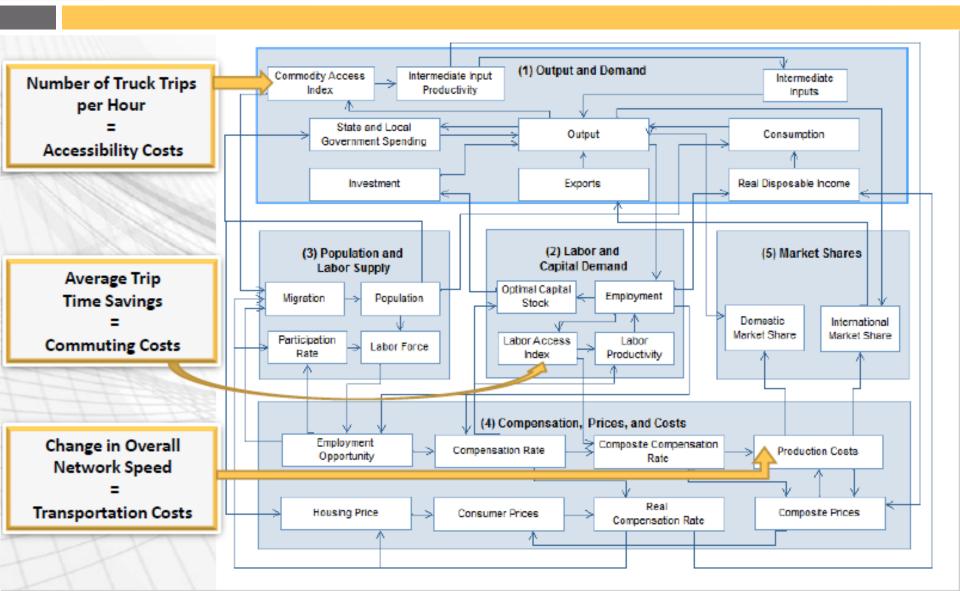
- Accessibility Costs
- Commuting Costs
- Transportation Costs
 - Parameterization

- Employment
 - GDP
- Personal Income
- Economic Migration

Outputs: Macroeconomic Results

TDM Integration with REMI





Static vs. Dynamic Analysis



Static Analysis

- Construction spending
- O&M spending

Dynamic Analysis

- Construction spending
- O&M spending
- Travel time savings
- Emissions savings
- Safety improvements
- Fuel expenditures
- Non-fuel VOCs
- Network speed improvements
- Access to labor
- Access to intermediate inputs

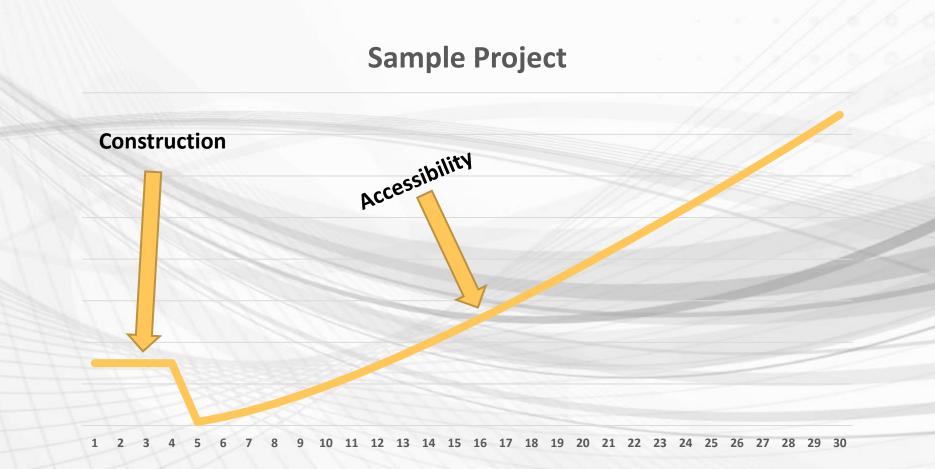
FHWA: TranSight is among the "best equipped to estimate productivity impacts"*

what does **REMI** say? sm

*https://ops.fhwa.dot.gov/publications/fhwahop15034/ch5.htm

Economic Impact Over a Project's Life Cycle





Three Simulations



- 1. Increase in trucking labor productivity
- 2. Decrease in commuting costs
- 3. Commuters move to suburbs

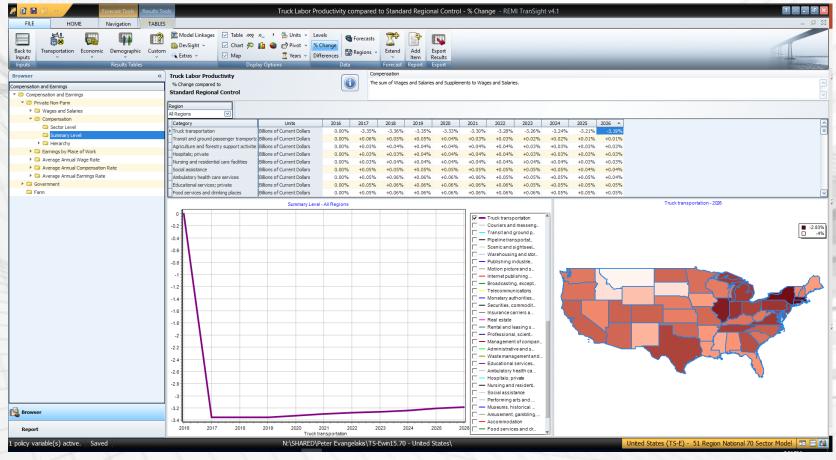


Autonomous vehicles increase labor productivity in truck transportation by 10%

Boon for trucking industry & U.S. economy, but trucking employment over 3% lower than baseline

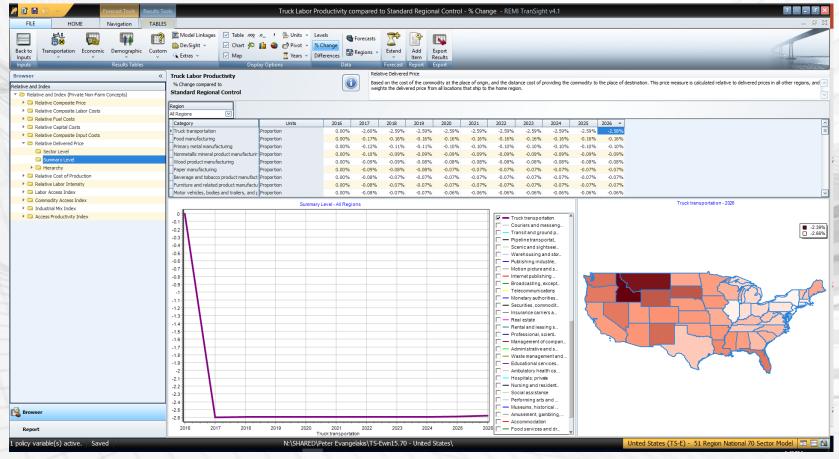


Productivity increase lowers trucking employment relative to baseline, labor costs fall



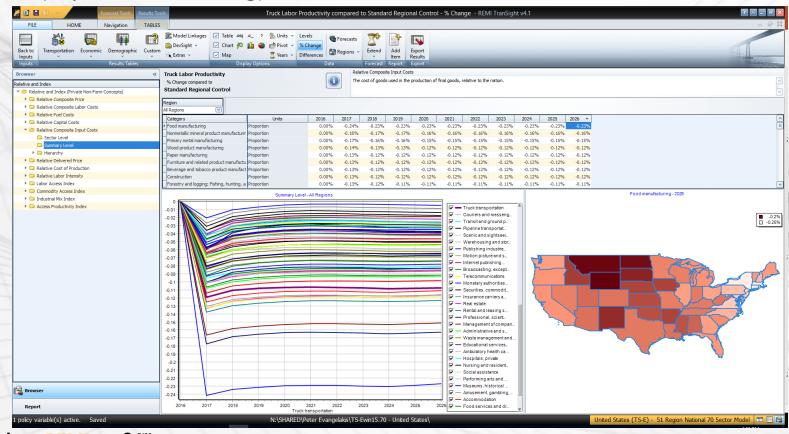


Lower labor costs reduce delivered price of trucking as intermediate input





This lowers input costs for trucking and industries that rely on trucking (esp. manufacturing)



say? sm what does **REMI**



In turn, this lowers production costs across the economy

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uction Costs	% Change compared to 1 The cost of local production using the Composite Input Prices and the Composite Labor Cost.
Relative Cost of Production	Standard Regional Control
Sector Level	Region
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	Category Units 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 -
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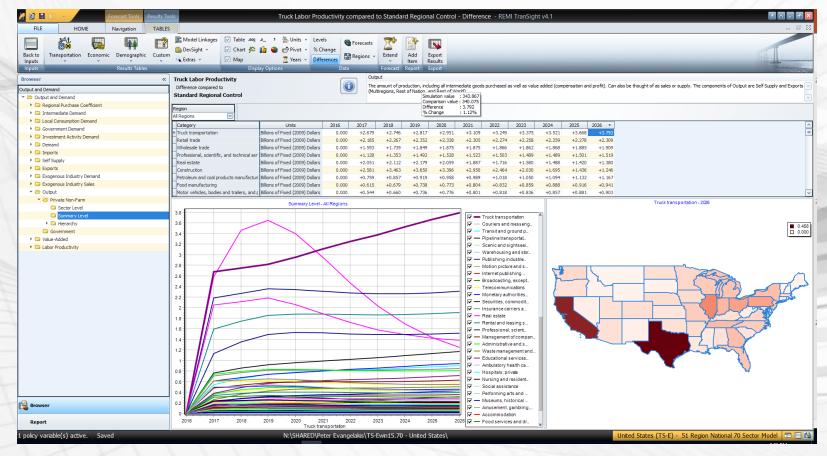


U.S. businesses more competitive, exports and self-supply rise

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Output and Demand	Standard Regional Control
Regional Purchase Coefficient	Region
Intermediate Demand	All Regions (V)
Local Consumption Demand	Category Units 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 -
Government Demand	Truck transportation Billions of Fixed (2009) Dollars 0.000 +2.165 +2.209 +2.254 +2.380 +2.533 +2.670 +2.793 +2.932 +3.065 +3.176
Investment Activity Demand	Petroleum and coal products manufacture [Billions of Fixed (2009) Dollars 0.000 +0.049 +0.080 +0.104 +0.130 +0.157 +0.185 +0.216 +0.251 +0.271 +0.288
Demand	Food manufacturing Billions of Fixed (2009) Dollars 0.000 +0.029 +0.051 +0.069 +0.087 +0.104 +0.119 +0.133 +0.146 +0.160 +0.171
> imports	Motor vehicles, bodes and tralers, and p Billions of Fixed (2009) Dollars 0.000 +0.018 +0.031 +0.040 +0.049 +0.057 +0.064 +0.070 +0.076 +0.082 +0.088
Self Supply	Computer and electronic product manufa Billions of Fixed (2009) Dollars 0.000 +0.030 +0.045 +0.054 +0.060 +0.065 +0.069 +0.073 +0.078 +0.083 +0.087
Exports	Machinery manufacturing Billions of Fixed (2009) Dollars 0.000 +0.018 +0.030 +0.039 +0.048 +0.055 +0.062 +0.068 +0.074 +0.080 +0.085
Exports to Rest of World	Chemical manufacturing Billions of Fixed (2009) Dollars 0.000 +0.016 +0.027 +0.035 +0.043 +0.050 +0.057 +0.063 +0.069 +0.075 +0.081
Private Non-Farm	Other transportation equipment manufac Billions of Fixed (2009) Dollars 0.000 +0.010 +0.015 +0.021 +0.025 +0.030 +0.033 +0.036 +0.039 +0.042 +0.044
C Sector Level	Primary metal manufacturing Billions of Fixed (2009) Dollars 0.000 +0.005 +0.009 +0.012 +0.015 +0.018 +0.021 +0.023 +0.027 +0.029
Summary Level	Summary Level - All Regions Truck transportation - 2026
Hierarchy	32
Exports to Rest of Nation	3.1
Exports to Multiregions	3 29 V — Couriers and messeng. V — Transitiand ground p.
Government Exports	23 28 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓
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This raises U.S. output, both in the trucking industry and overall





1% decrease in commuting costs among SoCal counties

Increased access to labor lowers production costs, making business more competitive and raising output across the economy

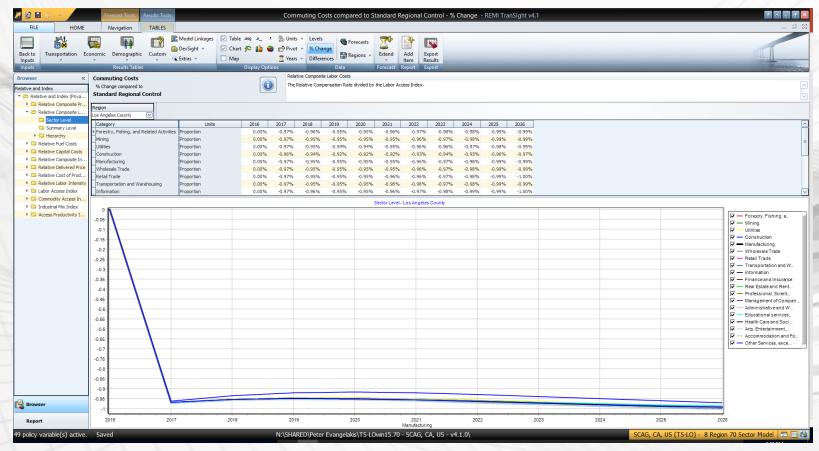


Lower commuting costs increase access to labor

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vser « ve and Index Relative and Index (Priva	Commuting Costs % Change compared to Standard Regional Control			Labor Access In An index that e		access to labor choic	e and individual character	stics by occupation a	and industry on labor	productivity. The index is relative to th	e nation, and benchmarked to the last hist	ory year.
Relative Composite Pr Relative Composite L Relative Fuel Costs	Region Los Angeles County											
Relative Capital Costs Relative Composite In Relative Delivered Price	Category Forestry, Fishing, and Related Ac Mining	2015=1	2016 0.00% 0.00%	2017 2018 +1.01% +1.02% +1.02% +1.03%	+1.04% +1.0	03% +1.03% 04% +1.05%	2022 2023 +1.03% +1.03% +1.05% +1.05%	+1.05% +1.	02% +1.02% 05% +1.06%			
Relative Cost of Prod Relative Labor Intensity Labor Access Index	Utilities Construction Manufacturing Wholesale Trade	2015=1 2015=1 2015=1 2015=1	0.00% 0.00% 0.00% 0.00%	+1.02% +1.03% +1.04% +1.06% +1.02% +1.03%	+1.08% +1.0	03% +1.04% 09% +1.09% 04% +1.04% 03% +1.03%	+1.04% +1.04% +1.09% +1.09% +1.05% +1.05% +1.03% +1.03%	+1.08% +1. +1.06% +1.	04% +1.04% 08% +1.07% 06% +1.06% 03% +1.03%			
Sector Level Summary Level Hierarchy	Retail Trade Retail Trade Transportation and Warehousing Information	2015=1 2015=1 2015=1 2015=1	0.00%	+1.02% +1.02% +1.02% +1.03% +1.02% +1.02% +1.02% +1.02%	+1.03% +1.0	03% +1.03% 04% +1.04% 03% +1.03% 02% +1.03%	+1.03% +1.03% +1.04% +1.04% +1.03% +1.03% +1.03% +1.03%	+1.03% +1. +1.03% +1.	03% +1.03% 03% +1.03% 03% +1.03% 03% +1.03%			
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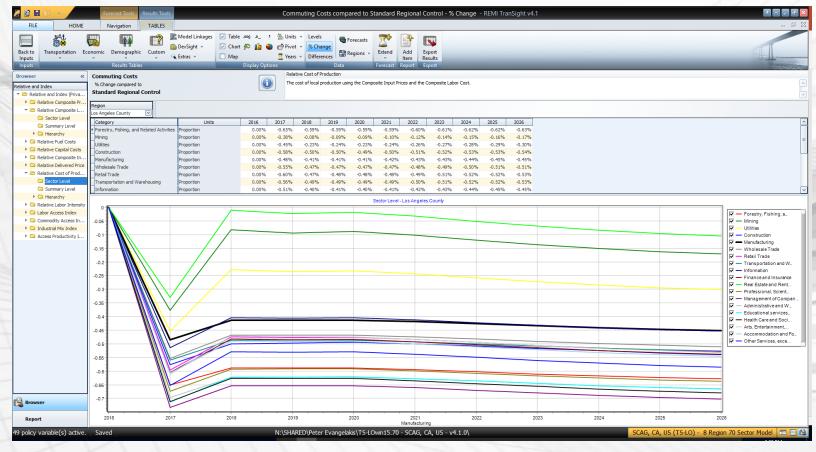


Reduce labor costs by improving pool of potential employees



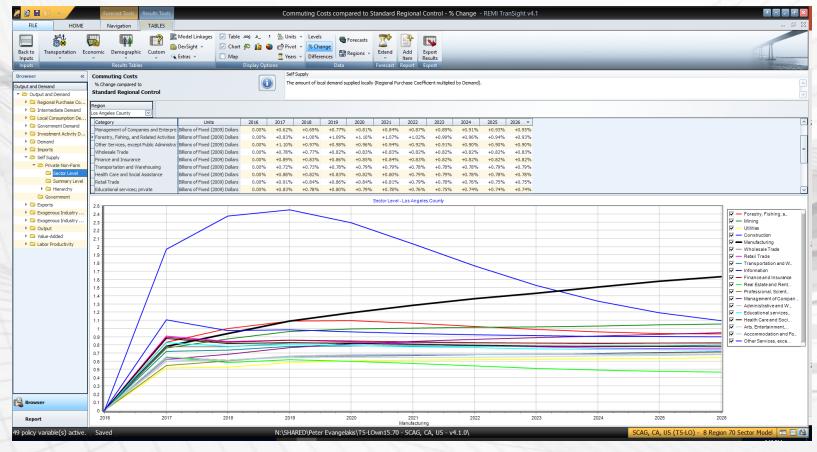


This lowers production costs across all sectors





This makes businesses more competitive...





...which raises output

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Local Consumption De	Category		Units	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026					
Government Demand Investment Activity D	Forestry, Fishing, a	and Related Activities			+0.74%	+0.90%	+0.99%	+1.00%	+0.98%	+0.95%	+0.92%	+0.90%	+0.89%	+0.88%					
Demand	Mining		Billions of Fixed (2009)			+0.82%	+0.91%	+0.93%	+0.93%	+0.93%	+0.93%	+0.94%	+0.95%	+0.96%					
Imports	Utilities Construction		Billions of Fixed (2009)		+0.52%	+0.53%	+0.58%	+0.60%	+0.61%	+0.62%	+0.62%	+0.63%	+0.64%	+0.64%					
Self Supply	Manufacturing		Billions of Fixed (2009) Billions of Fixed (2009)		+1.97%	+2.37%	+2.45% +0.84%	+2.29% +0.92%	+2.04%	+1.77%	+1.53%	+1.33% +1.15%	+1.19% +1.21%	+1.09%					
Exports	Wholesale Trade		Billions of Fixed (2009)		+0.56%	+0.57%	+0.61%	+0.63%	+0.63%	+0.63%	+0.63%	+0.63%	+0.64%	+0.64%					
Exogenous Industry	Retail Trade		Billions of Fixed (2009)		+0.88%	+0.83%	+0.85%	+0.83%	+0.81%	+0.80%	+0.79%	+0.78%	+0.77%	+0.77%					
Exogenous Industry	Transportation and	Warehousing	Billions of Fixed (2009)		+0.56%	+0.60%	+0.65%	+0.67%	+0.68%	+0.69%	+0.70%	+0.71%	+0.72%	+0.73%					
Output Private Non-Farm	Information		Billions of Fixed (2009)	ollars 0.00%	+0.37%	+0.39%	+0.44%	+0.47%	+0.50%	+0.52%	+0.54%	+0.55%	+0.57%	+0.58%					
Private Non-Farm Sector Level	2.5							St	ector Level - L	os Angeles Co	ounty								
Summary Level	2.5					_													Forestry, Fishing, a
Hierarchy	2.4		/																Mining
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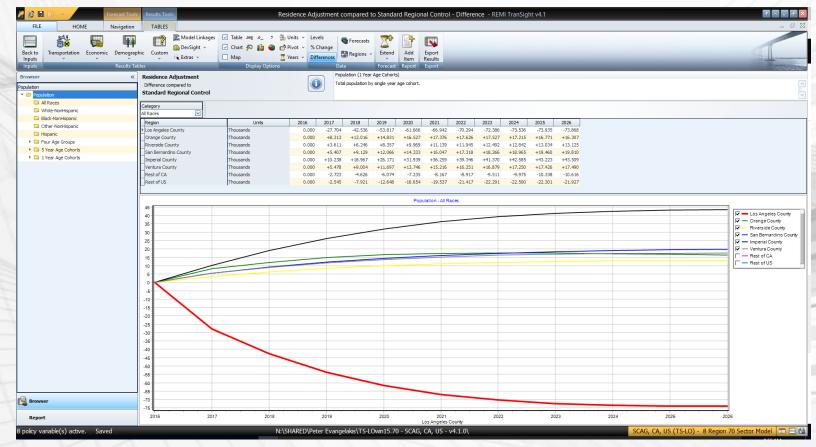


\$5 billion of commuter personal income from L.A. to surrounding counties

 In surrounding counties, temporary construction booms and permanent increases in population-reliant industries such as real estate, retail trade, health care



Population shift from L.A. to surrounding counties



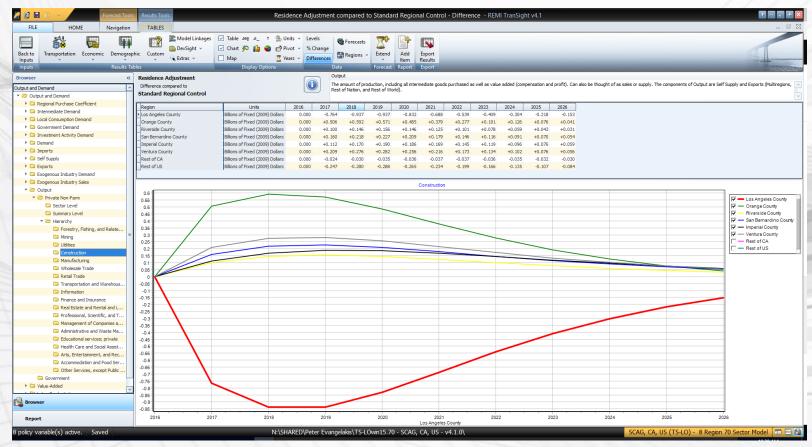


Optimal housing stock falls in L.A., rises in surrounding counties

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Labor Intensity Determinants	Region	Units	2016	2017 20	018 2019	2020	2021	2022 2023	2024	2025	2026			
Output Components by Demand Source	Los Angeles County	Billions of Fixed (2009) Dollars	0.000	-15.222 -	-13.504 -13.529	-13.278	-13.014	-12.686 -12.4	53 -12.218	-11.909	-11.611			
Export Determinants	Orange County	Billions of Fixed (2009) Dollars	0.000		+5.765 +5.655			+4.957 +4.7		+4.468	+4.320			
Sources for Meeting Local Demand	Riverside County	Billions of Fixed (2009) Dollars	0.000		+1.554 +1.569			+1.474 +1.4		+1.363	+1.326			
Sources for Meeting Local Demand	San Bernardino County	Billions of Fixed (2009) Dollars	0.000		+2.354 +2.355			+2.263 +2.2		+2.160	+2.119			
Regional Purchase Coefficient Determinants	Imperial County	Billions of Fixed (2009) Dollars	0.000		+2.308 +2.448			+2.524 +2.4		+2.396	+2.345			
Final Demand Components	Ventura County Rest of CA	Billions of Fixed (2009) Dollars	0.000		+2.843 +2.835 -0.246 -0.302			+2.696 +2.6		+2.534	+2.477			
Consumption Determinants	Rest of US	Billions of Fixed (2009) Dollars Billions of Fixed (2009) Dollars	0.000		-0.246 -0.302 -0.071 -0.281			-0.429 -0.4		-0.510	-0.524			
Residential Investment Determinants	Linear of 05	owons of Fixed (2003) Dollars	0.000	0.000	0.071 -0.201	-0.595	-0.453	0.500 -0.5	-0.005	-0.350	0.050			
Nonresidential Investment Determinants														
Nonresidential Optimal Capital Stock Determin.					Residential Investm	tent Determi	nants - Regional	Residential Optima	Capital Stock					_
State and Local Government Spending Deter		<u> </u>												Los Angeles County
Real Disposable Income Determinants	6													✓ — Orange County
Personal Income Determinants	5													Riverside County
Disposable Personal Income per Capita Deter	4													🔽 — San Bernardino Cou
Population Determinants	3					_								🖉 — Imperial County
Net Economic Migrant Determinants	2						_							Ventura County
Labor Force Determinants														Rest of CA
Participation Rate Determinants														Rest of US
Compensation Rate Determinants	0													
Real Relative Compensation Rate (RWR) Det	-1													
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PCE-Price Index Determinants	-3													-
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Relative Housing Price Determinants	-5													
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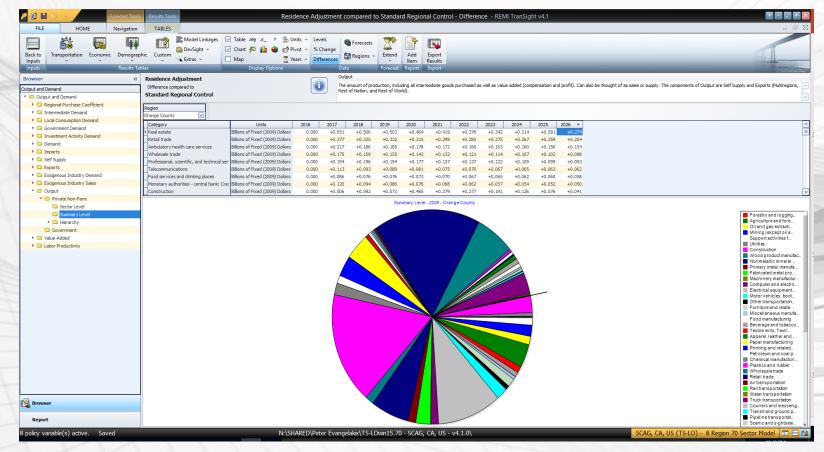


Construction slowdown in L.A., boom in surrounding counties



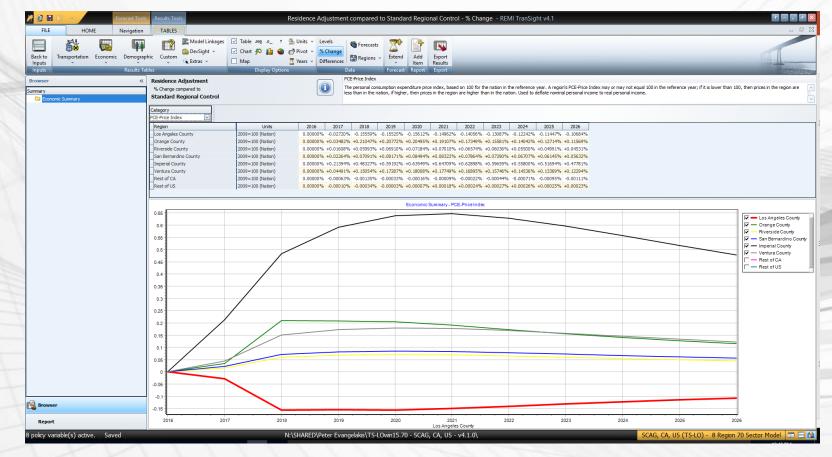


Permanent geographic shift in population-reliant industries





□ L.A. cheaper cost of living, surrounding counties more expensive



Conclusion



- Transportation and the economy are closely linked
- Innovations can have significant national and regional effects
 Ride hailing apps, low emissions vehicles, driverless vehicles*
- Using TranSight, we comprehensively evaluate the impacts of:
 - Increased trucking labor productivity
 - Decreased commuting costs
 - Changing structure of metro areas