

ECONOMIC IMPACT OF TRANSPORTATION INNOVATION, TRANSIGHT 4.0

Billy Leung, Vice President Peter Evangelakis, Economist

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

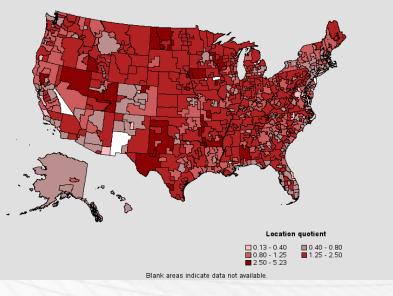
Trucking



- 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

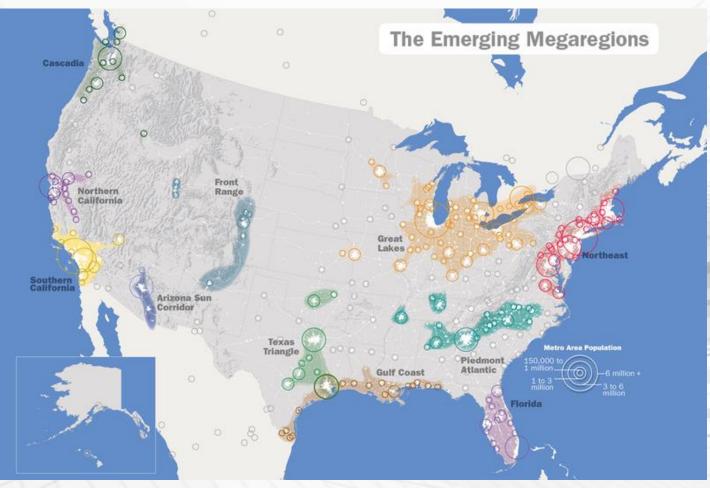
Goods and services to consumers





Emerging Megaregions





what does **REMI** say? sm

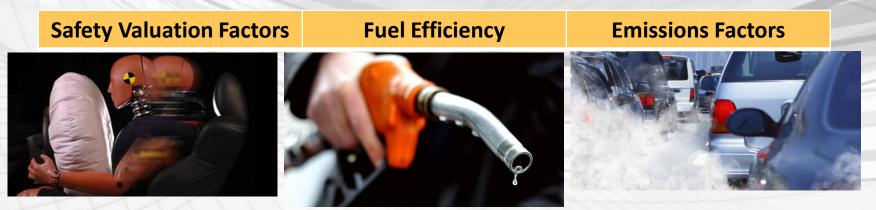
Graphic: Regional Plan Association

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

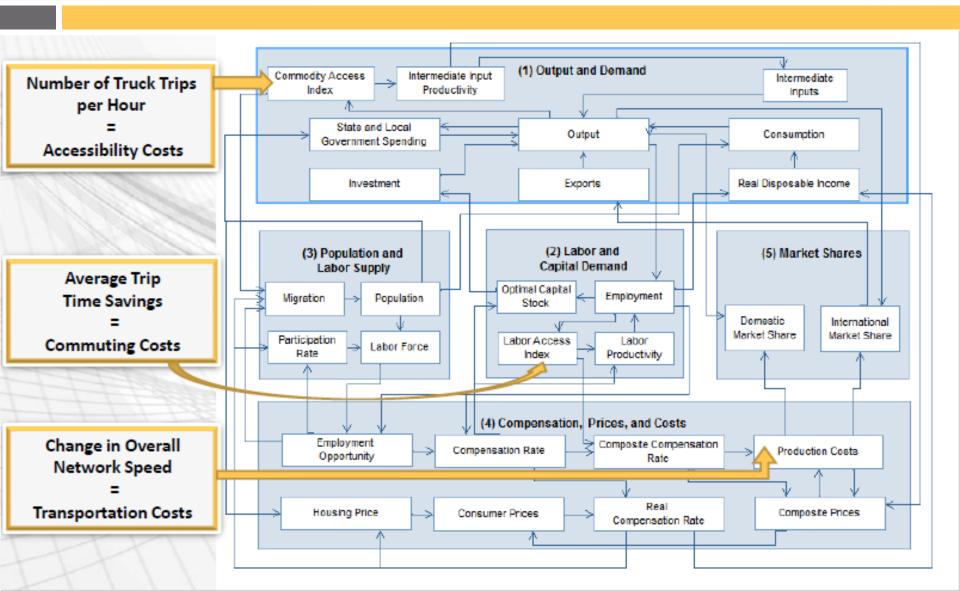
- Accessibility Costs
- Commuting Costs
- Transportation Costs
 - Parameterization

- 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

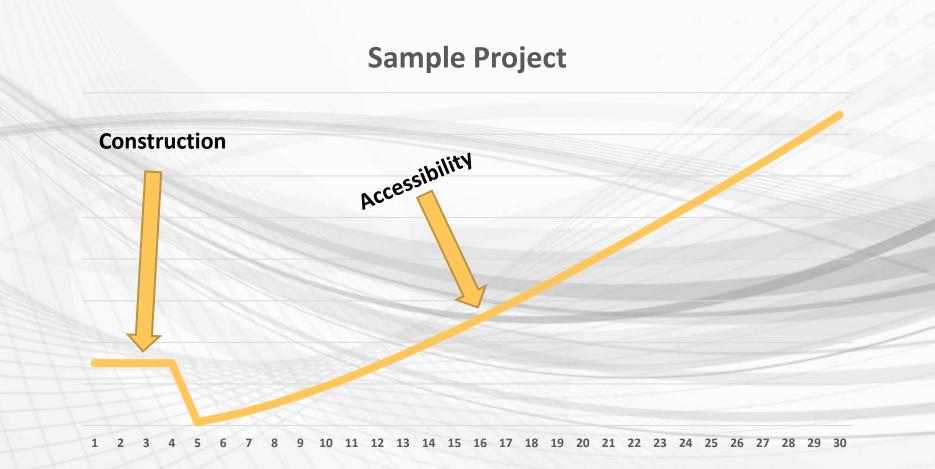
FHWA: TranSight is among the "best equipped to estimate productivity impacts"*

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

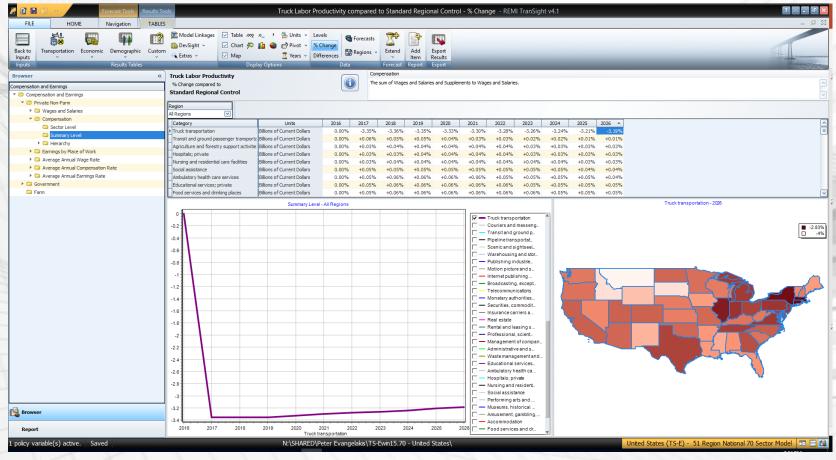


Autonomous vehicles increase labor productivity in truck transportation by 10%

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

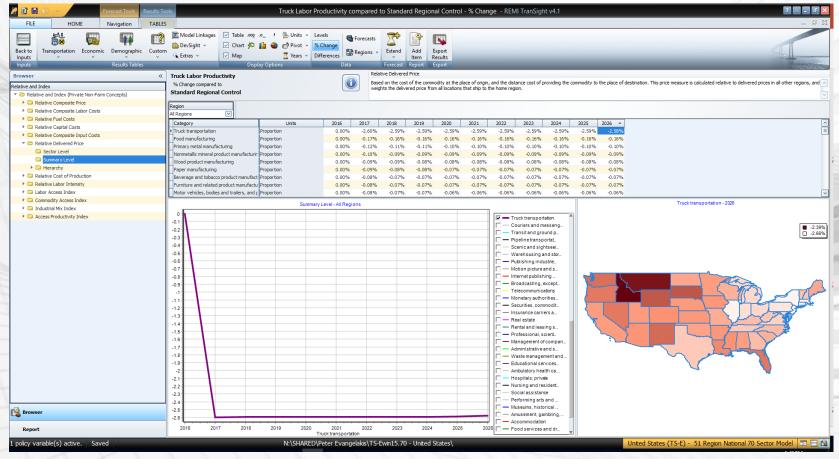


Productivity increase lowers trucking employment relative to baseline, labor costs fall



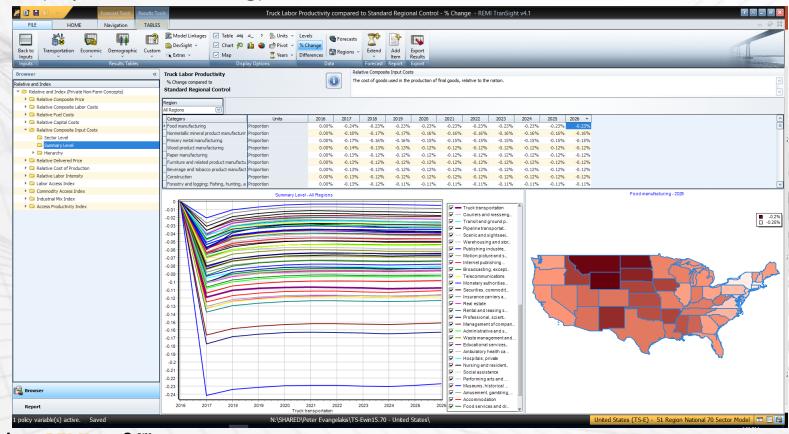


Lower labor costs reduce delivered price of trucking as intermediate input





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

| ck to Transportation Economic Demographic Cus puts Results Tables | T 🚹 DevSight 🗸 🔰 🚰 🕋 Pivot 🖌 % Change 🖉 📟 🐨 |
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| | Truck Labor Productivity Relative Cost of Production |
| 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 |
| Summary Level Interacting the second seco | A Regions |
| | Category Units 2016 2017 2018 2019 2020 2021 2022 2023 2024 2025 2026 - |
| | Plank transportation Propertion 0.00% -2.69% -2.59% |
| | Privary metal manufacturing Properties 0.00% 0.11% 0.11% 0.11% 0.10% 0.00% 0.00% 0.00% 0.00% 0.00% 0.00% |
| | Normetalic mineral product manufacturin Proportion 0.00% -0.10% -0.09% -0.09% -0.09% -0.09% -0.09% -0.09% -0.09% -0.09% |
| | Ved product manufacturing Proportion 0.00% 0.09% 0.09% 0.08% 0.08% 0.08% 0.08% 0.08% 0.08% 0.08% |
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| | Eurologie and deleted product manufactul (Proportion) 0.00% 0.00% 0.07% 0.07% 0.07% 0.07% 0.07% 0.07% 0.07% 0.07% |
| | Motor vehicles, bodies and trailers, and proportion 0.00% -0.08% -0.07% -0.07% -0.06% -0.06% -0.06% -0.06% -0.06% -0.06% -0.06% |
| | Summary Level - All Regions Truck transportation - 2026 |
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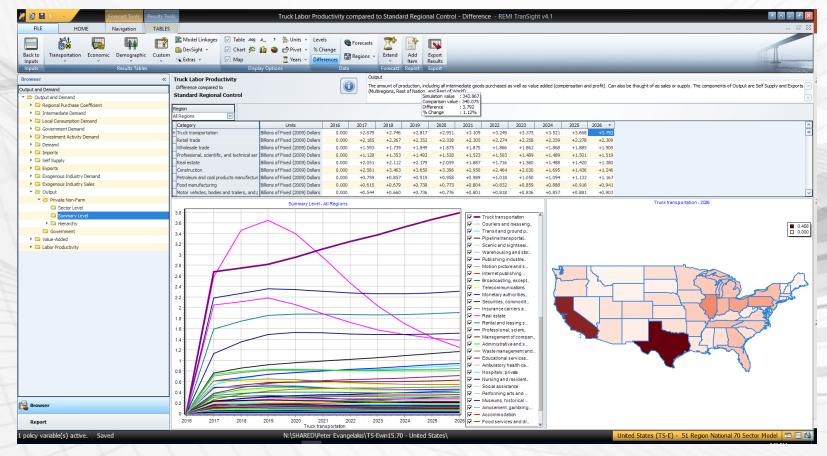


U.S. businesses more competitive, exports and self-supply rise

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| ut and Demand | |
| 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 ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ ↓ |
| Exogenous Industry Demand Exogenous Industry Sales | 2.7 |
| Couput | 2.6 V Concentration of Synthesis V Concentration of Synthyst V Concentration of Synthesis V Concentrati |
| Value-Added | 2.4 Vertishing industrie |
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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

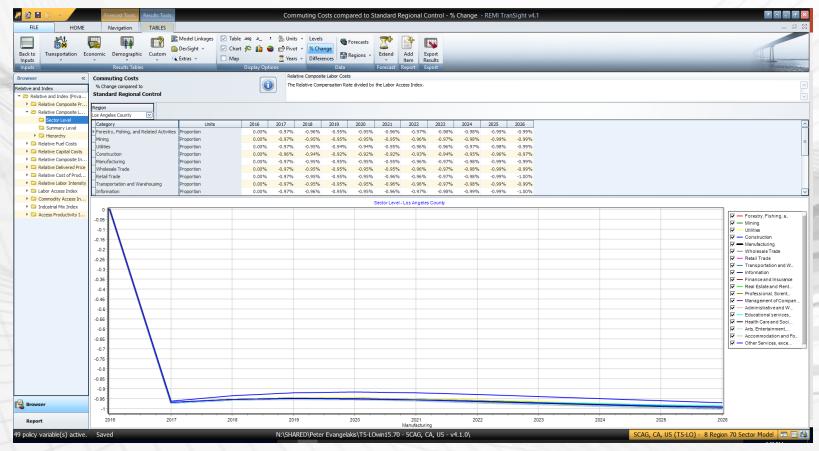


Lower commuting costs increase access to labor

| FILE HOME | Forecast Tools Results To Navigation TABLE | s | | | | to Standard Re | gional Control - % | Change - REN | II TranSight v4.1 | | | |
|---|--|--------------------------------------|--|--|----------------|--|---|--------------------------|--|---|--|---|
| _ | nomic Demographic Custor Results Tables | DevSight ~ | ✓ Table .oog .o_ , ✓ Chart ✓ Map Display Optic | Pivot v %C | hange | s v Extend | Add Export tem Results eport Export | | | | | II |
| 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% | | | |
| Commodity Access In | 1.1 - | 2013-1 | 0.00 % | +1.02 % +1.02 % | 5 T1.02 /8 T1. | | Los Angeles County | +1.05 /8 | 0578 +1.0578 | | | |
| Access Productivity I | 1.05 1.09 0.99 0.86 0.8 0.75 0.77 0.77 0.75 0.77 0.66 0.55 0.6 0.55 0.6 0.55 0.45 0.45 0.45 0.45 0.22 0.22 0.22 0.25 0.25 0.25 0.3 0.45 0.55 | | | | | | | | | | | Image: Test provides and the second secon |
| leport | ۰ ال | 2017 | 2018 | 2019 | 2020 | | 2021 | 2022 | 20 | 23 2024 | 2025 | 2026 |
| icy variable(s) active. | | | | | | | Ianufacturing SCAG, CA, US - v⁴ | 4.01 | | | | 8 Region 70 Sector Model |

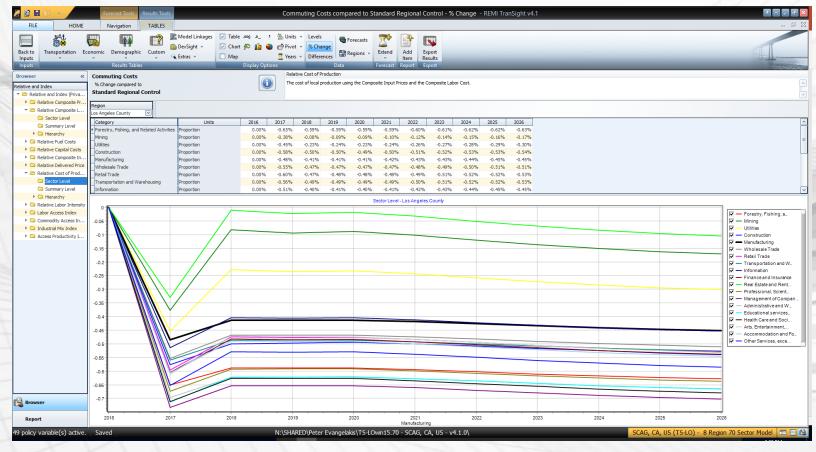


Reduce labor costs by improving pool of potential employees



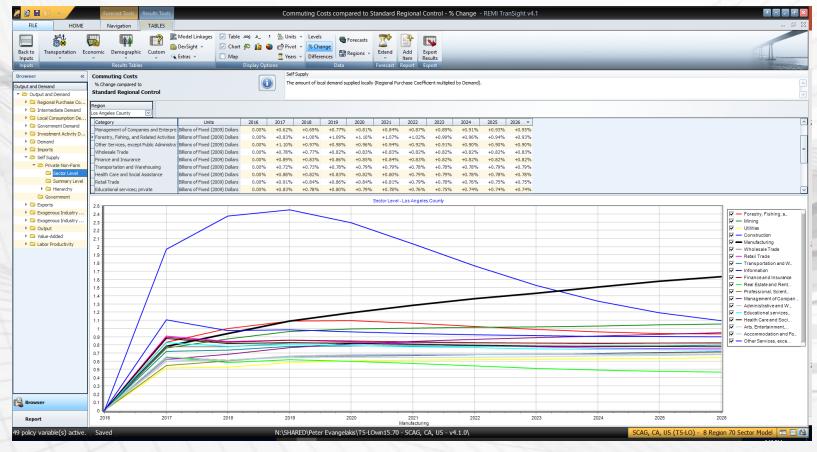


This lowers production costs across all sectors





This makes businesses more competitive...





...which raises output

| | Navigation | ohic Custom | DevSight - | Table .000 .0_ Chart 📯 🏰 (Map Display Op | Pivot Years | Levels % Change Different | ge ED o | , | | Add Expo tem Result | ort llts | _ | _ | _ | _ | _ | _ | _ | |
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| t and Demand Output and Demand | Commuting Cos % Change compare Standard Region | ed to | | | Output The a Rest of | | uction, includ | ing all interm | ediate goods (| ourchased as v | well as value | added (comp | ensation and j | profit). Can al | to be thought of as s | ales or supply. The | components of Output a | are Self Supply and Exports | (Multiregions, Rest of Nation, and |
| Regional Purchase Co Intermediate Demand | Region Los Angeles County | | | | | | | | | | | | | | | | | | |
| 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 |
| Government | 2.2 | | | | | | | <u> </u> | | | | | | | | | | | Vilities |
| Value-Added | 2.1 | | | | | | | | ~ | | | | | | | | | | Construction |
| Labor Productivity | 2 | | | | | | | | | | | | | | | | | | Manufacturing |
| | 1.9 | | | | | | | | | | | | | | | | | | Retail Trade |
| | 1.8 | / | | | | | | | | | | | | | | | | | Transportation and V |
| | 1.7 | | | | | | | | | | | | ~ | | | | | | - Information |
| | 1.6 | | | | | | | | | | | | | | | | | | Finance and Insurance |
| | 1.5 | | | | | | | | | | | | | | | | | | Professional, Scient. |
| | 1.4 | | | | | | | | | | | | | | | | | | Management of Comp |
| | 1.3 | | | | | | | | | | | | | | | | | | Administrative and W |
| | 1.1 | | | | | | | | | | | | | | | | | | Educational services. Health Care and Soci. |
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| eport | 2016 | 2017 | 2 | 018 | 2019 | | 20 | 20 | | 2021 | | 2022 | | 202 | 3 | 2024 | 2025 | 20 | 26 |
| | | | | | | | | | Ma | nufacturing | | | | | | | | | |

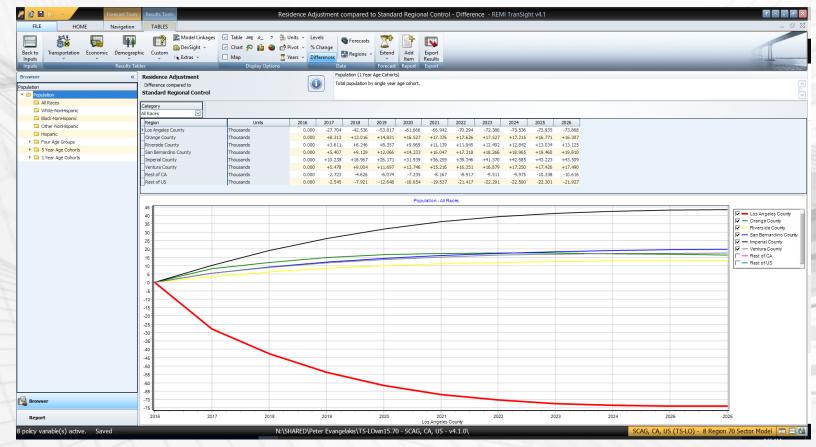


\$5 billion of commuter personal income from L.A. to surrounding counties

 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



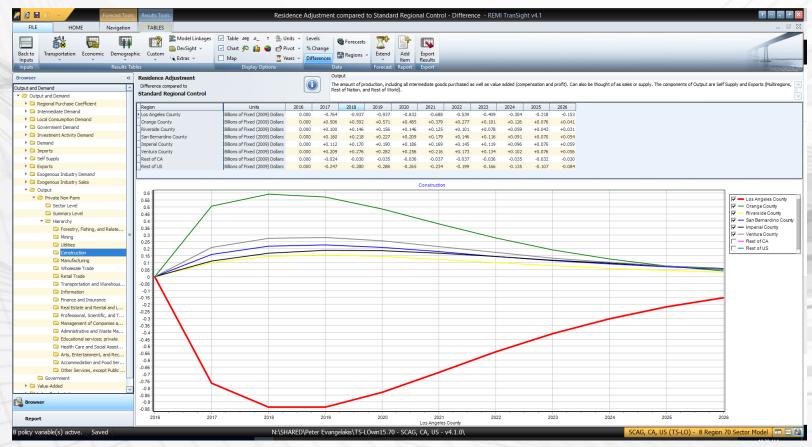


Optimal housing stock falls in L.A., rises in surrounding counties

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| wser | Residence Adjustment | | - | - | | | | | | | | | | |
| tical Graphs | Difference compared to | | 1 | | | | | | | | | | | |
| Analytical Graphs | Standard Regional Control | | | | | | | | | | | | | |
| Total Employment Components | | | | | | | | | | | | | | |
| Private Non-Farm Employment Components b | Category | | | | | | | | | | | | | |
| Private Non-Parm Employment Components D Private Non-Farm Employment Determinants | Regional Residential Optim | | | | | | | | | | | | | |
| 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 | | | | | | | | | | | | | |
| C Relative Employment Opportunity (REO) Det | -2 | | | | | | | | | | | | | - |
| PCE-Price Index Determinants | -3 | | | | | | | | | | | | | - |
| PCE-Price Index with Housing Price Determin | -4 | | | | | | | | | | | | | |
| Relative Housing Price Determinants | -5 | | | | | | | | | | | | | |
| Relative Cost of Production Determinants | | | | | | | | | | | | | | _ |
| International Market Share Determinants | | | | | | | | | | | | | | |
| Domestic Market Share Determinants | -7 | | | | | | | | | | | | | |
| Composite Labor Cost Determinants | | | | | | | | | | | | | | |
| Composite Price Determinants | -9 | | | | | | | | | | | | | |
| Commodity Access Index Determinants | -10 | | | | | | | | | | | | | - |
| Delivered Price Determinants | -11 | | | | | | | | | | | | | - |
| | -12 | | | | | | | | | | | | | - |
| | -13 | | | | | | | | | | | | | |
| | -14 | | | | | | | | | | | | | |
| Browser | -15 | | | | | | | | | | | | | |
| | | | | | | | | | <u> </u> | | | | | |
| Report | 2016 2017 | 2018 | | 2019 | 2020 | | 2021 Los Angeles Co | | 2022 | 202 | 3 | 2024 | 2025 | 2026 |

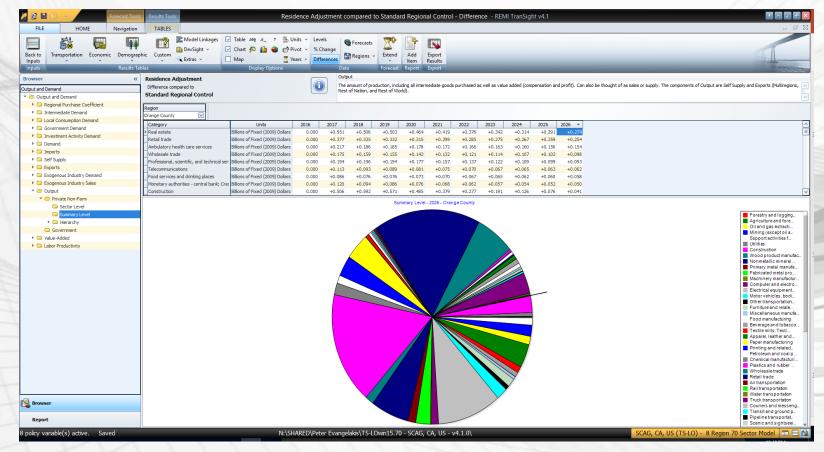


Construction slowdown in L.A., boom in surrounding counties



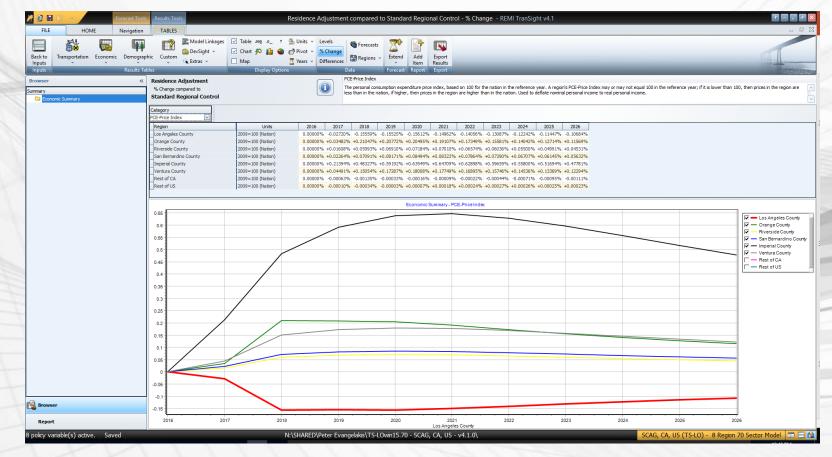


Permanent geographic shift in population-reliant industries





□ 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