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Estimating Wider Economic Impacts in Transport Project Prioritisation using Ex-Post Analysis

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OECD / International Transport Forum
Roundtable on Quantifying the Socio-Economic Benefits of Transport

International Energy Agency, Paris, France.
November 10, 2015

Topics

1. Perspective: Analysis Objectives

- Factors in Planning Decisions
- Available Accounting Systems
- Available Measurement Tools

2. Ex-post Measurement

- Ex-Post Database System
- Findings from Ex-Post Cases
- Examples of Case Studies

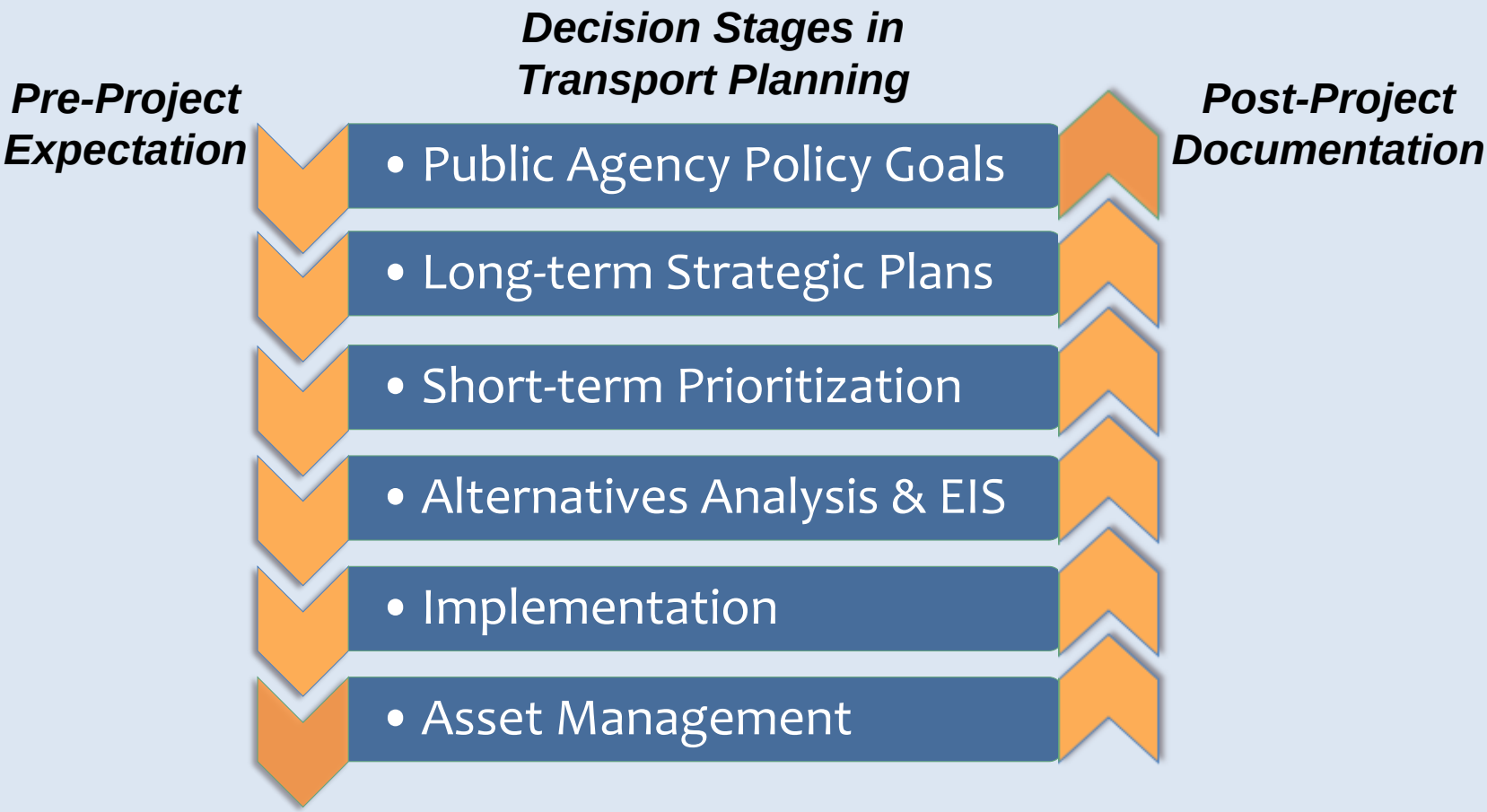
3. Ex-Ante Forecasting

- Improved Metrics
- Examples of Projects
- Communications

Part I: PERSPECTIVE

Factors in Planning Decisions
Available Accounting Systems
Available Measurement Tools

Different issues at different decision stages



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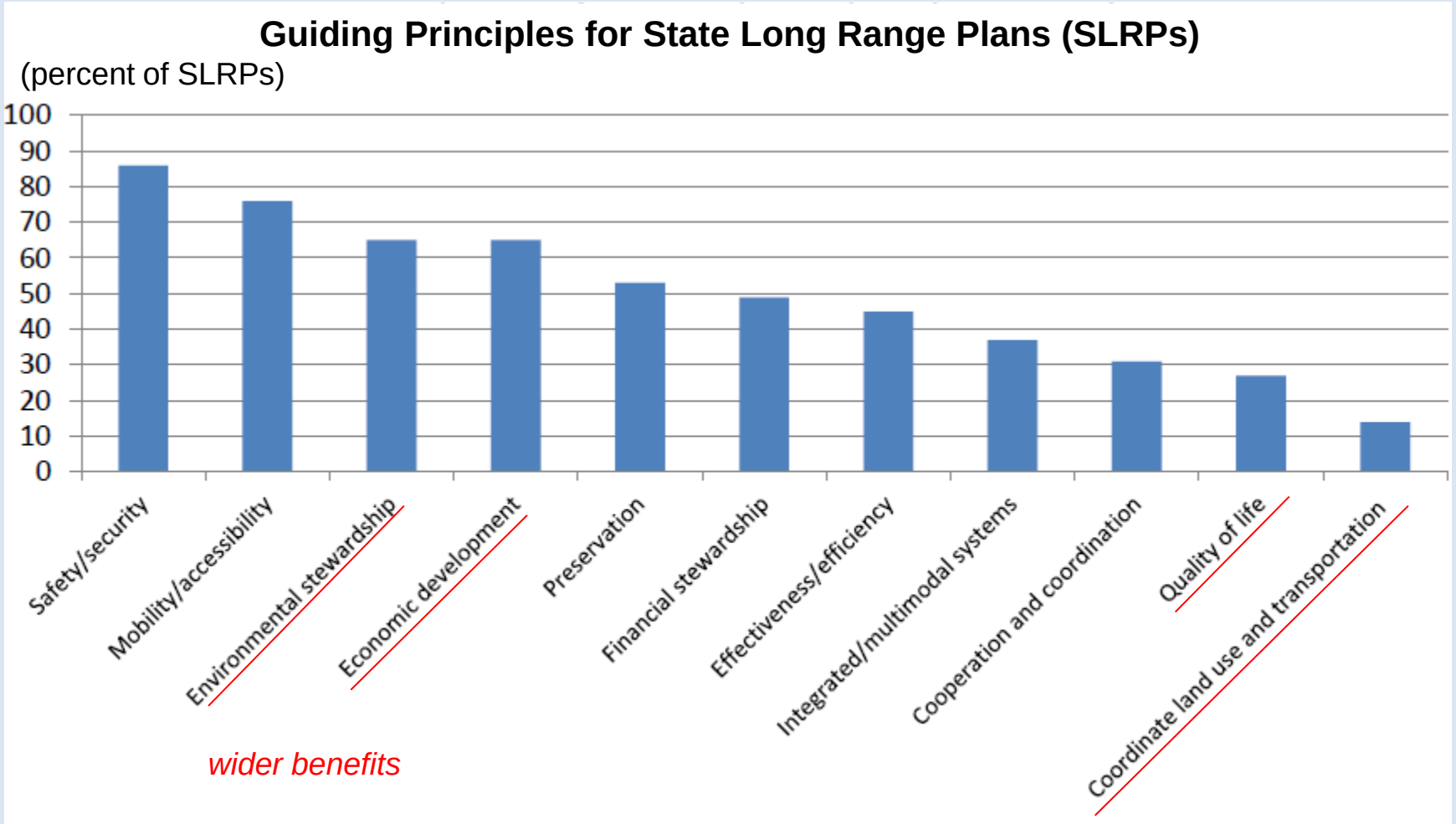
State DOT policy goals feature wider benefits



Source: Volpe Center, US DOT, Trends in Statewide Long-range Transportation Plans, 2015)

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State DOT mission statements:

…Economy & Environment

2015 STRATEGIC DIRECTION

UTAH DEPARTMENT OF TRANSPORTATION

MISSION

INNOVATING TRANSPORTATION SOLUTIONS THAT STRENGTHEN UTAH'S ECONOMY AND ENHANCE QUALITY OF LIFE

GOV. McCRORY'S year 25

Vision for North Carolina

MAPPING OUR FUTURE

multi-modal solutions that will create a stronger, more reliable transportation network that connects people to places, products to markets, expands jobs and industry, and enhances the overall quality of life in North Carolina.

CALIFORNIA DEPARTMENT OF TRANSPORTATION

Sustainability, Livability and Economy

Make long-lasting, smart mobility decisions that improve the environment, support a vibrant economy, and build communities, not sprawl.

MDOT Mission, Vision, Values

Mission - Providing the highest quality integrated transportation services for economic benefit and improved quality of life.

OHIO DEPARTMENT OF TRANSPORTATION

MISSION

We will provide a world-class transportation system that links Ohio to a global economy while preserving the state's unique character and enhancing its quality of life.

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Long-range goals reflected in prioritization

Rating Factor	CO	OH	NC	MO	WI	KS	UK
Traveller Benefit & Environment (quantitative)							
Efficiency: Travel time, cost, level of service	X	X	X	X	X	X	X
Safety (accident rate)	X	X	X	-	X	X	X
Pollution: emissions/greenhouse gases	X	X	-	X	X	-	X
Strategic (System Productivity) Benefit							
Intermodal facilities, access & interchange	(c)	X	*(a)*	X	*(a)*	*(a)*	X
Reduce localized congestion bottlenecks	X	X	X	X	X	X	*(b)*
Connectivity to key corridors, global gateways	-	-	*(a)*	X	X	*(a)*	-
Reliability of travel times	X	X	*(a)*	-	*(a)*	*(a)*	X
Truck freight route, supply chain impact		-	X	X	*(a)*	X	-
Social Goal Achievement (qualitative)							
Location: area revitalization / regeneration	-	X	-	X	-	-	X
Land use: supports cluster or in-fill devel	X	X	-	X	-	-	X
Econ Policy: support target industry growth	X	-	-	X	-	-	-
Leveraging private investment	-	X	-	-	-	-	-
Local public Support	X	X	X	-	X	X	-
Macroeconomic Outcomes (modelled)							
Econ Productivity Calculation	X	*(a)*	*(a)*	-	*(a)*	*(a)*	X
Job Growth, reduced unemployment	X	X	X	-	X	-	-
Gross Regional Product	X	X	X	-	-	X	*(a)*

X = explicitly included as an element of the rating system;
(a) = implicitly allowed via calculation of additional productivity benefit
(b) = included in travel efficiency benefit shown above
" - " = not formally part of the rating system, but may still be considered through other elements of the decision process

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"Accounting System" to implement prioritization?

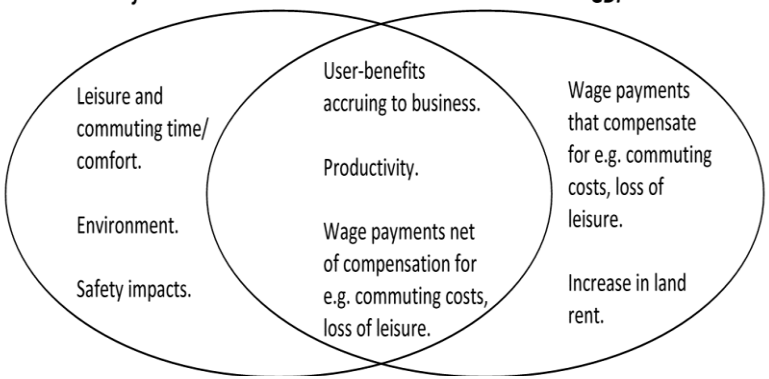
- Logically, benefits should reflect achievement of intended objectives (plus adjustment for unintended effects)
- Two accounting options:
  (1) money-based benefit valuation (e.g., CBA) or
  (2) non-money metrics with point scoring (e.g., MCA)
- Preferred method should be based on consideration of
  (a) completeness of coverage,
  (b) accuracy of measurement,
  (c) ability to represent value for decisions today.

Theoretical CBA differs from today's practice

… as an accounting system covering all benefits and costs

In theory we could:

- Use *dynamic models* not only for transport, but also for economics and environment for more complete coverage
- Capture *other wider benefits of concern* such as social inclusion
- Capture present value of addressing *distributional effects*
  - across time (e.g., cumulative effects that preclude future options),
  - across space (e.g., regeneration),
  - across elements of the population (e.g., low income & elderly pop)
  - And elements of the economy (e.g., dying vs. high growth industries & occupations).



Today's incomplete accounting

Alternative MCA ranking works for now

… and perhaps that's the best to realistically expect for now

- Allow mix of (1) money unit measures, (2) quantitative but not monetized metrics and (3) qualitative metrics.
- Include existing CBA elements as efficiency metrics
- Use models for transport, economy & environment to assess distributional consequences, when possible
- Add qualitative ratings for other social factors
- Assign weights to all measures

Traveller Benefit & Environment (quantitative)
Efficiency: Travel time, cost, level of service
Safety (accident rate)
Pollution: emissions/greenhouse gases
Strategic (System Productivity) Benefit
Intermodal facilities, access & interchange
Reduce localized congestion bottlenecks
Connectivity to key corridors, global gateways
Reliability of travel times
Truck freight route, supply chain impact
Social Goal Achievement (qualitative)
Location: area revitalization / regeneration
Land use: supports cluster or in-fill devel
Econ Policy: support target industry growth
Leveraging private investment
Local public Support
Macroeconomic Outcomes (modelled)
Econ Productivity Calculation
Job Growth, reduced unemployment
Gross Regional Product

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Economic analysis methods (tools)

… each tool has a different intended use

CBA	**Discounted $** *(future year values are diminished by the time value of money)*	Present Value for Net Benefit (B-C) or Benefit Cost Ratio (B/C) *(sum of stream over time)*	**Efficiency of Investment** *(reflecting roll-up of all benefits and costs over time, space, elements of economy)*
EIA	**Constant $** *(reflects today's $)*	Change in GVA or GDP (and assoc. jobs, wages) *in specific target years*	**Strategic Goal Achievement** *(in terms of economic growth for specified areas, times and elements of the economy)*
FIA	**Nominal $** *(future year values are increased by inflation growth over time)*	Annual Cash Flow and Return on Investment *by year over facility life*	**Feasibility of Financing** *(in terms of expenditures required and revenues achieved over time)*

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Defining appropriate analysis methods

1. **Must match to intended use of analysis**:
   …to inform current investment decision? Or to inform planning for the future?
2. **Must match to decision questions** being asked:
   …cost-effectiveness of spending, income payback or achievement of strategic social & economic goals
3. **Must match to constituencies** of interest:
   …effect on community development goals, or economic growth, or government revenue – viewed from national, state, local or neighborhood perspectives
4. **Must select appropriate dimensions** of observation:
   …space, time and impact elements
5. **Must be seen as unbiased**, *particularly in terms of urban/rural and income levels*

- Public Agency Policy Goals
- Long-term Strategic Plans
- Short-term Prioritization
- Alternatives Analysis & EIS
- Implementation
- Asset Management

→ **Its not only the accounting system that matters, the coverage of benefit factors is equally important.**

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Evolution of US transport appraisal practice

- 1936 Flood Control Act requires analysis of full benefits and costs, allows primary & secondary benefits
- 1960 AASHO Red Book (*"Road user benefit analysis for highway improvements"*) codifies social welfare analysis for state DOTs
- 1990s environmental impact valuation added to standard CBA, initial efforts to include wider economic (GDP) impacts
- 2005+ growth of multi-criteria analysis to supplement consideration of CBA factors with wider impacts
- 2012+ development of national ex-post case study database

Part 2: EX-POST MEASUREMENT

Ex-Post Database System
Findings from Ex-Post Cases
Examples of Case Studies

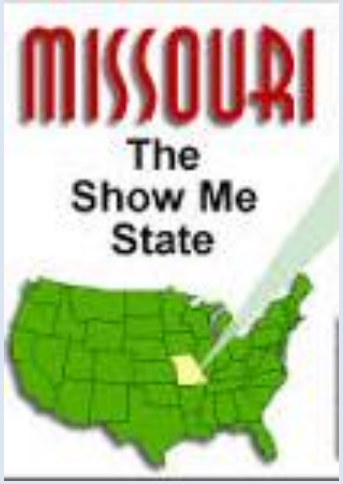
Multiple motivations for US ex-post database

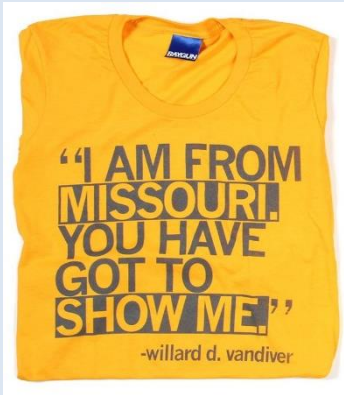
Ex-post Analysis: Learning about actual impacts observed in real world cases:
…processes, factors, results and metrics

Early stage scenario planning

Program funding justification

Ex-ante analysis models





US: focused on measuring tangible economic outcomes that are visible to the public rather than validating transport models

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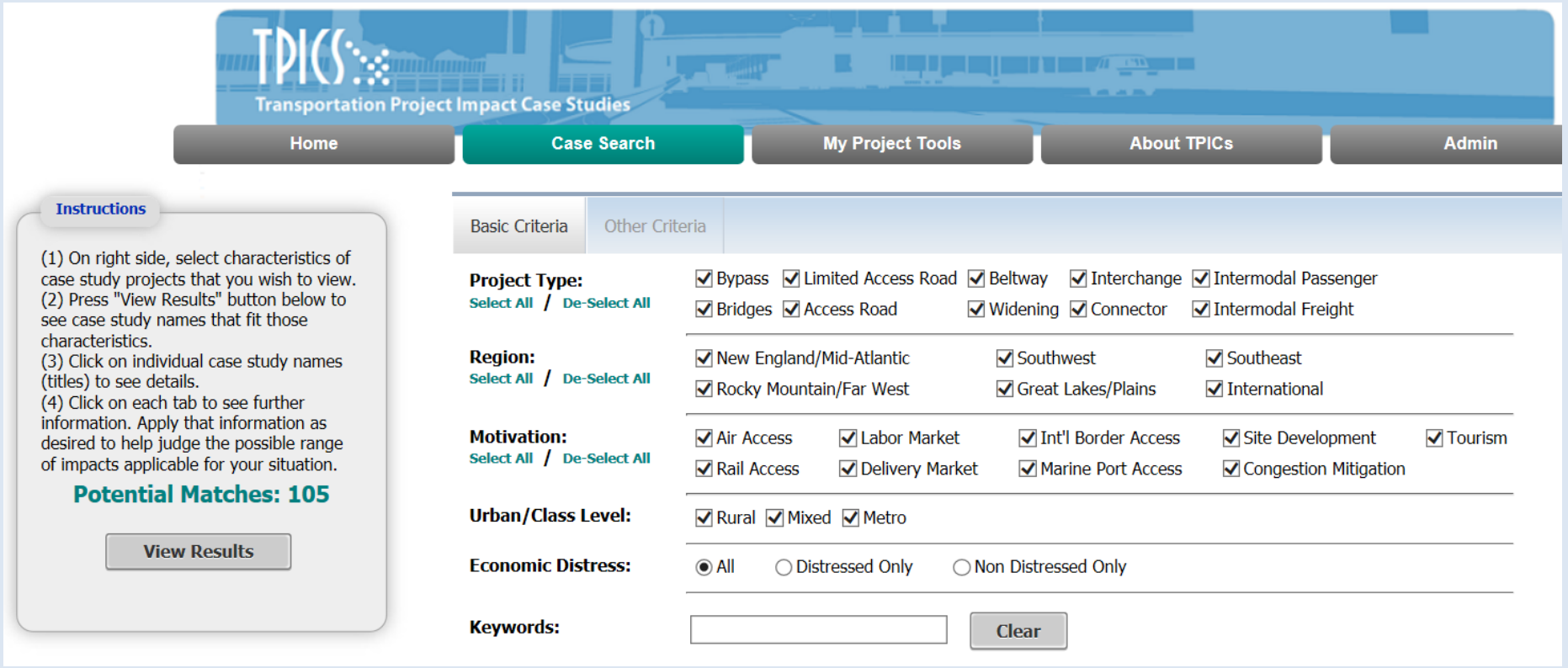
Ex-post transportation project case studies

www.TPICS.us



Home page for initial US version. Extension to public transport is forthcoming in January 2016, and redesign as "EconWorks" is also pending.

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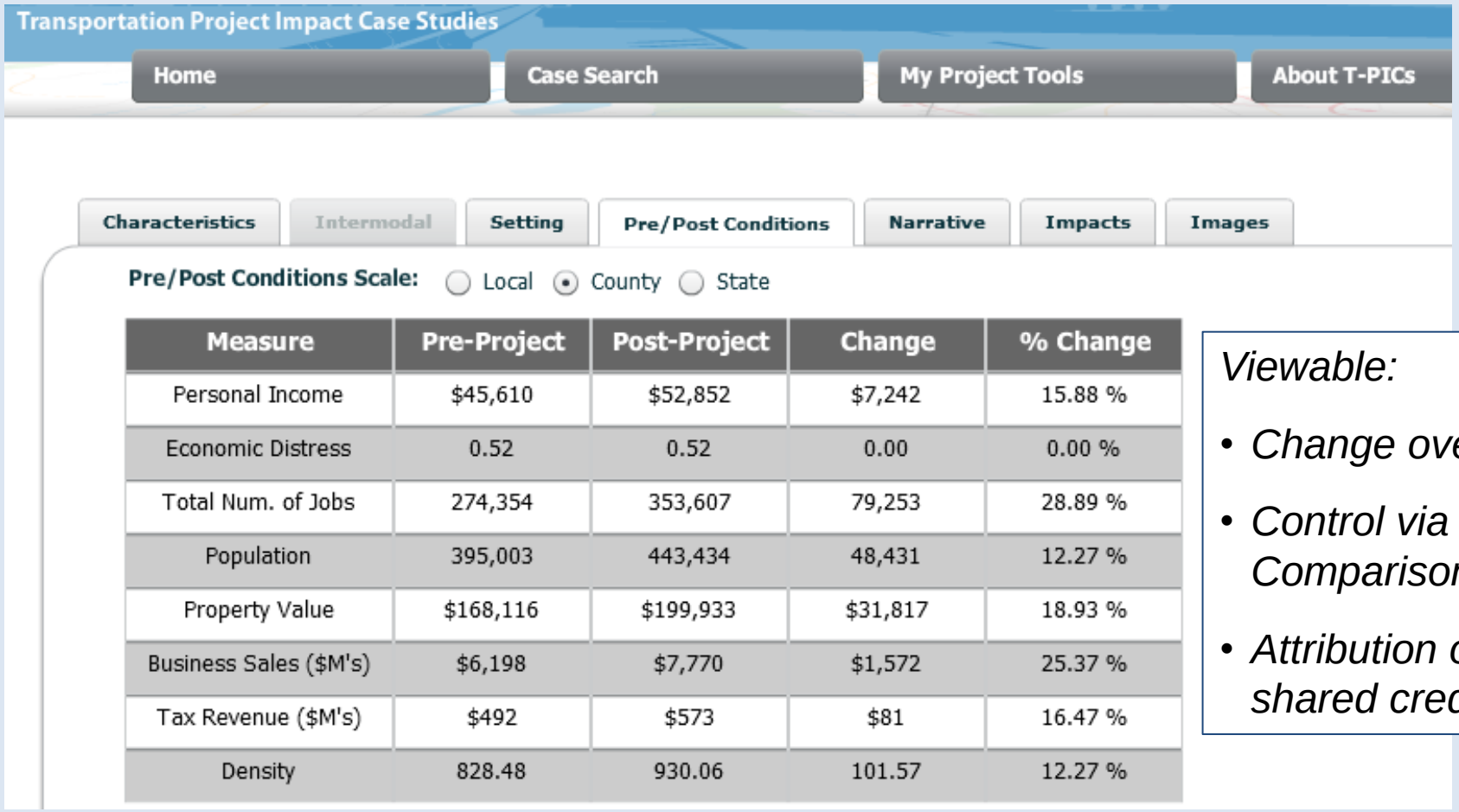
Ex-post cases: gross, net and apportioned effects

Example of a single project in TPICS (www.tpics.us)



Measure	Pre-Project	Post-Project	Change	% Change
Personal Income	$45,610	$52,852	$7,242	15.88 %
Economic Distress	0.52	0.52	0.00	0.00 %
Total Num. of Jobs	274,354	353,607	79,253	28.89 %
Population	395,003	443,434	48,431	12.27 %
Property Value	$168,116	$199,933	$31,817	18.93 %
Business Sales ($M's)	$6,198	$7,770	$1,572	25.37 %
Tax Revenue ($M's)	$492	$573	$81	16.47 %
Density	828.48	930.06	101.57	12.27 %

Viewable:

- *Change over time*
- *Control via Comparison Area*
- *Attribution of shared credit*

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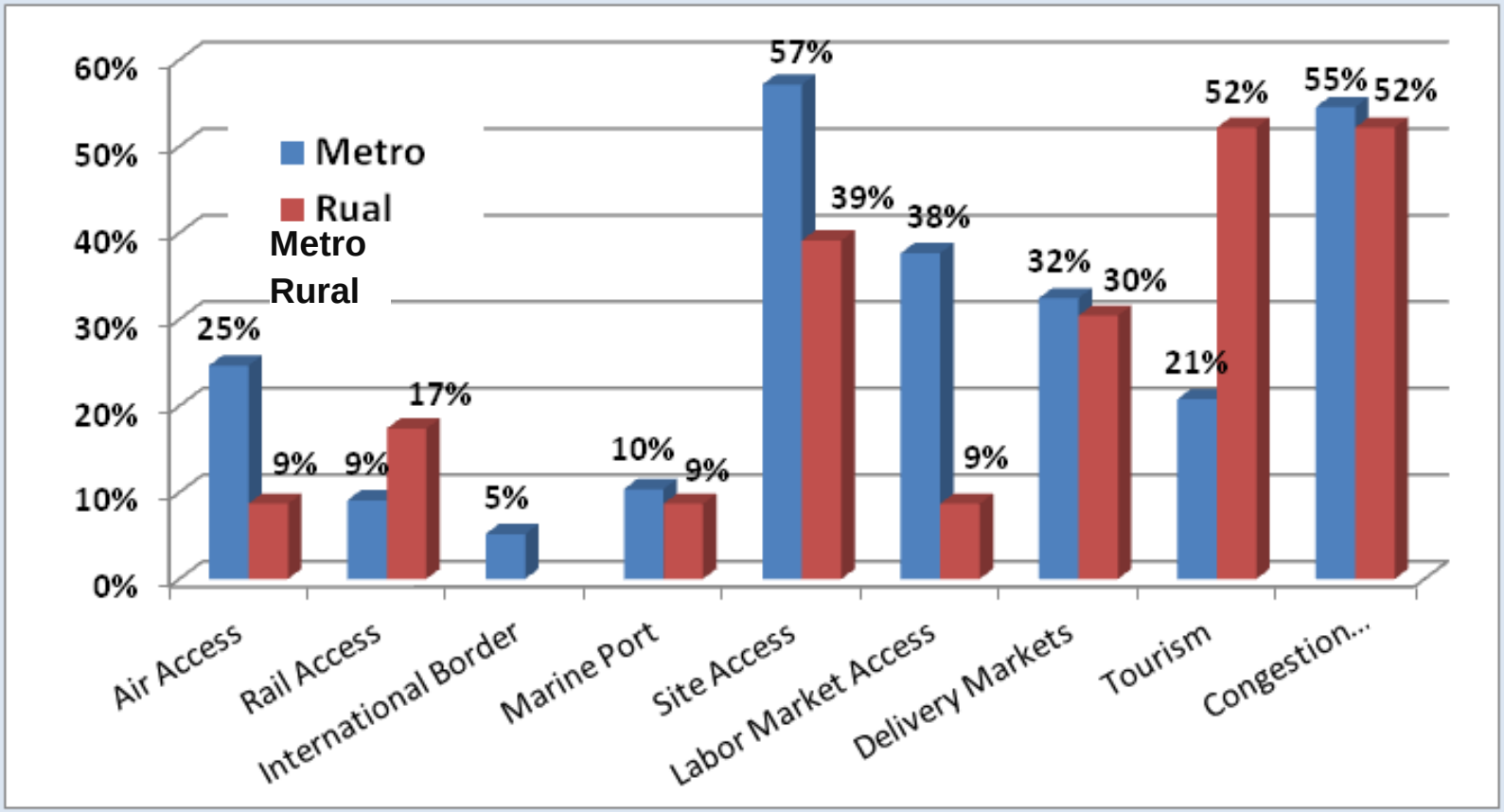
Ex-post highway cases: project motivation

Projects are motivated by need for access and connectivity. Economic impacts follow. *There is a causal story to be told!*



highway projects only; source: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-C03-RR-1.pdf

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Ex-post cases: different agglomeration elements

1) **Supply chain effects**
   enabled technologies: lean manufacturing, just-in-time logistics, centralized warehousing & distribution
   productivity from: freight reliability, scale economies in both business operations and customer delivery

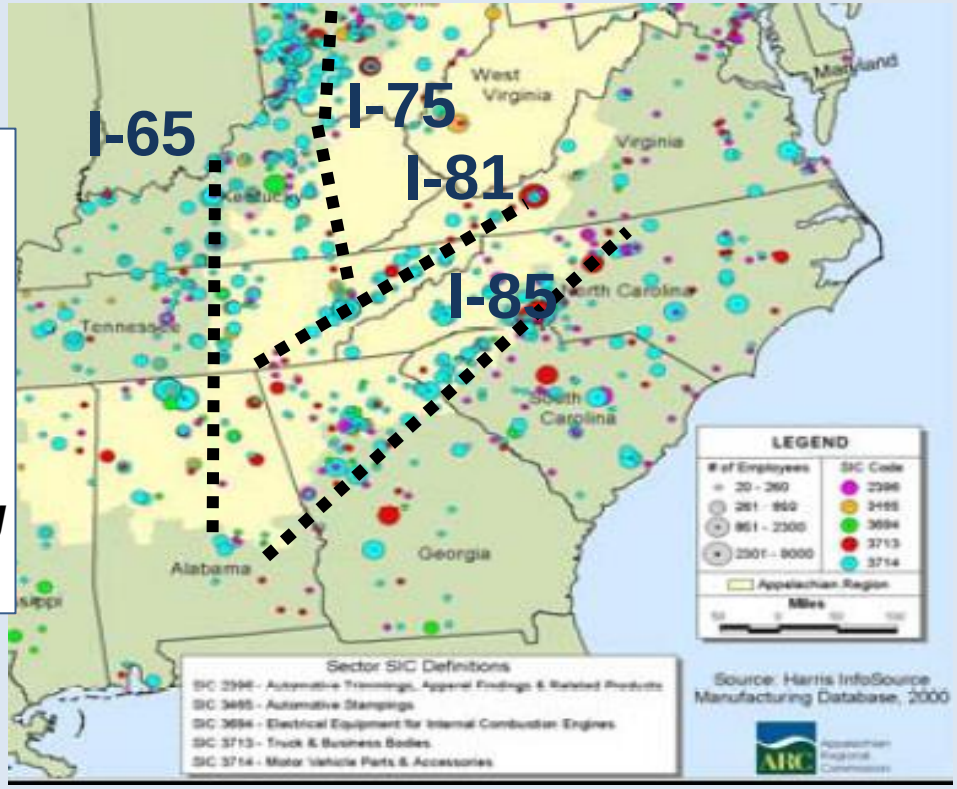
2) **Regional specialty technology clusters**
   enabled technologies: technology transfer from research centers
   productivity from: workforce reliability, workforce access (skill matching), travel proximity/connectivity to R&D sites

3) **Business headquarters centers**
   enabled technologies: corporate headquarters functions, convention and visitor services
   productivity from: workforce access, connectivity to convention center, intercity rail and international airport (as portals to wider markets)

Supply chain: southern auto cluster

Auto assembly plants and parts suppliers locate along same-day delivery corridors to support just-in-time production processes, while avoiding urban congestion.

Specialization: supply chain, manufacturing parts & assembly
Cluster location: rural
Cluster span: 290 km (180 miles)
Internal spacing: 2+ km (1+ mile)
Purpose: same-day parts delivery
Technology: just-in-time processing
Productivity: logistics, reliability



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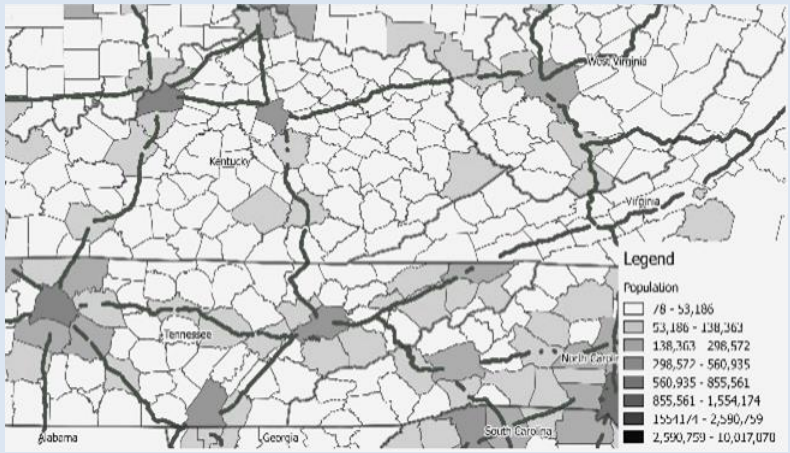
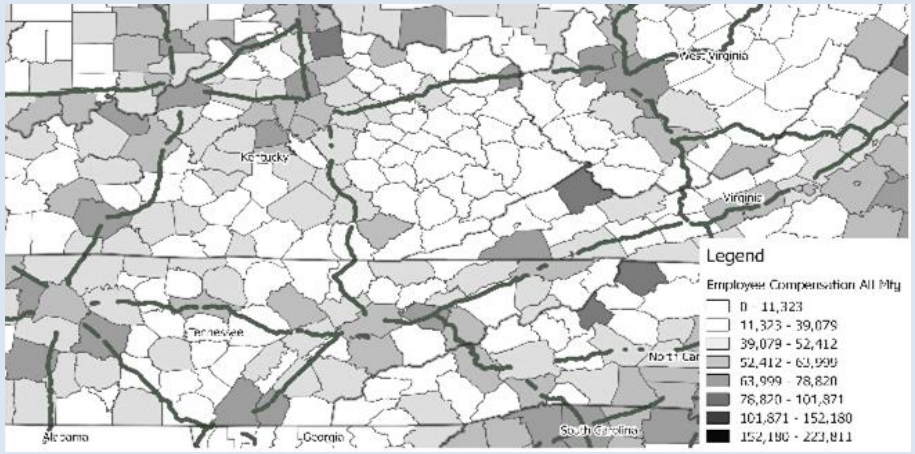
Auto cluster: raised labor productivity

Population (concentrated at intersecting highway nodes)



Average Manufacturing Wage (concentrated along corridors)



US Bureau of Labor Statistics and IMPLAN Group

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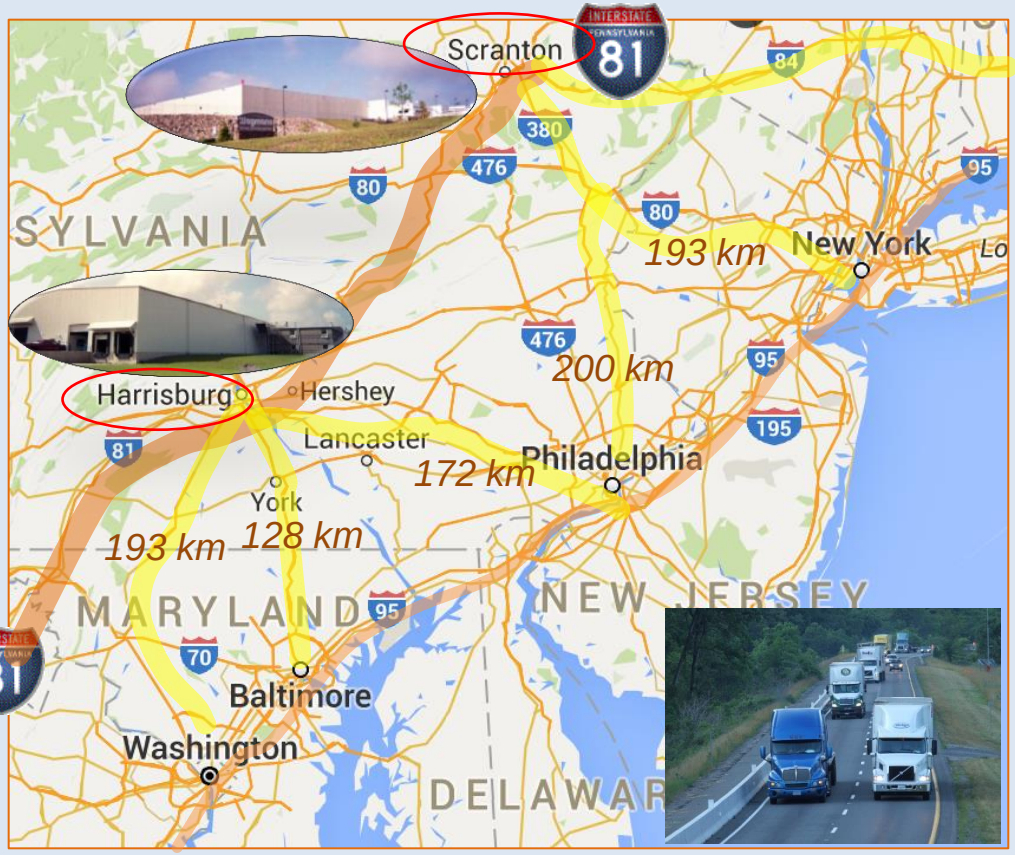
Supply Chain : logistics centers

With I-95 Corridor built up, newer I-84 enables improved logistics reliability, with centralized warehousing located in distant Pennsylvania for delivery to major eastern cities (New York, Philadelphia, Baltimore, Washington, DC

Specialization: wholesale distribution
Cluster location: outside major metro
Cluster span: 16 km (10 miles)
Distance to markets: same day delivery within 290 km (180 miles)
Purpose: regional distribution to (multiple) urban markets
Technology: centralized warehouse
Productivity: highway connectivity, scale economies



Local Development:
+ 2 million m² warehouses

www.fhwa.dot.gov/planning/economic_development/studies/i81trip2005.cfm, also www.tpics.us

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Supply Chain: intermodal center

New intermodal rail center with adjacent warehouse park at south edge of Chicago area. Connects manufacturers via interstate highways (I-80, I-55 and I-355 beltway). Rail service to west coast ports for Asian sea trade. Import electronics and retail, export agricultural products.

Specialization: import/export
Cluster location: rural (metro fringe)
Service area: 290 km (180 miles)
Cluster span: 3 km (2 miles)
Purpose: regional distribution/transfer
Productivity: scale economies (widens truck distribution area), efficiency of intermodal transfer

Local Impacts

- Over 220k m² (2.4m sq.ft.) warehouse
- Over 200 (now 500) new jobs
- Cost efficiency calculator available

www.tpics.us/

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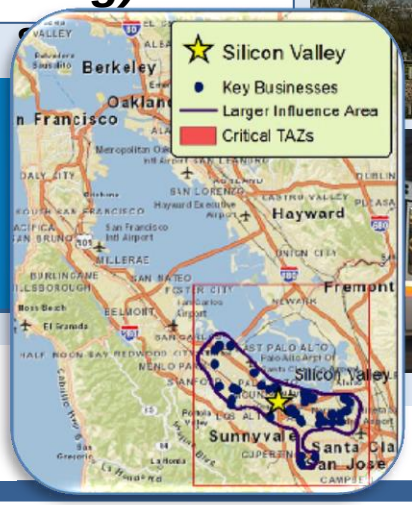
Regional: high tech R&D clusters

Silicon Valley in California and Denver Tech Center represent highway oriented clusters facing growing traffic congestion. Solution has been to develop new transit services to maintain access to large, skilled labor market and connectivity to R&D centers.

Specialization: computer & biotech R&D
Cluster location: suburban
Cluster span: 16 km (10 miles)
Purpose: access to R&D and skilled labor
Productivity: worker reliability, urbanization (labor force scale economies), and localization (for knowledge sharing)



APTA AMERICAN PUBLIC TRANSPORTATION ASSOCIATION

The Role of Transit in Support of High Growth Business Clusters in the U.S.

The role of transit in support of high growth business clusters in the U.S., American Public Transportation Association.
www.apta.com/resources/reportsandpublications/Documents/TransitHighGrowthClustersUS-Final2013-1124.pdf

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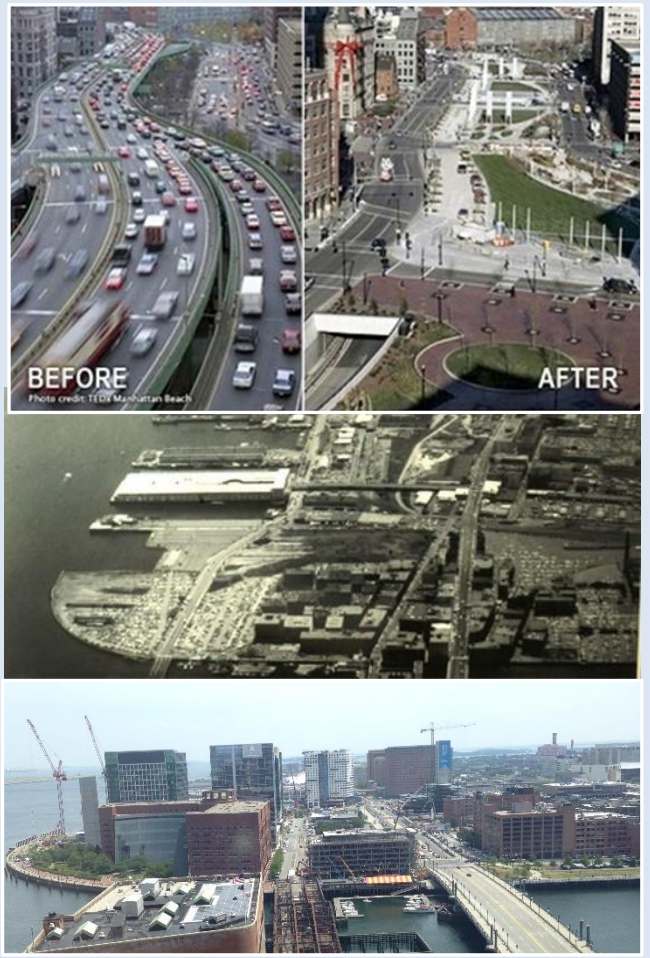
Local: international business center

Central Artery/Tunnel Project (Boston): underground relocation of highways and new underground BRT connecting to intercity rail and airport, opens waterfront location for international business center

Specialization: tech industry office and convention center
Cluster location: large urban
Cluster span: 2 km (1 miles)
Distance to airport & financial center: 3 km (2 mile)
Productivity: multi-modal connectivity to wider markets via road, air, transit



<u>Local Development:</u>
+ 1 million m² office & retail
+ 7,700 housing units
+ 2,600 hotel rooms

<u>Regional impact (direct effect):</u>
+ 50,000 jobs added

Transit cases are forthcoming in www.tpics.us

Local: transit oriented development

New public transport station in Atlanta enables concentrates development in the city and enables redevelopment (regeneration) of an older area of the city.

Specialization: mixed use development
Cluster location: city neighborhood
Cluster span: 2 km 1 mile)
Purpose: revitalization (regeneration)
Productivity: incremental (widens labor market access, enables headquarters for telecom industry)

Local Impacts

- 100k m² (900k sq.ft.) new office space
- 35k m² (300k sq.ft.) new retail
- 714 new housing units
- 373 net new jobs

Hybrid: local multi-modal gateway supports region

Vancouver, BC: Multimodal rail, truck, marine and airport access enhancements made to expand trade competitiveness and freight connectivity for two Canada provinces. Features new public transit line from seaport to airport, which frees road capacity for truck deliveries.

Specialization: import/export
Location: urban core
Purpose: international trade; access to air, sea and rail
Productivity: efficiency of intermodal freight transfer

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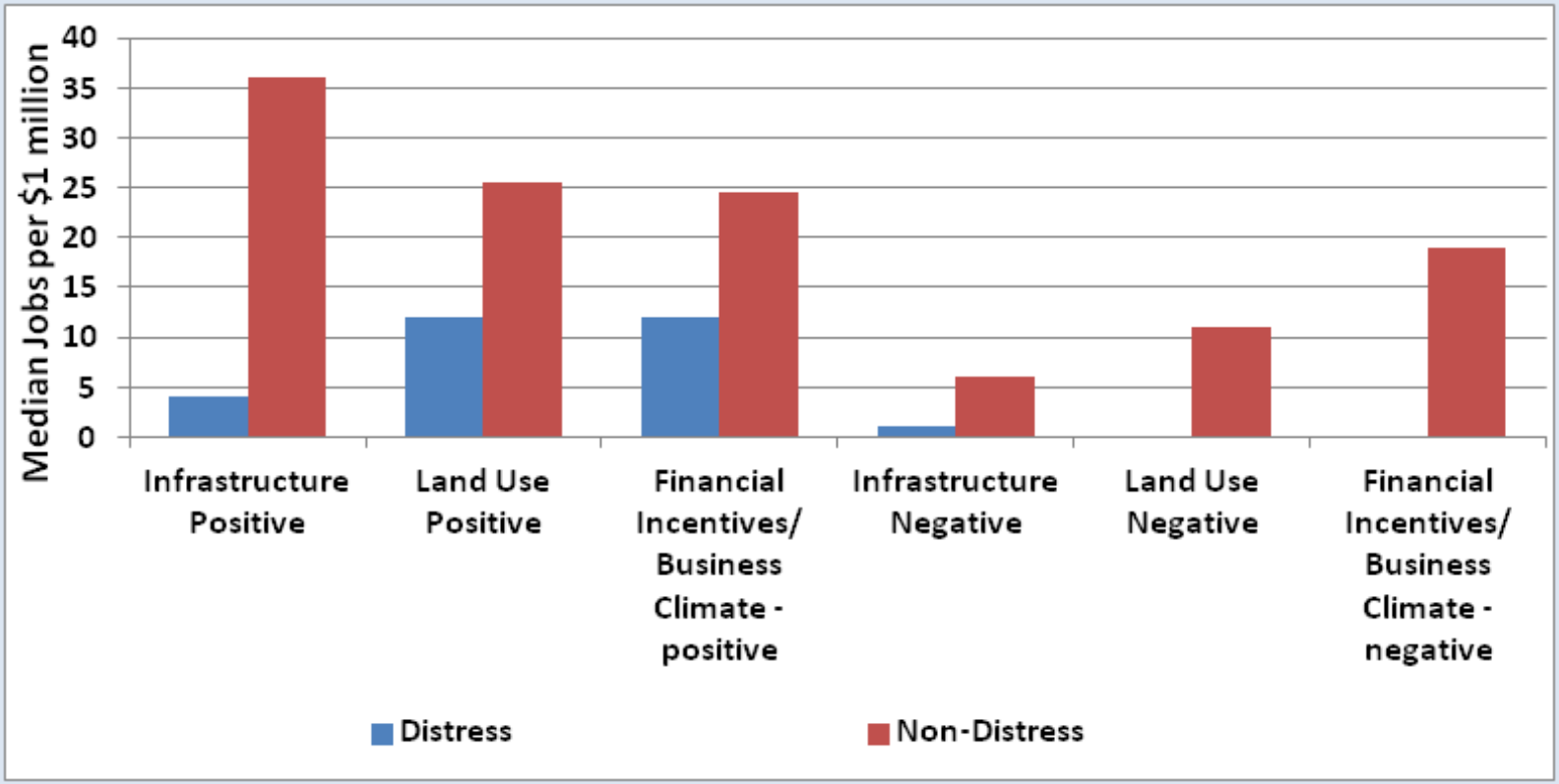
Ex-post cases help sort out economic geography

Business Cluster Type	Preferred Location	Centripetal (urbanization) forces	Centrifugal effects	Cluster (localization)
Financial Center	Core, large metro	Skilled Labor Market (45 min)	--	High density, areas with intl. air service
High Tech	Non-core, urban	Skilled Labor Market (45 min)	--	Mid density, with Univ./ R&D access
Distribution	Periphery	Same Day Truck Delivery Mkt. (3 hr)	Minimize land cost	At hwy crossroads between cities
Auto parts manufacturing	Non-metro	Same Day Truck Delivery Mkt. (3 hr)	Minimize land cost, delivery congestion	On hwys, near rail, Along supply chains
Agriculture, Raw materials	Non-metro	--	Dispersed land locations	--
Neighborhood Shopping	Urban	Customer Market (15 min.)	--	--

Ex-post cases show interaction with other factors

Planners can design better projects by recognizing the roles of land, utilities and business considerations in determining the economic outcomes that follow transportation investments.



Highway projects only; source: http://onlinepubs.trb.org/onlinepubs/shrp2/SHRP2_S2-C03-RR-1.pdf

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Analysis: Access factors for different industries

Industry sensitivity to different forms of access

	NAICS	Sector	Sensitivity to Access Measure (1-10 scale) 40-min Market	3-hr Delivery Market	Commercial Airport	Rail Intermodal
Resource	212-213	Mining	3	0	4	5
	311	Food	3	0	0	0
Resource Based-Mfg	312	Beverage	10	0	0	3
	313	Textile Mills	5	5	2	3
	314	Textile	5	10	0	0
	315	Apparel	5	5	0	0
	316	Leather	5	3	2	5
	321	Wood	0	5	0	5
	322	Paper	0	5	0	5
Durables Mfg	323	Printing	10	0	7	0
	324	Petroleum	6	0	0	0
	325	Chemical	5	3	4	3
	326	Plastics	8	10	0	3
	327	Nonmetal Mineral	5	5	2	0
	331	Primary Metal	3	5	4	0
	332	Fabricated Metal	10	5	2	0
	333	Machinery Mfg	0	5	2	0
	334	Computer	3	5	2	3
	335	Elec Appliances	0	10	3	0
	336	Transport Equip	5	5	3	3
	337	Furniture	5	10	3	0
	339	Miscellaneous Mfg	5	5	5	0
Trade & Distrib	420	Wholesale Trade	10	0	3	0
	441-454	Retail Trade	8	3	3	5
	481-487	Transportation	5	0	3	0
	491-493	Del & Warehousing	10	0	2	3
Tech/ Services	511	Publishing	10	0	10	0
	512	Movie & Sound	10	3	9	0
	513	Broadcasting	10	0	5	0
	514	Internet & DP	8	3	5	0
	521-531	Finance,Insurance	10	0	3	0
	541-551	Prof. Scien Tech	10	3	10	0

Notable reliance:

Resource industries reliant on *rail access*;

Manufacturing reliant on *same-day truck delivery markets;*

Professional services reliant on *labor market* and *airport access*

Source: Alstadt, Weisbrod, and Cutler. The Relationship of Transportation Access and Connectivity to Local Economic Outcomes: A Statistical Analysis. Economic Development Research Group, published in Transportation Research Record, No 2297, 2012.

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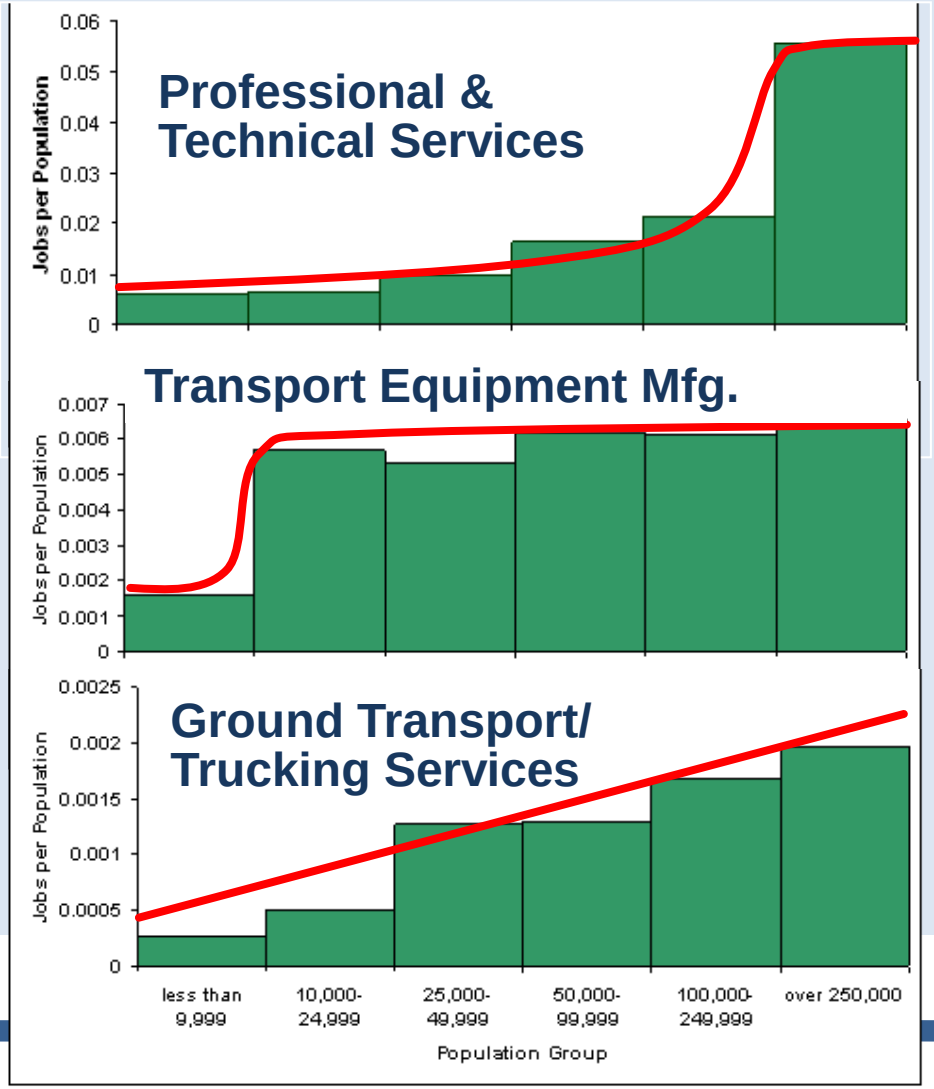
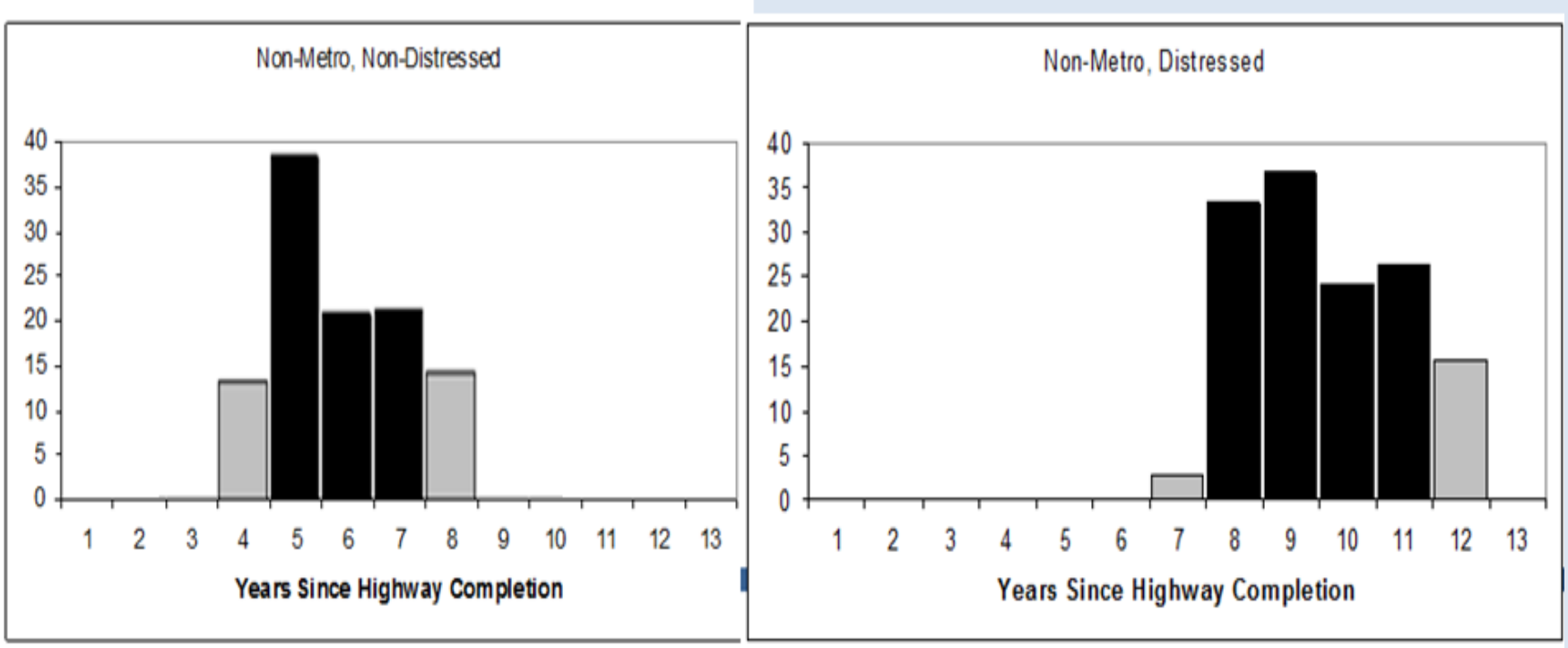
Market access (size) thresholds confirmed by data

- Appalachian Region – reducing isolation
- Industry concentration (location & growth) differs by market size
- Expanding labor and delivery markets enable activities that were previously not feasible



Sources of growth in non-metro Appalachia, Volume 3, statistical studies of spatial economic relationships, Appalachian Regional Commission. www.arc.gov/research/researchreportdetails.asp?REPORT_ID=84

Time lag depends on local economy



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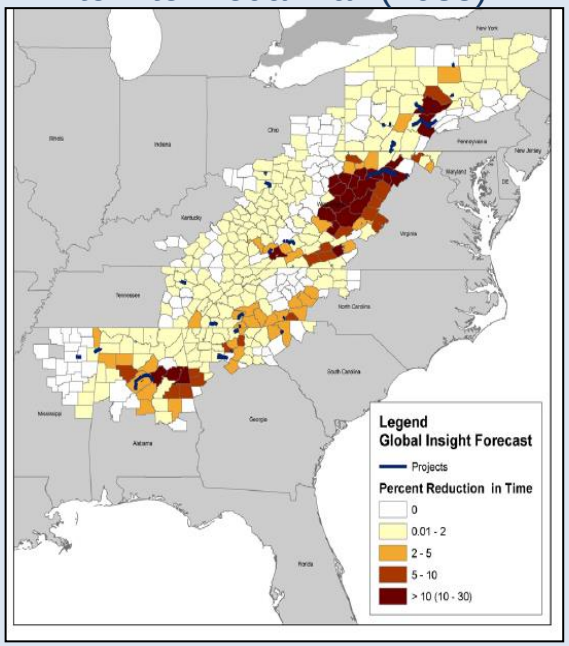
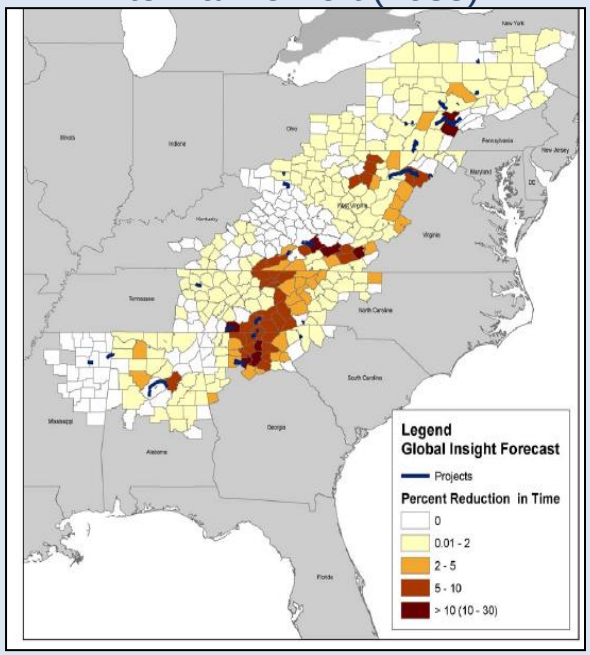
Regional access effects differ among locations

Impact of Completing the Appalachian Development Highway System (ADHS)

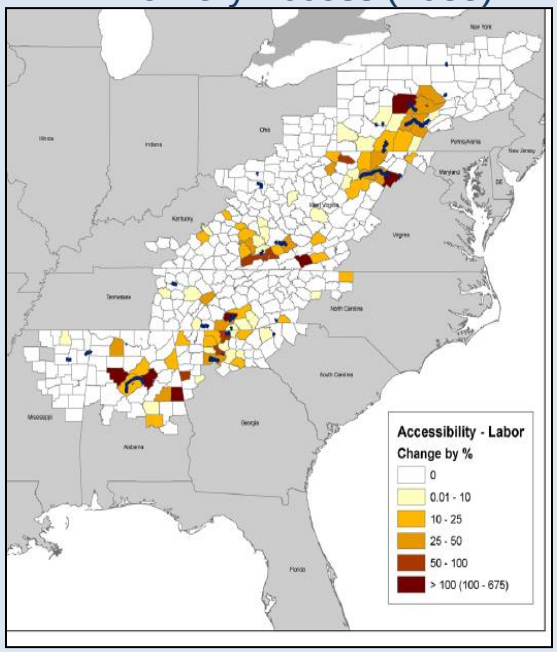
Improvement in Access to Intermodal Rail (2035)



Improvement in Access to Marine Port (2035)



Improvement in Same Day Delivery Access (2035)



Economic impact study of completing the Appalachian Development Highway System, prepared for the Appalachian Regional Commission. *www.arc.gov/assets/research_reports/EconomicImpactStudyofCompletingADHS.pdf*

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Part 3: EX-ANTE USE

Improved Metrics
Examples of Projects
Communications

Using case findings to enhance ex-ante prediction

Transportation changes recognized as CBA and EIA inputs

Generalised Cost Factors
(by mode and purpose)

- In-vehicle travel time
- Wait/schedule delay time
- Out of vehicle travel time
- vehicle-kms (VKM)
- Reliability (std. dev., buffer time, vol/capacity ratio)
- Fare/Fee/Toll – per person, per ton, per vehicle or per km

Accessibility Characteristics

Local (e.g., 45 min) market
- for labour commute to work (car, transit only)
- for goods and services delivery (truck only)

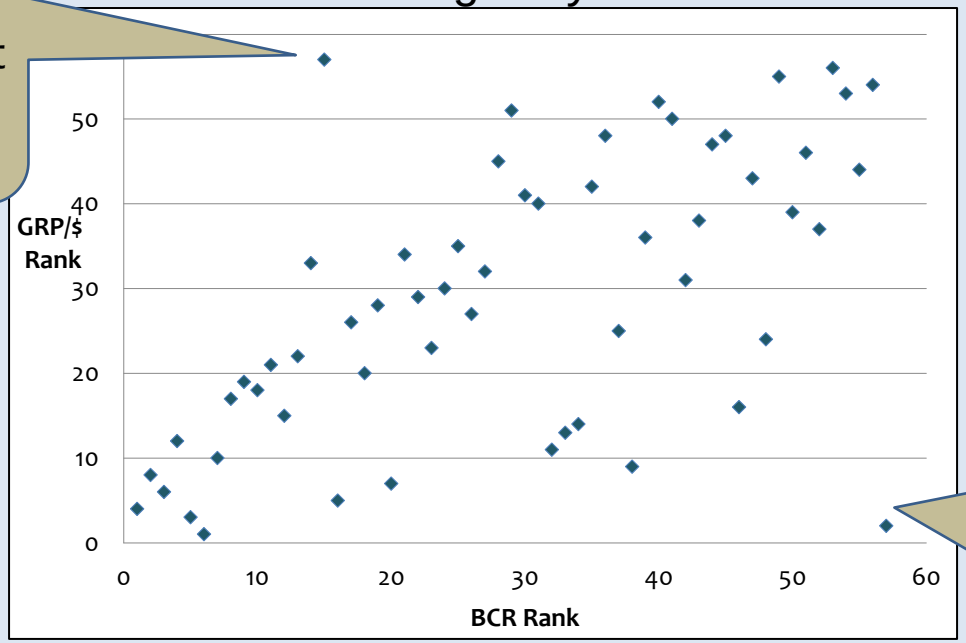
Regional (e.g., 180 min) market
- for same day passenger trips (car, bus, rail)
- for same day freight delivery (truck only)

Long distance access:
- to cargo airport (truck only)
- to air passenger terminal (car and transit)
- to intermodal rail freight facility (truck only)
- to passenger train station (car and transit only)
- to marine cargo port truck and freight rail)

Kansas prioritization: using CBA & EIA metrics

Low BCR
but high econ impact
(e.g., market access
benefit)

Kansas DOT Highway Prioritization Scores)



High BCR
but low econ
impact (e.g., pass-
through traffic)

Correlation = .54

Source: Yvonne Keinembabazi (2015). A comparative study of transport investment appraisal tools and their implications on project selection, dissertation, ITS, Univ. of Leeds, 2015

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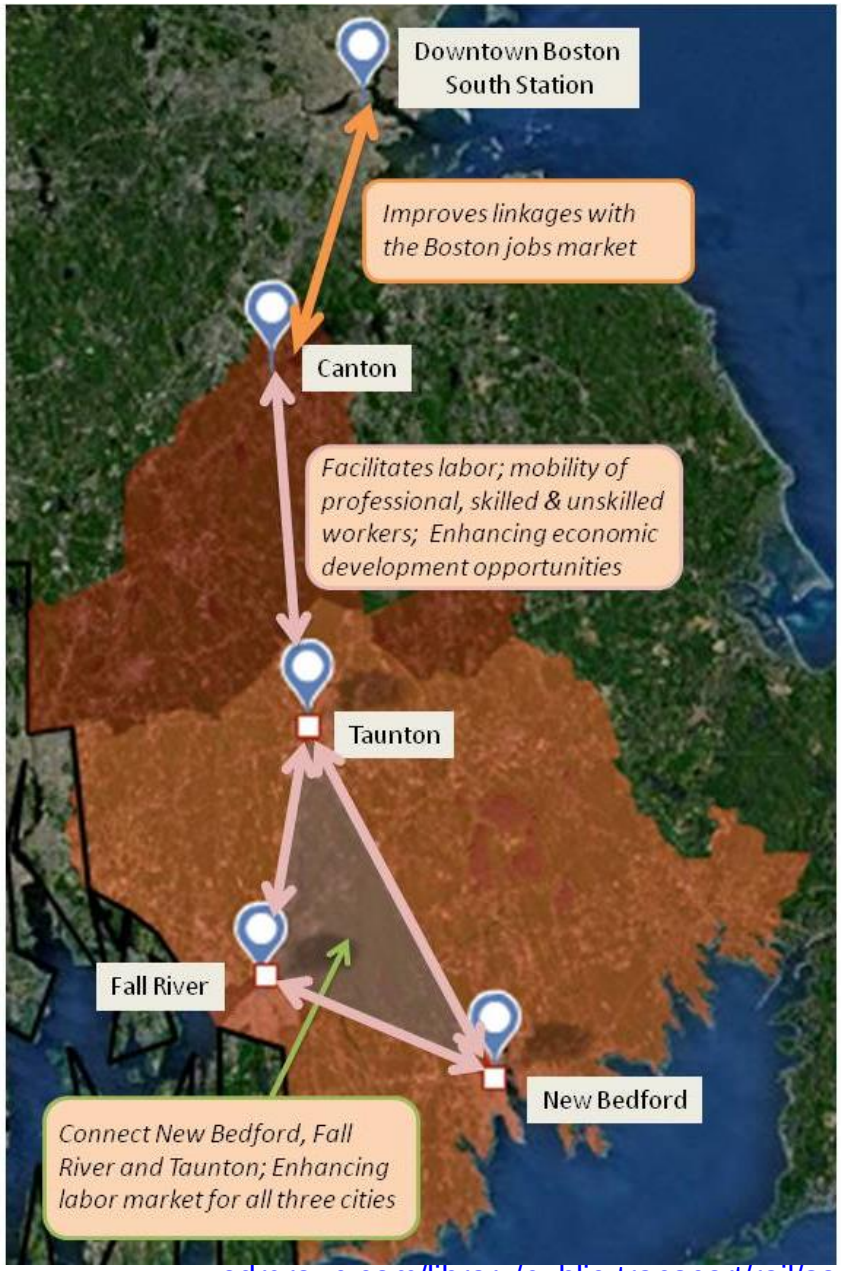
Using CBA and EIA



Massachusetts South Coast Rail study: Linking labor markets to enable scale economies & high tech development

www.edrgroup.com/library/public-transport/rail/south-coast-commuter-rail-alternatives.html

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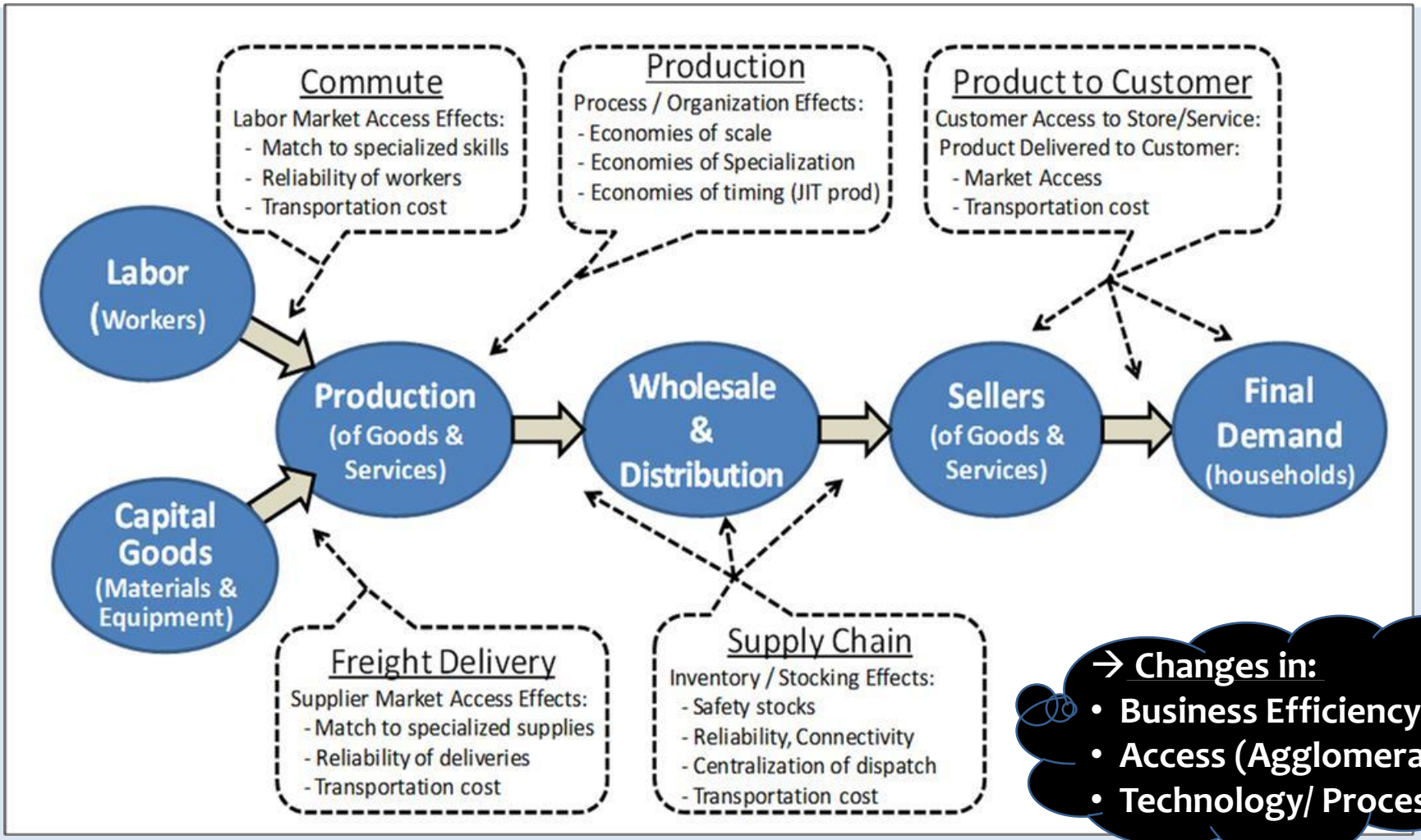
Causal story behind productivity effects



→ Changes in:
- Business Efficiency (Cost)
- Access (Agglomeration)
- Technology/ Process

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Conclusions

1. Factors that matter for decision-making:

a) *Completeness of coverage* – for impact/benefit outcomes;

b) *Freight* – not just passenger access;

c) *Technology and reliability* – not just scale economies;

d) *Realism* – recognizing thresholds (for causality and impact) and distributional effects (across space, time and elements of the economy)

2. Wider effects

a) *Regeneration* **(**of depressed areas) and global *competitiveness* (for the future) represent strategic social goals -- beyond the P.V. of added income.

b) *Suspicion of bias* (toward large urban projects) limits reliance on purely statistical elasticity calculations and supports more use of ex-post analysis.

c) *CBA can provide even more insight* if used in combination with other economic tools to present a more comprehensive set of perspectives.

d) Future research should give attention to enhancing CBA applicability by addressing the above-cited themes.

Copies of reports and articles and further information

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