Benefit-Cost Analysis for Transportation Infrastructure: A Practitioner's Workshop: U.S. DOT, May 17, 2010

Employment, Productivity and Real Estate Value in Benefit-Cost Analysis

David Lewis, Director, Economics and Financial Services

HDR | ONE COMPANY | *Many Solutions*℠

Summary

- Foundations
- Effects of Transportation Investments in Labor Markets
- Transportation Investments and Real Estate Value

Foundations

- Benefit-Cost Analysis measures the creation or erosion of real economic value
  - *"Value" denotes welfare or quality of life*
- Transfers of value between people (or places or firms, etc.) should not be counted as costs or benefits
- Benefits and costs may manifest themselves in multiple effects
  - *e.g., travel time savings and property values; shipping costs and the price of consumer goods*
  - *Effects need to be counted once only*

Effects of Transportation Investments in Labor Markets

1) Short-term jobs due to project construction
2) Long-term jobs due to project operations and maintenance
3) Productivity benefits from business reorganization
4) Other productivity effects
   - *Agglomeration*
   - *Diversion to more productive modes …*

1) Short-term Jobs due to Project Construction

- Labor used for construction in general a cost, not a benefit:
  - *Using labor for Project X makes it unavailable for other value-creating opportunities*
- If wages reflect the real opportunity cost of labor
  - *A "wash" from the worker's point of view*
  - *Labor a project cost*

What is the "Opportunity Cost of Labor?"

- What workers do in the absence of Project X
  - ***Employed, in similar activity***
  - *Employed, at lower-productivity job*
  - *Unemployed, but engaged in productive activity:*
    - Job search
    - Child or parent care
    - Home improvements
  - *Unemployed, at leisure*

Opportunity Cost of Labor and Unemployment

- With “low” unemployment
  - *Project X workers likely be working in similar jobs*
  - *Wage rate close to real opportunity cost*
- With “high” unemployment
  - *Project X workers may be otherwise un- or under-employed*
  - *Wage rate exceeds real opportunity cost*
    - Gap maintained by minimum wage legislation or real wage rigidity
  - ***IMPLICATION: Project X labor cost measured at market wage may be REDUCED to better reflect true cost of labor (called: “Shadow Pricing”)***

Example of Shadow Pricing
European Commission Guidelines

- Under severe unemployment, “shadow wage” may be inversely correlated to level of unemployment:

$$\textit{Shadow Wage} = \textit{Market Wage}\ (1-u)$$

- EC example: investment in new motorway:
  - Regional unemployment u=12% (unskilled workers only)
  - Conversion Factor = (1-u) = 0.88

Source: European Commission, Directorate General Regional Policy, Guide to Cost-Benefit Analysis of Investment Projects, July 2008

2) Long-term Jobs due to Project Operations and Maintenance

- Labor used for operations and maintenance is also a cost:
  - *Using labor for Project X, makes it unavailable for other value-creating opportunities*
- Shadow pricing more difficult due to uncertainty in market conditions in medium and long term

3) Productivity Benefits from Business Reorganization

- Firms can take advantage of improved transportation services by reorganizing logistics
- More reliable transportation permits JIT, reducing inventories
- Firms substitute transportation for warehousing and inventory
- Shippers can serve a larger market area with existing facilities
- Lower transportation costs allow reduced prices and increased output and employment

Benefits of Improved Freight Transportation

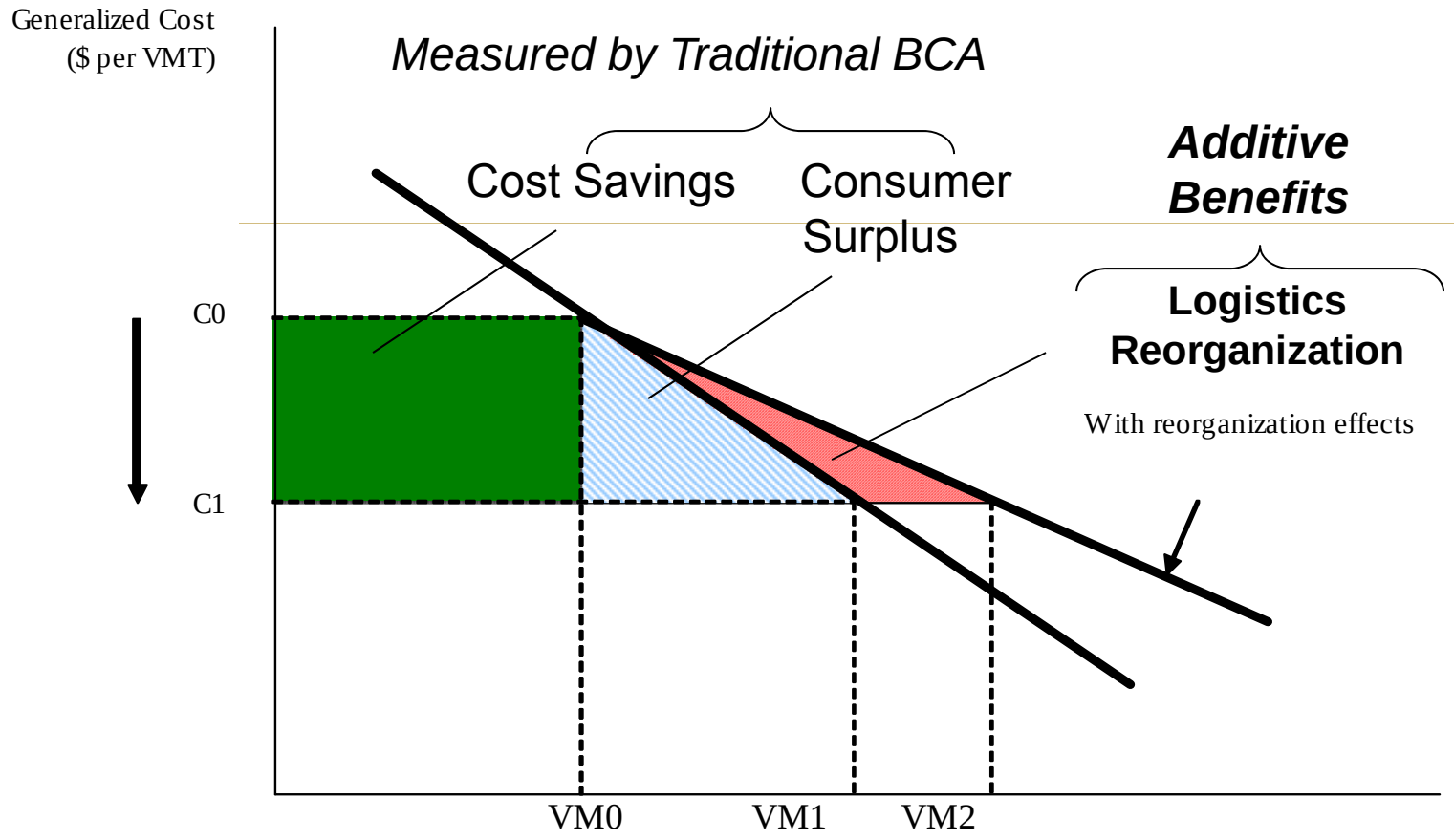
First-Order Benefits
- Cost reductions on current freight miles
- Reduced transit times and increased reliability

Second-Order Benefits
- Firms improve logistics
- Firms serve larger market and output increases
- Freight miles increase

Third-Order Benefits
- Improved products
- New products

Other Effects—include increases in regional employment and the rate of growth of regional income.

Reorganization Effects in Relation to Traditional Benefits



U.S. Department of Transportation, Federal Highway Administration, *Freight Transportation, Improvements and the Economy*

4) Other Productivity Effects
Analysis of Agglomeration Benefits

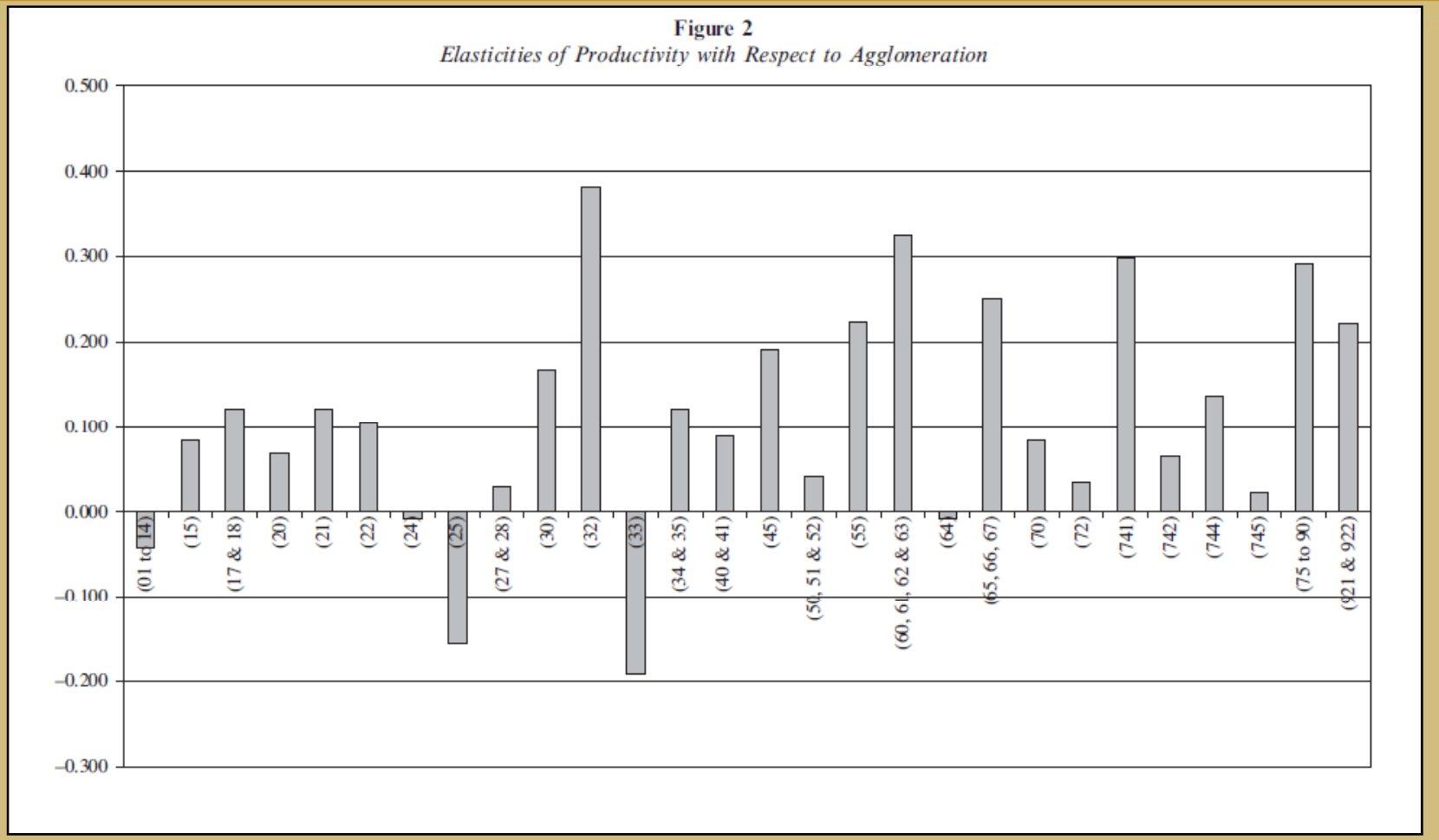
Table 6

Applying the New Appraisal to CrossRail (DfT Calculations)

Benefits	*Welfare (£ million)*
Business time savings	4,847
Commuting time savings	4,152
Leisure time savings	3,833
Total User benefits (conventional)	**12,832**
Agglomeration benefits	3,094
Total benefits (new approach)	**15,926**

Source: Graham, D.J. Agglomeration, Productivity and Transport Investment, Journal of Transport Economics and Policy, Volume 41, Part 3, Sept. 2007

4) Other Productivity Effects
Analysis of Agglomeration Benefits



Source: Graham, D.J. Agglomeration, Productivity and Transport Investment, Journal of Transport Economics and Policy, Volume 41, Part 3, Sept. 2007

Transportation Investment and Real Estate

- Like employment, real estate investment not, in itself, an economic benefit
  - *Development consumes scarce resources*
  - *Benefits of development to the community are balanced by costs to the developer*

Some Real Estate Impacts May be Welfare Benefits

- Projects can create additional economic value through provision of better access, reduced travel time, amenity, option value, densification and agglomeration
- Location becomes more attractive to investors and buyers, driving the price of land/property up
- Price premium reflects real value, but may be accounted for in travel time and cost savings
- However, part of the increase in value may be more than the capitalized transportation benefit, due to:
  - *Option value*
  - *Amenity value*
  - *Densification and agglomeration value*

One Measurement Approach *"Value Premiums"*

- Application of estimated value premiums one method of assessing real estate benefits
- Premiums typically estimated from "hedonic" price studies

  A hedonic price function describes how the quantity and quality of a property's characteristics determine its price in a particular market – D. Banister

Hedonic Price Function: Example

- Proximity to Pleasant Hill Station, BART, S.F.

$$HomeVal = \alpha + \beta_1 Dist\_to\_Bart + \beta_2 Dist\_to\_Hwy + \beta_3 HomeAge + \beta_4 HomeSize + error$$

  - ***Distance to BART*** *- walking distance to BART station*
  - ***Distance to Highway*** *- Distance to highway interchange*
  - ***Home Age*** *- home age in years*
  - ***Home Size*** *- home size in square feet*

Hedonic Price Function – Example (Cont'd)

- Pleasant Hill Station, BART, S.F: Regression Results with Linear Specification

Dependent Variable: Home Sale Price

Variable	Coefficient (t-statistic)
C	143,504.9 (8.70)
Home Characteristics	
Age of Home	-422.79 (-2.48)
Size of Home	100.39 (21.14)
Transportation Characteristics	
Distance to BART	-15.78 (-5.79)
Distance to Highway	7.94 (3.15)
All coefficients are significant at the one percent level	
Summary Statistics	
Number of Observations	263
R^2	.81
Mean Dependent Variable	249,848.4
F-Statistic	272,999

Hedonic Price Function: Example (Cont'd)

INTERPRETATION:

- BART Access worth a premium of $15.78 more for each foot closer to station
- Some consumers pay premium regardless of transit use
- Premium too large to represent user benefits alone

Evidence of Incremental Property Value Effects - Residential

Residential Effects				Premium			Distance Measured (Miles)
System	City	Mode Type	Year of Study	Single-family Homes	Multifamily Homes	Condos	
BRT- Ventura Line	Los Angeles, CA	BRT	2002	-6.1%	-6.0%	-5.1%	0.5
BRT- Whittier Line	Los Angeles, CA	BRT	2002	-15.2%	-1.6%	-8.4%	0.5
Coaster Commuter Rail	San Diego, CA	Commuter Rail	2002	17.0%	-7.1%	46.1%	0.5
MARTA	Atlanta	Heavy Rail	2001	19.0%			0.25
Philadelphia - Heavy Rail	Philadelphia, PA	Heavy Rail	1993	7.5%			
Boston - Heavy Rail	Boston, MA	Heavy Rail	1994	6.7%			
Chicago - Heavy Rail	Chicago, IL	Heavy Rail	1997	20.0%			
Highway Interchange*	Los Angeles, CA	Highway	2002	-1.8%-4.7%	1.2%-3.4%	1.3%-8.6%	
Highway Interchange*	San Diego, CA	Highway	2002	0.6%-17%	-7.1%	3.5%-6.4%	
Highway Interchange*	San Jose, CA	Highway	2002	-2.5%			
MAX - LRT	Portland, OR	Light Rail	1993	10.6%			0.25
Sacramento Light Rail	Sacramento, CA	Light Rail	1995	6.2%			900m
LRT	San Jose, CA	Light Rail	2002	45.0%			0.25
LRT- North Line	San Diego, CA	Light Rail	2002	-4.2%	3.8%	3.0%	0.5
LRT- South Line	San Diego, CA	Light Rail	2002	0.6%	9.9%	3.5%	0.5
LRT- East Line	San Diego, CA	Light Rail	2002	-1.5%	17.3%	6.4%	0.5
LRT- downtown	San Diego, CA	Light Rail	2002		5.1%	2.2%	0.25
LRT- Blue Line	Los Angeles, CA	Light Rail	2002	3.4%	1.2%	-6.2%	0.5
LRT- Green Line	Los Angeles, CA	Light Rail	2002	-1.8%	3.4%		0.5
LRT	Minneapolis, MN	Light Rail	2009	3.3%	8.0%		0.5
LRT	St. Louis, MO	Light Rail	2004	32.0%			0.25
DART (rail, bus, and light rail)	Dallas	Multi	2001	12.2%			0.25

** No percentage premiums reported for this mode. The bounds here taken from rail premiums with closest model coefficients reported (model not specified)- to be interpreted as percent per mile*

Evidence of Incremental Property Value Effects - Commercial

Commercial Effects					
System	Mode Type	City	Year of Study	Commercial Premium	Distance Measured (Miles)
BRT- Ventura Line	BRT	Los Angeles, CA	2002	3.5%	0.25
BRT- Whittier Line	BRT	Los Angeles, CA	2002	13.3%	0.25
Coaster Commuter Rail- downtown	Commuter Rail	San Diego, CA	2002	91.0%	0.25
Coaster Commuter Rail	Commuter Rail	San Diego, CA	2002	-9.9%	0.5
Philadelphia	Heavy Rail	Philadelphia, PA	1993	7.5%	0.25
Boston	Heavy Rail	Boston, MA	1994	6.7%	0.25
Highway Interchange*	Highway	Los Angeles, CA	2002	-3.4%-0%	-
Highway Interchange*	Highway	San Diego, CA	2002	-9.2%-(-1.1%)	-
MAX	Light Rail	Portland, OR	1993	10.6%	0.25
LRT- downtown	Light Rail	San Diego, CA	2002	4.4%	0.25
LRT- North Line	Light Rail	San Diego, CA	2002	71.9%	0.5
LRT- South Line	Light Rail	San Diego, CA	2002	-9.2%	0.5
LRT- East Line	Light Rail	San Diego, CA	2002	-1.1%	0.5
LRT- Blue Line	Light Rail	Los Angeles, CA	2002	1.1%	0.5
LRT- Green Line	Light Rail	Los Angeles, CA	2002	0.2%	0.5
DART (rail, bus, and light rail combined)	Multi	Dallas, TX	2001	13.3%	0.25
Meta Study	Multi	Multi-City	2007	25.7%	0.25

* No percentage premiums reported for this mode. The bounds here taken from rail premiums with closest model coefficients reported (model not specified)- to be interpreted as percent per mile

Considerations when Including Property Value Effects

- Evidence is varied and not consistently available by transit mode
- Real estate premiums include capitalization of travel benefits, often accounted for elsewhere in CBA
  - *Extent of "double counting" uncertain*
- Uncertainty with respect to inter- and intra-regional effects
- Information from studies may not truly reflect local project conditions

A Procedure for Estimating Benefits from Property Value Premiums

- Applying Premiums Derived from Hedonic Price Studies
  - Identify premiums through selection of similar existing systems with hedonic study data
  - Adjust premiums based on forecast ridership, population, development supporting conditions
  - Apply adjusted premiums to existing and/or forecast residential/commercial facilities
  - Account for premium as a single increase in value (obtained over time)
  - Adjust benefit estimate to account for:
    - Double-counting of travel benefits
    - Regional transfer
    - Sensitivity analysis

Example:
Property Value Premium Approach (Cont'd)

- Sample Project: LRT Extension to an existing system
  - *105,000 weekly system unlinked trips*
  - *2.2 M metro-area population*
  - *New alignment will carry 60,000 weekly trips in 2020*
  - *New alignment will serve major regional commercial center and residential areas*

Example:
Develop Premiums

Identify Similar Systems

- San Diego Trolley LRT
  - *North Line & East Line serve similar residential / commercial mix*
- Los Angeles LRT

Collect Observed Premium Data

- Commercial Premiums from -1.10% to 71.9%
- Residential Premiums from -4.2% to 17.3%
- Weekly Ridership / Population ratios at 3.46% and 3.54%

Example:
Develop Forecast Premiums

- Evaluate ridership and population statistics relative to comparator cities
- Evaluate development supporting conditions based on stakeholder assessment

	Adjusted Premium based on Workshop & Ridership		
	Low	**Med**	**High**
Residential			
Area 1	-2.5%	4.4%	11.2%
Area 2	-5.0%	8.7%	22.5%
Area 3	-3.8%	6.6%	16.9%
Commercial			
Area 1	-6.4%	19.1%	44.5%
Area 2	-9.1%	27.3%	63.6%
Area 3	-7.3%	21.8%	50.9%

Example:
Apply Premiums

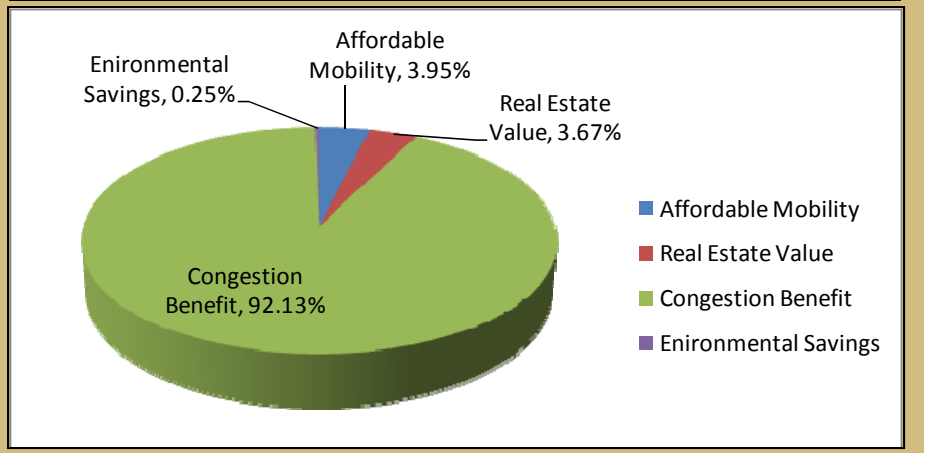
- Applied by area to existing building stock
  - *No forecast of development available for this study*
- Premiums assumed to be generated once during lifecycle but experienced over time
  - *Area 2 home increased in value by 9.00% - benefit taken in 30 increments over time*

Discounted Premium per Property (2018-2048) in 2008 dollars	
Residential	$16,196
Area 1	$42,817
Area 2	$24,424
Area 3	$12,216
Commercial	$105,549
Area 1	$95,525
Area 2	$134,316
Area 3	$75,800

Example:
Apply Premiums (Cont'd)

- Reduce benefit claim to account for capitalized travel benefit
  - *Assume 25% to 75% of benefit is capitalization of travel benefits accounted for elsewhere*
- Test sensitivity to real estate premium

Discounted Premium per Property (2018-2048) in 2008 dollars	
Residential	$8,098
Area 1	$21,408
Area 2	$12,212
Area 3	$6,108
Commercial	$52,775
Area 1	$47,763
Area 2	$67,158
Area 3	$37,900



References

- David Banister, Transport Studies Unit, *Quantification of the Non-Transport Benefits Resulting From Rail Investment,* Working Paper No. 1029, Transport Studies Unit, Oxford University Centre for the Environment, October 2007
- David Gillen, David Levinson, *Assessing the Benefits and Costs of ITS, Making the Business Case for ITS Investment*, Kluwer Academic Publishers, 2004
- David Lewis, Hickling Corporation, Silver Spring, Maryland, *NCHRP Report 342, Primer on Transportation Productivity and Economic Development*, Transportation Research Board, National Research Council, Washington, D.C., September 1991
- David Lewis and Fred Laurence Williams, Ph.D., *Policy and Planning as Public Choice, Mass transit in the United States*, Ashgate, 2000
- European Commission, Directorate General Regional Policy, *Guide to Cost-Benefit Analysis of Investment Projects, Structural Funds, Cohesion Fund and Instrument for Pre-Accession*, 2008
- Kenneth A. Small, Robert Noland, Xuehao Chu, and David Lewis, HLB Decision Economics Inc., Silver Spring , MD, *NCHRP Report 431, Valuation of Travel –Time Savings and Predictability in Congested Conditions for highway User-Cost Estimation,* National Academy Press, 1999
- U.S. Department of Transportation, Federal Highway Administration, *Freight Transportation, Improvements and the Economy*

CONTACTS

David Lewis,
David.Lewis@hdrinc.com

Stephane Gros, Principal Economist,
Stephane.Gros@hdrinc.com

Neil Pogorelsky, Principal Economist,
Neil.Pogorelsky@hdrinc.com