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CENTER for URBAN TRANSPORTATION RESEARCH

Vehicle Miles Traveled Trends and Implications for the US Interstate Highway System

The National Academies of Sciences, Engineering, and Medicine
Transportation Research Board
Future Interstate Study

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Disclaimer: **"Prediction is very difficult, especially if it's about the future."**

Nils Bohr, Nobel laureate

How are we doing at forecasting:

Stock market?

Election results?

Retail hot sellers?

Movie/media hits?

Factors Influencing Travel Demand

Social and Economic Interactions Create Demand for Travel

Time

Growth in

- Income
- Knowledge

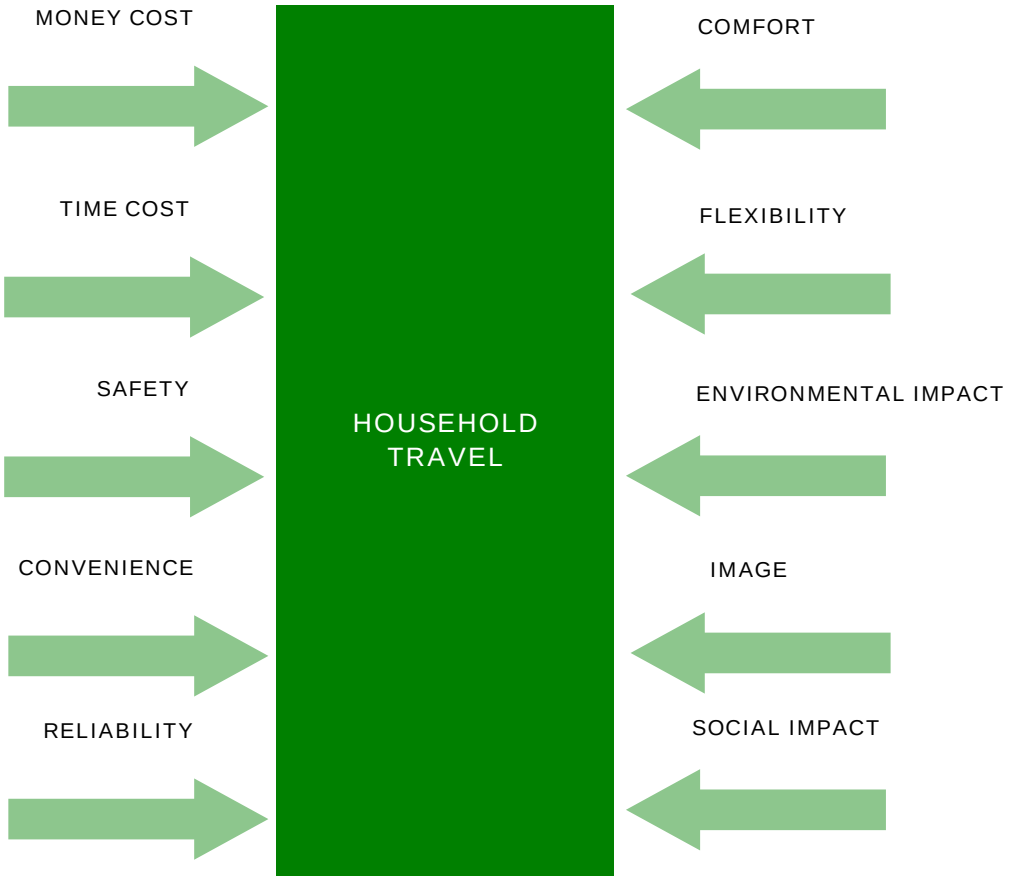
Specialization in

- Employment
- Consumption
- Social relationships
- Time use

Growth in

- Person Travel
- Commerce
- Communication

Characteristics that Influence Travel Decisions



"…the current pace of change and uncertainty with regard to key factors that influence travel demand is unprecedented in the history of our Interstate System."

Historic Considerations

- Population
- Demographic/household characteristics
- Geographic distribution
- Economic conditions
- Capital and operating/fuel costs
- Modal traits/preferences

Emerging Considerations

- Environmental/social values
- Communication substitution for travel
- Emerging mobility options (TNC, Bikeshare, carshare, etc.)
- Driverless/autonomous vehicles and mobility services

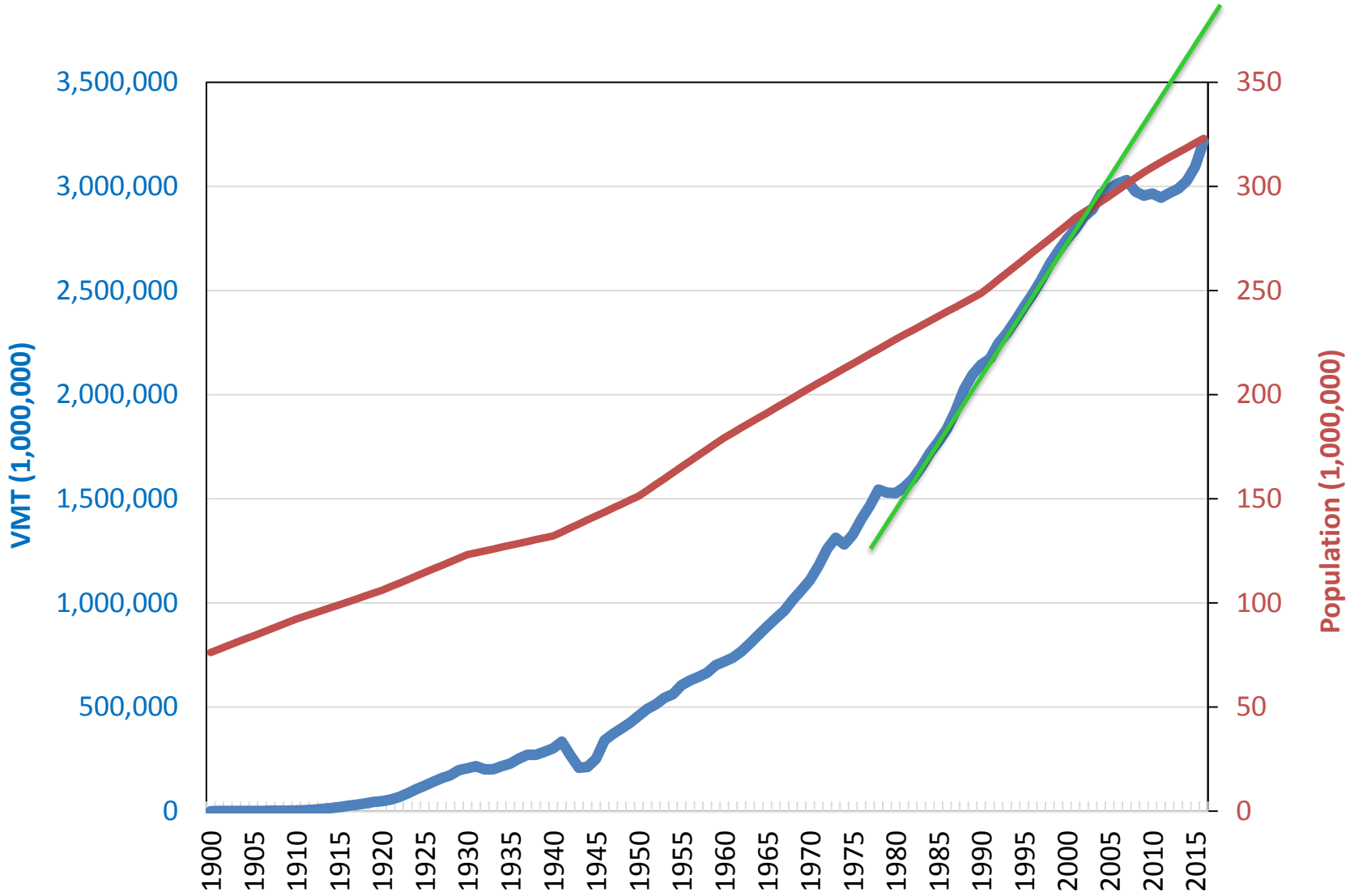
Predicting Future Demand

1. Determine factors that impact demand.
2. Determine the relationship between those factors and travel (and all the interrelationships).
3. Predict those factors into the future.

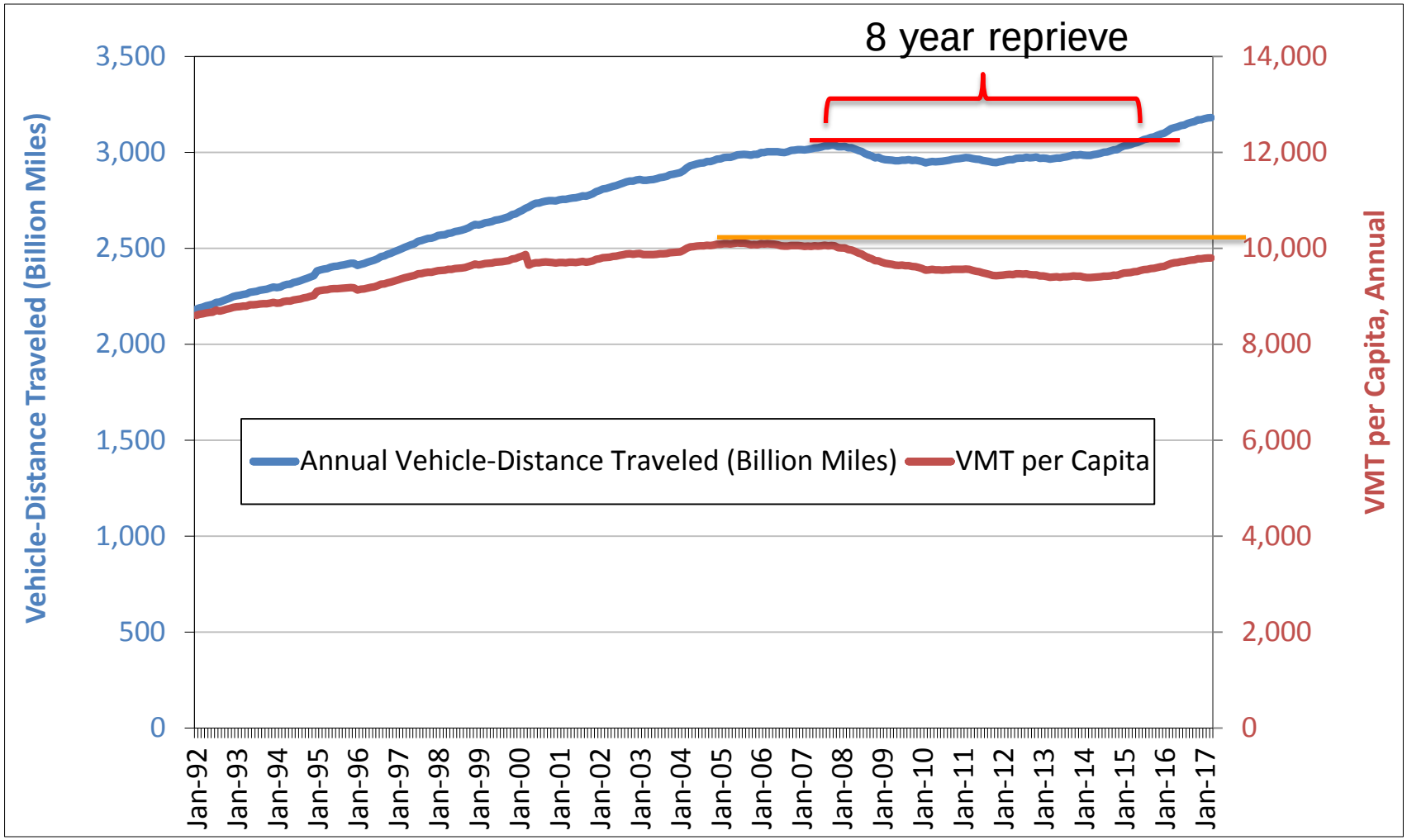
Therefore: Uncertainty

- Uncertainty regarding our knowledge of travel behavior in the emerging contexts.
- Uncertainty regarding future demand
  - In total
  - By mode
  - By functional class/on the Interstate
- Uncertainty regarding future facility capacity
  - Amount of transportation infrastructure that will be available
  - Throughput of a given facility

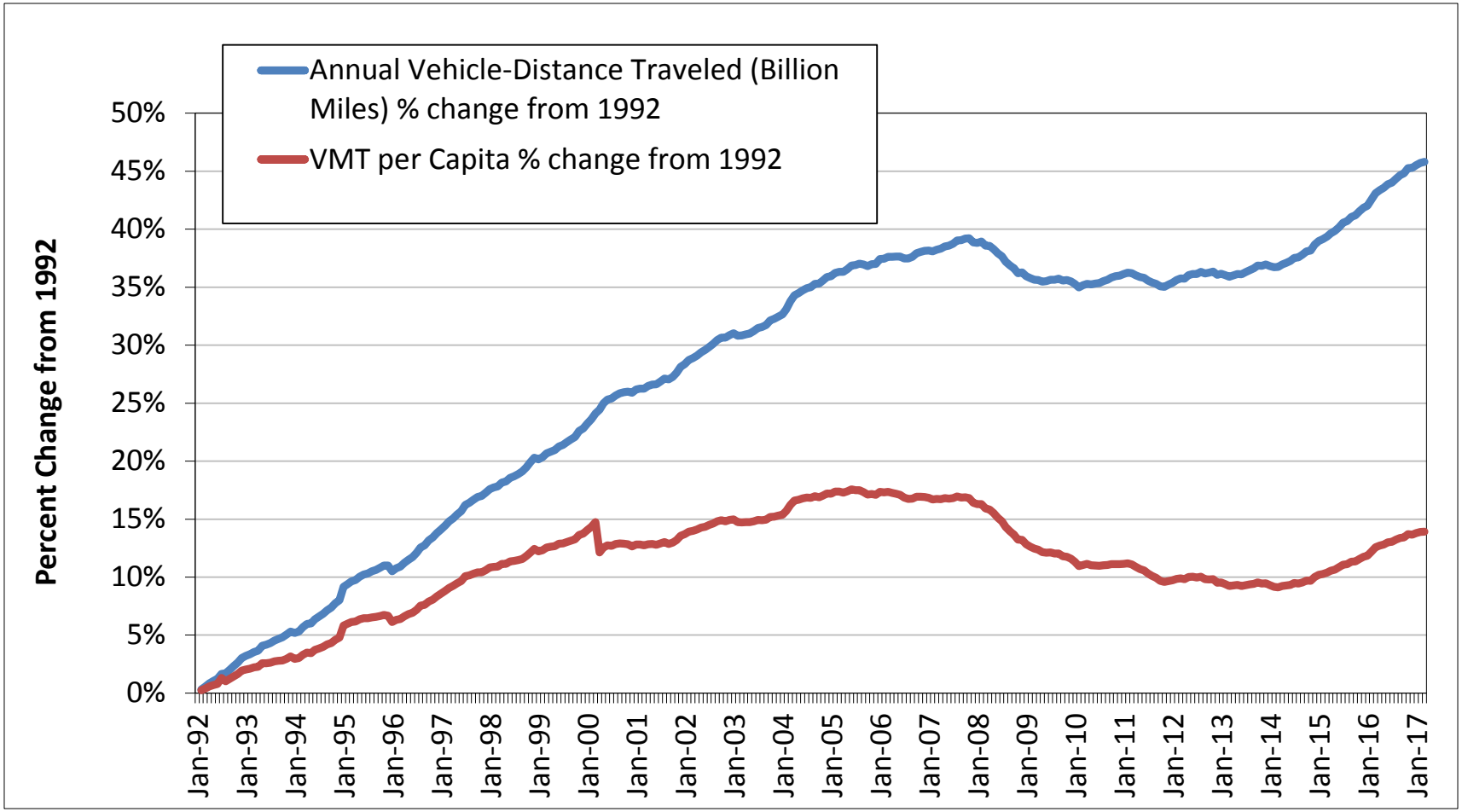
National Annual VMT Trend and Population Trends, 1900–2016



National VMT and VMT per Capita Trend, Moving 12-Month Total, 1990–2016



National VMT and VMT per Capita, Percent Change from 1992

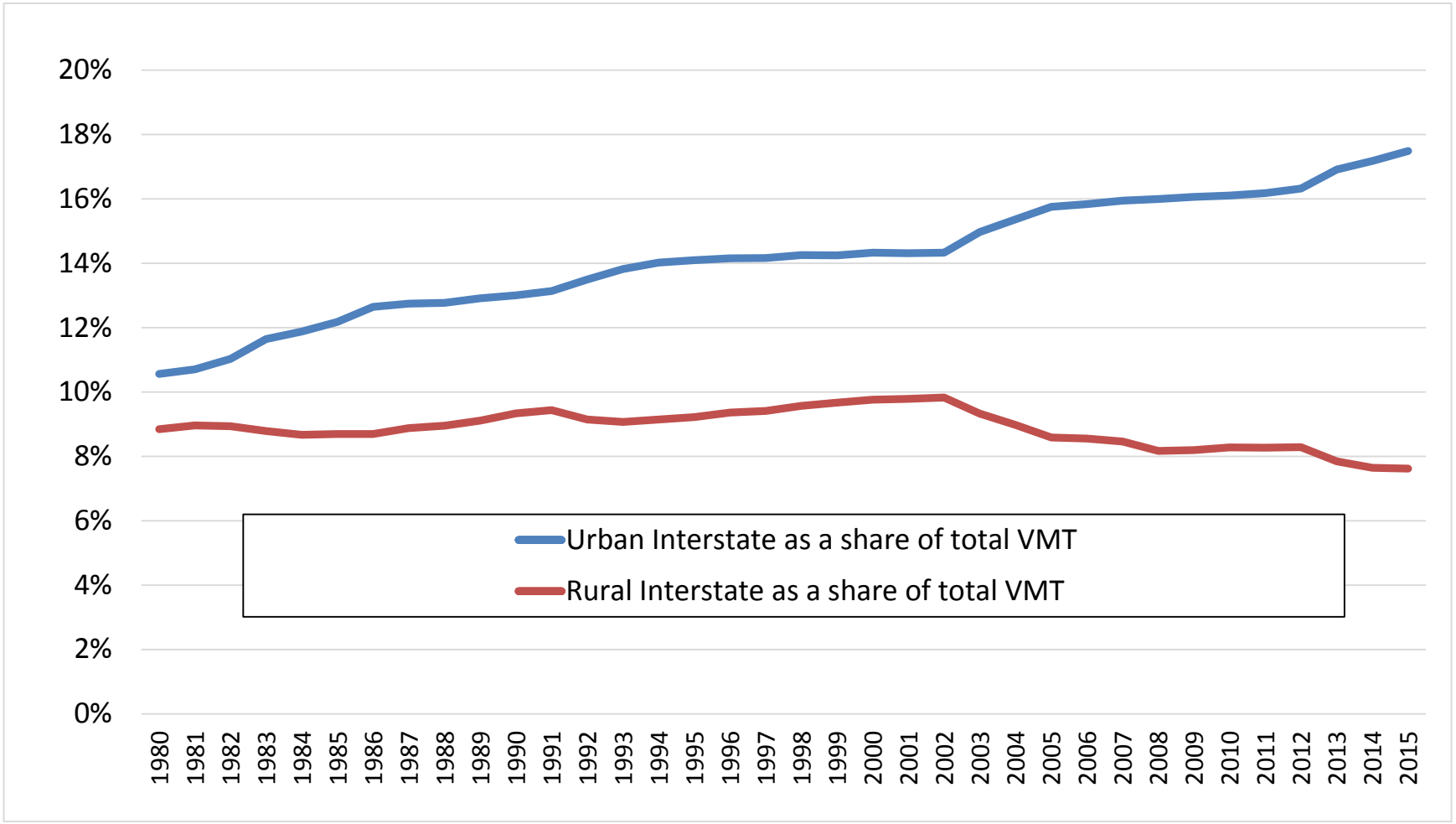


Vehicle Miles of Travel Shares by Market Segment

	Light Vehicles		Heavy Vehicles	Total
Urban	64.56%		5.45%	**70.0%**
	Household-Based	***Public Vehicle, Utility, Service-Based***		
	55.52%	9.04%		
Rural	25.46%		4.54%	**30.0%**
	Household-Based	***Public Vehicle, Utility, Service-Based***		
	21.90%	3.56%		
Total	77.42%	12.60%		
	90.02%		**9.98%**	**100.0%**

Sources: CIA 2013, Table 2-1, Commuting in Perspective; 2015 Highway Statistics, Tables VM2 and VM4

Role of Urban and Rural Interstate Highways in Accommodating VMT



Changes in US Interstate Extent and Use, 1980–2015

		Centerline Miles	Lane Miles	VMT (M)
Urban Interstate	Change	9,848.1	56,279.5	379,944.3
	Percent	106.9%	116.1%	235.6%
Rural Interstate	Change	-2,914.9	-12,728.3	100,681.6
	Percent	-9.14%	-9.7%	74.53%

Note: Decline in centerline miles and lane miles for rural Interstate attributable to reclassification of roadway segments to urban. As urban areas expand, more geography classified as urban.

Source: Highway Statistic Series, Tables VM-202, HM-260, HM-220

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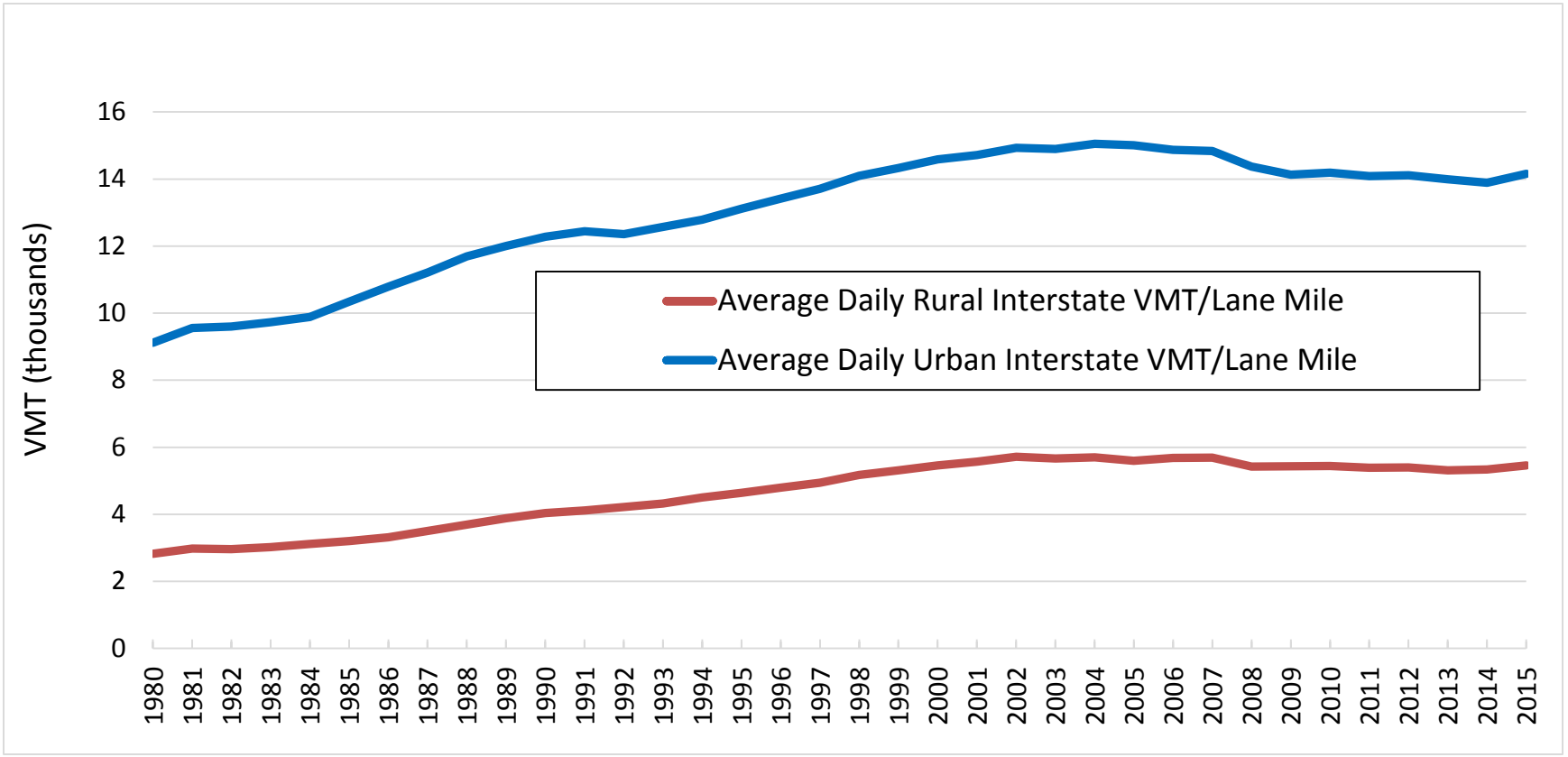
Average Daily VMT per Lane Mile, Urban and Rural



Uncertainty Favors Seeking Robust Strategies and Testing against a Range of Conditions

(Merriam-Webster)

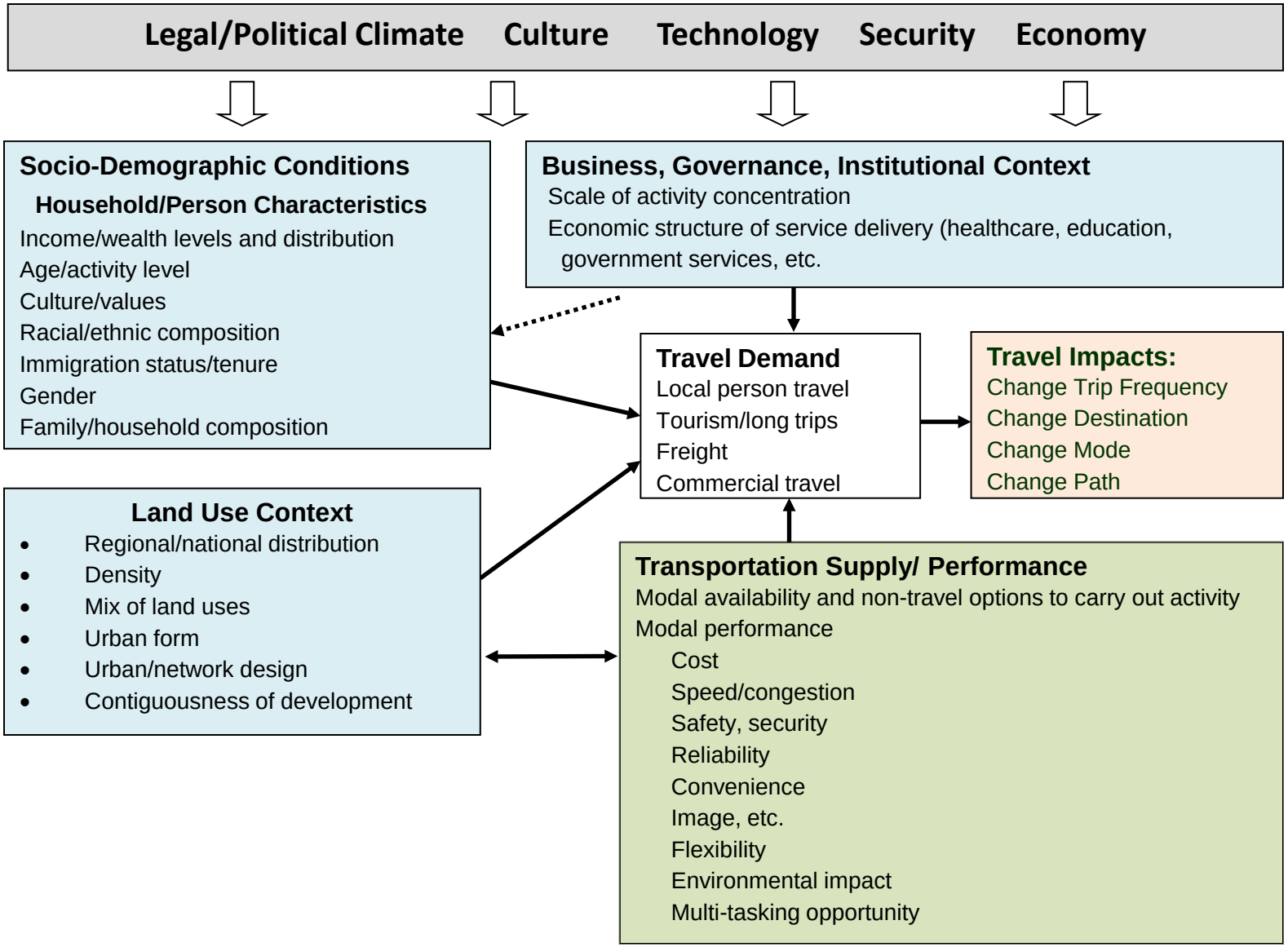
- ***robust***

  d **: capable of performing without failure under a wide range of conditions**

What Considerations go into Scenario Development?

- What consideration do we believe will be significant with respect to future travel demand?

Framework for Exploring Factors Influencing Travel Demand



Population Growth Considerations

US Population Change by Census Region

Census Region	Net Change 2000–2016
Northeast	4.88%
Midwest	5.51%
South	22.03%
West	21.30%

Source: Census Fact Finder, Table B01003

US County Population Growth Trends, 2000–2016

Growth Category	Number of Counties	Sum of Change	Percent of Counties	Percent of Growth
Counties that grew more than 25,000	377	37,783,846	12.00%	91.31%
Counties that grew more than 5,000 to 24,999	439	5,160,638	13.97%	12.47%
Counties that grew more than 1,000 to 4,999	574	1,443,389	18.27%	3.49%
Counties that grew less than 1,000	457	189,584	14.54%	0.46%
Counties that shrunk from 1 to 999	749	-325,475	23.84%	-0.79%
Counties that shrunk from 1,000 to 4,999	472	-997,254	15.02%	-2.41%
Counties that shrunk more than 5,000 to 24,999	59	-577,965	1.88%	-1.40%
Counties that shrunk more than 25,000	15	-1,299,029	0.48%	-3.14%
Total	3,142	41,377,734		

Source: Census Fact Finder, Table B01003

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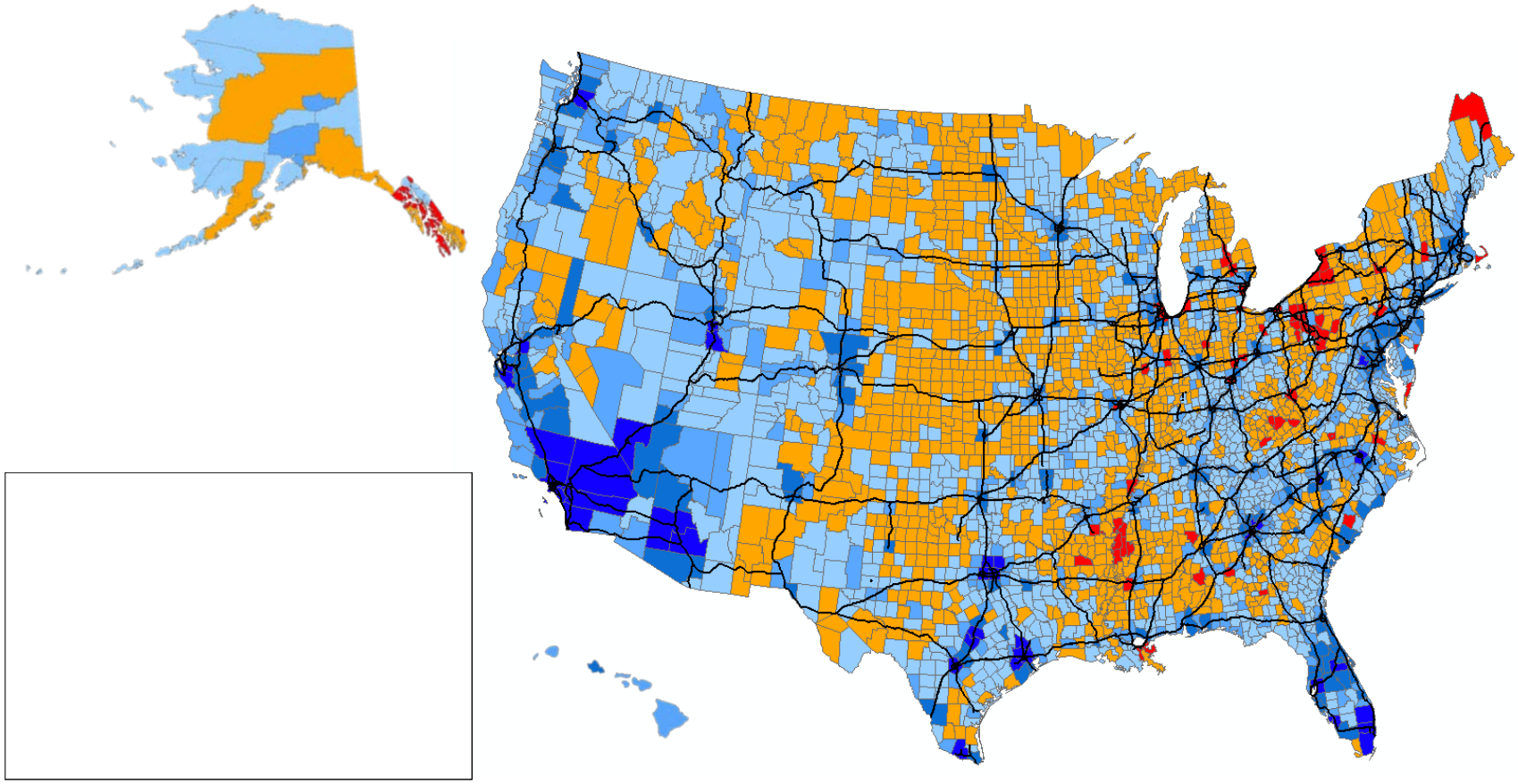
Population Growth Variation across US Counties



Implication of Population Growth and Settlement Patterns

- Base growth around 0.7% per year for next few decades
- Growth highly concentrated in modest share of geography
- Growth highly concentrated in urban areas
- Interstate capacity challenges exacerbated by the relocating population (net relocation has approximated half of net growth).

Implication of Population Growth and Settlement Patterns

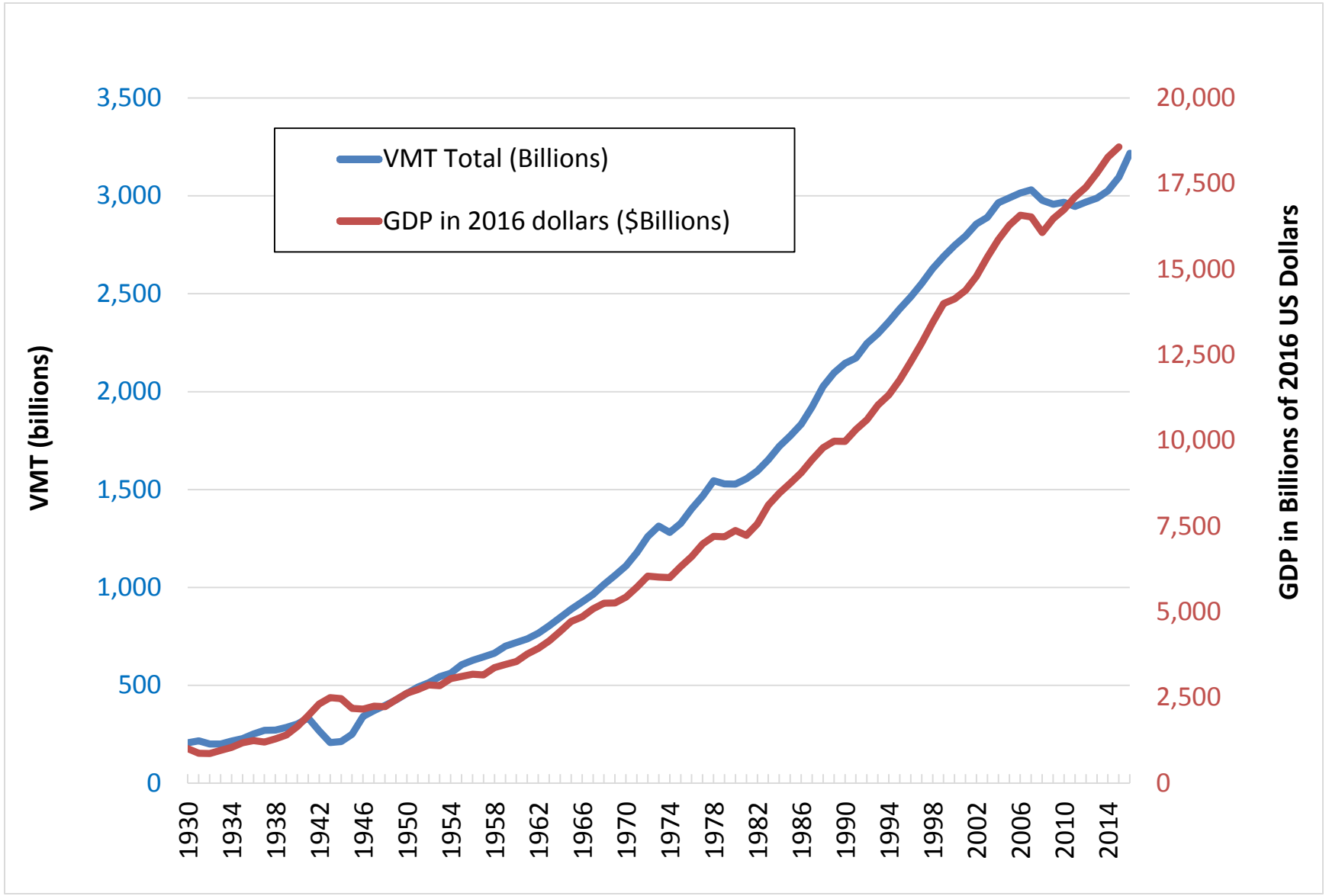
Aggregate analyses at the national level are inherently different from those that consider specific facilities. In the case of the latter, more granularity is not only possible but critical.

Thus, the percentage increase in additional capacity to maintain performance will be larger than the average percent increase in roadway volumes.

Economic Growth Considerations

- The GDP – VMT relationship is changing
- Income distribution impacts travel demand

National VMT & GDP Trends



Transportation Intensiveness of Economic Sectors

Sector	Amount of Transportation Required to Produce $1 of Output (2014)	Contribution to GDP (2015, billions)
Natural Resources and Mining Sector	**4.2¢**	**$500.9**
Utilities Sector	**4.6¢**	**$288.3**
Construction	**3.8¢**	**$716.9**
Manufacturing	**3.7¢**	**$2,167.8**
Wholesale and Retail Trade	**9.9¢**	**$2,130.1**
Service Sectors: Information Financial Professional/business Education and Health Leisure and Hospitality Other	**1.5¢** **0.8¢** **2.8¢** **1.6¢** **3.2¢** **2.9¢**	**$9,291.7**
Government	**4.7¢**	**$2,323.6**

Source: "Industry Snapshots: Uses Of Transportation," 2015, Bureau of Transportation Statistics, US Department of Transportation

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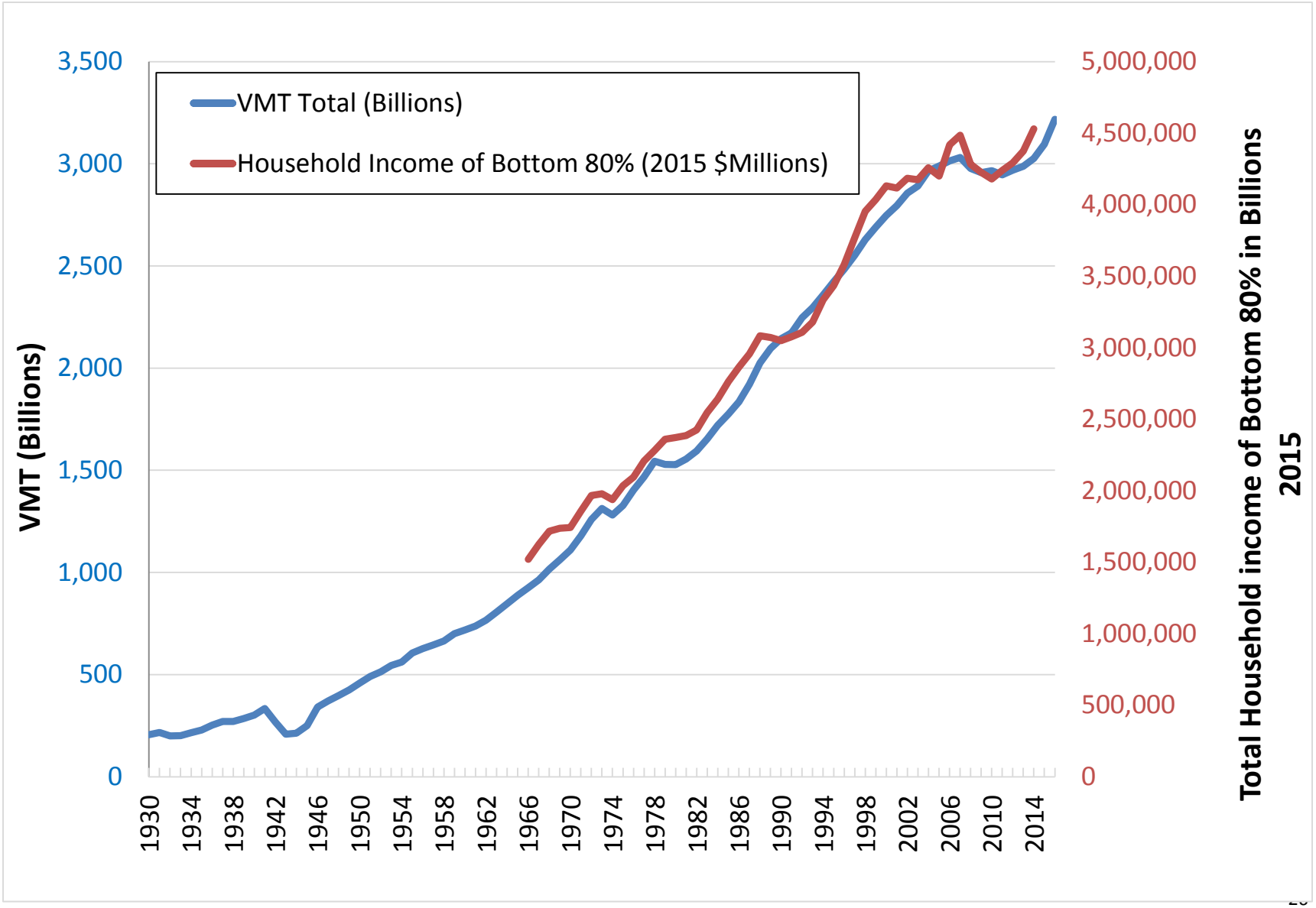
National VMT & Household Income in Bottom 80% of US Households



Key Factors in Travel Demand

- Fuel Prices
- Congestion/Travel Time
- Induced Demand
- Transportation Land Use
- Automation – Self-Driving Vehicles

How Fuel Prices Influence VMT

A change in fuel price results in changes in the cost of driving, which, in turn, leads to changes in the amount of driving or VMT.

VMT is relatively insensitive to changes in fuel prices, ("inelastic"), especially in the short run.

A study by Small and Van Dender estimates the fuel price elasticity of VMT in the US during 1966-2001 at -0.047 in the short term (≈20% decrease in fuel price results in ≈ 1% increase in VMT).

The study estimates the long-run fuel price elasticity of VMT to be -0.22, almost five times as large as the short run value.

How Travel Time Influences VMT

- **Congestion** increases time cost of travel and discourages travel.
- With **Self-driving vehicles**, travel time will not be as important to travelers because they can be doing other things simultaneously.

Travel Time Elasticity of VMT

Short run: -0.38 Long-run: -0.68

Lee, Douglass B., and Mark W. Burris (2005), "Demand Elasticities for Highway Travel, Appendix C," *Highway Economic Requirements System-State Version*, Technical Report, Federal Highway Administration, p C-14.

Short run: -0.5 Long-run: -1.0

	Urban	*Rural*
Short-run	-0.27	-0.67
Long-run	-0.57	-1.33

Litman, Todd (2017), "*Understanding Transport Demands and Elasticities*," Victoria Transport Policy Institute, p. 48.

Induced Travel

Induced travel is the increase in use of a transportation facility due to a reduction in the cost of travel that results from capacity expansion to an existing highway.

Recent evidence suggests a range of 0.3–0.6 for the short-run elasticity of VMT with respect to highway lane-miles. Thus a 100 percent increase in roadway lane miles could result in a near-term 30–60 percent increase in VMT.

The long-run elasticity is estimated to range from 0.6–1.0, indicating that roadway expansion in congested environments might ultimately produce 60–100 percent more VMT as travelers took advantage of the new capacity in the short term and perhaps made residential and travel destination decisions in the long term that further increased their travel.

Land Use Context – Per Capita VMT by Location Type

Urban Continuum	Daily VMT per Capita (Ages 20–39)
Urban	18.0
Second City	23.1
Suburban	27.1
Town and Country	32.7
Location in Urbanized Area	
In an urban area	24.1
In an Urban cluster	25.7
In an area surrounded by urban areas	32.9
Not in urban area	35.2
Size of Urbanized Area	
1 million + with subway or rail	20.2
1 million + w/o subway or rail	25.8
500,000–999,999	27.9
200,000–499,999	24.7
50,000–199,999	25.9
Not in urbanized area	32.4
Urban/Rural	
Urban	24.3
Rural	35.2

Source: Polzin, S. E., et al., "The Impact of Millennials' Travel Behavior on Future Personal Vehicle Travel," *Energy Strategy Reviews* (2014), http://dx.doi.org/10.1016/j.esr.2014.10.003

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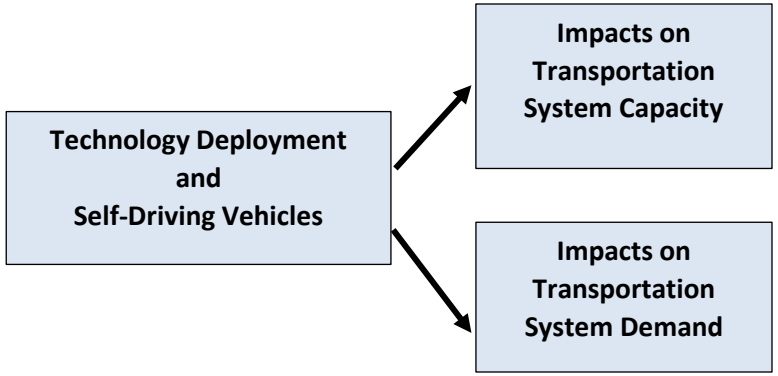
Automation – Self-Driving Vehicles

- Technology changes are unique in that they affect both demand and supply



- Scenario research suggests VMT impacts of automation ranging from -35% to plus 130%

VMT Forecast Sources

- FHWA forecasts an annual average growth rate of 0.47 percent for light-duty vehicles, 1.50 percent for single-unit trucks, and 1.87 percent for combination trucks, and 0.61 percent for all vehicles combined during 2014-2044.
- DOE for its 2017 *Annual Energy Outlook*, projects an average annual growth rate of 0.70 percent for personal and light-duty fleet travel, 1.50 percent for light commercial truck travel, and 1.3 percent for freight truck travel during 2015-2050.
- 2015 AASHTO Bottom Line Report uses 1.0 and 1.4% per year VMT growth Scenarios.
- 2015 Status of the Nation's Highways, Bridges, and Transit: Conditions and Performance uses 1.04% per year growth in VMT.

Role of Forecasts

- VMT forecasts can inform discussion regarding future Interstate System capacity requirements; however, financial and policy decisions, many made locally, will inevitably govern actual capacity expansion.
- The criticality of precision in VMT forecasts is muted by the fact that the Interstate System is part of a broader network of transportation facilities and services in which the consequences of failing to expand capacity are spread over a broader network.

Average VMT Growth in Context

- ✓ <1 % increase in population
- ✓ 2 % increase in GDP
- ✓ = ≈ 2 % increase in total VMT
- ✓ = need for ≈ 3 % increase in Interstate System capacity,
- ✓ = ≈ 5+% increment in Interstate infrastructure asset value to sustain Interstate System performance.

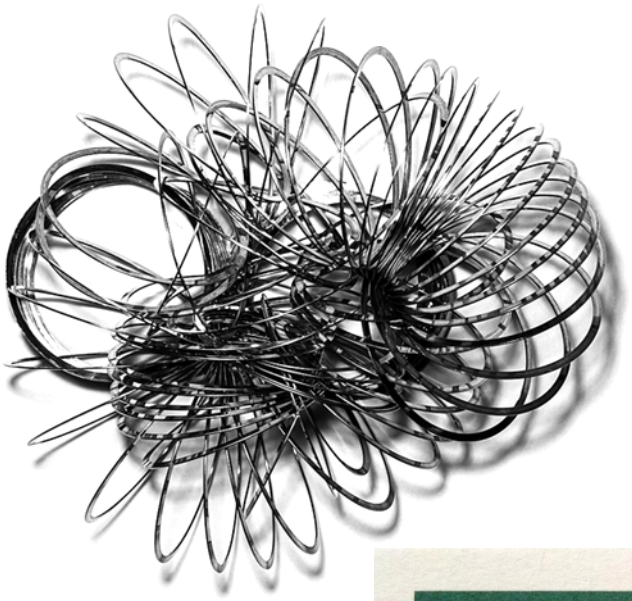
VMT Growth Levels

- ✓ For the next two decades VMT growth levels between 0.7% (population growth level) to 2% are reasonable absent extraordinary economic events.
- ✓ Beyond two decades, automation may impact demand and capacity in ways that will require scenario updates based on emerging evidence.

Caveats

- Urban Interstate capacity expansion is the most complex and expensive context for capacity expansion. In urban environments, policy considerations associated with the social, environmental, and financial implications of capacity expansion will create huge challenges and place a premium on capacity expansion strategies that can be deployed within existing facility footprints.
- The investment requirements will be even higher if the cost of consensus results in low-priority investments working their way into the program of improvements.

Contact Information



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