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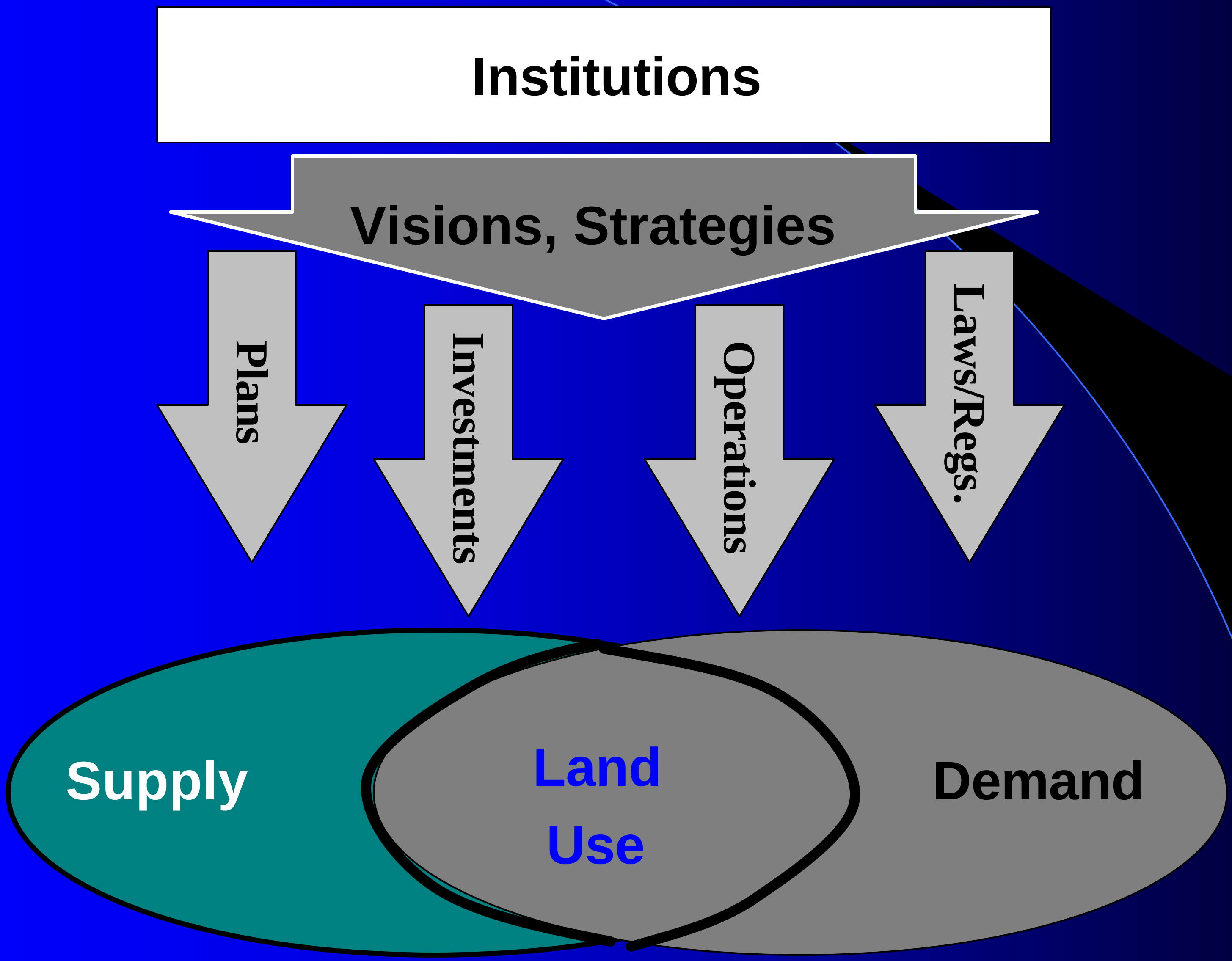
Urban Transportation, Land Use, and the Environment in Latin America: A Case Study Approach

14 February, 2002

Lecture 3:
Transportation Strategies, Options, Examples

Paths of Intervention



“Supply-Side” Interventions

- Roadway Infrastructure
  - Challenge: multi-agency responsibility
    - local, regional, national
    - ➔ maintenance,
      - ➔ management
        - ➔ expansion
    - provision (public) vs. operation (generally private)
  - Challenge: Prices charged do not reflect costs
    - [Finance issues detailed in future class]

Roadway Maintenance

- Roadway systems already constitute massive public investments
  - Typically poorly maintained
  - Maintenance investments typically exhibit very high rates of return
  - Institutional challenges:
    - responsibilities allocated according to traffic (local, regional, national);
    - revenue raising capabilities not necessarily matched with institutional responsibilities nor user impact (i.e., distance and weight related registration fees).

Roadway Maintenance

- Need for a “maintenance culture” and maintenance management systems
  - to plan and budget for required maintenance on a systematic basis
  - Implementing surveys of road condition, distinguishing routine, periodic maintenance, and rehabitation/reconstruction
- Impacts:
  - Traffic flow (congestion)
  - roadway safety
  - vehicle maintenance and performance

Traffic Management

- Maximize efficiency of existing infrastructure
  - Focus on moving goods and persons (not vehicles, per se)
  - Defer capital expenditures for expansion (‘buy time’)
  - Immediate impacts, often with minimal adverse side effects and at relatively low cost
- Improve safety and environmental performance
- Challenges
  - Virtually impossible to satisfy needs of all users (i.e., pedestrians vs. motor vehicles, bus priority vs. auto, etc.)
  - Often “low profile” – little political visibility
  - Implies a continuous process – not a “one shot” solution

Traffic Management - Measures

- Traffic circulation design
  - one way streets,
  - vehicle bans during certain hours and/or in certain areas
  - traffic calming and other measures to improve non-motorized transport conditions
- Traffic signal management (computerized, synchronized, specific user priority – i.e., buses, pedestrians, cyclists)
  - Linked to advances in telecommunications and intelligent transportation systems (ITS)
  - Technology “leapfrog” opportunity?
- On-street parking policies
- **Enforcement**

Traffic Management – Bus Priority

- Bus lanes: typically re-allocating general roadspace to bus-only use; normally not physically separated
- Busways: segregated, higher capacity, often requires new right of way.
- Latin America, particularly Brazil, has been a pioneer
  - Curitiba, Recife, Porto Alegre, Sao Paulo, Belo Horizonte, Quito, Bogota, Lima, Santiago
- Signal priority: much less common (non-existent?) in developing countries
  - complex to design and manage, difficult to organize with multiple operators (on-vehicle hardware requirements)

Bus Priority - Challenges

- Operational
  - difficult to enforce bus lanes (i.e., encroaching traffic)
  - with high “informal” sector presence and/or many small vehicles, and/or exceptionally high bus flow - limited effectiveness
- Engineering
  - integration with other road traffic
  - protecting passengers coming/going from stops
- Political
  - opposition to space re-allocation
  - desire for high-tech solutions (i.e., metros)

Infrastructure Expansion - Roadways

- Optimal transport network size?
  - U.S. cities, avg. 35% of urban area for transport infrastructure; European cities, 20-25%; Asian cities, 10-12%…
- Key is hierarchical network appropriately scaled to urban fabric and adequately fit according to need and use

Roadway Hierarchy

Type	Function	NMT Facilities	Design speed	Direct Land Access	Comments
Sidewalks, paths	Pedestrian flow	Yes		Unrestricted	Essential for access
Cycle paths	Bike flow	Yes		Unrestricted	Continuous system preferable
Local Streets	Property Access	Sidewalks	30-40 Km/hr	Unrestricted	Discourage through traffic
Collector Streets	Links local street to arterials	Sidewalks; bike lanes possible	40-50 Km/hr	Generally Unrestricted	Discourage through traffic
Arterials	Intra-city travel	Sidewalks; bicycle lanes w/ demand	50-75 Km/hr	Only to major traffic generators	"Backbone" of urban street system
Express-ways	Inter and Intra-city travel	None	>75 Km/hr	No direct land access	Grade separated inter-sections

Source: World Bank, 2001, p. 91.

When to Expand Capacity?

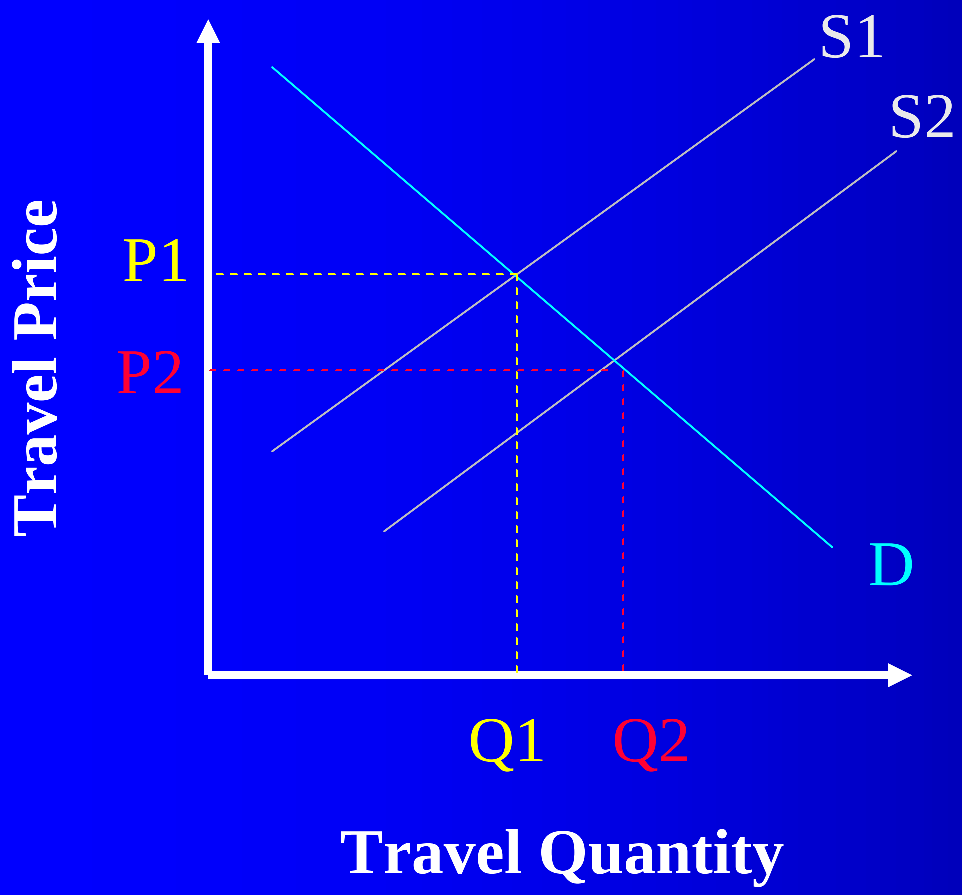
- Typically requires system-wide analysis
  - Avoid "shifting bottlenecks"
  - Full comparison to alternatives (traffic management and demand management)
  - Impacts on non-motorized transport
  - Comparison of full costs and benefits is necessary, but not sufficient
    - Valuation of environmental externalities,
    - Better understanding of impacts on urban form
    - Distributional effects of investments
  - Must take into account induced demand

Capacity Expansion & Induced Demand

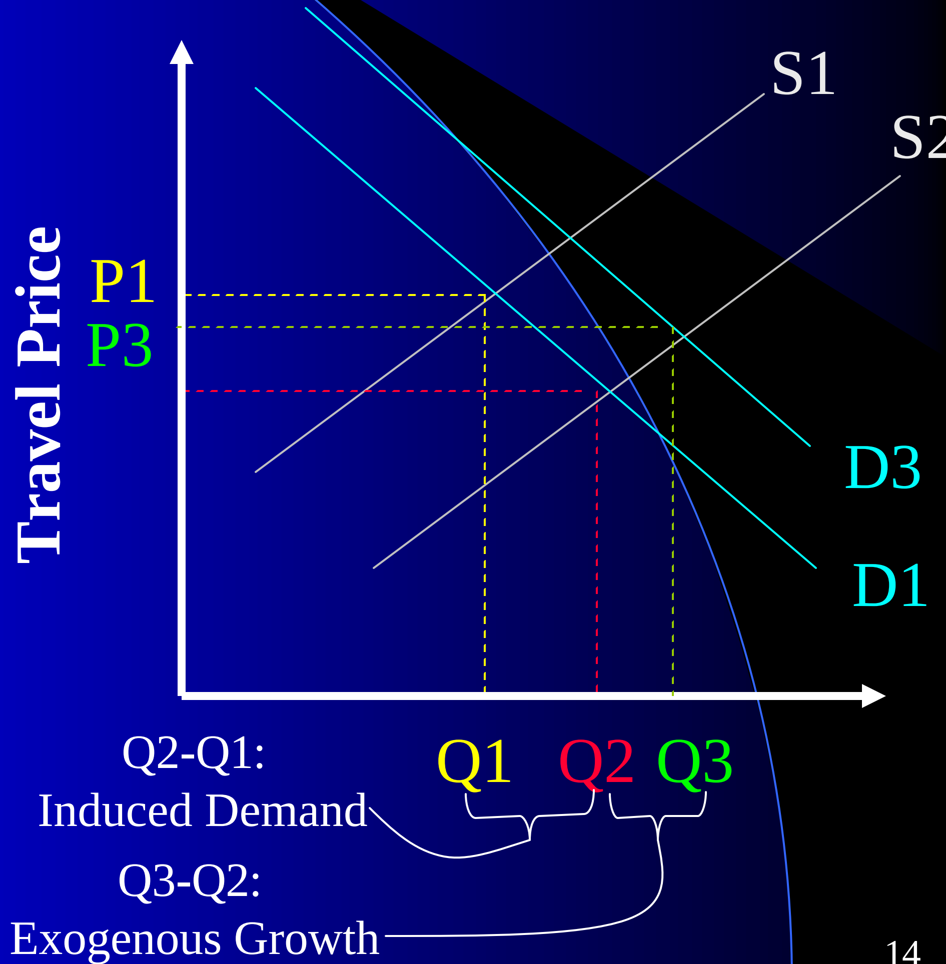
- Theory: Increases in roadway capacity attracts increases in traffic
  - Reduced travel costs (time) produces increases in demand
- Implications
  - Underestimated social costs from generated traffic (over-estimated benefits of reduced congestion);
  - Additional benefits of greater overall mobility
- Empirical estimates: Elasticities of Vehicle Distances Traveled with respect to lane miles
  - Short run: 0.5 (Noland, US State Level)
  - Long run: 0.8 (Noland); 0.9 (Hansen & Huang, CA); 1.0 (SACTRA)

Induced Demand - Graphically

Induced Travel



Induced Travel w/ Growth in Underlying Demand



Induced Demand - Effects

- Short Run
  - Changes in travel departure times, route switches, mode switches, longer trips, and some increase in trip generation.
- Long Run
  - Changes in land use patterns and spatial location of activities

Induced Demand - Implications

- Need to differentiate between induced demand and demand growth due to demographic factors (income, population, etc.)
  - Noland's models for US estimate over 5 year period approximately 25% (21%-29%) of VMT growth due to induced demand
    - Implies 43 million additional tonnes of CO2 emissions
- Need to balance induced demand's benefits (increased mobility/accessibility) with its social costs
- Road construction cannot solve congestion

Does Induced Demand Exist for Other Modes?

- Busways, Rail, NMT facilities – an attempt, in part, to induce demand to these modes
  - Improving travel times, improving travel comfort, security, safety
- Noland (1995) shows that increased cyclist perception of safety produces a greater than proportional increase in bicycle use
- Ortuzar et al (2000) estimate that cycle network construction in Santiago (3.2 km per km^2 would produce a 350% increase in bike mode share (from 1.6% to 5.8% of trips)

Infrastructure Expansion – Mass Transit

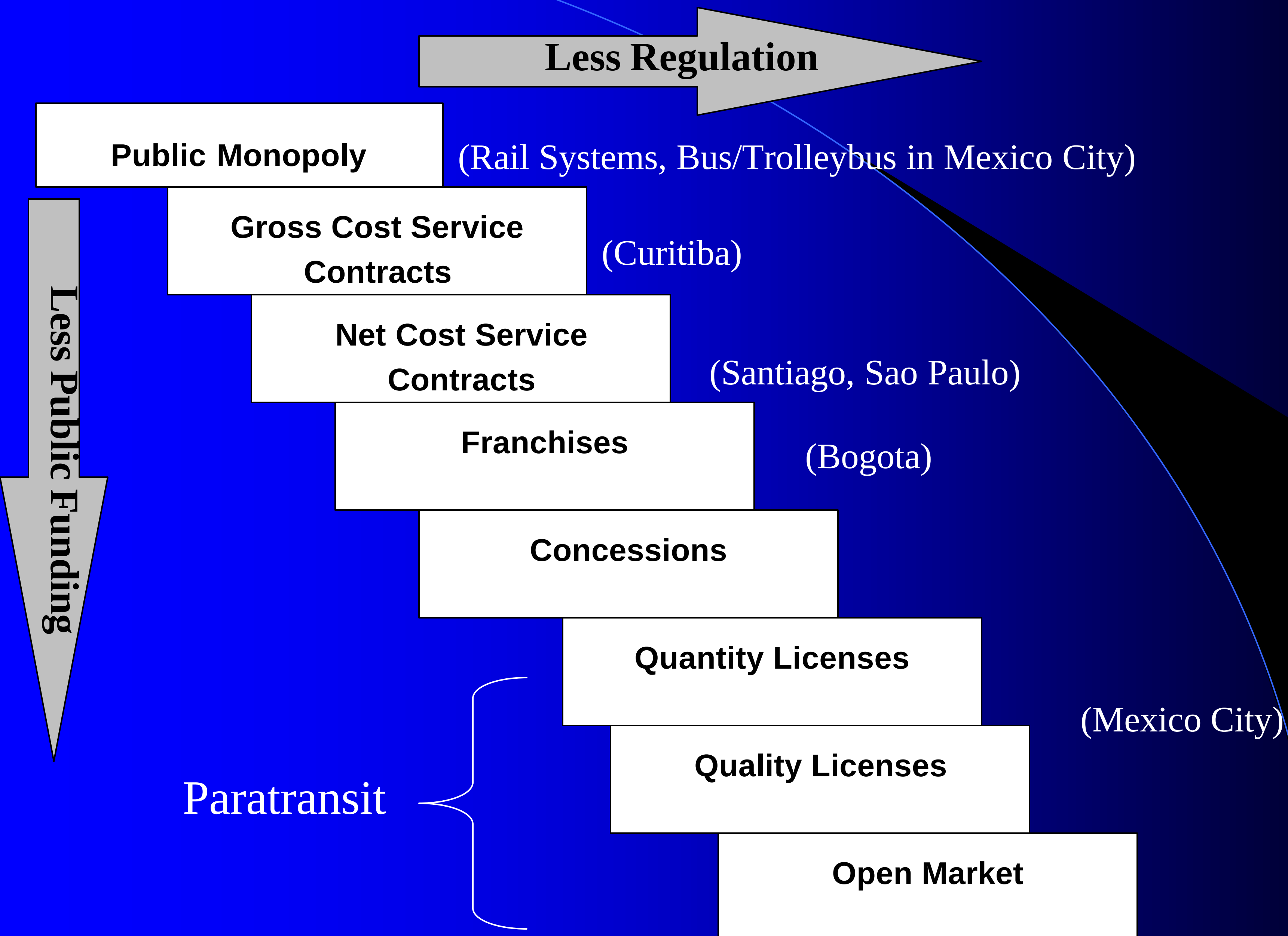
Item	Caracas	Bangkok	Mexico	Kuala Lumpur	Tunis	Quito	Bogota	Porto Alegre
Type	Metro	Metro	Metro	Light Rail	Light Rail	Trolley-busway	Busway	Buway
Layout	100% tunnel	100% elevated	20% E 55% G 25% T	100% elevated	At grade	At grade	At grade	At grade
Capital Cost/km ($mns)	90 70 w/o veh.	74 29 w/o veh.	41 23 w/o veh.	50	13 9 w/o Veh.	10 1.8 w/o veh.	5.2	1
Max. capacity (p/h/d)	32,400	50,000	39,300	30,000	12,000	15,000	35,000	20,000

Source: World Bank, 2001, p. 120.

Mass Transit Infrastructure – Major Issues

- Busways
  - as discussed earlier (slide 9)
  - rapid to deploy
  - ability to integrate with urban form? (Curitiba)
- Rail
  - typically viewed as far too expensive for developing cities
  - Clearly play a role in dense travel corridors
  - As income grows, justification can grow – investments become relatively more affordable; value of time savings increases
  - How to better integrate with urban form (both existing and new infrastructure); value capture, station development, etc.
  - What should pricing policy be?

Transport Supply – Public Transport Mgmt.



Example of Roles in "Loose" Regulation

City	Authority(ies)	Companies
Bogota	Issues licenses (route, hours, capacity); basic fares; poor overall regulation	Vehicle Owners pay "entry fee" to licensed company; premium fare
Buenos Aires	Issues concession licenses; Ministry of Economy sets fares; Transport Authority routes/schedule	Vehicles are "share" in company (association); operators set vehicle type; company influences sched.
Mexico City	Issues route-based licenses for buses and minibuses; sets fares and routes	Operators determine vehicle type and schedule

Source: Halcrow Fox, 2000.

Example of Roles in "Strong" Regulation

City	Authority(ies)	Companies
Curitiba	Gross cost contracts on area basis; reimburses operators based on per kms; fares, vehicle type, schedule, route, # buses specified.	10 "Formal" Companies.
Rio	Licenses specify level of service and fares, routes and vehicle types.	33 licensed companies.
Santiago	Contract specifies route and frequency; fare and vehicle type established in bidding.	~250 companies set fares and vehicle type via bidding.
São Paulo	Contract – based on standardized cost schedule – specifies route, frequency and vehicle type; payment on per km basis.	50 private operators; contract does not allow for much innovation.

Source: Halcrow Fox, 2000.

Public Transport Management

- Obstacles and Challenges
  - Ensuring competitive route bidding
  - Service and Fare Integration
  - Adequate enforcement of service conditions (frequencies, fares, etc.)
  - “Formalization” of Companies
  - Reducing “incumbents’ advantage”
  - Long-Term profitability
  - Institutional capacity and political influence

Transport Supply –Vehicle Owners

- Private Vehicle Characteristics and influence
  - Size, Weight – price based
    - potential influence via tax policy, registration fees
  - Emissions, Safety – regulation based, possibly price based
    - New vehicle standards, in-use vehicle standards, I/M programs,
    - Potential to link to pricing mechanisms (fuel prices, registration prices, purchase prices).
- Public Vehicle Characteristics and influence
  - Via the management/regulatory regimes

Transport Demand Management

- Prices, Fares, Subsidies
  - Fuel charges, road pricing charges, insurance charges
- Blunt instruments
  - Driving bans ("Hoy no Circula")
- The Role of Traffic Management and Supply Management

Land Use: Supply-Demand Interaction

Hypotheses of The “Three D’s”

Characteristic	Vehicle Trip Rates	Choice of non-private vehicle for:	
		Non-Work Trips	Work Trips
Density	Reduce	Increase	Increase
Diversity	Reduce	Increase	Increase
Design	Reduce	Increase	Increase

Land Use: Reality of the “Three D’s”

- “Modest to moderate at best”
  - Densities important for personal business
  - Commercial activity accessibility important for HH VMT
  - Retail activity accessibility important for work trip mode choice
  - Design elements (Grid layout, limited on street parking) important for non work travel
  - Need for co-existence of the Three D’s
- In the developing world what can really be achieved??
  - (see, for example, WBCSD, Table 4.10, p. 4-28)

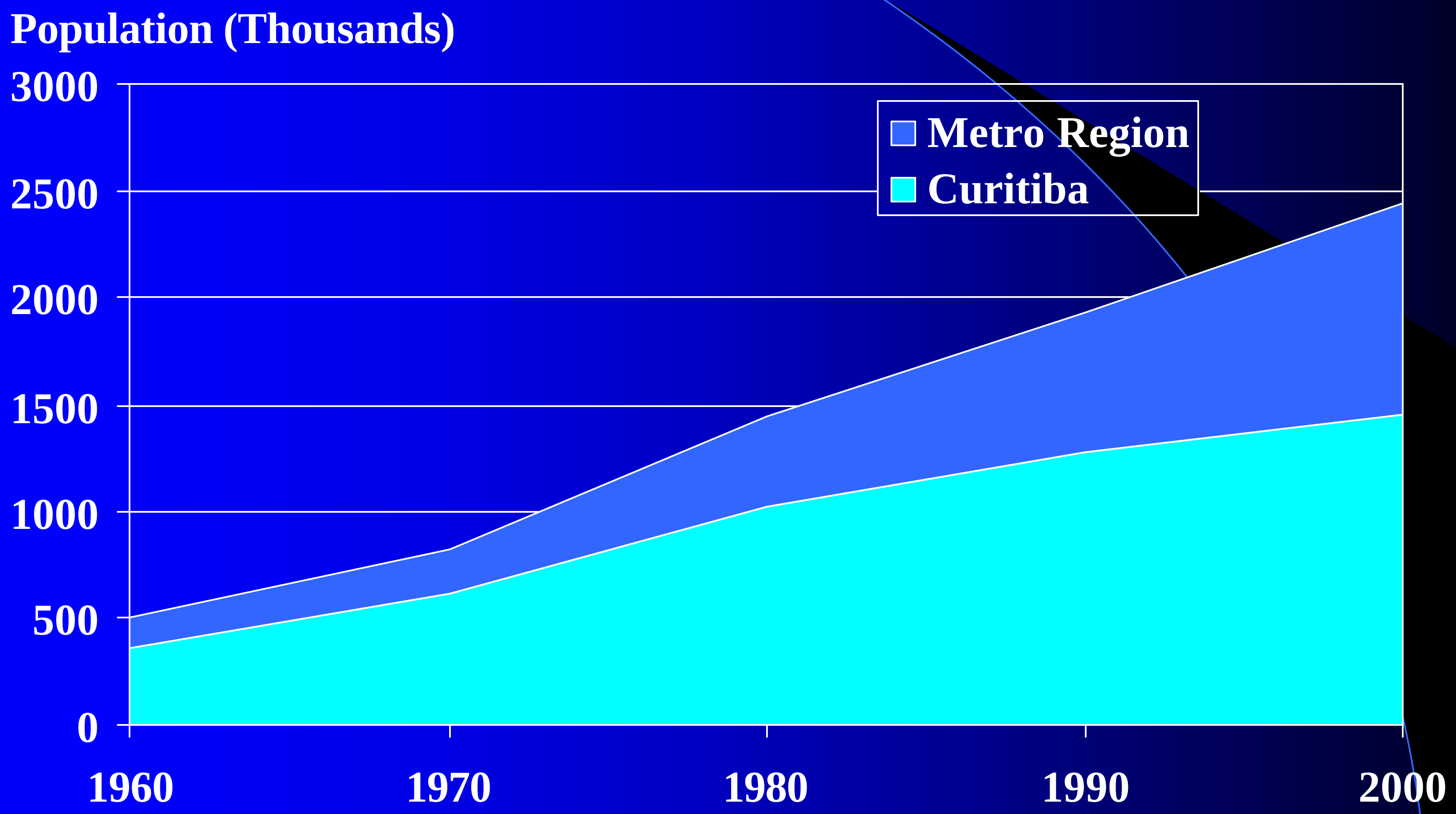
Source: Cervero & Kockelman, 1997.

Solution Sets - Key

- Vision
- Strategy
- Tactics
- Integrated Approach
- Institutional Implications

The Curitiba “Story”

Curitiba: Background



Source: Curitiba Prefeitura Municipal

Curitiba: Background

• City Size:	431 km^2, city proper ~800 km^2, metro region
• GDP per Capita:	$5,150 (US$1994)
- employment:	35% retail-commercial; 19% manufacturing
• Private Autos: (1993)	270 per 1000 people

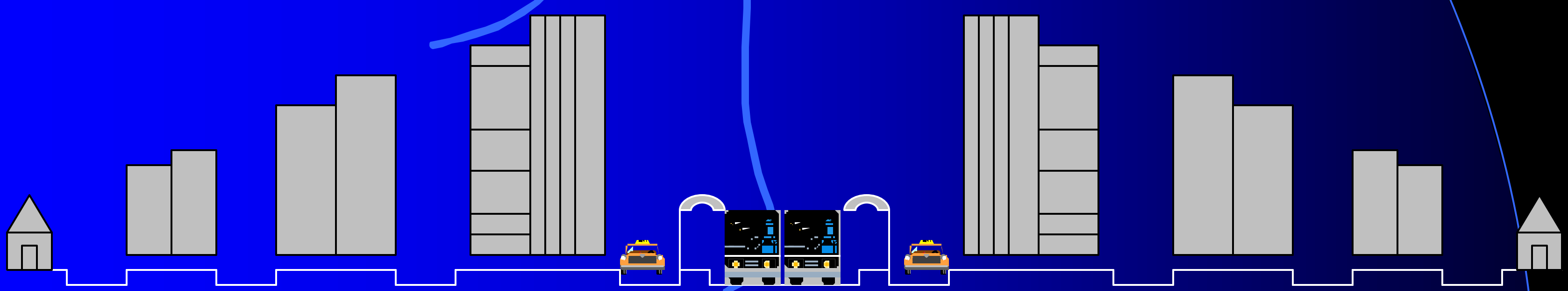
Curitiba: Evolution of a Transport System

1965:	**Linear Access Plan Conceived**
1970:	**Jaime Lerner Elected Mayor**
1972:	**Pedestrianization of Downtown Streets**
1974:	**First Two Busways**
1978:	**Additional Busway**
1979:	**First Interdistrict Bus Line**
1980:	**East-West Busway**
	Fare and Service Integration
1991:	**Express Bus with Tube Stops**
1992:	**Bi-articulated Buses**

Fundamental Principle I: Land Use-Transport Integration

A "Linear City":

- Focusing urban expansion along structural axes
  - Centered on busways
- Promote densification of land uses on axes
  - Zoning, Regulations, Incentives



Fundamental Principle II:
Public Transport Priority in Road Infrastructure

<u>"Trinary" Road System</u>