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Transport Modes and Technologies

A Walking Tour on LOS, Capacity...

Urban Transportation Planning
MIT Course 1.252j/11.380j
Fall 2002

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Transport Modes and Technologies

- The automobile
- Transit
  - Bus
  - Light Rail
  - Rapid Transit
- Non Motorized Modes
  - Walking
  - Biking

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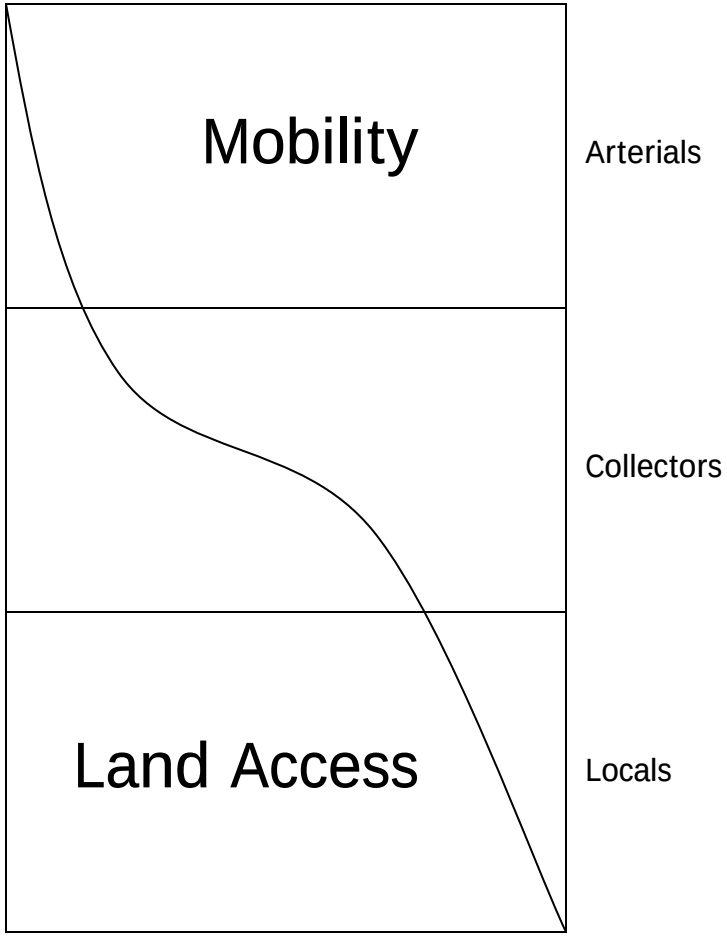
The Automobile - Infrastructure

- Road system:
  - Hierarchical system:
    - From turnpike to local street
    - From unimpeded movement to access to properties
  - Uninterrupted segments:
    - Turnpike (access control)
  - Interrupted segments:
    - Traffic signals, stops...



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The Automobile + Infrastructure

- Other support systems:
  - Traffic Police
  - Traffic Management Centers
  - Parking
  - Gas stations
  - Garages

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The Automobile – Demand Served

- HBW: Home-based work
- HBO: Home-based other:
  - Shopping trips
  - School trips
  - Personal and recreational trips
- NHB: Not home-based (ie: Business trips)

HBW represents less than 35%

Peak-spreading and latent demand

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Highway Capacity

- The Power of Little Numbers
  - Sophisticated models are indeed needed
  - But so, are little numbers in the back of an envelope
  - Who wants to be taken for a ride?

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Automobile Capacity = Throughput (Veh/hr/ln)

Level-Of-Service (LOS) = Flow/Capacity (or I/C or V/C)

Notice density and spacing among vehicles

Level of Service A

Level of Service F

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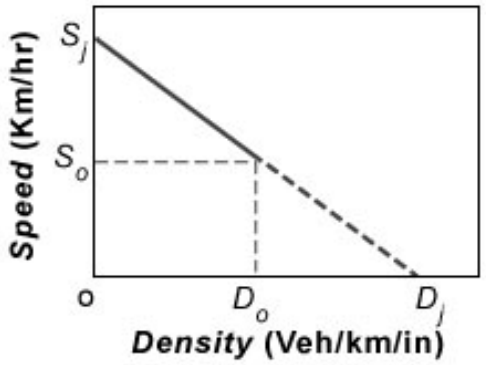
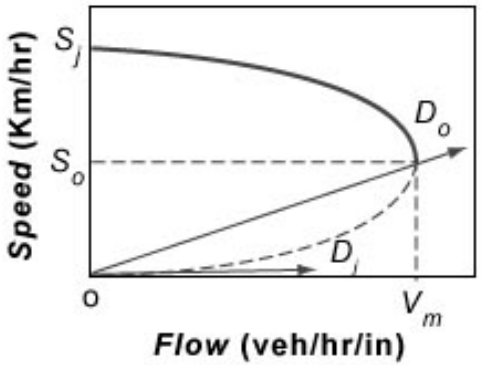
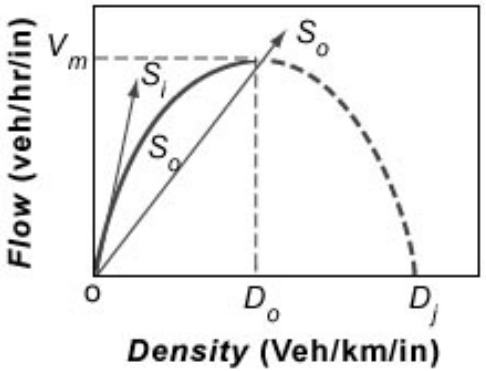
The Automobile – Capacity

- Vehicle Throughput in uncontrolled sections:

  -Speed-density curves







Legend:

--- Oversaturated flow

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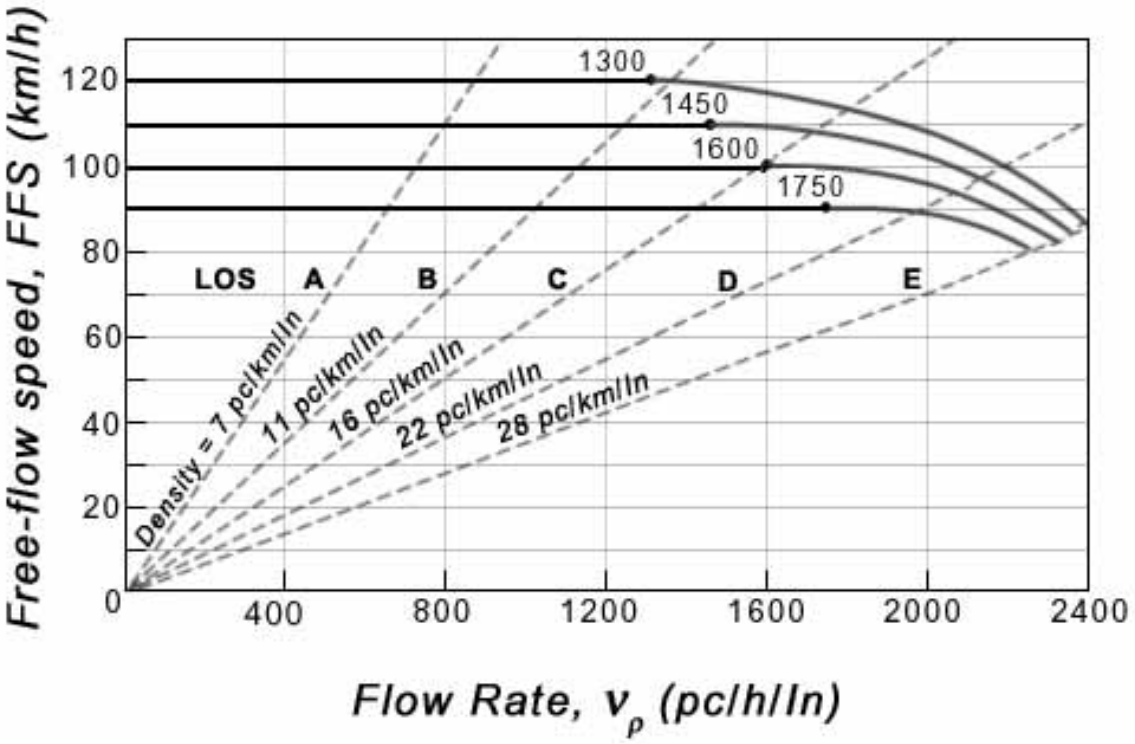
The Automobile – Capacity and LOS

- Vehicle throughput in uncontrolled sections:

  -Speed-density curves



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LOS: A changing reality

- Human adaptation is the key...
  - From infrastructure construction to management of the existing system
  - The Highway Capacity Manual (HCM) speed-flow curve:
    - People learning to drive congested roads
    - The initial dream of ITS

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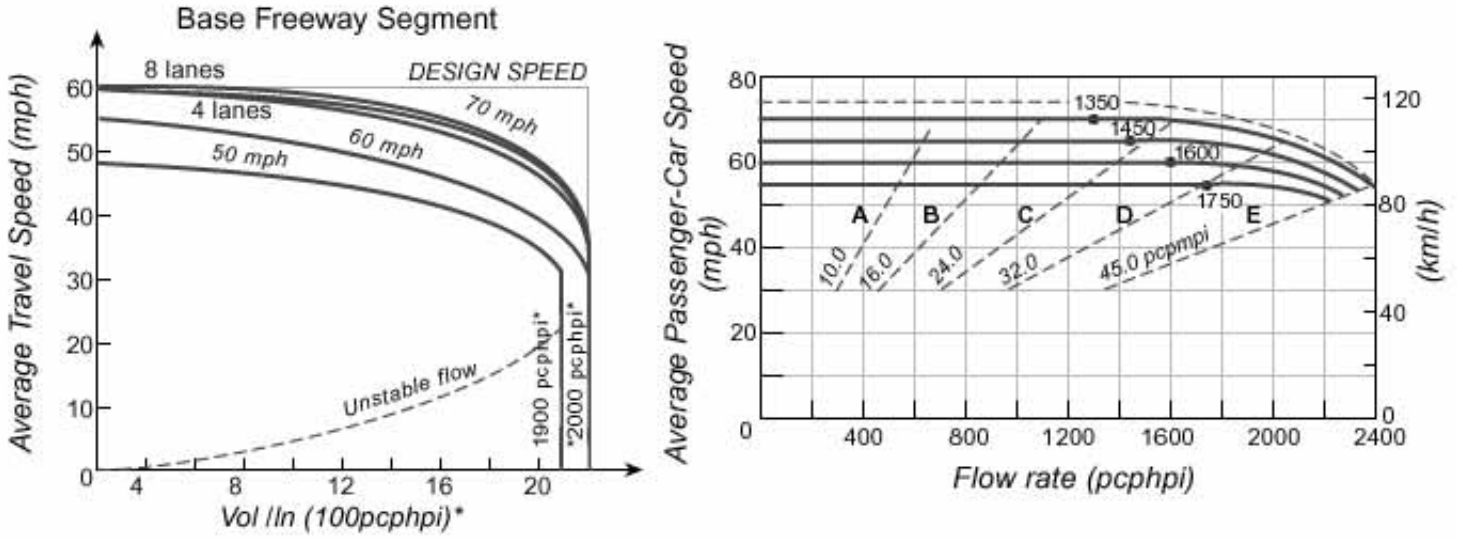
Human adaptation

HCM speed-flow curve, before and after



* Capacity

**v/c ratio based on 200pcphpi valid only for 60- and 70-MPH design speeds.

Note: Capacity varies by free-flow speed.

Free-flow speed (mph)	Capacity (pcphpi)
≥ 70	2400
65	2350
60	2300
55	2250

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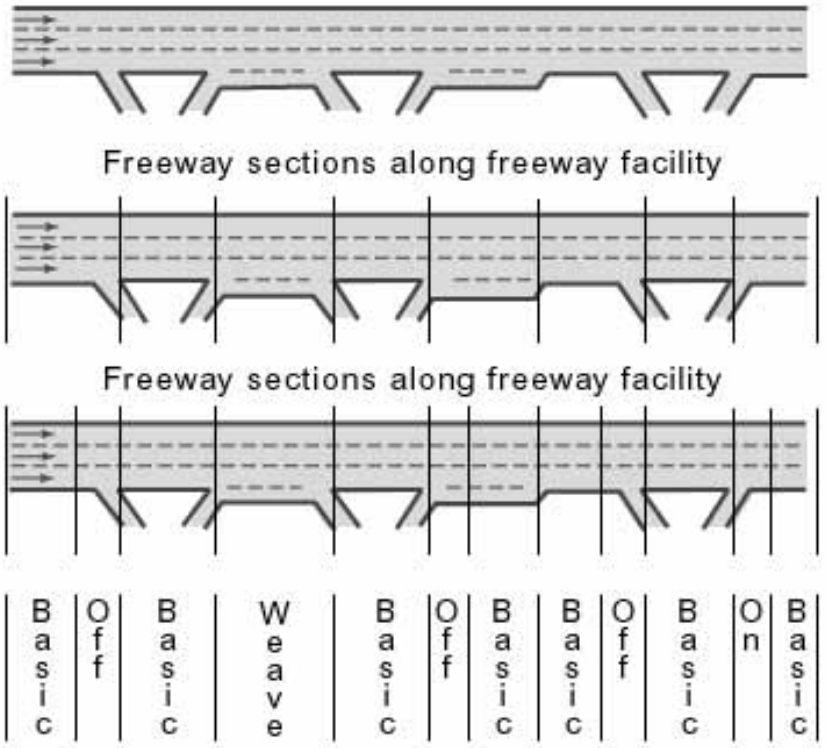
The Automobile – Capacity and LOS

- Vehicle throughput in uncontrolled sections:

  -Automobiles and trucks

  -Geometry

  -V/C above 1?



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The Automobile – Capacity

- Vehicle throughput in controlled sections:
  - Traffic signals, roundabouts, all-stops...
  - Automobiles and trucks – reaction times
  - Saturation and gridlock

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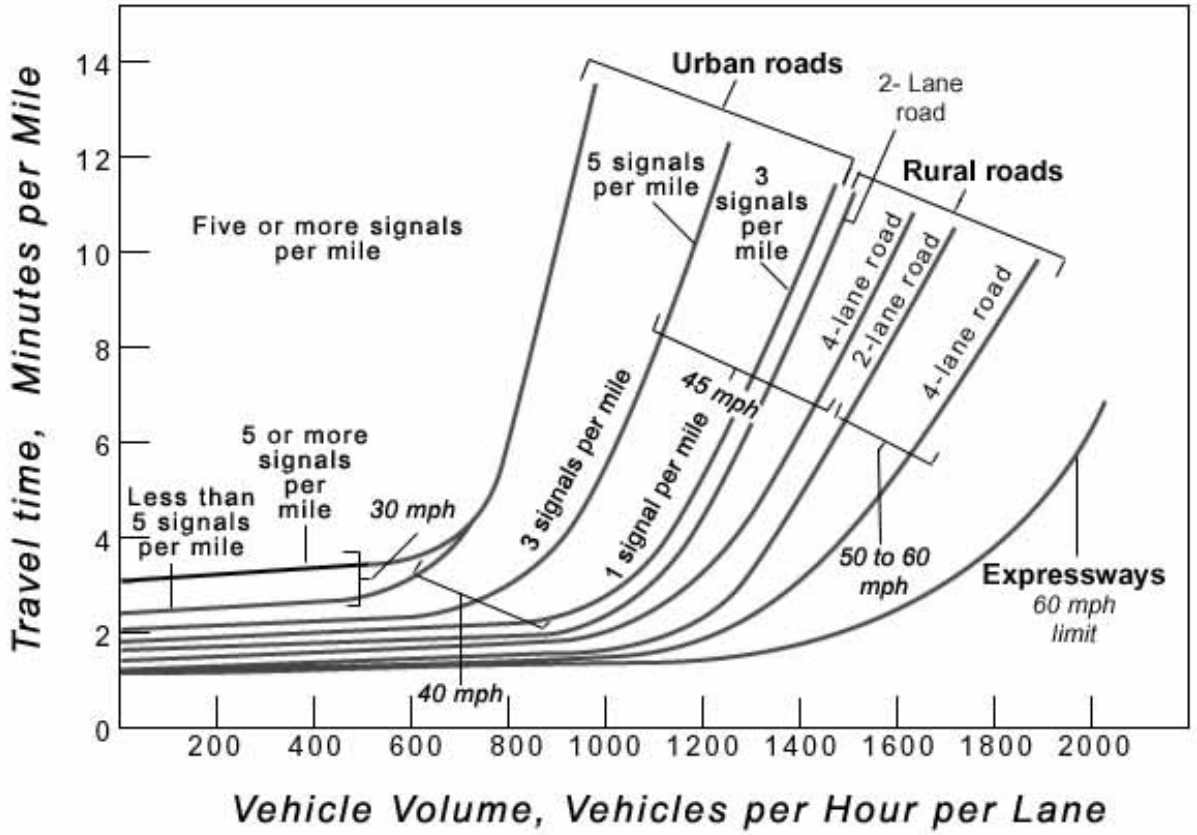
The Automobile – Capacity Reference Nos



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The Automobile – Capacity

- PEOPLE throughput :
  - Vehicle throughput times OCCUPANCY
  - Auto-occupancy (a non-technical issue)
    - HBW... 1.1
    - HBO-shop... 1.4
    - HBO-social... 1.7
    - NHB..... 1.6

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The Automobile – Levels-Of-Service

- The power of A to F
- From spot values to travel times
- Living under saturated conditions

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The Automobile – Costs

- Fixed Costs:
  - Vehicle purchase
  - Insurance

Not considered out-of-pocket expenses

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The Automobile – Costs

- Variables Costs:
  - Gasoline
  - Oil and maintenance
  - Parking
  - Tolls
  - Automobile Industry -> Service Economy

Ratio between Fixed and Variable Costs

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The Automobile – Costs

- Social costs:
  - Roads
  - Management of road system
- Environmental costs:
  - Accidents (Swedish Govt.)
  - Noise (pedestrian areas)
  - Air pollution: cold-start, f(speed)
  - Land consumed
  - Energy
  - Segregation
  - .....

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Transit vs The Automobile

Courtesy of CERTU

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Transit – Demand Served

- HBW represents > 50%
- Peak hours
- Peak directional flows

Easy to accept overcrowding at peak to justify service during off-peak hours

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Transit - Capacity

- Vehicle size
- Headway (and fleet size)
- Commercial speed

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Transit - LOS

PASSENGER POINT OF VIEW "QUALITY OF SERVICE"

AVAILABLITY

- Service coverage
- Hours of service
- Sidewalk condition
- Park & Ride spacing

CONVENIENCE

- Passenger loading
- Transit/auto travel time
- Amenities
- Safety

LOS related to Capacity **and Quality of Service**

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Transit - LOS

- Occupancy
- Hours of service
- Headway
- Lateness or reliability
- Comfort
- .... And other quality-related aspects

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Transit - LOS

LOS	Bus		Rail		Comments
	ft^2/p	*p/seat**	ft^2/p	*p/seat**	
A	>12.9	*0.00-0.50*	>19.9	*0.00-0.50*	No passenger need sit next to another
B	8.6-12.9	*0.51-0.75*	14.0-19.9	*0.51-0.75*	Passengers can choose where to sit
C	6.5-8.5	*0.76-1.00*	10.2-13.9	*0.76-1.00*	All passengers can sit
D	5.4-6.4	*1.01-1.25*	5.4-10.1	*1.01-2.00*	Comfortable standee load for design
E	4.3-5.3	*1.26-1.50*	3.2-5.3	*2.01-3.00*	Maximum schedule load
F	<4.3	*>1.50*	<3.2	*>3.00*	Crush loads

*Approximate values for comparison. LOS is based on area per passenger.

Transit/Auto Travel Time LOS

LOS	Travel Time Difference (min)	Comments
A	≤0	Faster by transit than by automobile
B	1-15	About as fast by transit as by automobile
C	16-30	Tolerable for choice riders
D	31-45	Round-trip at least an hour longer by transit
E	46-60	Tedious for all riders; may be best possible in small cities
F	>60	Unacceptable to most riders

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Transit - LOS

TCRP Web Document 6
(Project A-15) Contractor's Final Report

Transit Capacity and Quality of Service Manual

Prepared for
Transit Cooperative Research Program
Transportation Research Board
National Research Council

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Transit - Cost

- Capital Costs:
  - >50-75 years horizon
  - Not included in operating costs
- Operating Costs:
  - $C_{op}=C_d$*veh-miles $+C_t$*veh-hr + C_s*fleet
- Environmental Costs:
  - Accident rate
  - Noise, soot...

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Buses

- Flexibility for route adjustments
- Closer stop spacing
- In search of higher quality:
  - Low floor buses for an aging population
  - Bus stops:
    - Real time info on arrivals (and eventually downstream)
    - Maps, transfers, info on ticketing and validation

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Buses

- In search of higher quality:
  - Real time info on board (like a good subway car)

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Buses

- Capacity:
  - Bus type and size:
    - Easy access and egress
    - No of doors
    - No of seated spaces and no of standees
  - Commercial speed:
    - Mixed traffic
    - Bus lanes
    - Signal priority

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Buses

- Capacity (Cont'd):
  - Headway: Peak-hour and off-peak
  - Access and ticketing:
    - No of doors
    - Access by the front door, other doors
    - Egress by one or two doors
    - Low floor
    - Ticket validation:
      - By the bus driver
      - On other machines on board
      - On the bus stops

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Rail-based systems

- Mass transit
- Sense of permanence
- Separate R.O.W.

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Rail-based systems

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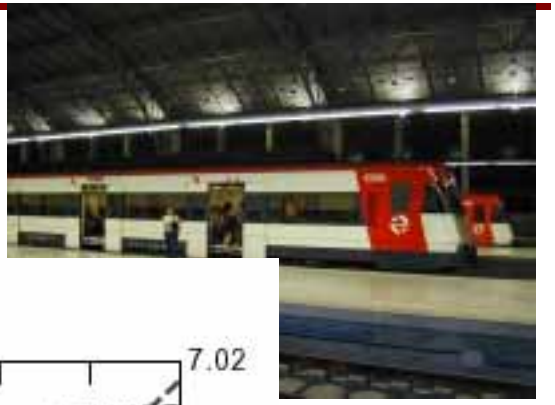
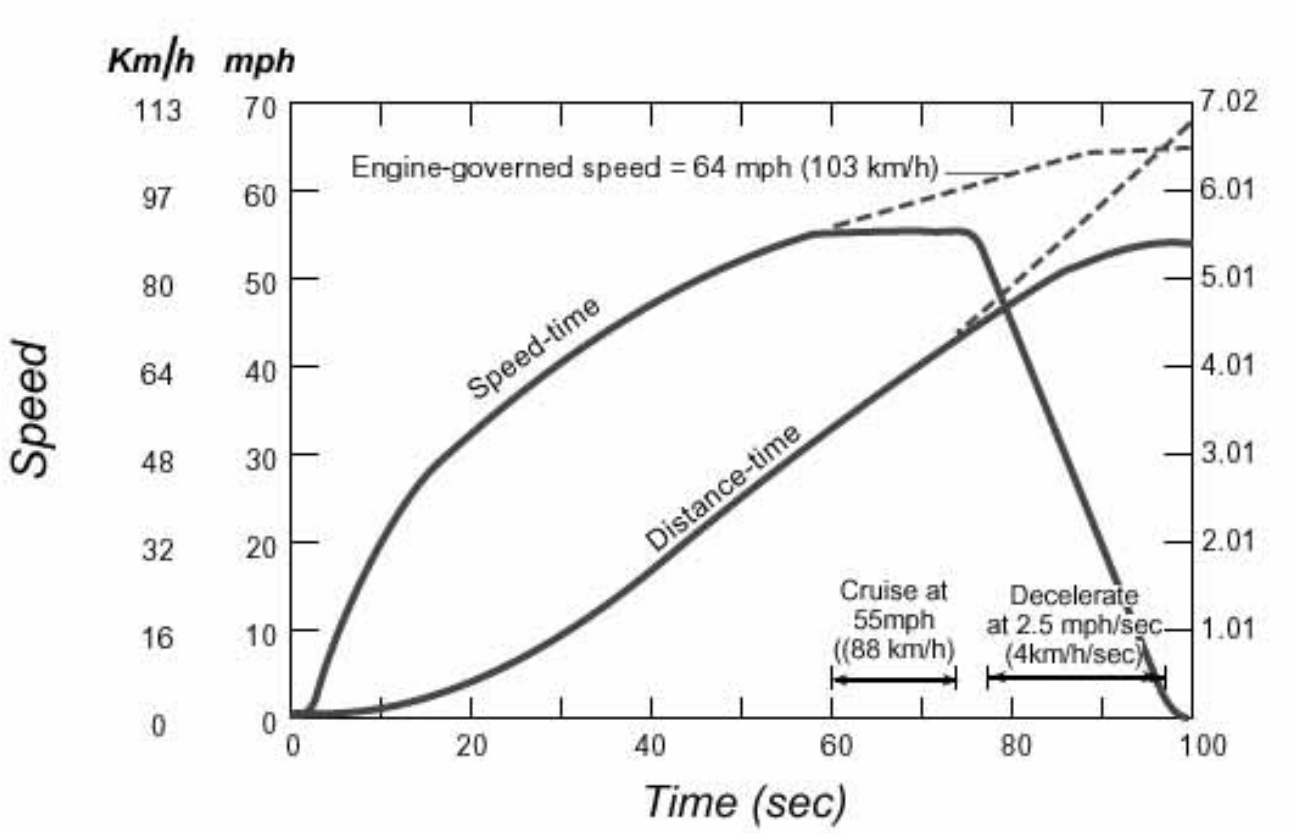
- Speed profiles





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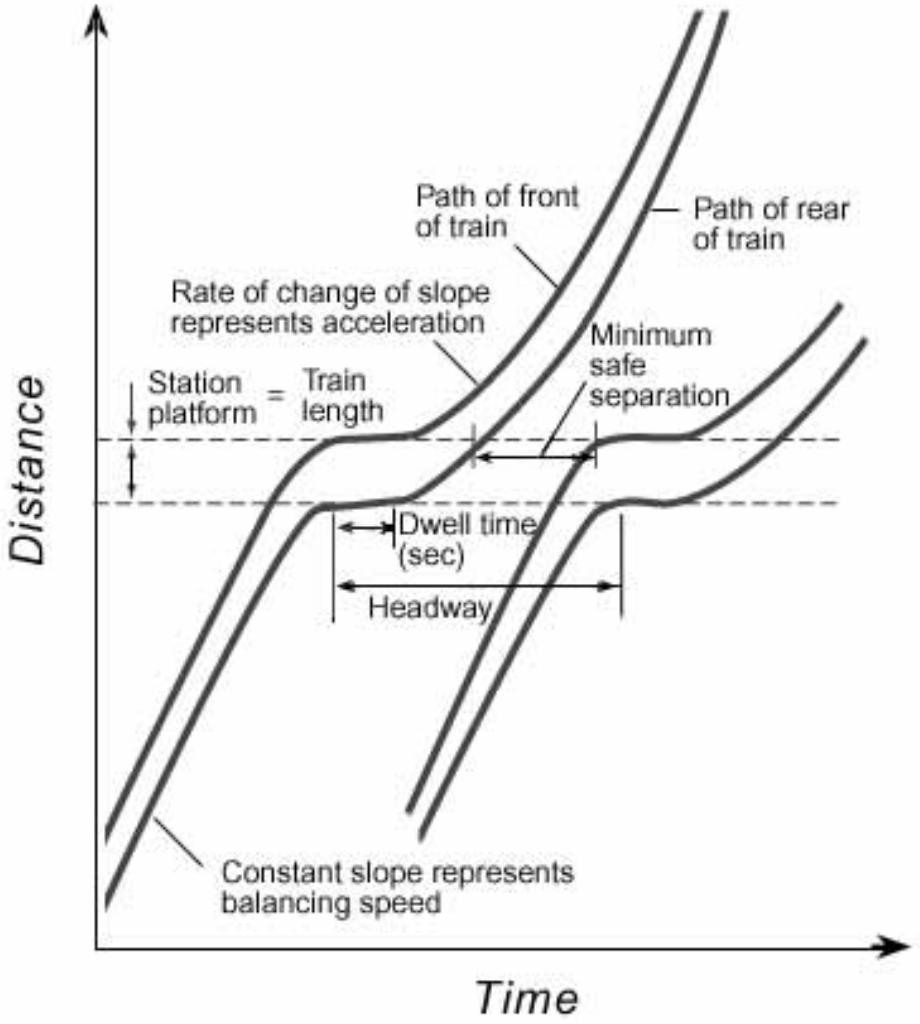
Rail-based systems

- Time-Space Diagrams



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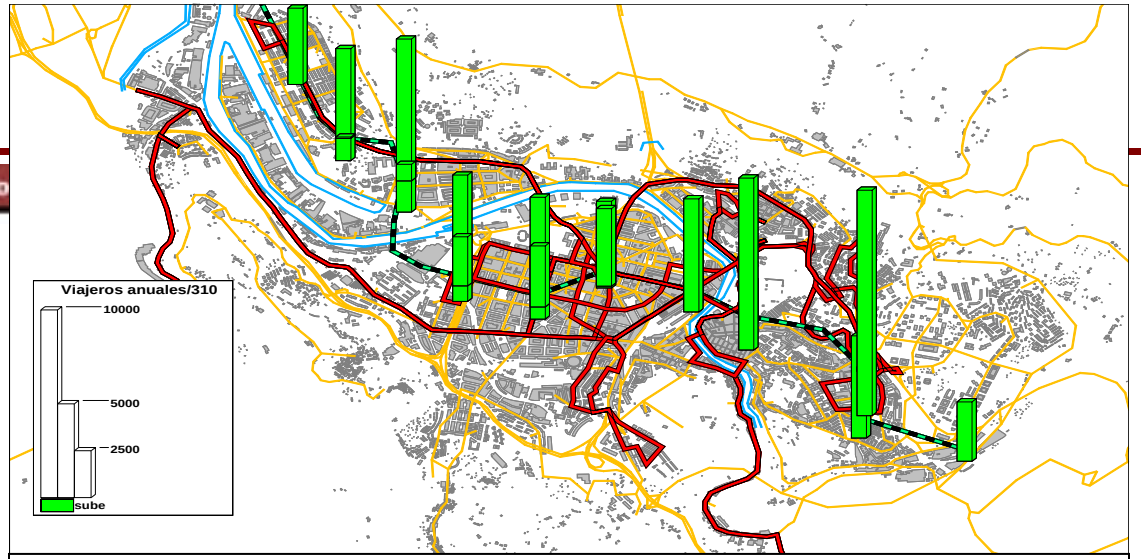
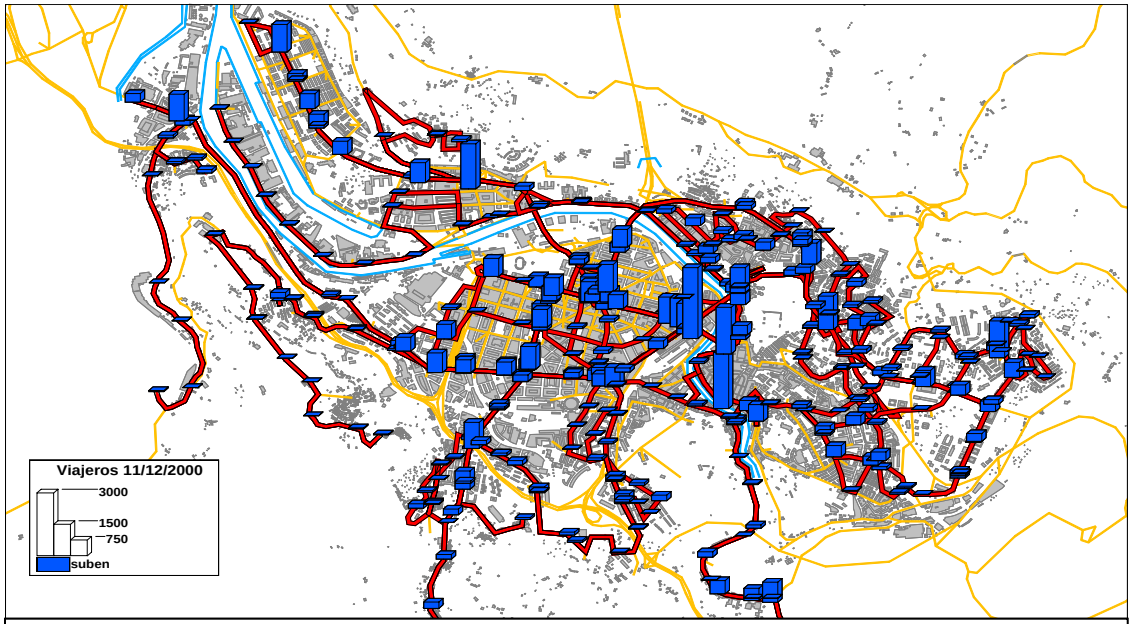
Rail vs Bus



Metro 90,000 viajeros en 11 estaciones



BilboBus 90,000 viajeros en >180 paradas

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Light Rail

- From Rapid Rail Transit to Light Rail:
  - Lower investments
  - But more *exciting* than buses
  - Mixed traffic segments
  - Easier to garner support for priority
  - Attracts local development

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Light Rail

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- Full reserved ROW or mixed traffic

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Light Rail

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- Priority easily awarded...

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From Public Transport to Collective Transport

- Jitney service
- Taxi-Bus
- Dial-a-Ride
- Taxi
- Car Sharing

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Some comparative numbers

	Car on city streets	Car on Freeway	Bus LRT on Mixed Traffic	Semi Rapid Transit	Rapid Transit
Vehicle occupancy	1.2	1.2	40-300	40-600	140-2,200
Speed (km/hr)	**20-50**	**60-120**	**5-20**	**15-45**	**25-70**
Veh/hr	600-800	1500-2200	60-80	40-90	10-40
Capacity (pers/hr)	**720 to 1,050**	**1,800 to 2,600**	**2,400 to 20,000**	**4,000 to 20,000**	**10,000 to 72,000**

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Walking

- Capacity and LOS:
  - Moving (flat, stairs, escalators)
  - Waiting
- Again, only related to throughput? What about quality of the experience?

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Walking

- Speed:
  - 2.5 mph, really?
  - Jaywalking prohibited in Boston?

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Biking

- The power of a can of paint
- Safety first and foremost

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Biking

- A process:
  - Target population?
  - Continuous O-D

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Biking

A process: Ideas about how to import this into Boston??

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Modal Split: A Critical Issue

- Let us see a few examples from Census Data (HBW):
  - Boston
  - Chicago
  - Los Angeles
  - Manhattan
- Any other??

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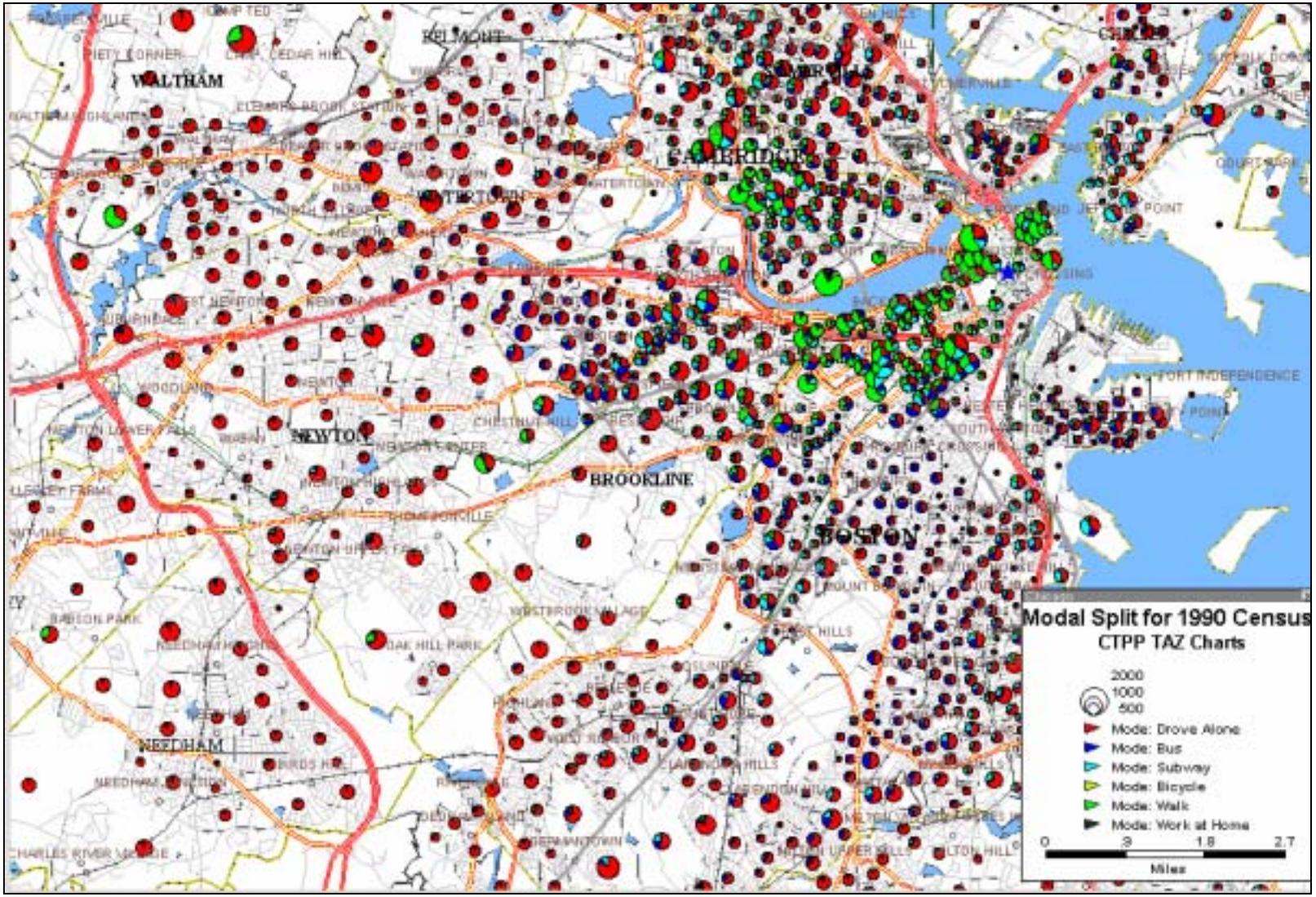
Green=Walk to Work, Blue= Transit, Red=Automobile...
Boston



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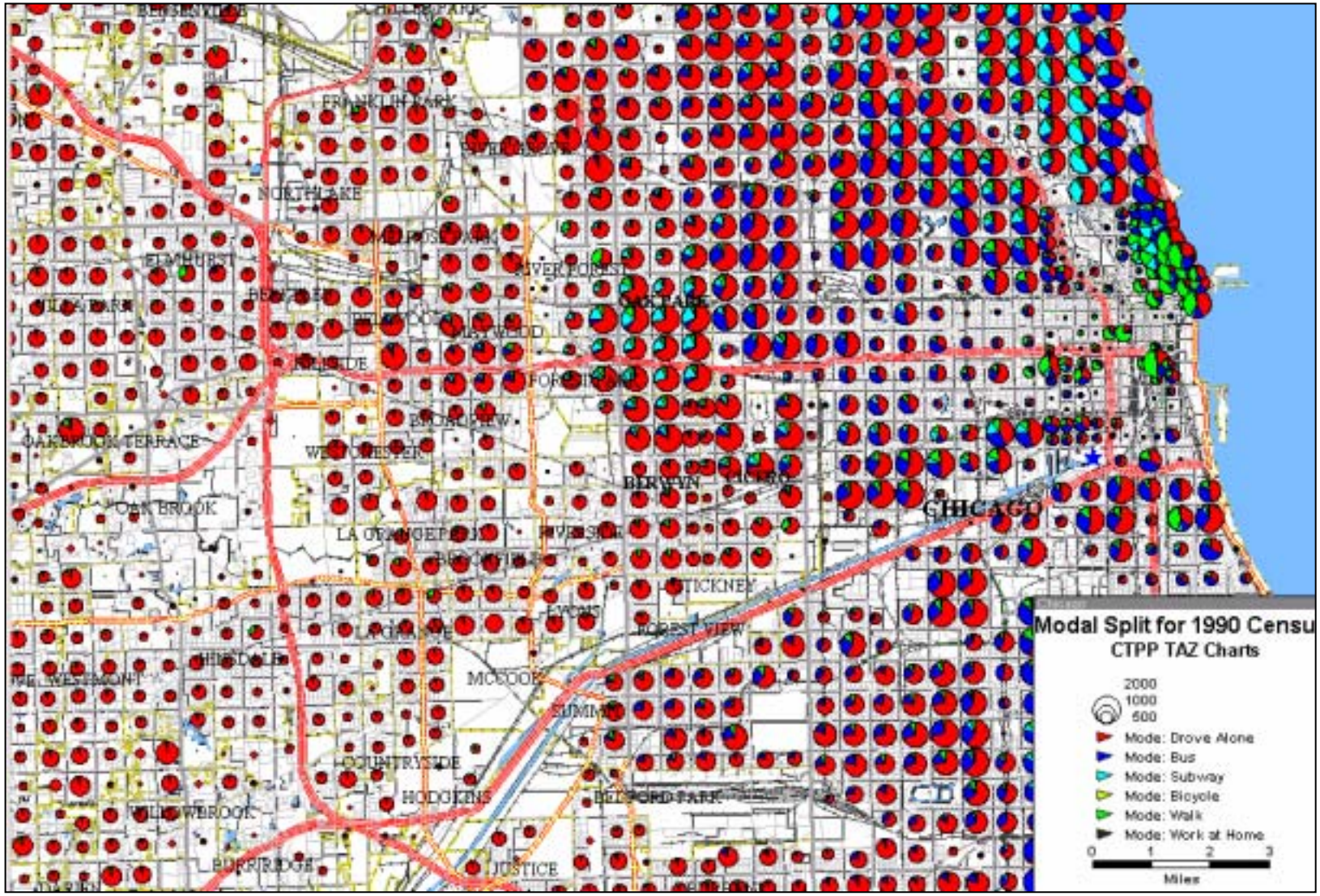
Green=Walk to Work, Blue= Transit, Red=Automobile...
Chicago



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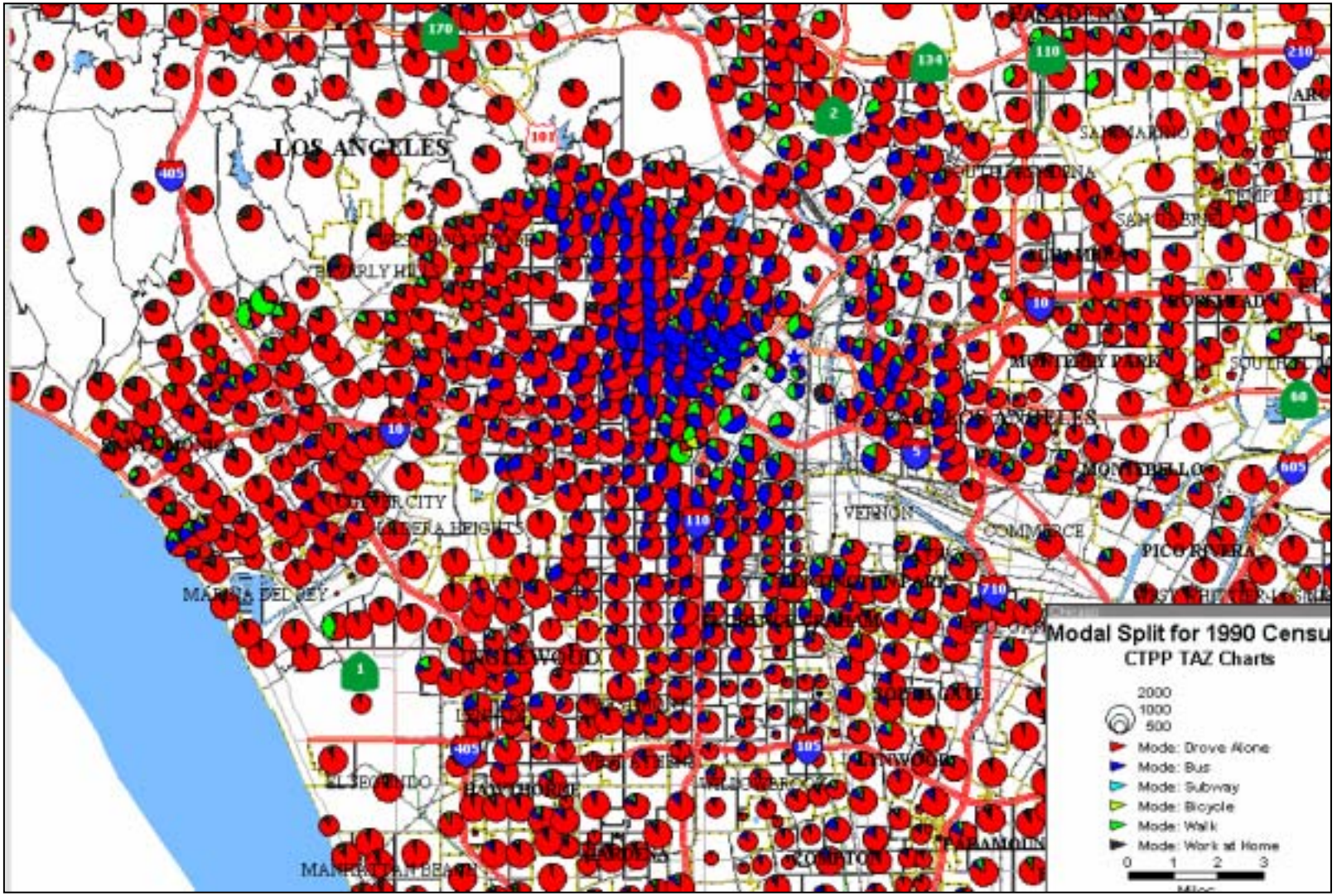
Green=Walk to Work, Blue= Transit, Red=Automobile...
Los Angeles



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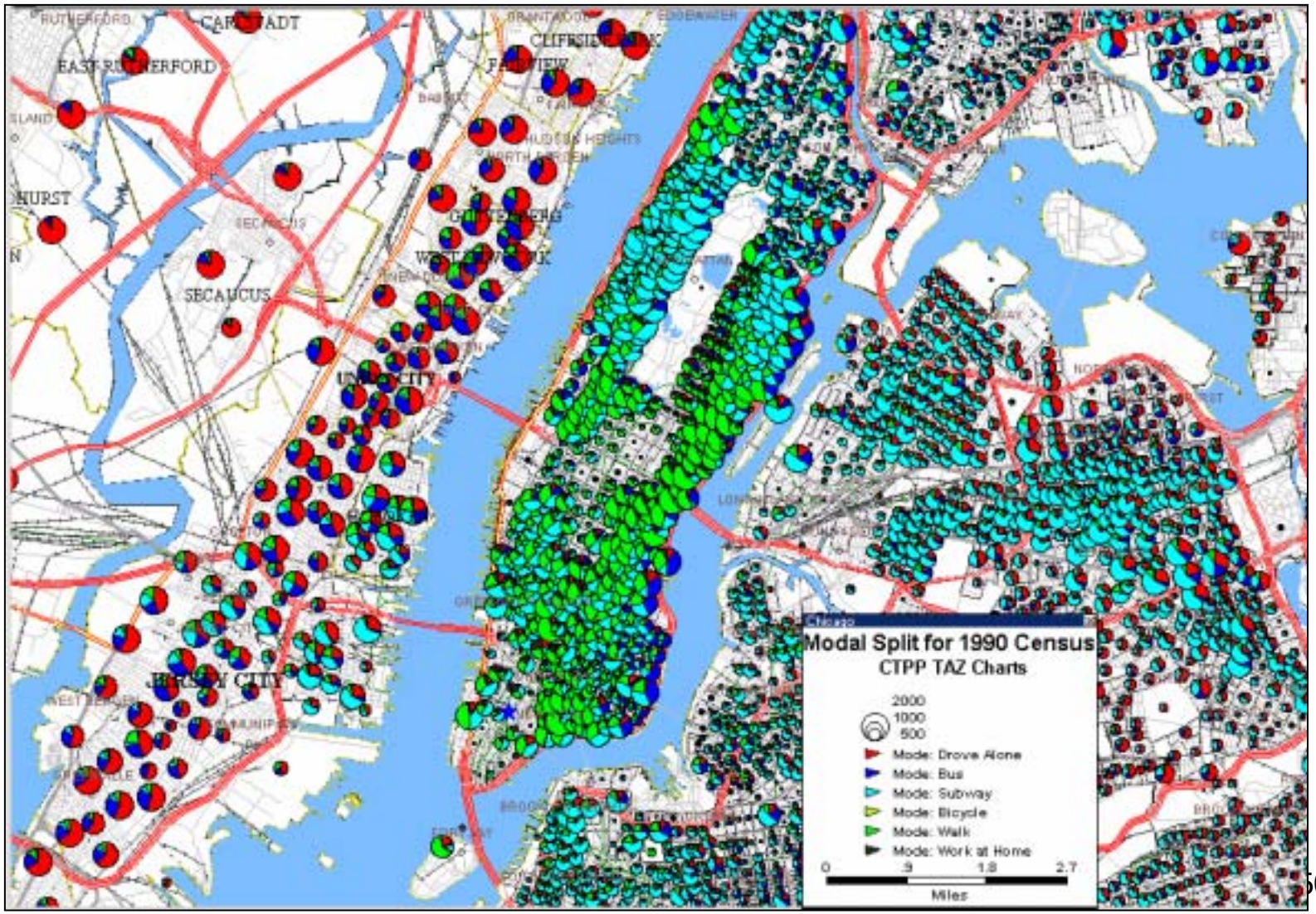
Green=Walk to Work, Blue= Transit, Red=Automobile...
Manhattan



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Assignment II:
The Millenium Cities Database

- This database is a world tour thanks to J.Kenworthy and F. Laube – “The Millennium Cities. Data base for Sustainable Transport” sponsored by the UITP
- A follow-up to the 1989 “Cities and Automobile Dependence” by P.Newman and J.Kenworthy

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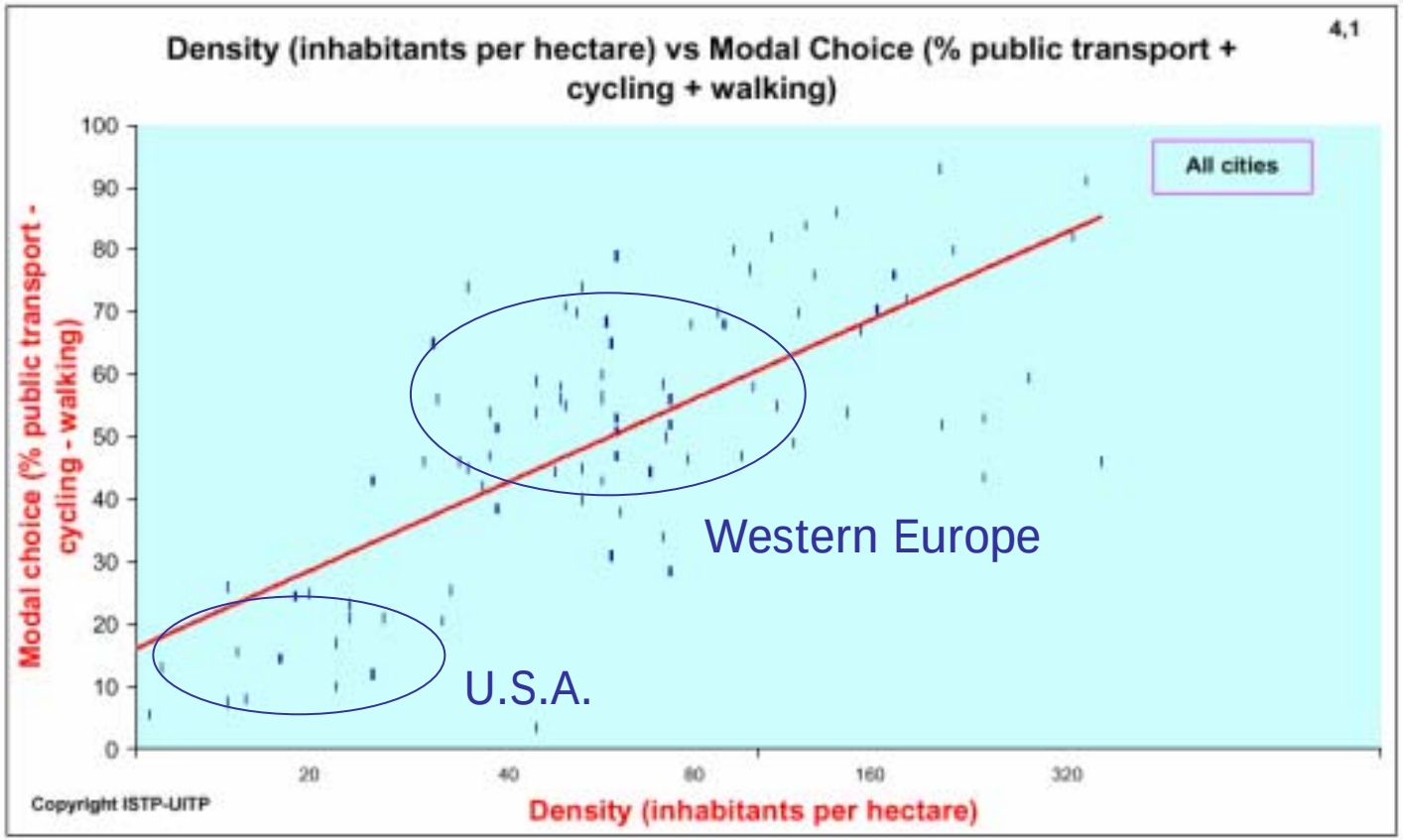
The higher the density, the higher...



... the percentage of sustainable modes

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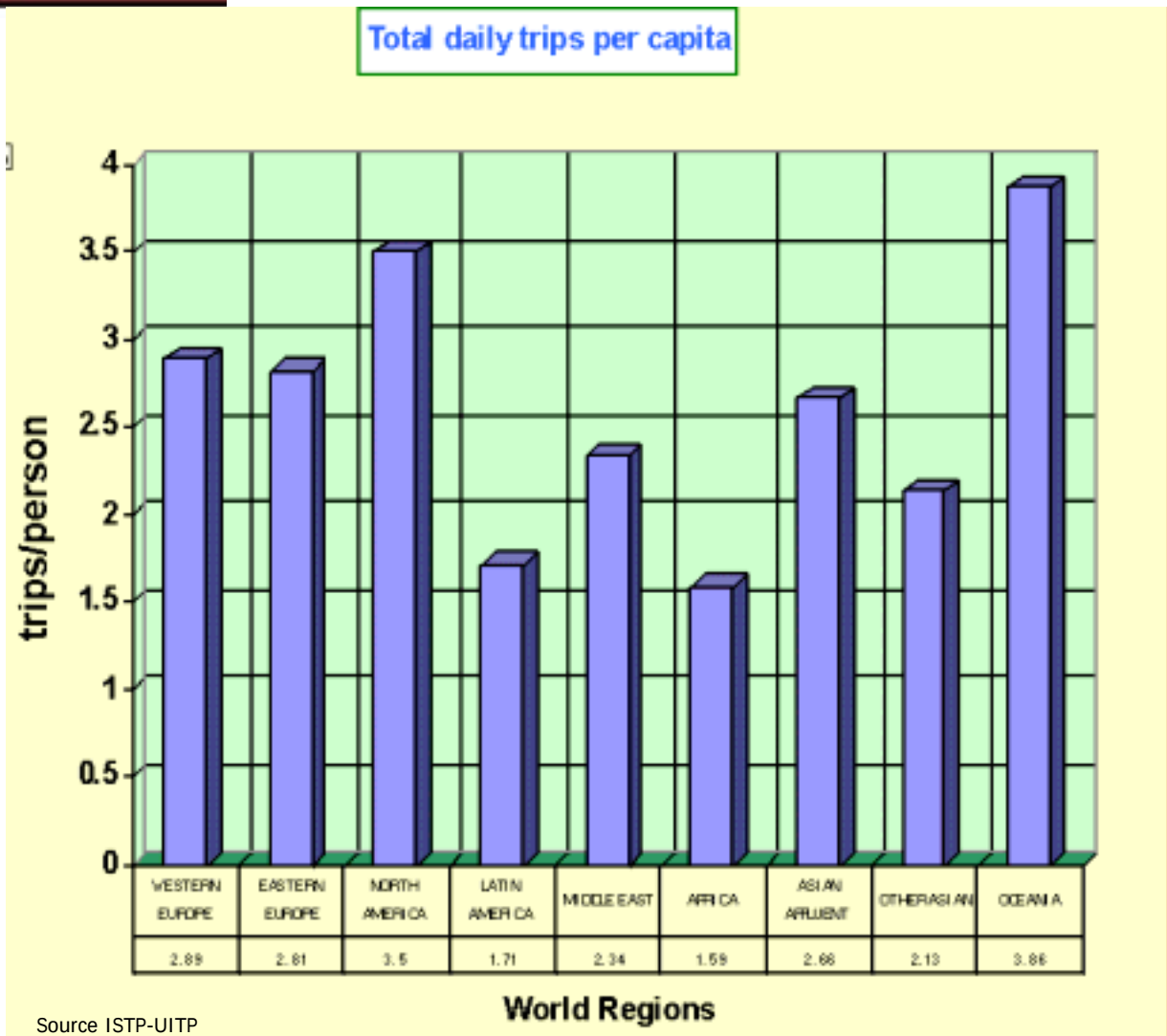
Number of trips, nearly a constant

- The number of trips result from the activities profile
- But be aware that non-motorized trips may go unaccounted for, in some surveys



Source ISTP-UITP

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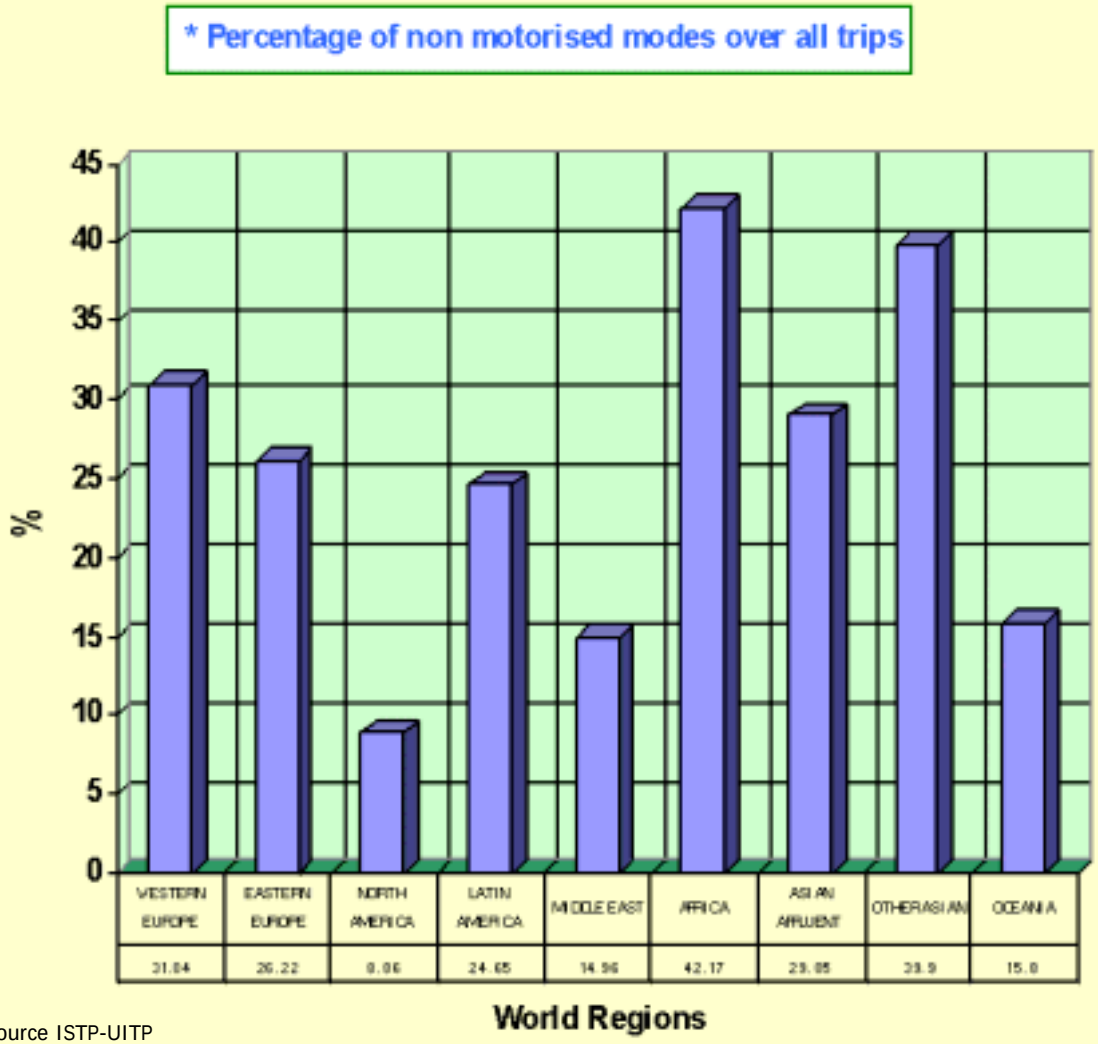
Percentage of non-motorized trips

Is this a surprise?



Source ISTP-UITP

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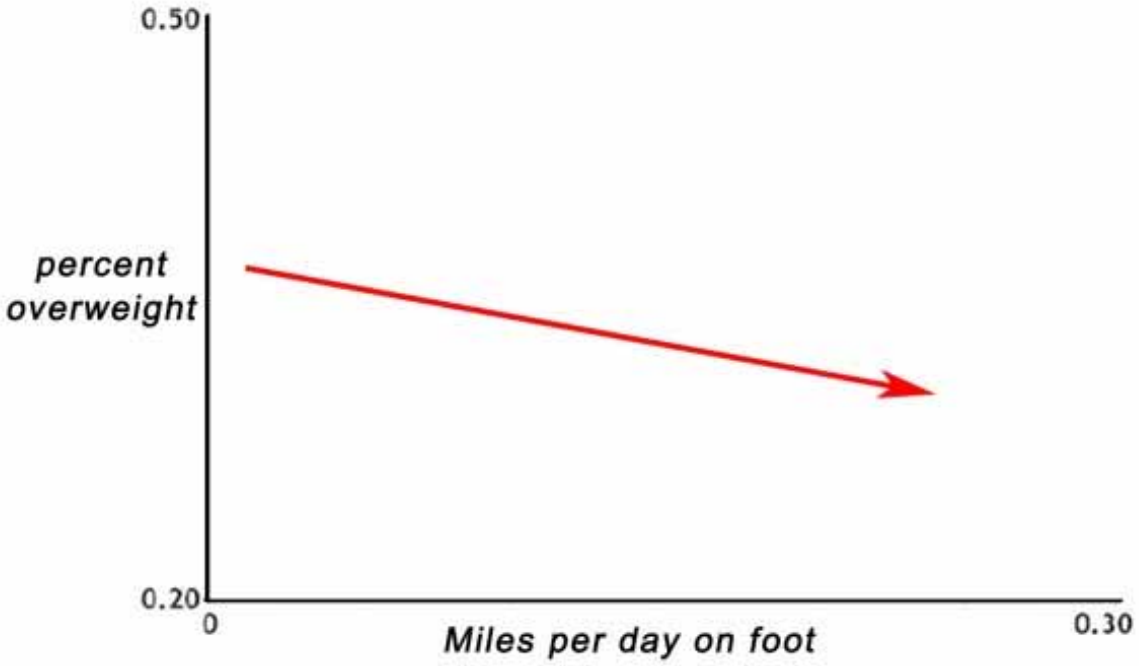
... not to be taken lightly

From Mean Streets 2000 by the Surface Transportation Project Policy (STPP)



Source ISTP-UITP

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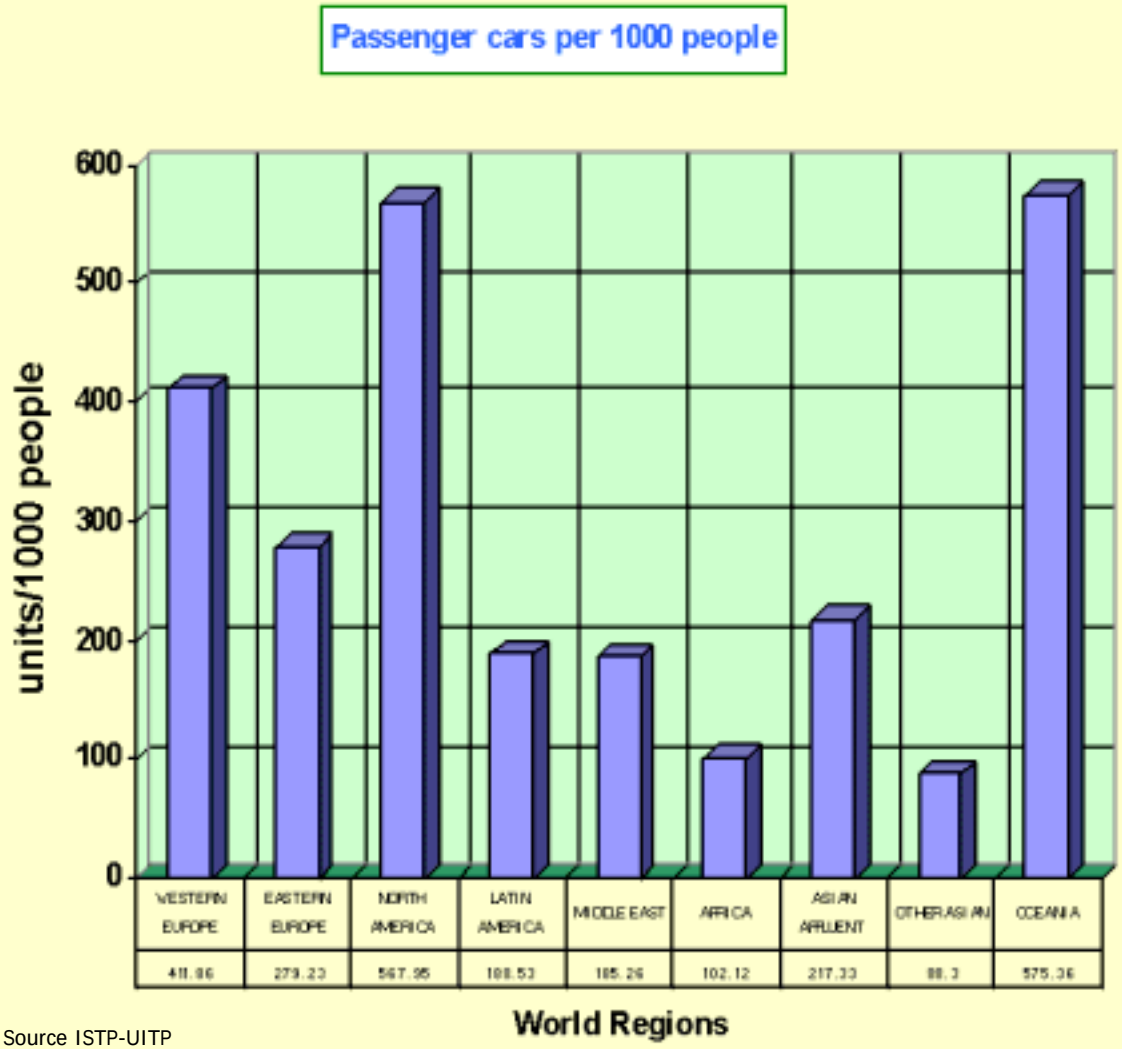
Automobile ownership

As the difference is not as big as the supply of roads...

... is congestion in Western Europe higher than in the States?



Source ISTP-UITP

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The role of the automobile

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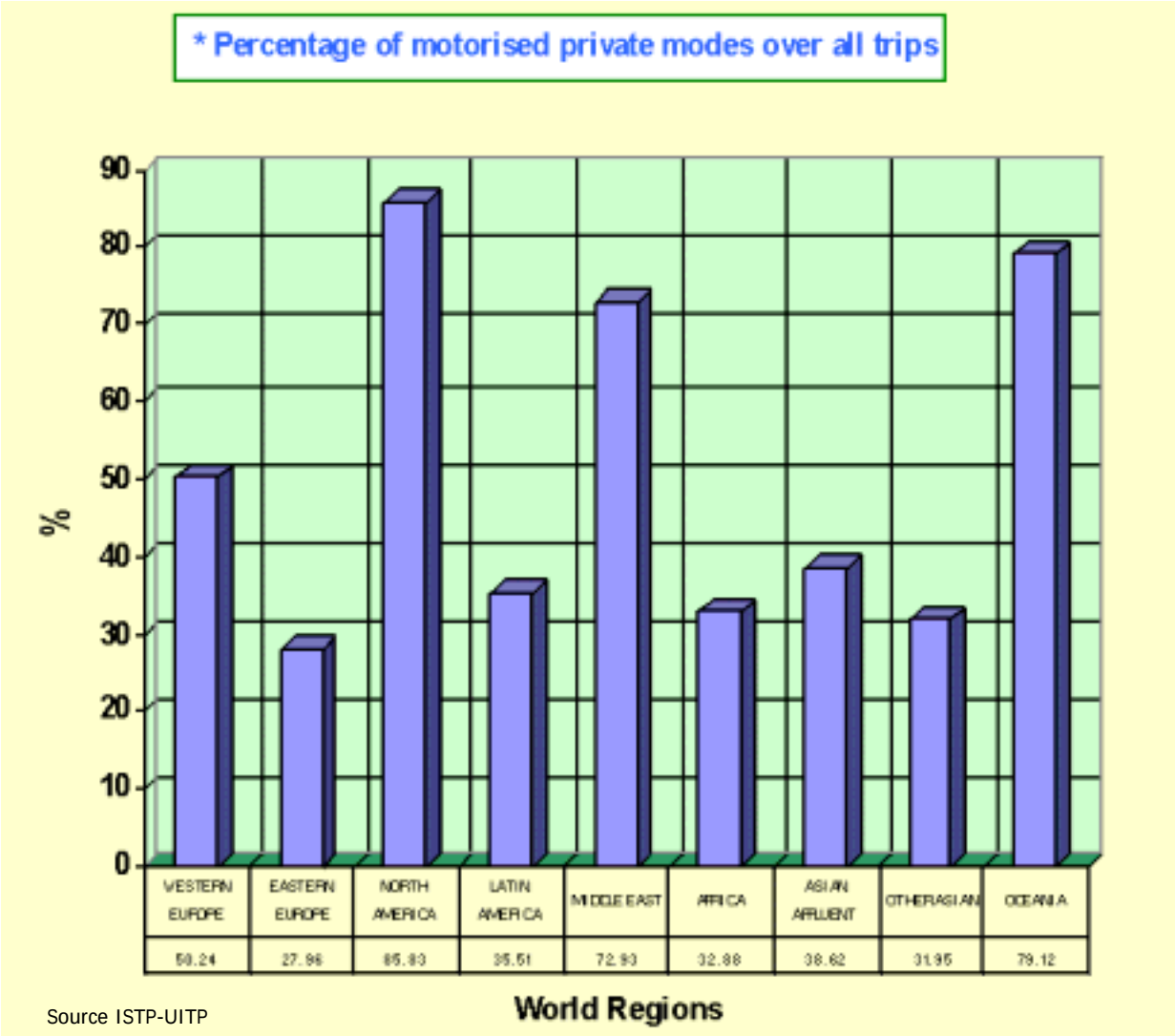
Again, this should come as no surprise



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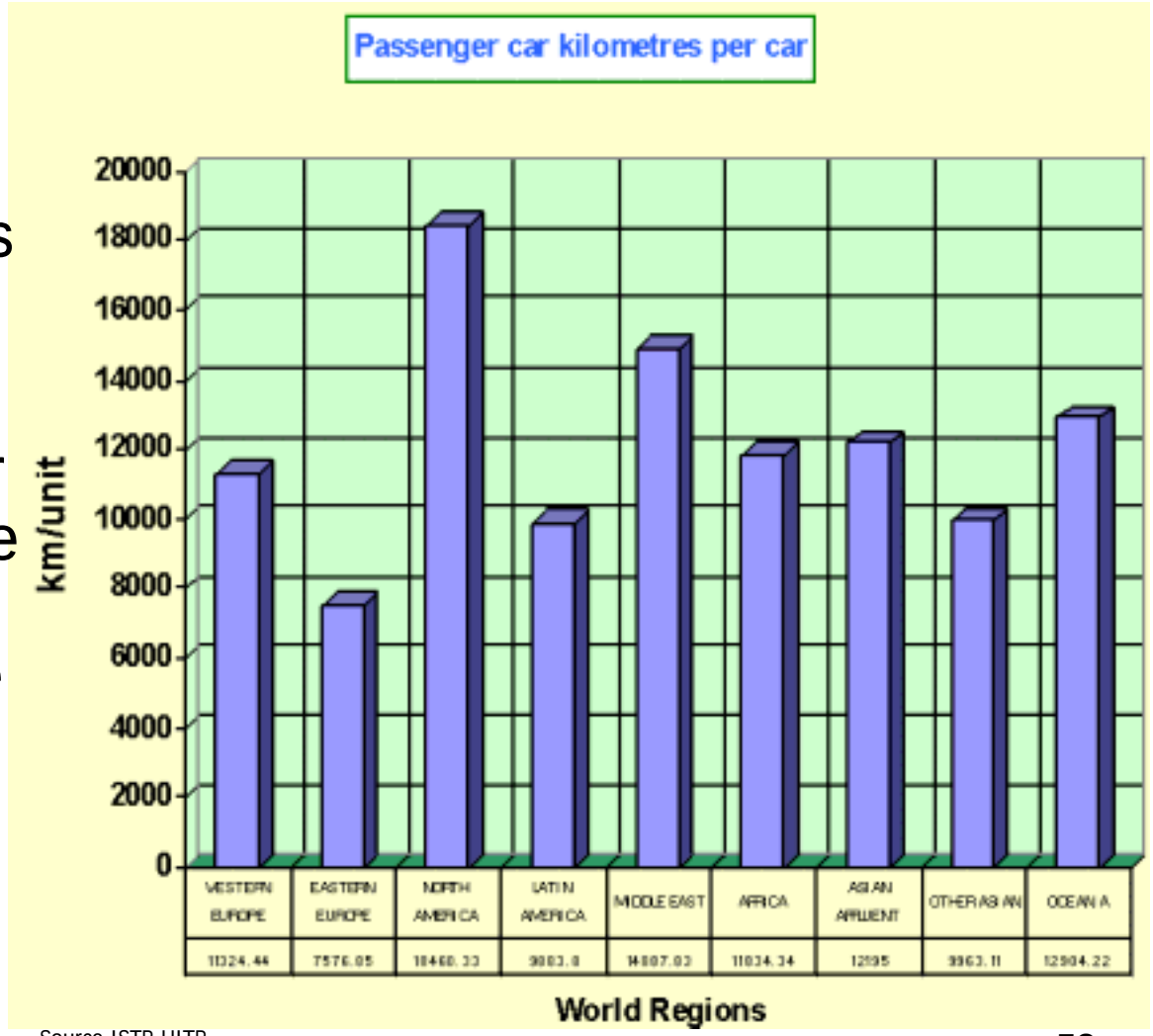
Trip length by car

If the number of trips are comparable...

Does the average car trip length increase inversely proportional to the metropolitan density?



Source ISTP-UITP

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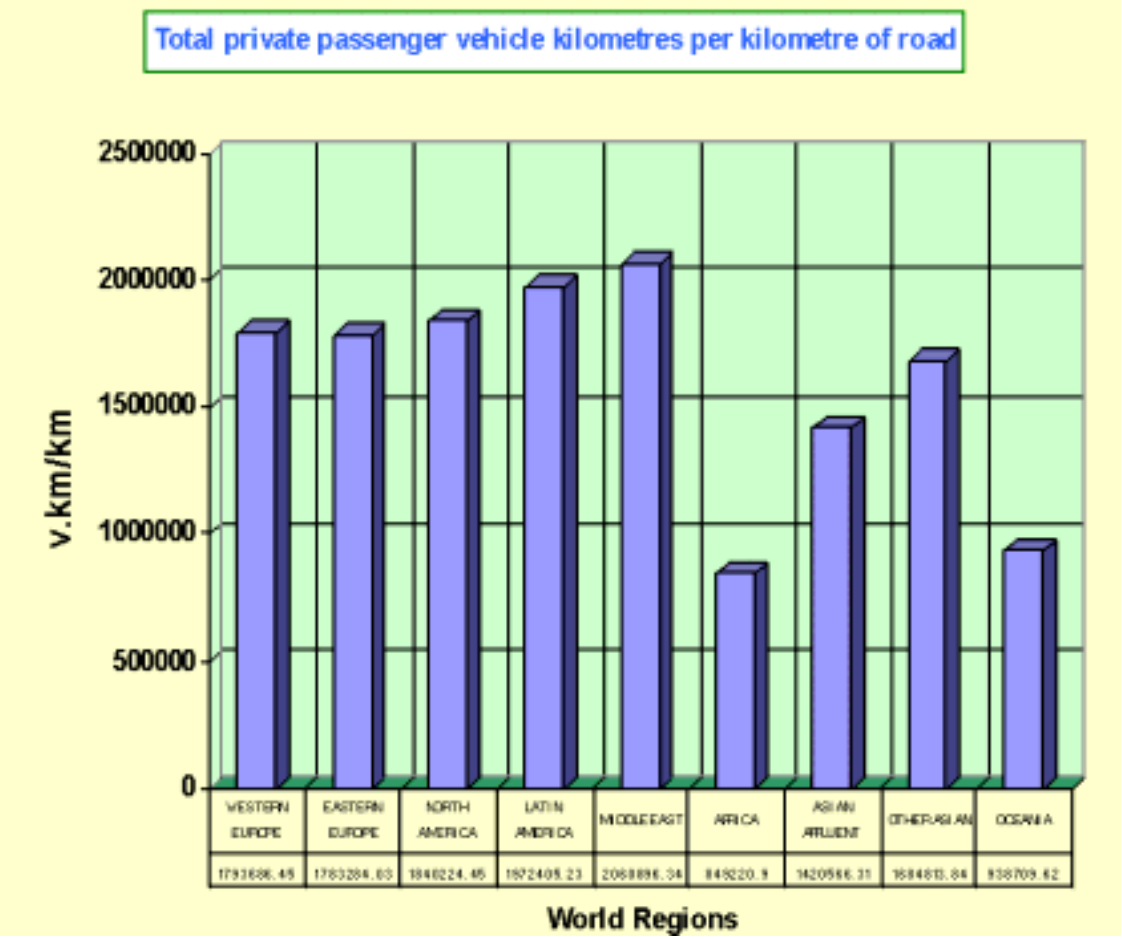
A congestion index

- In spite of the differences, a similar congestion ratio
- One reason the higher trip length in the States
- Is traffic like an expanding gas?



Source ISTP-UITP

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Parking supply in downtown

Again the U.S. leads clearly over Western Europe

Source ISTP-UITP

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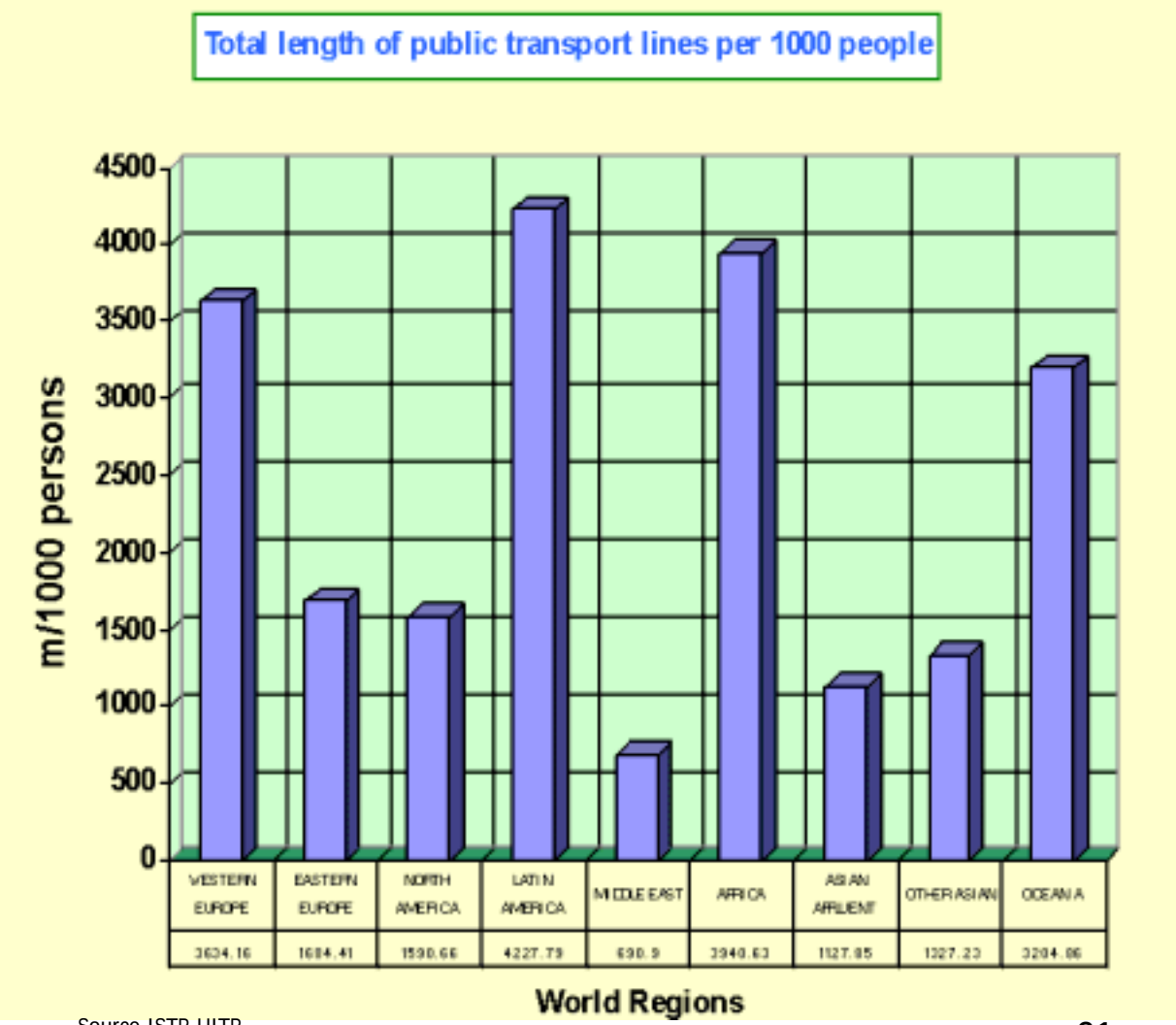
Transit coverage

Notice that the Western Europe ratio more than doubles the US ratio



Source ISTP-UITP

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The high price of road fatalities

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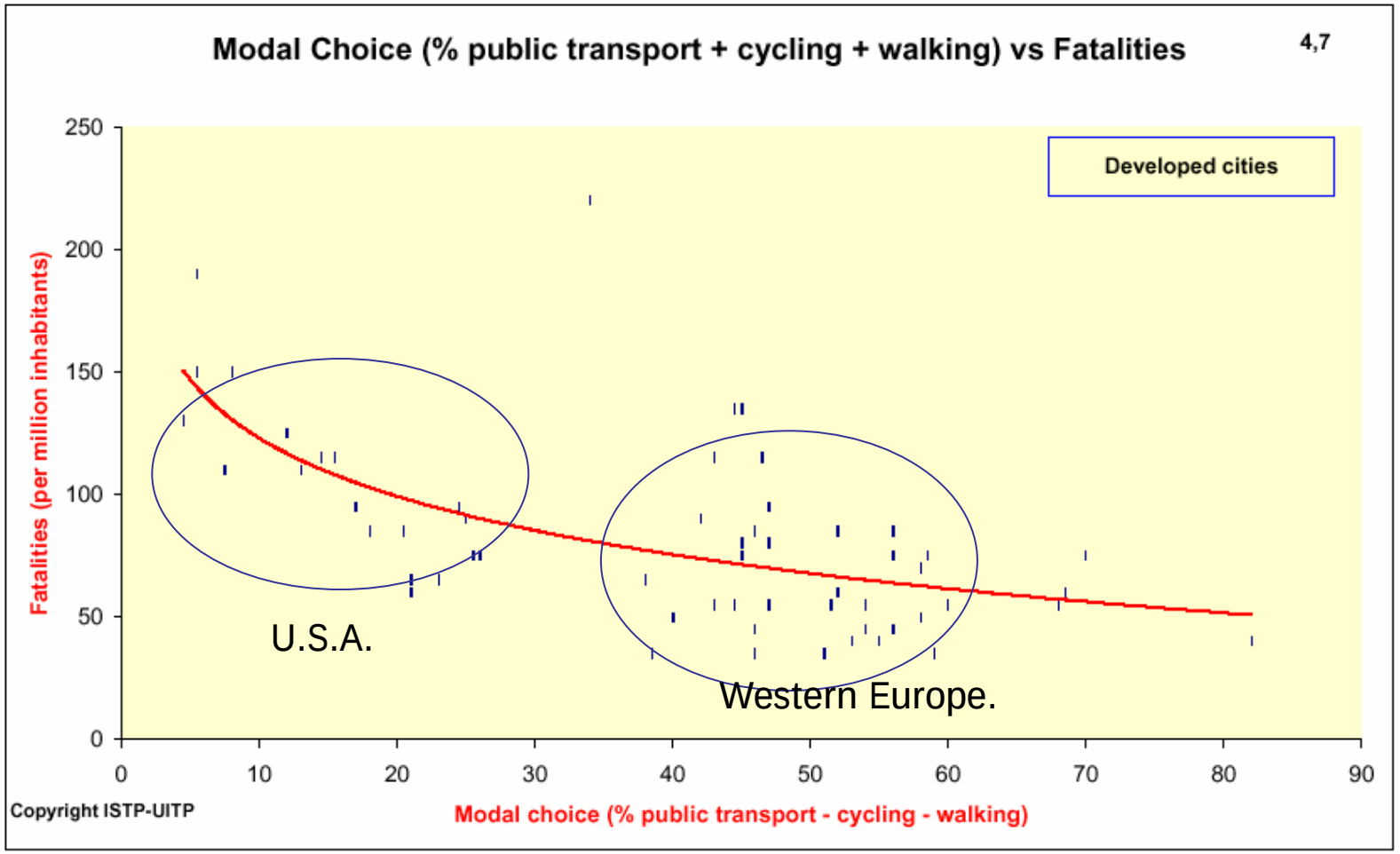

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CO emissions per capita

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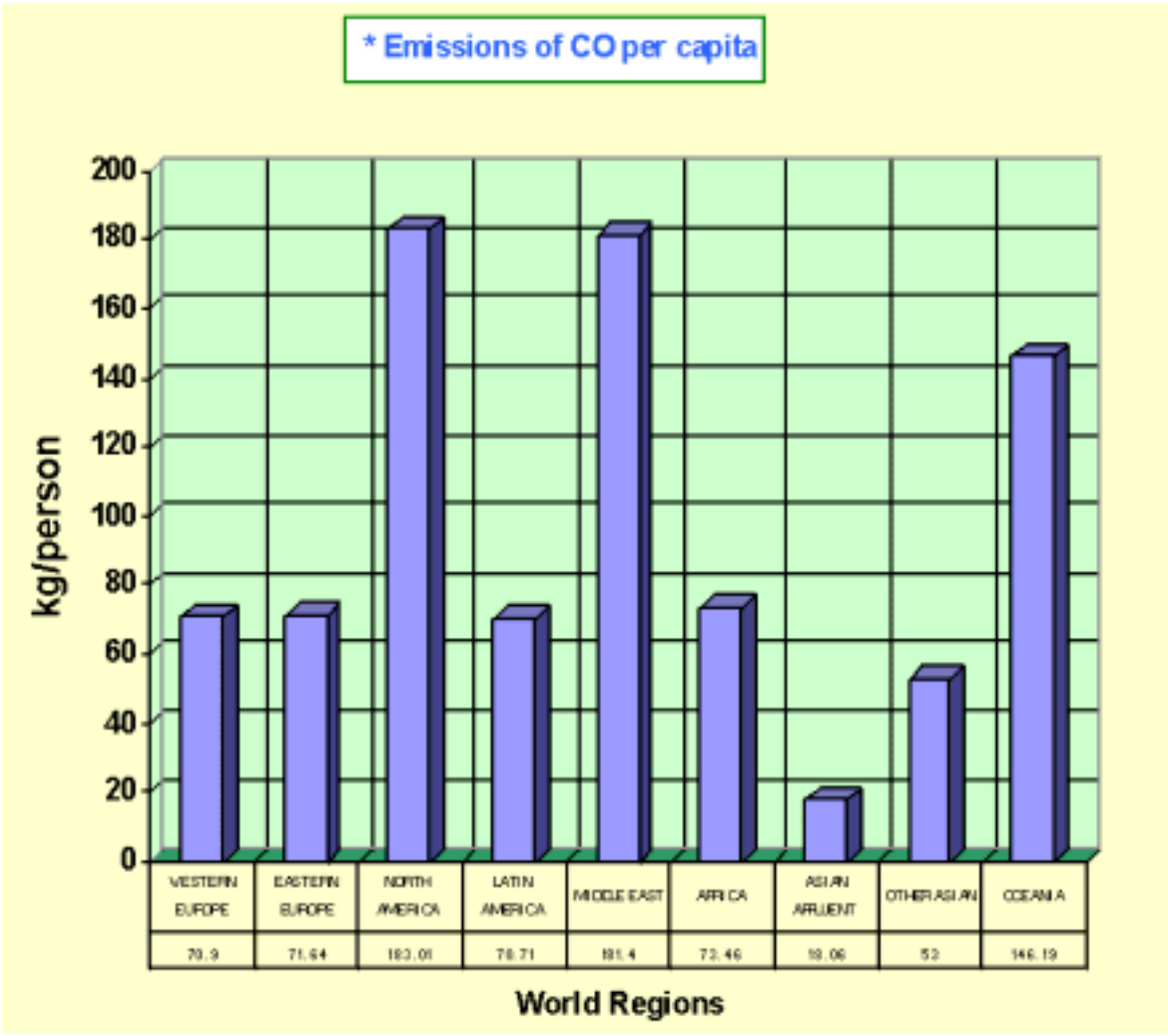
The Environmental cost



Source ISTP-UITP

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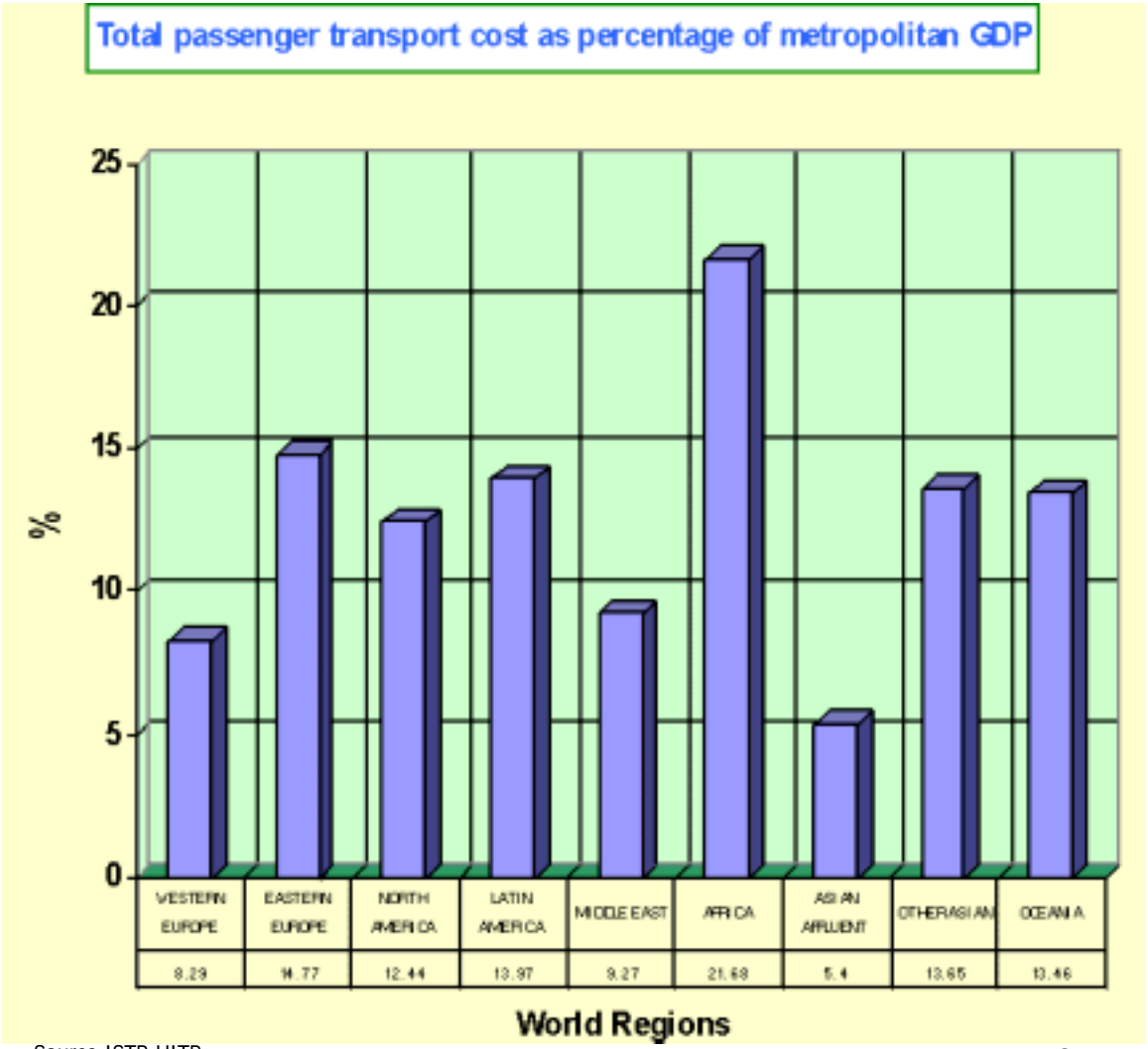
Economic efficiency

- The arguments go well beyond environmental concerns, quality of life issues, moral grounds...
- **Clear economic consequences**



Source ISTP-UITP

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The cost of a balanced system

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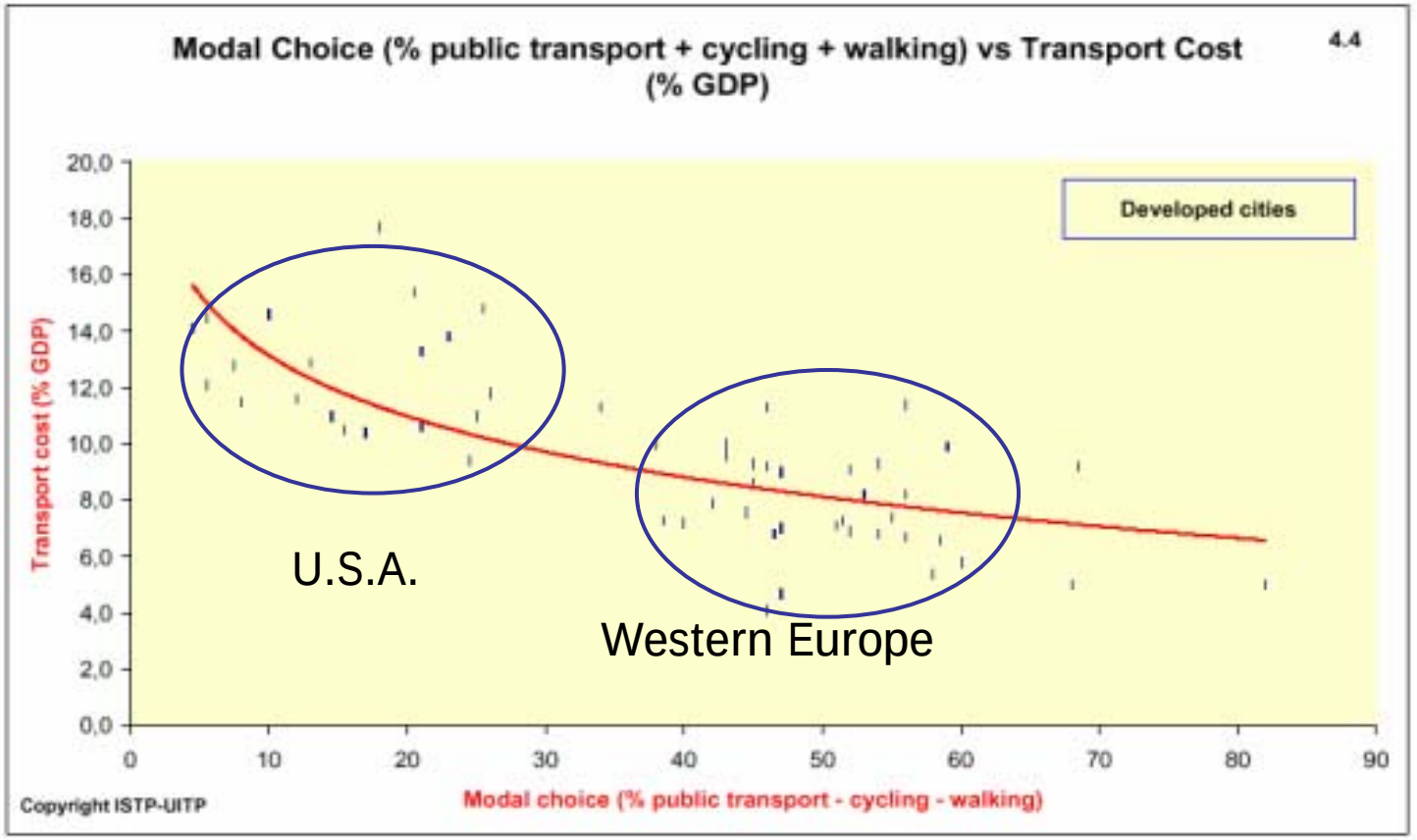

Economic sustainability

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Assignment II: The Millenium Database

- An Open-Ended Exercise:
  - Data Mining
  - Different interpretations
  - Raising the right questions is more challenging than answering them properly
  - Come out with your own findings
  - Ortega y Gasset said...