Long-Term Trends in Global Passenger Mobility

2006 U.S. FRONTIERS OF ENGINEERING SYMPOSIUM
September 21-23, 2006
Ford Motor Company
Dearborn, Michigan

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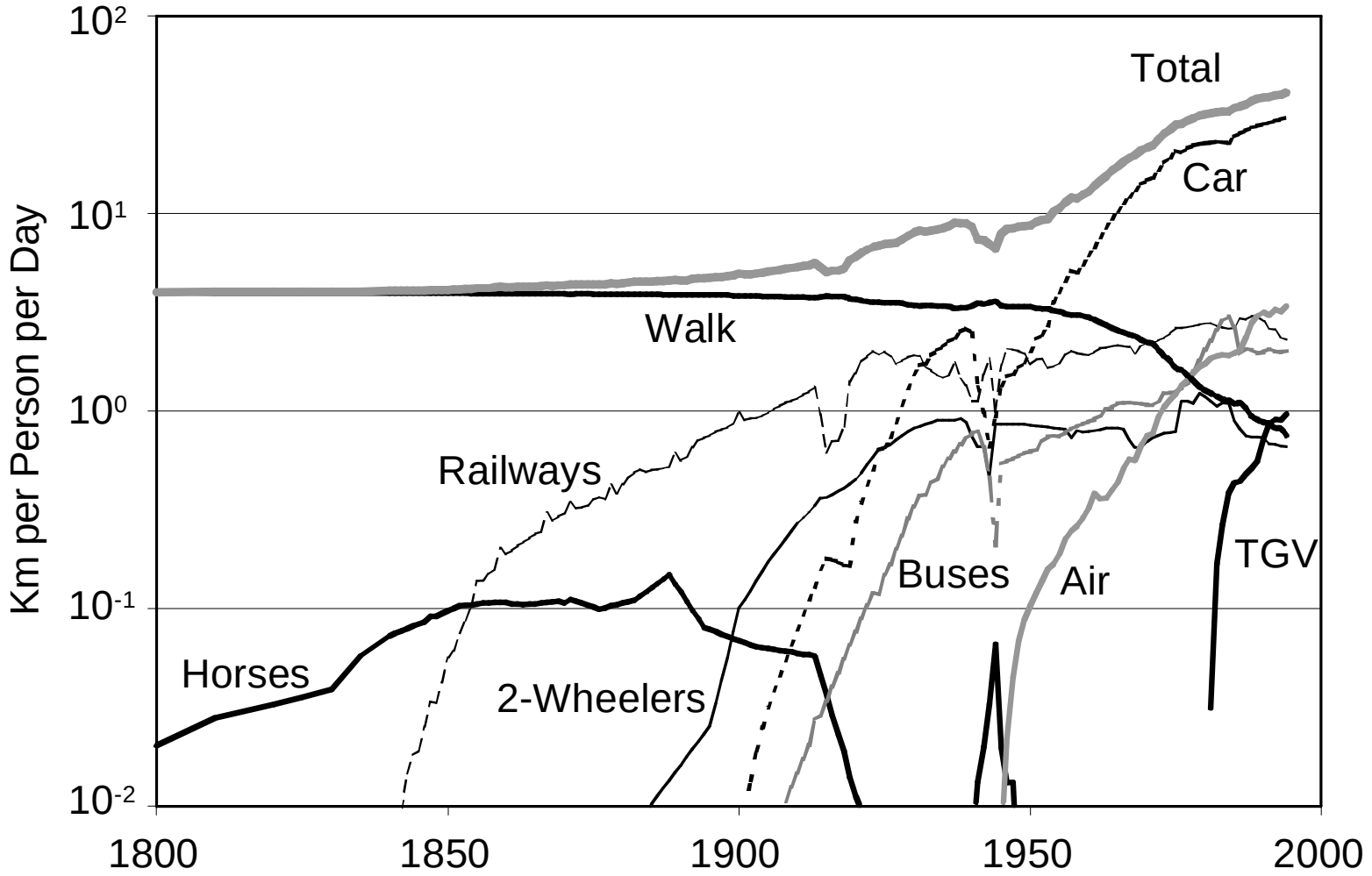
FRANCE: 1800 – 1994

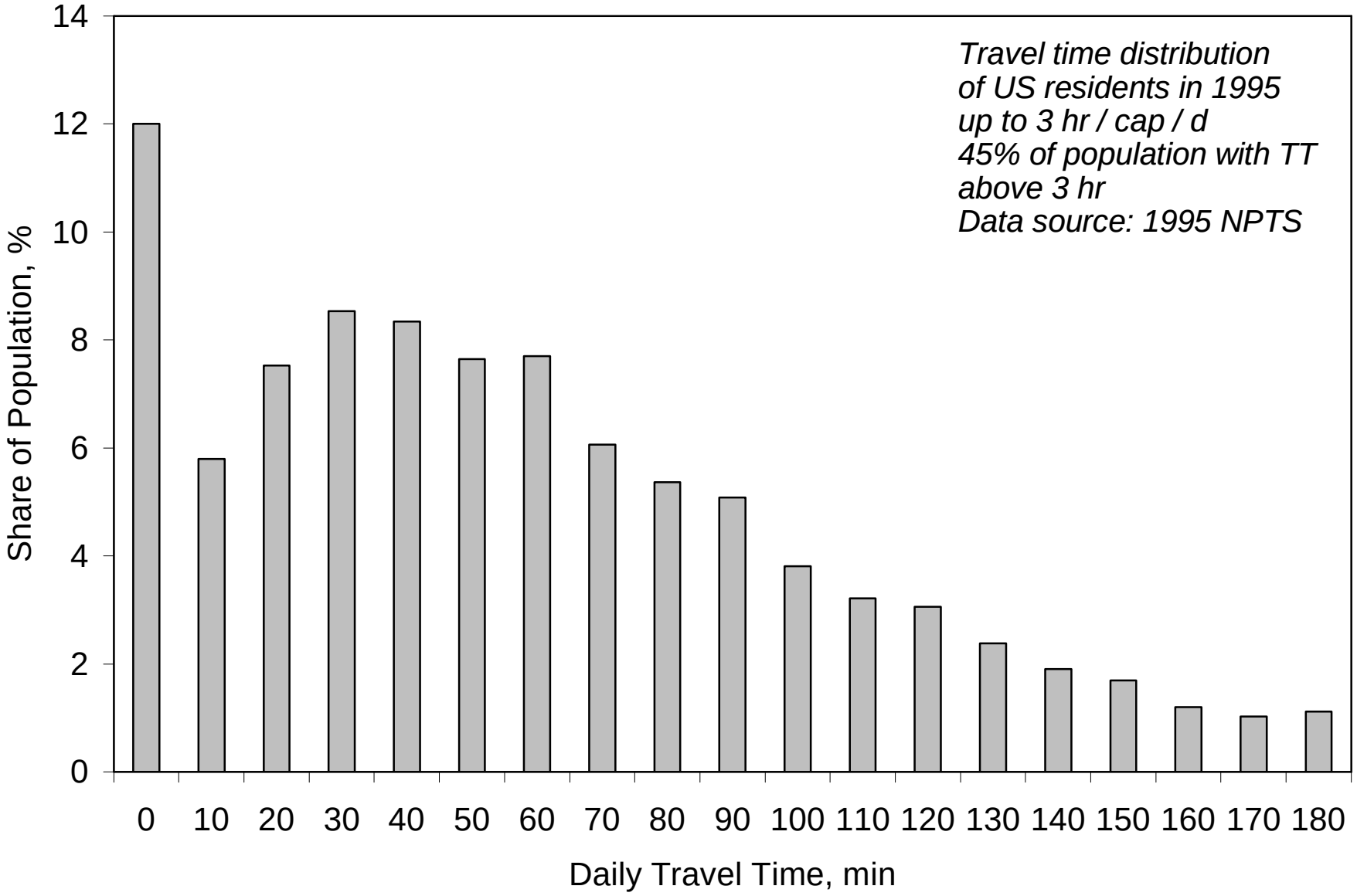


Source: A. Grübler (1998); http://www.iiasa.ac.at/~gruebler/Data/TechnologyAndGlobalChange/

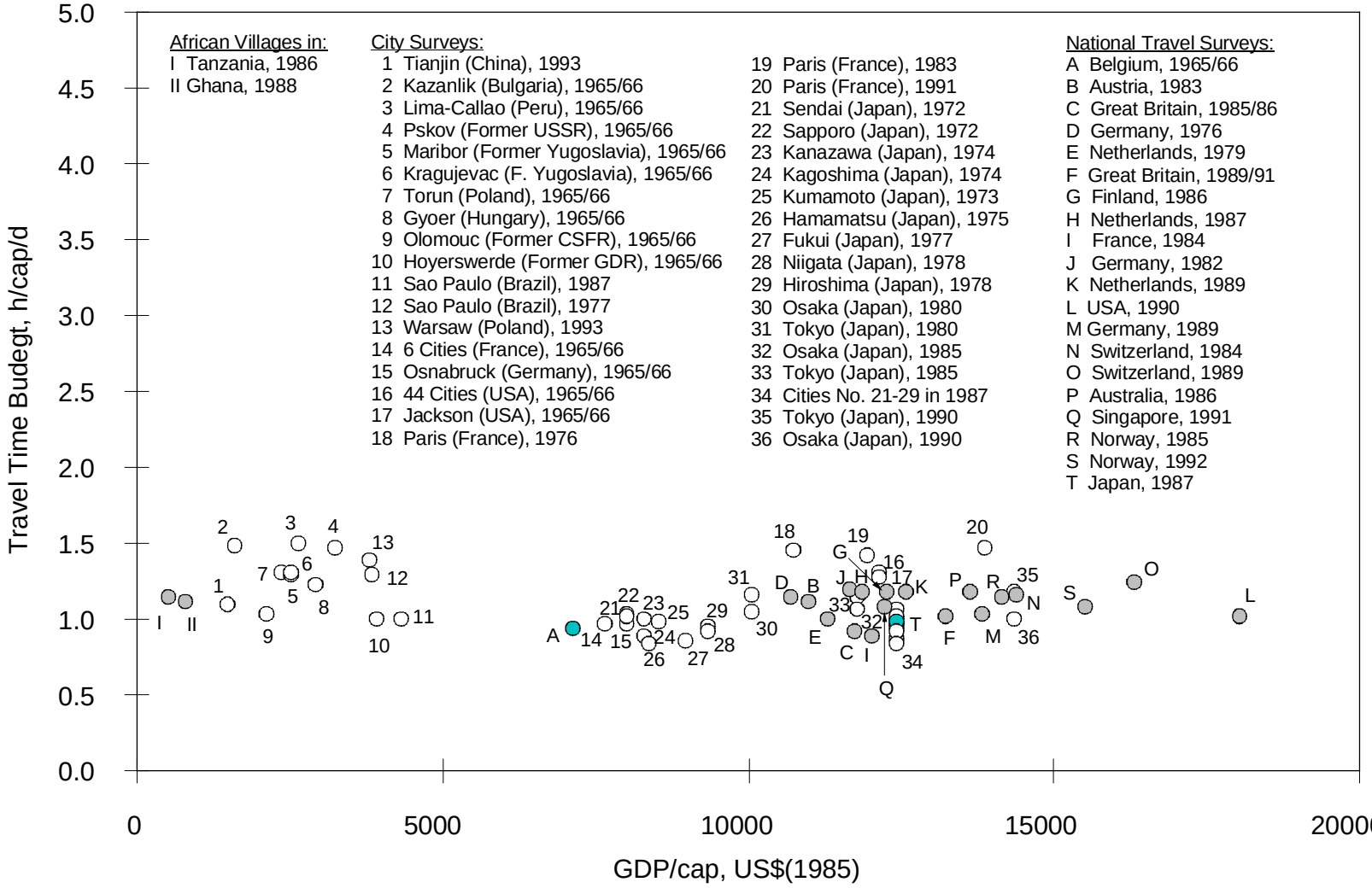
GLOBAL TRAVEL DEMAND MODEL

- Driving forces: growth in population and GDP/cap
- First version:
  - Historical dataset: 1960 - 1990
  - Constraints: fixed (Zahavi) budgets of money and time, others
  - Balancing equations of travel time and speeds
  - Aggregate of urban and intercity transport
- Currently being finalized:
  - Historical dataset: 1950 - 2000
  - Multinominal LOGIT model for mode choice simulation
- Next generation:
  - Separation of urban and intercity travel
  - Mixed LOGIT model for mode choice simulation

TRAVEL BUDGETS: MICROMOTIVES …

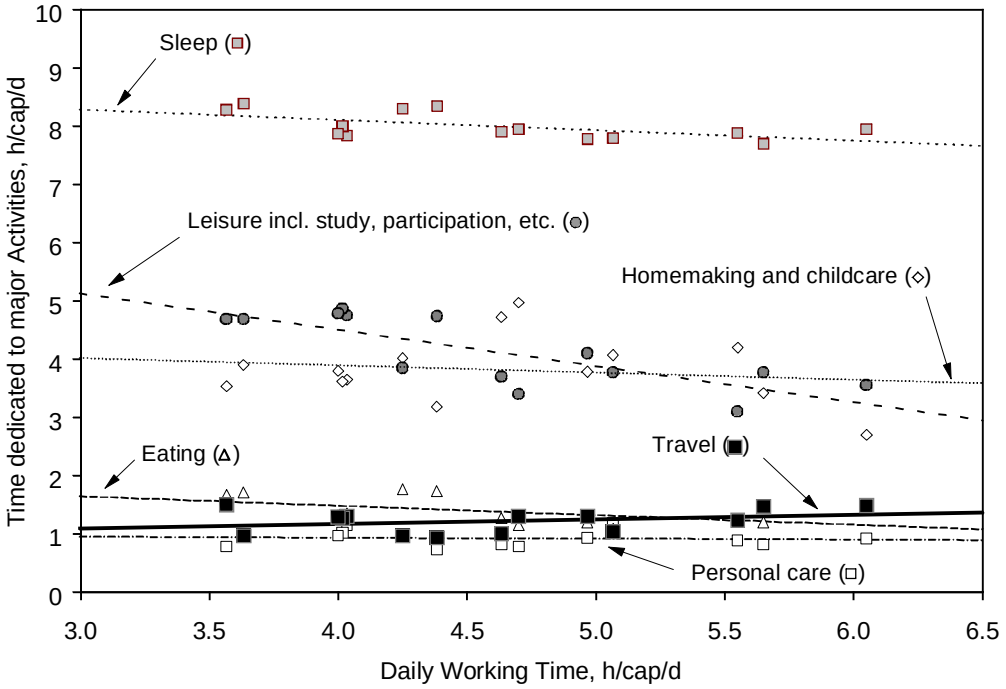


… AND MACROBEHAVIOR: TTB

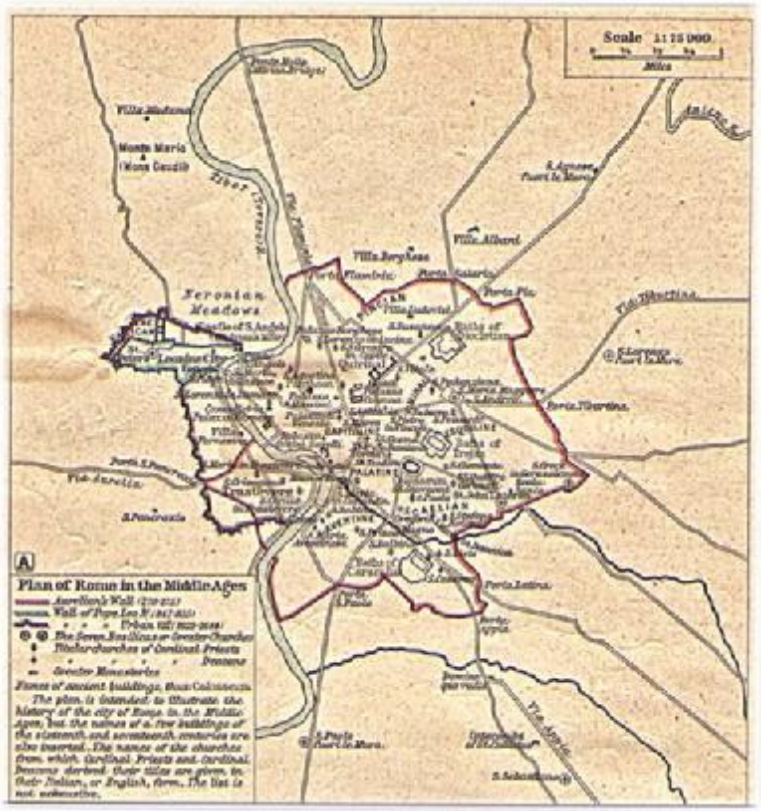


Source: Schäfer A., Victor D.G. (2000) The Future Mobility of the World Population, *Transportation Research A*, 34(3): 171-205

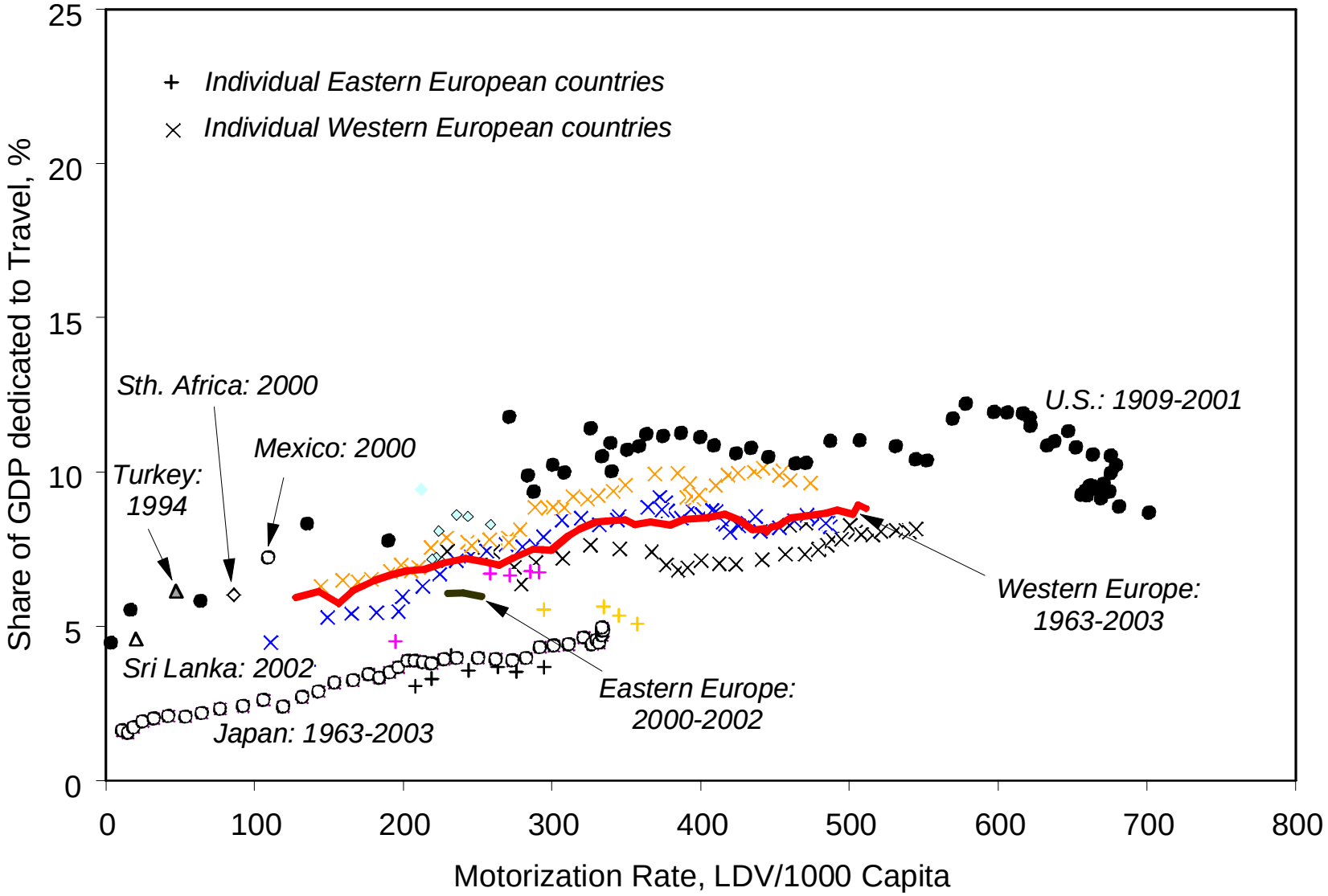
STABILITY OF TRAVEL TIME BUDGET



Data source: Szalai et al.(1972), data from 11 countries, population between 18 and 65 years of age

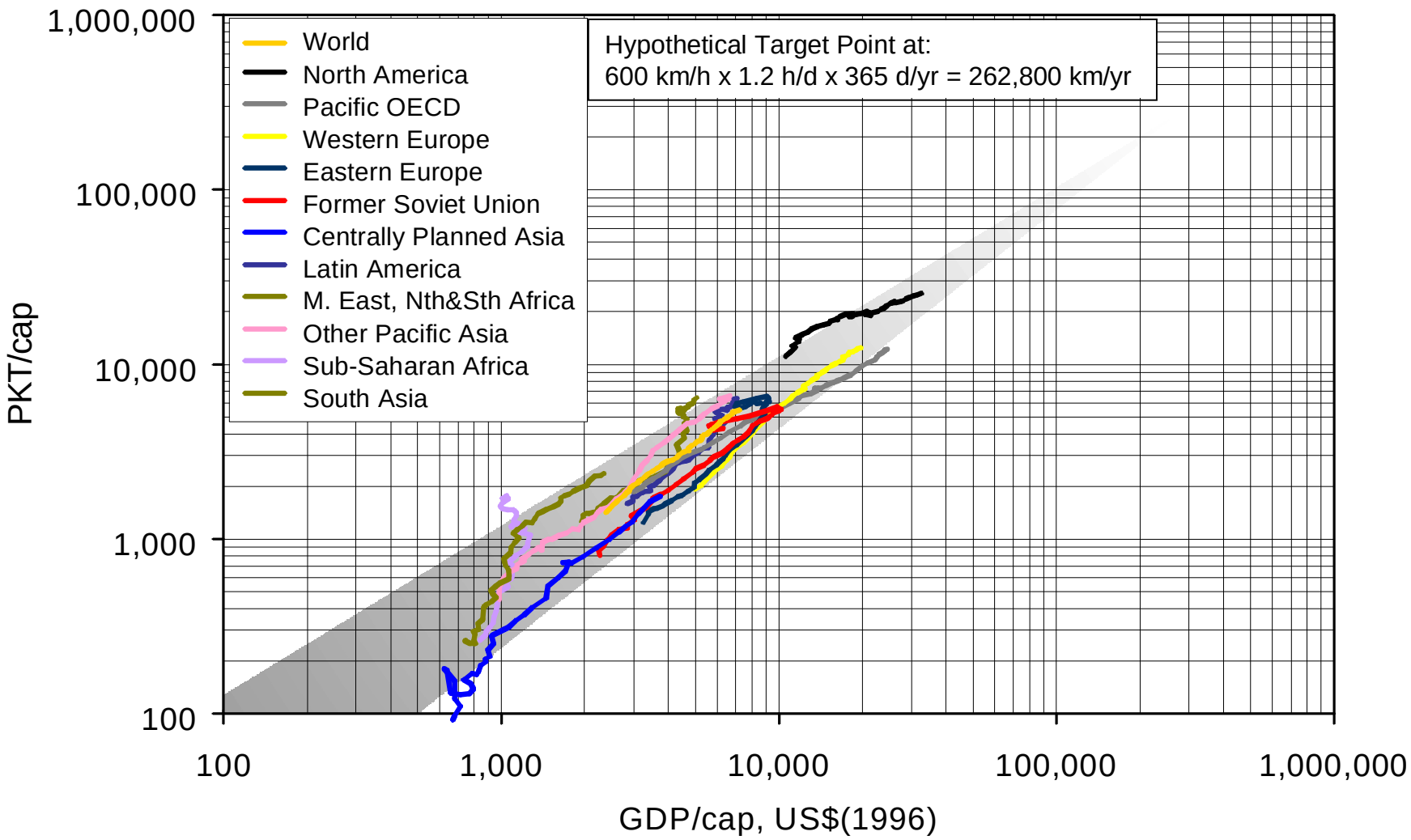


AGGREGATE TRAVEL BEHAVIOR: TMB



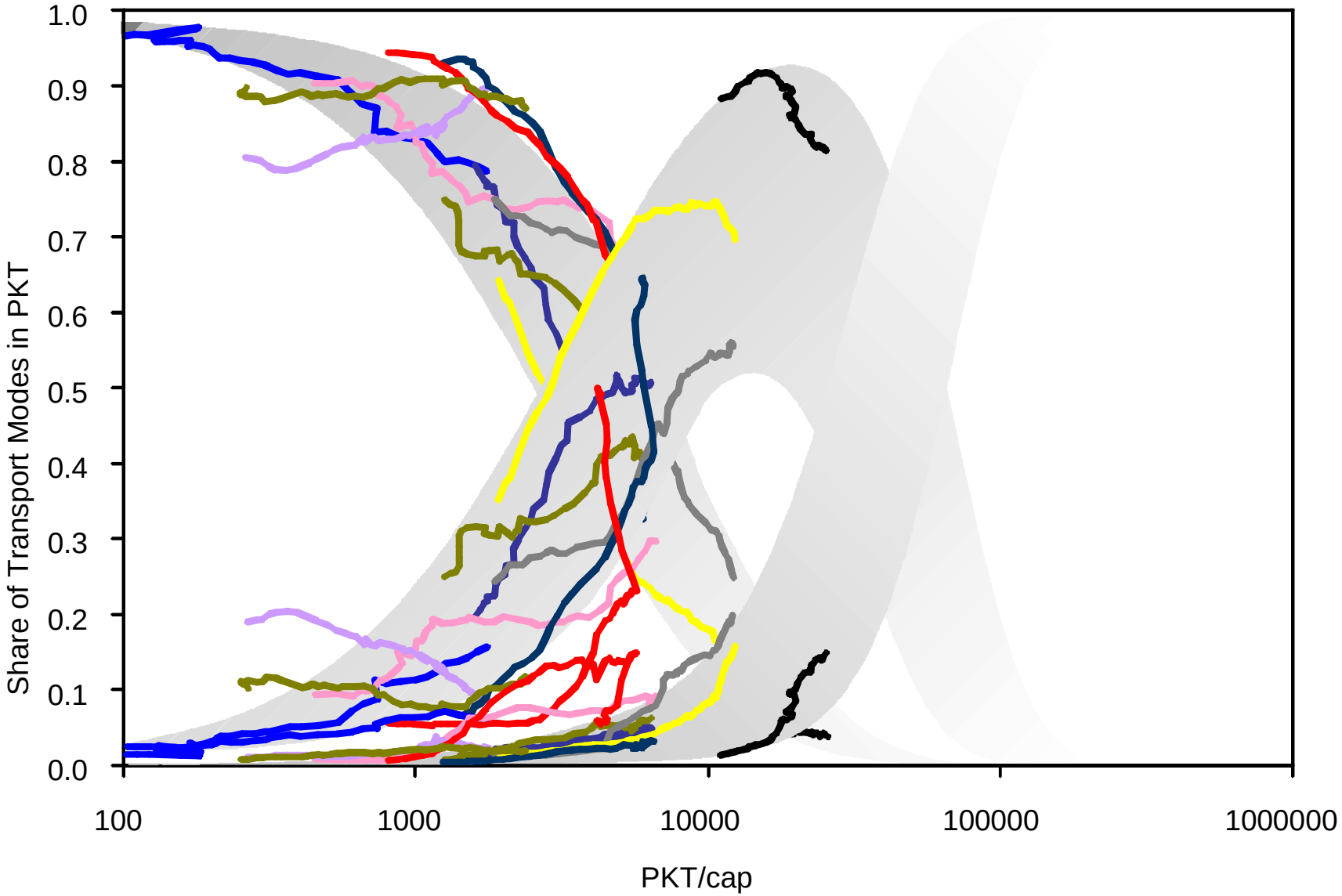
Source: Schäfer A., Global Passenger Mobility Data Set, Version 1.0, University of Cambridge, Sept. 2005

GLOBAL MOBILITY TRENDS (1950-2000)



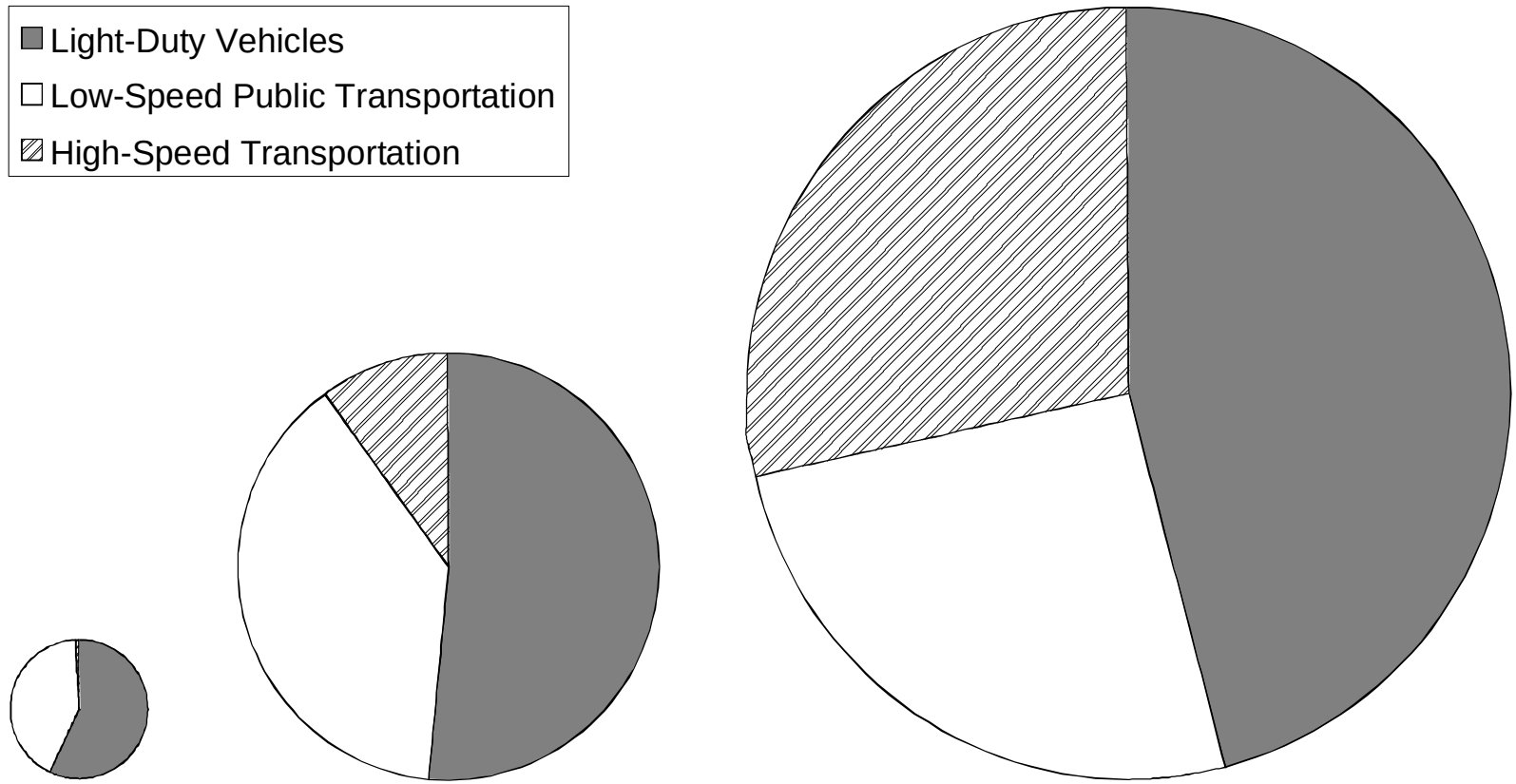
Source: Schäfer A., Global Passenger Mobility Data Set, Version 1.0, University of Cambridge, Sept. 2005

SHIFT TOWARD FASTER MODES (1950-2000)



Source: Schäfer A., Global Passenger Mobility Data Set, Version 1.0, University of Cambridge, Sept. 2005

GLOBAL MOBILITY: PAST, PRESENT, FUTURE



1950

3.6 billion PKT

2000

33.3 billion PKT

2050

105.7 billion PKT

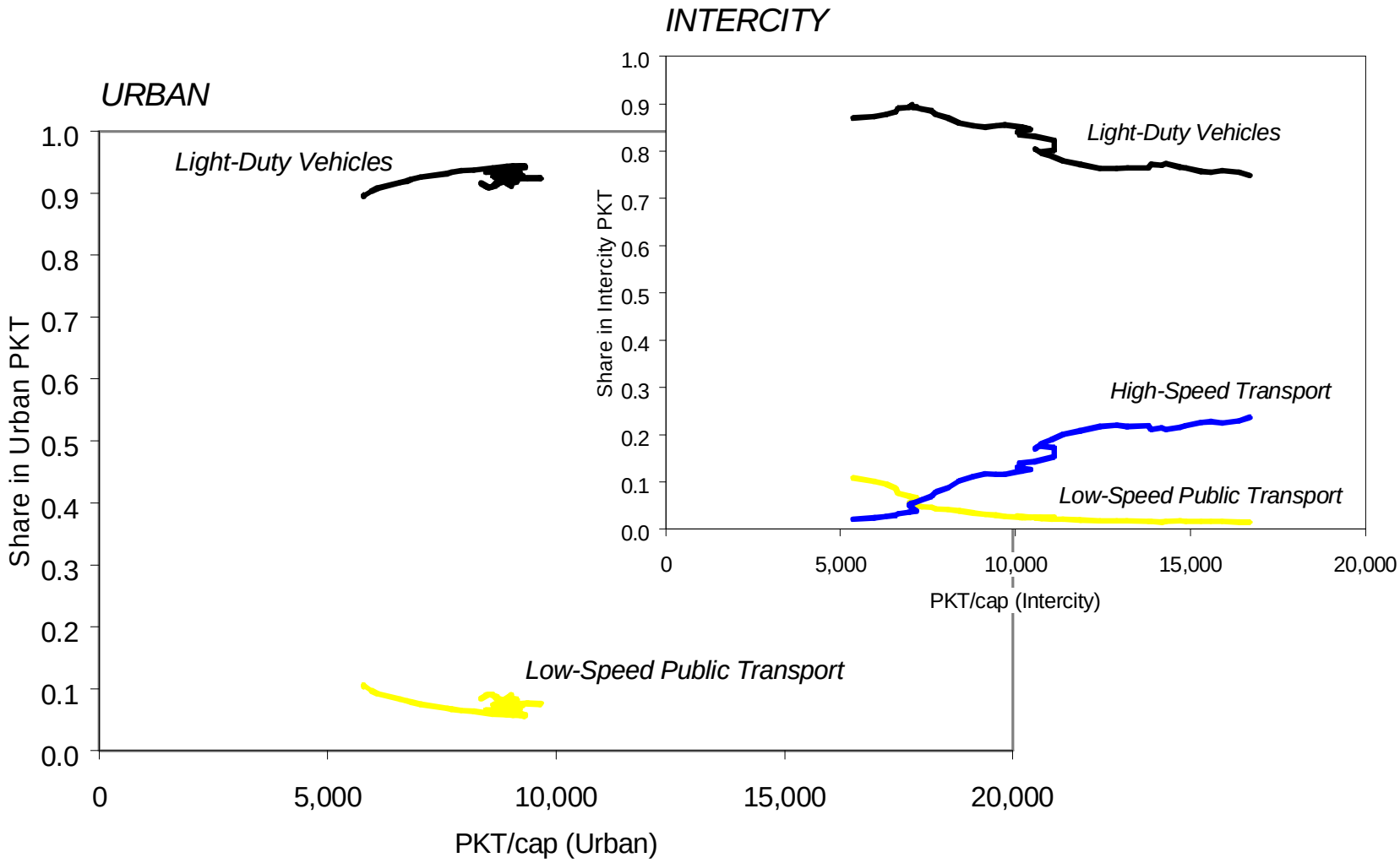
Source: Schäfer A., Global Passenger Mobility Data Set, Version 1.0, University of Cambridge, Sept. 2005

SATURATION OR UNLIMITED DEMAND?

- *Unconstrained* world:
  - Shift toward ever faster modes
  - World becomes a global city already below
    V = 20,000 km / 1.2 h = 16,700 km/h (≡ Mach 13.6)
    NASA X-43A: Mach 9.6 on Nov 16, 2004;
    1973 RAND study on “Trans-Planetary Subway Systems”

- *Constrained* world:
  - Saturation of demand dependent on penetration and mean speed of fastest available mode
  - Constant travel money budget may result in increasingly luxurious travel

URBAN AND INTERCITY TRAVEL: U.S.



HOWEVER: More careful separation between urban and intercity travel necessary!

Source: Schäfer A., Global Passenger Mobility Data Set, Version 1.0, University of Cambridge, Sept. 2005

CAN GROWTH IN WORLD PKT ENDURE?

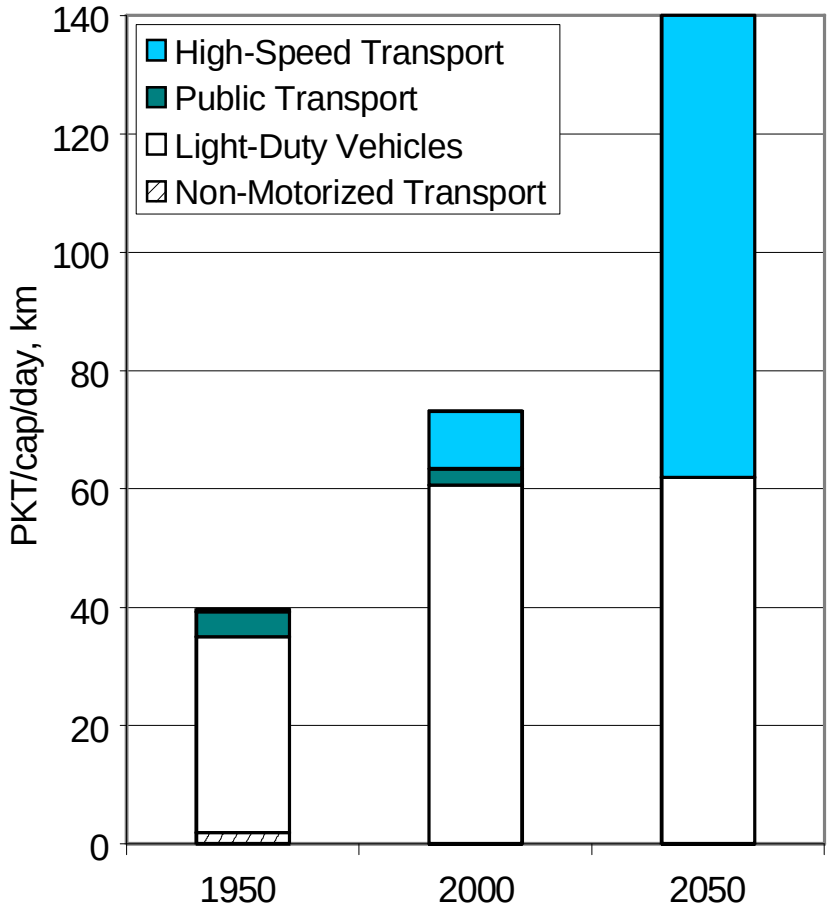
- Availability of high-speed transport technology ($\Rightarrow$ supersonic transport, rapid access to airplane)
- Traffic congestion ($\Rightarrow$ innovation and adaptation)
- Telecommunication ($\Rightarrow$ complement vs. substitute)
- Energy resources ($\Rightarrow$ geographic location of reserves)
- Environment ($\Rightarrow$ impact of global warming policies)

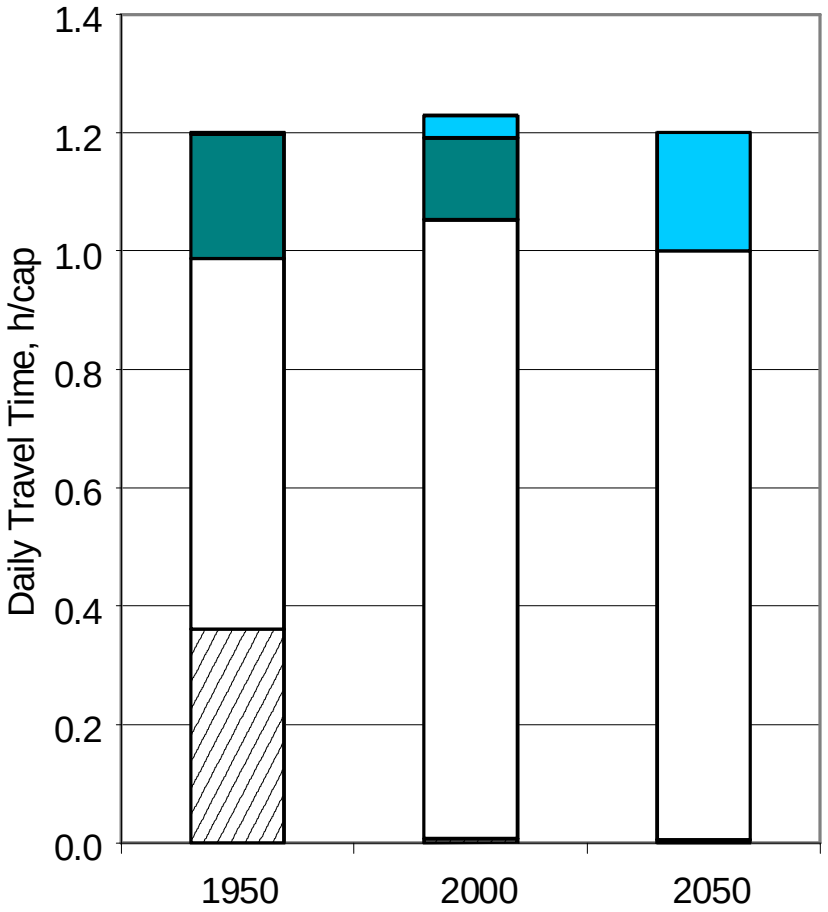
SENSITIVITIES

- Hypothetical Target Point
  - A 10% change in target point location (through e.g. an increase in travel time budget or mean speed of fastest mode) results in a 0.5% change in projected 2050 North American traffic volume
- Travel Time Budget
  - Increasing the travel time budget by 25% from 1.2 to 1.5 h/cap/d reduces 2050 air traffic share in North America from 56% to 44% at a corresponding increase in automobile travel

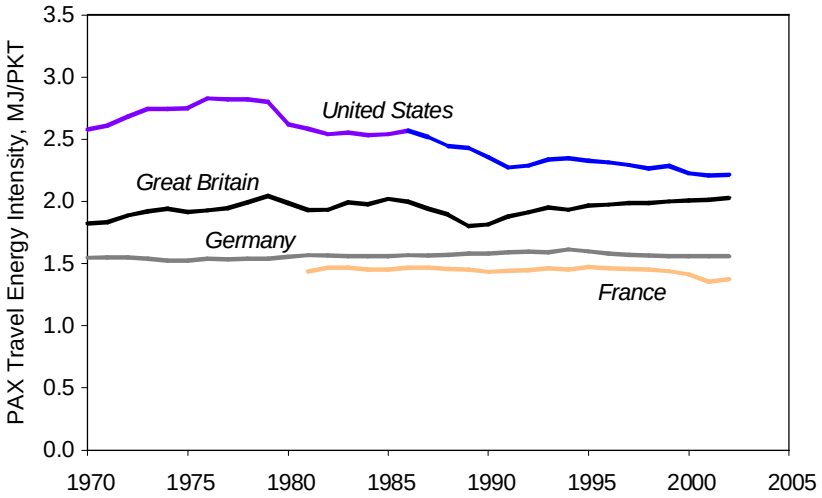
IMPLICATIONS: TRAVEL TIME BY MODE

North America





IMPLICATIONS: ENERGY INTENSITY



Constant energy intensity:
$\Delta E \sim \Delta PKT$
$(E = E/PKT \cdot PKT)$

All other factors equal, passenger travel energy intensity will likely increase due to

- Shift toward faster modes
- Substitution of aircraft for auto intercity travel
  - Rising energy intensity of aircraft
  - Rising energy intensity of (urban) automobile travel

Thus: energy efficiency improvements already required to maintain current levels in energy intensity!

GREENHOUSE GAS EMISSIONS: IDENTITY

$$GGE = \frac{GGE}{E} \cdot \underbrace{\frac{E}{VKT} \cdot \frac{VKT}{PKT}} \cdot PKT$$

$$\frac{E}{PKT} = Energy\ Intensity$$

AIR TRAVEL: ENERGY USE VS. DEMAND

% Energy intensity change by 2050:

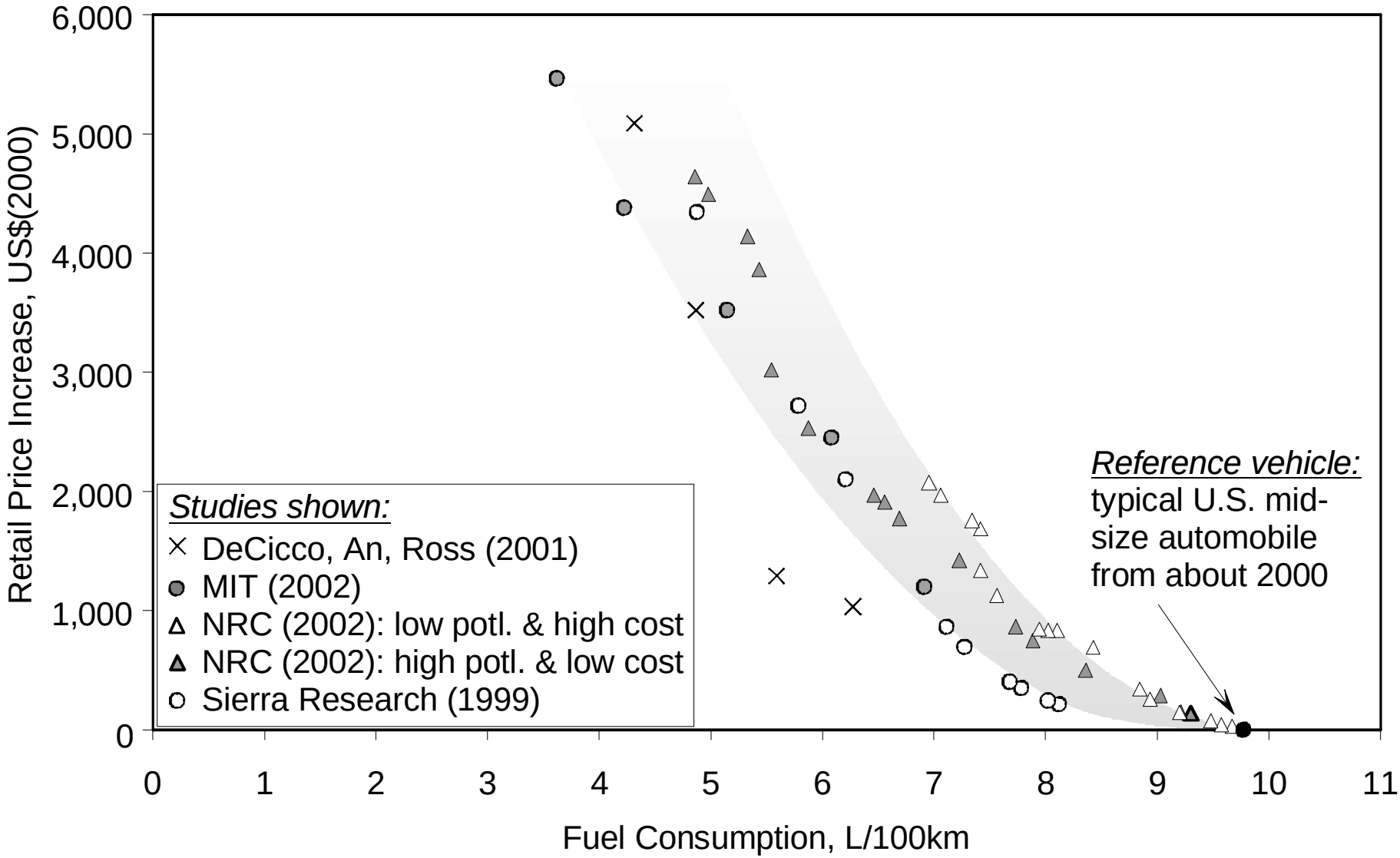
	Low	High
Aircraft Technology †	-25	-45
PAX Load Factor	-10	-10
High-Speed Rail ‡	-1	-1
Direct Flight Routings	0	-11
TOTAL	-33	-56

† Due to fleet turnover, average aircraft technology in 2050 corresponds to average new aircraft technology in 2025 (ultimately dependent on fleet growth)
‡ High-speed rail substitutes 50% of A/C-PKT in 10 U.S. high-density corridors with a cumulative great circle distance of 16,700km

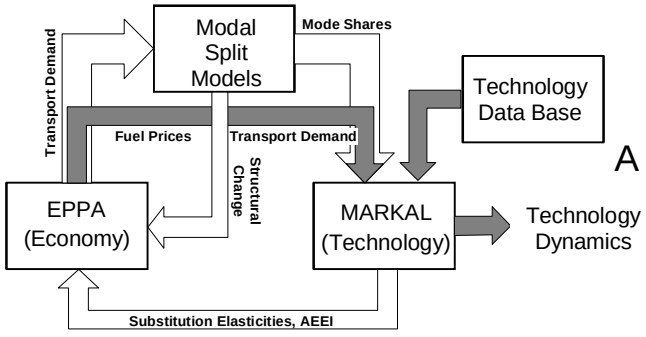
Projected (global) growth in A/C-PKT: 3 – 12 X yr 2000-level

Sources: Lee J.J., Lukachko S.P., Waitz I.A., Schäfer A., 2001, "Historical And Future Trends In Aircraft Performance, Cost, and Emissions"*, Annual Review of Energy and the Environment 2001*, 26: 167-200.
Jamin S., Schäfer A., Ben-Akiva M.E., Waitz I.A., 2004, Aviation Emissions and Abatement Policies in the United States: A City Pair Analysis, *Transportation Research D,* 9(4): 294-314.

APPLICATIONS: REDUCING FUEL USE

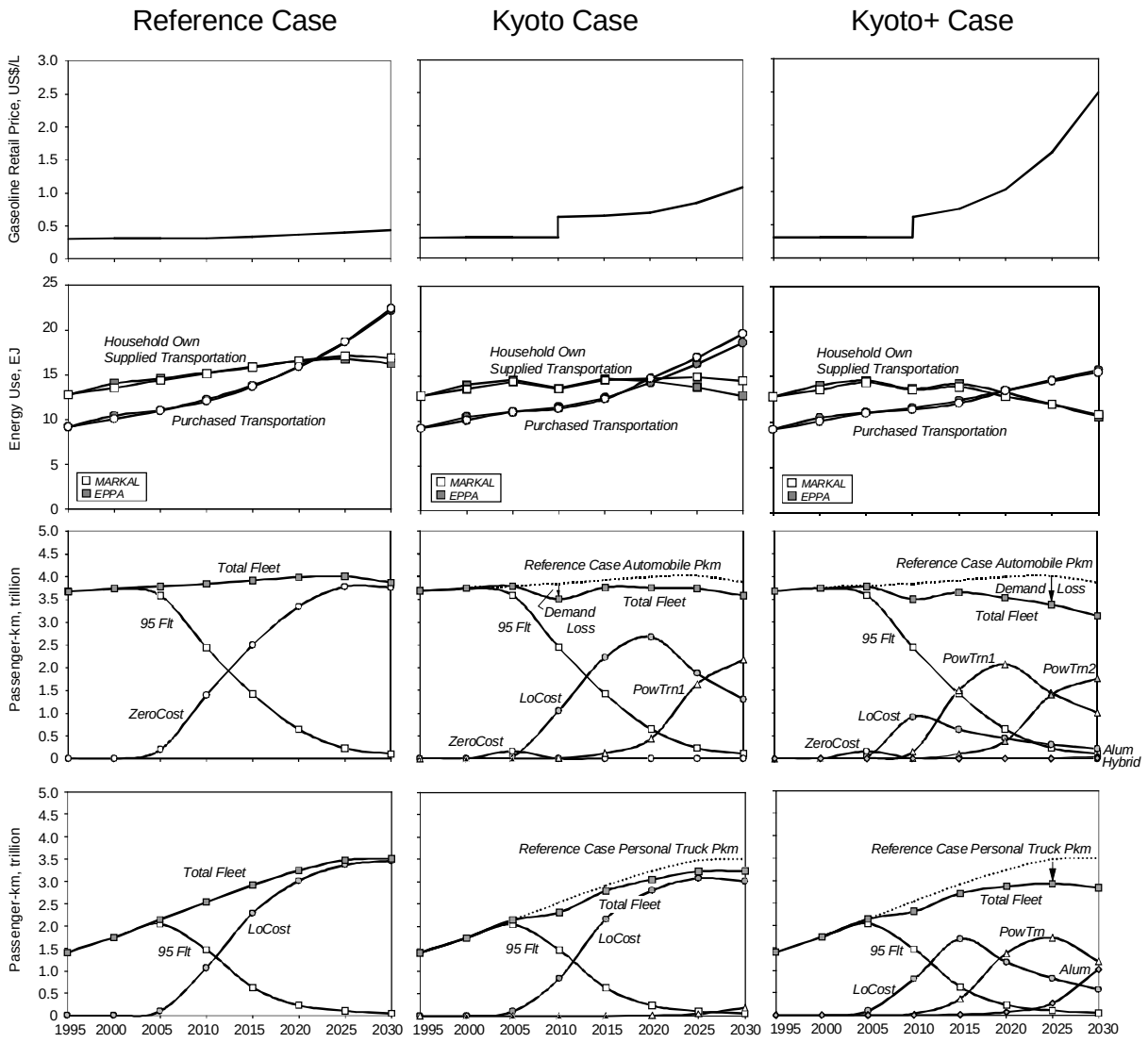


UNIFORM C-TAX: TECHNOLOGY-DYNAMICS



Calibration Stage

Simulation Stage



Source: Schäfer A., Jacoby H.D., 2005, Technology Detail in a Multi-Sector CGE Model: Transport under Climate Policy, *Energy Economics*, 27(1): 1-24.