Long-Term Dynamics in World Passenger Transportation: Can Policy Make A Difference?

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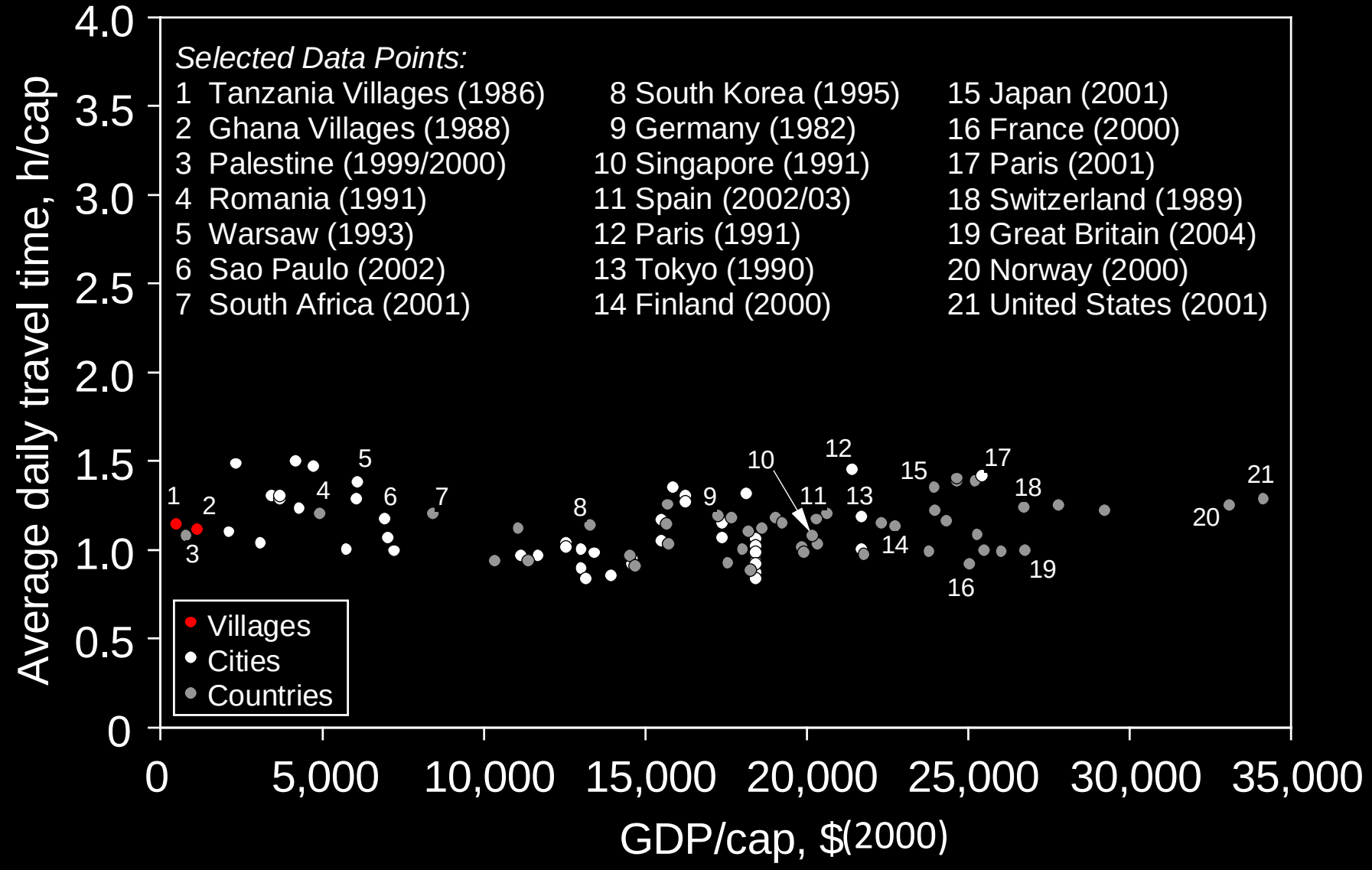
Andreas W. Schäfer
University College London
(a.schafer@ucl.ac.uk)

Greenhouse Gas Emissions: Identity

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

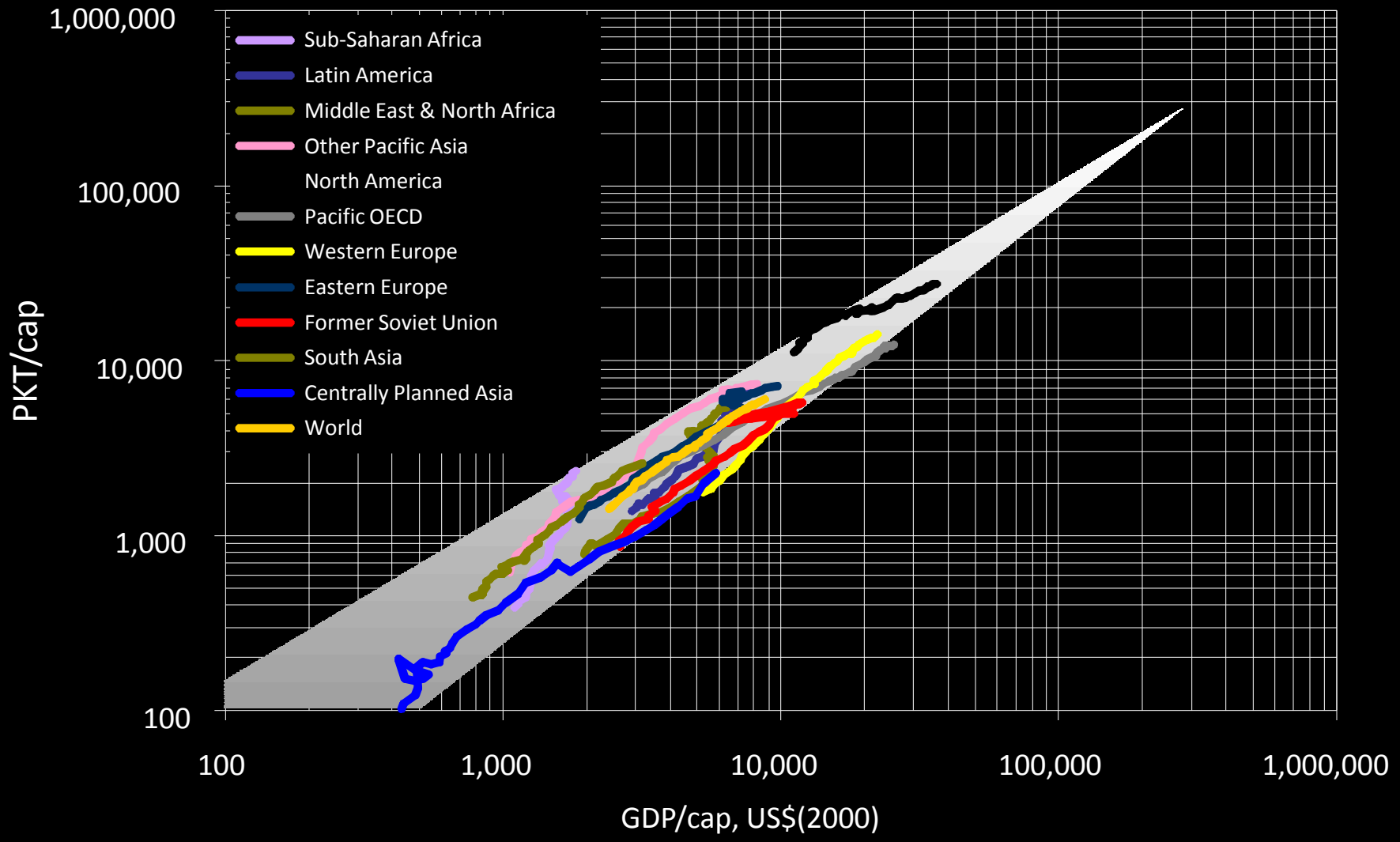
Three possible bifurcations

Determinants of Travel Demand



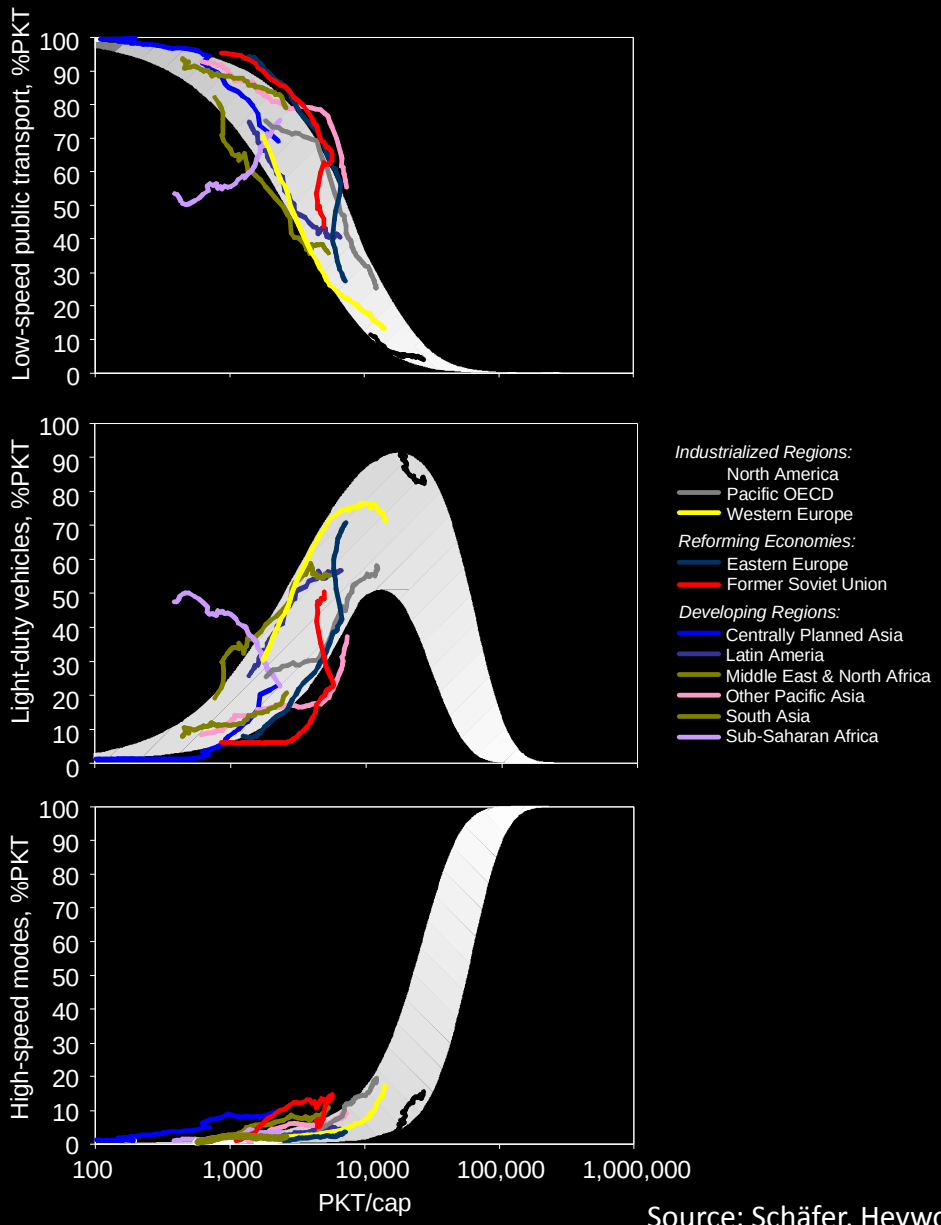
Source: Schäfer, Heywood, Jacoby, Waitz (2013)

Growth in Global Mobility (1950-2005)



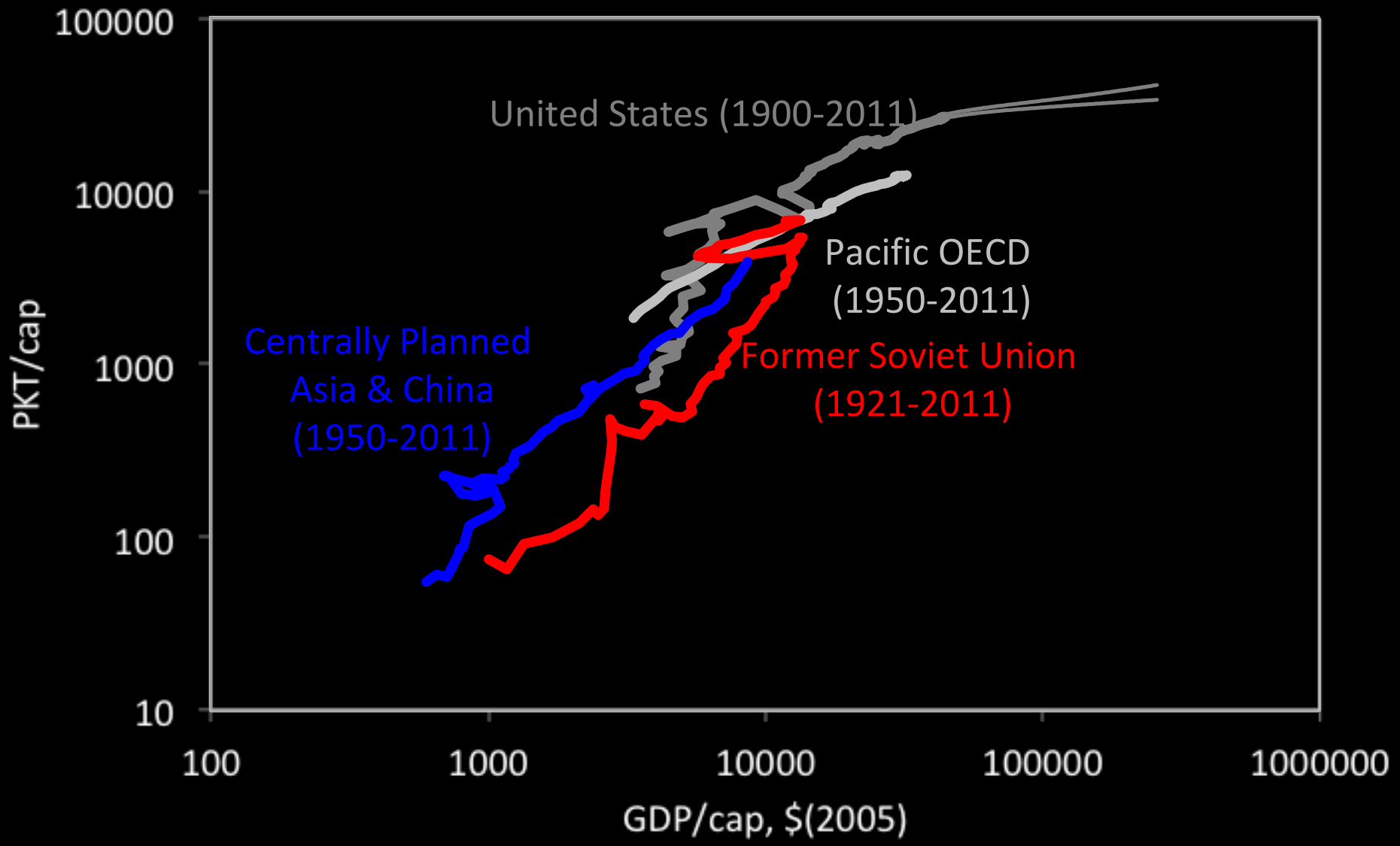
Source: Schäfer, Heywood, Jacoby, Waitz (2013)

Shift from Slow to Fast (1950-2005)

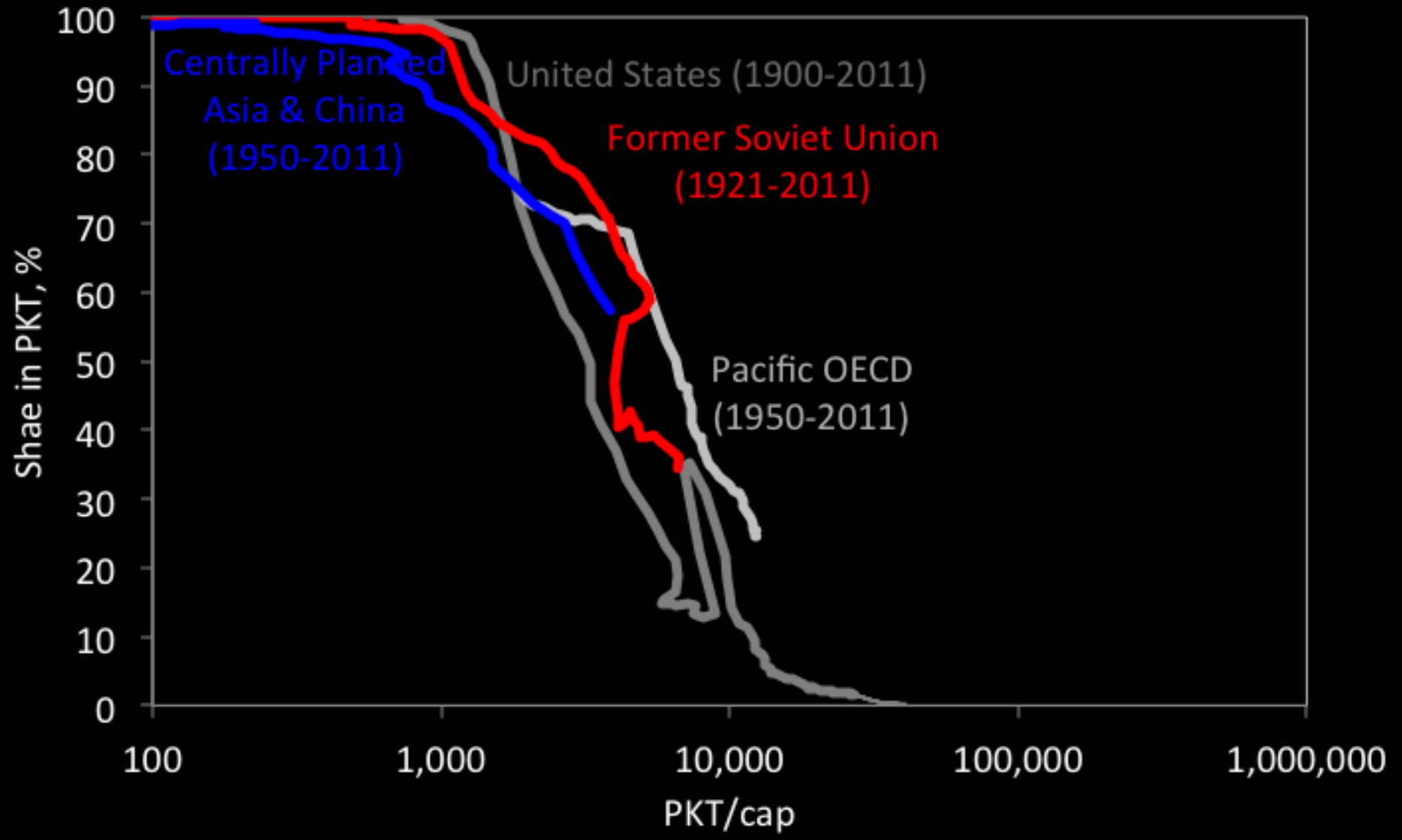


Source: Schäfer, Heywood, Jacoby, Waitz (2013)

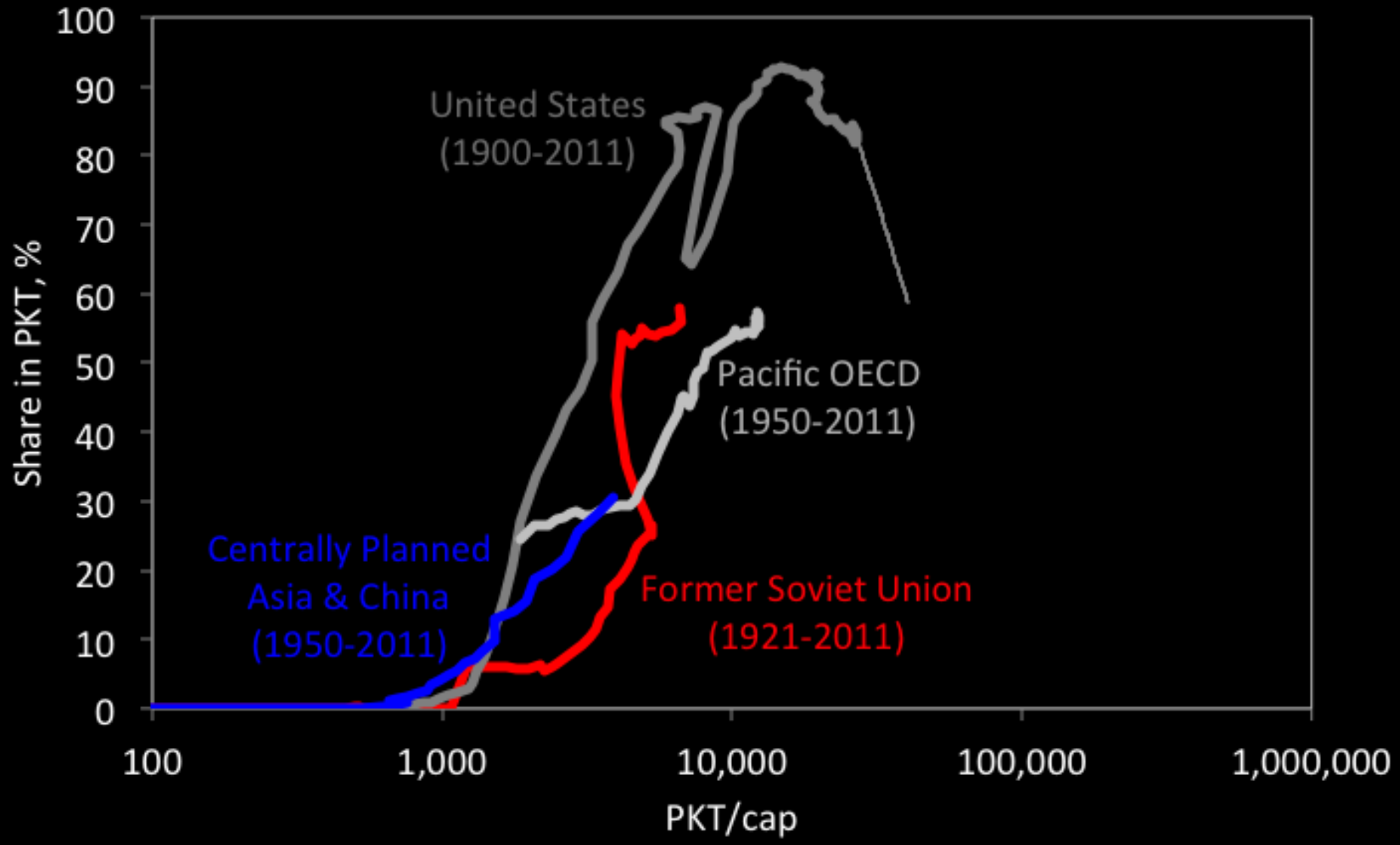
Growth in Total Mobility



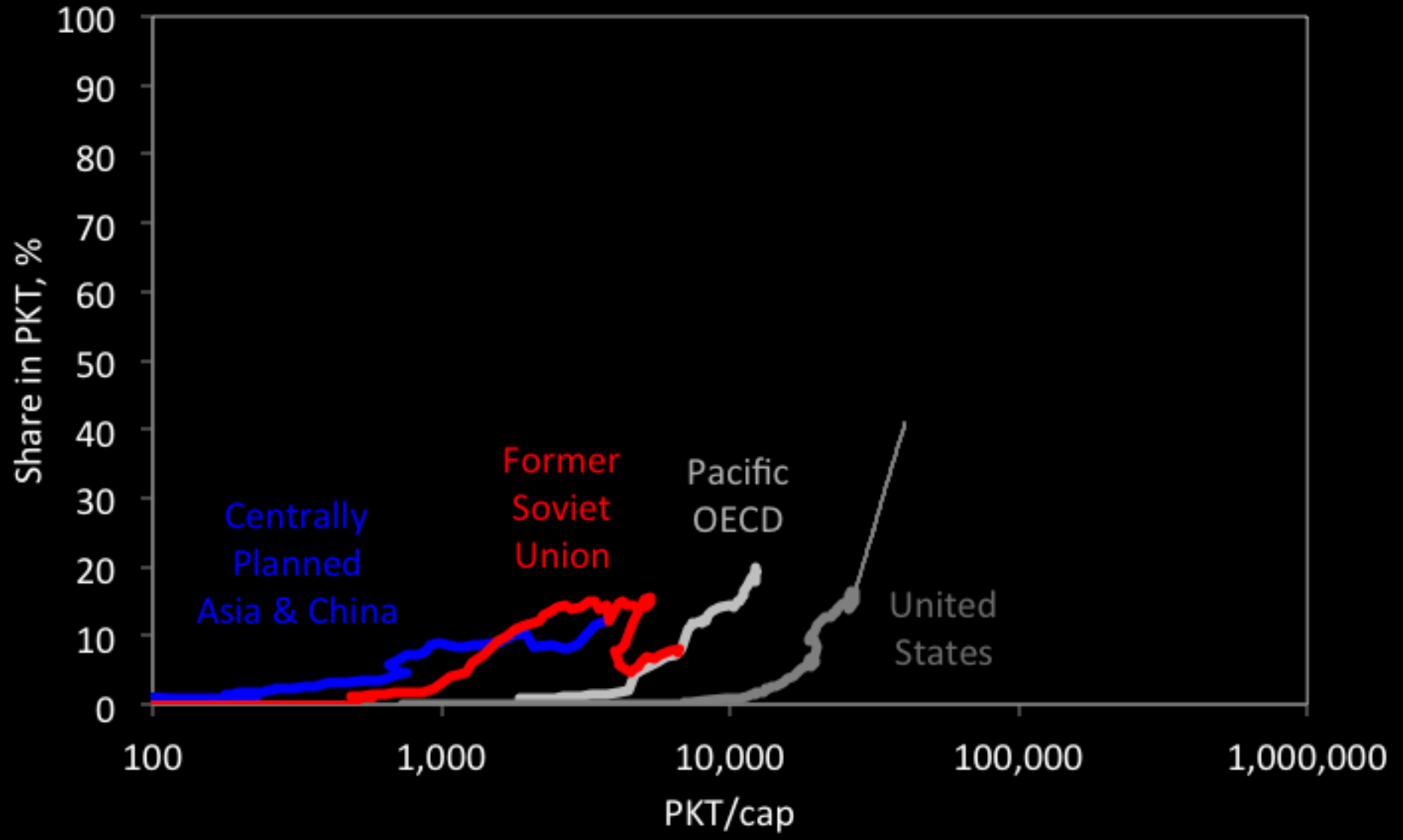
The Decline of Public Transport



The Rise and Fall (?) of the Automobile



The Rise in High-Speed Transportation



Modelling World-Regional Travel Demand: System of 3 Equations

$$ln\,pkt_t = \gamma_0 + \gamma_1\ ln\,pkt_{t-1} + \gamma_2\ ln\,gdp_t + \gamma_3\ ln\,gdp_{t-1}$$

$$+\gamma_4\,ln\left(ln\sum_M e^{V_{m,t}}\right) + \gamma_5\,ln\left(ln\sum_M e^{V_{m,t-1}}\right) + \delta \cdot D + \varepsilon_t$$

$$ln\left(\frac{Sh_{LDV}}{Sh_{Air}}\right)_t = \beta_{LDV} + \beta_1\ ln\left(\frac{Sh_{LDV}}{Sh_{Air}}\right)_{t-1} + \beta_3\left(\frac{VOT}{S_{LDV,t}} - \frac{VOT}{S_{Air,t}} + \frac{C_{LDV,t} - C_{Air,t}}{(GDP/h)_t}\right) + \epsilon_t$$

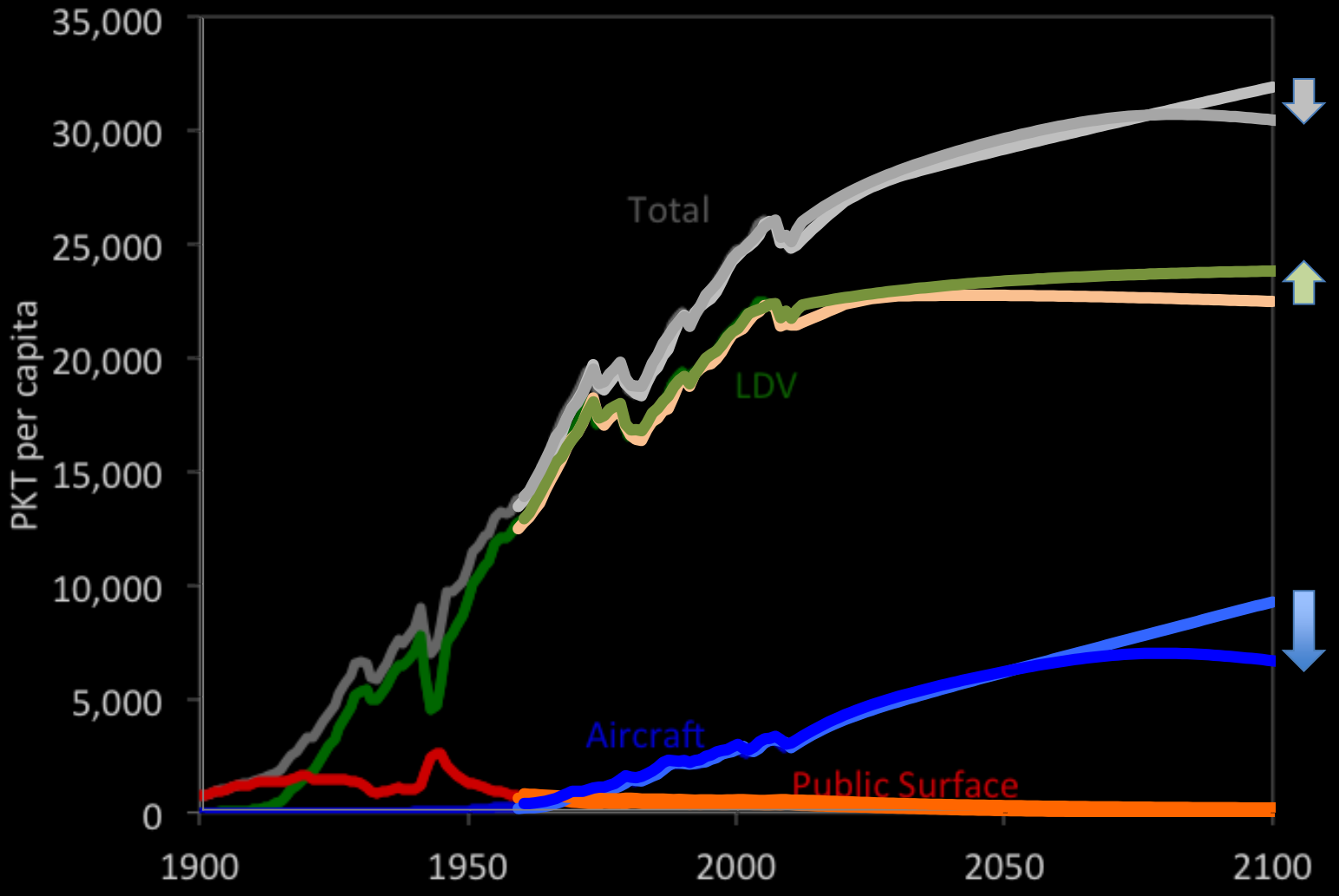
$$ln\left(\frac{Sh_{Pub}}{Sh_{Air}}\right)_t = \beta_{Pub} + \beta_1\ ln\left(\frac{Sh_{Pub}}{Sh_{Air}}\right)_{t-1} + \beta_3\left(\frac{VOT}{S_{Pub,t}} - \frac{VOT}{S_{Air,t}} + \frac{C_{Pub,t} - C_{Air,t}}{(GDP/h)_t}\right) + e_t$$

Iterate VOT to stay within specified travel time budget

Source: Schäfer (under review)

Projected Development

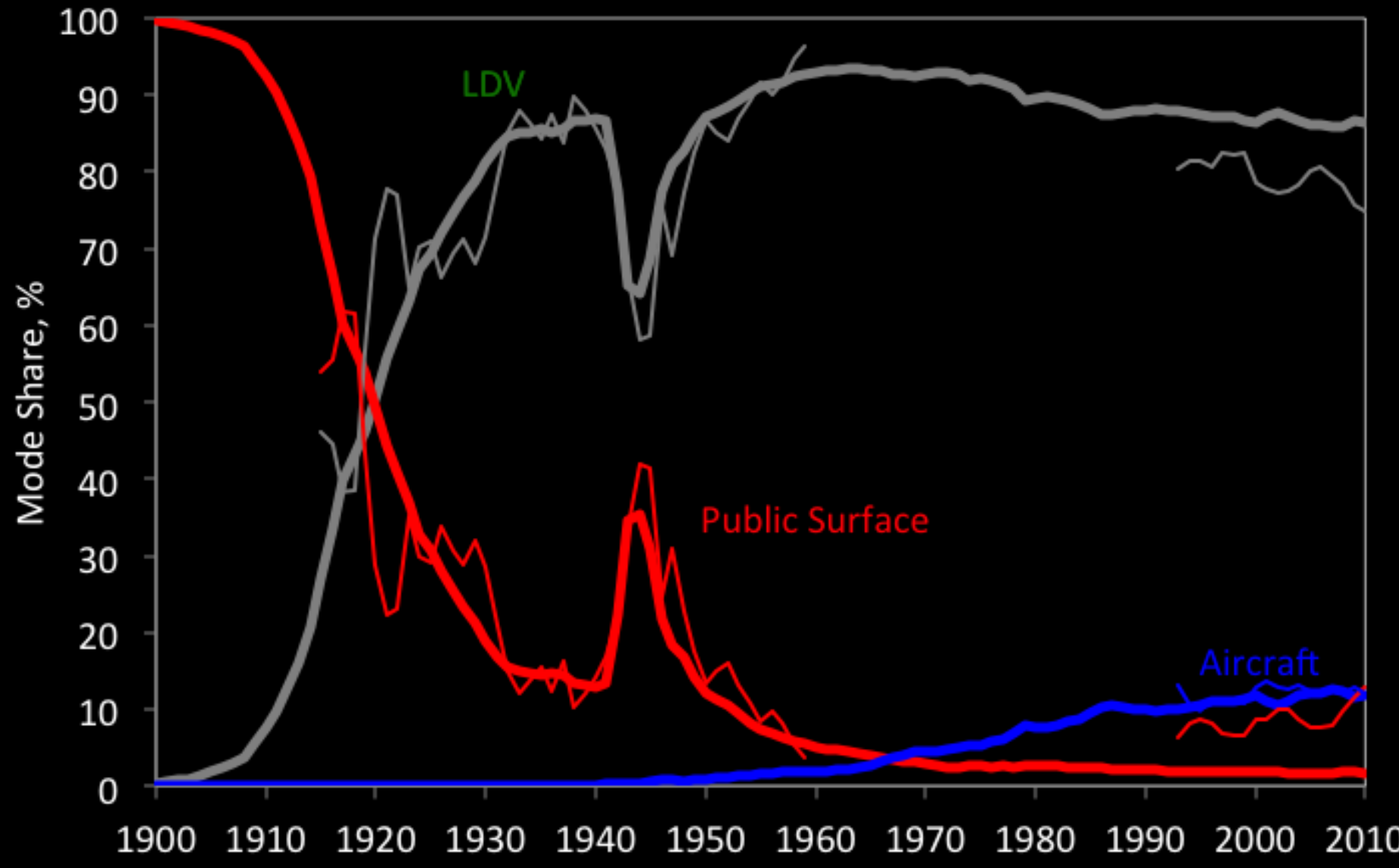
(Observations: 1900 – 2010; Projections: 2011 – 2100)



Source: Schäfer (under review)

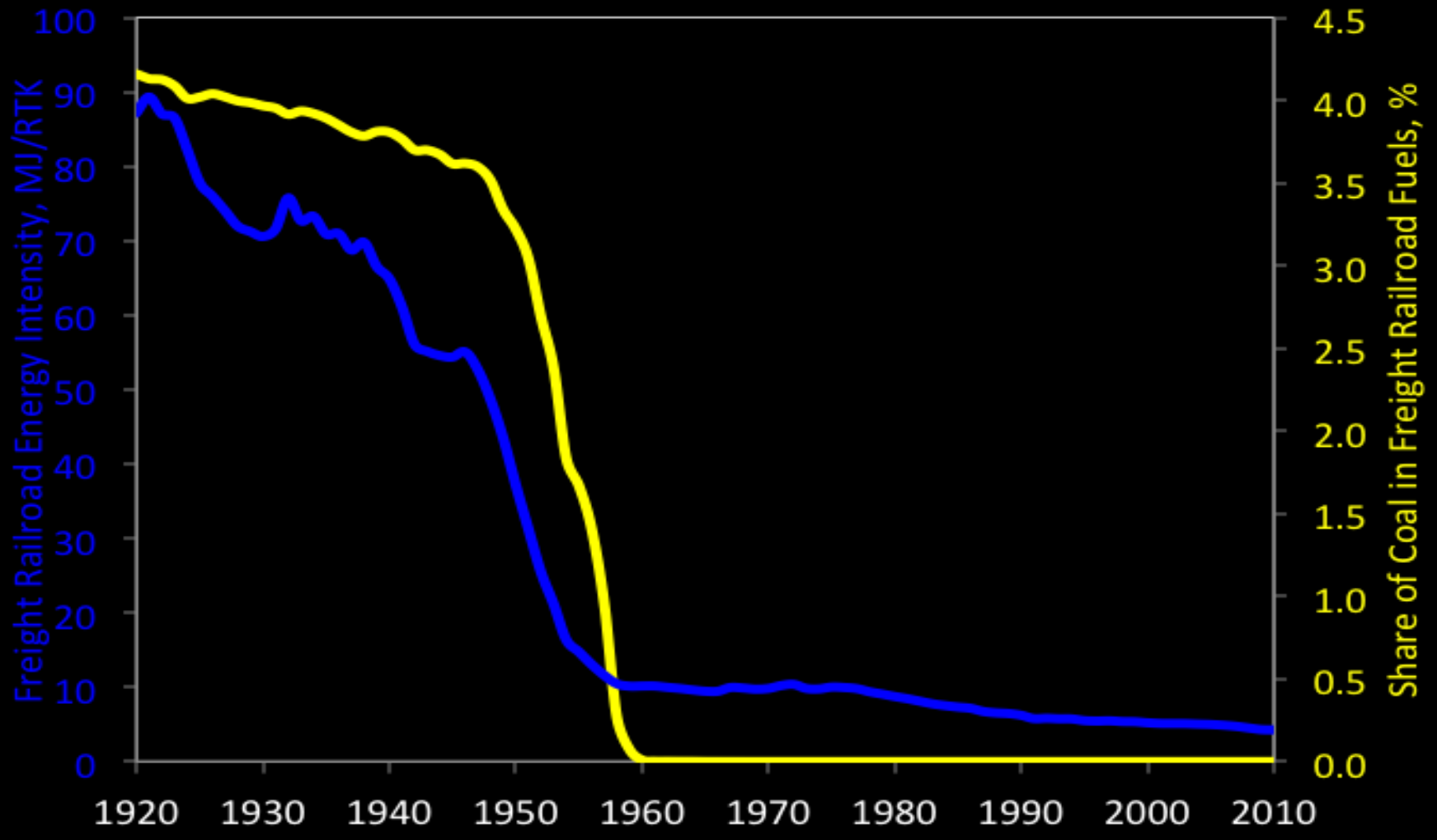
Shares in Infrastructure Investments and Modes

(thick lines: share in PKT; thin lines: share in infrastructure investments)



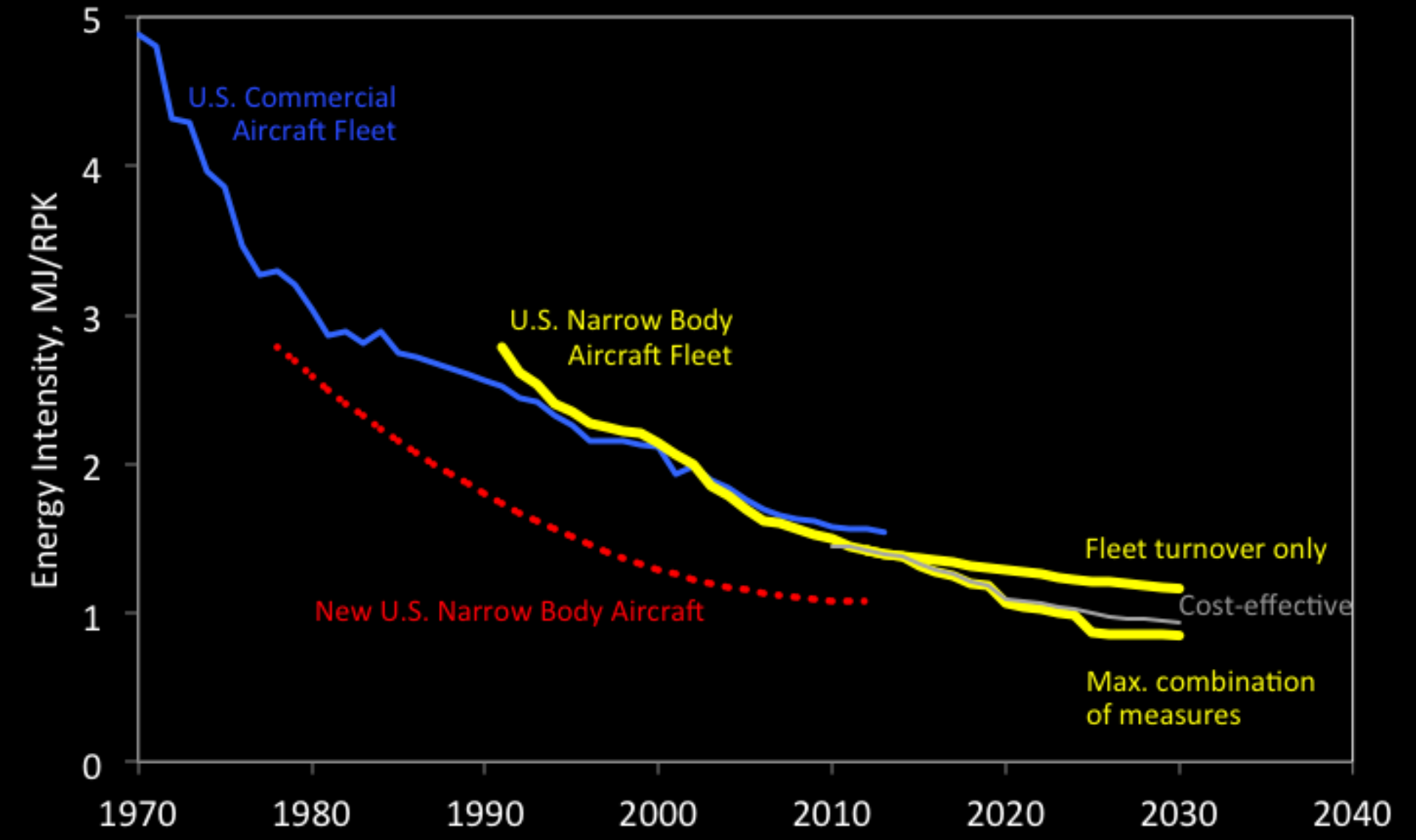
Bifurcation in GGE/PKT

US Freight Railroad Energy Intensity



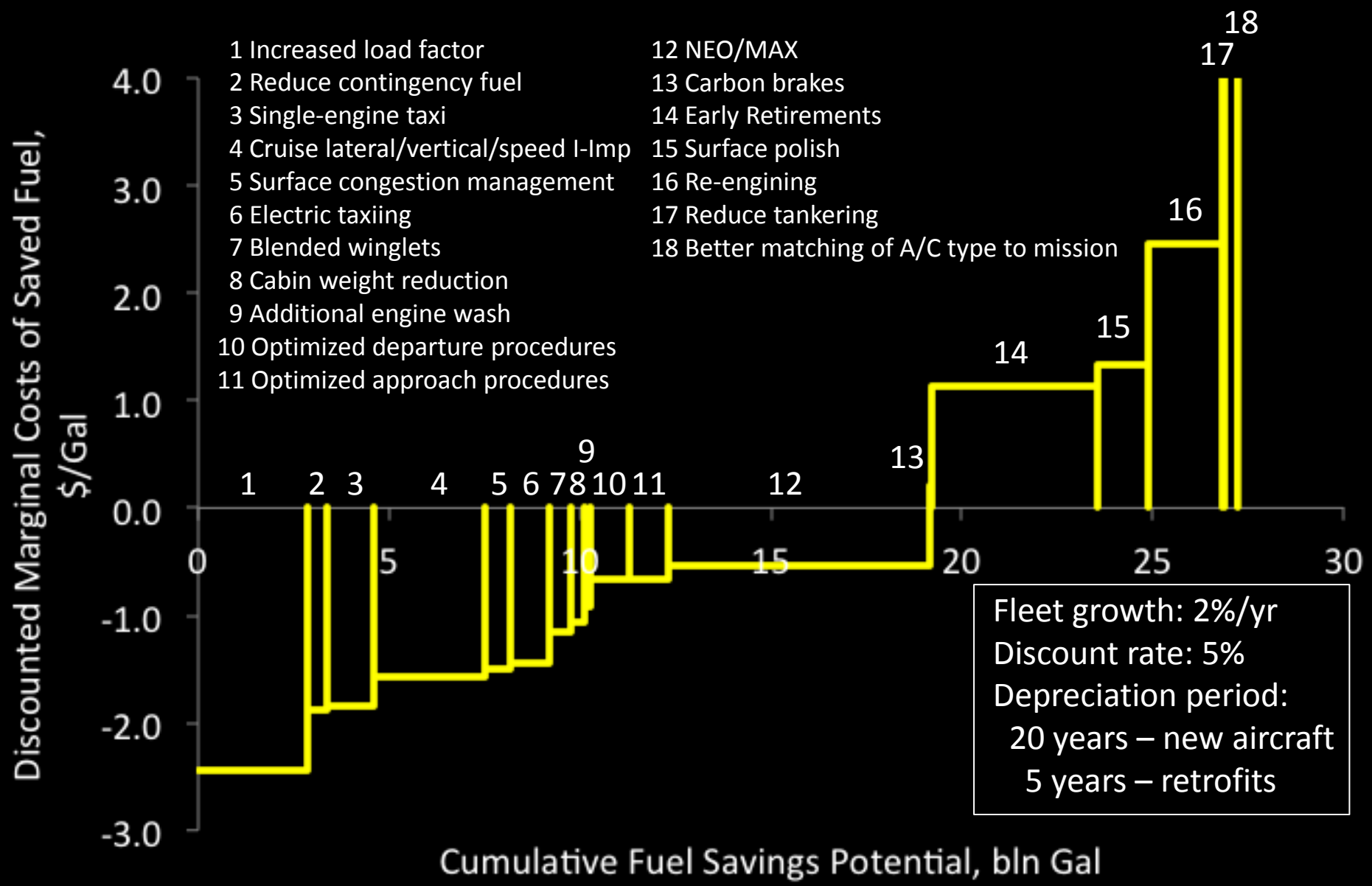
Source: Schäfer (2013)

Aircraft Energy Intensity (U.S. Domestic Market)



Source: Schäfer, Evans, Reynolds, Dray (2014)

Fuel Burn Reduction Costs in U.S. PAX Air Transport



Source: Schäfer, Evans, Reynolds, Dray (2014)

Conclusions

- People behave fundamentally similar
  - Differences in trends across regions due to different initial conditions, availability of technologies, etc.
- Long-term dynamics are very stable
  - U.S. Analysis:
    - Only radical policies seem to influence “development pathways”
    - Provision of alternative infrastructures & modes may not be sufficient → need for enabling policies
  - Emerging Economies analysis to follow. BUT: why should it be fundamentally different?
- Caveat: Very simple model w/o heterogeneity (spatial, social, etc.) → Benchmark/reference development only
- Technological change likely to remain the key opportunity for climate change mitigation
  - But it won’t work without behavioral change