Moving towards modal shift in TIMES

ETSAP workshop, 9th November 2011
Athens, Greece

Presented by Hannah Daly, University College Cork

1

Collaborators

- Alessandro Chiodi[1]
- Hannah Daly[1]
- Maurizio Gargiulo[1,2]
- Brian Ó Gallachóir[1]
- Kalai Ramea[3]
- Sonia Yeh[3]

1 – Environmental Research Institute, University College Cork, Ireland
2 – e4sma s.r.l., Turin, Italy
3 – Institute of Transportation Studies, University of California, Davis, USA

2

Overview

- Motivation
  - Transport modelling & mode choice
- Conceptual model for modal shift
  - Spreadsheet model
  - Modal shift framework in TIMES
- Preliminary results
- Discussion & next steps

3

Motivation

Transport Energy

- The transport problem
- Urban: Public transport vs. auto
- Regional: High speed rail vs. aviation

4

Motivation

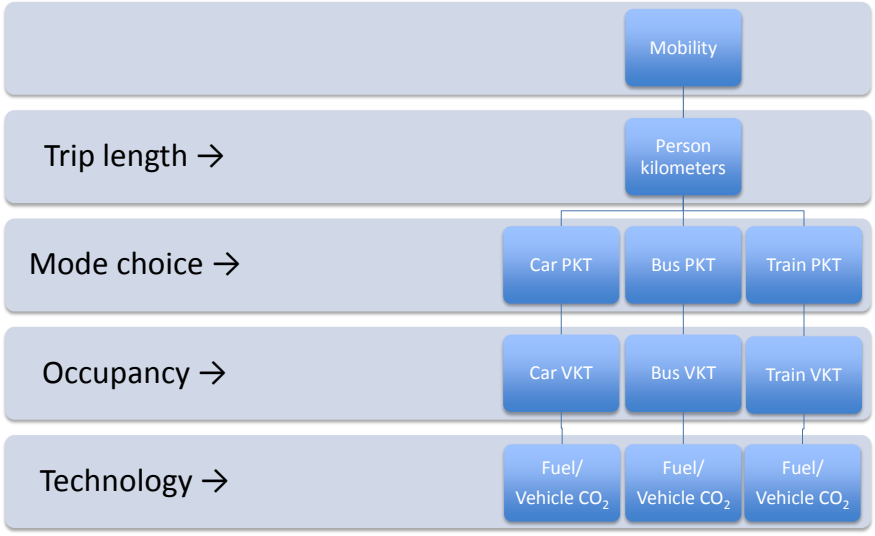
Mode Choice

- Urban congestion
  - frustration
  - longer travel times
  - lost productivity
  - accidents/insurance
  - fuel consumption
  - freight costs
  - air quality
- Regional congestion
  - regional economic development
  - national productivity
  - competitiveness
  - environmental quality

5

Motivation

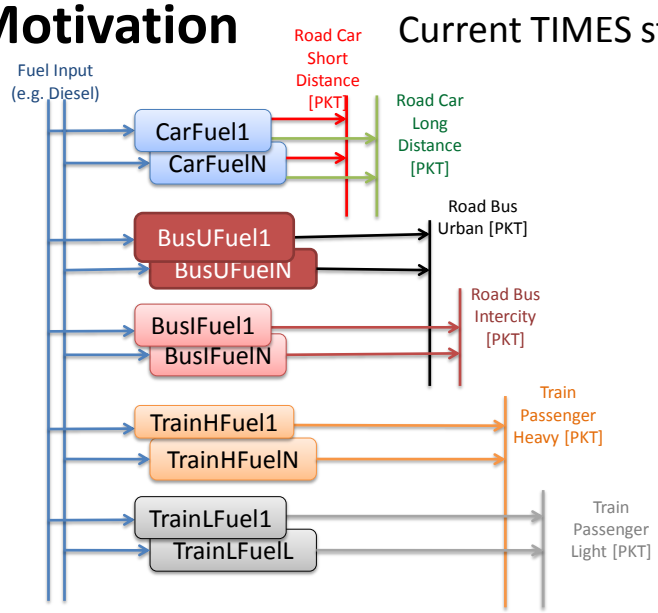
Mode Choice



6

Motivation

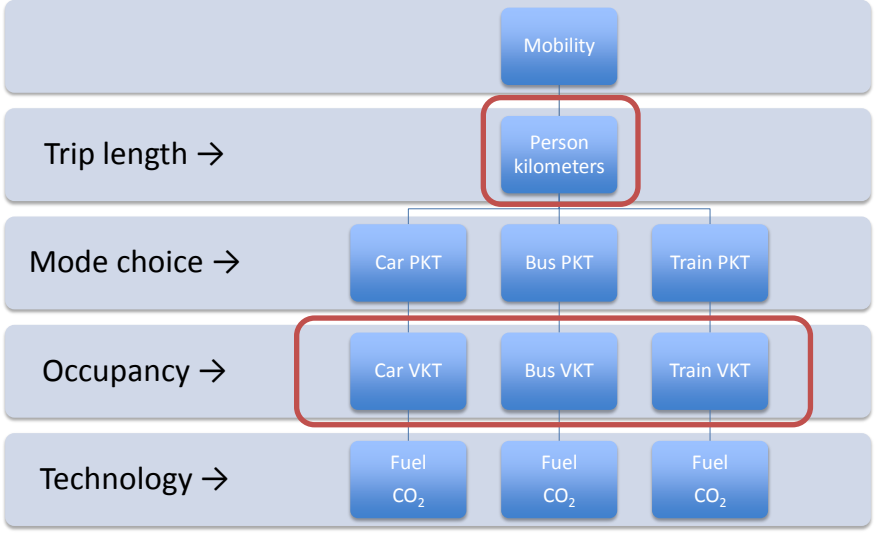
Current TIMES structure



7

Motivation

Mode Choice



8

Transport modelling Factors of mode choice

- Household composition
- Working/living location
- Gender and age
- Socio-economic status
- Education
- Quality and reliability of PT
- *Travel time*
- *Availability*

9

Conceptual model Overview

- Exogenous Urban and Regional Passenger Kilometres Travelled (PKT) - D
- Cost of Time added to objective equation:
  - TTIME commodity an auxiliary input
  - Speed of each technology (s, in VKT/hr)
  - Value of time (€/hr)
- Disaggregate by income groups to give mode choice
- Travel Time Budget (TTB) for each income group a limiting "availability" of TTIME: 1.1 hr/day

10

Conceptual model Formulation

Minimize

$$C = \sum_{i,m} PKT_{i,m} \cdot c_{i,m}$$

such that

$$\sum_{i,m} PKT_{i,m} = D;$$

$$\sum_{m} s_m \cdot PKT_{i,m} = TTB_i$$

i – income group	*m – mode*
C – overall cost	*$c_{i,m}$ – fuel, investment & time cost per PKT*
s_m – speed by mode, hrs/pkm	*D – overall PKT travel demand (modelled exogenously)*
TTB_i – travel time budget (hrs)	

11

Conceptual model Cost per PKT

- Cost per PKT: $c_{i,m} = fc_m * ic_m * tc_i$
  - Fuel cost: fuel price * fuel intensity / load factor

$$\frac{€}{PKT} = \frac{€}{MJ} \cdot \frac{MJ}{VKT} / \frac{PKT}{VKT}$$

  - Investment cost: Cost of vehicle / lifetime VKT / load

$$\frac{€}{PKT} = \frac{€}{vehicle} \cdot \frac{1}{life\ VKT} / \frac{PKT}{VKT}$$

  - Time cost: Time value / speed

$$\frac{€}{PKT} = \frac{€}{hour} \cdot \frac{hours}{VKT} / \frac{PKT}{VKT}$$

12

Conceptual model Value of Time (VoT)

- Estimate that willingness to pay for time saving is 40% * hourly wage
  - Irish VoT by income deciles:

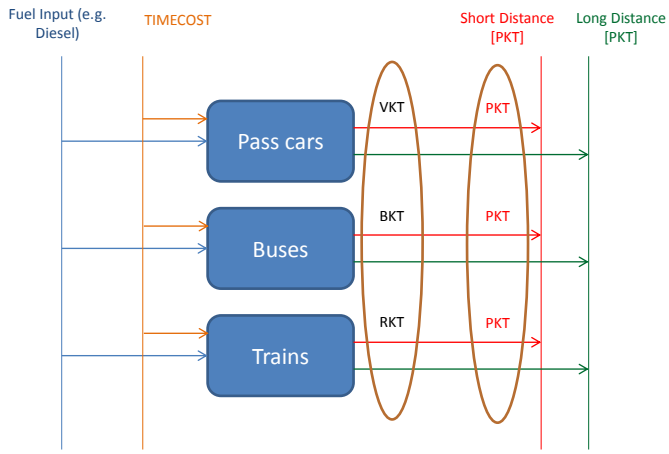
Income deciles	1	2	3	4	5	6	7	8	9	10
Weekly income (€)	165.3	243.7	285.9	338.8	412.2	483.7	582.7	688.2	864.2	1460.9
Hourly wage (€)	4.4	6.4	7.5	8.9	10.9	12.7	15.3	18.1	22.7	38.4
Value of Time (wage * 40%)	1.7	2.6	3.0	3.6	4.3	5.1	6.1	7.2	9.1	15.4

  - California VoT by income quintiles:

Quintile	Lowest fifth	Second fifth	Third fifth	Fourth fifth	Highest fifth	Top 5%
Value of Time ($/hr)	0.75	1.94	3.34	6.18	13.25	22.48

13

Conceptual model TIMES structure



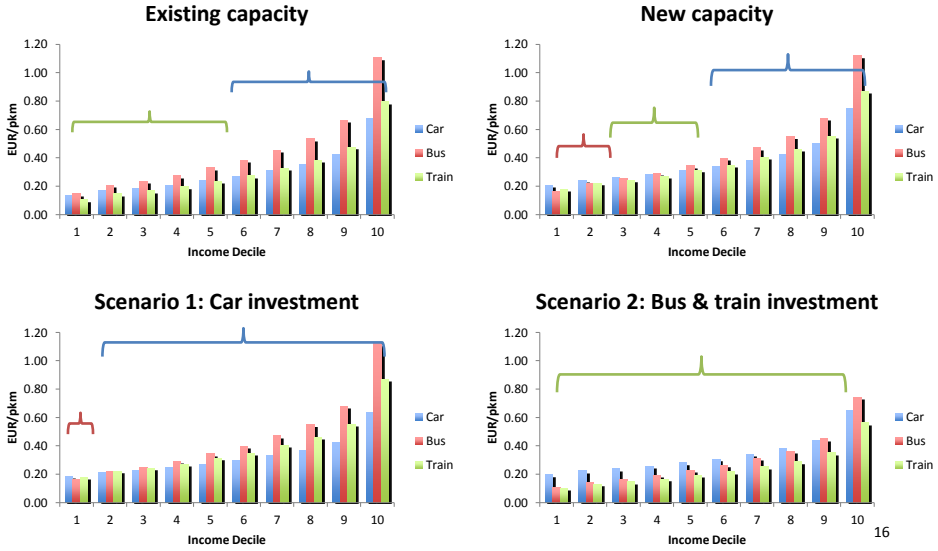
14

Conceptual model Spreadsheet model

- To calculate the cost per PKT for each mode, income decile
- Scenarios:
  - Existing capacity (fuel + time cost)
  - Added capacity (+ investment cost)
  - Scenario 1: Car investment (Car speeds and annual distance increases by 20%)
  - Scenario 2: Bus and rail investment (Speed, occupancy and annual distance increases by 50%)

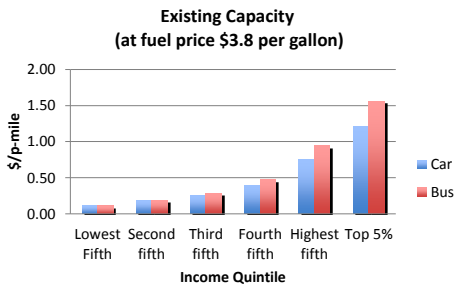
15

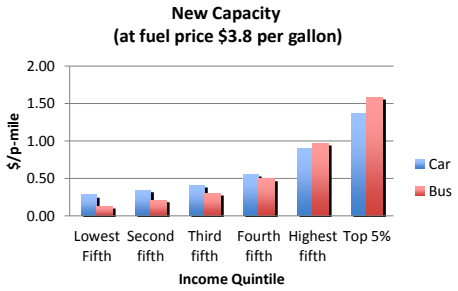
Spreadsheet Results Ireland

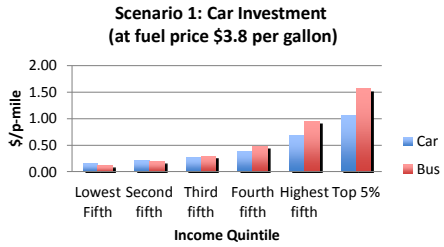


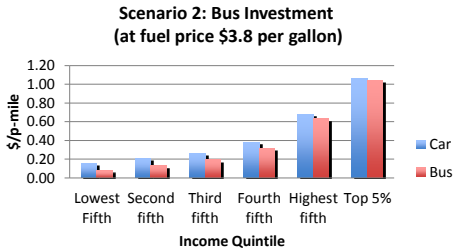
16

Spreadsheet Results California

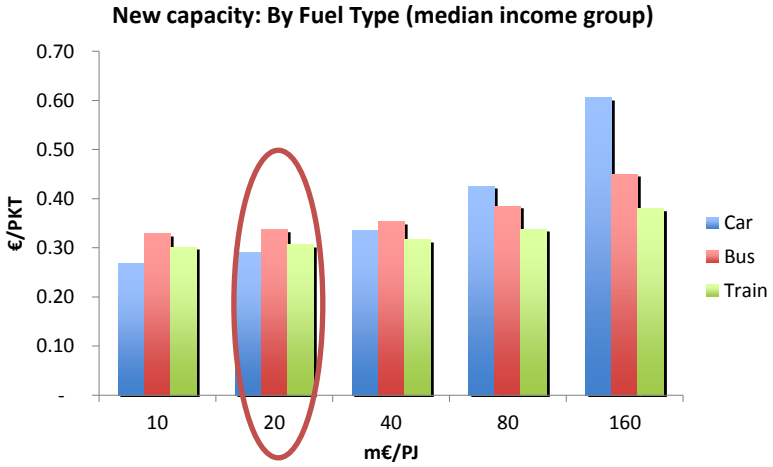








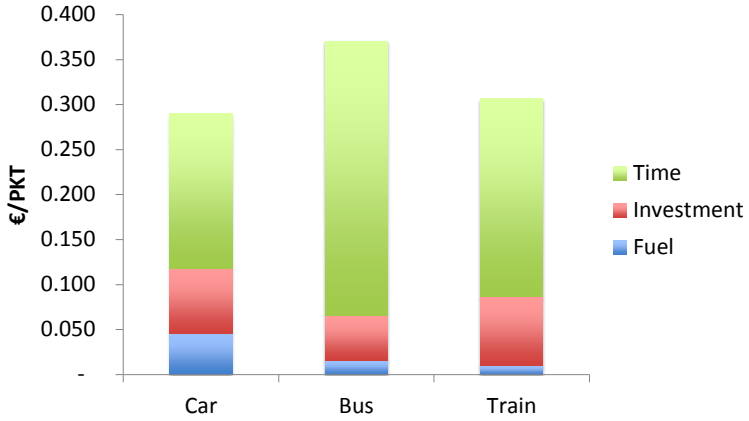
Spreadsheet Results Ireland



18

Spreadsheet Results Ireland

- Source of travel costs for "Added capacity"



- Median income group, m€20/PJ fuel cost

19

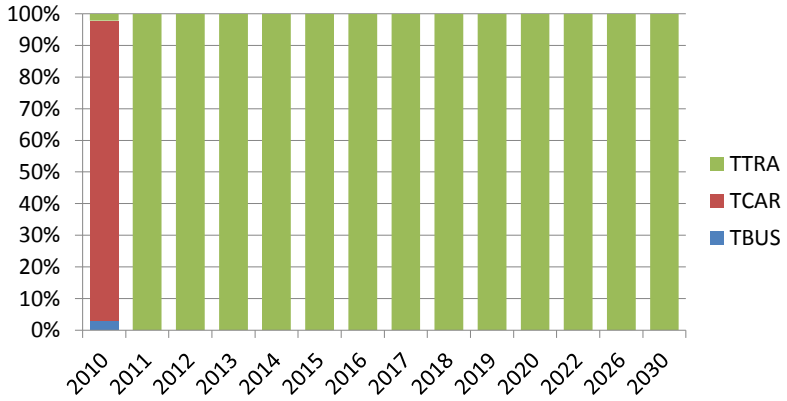
TIMES Model Overview

- Implemented simple models for Ireland and California, populated with data from each TIMES model
- One fuel input (Diesel/gasoline)
- One travel demand – PKT/PMT
- 3 competing modes - pass car, bus, train
  - Characterised by
    - Efficiency (mVKT/PJ)
    - Investment cost
    - Speed

20

TIMES Model Results: No TC, no TTB

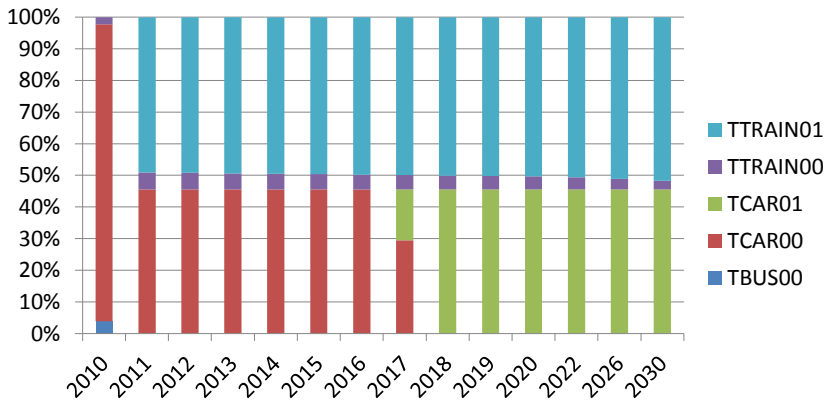
- One optimum mode chosen



21

TIMES Model Results: No TC, TTB

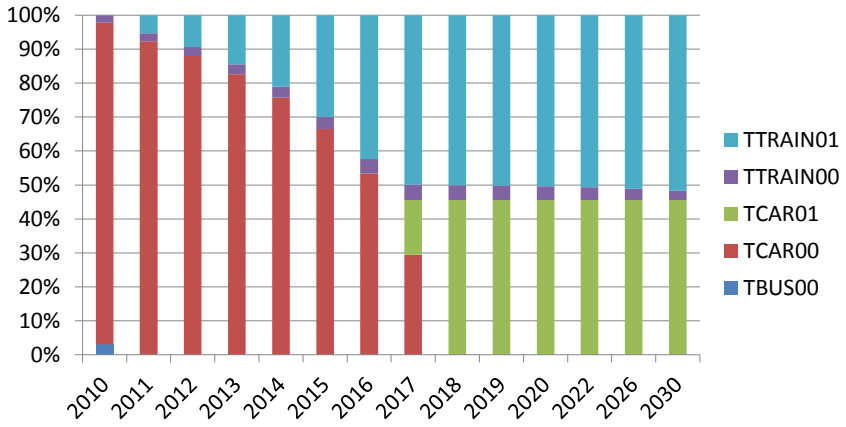
- Equilibrium reached immediately



22

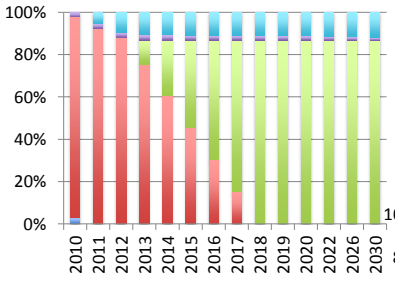
TIMES Model Results: TC & TTB imposed

- New train and new car investment



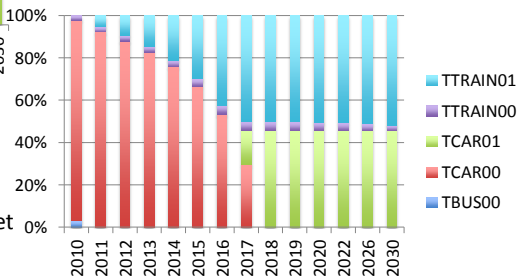
23

TIMES Model Results: TC Sensitivity



Increased time cost by 50%: More investment in cars (more expensive fuel cost is recovered in time cost savings)

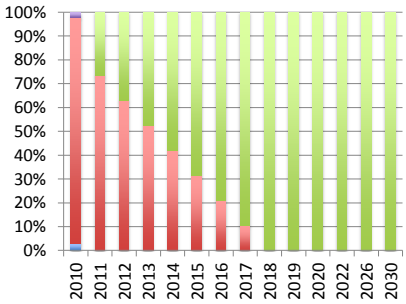
Decreasing time cost by 50%: Same technology selection, since time budget is limiting slower modes.



24

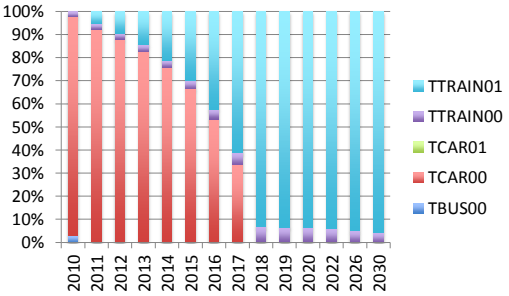
TIMES Model

Results: TTB Sensitivity



TTB decreased to 0.8 hrs/day: Total investment into cars (fastest mode)

TTB increased to 1.5hrs/day: Investment into cheaper, slower mode (Train)



25

Discussion

- Model does show modal competition, but
  - Calibration needed to replicate base year and simulate to the future
  - Issues with VoT/disaggregated income approach:
  - "Time availability"?
  - Income groups travel differently
  - *Access*
    - Public transport: 95% urban and 51% rural
    - Car ownership

26

Discussion

Next steps

- Issues
  - Competition between high speed rail & aviation
  - Cycling
- Approaches
  - More detailed technologies
  - Short vs. long, Urban vs. regional travel.
  - Transport within energy systems model

27

Discussion

Next steps

- Next next steps
  - The role of **Infrastructure**: Bus lanes, space availability
  - The role of **Space**: constraints and costs
  - Feasibility study of using **logit model** (or other) for mode share: non-linear probability equations => code change would be needed.

28

- Thank you for your attention
- h.e.daly@umail.ucc.ie

29