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Paris light train
Something to learn for Urban transportation?

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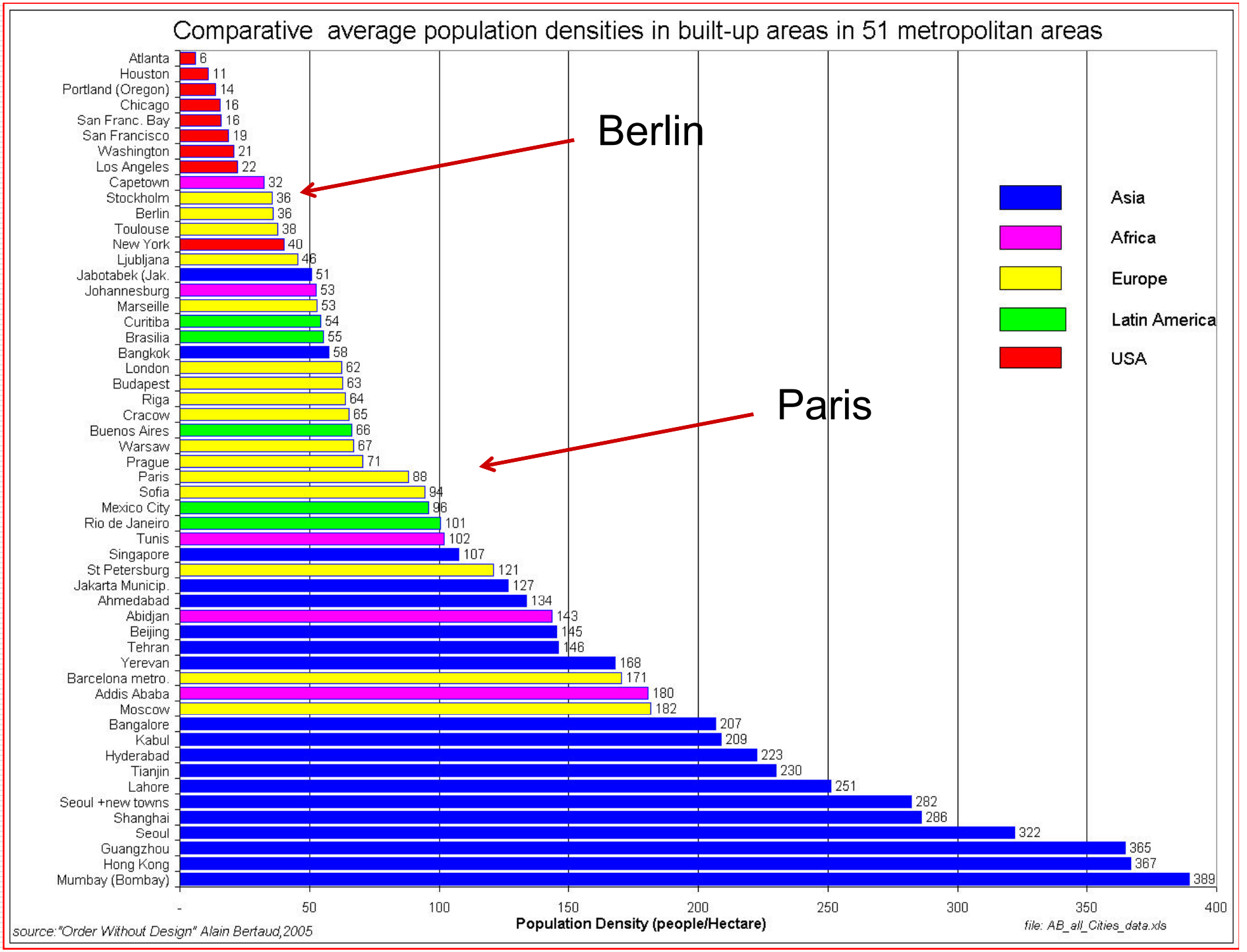
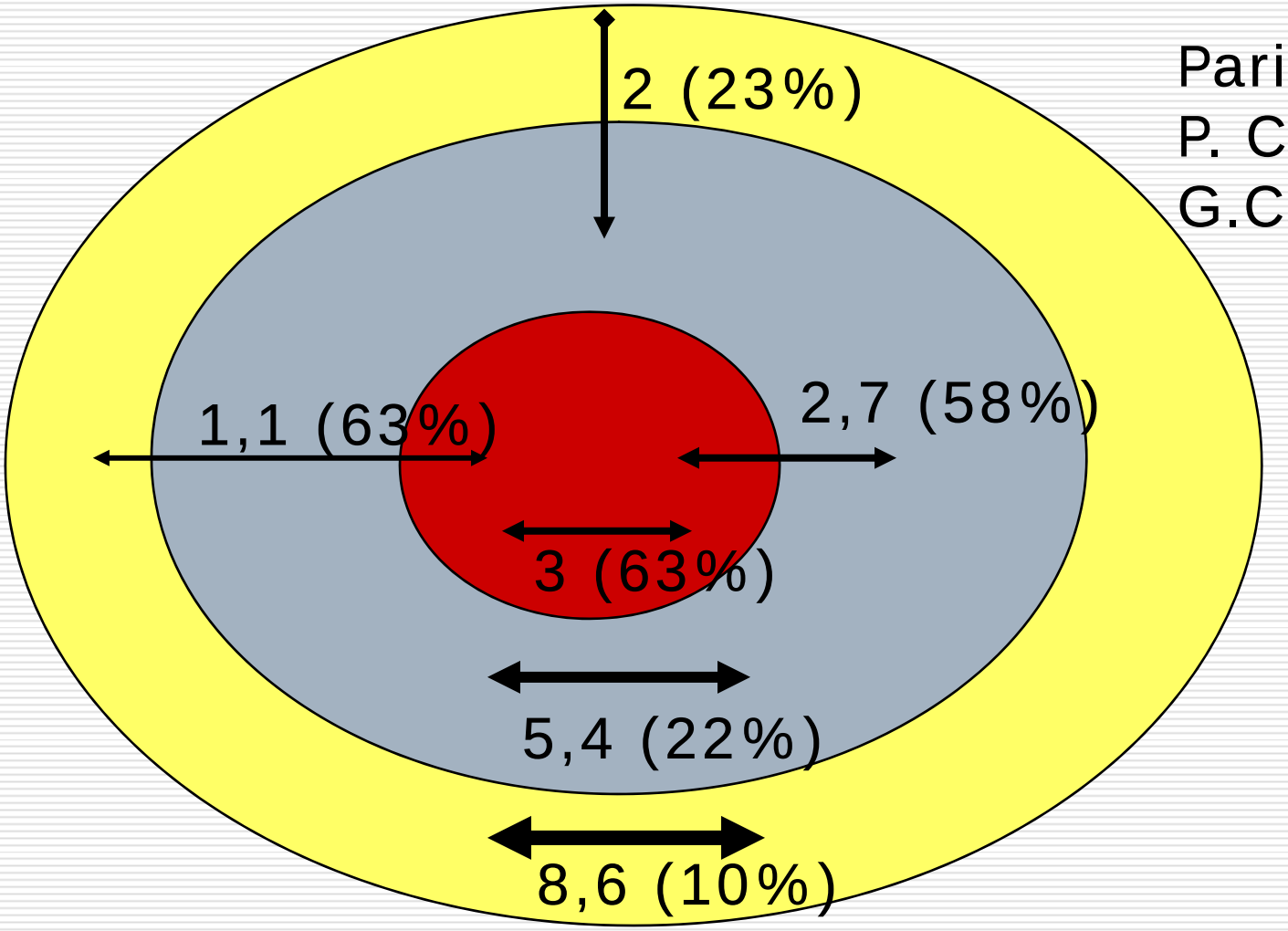
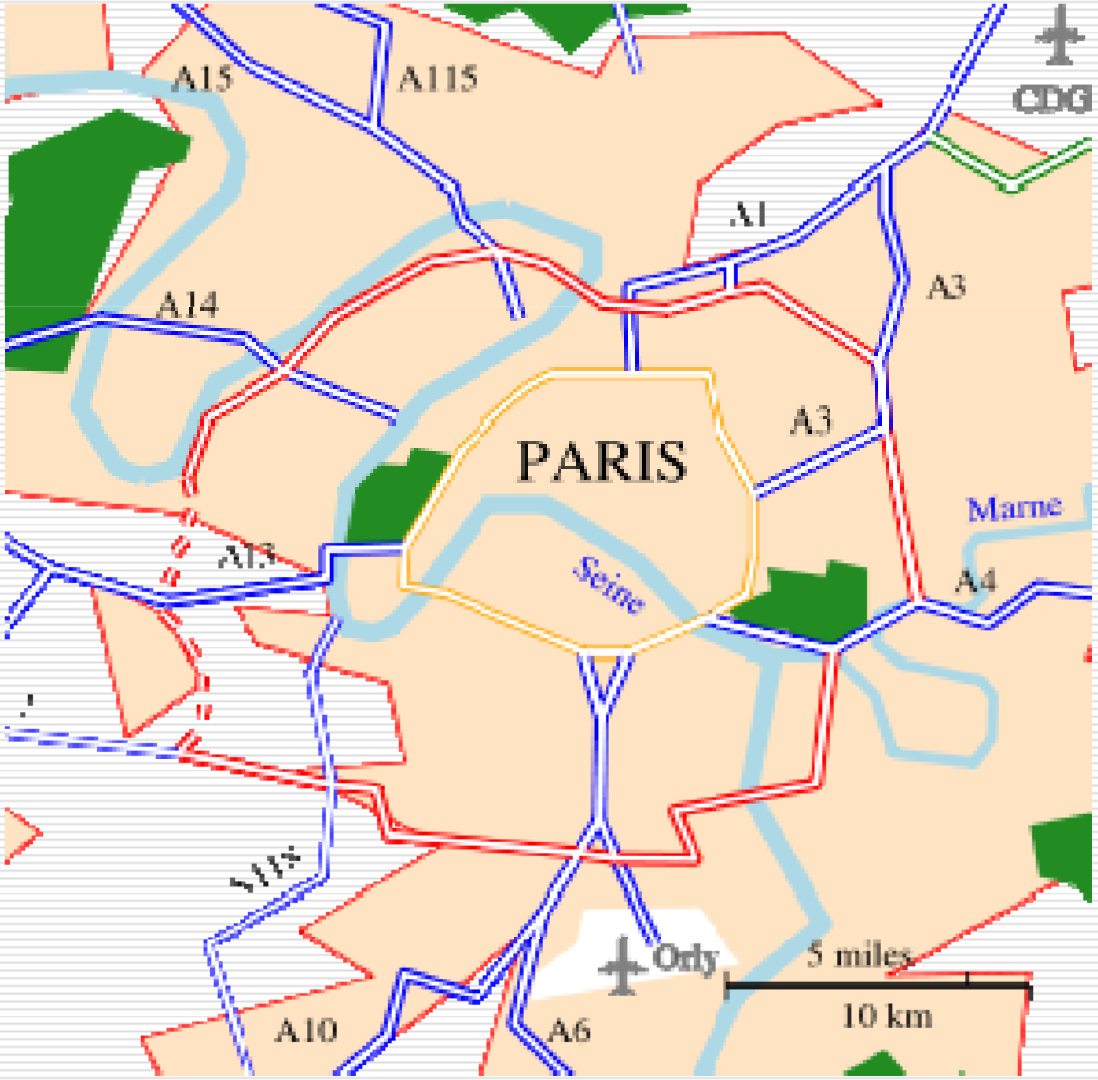

Comparative average population densities in built-up areas in 51 metropolitan areas
Atlanta 6
Houston 11
Portland (Oregon) 14
Chicago 16
San Franc. Bay 16
San Francisco 19
Washington 21
Los Angeles 22
Capetown 32
Stockholm 36
Berlin 36
Toulouse 38
New York 40
Ljubljana 46
Jabotabek (Jak. 51
Johannesburg 53
Marseille 53
Curitiba 54
Brasilia 55
Bangkok 58
London 62
Budapest 63
Riga 64
Cracow 65
Buenos Aires 66
Warsaw 67
Prague 71
Paris 88
Sofia 94
Mexico City 96
Rio de Janeiro 101
Tunis 102
Singapore 107
St Petersburg 121
Jakarta Municip. 127
Ahmedabad 134
Abidjan 143
Beijing 145
Tehran 146
Yerevan 168
Barcelona metro. 171
Addis Ababa 180
Moscow 182
Bangalore 207
Kabul 209
Hyderabad 223
Tianjin 230
Lahore 251
Seoul +new towns 282
Shanghai 286
Seoul 322
Guangzhou 365
Hong Kong 367
Mumbay (Bombay) 389
Berlin
Paris
Asia
Africa
Europe
Latin America
USA
- 50 100 150 200 250 300 350 400
Population Density (people/Hectare)
source:"Order Without Design" Alain Bertaud,2005
file: AB_all_Cities_data.xls

TRANSPORTATION IN PARIS AREA



Paris = 2,2M
P. C. = 4 M
G.C = 4,8M


A15
A115
CDG
A1
A3
A14
A3
PARIS
Marne
A13
Seine
A4
A11
Orly
5 miles
10 km
A10
A6

MY NAME IS T3

POLITICAL CONTEXT

- Congestion, CO2
- Price versus quantity: London toll, Paris road diet
- Light train is a symbol of modernity
- A political and mediated success. Mayor re-elected
- Need for CBA

T3's CONSEQUENCES

- T3 is a switch from bus to light train
- Political and mediated success. Mayor re-elected
- Different groups of citizens are concerned: PT users (T3, subway), car users (on Bd Marechaux radials, Ring Road)
- We study the variations of their economical surplus (welfare approach)
- And the environmental impact (one of T3's objectives)

WHO ARE THE USERS?

- Ex-bus (50%) or subway (33%) users
- Low modal shift from cars (2.7%)
- 144,000 bus riders*km before
- 256,000 train riders*km today (2.56 km in average length)
- Time gains and comfort gains
- Decrease mobility's price and increase welfare gains

LIFE IS BETTER FOR TRAIN USERS

- **Time gain**

- The average speed is now 20 km/h (before 16 km/h)
- Waiting time increased: +0.5 minute
- The travel cost (in time) decrease by 0.4 min/riders*km
- With a time value of 10 €/h, annual gains is 4.5 M€

- **Comfort gains**

- Tricky question (contingent evaluation, *WTP*)
- Simplifying assumption: these gains are in the same order of magnitude than those of time (4.5 M€)

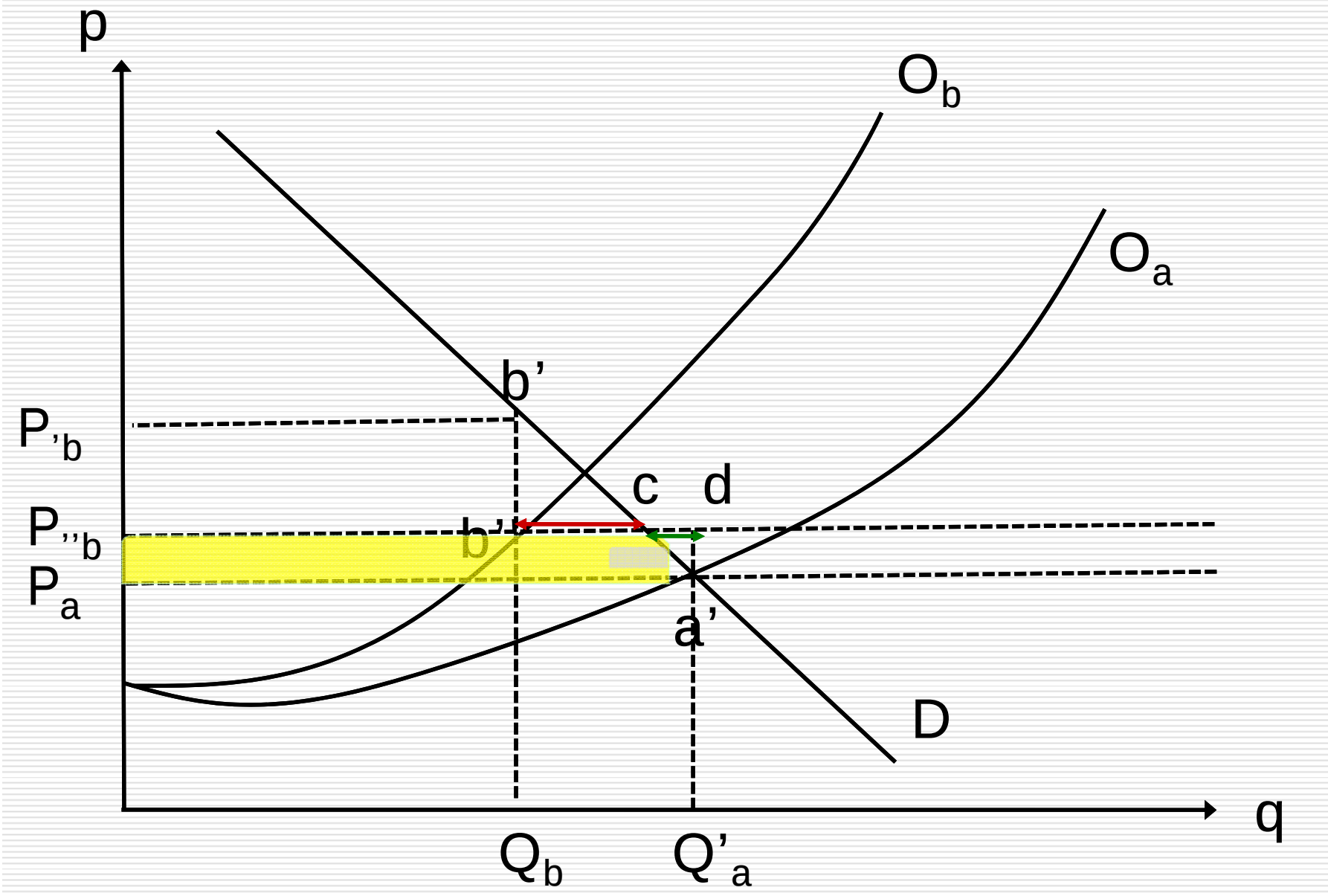
AS WELL AS FOR SUBWAY USERS

- (Small) decongestion in the subway: -96,000 riders*km (-0.4%)
- Very few studies on congestion in PT
- Litman (2007) proposed an elasticity of the cost in time in respect to the frequentation =0.4
- **Comfort gains**: 0.5 Mh = 4.6 M€

AND WORST FOR CAR USERS

- Car traffic has fallen from 198,000 riders*km to 116,000 riders *km (-82,000)
- But Modal Report from Cars to T3 is low:

  -7,000 riders*km
- Did they disappear?
- Structural decrease (Paris public policy + oil price's increase) : -10,000 riders*km
- Real decrease in traffic = 65,000 riders*km (-36%)


p
O_b
O_a
b’
$P_{’b}$
c
d
$P_{’’b}$
b’’
P_a
a’
D
q
Q_b
$Q’_a$

HERE THEY COULD BE!

- On the Ring Road: Cost gap equal to the roundabout way plus the waste of time necessary to reach the ring road
- Average length of trip on the boulevard = 4 km
- Roundabout way = 2*400 m = 800 m
- Average speed = 20 km/h
- With these parameters :
- Δcost = 0.6 min/car*km= 0.102 €/rider*km

COST CONSEQUENCES

- Welfare decrease = - 6.87 M €/ year
- Wastes of time on radials : - 1.83 M €

RING ROAD CONGESTION

- Debates on congestion costs in urban areas

- We use Prud'homme-Sun's model of congestion (2000): « *disaggregated approach* » by distinguishing congestion costs with respect to the speed of displacement (Koning, 2009).

- Speed-density relation :
  $V(q) = 85.3 - 0.264*q$
- Private cost :
  $l(q) = 0.12 + 1.3*10.2/V(q)$
- Social cost :
  $S(q) = l(q) + l'(q)*q$
- Marginal congestion cost :
  $Cm(q) = 3.5*q/(85.3 - 0.264*q)^2$

RING ROAD: COST OF CONGESTION

Speed (km/h)	Distribution (%)	Report (veh*km)	Cm(q) (€/veh*km)	Congestion costs (€/day)
5<x<10	3.2	1,363	18.33	24,999
15<x<20	5.1	2,159	2.94	6,336
35<x<40	3.6	1,098	0.45	495
70<x<75	18.3	7,753	0.03	250
Total M€				**33**

ENVIRONMENTAL IMPACT
TWO IMPORTANT RELATIONS

Number of cars and CO_2 are correlated

CO_2 emissions = inverse speed function speed under 50 km/h.

- Suppression of buses (-)
- Modal report Cars/Train (-)
- Decrease car speed on Blv Maréchaux (+)
- Longer trips to access the RR (+)
- Decrease in car speed on RR (+)

CO_2 EMISSION ON THE RING ROAD

- According to US Ministry of Energy :
- If s< 50 km/h

  $CO_2(kg/km) = 0.624 – 0.00925*s$
- If s> 50 km/h

  CO_2 (kg/km) = 0.16
- By matching this relation with the speed-density relation, we can deduce the « marginal emission » on the BP (as a function of density):

$$CO_2M\ (kg/veh*km) = 0.0024*q$$

BAD CO2 BALANCE (0.1M€)

Trains	Before	After	Variation
Bus Suppression	966	0	-966
Modal report	709	0	-709
Longer trips	0	1,337	+1,337
ΔSpeed Maréchaux	14,144	15,046	+902
ΔSpeed on RR			+2,900
Total			**+3,464**

Cost Benefit Balance M€	Annual
Δ surplus operator	+0.84
Δ surplus users CT :	
Time gains	+4.47
Comfort gains	+4.47
Subway's decongest	+4.57
Δ surplus car users :	
On Maréchaux	-6.87
On radials	-1.83
Externalities :	
Congestion RR	-31.82
CO2 emissions	-0.10
Total	**-26.25**

WHAT DID WE LEARN?

- Negative NPV of 900 M€ with a 30 years horizon and a 4% discount rate
- Impossible to find a positive IRR
- Environmental objective is not reached
- Car users (mainly from suburbs) are the losers of the T3's project
- The T3 users are the winners : 60% are Parisian
- But only 15% of the cost is paid by the municipality, the rest by the region and the state