Is the impact of transport modes on health an individual determinant of transport mode choice?

Hélène Bouscasse[1] Sandrine Mathy[2] Rim Rejeb[2] Carole Treibich[2]

Centre d'Economie et de Sociologie appliquées à l'Agriculture et aux Espaces Ruraux (CESAER)[1], Grenoble Applied Economics Lab (GAEL)[2]

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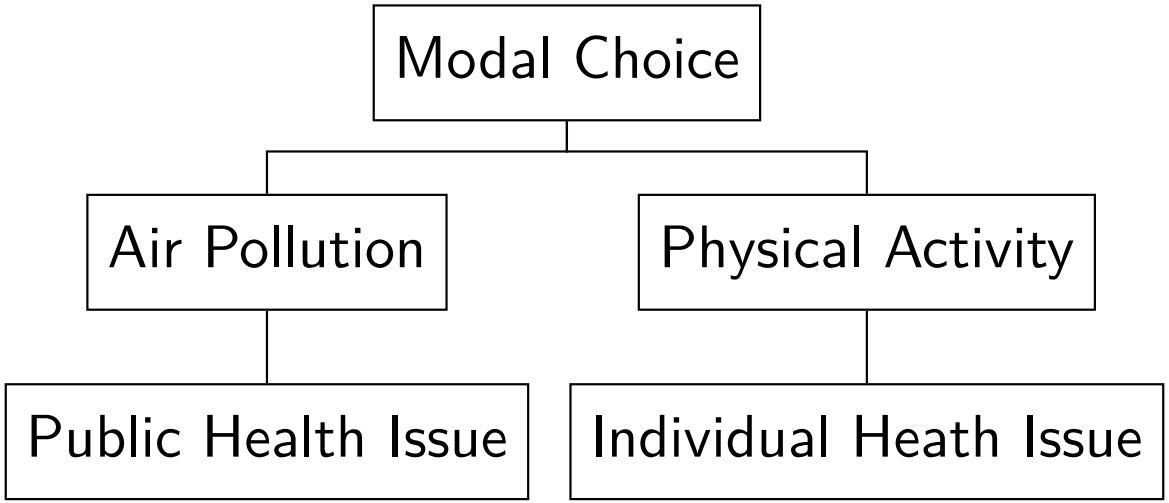
Outline

Context


Modal Choice
Air Pollution
Physical Activity
Public Health Issue
Individual Heath Issue

Context

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  - Psychological determinants: perceptions, attitudes, norms, etc.

$\Rightarrow$ A focus on **individual perception** of a given information (Health perceptions)

Contribution

- Health considerations are an element of choice (Shepherd et al., 2005; Paul & Rana, 2012)

- Sottile et al. (2015): the first to include information about the environmental (CO_2 emissions) and the sanitary impact (Stress level) of modal choice as attributes in a DCE.

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  But, no previous studies making a direct link between the reduction of health risk due to a specific behavior (diet, physical activity, smoking, etc.) and behavioral change.

- **Research question: How does information provided to individuals on the positive individual and public health impacts induced by active and less polluting modes of transport modify their modal choice?**

Outline

A Discrete choice experiment (DCE)

- An online Stated preferences survey (June to September 2019) with 1,000 participants from Grenoble metropolitan area
- **4 modes** of transport to make a personalized trip (above or below 3km) done with a reference mode (i.e. status quo)
- **Attributes** for the first 2 choices : travel time, travel cost

* **Maintenant c'est à vous de choisir ! (choix 1/2)**

Les choix qui s'offrent à vous sont présentés dans le tableau ci-dessous.

Nous vous demandons de bien vous baser sur les temps et coûts indiqués dans les questions et qui varient de questions en questions.

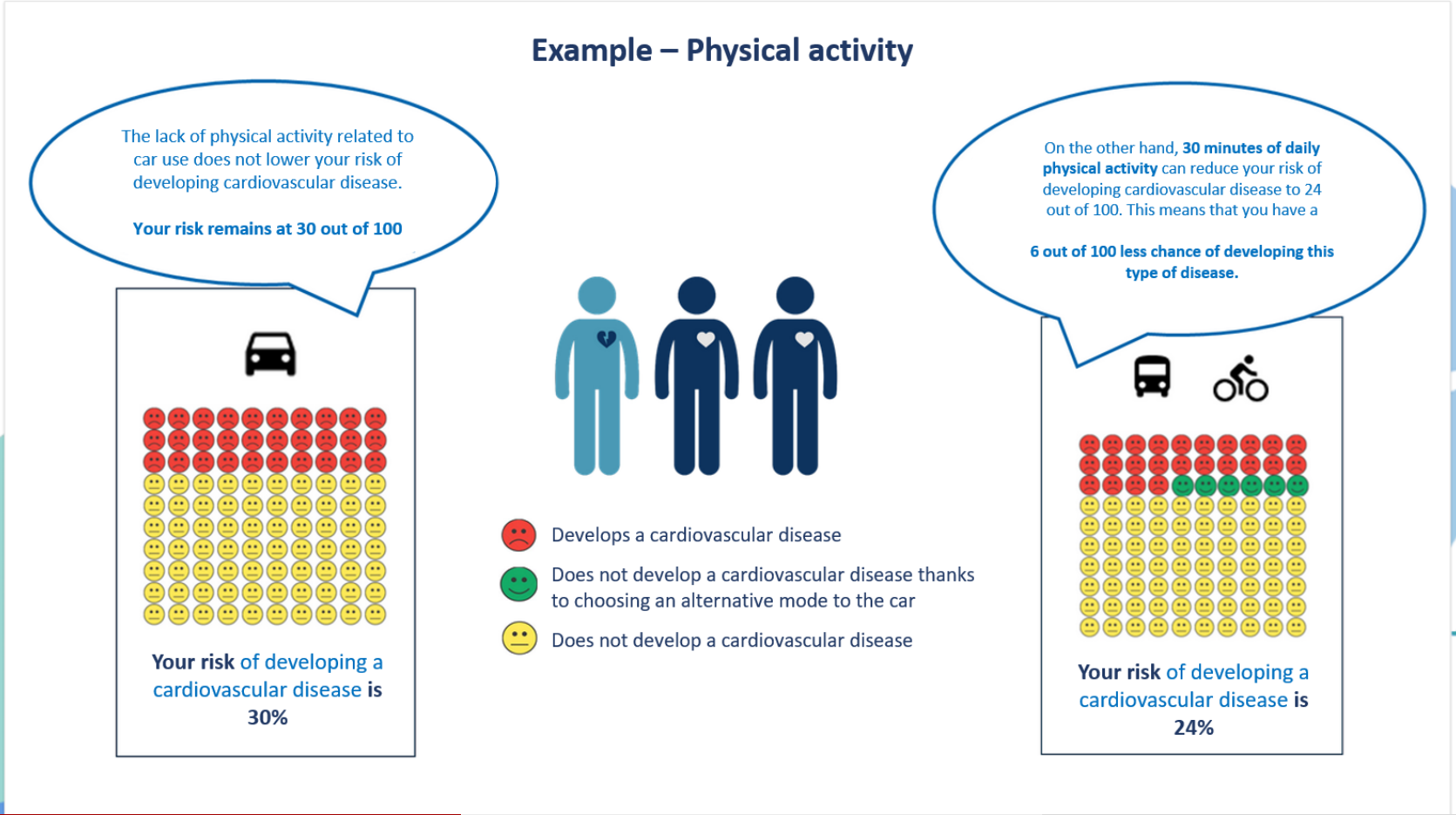
Imaginez que vous vous déplaciez de GRENOBLE (domicile) à GRENOBLE (travail/étude)

Mode de transport				
Temps de trajet	13 min	13 min	25 min	13 min
Coût par trajet	0,5€	1,5€	0€	0€
Quel est votre choix ?	○	○	○	○

Originality of the design

Introduction of **health related attributes** for the 7 other choices

1. Impact of physical activity (walking or cycling instead of driving) on its own health (**individual health motivation**).



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Introduction of **health related attributes** for the 7 other choices

2. Impact of the mode of transport on public health (**public health motivation**) with varying % of the population adopting active and less polluting transport modes

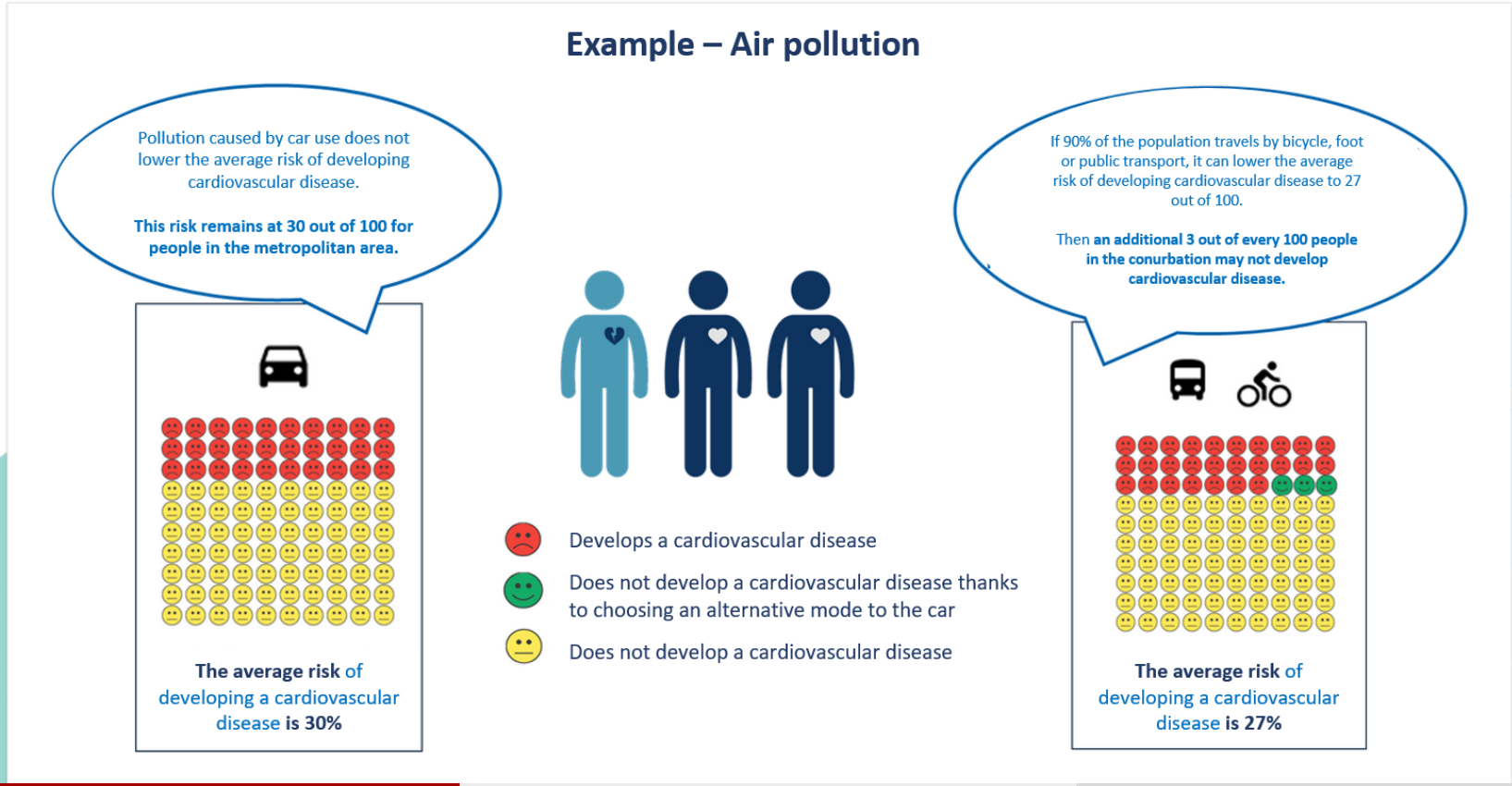

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Table 1: Health attributes and levels

Attributes	Mode	Definition	Levels	
			<3km	>3km
Pollution (Public health)	**Car**	Average risk of developing a cardiovascular disease for a person in the Grenoble urban area considering that [50/75/90]% of the population adopt this mode of transport	30%	
	Public Transport		[27/ **28**/ 29]%	
	Bicycle		[25/ **26**/ 27]%	
	Walk		[25/ **26**/ 27]%	
Physical activity (Individual health)	**Car**	Individual risk of developing a cardiovascular disease	30%	
	Public Transport		[24/ **26**/ 28]%	
	Bicycle		[24/ **26**/ 28]%	[15/ **20**/ 25]%
	Walk		[20/ **24**/ 27]%	

Notes: In the level column, figures in bold refer to the "status quo" levels.

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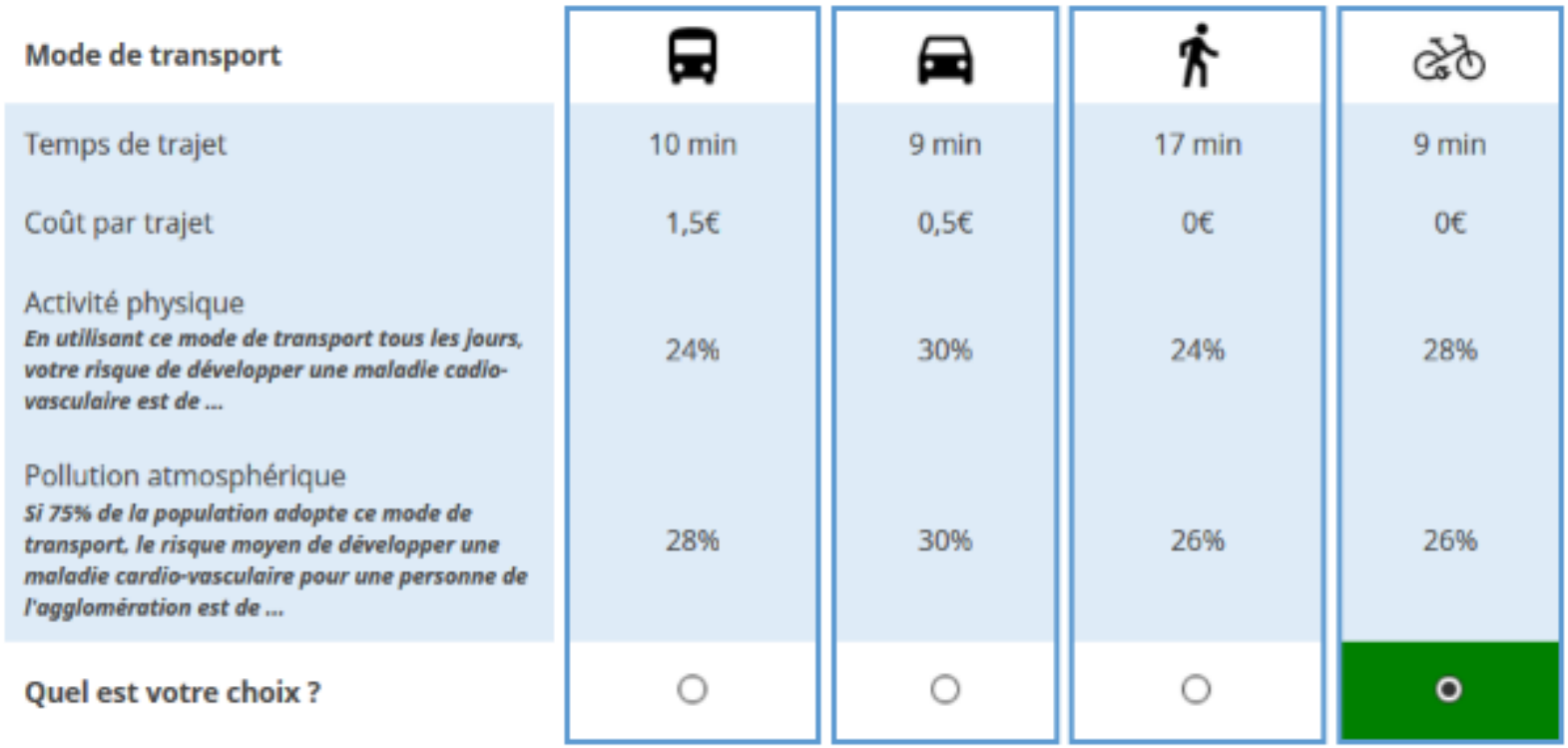

Mode de transport				
Temps de trajet	10 min	9 min	17 min	9 min
Coût par trajet	1,5€	0,5€	0€	0€
Activité physique *En utilisant ce mode de transport tous les jours, votre risque de développer une maladie cadio-vasculaire est de ...*	24%	30%	24%	28%
Pollution atmosphérique *Si 75% de la population adopte ce mode de transport, le risque moyen de développer une maladie cardio-vasculaire pour une personne de l'agglomération est de ...*	28%	30%	26%	26%
Quel est votre choix ?	○	○	○	◉

The model framework

- Use of the standard **Discrete Choice Modeling** formulation (McFadden, 1974)
- We model the utility U_j associated with each transport mode j.

$$j \in \mathbf{C} = \{1, 2, 3, 4\} = \{\text{car, public transport PT, bicycle, walking}\}$$

The utility function is $\forall j \in \{1, 2, 3, 4\}$

$$\begin{aligned} U_j = & ASC_j + \beta_T j \times T_j + \beta_C \times C_j + \beta_{PHYS} \times PHYS_j \\ & + \beta_{POLL} \times POLL_j + \beta_A \times A_j + \beta_{POLL_A} \times A_j \times POLL_j \\ & + \gamma_{AGE} \times AGE + \gamma_{GENDER} \times GENDER + \gamma_{STATUS_j} \times STATUS \end{aligned} \tag{1}$$

Outline

Descriptive statistics

Table 2: Descriptive statistics

Label	Variable definition	Distance of reference trip					
		All distances		*Below 3 km*		*Above 3km*	
		Mean	S.D.	Mean	S.D.	Mean	S.D.
Individual variables		$(n = 1,003)$		$(n = 211)$		$(n = 792)$	
Male	Gender (1 if male)	48.06		44.55		48.99	
Age	Age (in years)	51.72	12.70	51.36	13.65	51.82	12.44
Commuting trip	% of reference trips which are commute to work						
		53.94		38.86		57.58	
		23.93		16.11		26.01	
		18.94		28.44		16.41	
		3.49		16.59		-	

Estimation results (1)

Table 3: Estimation results

Variable	Below 3km No Health Attributes	Below 3km With Health Attributes	Above 3km No Health Attributes	Above 3km With Health Attributes
$ASC_{Bicycle}$	-3.11 (2.09)	-5.03 (1.02)***	-0.03 (0.90)	1.02 (0.58)*
ASC_{PT}	-4.28 (2.14)**	-6.24 (1)***	-0.134 (0.90)	1.14 (0.55)**
ASC_{Walk}	-2.16 (2.09)	-3.87 (1.02)***		
ASC_{Car}				
Cost	-0.97 (0.28)***	-0.35 (0.16)**	-0.66 (0.10)***	-0.48 (0.056)***
$Time_{Bicycle}$	-0.06 (0.05)	-0.02 (0.03)	-0.08 (0.01)***	-0.07 (0.003)***
$Time_{PublicTransport}$	-0.011 (0.02)	0.01 (0.01)	-0.06 (0.01)***	-0.07 (0.004)***
$Time_{Car}$	-0.01 (0.06)	0.02 (0.04)	-0.04 (0.01)***	-0.05 (0.01)***
$Time_{Walk}$	-0.14 (0.02)***	-0.11 (0.01)***		
$CardioRisk_{Phys}$		-0.03 (0.02)		-0.04 (0.01)***
$CardioRisk_{Poll}$		-0.21 (0.07)***		-0.05 (0.04)
75% of pop		-2.2 (1.82)		1.61 (0.98)
90% of pop		-3 (2.04)		2.06 (0.98)***
$CardioRisk_{Poll}$ * 75% of pop		0.13 (0.07)*		-0.05 (0.04)
$CardioRisk_{Poll}$ * 90% of pop		0.13 (0.08)*		-0.07 (0.04)***
Male	0.34 (0.29)	0.37 (0.18)**	0.17 (0.12)	0.08 (0.07)
Age	0.14 (0.08)*	0.16 (0.04)***	0.01 (0.03)	-0.04 (0.02)***
Age^2	-0.002 (0.01)**	-0.002 (0.0003)***	-0.0002 (0.0003)	0.0003 (0.0002)
Distance (=1 if distance<3km)				
$STATUS_{Car}$				
$STATUS_{PT}$	1.45 (0.46)***	1.3 (0.26)***	1.6 (0.18)***	1.93 (0.11)***
$STATUS_{Bicycle}$	2.18 (0.49)***	3.65 (0.52)***	2.33 (0.26)***	2.74 (0.18)***
$STATUS_{Walk}$	3.09 (1.05)***	3.6 (0.73)***		
$L(\hat{\beta})$	-444.37	-1563.22	-1443.05	-4858.39
$\bar{\rho}^2$	0.216	0.227	0.164	0.2
Observations	*422*	*1,477*	*1,584*	*5,544*

Notes: Standard errors in parentheses. *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Estimation results (2)

1. *Distances below 3km:*

- Information about the **positive impact of reduced air pollution** on public health **encourages** the use of car alternatives when smaller share of the population does it.

2. *Distances above 3km:*

- Information about **the positive impact of physical activity** on individual health **encourages** the use of car alternatives.
- Information about the **positive impact of reduced air pollution** on public health **discourages** the use of car alternatives when larger share of the population does it (Free-riding?).

Economic outputs

Willingness To Pay (WTP): the variation of the cost attribute (β_C) that an individual would accept to maintain the same level of utility when there is a variation in another attribute (e.g. Time attribute in the case of calculating the value of time VoT).

Economic outputs

Table 4: Value of time (VOT) and Willingness to pay (WTP) for the attributes of the DCE

	Below 3km No Health Attributes	Below 3km With Health Attributes	Above 3km No Health Attributes	Above 3km With Health Attributes
VOT (€/hour)				
Car	-	-	3.8	5.96 (+57%)
Public Transport	-	-	5.8	8.54 (+47%)
Bicycle	-	-	6.82	9.08 (+33%)
Walk	8.85	18.8		
WTP_{PHYS} (€/10% lower risk)				
All modes		-		0.75
WTP_{POLL} (€/10% lower risk)				
All modes (50% of pop adopting the behavior)		6.04		-
All modes (75% of pop adopting the behavior)		-		-
All modes (90% of pop adopting the behavior)		-		2.6

Note: "-" = the economic measure cannot be calculated because of the presence of one (or more) non significant coefficient(s)

(Hensher et al., 2005).

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Conclusion

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- Information about the impact of mode choice on public or individual health influences the choice of less polluting and more active modes
- Interesting results for policies implemented by environmental, urban and transport policy-makers
- Possible extension: Focus on the relation of these results with other psychological factors (eg. attitudes and norms) through a more complex model (eg. Hybrid choice models)

Thank you for your attention

Rim REJEB: rim.rejeb@univ-grenoble-alpes.fr