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# A commuting generation model requiring only aggregated data

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**Prototypical Policy Impacts on Multifunctional Activities in rural municipalities**

A collaborative project under the  
EU Seventh Framework Programme



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# Motivation

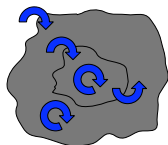
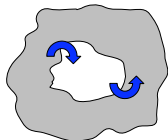
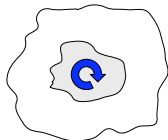
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- Studies on traffic and planning infrastructures  
(*Ortùzar and Willumsen, 2011*)
  - Diffusion of epidemics  
(*Balcan et al., 2009*)
  - Large demographic simulations  
(*Huet and Deffuant, 2011*)

# Problem description

**INPUT:** Total out and in-commuters (dark grey line and column)

**OUTPUT:** Origin-destination region table (light grey table)

Residence \ Work	Work								
	$M_1$	...	$M_j$	...	$M_n$	$M_{n+1}$	...	$M_m$	Total
$M_1$	0	...	$R_{1j}$	...	$R_{1n}$	$R_{1n+1}$	...	$R_{1m}$	$O_1$
...	...	...	...	...	...	...	...	...	...
$M_i$	$R_{i1}$	...	$R_{ij}$	...	$R_{in}$	$R_{in+1}$	...	$R_{im}$	$O_i$
...	...	...	...	...	...	...	...	...	...
$M_n$	$R_{n1}$	...	$R_{nj}$	...	0	$R_{nn+1}$	...	$R_{nm}$	$O_n$
Outside	X	...	X	...	X				
Total	$I_1$	...	$I_j$	...	$I_n$	$I_{n+1}$	...	$I_m$	



# Summary

- 
- 1 Commuting generation model
  - 2 Exponential law versus power law
  - 3  $\beta$  estimation for universal calibration

# Commuting generation model

## Input of the model

- $D = (d_{ij})_{\substack{1 \leq i \leq n \\ 1 \leq j \leq m}}$  the Euclidean distance matrix between the municipalities both in the same region and in the outside.
- $(I_j)_{1 \leq j \leq m}$  the number of in-commuters of the municipality  $j$  of the region and outside of it.
- $(O_i)_{1 \leq i \leq n}$  the number of out-commuters of the municipality  $i$  of the region only.

# Commuting generation model

## Algorithm description

For each remaining commuter who has not already found its place of work (while  $O_i > 0 \forall 1 \leq i \leq n$ ), do:

- Select a living municipality  $i$  at random among the municipalities where at least one out-commuter remains (such as  $O_i \neq 0$ )
- Select the working destination  $j$  randomly following the probability distribution given by:

$$P_{i \rightarrow j} = \frac{I_j f(d_{ij}, \beta)}{\sum_{k=1}^m I_k f(d_{ik}, \beta)}, \quad \beta > 0.$$

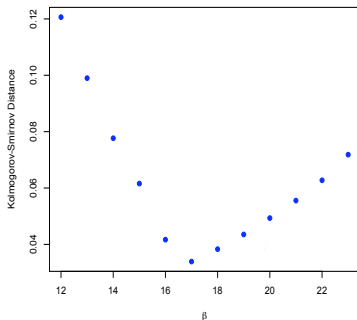
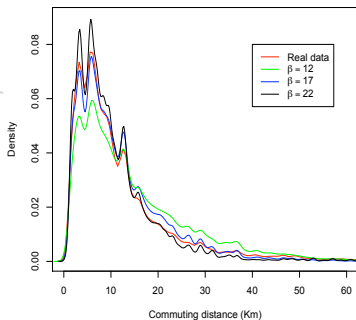
- Update the number of in-commuters of  $j$ :  $I_j = I_j - 1$
- Update the number of out-commuters of  $i$ :  $O_i = O_i - 1$

$$f(d_{ij}, \beta) = d_{ij}^{-\beta} \text{ or } e^{-\beta \frac{d_{ij}}{\bar{d}}} \quad 1 \leq i \leq n \text{ and } 1 \leq j \leq m$$

$\bar{d}$  is the average distance between the municipalities of the region


# Commuting generation model

## Calibration





# Summary

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  - 3  $\beta$  estimation for universal calibration

# Exponential law versus power law

## Comparison indicators

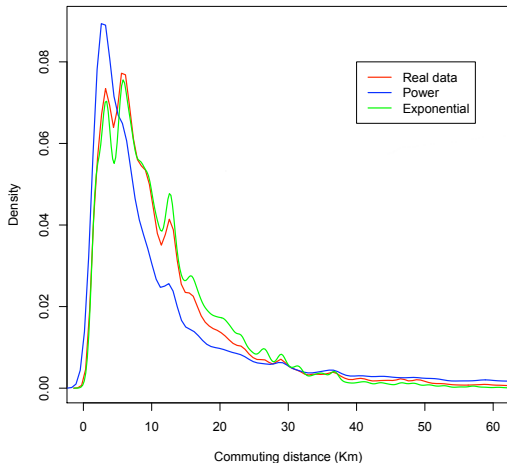
- 1 The commuting distance distribution

- 2 
$$CPC_{n \times m}(S, R) = \frac{2NCC_{n \times m}(S, R)}{NC_{n \times m}(R) + NC_{n \times m}(S)}$$

- $NCC_{n \times m}(S, R) = \sum_{i=1}^n \sum_{j=1}^m \left( S_{ij} \mathbb{1}_{(R_{ij} - S_{ij}) \geq 0} + R_{ij} \mathbb{1}_{(R_{ij} - S_{ij}) < 0} \right)$
- $NC_{n \times m}(R) = \sum_{i=1}^n \sum_{j=1}^m R_{ij}$

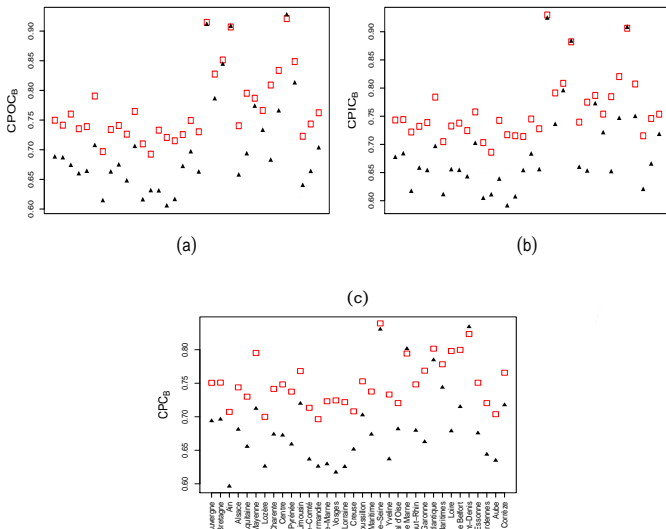
# Exponential law versus power law

## Commuting distance distribution



# Exponential law versus power law

## Common part of commuters

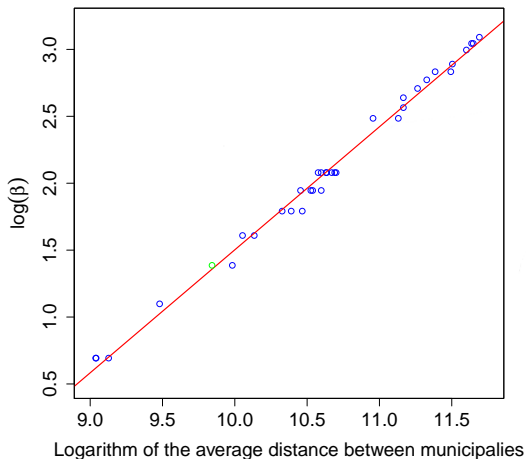


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# $\beta$ estimation for universal calibration

$$\beta = e^{-7.69 \bar{d}} \bar{d}^{0.92}$$



# $\beta$ estimation for universal calibration

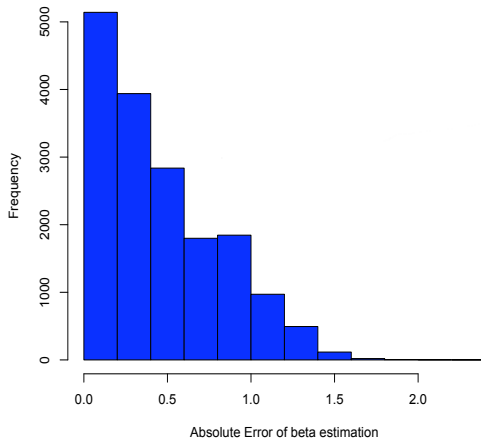
## Cross validation

- 
- We draw at random  $\frac{2}{3}$  of the 34 observations to build the model.
  - We predict the remaining third with this model.
  - We compute the absolute error between prevision and observation.

⇒ The process is repeated 1,000 times.

# $\beta$ estimation for universal calibration

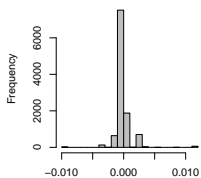
## Cross validation



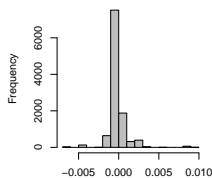


# $\beta$ estimation for universal calibration

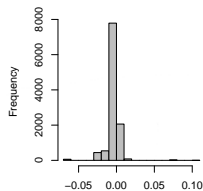
## Cross validation



(a)



(b)



(c)

# Conclusion and perspective



## Conclusion

- Generation model managing with the lack of data
- Universally calibrated
- Tested on 35 case studies

## Perspective

- Tested on more case studies
- Include the zero distance (Commuters and non-commuters)