Commuting, Air Quality and Welfare

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Motivation

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- Ambient air pollution
  - Causes acute reactions, chronic diseases, and early deaths
    - World: 7 million a year (10% of total)
    - Europe: 350,000 (7%)
  - Lowers housing prices (measure of **amenities**) across cities (Chay and Greenstone, 2005; Bayer et al., 2009; Champalaune, 2025) and within cities (e.g., Amini et al., 2022)
  - Deterioration of economic outcomes: lower labour supply and **productivity** (Graff Zivin and Neidell, 2012; Chang et al., 2016, 2019)

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- Within cities, air pollution largely depends on **road traffic** (Tessum et al., 2022)
  - Hence congestion pricing or low-emission zones (LEZ)
- Can **public transport infrastructure** be a useful tool?

This paper

Research questions

1. Does public transport (PT) infrastructure affect air quality?
2. How does accounting for this channel affect estimates of the welfare gains from PT infrastructure?

Methodology

- Focus on Paris metropolitan area
- Neighborhood-level information from census and administrative datasets
- **Reduced-form** evidence: effects of PT on air quality and other outcomes
- **Structural** evidence: welfare gains based on a new Quantitative Urban Model

Contributions to the literature

1. **Economic effects of public transport infrastructure**
    - Reduced-form evidence on
        - employment, housing prices (e.g., Mayer and Trevien, 2017)
        - air quality (mostly developing countries) (Chen and Whalley, 2012; Li et al., 2019; Gendron-Carrier et al., 2022; Xie et al., 2024)

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2. **Quantitative Urban Model** (QUM) *à la* Ahlfeldt et al. (2015)
   - Transport infrastructure evaluation (e.g., Heblich et al., 2020; Tsivanidis, 2025)

   → *This paper:*
     - **Endogenous air pollution** at neighborhood level affecting amenities/productivity
     - Heterogeneity across **skill levels** and **transport modes**
     - Role of **averted road traffic pollution**

Focus on fine particulate matter ($PM_{2.5}$)

What is $PM_{2.5}$?

- Very small particles
  - Enter easily and stay in the body
- Directly emitted, or generated from chemical reactions between other pollutants
  - Main primary emitters in Paris: **road transport (35%)**, residential heating

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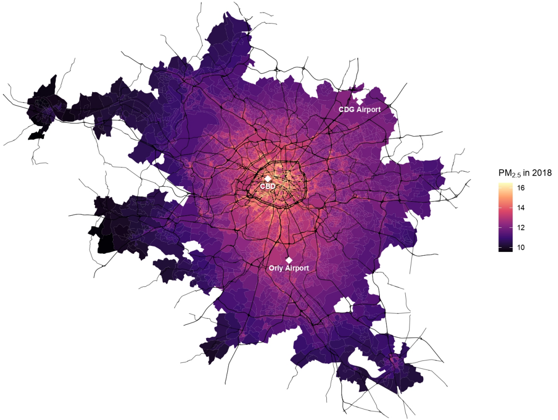
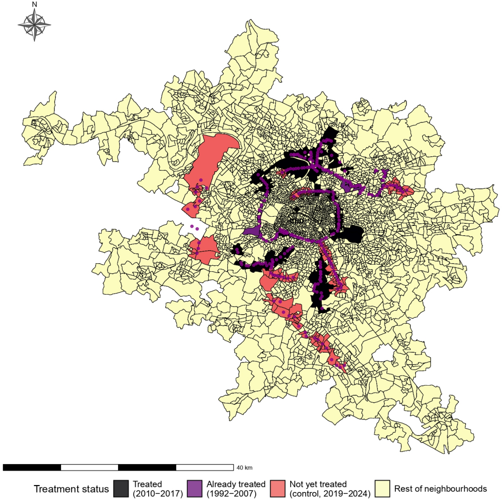
$PM_{2.5}$ in 2018



Reduced-form evidence

1. Tramway line openings in the 2010s



- Data for 2008 (pre-treatment) and 2018 (post-treatment)
- Compare **treated** neighborhoods (2010-2017) to **not-yet-treated** neighborhoods (2020-2024)

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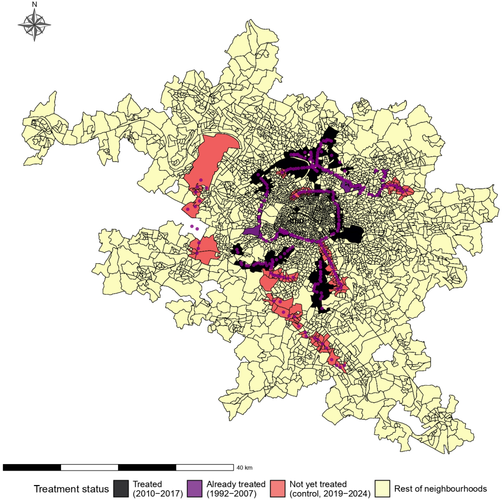

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- Compare **treated** neighborhoods (2010-2017) to **not-yet-treated** neighborhoods (2020-2024)

↓ 3.5% $PM_{2.5}$ concentration Table

↑ 6% housing prices Table

↑ 5ppt (12%) share of PT users Table

Structural evidence

Quantitative Urban Model: objectives and ingredients

1. Rationalize within-city spatial equilibrium with
   - commuting flows by skill$\times$mode
   - local air pollution

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   c) productivity
   d) housing demand

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3. Counterfactual exercises
   i) *Grand Paris Express*
   ii) banning cars

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Required data at the neighborhood level

a) residence & workplace empl. by skill×mode
b) air pollution
c) rent
d) bilateral commuting time

Model Environment

QUM: Workers

- A homogeneous mass of type-specific workers within an open city of N locations
- An individual o of type g derives a utility from living in n and working in i, using mode m:

$$U_{nim,g}(o) = \frac{B_{n,g}\ w_{i,g}}{d_{nim,g}\ P_n^{\beta_g}\ Q_n^{1-\beta_g}}\ z_{nim,g}(o)$$

  - $B_{n,g}$: type-specific amenities enjoyed at residence n
  - $w_{i,g}$: type-specific wage in workplace i
  - $d_{nim,g}$: commuting costs from residence n to workplace i, using transport mode m
  - P_n: the price of final consumption good in n (numéraire: $P_n = 1$)
  - Q_n: rent in n, and $(1-\beta_g)$ is the share of income devoted to housing
  - $z_{nim,g}(o)$: type-specific idiosyncratic shock following Fréchet distribution, $F(z_{nim,g}(o)) = e^{-T_{nm,g}\ E_{im,g}\ z_{nim,g}^{-\epsilon_g}} \quad z_{nim,g} > 0,\ \epsilon_g > 1$

QUM: Workers

Using standard properties of Fréchet distribution (McFadden, 1974)

- Probability that a worker chooses the location pair (n, i), using mode m:

$$\lambda_{nim,g} = \frac{L_{nim,g}}{L_{N,g}} = \frac{T_{nm,g} E_{im,g} (B_{n,g} w_{i,g})^{\epsilon_g} (d_{nim,g} Q_n^{1-\beta_g})^{-\epsilon_g}}{\sum_{k \in N} \sum_{l \in N} \sum_{m'} T_{km',g} E_{lm',g} (B_{k,g} w_{l,g})^{\epsilon_g} (d_{klm',g} Q_k^{1-\beta_g})^{-\epsilon_g}}$$

  - k, l: all the other residences and workplaces in the city
  - $m' \in \{car, public\}$: all transport modes

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  - k, l: all the other residences and workplaces in the city
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- Expected utility: $\mathbb{E}[U_{nim,g}] = \overline{U}_g = \delta_g \left[\sum_{k \in N} \sum_{l \in N} \sum_{m'} \Phi_{klm',g} \right]^{1/\epsilon_g}$

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- Share of type-specific workers choosing the Paris region: $\frac{L_{N,g}}{L_{M,g}} = \left(\frac{\overline{U}_g}{\mathbb{U}_g} \right)^{\phi}$

QUM: Firms

Firms produce a final good using a Cobb-Douglas technology under CRS:

$$Y_i = A_i \left(\frac{L_i}{\alpha}\right)^{\alpha} \left(\frac{H_i^L}{1-\alpha}\right)^{1-\alpha},$$

- A_i: productivity at workplace i
- L_i: workforce used in production follows a CES function between both (low- and high-skilled) types of workers
  - $L_i = (\sum_g a_{i,g} L_{i,g}^{\rho})^{1/\rho}$
  - $a_{i,g}$ represents the skill intensity of type g in location i and ρ the substitution parameter
- H_i^L: commercial floorspace used for production

QUM: Housing market

- Housing is owned by landlords

- Following Combes et al. (2021), housing (H_i) is supplied by developers with a Cobb-Douglas technology function of land (K_i) and capital (M_i):

$$H_i = k_i \, Q_i^{\frac{(1-\mu)}{\mu}}$$

  - $k_i = (1-\mu)^{\frac{(1-\mu)}{\mu}} K_i$: land availability in location i
  - Q_i: rent in location i
  - $\frac{1-\mu}{\mu}$: housing supply elasticity

- No distortion of housing allocation between residents and firms

QUM: Agglomeration forces - standard ingredients

Allow productivity to depend on

- exogenous production fundamentals
- endogenous production externalities

$$A_i = a_i \quad \left(\frac{L_i}{K_i}\right)^{\eta^L}$$

Allow amenities to depend on

- exogenous residential fundamentals
- endogenous residential externalities

$$B_{n,g} = b_{n,g} \quad \left(\frac{R_n}{K_n}\right)^{\eta^R}$$

QUM: Agglomeration forces - new ingredients

- Choosing the car **generates air pollution along the route** used to commute from residence to workplace, such that, in neighborhood j:

$$\Xi_j = \psi_j \, e^{\theta^F \, F_j}$$

  - θ^F estimated using neighborhood-level census data and 50m×50m $PM_{2.5}$ data

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- **Decrease in neighborhood amenity and productivity** when it is crossed by cars

$$B_{n,g} = b_{n,g} \left(\frac{R_n}{K_n}\right)^{\eta^R} e^{\,\zeta_g^R \; \Xi_n}$$

$$A_i = a_i \left(\frac{L_i}{K_i}\right)^{\eta^L} e^{\,\zeta^L \; \Xi_i}$$

  - ζ_g^R estimated, ζ^L calibrated (Champalaune, 2025)

Model Quantification

QUM: steps for model quantification

1. structural parameters calibration and estimation Slides

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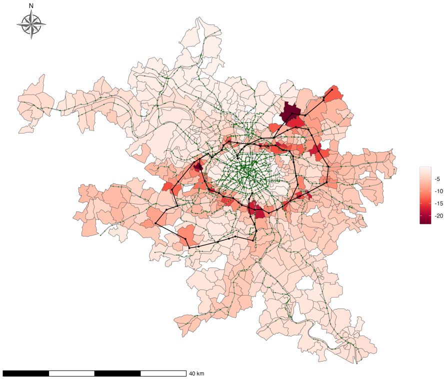
5. recover (type-specific) **amenities** Slides, using
   - expected utility in a open city settings
6. recover **housing** Slides, using
   - housing market clearing condition
   - commercial and residential housing demand

Counterfactual Exercises

Grand Paris Express (planned 2030+)



- **Largest PT infrastructure project** since the suburban rail network (RER) of the 1970s
- **Doubling the length:** 200 km (current metro: 226 km), 68 new stations
- Much faster commercial speed

Grand Paris Express: Welfare gains

	Counterfactual scenario		
	(1)	(2)	(3)
Welfare Δ%			
High-skilled	2.15		
Low-skilled	1.07		
λ_{Public} Δ%			
High-skilled	3.5		
Low-skilled	3.2		
(Mean) pollution Δ%			
Whole area	−0.46		
Parameters			
Migration elasticity	0.0		
η^L	0.0		
η^R	0.0		
ζ_L^R	−0.015		
ζ_H^R	−0.032		
ζ^L	−0.03		

Full results

Grand Paris Express: Welfare gains

	Counterfactual scenario		
	(1)	(2)	(3)
Welfare Δ%			
High-skilled	2.15	1.32	
Low-skilled	1.07	0.69	
λ_{Public} Δ%			
High-skilled	3.5	8.3	
Low-skilled	3.2	6.1	
(Mean) pollution Δ%			
Whole area	−0.46	−0.38	
Parameters			
Migration elasticity	0.0	3.0	
η^L	0.0	0.07	
η^R	0.0	0.1	
ζ_L^R	−0.015	−0.015	
ζ_H^R	−0.032	−0.032	
ζ^L	−0.03	−0.03	

Full results

Grand Paris Express: Welfare gains

	Counterfactual scenario		
	(1)	(2)	(3)
Welfare Δ%			
High-skilled	2.15	1.32	1.04
Low-skilled	1.07	0.69	0.48
λ_{Public} Δ%			
High-skilled	3.5	8.3	7.4
Low-skilled	3.2	6.1	5.4
(Mean) pollution Δ%			
Whole area	−0.46	−0.38	−0.41
Parameters			
Migration elasticity	0.0	3.0	3.0
η^L	0.0	0.07	0.07
η^R	0.0	0.1	0.1
ζ_L^R	−0.015	−0.015	0.0
ζ_H^R	−0.032	−0.032	0.0
ζ^L	−0.03	−0.03	0.0

Full results

Banning cars: Welfare gains

	Counterfactual scenario		
	(1)	(2)	(3)
Welfare $\Delta\%$			
High-skilled	0.87		
Low-skilled	0.6		
λ_{Public} $\Delta\%$			
High-skilled	8.4		
Low-skilled	4.7		
(Mean) pollution $\Delta\%$			
Whole area	-1.25		
Paris municipality	-5.69		
Parameters			
Migration elasticity	0.0		
η^L	0.0		
η^R	0.0		
ζ_L^R	-0.015		
ζ_H^R	-0.032		
ζ^L	-0.03		

Full results

Banning cars: Welfare gains

	Counterfactual scenario		
	(1)	(2)	(3)
Welfare Δ%			
High-skilled	0.87	0.65	
Low-skilled	0.6	0.44	
λ_{Public} Δ%			
High-skilled	8.4	11.3	
Low-skilled	4.7	6.9	
(Mean) pollution Δ%			
Whole area	−1.25	−1.29	
Paris municipality	−5.69	−5.69	
Parameters			
Migration elasticity	0.0	3.0	
η^L	0.0	0.07	
η^R	0.0	0.1	
ζ_L^R	−0.015	−0.015	
ζ_H^R	−0.032	−0.032	
ζ^L	−0.03	−0.03	

Full results

Banning cars: Welfare gains

	Counterfactual scenario		
	(1)	(2)	(3)
Welfare $\Delta\%$			
High-skilled	0.87	0.65	-0.55
Low-skilled	0.6	0.44	-0.32
λ_{Public} $\Delta\%$			
High-skilled	8.4	11.3	5.2
Low-skilled	4.7	6.9	2.7
(Mean) pollution $\Delta\%$			
Whole area	-1.25	-1.29	-1.14
Paris municipality	-5.69	-5.69	-5.69
Parameters			
Migration elasticity	0.0	3.0	3.0
η^L	0.0	0.07	0.07
η^R	0.0	0.1	0.1
ζ_L^R	-0.015	-0.015	0.0
ζ_H^R	-0.032	-0.032	0.0
ζ^L	-0.03	-0.03	0.0

Full results

Takeaways

1. **Public transport** infrastructure **decreases air pollution**
   - Even in a context with high initial public transport take-up
   - Omitting this leads to an **underestimation of welfare gains**

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   - Even in a context with high initial public transport take-up
   - Omitting this leads to an **underestimation of welfare gains**
2. Decrease in air pollution **amplifies** baseline increases in **amenity and productivity** from public transport
   - Further increases housing prices
   - Further fuels **sorting** of higher-skilled households into neighborhoods with new infrastructure and lower air pollution
   - Public transport as a vector of disparities in exposure to air pollution

Thank you!

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Reduced-form effects of tramway openings: Air pollution

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
				$\Delta_{2018\text{-}2008}$ $PM_{2.5}$				
Treated	-0.75***	-0.73***	-0.37**	-0.39**	-0.76***	-0.75***	-0.60***	-0.61***
	(0.21)	(0.21)	(0.19)	(0.17)	(0.14)	(0.14)	(0.19)	(0.19)
(log) workers in 2008		-0.35**		-0.24		-0.15		-0.12
		(0.16)		(0.15)		(0.16)		(0.15)
(log) distance to CBD			0.87**	0.80**			0.51	0.48
			(0.36)	(0.34)			(0.33)	(0.32)
2008 mean $PM_{2.5}$	16.94	16.94	16.94	16.94	16.94	16.94	16.94	16.94
Mean outcome	-3.76	-3.76	-3.76	-3.76	-3.76	-3.76	-3.76	-3.76
R^2	0.105	0.120	0.154	0.161	0.485	0.487	0.493	0.495
Observations	328	328	328	328	328	328	328	328
Fare zone FE					Yes	Yes	Yes	Yes

Standard errors clustered at the tram stop level in parentheses. Signif. codes: ***: 0.01, **: 0.05, *: 0.1.

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Reduced-form effects of tramway openings: Housing prices

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Delta_{2018\text{-}2008}$ log housing price							
Treated	0.08***	0.08***	0.08***	0.07***	0.05**	0.05**	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
(log) workers in 2008		0.05		0.05		0.02		0.04
		(0.04)		(0.04)		(0.04)		(0.04)
(log) housing price in 2008			0.02	0.005			-0.07	-0.08*
			(0.04)	(0.03)			(0.05)	(0.04)
2008 mean housing price	8.12	8.12	8.12	8.12	8.12	8.12	8.12	8.12
Mean outcome	0.033	0.033	0.033	0.033	0.033	0.033	0.033	0.033
R^2	0.048	0.055	0.049	0.055	0.124	0.125	0.138	0.144
Observations	328	328	328	328	328	328	328	328
Fare zone FE					Yes	Yes	Yes	Yes

Standard errors clustered at the tram stop level in parentheses. Signif. codes: ***: 0.01, **: 0.05, *: 0.1.
Log housing price is a neighborhood-year fixed effect from a transaction-level regression of log housing price per square metre on floor area, lot size and a fixed effect for quarter of transaction.

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Reduced-form effects of tramway openings: PT commuters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Delta_{2018\text{-}2008}$ Share resident PT commuters							
Treated	0.01	0.01	0.06**	0.06***	0.01	0.01	0.05**	0.05**
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
(log) workers in 2008		0.03		0.06*		0.03		0.05*
		(0.04)		(0.03)		(0.04)		(0.03)
2008 mean share PT	0.403	0.403	0.403	0.403	0.403	0.403	0.403	0.403
Control 2008 share PT			Yes	Yes			Yes	Yes
R^2	0.001	0.005	0.197	0.213	0.007	0.012	0.210	0.222
Observations	328	328	328	328	328	328	328	328
Fare zone FE					Yes	Yes	Yes	Yes

Standard errors clustered at the tram stop level in parentheses. Signif. codes: ***: 0.01, **: 0.05, *: 0.1.

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Reduced-form effects of tramway openings: Car commuters

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	$\Delta_{2018\text{-}2008}$ Share resident car commuters							
Treated	-0.004	-0.002	-0.03	-0.03	0.01	0.01	-0.02	-0.02
	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)	(0.02)
(log) workers in 2008		-0.04*		-0.02		-0.04*		-0.003
		(0.02)		(0.02)		(0.02)		(0.02)
2008 mean share car	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286
Control 2008 share car			Yes	Yes			Yes	Yes
R^2	0.001	0.010	0.169	0.172	0.032	0.040	0.219	0.219
Observations	328	328	328	328	328	328	328	328
Fare zone FE					Yes	Yes	Yes	Yes

Standard errors clustered at the tram stop level in parentheses. Signif. codes: ***: 0.01, **: 0.05, *: 0.1.

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Step 1: model parameters

Parameter	Description	Method	Value
		Calibrated	
ζ^L	$PM_{2.5}$ productivity loss	Champalaune (2025)	-0.03
η^R	Residential agglo forces	Ahlfeldt et al. (2015); Heblich et al. (2020)	0.10
η^L	Production agglo forces	Ahlfeldt et al. (2015); Heblich et al. (2020)	0.07
α	Labor share	Cette et al. (2019); Gutiérrez and Piton (2020)	0.75
$1-\beta_H$	Housing share, high-skilled	Combes et al. (2019)	0.3
$1-\beta_L$	Housing share, low-skilled	Combes et al. (2019)	0.35
$1-\mu$	Machinery capital	Combes et al. (2021)	0.54
ρ	Elasticity of skill substitution	Card (2009)	0.3
ϕ	Elasticity of migration	Monte et al. (2018); Takeda and Yamagishi (2024)	3
		Estimated	
$\nu_{m,g}$	Commuting time elasticity	OLS, gravity equation	Table
ϵ_H	Fréchet parameter, high-skilled	Min. variance	7.04
ϵ_L	Fréchet parameter, low-skilled	Min. variance	10.38
ζ^R_H	$PM_{2.5}$ disamenity effect, high-skilled	OLS, FD	-0.032
ζ^R_L	$PM_{2.5}$ disamenity effect, low-skilled	OLS, FD	-0.015
θ^F	$PM_{2.5}$ elasticity to commuting	OLS, FD	0.0276

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Step 2: type-specific wages $(w_{i,g})$

Using

- $\omega_{im,g} = E_{im,g} w_{i,g}^{\epsilon_g}$, and an estimated $\upsilon_{m,g} = -\kappa_m \epsilon_g$
- a normalisation of the scale parameter $E_{i\ PT,\ g}$ for public transport, and an estimation of ϵ_g
- prob. that a worker commutes to workplace i using mode m conditionally on living in n
- commuting market clearing conditions

$$L_{im,g} = \sum_{n \in N} \frac{\left(\omega_{im,g} / e^{\upsilon_{mg}\ \tau_{nim}}\right)}{\sum_{l \in N} \left(\omega_{lm,g} / e^{\upsilon_{mg}\ \tau_{nlm}}\right)} R_{nm,g}$$

$\rightarrow$ retrieve type specific wages vector $(w_{i,g})$

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Step 3: skill intensity ($a_{i,L}$)

Using

- estimated $w_{i,g}$
- observed vectors
- FOC of firm profit maximization with respect to the labor supply

$$\frac{1 - a_{i,L}}{a_{i,L}} = \frac{w_{i,H}}{w_{i,L}} \left(\frac{L_{i,L}}{L_{i,H}} \right)^{\rho - 1}$$

$\rightarrow$ retrieve skill intensity vector

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Step 4: productivity (A_i)

Using

- free entry condition
- FOCs of firm profit maximization
- aggregate wage cost: $W_i = \left(\sum_g a_{i,g}^{\frac{1}{1-\rho}} w_{i,g}^{\frac{\rho}{\rho-1}} \right)^{\frac{\rho-1}{\rho}}$

$$A_i = W_i^{\alpha} \; Q_i^{1-\alpha}$$

$\rightarrow$ retrieve productivity vector

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Step 5: type-specific amenities ($B_{n,g}$)

Using

- type-specific probability of residence $\lambda^R_{nm,g}$
- expected utility
- population mobility
- open city settings

$$\Omega_{nm,g} = \frac{\lambda^R_{nm,g} Q^{(1-\beta_g)\epsilon_g}}{\sum_{i \in N} \left(\omega_{im,g} / e^{\nu_{mg} \tau_{nim}} \right)}$$

$\rightarrow$ retrieve amenities vector

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Step 6: housing development (H_n)

Housing market clears,

$$H_n = \underbrace{\sum_{m'} \sum_{g} (1-\beta_g) \sum_{i \in N} \lambda^R_{nim|nm,g} \frac{w_{i,g}}{Q_n} R_{nm,g}}_{=H_n^R} + \underbrace{\left((1-\alpha)\frac{A_i}{Q_i}\right)^{1/\alpha} L_i}_{=H_n^L}$$

with,

- H_n^R the residential housing demand in location n
- H_n^L the total commercial housing demand in location n

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Gravity equation - empirical specification

Log-linearising $\lambda_{nim,g}$ leads to this gravity equation of commuting flows:

$$ln\ \lambda_{nim,g} = \zeta_{im,g} + \vartheta_{nm,g} - \underbrace{\epsilon_g \kappa_{m,g}}_{\nu_{m,g}}\ \tau_{nim} + \xi_{nim,g}$$

where

- $\lambda_{nim,g}$: type-specific commuting flows between residence n and workplace i with mode m
- τ_{nim}: commuting time between residence n and workplace i with mode m
- $\nu_{m,g}$: type-specific commuting time disutility by mode m
- $\zeta_{im,g} \equiv ln(E_{im,g}\ w_{i,g}^{\epsilon_g})$: type-specific workplace×mode FE
- $\vartheta_{nm,g} \equiv ln(T_{nm,g}\ B_{n,g}^{\epsilon_g}\ Q_n^{(\beta_g - 1)\epsilon_g})$: type-specific residence×mode FE
- $\xi_{nim,g} \equiv -ln\Big(\sum_{k \in N} \sum_{l \in N} \sum_{m'} \Phi_{klm',g}\Big)$: error term

Gravity equation - results

Table 1: Estimation of $\nu_{m,g}$

	HS car (1)	LS car (2)	HS public (3)	LS public (4)
Commuting time by car	-0.1042***	-0.1224***		
	(0.0006)	(0.0008)		
Commuting time by PT			-0.0529***	-0.0582***
			(0.0002)	(0.0003)
Origin	Yes	Yes	Yes	Yes
Destination	Yes	Yes	Yes	Yes
Observations	544,643	539,484	544,644	545,382

Notes: Signif. Codes: ***: 0.01, **: 0.05, *: 0.1. Heteroscedasticity-robust standard errors in parentheses.

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$PM_{2.5}$ elasticity through commuters

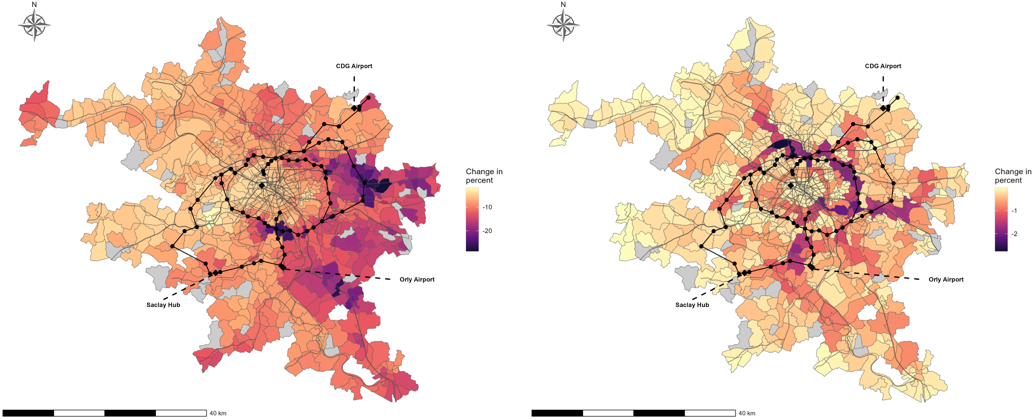
Log-linearising the relationship between local air pollution and car commuters through, and taking the first-difference:

$$ln\ \widehat{\Xi}_n = \psi_0 + \theta^F\ \Delta F_n + ln\ \widehat{\psi}_n$$

	$ln\ \widehat{\Xi}_n$
ΔF_n	0.0276***
	(0.0056)
Observations	672
R^2	0.0614

Notes: Heteroscedasticity-robust standard errors in parentheses. Signif. Codes: ***: 0.01, **: 0.05, *: 0.1

Grand Paris Express: Predicted changes in car usage and $PM_{2.5}$



Countefactual: *Grand Paris Express* - full results

	Counterfactual scenario					
	(1)	(2)	(3)	(4)	(5)	(6)
Welfare $\Delta\%$						
High-skilled	2.15	1.06	1.32	1.04	1.19	1.19
Low-skilled	1.07	0.67	0.69	0.48	0.6	0.59
λ_{Car} $\Delta\%$						
High-skilled	-9.6	-6.8	-7.7	-8.4	-8.0	-8.1
Low-skilled	-10.4	-8.6	-10.8	-11.2	-11.0	-11.0
λ_{Public} $\Delta\%$						
High-skilled	3.5	6.9	8.3	7.4	7.9	7.9
Low-skilled	3.2	5.4	6.1	5.4	5.8	5.8
(Mean) pollution $\Delta\%$						
Whole area	-0.46	-0.34	-0.38	-0.41	-0.39	-0.4
Paris municipality	-0.48	-0.32	-0.35	-0.39	-0.37	-0.35
Outside Paris municipality	-0.46	-0.35	-0.39	-0.41	-0.4	-0.4
(Mean) rent $\Delta\%$						
Whole area	0.18	1.27	1.86	1.51	1.77	1.62
Total population $\Delta\%$						
Whole	0.0	2.78	3.3	2.53	2.94	2.93
High-skilled	0.0	3.22	4.0	3.17	3.6	3.6
Low-skilled	0.0	2.03	2.09	1.45	1.8	1.77
Parameters						
Migration elasticity	0.0	3.0	3.0	3.0	3.0	3.0
η^L	0.0	0.0	0.07	0.07	0.07	0.07
η^R	0.0	0.0	0.1	0.1	0.1	0.1
ζ_L^R	-0.015	-0.015	-0.015	0.0	0.0	-0.015
ζ_H^R	-0.032	-0.032	-0.032	0.0	0.0	-0.032
ζ^L	-0.03	-0.03	-0.03	0.0	-0.03	0.0

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Countefactual: Banning cars - full results

	Counterfactual scenario					
	(1)	(2)	(3)	(4)	(5)	(6)
Welfare $\Delta\%$						
High-skilled	0.87	0.45	0.65	−0.55	−0.06	0.0
Low-skilled	0.6	0.35	0.44	−0.32	0.06	0.01
λ_{Car} $\Delta\%$						
High-skilled	−23.1	−22.1	−23.7	−20.3	−26.0	−19.5
Low-skilled	−15.1	−14.3	−16.4	−12.7	−20.0	−10.4
λ_{Public} $\Delta\%$						
High-skilled	8.4	9.9	11.3	5.2	9.3	7.1
Low-skilled	4.7	5.8	6.9	2.7	6.5	3.3
(Mean) pollution $\Delta\%$						
Whole area	−1.25	−1.21	−1.29	−1.14	−1.41	−1.08
Paris municipality	−5.69	−5.69	−5.69	−5.69	−5.69	−5.69
Outside Paris municipality	−0.71	−0.66	−0.75	−0.59	−0.88	−0.52
(Mean) rent $\Delta\%$						
Whole area	0.22	0.71	0.86	−0.46	0.98	−0.22
Total population $\Delta\%$						
Whole	0.0	1.24	1.73	−1.39	−0.05	0.02
High-skilled	0.0	1.36	1.96	−1.65	−0.17	0.01
Low-skilled	0.0	1.05	1.33	−0.95	0.17	0.02
Parameters						
Migration elasticity	0.0	3.0	3.0	3.0	3.0	3.0
η^L	0.0	0.0	0.07	0.07	0.07	0.07
η^R	0.0	0.0	0.1	0.1	0.1	0.1
ζ_L^R	−0.015	−0.015	−0.015	0.0	0.0	−0.015
ζ_H^R	−0.032	−0.032	−0.032	0.0	0.0	−0.032
ζ^L	−0.03	−0.03	−0.03	0.0	−0.03	0.0

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