Fertility, Housing Costs and City Growth

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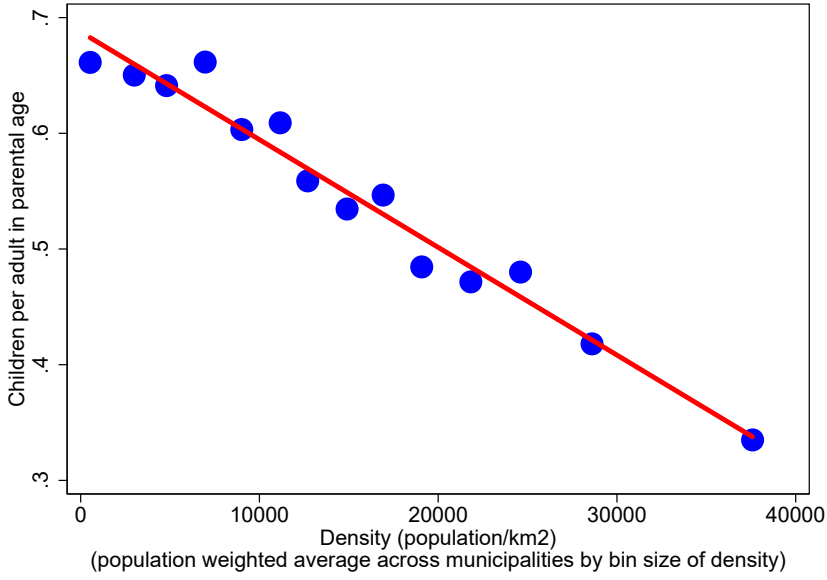
Density-Dependent Fertility

We document *negative density-dependence* of fertility across space in French urban areas.


Children per adult in parental age
.3
.4
.5
.6
.7
0
10000
20000
30000
40000
Density (population/km2)
(population weighted average across municipalities by bin size of density)

The Story

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- Children are costly in terms of housing space.
  1. **Sorting.** Households with a preference for larger families locate in cheaper (less dense) locations.
  2. **Endogenous fertility choice.** For given fertility preference, households in more expensive (denser) locations have fewer children.
- Generates negative density-dependence of fertility.

This Paper

- Develops a quantitative life-cycle spatial model with endogenous fertility and demographics to account for
  1. Sorting patterns across demographics.
  2. The dynamics of fertility across time and space. The housing market acts as an **automatic stabiliser** of fertility over time.
  3. The **joint** determination of population dynamics and housing prices.
- Structural estimation using French data for counterfactuals since WWII. [not there yet]

Related Literature

Ecology and Demography

- *Density-dependent population dynamics.* Sibly and Hone (2002), Sinclair (1989, 2003), Mills (2012) for references. Relevance for humans discussed in Lee (1987) and Lutz et al. (2006).
- *Demographic Transition and Urbanization.* Thompson (1916, 1929), Davis (1937) and Notestein (1945). Caldwell(2006) for a survey.

Fertility in Economics

- Becker (1960). References in Hotz et al. (1997), Jones et al. (2008) and Doepke et al.(2022).

Demographics and housing prices

- *Demographics and housing prices (macro).* Starting with Mankiw and Weil (1989).
- *Housing costs and fertility choice (applied micro).* Simon and Tamura (2009), Lovenheim and Mumford (2013) and Dettling and Kearney (2014).

Sorting of individuals across urban space

- *Sorting across skills.* Glaeser & Mare (2001), Combes et al. (2008), Baum-Snow et al. (2011), Eeckhout et al. (2014), Diamond (2016), Roca and Puga (2017), Couture et al. (2019), ...
- *Suburbanisation vs. the revival of cities.* Baum-Snow (2007) and Redding (2021). Couture and Handbury (2020), Moreno-Maldonado and Santamaria (2022).

Empirical Facts from France

Data

- **Household census data.** SAPHIR dataset of harmonized individual census data (1968-2015). Demographic variables at the municipality level. Fertility measured as children (0-17) per adult in parental age (27-53).

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- **Housing prices.** Notary data on transactions of second-hand dwellings. Price index at the municipality level (2000-2012).
- **Housing consumption.** Household level data from Enquête Nationale Logement (ENL, 1984-2013) on housing consumption and other household characteristics (composition, income, ...).

Fact 1: Housing Consumption and Demographics

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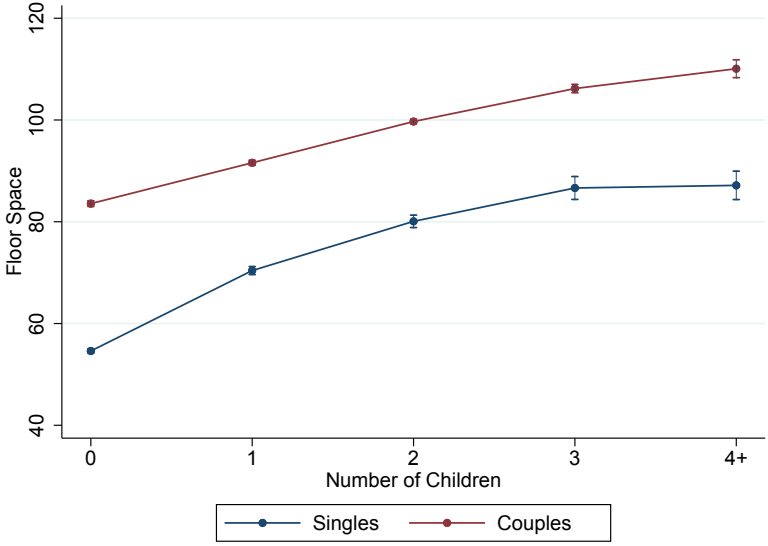
$$h_{i,\ell_k,t} = c_{k,t} + f_k\left(d_{\ell_k}\right) + \sum_{m=1}^{N} \beta_m \cdot \mathbf{1}_{\{i \in \mathbb{S}_m\}} + X_{i,\ell_k,t} \cdot \alpha + \nu_{i,t}$$

$$(i, k, \ell_k, t) = (\text{Household, Urban Area, Commune in Urban Area, Year})$$

$$X_{i,\ell_k,t} = (\text{Age, Education, Income, Owner})$$

Fact 1: Housing Consumption and Demographics



Spatial Sorting across Demographics

Fact 2: Fertility within Cities

Fact 2: In a *given* urban area, fertility is higher in more suburban locations.

- Fertility higher by about 30% in the most suburban locations.
- Holds across census waves. Drop in fertility over time in all locations.
- Within city, fertility lower in more expensive locations (e.g. central locations)

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At Commune (ℓ_k) Level!

$$y_{\ell_k,t} = c_{k,t} + f_k\left(d_{\ell_k}\right) + X_{\ell_k,t} \cdot \alpha + \nu_{\ell_k,t}$$

Fact 2: Fertility is Higher in Suburbs

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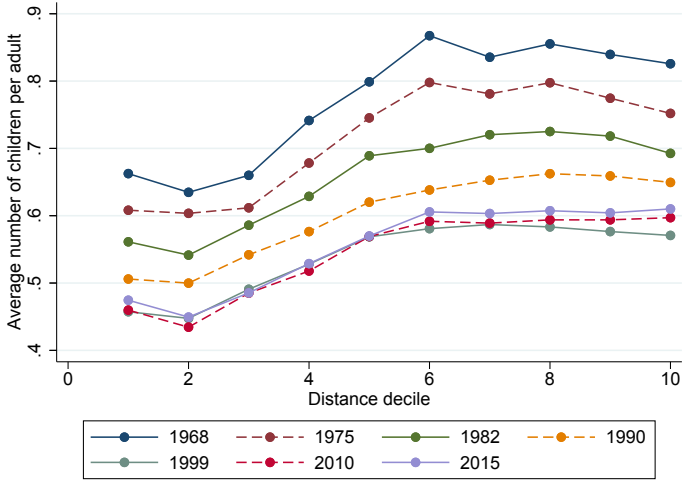
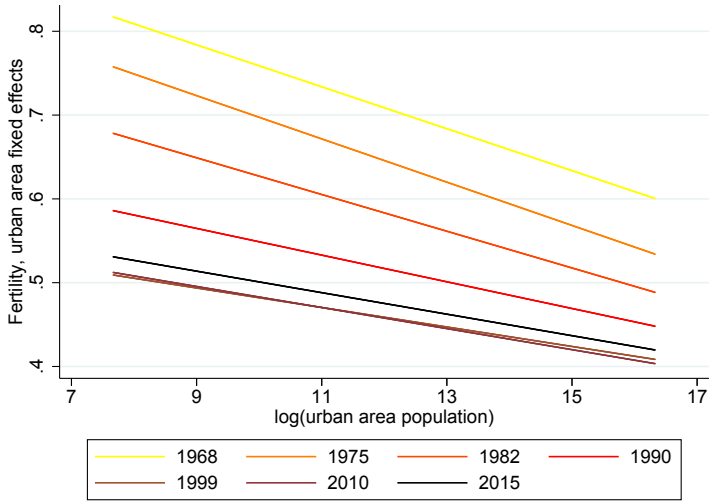


Fact 3: Central Fertility Higher in Smaller Cities

$$y_{\ell_k,t} = c_{k,t} + f_k\left(d_{\ell_k}\right) + X_{\ell_k,t} \cdot \alpha + \nu_{\ell_k,t}$$



Fact 4: Average Age is Higher in Suburbs and Smaller Cities

Within and Across Cities

Figure: Within Cities

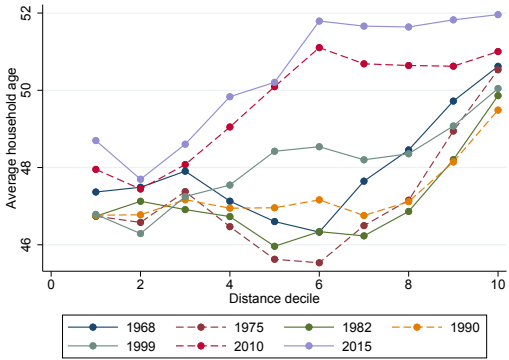
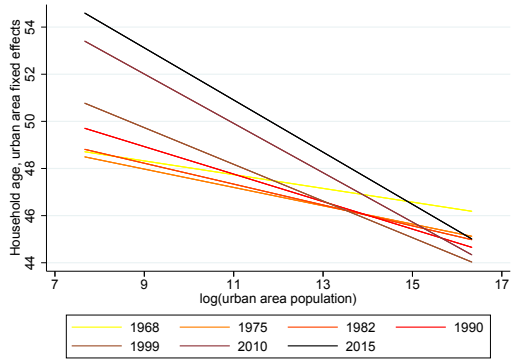


Figure: Across City Centers



Theory

Set-up

- **Overlapping generations** of ex-ante identical individuals (can be relaxed).

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- **Stages of life.** Four stages of life, **children** (c), **young** (y), **parents** (p) and **old** (o). Children sheltered by parents making fertility decisions, young and parents work and old retired. Enter each stage at age a_s, $s \in \{y, p, o\}$.

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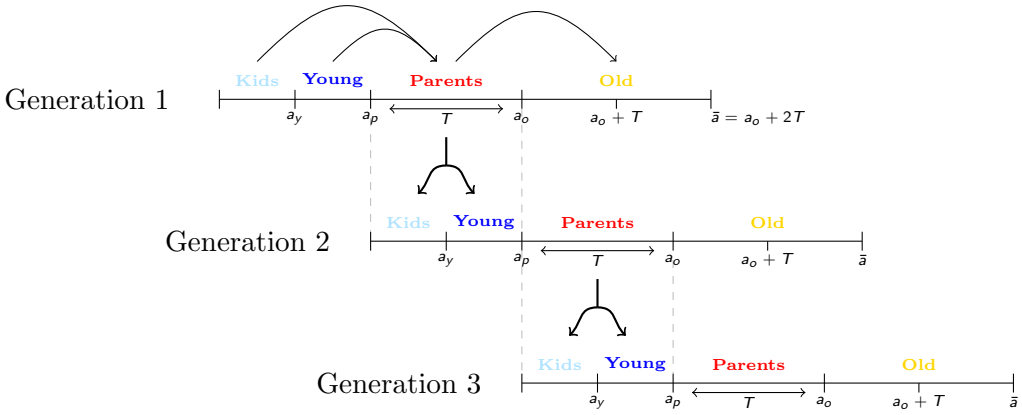
- **Spatial Structure and Household Income.** K cities. City made of a fixed number $\mathcal{L}_k$ of locations, $\ell_k \in \{1, ..., \mathcal{L}_k\}$.
  Household income net of commuting costs in ℓ_k at age $a \geq a_y$,

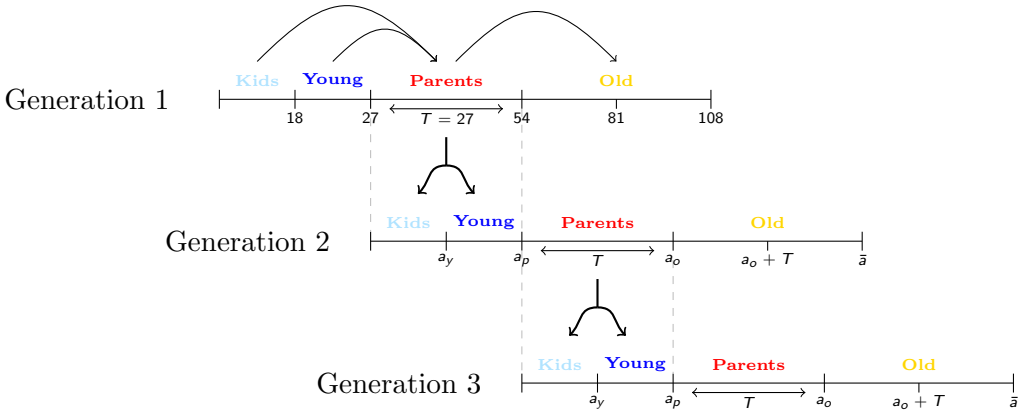
$$y(a, \ell_k) = \theta_k \cdot w(a, \ell_k) + b(a),$$

  with wage income net of commuting costs $w(a, \ell_k)$ decreasing with ℓ_k within a city k, retirement benefits $b(a)$ independent of location, θ_k a city-level income fixed effect.

Timing


Generation 1
Kids
Young
Parents
Old
a_y
a_p
T
a_o
$a_o + T$
$\bar{a} = a_o + 2T$
Generation 2
Kids
Young
Parents
Old
a_y
a_p
T
a_o
$a_o + T$
$\bar{a}$
Generation 3
Kids
Young
Parents
Old
a_y
a_p
T
a_o
$a_o + T$
$\bar{a}$

Timing


Generation 1
Kids
Young
Parents
Old
18
27
$T = 27$
54
81
108
Generation 2
Kids
Young
Parents
Old
a_y
a_p
T
a_o
$a_o + T$
$\bar{a}$
Generation 3
Kids
Young
Parents
Old
a_y
a_p
T
a_o
$a_o + T$
$\bar{a}$

Preferences and budget constraints

- **Budget constraints.** At age a in location ℓ_k,

$$c(a, \ell_k, n) + q_{\ell_k} h(\mathcal{N} + n) = y(a, \ell_k),$$

with consumption $c(a, \ell_k, n)$, housing space h increasing in the number of sheltered children n ($n = 0$ for young and old) and q_{ℓ_k} the housing price in ℓ_k.

- **Preferences.** Instantaneous utility,

$$U(a, \ell_k, n) = A_k + u\left(c(a, \ell_k, n)\right) + v(n) + \sigma \varepsilon_{n,\ell_k}.$$

with city amenity A_k, household specific preferences for location at any age and for fertility at age a_p. Preference shock for location (and fertility at age a_p), ε_{n,ℓ_k}, drawn from a type 1 Extreme Value distribution with scale parameter σ.

Spatial Equilibrium

- Assuming no moving costs, and parental stage lasting for one period only: Decisions independent from each other at each age.

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- Location decisions at all ages and fertility decisions at age a_p expressed as discrete choice probabilities.

$$\begin{aligned}\max_{\ell_y,(\ell_p,n),\ell_o} V &= \max_{\ell_y,(\ell_p,n),\ell_o} U(a_y,\ell_y) + U(a_p,\ell_p,n) + U(a_o,\ell_o) \\ &= \max_{\ell_y} U(a_y,\ell_y) + \max_{(\ell_p,n)} U(a_p,\ell_p,n) + \max_{\ell_o} U(a_o,\ell_o)\end{aligned}$$

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- Given aggregate demographic composition of adult households, this determines the housing demand $H_d(\ell_k)$ in each location ℓ_k.

Quantitative Evaluation using French data since WWII

Numerical illustrations

- Quantitative evaluation using French data since WWII in progress.
- For now, provide numerical illustrations of a calibrated simulated multicity economy aiming at reproducing qualitatively French data since WWII.
- Investigates the response across space and time of cities to
  1. Aggregate demographic changes (e.g. baby-boom and rising longevity)
  2. Aggregate changes in the urban structure (e.g. shifts in commuting costs and housing supply regulations)

- **Baby-boom.** Fertility preference shifter $\Delta_t \nu$ in period $t \in \{0, 1, 2\}$, with $\Delta_0 \nu > \Delta_1 \nu > \Delta_2 \nu > 0$.
  Magnitude to roughly match the increase in fertility during the baby-boom in France. Progressive phasing-out.

Numerical illustrations

Aggregate demographic changes

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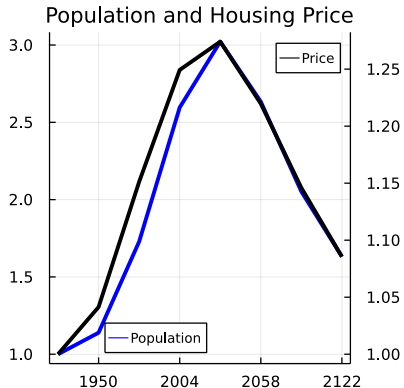
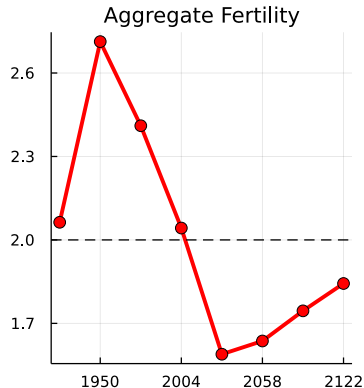
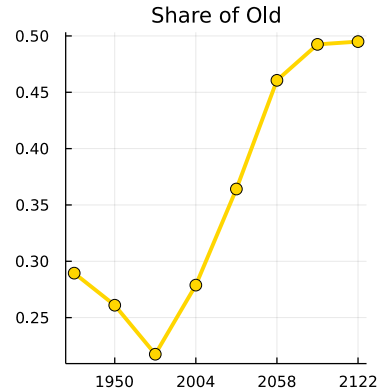
- **Rising longevity.** Increase in survival probabilities at older ages in line with data. Probablity to survive into old age, above 54 (resp. very old age, above 81) increases from 0.5 to 0.7 (resp. 0.04 to 0.3) between $t = 0$ and today.

Aggregate demographic changes

Population dynamics



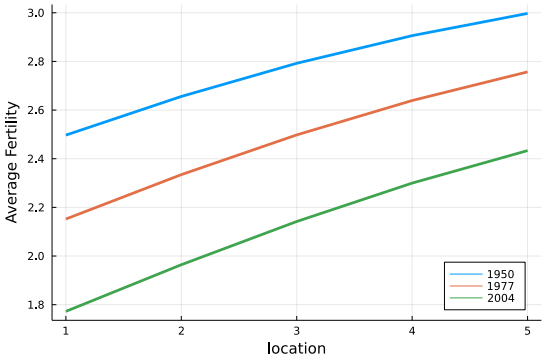




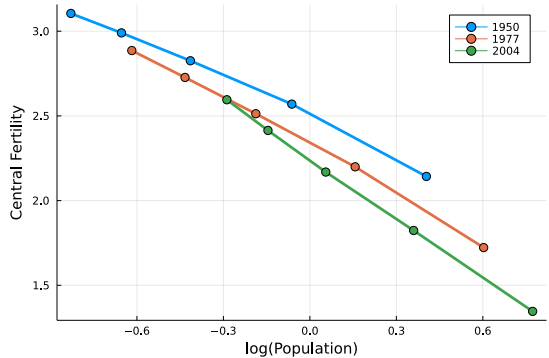
Fertility across urban locations

Facts 2 and 3. Fertility within and across urban areas.

(a) Fact 2: Within city



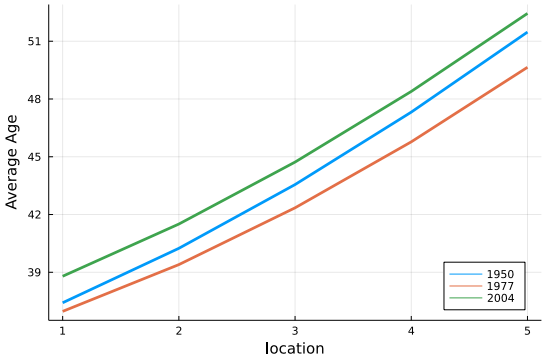
(b) Fact 3: Across cities



Spatial sorting by age

Fact 4. Average age across urban locations

(a) Fact 4: Within city



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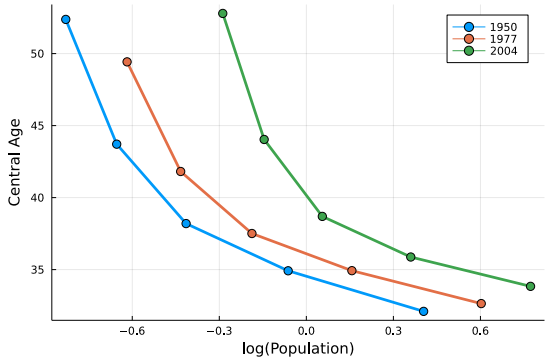
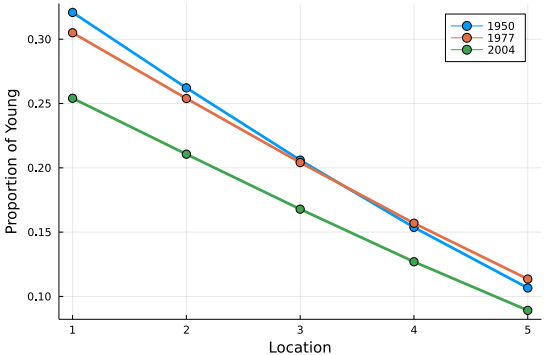


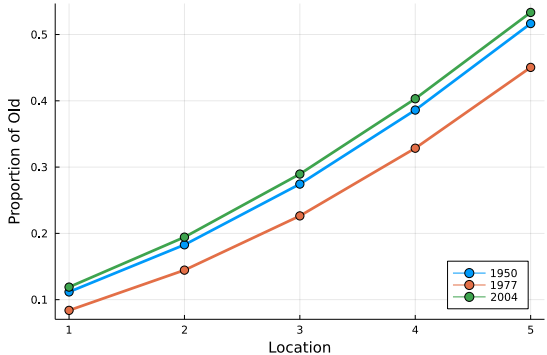
Spatial sorting by age

Fact 5. Young vs. Old across urban locations

(a) Fact 5: Young within city



(b) Fact 5: Old within city



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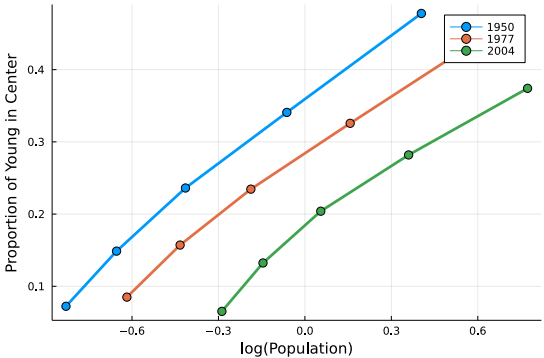

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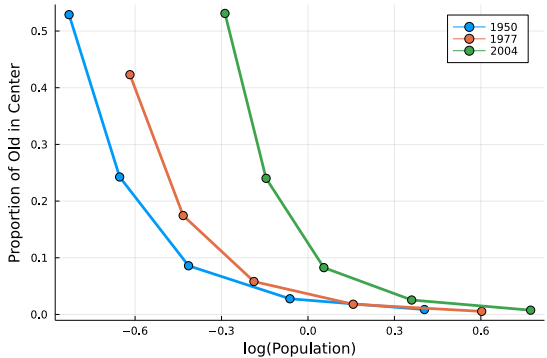
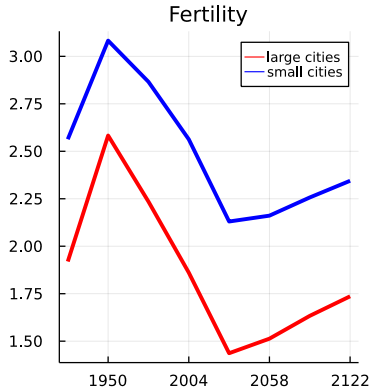
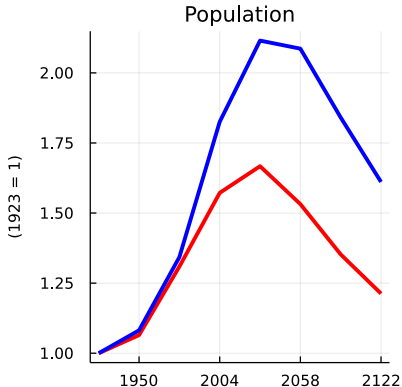
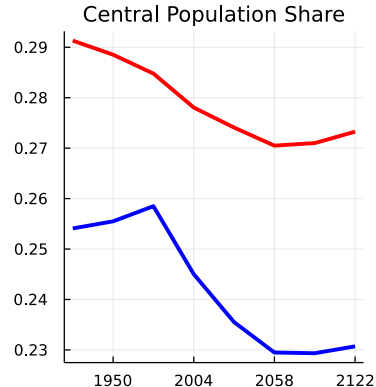


Spatial Distribution of Population

Large vs. Small cities







Numerical illustrations

Aggregate changes in the urban structure

- **Drop in commuting costs.** Drop in commuting costs at date $t = 1$, $\tau_t = \tau - \Delta_t \tau$, with $\Delta_t \tau > 0$ for $t \geq 1$ and 0 otherwise.
  Corresponds to better commuting technologies (e.g. automobiles, ...) in the 1960s-1970s.

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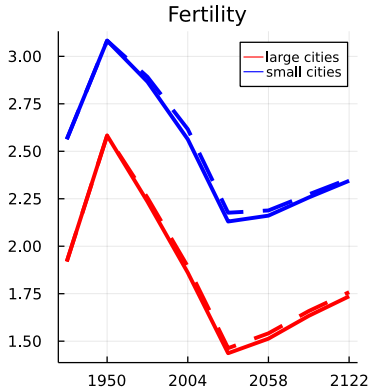
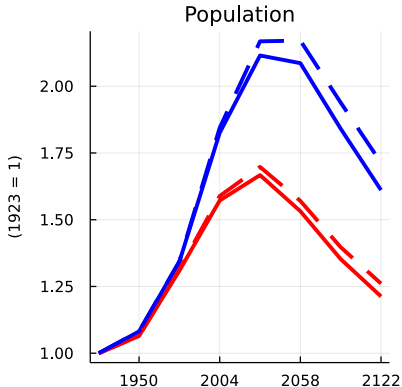
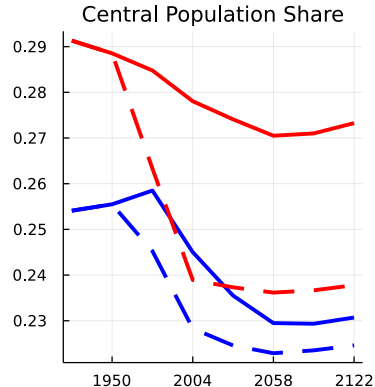
- **Stricter housing supply regulations.** Tightening of housing supply in the recent period, at date $t \geq 2$, $\delta_t = \delta - \Delta_t \delta$, with $\Delta_t \delta = \Delta \delta > 0$, for $t \geq 2$ and 0 otherwise.
  Corresponds to stricter urban planning in France starting the 1990s. Partly mimic the recent rise in housing prices.

Commuting costs, fertility and suburbanisation

Drop in commuting costs







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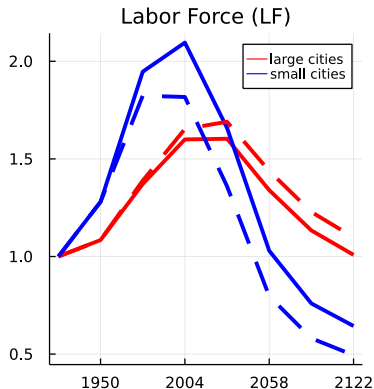
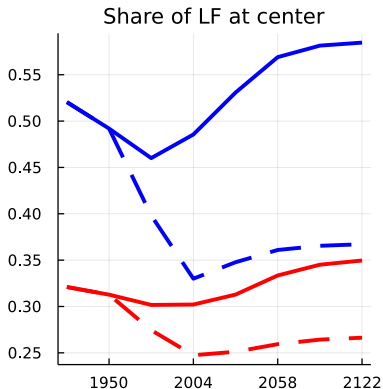
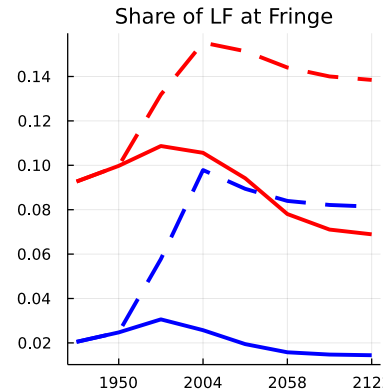
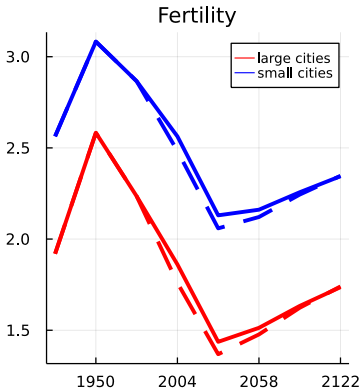


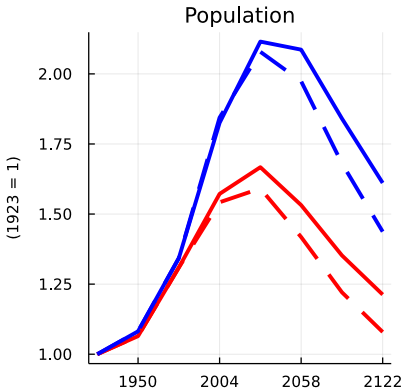


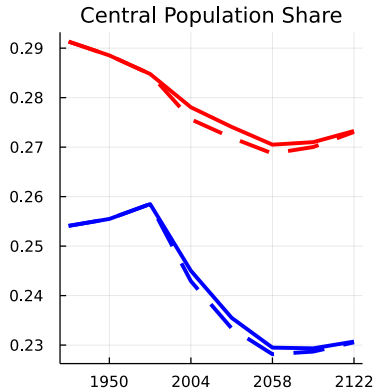


Housing supply regulations, fertility and city growth

Stricter housing supply regulations







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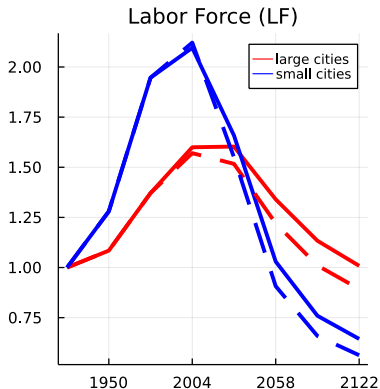

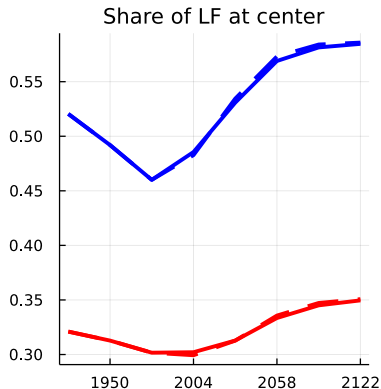

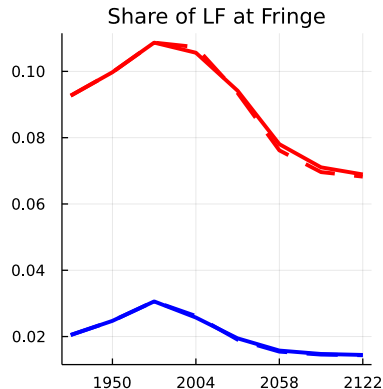

Conclusion

- Novel facts about fertility and demographic sorting across urban locations in France.
- Spatial overlapping generations equilibrium model with endogenous population dynamics reproduces these stylized facts (qualitatively).
- Quantitative estimation (in progress) to identify through a variety of counterfactuals
  - the role of demographic shifts in explaining the spatial distribution of population.
  - the role of changes in commuting technologies and/or housing supply regulations for the population dynamics of cities.
  - the side-effects of family policies for the distribution of population and economic activity across space.
- With agglomeration forces, fertility and population dynamics matter for aggregate productivity.

References I

Chad Jones (2022): The End of Economic Growth

- $N_t = N_0 e^{-\eta t}, \eta = 0.005$

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Chad Jones (2022): The End of Economic Growth back

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