

Structural Change, Land Use and Urban Expansion

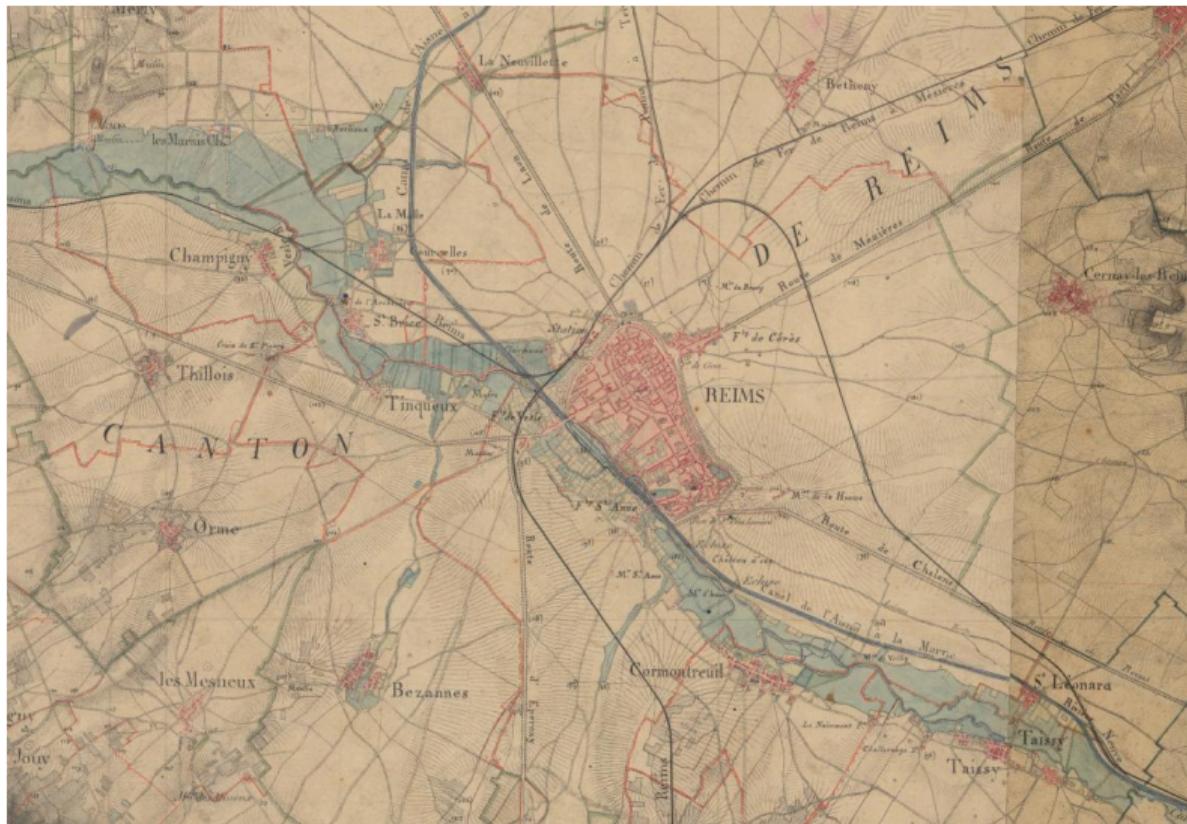
Nicolas Coeurdacier (SciencesPo & CEPR)

Florian Oswald (SciencesPo)

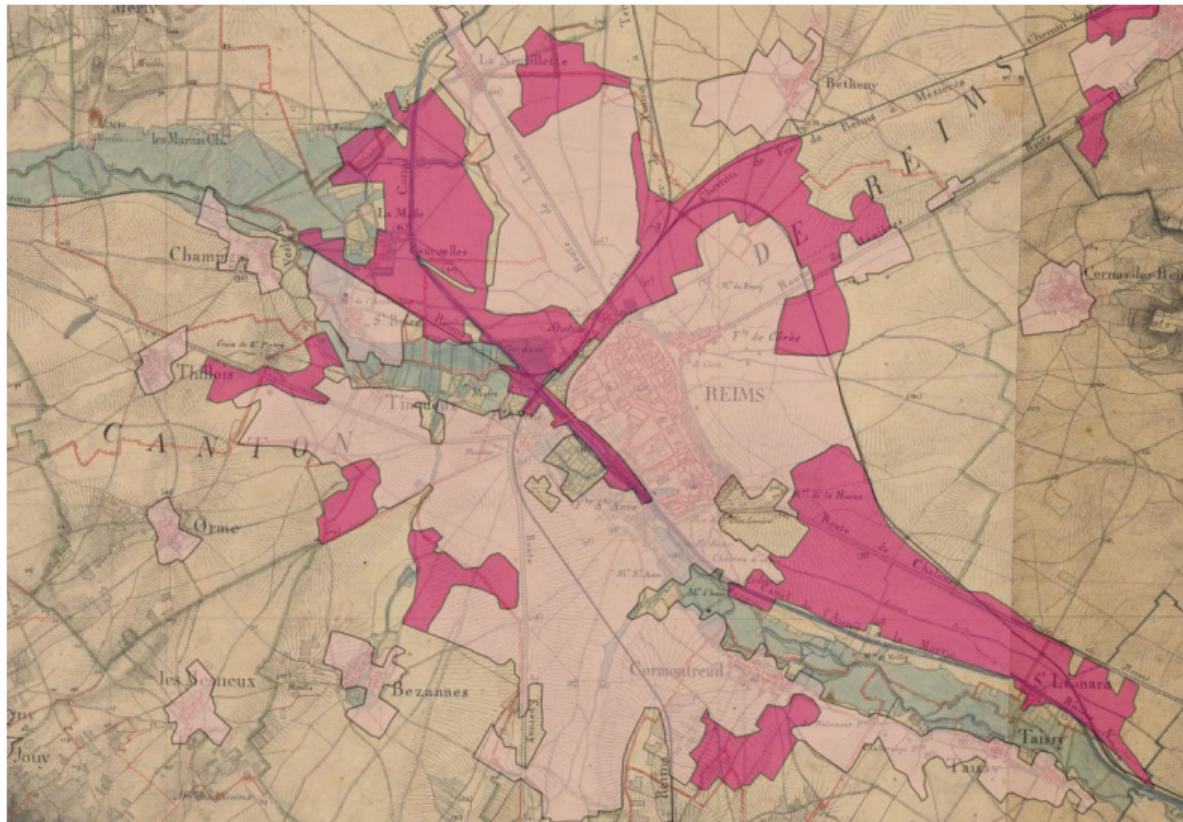
Marc Teignier (U. Barcelona)

ECHOPPE 2021 Meeting

Motivation: Reims in 1866



Motivation: Reims in 1866 vs IGN Buildings in 2017

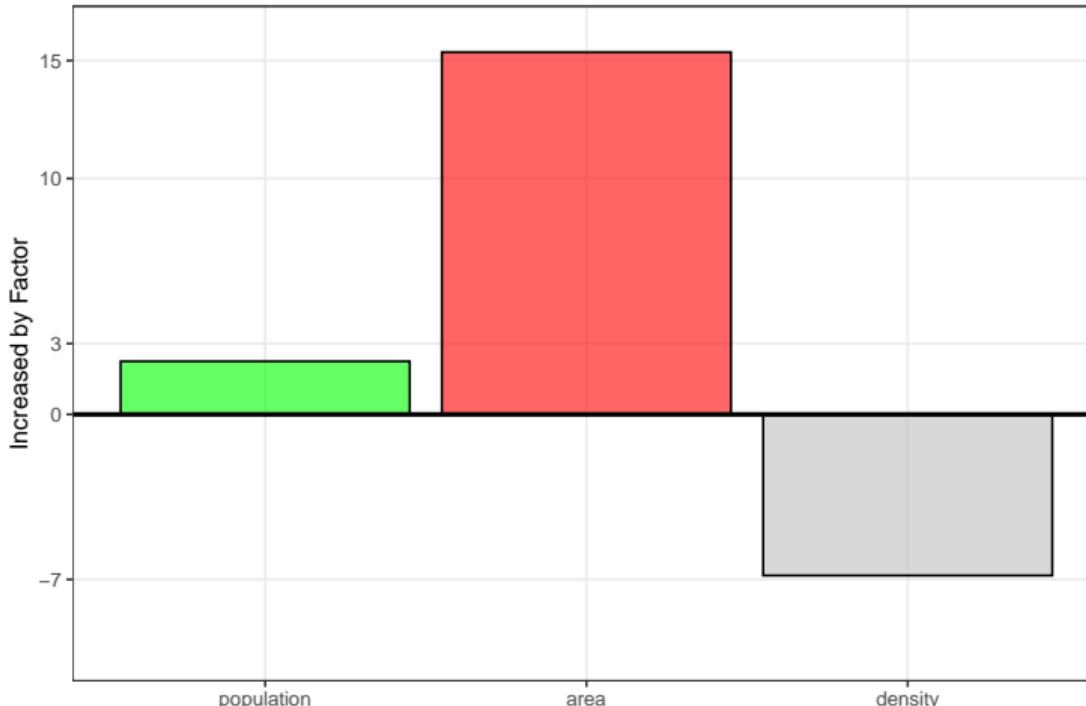


Motivation: Reims in 1950 vs IGN Buildings in 2017



Motivation: Fall in Urban Density

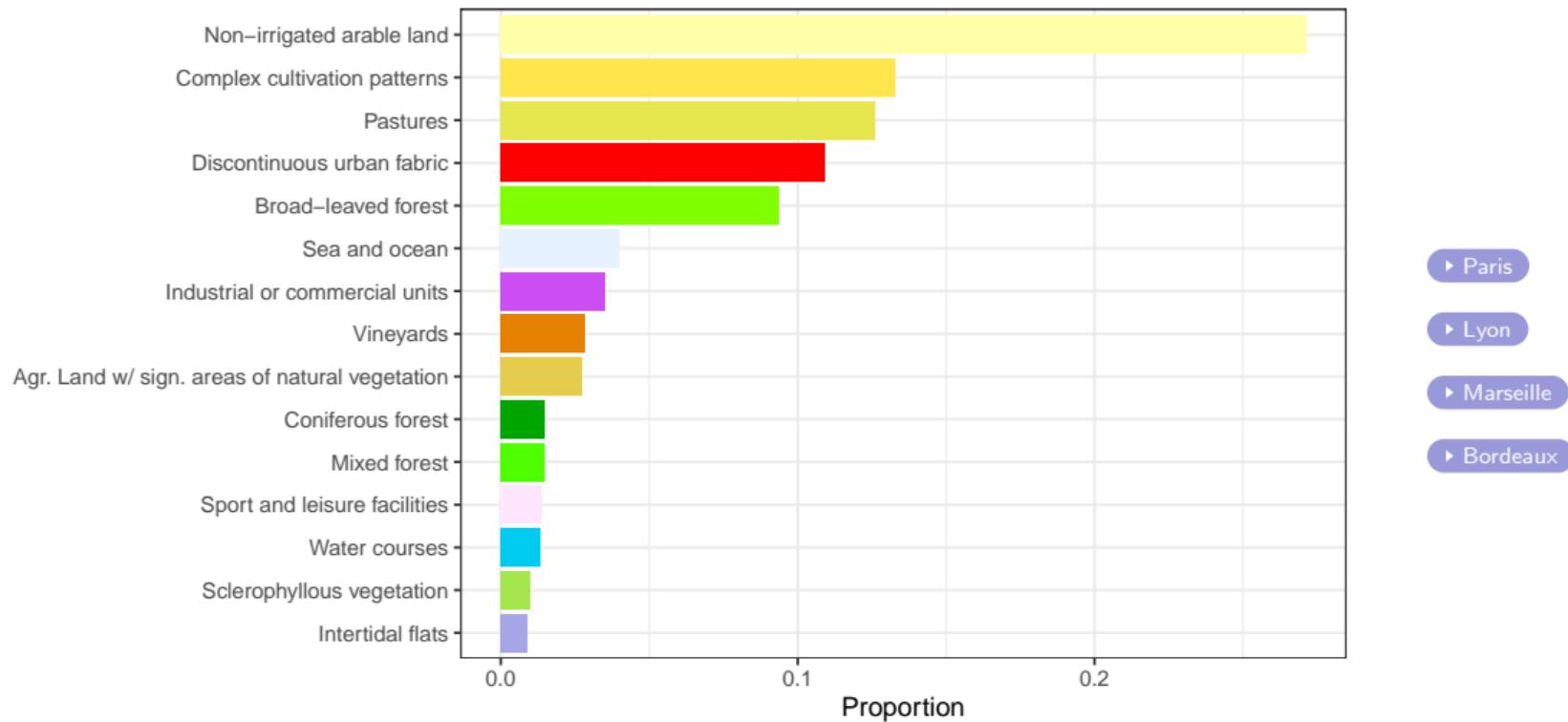
Reims from 1866 to 2015



- ▶ 50% work in Agriculture in 1866, 2% in 2015.
- ▶ Urban Surface increased about 15 fold.
- ▶ Density fell about 7 fold.
- ▶ Why?

Land Use Outside Top 100 French Cities Today

Average Land Use Outside top 100 Cities



Urban Expansion: Different Views

1. Urban Economics:

- ▶ Decline in commuting cost over time allows residing further away from city centre.
- ▶ New technologies (like train) push city fringe outwards. Suburbanisation.

Urban Expansion: Different Views

1. Urban Economics:

- ▶ Decline in commuting cost over time allows residing further away from city centre.
- ▶ New technologies (like train) push city fringe outwards. Suburbanisation.

2. Structural Change:

- ▶ Food subsistence constraint is binding pre industrial revolution. High land values. No income left for bigger houses. (No need to commute to large suburban houses.)
- ▶ Agricultural productivity growth solves food problem, and puts downward pressure on land values. City can expand easily to accommodate greater housing demand. Urban Density falls.

Urban Expansion: Different Views

1. Urban Economics:

- ▶ Decline in commuting cost over time allows residing further away from city centre.
- ▶ New technologies (like train) push city fringe outwards. Suburbanisation.

2. Structural Change:

- ▶ Food subsistence constraint is binding pre industrial revolution. High land values. No income left for bigger houses. (No need to commute to large suburban houses.)
- ▶ Agricultural productivity growth solves food problem, and puts downward pressure on land values. City can expand easily to accommodate greater housing demand. Urban Density falls.

This paper: Try to reconcile both views in a unified framework.

Why Do We Care?

A general equilibrium spatial model of land use

- ▶ Understanding land/housing prices across space and time in the long-run.
 - ▶ Housing Affordability crisis.
- ▶ Understanding sprawling and soil artificialization.
 - ▶ Environmental impact (IPCC (2019)).
- ▶ Implications for welfare and aggregate productivity of land use restrictions. [not there yet]
 - ▶ Is sprawling 'excessive'? Benefits of compact cities?
 - ▶ General equilibrium implications of lowering commuting costs.

Related literature

(Traditional) Macro and Land Values

- ▶ Ricardo (1817), Nichols (1970), Grossman and Steger (2016). Measurement. Morris and Heathcote (2007), Piketty and Zucman (2014), Knoll, Schularick and Steger (2017), Miles and Sefton (2020)

(Macro) Structural Change

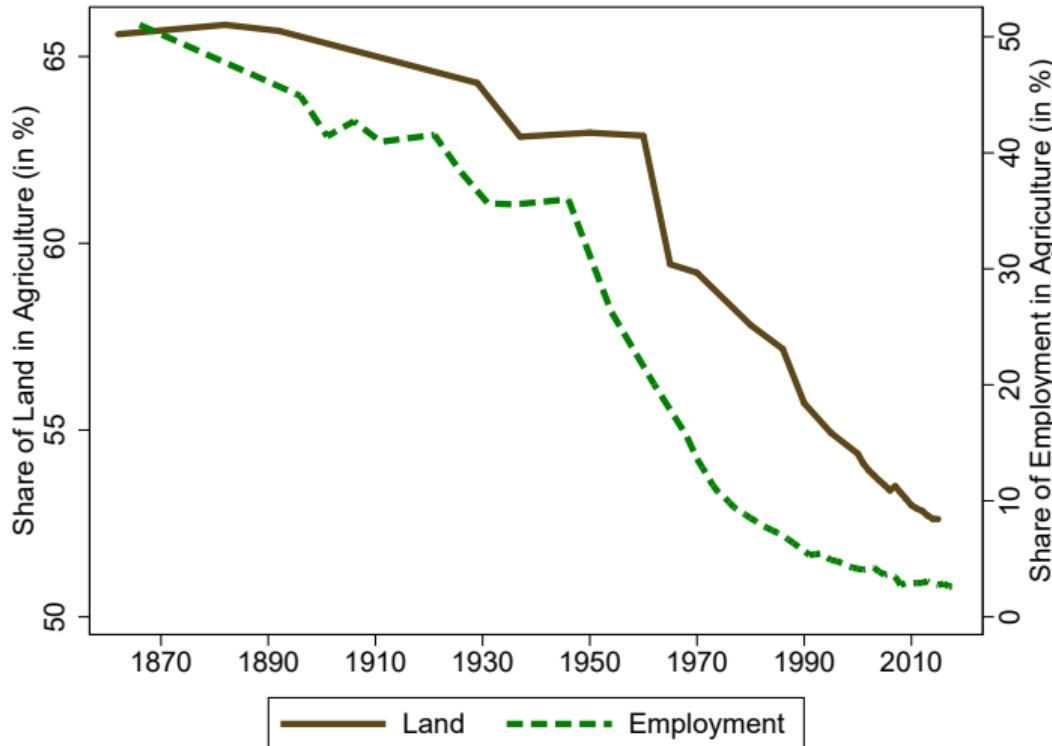
- ▶ Survey: Herrendorf, Rogerson and Valentinyi (2014). Theory: Kongsamut et al. (2001), Gollin et al. (2002), Boppart (2014), Acemoglu and Guerrieri (2008), Ngai and Pissarides (2007)...
Structural change and urbanization. Lewis (1954), Michaels et al. (2012). Eckert and Peters (2018).
- ▶ Agricultural Productivity Gap. Gollin et al. (2014), Lagakos and Waugh (2013), Young (2013), Restuccia et al. (2008).

Urban — Size and Expansion of Cities

- ▶ Theory. Alonso-Mills-Muth. Surveys by Duranton and Puga (2014, 2015). Brueckner (1990), Brueckner and Lall (2014), ...
Quantitative Spatial Economics. Redding and Rossi-Hansberg (2017). Sprawl/Density. Glaeser et al., Ahlfeldt et al. (2015), Angel et al. (2010)
- ▶ Land Prices and Rents. Combes et al. (2021), Combes et al. (mimeo 2021), Albouy (et al.) (2016, 2018), Glaeser et al. (2005).

Urban Expansion in France: Facts

Land and labor reallocation: Aggregate France

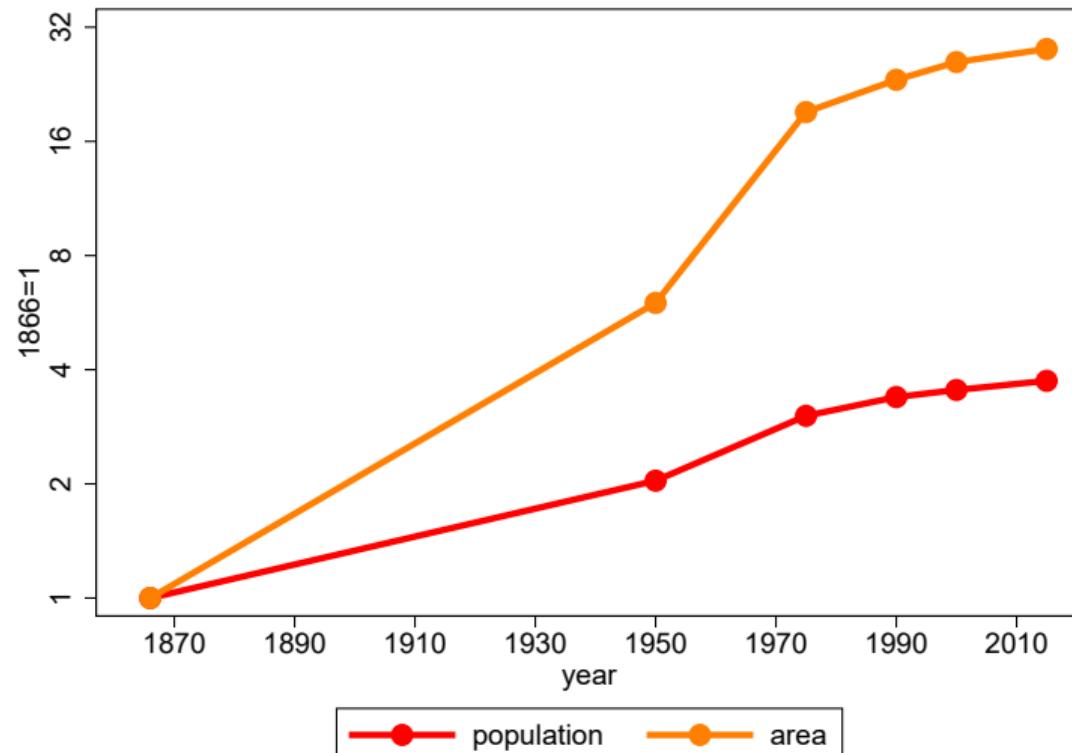


Sources:

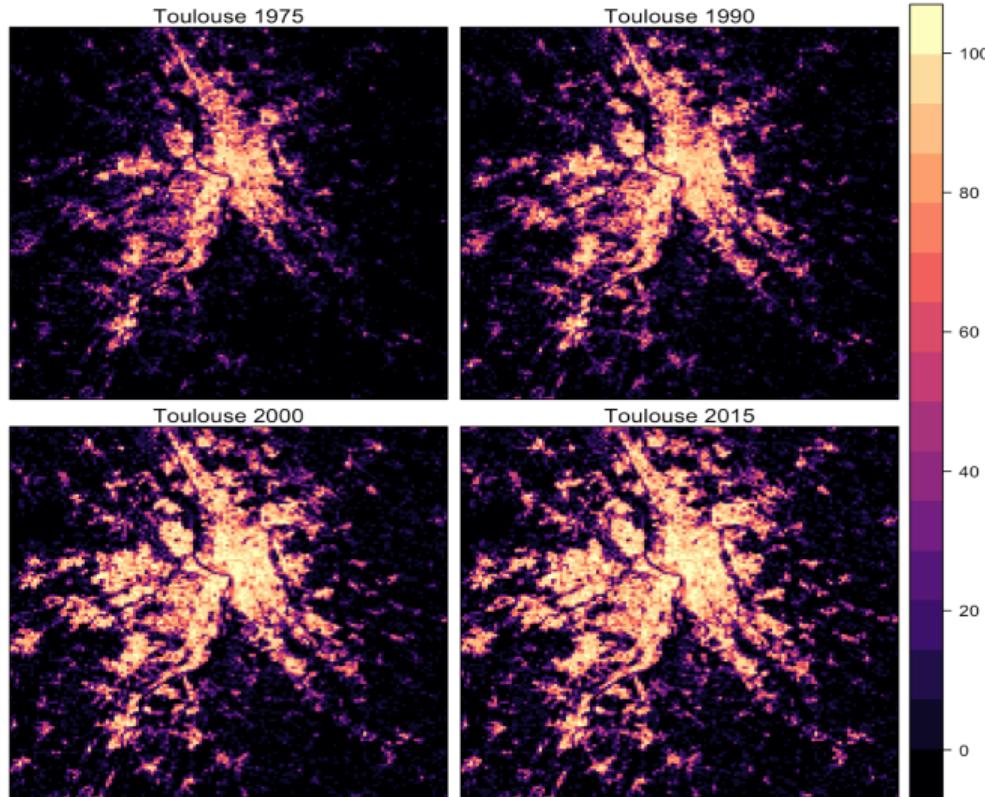
1. Toutain (1993)
2. Recensement Agricole (Ministry of Agriculture)
3. INSEE
4. Villa (1996)

Urban Expansion

Top 100 Cities in France



City Area and Population Measurement

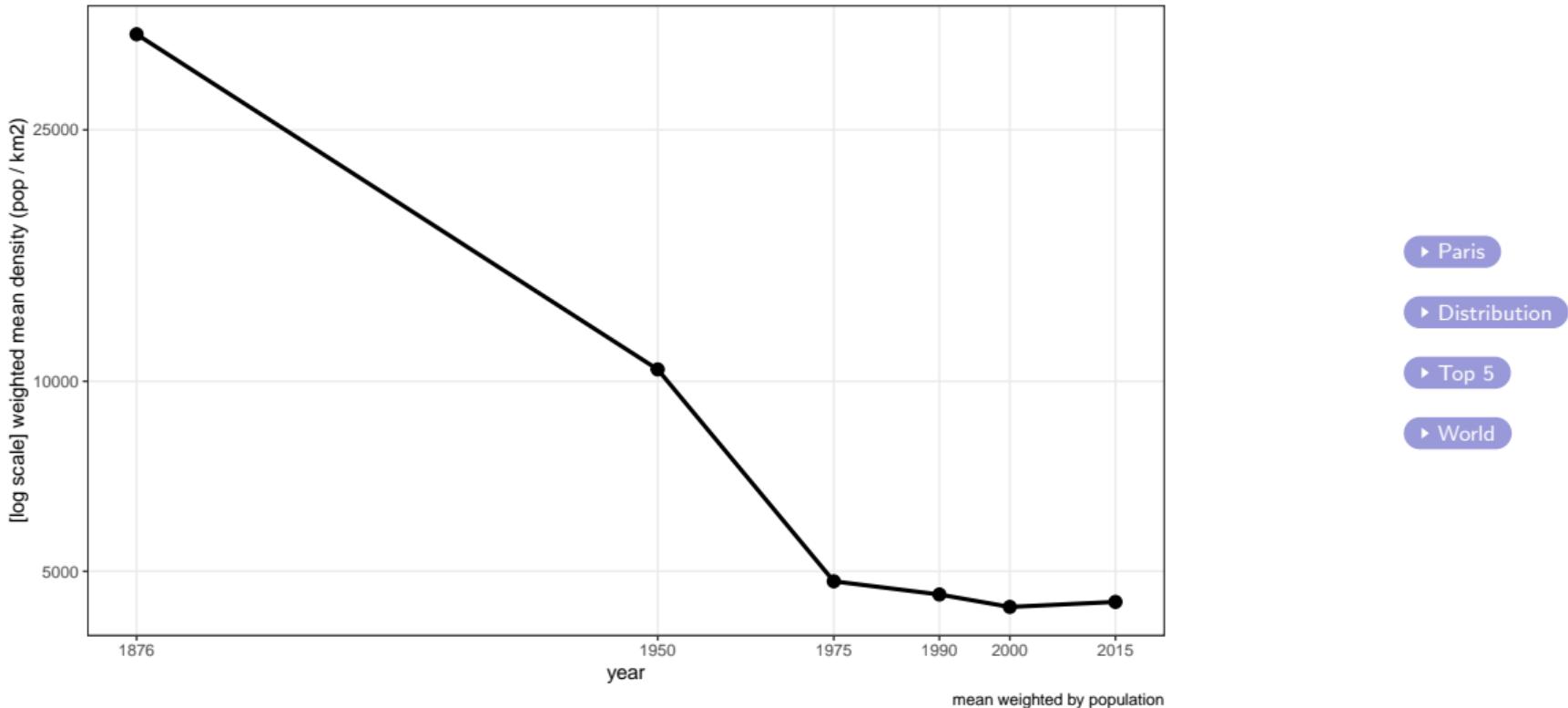


- ▶ 1866: Manual + Census
- ▶ 1950: Manual + Census
- ▶ 1975, 1990, 2000, 2015: GHSI

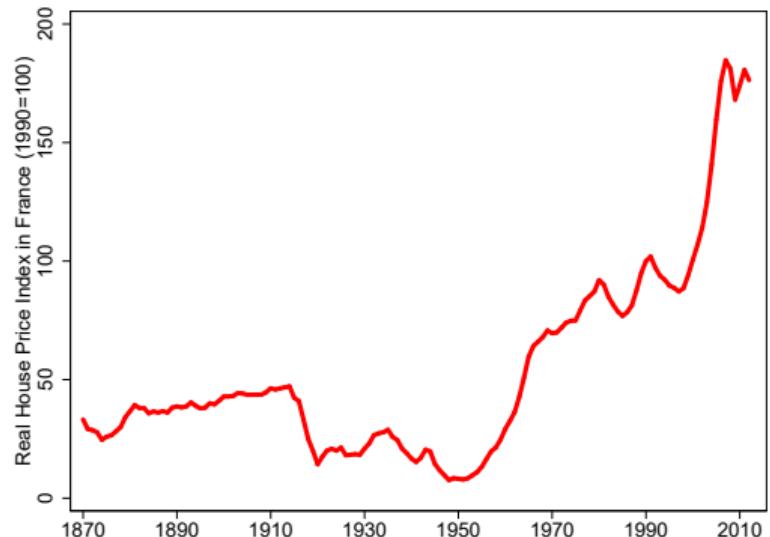
The Historical Fall in Urban Density

Mean Urban Density in France fell by Factor 8

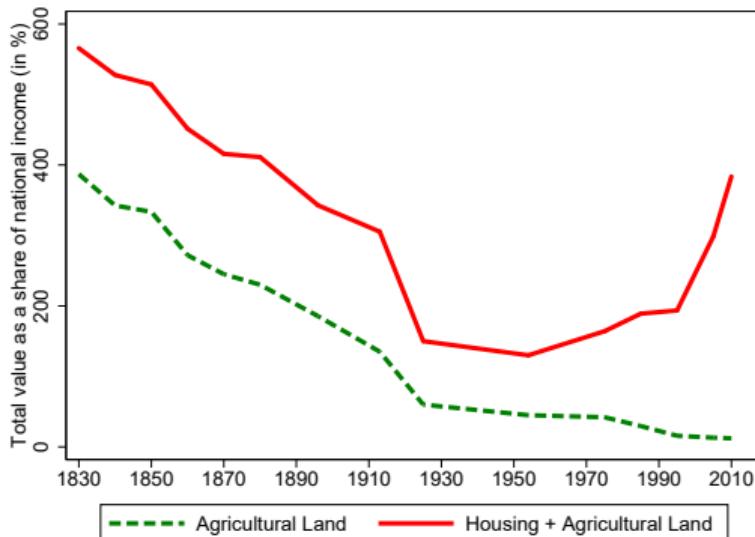
Top 100 French cities



Hockey-stick in housing prices and Fall in Agricultural Value Share



(a) Hockey Stick: Knoll et al. (2017)



(b) Picketty and Zucman (2014)

Model

A general equilibrium model of land use

Set-up

- ▶ Three sectors and goods: rural, urban and housing.
 - ▶ Different intensity in the use of land as input
 - ▶ Rival Land Use: Agriculture *or* Housing
 - ▶ Fixed Supply of Land
- ▶ Urban versus Rural Land: (Endogenous) commuting costs for urban workers.
- ▶ Drivers of Structural Change
 - ▶ Non-homothetic preferences for the rural good.
 - ▶ Increases in productivity during transition.

Spatial Structure: Wage Function $w(\ell)$

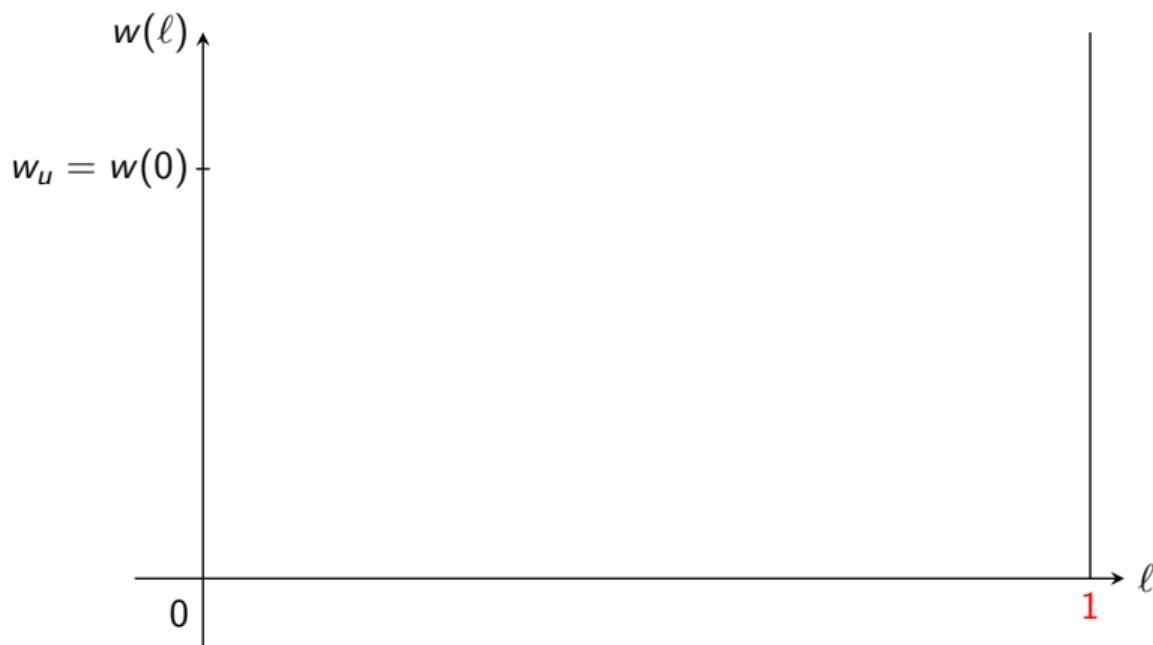
Wages Net Of Commuting Costs in Spatial Equilibrium: $C(\ell) = \bar{U}$

1. Space $\ell \in [0, 1]$



Spatial Structure: Wage Function $w(\ell)$

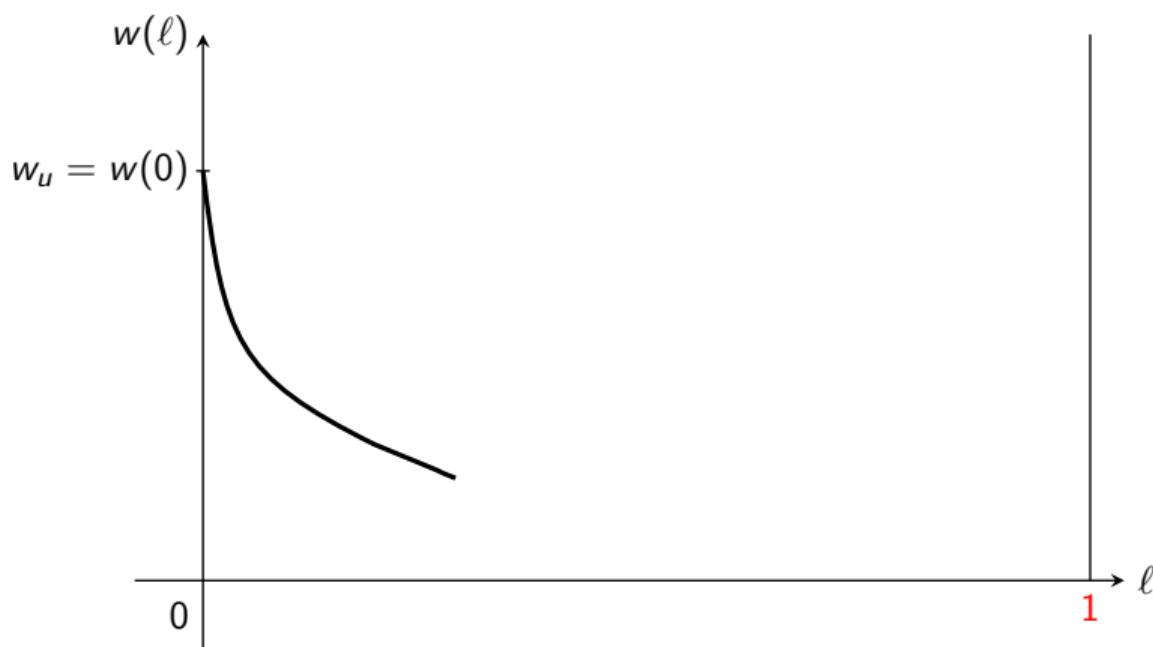
Wages Net Of Commuting Costs in Spatial Equilibrium: $C(\ell) = \bar{U}$



1. Space $\ell \in [0, 1]$
2. Urban production at $\ell = 0$
3. Residence at any $\ell \in [0, 1]$

Spatial Structure: Wage Function $w(\ell)$

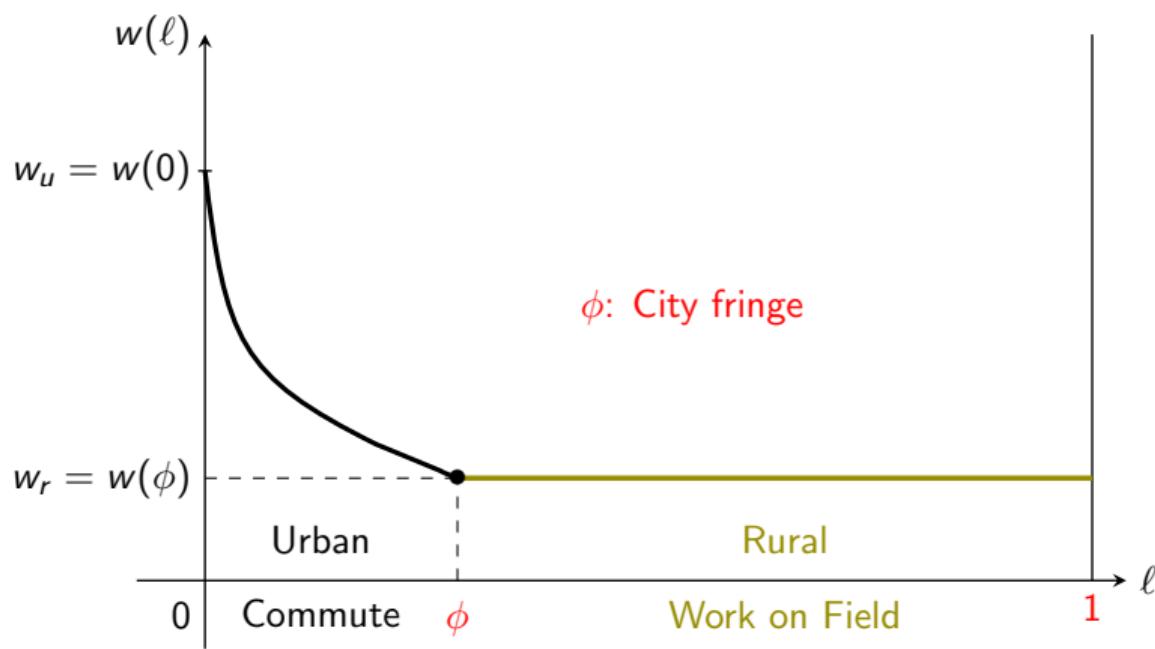
Wages Net Of Commuting Costs in Spatial Equilibrium: $C(\ell) = \bar{U}$



1. Space $\ell \in [0, 1]$
2. Urban production at $\ell = 0$
3. Residence at any $\ell \in [0, 1]$
4. $\tau(\ell)$: commuting cost from ℓ
5. $w_u - \tau(\ell)$ urban wage

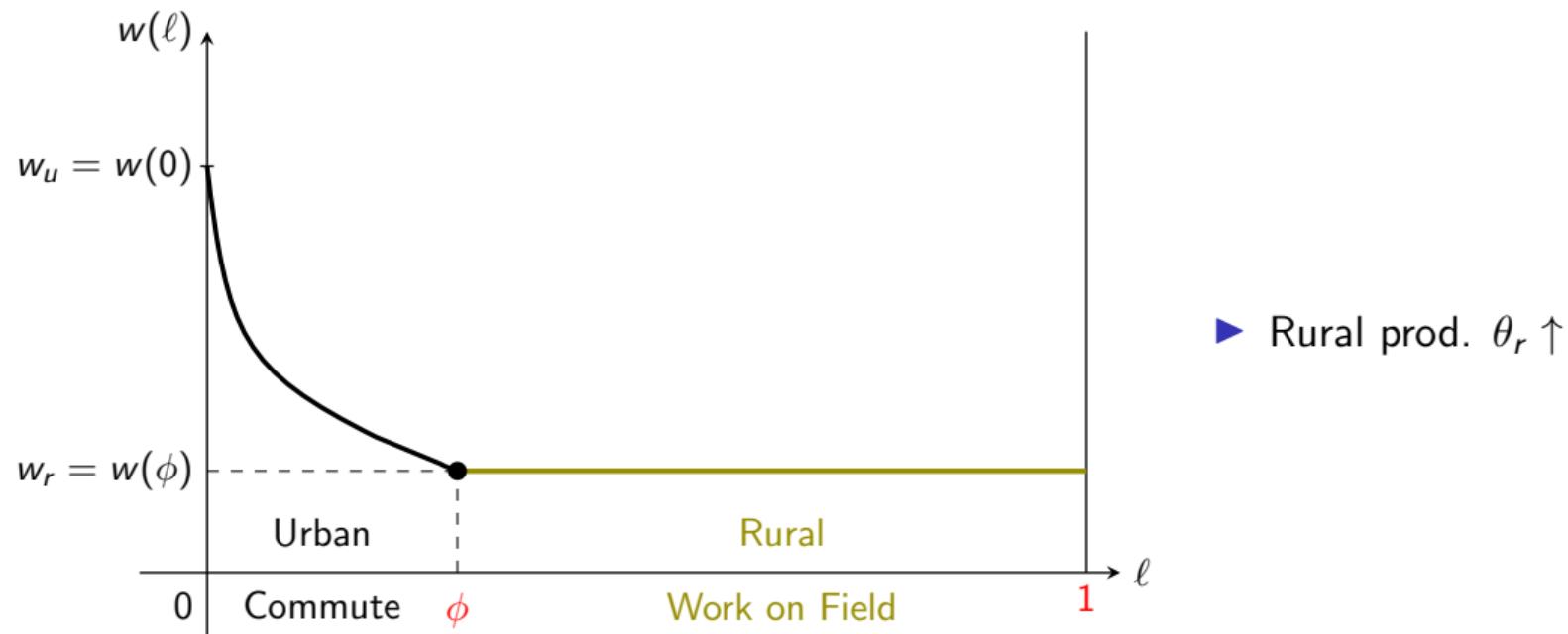
Spatial Structure: Wage Function $w(\ell)$

Wages Net Of Commuting Costs in Spatial Equilibrium: $C(\ell) = \bar{U}$

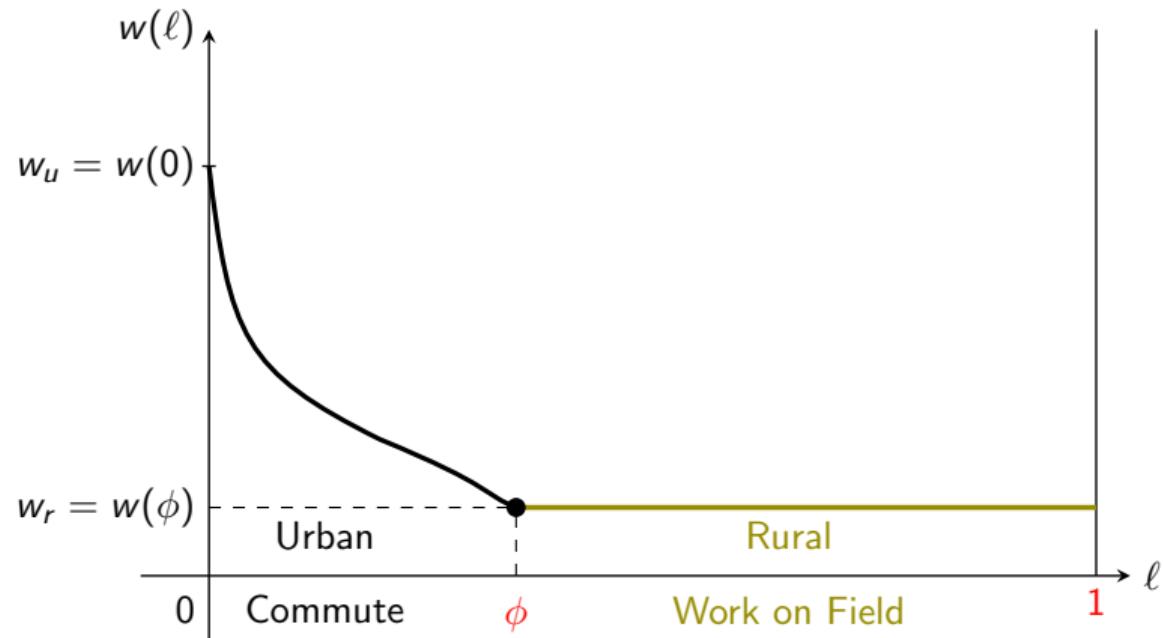


1. Space $\ell \in [0, 1]$
2. Urban production at $\ell = 0$
3. Residence at any $\ell \in [0, 1]$
4. $\tau(\ell)$: commuting cost from ℓ
5. $w_u - \tau(\ell)$ urban wage
6. ϕ denotes urban fringe.

Comparative Statics: Increase in Rural Productivity

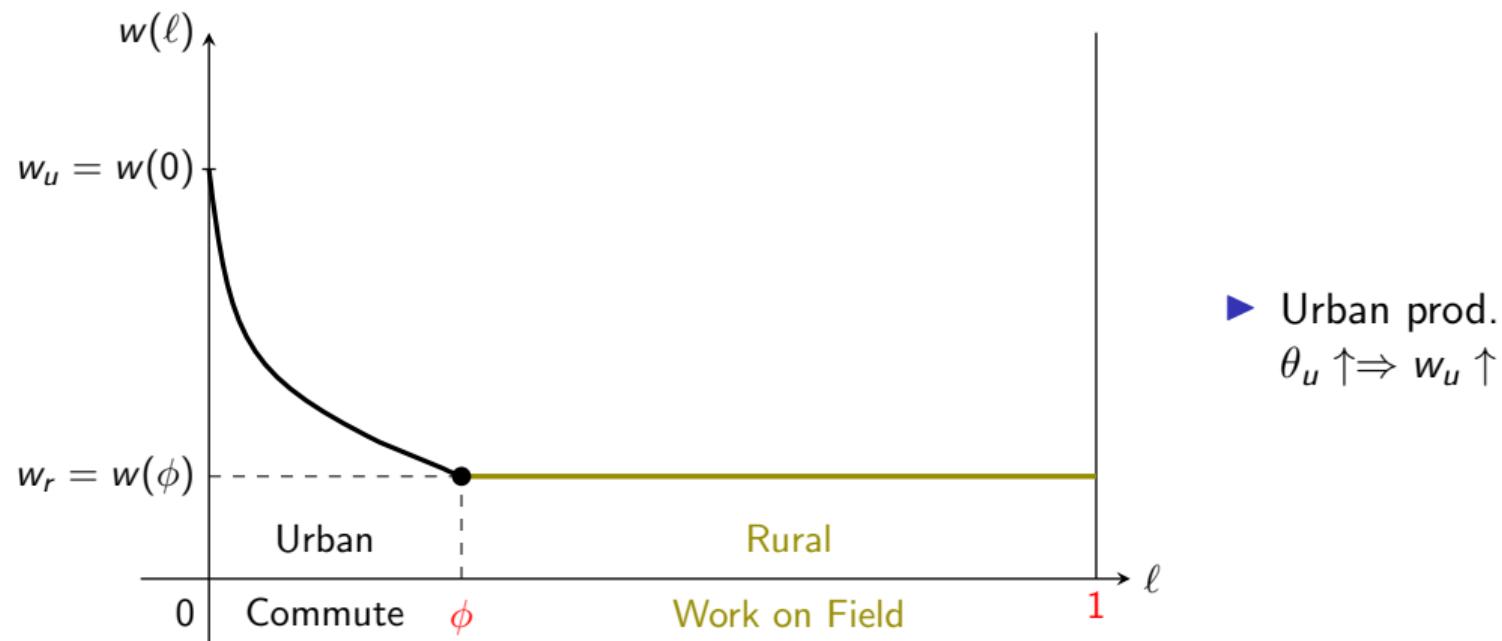


Comparative Statics: Increase in Rural Productivity

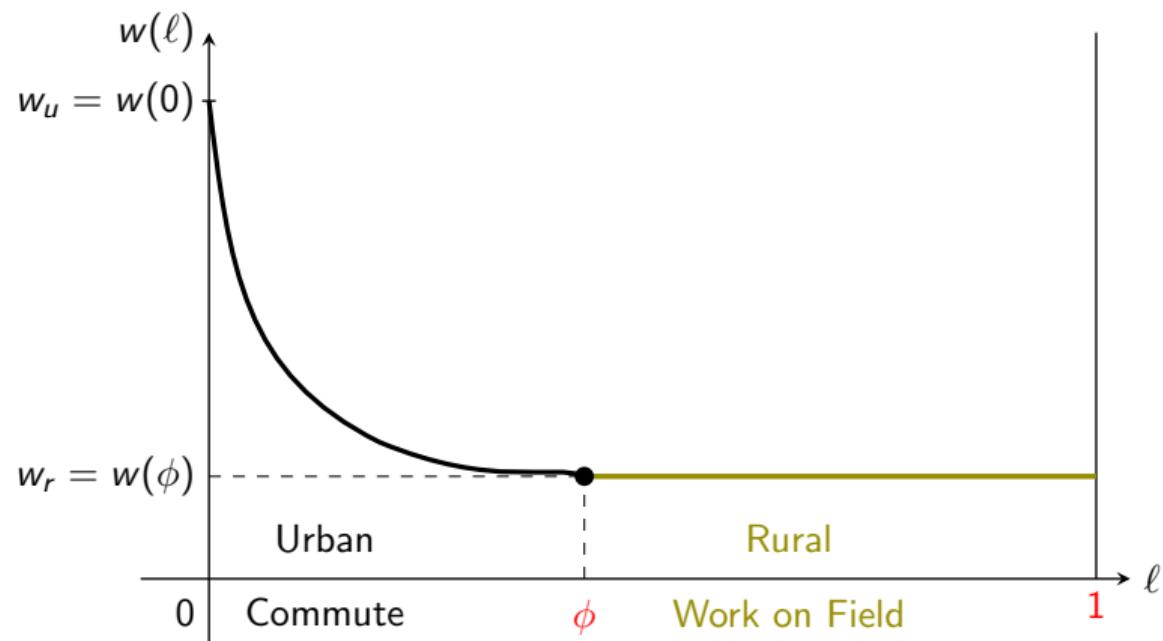


- ▶ Rural prod. $\theta_r \uparrow$
- ▶ $\theta_r \uparrow \Rightarrow (\rho_r \downarrow, w_r \downarrow)$
- ▶ Indifference point is pushed outwards.

Comparative Statics: Increase in Urban Productivity



Comparative Statics: Increase in Urban Productivity



- ▶ Urban prod.
 $\theta_u \uparrow \Rightarrow w_u \uparrow$
- ▶ all else equal, last worker will commute longer distance.

Equilibrium

- ▶ Land developers buy land and numeraire good to provide residential floorspace.
- ▶ Arbitrage across land use at the fringe pins down land values and house prices:

$$\rho_r = \frac{q_r^{1+\epsilon}}{1+\epsilon} = (1-\alpha)p\theta_r \left(\frac{L_r}{S_r}\right)^\alpha$$

- ▶ Land Market Clearing.
- ▶ Labour Market Clearing.
- ▶ Land Rents consistently defined.

Summary of Main Mechanisms

Transitory Dynamics with Rising Productivity and Falling Commuting Costs

- ▶ **Old Times:** Land is scarce. High values of farmland with respect to income due to low productivity ('food problem'). Very small and dense, *walkable* cities.

Summary of Main Mechanisms

Transitory Dynamics with Rising Productivity and Falling Commuting Costs

- ▶ **Old Times:** Land is scarce. High values of farmland with respect to income due to low productivity ('food problem'). Very small and dense, *walkable* cities.
- ▶ **Transition:** Agricultural productivity growth frees up labor and land for cities to expand. Urban workers use faster commuting modes. Cities getting large (in area) and much less dense *without* a large increase in land values.

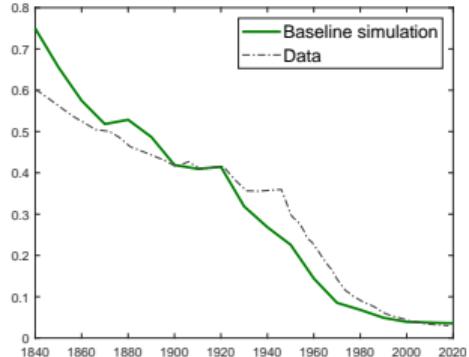
Summary of Main Mechanisms

Transitory Dynamics with Rising Productivity and Falling Commuting Costs

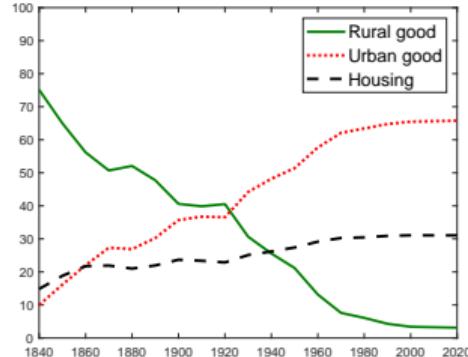
- ▶ **Old Times:** Land is scarce. High values of farmland with respect to income due to low productivity ('food problem'). Very small and dense, *walkable* cities.
- ▶ **Transition:** Agricultural productivity growth frees up labor and land for cities to expand. Urban workers use faster commuting modes. Cities getting large (in area) and much less dense *without* a large increase in land values.
- ▶ **Recent Times:** Reallocation of factors/land use slows down. Cities expand less and land prices increase more with rising productivity. Land particularly scarce in some locations.

Results

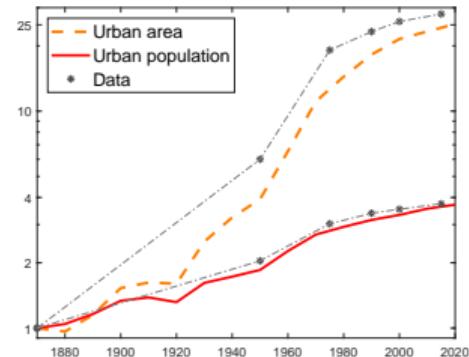
Numerical Model Results: Feed θ_{ut}, θ_{rt} from Data



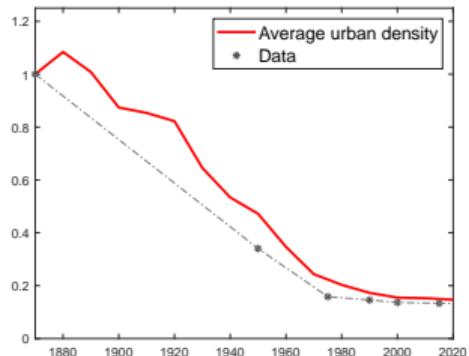
(a) Rural Employment



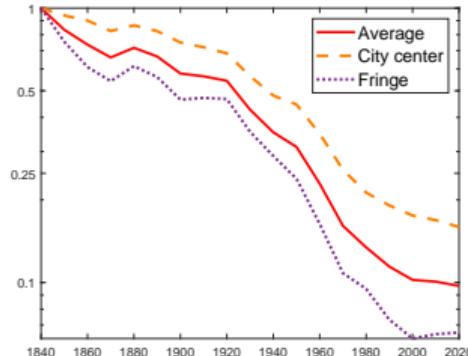
(b) Spending Shares



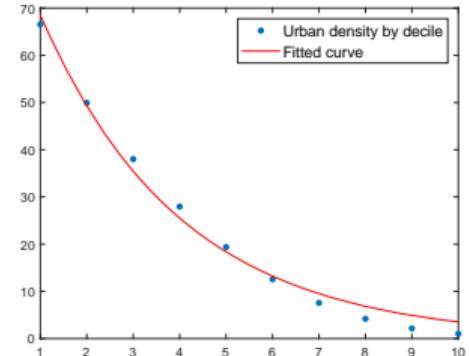
(c) Urban Population and Area



(d) Avg Urban Density

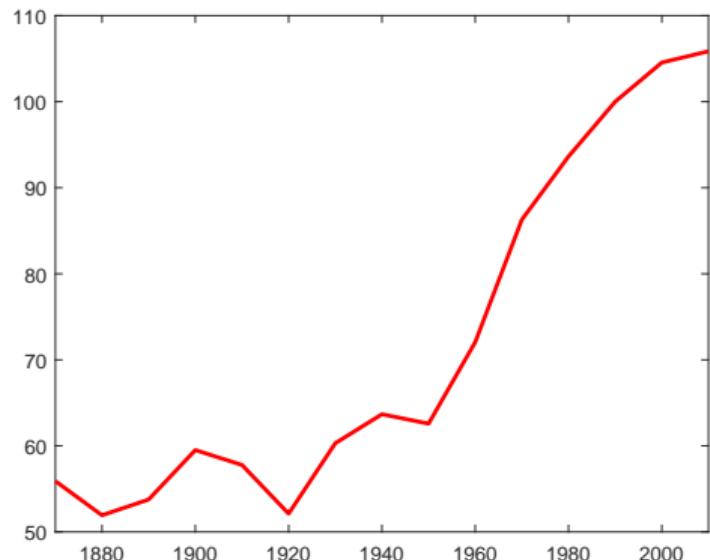


(e) Relative densities

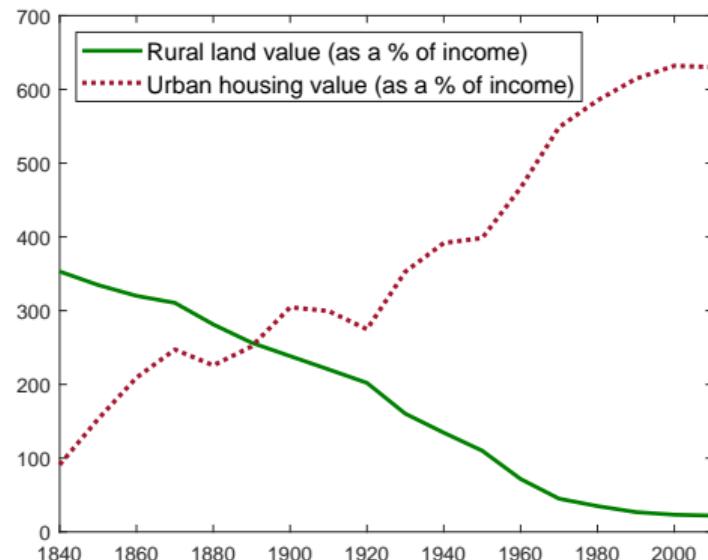


(f) Within Density gradient

Numerical Model Results



(a) House Price index (1990=1)



(b) Wealth / Income

Multiple Cities

- ▶ Larger cities are denser than smaller cities in the cross section.
- ▶ Over time, however, large cities get less dense at a faster rate.
- ▶ Our model can reproduce the French cross section of cities over time.

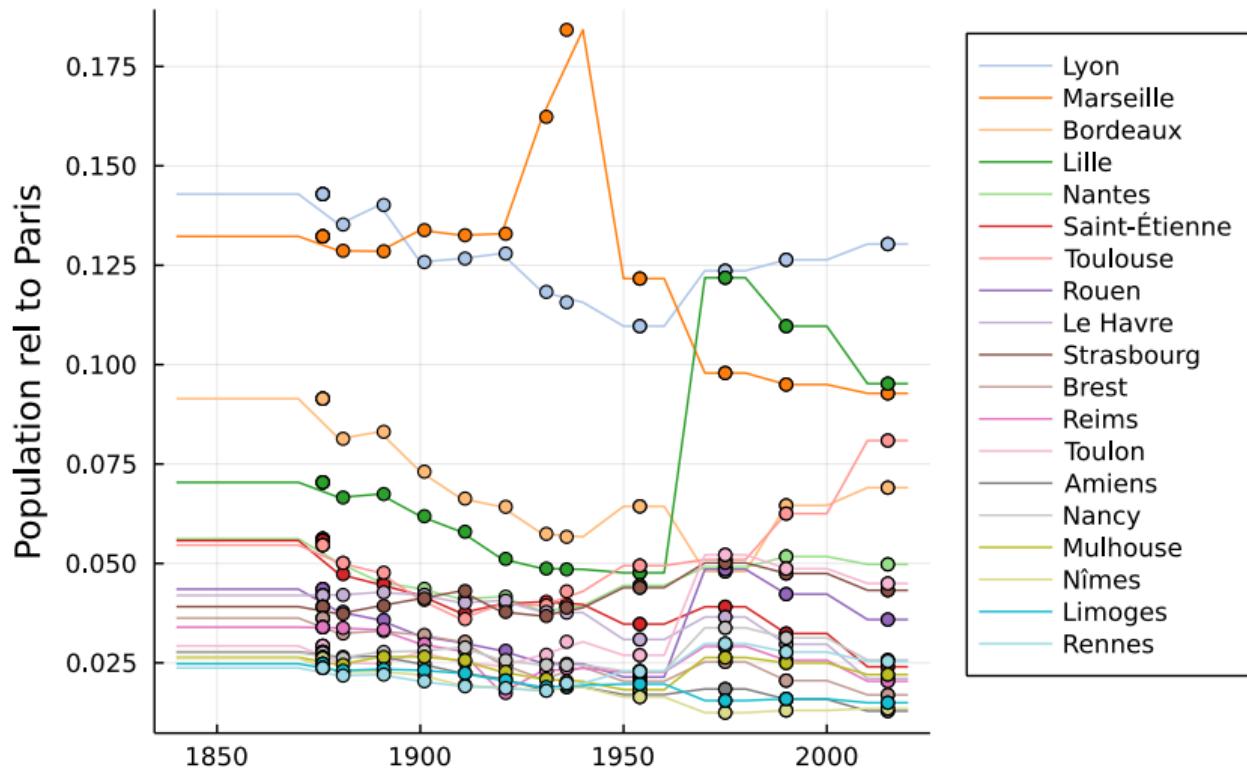
Multiple Cities

A Country with K Regions

- ▶ Split total area into K equal parts. (arbitrary)
- ▶ Assume that rural productivity $\theta_{r,k} = \theta_r, \forall k$.
- ▶ Initial level and growth of urban productivity $\theta_{u,k}$ determines city sizes.

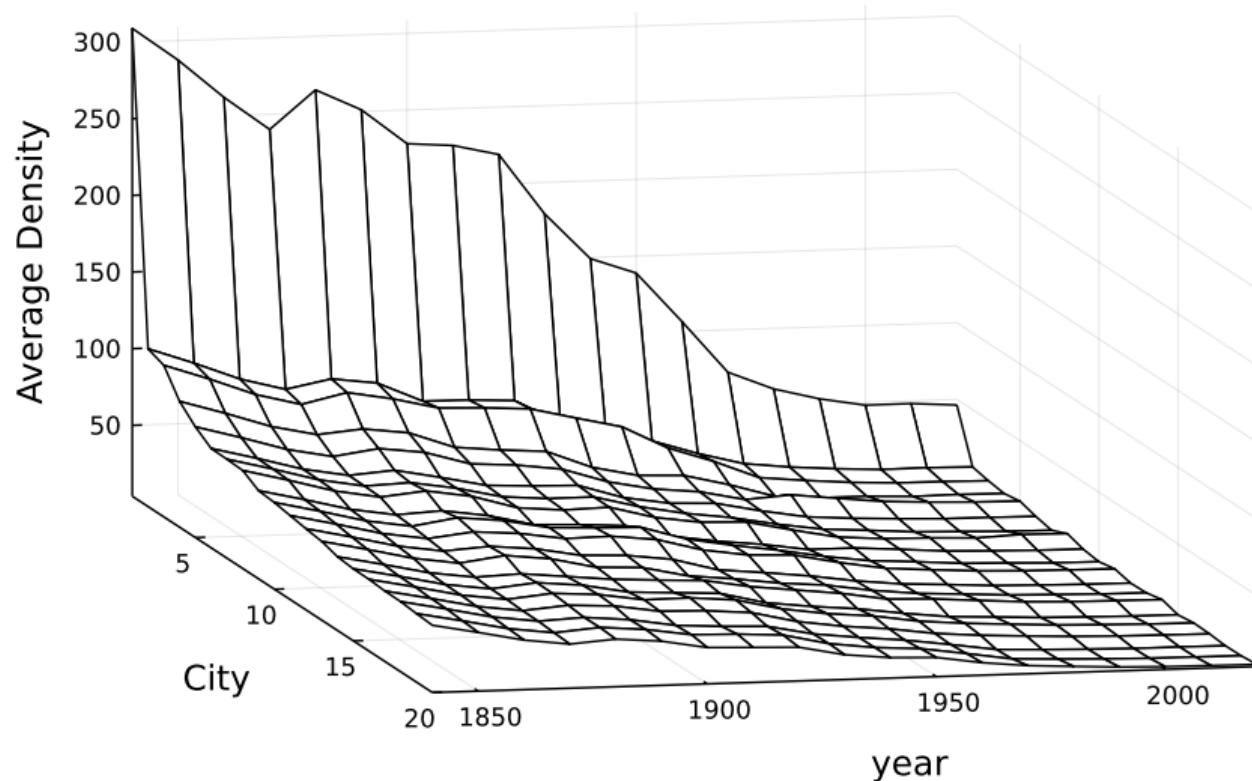
French Top 20 Population Evolution relative to Paris

Model (Lines) vs Data (Points)



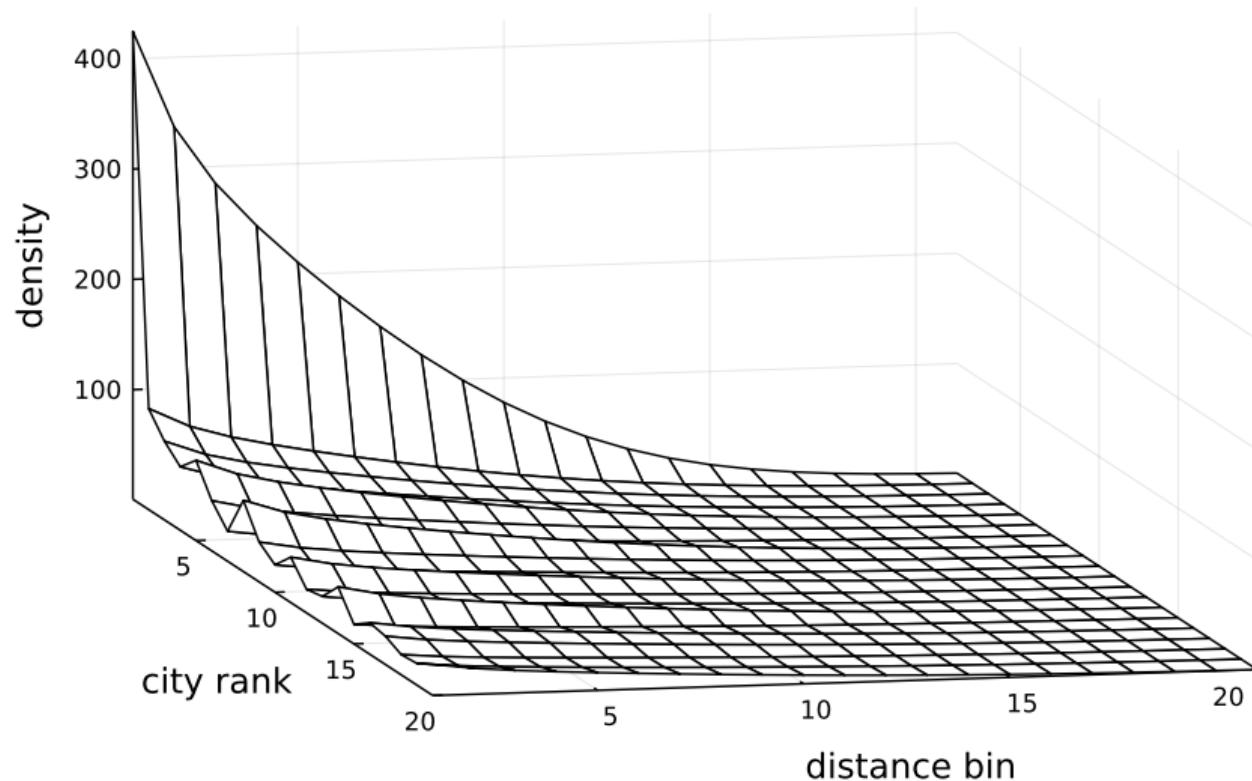
French Top 20

Density Cross Section over Time



French Top 20

year 2020 within city gradients



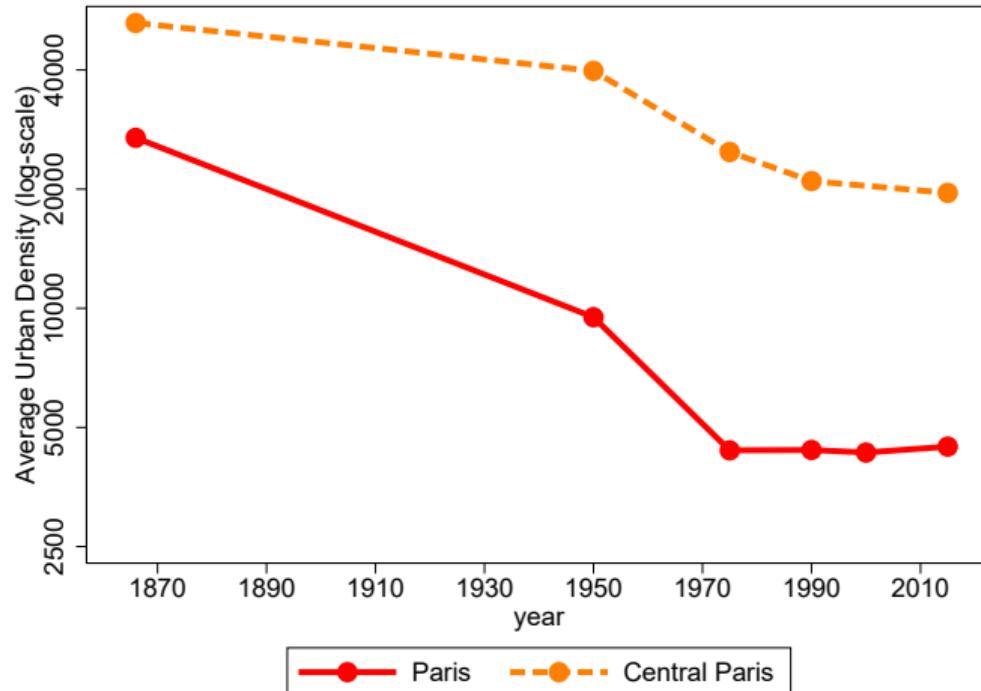
Conclusion

- ▶ Spatial general equilibrium of land use to explain
 - ▶ The evolution of the sectoral allocation of economic activity across space.
 - ▶ The evolution of the density of settlements.
 - ▶ The evolution of the distribution of land values.
- ▶ Beyond positive implications, a potentially useful tool to evaluate the welfare effects of land use restrictions.

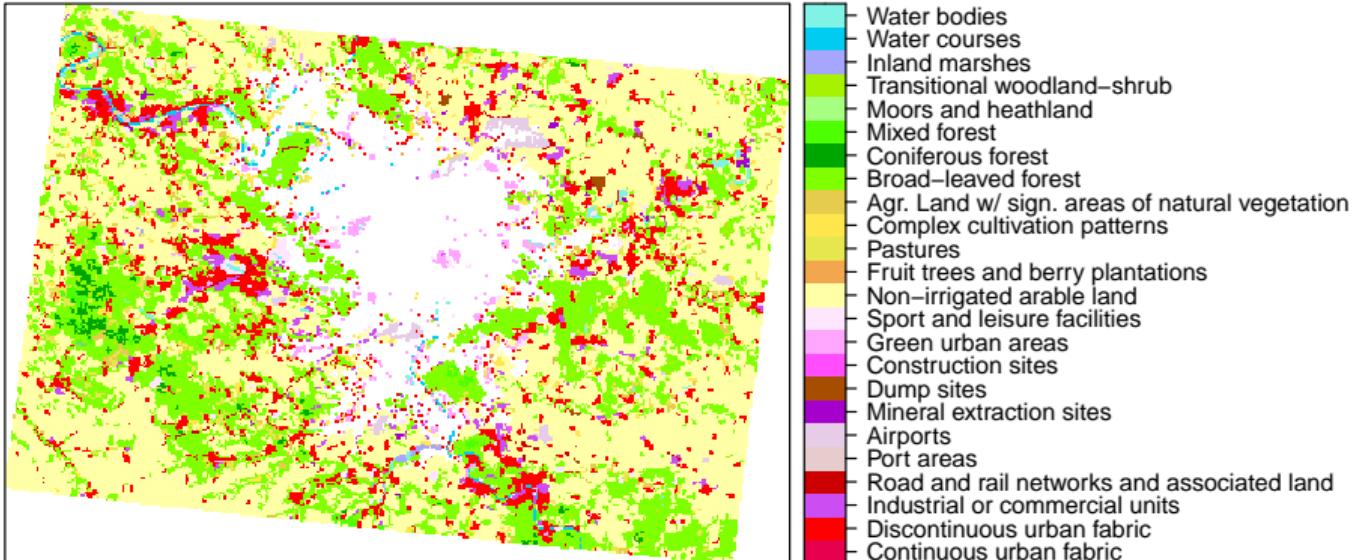
THANK YOU!

The historical fall in urban density

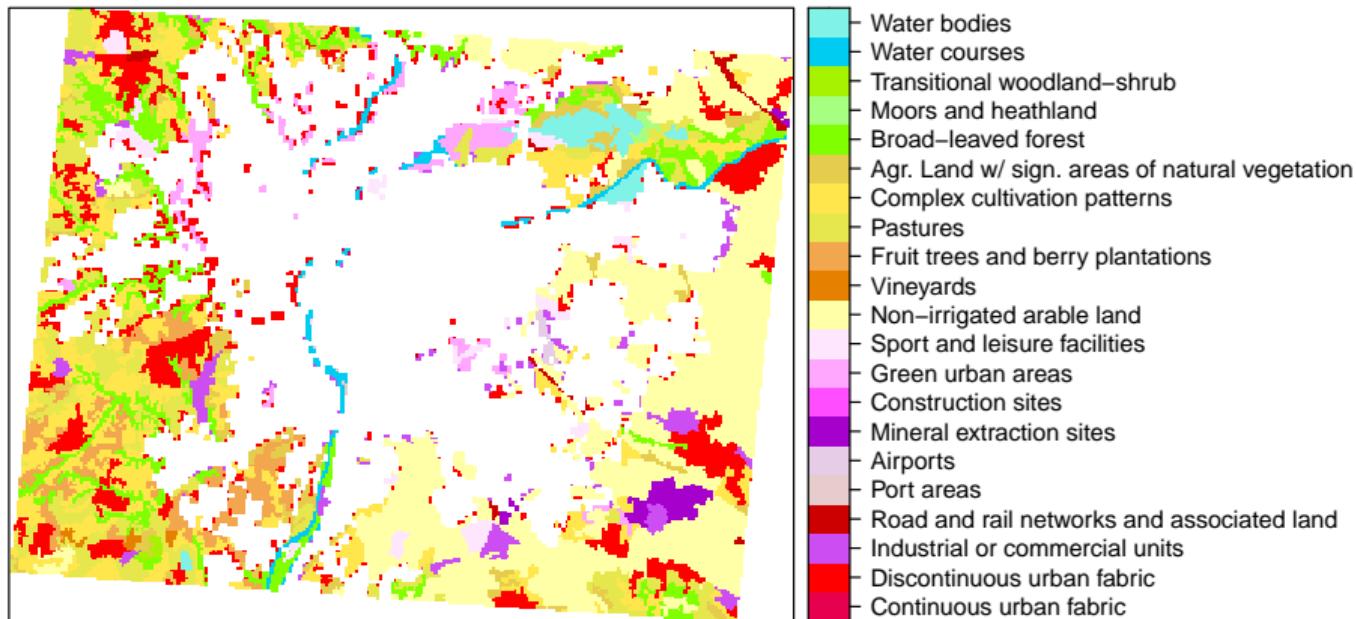
Paris



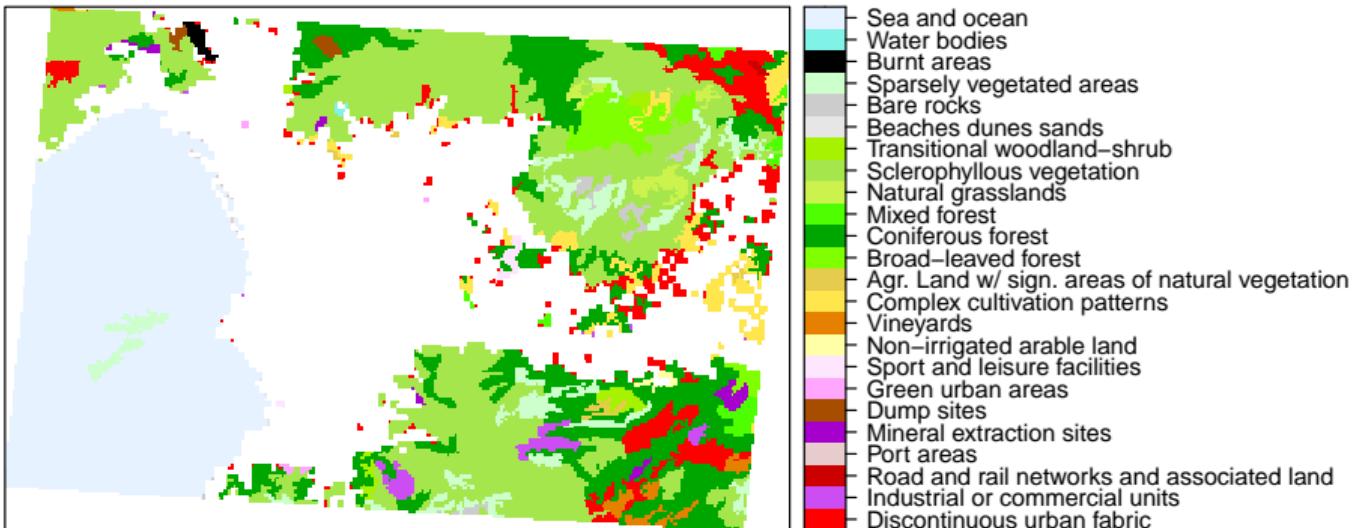
Land Use outside Paris 2020



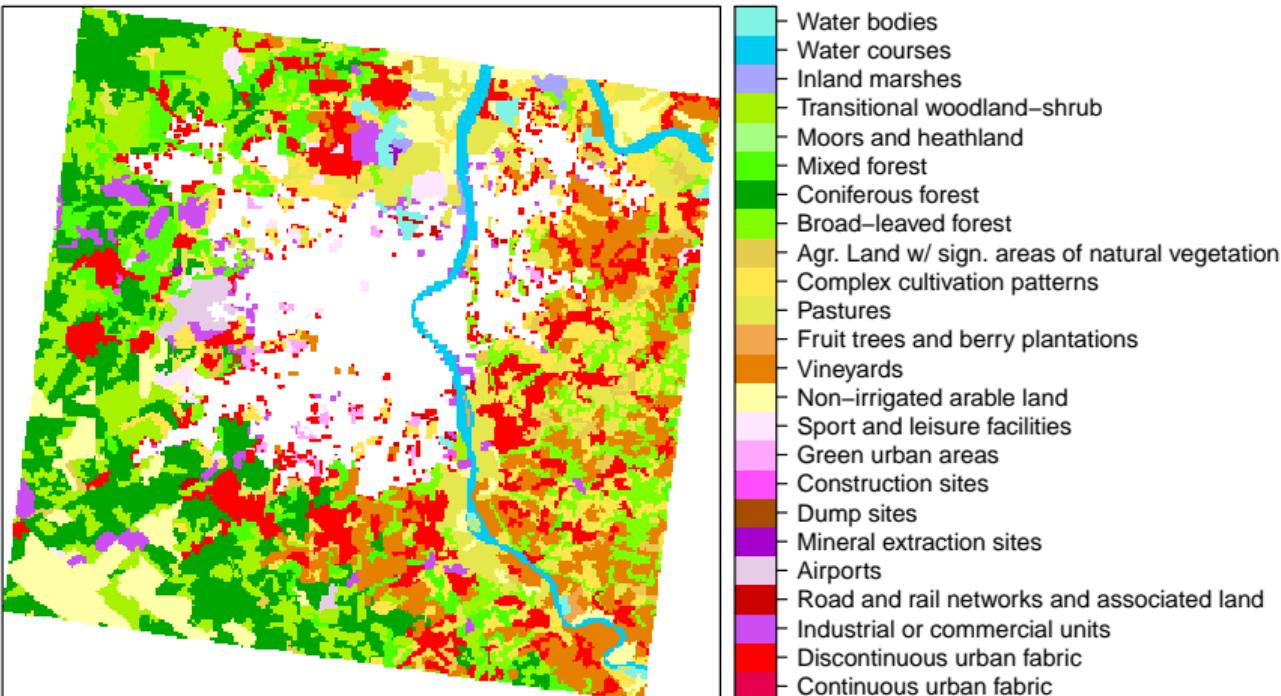
Land Use outside Lyon 2020



Land Use outside Marseille 2020

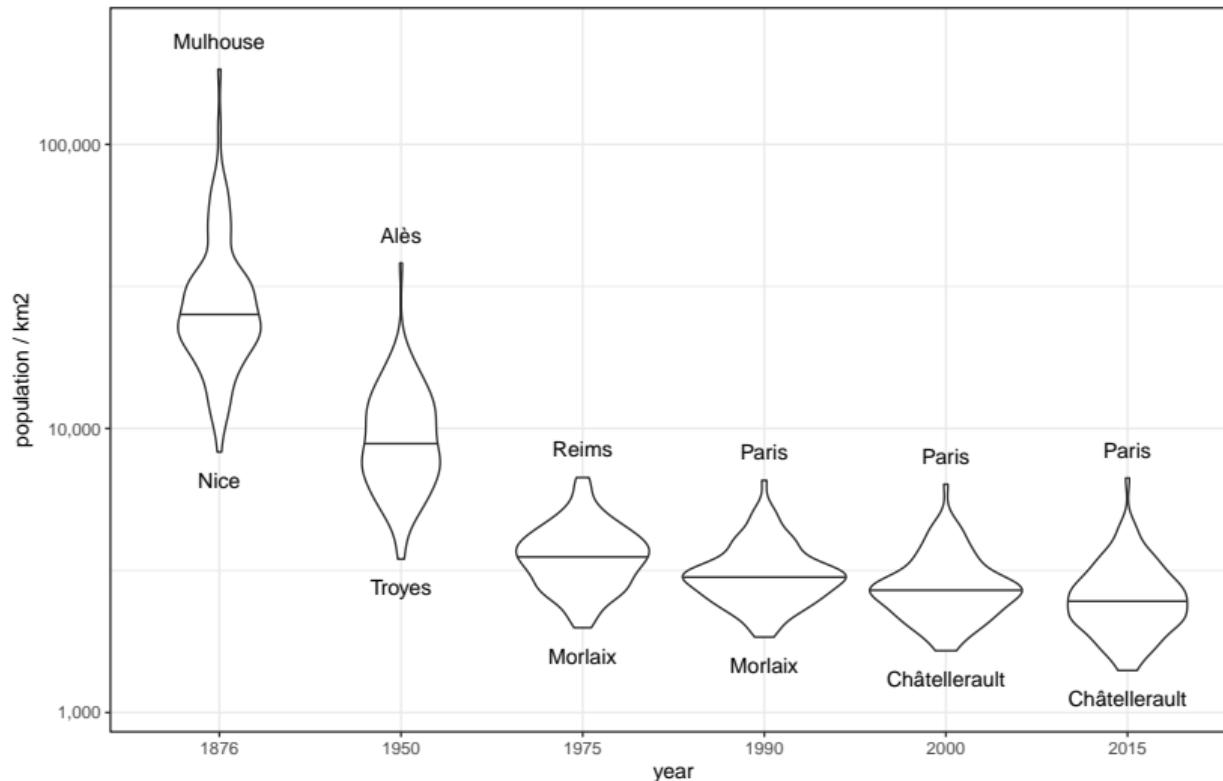


Land Use outside Bordeaux 2020

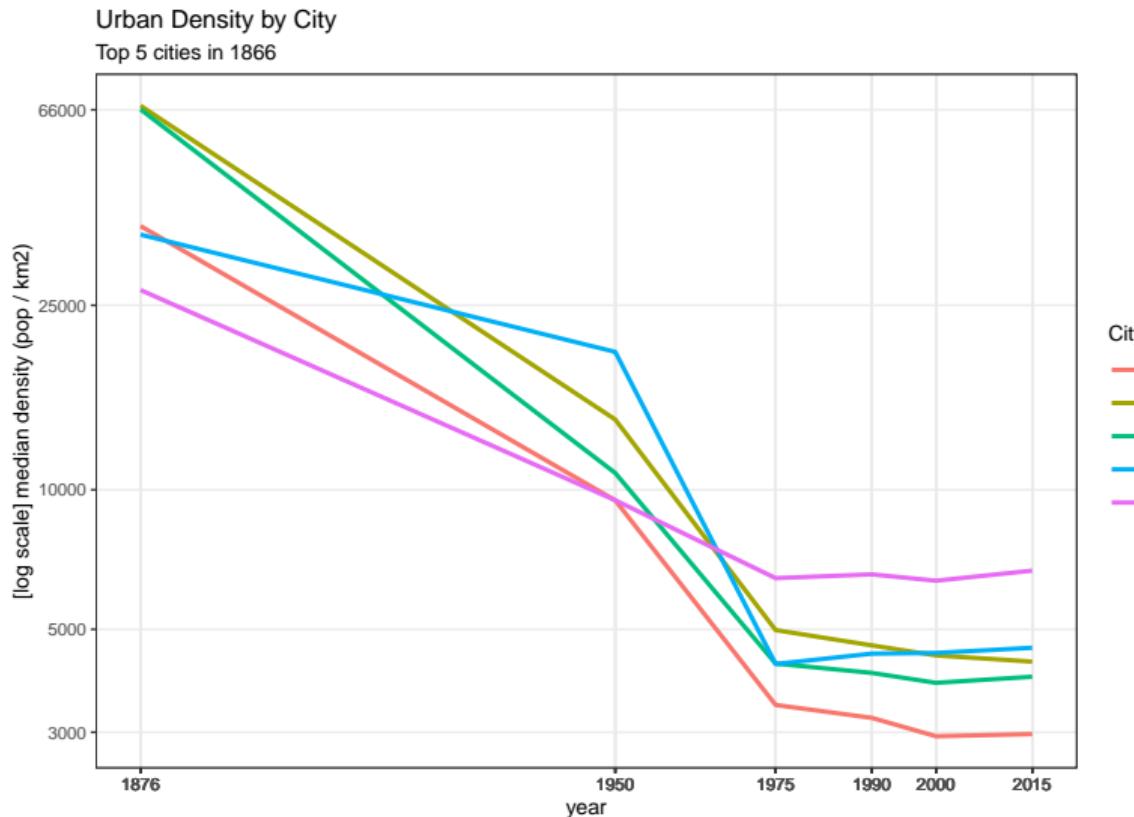


The historical fall in urban density

Urban Density over time in France

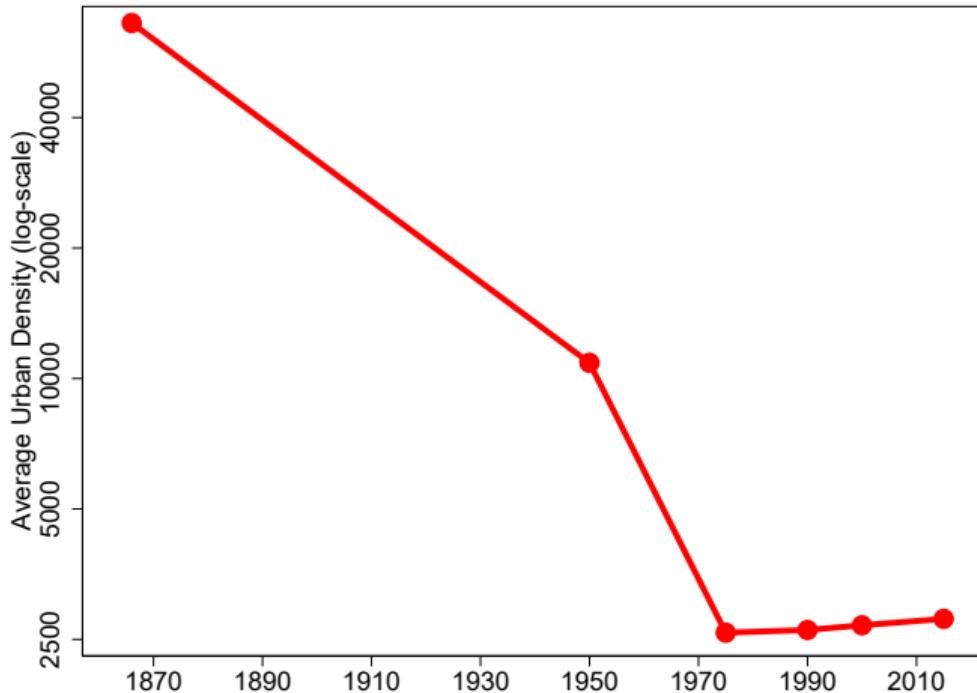


The historical fall in urban density



The historical fall in urban density

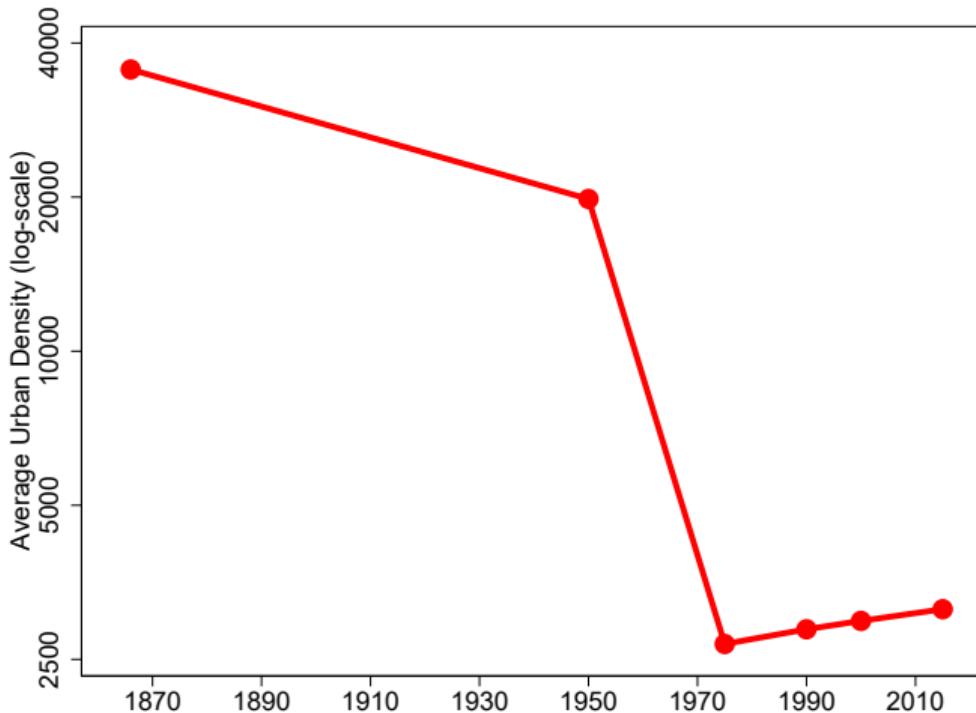
Lyon



▶ back

The historical fall in urban density

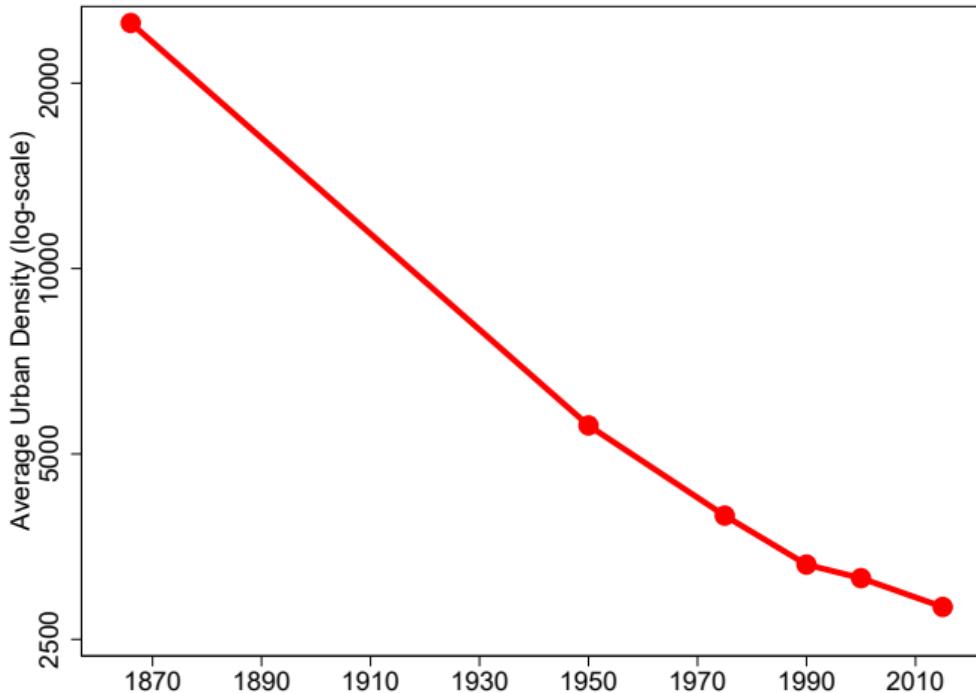
Marseille



▶ back

The historical fall in urban density

Reims



▶ back

The fall in urban density across the globe, 1990-2015

World sample of large cities

