A Spatial Explanation for the Balassa–Samuelson Effect

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Introduction

The Balassa–Samuelson effect

- Rich countries are more expensive than poor ones.
- In Penn World Tables,

$$\ln P = 0.25 \ln Y + e.$$

- This is mostly due to differences in non-tradable prices, as tradable prices vary little across countries.

Productivity-based explanations

- Balassa–Samuelson: Productivity differences in non-tradables are smaller than in non-tradables.
  - But why is technical progress slower for non-tradables?
- Kravis–Lipsey–Bhagwati:
- Non-tradables are more intensive users of the non-reproducible factor (labor).
- This raises their price with capital accumulation.
  - But the difference in labor intensity is small (Herrendorf and Valentinyi, 2007).
- We propose a simple model in which ***

Basic idea

- Tradable sectors locate to where land is cheap.
- Non-tradable sectors have to locate near consumers in big cities.
- They compete with housing for scarce urban land.
- Urban land becomes more and more scarce with development.
- Raising the relative price of non-tradables.

Stylized facts

- Land is scarce and has a non-negligible share in production.
- Demand for residential land increases with development.
- Tradable sectors move out of cities.

Outline

1. Some stylized facts about the role of land and space.
2. A simple spatial model.
3. Empirics.***

Key ingredients

Land is scarce

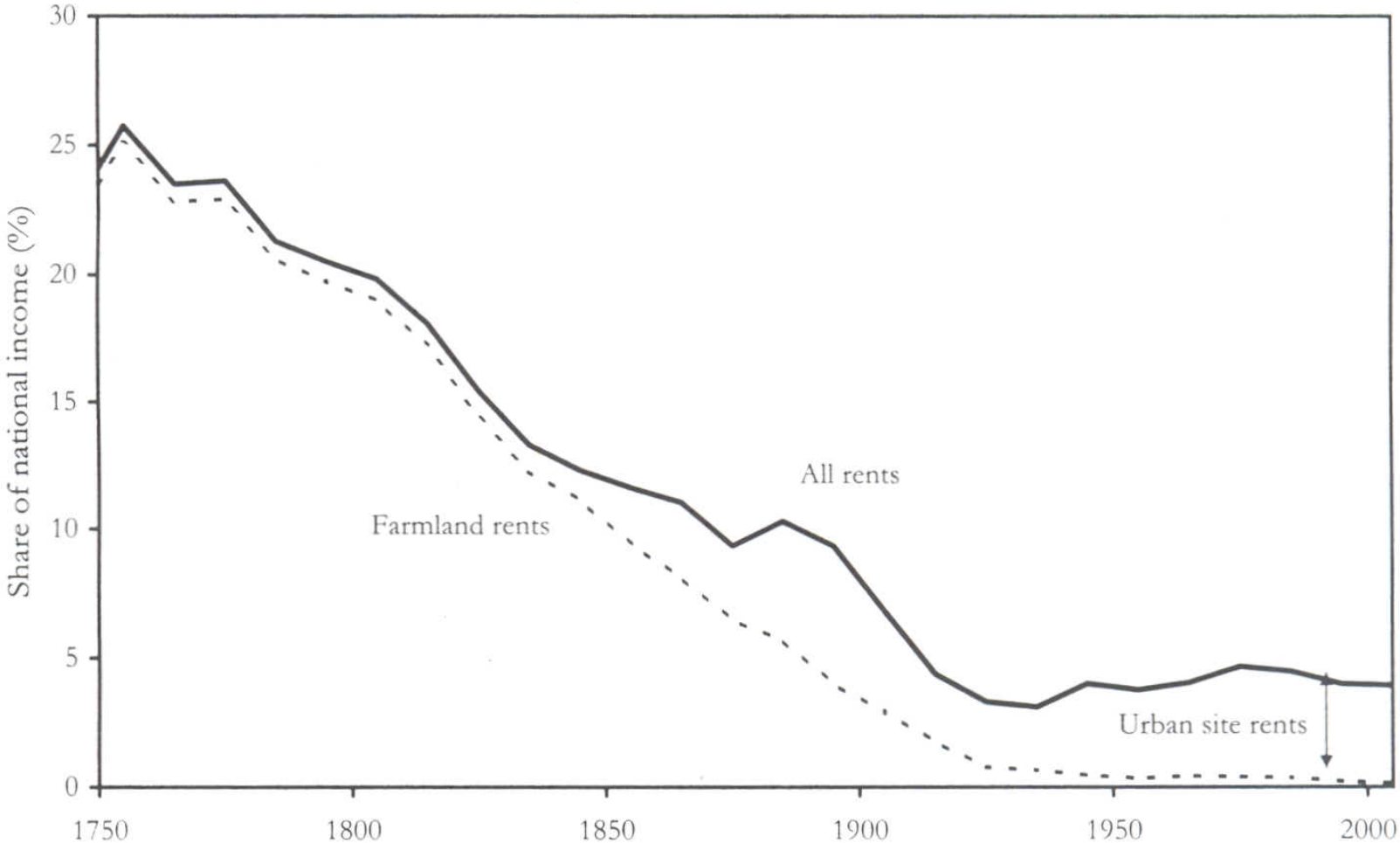
- Population density of the Earth is $42/\text{km}^2$, so land is abundant.
- However, the average person lives in an area with a population density of $7{,}300/\text{km}^2$ (LandScan 2005), so *land close to consumers* is scarce.

Land share

- Decreased from 25% in mid 1700s to around 5% now — mainly because of the shrinking share of agriculture in GDP (Clark, 2007)
- Sector income shares in various industries in the US (Herrendorf and Valentinyi, 2007)

Industry	Capital	Land	Structures	Equipment
GDP	0.32	0.05	0.13	0.14
Agriculture	0.43	0.18	0.10	0.15
Manufacturing	0.31	0.03	0.08	0.20
Services	0.32	0.05	0.15	0.12

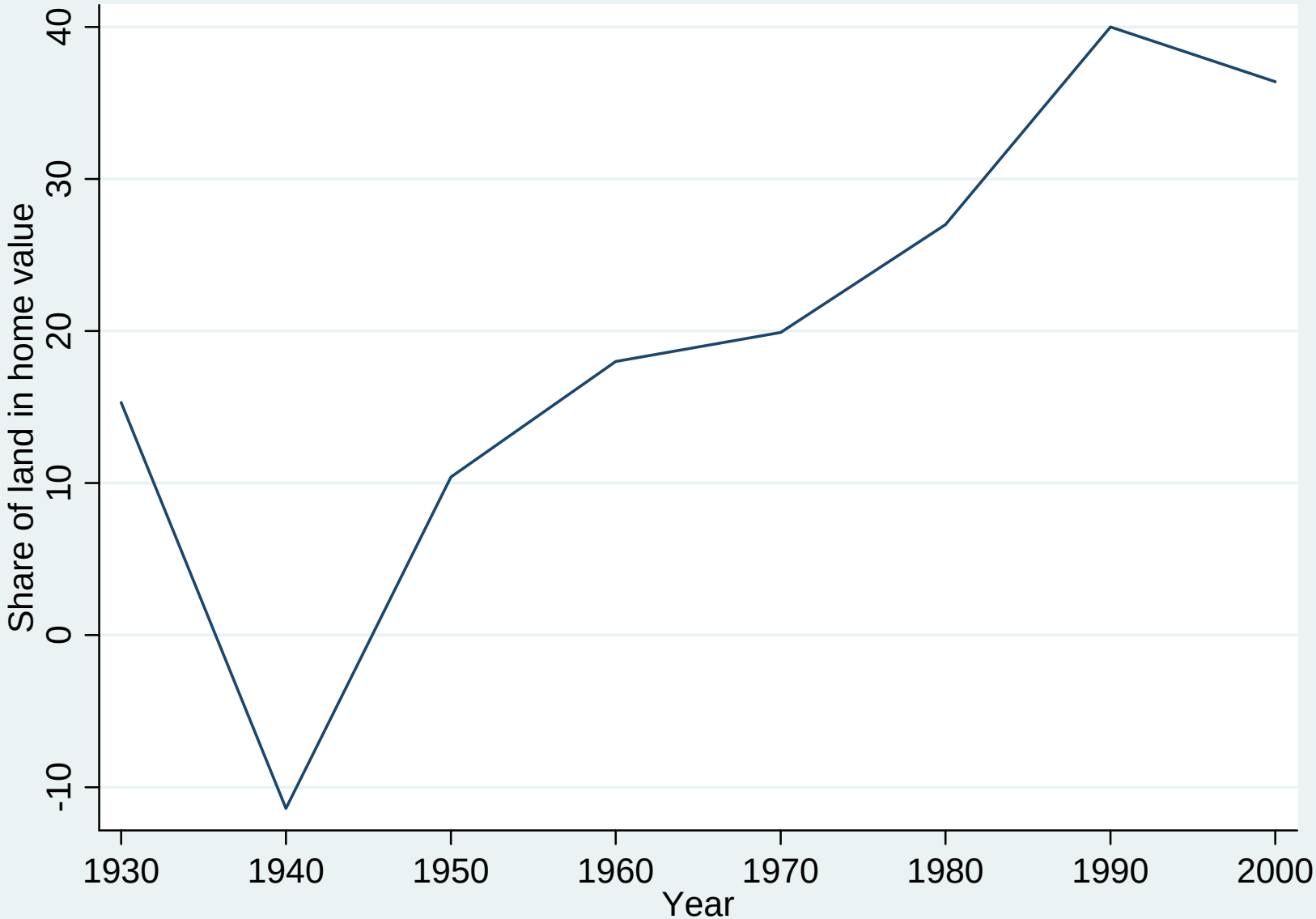
Agricultural and urban land rents in England (Clark, 2007)



Demand for residential land increases with development

- Between 1950 and 2000, the share of land in the value of a home increased from 10% to 36%. (Davis and Heathcote, 2007)
- During the same period, the price of residential land increased more than nine-fold.
- Between 1976 and 1992, residential land per capita increased by 25%. (Burchfield, Overman, Puga and Turner, 2006; Overman, Puga and Turner, 2007)

The share of land in home value (Davis and Heathcote, 2007)



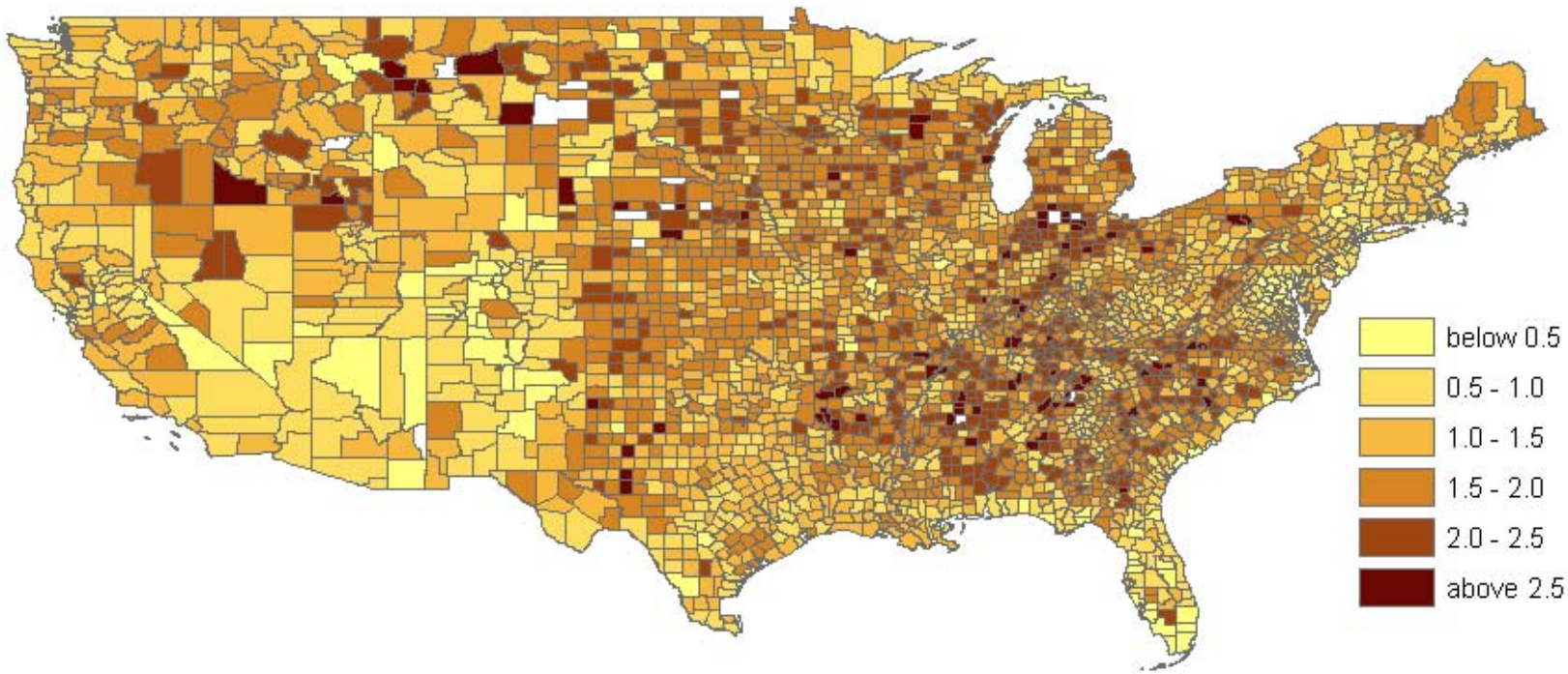
Income and the demand for housing

Explanatory variables	Dependent variable	
	Land value (log)	Number of rooms per capita (log)
Income (log)	**2.77**	**0.26**
	(0.67)	(0.08)
Population (log)	0.13	**-0.07**
	(0.18)	(0.01)
R^2	0.42	0.26
No. of obs.	46	3219

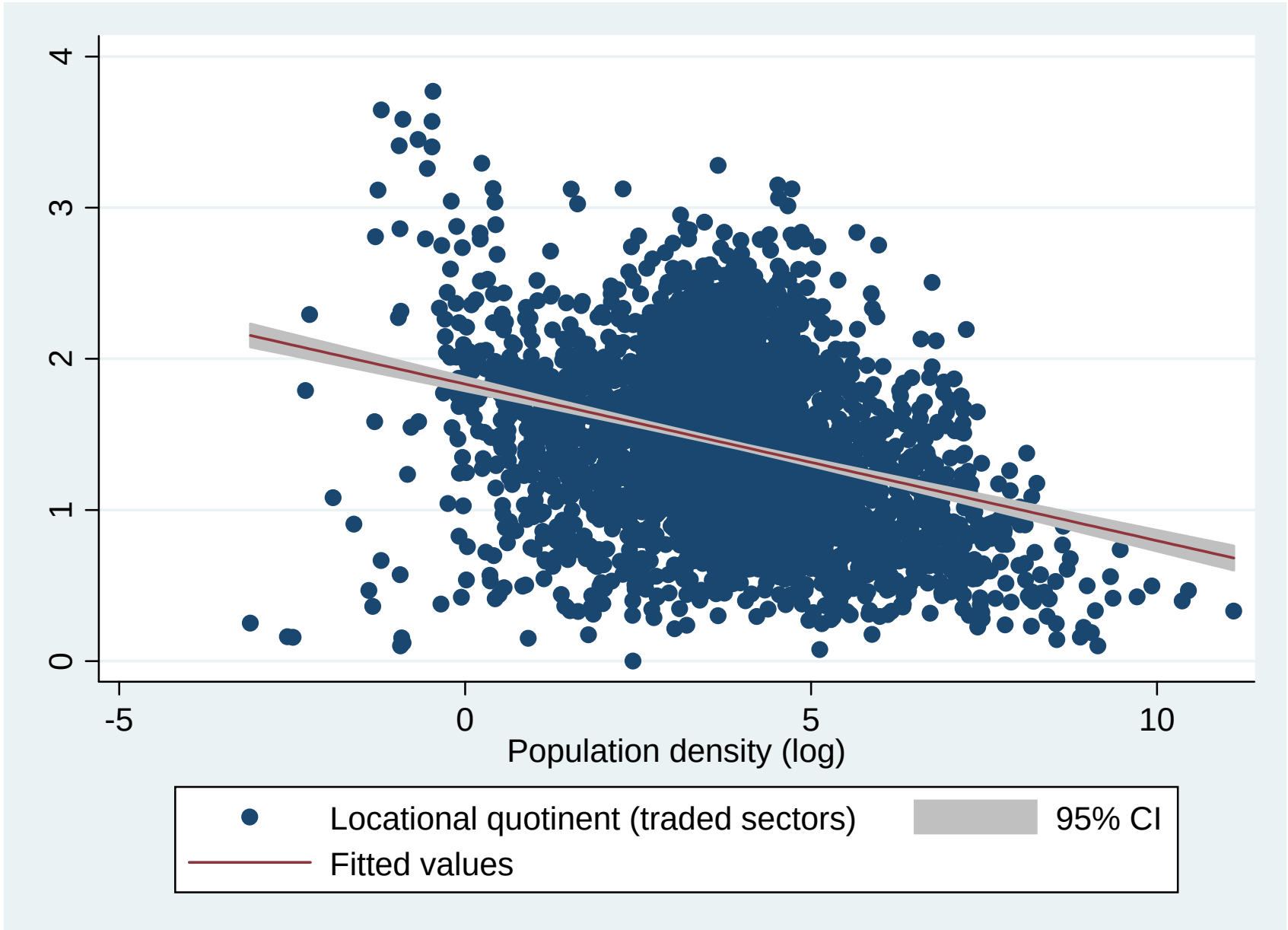
Tradable sectors move out of cities

- Burchfield, Overman, Puga and Turner (2006): commercial land is more scattered than residential land, more so in 1992 than in 1976.
- Holmes and Stevens (2004): in 1997 manufacturing is underrepresented in large cities.
- Desmet and Fafchamps (2006): manufacturing deconcentrated between 1970 and 2000.

Locational quotient of tradable sectors



Tradables stay away from dense counties



Model

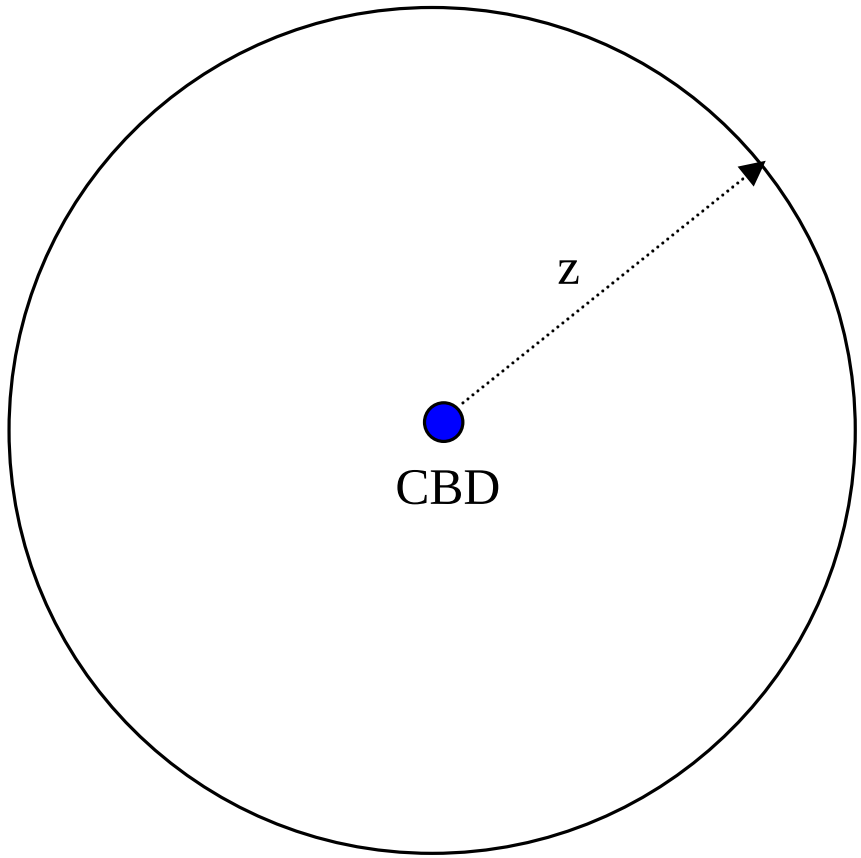
Basic structure

- There are three industries, manufacturing (m), services (s), and housing (h).
- Technology is identical in the two productive sectors.
- Goods are costly to transport.

Spatial structure

- We model countries as monocentric cities (von Thünen).
- All market exchange takes place in a central business district (CBD).
- CBD is a point in the plain.
- Residents, manufacturing and service establishments can choose their location freely in the plain.
- Location is indexed by distance to the CBD, z.

The monocentric city



Technology

- Land is the only factor of production. (We add labor later.)
- Production functions:

$$m = A_m l_m$$
$$s = A_s l_s$$
$$h = A_h l_h$$

Tastes

- Consumers have a homothetic utility over m, s and h.
- With indirect utility function

$$u(I, p_m, p_s, p_h) = \frac{I}{P(p_m, p_s, p_h)}.$$

- Assume nested structure

$$P[\Phi(p_m, p_s), p_h].$$

Transport costs

- Goods are shipped to the CBD.
- Both manufacturing and services have iceberg transport cost.
- One good i shipped from location z melts to

$$1 - \tau_i z.$$

- Services are less tradable:

$$\tau_s > \tau_m.$$

Commuting costs

- People go to the CBD to shop.
- Commuting distance z costs $\tau_h z$ fraction of the consumption bundle.
- So that indirect utility is

$$u(I, p_m, p_s, p_h) = \frac{(1 - \tau_h z)I}{P[\Phi(p_m, p_s), p_h]}.$$

- Commuting is the costliest of all,

$$\tau_h > \tau_s > \tau_m.$$

Equilibrium

- Firms maximize profits and choose location optimally.
- Households maximize utility and choose residence optimally.
- Manufacturing and service markets clear at the CBD.

Profit maximization

- Land rent at location z: $r(z)$.
- Profits for industry i at location z:

$$(1 - \tau_i z) p_i A_i l_i(z) - r(z) l_i(z).$$

- Optimum requires

$$(1 - \tau_i z) p_i A_i \leq r(z),$$

with $=$ if industry i produces at location z.

The bid rent curve

- Define a bid rent curve:

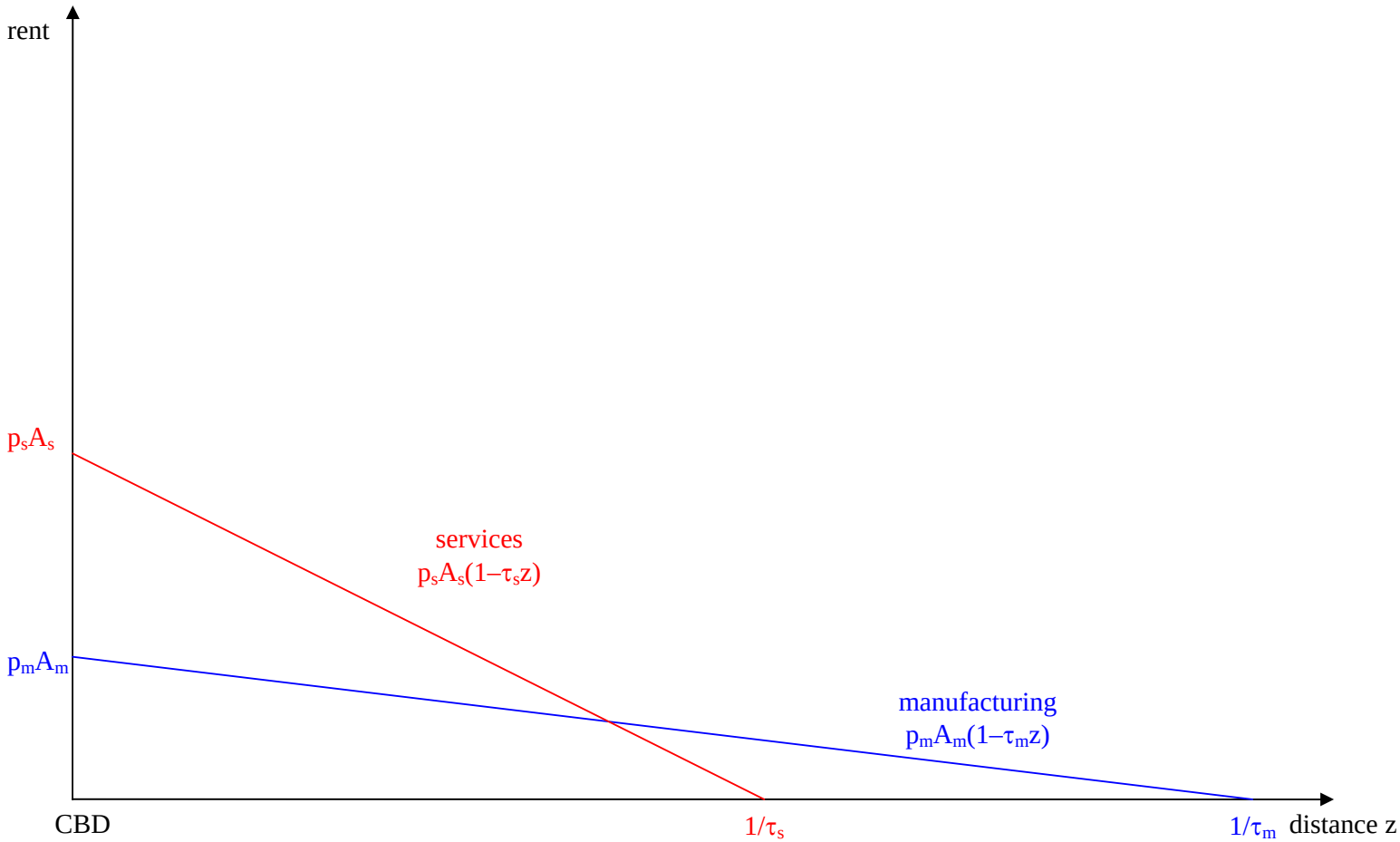
$$R_i(z) = p_i A_i(1 - \tau_i z).$$

- Profit maximization requires

$$r(z) \geq R_i(z)$$

- Industry i produces at location z only if $=$.
- Rent $r(z)$ is the upper envelope of the bid rent curves.

Bid rent curves of two industries



The bid rent curve of households

- Housing at z costs $r(z)/A_h$.
- Other two prices do not depend on residence.
- To achieve utility u at location z,

$$u = \frac{(1-\tau_h z)I}{P[\Phi(p_m, p_s), r(z)/A_h]}.$$

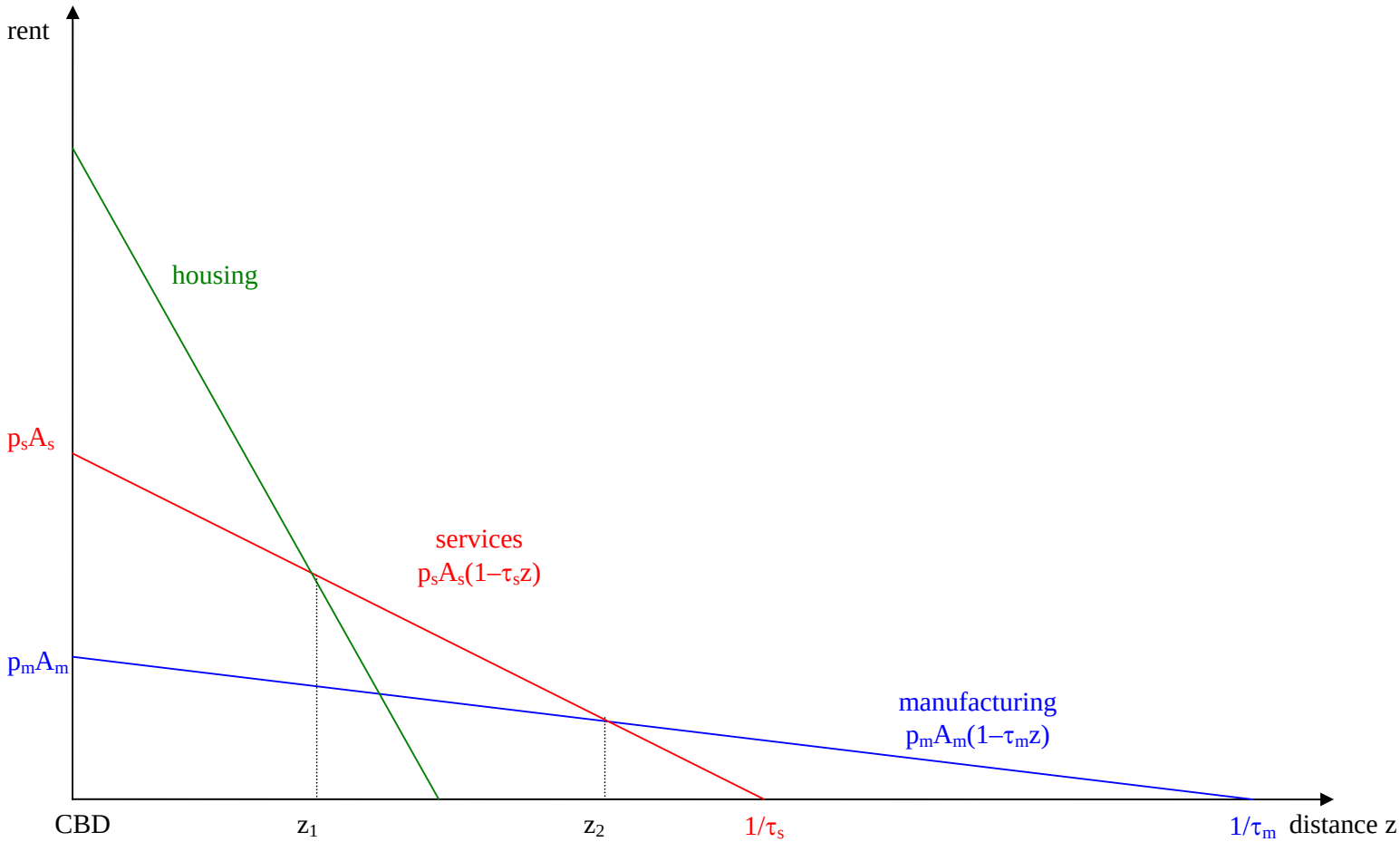
- Bid rent function

$$R_h(z) = A_h \Phi(p_m, p_s) P_2^{-1} \left[\frac{(1-\tau_h z)I}{u\Phi(p_m, p_s)} \right].$$

Equilibrium city structure

- Residents live closest to CBD, $\in [0, z_1]$.
- With a (weakly) declining population density.
- Followed by a ring of service establishments, $\in (z_1, z_2]$.
- Followed by a ring of manufacturing plants, $\in (z_2, z_3]$.
- City boundary is $z_3 = 1/\tau_m$.

Equilibrium spatial structure



Aggregate supplies

- All land between z_1 and z_2 is allocated to services.
- A fraction $\tau_s z$ gets lost in transit.
- Overall supply:

$$s = \int_{z_1}^{z_2} 2\pi z(1 - \tau_s z)dz = s(\underset{-}{z_1}, \underset{+}{z_2})$$

$$m = \int_{z_2}^{z_3} 2\pi z(1 - \tau_m z)dz = m(\underset{-}{z_2})$$

The relative price of services

- At the manufacturing–service boundary z_2,

$$p_m A_m (1 - \tau_m z_2) = p_s A_s (1 - \tau_s z_2).$$

- The relative price of services

$$\frac{p_s}{p_m} = \frac{A_m}{A_s} \frac{1 - \tau_m z_2}{1 - \tau_s z_2}.$$

- This increases if A_m / A_s does or if z_2 does (because $\tau_m < \tau_s$).

Productivity growth

What happens if A_m and A_s increase in parallel?

Balanced growth

Productivity growth does not change the relative price of services if

1. housing productivity grows at the same rate,
2. *or* demand for housing is Cobb–Douglas.

Balassa–Samuelson and the sprawl

Service prices rise with development if and only if residential land rises with development.

Proof

- The relative price of services

$$\frac{p_s}{p_m} = \frac{1 - \tau_m z_2}{1 - \tau_s z_2}.$$

- Relative demand is

$$\frac{s}{m} = \phi\left(\frac{p_s}{p_m}\right) = \phi\left(\frac{1 - \tau_m z_2}{1 - \tau_s z_2}\right),$$

  decreasing in z_2. (ϕ denotes Φ_2/Φ_1.)
- Relative supply is increasing in z_2.
- For a given z_1, there is a unique z_2 that equates relative demand and supply.
- This z_2 is increasing in z_1.

Complementary housing

- We need to restrict preferences to increase housing demand.
- Housing is complementary with m and s (Leontief).
- Productivity growth in housing is slower (zero).

Comparative statics

As productivity increases,

1. residential land increases,
2. home prices increase,
3. the rent gradient becomes steeper,
4. services become more expensive.

All are consistent with stylized facts.

Adding labor

1. Change technology to $Af(n, l)$ (n denotes labor).
2. Workers have to commute to CBD to meet their employers.

Equilibrium city structure

- Spatial structure remains the same.
- Employment density declines with distance to CBD.
- Labor productivity is lower in services.

Comparative statics

As population density increases,

1. wages decrease,
2. residential land increases,
3. home prices increase,
4. the rent gradient becomes steeper,
5. services become more expensive.

Empirics

- 1.