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 the Penn World Table,

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

- This is mostly due to differences in non-tradable prices, as tradable prices vary little across countries.
- Over time, as a country grows, its non-tradables become relatively more expensive.

Tradable and non-tradable prices

	Shampoo	Women's haircut	Relative price
Real GDP per capita	-0.018	0.387***	0.405***
	(0.027)	(0.038)	(0.041)
Observations	135	135	135
R^2	0.00	0.47	0.49

EIU price data 1997–2006

What we do

- We propose a simple spatial model in which relative price changes arise endogenously from the location choice of industries.
- Industries share the exact same technology, they only differ in *tradability*.

Basic idea

- Non-tradable sectors have to locate near consumers in big cities.
- Tradable sectors locate to where land is cheap.
- Urban land becomes more and more scarce with development.
- This raises urban rents, raising the relative price of non-tradables.

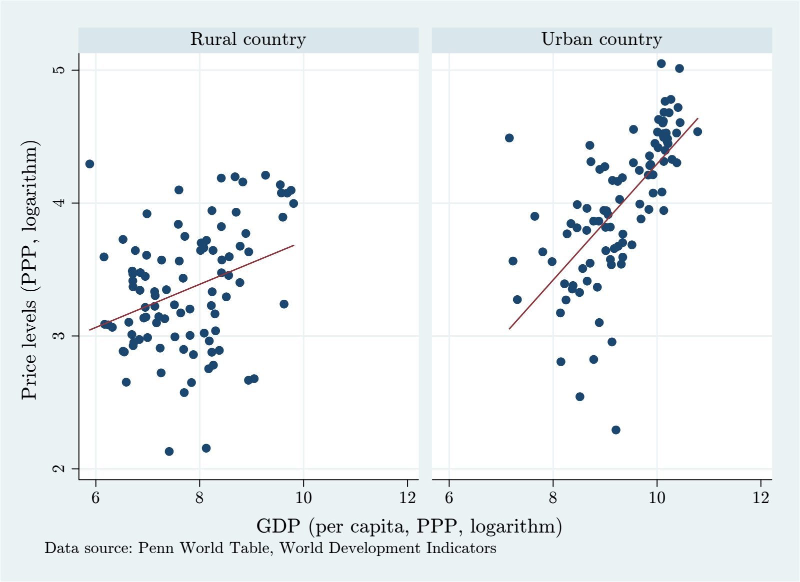
Technology-based explanations

- Balassa–Samuelson: Productivity growth in non-tradables is slower than in tradables.
- Bhagwati–Kravis–Lipsey: Non-tradables are more intensive users of the non-reproducible factor (labor).
- This raises their price with capital accumulation.

Issues with technology-based explanations

- Is it just a coincidence that technology is correlated with tradability?
- Why does Balassa–Samuelson work in some cases and not in others?

Balassa–Samuelson is stronger in urban countries



Not everything is technology

	Frozen chicken	Fresh chicken	Relative price
Real GDP per capita	0.072**	0.158***	0.086***
	(0.029)	(0.030)	(0.021)
Observations	125	125	125
R^2	0.05	0.21	0.13

EIU price data 1997–2006

Model

Environment

Basic structure

- There are two sectors, manufacturing (m) and services (s).
- We study how the relative prices of these industries depend on their choice of location...
- ...and how location varies with development.

Spatial structure

- We use the monocentric city model.
- All market exchange takes place in a central business district (CBD), which is a point on the real line.
- Manufacturing and service establishments can choose their location freely on the real line.
- Location is indexed by distance to the CBD, z.

Technology

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

$$m = A_m l_m$$
$$s = A_s l_s$$

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

$$e^{-\tau_i z}.$$

- Services are less tradable:

$$\tau_s > \tau_m.$$

Characterizing the supply side

Profit maximization·

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

$$e^{-\tau_i z} p_i A_i l_i(z) - r(z) l_i(z).$$

- Optimum requires

$$e^{-\tau_i z} p_i A_i \leq r(z),$$

with equality if industry i produces at location z.

The bid rent curve·

- Define a bid rent curve:

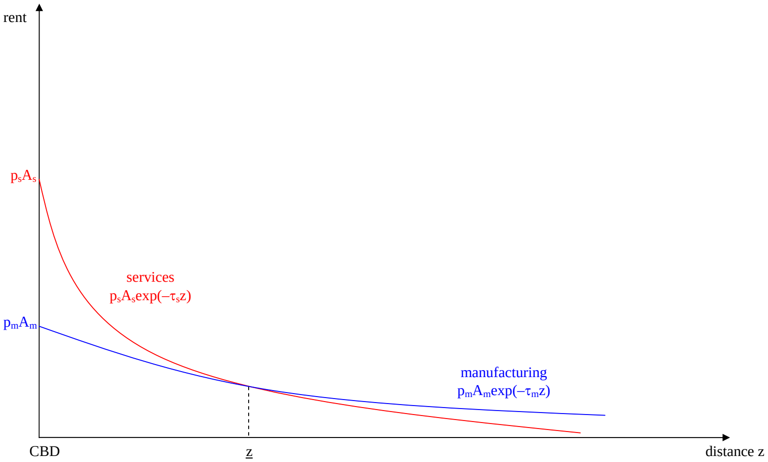
$$R_i(z) = p_i A_i e^{-\tau_i z}.$$

- Profit maximization requires

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

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

Bid rent curves of two industries



Optimal location choice·

- Services are produced between 0 and $\bar{z}$:

$$s = \int_0^{\bar{z}} A_s e^{-\tau_s z} dz.$$

- Manufacturing takes place between $\bar{z}$ and ∞.

$$m = \int_{\bar{z}}^{\infty} A_m e^{-\tau_m z} dz.$$

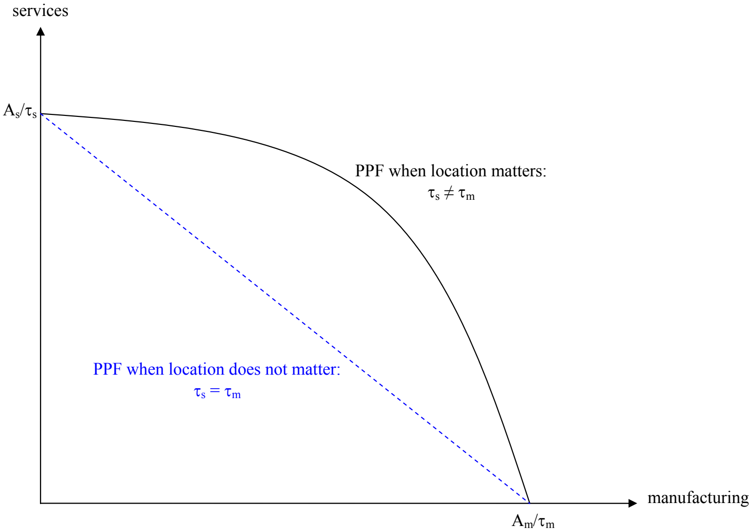
- Production possibilities frontier:

$$s = \frac{A_s}{\tau_s} \left[1 - \left(\frac{m}{A_m/\tau_m} \right)^{\tau_s/\tau_m} \right]$$

- Relative price is pinned down by MRT:

$$\frac{p_s}{p_m} = \frac{A_m}{A_s} e^{(\tau_s - \tau_m)\bar{z}}.$$

The production possibilities frontier



Balassa–Samuelson with location-specific land

- Trade costs make land location specific: “urban” land is different from “rural” land.
- Services are more intensive users of “urban” land.

Proposition

Assume A_m/A_s is constant. Service price increases if and only if demand for “urban” land ($\bar{z}$) increases relative to “rural” land.

Closing the model

Development and urban land

Demand for urban land may increase for a number of reasons.

1. Structural change shifts demand towards services.
2. Development increases the demand for residential land.
3. Manufacturing shipping costs decline disproportionately.

Empirical evidence

Question

Does sector location affect the relationship between prices and income?

Data

- We use city-level product price data from the Economist Intelligence Unit.
- We construct measures of industry location from U.S. Census data. (Assuming that tradability differences are similar for all countries.)
- GDP per capita comes from WDI, other sector-level measures from the NBER productivity database.

EIU data

- Collected for cost-of-living comparisons.
- 150 products are surveyed.
- 140 cities in 89 countries.
- For each product–city pair, we take average USD price between 1997 and 2006.

Industry location

- "County Business Patterns" records the number of plants by county and NAICS sector: n_{ic}.
- Decennial Census has population density for each county, d_c.
- For each sector i, we calculate the population density of its *average plant*:
$$\rho_i = \frac{\sum_c n_{ic} d_c}{\sum_c n_{ic}}$$
- Sectors with high ρ_i locate closer to residents.
- We match EIU products to sectors in which they are *produced*.

Sectors close to residents

Product/Sector	Population density
Taxi: initial meter charge	
Taxi and Limousine Service	1316
Compact disc album	
Manufacturing Magnetic and Optical Media	1268
One good seat at cinema	
Motion Picture and Video Industries	1197
Four best seats at theatre	
Performing Arts Companies	1127
Babysitter's rate per hour	
Other Personal Services	966
Laundry (one shirt)	
Drycleaning and Laundry Services	832

Sectors far from residents

Product/Sector	Population density
Frozen fish fingers (1 kg)	
Seafood Product Preparation and Packaging	115
Electricity, monthly bill	
Electric Power Generation and Distribution	147
Chicken: frozen (1 kg)	
Animal Slaughtering and Processing	161
Lamb: chops (1 kg)	
Animal Slaughtering and Processing	161
Insect killer spray (330 g)	
Pesticide and Fertilizer Manufacturing	168
Regular unleaded petrol (1 l)	
Oil and Gas Extraction	172

Industry location and the Balassa–Samuelson effect

	Dependent variable: product price (log)			
	[1]	[2]	[3]	[4]
GDP per capita (log)	0.148***	0.139***		
	[0.027]	[0.027]		
GDP per capita × proximity		0.034***		0.051***
		[0.009]		[0.014]
GDP per capita × agriculture			0.183***	0.192***
			[0.029]	[0.034]
GDP per capita × manufacturing			0.099***	0.094***
			[0.024]	[0.024]
GDP per capita × services			0.201***	0.182***
			[0.037]	[0.038]
Product fixed effects	YES	YES	YES	YES
Observations	37552	33593	37552	33593
Clusters	89	89	89	89
R-squared	0.954	0.954	0.955	0.955

Standard errors (in brackets) are clustered by countries.
*** p<0.01, ** p<0.05, * p<0.1

Industry location and labor intensity

	Dependent variable: price (log)		
	[5]	[6]	[7]
GDP per capita (log)	0.083***	0.095***	0.084***
	[0.024]	[0.025]	[0.024]
GDP per capita x proximity	0.091***		0.086***
	[0.016]		[0.014]
GDP per capita x labor share		0.187*	0.087
		[0.097]	[0.090]
Product fixed effects	YES	YES	YES
Observations	16698	16698	16698
Clusters	89	89	89
R-squared	0.946	0.946	0.946

Robust standard errors in brackets are clustered by countries

*** p<0.01, ** p<0.05, * p<0.1

Results

- Prices of goods produced closer to residents are more sensitive to income.
- "Urban" goods have a B–S elasticity of $0.18 - 0.20$, "rural" goods $-0.04 - 0.09$.
- This effect is robust to controlling for major sectoral groupings and labor shares.

Conclusions

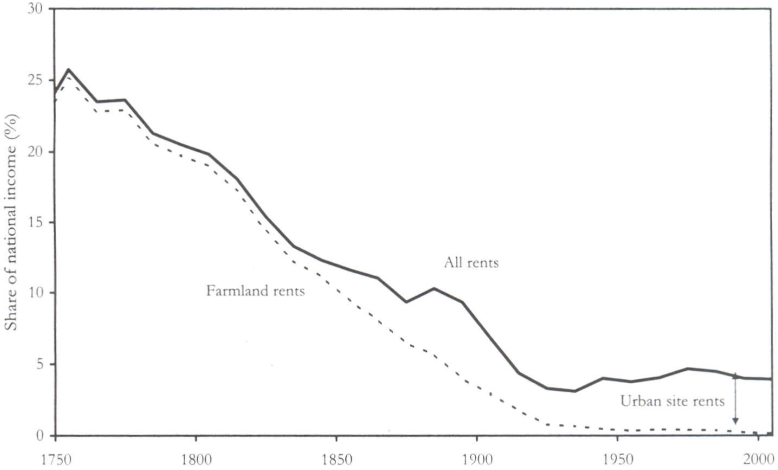
Conclusions

- We incorporated a tractable model of industry location into a macro model.
- If sectors differ in their tradability, this spatial model yields interesting sectoral shifts with development.
- The Balassa–Samuelson effect is stronger for sectors that locate close to consumers.

Appendix

Land and location matter

Why has land disappeared from macro? (Clark, 2007)



Land is scarce

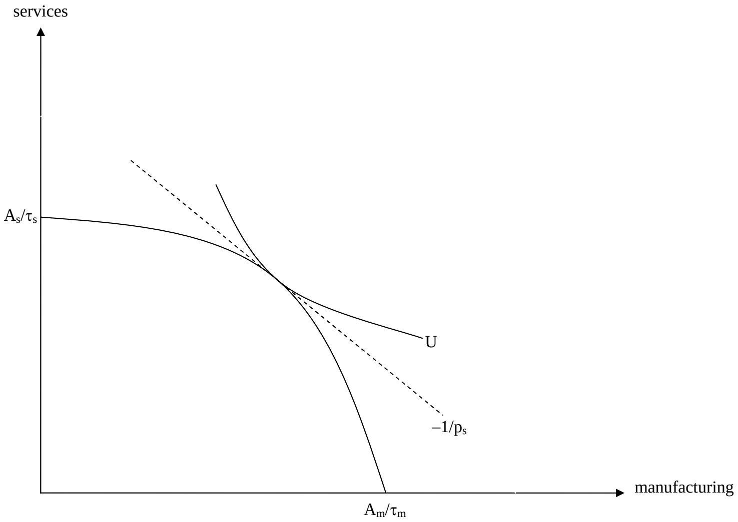
- Population density of the Earth is $42/\mathrm{km}^2$, so land is abundant.
- However, the average person lives in an area with a population density of $7{,}300/\mathrm{km}^2$ (LandScan 2005), so *land close to consumers* is scarce.

The share of land in GDP·

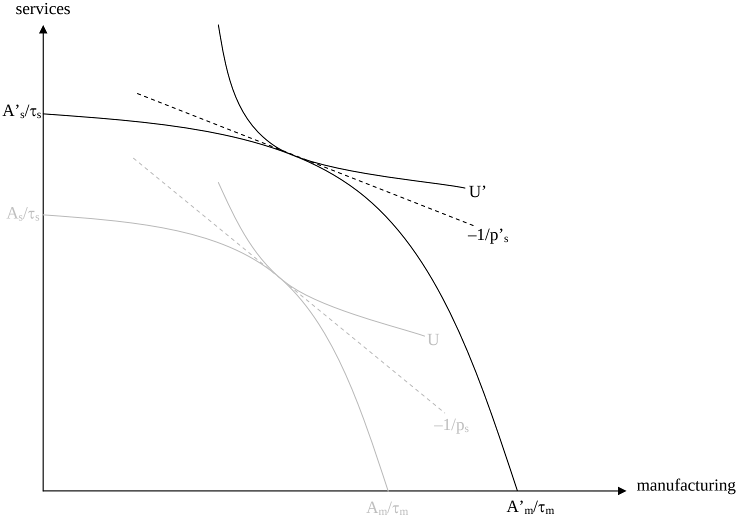
Sector income shares in various industries in the US (Herrendorf and Valentinyi, 2007)

Industry	Capital	Land	Structures+Equipment
GDP	0.32	0.05	0.27
Agriculture	0.43	0.18	0.25
Manufacturing	0.31	0.03	0.28
Services	0.32	0.05	0.27

Structural change



Structural change



Introducing housing

- We introduce homothetic preferences for housing.
- Housing is complementary with consumption:

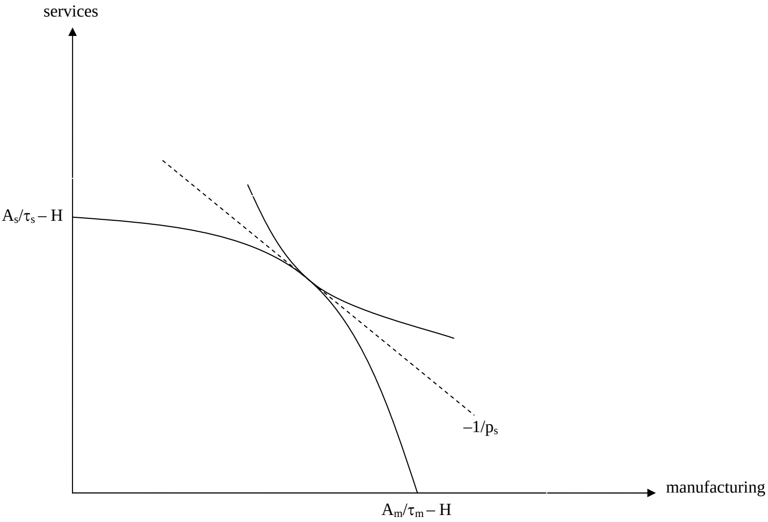
$$u(m, s, h) = \min\{m^{\gamma} s^{1-\gamma}, h/H\}.$$

- No technical progress in housing (or slower than in manufacturing).
- High commuting costs.

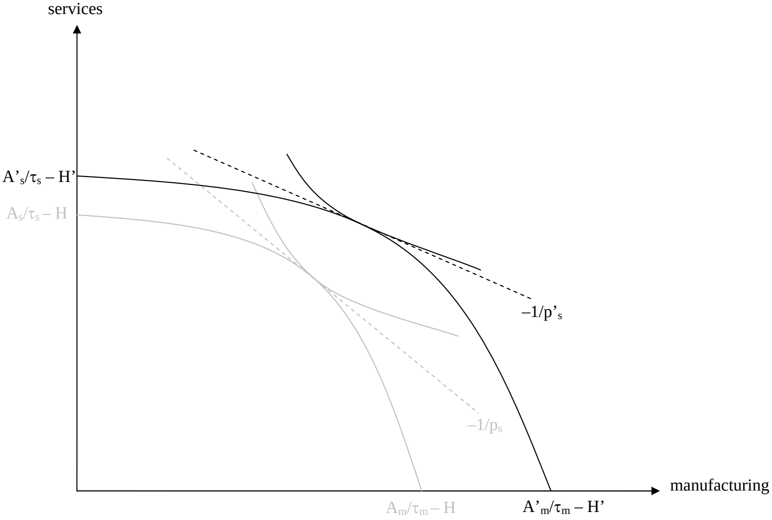
These assumptions imply that

1. residents live closest to CBD,
2. residential land increases with development.

Housing demand increases



Housing demand increases



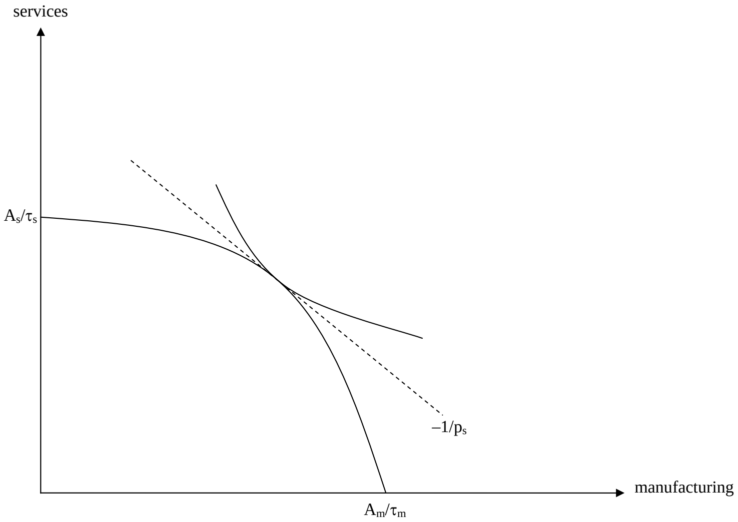
Predictions

As productivity increases,

1. residential land increases,
2. home prices increase,
3. the rent gradient becomes steeper,
4. tradable industries move away from center,
5. services become more expensive,
6. labor productivity increases faster in manufacturing.

7. All of these effects are stronger for more densely populated countries.

Transportation becomes cheaper



Transportation becomes cheaper