Urban Economics

Lecture 10: Spatial equilibrium across cities

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Outline

In this lecture, we analyze the tradeoff between income, amenities and housing costs across cities or regions

A key ingredient is identical utility levels and firm profits across regions, i.e. spatial equilibrium across regions

We will use material from Brueckner's Chapter 11, but the slides include some additional analysis

Rosen-Roback model

The core tool for this analysis is referred to as the Rosen-Roback model

- Rosen, S. 1979. Wage-Based Indexes of Urban Quality of Life. In *Current Issues in Urban Economics*, edited by P. Mieszkowski and M. Straszheim. Baltimore: Johns Hopkins Univerity Press.
- Roback, J. 1982. Wages, Rents, and the Quality of Life. *Journal of Political Economy* 90(4), 1257–1278.

The name Rosen-Roback refers to a family of models which share the common core of spatial equilibrium across regions

Rosen-Roback model

Questions:

- What can we learn from wage or house price differences across cities or regions?
- How can we compare the quality of life across cities or regions?
- Who benefits from a productivity shock that affects one region, but not others?
- How does this depend on workers mobility and housing supply conditions?
- Can “place-based policies” work?

Roback (1982)

A famous paper from Jennifer Roback's 1980 PhD thesis

Not only important to urban economics, but also to

- Labor economics (local labor markets)
- Environmental economics (pricing of environmental amenities)
- Trade (markets and industry concentration)
- Development economics (migration)
- Local public finance

Many theoretical extensions to consider heterogeneous workers, tax policy, agglomeration and congestion

Set-up

In the basic monocentric city model, everyone earned the same income and housing price differences served to compensate for location disadvantages (commuting cost)

Now we move to analyzing location decisions between cities where, in addition to housing costs, incomes/wages can differ across cities

- Both housing costs and wages can vary to compensate consumers for intercity differences in "quality of life" (i.e. how nice and livable cities are)

Basic assumptions

The basic framework for the analysis is a simple general equilibrium model in which both capital and labor are assumed completely mobile across cities

- Complete mobility of labor means that the costs of changing residence are zero
- Intercity commuting costs are assumed prohibitive to rule out the possibility of a person living in one city and working in another
- Intracity commuting costs are ignored in what follows to focus attention on the across-city allocation of workers and firms

Housing or real estate supply is fixed within cities, but is assumed interchangeable between uses within a city

Amenities

In the within-city analysis, consumer utility depended on the consumption of bread and housing (*c* and *q*)

In this model, consumers or workers also get utility from urban amenities

Different cities have different exogenous amenities

- E.g. pleasant climate, nature, clean air, low crime
- In reality, amenities may be endogenous, *e.g.*, increase in city's population may make the city better or worse
- Even though cities have many different amenities (or disamenities), we will denote them with a single index *a*

Worker utility

Formally, worker utility is a function of *a*, of composite commodity *c*, and of housing *q*: *u*(*c*, *q*, *a*)

In each city, the utility level that the worker will reach will depend on income *y*, housing prices per square meter *p* and amenity level *a*

- Price of c is the same everywhere and set equal to 1

This dependence can be summarized using an indirect utility function *V*(*y*, *p*, *a*)

- $V \uparrow$ as $y \uparrow$ and $V \downarrow$ as $p \uparrow$
- If a is an amenity, then $V \uparrow$ as $a \uparrow$

Spatial equilibrium

In equilibrium, workers must be as well off in all locations

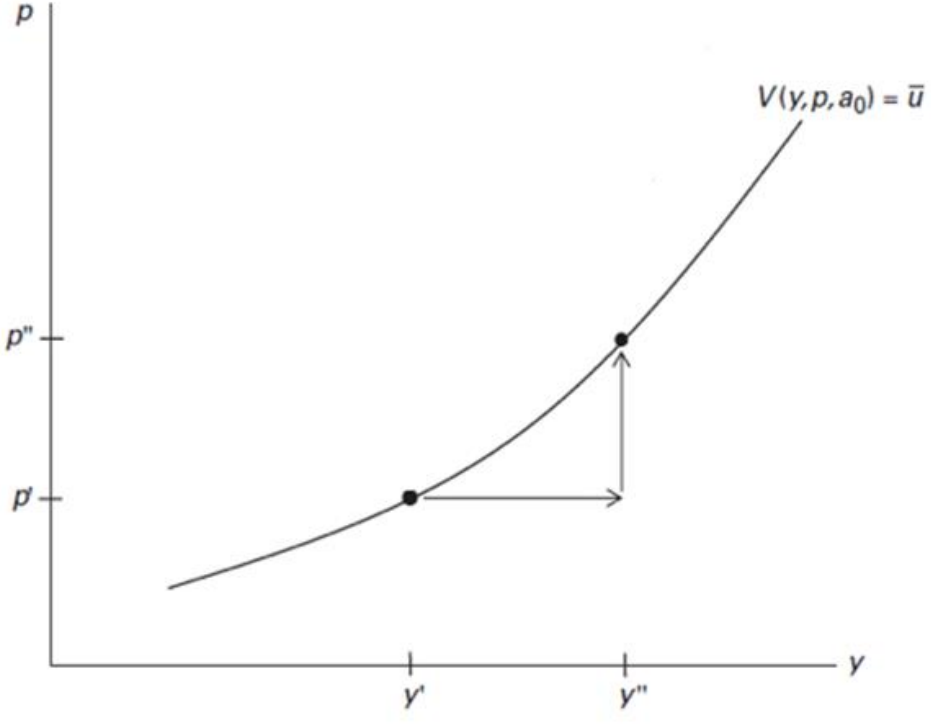
- If not, workers would move to locations offering higher utility, bidding up housing prices or pushing down wages until utilities are equalized everywhere

To compare cities or regions with different amenities, it is useful to use indifference curves

Here the indifference curve shows the different combinations of *p* and *y* that yield the same utility, for a given level of amenity

$V(y, p, a) = \bar{u}$

Indifference curves are upward sloping



Consider the point (p', y')

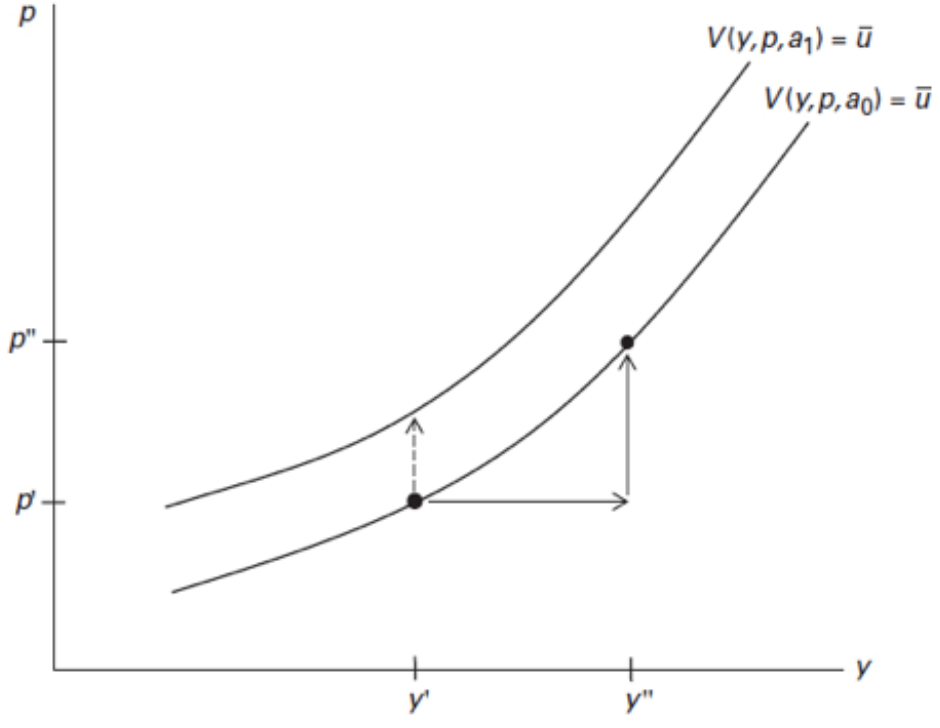
Suppose that income increases from y' to y"

This change would raise utility so a change in housing price is needed to keep utility constant

Since utility decreases with p, the required adjustment is upward so that p rises from p' to p"

Indifference curves with different amenity levels

$a_1 > a_0,\ V(y_0, p_0, a_1) > V(y_0, p_0, a_0)$



Now consider two amenity levels ($a_1 > a_0$)

Why does the indifference curve with higher a lie above the curve with lower a?

Again, starting from (p', y') higher a leads to higher utility and adjustments in p and y are needed to cancel the gain

For example, if only housing price adjusts, housing price must increase to cancel the utility gain

Firms

Firms produce the non-housing commodity *c* using labor and "real estate" (floor space of factories and offices) as inputs

- Other inputs can be ignored, as long as their price is the same in all regions (capital)
- Both firms and workers use real estate with a common price *p* across residential and business uses

Firms incur costs from labor (wage cost *y*) and from real estate (price *p*)

Firm cost (may) also depend on the amenity *a*

- An amenity to workers may be an amenity to firms (low crime) or it may be a disamenity to workers, but an amenity to firms etc.

Firms - unit cost function

We assume that cost per unit of output is the same no matter how much is being produced

- Constant returns to scale

This cost is given by the unit cost function $C(y, p, a)$, which just states that costs depend on wages, price of real estate and amenity level

Firms – zero profit condition

Firms are mobile, so in equilibrium firm profits must be the same in all regions

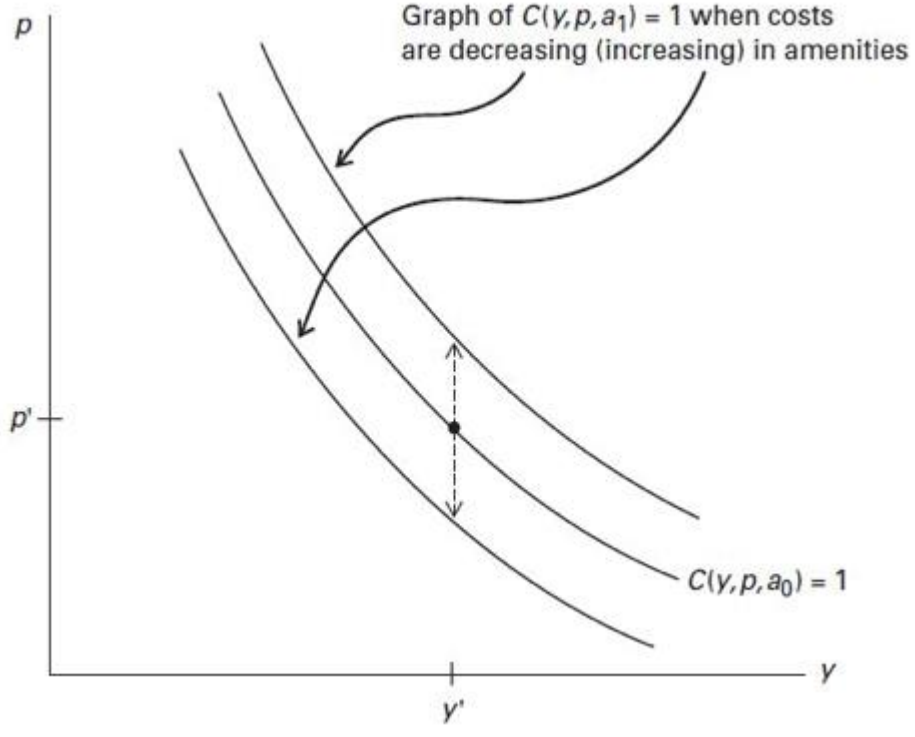
- This means that the unit cost must equal to the price of *c*
- If not, firms could relocate to more profitable cities, which would increase factor prices (real estate, labor) in those cities until equilibrium is reached

Recalling that the price of *c* is set equal to 1, this spatial equilibrium condition for firms can be written as $C(y, p, a) = 1$

This condition generates iso-profit curves in the *p* and *y* space

- An iso-profit curve shows, for a given level of amenity, the combinations of p and y that yield zero profits

Iso-profit curves



Iso-profit curves are downward-sloping

At a given level of amenity, a higher y must be accompanied by a lower p

If the amenity lowers costs than the iso-profit curve with higher amenity (a_1) lies above the iso-profit curve with lower amenity (a_0)

The positions are reversed when costs are increasing in the amenity level

Comparing outcomes in high-amenity and low-amenity regions

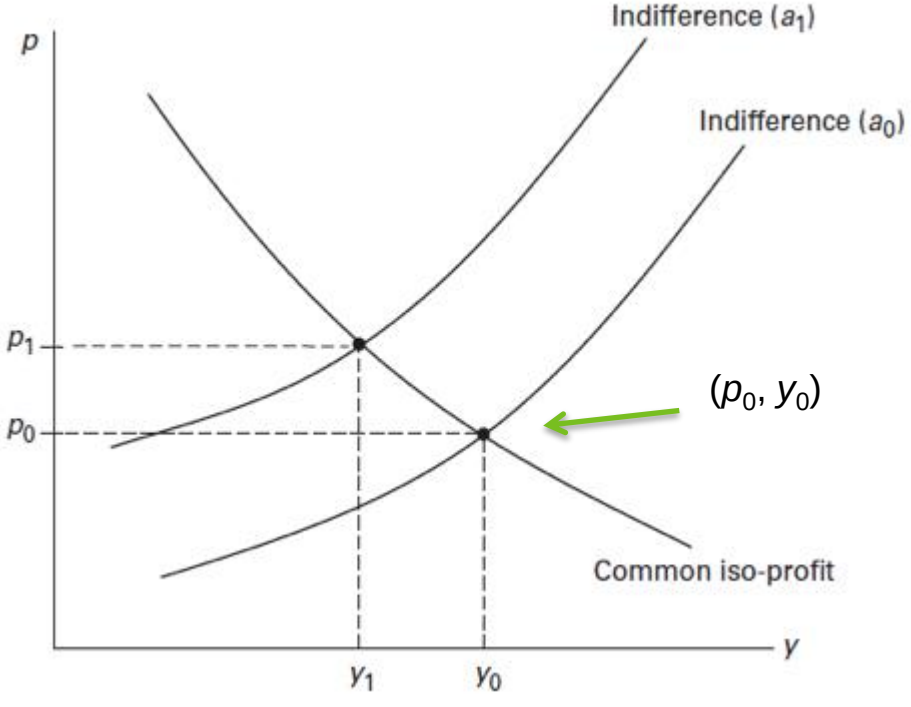
Three cases

1. **Consumers value the amenity, but it has no effect on firms' costs**

2. **Consumers value the amenity, and it decreases firms' costs**

3. **Consumers value the amenity, and it increases firms' costs**

Consumer amenity, no effect on firm costs => one iso-profit curve

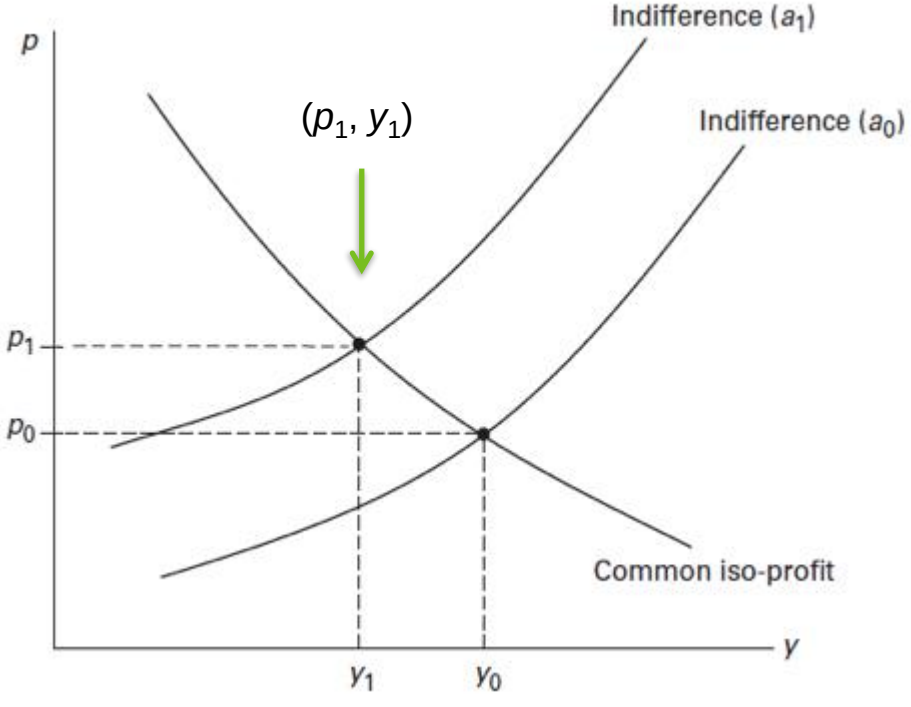


In the low amenity city, real-estate price and the income level are given by the intersection point of the a_0 indifference curve and the iso-profit curve

This intersection point (p_0, y_0) satisfies two requirements:

1. When paying p_0 for real estate and earning y_0 in income, consumers enjoy utility level $\bar{u}$ since the point (p_0, y_0) lies on the a_0 indifference curve
2. Firms earn zero profit since the inter-section point lies on the iso-profit curve

Consumer amenity, no effect on firm costs



In the high amenity city, real-estate price and the income level are given by the intersection point of the a_1 indifference curve and the iso-profit curve

This point (p_1, y_1) lies uphill from the low-amenity intersection on the iso-profit curve

The high-amenity city has a higher real-estate price than the low-amenity region ($p_1 > p_0$) and a lower income level ($y_1 < y_0$)

When firm costs are independent of amenities, better amenities lead to higher real-estate prices and lower incomes

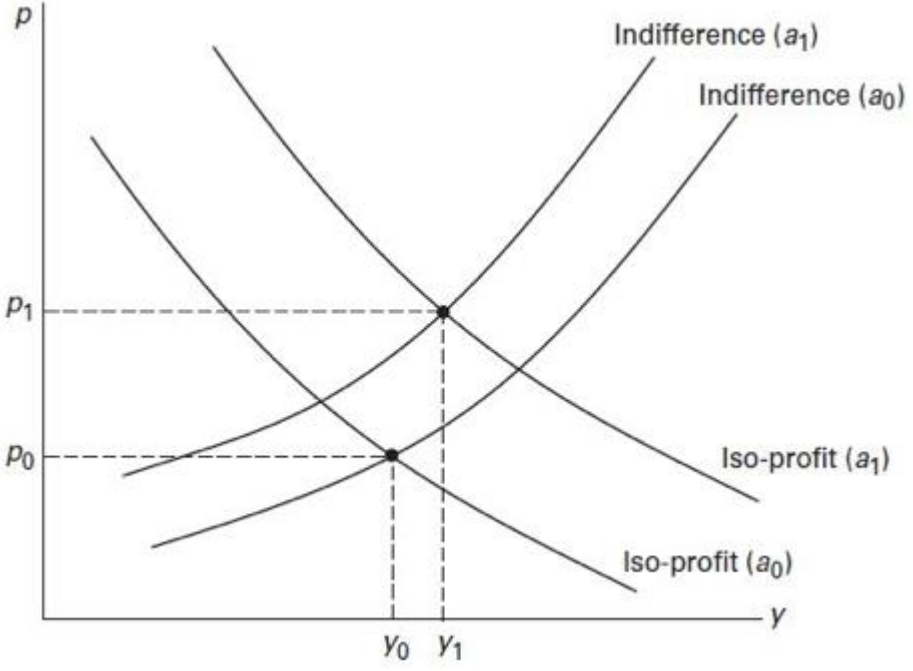
Consumer amenity, no effect on firm costs

This conclusion is intuitively appealing because it mirrors the separate compensating differentials in prices and incomes that would be required on the consumer side to equate utilities between the regions.

- In other words, if real-estate prices had to do all the work in equating utilities, then p_1 would have to be greater than p_0, whereas if incomes had to do all the work, y_1 would have to be less than y_0.

When firm costs are independent of amenities, both adjustments happen together

Firm costs decreasing in consumer amenity



High (low) amenity case corresponds with the intersection of high (low) amenity indifference and iso-profit curves

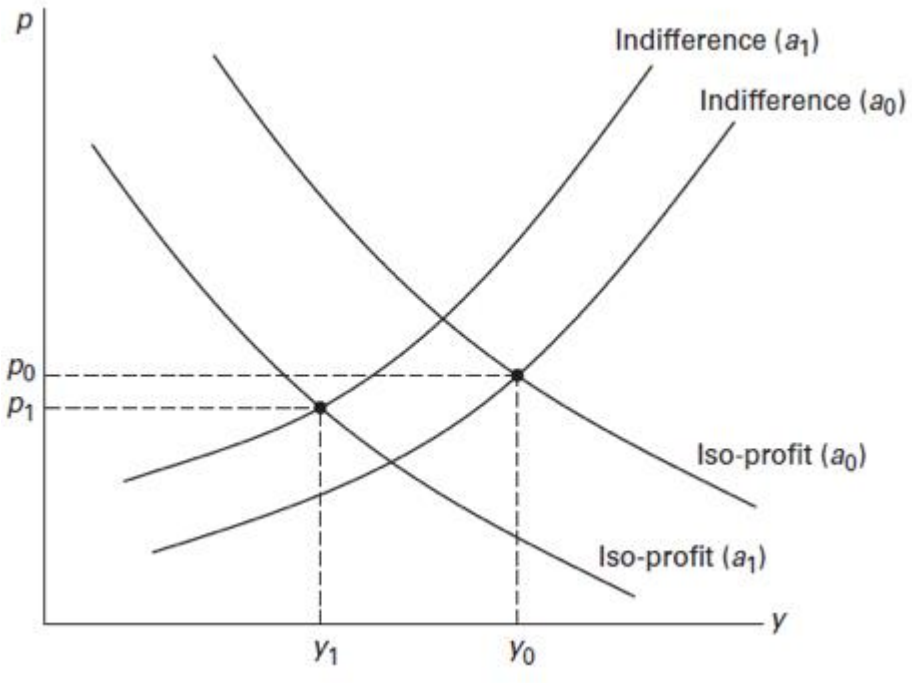
Now we have two iso-profit curves where the higher one corresponds to the high amenity region

In the figure, the high amenity region has both higher incomes ($y_1 > y_0$) and higher house prices ($p_1 > p_0$)

However, the conclusion w.r.t. income depends on how much the amenities decrease costs

If the shift in the iso-profit curve is modest, better amenities lead to lower incomes as well

Firm costs increasing in amenity



High (low) amenity case corresponds with the intersection of high (low) amenity indifference and iso-profit curves

Again, we have two iso-profit curves, but now the lower one corresponds to the high amenity region

In the figure, the high amenity region has both lower incomes ($y_1 < y_0$) and lower house prices ($p_1 < p_0$)

But the conclusion w.r.t. house prices depends on how much the iso-profit curve shifts

If the shift in the iso-profit curve is modest, better amenities lead to higher house prices as well

Recap

Amenity or quality of life differences across cities can be adjusted for both through house prices and wages

If amenities have no effect on firm costs, higher amenities lead to higher house prices and lower incomes

If amenities have only a sufficiently small effect on firm costs, higher amenities lead to higher house prices and lower incomes

If amenities have a large effect on firm costs, these relationships become ambiguous

Empirical implementation

It is possible, in principle, to use this framework for estimating the quality of life in different regions

- E.g. Albouy, D. (2012): Are Big Cities Bad Places to Live? Estimating Quality of Life across Metropolitan Areas. Mimeo.

Data on wages and worker characteristics

- Need to control for worker quality differences across regions

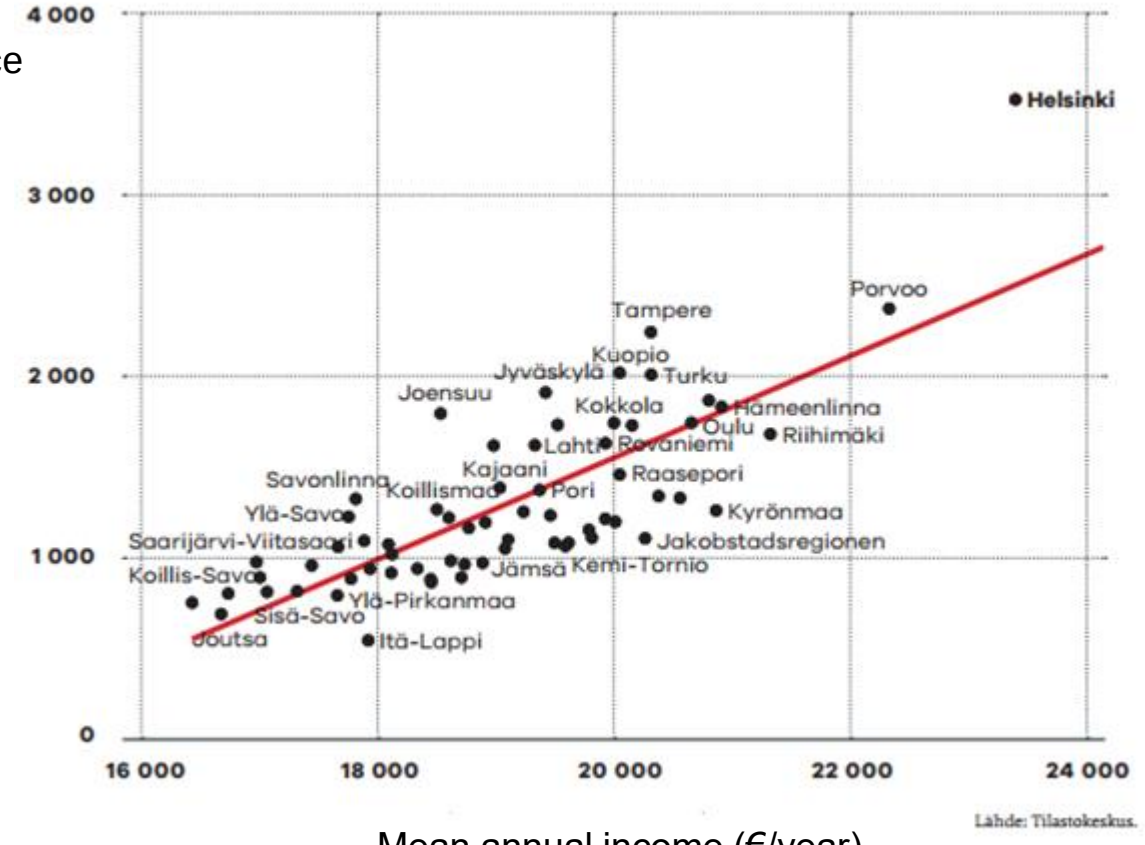
Rents or house prices and house characteristics

- Need to control for house quality differences across regions

Also, data on amenities if interested in which amenities are correlated with quality of life

Quality of life in Finnish regions

Mean house price
(€/m^2)



Mean annual income (€/year)

Extensions

Extensions

So far, we (implicitly) assumed that

- Labor is perfectly mobile, housing/real estate is fixed and workers only care about nominal wages, cost of housing, and local amenities

But labor is not perfectly mobile and housing and real estate are not completely fixed

- People may care about a particular city for idiosyncratic reasons (family, social ties etc.)
- Housing and real estate supply elasticity varies across regions

Now we turn to a model where these assumptions are modified

Workers

In addition to income, housing price and amenities, here workers may have a preference for a particular city

- This preference may reflect social and family ties to the city/region or any other reason someone likes a particular city

We continue to assume that everyone in a particular city will earn the same income and pay the same housing cost and that all workers are renters

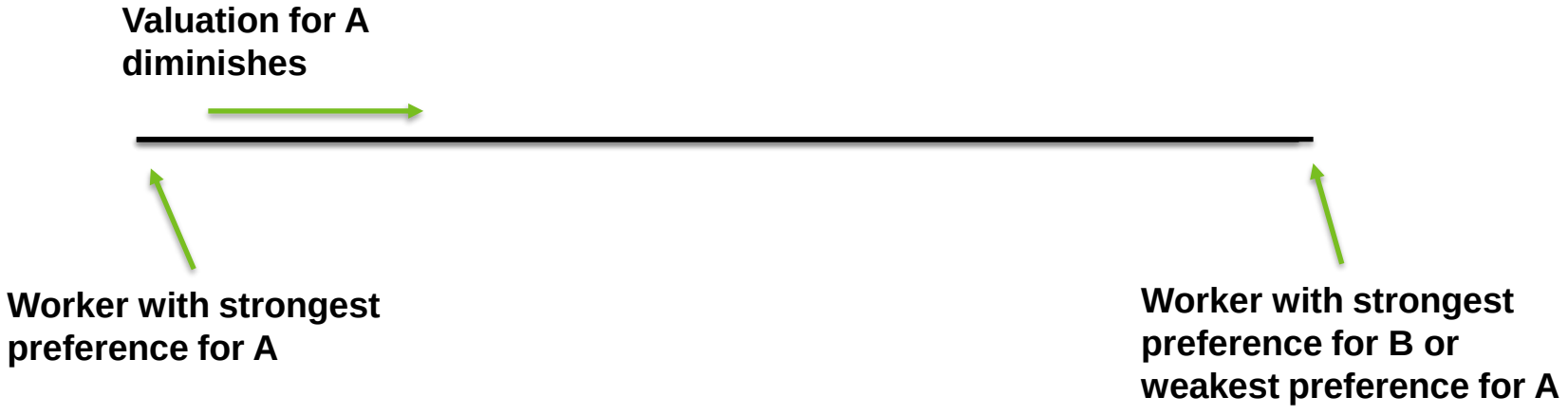
A useful concept used in this type of models is the real wage

- real wage = nominal wage – housing costs

Two cities

Consider two identical cities A and B (in terms of *y*, *p*, *a*)

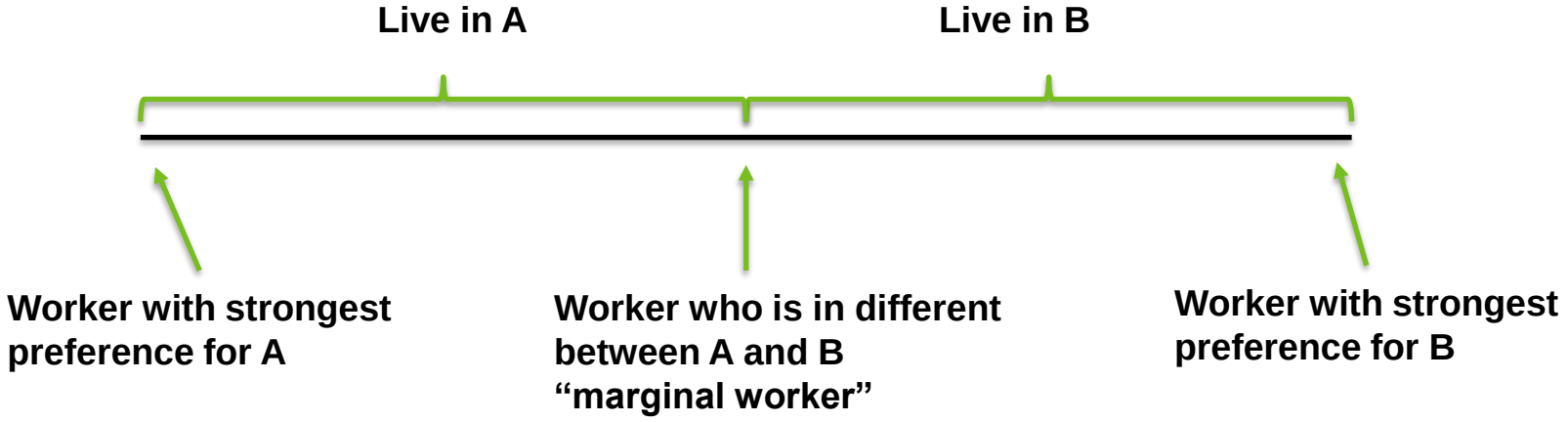
We can rank all workers with respect to their preference for city A over city B



Two cities

At some point of this line, we will come across a worker who is indifferent between the two cities (the marginal worker)

Those with a stronger preference for A will live in city A and the rest in city B



Illustrating the role of preferences for cities

In this equilibrium, the marginal worker is indifferent between cities, not all workers, others are inframarginal

- This is one example of an initial equilibrium where the marginal worker is indifferent, and others strictly prefer the city they reside in

This model can be used to analyze what happens when one city experience a productivity shock or an improvement in quality of life/amenities

Productivity shock in A

Let's start with a productivity shock

What happens when one city experiences a positive productivity shock leading to nominal wage increase in that city?

- At first when housing prices haven't reacted, this leads to an increase in real wages in A and some workers in B are now willing to move to A
- Whether and how much there will be migration from B to A will depend on the housing supply in A

Productivity shock in A – inelastic housing supply

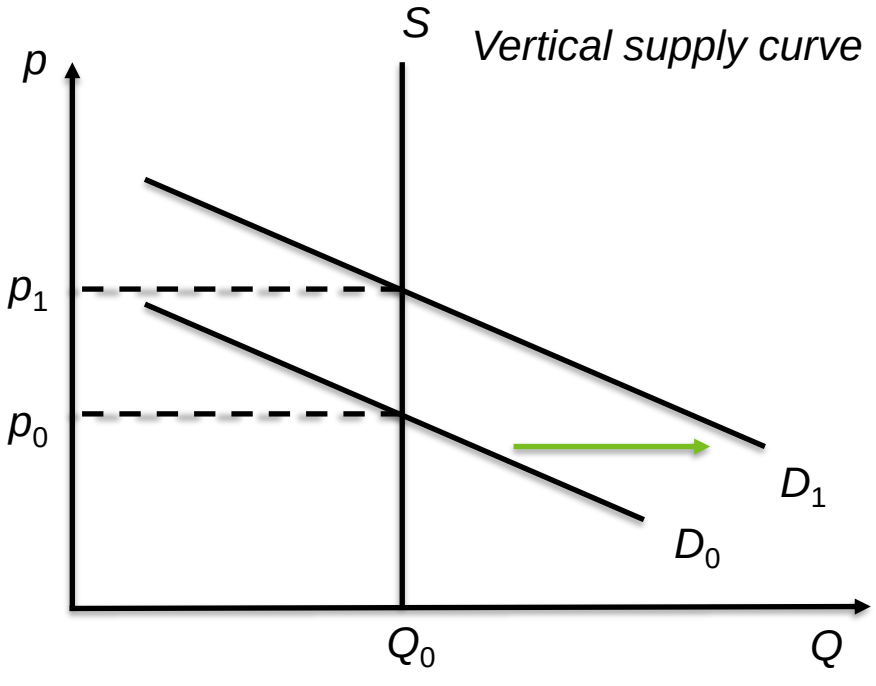
City A is now more attractive especially to workers who were more or less indifferent between the cities

This results in higher housing demand in city A

- In the short run, housing prices will increase
- This creates incentives for developers to build more housing

If housing supply is constrained for some reason, supply cannot adjust, and housing prices will remain high even in the longer run

Productivity shock in A – inelastic housing supply



The figure depicts how the number of houses Q is related to the price of housing p

As demand increases in A, the demand curve shifts to the right

At a given price, more workers are wiling to move to A

If supply is not responsive to prices, the supply curve is vertical

The increased demand leads to higher prices, but the housing stock remains fixed

Productivity shock in A – inelastic housing supply

As a result, real wages in A do not change and in the longer run no one has incentives to move to city A from B

- In fact, house prices can adjust quite quickly

In this (rather extreme) case, all the benefits of the productivity shock accrue to the landowners in city A through higher housing prices and higher land values

Productivity shock in A – elastic housing supply

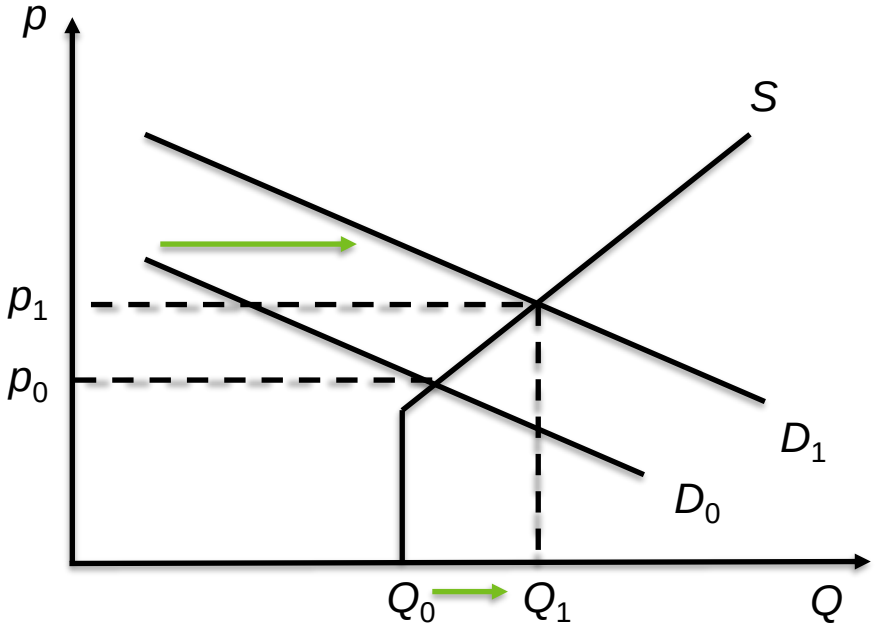
Again, city A is more attractive especially to workers who were more or less indifferent between the cities

This results in higher housing demand in the city

In this case, housing supply is elastic and adjusts to the increased demand

- Higher housing prices incentives developers to build more and housing prices will come back down in the longer run

Productivity shock in A – elastic housing supply



Again, as demand increases in A, the demand curve shifts to the right

Now supply is more responsive to prices and the supply curve slopes to the right

The increased demand leads to higher prices and the housing stock adjusts as more housing is built

The result is higher housing prices and a larger housing stock

The population in A increases

Productivity shock in A – elastic housing supply

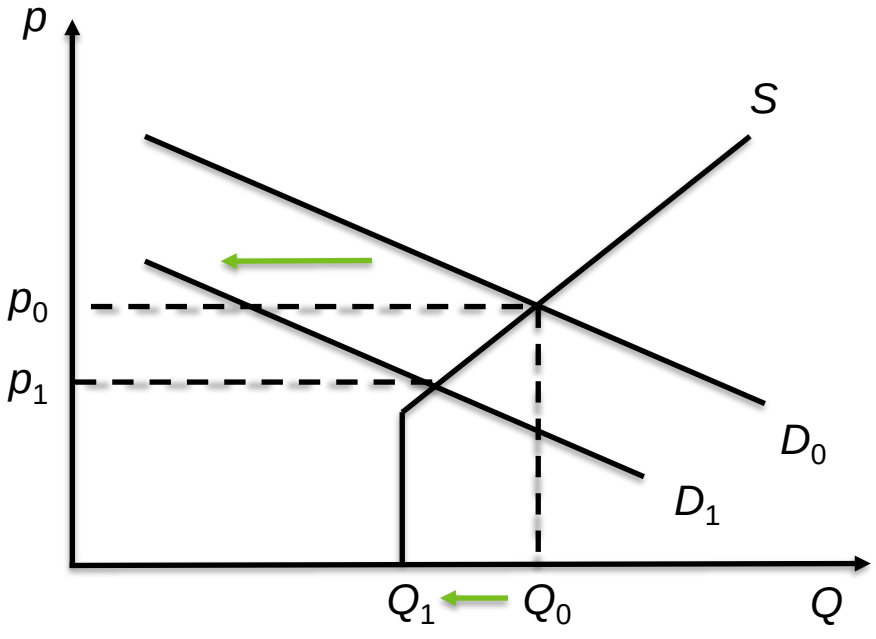
In this case, the productivity increase in A will have repercussions in city B as well

- This is because as city A becomes relatively more attractive and workers can move there, housing demand declines in city B
- This in turn increases real wages in city B as well

As a result, real wages have grown in both cities and workers in both cities benefit from the positive productivity shock even though it only affected firms in city A

Landowners in A benefit (but less compared to the inelastic case), but landowners in B lose

Productivity shock in A – elastic housing supply



In city B, we see the opposite effects

Housing demand decreases leading to lower housing prices and eventually to a smaller housing stock

Note: the adjustment of the housing stock may take a long time as housing is durable

Recap – productivity shock

	Inelastic supply		Elastic supply	
	City A	City B	City A	City B
Amenity (A)	0	0	0	0
Real wage	0	0	+	+
Nominal wage	++	0	++	0
Housing cost	++	0	+	-
Worker welfare	0	0	+	+
Landowner welfare	++	0	+	-

Amenity shock in A – inelastic housing supply

City A becomes more attractive because of better amenities or quality of life

- Nominal wages do not change, just the amenity

As in the case of productivity increase, this results in higher housing demand in city A

If housing supply cannot adjust housing prices will remain high even in the longer run

- This will result in lower real wages in city A
- These lower real wages are compensated by the higher amenity

Amenity shock in A – inelastic housing supply

Thus, nothing happens to the welfare of workers in either city

- Remember, nothing happens in city B, because nobody is unable to move to city A

The amenity shock only benefits the landowners in City A

Amenity shock in A – elastic housing supply

If housing supply is elastic and adjusts to the increased demand, workers from city B can move into city A

Housing prices will come back down in the longer run

- But will remain higher compared to the original level (depends on the elasticity of supply)

Amenity shock in A – elastic housing supply

Again, because of migration between cities, the amenity increase in A will have repercussions in city B

As city A becomes relatively more attractive and workers can move there, housing demand declines in city B

This in turn increases real wages in city B

- Remember nothing happened to nominal wages in either city

As a result, workers in both cities benefit from the positive amenity shock even though it only affected city A

Landowners in A benefit, but landowners in B lose

Recap – amenity shock

	Inelastic supply		Elastic supply	
	City A	City B	City A	City B
Amenity (A)	++	0	++	0
Real wage	--	0	-	+
Nominal wage	0	0	0	0
Housing cost	++	0	+	-
Worker welfare	0	0	+	+
Landowner welfare	++	0	+	-

Recap

Due to migration between cities, local shocks will influence both cities

- Any initial welfare differences due to a shock will be mitigated

Which groups benefit from a local shock, depends on the elasticity of housing supply

Extra: further extensions and some policy issues

Mobility costs

If there are high mobility costs, local productivity or amenity shocks may not result in migration (or less migration compared to lower mobility costs)

- E.g. an increase in real wages in A, may not attract workers from B if they must pay a high mobility cost

What happens after a productivity shock in A, if workers are totally immobile?

- E.g. have a very strong preference for their home city

Two types of workers

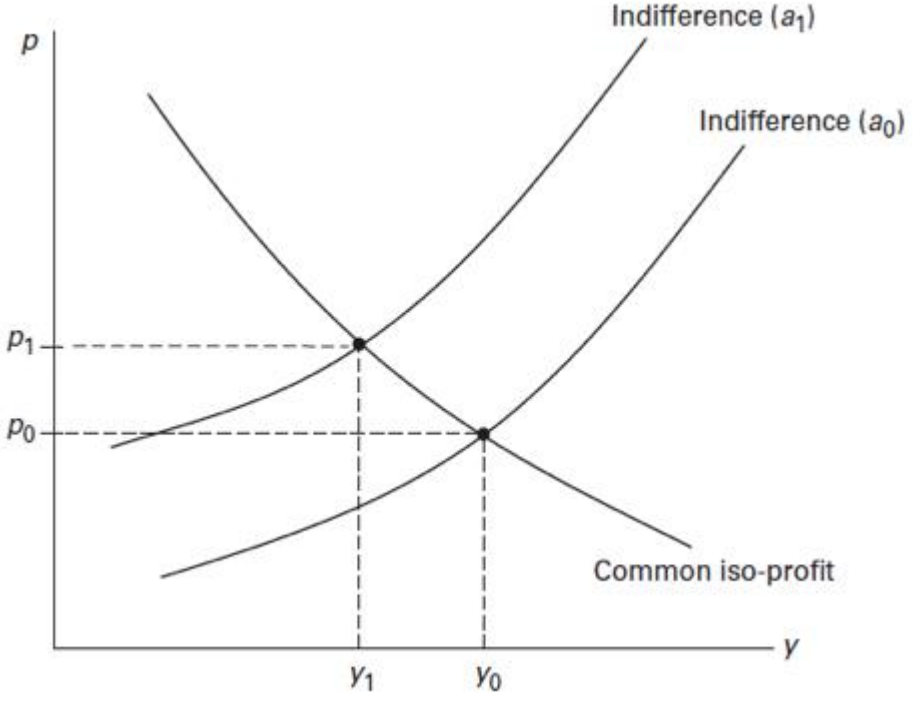
Two types of workers: low- and high-educated

What happens when the nominal wages of highly-educated increase in city A?

- City A is now more attractive to the highly-educated leading to increased housing demand in city A
- Housing costs increase in A and fall in B
- Real wages of highly-educated in A increase, but so does the real wage of everyone in B
- However, real wages of low-educated workers in A decrease and they have an incentive to move to B

A productivity shock that affects only one group of workers may lead to a two-way migration pattern between cities

Measuring welfare differences

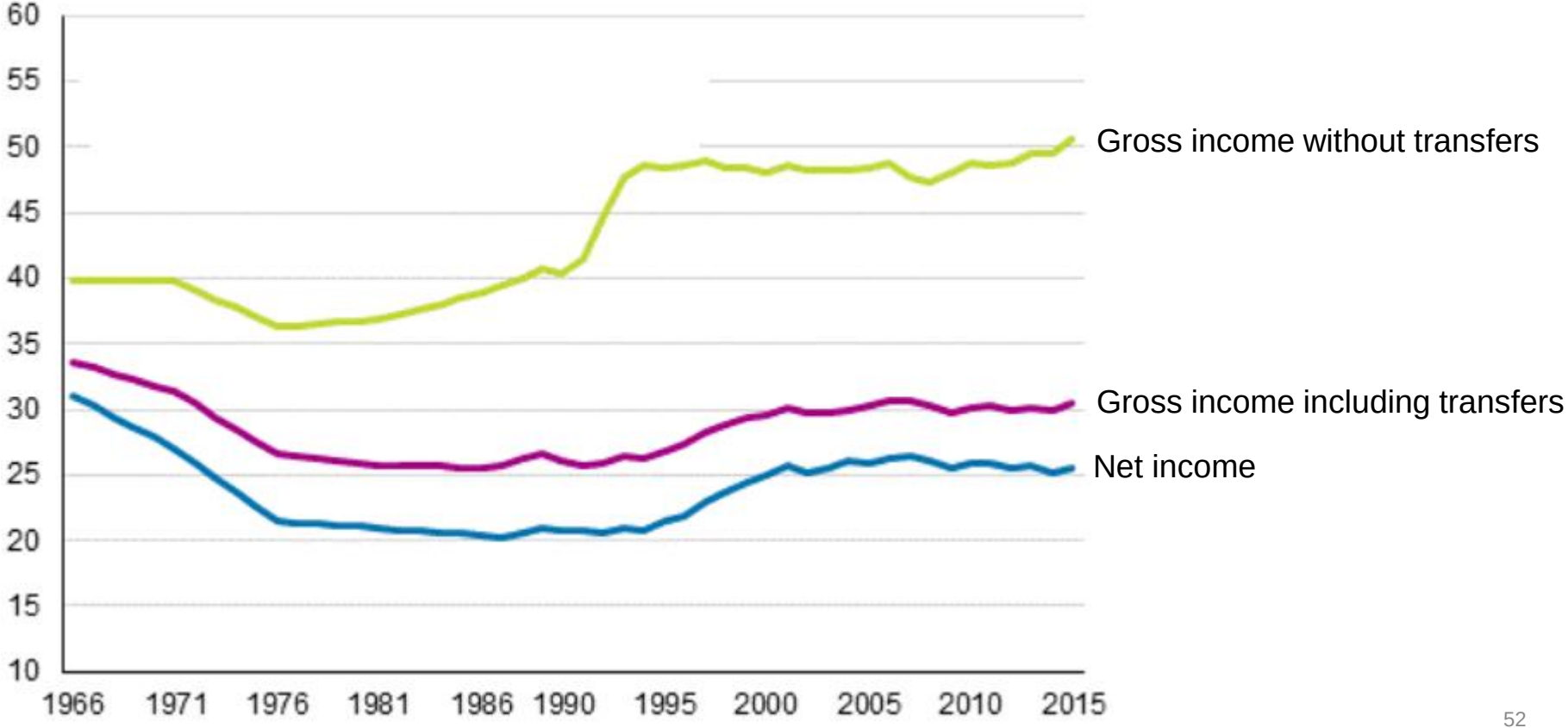


Inequality in a society is often measured based on household income and some inequality index

But now we know that people residing in different regions may have different nominal incomes, but the same welfare

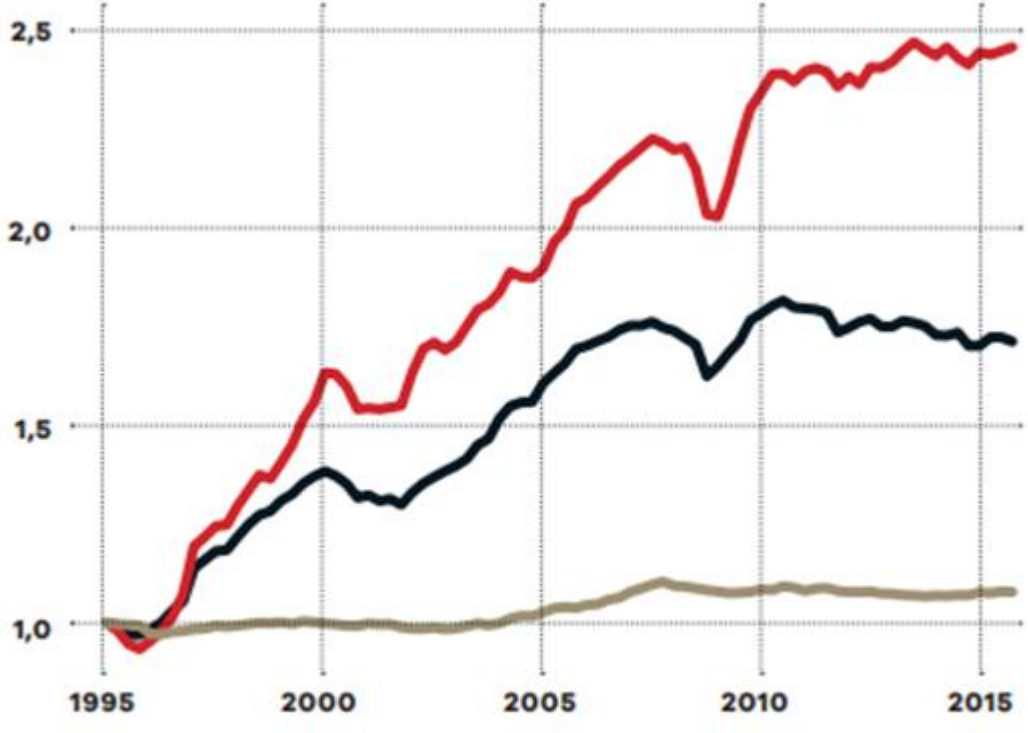
That is, income differences do not necessarily imply welfare differences!

Income inequality (Gini-index)



Source: Statistics Finland.

Prices and construction costs



House prices in Helsinki Metropolitan Area

House prices in rest of Finland

Construction costs

Lähde: Tilastokeskus.

Homeowners

If some workers are homeowners (and landowners), they will also experience changes in their wealth position just like landowners in the model where all workers are renters

If a homeowner lived in city A that experiences a positive productivity shock, the homeowner will benefit from the increase in real wage and the increase in wealth

- The productivity shock will capitalize into homeowner's house values just as it did in the case of landowners

Taxation

One of the reasons that migration takes place in the model is that cities with higher real wages attract workers

In reality, nominal wages are taxed (income tax and VAT) meaning that part of the wage increase a worker would get from moving is taxed away

At the same time, amenities are not taxed

This may lead to:

- Productive, high real wage areas become less attractive and high amenity areas more attractive to workers
- We have less workers living in high real wage (and nominal) areas than in the absence of income and VAT taxes (empirical question)

Taxation

From society's point of view, a move benefits the worker by the increase in real wage and also the rest of society through higher tax revenue (gross or before tax wage)

- But the individual worker only considers the change in real wage and not the tax revenue that benefits others through
- If the after-tax real wage increase is not enough to cover increased housing costs, the worker will not move even though the move might be beneficial when we consider tax revenue as well

Place-based policies

One often hears that regional inequality is a major concern

- However, if people are mobile, it is unclear what this statement really means

On the other hand, there are different types of regional or place-based policies

- E.g., transfers that targeted at specific regions, not specific people
- But the effects of these types of policies become unclear once we allow for worker (and firm) mobility and think carefully about housing price adjustments
- The question is who really benefits from regional transfers?