Urban Economics

Lecture 3: Monocentric city model - Extensions

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Outline

The model analyzed so far has been very stylized

In this lecture, we will analyze some extensions and modifications to the model

1. Intercity predictions
2. A city with two income groups
3. Commuting by freeway
4. Employment outside the CBD
5. Durable housing

This lecture will follow Brueckner's Chapters 2 and 3

Intercity predictions

Intercity predictions

Even though we are dealing with a closed model, that is, there is no migration from other cities, we can still use the model to make some predictions about intercity differences

- E.g. how do cities of different size differ?

We will later deal with a model of multiple cities

- In these types of models, we abstract away from the within city structure and analyze the between city differences in wages, housing costs and local amenities
- There we will rely on another type of spatial equilibrium concept; the spatial equilibrium across cities

Geographic size of the city

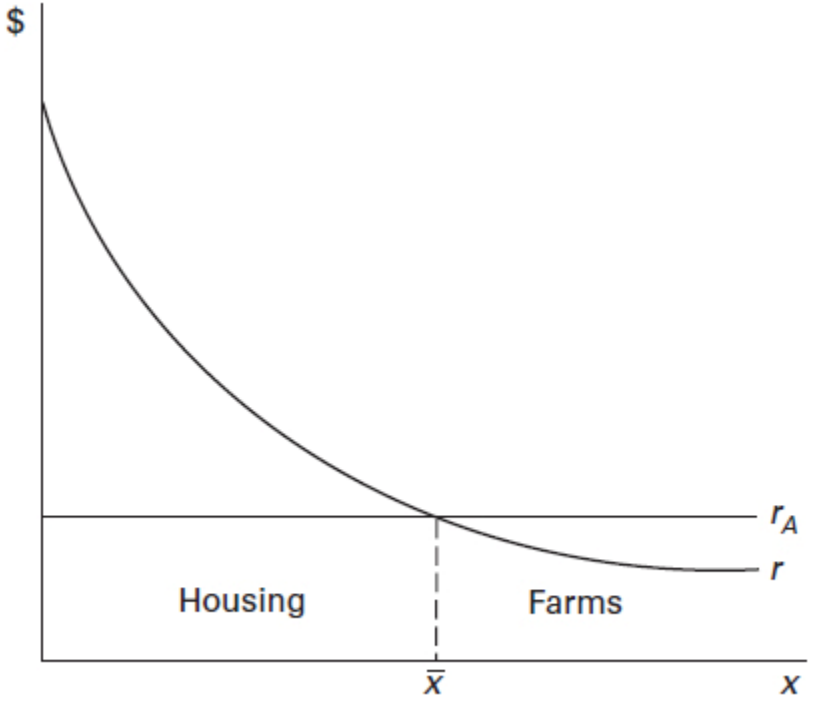
Supply-demand equilibrium of the city

- The city fits its population so that the supply of housing equals the demand for it

The city's land area is a result of competition between housing developers and farmers

- Suppose that farmers are willing to pay r_A for a hectare or km² of farmland and that this agricultural rent is constant through space (independent of x)
- Landowner will rent the land to the highest bidder

Determination of the city's edge



Urban land rents for housing r slope downwards (and are convex)

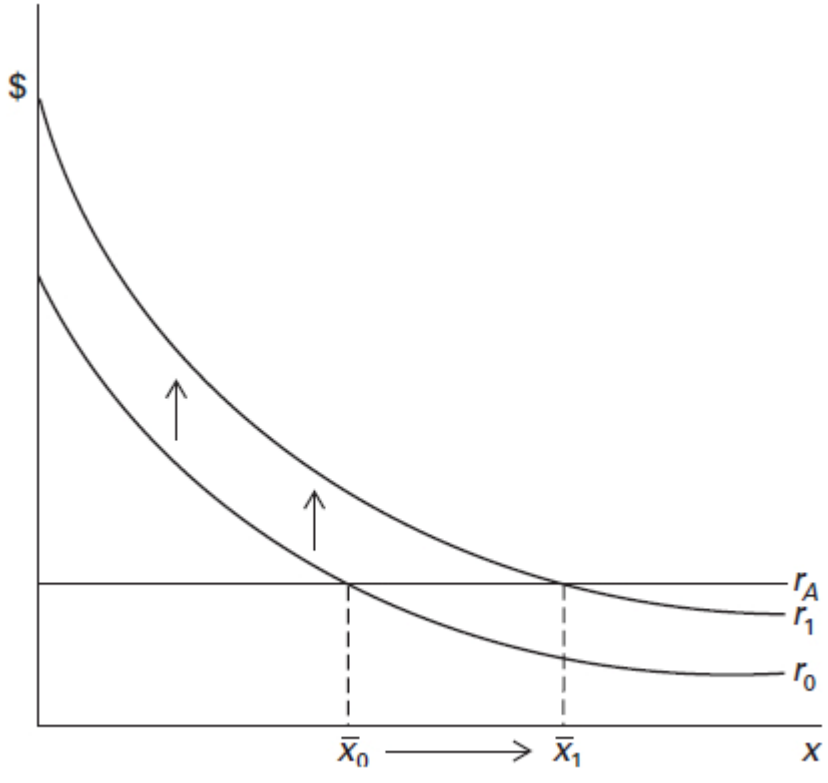
At some distance $\bar{x}$, urban and agricultural land rents are equal

Beyond this point farmers can outbid landlords for the land

Housing is built inside the intersection of the rent curves and land outside the intersection is in agricultural use

This determines the city's edge

Increase in population size



Leads to excess demand for housing:

- Higher housing prices *p* everywhere in the city so that people economize on dwelling size *q*
- Housing price increase makes building more profitable and developers compete for land driving up land rent *r* at all locations
- Higher cost of land leads to taller buildings as developers substitute capital for land
- City edge expands as developers can outbid farmers farther away from the CBD
- With taller buildings and smaller dwellings, population density *D* increases at all locations
- Population density has increased and city's land area has expanded so that the new city can fit the larger population

Increase in population size

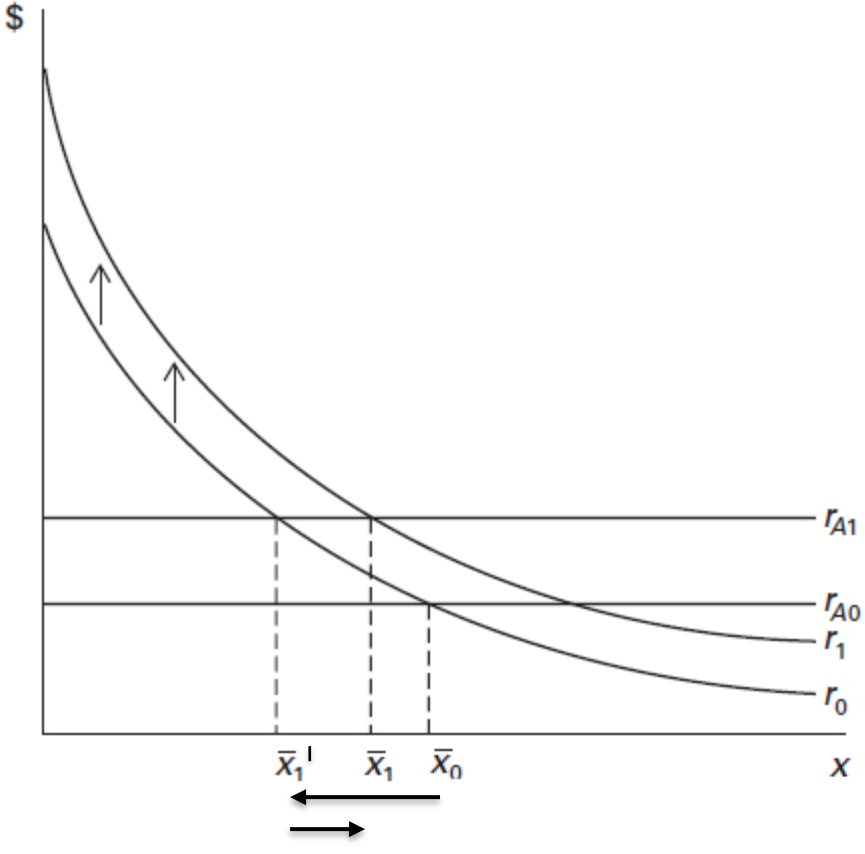
The larger city occupies more land than the smaller city

At a given distance to CBD,

- The larger city has taller buildings
- Smaller dwellings
- Higher housing price per square meter
- Higher land rent per square meter
- Higher population density

These predictions match many of the observed differences between large and small cities in the real world

Increase in agricultural rent



This might happen because yields increase, or the prices of agricultural products increase

As land rent increases, farming takes over some of the residential land at the edge of the city

With fewer dwelling, the city cannot fit its population anymore

The adjustment process is exactly as in the case of population increase just discussed

Increase in commuting cost

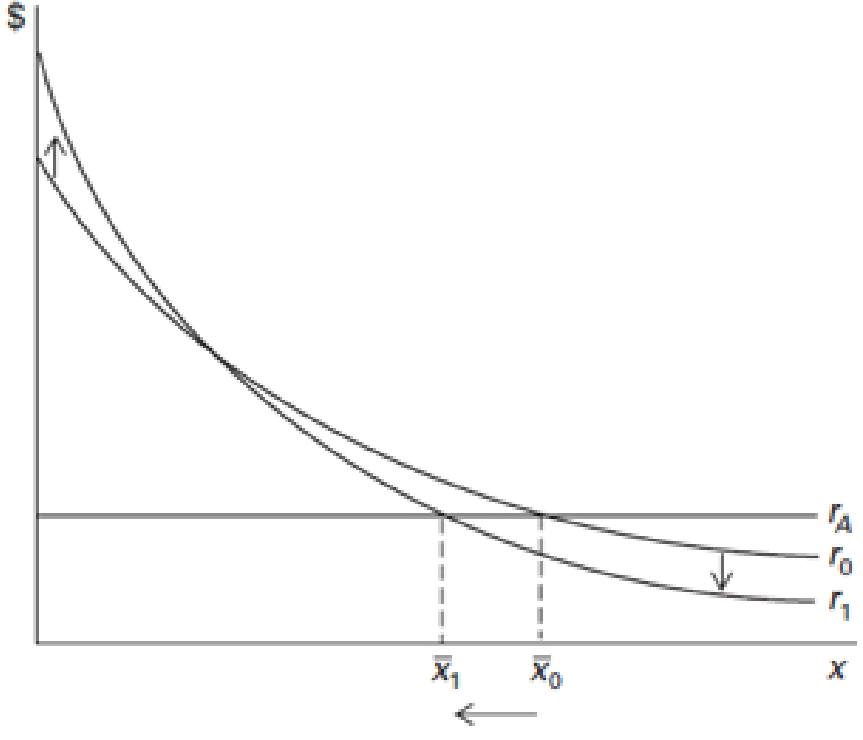
Increase in commuting time means that the housing price differences between central-city and suburban locations are no longer enough to equate utility

- Suburban commuters can increase their utility by moving closer to the CBD (at the prevailing house prices)

This increased demand pushes housing prices up near the CBD, while the lower demand in suburbs lowers prices there

- Housing prices will adjust until a new equilibrium is reached
- The housing price curve rotates in a clockwise direction

Increase in commuting cost



Housing price changes increase developer profits near the CBD and decreases profits in the suburbs

This leads to stronger competition for land near the CBD and weaker competition for suburban land

The land rent curve rotates in a clockwise direction as depicted in the figure

Due to this rotation, the city edge moves closer to the CBD

Additionally, higher land rents near the CBD lead to taller buildings there

Population heterogeneity

City with two income groups

Suppose that instead of all having the same income, some households in the city are rich (y_R) and some are poor (y_P)

- So that $y_P < y_R$

Assume that the commuting cost is still the same monetary cost as before and the same for both groups

What does the model predict about the residential location of these two groups?

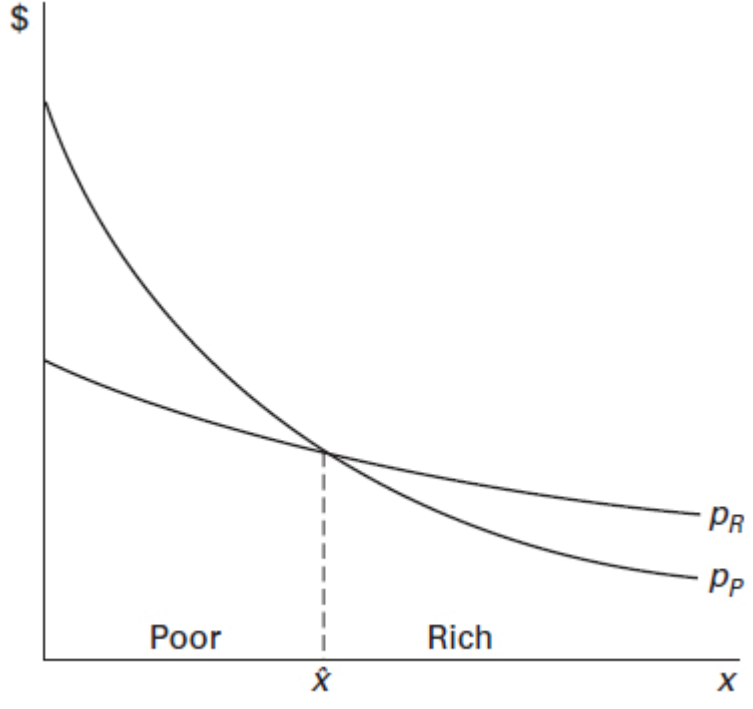
Two housing price curves

With two income groups, there are going to be two housing-price curves (p_R and p_P)

This result follows again from the locational/spatial equilibrium condition

- Paying housing prices per square meter along the p_R curve, rich households will be locationally indifferent reaching the same welfare level everywhere
- The same applies to poor households and housing price curve p_P

Two housing price curves



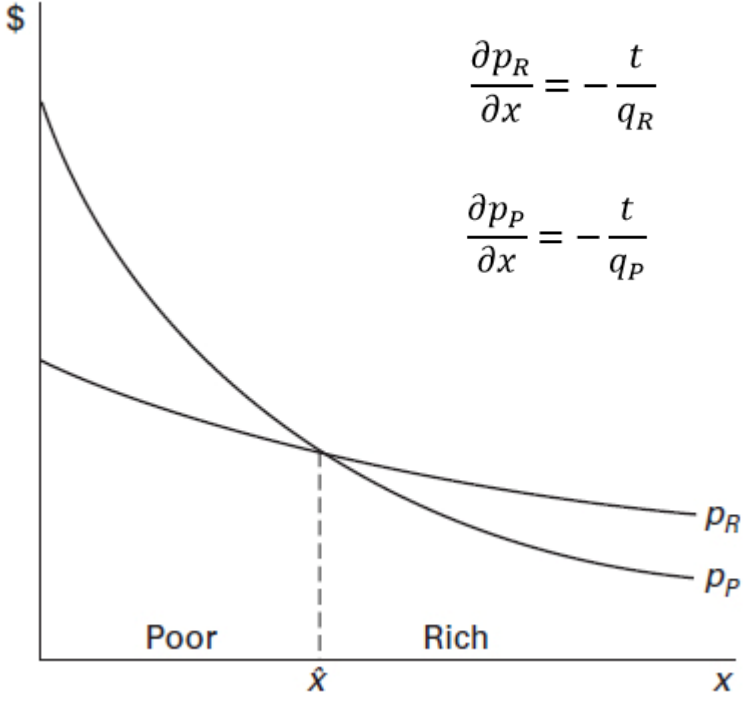
Examples of these curves are depicted in the figure

For the members of an income group to live in a particular location, they must be the highest-bidder at that location

If the curves are as in the figure, poor households are the highest-bidder inside the intersection point $\hat{x}$ of p_R and p_P

In this example, the poor live near the CBD, while the rich live in the suburbs

Two housing price curves

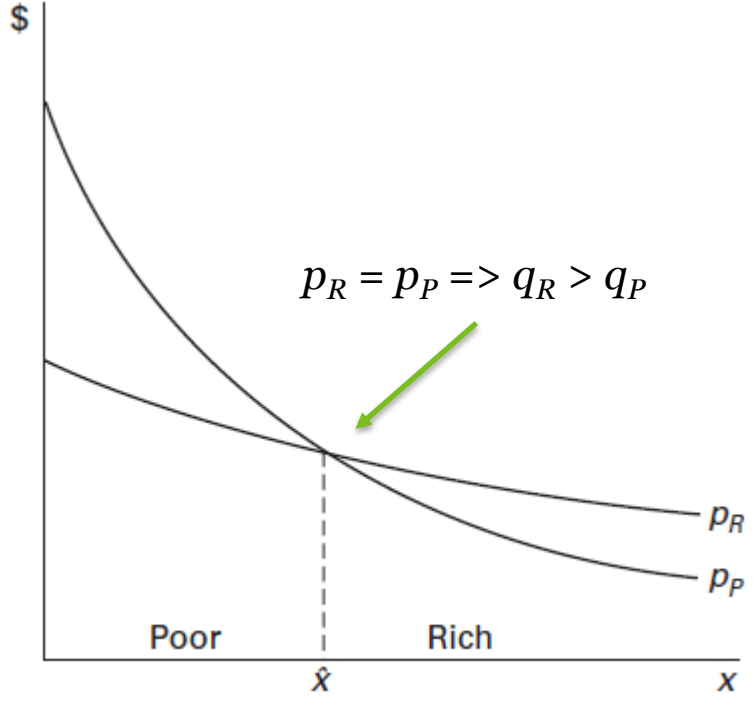


With the assumptions that we have, this outcome is, in fact, the only possible one

This is because the slope of the price curve is $-t/q$ with different housing consumption for the groups (q_P and q_R)

One would expect that rich people consume more housing space ($q_R > q_P$), but this is true for sure only when the groups face the same price per square meter!

Two housing price curves



This happens when the curves intersect

At this point, the p_R curve must be flatter than the p_P curve, so that the price-curve diagram must look like this

Thus, the model predicts that under these assumptions the poor live in the central-city and the rich in the suburbs

The prices that we would actually observe are always the highest curve in each location

Opportunity cost of time

This result, however, depends on the absence of time costs related to commuting

If there are time costs, the predictions concerning the location of different income groups become ambiguous

One way to show this is to assume (unrealistically) that leisure time is fixed and commuting time is away from working time

- Thus, a longer commute would lower the workers income because of monetary commuting cost as before *and* because of diminishing income from work

Opportunity cost of time

If an extra km of commuting reduces work time by some fraction δ of an hour, one extra km reduces income by δw

- Instead of just t, the new commuting cost would be $m = \delta w + t$

Given that wages/income differ, the groups will face different commuting costs: $m_P = \delta w_P + t$ and $m_R = \delta w_R + t$

Thus, the slopes of the of the housing price curves change so that t is replaced with m_P or m_R:

- $\frac{\partial p_P}{\partial x} = -\frac{m_P}{q_P}$ **and** $\frac{\partial p_R}{\partial x} = -\frac{m_R}{q_R}$

But since $q_R > q_p$ and $m_R > m_p$, it is unclear which slope is flatter

Opportunity cost of time

Thus, when there are time costs present, the model does not offer a clear prediction about the relative location of different income groups

The ambiguity arises from two opposing forces:

- The desire to rent their large dwellings at a low price per square meter pulls the rich toward the suburbs
- And the desire to limit their high time cost of commuting pulls them toward the center

Depending on the relative strengths of these forces, either location is possible for the rich (and the poor)

Other explanations – transportation mode

In US cities, richer people tend to live farther away from CBD in large houses (of course there are exceptions)

One explanation for this pattern is related to transport modes

- The hypothesis is that the poor cannot afford cars, and thus, need to locate in central parts of the city where population density is high enough for public transit
- That is, poor households need to live in central cities in order to have mobility

However, this pattern is not universal

Other explanations – age of the housing stock

Another hypothesis is that high-income households prefer newer and higher quality housing

Newest housing stock is often in the suburbs or far from the CBD, and thus, these locations attract the rich

If old buildings in the city center are replaced with new ones, this pattern might change

- This type of development is often referred to as "gentrification"
- Rich households displace the poor in these areas

Other explanations – urban amenities

Some European cities (e.g. Paris) have the opposite pattern to the US, so that high-income households tend live in the city center

One hypothesis is that in these cities central locations have high urban amenities

- Historical monuments, architecture, natural amenities

If the rich value living next to these more than the poor, we may observe a pattern where the rich live in city center and poor farther away

But these aspects are missing form our simple model!

Recap – heterogeneous population

The simple monocentric city model is less successful in predicting the residential patterns of different income groups than it is in predicting price, density and building height patterns

- The model is missing some important components in this respect

At the same time, the model does predict segregation by income groups, which is a prevalent feature in many cities

We will talk about issues related to segregation during the latter part of course

Other extensions

Commuting by freeway

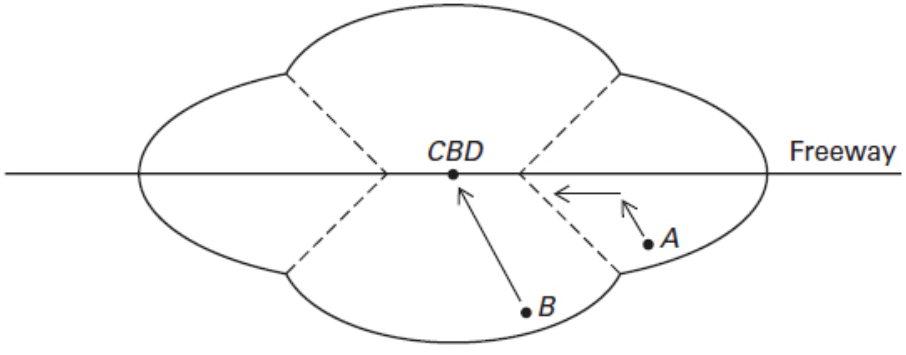
Suppose that there is a single freeway passing through the city

The freeway is faster than the smaller city streets

- Since the freeway is faster, commuters living close to the freeway will use the city streets to get to the freeway and use it for the rest of the way
- Those who live far from the freeway, will use the smaller and slower city streets

- **What implications does this have for the main predictions of the model?**

Commuting by freeway



For example, locations A and B may have the same commuting cost even though location A is farther away from the CBD

Then the rent per square meter p would be the same in these locations as is land rent r

Land rent falls more slowly along the freeway catchment area than outside of it

Land rent takes longer to fall to the agricultural rent level => the edge of the city expands

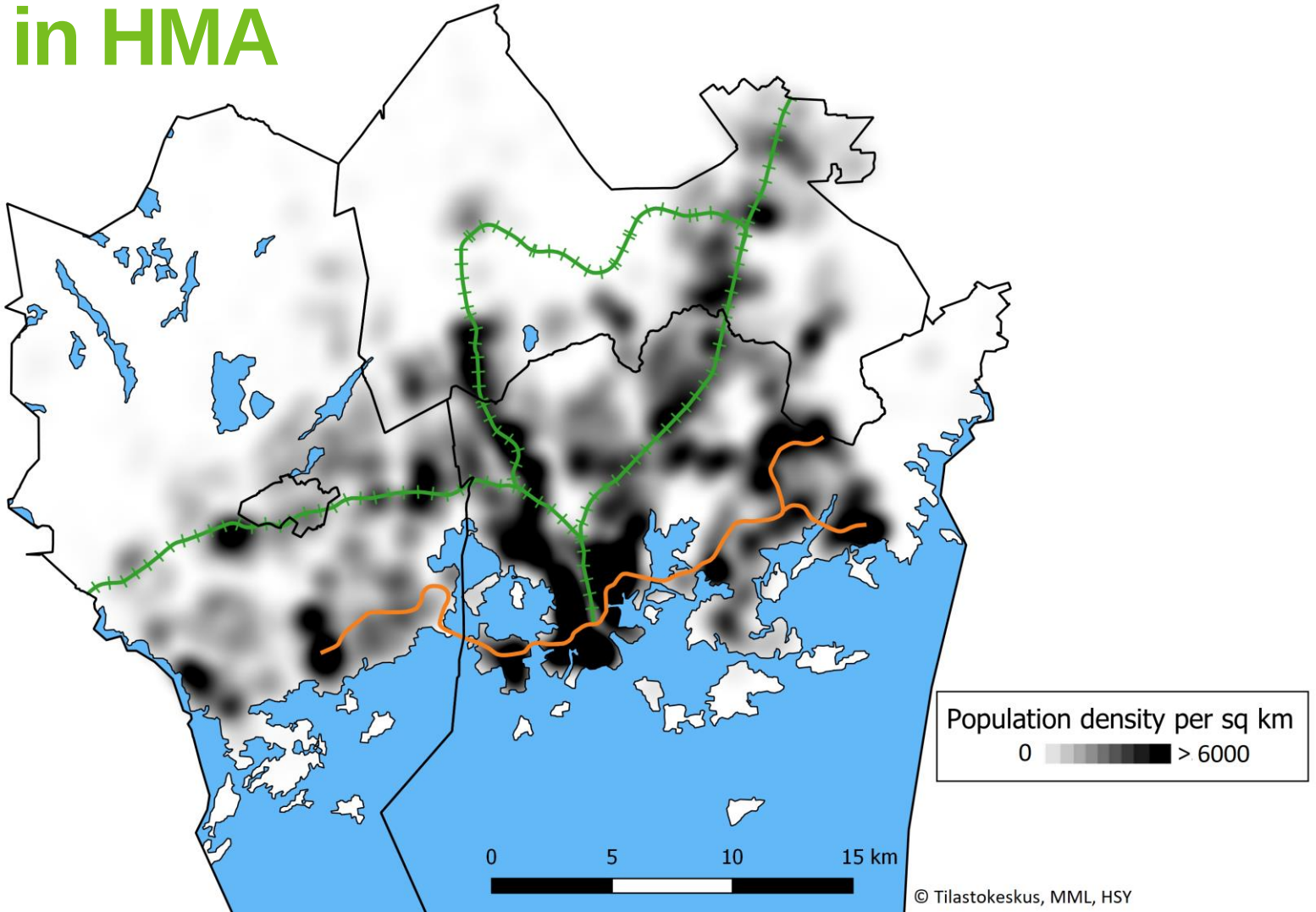
Commuting by freeway

The freeway causes the city to sprawl and take up more space

Otherwise, the model's predictions are unaffected

- Housing price p, land rent r, building heights and population density D all decrease as distance to CBD grows
- Their rates of declines are less along the freeway catchment area
- Dwelling size increases with distance, but again the rate is different along the freeway

Population density in HMA



Employment outside CBD

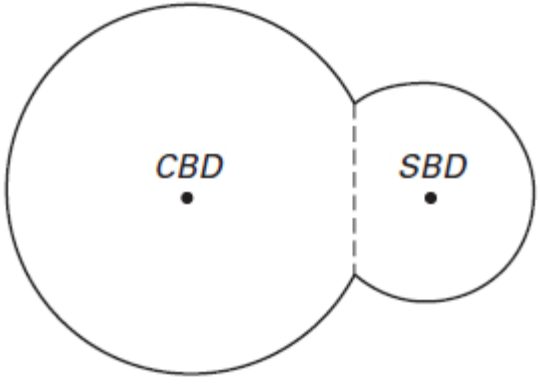
In real-world cities, all employment is not concentrated to the CBD

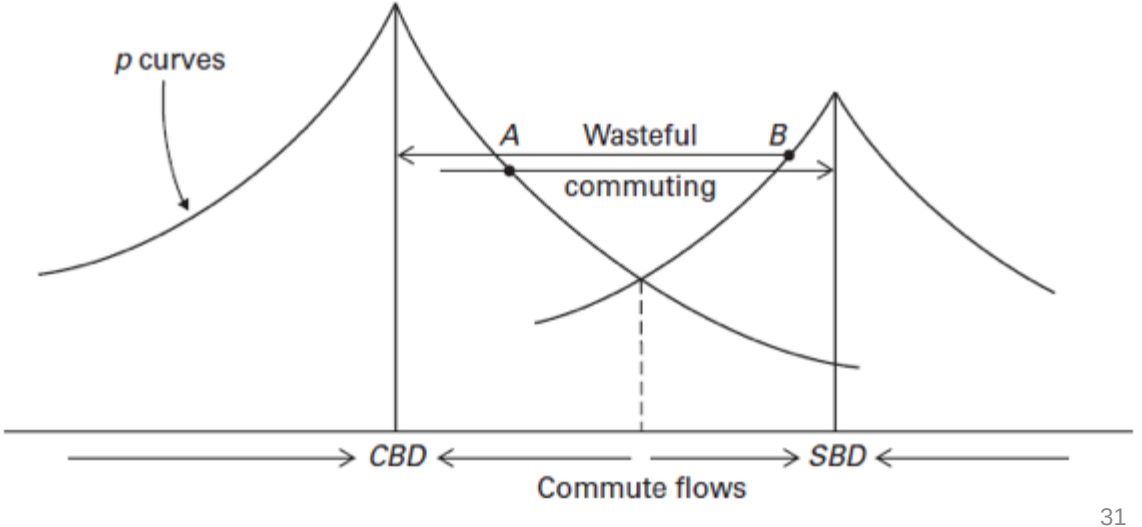
Often employment is high in the center, but additional jobs may be widely dispersed throughout the city, or some may be in secondary employment centers

How do these different employment patterns affect the predictions of the model?

Employment subcenters

The existence of another employment center would, in effect, generate another city joined to the original city





Durable housing

Buildings usually last for decades and we often observe old buildings standing next to newer ones

This may invalidate the predictions of the model as the newer buildings may be taller than older ones

Thus, the spatial pattern of building height will depend on both location and construction date

- For buildings constructed at a given date, those farther from the CBD will be shorter
- For buildings constructed at a given location, those constructed later can be either taller or shorter

Durable housing

CBD is built first and has the oldest housing stock

The city then expands by adding blocks farther away from the CBD

If improvement in construction technology leads to newer buildings being taller, we could observe taller buildings farther away from the CBD than near the CBD

- But this depends on the durability of buildings and what happens to the cost of adding extra floors to buildings

See Brueckner for an illustration

Cities and working from home

Cities and working from home

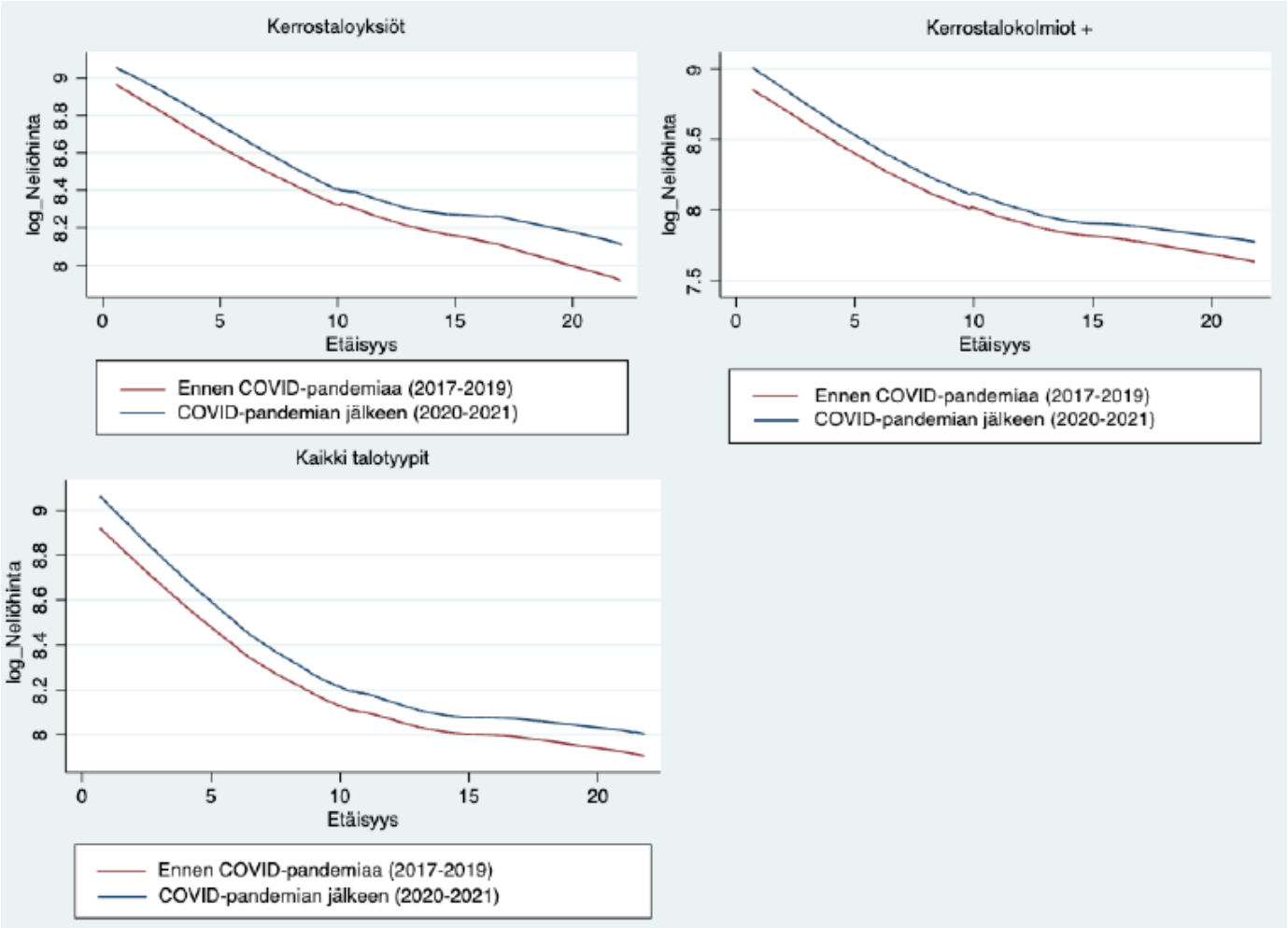
If working from home (WFH) increases

- Firms need less office space => the demand for office space decreases
- Commuting costs decrease for workers who can work from home
- Location w.r.t. to jobs and the CBD less important to these workers => demand for housing space decreases in the CBD

This should be reflected in prices and rents

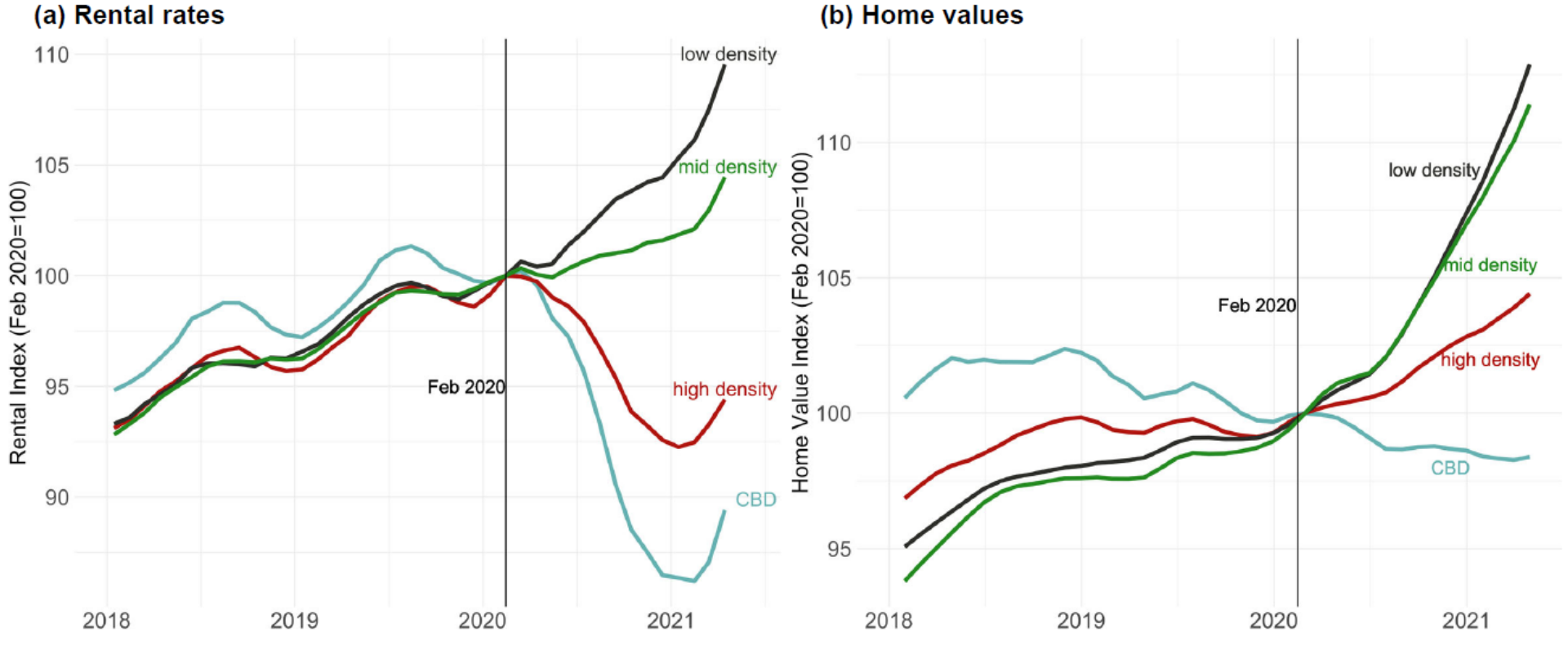
- Office rents should decrease
- Housing prices and rents should decrease in the CBD and maybe increase farther way form CBD

House prices – Helsinki region



Lähde: Sarnes, L. (2022): COVID-19-pandemian vaikutukset kiinteistöhintoihin ja kaupunkirakenteisiin. Pro gradu. Aalto-yliopisto.

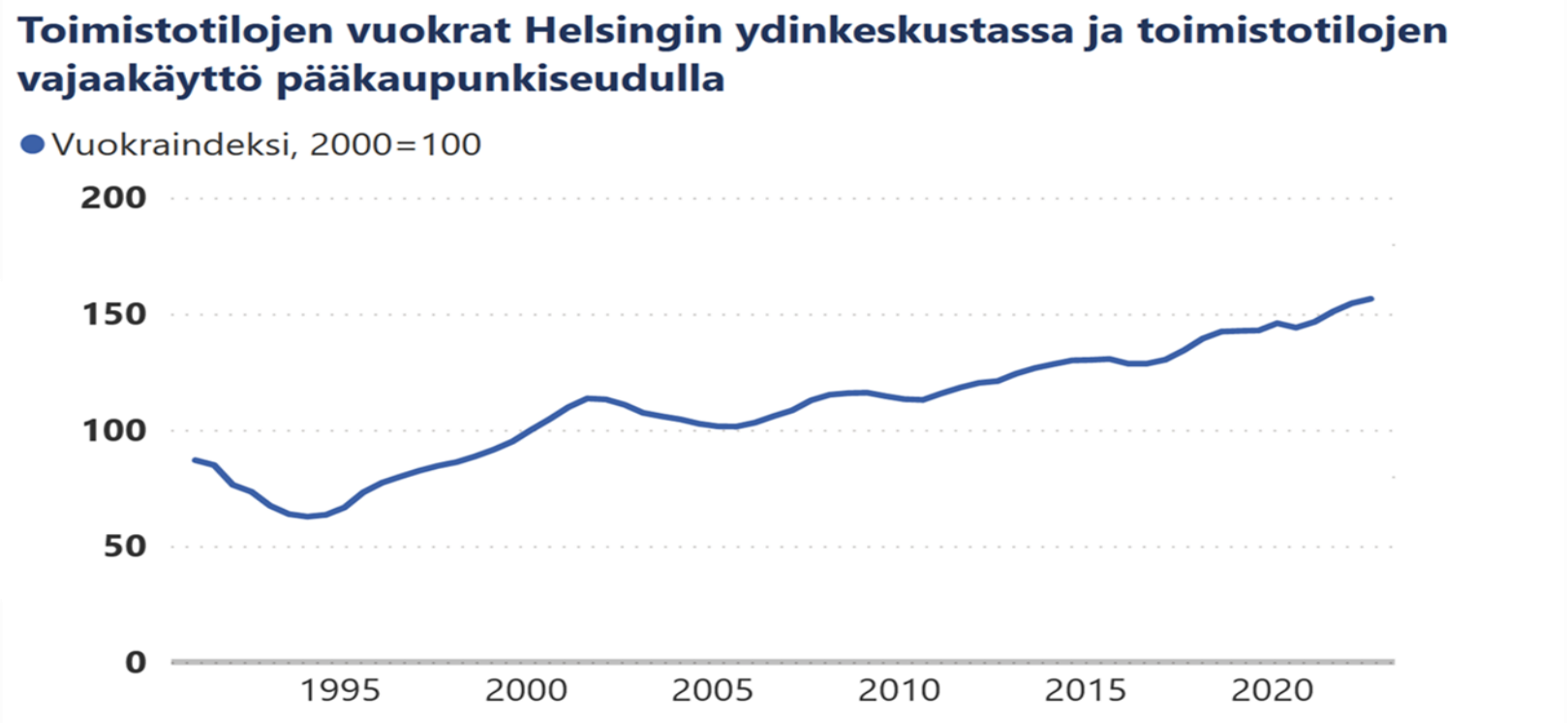
Figure 1: The donut effect for the largest twelve US cities



Notes: The figure shows Zillow's observed rental index (left) and home value index (right) in the 12 largest US metro areas (New York, Los Angeles, Chicago, Dallas, Houston, Miami, Philadelphia, Washington DC, Atlanta, Boston, San Francisco, and Phoenix – ordered by population). Zip codes are grouped by population density or presence in a Central Business District (CBD). A population weighted average is taken across all zipcodes in each bucket, and each aggregated index is normalized such that Feb 2020 = 100. Groups are given by high density = top 10%, mid density = 50-90th percentile, low density = 0-50th percentile and the CBD is defined by taking all zip codes with centroids contained within a 2 km radius of the CBD coordinates taken from Holian (2019). Population data taken from the 2015-19 5-yr ACS. Sources: Zillow, Census Bureau, Holian (2019). Data: Jan 2018 – Apr 2021.

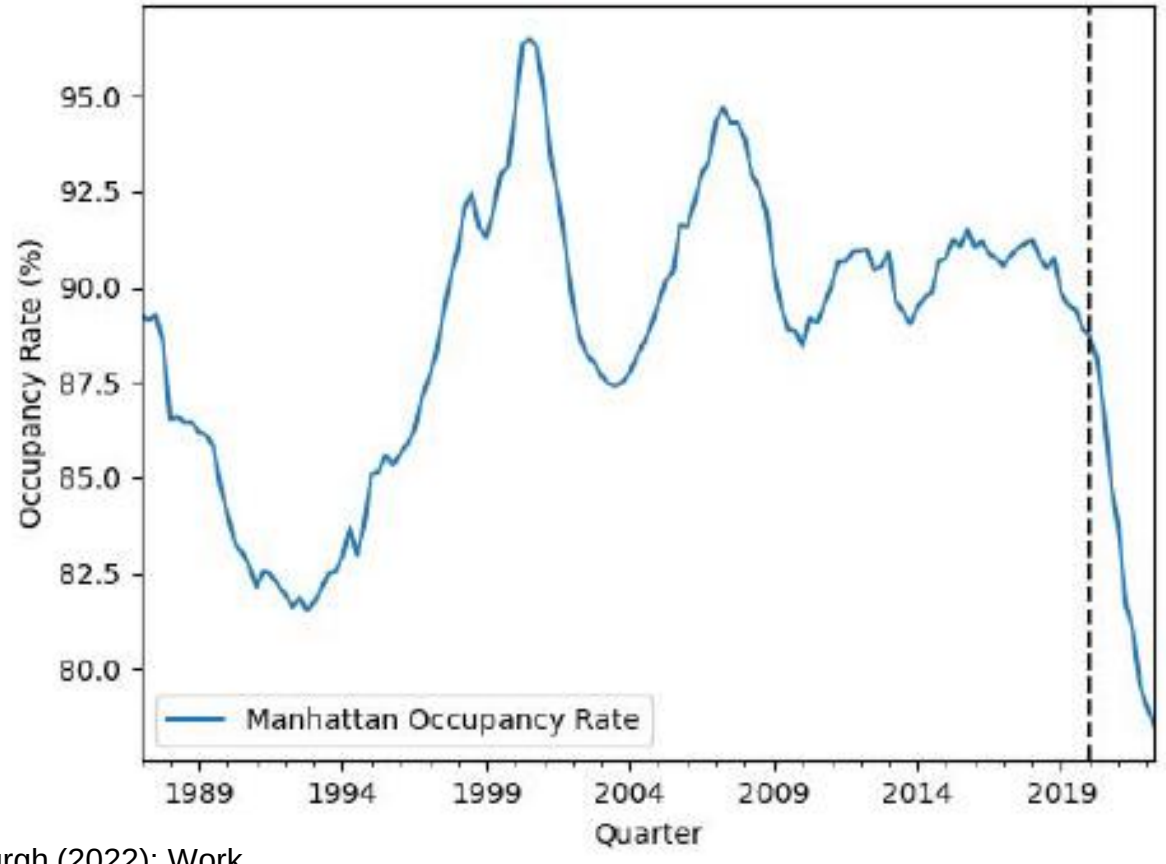
Ramani & Bloom (2021): The Donut Effect of Covid-19 on Cities.

Office rents – Helsinki CBD

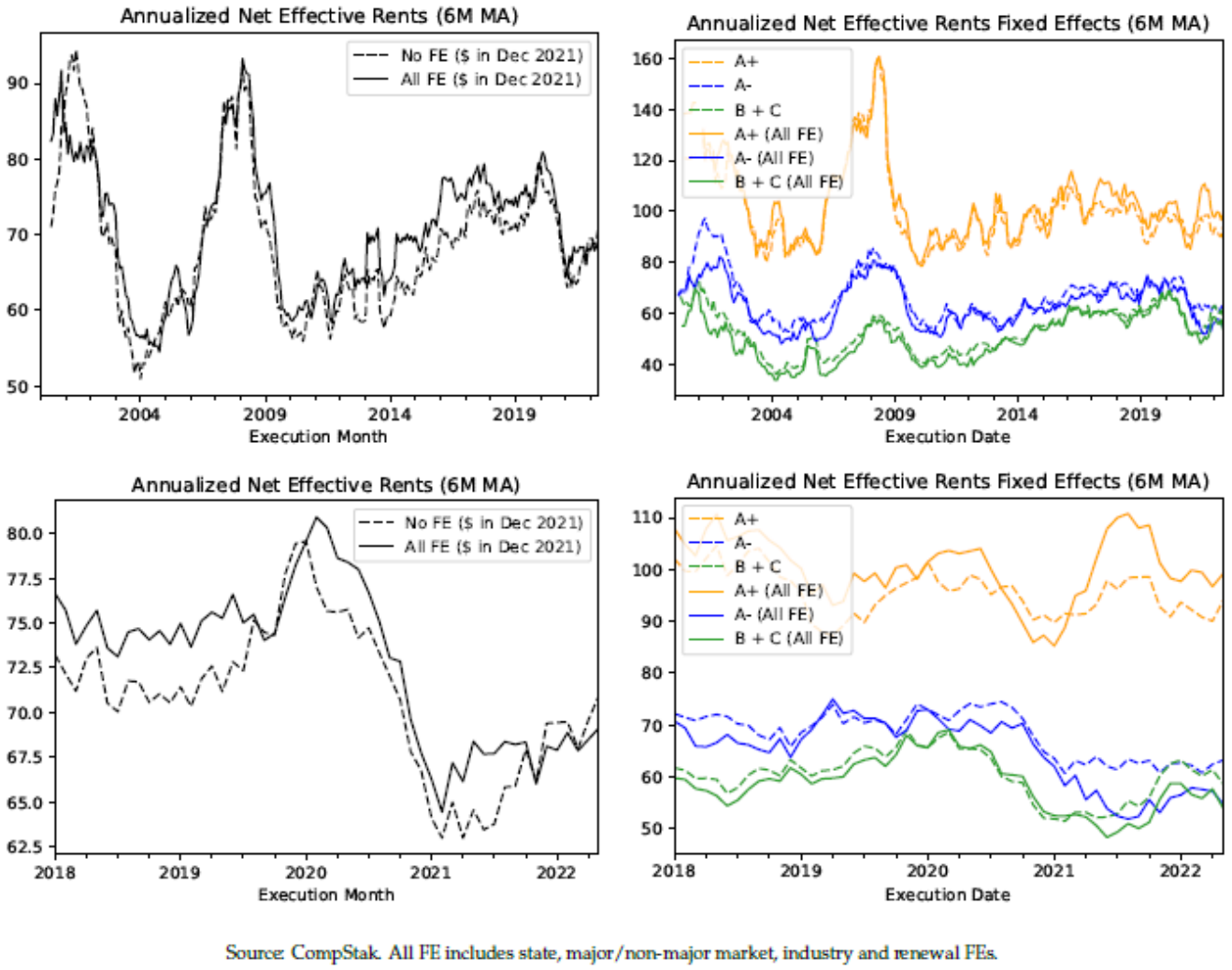


Lähde: Helsingin Seudun Suunnat / Catella Property Oy ja KTI Kiinteistötieto Oy

Figure 5: Manhattan Occupancy Rate



Source: Gupta, Mittal & Van Nieuwerburgh (2022): Work From Home and the Office Real Estate Apocalypse.



Source: CompStak. All FE includes state, major/non-major market, industry and renewal FEs.

Source: Gupta, Mittal & Van Nieuwerburgh (2022): Work From Home and the Office Real Estate Apocalypse.

What to do?

It is too early to say whether WFH or some hybrid models will stick

- Firms and workers are still learning about the effects of WFH
- Workers will make new housing choice only after they know that WFM is possible also in the future

If the demand for office space decrease it would be natural to allow offices to be converted into housing

Recap

The simple monocentric city model can be used to compare different types of cities

It does not give as unambiguous predictions about segregation patterns, but does predict segregation

- Segregation patterns depend on the nature of commuting cost, neighborhood and housing quality, and transportation mode

Other extensions, such as secondary employment centers, freeways and durable housing, modify some of the predictions in interesting ways

WFH has the potential to disrupt the inner structure of cities