COSTS AND BENEFITS OF AGGLOMERATION

LSE GY457 – MT 2023

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I COURSE COMPONENTS

the idea

- Block I
  - Introduction to Urban and Regional Economics and Course Overview
  - Topic I: Regional and urban concentration forces
  - Topic II: The empirics of agglomeration
  - **Topic III: Costs and benefits of agglomeration**
- Block 2
  - Topic IV: Monocentric city I (household location choice)
  - Topic V: Monocentric city II (household location choice)
  - Topic VI: Firm location choice
  - Topic VII: The urban economy in general equilibrium
- Block 3
  - Topic VIII: The vertical dimension of cities
  - Topic IX: Suburbanization and gentrification
  - Topic X: Spatial inequalities

I INTRODUCTION

roadmap

- **Last time: Empirics of agglomeration**
  - **1) Determinants of agglomeration**
    - **Which sectors**
    - **At what spatial level**
    - **Correlation with proxies for MAR externalities?**
  - **2) The effects of agglomeration**
    - **Productivity effects in agglomerations**
  - **3) The Spatial scale of agglomeration effects**
    - **How far to spillover effects travel?**
  - **4) Urbanization vs. localization effects**
    - **What matters for urban growth (implications for RE markets)**

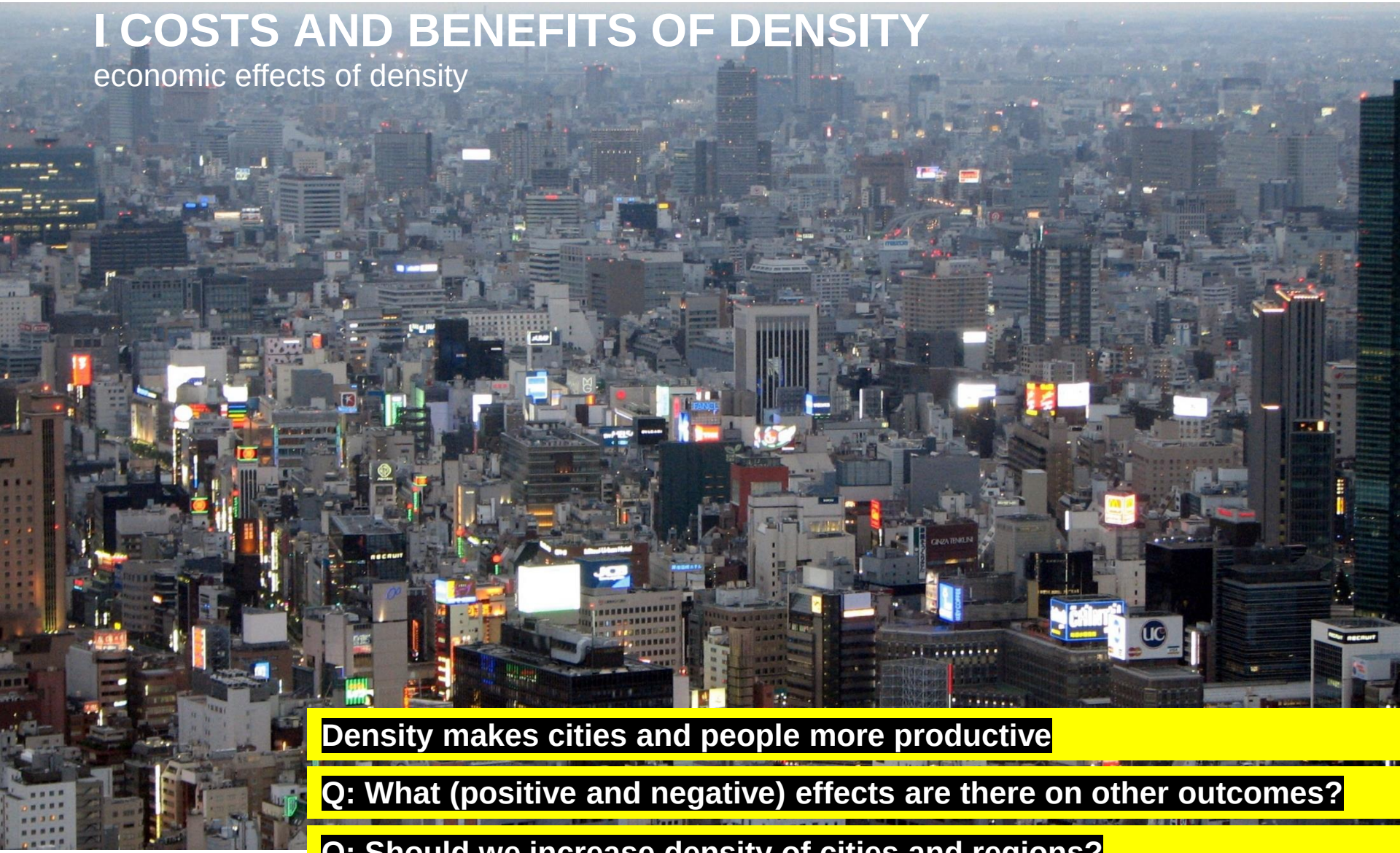
I INTRODUCTION

roadmap

- **This time: *Costs and benefits* of agglomeration**
  - **1) The economic effects of density**
    - **Density elasticities of economic outcomes**
    - **Net effect of density**
    - **Origins of rent effects of density**
  - **2) Equilibrium city size**
    - **Optimal city size**
    - **A system of cities**
  - **3) Compensating differentials**
    - **Real wages in spatial equilibrium**

I COSTS AND BENEFITS OF DENSITY

economic effects of density



Density makes cities and people more productive

Q: What (positive and negative) effects are there on other outcomes?

Q: Should we increase density of cities and regions?

I EVIDENCE ON DENSITY EFFECTS

- **Some effects of density intensely studied:**
  - Economists
    - Density has positive effects on productivity (e.g. Ciccone & Hall 1996; Ahlfeldt et al. 2015; Combes et al. 2012).
  - Planners
    - Density makes cities less car-dependent (Ewing & Cervero 2010)
- **For other effects, evidence is less compelling and difficult to access**
  - Scarce, inconsistent or not robust
  - Scattered across various separate literatures in different disciplines
  - E.g. consumption benefits, local public spending, green spaces, health, wellbeing

Ahlfeldt & Pietrostefani (2019) provide a synthesis on the state of knowledge on the economic effects of density

I DENSITY ELASTICITIES IN LITERATURE

	Elasticity of outcome		Proportion				Med.	Mean	Elasticity[d]	
ID	with respect to density	N	Poor[a]	Acad.	Econ.	With.	year[b]	SMS[c]	Mean	S.D.
1	Labour productivity	47	0.19	0.79	0.74	0.06	2007	3.02	0.04	0.04
1	Total factor productivity	15	0.13	0.87	0.80	0.20	2004	2.80	0.06	0.03
2	Patents p.c.	7	0.00	1.00	0.14	0.00	2006	2.86	0.21	0.11
3	Rent	13	0.00	0.69	0.62	0.62	2013	3.00	0.15	0.13
4	Commuting reduction	36	0.03	0.56	0.08	0.56	2005	2.17	0.06	0.12
4	Non-work trip reduction	7	0.00	0.71	0.00	0.86	2005	2.00	-0.20	0.44
5	Metro rail density	3	0.00	1.00	0.00	1.00	2010	3.33	0.01	0.02
5	Quality of life	8	0.38	0.88	1.00	0.13	2014	3.00	0.03	0.07
5	Variety (consumption amenities)	1	0.00	1.00	0.00	0.00	2015	4.00	0.19	-
5	Variety price reduction	2	0.00	0.00	1.00	1.00	2016	4.00	0.12	0.06
6	Public spending reduction	20	0.00	1.00	0.05	0.00	2007	2.00	0.17	0.25
7	90th-10th pct. wage gap reduction	1	0.00	1.00	0.00	0.00	2004	4.00	0.17	-
7	Black-white wage gap reduction	1	0.00	0.00	1.00	0.00	2013	2.00	0.00	-
7	Diss. index reduction	3	0.00	1.00	0.33	0.00	2009	3.33	0.66	0.94
7	Gini coef. reduction	1	0.00	1.00	0.00	0.00	2010	4.00	4.56	-
7	High-low skill wage gap reduction	3	0.00	0.67	1.00	0.00	2013	4.00	-0.13	0.07
8	Crime rate reduction	13	0.00	0.69	0.15	0.92	2014	2.54	0.24	0.47
9	foliage projection cover	1	0.00	1.00	0.00	1.00	2015	1.00	-0.06	-
10	Noise reduction	1	0.00	1.00	0.00	0.00	2012	1.00	0.04	-
10	Pollution reduction	18	0.44	0.33	0.33	0.39	2014	2.83	0.04	0.47
11	Energy reduction: Domestic & driving	21	0.10	0.90	0.38	0.24	2010	1.81	0.07	0.10
11	Energy reduction: Public transit	1	0.00	1.00	1.00	0.00	2010	1.00	-0.37	-
12	Speed	2	0.00	0.00	1.00	0.00	2016	4.00	-0.12	0.01
13	Car usage (incl. shared) reduction	22	0.00	0.95	0.00	0.95	2004	2.00	0.05	0.07
13	Non-car use	76	0.05	0.79	0.00	0.86	2006	2.03	0.16	0.24
14	Cancer & other disease reduction	5	0.00	1.00	0.00	0.60	2000	2.40	-0.33	0.20
14	KSI & casualty reduction	4	0.00	1.00	0.00	0.00	2003	2.00	0.01	0.61
14	Mental-health	1	0.00	1.00	0.00	1.00	2015	2.00	0.01	-
14	Mortality reduction	3	0.00	1.00	0.00	0.00	2010	2.00	-0.36	0.17
15	Reported health	3	0.00	1.00	0.00	0.00	2013	1.00	-0.27	0.11
15	Reported safety	1	0.00	1.00	0.00	1.00	2015	2.00	0.07	-
15	Reported social interaction	6	0.00	0.17	0.83	0.00	2007	3.50	-0.13	0.19
15	Reported wellbeing	1	0.00	1.00	1.00	0.00	2016	3.00	0.00	-
	Sum	347								

I META-ANALYSIS OF DENSITY ELASTICITIES

Benefits and costs of density appear to be larger in developing countries!

Q: why?

Density elasticity of rent increases in density!

Log-convexity, not present for wages

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Normalised density elasticity estimate	Estimated density elasticity of wages	Estimated density elasticity of wages	Estimated density elasticity of rent	Estimated density elasticity of commuting reduction	Estimated density elasticity of energy use reduction	Estimated density elasticity of sustainable mode choice
Category ID	All	1	1	3	4	11	13
Non-high-income country	-0.111 (0.25)	0.025 (0.02)	0.050*** (0.00)	-	-0.247 (0.21)	-0.195 (0.26)	-0.162*** (0.04)
Not published in academic journal	0.401** (0.19)	0.004 (0.02)		-0.021 (0.07)	0.150 (0.13)	0.364*** (0.10)	0.164 (0.16)
Non-economics discipline	0.043 (0.18)	0.007 (0.02)		-0.081 (0.07)	0.041 (0.07)	0.003 (0.06)	-
Round 3 [a]	0.077 (0.18)	0.022* (0.01)		-0.109+ (0.06)	0.003 (0.06)	0.101* (0.05)	-0.178** (0.07)
Within-city variation	-0.136 (0.18)	-0.020+ (0.01)		-0.146 (0.10)	-0.071 (0.07)	0.187** (0.07)	-0.085 (0.11)
Citation index normalised by s.d.	-0.091* (0.05)	-0.005+ (0.00)		0.307+ (0.18)	0.058 (0.05)	-0.010 (0.01)	0.030 (0.04)
SMS >=3	-0.203 (0.16)	-0.014 (0.01)		-0.040 (0.08)	-0.025 (0.05)	0.070 (0.07)	-0.007 (0.09)
Pop. density in study area (1000/km²)	-0.008 (0.01)	-0.005 (0.00)		0.063** (0.03)	0.011 (0.07)	0.017 (0.04)	-0.001 (0.00)
Constant	0.000 (0.05)	0.048*** (0.01)	0.048*** (0.00)	0.131*** (0.02)	0.051** (0.02)	0.115*** (0.02)	0.183*** (0.04)
Study effects	-	-	Yes	-	-	-	-
N	337	47	47	13	36	21	76
r2	0.043	0.126	0.846	0.805	0.306	0.763	0.131

I MONETARY EQUIVALENTS

(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Category			Quantity, p.c., year		Unit value		PV of 1%
ID	Outcome	Elast.	Variable	Value	Unit	Value	dens. incr.
1	Wage	4%	Income ($)	35,000	-	1	**280**
2	Patent intensity	19%	Patents (#)	2.06E-04	Patent value ($/#)	793K	**7**
3	Rent	21%	Income ($)	35,000	Expenditure share	0.33	**347**
4	VMT[b] reduction	6%	VMT[b] (mile)	10,658	Priv. cost $/mile	0.83	**107**
5	Variety value[c]	12%[b]	Income ($)	35,000	Expenditure share[d]	0.14	**115**
6	Local public spending	17%	Total spending ($)	1,463	-	1	**50**
7	Wage gap[e] reduction	-3.5%	Income ($)	35,000	Inequality premium	0.048	**-12**
8	Crime rate[f] reduction	8.5%	Crimes (#)	0.29	Full cost ($/#)	3,224	**16**
9	Green density	28%	Green area (p.c., m²)	540	Park value ($/m²)	0.3	**100**
10	Pollution reduction	-13%	Rent ($)	11,550	Rent-poll. elasticity	0.3	**-90**
11	Energy use reduction	7%	Energy (1M BTU)	121.85	Cost ($/1M BTU)	18.7	**32**
	(private and social effects)	7%	CO2 emissions (t)	25	Social cost ($/t)	43	**15**
12	Average speed	-12%	Driving time (h)	274	VOT ($/h)	10.75	**-71**
13	Non-car mode choice	7%	VMT[b]	10,658	Social cost ($/mile)[g]	0.016	**2**
14	Health	-9%	Mortality risk (#)	5.08E-04	Value of life ($/#)[h]	7M	**-64**
15	Subjective well-being[j]	-0.4%	Income ($)	35,000	Inc.-happ. elasticity	2	**-52**

Monetery equivalents represent area-based effects, including selection effects. [a] The per-capita present value for an infinite horizon and a 5% discount rate. [b] Vehicle miles travelled. [c] Reduction in price index of consumption varieties. [d] Local non-tradeables: home, entertainment, and apparel and services. [e] Assuming a wage gap of high-skilled vs. low-skilled that corresponds to the 80th vs. 20th percentiles in the wage distribution. [f] All crimes against individual and households, [g] Emissions externality [h] Statistical value of life. [i] Pre-mature (> 70) mortality rate. [j] Self-reported well-being. See appendix section 5 for a discussion of the assumptions on quantities and unit values by category.

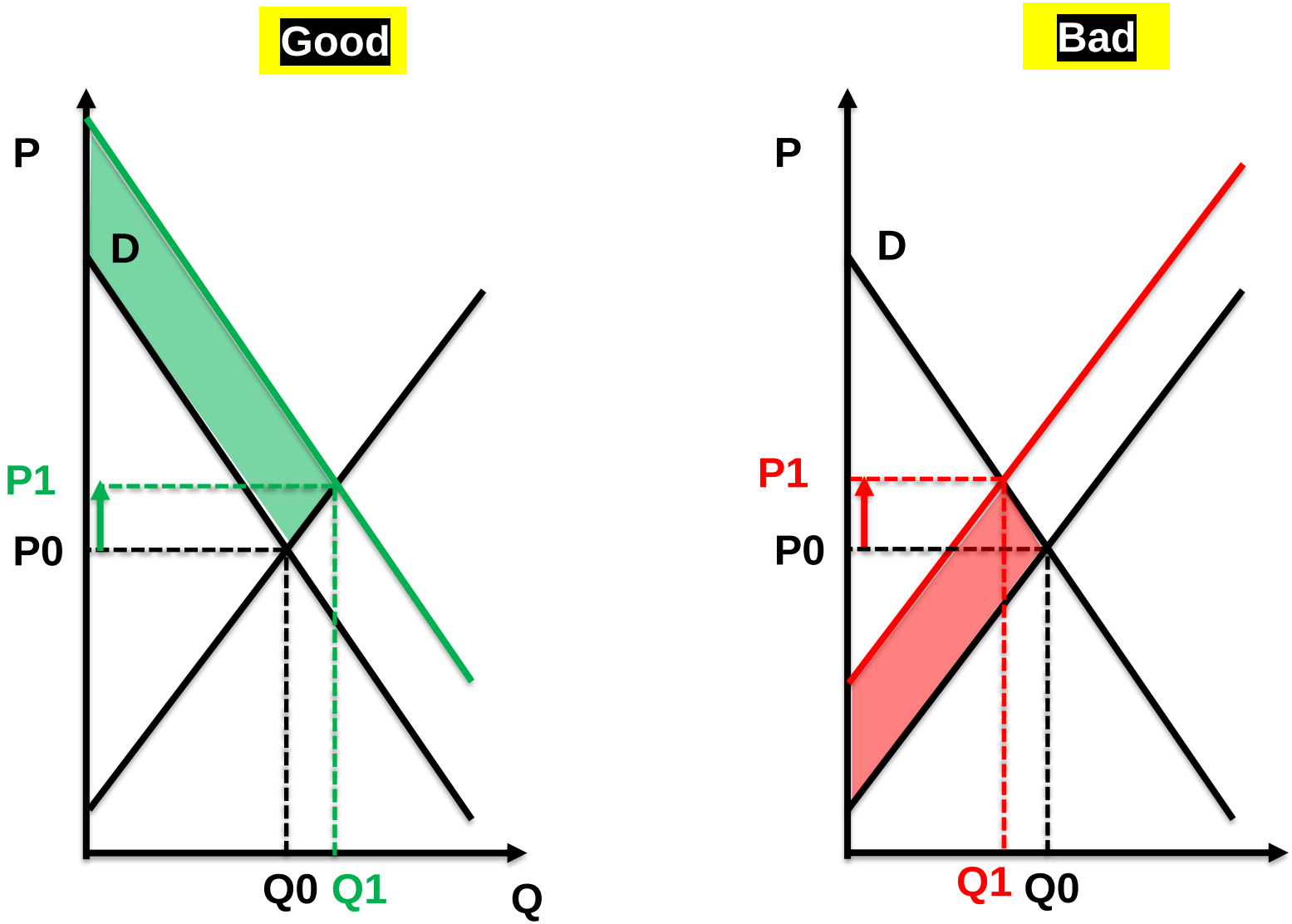
I SUMMARY OF DENSITY EFFECTS

Desity empirically associated with	
Higher wages	Higher pollution concentration
Shorter trips	More congestion
More consumption variety	Adverse health effects
Preserved green spaces	Lower subjective wellbeing
Energy savings and sustainable transport	More inequality
More efficient local public services provision	
Less crime	
More innovation	
Higher property rents and prices	

Research priority areas are density effects on
Crime, urban green, income inequality, pollution, health, subjective well-being
(potentially relevant for GY458/GY485)

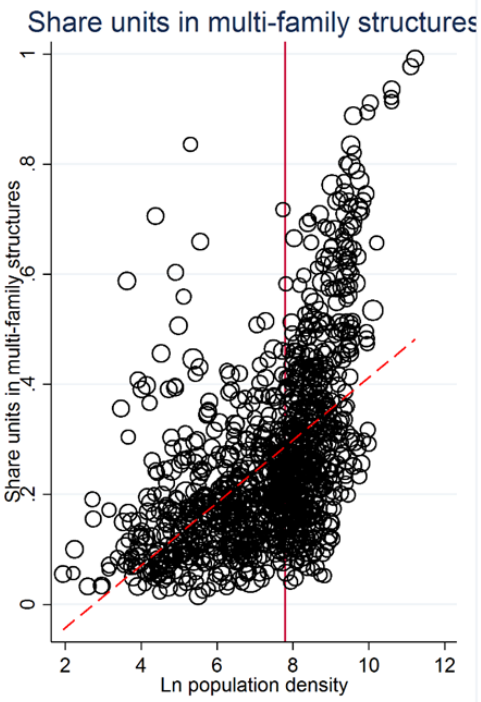
Q: Are prositive rent (price) effects good or bad?

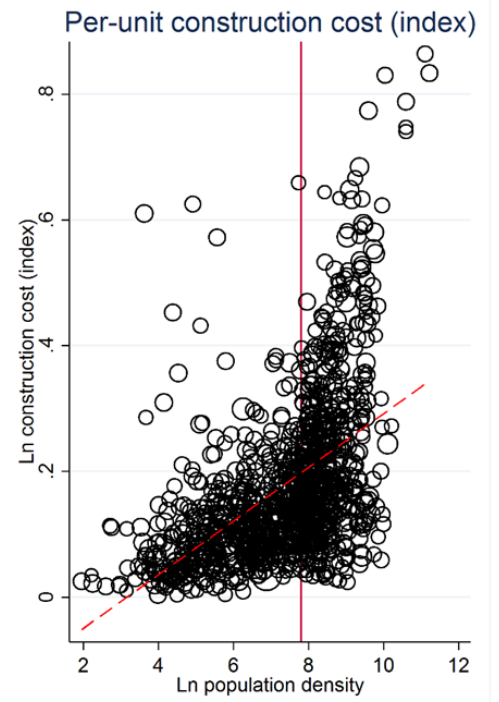
I WELFARE EFEFCT OF DENSTY INCREASE



I EVIDENCE ON DENSITY EFFECTS

- **Density effect on construction cost:**
  - **Cost elasticity of density: 4-7% (Ahlfeldt & Pietrostefani, 2019)**
  - **Building denser =>**
    - **Increase developed area**
    - **Build taller (at high density)**
  - **Building taller is more expensive**
    - **Height elasticity of** per floor space **construction cost: 25% to >100%**
    - **(Ahlfeldt, McMillen, 2018)**
    - **See topic VIII)**



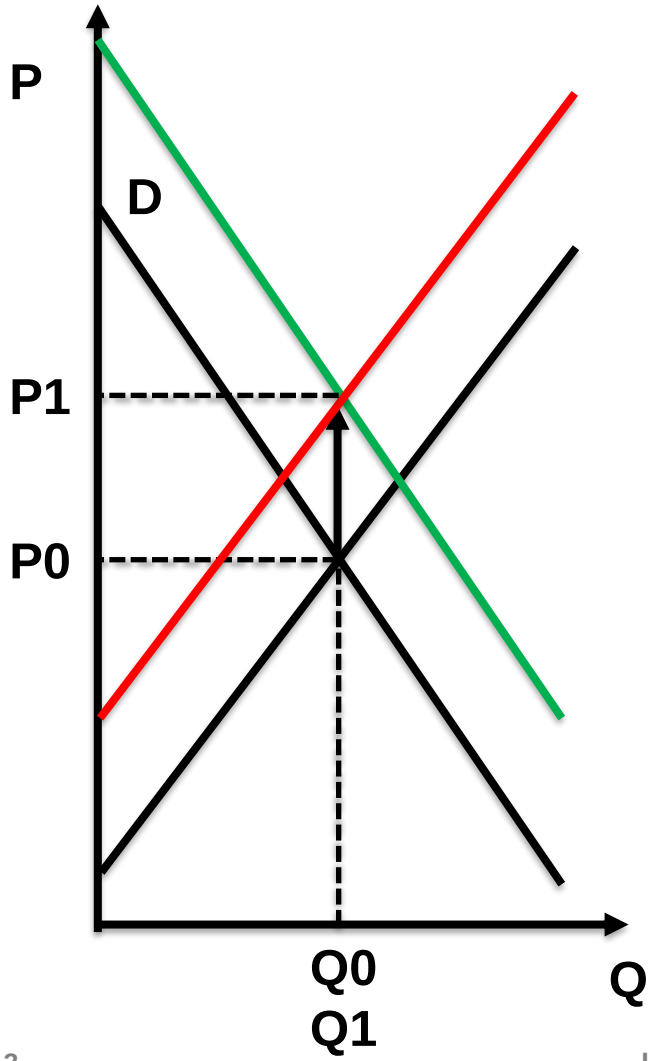


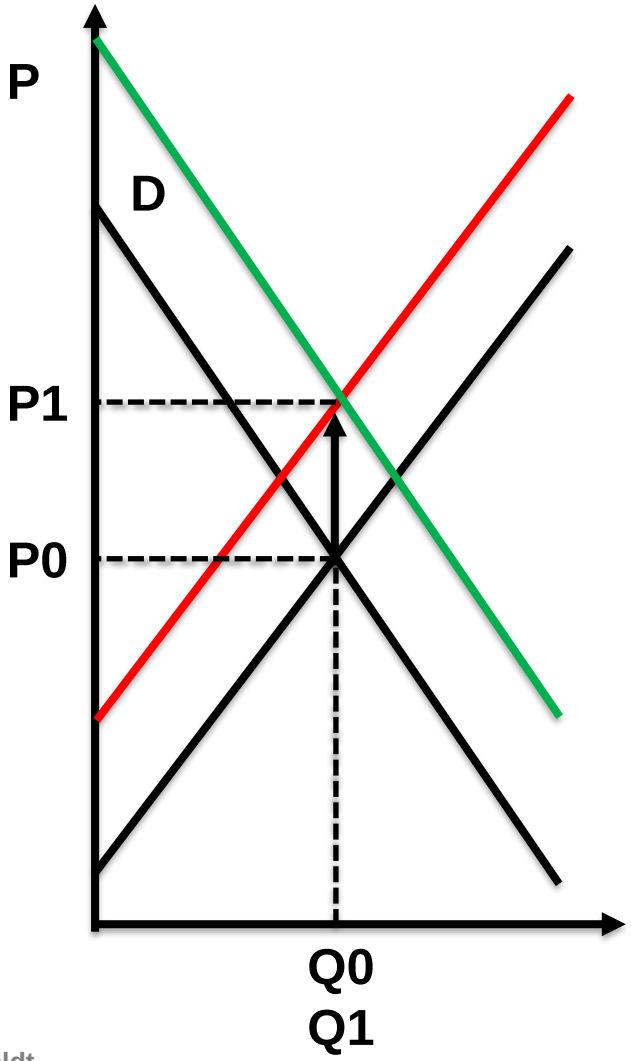
Building denser is more expensive

Per-unit cost larger for multi-family than for single-family structure

I WELFARE EFEFCT OF DENSTY INCREASE

Evidence in Ahlfelfeldt and Pietrostefani (2019) suggests that it is a mix of both!





I DENSITY EFFECT

- There are costs and benefits of density
  - Positive density effects seem to dominate for medium to large city in developed world
- Large positive effect of density on property prices
  - Partially reflects willingness to pay for positive density effects
  - Partially reflects cost of supplying housing at higher densities
- Important welfare implications
  - Policies that generate higher density can increase welfare
  - But restricting supply too much can decrease welfare and harm renters and first-time buyers in particular

More on the effects of housing supply restrictions in lent term!

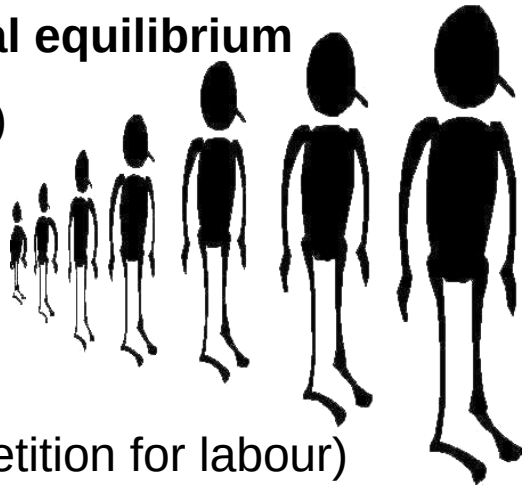
II EQUILIBRIUM CITY SIZE

roadmap

- **This time: *Costs and benefits* of agglomeration**
  - 1) The economic effects of density
    - Density elasticities of economic outcomes
    - Net effect of density
    - Origins of rent effects of density
  - 2) **Equilibrium city size**
    - **Optimal city size**
    - **A system of cities**
  - 3) Compensating differentials
    - Real wages in spatial equilibrium

II CITY SIZE AND MIGRATION

equilibrium city size

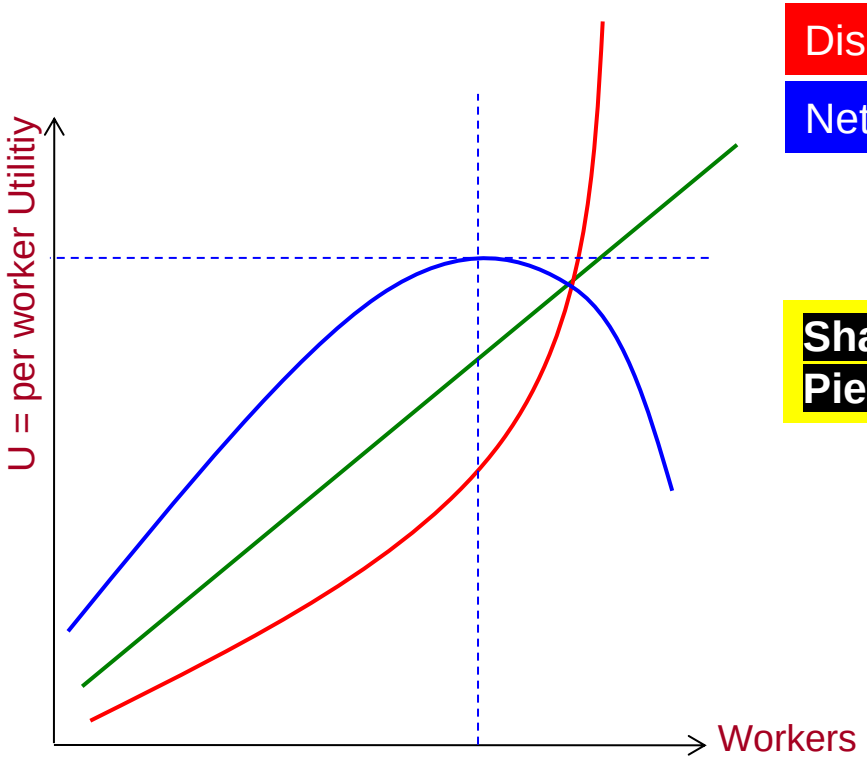


- **Migration** ensures that prices adjust to maintain **spatial equilibrium**
  - At some point the city stops growing (rent too high)
  - Is the resulting **equilibrium efficient**?
- **Agglomeration** associated with **benefits** and **costs**
  - **Agglomeration benefits**
    - Higher productivity and wages (through competition for labour)
    - Consumption benefits (diversity, large-scale amenities, etc.)
  - **Agglomeration costs**
    - High rents (scarcity of land)
    - Commuting cost, congestion, noise, pollution, crime, etc.
- As the city **grows, costs** start **outweighing benefits** (or “explosive” growth)

Q: When does a city stop growing, when it is too large, too small, or just right?

II CITY SIZE II

equilibrium city size



Agglomerations economies and diseconomies

Utility per worker increases in size

Disutility per worker increases (increasing rate)

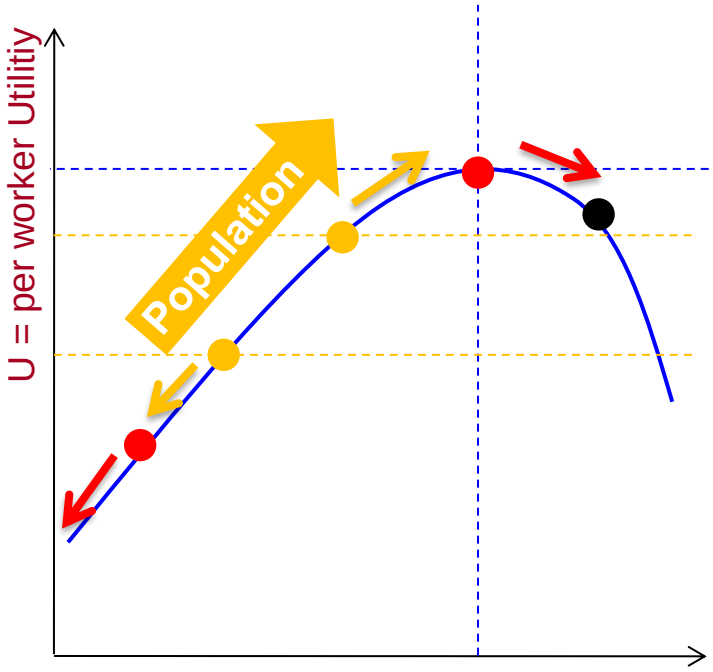
Net-utility “inverse u-shaped” (not in same scale)

Shapes in line with evidence (Ahlfeldt & Pietrostefani, 2019, meta-analysis in section I

Illustrations based on O‘Sullivan, chapter 4.
For more elaborate versions: Henderson (1974) and Duranton (2008)

II CITY SIZE II

equilibrium city size



Agglomerations economies and diseconomies

Utility per worker increases in size

Disutility per worker increases (increasing rate)

Net-utility “inverse u-shaped” (not in same scale)

Migration to larger cities with higher net-utility

Migration does not stop at optimum size

Cities in equilibrium likely are too big!

II SYSTEM OF CITIES

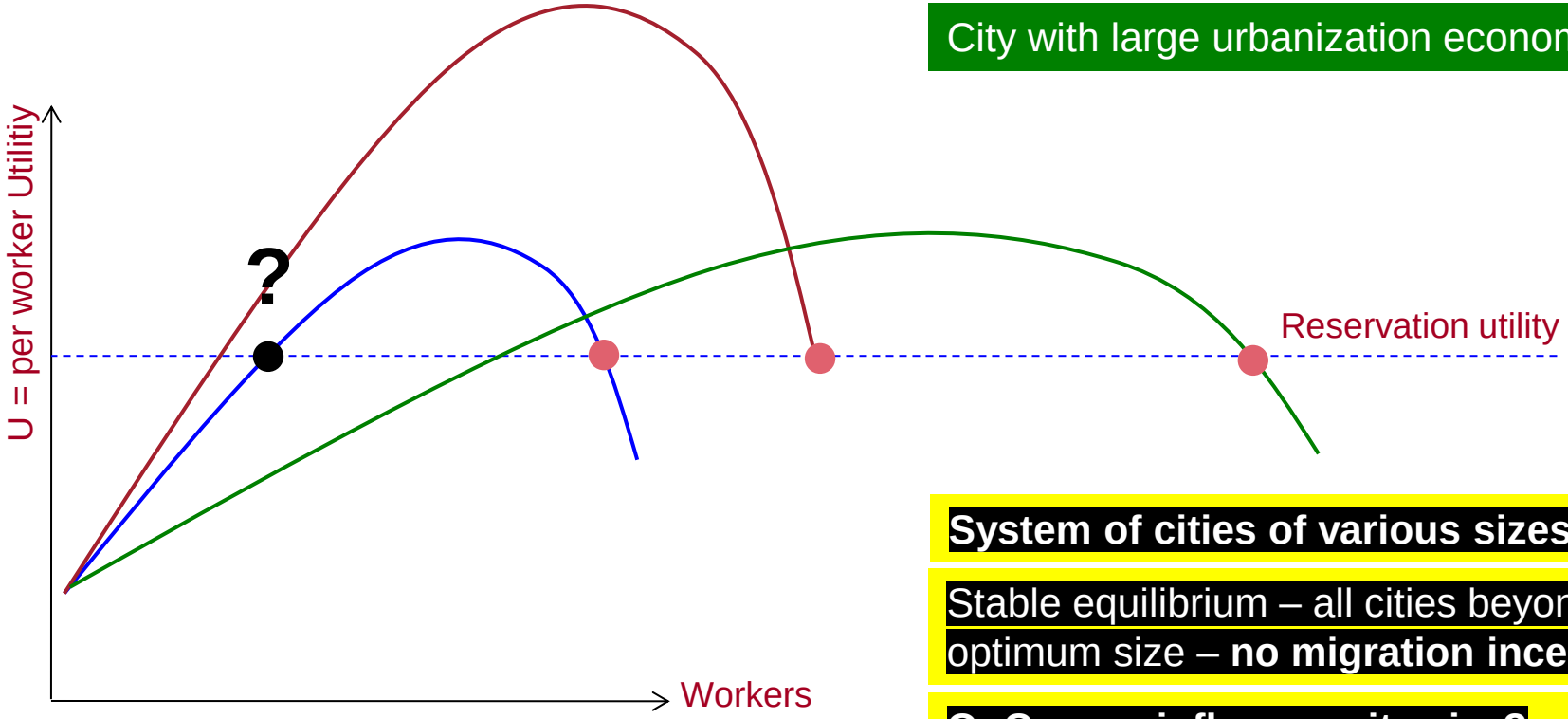
equilibrium city size

- **Differences in city size**

City with small localization economies

City with large localization economies

City with large urbanization economies



System of cities of various sizes!

Stable equilibrium – all cities beyond optimum size – **no migration incentive**

Q: Can we influence city size?

II POLICY AND CITY SIZE

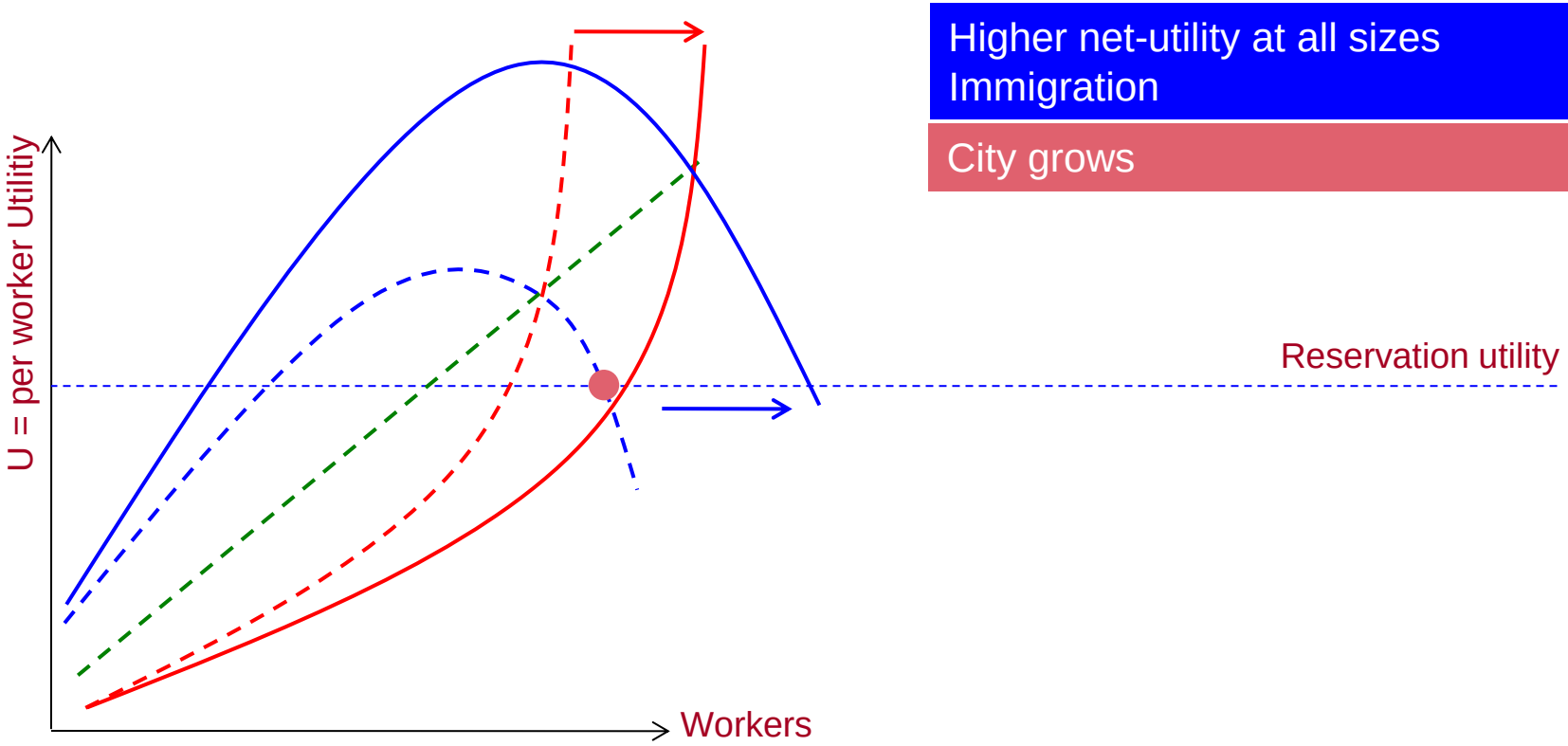
equilibrium city size

- **Growth policies can influence city size**

Improvements in urban infrastructure that reduce congestion cost, e.g. tube

Higher net-utility at all sizes
Immigration

City grows



II POLICY AND CITY SIZE

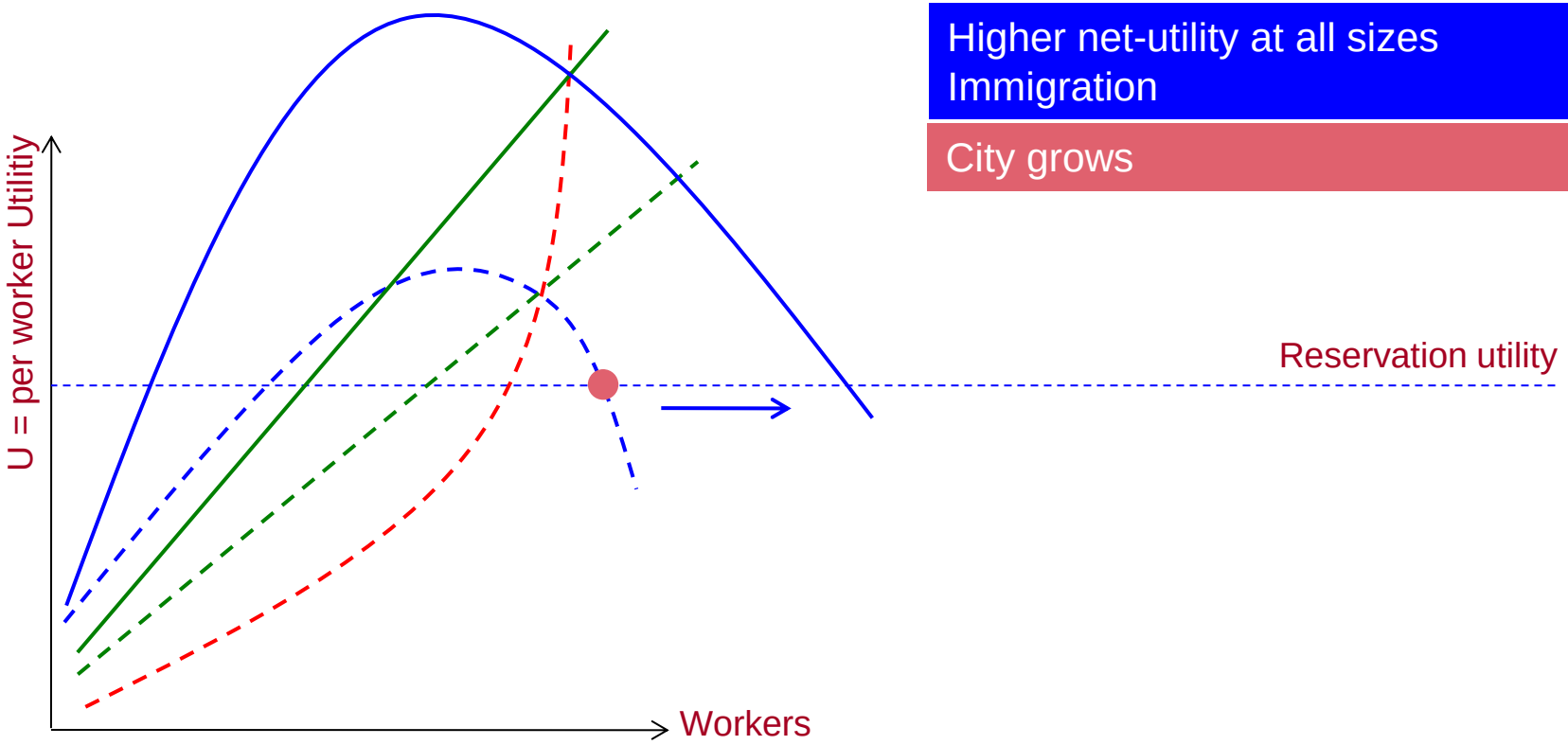
equilibrium city size

- **Growth policies can influence city size**

Attraction of sectors with high loc. econ.
Increases agglomeration benefits

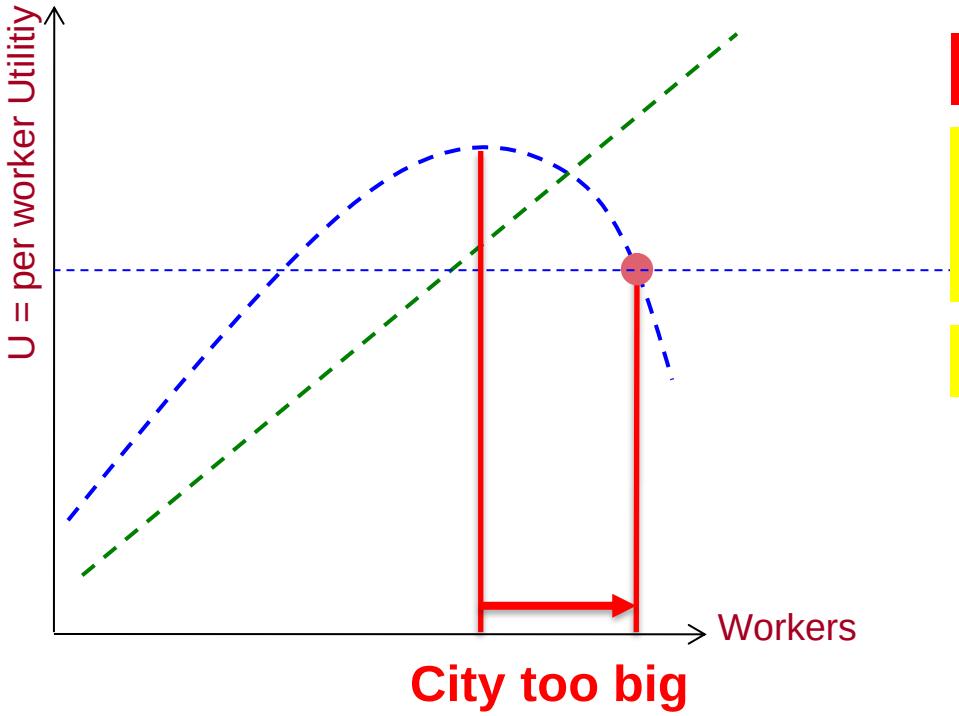
Higher net-utility at all sizes
Immigration

City grows



II OPTIMAL CITY SIZE

equilibrium city size



Cities in equilibrium likely are too big!

Ahlfeldt & Pietrostefani (2019) suggest that denser (bigger) cities may be welfare enhancing

Q: How can we reconcile?

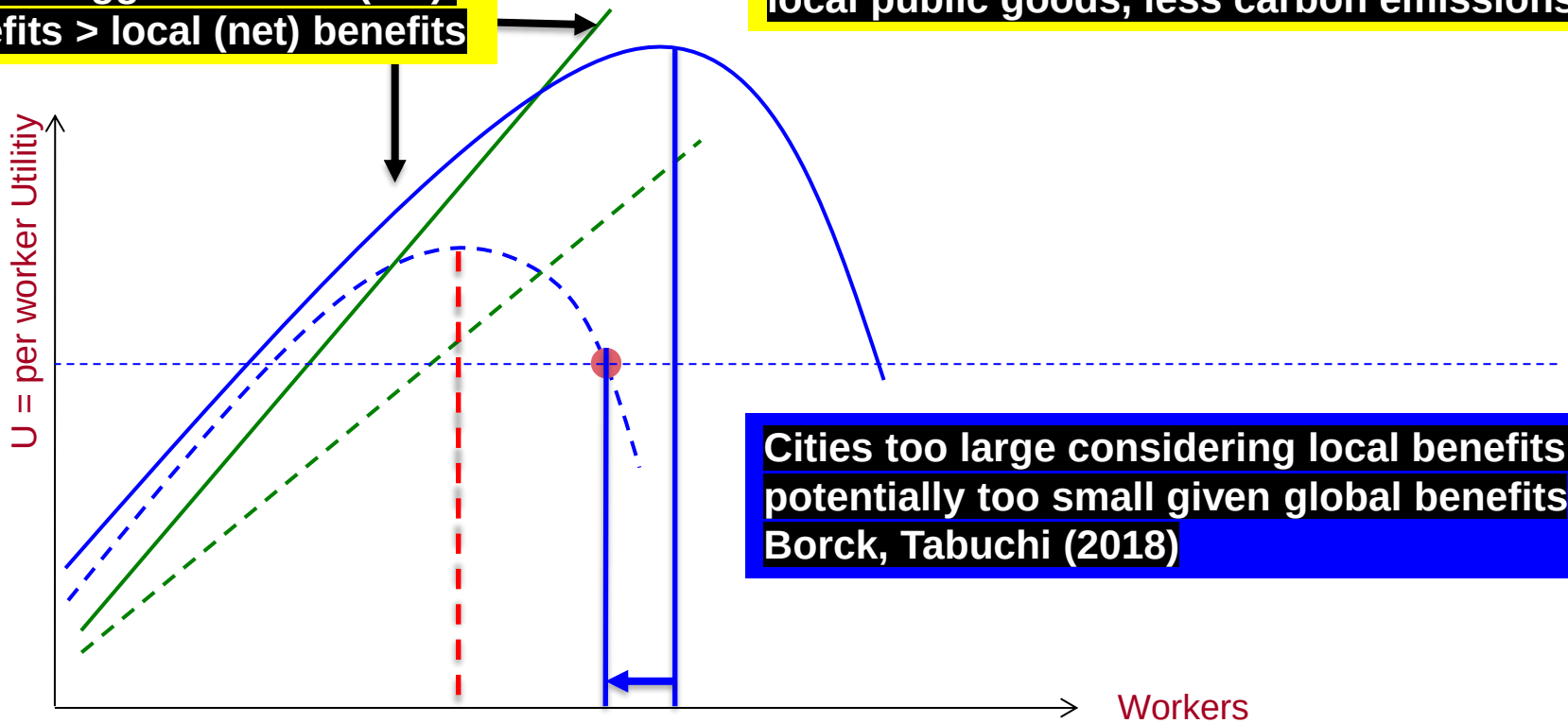
II OPTIMAL CITY SIZE

equilibrium city size

Migration decisions based on local cost

But national/global benefits of density (efficient local public goods, less carbon emissions)

Global agglomeration (net) benefits > local (net) benefits



Cities too large considering local benefits, but potentially too small given global benefits
Borck, Tabuchi (2018)

City too small

III COMPENSATING DIFFERENTIALS

roadmap

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  - **1) The economic effects of density**
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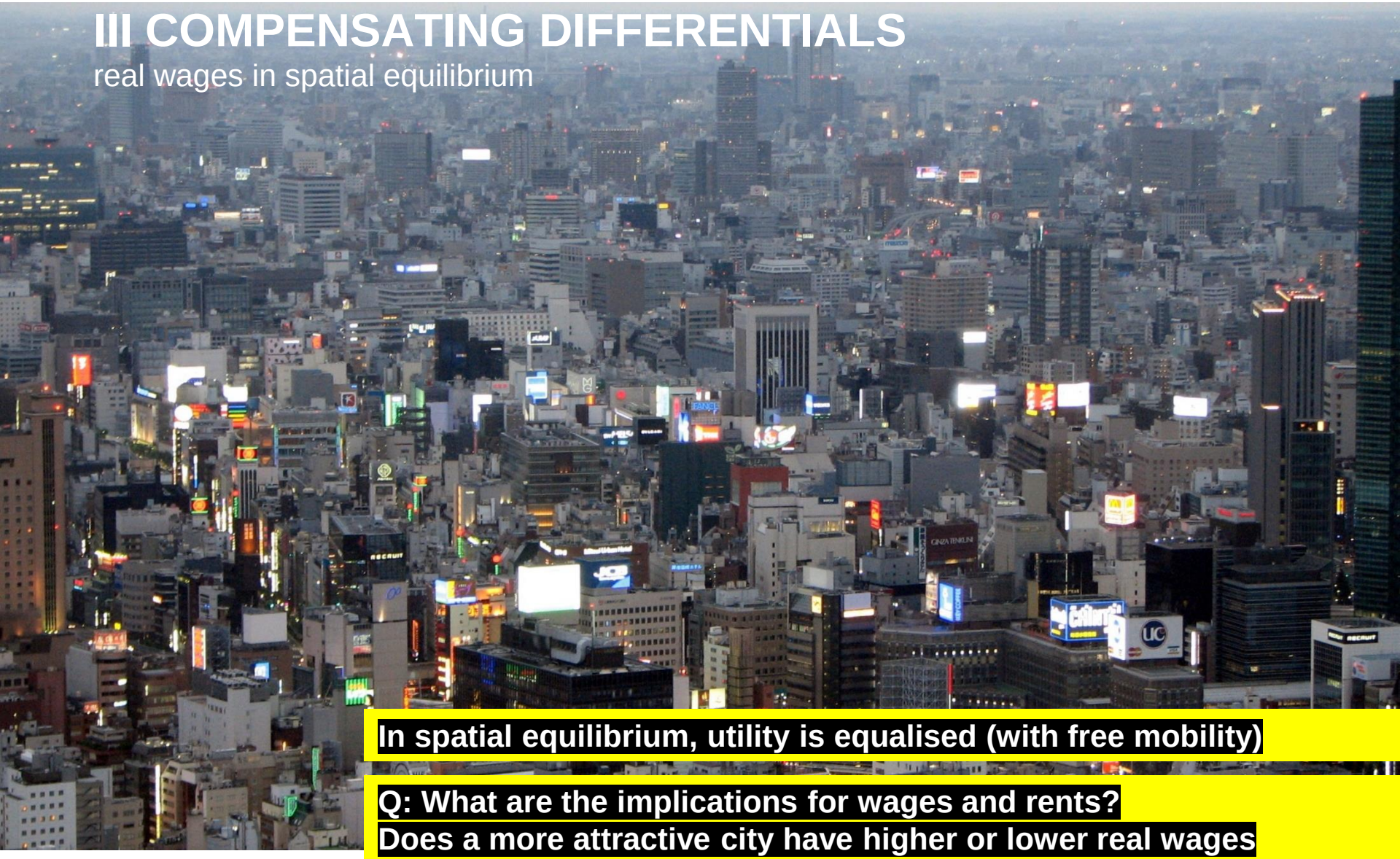
III COMPENSATING DIFFERENTIALS

real wages in spatial equilibrium



In spatial equilibrium, utility is equalised (with free mobility)

Q: What are the implications for wages and rents?
Does a more attractive city have higher or lower real wages

III ROSEN-ROBACK FRAMEWORK

compensating differentials

- **Spatial equilibrium framework by Rosen (1979) and Roback (1982)**
  - **Workhorse tool to analye local labour markets**
- **Consider a toy version:**
  - **Two cities, j=1,2**
  - **Two goods: traded composite good Q and land H**
  - **Productivity and utility differ by city in exogenous amenity A_j**
  - **No transport costs for traded good, price normalized to 1**
  - **Firms and residents are mobile and move beteen cities**
  - **Wages and rents adjust to clear markets**
  - **Spatial equilibrium implies that utility and (zero) profits are constant**

This is a simplified version of Roback (1982) based on Sieg (forthcoming)

III FIRM SIDE

compensating differentials

- **Firms produce Q using labour L and land H**
  - **Output depends on amenity A:** $Q_j = A_j(L_j, H_j)$
- **Firms pay rents *p* and wages *w***
  - **Profits are defined by:** $\pi_j = Q_j - p_j H_j - w_j L_j$
- **Competition implies zero profits** $1 = \left(\frac{p_j H_j + w_j L_j}{A_j(L_j, H_j)} \right)$
  - **Average cost of producing Q must be equal to the price, which is 1**
  - **Same price and average cost in all cities**

$$C_1(p_1, w_1) = 1 = C_2(p_2, w_2)$$

As *p increases w* must *decrease* and vice versa (what firms spend on one factor they have to save on the other)

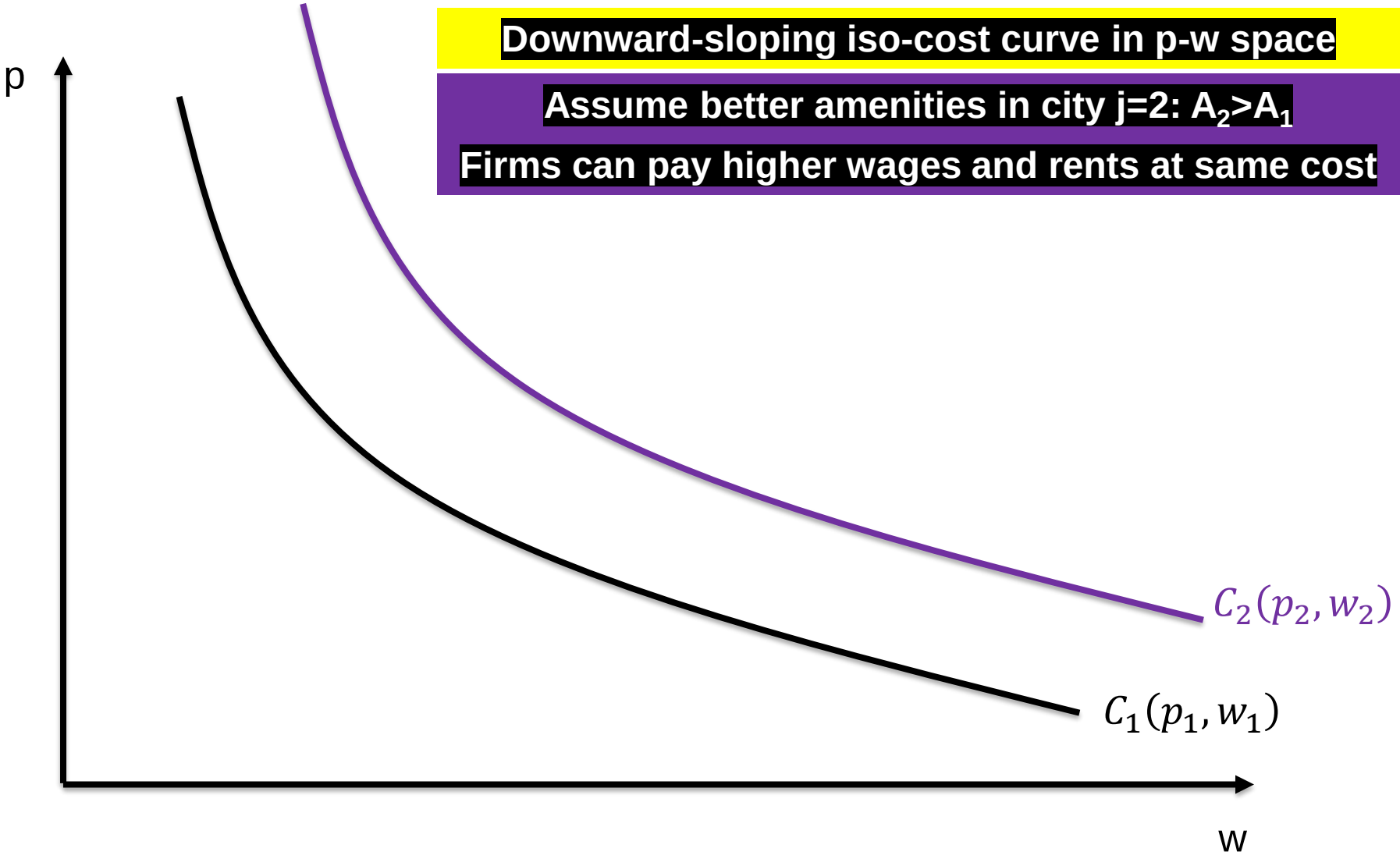
III FIRM SIDE

compensating differentials

Downward-sloping iso-cost curve in p-w space

Assume better amenities in city j=2: $A_2 > A_1$

Firms can pay higher wages and rents at same cost



III WORKER SIDE

compensating differentials

- **Workers derive utility from consumption of the composite good *q* and land *h*, and amenity *a***
  - **Lower case letters for workers:** $U_j = U(a_j, q_j, h_j)$
- **Workers spend income on composite good and land consumption**
  - **Budget constraint:** $w_j = q_j + p_j h_j$
- **Maximization subject to budget constraints gives indirect utility function**
  - **Utility is fixed to exogenous level** $V_j = U(a_j, q_j(p_1, w_1), h_j(p_1, w_1))$
  - **Utility must be the same in all cities**

$$V_1(p_1, w_1) = \bar{V} = V_2(p_2, w_2)$$

As rent *p increases*, wage *w* must *increase* and vice versa

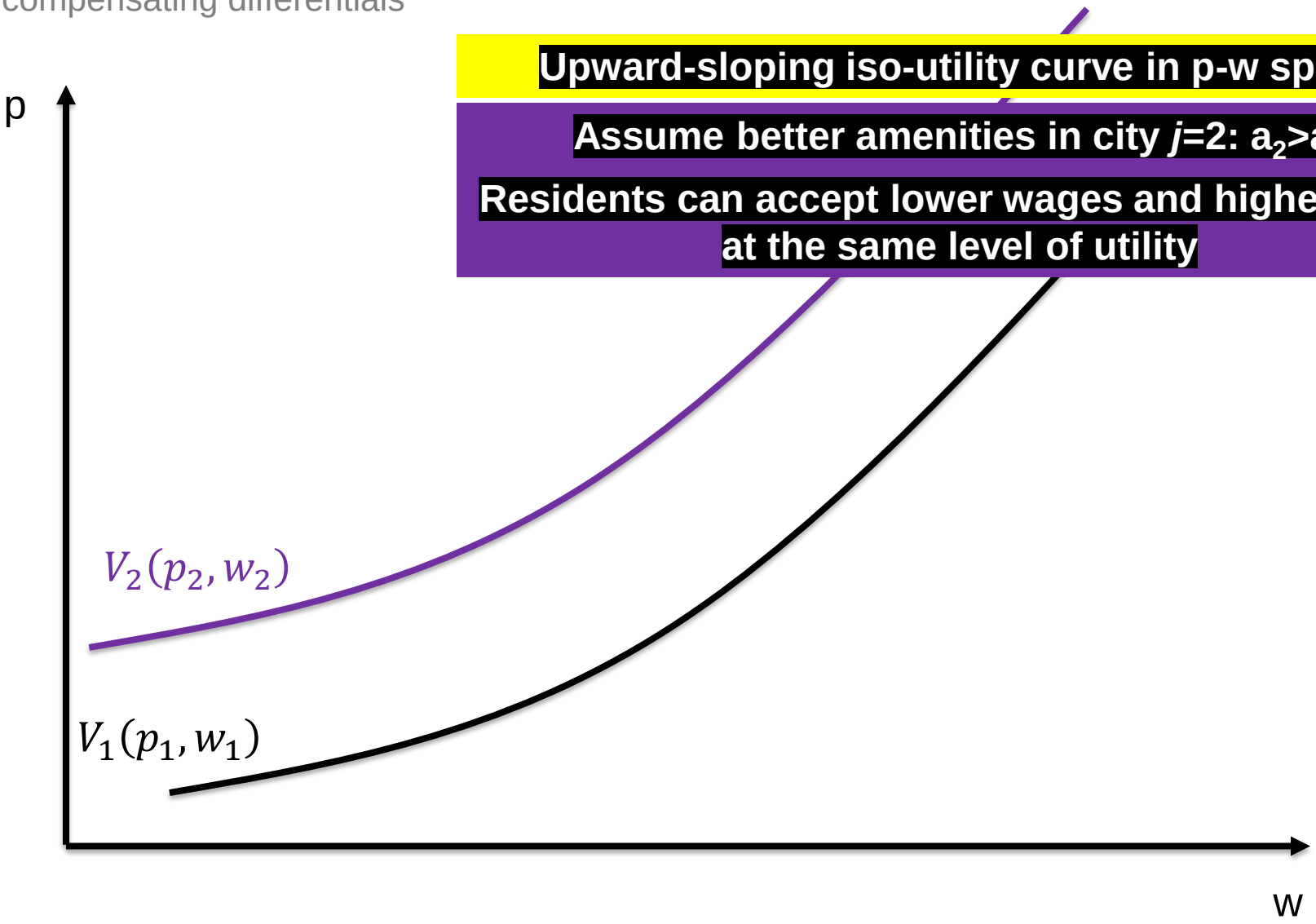
III WORKER SIDE

compensating differentials

Upward-sloping iso-utility curve in p-w space

Assume better amenities in city *j*=2: $a_2 > a_1$

Residents can accept lower wages and higher rents at the same level of utility

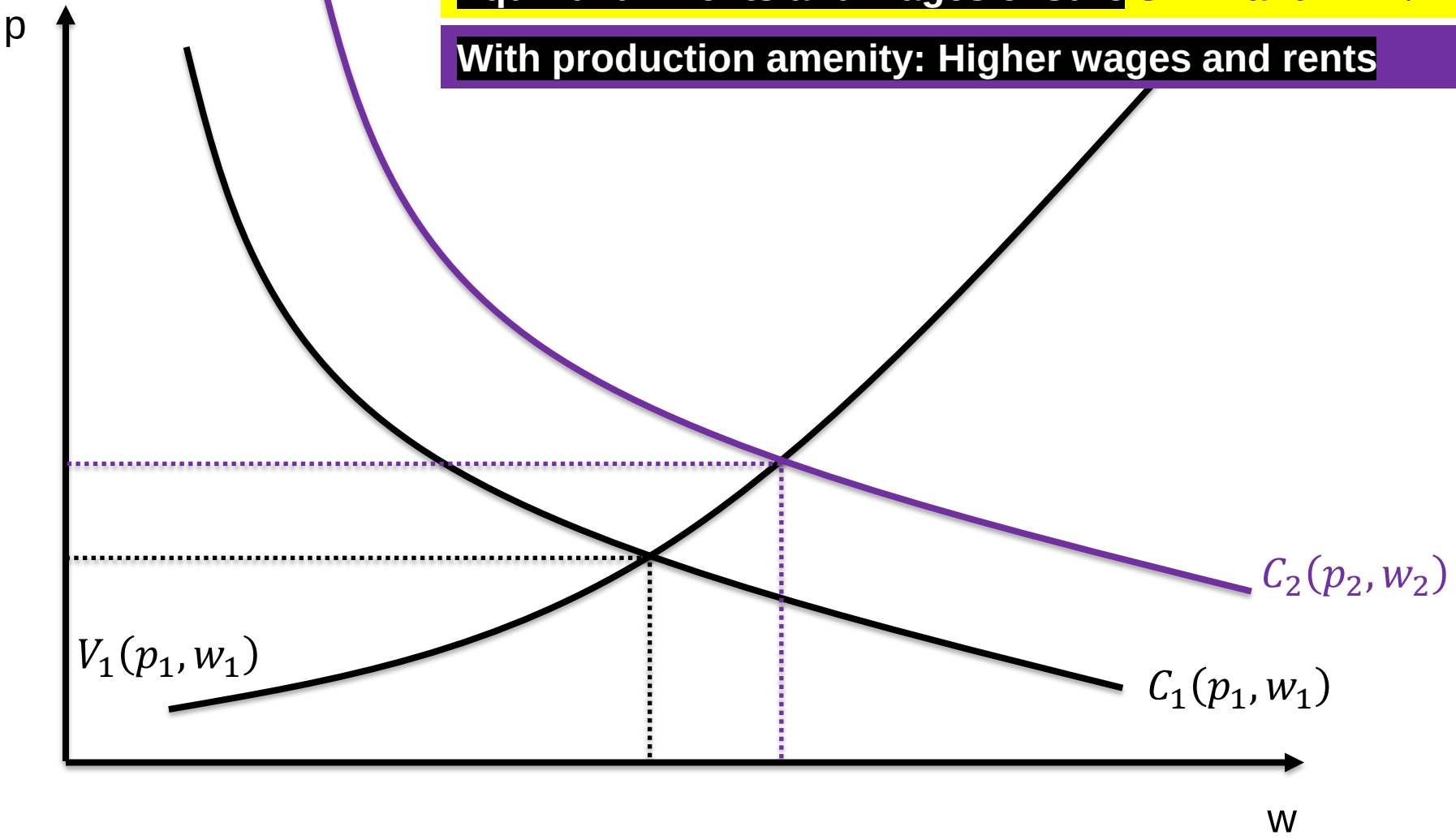


III EQUILIBRIUM

compensating differentials

Equilibrium rents and wages ensure $C = 1$ and $V = \bar{V}$

With production amenity: Higher wages and rents

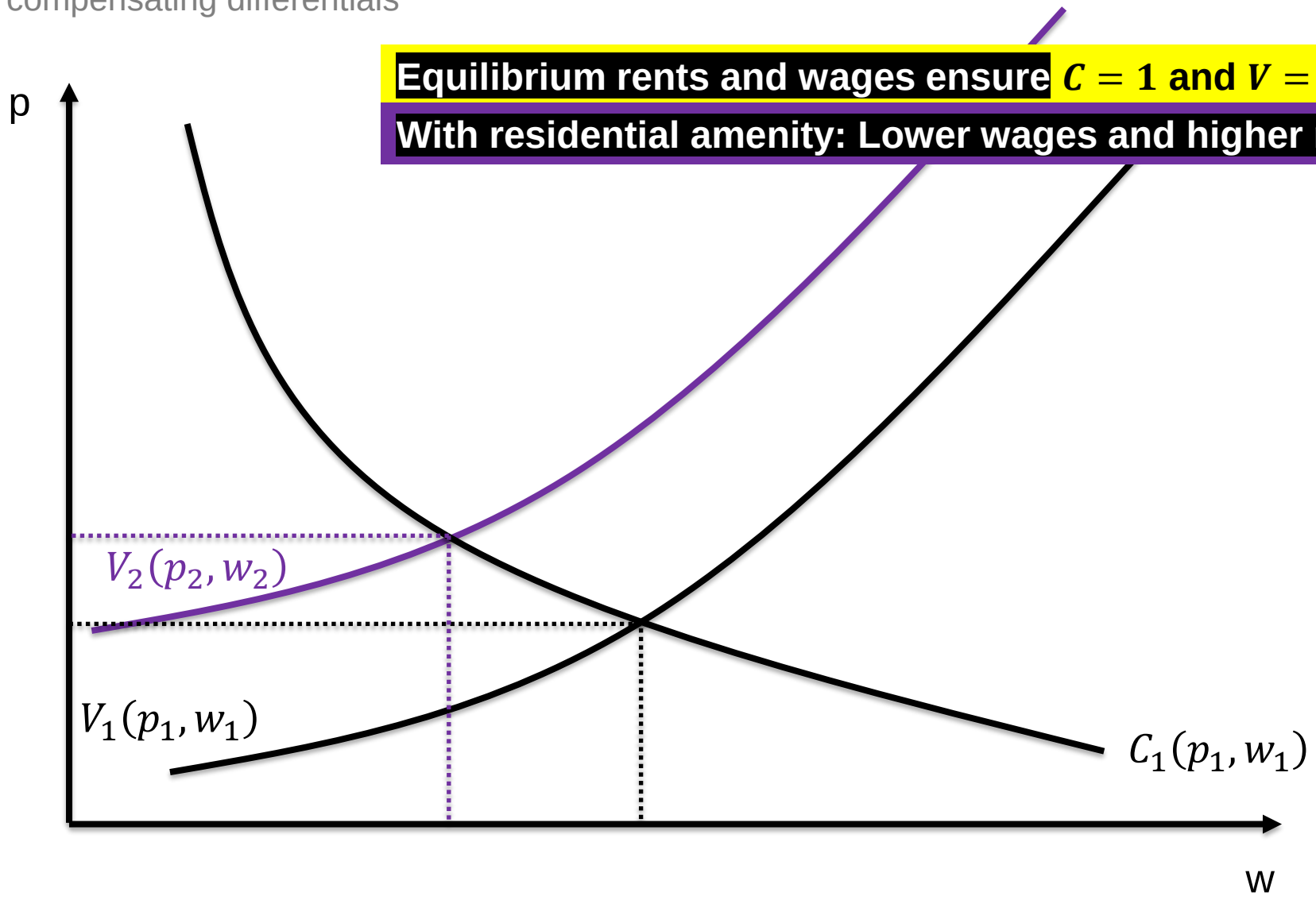


III EQUILIBRIUM

compensating differentials

Equilibrium rents and wages ensure $C = 1$ and $V = \bar{V}$

With residential amenity: Lower wages and higher rents

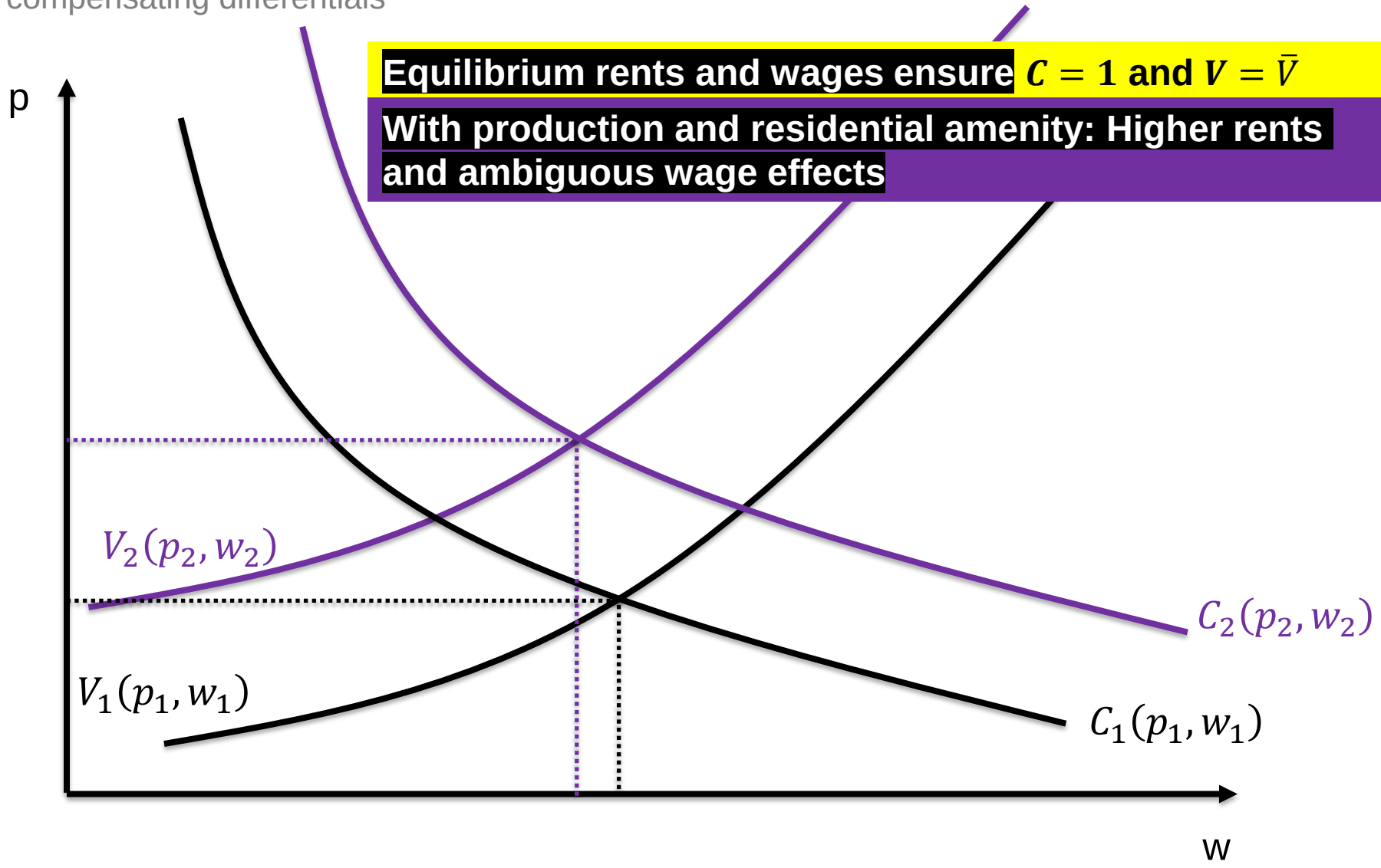


III EQUILIBRIUM

compensating differentials

Equilibrium rents and wages ensure $C = 1$ and $V = \bar{V}$

With production and residential amenity: Higher rents and ambiguous wage effects



III ROSEN-ROBACK FRAMEWORK

compensating differentials

- **Standard predictions:**

Residential amenities e.g. scenic location by a lake	Production amenities e.g. firm subsidies (from national government)
Higher rents	Higher rents
Lower wages	Higher wages
Residents willing to accept lower real wages Residents bid up rents Firms must lower wages to keep profits constant	Firms able to pay higher rents and wages Firms bid up rents Residents demand higher wages to keep utility constant

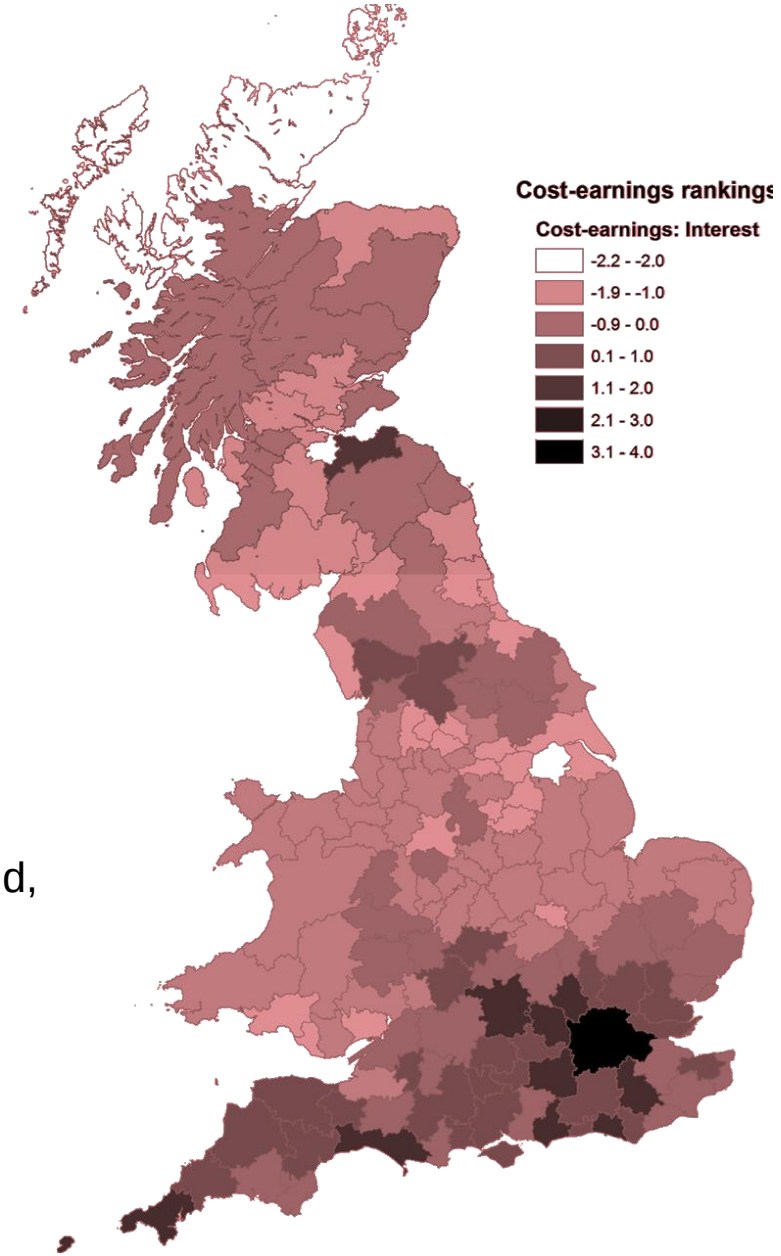
- **Production (dis)amenities can simultaneously be consumption (dis)amenities**
- **Some amenities (local public goods) are funded by local taxes**
  - LPG is a residential amenity, but business tax is a production disamenity
- In the long run, residential amenities may lead to population concentration, induce agglomeration effects and increase rents (production amenity)
- Rent increase due to production amenities rests on the assumption of relevant crowding
  - Needs to be relevant for various industries

RR framework is a workhorse tool to value amenities!

III EVIDENCE FROM THE UK

compensating differentials

- **UK Example**
  - Gibbons, Overman, Resende (2011)
- TOP Places **– higher rents & low wages**
  - 1 London
  - 2 Brighton
  - 3 Guildford
- Compare cost-earnings differential to endowment with features to identify amenities and disamenities
- Amenities (in places with lower real wages)
  - Employment access, jobs/household, woodland, museums, mean slope, etc.
- Disamenities (in places with higher real wages)
  - Rainfall, particulate matter, crime, etc.

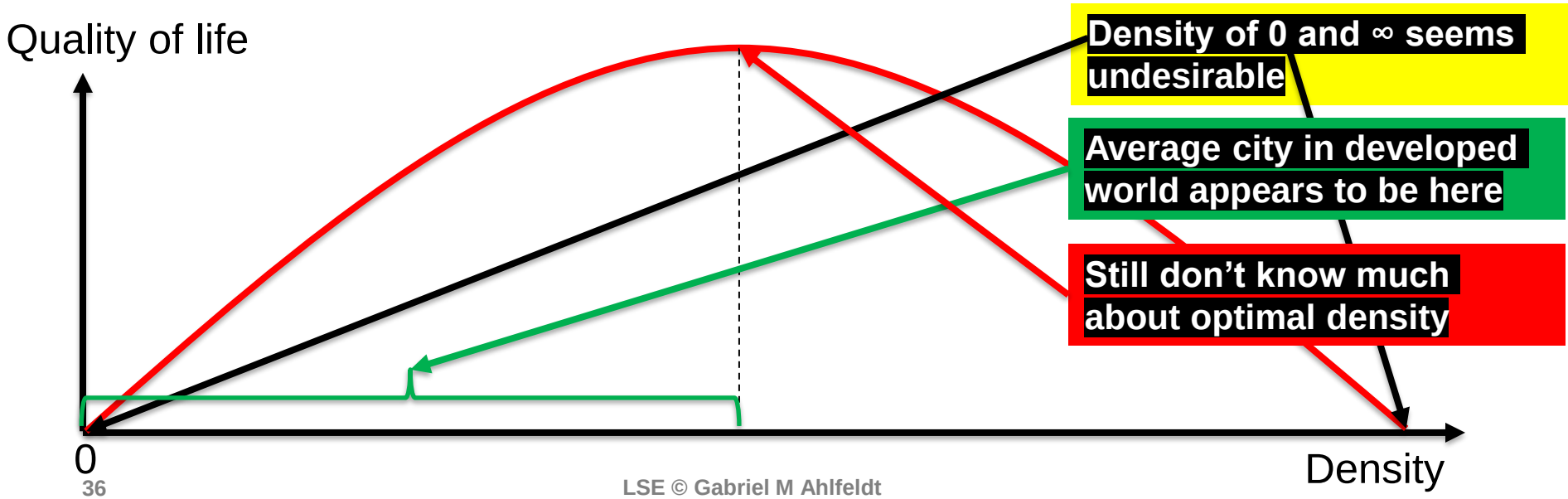


Q: Is density an amenity?

III IS DENSITY AN AMENITY?

compensating differentials

- **Density increases wages and rents (see elasticities in Section I)**
  - **Must be a production amenity**
- **Density increases rents more than wages (see PVs in Section I)**
  - **Must also be a residential amenity**
- **But density effect is likely inverse-u shaped**



SUMMARY

Conclusion

- **Costs and benefits of agglomeration**
  - Density associated with a range of costs and benefits
  - Density appears to be a net amenity
  - Positive effect on rents originates from demand and supply side
- **Equilibrium city size**
  - Cities are likely too big given local costs and benefits
  - Cities may be too small given global externalities
- **Compensating differentials**
  - Productive cities have high wages and rents
  - Livable cities have high rents relative to wages
- **Next: Looking into cities**
  - The monocentric city model


THANKS

READING

- Core readings:
  - Ahlfeldt, Gabriel, Pietrostefani, Elisabetta (2019): Journal of Urban Economics. , 2019, Vol.111, p.93-107
  - O'Sullivan, chapter 4 & 5
- Complementary readings and references:
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