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11.433J / 15.021J Real Estate Economics
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Week 2: The Urban Land Market, location, rents, prices.

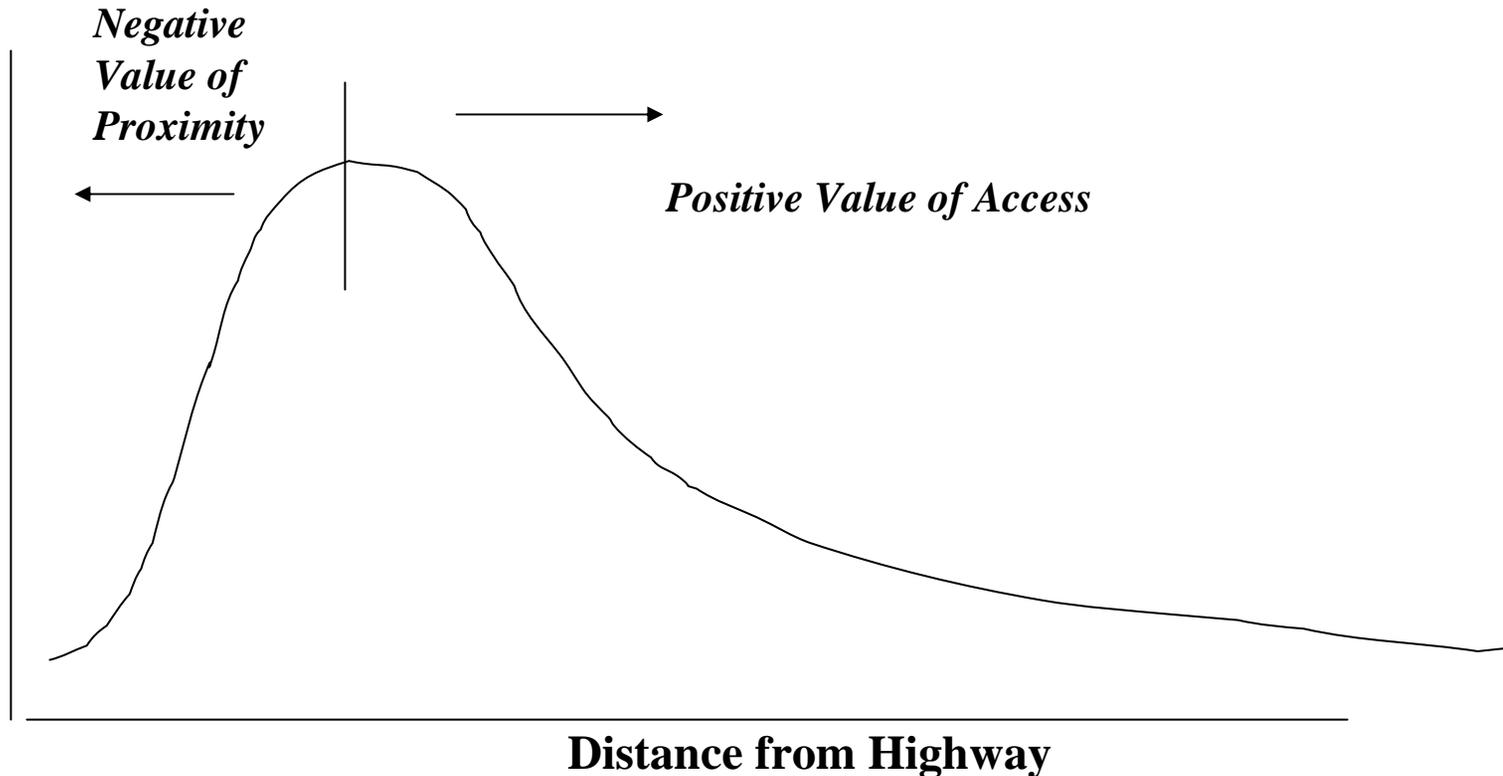
- Ricardian Rent with Commuting in a radial city.
- Land Supply and Urban Comparative Statics.
- Spatial capitalization of Ricardian Rent.
- Multiple land users, market competition, “highest use” segmentation.



Empirical Studies of Location and Land Prices (e.g. Waddell)

Sometimes the relationships are complicated.

Land or Housing Price





1). $R(d) = R(b) + k(b - d)$: “Housing Rent”

d = any “interior” location

b = Most “marginal or farthest location

0 = “Best”, most central location

k = annual commuting cost [inc. time]
per mile from “best” or central location

2). $R(b) =$ “replacement” cost [annualized]

$= R_a + c$

$R_a =$ “Agricultural” rent for a lot

$c =$ annual “rent” for construction



3). $r(d) = [R(d) - c]/q$ “Land Rent=a residual”

q = lot size, acres

4). $r(d) = r_a + k[b - d]/q$

$r_a = R_a/q$, land price per acre

5). $b = [Nq/\pi V]^{1/2}$

N = # households [population]

V = fraction of land within circle
available for development

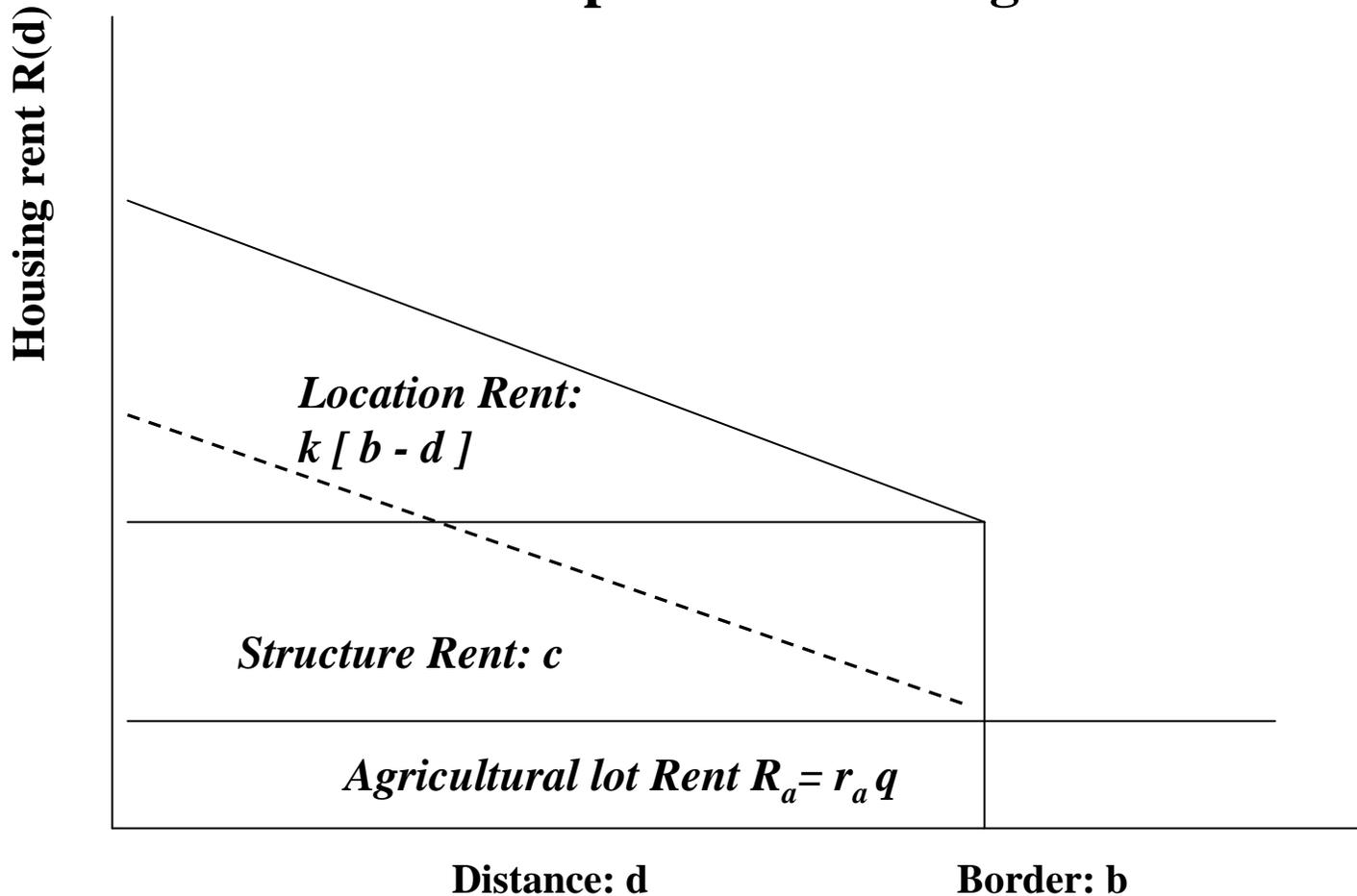


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Components of Housing Rent

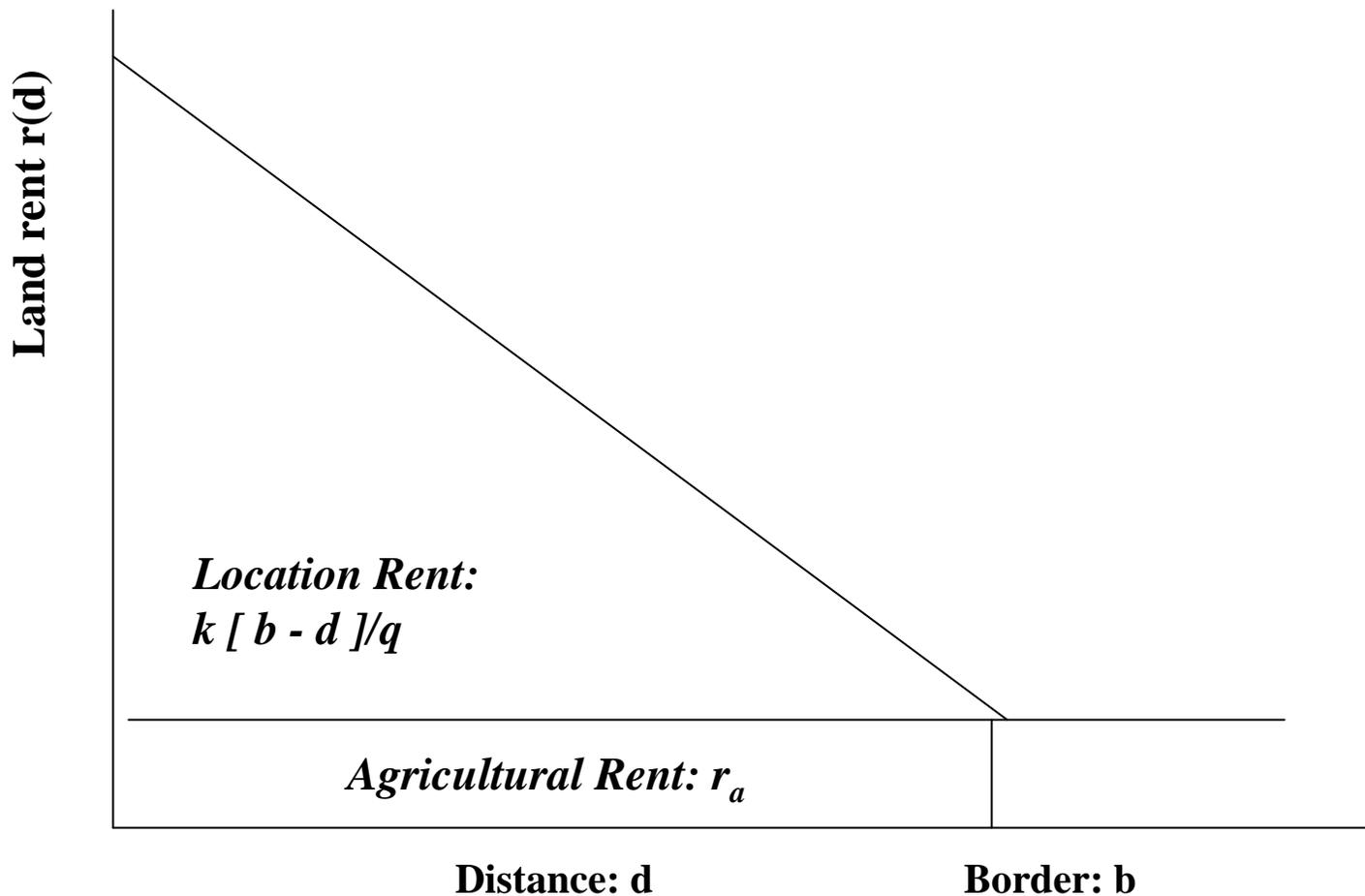
dashed line:

rent without development at the edge = rent for the lot





Components of Land Rent: [Housing rent-structure rent] /q





6). City Comparisons:

- a). More population N implies higher $R(d)$
- b). Denser cities have higher land rent?
- c). Transportation improvements:
reductions in k .
- d). Transportation access: increases V .
(Bombay, SF).
- e). Other geographies [islands, coastlines]



Bombay:
World Bank
Project.
What are the
benefits of
constructing a
new bridge?

Bombay Bridge

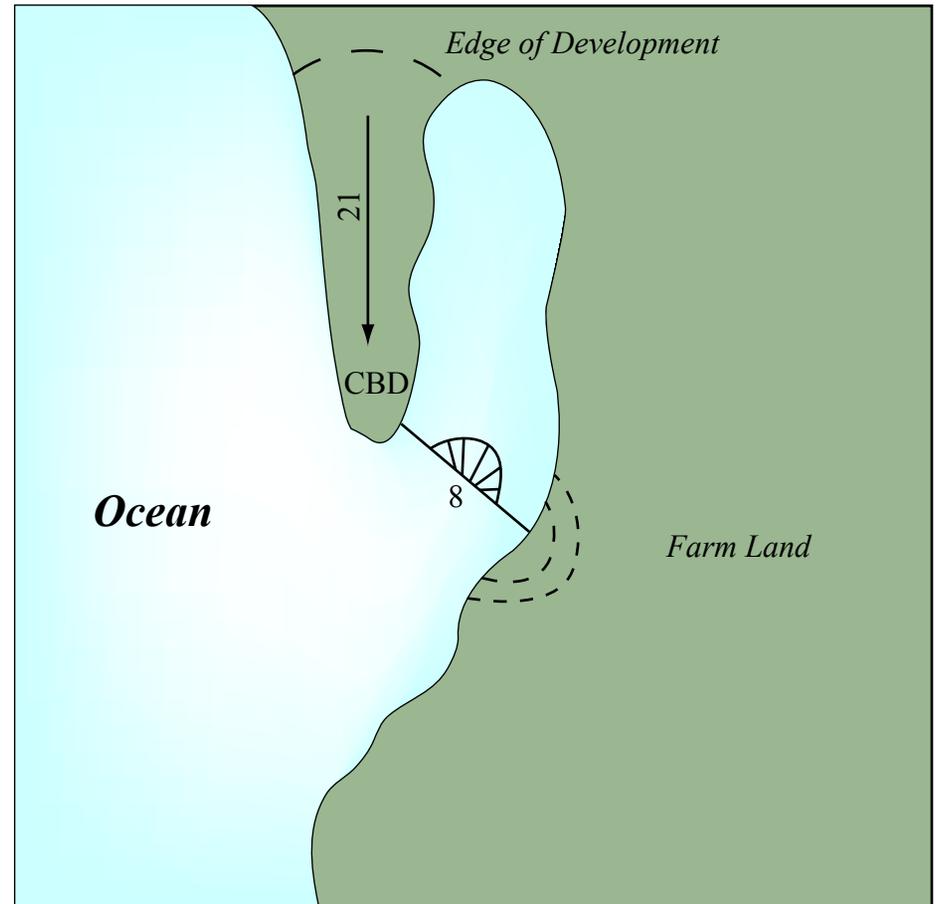


Figure by MIT OpenCourseWare.



7). Population growth at rate $2g$ implies boundary $[b]$ growth rate of g [see previous equation]

$$b_t = b_0 e^{gt}$$

$$n_t = n_0 e^{2gt}$$

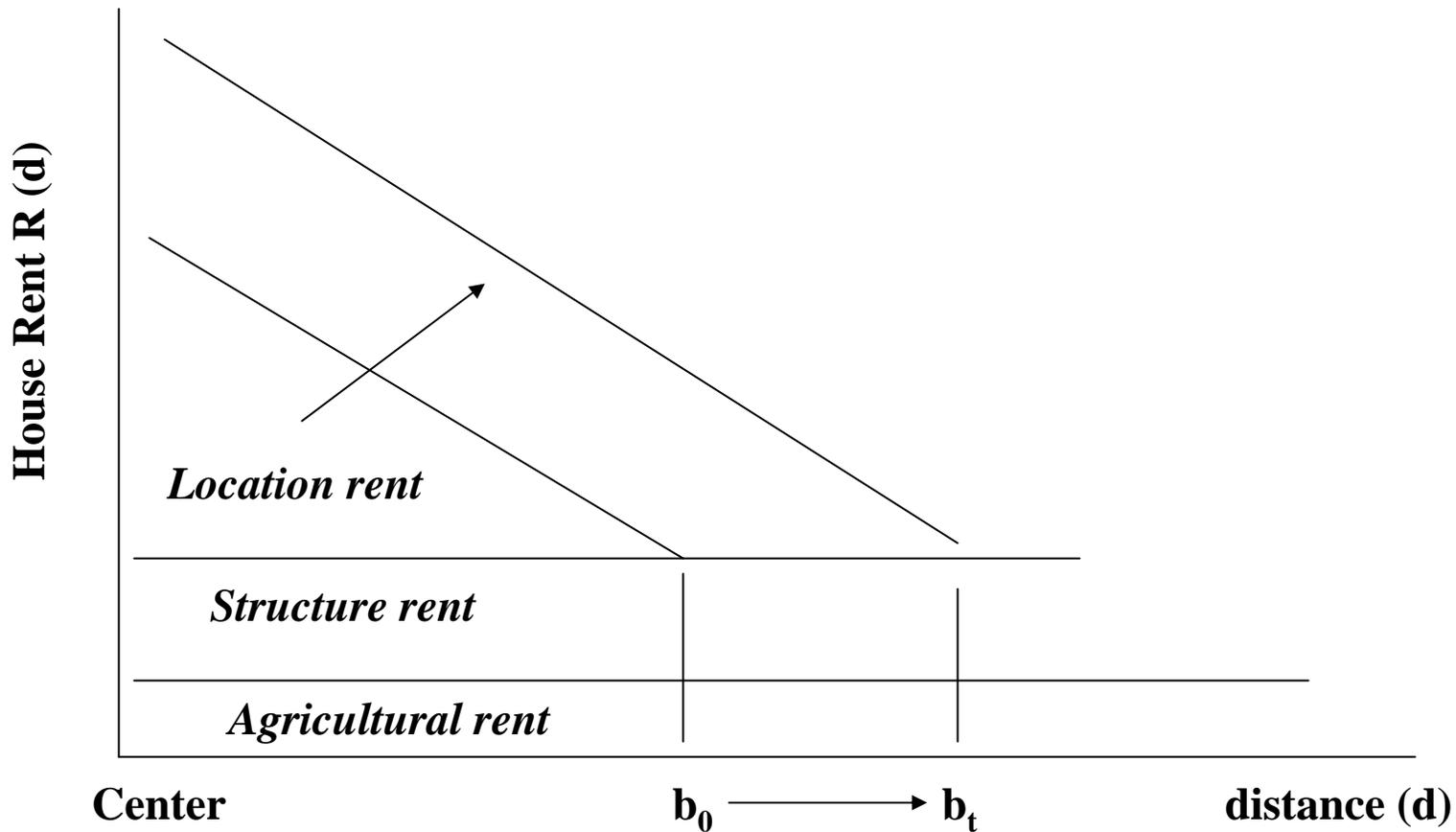
8). Hence Ricardian Rent for existing structures located at (d) in time t :

$$R_t(d) = (r_a q + c) + k(b_t - d)$$

$$[d \leq b_t]$$



Expansion of Housing Rent as the city grows in population and the border moves from b_0 to b_t .





9). Price of existing structures at (d) in time 0 is PDV of future Rent. With discount rate i:

$$P_0(d) = r_a q / i + c / i + k[b_0 - d] / i + k b_0 g / [i - g] i$$

term1 = value of land used perpetually in agriculture

term2 = value of constructing structure

term3 = value of current Ricardian Rent

term4 = value of future growth in Ricardian Rent

[note that $d \leq b_0$, and $i > g$, if $g=0$ reduces to ?]



10). Spatial multipliers or capitalization rates.

With much effort the price/rent multiplier today for existing structures is:

$$P_0(d)/R_0(d) = 1/i + kb_0g /i[i - g] R_0(d)$$

As we examine farther locations where rent is lower this term implies a greater price multiple or lower cap rate. Why?

With no growth [$g=0$] the multiple is the inverse of the discount rate – at all locations

More?



11). Like land rent, land price is a residual from structure price, for existing structures.

$$p_t(d) = [P_t(d) - c/i]/q$$

What about the price of land beyond the current border (b_0). In t years from now the border will have expanded to $b_0 e^{gt}$.

Inverting, land at distance $d > b_0$ will be developed in $T = \log(d/b_0)/g$ years from now.



12). Hence for $d > b_0$ the value of land has two components: the discounted value of agricultural rent until developed, plus its value once developed – discounted to now.

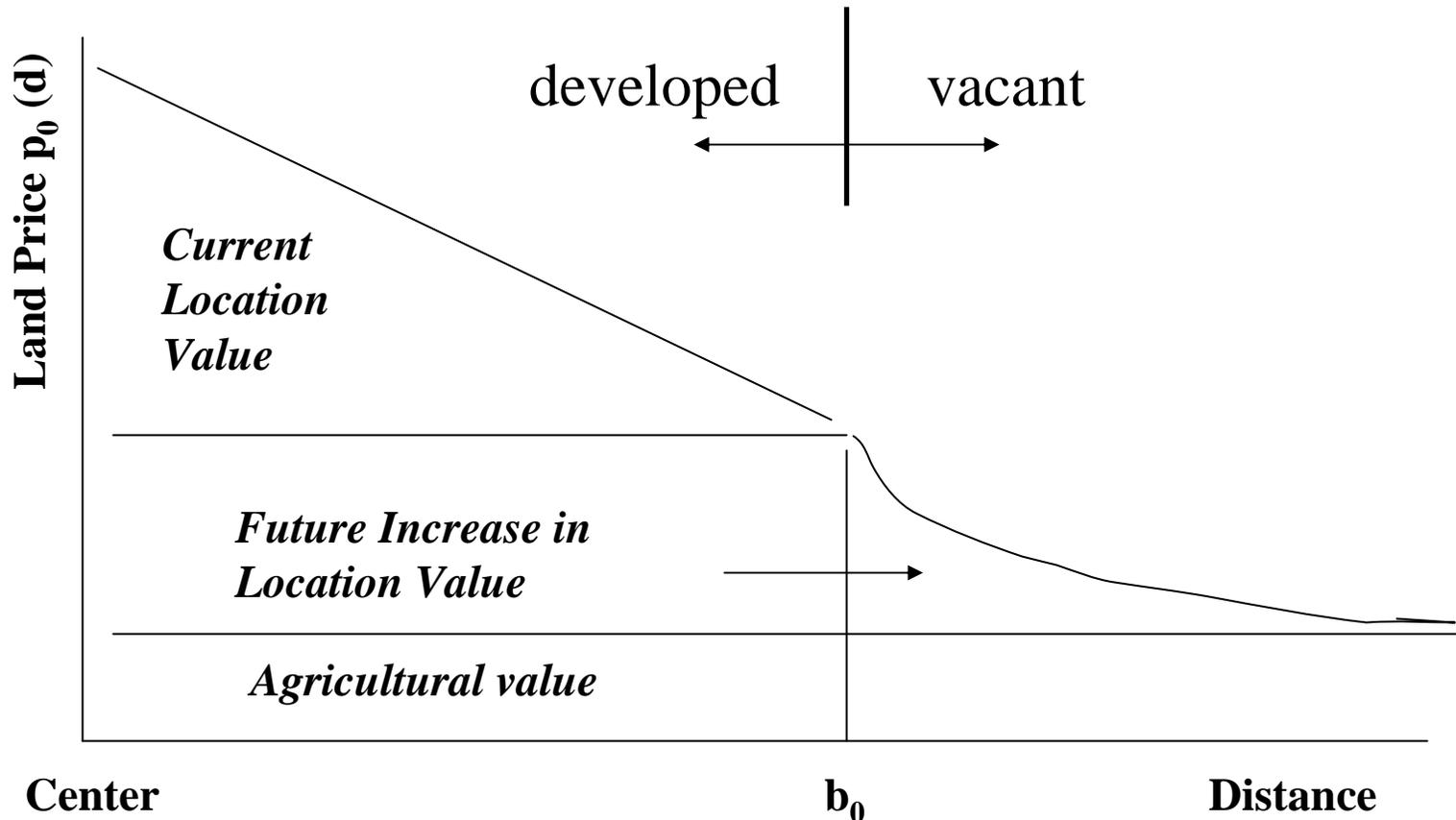
$$\begin{aligned} p_0(d) &= PDV_{0 \rightarrow T}(r_a) + e^{-iT} p_T(d) \\ &= r_a/i + e^{-iT} kb_T g/[i - g]iq \end{aligned}$$

For locations $d = b_0 e^{gT}$ which will be developed at T years hence.

Notice that as g hits zero the last term vanishes. Where are land prices most volatile as g fluctuates?



The components of Land Prices





Numerical Example

- Parameters: $N=2$ million, $q=.25$ acre (.0004 square miles), $k=\$200$ per mile per year, $c=\$7000$, $i=.07$, $r_a=\$1000$ per year, $V=.6$

- Solution:

$b = 20$ miles (approximate)

$R(0) = \$11,250$, $R(b) = \$7250$

$r(0) = \$17,000$ (acre), $r(b) = \$1000$

If $g=.02$, then:

$P(b) = \$127,000$, $P(0)=\$184,000$

$p(b) = \$105,000$, $p(0) = \$334,000$



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The Four variables of the simple model do quite well in explaining the large difference in average house prices between US metro areas.

	1990 Construction Cost Index	1990 Value	1980 HHs*	1990 HHs	% Difference
Boston CMSA	248.8	176,400	1,219,603	1,547,004	26.8
Cincinnati CMSA	203.9	71,400	586,818	652,920	11.3
Dallas/Ft. Worth CMSA	187.9	78,700	1,076,297	1,449,872	34.7
Denver CMSA	198.4	89,300	609,360	737,806	21.1
Detroit CMSA	227.4	69,400	1,601,967	1,723,478	7.6
Houston CMSA	192.8	63,800	1,096,353	1,331,845	21.5
Kansas City MSA	209.7	66,500	493,485	602,347	22.1
Los Angeles CMSA	239.8	211,700	4,141,097	4,900,720	18.3
Miami CMSA	191.1	88,700	1,027,347	1,220,797	18.8
Minneapolis MSA	213.7	88,700	762,376	935,516	22.7
New Orleans MSA	188.2	70,000	418,406	455,178	8.8
Philadelphia CMSA	230.5	102,300	1,925,787	2,154,104	11.9
Phoenix MSA	195.4	85,300	544,759	807,560	48.2
Pittsburgh CMSA	213.9	55,200	828,504	891,923	7.7
Portland CMSA	216.3	72,600	477,513	575,531	20.5
Rochester NY MSA	218.4	86,600	342,195	374,475	9.4
San Antonio MSA	182.6	57,300	349,330	451,021	29.1
San Francisco CMSA	267.3	257,700	1,970,549	2,329,808	18.2
Tampa MSA	191.3	71,300	638,816	869,481	36.1
Washington DC MSA	205.6	166,100	1,112,770	1,459,358	31.1

Adapted from DiPasquale and Wheaton (1996)

*HH, household

CMSA, Consolidated Metropolitan Statistical Area.

MSA, Metropolitan Statistical Area

$$PRICE = -298,138 + 0.019HH + 152,156 HHGRO + 1,622 COST$$

$$R^2 = .76$$



13). Suppose that Population is not growing but k is increasing at the rate g because of high gas prices and worsening transport congestion (sound familiar).

$$k_t = k_0 e^{gt}$$

14). Hence Ricardian Rent for existing structures located at (d) in time t is:

$$R_t(d) = (r_a q + c) + k_t (b_0 - d)$$

$$[d \leq b_0]$$

15). And Prices: $P_t(d) = r_a q/i + c/i + \frac{k_t [b_0 - d]}{(i - g)}$

16). What are the spatial multipliers now? What parts of the city have prices rising the fastest?

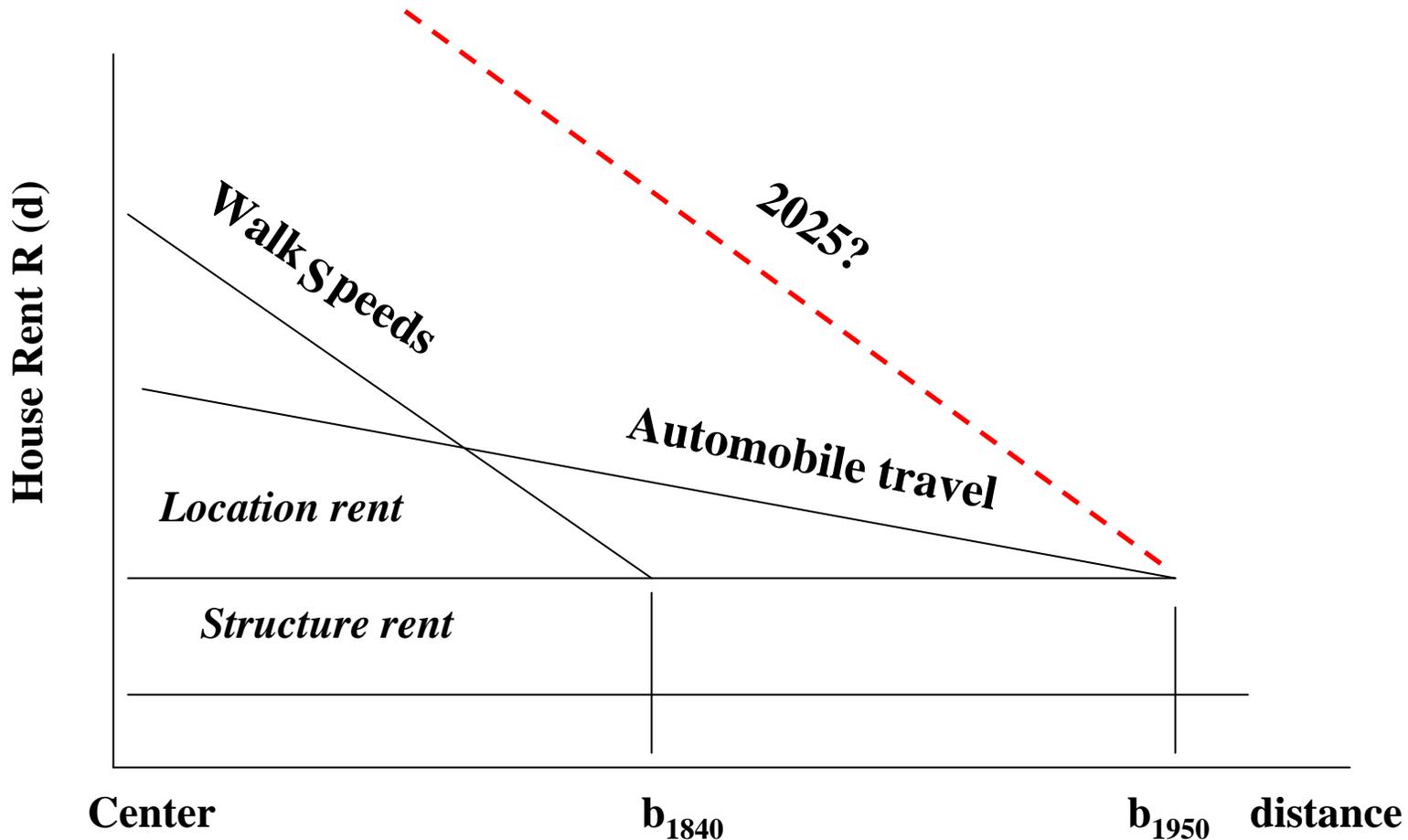


Transportation: the real explanation for Historic appreciation (or lack thereof).

- Average commute speeds were 3 mph in 1840 (walk).
- Increase to 7 mph with trolley cars (1870).
- Then 15 mph with more modern subways (1910).
- Cars average about 25 mph (1950-Today).
- 8-fold increases in speed have offset 8-fold increases in travel distance as NYC grew from 300,000 to 12 million households!
- What transportation improvements will happen in the future?



Expansion of Housing Rents as population growth expands the border, but technology improves transportation.





17). Suppose there are *two groups* of households with different commuting costs [days/week, value of time...].

$$R_1(d) = R(b) + k_1(b - d)$$

$$R_2(d) = R(b) + k_2(b - d), \quad k_1 > k_2$$

18). Location equilibrium involves giving all the best locations [closest] to the group that values it most (1). Highest use implies that this group is willing to pay more for all houses from 0 to m . Group 2 gets m to b .



19). Hence in equilibrium.

$$R_2(m) = R(b) + k_2(b - m)$$

$$R_1(0) = R_2(m) + k_1(m - 0),$$

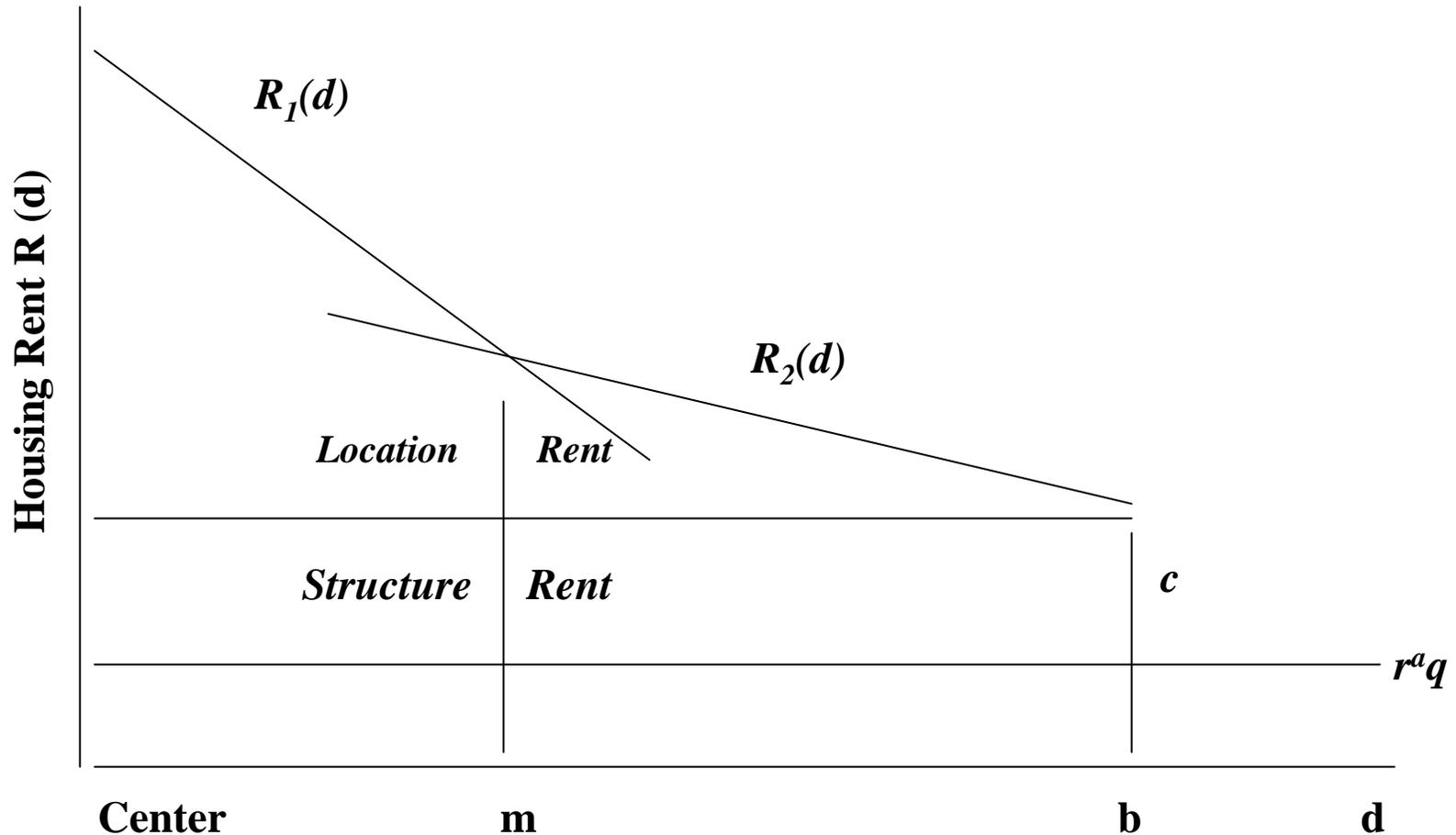
20). Determining b, m depends on how many households of each type there are: n_1, n_2 .

$$m = [n_1 q / \pi V]^{1/2}$$

$$b = [(n_2 + n_1) q / \pi V]^{1/2}$$



Housing Rents and Land Use Competition with 2 Household types [1,2]





21). Market Segregation/segmentation.

- a). A natural result of market competition – not necessarily an “evil”.
- b). Contrary to “new urbanism” which pins the “blame” for segregated uses on zoning.
- c). Is there a “value” to mixing? What patterns do we see in dense urban mixed use? Vertical versus horizontal segregation.