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In adding land vertically, builder pays full price, & more: Δ taxes, elevator mnpy, etc.

Adding horizontally, roads are free!

Enlist Otis Elevator Co. as ally!!

There are some grotesque disproportions we have learned to accept as given. One is downtown streets ~~i~~ w/o 3d dimension. It is free to expand streets horizontally, to individ, but impossible to extend them vertically.

Anomaly, people suffer in congestion, but offer plan to relieve it, automatically jump at you w. assumption the plan will make it worse. Solution: begin by offering this as plan to relieve congestion.

N.Y. 'Spread-City' Sighted by 1985

10-10-61

By Harry C. Kenney

Staff Correspondent of The Christian Science Monitor

New York

Rural land and open spaces in the New York metropolitan area are being consumed at an enormous rate by housing and industry.

In fact, the Regional Plan Association is convinced that all the land within 50 miles of Times Square will be built up in 25 years if present development trends continue.

There will be urbanizing of land in the next 25 years at twice the speed of the past 30 years—according to the association — and well over 100 square miles of rural land will be built up each year.

In a preview of a major research project which will describe the land use and capital needs of this region by 1985, the association declared that present building and zoning patterns will result in a continuous but sparsely populated city with few patches of open space.

Spread—Not Suburb

The increasing city development includes the tri-state area of New Jersey, New York, and Connecticut. It will stretch as far out as Brooklyn in the middle of Suffolk County, Long Island, up to Danbury, Connecticut, and beyond Morris and Monmouth Counties in New Jersey, filling up the nine counties of northeastern New Jersey.

All of Westchester and Rockland Counties and much of Orange and Putnam in New York will be covered by the new "spread-city" built around the older centers of the region, according to the association findings.

The executive vice-president of the association, C. McKim Norton, said the "spread-city" development differs from the suburbs of the 1930's and 1940's.

New-Type Urbanism

" 'Spread-City' is not just a satellite of the region's central cities," he said. "Jobs are moving out of the older cities as well as residents."

In many former bedroom suburbs, jobs are increasing at a faster rate than residents.

"Furthermore," Mr. Norton explained, "these outer areas do not rely on the central cities for shopping or recreation as the older suburbs do. So 'spread-city' is not a suburb.

"Neither is it a city in the usual sense because it has no single center of its own," he added. "At the same time this outer area is urban, not rural. It is being built up solidly, though not densely. It is therefore a new form of urban settlement with jobs, shopping, and houses spread across the land."

This picture of the tri-state area development, Mr. Norton emphasized, is not one the association endorses. "This is simply the kind of region that is in fact being built here with little thought of the end result," he said. "The pattern can be changed if we want to change it."

The association intends within the next year to present some alternative ways the region could develop and to involve a broad group of regional leaders in determining preferred patterns.

Land Priced Out?

"Present zoning ordinances of the 550 municipalities in the region require a spread development," Mr. Norton said. "Of all the vacant land left in the 7,000-square-mile region, two-thirds is zoned to require single-family houses on half-acre lots or larger. Nearly half of the land is zoned for acre lots or larger."

"These local zoning codes represent today's thinking of municipal officials about the kind of town they want," Mr. Norton continued. "The question is whether all these towns will add up to the kind of region they want.

"The sum of all these local laws may not even be attainable," he continued. Then he asked the question: "Can one-fifth of this region's expected 1985 population afford to live in new single-family houses on half-acre lots or larger? It seems unlikely. Yet that is the mosaic of the region of 1985 that today's local ordinances would put together."

$50 Billion Complex

According to association preliminary estimates, spending for community facilities — transportation, schools, hospitals, utilities, and other public and semi-public construction and rehabilitation—"must reach at least $50,000,000,000 over the coming 25 years.

The largest single expenditure will be for highways and other transportation to tie together the scattered elements of the "spread-city" and to preserve and improve essential rail passenger service to the older central business districts.

Further discussion of the "spread-city," industrial expansion, land use, and living patterns will be taken up in detail by experts in a conference Oct. 11.

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Scan for relevant stuff.

Oxford Ec. Papers

2-61

Ecs. of Scale in Road Haulage.

A.A. Walters

Illustration of importance of distinguishing land.

S.r. Δg costs from congestion of roads. In rural area, tho, are l.r. $-\Delta g$ costs, when expand road.

But in crowded city, are also l.r. Δg costs. Saturate space, ... a more ultimate limit than pavement.

Ferguson, Allen R. (RAND) "A Marginal Cost Function for Highway Construction and Operation." PAPERS & PROCEEDINGS, 70th Annual Meeting, AEA, 1957, Vol. 48 No. 2, published May, 1958. pp. 223-34

Only fly in ointment of this study is hint that Ferguson speaks ex parte American Trucking Association, p. 223

He conceives of mc in terms of more pavement, depth to handle weight and width to handle volume. I find no suggestion of increasing cost of right of way in crowded areas. Assumption of constant price of land seems to be made

p. 228 Pavement cost increases less than alpha(¢) thickness. Pavement strength probably increases more than ¢ thickness(my idea.) his too, p.234 Stress ds less than ¢ weight, bcs use more axles. Weight of truck ds less than kx wt. of load bcs truck weighs something, empty. Ergo, is folly to tax trucks by weight. The limitational factor is bulk, not weight; and surface area, not height. Therefore let trucks be taxed on their area. Also, allow a discount for maneuverability, if means can be devised to measure this. Might go so far as ~~¢/¢~~ to tax drivers according to a rigorous test of their handiness.

In country areas, space is a limitation not because land, raw, is limiting, but because grading and paving costs are. In short run this makes no diff., and even in fairly long run ditto. But in long run makes this big diff., that where land is limiting, you have increasing costs of widening highway; where pavement is limiting, you have decreasing costs. That is a pretty fundamental difference. It implies free use of rural roads, and taxes to use city streets. It implies that it is fitting and proper to subsidize rural roads and to tax use of city streets! Maybe our farm-dominated legislatures are inadvertently acting quite rationally!!(??)

A good measure of maneuverability, or at least a rough index to one aspect of it, would be ratio of motor torque to weight. On this basis heavy trucks should be taxed heavily.

Now if central cities suffer from congestion and increasing costs, (not only re traffic but some other things, such that one habitually pays tips etc for things in central city that are free in country), this is quite revealing re 2dry benefits. If we take resources from urban areas and invest them in underdeveloped rural areas we are taking them from areas of decreasing returns and transplanting them to areas of increasing returns. This is what is needed to justify 2dry benefits!

Note now another distinctive feature of land. It is the basic cause of increasing costs. In two ways. One, expanding things you press on limited space; or, two, if space is not limited, you spread out and xptn costs increase within your system -- which is fundamentally the reason space is limited at the center of the system, anyway, so these are two aspects of same idea. Building wider highways, bigger houses, etc., get decreasing costs, and finally at worst about constant costs, were it not for increasing cost of land. Likewise larger cars, etc. Maybe last is best e.g. Why not build ever larger cars and ever wider lanes and hig ways for them, due to decreasing costs? Bcs space limited.

But note, as firm expands, has to supply more of its own xptn, uses less of public's. This way, at least, (over)

public subsidy to xptn. encourages small farms.

Summary, p. 233-34, says hiways costs are funs of weights and mileages. Interesting that he does not mention vehicle sizes, even tho he previously pointed out that truck routes get an extra foot in each lane, from 11' up to 12', and of course if we all droye VWs all lanes could be much narrowers. Showing pretty clearly he doesn't appreciate this factor, even as it affects pavement costs. Which is the more curious since he is deprecating weight as a measure.

But perhaps the curiousity is explicable by hig working for trucking interests, and perhaps they would be even more opposed to bulk than to weight criteria!

We msre xptn in "ton-miles" as tho this were some sort of basic concept, like a "foot-pound" of physical work. But all the time the weight of a load is less relevant than the bulk, esp. on congested highways. The maneuverability of the vehicle is important, so vehicle charges should ∆ progressively with size, esp. in 1st 2 dimensions.

Central sites, ~~intensive vs.~~ hi volume vs. hi markup uses.

If we do not pay mc of using streets, use Δs until congestion makes costs to individuals (+this is folly, if ever you want to reduce use of something do it by raising money, not by creating waste in form of barriers), & each individ Δs congestion (& mc to him = mc to society in this sense).

If we paid to use streets, volume uses wd. get to places of cheap max. access, bcs their customers wd. seek to min. travel. Hi mark-up uses wd. move out bcs their rich customers wd. not resist travel.

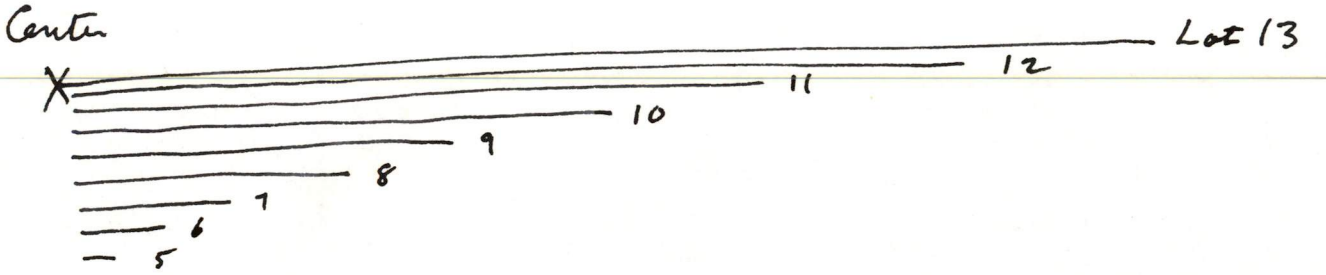
When congestion replaces price as mc of use, not only is there a waste in congestion, but the new sort of rationing selects out a different set of users. Where the experience is sensitive & esthetic, it crowds out the sensitive & esthetic & consigns the facility to the vulgarians who are not repelled by one another.

Congestion as a cost is also expressed in auto insurance rates, but unfortunately these are not functions of use, nor size of auto.

Should high cost of peripheral service ever be expressed in hi taxes & flat rates rather than hi variable rates? In dynamics, during early period of excess capacity, yes. But when reach ~~dog~~ period of srmc ≅ lrmc, charge the cost.

Now suppose in result use at peripheries declines, some land goes out of use? This wd. leave excess capacity, srmc ↘ < lrmc & lrac, require Δ taxes on the lands provided w. service they're not using.

Anomaly that peripheral lands require highest fixed costs to serve, so shouldn't they pay highest fixed annual rate?



Central lots pay hi fixed charge, not bec it costs much to serve them, but to traverse them. On this principle outer lots need pay nothing. How reconcile the two principles? Make them all pay! If pvt. mkt. worked as most ecists seem to think, central lots wd. not need to pay (except for equity reasons).

Solution: at first they get free service like everyone, and therefore pay hi taxes like everyone. As srmc rise, they will rise more & faster at end of line, so their rates go up. As rates go up, taxes fall. When reach "capacity", [i.e srmc = sr ac, or thereabouts] maybe (more)

they'll stop taking, but that's ok, we want demand to shrink in from the fringes.

Problem: suppose srmc do not Δ with length of line, (altho lrmc do). First, decide what min. time unit is your "short run." E.g. one year. That wd. include mntnce.

[Supposition may be impossible. Press on capacity, cause scheduling problems all along the line]

You build in such a way that srmc <u>are</u> higher for end of line. Because you know lrmc are higher and you want to recoup them, & also want to set xptn rate = srmc. So you build smaller capacity at end of line, & perhaps all along line, to make sure you have srmc.

But this happens naturally. When you ~~scale~~ press on capacity, srmc rise everywhere, ↑ in a length of line, -- not exact proportion nec., but roughly that way.

Allocating fixed costs at center between central & outer lots, center gets them, & outer lots get lrmc. Because center will be served by a smaller system, Δ size is for outer lots. Thus justify higher taxes on inner lots.

But when lrmc rise at center, as with city streets, this means hi mgnl rates are called for, hitting outer users. Still ok – & center still bears heavy fixed cost.

(More)

Outer lots are responsible for longer lines, and for the hi initial unit costs of the last segments of the lines, but only the mc of the inner segments.

They should pay in flat taxes until smc rise, thence forward in hi rates, the rates rising with length of line, as smc does.

There are increasing l.r.m.c in widening streets. E.g. narrowing the lots in between. As the lots get ~~too~~ shorter and fewer (or narrower) the mc rises.

Within downtown, ∴, reasonable to control access & charge for the time spent inside congested zone. More practical, keep cars out of some part altogether, use public xptn.

At all times planners should be putting values on street space & dfg it vs. pvt. uses. Move the margin to equalize mp of land.

How much value of street? An approach: difference of pvt. l.v. along it — i.e. the value is higher nearer the center, & street gets credit for this. Needs much work.

∆ l auto using route customarily, ∆ costs in congestion. Or, if street improved to offset this, in form of improvement costs.

Tax cars by area, promote small cars.
Surtax to park on streets, unmetered areas. Workable?

There is . . . ?

Putnam wd. say let rates = s.r.m.c, all times, instantaneous. But this must be modified in practice bec so costly to keep changing rates.

What of decreasing costs in bldg streets? After reach congestion point, costs ∆. E.g. double decker road: or clipping off lots, hit ∆g costs. Remember principle, only when space is free are -∆g costs.

So outside cities, mc low, users should not carry costs of hiways.

Inside cities, mc >> ac.

So charge a high fee for permission to drive in cities, based on car area. Shown by a plaque, like State license plate. Visitors can pull over & buy temporary permission.

Stiff fines for obstructive driving practices.

Now as move to edge of town, mc of widening street falls very low; but mc. of lengthening st. is hi. So compact settlement seems desirable. How charge out here?

Outer dweller who drives in uses more street. How charge him for it?

Big problem, Putnam & land & location costs, has been their failure to conceive of lr mc, ~~no~~ Putnam explicitly so & others implicitly. So they took fixed xptn facility for granted, analyzed just prt. part. Even Pigou, who condemns flat rates, seems thinking just of variable costs of running trains, gives no clue to treatment of fixed costs. (or does he later?)

Another distinctive quality of land.

Decreasing costs in distrib. nets are inside given area.

Extend area, lrmc is entire cost of extension.

Rates shd = lrmc (chide Putnam to contrary). Then seek to plan so srmc ≅ lrmc during much of life.

Lrmc of supplying lot 13 is entire cost of bringing line from lot 12 to lot 13, plus whatever expansion of basic facility is entailed, & of line from center to lot 12.

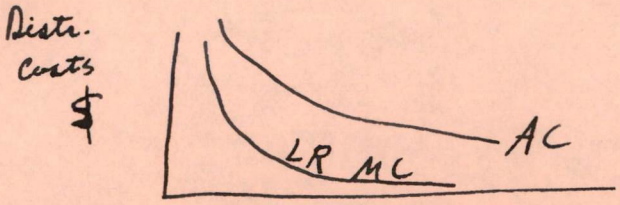
Lot at end of line, ∴, mc is tc of extension, [+ mc of expansions]

Lot near center, shares line extension cost w. others, mc is only small mc of enlarging for 1 lot, which gets smaller as capacity rises, & gets very small.

So rates should be very hi at outside, very low in center. All extensions should be made which can pay those hi rates, & no more. [Utilities act opposite, bcs is more compn at periphery]

Hoover's & Isard's law of xptn cost falling w. distance is reverse of facts re fixed installations.

Why we have slums? Land too cheap! We bring in new land by free xptn, leave dead area behind. Instead, charge for xptn extensions, inhibit them, also charge for holding land, centrally, compel renewal.



Trouble w. ~~above~~ Boone, which I used to teach at N.C., begs qu. at fringe, MC means cost of expand'g area. And MC differs at every point along distr. lines.

Boone applies to xmsn between two given points. E.g. two cities. So inter-urban xptn shd be free. And trunk wheeling from dam to city. Unless there is alternative shorter route, e.g. nearer dam or nearer city.

It is true in many & probly most cities that the landholders around the terminals or other initial locating factor have undertaken to avoid maximizing access to that spot, to interpose barriers to movement & so contain the rent within a smaller compass than necessary. This wd. also block access among the parts of downtown.

Probly nowhere does there exist a downtown truly planned so as to bring into its sphere as much land as cd. be justified by devmt cost.

But these artificially hi ground rents have spurred independent urban developments in suburbs or elsewhere, so we get enough commercial sites in aggreg., but lose advantages of max. access. Note I do not say we get too little congestion. Barriers to access create congestion before needed. We get resistance to clearing up congestion, premature & artificial congestion.

"supra marginal"

"Wages and profits represent the universal elements in production, while rent may be taken to represent the differential and peculiar. " Mill, p. 290 Continues in confused way.

So classical economists bequeathed us this befuddling notion of "rent."

Why not shift ordinary land into high yielding urban uses, until there is little remaining differential value? E.g. why not downtown expand? Or new shopping centers be formed until differential value disappears? This is what tends to happen in fact, very slowly. But increasing returns at the center keep attracting commerce there, even though land costs more and has to be crowded on, it is worth the difference.

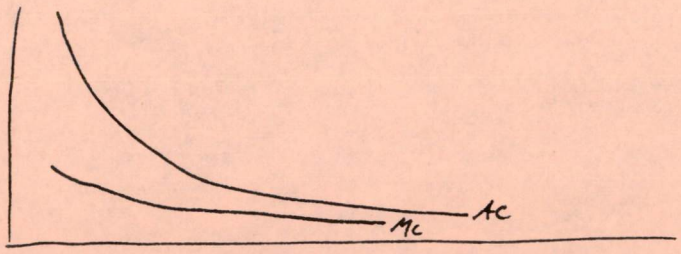
There are two elements promoting centralization: everyone wants near major xptn terminals; and increasing returns to cluster as whole, which to individuals shows up as advantage in being at center of cluster, regardless of xptn terminals.

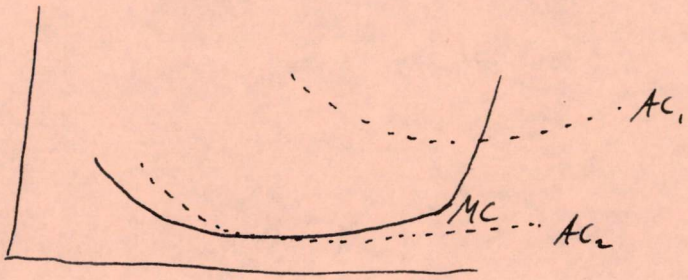
The xptn terminals fix the center fast. But if they are relatively unimportant, or become so, and increasing returns becames more important, then the center is freely floating, and subcenters, which will exist originally as retail suburbs, can challenge the center for primacy. Or when new kinds of xptn are succeeding old, they can attract the new routes.

Critics of m.c. pricing say it has ambiguities etc.

But w. utilities, a c pricing has worst ambiguity, value of franchise, use of streets, etc. ~~Value depends~~ Value depends on rate, but rate depends on value, etc.

W. mc pricing, solve this problem, $p = mc$, that puts value on franchise. And if value is low enough, costs are not decreasing after all! It might even be negative, thus making it an Δg cost indy! Brodey!!





AC is a shadow concept, varying with rates permitted.

Only if AC is based on OC in a clearly demonstrable sense is there a real ec. problem of covering fixed cost.

Great advantage of MC pricing is to cut out all these phantom fixed costs, this malicious raising of shades & spirits by which hocus-pocus the ~~Greedy~~ greedy insiders make off with so much loot.

Just set P = MC where MC = demand, this automatically puts a nice low value on fixed costs, if they are rent type "costs".

This is a 2d way that rent helps solve problems of MC pricing.

INDIANA UNIVERSITY
School of Business
Box B
BLOOMINGTON, INDIANA

November 1, 1960

I see my secretary placed your initial in the wrong place.

Professor Mason M. Gaffney
Department of Agricultural Economics
University of Missouri
Columbia, Missouri

Dear Mason:

Thank you for your letter of October 19. My debate with Scott on the alleged divergence of private and social costs in the "ghost town" case related: (1) to the divergence of expectations between primary and secondary investors; (2) to the difficulty of estimating the future even under centralized decision making; and (3) to the question of sunk costs once the mine and the town were constructed. In addition I think that Scott failed to distinguish between questions of efficiency in the allocation of resources as opposed to matters concerning the distribution of income.

I have not read Stigler as you suggested, but I hope to very soon and I will give you my opinion on him within a week or so. However, I am enclosing a copy of a debate I had last year with Ed Mason which apparently deals with a similar question.

Your comments upon the policy of utilities to subsidize outlying customers at the expense of the centrally located users are certainly well taken. And I feel that my friend and boss, Bob Turner, is going to be hard put when he testifies next month for Indiana Bell on the policy of raising the flat rates in the central area of Indianapolis in order to extend toll-free service to the suburbs. Incidentally, it sort of worries me as to why Indiana Bell favors such a policy unless they assume that the demand for service in the central area is relatively inelastic while the demands in the urban area are relatively elastic.

I am in agreement with you, of course, on the efficiency to be gained from centralization and on the apparent economies of scale which accrue to centralized cities. In my opinion the advantages of suburbization are much over-done and depend primarily upon an under-assessment of the social cost they incur.

What is your opinion, Mason, about some of the work in the area of economic base analysis? I have assigned some of this material to my doctoral students in land economics and I am coming to the conclusion that much of it is a lot of bunk and that many of these men should go back and take a course in international trade theory.

Keep your comments coming. I hope you have a chance to see the book before we get together in St. Louis. All best wishes.

Sincerely yours,

Jerry

J. W. Milliman

JWM/vmp

MERAMEC BASIN RESEARCH PROJECT

WASHINGTON UNIVERSITY
ST. LOUIS 30, MISSOURI

November 21, 1960

Professor Mason Gaffney
Department of Agricultural Economics
University of Missouri
Columbia, Missouri

Dear Mase:

My thanks to you and Estelle for a very pleasant evening on the 15th. I hope there will be opportunities for continuation of same in the future. Perhaps I can manage it so that my spouse will accompany me sometime. I enjoyed meeting your historian colleague.

The article on pumping costs for irrigation in the San Joaquin is in the October, 1960 issue of California Agriculture. The article is by Charles P. Moore and Trimble R. Hedges.

The article on the irrigation water rental market is by Ray L. Anderson and is entitled "Operation of the Irrigation Water Rental Market in the South Platte Basin". It was presented at the AFEA meetings on August 11, 1960.

Somewhere in your many communications to Ed I noted a suggestion of yours, something to the effect that varying utility rates might be a means of preventing, or at least limiting "development". This is of course a solution which would appeal to economists, especially those of the Chicago school! However given the regulated nature of the utility industries -- water and power -- and the imperfections of the market system, I'm not sure how effective this would be even if it were administratively feasible. An alternative to the use of the price mechanism is direct regulation. The city of Cleveland has adopted a procedure by which regulations on water and sewage are used to prevent inefficient land use development. Land developers are required to provide adequate water and sewage before their developments are approved. The result has been that, instead of jumping over open areas and moving into the farther suburban hinterlands, the developers have taken up the available open spaces closer in to the center of the metropolitan area. I suppose the most effective measure would be a combination of regulation and pricing.

read "politically"

I don't anticipate getting to Columbia again until after the first of the year, unless something unanticipated develops. If you are coming to the AEA meetings at Christmas time I'll look forward to seeing you then.

Best regards,

Blair

Blair T. Bower

BTB:md

If we brought less land into urban use by new roads etc., it wd. be dearer, & ∴ old bldgs wd. be replaced faster.

We run away from this w. new roads, overcome frictions of space at public expense, keep land too cheap.

W. cap., qu. is when to scrap it.

W. land, qu. is when to clean & renew it.

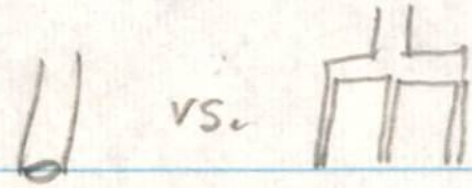
Tiebout, Chas. M. "Intra-Urban Location Problems: an Evaluation." 51 AER (2): 271-78 (May '61).

(Very sloppy.)

Mentions 2 prime barriers to ec. urban location: 1, Xpt. costs are lower along better roads

2. External economies.

No mention of pvt ≠ social costs of xpt. Seems familiar w. much literature, so this is evidently missing from lit.



Blue Book says mc, sr, of wtr delivery, is same, so shd be no quantity discount

? question. If lr mc is greater, design system so sr mc is two, $p = mc$

String devmts result from subsidized xptn.

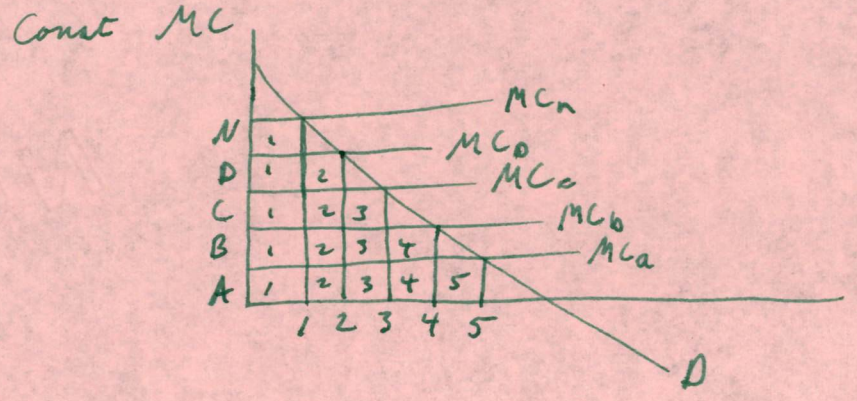
Otherwise wd. be building in 3-D. The subsidy is all one-D.

Traversal & Extension Costs

In 3-d, traversal costs stick out forwards on z-axis rep'g distance w. decr'g costs, commonly allocated, the cells ~~they~~ fall in size moving out on z. just as they do moving ~~up on y~~ right on x. Try to match them.

Also try preserving visual equality of cells by adjusting z-scale to make them =. ?

1st, show that if you have const. MC & AC, then traversal costs = extension costs + c.s. With that established, will be able to handle decr. costs. (re which, remember graph is 3-D, some cells count twice, so be volume not just area, i.e. each cell has 3 coords. (cd. one then give ea. cell 4 coords?))



Extension costs, B to N, ~~are~~ line N, are 3 cells: C1, D1, N1.

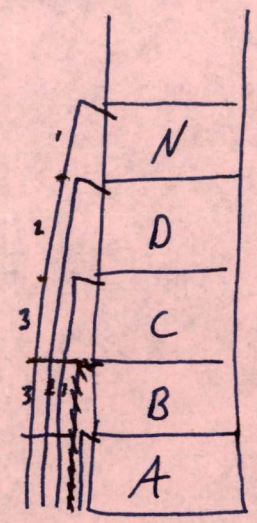
Traversal costs of B are:

For line N — B1
For line D — B1 + B2
For line C — B1 + B2 + B3
For line B — Nil, line deactivated or retired.

The loss of c.s. to B by moving to N is 0 on the last unit up to the full Δ of costs per unit capacity on the first.

The excess of traversal over extension costs ranges from 0 in cfg line N to line N up to the full Δ of unit capacity costs on the last of seven.

Etc. enough for now

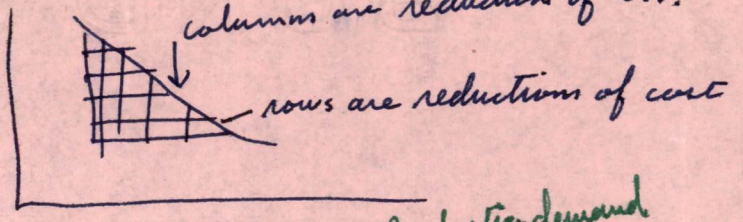


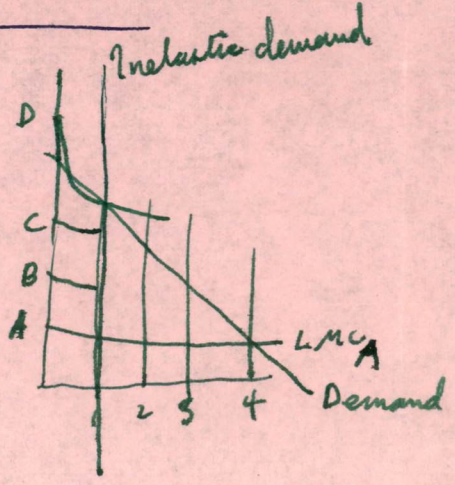
Treasonal cost = B1 + B2 + B3

Extension cost = C3 + D2 + N1

$C_3 = B_3$, bes same line

$B_2 > D_2$, and the amount of the excess is the no. of extra units of capacity out to the demand curve from the 1st column, that is the c.s. lost by B by moving out one lot.





Cost of traversing Lot B is full triangle, and will approximate cons. surplus.

Sum of traversal costs part B

Lot	Units of capac.	Size classes of units (along diagonals)
~~B~~ N	1	5
D	2	5, 4
C	3	5, 4, 3

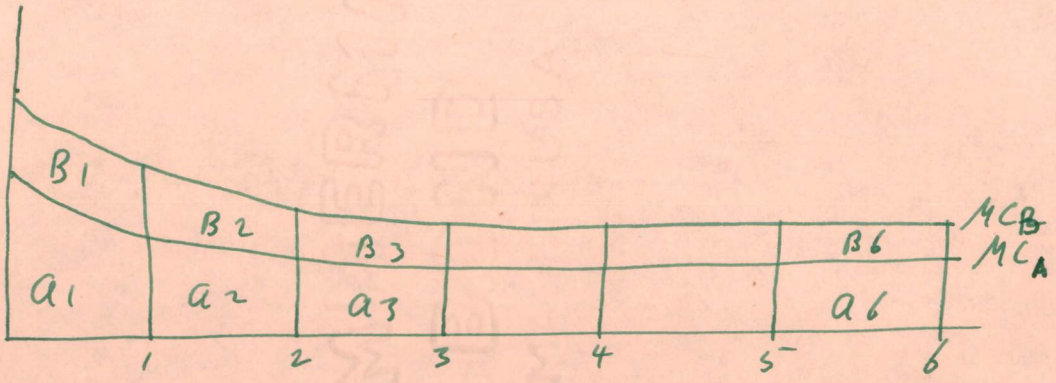
When B is bumped from B to E, suffers 2 losses:

a. Δl costs on wts he still takes at E, 1 unit. 3 cells, ? I'm not sure which.

b. Loss of previous gains on wts he no longer can afford. 3 cells.

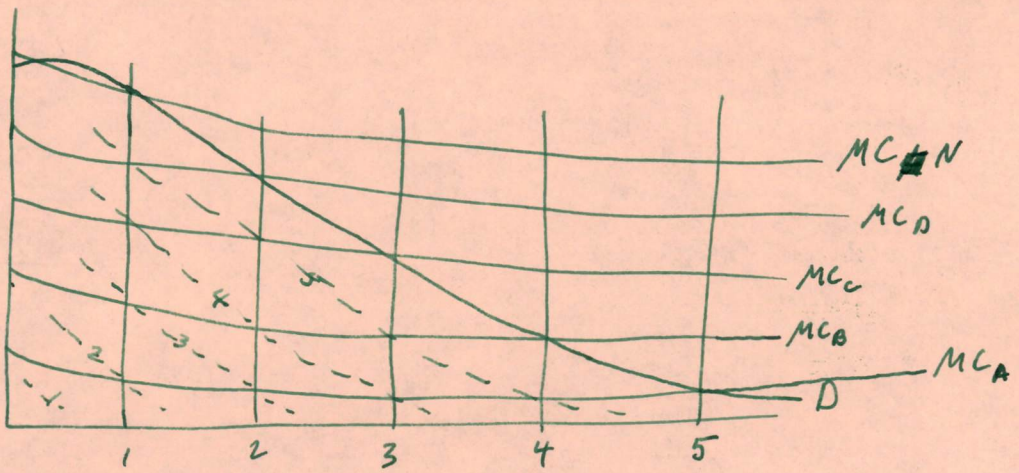
So its 6 cells loss to B; & 6 cells are traversal costs of B.

Express succinctly: ? Anyway, can say its roughly true.



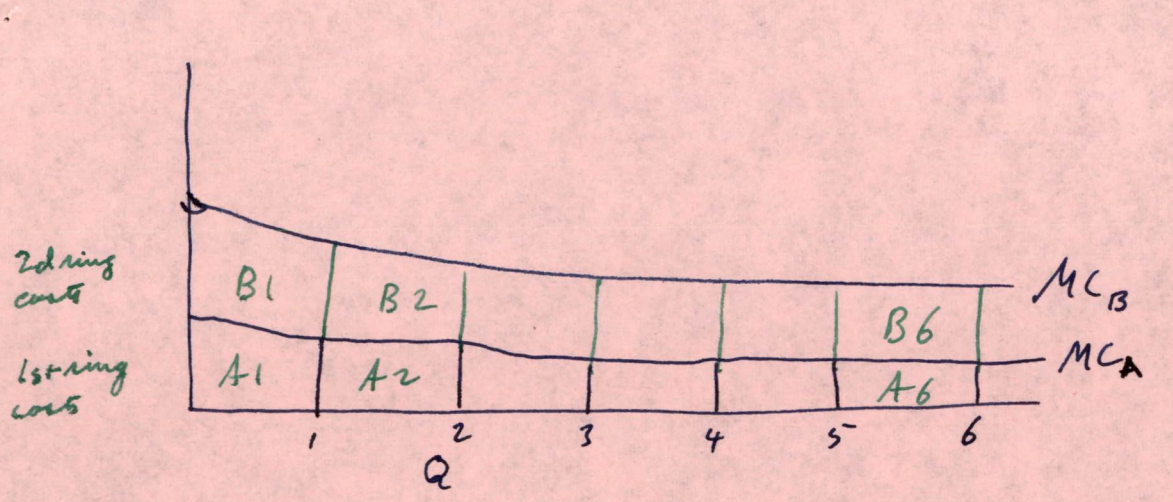
If we assume cell-row a, the bttm. layer, is built first, then we have to make later adjustments at margins.

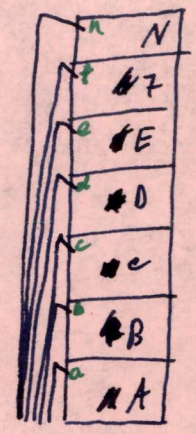
So assume first unit of capacity is built first? Same problem? Can solve. As addition of later cells makes earlier cells smaller, hold them fixed and subsume the lower MC in lower MC at fringe where you are. But will cells then cease to rep. specific traversal costs?



Draw MC curves as tho they expanded simul along a front || demand curve, so all reach it simul. Diagonals cells become exactly =?

Cost of line N is then column under MC_n, ~~cost~~ reading upside down, assuming homog. terrain. Bottom cell is cost of line n part n; next one up is cost of line n part lot n-1, which is same as first cell of line B bec it is 2d ring.





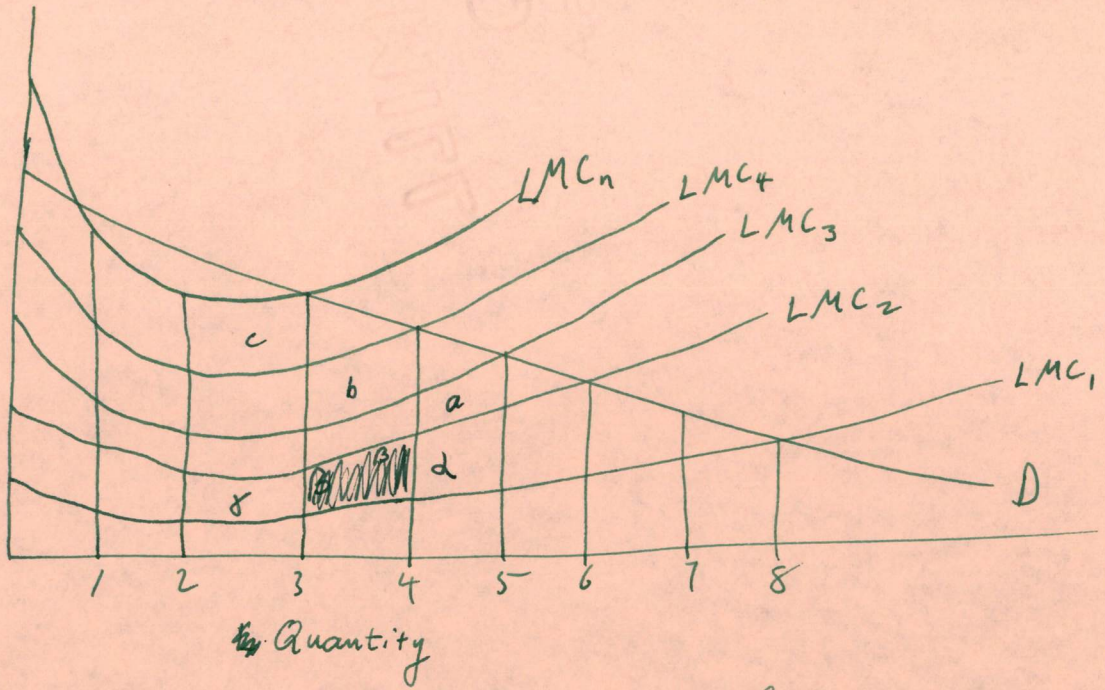
Re Higher traversal costs. Cf. Pipe N part C (5th ply) vs Pipe 7 part B (5th ply)

7 part B is higher capac. The extra cost of the extra capac. is shown by one cell. But one cost cell will be about 2x one triangle of net gain.

Problem: drawing MC curves, how define MC? Assume other plies all in, or begin from 0? Let A begin from zero -- initial costs shd be allocated somewhere. It is a qn. of sequence.

~~Suppose~~ Suppose we regard A service as fully built, then proceed to B? Then the B-reach (the length traversing B) of line B wd. have same MC curve as the A-reach of line A (if homog. terrain), while the B-row of cells, cell-row B wd rep. cost of ~~1 ply~~ line B part A, where ~~5th ply~~ line B is the 2d ring (where each successive ring reps. service to one lot, and gets progressively smaller.)

The qn. only comes up when trying to define traversal costs. This is a reason for trying to allocate line costs to land or frontage traversed. Otherwise it is clear. Mgnl. extension cost is area under MC_B curve, and division between A & B is unnecessary.



Shaded area is cost of taking fourth ply past lot 2

Columns are costs of taking one ply past no. of frontages + there are squares. Not any old ply, but the one numbered.

Mesokurtic rows are costs of taking no. of plies + there are squares past one frontage.

Squares in each column are roughly =. Exactly = if extension costs are constant.

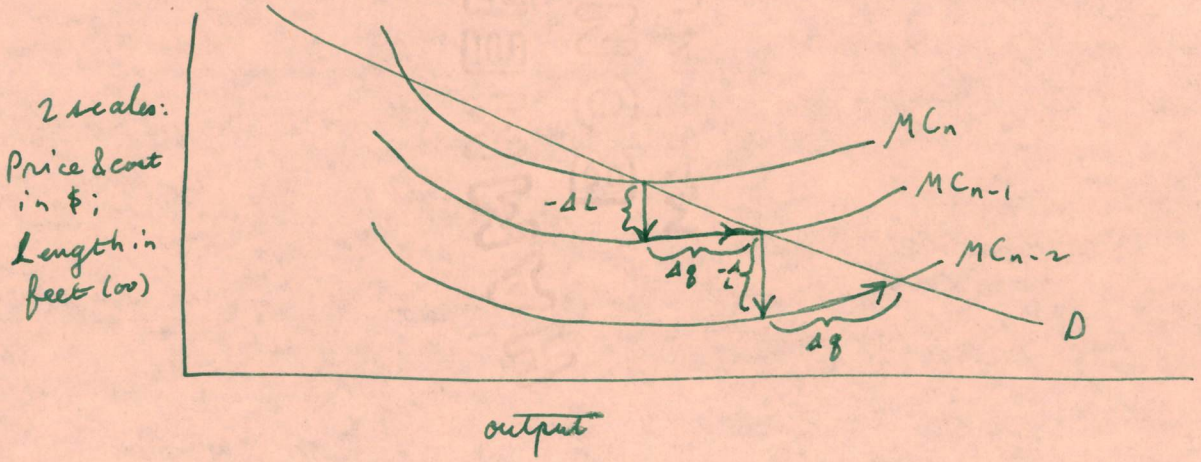
Squares get smaller tho in some columns of lo MC.

Cost of traversing 2 is: $\alpha\beta\gamma$

Cost of one ply from 2 to n is abc?

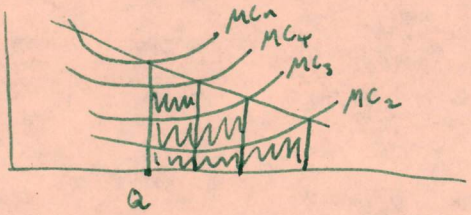
Problem: ~~does rent~~ do B's losses, or rent, = costs of traversing 2?

Traversal cost of 2 > extension cost C_2^n because all plies but nth are larger than nth.

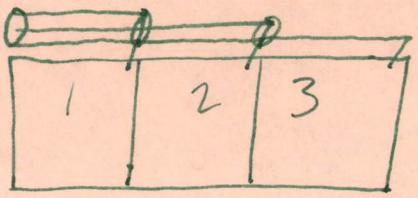


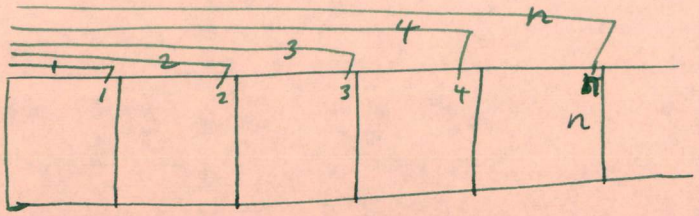
Reduce length (down): Δ capacity to right

At any q_1 distance between successive MC curves is about same, less each reps adding 100 fo length.



The Δl traversal costs of 2 rep ½ of ΔC from q_n to q_2 (where l is lot no.) ~~Δl~~ ΔC from q_n to q_l are almost = gross benefs. i.e. D curve.





A buys 2 from B, B moves to n.

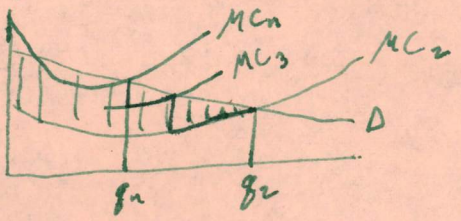
A applies same amt of wtr on 1 & 2 as previously on 1 alone. Delivers at 2, abandons line 1

B adds line n. Δl line is ∴ n-1. Previously I said n-2, assuming 2 took no wtr, but is more realistic to assume it still takes wtr, is spread thin over 1 & 2.

Alternatively we cd. assume this is an internal distr.n. problem for A, and he still gets delivery at 1. Do this — it simplifies

✓ OK. New cost is ~~cost~~ n's capac. past 3 lots, $C_n - C_2$. But also reduced capac. from 0 - 2 bcs B takes less at n than at 2.

At n, rent = 0, by assumption. Net value of position = 0. Rent at 2 is net value there: (shaded area)



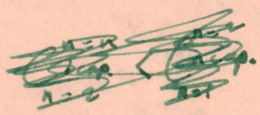
If demand were abs.ly inelastic, rent wd. be "mesomgul" area, "meskuntic" area left of q_n, repg lower cost of q_n at 2. But meskuntic area q_n to q_2 is also rent at 2. This reps total losses to B, and is proper constraint, (C & D being unaffected. (save small ± ΔMC)

Problem of summarizing costs imposed by occupying space.

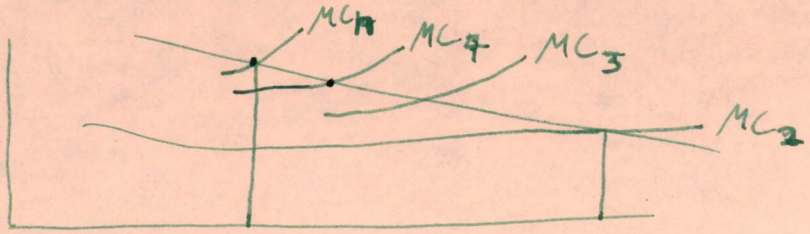
1. It is a qn. of MP of land. I.e. we say suppose A ~~perform~~ applied <u>same inputs</u> to less land, what gains result; or if A took more land, applied same inputs (including same water), what losses?

2. Qns:
   a. Are all imposed costs & other losses for all summed up in one? He is bumped from lot 2 to n. He puts in a smaller pipe. So ~~Cost~~ $C_{n=2}^{n=n}$ < Cost of n-2 capacities past frontage 2.

But no one else is affected. <u>Lots 3 to n-1 remain same.</u> So all is summed up in mgnl one. (only minute diff. maybe if in -Δ MC, decline in total capac. from 0-2, and increase from 2-n, some effect. Surely will be Δ MC from 0-2 and -Δ near n, so ~~expansion~~ extension wd. encourage more extension, possibly sometimes signif.)



Mgnl lot takes less than any other, so cost ~~out~~ to it < traversal costs for all. However loss at n exceeds C_2^n anyway, and the extra loss probly just = the higher costs on inner lots, working ~~up~~ down D curve:



Pipeline Pricing problem

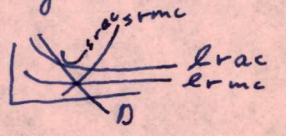
Widening capac., decr. costs.

Lengthening capac., Δg cost.

How price at last plot?

1. assume static conditions ☆ (later consider 2 dynamic factors: depreciation & Δg demand)

2. Make lr mc = sr mc, let p = sr mc



But still p < ac. Which bands shd pay?

3. MC of doing what? Enlarging or lengthening

How price at first plot? MC_A of widening declines as line gets longer, so proper charge at center ~~shifts from variable to fixed.~~ falls as line lengthens.

But approaches const. costs, so p covers almost all costs

We have 3 "runs" here at least. Longest, extending lines, Δg cost; long, enlarging lines, decr. cost; short, Δg flow in lines, slightly falling ac, rapidly rising mc, and rising avc.

But the longest is not comparable. The cost "increases" only in sense that you carry wtr farther, but that is doing something more than before. Each point of delivery reps. a diff. service, is not a homog. unit.

Each plot regarded as tied to center or source by individ. pipe. Each lot shd. pay for its pipe. How? Decr. cost on ea. pipe, so put p = mc. Remaining benefic on that lot Δs rent, so charge annual rent or tax to cover, net of fixed cost. Extend pipe until p×q + Δ rent = full extension cost.

☆ Note Blue Bk. goofs here. They have you aim for mean situation over time of MC = aC, when you should aim for sr mc = lr mc.

They underbuild, overprice.

Pricing problem. 2

MC will step up for ea. plot out, but this is not to be confused w. th Δg costs. However rates should step up as go out.

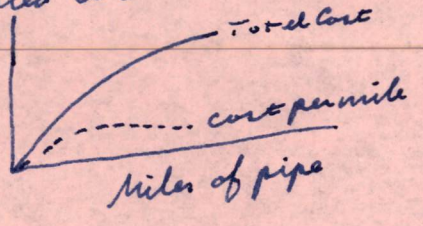
This seems pretty well to conn problem.

The excess of AC over MC will rise toward end of system, bcs more of its capac. is in rapidly decreasing costs.

Variable/fixed cost rises toward end of system bcs pump'g e.g. is const. fn of distance & height, but capac. per foot gets cheaper, as central capacities rise lrmc per foot fall.

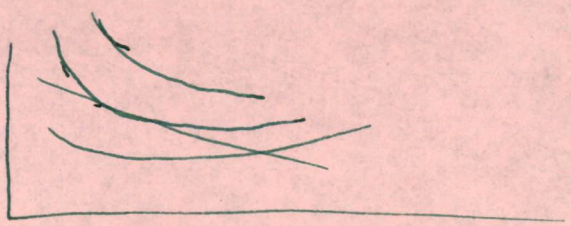
As telescope extends & lowers mc at center, gn. might arise of sharing hi fixed costs. Central lots shd not slough these out. Their costs cannot be premised on prior dewmt of outer lots, but v.v.

Cost per mile behaves for public or fixed costs somewhat as Hoover premised for put xpstn costs



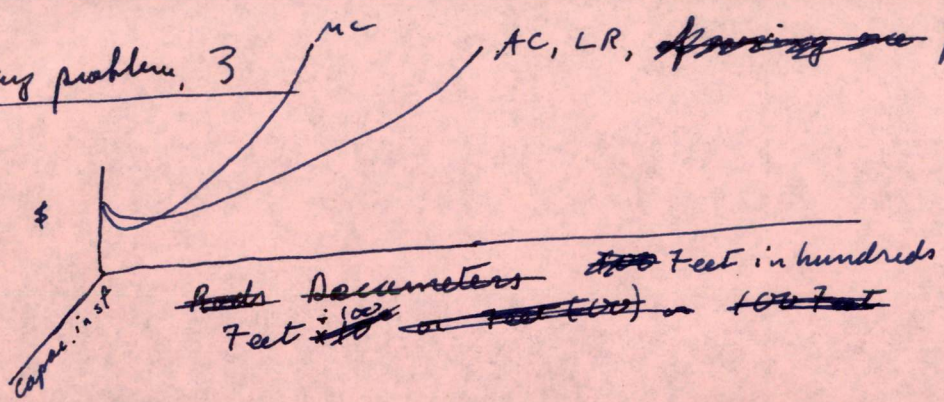
For different reason: decr. cost of capac. at center.

Fixed/vble costs rise toward end of system, if you allocate lrmc at outer ring of pipe to all lots. Outer lots, higher rates, given capac. gets used less. But it costs more per foot, bcs pay for inner rings.



Also indicated by steeper decr'g costs at ends lots

∴ Pricing problem 3



There is a MC of extending lines at any sf capac.; & of enlarging sf capac. at any length.

LRTC = f(capacity, length)

Which MC shd. user pay? On a 3-D curve, what they =?

Yes. One is falling & one rising, but they are rarely =. That shd solve problem, partly.

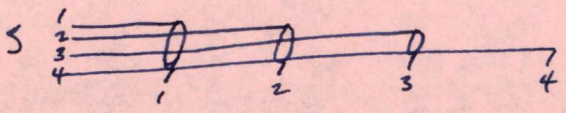
Say all cost are annual, & fixed forever, for simplest analysis.

Situation unusual, or differs from usual anal., in that each consumer gets a diff. service, in a sense. Can it be treated as diff. quantity of same service?

All MC should be regarded l.r.; & on assumption whole system built, i.e. all eligible lands take service. Then MC are very low at center. MC of what? Of extending one sf capac. ~~one frontage long~~ from source to service. ✓

That is the mc, & there is only one. It is as w. length & declines w. capac., but at any pt. it is one value.

Pricing problem, 4



Qns:
a. Pay for line capac., or quantum taken, or combo?
b. What are A.C.? Allocable among plots?
c. What if capac. not used?

b. MC of service 4 is line 4. Ea. line reps. 1 sf. capac. (assume all capac. used)

MC is not ≡ cost of Q taken. Space impacts MC, lr & sr, by simply intervening. For this it should be charged.

If we cd. assume all lots wd. take along demand curves of MP, just bes. oppy. exists, maybe implicit rent wd. do trick, no charge necy. ~~Rents~~ We can't, but can consider reasoning if we could.

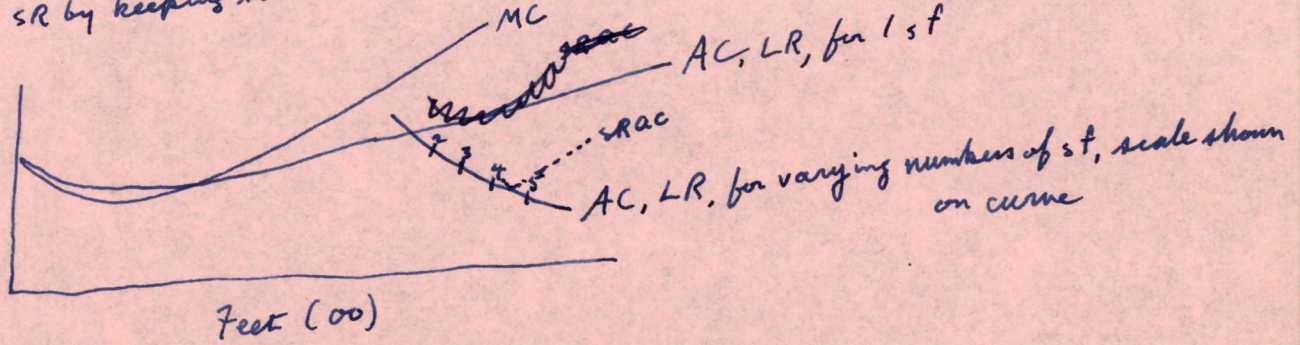
Assume for simplicity you pay for capac, so much a month. The quantity payment problem involves here only s.r. use of capac. Qns (wtr. assumed free at source.) (also pump costs. sr mc)

Space problem doesn't arise solely bes mc < ac.
Even if mc > ac, sr & lr, still p = mc wd. not charge for space occupied. However, rent (if it worked) wd. ~~[illegible]~~ constrain them to economize on space; & as to repayment l equity, those cd. be considered separate qns.

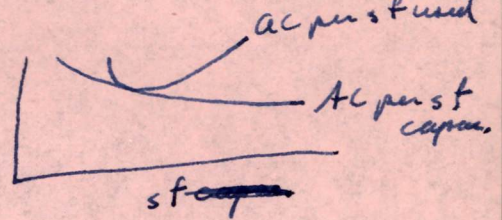
Now the AC of service to pt. 4 is cost per sf capac. of line 4. It is right to presume that 1, 2 & 3 are served first, so the higher initial costs are properly allocated to them, just as initial cost of section 3-4 of line 4 is alloc'd to plot 4.

Thus hit up inner lots hi

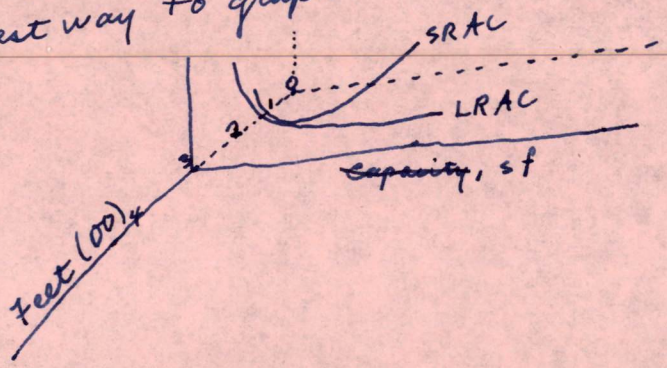
Envelopes on s.r. cost curves are ~~exactly~~ same as a 3d dimension. So add 2 envelopes? Not quite same, bec scale of units differs. Can use envelope technique on LR vs. SR by keeping same units.



How about using it for capacity vs. use? ?



That is basically same thing as lr vs. sr. Maybe minor but imptnt. diff., in that cfs is not convertible to afpersp; bec afy presumes changes in instantaneous rate of flow, while cfs almost is instantaneous. Best way to graph:

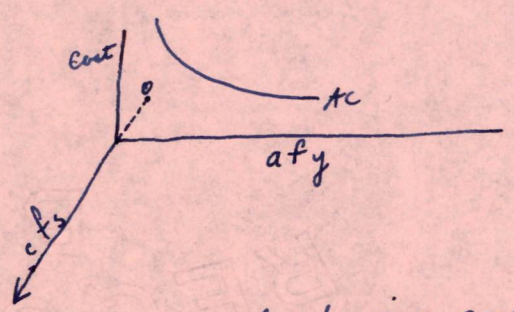


But let the 3d D. be implicit, just show dec. cost w. capac.

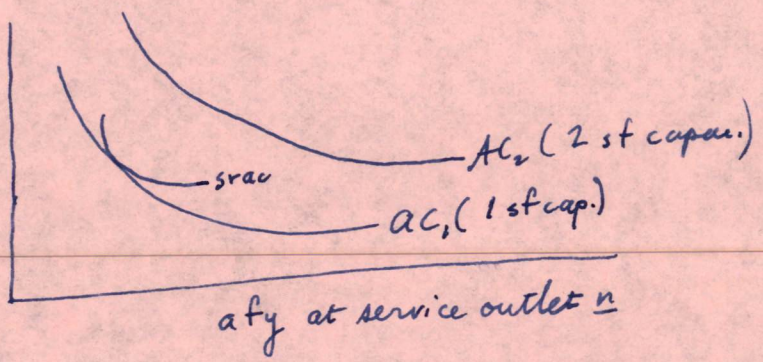
The SRAC curve allows for all the elements of elasticity in a fixed system, like night deliveries. It will vary in shape with label on abscissa. Thus cfs are quite fixed, while afy are quite elastic. Demand curve also varies

LRTC = f(length, capacity, use or quantity)

LRAC declining reflects declining AC of adding capacity.
SRAC reflects use of any given capacity



Instead of showing 3-axis diag., it comes straight at you, use nos.



Select that 1st capac. where max. net income. But this declines toward extremes or peripheries (hence petty lines in country). Res. MC of capacity is higher. Higher rate.

Peripheral customer, hi srvc, hes ties up capac. all along line. (Central user is much less likely to, tho by tieing up central trunk might force underuse of outer lines. But outer customer presents this danger all along line.)

See p. 7 for better view.

Need for excess capac. much greater at center clearly, hes clogging there affects whole line.

When does foregone gain become more of mc? When s r mc > demand.
Then instead of meeting surplus demand you deny it, & smc to all is the level of intersection

---

As you move out, peripheral services pay higher rates & have lower capacity.

Rates = s r mc. = l r mc, for capac. selected as optimal by dfg net inc. at diff. capacities

Even tho outer rates are higher, they are further below ac bec in stage of faster decreasing costs. So 2-charges necy.
an extension-capacity charge, flat per yr: & a use charge.
Both charges grow higher toward peripheries.

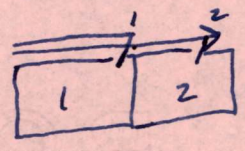
What flat rate to charge at center? No matter, bec rent is rent.

Let each service outlet have a capac., of course, as well as lines. Higher peripheral costs here, too, bec when are one or a few on line, chances of ~~too~~ clogging greater, & of demand greater. So nearer center, can play stat. some & allow less ~~so~~ line capacity per outlet. ~~&~~ V. y. lines round the clock.

But cd. also look at it so. Ea. owner shd pay two charges. One for bringing wtr to his outlet; & another for lg cost of bringing to those beyond. First is for one ply across his lot; 2d is for the others. Outsiders pay MC of lg cap; he pays MC of lg length?

Suppose line is extended x ft. not by new user, but by all inner users expanding $\frac{100}{n}$ %. Same Δ costs. Rent shd. constrain. But not all equally. Best way is, rent for any frontage = cost of transmal. Full cost, fixed plus vble.

We might reason so:



When 2 comes in, 2 shd pay only cost of extending from 1. 1 shd pay transmal cost, bes he is standing in way. But you cd. only soak him for fixed cost. S + mc must constrain 2. Also, 2 & 1 cd. not be decision makers. So far as efficiency goes, income from 2 must justify the extension. And rent arises on 1 even w/o 2 must justify the extension. And rent arises on 1 even w/o I.D. charging for space.

Wd. flat annual charges at end of line affect rent at center? Yes, by inhibiting extensions, making mgnl land submgnl.

At all points, capacity – extension charges shd be based on m.c. To avoid overconstraining demand for capacity. So will be unmet charges. Central lots pay these, for their share of transmal costs. But they pay them for their position, regardless of capacity.

as to capacity for inner lots, individual choice given only in sense indivds can take or leave what I.D. decides to supply, & I.D decision based on demand.

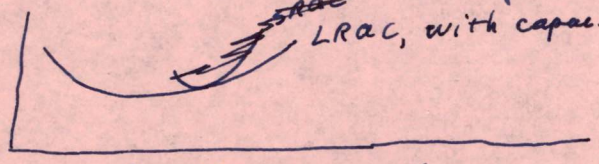
* increase

So rents based on diff. xpth charges; & xpth charges based on

a_1 = srmc = lrmc

b_1 = capac.-ext. flat charge

Each srac curve presumes not only a given capac., but a given timing of demand. Could we handle this with envelope demand curves? Yes.



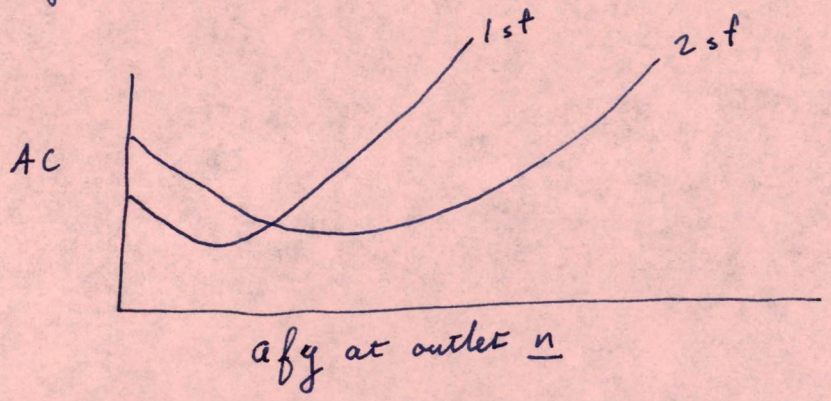
a separate demand curve for each capacity, recognizing deterioration of service from overtaxing capacity.

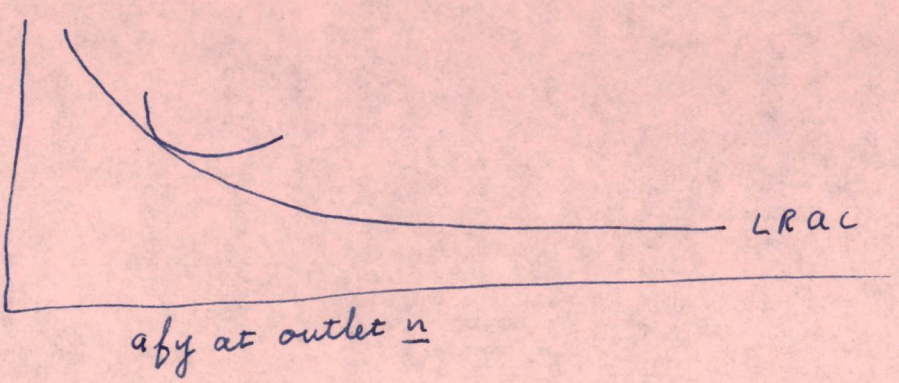
? flat rates if Δg cost?

Why flat rates if Δg cost? Res land served by sewer net occupies special position re p.u. Not like other, optional customers.

If $-\Delta g$ costs, might have system bring in less than TC; if Δg costs, might bring in more.

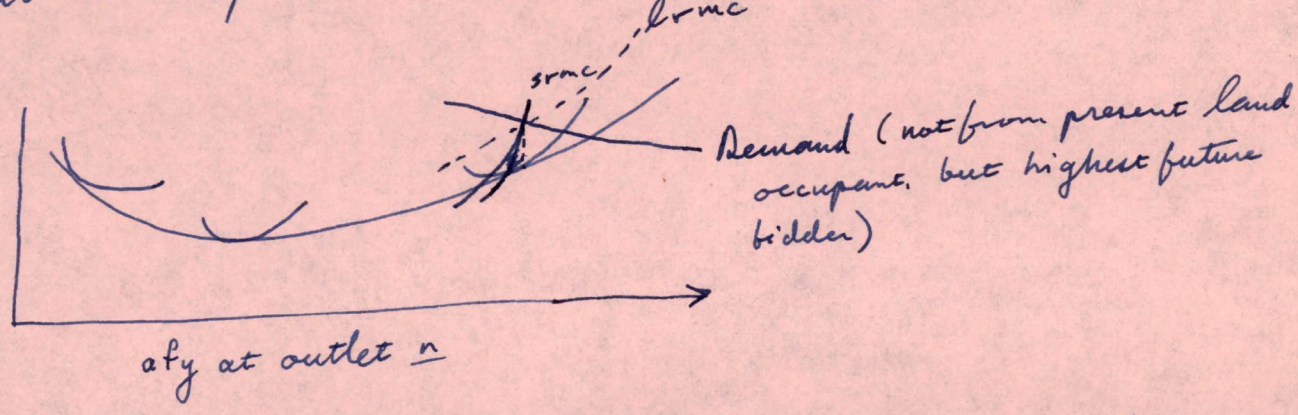
?





Instead of bothering w. envelope demand curves, draw sr supply curves to show cost of given quality of service? No, that is arbitrary, let service deteriorate optimally. Needn't however draw all the curves. Assume this is being done, by saying demand curve is envelope of demand curves at given sizes of pipe. (Alternatively, cd. keep one d curve & subsume deteriorating service in SRAC curve, by making it rise faster.)

Now can use traditional envelope cost curves meaningfully (& still have a spare 3d dimension for other needs.)

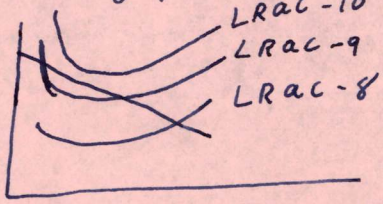


Now suppose MC > AC. Fixed charge still warranted bcs. fixed capacity is laid out w/o any custom, & can only be used for the lands to which laid out. How much fixed charge? Fixed costs? (note fallacy of I.D.s to end fixed charges when bonds paid off. Implicit & some explicit fixed costs continue.) Diff. principles apply here than with production at a point from a factory, on which ec. cost analysis is based as a prototype. Fixed costs in distrib. nets cannot be spread over output indifferently, but are for specific customers.

So let each lot pay l.r. mgnl extension costs (annualized). [These become "fixed" costs for s.r. analysis, but in "extension run" are mgnl.] Size the extension where lrmc = price, & srmc = lrmc (as described above)

Now charge $p = s + mc$, ... not down to the second, but to as small a time unit as practical.

If Δg ~~reduces~~ costs, this mc price will more than cover a c. So now where is rationale for extension charge? ? ✓ Big question



c.s. even at last lot?

Yes. And at last lot always ✓ in $-\Delta g$ costs. Must pull out every trick from ecsts' bag to justify service, collect c.s. by fixed charge.

How be sure of decr. cost at last lot? Bcs $-\lambda$ of demand ✓ curve. Eureka! →

Each lot is an individ customer w. diminishing mgnl demand. Ea. one has a c.s., even the mgnl one. On the mgnl one this full c.s. must be taken by flat rate, & besides charged $p = mc$, to just warrant extension.

On all intra mgnl lots there is more, a system surplus, which cd. be taxed for other reasons, perhaps by other bodies.

Cannot leave price to individual bargaining: bilateral mopoly & seller already committed hostage of sunken capital.

Back to fn. of rent, in wth pumpg system.
(Regard bundle of pipes as a fascia.)
Assume system extended to last ex. lot? Full allocated cost charged there: mc × Q, plus fixed charge on Δ rent and = to it. So anyone bumped there or beyond gets no advantage from system.

To introduce pt., assume pipe in, just consider pumping charge. But can immediately step ahead to cost of extension. If Δg cost at n, is covered by mc; if decr. cost, is a fixed charge plus mc × Q. Either way, lot n is less desirable than 2 by full ~~traversal~~ extension costs. These = costs of traversing 2

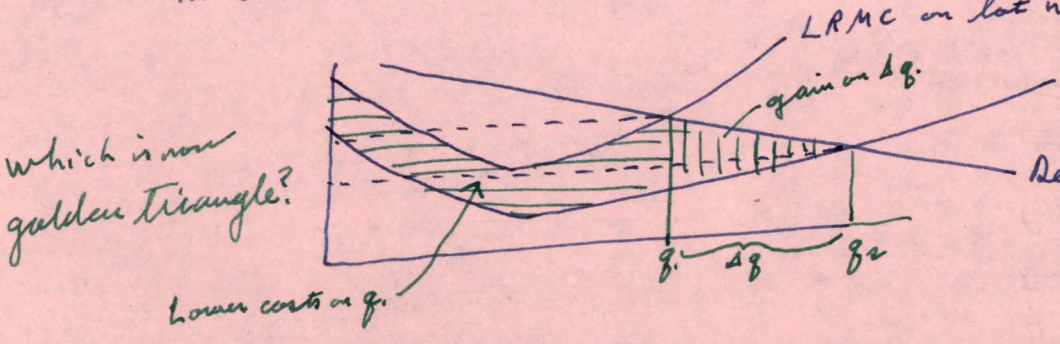
Problem: What if conditions not homogeneous, do they still?

If conditions are homog., cost of carrying supply of lot n past lots ~~[illegible]~~ 3 to n = cost of carrying supply of lots 3 to n past lot 2. Cost of x capacities past one frontage = cost of one capac. past x frontages.

But if pump gradient Δs; & use gets thinner, as it will at higher ~~[illegible]~~ rates; then cost of one capac. past four frontages > four capacs. past one frontage. In gnrl. use per acre declines at higher rates. ~~so in gnrl~~ ~~the cost of carrying~~ But this means is less to carry past lot 2 also. So varying intensity doesn't destroy equality. Varying gradient may.

Return.

Disadvantage of lot n is not just cost of carrying what it does take; also loses a rent triangle from what it doesn't take bcs hi costs. Here is perfect application of golden triangle theory.



If move from lot n to lot 2, part of gain accrues to customer; but part also to seller. Total gain is area between mc curves. Buyer gets benefit between ~~shaded~~ dash lines; seller gets remainder.

Is rent constraint adequate to reflect this system gain not reflected in customer constraints? The flat extension charge ~~may~~ covers it.

~~Rent~~ Lot n gets no net rent from the pipe: hi rate plus flat charge to cover extension costs, which at margin just = c.s. = rent, exhaust all. So lot n is no-rent land, re pipe.

Rent on lot 2 will exceed TC of extending service to n, bcs of diminishing productivity.

So rent on 2 differs from transmsn costs for 2 reasons:

a, Transmsn costs ≠ extension costs if costs per mile vary (?)

b. advantage of 2 > extension costs, bcs. of Adme

?. c.

Re a, suppose cost of traversing 2 is zero, for some reason. Does that mean 2 imposes no costs on system? It does, by bumping others out to mgn.

Again, suppose 2 is unusable land. It costs to traverse, but commands no rent.

Costs are not imposed ∴ by merely being there, but by being kept from alternative uses. The cost ~~of supplying them is the proper~~ imposed on others is the proper ec. constraint. --- including foregone gains.

Interesting corollary, if any net is worth building at all, it produces surplus on all intramgnl lots, ~~both produces & contains~~. (But don't forget we charge higher initial costs to central lots. ~~Expand~~ matter, mgnl extension also pays hi initial charges & more.) No

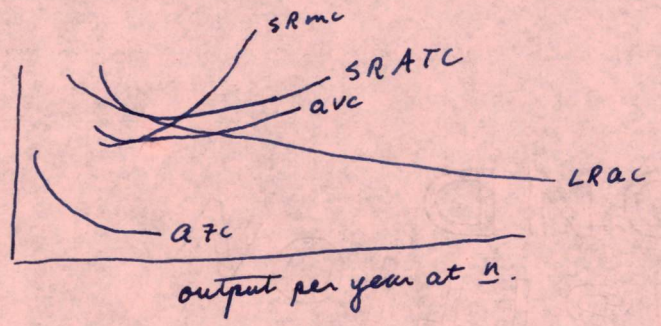
Are all rents ∴ supramgnl? From the head of distribn, yes, but surplus may all be needed to justify large common cost before that point. Thus justify taking intramgnl rents. They are either ↑ from an outlay or a natural advantage, either of which is state propty & taxable -- whether net B, who is bumped to end of line, may go elsewhere, but no matter. There is still someone at end of line, & others all along line, whom B represents.

is built or not, thus forcing net-building.

Costs are fns. of time or use. Time costs levy flat on land; use costs on use.

In extending mgnl service, ~~just raise tax~~ land shd pay time costs as flat rate; & use shd pay m.c., s.r.

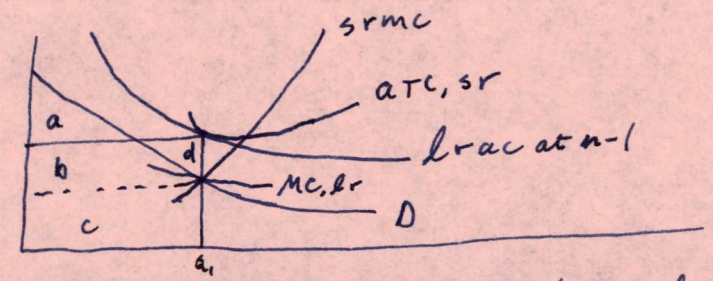
This is same as say'g land pays fixed costs & use pays variable -- except here, variable to most people wd. mean AVC, & I mean SRMC.



Some qns:

1. at mgnl lot, TC $\stackrel{?}{=}$ c.s. P = srmc = lrmc, but do they = avc?

If so, price covers VC exactly --- "exhausts" V.C., sey --- and land tax exhausts FC, so together P & tax exhaust t.c.



Move out, to higher lrac curves, until a = d. There, c.s. = a + b. PQ = c. Remaining cost = b + d. But d = a, so b + d = b + a = c.s.

Only qn now is: does srmc = avc at q_1? q_1 is determined by lrmc = srmc? Initially by D = lrmc. Then size pipe so srmc = lrmc at q_1. As far as whether ~~srmc = lrmc~~ avc = srmc, demand doesn't matter, only costs, so focus on that relationship.

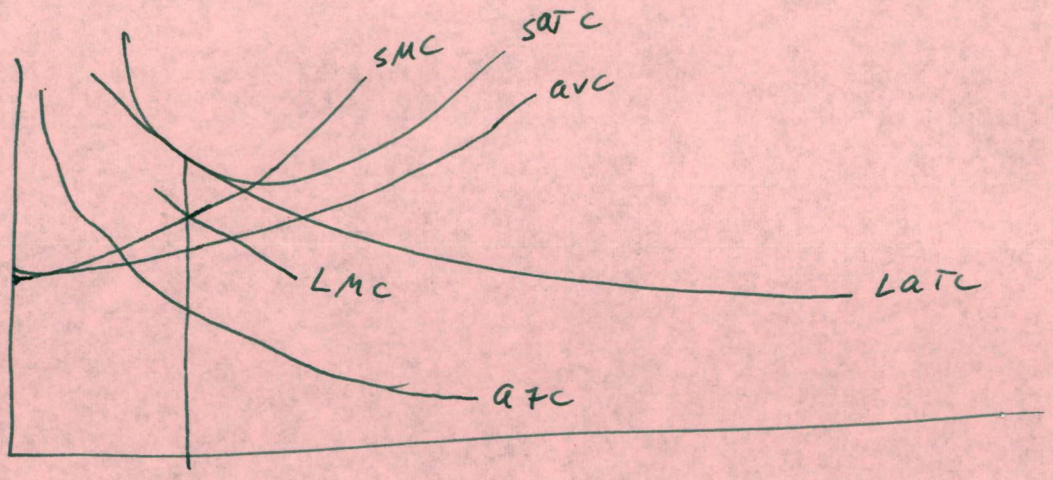
pp. 16-27

Tried & failed to show

SMC = SAVC when SMC = LMC

Decided tentatively SMC > SAVC

when SMC = LMC see on p. 27


SMC
SATC
AVC
LMC
LATC
ATC

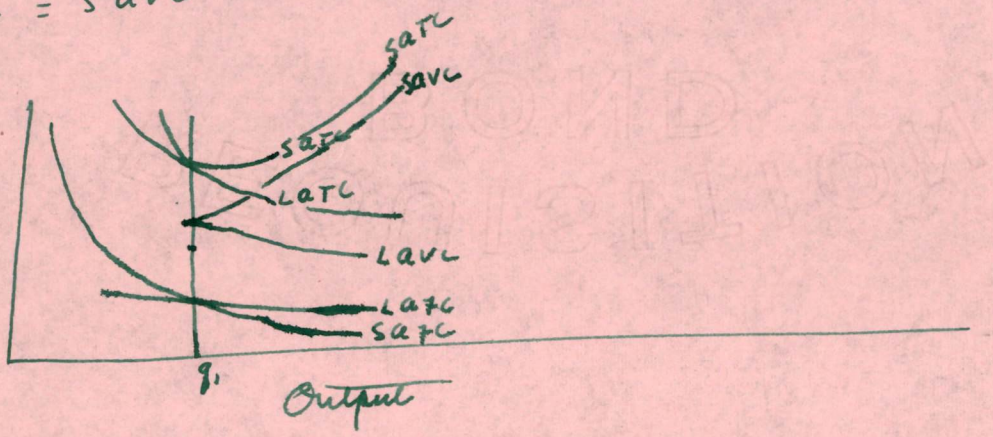
At q_1, $LRAC = SRAC$

$SRAC = SAFC + SAVC$

$LRAC = LAFC + LAVC$

$LAFC \overset{k}{=} SAFC$

$LAVC = SAVC$



If $SAVC = SMC$, at q_1, then $l\text{-}mc = lavc$. and if not then not.

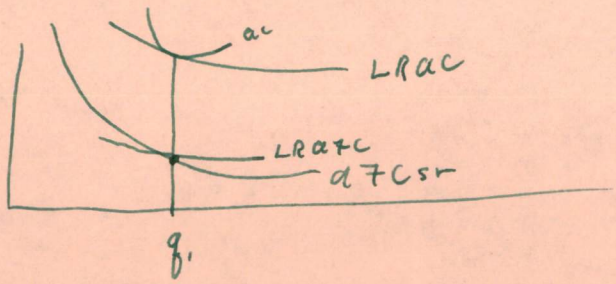
If $AVC = MC$ when $LMC = SMC$ etc, then some relations follow.

List them & see if they hold.

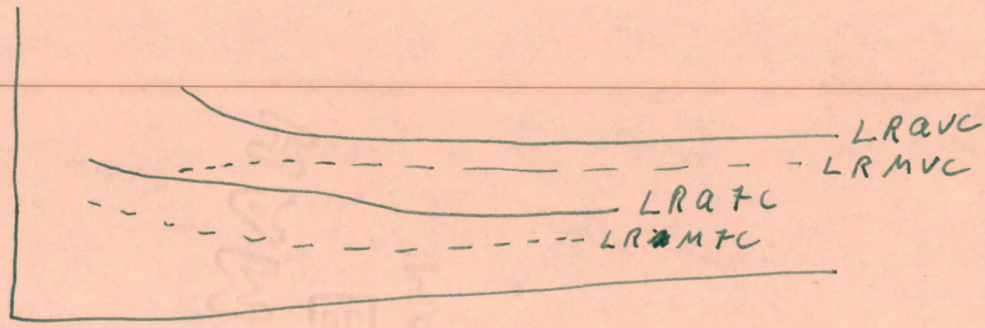
1. $MC + AFC = ATC$
2. $-\Delta ATC = -\Delta AFC$ bec $ATC \parallel AFC$
3. FC just begins to be treated in some sense as a free good or better. Output per unit variable input is brought to a max. It may follow that input value of Δl fixed input at that intensity $= 0$; & at lesser intensities is negative, so you cd. Δ output by $-\Delta q$. FC.

This seems conclusive. If $AVC = MC$, $l\text{-}mc = \infty$. So AVC must be Δq where $SMC = LMC$

How does a ATC curve relate to LR ATC? It is a point on it.



If avc rising, atc falling faster than atc, and you cd. lower tc faster by holding vc fixed & expanding on lr curve. But then you wdn't have a pt. on envelope curve. So if you are on envelope curve, ATC || ATC. (But you wd. have to follow LRATC curve?)



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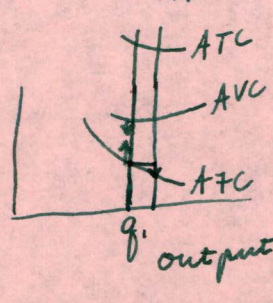
2 approaches

a. Cd. lower cost bec avc not horiz.

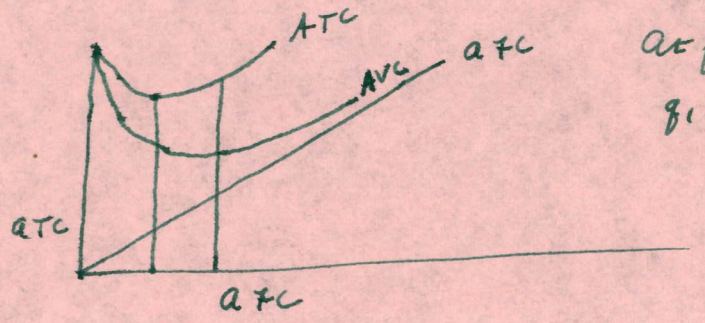
b. " " " " " = lrmc

b. If avc < lrmc, have we got right lrmc curve?

When avc become const., they become = lrmc. We ΔTC & -ΔVC until Δs are = & opp.

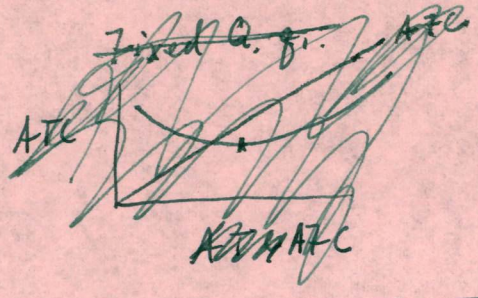


If ΔTC & ΔVC by same %, keep same proportions, then stay on aTC curve, ∴ λ of TC = λ of aTC

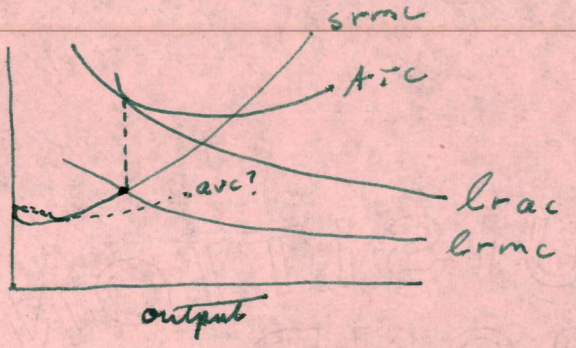


at fixed q_1.

~~fixed Q. q_1.~~



If avc were ~~below~~ below lrmc, cd. you lower lrac for q_1 by changing mix?



q_1 is a place where by ΔTC you lower VC. If avc are const., this is still possible, bec VC can change.

If avc is rising, then Δ_q TC will reduce not just VC, but avc.

? If avc are const., ΔTC won't change avc

Just suppose lrmc ≠ avc. Can we be on envelope curve? We cd. then

~~MTC < aTC~~

MLRTC < aLRTC, since LRTC are falling. But they aren't nec'ly.

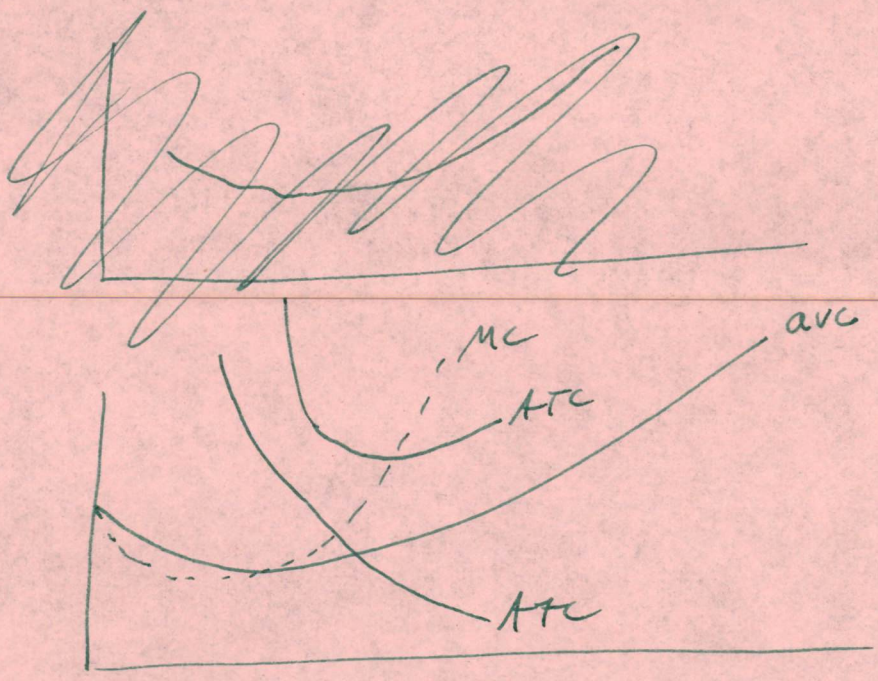
Maybe the fall is all in LRVC

If aVC are falling, wd. be no gain in Δg TC, unless LRMC < srmc.

But left of q_1, srmc < lrmc.

aVC are regardable as MC of big Δ of output from 0 to q_1.

If that big MC > lrmc, how cd. you be on envelope curve?



AVC are to be cfd vs. MTC at any pt. Res by Δq ATC you can do away with whole schedule of AVC.

So if AVC > MC when srmc = lrmc, wd. mean AVC > MTC, and this wd. mean that isn't right mic for q_1. Res you cd. ~~ATC~~ maintain q_1 by ~~[illegible]~~ Δ ATC less than $-\Delta$ AVC

[Treat TC as free good? SR opt.?
analogy to lrmp ideas & adjustments

Merely to equate lrmc & srmc is ~~no~~ insufficient proof you have reached min ATC for q_1? To find opt. mix, have Ad TC & reduced VC for q_1 until Δ of TC = $-\Delta$ VC

~~But also, say~~ LRTMC, i+j-h, has to = them also.

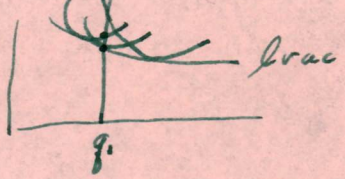
Then $i+j-h = j-k$;

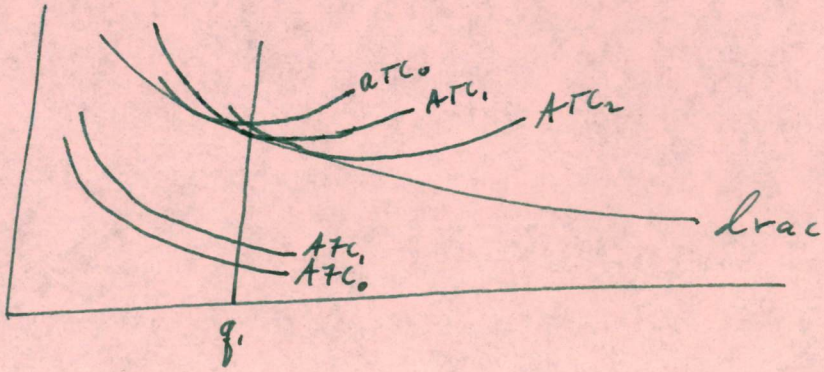
and

$i+j-h = i-h+k$; or $j = k$, impossible

We have skidded down the l.r. curve.

~~Left of q_1: Δ TC < Δ VC~~ We have stayed at q_1, but used curves of ATC which skid down.



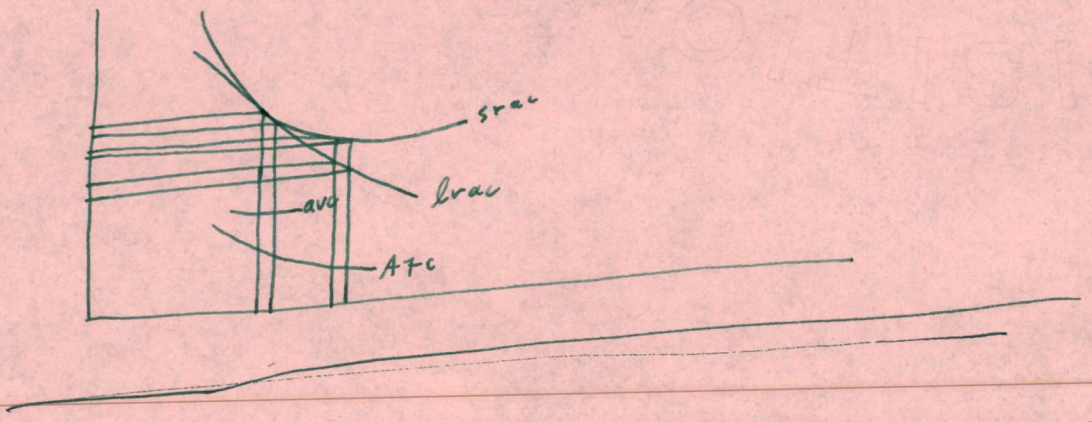


At tangency, srmc = lrmc

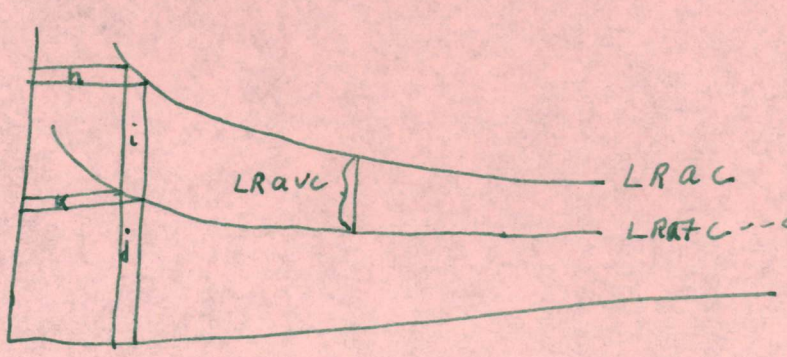
MC = ac − x, everywhere

$$\left[x = q_1 \times \Delta ac \qquad \Delta ac = \frac{TC + MC}{n+1} - \frac{TC}{n} \right]$$

To prove: x = y = atc when srmc = lrmc



Suppose srmc = lrmc where avc > mc. Then you must have wrong mix. You cd. produce output from larger plant, subst. FC for VC, same money -- i.e. lower atc for q_1.



LRMC = (i + j) − h = lr afc + lr avc − h

LRMC = lr mfc + lr mvc

At all points, MFC = MVC = LRMC

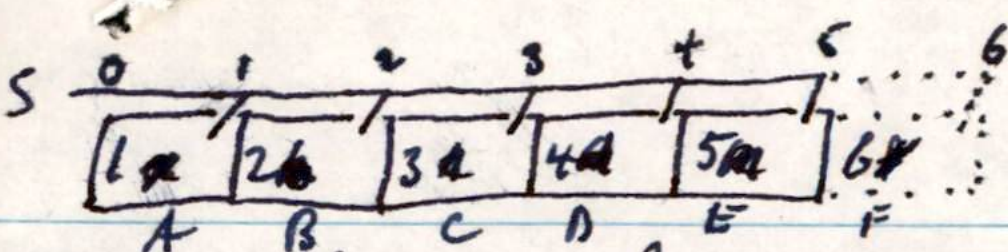
mfc = mvc at = m.

mfc = j − k

mvc = i − p, where p = h − k

so j − k = i − h + k or

j + h = i + 2k



Owner A owns lot a, etc.

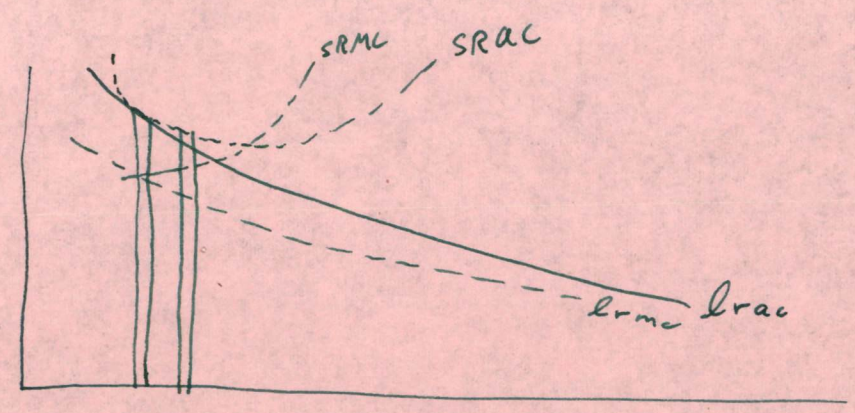
Let A buy 2b from B.

B moves to 6f. Is same as moving B to c, C to d, etc.

Δl cost is conceived in 2 ways that must be equivalent

1. Move pipe serving b-e one step right. Δl cost is cost of traversing b w. 4-ply pipe

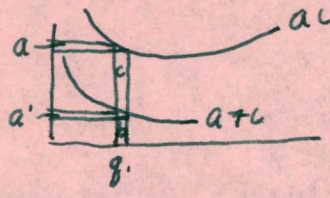
2. Move B to slot f. Δl cost is cost of adding one ply of pipe ~~from~~ traversing c - f.



What is relationship of ATC & LRAC at tangency of LRAC & SRAC?

Or just of AFC to SRAC. We have mixed FC & VC such that a $ (per yr.) spent either way has = mp. Or, SRMC = LRMC

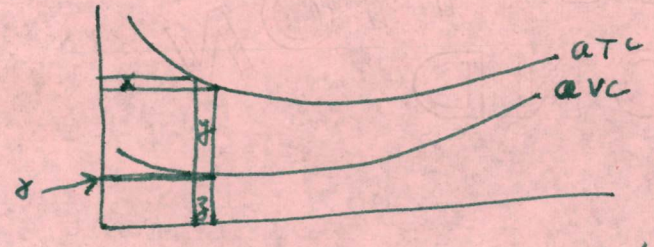
$AFC = ATC - AVC$



How does AFC relate to AC when SRMC = LRMC

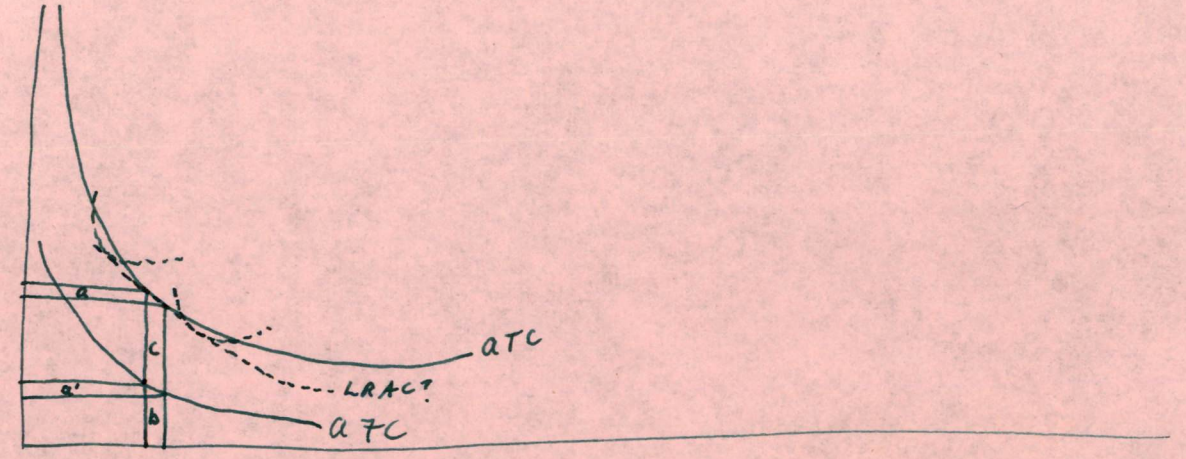
$SRMC = (b+c) - a = LRMC = ATC + AVC \rightarrow$ "a"

So at q_1, $LRMC = AC \rightarrow$ "a"



$MC = MC_v$ from either curve. AVC is min. when $\gamma = 0$. Then $z = MC$

$y = x$. always. $y = AFC$, so $x = AFC$ at min AVC



Where $aVC = MC$, λ of $aTC = \lambda$ of aTC less λ of $aVC = 0$

$MC = c + b - a$.

Where slopes are $=$, $a = a'$. But a' always $= b$, so $a = b$.

Then $MC = c$

But $c = aVC$.

∴ when $aTC \parallel aTC$, $aVC = MC$

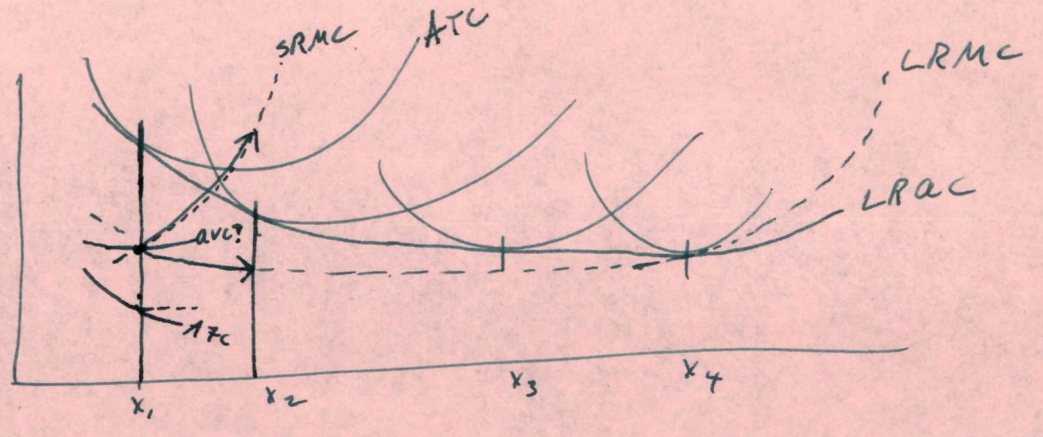
How do we know this is where $lrmc = srmc$?

$LRMC = SRMC$ where $LRAC \parallel SRAC$, and $=$.

$SRMC = aVC$ where $aTC \parallel SRAC$, (or aTC)

Problem: when is $aTC \parallel LRAC$?

How do we know we have a pt. on LRAC curve? When cannot lower cost by changing TC, at that output. ~~Partial derivative of fixed costs is ∴ zero?~~ Select the output, start with low TC & hi VC, change the mix until the last $ ΔTC produces a $1 decrease of VC for that output. (So $srmc = lrmc$.)



How find LRMC?

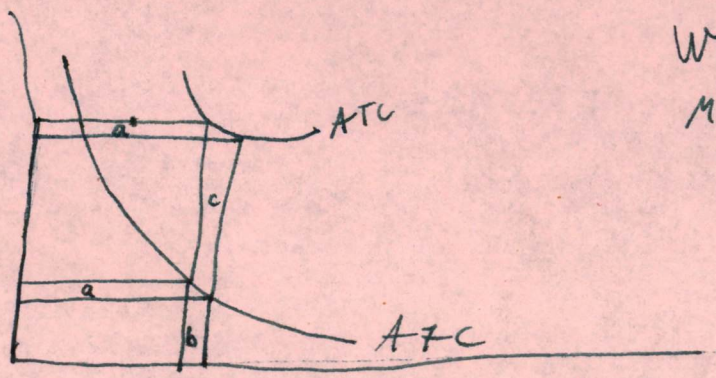
Steps:

1. Find min. TC for producing given outputs. Combos of fixed & variable costs.
2. LRMC = Δ TC between such optimal plants.

Cd. draw LR "fixed costs", & LR variable costs,
or LRMFC & LRMVC. LRMC = LRMFC + LRMVC

If at X_1, avc were falling, srmc wd. be < avc

Assume smooth continuous curves. When does lr expansion path look better than sr? When lrmc < srmc of course, & that is when the rate of substn. changes so instead of holding capac. const. & Δg other inputs, becomes better to hold others const. & Δ capac. Substt. expansion of fixed inputs ~~for~~ (or time-fxn. inputs) for expansion of output-fxn inputs.



Where λ of AFC = λ of ATC

MC = c

c = avc

∴ MC = avc

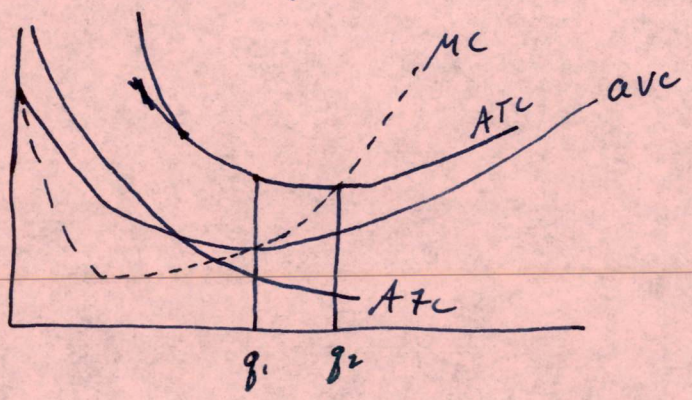
a = b
a' = a only when slope of ATC = λ of AFC

If at q_1, avc were const, then the neg. λ of static wd. be due entirely to decline of aTC.

Suppose avc were falling at q_1. Then aTC wd. fall faster than aFC. It is unlikely obviously. (& probly impossible) that it wd. be desirable to expand FC while avc still falling. So likely avc are rising to right of q_1.

At q_1, lrmc should = avc

At pt. where avc are flat or const., λ of aTC = λ of aFC.



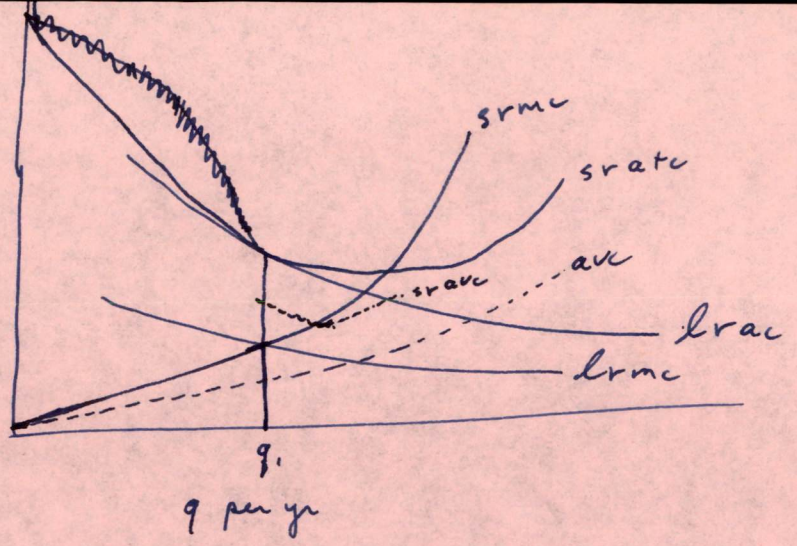
At q_1, λ of aFC = λ of aTC

At q_2, λ of aFC = $-\lambda$ of aVC

Assume aTC is on envelope lrac curve

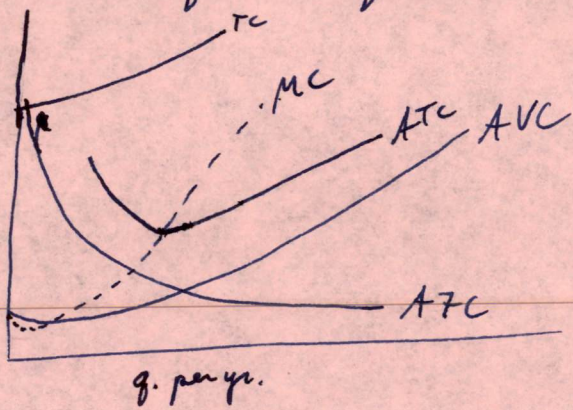
To prove: pt. of tangency is q_1, where MC = avc

If we cd. get lower AVC w/o bldg a larger plant & Δq aFC, that wd. seem optimal. Or cd. we lower avc more by Δq aFC a little?



atc is min. where Δ of avc = decrease of atc.

$$\Delta \text{ of avc} \cong \frac{\Delta TC}{q} = \frac{mc}{q}$$



Decline of ATC is $\dfrac{d\frac{TC}{q}}{dq} = -TC\,q^{-2} = \dfrac{-TC}{q^2}$

change of avc is $\dfrac{d\frac{VC}{q}}{dq}$ ~~to~~ ~~$\frac{-VC}{q^2}$~~ where $VC = f(q)$

Get us no where.

Do avc = lrmc where avc = srmc?

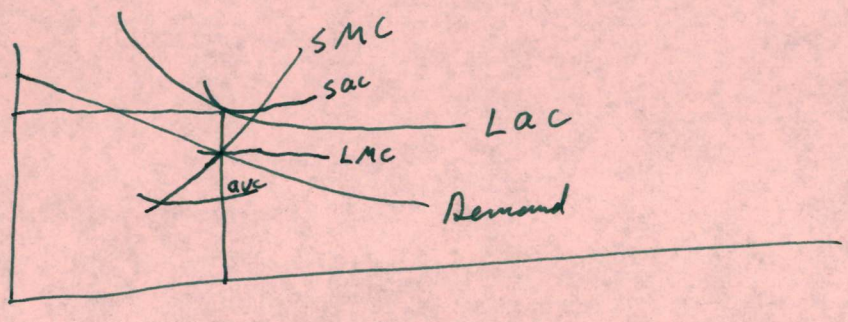
At q_1, lr tc = sr tc. That means there is no cheaper way to produce that output. But if avc were not a min. there, you cd. ~~so~~ change size & lower cost.?

From q_1 on, srac rise faster than lrac. Why? Bec srmc ? lrmc --

Expand, maybe on track.

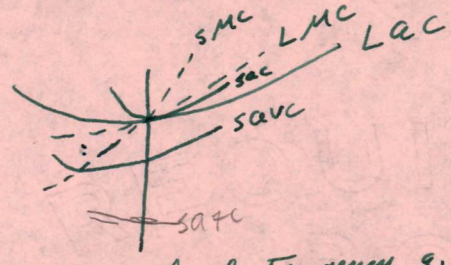
Extending mgnl service, land pays flat rate to cover time-fn costs; & use rate for use-fn costs. Use rate = SMC; SMC = LMC.

If, as I now believe, MC > AVC here, this brings in more than TC. You will not want to change this much bcs. wd. prohibit mgnl extensions part sum of charges



Mgnl lot

Suppose const. returns to scale

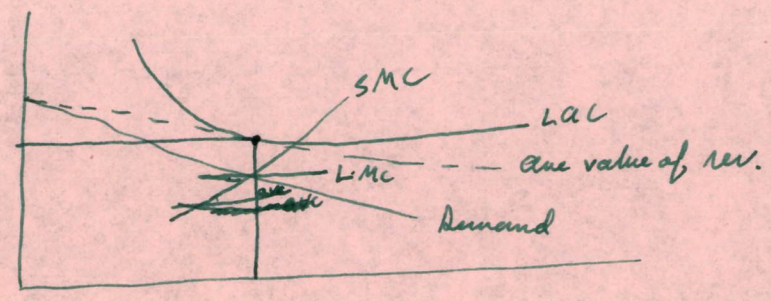


Min. AVC is clearly left of tangency, q_1. At q_1, AVC < MC. Can this suddenly change when q_1 moves a little left? I think not. Or suppose sac etc. stay fixed and LAC tilts down to right, & LMC falls. It can fall a long way before intersecting SAVC. The higher one ATC the lower are AVC & the truer this is.

At q_1 eqm., LRAC must fall slower than SRATC. Bcs LRAC presumes you ΔTC. If you didn't you go even more upwards (or less downwards at first) along SAC. To avoid this you ΔTC, making LAC flatter than ATC. Only exception which requires rising AVC.

wd. be if AVC were const., then SAC wd. follow down LAC // ATC, over some ΔQ. But this wd. mean cd. -ΔTC and not -ΔQ. This remains ultimate argument.

Easiest expository tool for this is ave. value of revenue curve.



Extend line until reach lot where LAC just touches ave. value of revenue. At this point LR MC crosses demand? Yes, bec tangency of LAC & AV of R.

Now we are in Δg costs w. VC, so P = SMC helps cover FC. Is this good dec. cost doctrine? SMC don't cover all FC, but part of FC.

[Note that prices which decline w. quantity --- quantity discounts --- in s.r. are perverse. Bec. sr mc are rising. If you want to put full FC on landholder can do so, then let rates vary along MC curve.]

If in sr your mc just covered yr. avc, then fixed resource has value = 0. ~~and is no reason to expand it, even if decreasing~~ Nothing remains to impute to FC? Yes, something: C.S. With simple single prices, Fixed Res. wd. have no value to seller, however. And at mgn. wd. have no value to anyone. I.e. even if you cd. enlarge it free, you wdn't?

If avc are flat, it means if we held VC fixed and ~~[illegible]~~ alter the mix by ΔFC, avc remain same. That means output hasn't changed. So MC from Δg FC is very hi or ∞, and not = SMC. AVC must be rising so when more left avc gets lower, meaning Δ output results from ΔFC.

To make land pay fc of extension, follow mc pricing to its ultimate conclusion & graduate rate? No, bec demand will vary above as well as below curve drawn, which is a mean demand.

So flat charge must be < [redacted] TC, and = c.s. Charge a flat price = MC, covering VC & part of FC.

Now let n pays full cost of service along pipe n, C_n.

Let 2 pays full cost along pipe 2, C_2. B will pay the difference, $C_n - C_2$, to get to C_2. and more, bec of foregone gain. This is not the financial cost; [redacted]

but does = cost from outlets 2 to n. Bec. costs from 0 to 2 are same bec we charge for all extensions at mgnl rate.

So specify price system before figuring rent. On inner lots, & all lots, know demand, then build for L MC = price. But figure all MC at the outer ring of the pipe. This matters -- at inner ring they wd. all be higher, you wd. build less.

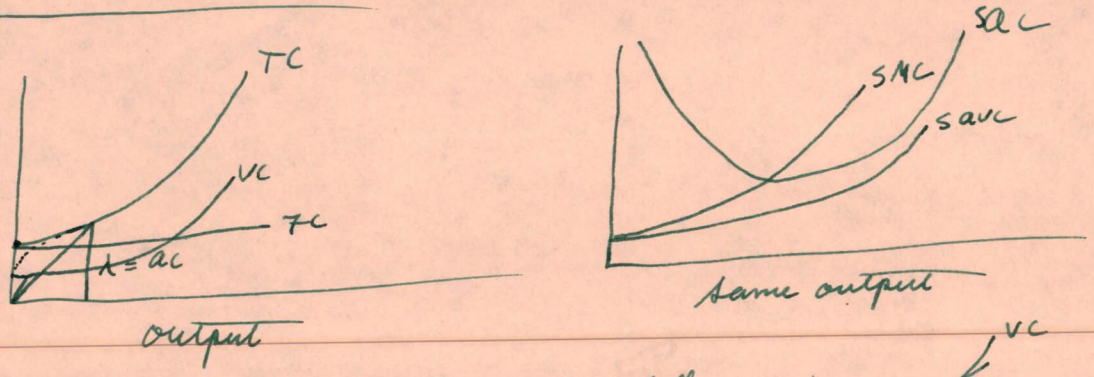
There wd. remain some unallocated TC, now, from center rings. But plenty of surplus -- all of which we've given to consumers.

Pricing, distrib. net.

Adm. of net must regard lands as perthy his. He ests. demand from best user, puts capac. accordingly. Rent charge then reserves that land for that user.

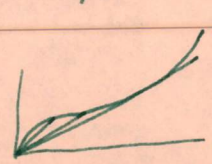
Do not size for present occupant, but best.

In s.r., is customary to think min. possible output is where $p = avc$. But w. land tax can collect c.s. to help comm avc, go to lower mc, until ave. value = avc.

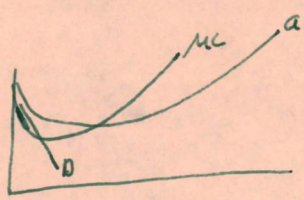


?

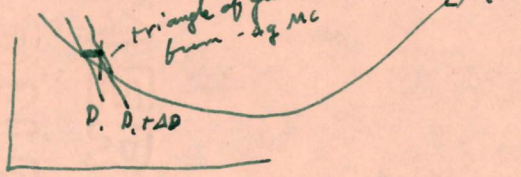
Maybe MC never do fall? No, probly do fall.



avc fall, then rise. Even if begin from zero.



? No, gain is from drop of MC curves, shift down.



(1) & (2) are two ways of expressing same thing.
to cost of traversing b w. 4 ply = cost of one ply part c, d, e, & f.

Does this imply constant costs? Or what?

No, just that you get same result adding four plies that run the gamut from 1 to 4 whether you add all of them ~~between~~ traversing b, or spread them out over c - #4
d - 3
e - 2
f - 1

to cost imposed on locations c-f = cost of traversing b
This entire cost will fall on B at f, if pvt. = social costs. B will ∴ demand a rent = to extra costs imposed.

Above presumes that costs are the same along the line, so cost of traversing b, [redacted] (γ_t^b), ≠ cost of extra sf cap. from c-f. Still ok. Really we are not adding ~~cost~~ γ_t^b. Had to traverse b anyway. Are adding capac. c-f. and that is what B will demand as rent on b, to move to f.

Thus demonstrate function of rent, economizing on xpstn cost.

The lateral expansion of ~~the~~ A is similarly constrained. if there are served lands behind, and laterals to serve them ... a grid.

Summary of pipeline pricing problem, to use in MS at III-13

Plots homog. in all respects but one: wtr.

Regard ea. plot tied to source by individ. pipeline.

This is simpler, obviously costs more to pump farther. First assume Δg cost, $p = MC$ cover FC, no flat charges. Then LR,

Assume full ~~[illegible]~~ xpt. costs are charged to customers. combo. of rate = lrmc + fixed charge to collect c.s.

Rent ~~tells us~~ needed to tell us how far to extend. Bcs decr. cost. Do not confuse w. Δg cost of extending

Costs imposed on others summed up in one, bumped to end of line where all benefits swallowed by costs. Same as shifting all users one lot out. Roughly = transversal costs. (over)

Costs on that one are cost of extending pipe, + resultant "excess burden" due to reduced use at higher rate. This cost is = to ~~higher~~ rent on 2, & is what he will pay.

Rent tells us what costs are imposed (extra costs aren't enough).

Rent blocks all uses that don't pay those extra costs.

Lot 2 imposes 2 FC: the line to serve it; & line to bumped ones beyond it. Former charged by system: latter as rent.

— —

New & unfinished material

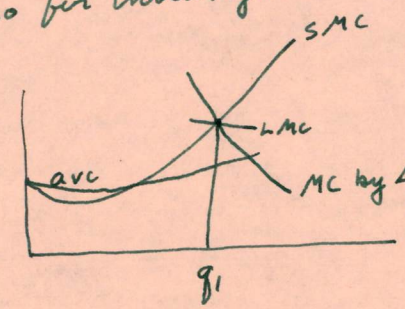
On mgnl lot, ~~y~~ system takes a slight risk. (This is all one way — landowner has option of using, getting full benefit.) Might charge this as a cost, thus Δg cost curves & restraining extensions. Other hand, mgnl extension is gain to inner system by lowering mc of capac. This lowers lrmc of capac, permits lower capac. charges. These $-\Delta p$ are just redistributive, but permit net gains from ΔQ on inner lots. Esply ~~on~~ n-1 lot, where lrmc fall much. This assumes not just $-\Delta g$ AC, but $-\Delta g$ MC. Ecs. of MC pricing in this stage have never been explored, by the mgnl customer seems to offer multiple gains all around, here. Wd. warrant prices even below MC probly. [But is uncommon & unlikely enough to skip here?] Wd. apply esply to last lot, & probly a subsidy shd be offered there equal to the triangle of gain inside. This wd.

Cost of ~~cost~~ one unit capac. part × frontages ≅ cost of carrying × units capac. part one frontage. Differs bcs conditions not homogeneous, e.g. steeper slope

Summary 2

lower charges there, in those situations when system MC in aggreg. falling.
Amazing! Super scalees!

Outside possibility to explore some day: maybe avc = MC for mgnl lot, even tho for intra mgnl ones MC > avc (when sMC = lMC).



On mgnl. lot, MC × P doesn't cover TC, but covers more than VC. So fixed charge wd. cover less than TC. But it wd. be possible to Δ fixed charge to cover time-for costs, and serve water free until the point necy to make Q × P cover VC. This is probly a good idea. (Anyway, wd. be in practice building ahead of peak demand, so cd. charge all at first.)

On mgnl lot, system collects entire rent. On inner lots, ac & MC are lower, so p = mc leaves more rent, & from this larger rent a smaller fixed charge need be collected, to meet TC not covered by price. If system just meets its costs, system gets no producer surplus from this. (Producer surplus comes when have Δg ac). In fact it runs a deficit bec cannot allocate its supramgnl TC to anyone, must spread that around as a fixed charge somehow -- just how is future problem.

Terminology: supramgnl costs or products of labor, vs. submgnl.
But w. land, intra mgnl vs. extra mgnl.

Summary

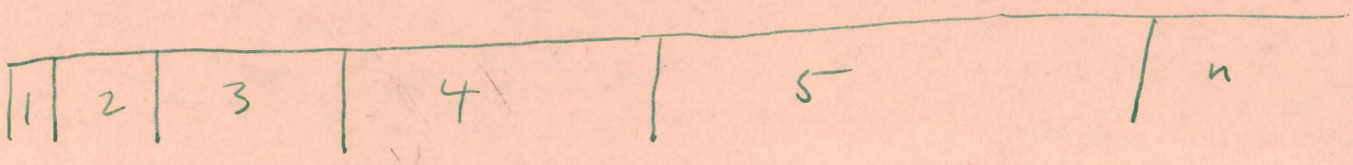
Existence of a distrib net implies existence of system rent from same outside source or cause. Res intra mgnl lots get better service than mgnl, & mgnl. just pay.

This system rent cd. be called value of franchise, & a flat rate charged by grantor of franchise to grantee to ensure his diligent improvement of his opps.

Mgnl lot is where LAC tang. to Ave Value of Rev.

Exposition. Meaning of rent depends on how well pvt. xpt. costs mirror social costs. First assume xpt costs are correctly figured & allocated. Give outlines but not details, & do not defend system here.

C_n is cost of serving lot n. 1st approxm. to rent on 2 is $C_n - C_2$. Charge all lots at mgnl ~~cost~~ ring cost, so $C_n - C_2 = C_{(n-2)} \equiv$ cost of service from 2 to n.



A shop with lower turnover, but higher %, might afford a better site. But most ec. for store to which most pedestrians travelled best located, avoid most travelling.

But hi markup low turnover shop won't nec. take the best site, just bec it could. Probly take lower rent site, save more on rent than lose on custom.

Real distrc. wd come, tho, where low turnover keeps good site to keep its few rich customers

over

saves their time, & it is valuable, ok. But pvt incentives just make the cfson of time, &c. pvt costs, but not cost of using free public space. Whereas mass consumers time may be worth less, they use as much public space as rich.

Therefore downtown sites shd be allocated by gross turnover, not net rent.

Or, devise means whereby people pay for using streets space, but that is very hard.

Problem of non homogeneous land.

If lot B is below par, traversal costs > social costs.

But social costs = traversal costs + that wd. be if outer land was same low carrying capacity as lot B.

✓ Note capacity, not "efficiency", is relevant here.

If lot B above par, social costs > traversal costs.

~~Since~~ What about higher quality due to central location itself?

No, that is already accounted for by dealing w. higher xpt costs further out. But how about higher quality due to other utilities being cheaper? That isn't accounted for in water rates.

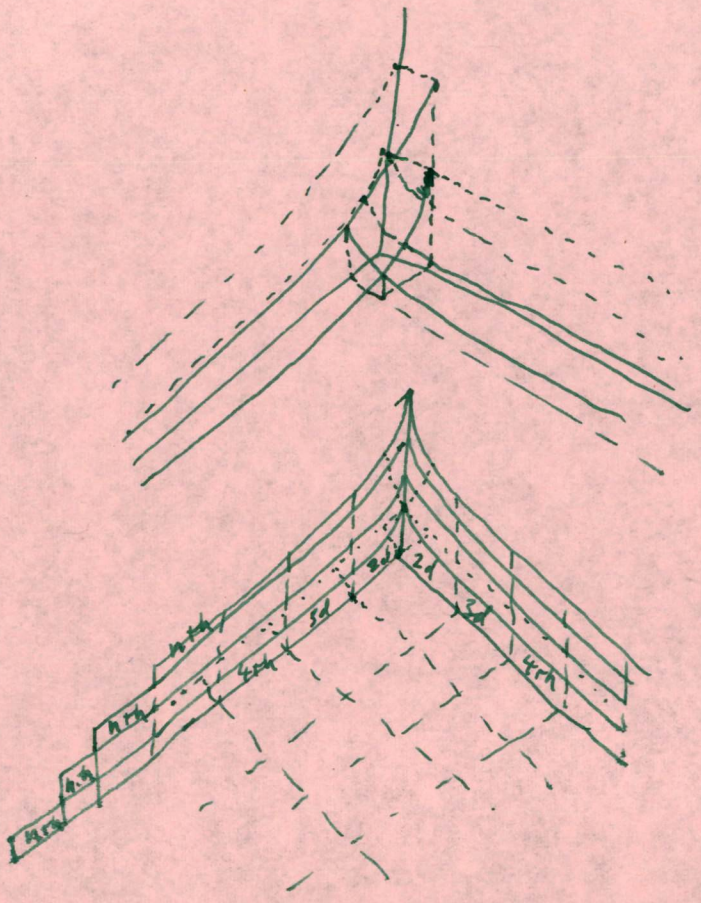
In gen'l, then, social costs > traversal costs bec central land better, in ways unrelated to water.

There are many angles to explore here in July.

1. Suppose employing all d.p.s. from B meant using more land at N. a, further out, and w/ reducing wtr used in toto.
   b, In 2d dimension w/o Δl xpt costs
2. Is demand more elastic at mgn bec land goes out of use at higher price?
3. Are social costs magnified much beyond loss of rent
4. How make perfectly gen'l?
5. Shd. I assume all dps go to N and just use less water on same area? If so, makes no difference how many or how few resources are employed in B?

For now, stick w. simple assumptions! Homog. lots.

Add in all angles of Δd cost:
1. a's Δl internal costs
2. B's Δl internal costs bec needs more land
3. Δl costs bec central lots better.



Extension costs will climb down face of pyramid. Along either axis ok, bes pyramid built on assumption of simul expansion in both directions. (Alternately might try expand'g along optimal path, i.e. as you wd. if each step was the last)

Transversal costs will comprise a layer of pyramid. Exceed extension costs. But will = cs, bes cells of comparable positions are =.

To cannibalize

"Cost of traversing B tends roughly = cost of reaching mgn from B with supply for dps."
~~It can be shown that cost~~

After this hasty summary of the ~~reasoning~~ rent-rationale, let us ~~look~~ reinforce the conclusion by ~~look~~ specifying more exactly the ~~cost~~ losses imposed on B, and their ~~equation~~ relation to social costs. Will also serve as basis for later analysis of xpt costs & opt. pricing.

Water previously pumped to B's turnout, b, must now be pumped four more lengths, to n. Likewise the WD must supply four more lengths of line capac., ~~must~~ from b to n. (Service at b having bn. discontinued, no Δl capac. needed below b)

As a 1st approx this is same as tho orig. pipeline had bn broken at a and the rt. side shifted bodily one ~~of~~ length to the rt. The B frontage wd. be filled in w. 4-capacity pipe. (~~to~~ p. 16)

Etc. Might save all this until discuss xptn costs.? No, it really is needed here, to clarify. "All this" is a, Cost is pump'g + extra capac; b, 4 lengths of one capac. = one length of 4 capacs. c, Extra losses, dim'g rets., lose c.s. d, Loss of cs = extra traversal costs, so traversal costs actually are more accurate index of what rent shd be than are extension costs.

Note how this implies accurate pricing & differential charging. Of all xpt. costs, not just variable. Note ~~implication~~ double damage from free xptn: waste given res: but also expand land use, necessitate further extensions

~~Mention cost to A, extra xpt inside firm)~~

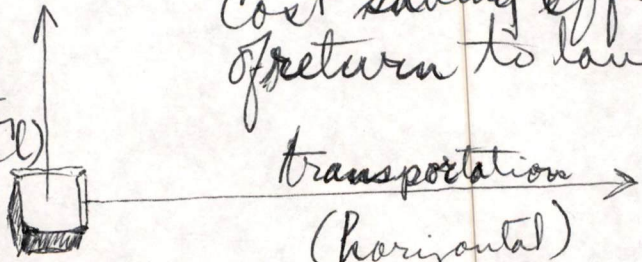
Skip (Another cost to B: he must occupy more land, bcs uses wtr less ~~wt~~ per acre. So requires extra length of pipe beyond n. But this is subsumed in loss of c.s. on N.)

Central mkt is often an captive mkt to be exploited.

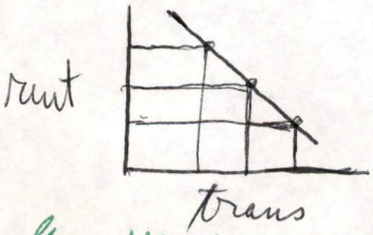
Mgnl mkts are more competitive.

Hyp can come from Hawtrey →

" Cost saving efficacy "
of return to land



about p 9



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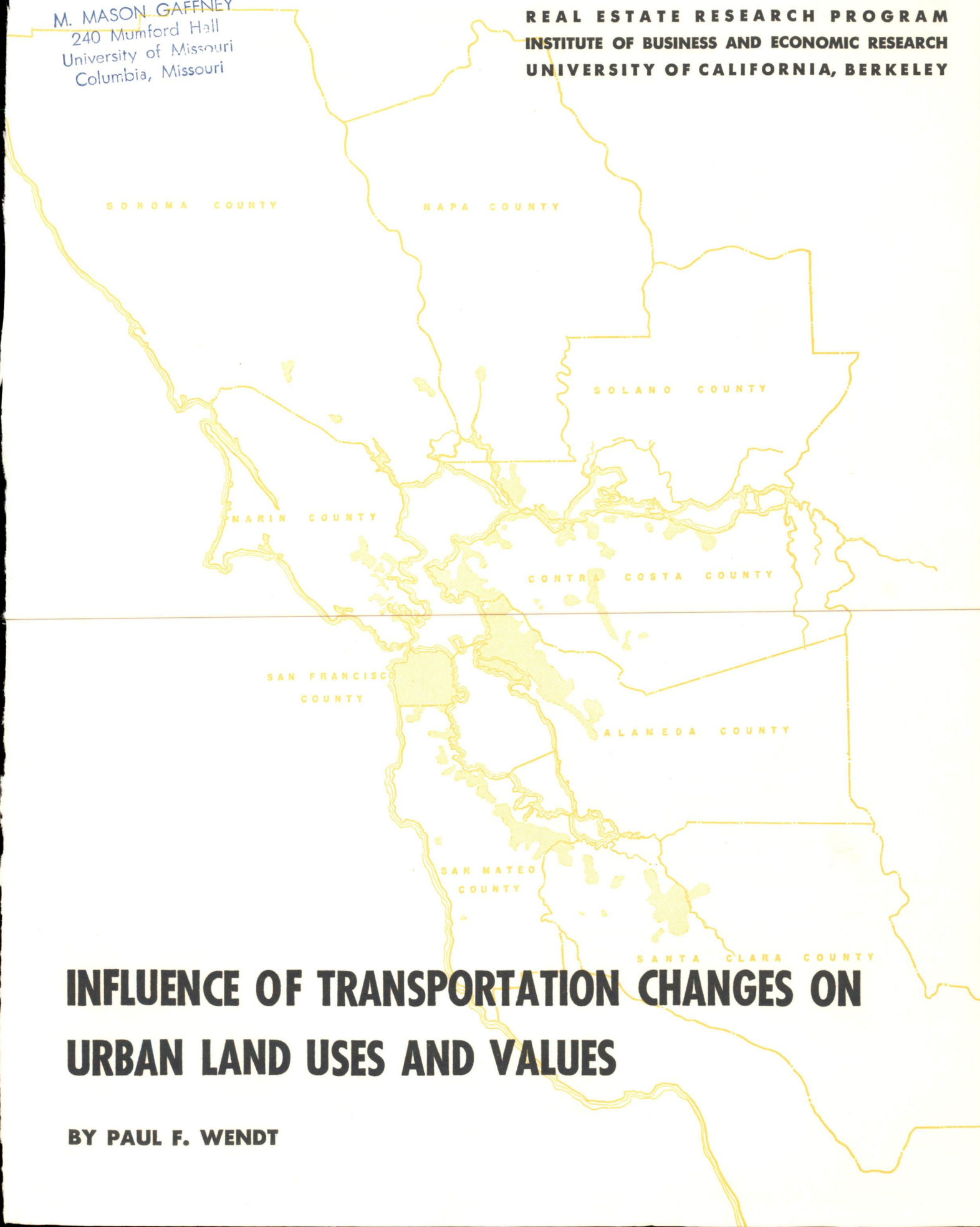

INFLUENCE OF TRANSPORTATION CHANGES ON URBAN LAND USES AND VALUES

BY PAUL F. WENDT

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INFLUENCE OF TRANSPORTATION CHANGES ON URBAN LAND USES AND VALUES

The revolution in transportation methods has been pointed to as the most significant factor affecting the structure and economic well-being of urban communities in the twentieth century. Meanwhile, little is known concerning the actual effects of changes in transportation on urban land uses and land values. Today, highway planners, appraisers, real estate brokers, local planning officials, and the general public ask, "What is the effect on land uses and land values of current programs of highway construction?" Highway right-of-way agents are interested in determining the influences of limited-access highways on adjacent land and the over-all impact of highways on land values. Appraisers are concerned with the impact of highway development on adjacent and nearby property. Real estate brokers and land developers seek to analyze highway impacts on land development and investment prospects. Metropolitan planning bodies must consider the probable influence of highway development as a basis for future master planning. City and county officials are concerned with the impact of highway development on property values which serve as the local tax base.

Although much research has been carried on in recent years by state highway authorities, universities, and others under the auspices of the Highway Research Board and other research groups, the problem of analysis is extremely complex and the results thus far permit only limited generalization.

The objectives of this paper are threefold:

1. To review and evaluate present theories of urban land values with particular reference to a recent exchange of views regarding the effects of transportation changes on land values.

2. To summarize the empirical evidence on urban land value trends.

3. To describe some new research approaches to the analysis of the influence of transportation on urban land uses and values.

Review and Evaluation of Present Theories of Urban Land Values

Economists are in general agreement that urban land values represent the present value of expected future net returns attributable to land (site rents). It is evident that the determination of urban land values in the market under this theory implies the capitalization of future expected urban land rents by investors, employing selected capitalization rates. This observation highlights the importance of the element of investor psychology and expectations as influences on the determination of land values in the market place.

The classical economic rent theory, which had its roots in Ricardo's rent theory based on differential fertility of soil, holds

that site rents result from superior accessibility advantages and that the owners of the relatively accessible sites will impose a rental charge equal to the saving in transportation costs which the use of their sites makes possible. Haig in his exposition of this theory, points out that general improvements in transportation or specific developments which make it easier or cheaper to get to or from the center of the city would decrease the relative accessibility advantages of central sites and hence reduce total urban site rents and land values.[1]

Haig's analytical framework and conclusions have been accepted by virtually all land economists. Based on this general theory, Dorau and Hinman argued that increasing the speed and decreasing the cost of transportation would result in an increase in the supply of urban sites by bringing more land into utilization. Thus, extending the city's boundaries by transportation improvements would increase the supply of sites, reduce the relative accessibility advantages of central locations and lower total land values.

From the same premises, Ratcliff argued that an increase in bus fares to the central city from the suburbs would tend to increase total urban land values and that, conversely, the improvement in transportation resulting from the spread in the use of the private automobile has tended to reduce land values in the central areas by making outlying retail centers more generally accessible.[2]

These and other analyses based on Haig's theory, failed to give adequate consideration to the highly important assumptions underlying Haig's theories. Further, in many cases, the distinction between the effect of transportation improvements on downtown commercial site values and total urban land values has not been explicit.

The implications of some of the conclusions which have been drawn for public transportation policy are surprising, if not alarming. If one accepts the conclusions which appear to have been drawn by Haig, Ely, and Ratcliff concerning the probable effect of transportation improvements on land values, without considering the limiting assumptions underlining their theories, any city desiring to preserve its land values as a tax base would oppose improvements in transportation.

Serious shortcomings can be observed in the attempts to apply classical price and rent theories to urban land valuation problems. The author has concluded that many accepted urban land valuation theories represent little more than unsubstantiated hypotheses and at best are abstract and theoretical formulations based on highly unrealistic assumptions.[3]

In an attempt to develop a more useful framework for analyzing urban land values, the author has classified the principal factors

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[1]Robert Murray Haig, Regional Survey of New York and Its Environs, Major Economic Factors in Metropolitan Growth and Arrangement, I (New York: Regional Plan Association of New York, 1927), 38-40.

[2]Richard U. Ratcliff, "Efficiency and the Location of Urban Activities," in The Metropolis in Modern Life, Robert Moore Fisher, ed. (New York: Doubleday, 1955), p. 129.

[3]Paul F. Wendt, "Theory of Urban Land Values," Land Economics, August 1957, p. 240.

influencing the aggregate of land values in a city. This theoretical reformulation of a theory of land values represents aggregate land values in a city as the present value of the expected future returns to urban land. A theoretical model of the factors influencing urban land value trends focuses attention on major determinants of urban land values in the following equation:

$$\text{Aggregate Value of Urban Land} = \frac{\text{Average Future Expected Aggregate Net Annual Urban Land Rent}}{\text{Capitalization Rate}}$$

It should be emphasized that, inasmuch as land values are based on investor's opinions which in turn are based on expectations, investor psychology is an important influence underlying urban land value trends. Three sets of factors are identified as influencing the value of urban land based on the foregoing conceptual model.

1. Factors influencing expected revenues to urban land: changes in population, consumer incomes, and total demand for urban services, competitive pull of other areas, supply of land, and prospective and actual investment in public improvements.

2. Factors influencing costs as an offset to urban land revenues: changes in local property taxes, operating and management expenses, interest on capital invested, and depreciation allowances.

3. Factors influencing the rate of capitalization applied in the real estate market to expected net returns from urban land: changes in interest rates, expectations of risk, and capital gains.

This analytical framework focuses attention on the complexity of factors influencing urban land value trends. Specifically, it draws attention to the fact that improvements in transportation to and from urban centers not only have the effect of adding to the supply of competitive land, but at the same time result in an increment to the population served and hence to the demand for urban land and its services.

Ratcliff argues that this approach "adds little to our understanding of urban land values."[4] He accuses the author of employing the "straw-man device" in his criticisms of urban land value theories and with missing "the obvious intent of Ely and Haig to state in hypothesis form a simple cause and effect relationship clearly restricted to a general tendency under limiting conditions." For reasons outlined in the following, Ratcliff's rejoinder cannot be accepted as invalidating the criticisms of classical theories as trite and unrealistic.

Specifically, the implicit assumptions in the theories of Ely, Haig, and Ratcliff that "other things remain the same" are not only unwarranted, but also illogical. Where A (a change in transportation) is associated with B (change in demand for urban land) and in C (change in supply of urban land), and where these influences have a combined effect on urban land values, one should not (even in theory) postulate changes in C without recognizing that changes will occur in B also. The unrealistic nature of Haig's theory becomes apparent when the implicit assumptions postulated in the phrase "other things remain the same" are made explicit, as in the following restatement:

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[4]Richard U. Ratcliff, "Commentary: On Wendt's Theory of Land Values," Land Economics, November 1957, pp. 360-62.

> Assuming that accessibility to the center of the city is the only criterion for both residential and business location, that all urban sites are substantially homogeneous, that total transportation costs are minimized by locating at the city's center, site rents and land values will tend to be highest in the center of the city.
>
> Under the above assumptions, general improvements in transportation might result in a decline in the value of sites in the center of the city, provided that they are not accompanied by an increase in travel to the area or any other increase in the demand for services of central area sites.

The assumption of ceteris paribus in the Haig analysis presupposes a "closed" urban area with constant population and incomes. However, it must also assume something about the relative elasticities of the demand and supply curves for transportation if an improvement in transportation is to result in a lowering of aggregate site values. If the effect of improving transportation is to increase the movement of people and the demand for urban services, it can be expected that even in a closed system such as that postulated by Haig, aggregate land values may rise with improved transportation. The relationships between transportation improvements and aggregate site rents under varying conditions of demand and supply elasticity can be conceived in the following manner.

The basic economic service provided in any city is the service of "getting you there." The place you want to go may be to your job, your church, shopping, or any of a great many objectives. This service may be called the "providing of trips" though it is understood that it is not the trip in itself which is wanted but rather what lies at the end of the trip.

Land and transportation are two factors of production which supply trips in the sense used here. If land is highly accessible little transportation is needed to "get you there."

If land is poorly accessible much transportation is needed. Haig refers to the cost of "getting you there" as the costs of "friction."

In Figure 1 the vertical axis represents either the price per trip which buyers would be willing to pay for different quantities of trips or the cost per trip at which suppliers would be willing to supply. The horizontal axis represents quantity demanded or supplied.

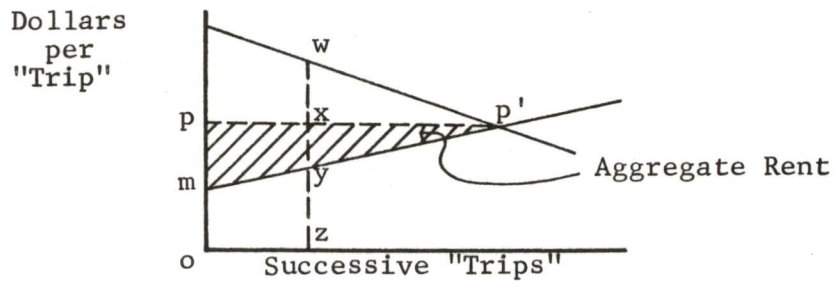

Figure 1.

The demand curve indicates that buyers are willing to buy more of the basic service provided the price per trip is reduced. This means that at lower prices they may not be so careful about ganging up working and shopping trips; they may make some trips which otherwise would be too long, etc.

The positively sloped supply curve, mp' represents the transportation charge for providing the quantities and kinds of trips demanded. It indicates that generally speaking, as the number and distance of trips are increased, the cost per trip increases. The basic assumption is that substantial increases in the number of trips are accompanied by increases in distance traveled per trip.

The market price and quantity are determined at point p'. At this point the value of the last trip demanded is just equal to the transportation cost in providing it. Then line p-p' is the price line for all units of the service.

The width of line wxyz represents one trip. For this particular trip the demand curve indicates that buyers are willing to pay the amount zw. Actually they only pay xyz, for that is the market price. But of the market price the cost of transportation is only zy--for this trip. The remainder, yx, is taken by land. Why does land take this residual? The land involved is so situated as to make possible the relatively low transportation cost zy. Then the rent to land is the whole area pp'm. This is aggregate rent.

Suppose the transportation system is improved. Line mp' becomes line m'p'''. The new price becomes op''. The new aggregate rent to land becomes p''p'''m' (Figure 2).

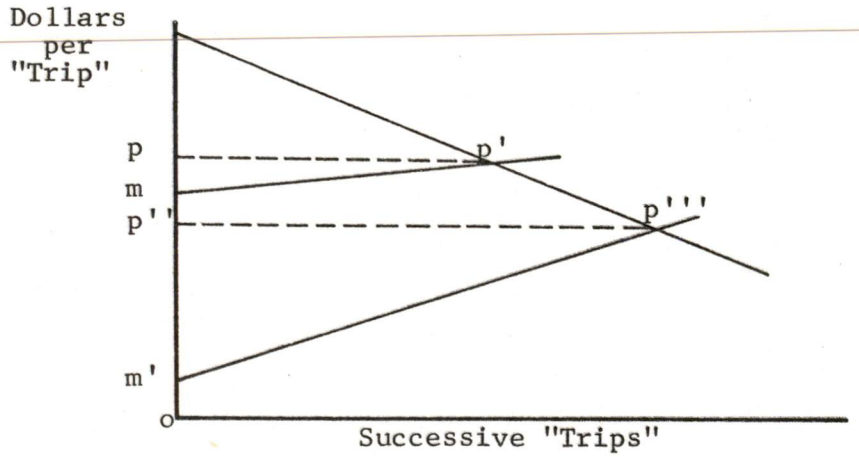

Figure 2.

The new rent to land may be either greater or less than before, depending on the elasticities of demand and supply.

The more inelastic the demand and the more elastic the supply becomes, the greater is the tendency toward a reduction in the aggregate rent to land as a result of an improvement in transportation as shown in Figure 3. The more elastic the demand and the more inelastic the supply becomes, the greater will be the tendency to an increase in the aggregate rent to land as a result of an improvement in transportation. This is illustrated in Figures 3 and 4.

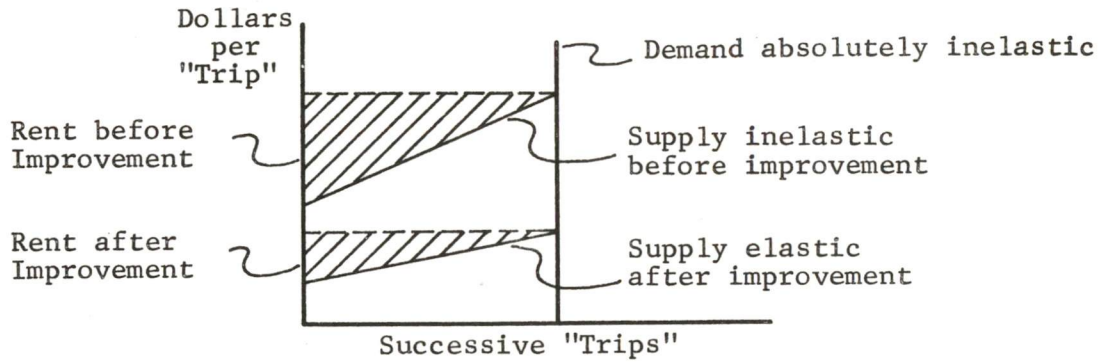

Figure 3.

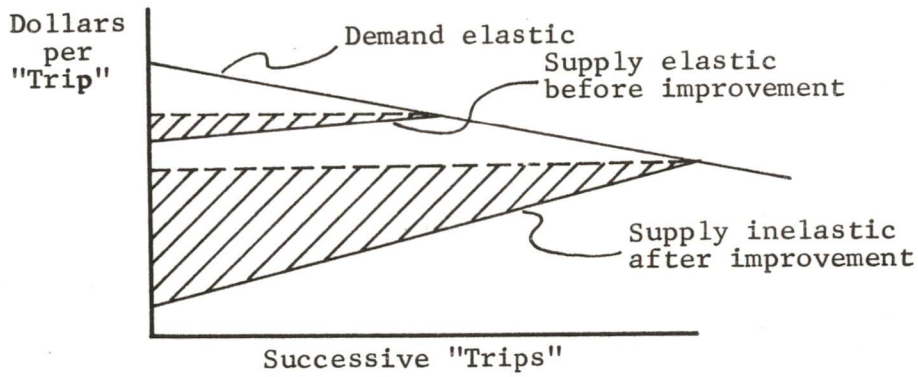

Figure 4.

Actually, relatively little is known at this time about the elasticities of the demand and supply curves for transportation. It is clear, however, that the conclusion that an inprovement in transportation will result in a decline in aggregate rents and hence in land values, represents a special case, and one that is unlikely to occur.

An absolutely inelastic demand curve for transportation to the center such as that postulated in Haig's theory is virtually inconceivable. Any improvement in transportation which increases travel by an existing population, or extends the boundaries of the area served by the center of the city, is certain to increase the number of trips by some amount, and this amount will be larger as the relative elasticity of the demand for transportation services is increased. The prospects of an upward shift in the demand for trips with any improvement in transportation are magnified by the fact that transportation improvements are usually made in response to an increased demand. Although the author is not prepared to present empirical evidence of the increases in travel to the center of American cities with the improvements in auto transportation facilities during the past decade, he is certain that transportation engineers will need little convincing that the price-elasticity of demand for trips may be high.

When these and other limitations of Haig's theory are carefully considered, it is apparent that one should not draw conclusions concerning the practical effect of a change in bus fares or of other transportation facilities on land values within the framework of his partial analysis.

The assumption that all urban sites are relatively homogeneous further vitiates the use of the classical analysis. In one sense, the supply of urban land is unlimited, inasmuch as virtually all cities can expand in some direction. In another sense it can be argued that urban sites are highly differentiated and that the urban land market is distinctive. Linkages between various types of activities which impede shifts in location are an important factor influencing differentiation of real estate markets. The effects on such markets of increments to supply are quite different than if land units were identical. Improvements in transportation must be viewed, therefore, in the light of their particular effect on various submarkets rather than on the urban land market as a whole. Freeway construction, for example, may result in major additions to the supply of residential land without increasing the supply of commercial or industrial land. Zoning, of course, and the tendency for complementary uses to be "linked" together contribute to site differentiation and to the compartmentalization of different segments of the real estate market.

The argument that the principles of monopolistic competitive pricing rather than pure competition pricing prevail in the urban land market has been misinterpreted by Ratcliff.[5] He fabricates his own "straw man" in attributing to the author the view that urban property owners have "monopoly" control over the supply of urban land. Because of this misinterpretation, most of his discussion has no bearing on the central argument that increments to the total supply of urban land may have limited effect on downtown commercial site values because of the highly differential character of urban sites and the existence of distinct submarkets.

The importance of the fact that the urban land supply is differentiated into various submarkets can be observed in Figure 5, which represents the supply of land with various accessibility advantages at three time intervals. The existing supply curve shows a relatively limited supply of sites with high accessibility features and hence high dollar values per acre. The supply of low-density residential land is, of course, much larger in amount and lower in value per acre. An improvement in transportation "A" (freeway construction), may result in a large increment to the supply of land suited to residential subdivision, but may not add appreciably to land suited to commercial and industrial uses. A different type of transportation improvement "B" may, however, add substantially to the supply of land with accessibility advantages suited to commercial use. Differences in the characteristics of land and in relative accessibility advantages contribute to the difficulty of generalizing concerning the effects of any given change in transportation on urban land values.

Although Ratcliff acknowledges the central premise that Haig, Ely, and others do not "set forth a comprehensive theory of urban land values" and that their analysis was "clearly restricted to a general tendency under limited conditions," he offers no explanation for the fact that he and others have employed such a restricted and noncomprehensive theory to draw conclusions regarding influences of transportation changes on land values that appear both illogical and indefensible.

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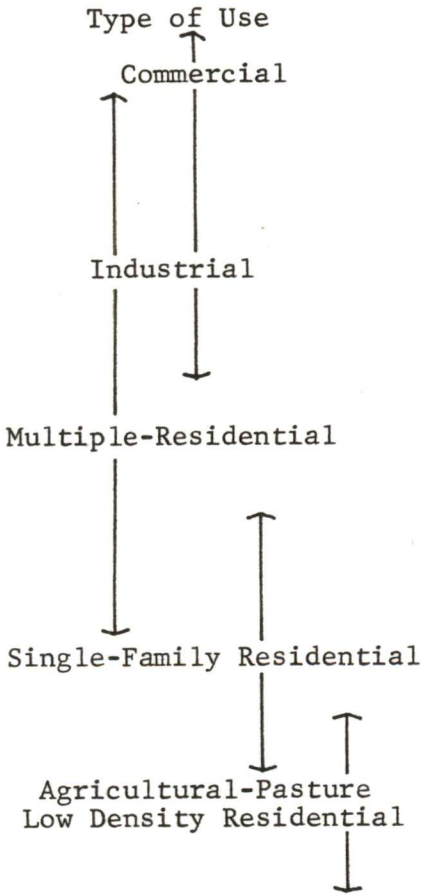
[5] Ibid., p. 362.



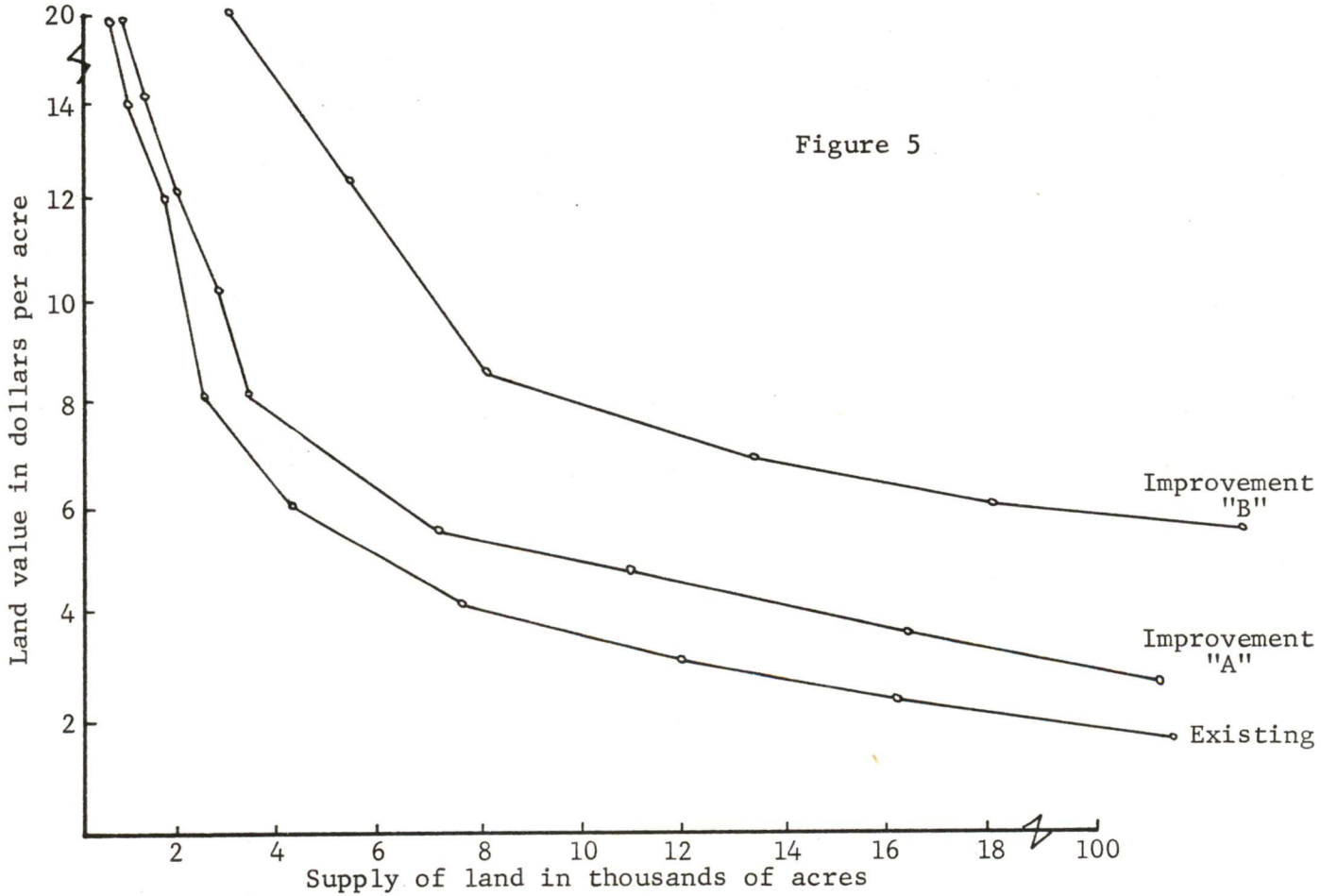


Figure 5

A - Improvement in transportation - expands supply residential land

B - Further improvement - commercial and multi-family uses Expand into outlying areas

Ratcliff's comment that "Professor Wendt is, of course, thinking in terms of the net effect (of transportation changes) which is quite another concept," is a partial recognition of the shortcomings in earlier analyses. It is indeed comforting to find that he agrees that "whether the total effect of all factors is a decline (in values) can be determined only by empirical methods." On this note of agreement, a review of the evidence concerning recent trends in urban land values follows.

Urban Land Value Trends

Well-organized data describing trends in urban land values in the United States are lacking. Any conclusions drawn, therefore, must rest on the pioneering work of Hurd and Hoyt during the period from 1900-1933, supplemented by more recent studies in a relatively few major cities. A limitation on interpretation of research results arises from the uneven quality of the basic data employed in various studies, because some rely on assessed values, whereas others are based on relatively small samples of market sales. Further difficulties arise from the fact that many of the existing studies are confined to land value trends in specific areas of cities, preventing descriptive analysis of changes in total values or of the internal structure of values within cities or metropolitan areas.

Notwithstanding these limitations, broad trends in urban land values can be described. Recent studies confirm the findings of Hurd and Hoyt that urban land values rose quite rapidly during the first quarter of the 20th century, culminating in a speculative peak in the late 1920's. Commercial land in the central business districts of the larger cities rose to particularly high levels during this period, although land speculation resulted in rapid increases in outlying commercial and residential land as well. Following a disastrous period of liquidation and foreclosures during the Great Depression, urban land values rose gradually in the prewar years, and more rapidly during and immediately following World War II, under the stimulus of high rates of urbanization and business prosperity.[6] By 1950, urban land values in the central business districts of some larger cities had recovered to the previous speculative peaks of the 1920's, although values appear to have risen more slowly in New York, Chicago, and a few other of the largest cities. Since 1950, land values in the central business districts of most large cities have risen further, accompanied by relatively high levels of commercial and office building activity. Rising local property taxes have constituted a "drag" on urban land values generally.[7]

Recent studies of urban land value trends in the San Francisco Bay Area revealed that total Bay Area urban land values have probably more than doubled since the peak of 1929-30.[8] The percentage increase in

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[6]Raymond W. Goldsmith, A Study of Saving in the United States, Vol. III, Part I (Princeton, N. J.: Princeton University Press, 1956), Tables W-1 and W-3.

[7]Paul F. Wendt, "Central City Property Values in San Francisco and Oakland," Parking as a Factor in Business, Special Report 11, Part 4 (Washington: Highway Research Board, 1953).

[8]----, "Urban Land Value Trends," The Appraisal Journal, April 1958; ----, "Economic Growth and Urban Land Values," ibid., July 1958.

land values was substantially greater in outlying commercial and residential areas than in the central areas of San Francisco or Oakland. Value increases during the postwar period were most striking, of course, in the newly developed commercial areas and shopping center locations. Although land values rose in both the central core and in the suburbs, striking differences in urban land value trends were noted within different parts of both central and outlying areas.

The dynamics of change in the structure of urban land values adds greatly to the difficulties of generalizations concerning trends. It is apparent that a general rise has occurred in the aggregate current dollar value of urban land values in the San Francisco Bay Area. Because of the more rapid rate of increase in land values in the outlying areas, the percentage of total increase in land values appears greater as the area included is increased in size.

Although these views cannot be supported with well-organized statistical data it is believed that distinctive trends can be observed in various Bay Area submarkets for urban land in the past decade. Rising values in the office building sections of the larger cities have been accompanied by lagging value trends for some downtown and string street retail store sites, and rapidly increasing values for newly developed retail areas. Meanwhile, booming values for sites suitable for high rent apartments or hotels have been countered by a relatively stable trend for other residential land within central areas. The impact of Federal subsidies for urban renewal programs has gradually been reflected in higher land values in selected slum areas. High rates of tract building in the suburbs have resulted in lot prices in many outlying areas equaling or exceeding those in more central locations. Little evidence can be found for a gradient of land values from the center to outlying areas in today's market.

These apparently diverse trends reflect in part imperfections in the real estate market apparatus, but to a degree they also support the view that urban sites are highly differentiated and enjoy narrow and specialized markets. Changes in the aggregate of urban land values in the Bay Area, therefore, cannot be identified as resulting from a total increment to supply, but rather from the totality of increments to both demand and supply for various sites having particularized accessibility and other advantages.

It is arguable whether a real rise has occurred in urban land values since 1939, after adjusting for changes in the value of the dollar. Because urban land values have risen more rapidly in outlying suburban areas, the conclusion reached might depend on the size of the geographical area included. There can be little doubt, for example, that total urban land values have risen substantially in constant dollars in the San Francisco Bay Area, in Los Angeles County, or in the New York Metropolitan Region over the peak level of the 1920's. It is probable, however, that the value trends in the City of San Francisco or New York would show a lesser increase, because values have risen more rapidly in outlying suburban locations.

The double peaks in land values reached in the 1920's and the 1950's adds to the difficulty of describing long-run trends in urban land values. The trend appears clearly upward if the researcher accepts the year 1900, 1940, or 1950 as a base, but the slope of the long-term trend line in urban land values is quite different if he uses the high levels of the 1920's as a base period.

Few systematic studies have been made of the relationship between transportation changes and land values. Research in the San Francisco Bay Area suggests that the influence of increments to the supply of urban land resulting from improvements in transportation are much more complex than assumed in classical economic analysis. Improved freeway transportation has undoubtedly been a factor influencing the more rapid rise in urban land values in outlying suburban areas. One might also conclude that the expansion in auto transportation has restricted the expansion in central city land values that would have occurred in the absence of extensive highway development. A decline in some central city functions can be observed. The results of the United States Census of Business for 1954 reveal, for example, that the percentage of total retail sales accounted for by cities with 100,000 or more inhabitants declined from approximately 43 percent in 1939 to 38 percent in 1954.[9] This observation, however, obscures the relatively large absolute increase which has taken place in retail sales in central cities, and takes no account of the expansion in administrative, financial, and tourist functions. It thus reflects the relative change in demand for only one type of urban service performed by central cities and may have been offset by an increasing dominance of the central city in the furnishing of many other types of business services.

The complex structure of urban land values and the constant shift in the internal structure of urban land values restricts generalization concerning value trends. One might be justified in concluding that the combined influence of improved transportation and other factors present during the postwar decade has been to result in a major expansion of urban areas, an increase in the demand for all urban services and a rise in land values in the central business districts, central cities as a whole, and in outlying residential and business locations.

Increases in aggregate urban land values in the San Francisco Bay Area during a period of rapid expansion in urban facilities for auto transportation suggest that any declining value influences resulting from the increase in supply of competitive urban land have been more than offset by expanded demand for urban land and its services. This observed trend would appear to confirm the earlier hypotheses that increments to the supply of urban land are usually accompanied by concomitant demand increments. In some sense, it can even be argued that increases in demand appear to bring about the increases in supply, rather than to follow.

Lessinger, of the Real Estate Research Program, is developing a comprehensive methodology to forecast the impact of highways on urban land use and values. Certain aspects of the method are in process of being tested in the nine-county San Francisco metropolitan area. The following brief account of the tentative method is necessarily oversimplified. There are eight essential points, as follows:

1. An economic concept of the metropolitan area is adopted to provide a land market within which highway impacts are considered.

2. Land use impacts are put in terms of different "rates of urbanization." The rate of urbanization is the number of acres urbanized over a period per 100 acres which are suitable and available for urbanization. The rate of residential urbanization is correspondingly the number of acres converted to residential use over a period

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[9] P. D. Converse, H. W. Huegy, and R. V. Mitchell, The Elements of Marketing (New York: Prentice-Hall, 1958), p. 307.

per 100 acres which are suitable and available. Likewise there are commercial and industrial rates. Different degrees of intensity in each use may also be identified as a basis for determining "rates."

3. Sectors are defined within metropolitan areas on the basis of different rates of urbanization. Suppose an entire metropolitan area is divided up by a grid of very small rectangles. Suppose the rate of residential urbanization is observed for each rectangle. The different rates can be visualized as different "heights" on a relief map. Presumably there will be a series of "hills" and "mountains" formed. These can be represented by a topographic map showing contour intervals. The contiguous area within any two contour intervals is defined as a sector. It is a residential sector if the rates are residential rates. It may be any other type of sector depending on the nature of the rates. Of course a map of residential sectors will be very different from a map of industrial sectors. It should be noted that the sectors are not fixed, but constantly shift in response to a large number of factors.

4. Factors explaining the boundaries of sectors can be organized into four groups: supply of and demand for accessibility, supply of and demand for base-productivity. Accessibility refers broadly to ease of making round trips from a site to other sites. Base-productivity refers to the ease of producing goods and services at a site. Buildings, views, drainage, and zoning are examples of base-productivity attributes. These illustrate the nonhomogeneity of sites. Incidentally, Lessinger's approach argues against the too inclusive preoccupation with the accessibility factor. In practice it is likely that there are large research benefits from the relative expansion of attention to the base-productivity variables.

5. In contrast to earlier theories, accessibility is identified as a cost schedule to reach wider and wider groupings of jobs, shopping services, and other potentially desired opportunities.

6. A study is carried out to determine for a particular metropolitan area how different accessibilities and base-productivities are associated with the various sectors. Two kinds of products are obtained from this study:

a. Combinations of accessibility and base-productivity are derived which belong to different sectors.

b. Projected sectors can be put in an array as to superiority or inferiority for each set of uses.

This kind of study is being carried out in the San Francisco area for residential sectors. The nine counties facing the San Francisco Bay are divided into a grid of more than 35,000 rectangles. Random points are projected within relevant rectangles, and over 25 types of information are compiled for each. This information bears either on the rate of urbanization or on accessibility or base-productivity.

7. An empirical law of distribution of land uses among the sectors tends to hold. This law is in the following form: the best 10 percent of all the land in the metropolitan area (as determined by the empirical work already described), will obtain x percent of the total acreage in the given land use. The best 20 percent will obtain y percent and so on. This is strictly comparable to the empirical laws of income and wealth distribution in economics which are represented by "Lorenz curves." It is determined from data for a given period, and then assumed to change slowly enough so that it would tend to hold for future periods.

8. Finally, it is desired to project for some future time period, changes in land uses (and ultimately land values) which are due to changes in a highway system and other variables.

a. Estimate total urbanization of a given type; for example, residential, for the metropolitan area as a whole.

b. For every site calculate accessibility and base-productivity attributes, given the future highway system.

c. Future sector boundaries are determined. This depends on the future accessibility and base-productivity attributes, and the relationships between accessibility base-productivity and sectors determined for a past period.

d. The total estimated acreage of the land use is then distributed over the various sectors in accordance with the empirical law of distribution.

e. Futher periods may be projected by taking the results of initial periods as a feedback.

f. Further refinements may be added: totals may be determined simultaneously with distributions on all levels.

As a result of the methodology developed by Lessinger, the impacts of highways emerge as one facet in a closely connected web of factors. The answer emerges from the reconstruction of the total web of factors. Further impacts may then be sought within the sectors. There, physical proximity to highways and freeways may be most important in differentiating sites.

Acknowledgments

The author acknowledges the assistance of the Real Estate Research Program, Institute of Business and Economic Research, University of California, Berkeley. The comments of Jack Lessinger and A. H. Schaaf in reviewing early drafts of this paper were particularly helpful. Dr. Lessinger suggested the diagrammatic presentation of the influence of transportation changes on aggregate site rentals, as shown in Fugures 1-4.

PUBLICATIONS OF THE REAL ESTATE RESEARCH PROGRAM

RESEARCH REPORTS

4. *Control of Subdivisions in California,* by MARYBETH BRANAMAN. 1953.
7. *Industrial Relations in the Construction Industry,* by GORDON W. BERTRAM and SHERMAN J. MAISEL. 1955. Price $.50.
8. *Growth of the San Francisco Bay Area Urban Core,* by MARYBETH BRANAMAN. 1956. Price $1.75.
10. *The Suburbanization of Administrative Offices in the San Francisco Bay Area,* by DONALD L. FOLEY. 1957. Price $1.50.
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