How do we build, or envisage, our future cities??
My proposition: high capacity radial axes; dense development along these; support;

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CenSES, RA3, wp 3. Also: supporting World Bank project
One working title: Agglomeration and the Commute

Another: A Crowded City

A third: I vestlandsbyen skal kollektivtransporten langt ut.

A fourth: Scale economies: their role in sustainable urban development.
Svante Arrhenius, 1896, Climate change, tonight: CCS: +3°C, +/- 1,5°C
IPCC IV Assessment report: And the icesheets cometh. And Himalaya: soon flushed out in the Ganges, Darjeeling tea and all
IPCC 2014: Warmer deep oceans; Equally dreadful; even a lower lower(!) bound does not cheer us up.

Not a bit.
Michael Hanemann:
2014:
Colder *and* warmer:
You cannot cheer me up with averages!
Kyle and El Nino: the correlation across space, this depression just eats you up, doesn’t it
Christian;
My heart,
the term
Structure of benefits and risks
Scott: And we humans! If only catastrophe had been certain, then maybe we could have worked this out together
Edvard Munch. OK. I can use much of that stensil again. Slightly lighter color of the sky that night. Midpoint estimate of range shifted slightly. Bridge to the future the same.
My tack: along with Scott’s: say; we’re a bunch of humans facing this together. Then, what happens?
A Crowded City:
An agenda for research

Today, mankind is building her future cities. What would it mean to do it well? Sustainably, say?

Now: there are good reasons to think about cities as well-informed, efficient, forwardlooking entities.

So if we want to think about cities in any other way; why, and what would that be (our unified analytical framework).

Our focus will be: Is the city in any way, typically, failing to handle city-wide (‘city internal’) externalities?
Today’s poor city: A featureless plain?

- Similar buildings everywhere
- Small streets everywhere
- People live and work everywhere
- Little evidence of
  - Land value gradient
  - Density gradient
  - Heterogeneity between neighborhoods
  - Specialization, concentration by trade
  - Agglomeration
  - Anyone going far everyday
Today’s poor city: Overly crowded?

• Nobody travels far everyday

• You live near to where you want to go, otherwise you cannot get there

• This – travel constraints – limits the value of any place that would have value: not many can get there, still: much is burned in travel (time)

• This – travel constraints – also limits agglomeration and the benefits thereof
Counterintuitive:

• If travel and sprawl has negative externalities (pollution, ghg, congestion); could there be too little of travel and too much of sprawl (too low densities)

• If intervention is to facilitate mobility, then
  – How, and
  – What underpins it, in welfare terms, as rationale for intervention, and
  – Can it be acceptable in terms of pollution and emissions, or even reducing these?
Model: Key elements

Objective of household:

- \( u = u(z,s) \)
  - \( s \): space (or land requirement), with more income, you want more space;
  - \( z \): other goods and services (with more income, you want more of this, too)

- Budget constraint: \( R(r)s + z + c(r) = y \)
  - You spend on rent, \( R(r)s \) (\( r \) is distance from CBD), other goods and services, and transport, \( c(r) \)
The textbook idea of a monocentric city
Rent, density

Key idea: you live with a tradeoff between high rent and where you want to be live

Rent offered in the market per sq m
Rural fringe

CBD
Distance from CBD
The tradeoff between livable places

Rent

Muth’s condition: $\frac{\partial R}{\partial r} S = \frac{\partial c}{\partial r}$

Identical households: same utility: farther out you have more space, but less income for other stuff, after transportation costs

Rent slope: $\frac{\partial R}{\partial r}$

Rural fringe

CBD

Distance from CBD
Trad: *expand* transport capacity, i.e. higher mobility

Trad. Model: city has a given ‘value’
Higher mobility flattens slope of bid-rent curve. Land values increase in much of city, especially periphery, but not centrally.

Rent slope: $\frac{\partial R}{\partial r} (c_t)$

Rural fringe: shifts outwards
A ‘crowded city’: investment in high capacity radial transportation axis

A ‘crowded city’ hypotheses: high capacity transportation axes lacking. Under agglomeration potential, even density lacking.
Agglomeration: When shoemakers Audun and Gunnar locate near each other, they become more *productive*.

My expansion: Also for households: with similar needs, better and cheaper (schools, water, sanitation, good life)
The case of agglomeration benefits, or ‘endogenous city value’

Rent

Higher mobility under endogenous city value: rent curve shifts outward, slope effect unknown (if agglomeration is in CBD)
Add ‘congestion’ and ‘emissions’ and ‘agglomeration’

Expanded Muth’s condition:

\[-\frac{\partial R}{\partial r} s = \frac{\partial c}{\partial r} + t_{cr} + t_{er} + S_{ar}\]

Household confronted also with location dependent internalizing fees for congestion $t_{cr}$ and for emissions, $t_{er}$.

(Of course, in a slightly more general (and practical) model, fees apply to travel and emissions, not to location of residence).
Emission tax on gasoline, \( ex \)

A travel related tax, for emissions, is in practice better attached to fuels, like gasoline, than residential location:

\[
t_{eg} = N \frac{-u_{el}}{u_z} \frac{\partial e_l}{\partial x_g} + 7bn \frac{\text{social cost of carbon}}{\text{capita}} \cdot \frac{\partial e_{GWP}}{\partial x_g}
\]

Where gasoline is taxed according to local benefits (Samuelson condition for optimal provision of pure public goods, city air quality, and global, equivalently.

(each element of which makes travel more costly: exceptions?)
Congestion and emissions

• If households have been charged ‘too little’, city is ‘too sprawled’, ‘too nondense’, ‘too mobility intensive’, isn’t it?

• In other words: when city introduces congestion charges and emission charges (or something to that effect), it raises transportation costs, steepens the rent gradient, and shrinks the city, doesn’t it?
Charging for congestion and emissions counterintuitive effects?

i. *Congestion* is itself *constraining* mobility; perhaps more than charges will???

ii. City may be ‘*underbuilt*’ with respect to mobility *capacity* (big roads, for instance)?

iii. Internalizing *emission costs*, in contrast, can only densify, reduce mobility, city size? Perhaps not even that! Are damages internal to city?

These are important questions in what follows
Increased mobility, less emissions?

That possibility lies in:

i. Congestion itself being *polluting*

ii. Higher mobility with *less polluting modes*; clean buses, for instance

(Apart from this, higher mobility (dense developments along high capacity transportation axes) is motivated by productivity and welfare arguments).
Von Thünen’s model of (agricultural) land use

Transportation costs and ‘land rent tolerance’ determines land use
Let us build a «Van Thünen model of the city»

- a center of interest (king, work, beer, goods, services: interaction)
- people pay, either to be near (rent) or through commute: time and other costs

‘Der Isolirte Staat, 1826.'
First: Can transport costs be more than proportional to distance from CBD?

This example: medium size vehicle: load factor falls farther out in the periphery, so costs per pkm rise (or alternatively: costs of filling vehicle rises with distance from ctr)

\[ c_{\text{minibus}, \text{pkm}}(d, p_e, s(d)) \]
Consequence; Scale economy in vehicle size ‘disappears’ farther out from CBD

Smaller vehicles towards periphery reduce the ‘convexity’, i.e. hold down the transportation costs in periphery

Costs per passenger km (pkm)

Walkers, bikers

CBD

Bus doughnut

Minibus zone

No service (or only cars)

Distance; declining density; s(d)

$c_{bus,pkm}(d, p_e, s(d))$

$c_{minibus,pkm}(d, p_e, s(d))$

$c_{car,pkm}(d, p_e, s(d))$
Price increase for emissions (or energy): greater role for larger vehicles; bus doughnut grows.

Travel costs more convex in distance from CBD.
A ‘von Thünen model of the commute’: scale economy in vehicle size

- Rural: no commute
- Periphery: car
- Dense urban and suburban: large vehicles
- CBD and beyond; walk, bicycle
Van Thünen’s model of the city

Basic results:
- concentric rings of *commuting technology*
- land rent high near town ctr; declining towards wilderness frontier
- mid-central land rents *raised* by congestion, *reduced* by transportation investments

=> all: scale economy in vehicle size
Scale economy in vehicle size: insights

• Since scale economy depends on density in demand, it is worth most fairly centrally (in the monocentric city)
• Scale economy creates ‘bus doughnut’: fairly near CBD you are well served by large vehicles (road, rail, boats)
• Scale economy coincides with emission economy and roadspace (congestion) economy. So ‘bus doughnut’ expands with pricing of environment and congestion.
Undercurrent in environmental and institutional economics:

• Humans, social animal, solve ‘near’ problems first: Local public goods; Ellinor Ostrom, for instance.

• Is road infrastructure in poor city a victim: we build small streets, but who wants big ones?
In other words:

• It takes political power, guts, capital, institutions, to make big roads (but not small ones);
• It takes political power, guts, institutions, to collect road user- and congestion charges, property taxes, easements;
• It takes public finances – or guts – to subsidize or prioritize lanes for public transport.

(so: not unthinkable this is underdone: crowded city)
Investing in high capacity radial axes:

Investments donate land values to periphery: ways to capture these: land sales, land leases, combined concessions, property taxes, road user charges

Von Thünen’s green city: the bus doughnut expands in starshaped fashion

Because its land use economy asks for high capacity axes
More theoretical developments: agglomeration and the commute on the plane $u = n^\alpha + n^\beta - cdn^\delta$

How do you divide the plane?
Et selskap i NHH miljøet
An agenda for intervention

Say we have a good idea of how cities can do better.

Should donors, have a support facility for medium size fastgrowing cities (say 100kpop to 1m; or half to one-and-half m)?

If so, what is supported, and how?

My main finding: agglomeration benefits are – in the established urban spatial model – worth a subsidy. This may weaken our instincts that transport shall not be expanded unless users are charged for congestion and local and global emission.

These agglomeration benefits may require high capacity efficient axes, exemplified by privileged bus lanes. Or rail, though the latter requires very high throughput.
Grateful for comments and questions:
Thanks!