Infrastructure, Accessibility and Agglomeration: Changing Views on the Role of Transport in the Urban Economy

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Introduction and motivation

- The role of transport in the urban economy has been the subject of much controversy
- Differences in treatment between urban economists and transport economists
- Urban economist's interest is in transport:
  - As a determinant of land use
  - As a determinant of urban growth and economic development
- Transport economist's interest is in:
  - Efficient use of urban transport infrastructure and cost of congestion
  - Appraisal of urban transport investment
- Past work by each group has frequently ignored contributions of others leading to a confused view of the interface between the transport system and the urban economy

Introduction and motivation

- The key to this is the evaluation of accessibility:
  - How transport users value time savings
  - Are user benefits an accurate measure of total economic benefits?
  - Should the possibility of any wider economic impacts be excluded because of the fear of double counting?
  - Or can they simply be captured by an arbitrary add on.
- Recent work has improved our understanding of the way in which accessibility
  - Affects the performance of firms,
  - The public sector
  - Labour markets.

Introduction and motivation

- However, the empirical evidence remains problematic
  - Endogeneity and causality questions
  - Conflicts between macro-and micro-based estimates
  - The interrelationship and spillovers between different areas
- This has policy implications:
  - Underinvestment in transport infrastructure could lead to
    - Lower growth
    - Congestion
  - Overinvestment could lead to
    - Problems for public budgets
    - Negative externalities associated with over expansion.

Outline

- Transport and the local economy
- Land rents and the urban land market
- The urban transport problem
- The agglomeration issue
- Looking for evidence:
  - Macro studies
  - Market studies
  - Micro studies
- Implications for appraisal
- Implications for policy

Transport and the local economy

- The multiple nature of transport
  - Transport as a derived demand
  - Transport as a substitutable input
  - Transport as an engine of growth
- Transport infrastructure and accessibility
  - External accessibility and the ‘two-way’ road
  - Internal accessibility and efficiency
- Accessibility, the cost of transport and economic efficiency
- User benefits and the wider economic benefits of transport

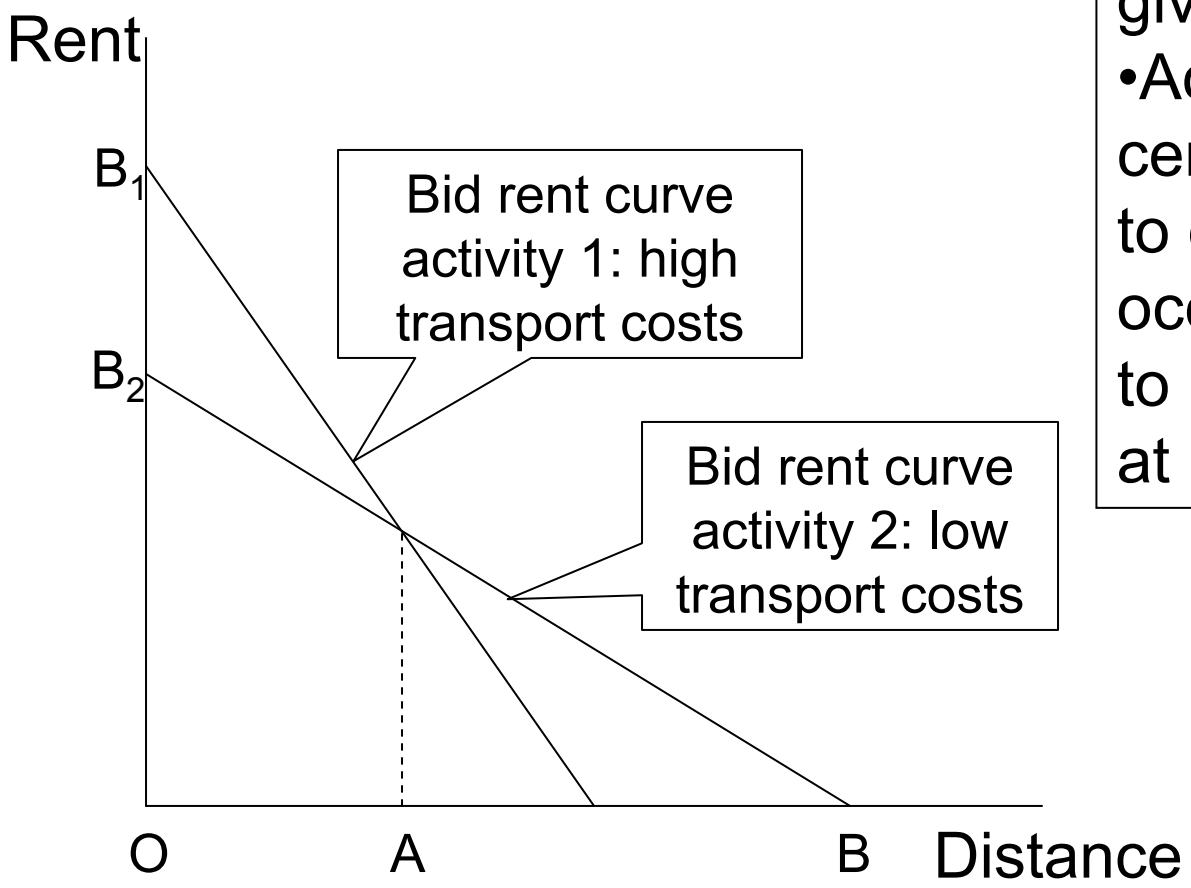
Accessibility as the key?

- Main role of transport is to provide access:
  - To markets
  - To jobs
- Transport as the cost of an urban location
  - Time savings will have a positive value
  - Location will be valued by its accessibility
  - Thus land rent (price of location) related to associated transport cost
- Hence the double counting issue:
  - Either measure cost of access or land rent but not both
  - But this assumes that all relevant markets are perfect such that price equals (social) marginal cost?
  - Can spatial markets ever satisfy the conditions?

Transport and land rents

- Traditional approach starts with perfect markets
- Based on adaptations of von Thünen's theory (1826)
  - How will land rents for different agricultural products vary within a market area and how will land be allocated between alternative uses?
  - Assume fixed market and free entry
  - At market centre firms will bid land rents up until they equal profits – i.e. pure economic rent to landowners
  - At locations away from market centre maximum bid-rent will be reduced by cost of transport to market centre
  - Produces equilibrium location for individual firm and equilibrium allocation of land between uses

von Thünen's theory



- Slope of bid-rent curve given by transport costs
- Activity 1 locates near to centre and occupies land to distance OA, activity 2 occupies remaining land to market area boundary at B

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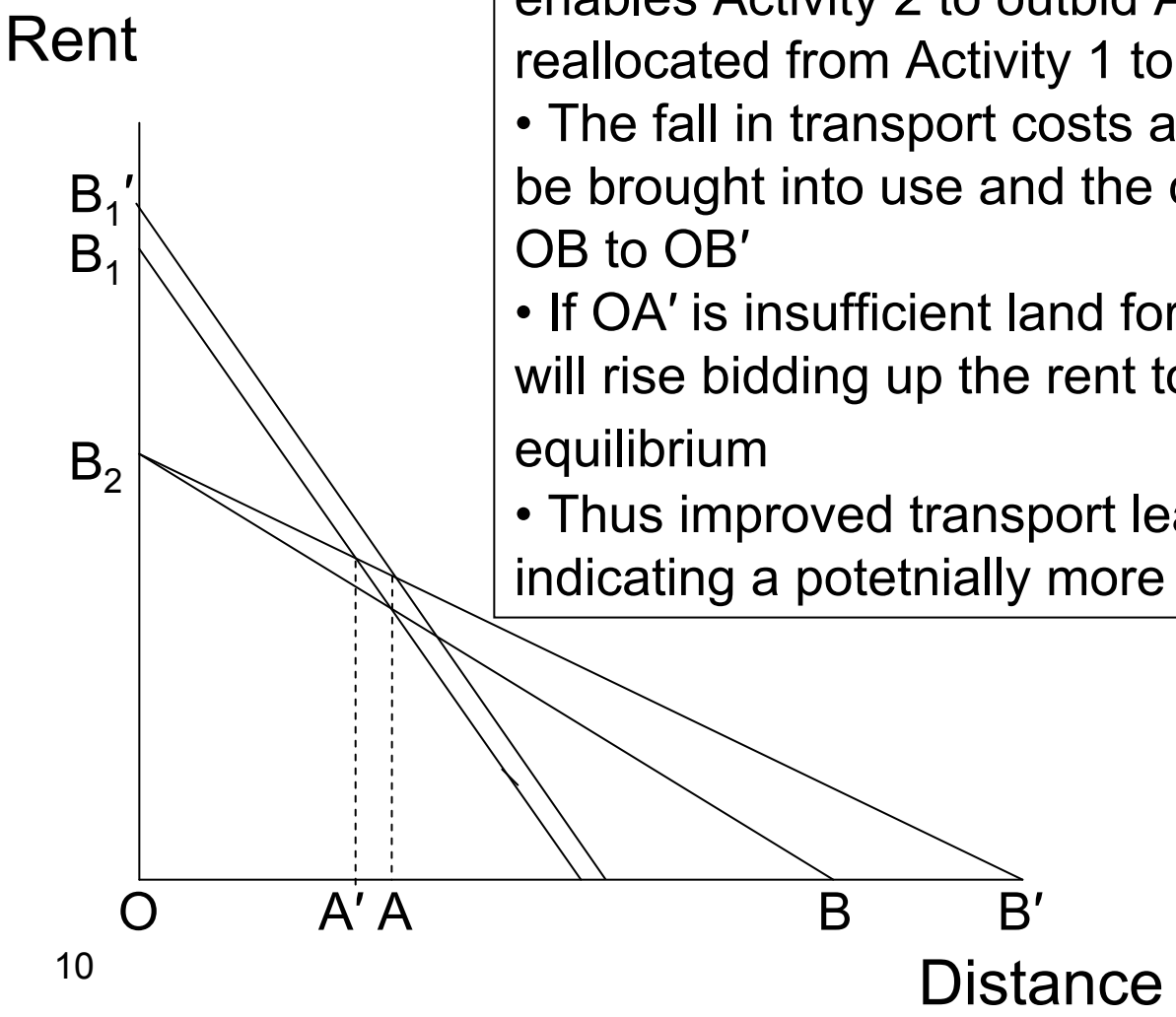
von Thünen's theory

- A fall in transport costs for Activity 2 from B_2B to B_2B' enables Activity 2 to outbid Activity 1 and land AA' is reallocated from Activity 1 to Activity 2.
- The fall in transport costs also enables more land to be brought into use and the city increases in size from OB to OB′
- If OA' is insufficient land for Activity 1 then its price will rise bidding up the rent to B_1' sufficiently to restore equilibrium
- Thus improved transport leads to higher rents indicating a potetnially more valuable city



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Transport and land rents

- Application to industry follows same basic principles but recognises need to combine markets in different locations (Weber 1909)
- Interest in urban application makes early links with land rent
- Translation to urban context best illustrated by Alonso (1964)
  - Assume monocentric city with all employment at CBD; transport costs given by distance from CBD
  - Enables trade-off between location (accessibility to employment etc) and lot-size (desire to spend more on housing with income)
  - But with urban land can develop density to compensate, hence need to consider role of land in production – offices in centre and industry further out, but note that poor often live in expensive centre and rich further out

Access-Space Trade-off Model

- Alonso model

  Maximise $U = U(x, s, d)$

  Subject to $Y = px + r_i s + t_i d$

  Where p, r_i, t_i are prices of goods, land and travel

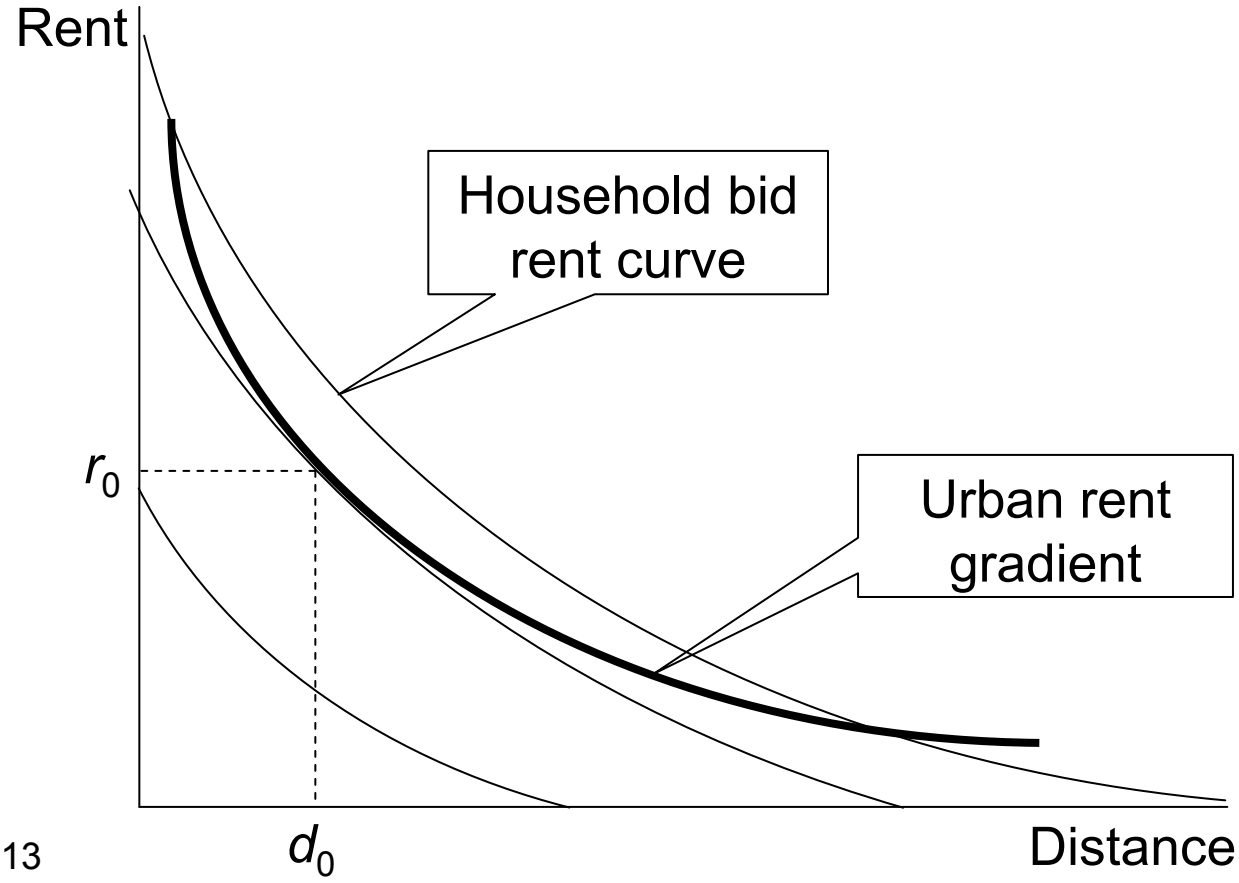
  $\Rightarrow$first order condition: $\frac{U_d}{U_x} = \frac{1}{p}\left[s.\frac{dr}{dd} + \frac{d(td)}{dd} \right]$

  This tells us that total land costs (rent x space) will decline at the rate at which commuting costs increase (NB since *s* is +ve and transport costs must increase with distance, *dr*/*dd* must be –ve to give conventional negative marginal rate of substitution)

- Such a view can be refined by a more thorough analysis of the time allocation decision of the individual (e.g. Evans, 1973)

Equilibrium of household

- At the optimum the household will equate its bid rent curve with the minimum rent which can be paid on the rent gradient
- Note that the urban rent gradient will be the envelope of the bid rent curves of all activities/household types



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Urban land market equilibrium

- The 'New Urban Economics' of the 1970s (Fujita, 1989) provides a complete model of land use in the city
- Aggregate all the demands for land at each distance *i* recognising that total supply of land is fixed for given size of city: $\sum s_i n_i = 2\pi i h_i$ where n_i is population at *i* and h_i is prop'n of land allocated to housing
- Assess if Σn_i (city population) can all be accommodated and total commuting needs e.g. do they give rise to congestion?
- And whether the growth of the city confers any advantages on activities located within it – economies of scale and agglomeration
- Note that NUE also provides an evaluation of the wider benefits of transport (the public good value as measured by aggregate land rents)

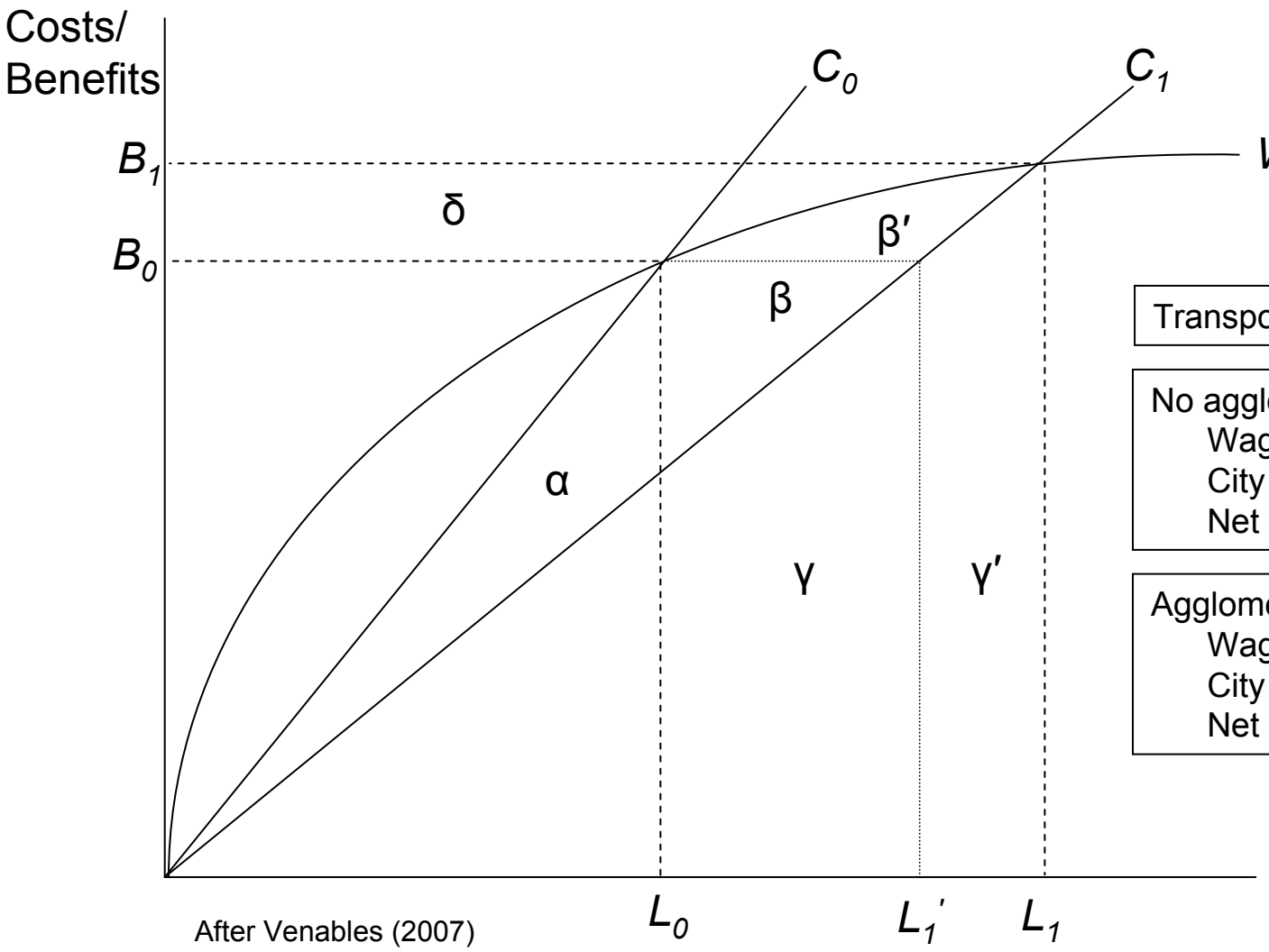
The urban transport problem

- The urban model needs to allocate land between transport and other uses
- In the monocentric city this provides a limit to city size as flows to the centre exceed capacity
- But the transport model tends to deal with maximising the efficient use of infrastructure for a fixed level of demand
- Congestion pricing ensures the allocation between different uses with different user values and indicates when capacity is inadequate
- But induced demand from expanding capacity (the variable trip matrix) often ignored
- This is a critical problem:
  - Bigger cities have more congestion – increased transport costs
  - But can also invest in more efficient transport systems – lower unit transport costs

The agglomeration issue

- 'New Economic Geography' provides the necessary linkages
  - Transport costs as determinant of the price of an urban location
  - And hence of the real wage
  - Thus going beyond the simple value of time savings as a transport benefit
- The theoretical basis of agglomeration
  - Increasing returns, transport costs and market size
  - Linkages in the local economy
  - The role of real wages in cumulative causation
- Is agglomeration universal and inevitable?
- Agglomeration benefits in labour markets
  - Changing participation rates
  - Increased working hours
  - Moves to more productive jobs - increased size of commuting area has impacts on productivity and wage differentials

City size and agglomeration benefits



After Venables (2007)

Transport costs fall C_0 to C_1

No agglomeration economies:
- Wage gap unchanged at B_0
- City size increases to L_1'
- Net Benefits = α+β

Agglomeration economies:
- Wage gap increases to B_1
- City size increases to L_1
- Net Benefits = α+(β+β′)+δ

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Refining the transport model

- Not sufficient simply to provide a linkage between the transport model and the urban model
- Traditional transport model based on Wardrop's principles of least cost assignment of traffic
- Generalised cost needs to allow for choice under charging and the possibility of competition within modes (including roads)
  - Horizontal and vertical competition
  - Parallel and serial links in a network
- Role of access, waiting and interchange times and parking

Looking for the evidence

- Theoretical explanations and numerical simulations demonstrate relevance, but useful application requires empirical evidence based on real data
- But such evidence is not straightforward and depends on:
  - The geographical scale of the empirical study
  - The unit of analysis
  - The ability to control for other factors which determine urban development
- Look at three levels and types of study
  - Those which only look at macro aggregates
  - Those which examine the working of individual markets
  - Those which look in detail at the behavioural responses of individual agents.

Evidence – macro studies

- The Aschauer legacy
  - The productivity of public infrastructure
  - Public infrastructure and the enhancement of the productivity of private infrastructure
  - Debunking crowding out
  - Excessive optimism
  - Geographic scale
- Econometric problems
  - Causality
  - Spatial autocorrelation and spatial spillovers
- What should we measure?
  - Output
  - Employment

Evidence – macro studies

- Alternatives to aggregate econometrics
  - Land Use Transport Interaction Models
    - Multiple markets with specific transport use
    - Based on static input-output relations
    - Need to allow for dynamic behavioural response
  - Computable General Equilibrium Models
    - Allow for whole network evaluation
    - More interaction between markets
    - Identify case specificity of results
    - Imply larger wider benefits/user benefits
- Ex post studies of impacts
  - Rare and less encouraging

Evidence – market studies

- Exploring detail of agglomeration models
- Competition effects
  - Ambiguity
  - Pro-competitive effects from lower transport costs
  - Limited by existence of imperfect competition and rent seeking
- Agglomeration effects
  - Localisation economies
  - Urbanisation economies
  - Productivity effects – elasticities typically 0.01 to 0.4 for industry but 0.2 or higher for services
  - Spatial scale variations
- Linkage effects
  - Labour markets

Estimates of agglomeration economies from production function analyses.

	Author	*unit of analysis*	*independent variable*	*elasticity*
1	Aaaberg (1973)	Swedish cities	city size (population)	0.02
2	Shefer (1973)	US MSAs	RTS at MSA aggregation	0.2
3	Sveikauskas (1975)	US MSAs	city size (population)	0.06
4	Kawashima (1975)	US MSAs	city size (population)	0.2
5	Fogarty and Garofalo (1978)	US MSAs	city size (population)	0.1
6	Moomaw (1981)	US MSAs	city size (population)	0.03
7	Moomaw (1983)	US MSAs	city size (population)	0.05
8	Moomaw (1985)	US MSAs	city size (population)	0.07
9	Nakamura (1985)	Japanese Cities	city size (population)	0.03^a
10	Tabuchi (1986)	Japanese Cities	city size (population)	0.04
11	Louri (1988)	Greek Regions	city size (population)	0.05
12	Sveikauskas et al. (1988)	US MSAs	city size (population)	0.01^b
13	Nakamura (1985)	Japanese Cities	industry size (employment)	0.05
14	Henderson (1986)	Brazilian Cities	industry size (employment)	0.11^c
15	Henderson (1986)	US MSAs	industry size (employment)	0.19^d
16	Henderson (2003)	US MSAs	industry size (no. of plants)	0.03^e
17	Ciccone and Hall (1996)	US States	employment density	0.06
18	Ciccone (2002)	EU regions	employment density	0.05
19	Rice et al. (2006)	GB NUTS 3	proximity / travel time	0.04

Notes:MSA - Metropolitan Statistical Area, a - mean value for 14 manufacturing industries, b - mean value from 5 model specifications, c - mean value for ten industries, d - mean value for 9 industries, e - mean value for 4 model specifications.

From Graham (2007)

Estimated elasticities of productivity with respect to agglomeration

industry	*elasticity*
Manufacturing	0.077
Construction	0.072
Distribution, hotels & catering	0.153
Trans, storage & communications	0.223
Real estate	0.192
IT	0.082
Banking, finance & insurance	0.237
Business services	0.224
Whole economy	0.119

From Graham (2007)

Evidence – micro studies

- Why micro studies – changes in behaviour and organisation
- Labour market effects
  - Accessibility and property prices
  - Jubilee Line impact (Gibbons and Machin)
    - Increase in values +9.3% in areas with new stations
    - 1km reduction in access led to 1.5% increase in values
- Business organisation
  - TGV effects and internal restructuring
  - Concentration to access to network rather than along network

Implications for appraisal

- From theoretical model to method of appraisal for individual projects.
  - Towards a more theoretically correct CBA recognising externalities and imperfect competition.
  - CGE models and scale of projects: link estimates and network effects
- Wider benefits include:
  - User benefits (journey time savings)
  - Productivity effects,
  - Agglomeration effects,
  - Competition effects
  - Labour market effects.
- Data requirements
  - Evidence at more detailed level then typical in CGE studies.
- A case study: the case for Crossrail
  - Evidence of agglomeration benefits
  - Public finance implications

Welfare and GDP impacts of Crossrail

Benefits	Welfare (£m)	GDP (£m)
Business time savings	4,847	4,847
Commuting time savings	4,152	
Leisure time savings	3,833	
Total transport user benefits - conventional appraisal	**12,832**	
Increase in labour force participation		872
People working longer		0
Move to more productive jobs		10,772
Agglomeration benefits	3,094	3,094
Increased competition	0	0
Imperfect competition	485	485
Exchequer consequences of increased GDP	3,580	
Additional to conventional appraisal	**7,159**	
Total (excluding financing, social and environmental costs and benefits)	**19,991**	**20,069**

Source: Department for Transport (2005)

Implications for policy

- Simple rules are dangerous
  - Investment in transport can damage your health
  - Failure to invest in transport can damage it too
- Appraisal rules need to be comprehensive but transparent
  - Decisions have to be robust
  - But clearly understood by all stakeholders
- Levels of decision making
  - Spillovers
  - Policy refraction in multi-level governments
  - Jurisdictional competition and over- or under-investment

Concluding remarks

- Full circle on wider benefits
  - From “transport is critical”
  - To “beware double counting”
  - To “wider benefits are the key”
- But beware all simple rules in transport appraisal
- There remains much on the research agenda
  - Imperfect competition and the productivity gains from transport
  - Micro-behavioural evidence
  - Link versus network effects
  - Spillovers and jurisdictional competition
  - More ex post studies, does transport investment really make the difference claimed?