Successes of LUTI modelling in UK planning

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Oregon Symposium 2005

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URBAN, REGIONAL AND TRANSPORT PLANNING

Objective of presentation

This presentation aims to show some of the ways in which land-use/transport interaction modelling is contributing to land-use and transport planning in the United Kingdom.

LUTI modelling in UK

A short history of LUTI modelling in UK:

- Lowry-influenced work from mid-60s to early 70s
- very little activity from then to mid-80s
- gradually increasing interest to mid-90s
- more and accelerating activity in last 10 years – probably more applied LUTI work in last 5 years than in whole previous history.

UK models by 5-year period

Present context

Current UK practice:

- transport planning is highly quantitative

- transport appraisal makes extensive use of formal cost-benefit analysis

- land-use planning uses unsophisticated models for projection of population change and housing demand, otherwise mostly qualitative.

We are trying to work across this divide!

Themes

Examples of LUTI modelling contributing to

- raising issues in planning

- helping to identify new policy and investment possibilities

- improving the analysis of the wider impacts of plans and schemes – confirming, moderating or correcting forecasts

- improving the appraisal of proposals.
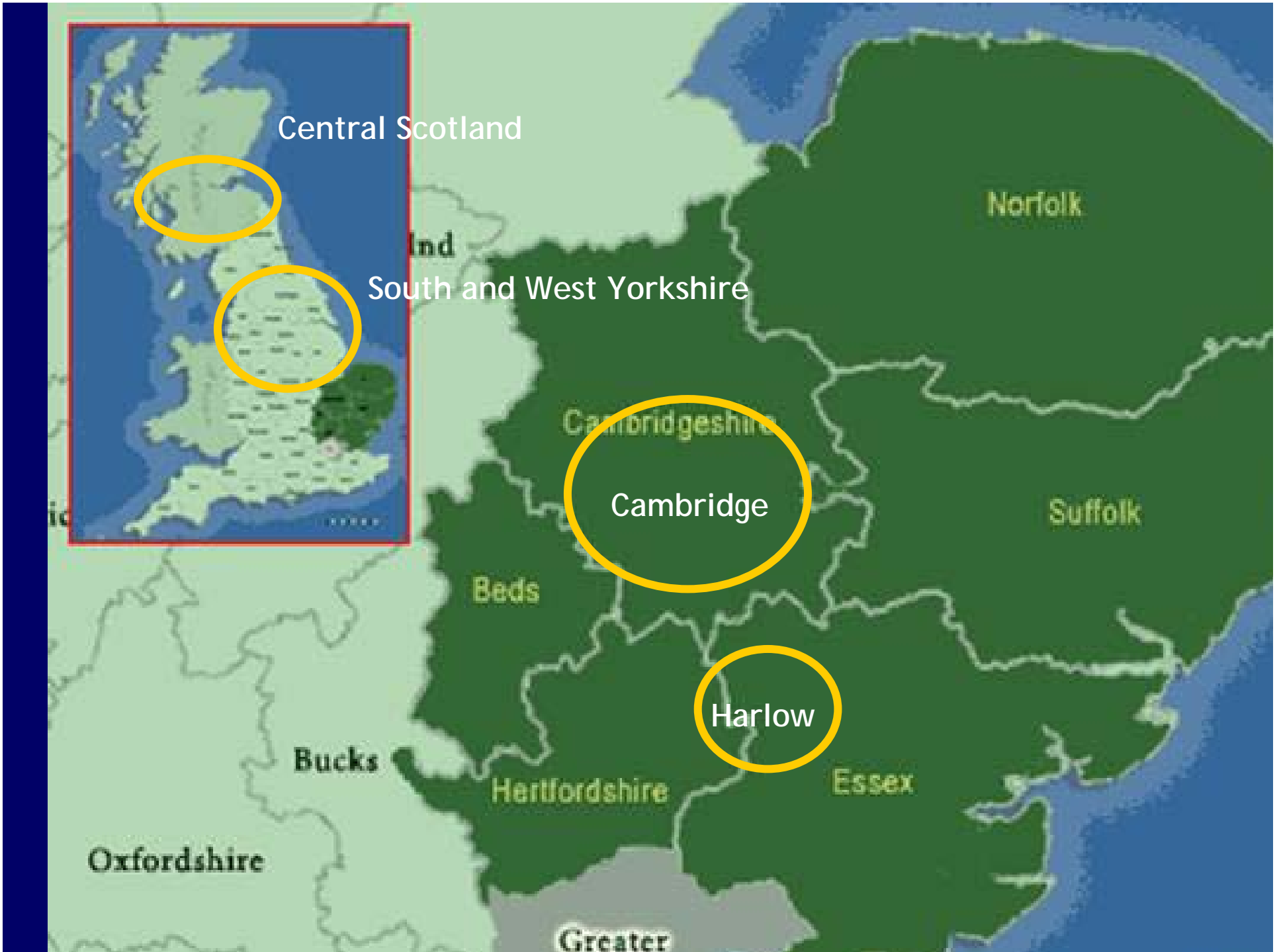
Central Scotland
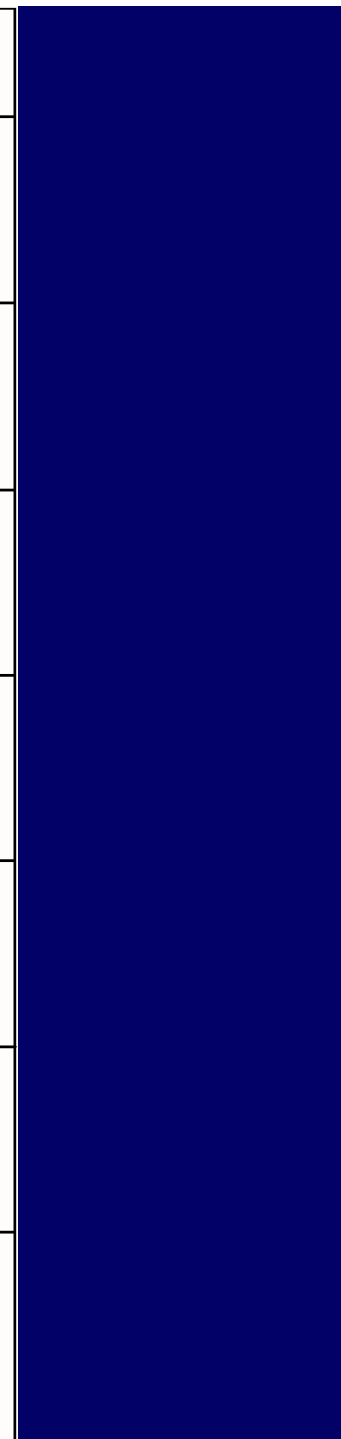
South and West Yorkshire

Norfolk

Cambridgeshire

Cambridge

Suffolk

Beds

Harlow

Essex

Bucks

Hertfordshire

Oxfordshire

Greater

Transport model	T1	T2	T3	T4	
Land-use model	No public transport, no modal split	Public transport, no logit, 24 h	Public transport, logit, peak hour	Multimodal, activity-based	
L1 None					
L2 Activity and judgement					
L3 No market-based land allocation					
L4 Logit allocation with price signals					
L5 Market-based land-use model					
L6 Activity-based land-use model					

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Harlow

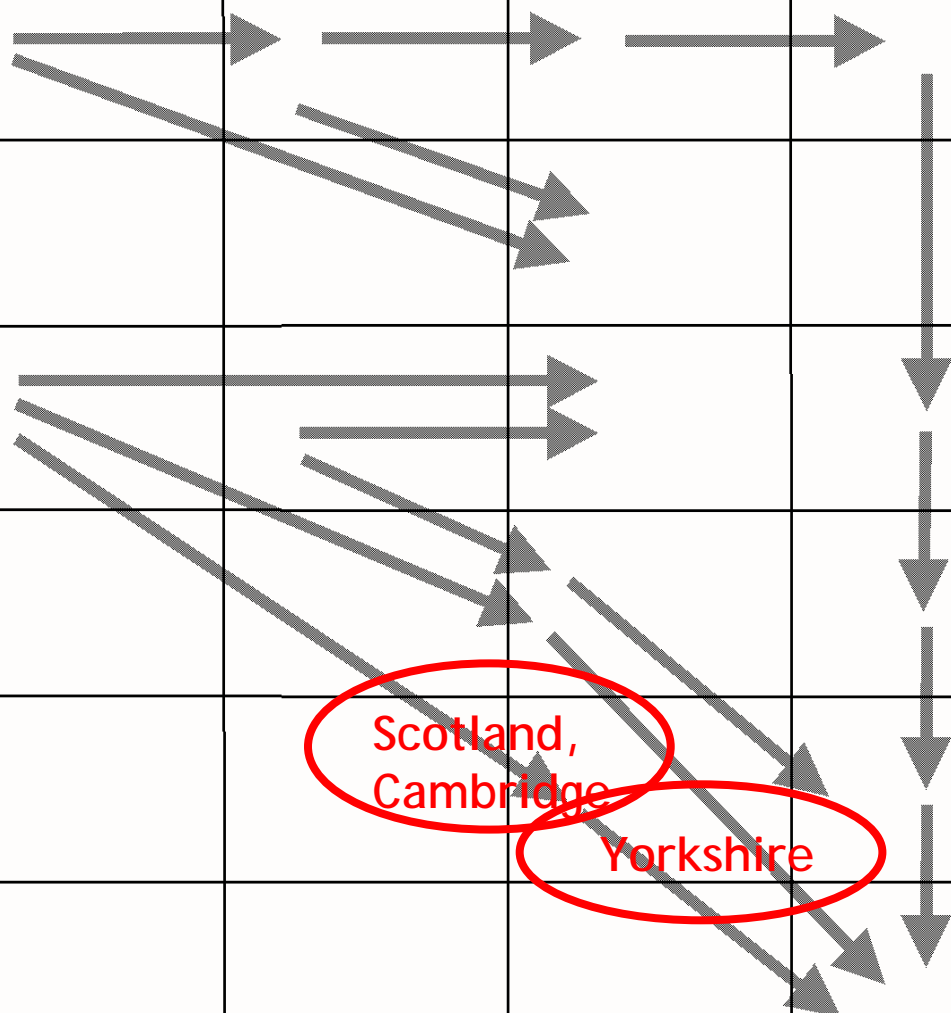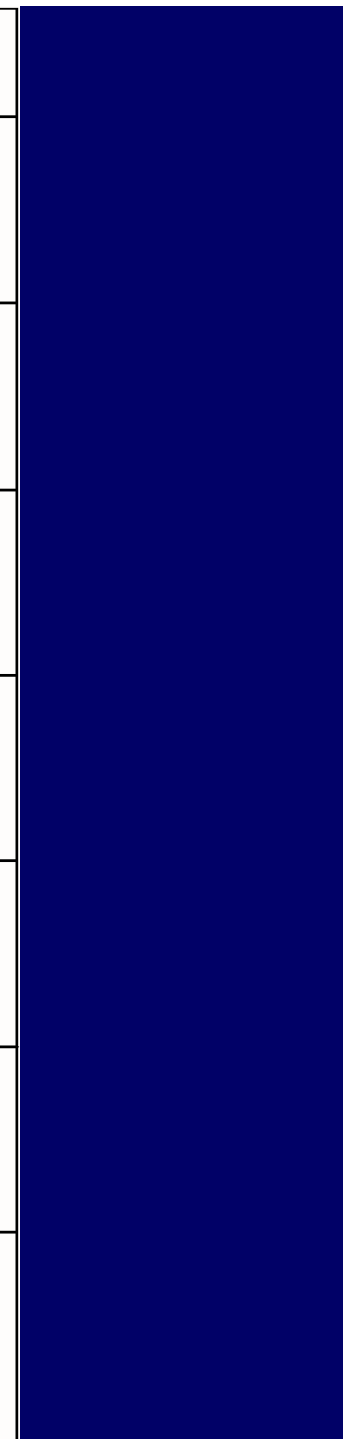| Land-use model	Transport model	T1	T2	T3	T4
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Harlow

Scotland, Cambridge

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Harlow

Scotland, Cambridge

Yorkshire

Raising new issues

- Harlow: land-use/transport study for Harlow Borough Council
- Model: DELTA application in land-use only form, used to generate inputs to a four-stage transport model (DSC/MVA).
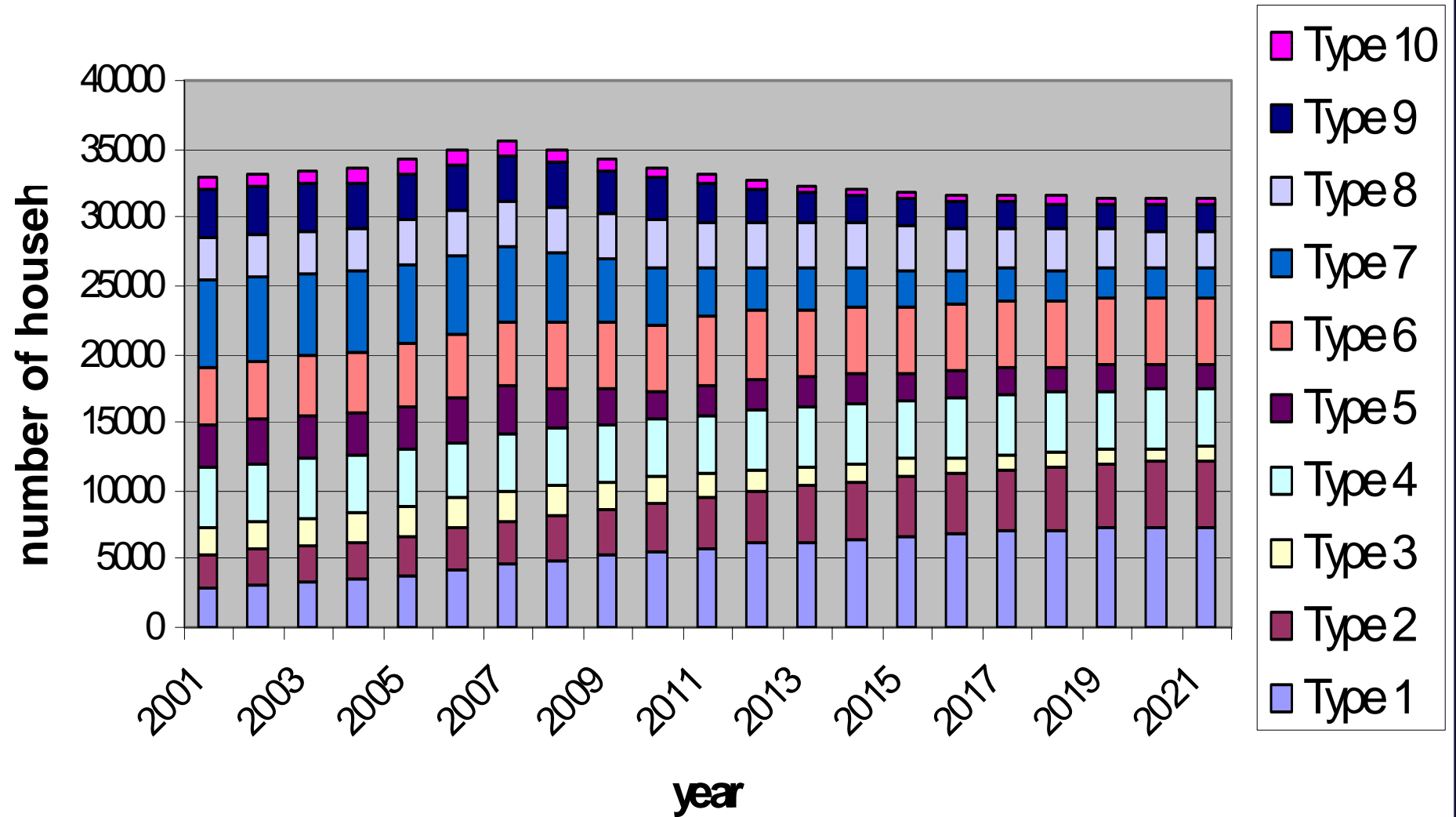
Household distribution, development zones

number of househ

year

Type 10
Type 9
Type 8
Type 7
Type 6
Type 5
Type 4
Type 3
Type 2
Type 1
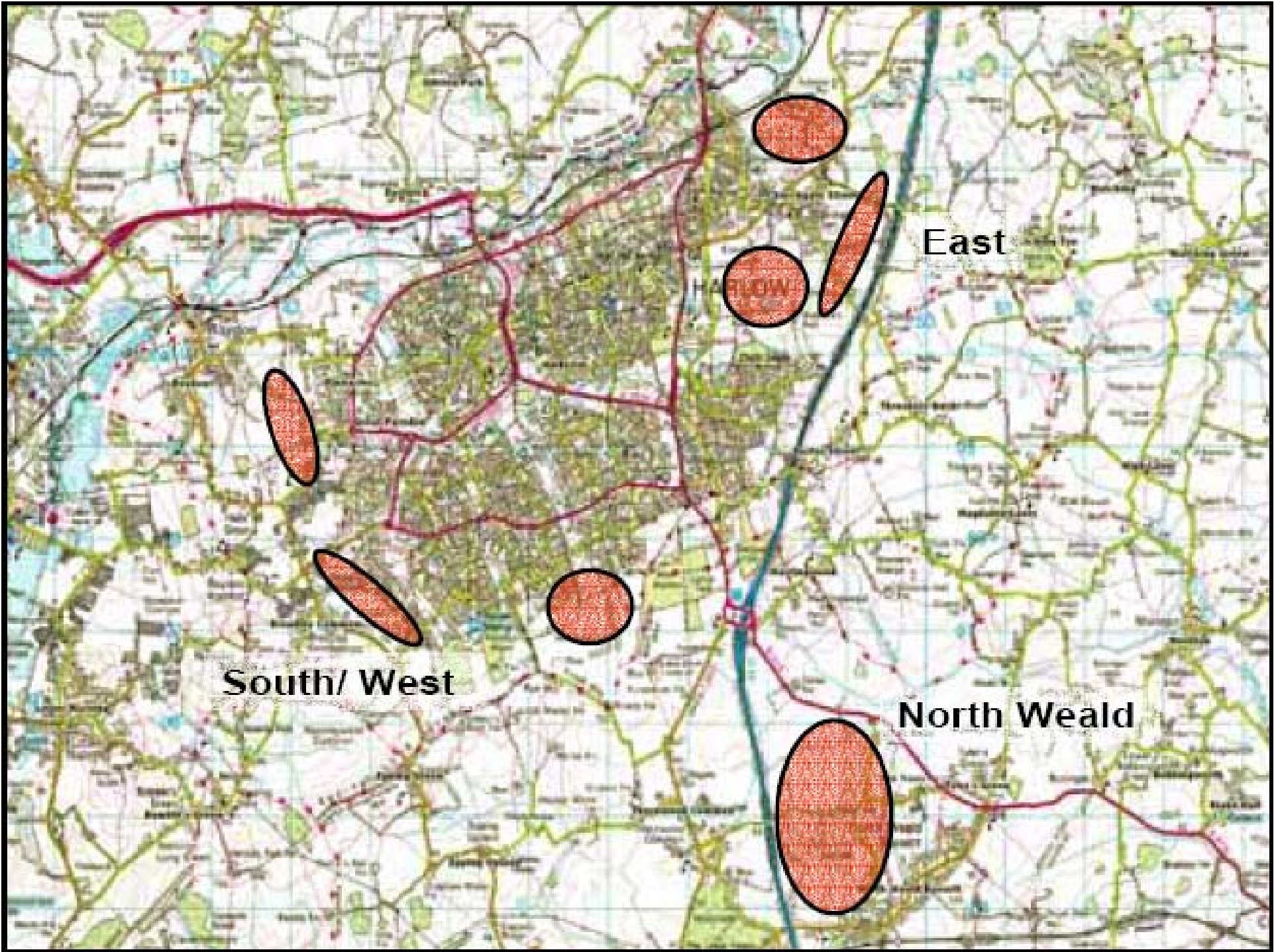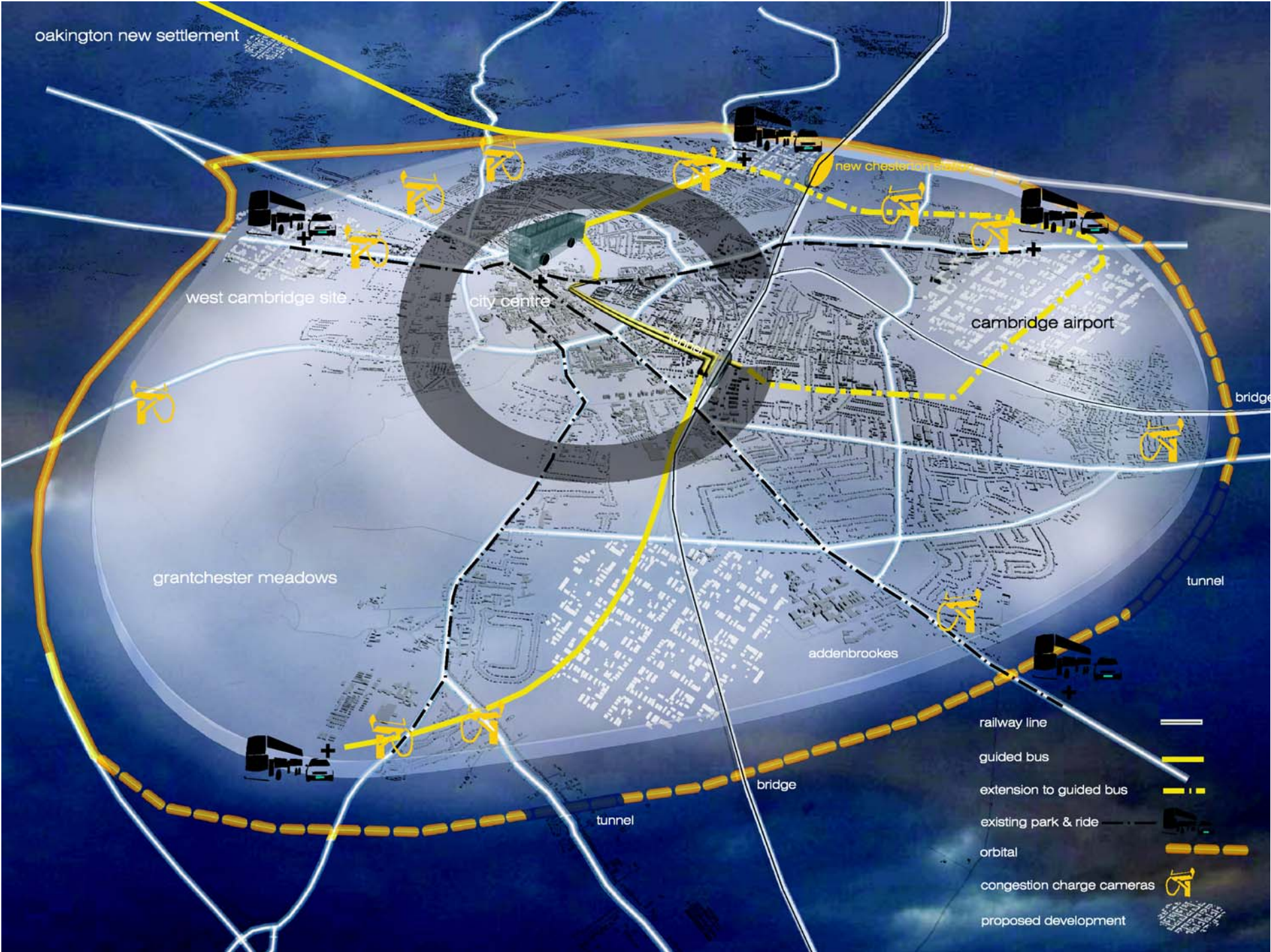
Household distribution, Harlow

Identifying new possibilities

- Cambridge Futures 2: value of major public transport infrastructure investment within Cambridge

- Model: MEPLAN land-use model linked to SATURN-based transport models (University of Cambridge/WSP/W S Atkins).

oakington new settlement

new chesterton station

west cambridge site

city centre

cambridge airport

bridge

tunnel

grantchester meadows

addenbrookes

bridge

tunnel

railway line

guided bus

extension to guided bus

existing park & ride

orbital

congestion charge cameras

proposed development

oakington new settlement
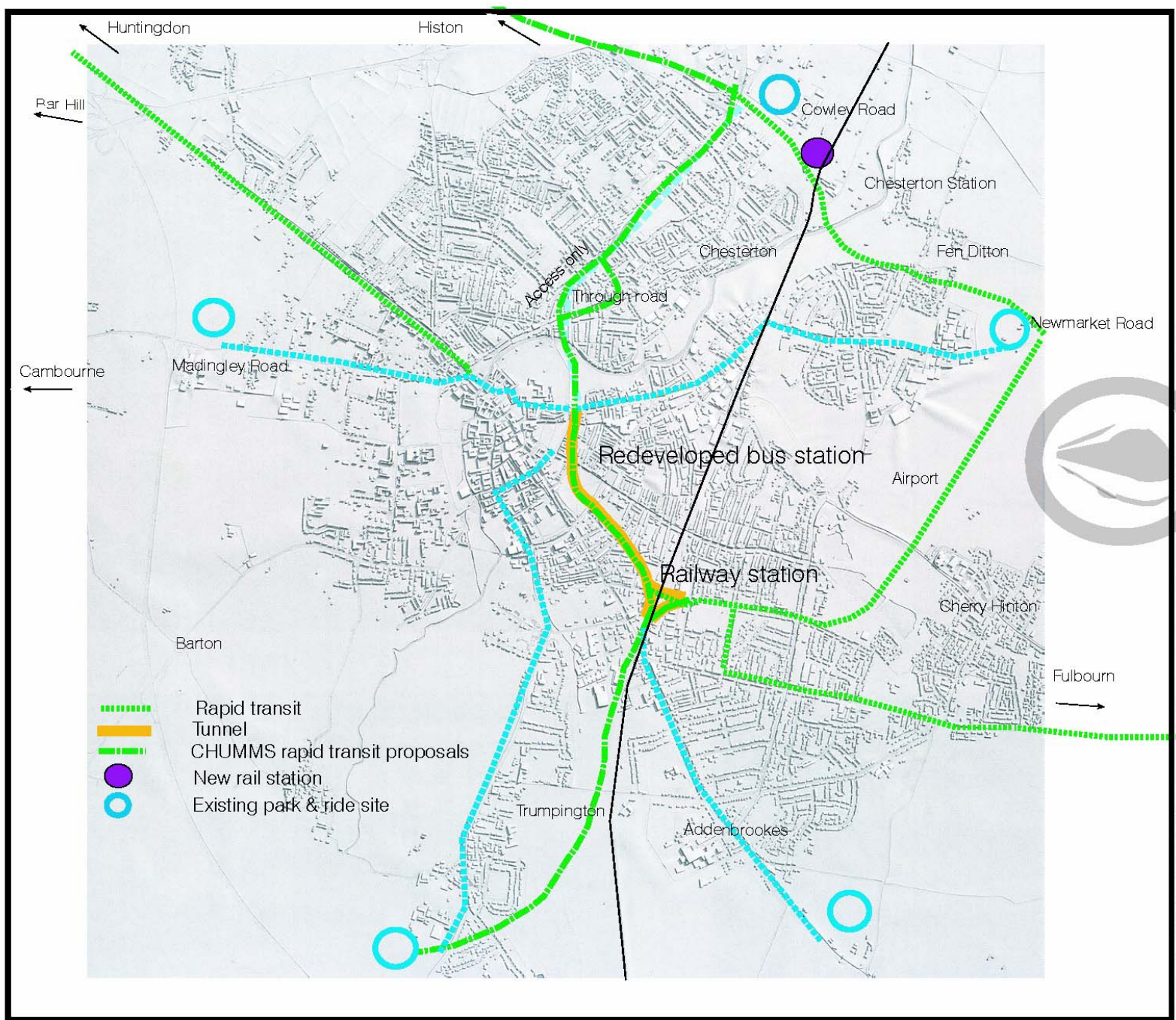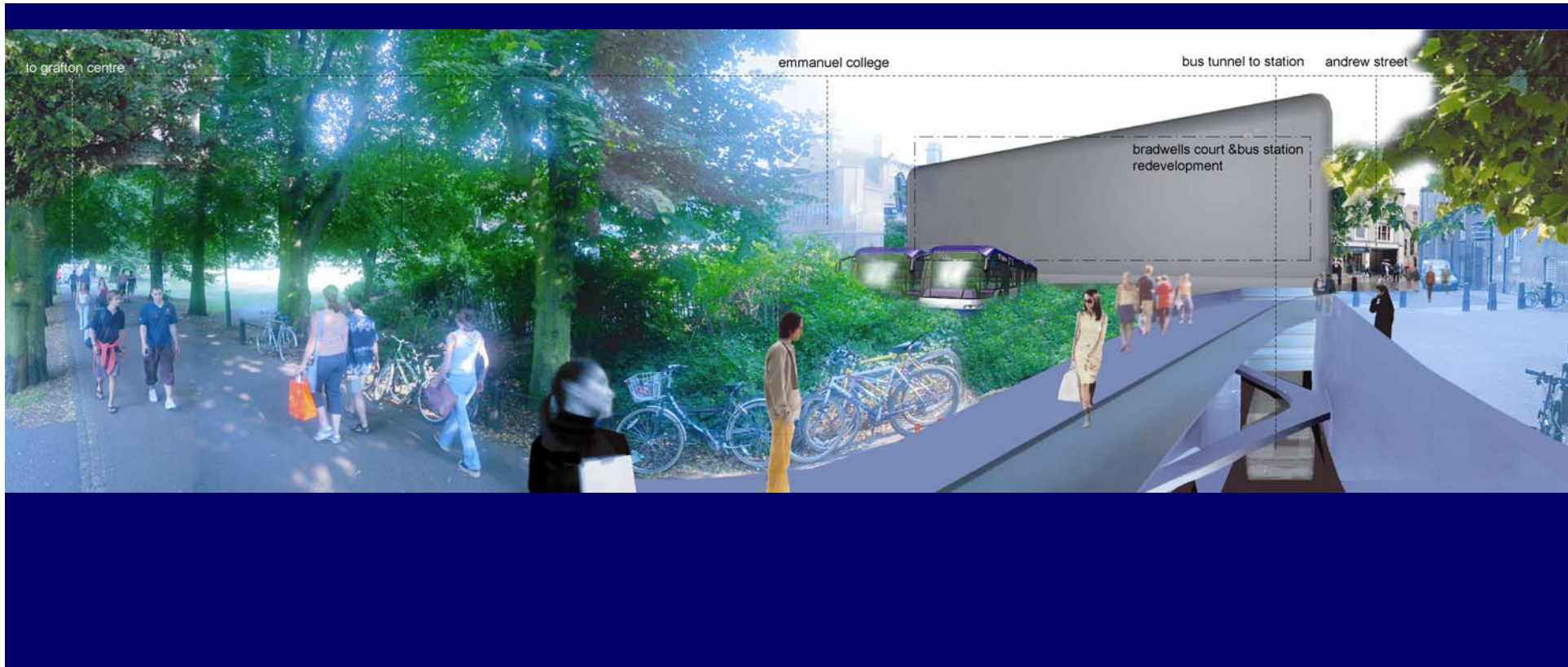
new chesterton station

west cambridge site

city centre

cambridge airport

cambridge railway station

grantchester meadows

addenbrookes hospital

railway line

guided bus

extension to guided bus

existing park & ride

proposed development

Figure 4.2 Public Transport Option: Optimized alternative

Map labels:
Huntingdon
Histon
Rar Hill
Cowley Road
Chesterton Station
Chesterton
Fen Ditton
Access only
Through road
Cambourne
Madingley Road
Newmarket Road
Redeveloped bus station
Airport
Railway station
Cherry Hinton
Barton
Fulbourn
Trumpington
Addenbrookes

Legend:
Rapid transit
Tunnel
CHUMMS rapid transit proposals
New rail station
Existing park & ride site

to grafton centre   emmanuel college   bus tunnel to station   andrew street

bradwells court &bus station redevelopment

rapid transit tunnel entrance   to bus station & city centre

earmarked for new development

new bus station & cycle park
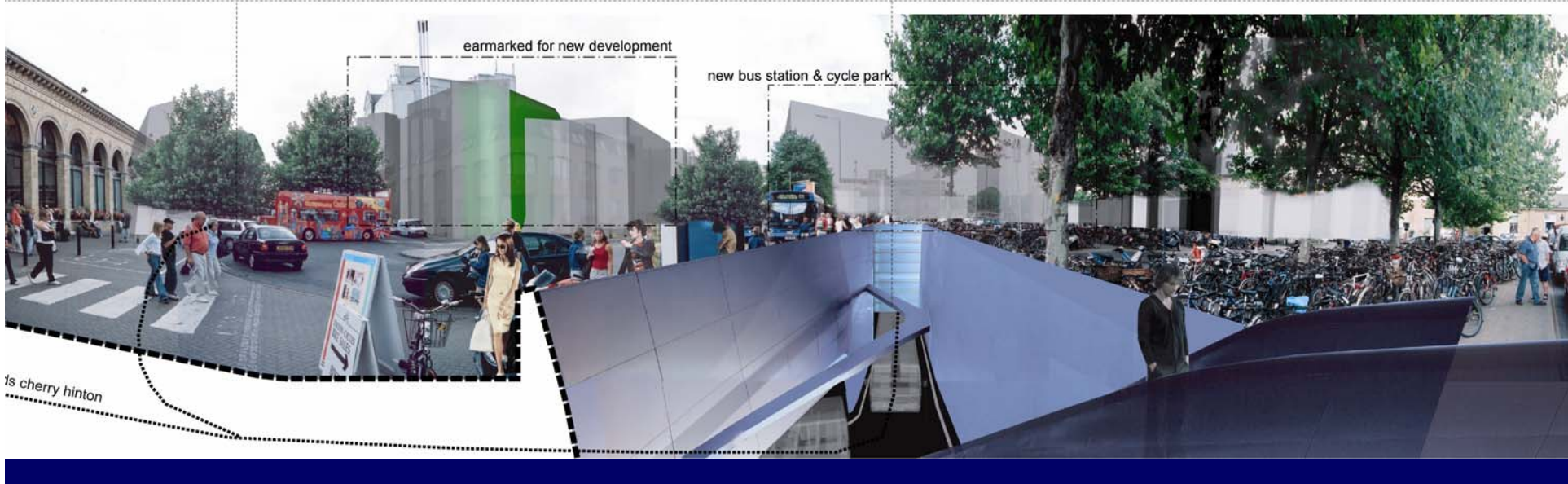
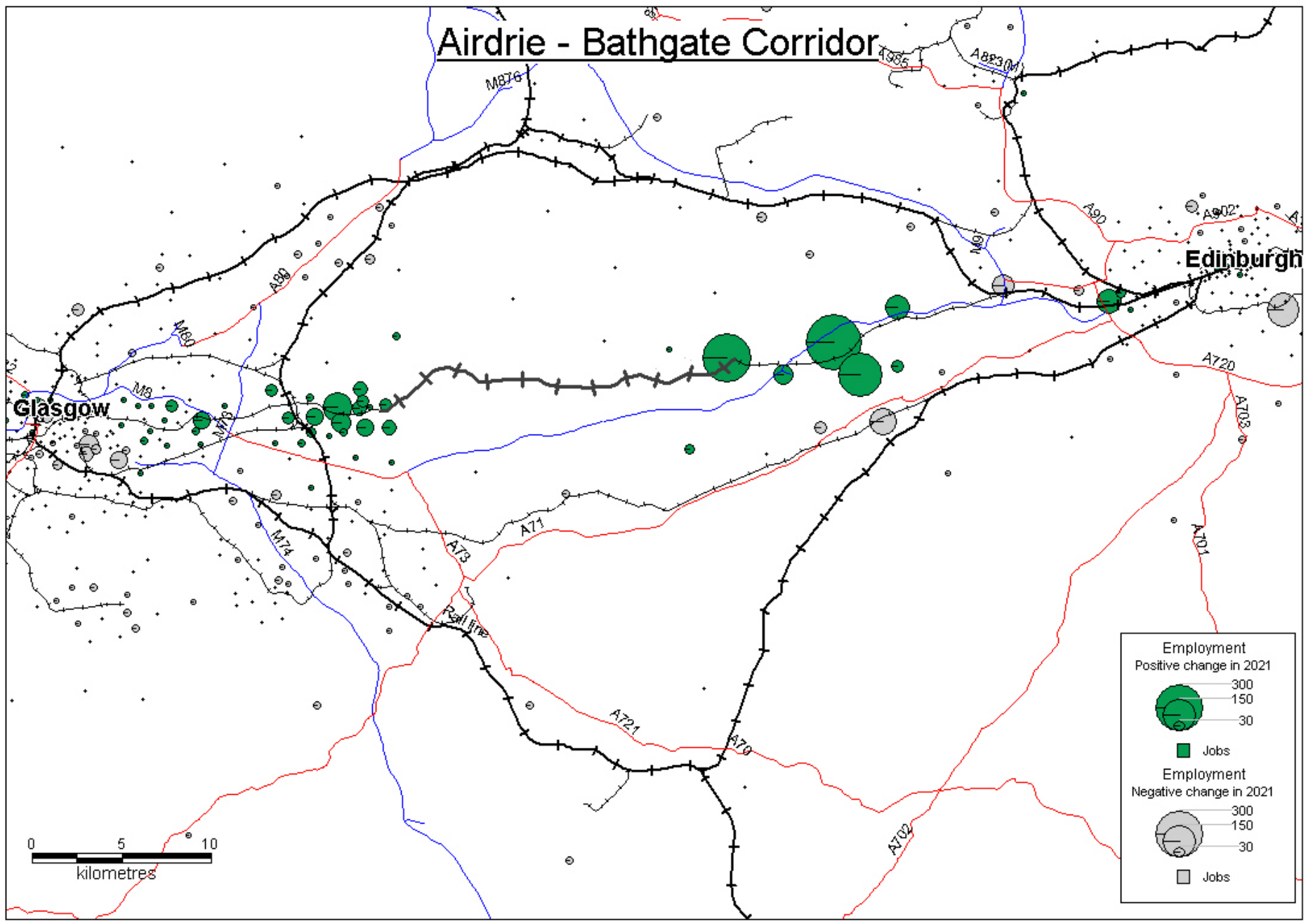cherry hinton

Improving forecasts

Examples of forecast impacts of transport proposals which have been

- as expected or greater in magnitude
- more moderate than expected
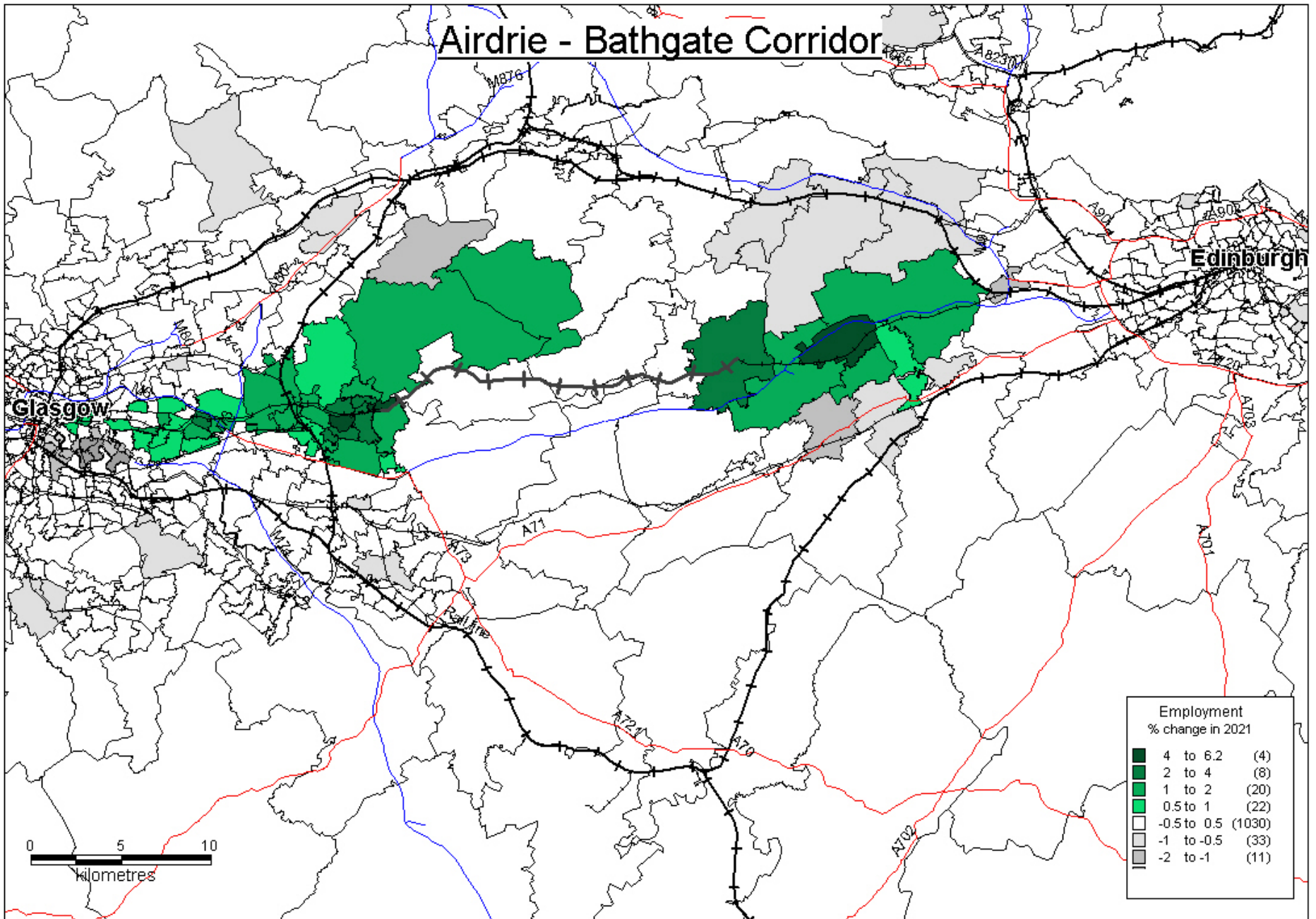- the opposite of what was hoped for!
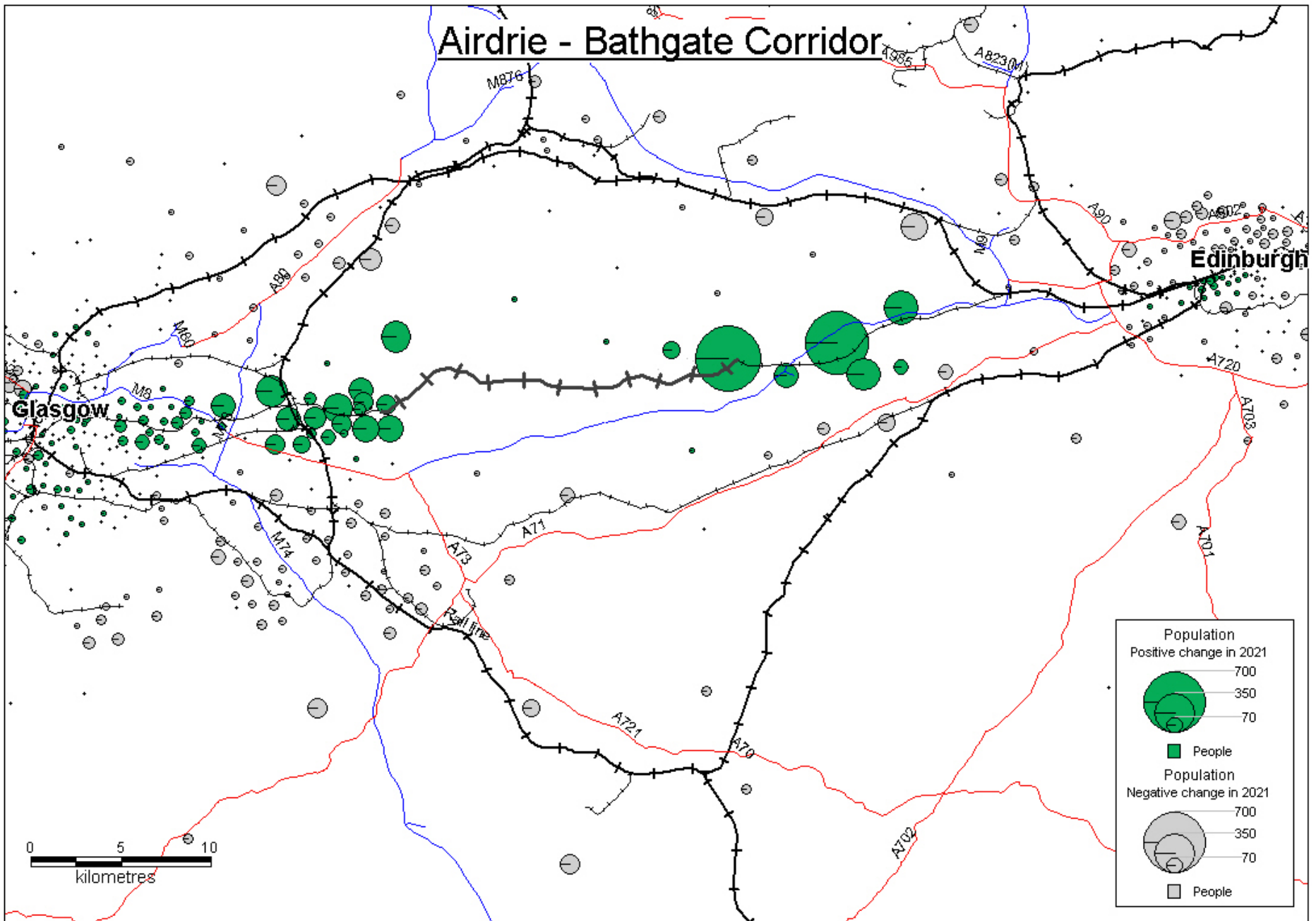
Airdrie-Bathgate reopening

- Proposal is to extend the existing cross-Glasgow electric suburban service from Airdrie/Drumgelloch to Bathgate and thence into Edinburgh Waverley – thus electrifying the Bathgate line which reopened in 1980s

- Model: DELTA land-use/economic model interacting with CUBE/Voyager transport model (DSC/MVA).

Airdrie - Bathgate Corridor

Airdrie - Bathgate Corridor

Glasgow

Edinburgh

Employment
% change in 2021

4 to 6.2	(4)
2 to 4	(8)
1 to 2	(20)
0.5 to 1	(22)
-0.5 to 0.5	(1030)
-1 to -0.5	(33)
-2 to -1	(11)

0   5   10
kilometres

Airdrie - Bathgate Corridor

Glasgow

Edinburgh

Rail line

kilometres

0   5   10

Population
Positive change in 2021

- 700
- 350
- 70

■ People

Population
Negative change in 2021

- 700
- 350
- 70

□ People

Airdrie - Bathgate Corridor

Glasgow

Edinburgh

Population
% change in 2021

4	to 5.47	(3)
3	to 4	(7)
2	to 3	(5)
1	to 2	(21)
0.5	to 1	(43)
-0.5	to 0.5	(945)
-1	to -0.5	(97)
-2	to -1	(9)

0   5   10
kilometres

Abs change in EMPLOYMENT

Legend: Bathgate Corridor, Livingston Corridor, Linlithgow Corridor

Jobs axis: 1200, 1000, 800, 600, 400, 200, 0, -200

Years: 2001–2021

% change in EMPLOYMENT

Legend: Bathgate Corridor, Livingston Corridor, Linlithgow Corridor

% change axis: 4, 3.5, 3, 2.5, 2, 1.5, 1, 0.5, 0, -0.5, -1, -1.5

Years: 2001–2021

Abs change in EMPLOYMENT

Legend: Cumbernauld Corridor, Airdrie Corridor, Motherwell Corridor

Jobs axis: 700, 600, 500, 400, 300, 200, 100, 0, -100, -200

Years: 2001–2021

% change in EMPLOYMENT

Legend: Cumbernauld Corridor, Airdrie Corridor, Motherwell Corridor

% change axis: 2.5, 2, 1.5, 1, 0.5, 0, -0.5

Years: 2001–2021

Results in South and West Yorkshire

- Model: DELTA land-use/economic model integrated with START transport model (DSC/MVA).
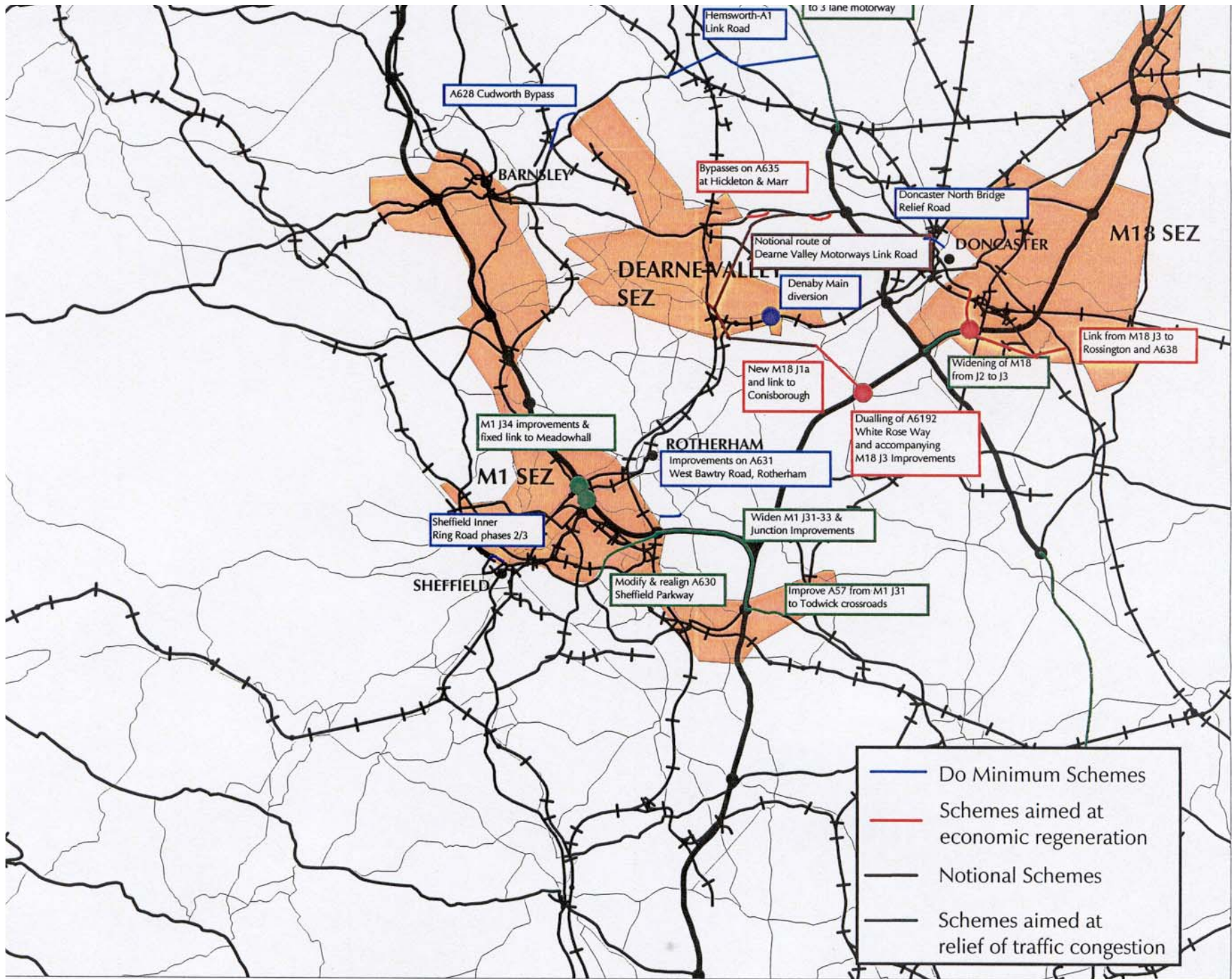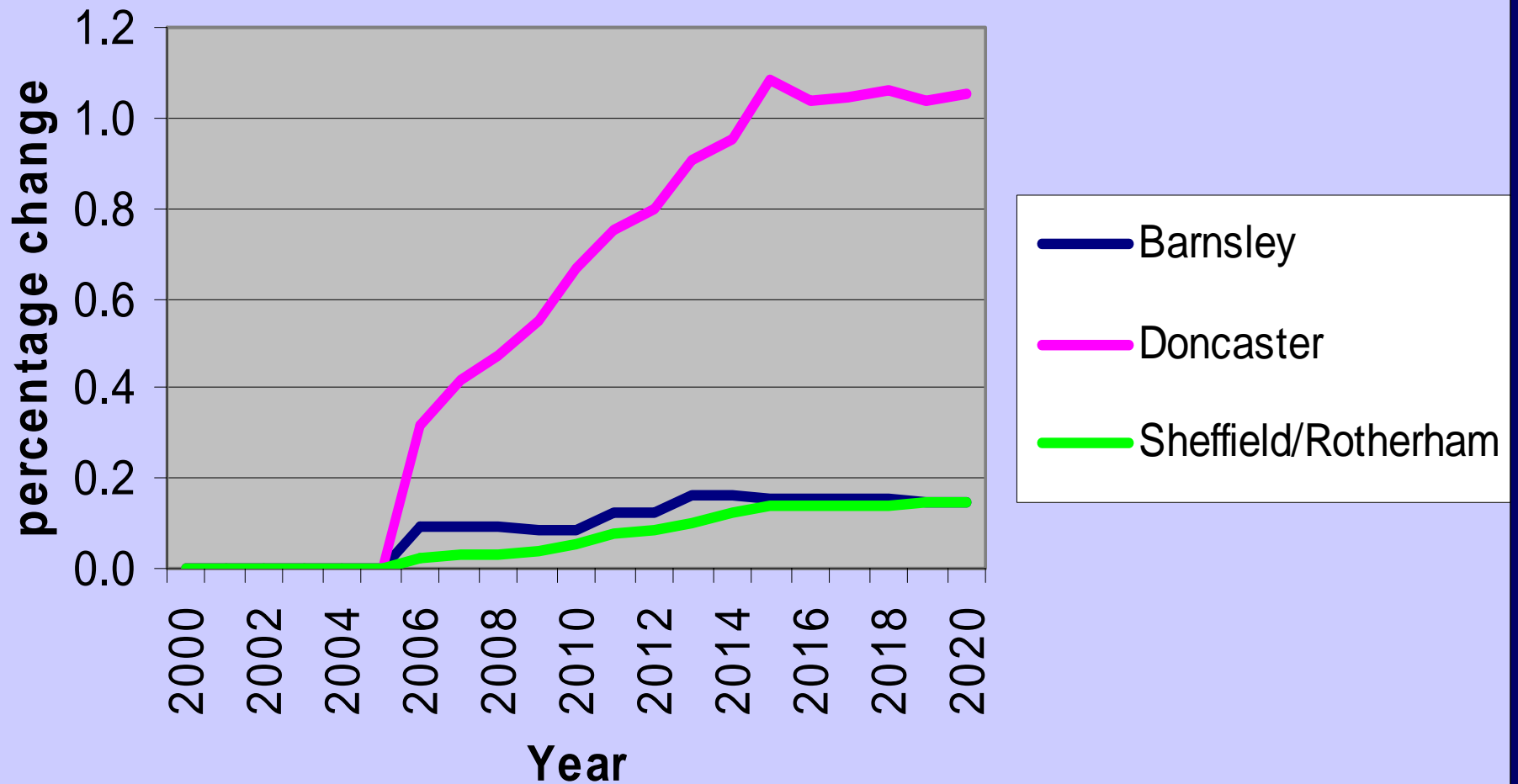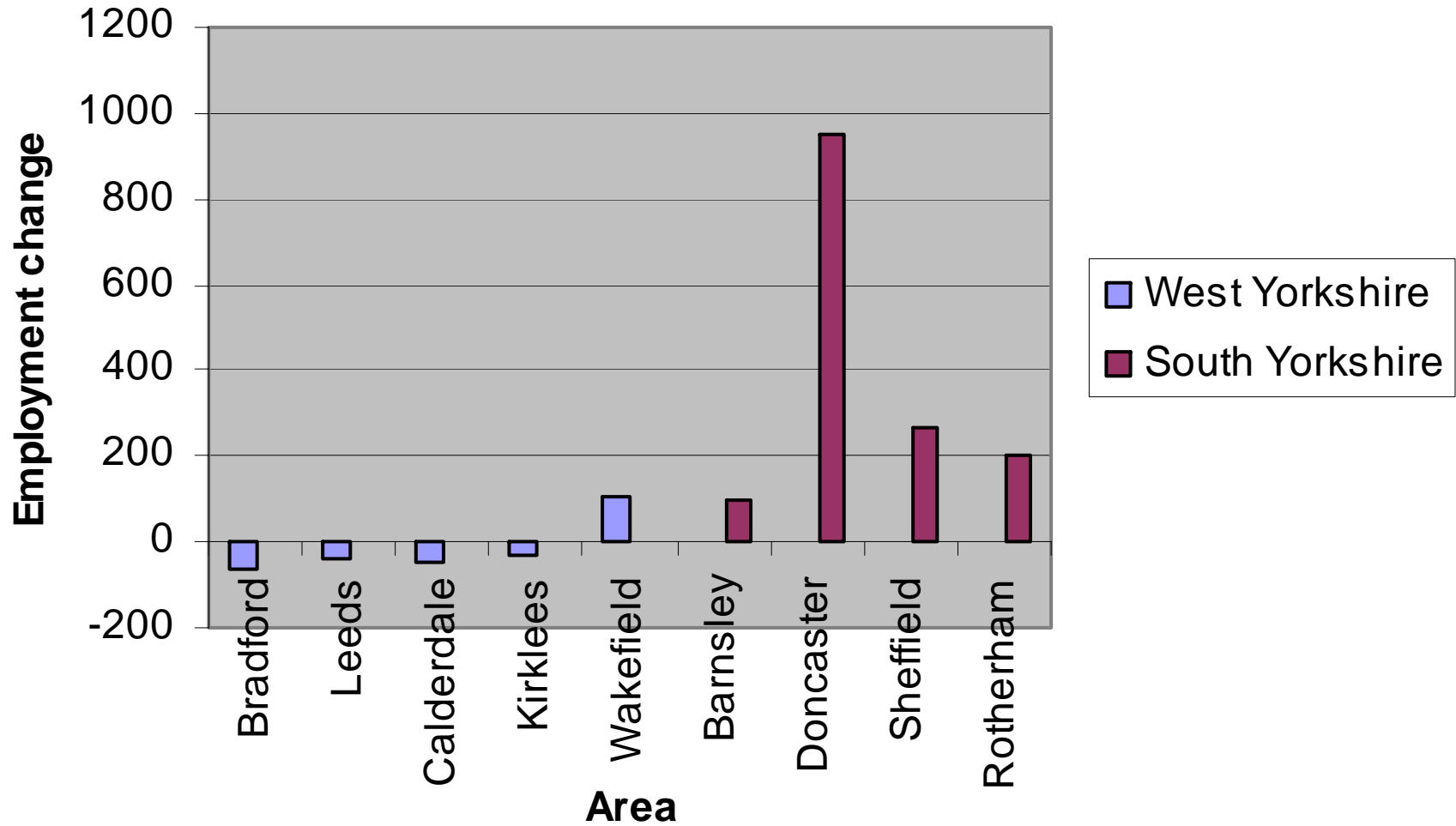
Results in South and West Yorkshire (1)

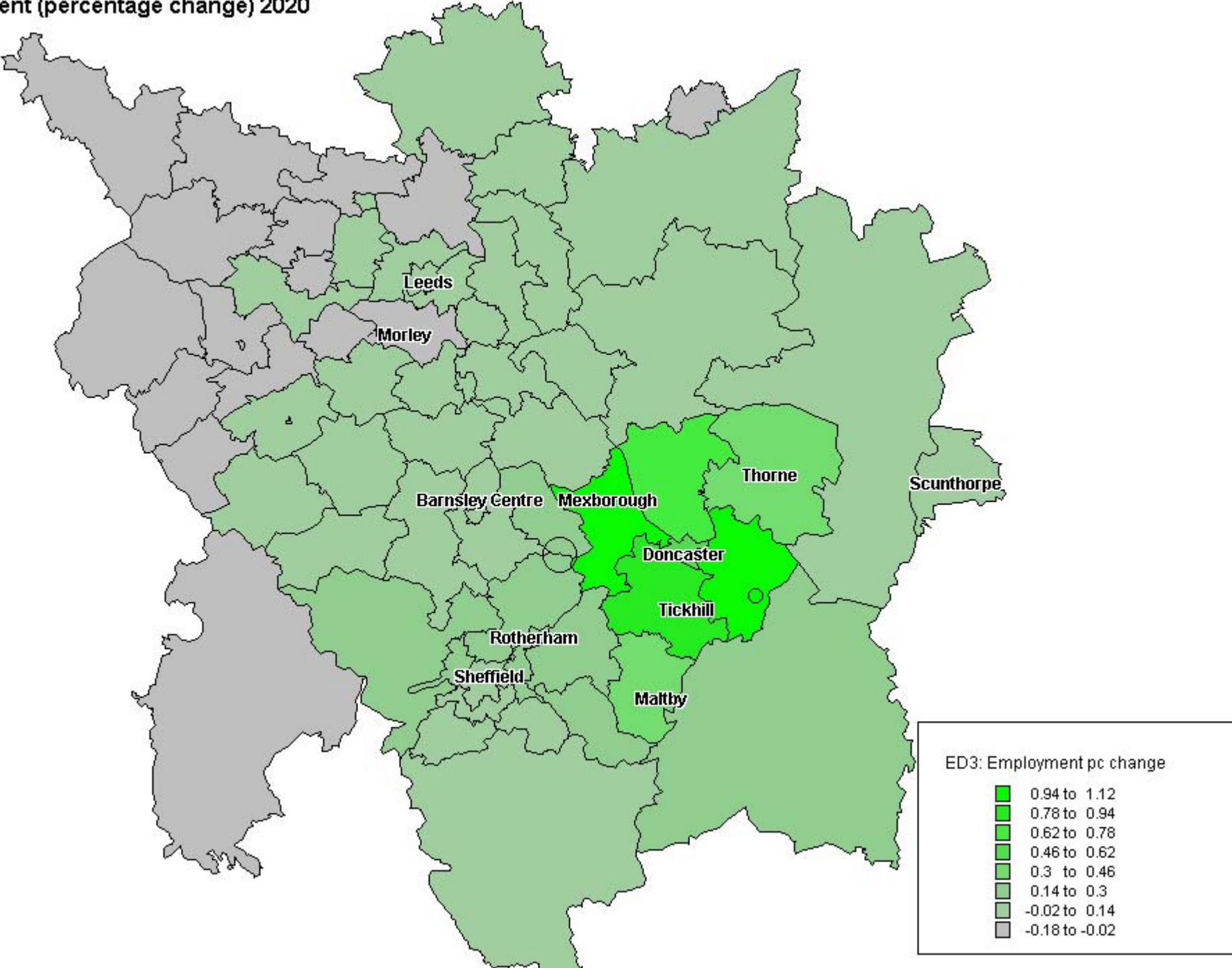- Road-building schemes intended to encourage economic development

Hemsworth-A1
Link Road

to 3 lane motorway

A628 Cudworth Bypass

BARNSLEY

Bypasses on A635
at Hickleton & Marr

Doncaster North Bridge
Relief Road

Notional route of
Dearne Valley Motorways Link Road

DONCASTER

M18 SEZ

DEARNE VALLEY
SEZ

Denaby Main
diversion

Link from M18 J3 to
Rossington and A638

New M18 J1a
and link to
Conisborough

Widening of M18
from J2 to J3

M1 J34 improvements &
fixed link to Meadowhall

Dualling of A6192
White Rose Way
and accompanying
M18 J3 Improvements

ROTHERHAM

M1 SEZ

Improvements on A631
West Bawtry Road, Rotherham

Sheffield Inner
Ring Road phases 2/3

Widen M1 J31-33 &
Junction Improvements

SHEFFIELD

Modify & realign A630
Sheffield Parkway

Improve A57 from M1 J31
to Todwick crossroads

Do Minimum Schemes

Schemes aimed at
economic regeneration

Notional Schemes

Schemes aimed at
relief of traffic congestion

Value added: ED3 road schemes vs Reference Case

Legend:
- Barnsley
- Doncaster
- Sheffield/Rotherham

Y-axis: percentage change (0.0 to 1.2)

X-axis: Year (2000 to 2020)

Impact of ED3 on employment in West & South Yorkshire, 2020

Employment (percentage change) 2020

ED3: Employment pc change

■	0.94 to 1.12
■	0.78 to 0.94
■	0.62 to 0.78
■	0.46 to 0.62
■	0.3 to 0.46
■	0.14 to 0.3
■	-0.02 to 0.14
■	-0.18 to -0.02

Map labels: Leeds, Morley, Barnsley Centre, Mexborough, Thorne, Scunthorpe, Doncaster, Tickhill, Rotherham, Sheffield, Maltby

Results in South and West Yorkshire (2)

- Subsidy to development of commercial floorspace in South Yorkshire
- Planning policies only allow development of commercial floorspace in major centres, so subsidy is to development in these locations.

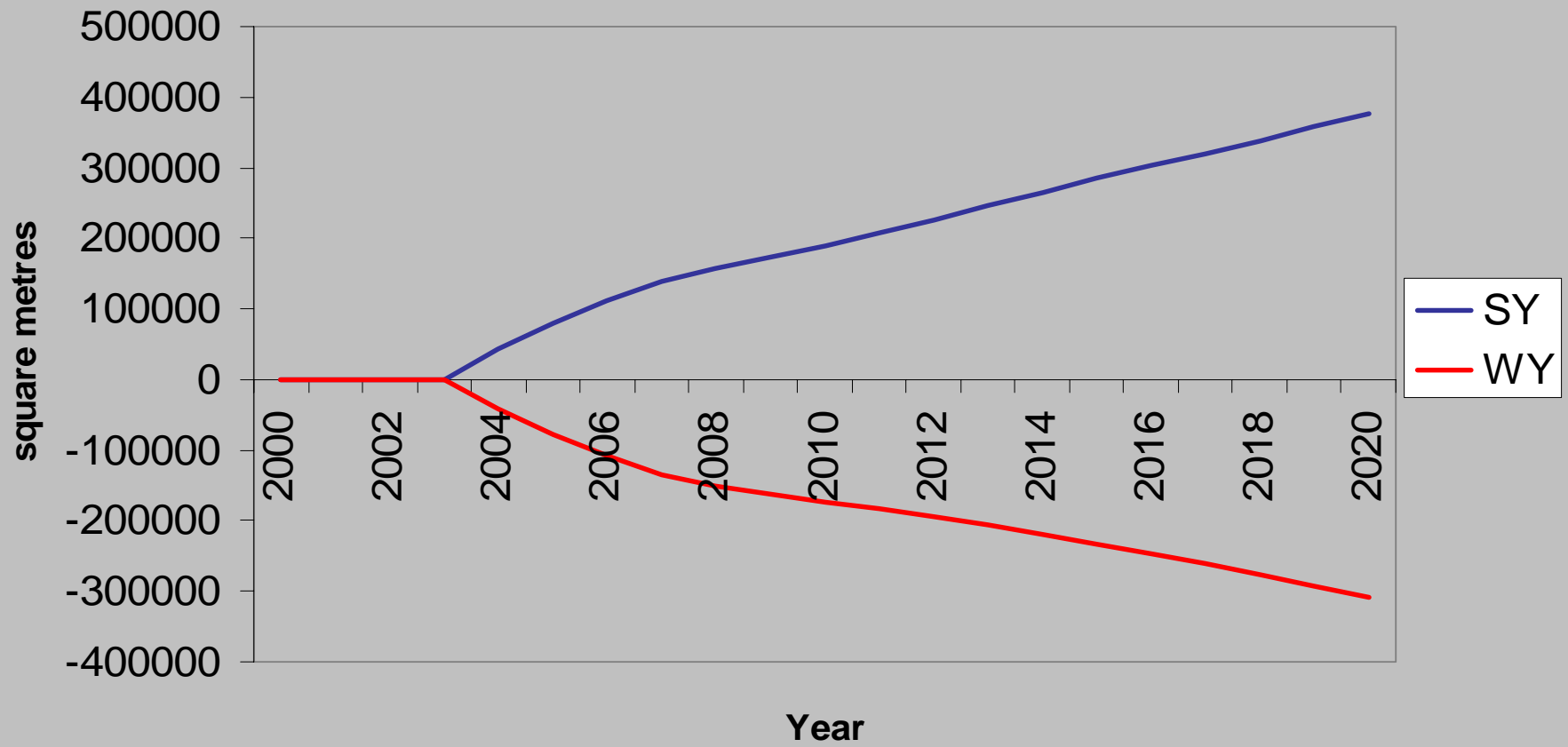SWYMMS Strategic Model: Fully Modelled Area and Buffer Zones

N Yorks (East)

N Yorks (West)

Humberside (N)

East Lancashire

Bradford Leeds

Wakefield

Humberside (S)

Greater Manchester

Barnsley

Doncaster

Rotherham
Sheffield

Lincoln

Stoke

Nottingham

Derby

SWYMMS Strategic Model FMA and Buffer Zones

Fully Modelled Area
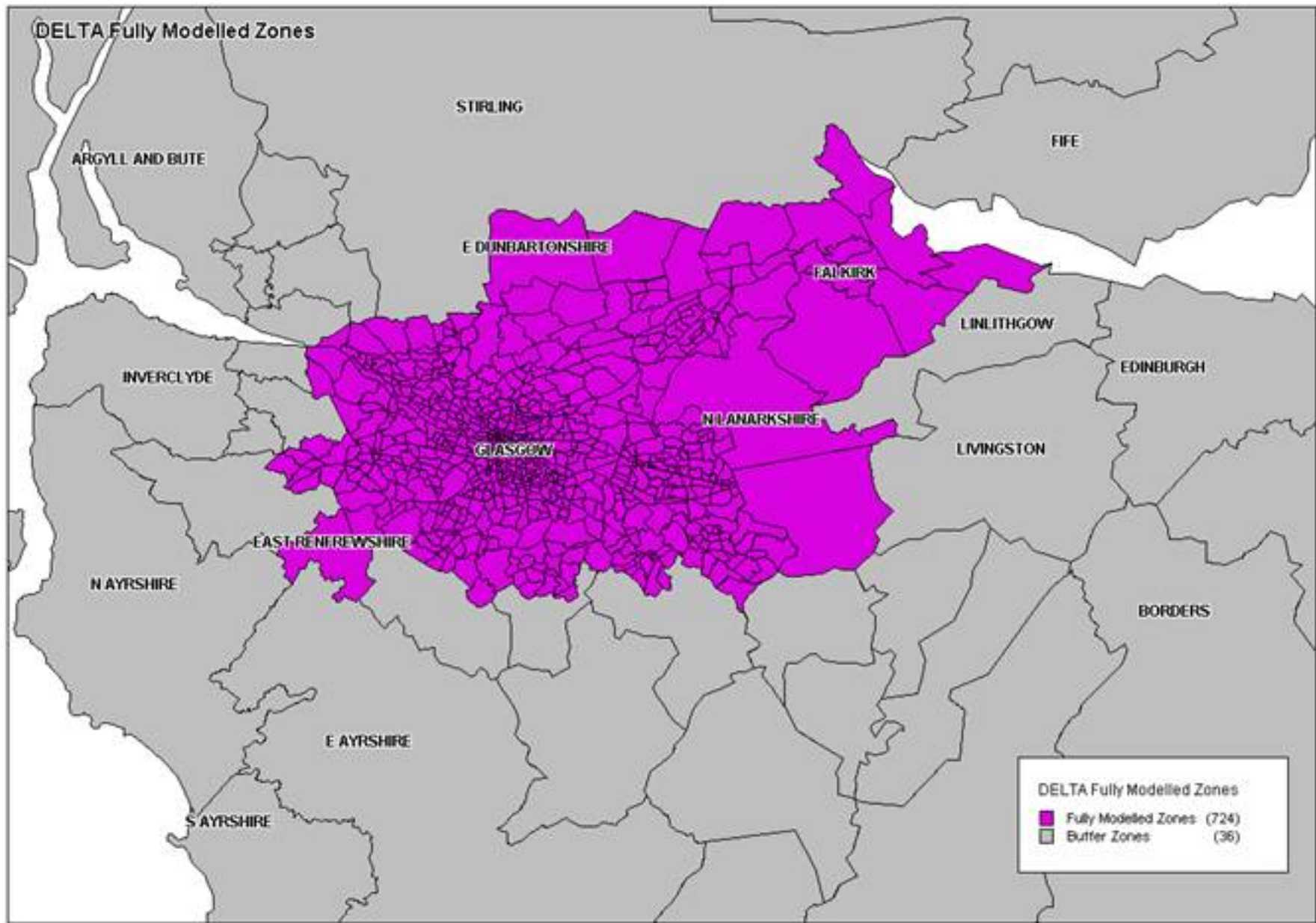Buffer Zones
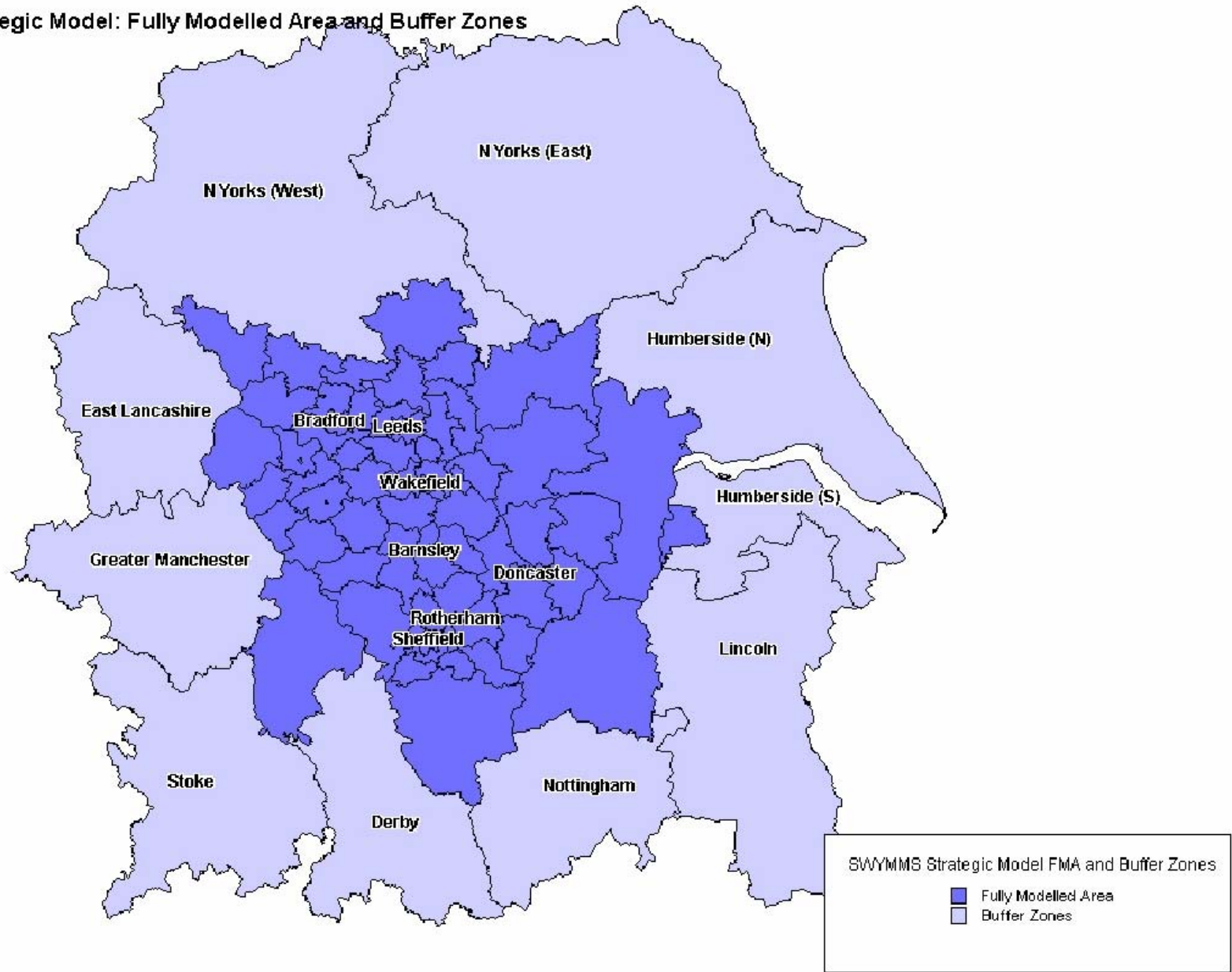
Figure 3.1

Office floorspace, ED6 vs ARC

Employment, ED6 - ARC
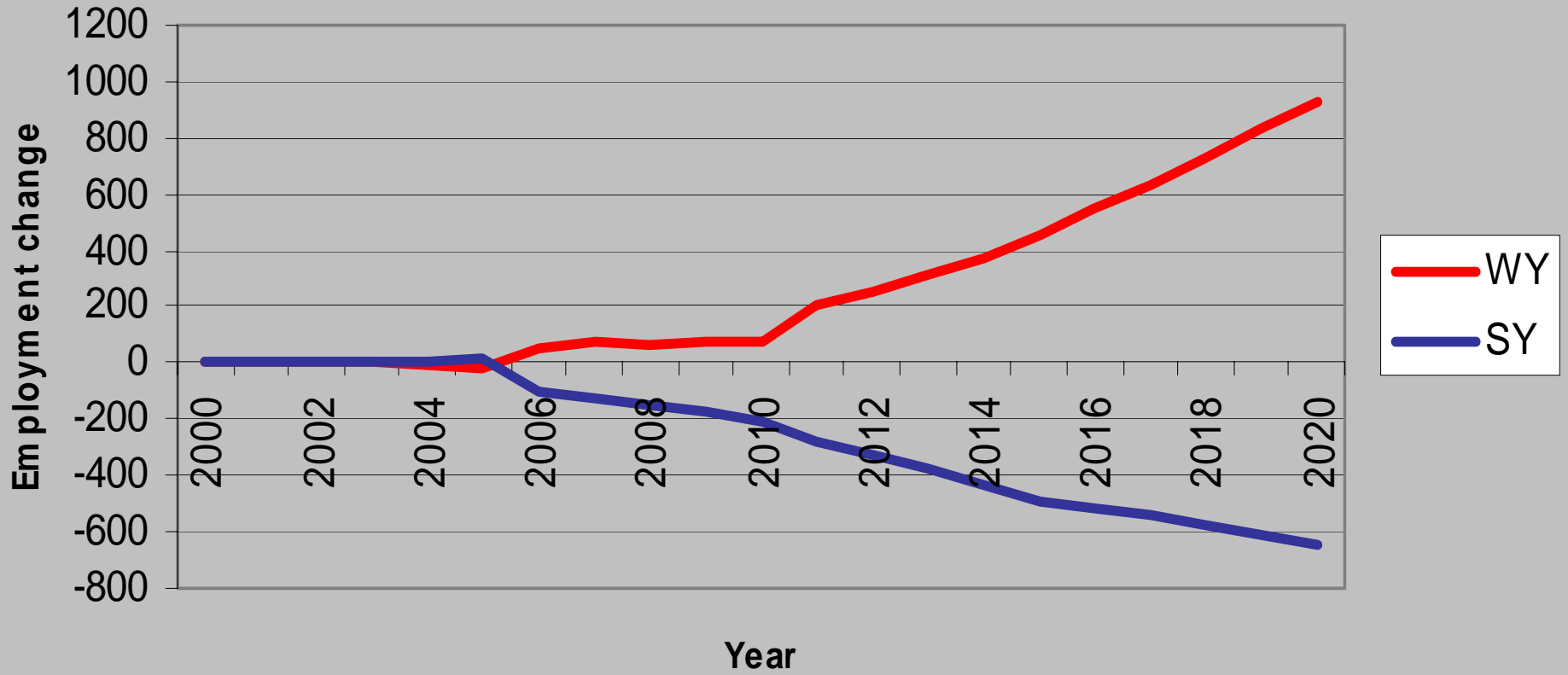
Difference in market accessibility, metal manufacturing, ED6-ARC

Accessibility measure (+ve difference = improvement)
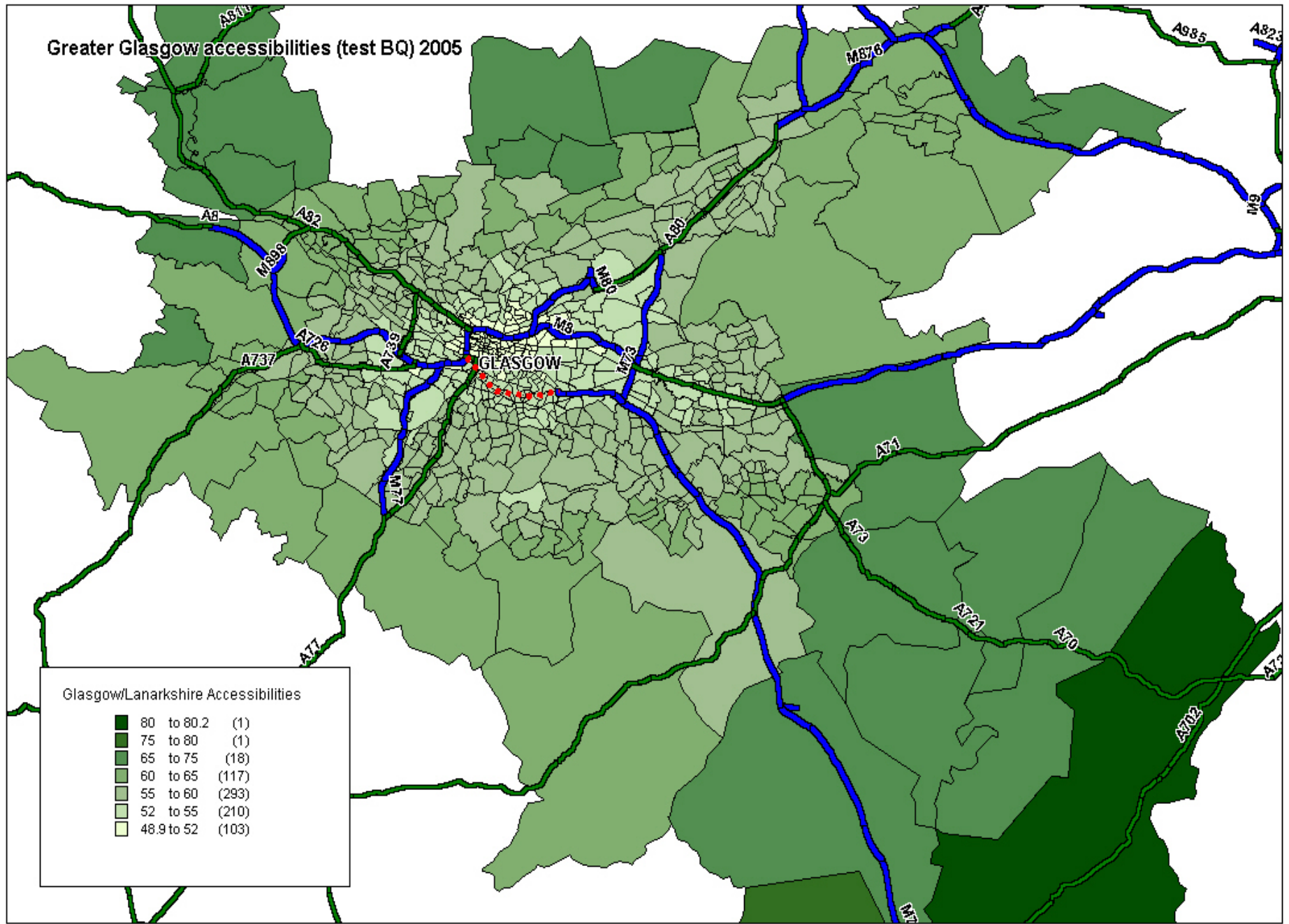
Year

— Leeds
— Sheffield
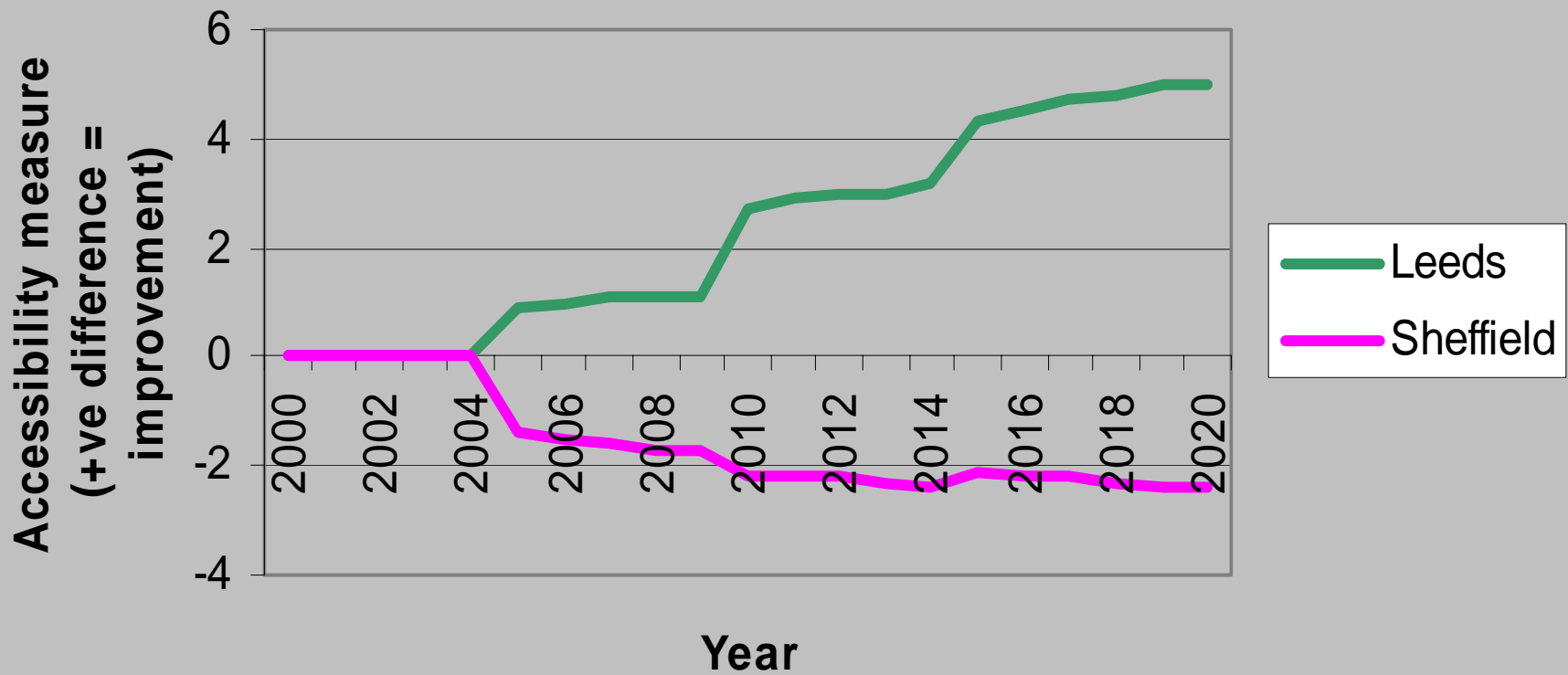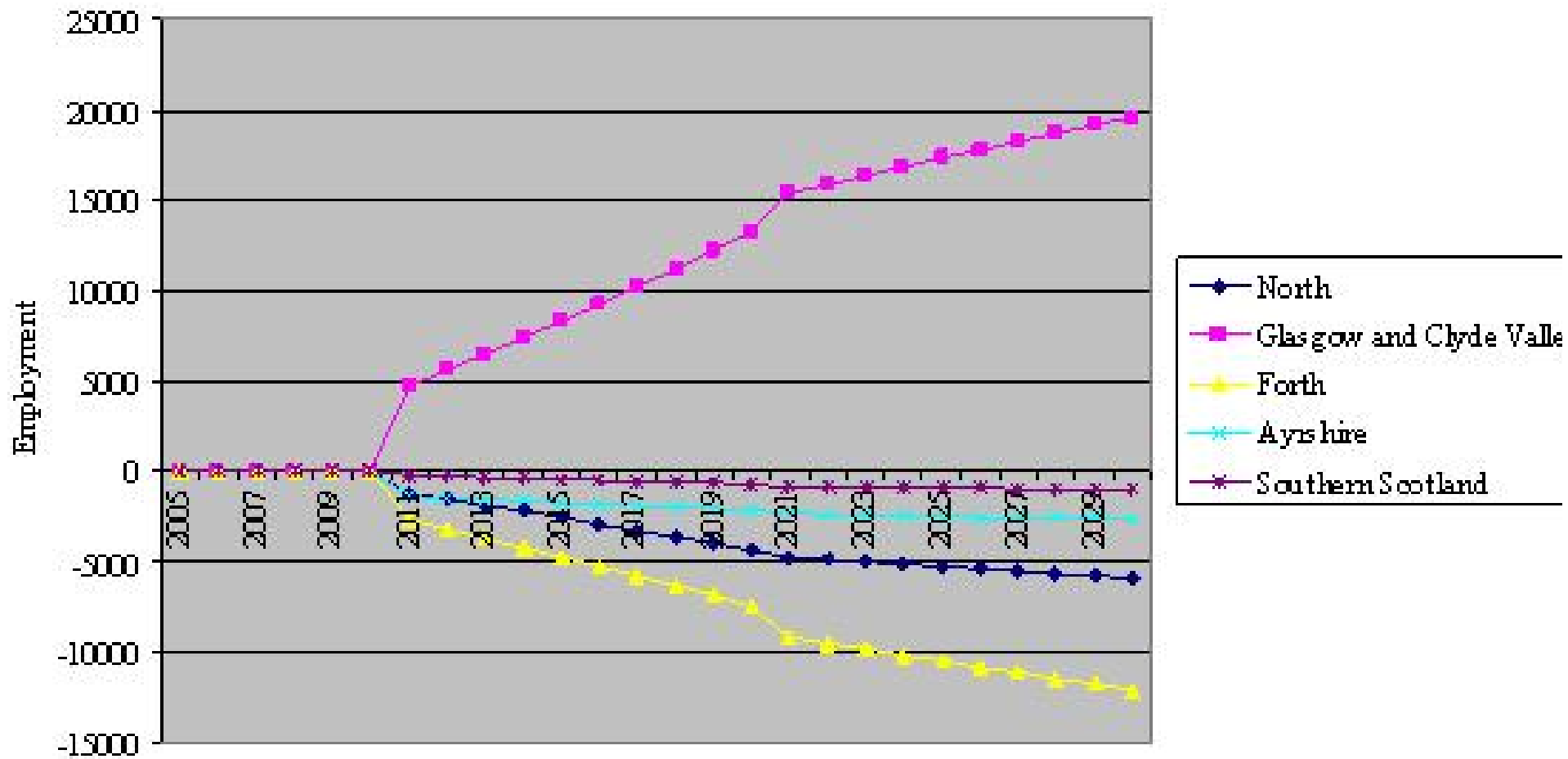
Contributions to appraisal

- Completion of the M74 - a major missing link in the Glasgow motorway (freeway) network

- Model: DELTA land-use/economic model linked to TRIPS transport model (DSC/MVA).
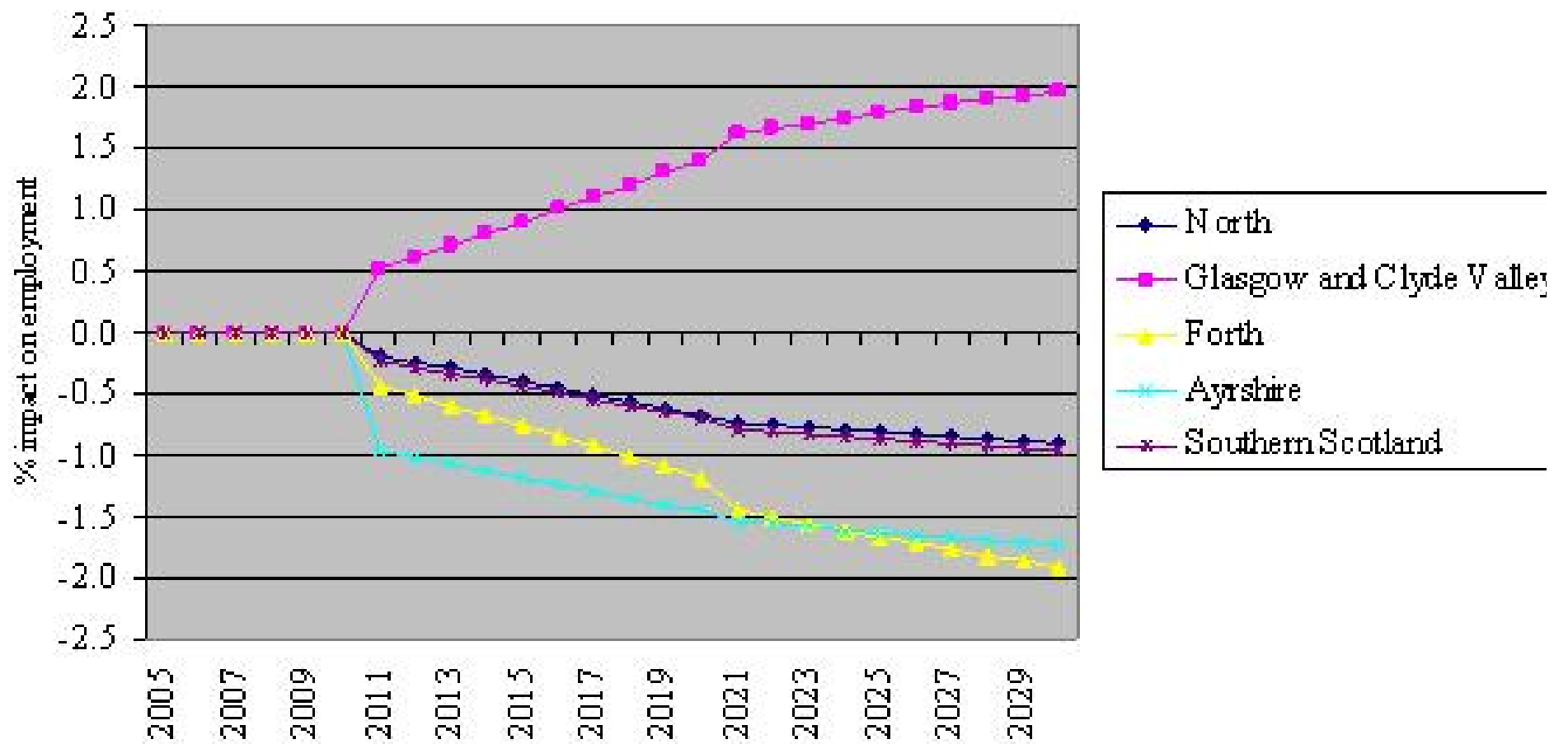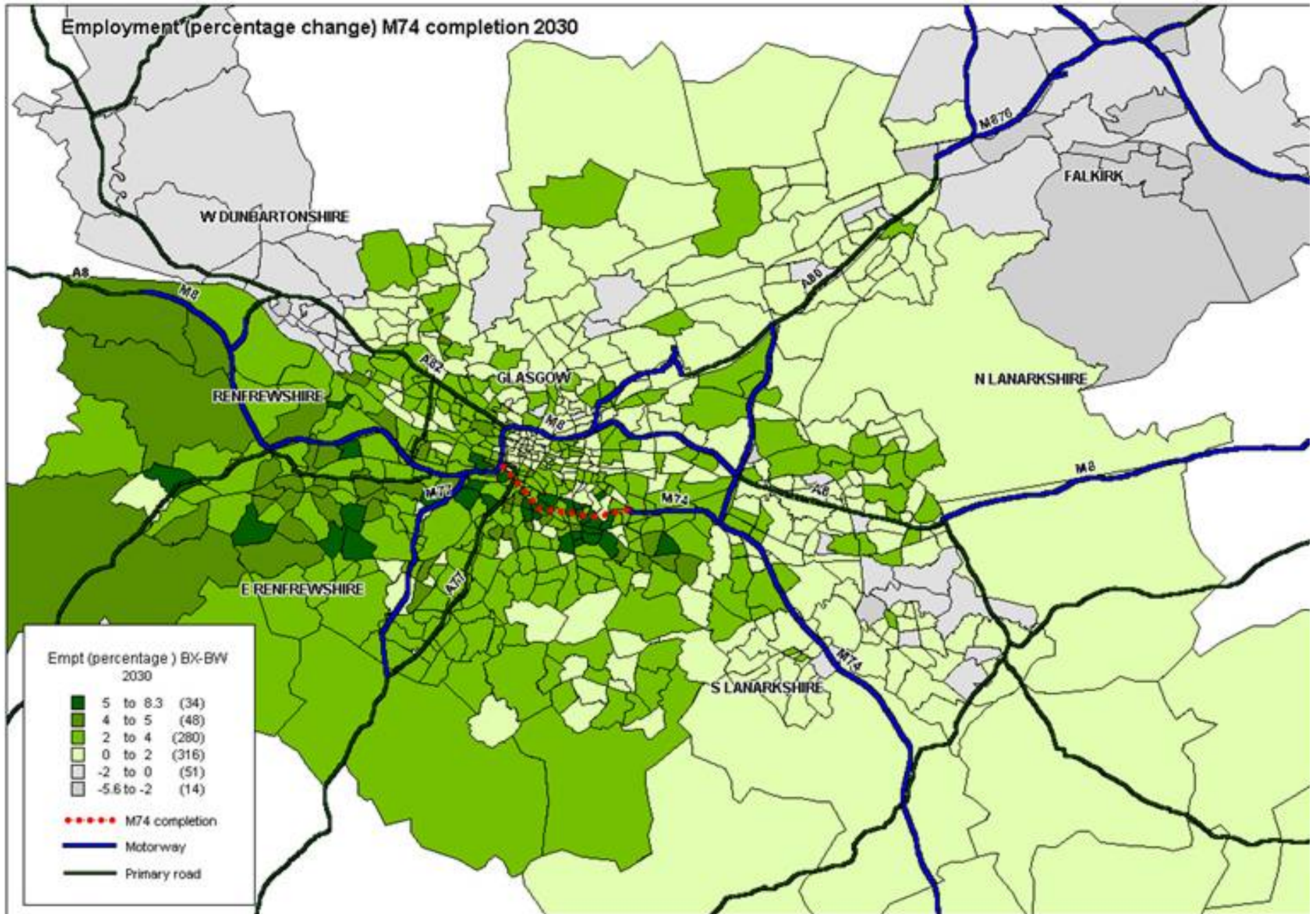
Greater Glasgow accessibilities (test BQ) 2005
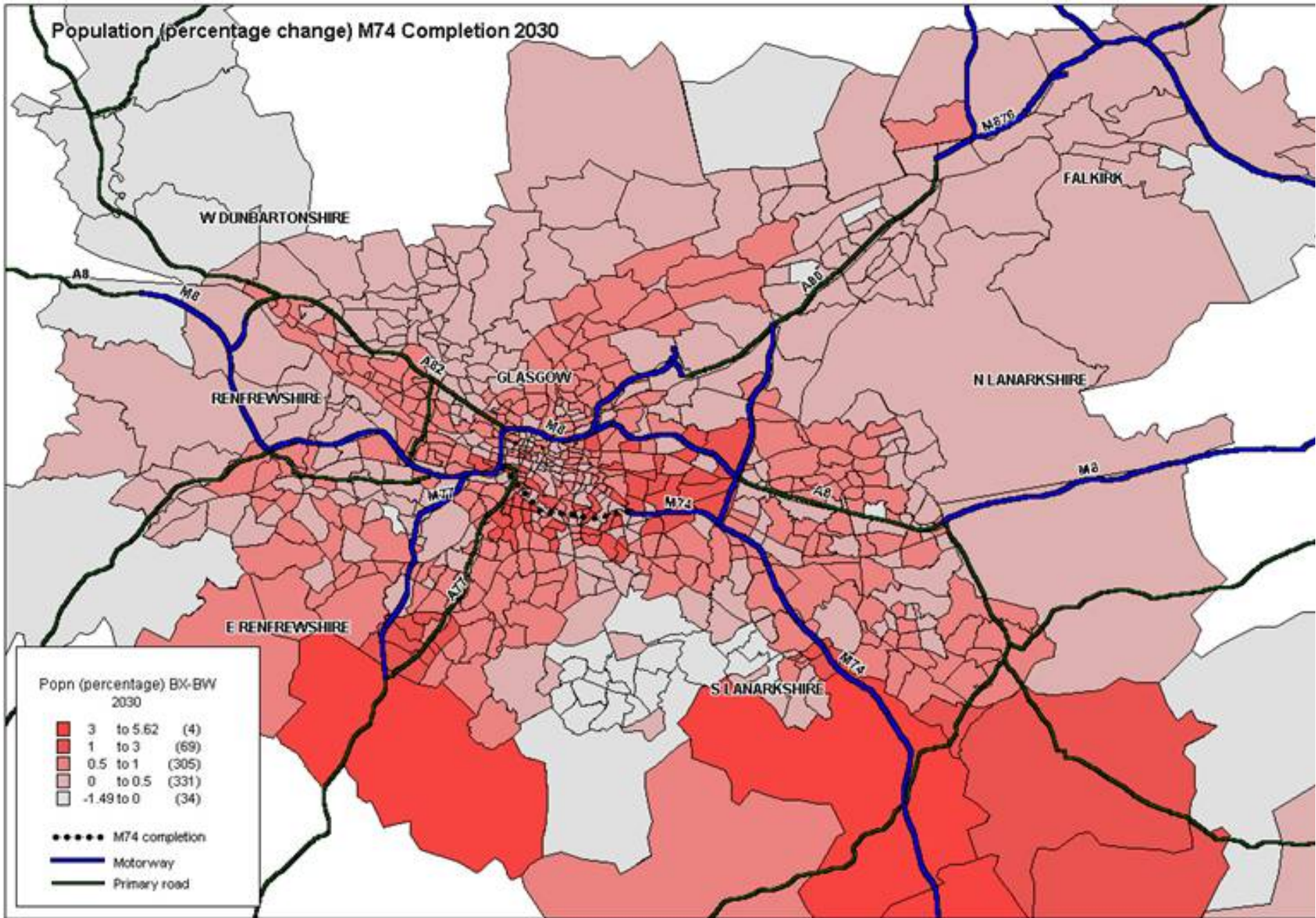
Glasgow/Lanarkshire Accessibilities

80 to 80.2	(1)
75 to 80	(1)
65 to 75	(18)
60 to 65	(117)
55 to 60	(293)
52 to 55	(210)
48.9 to 52	(103)

Aggregated areas BX-BW

Aggregated areas: employment BX-BW

% impact on employment

Legend:
- North
- Glasgow and Clyde Valley
- Forth
- Ayrshire
- Southern Scotland

X-axis: 2005, 2007, 2009, 2011, 2013, 2015, 2017, 2019, 2021, 2023, 2025, 2027, 2029

Y-axis: -2.5, -2.0, -1.5, -1.0, -0.5, 0.0, 0.5, 1.0, 1.5, 2.0, 2.5

Employment (percentage change) M74 completion 2030

W DUNBARTONSHIRE

RENFREWSHIRE

E RENFREWSHIRE

GLASGOW

N LANARKSHIRE

FALKIRK

S LANARKSHIRE

Empt (percentage) BX-BW
2030

- 5 to 8.3 (34)
- 4 to 5 (48)
- 2 to 4 (280)
- 0 to 2 (316)
- -2 to 0 (51)
- -5.6 to -2 (14)

•••••• M74 completion

——— Motorway

——— Primary road

Population (percentage change) M74 Completion 2030

W DUNBARTONSHIRE

FALKIRK

RENFREWSHIRE

GLASGOW

N LANARKSHIRE

E RENFREWSHIRE

S LANARKSHIRE

Popn (percentage) BX-BW
2030

3	to 5.62	(4)
1	to 3	(69)
0.5	to 1	(305)
0	to 0.5	(331)
-1.49	to 0	(34)

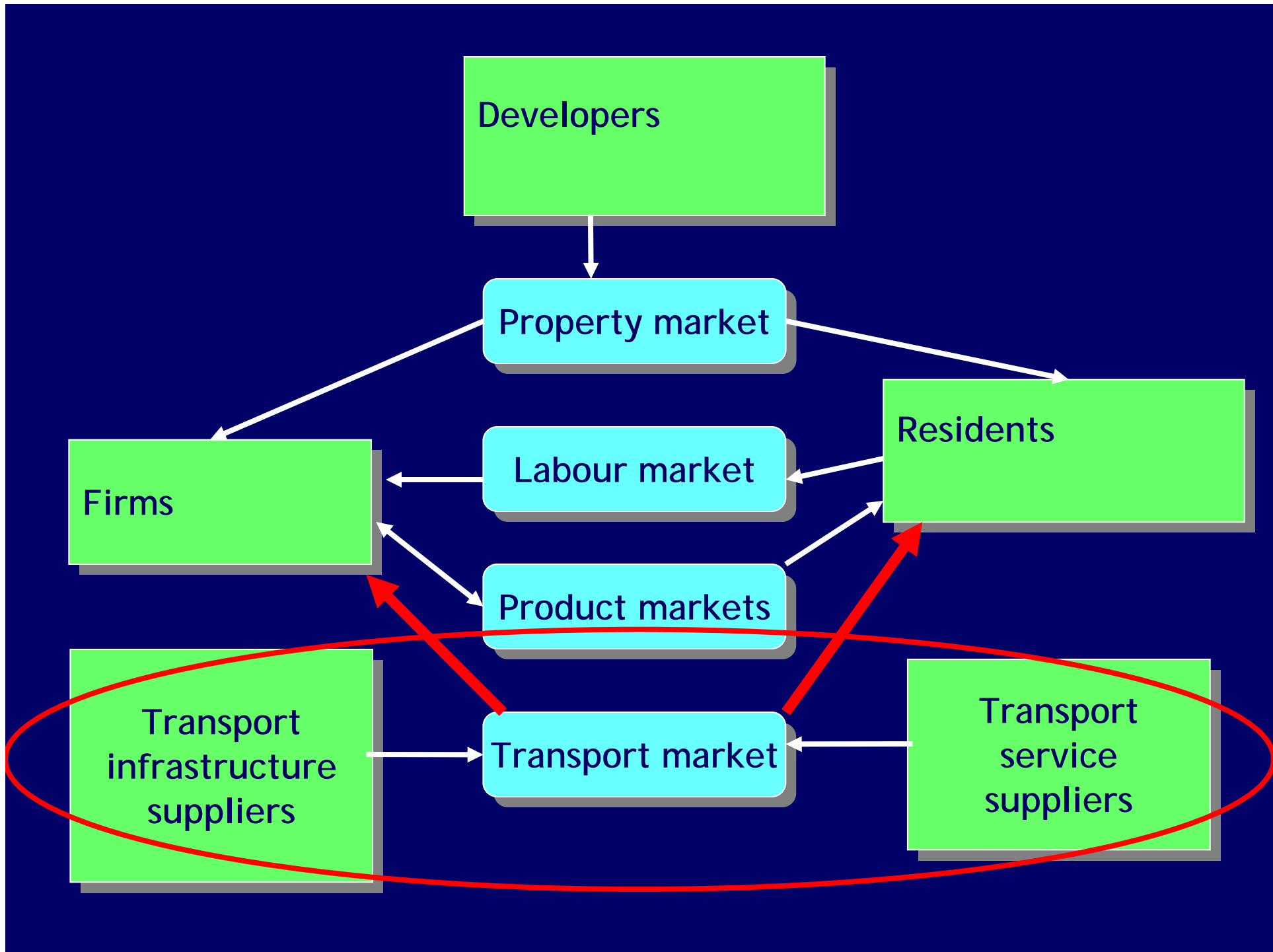••••• M74 completion

Motorway

Primary road

Conclusions

- LUTI modelling is making an increasing contribution to policy and project analysis in the UK

- To be effective this analysis must be timely...

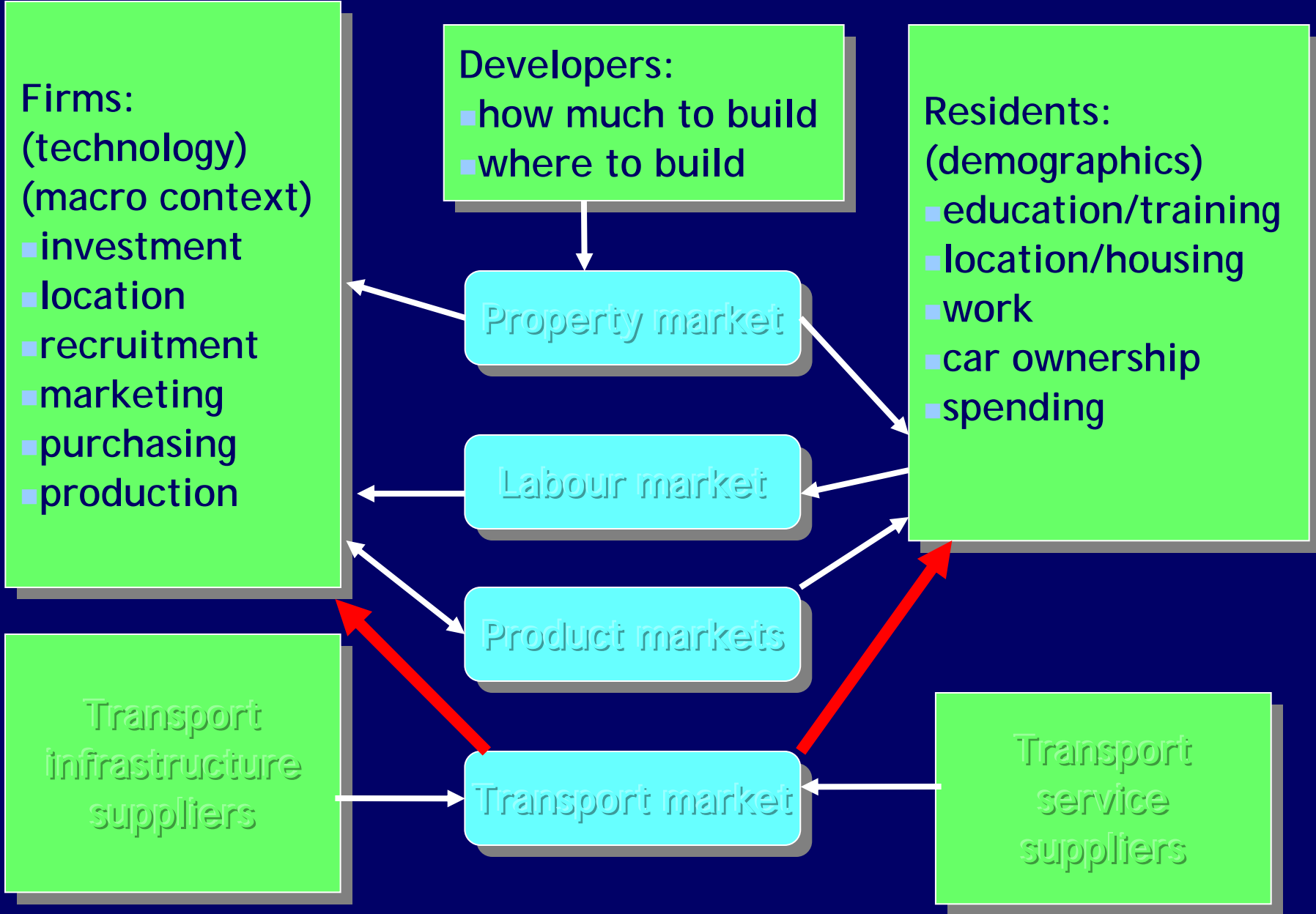- ... which requires investment in models in anticipation of specific questions.

For further details please contact
David Simmonds (dcs@davidsimmonds.com)
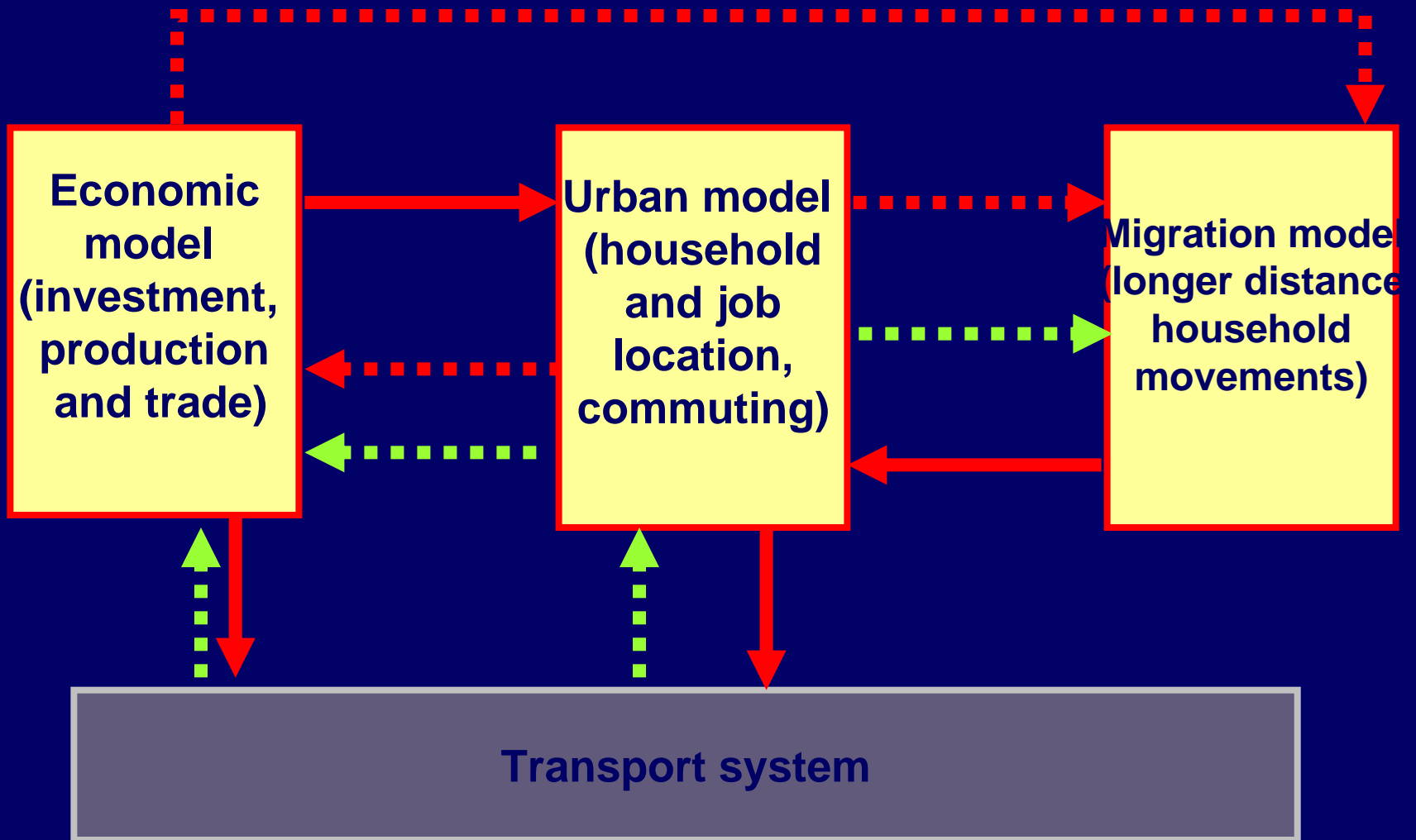Andy Dobson (acd@davidsimmonds.com)
or visit www.davidsimmonds.com

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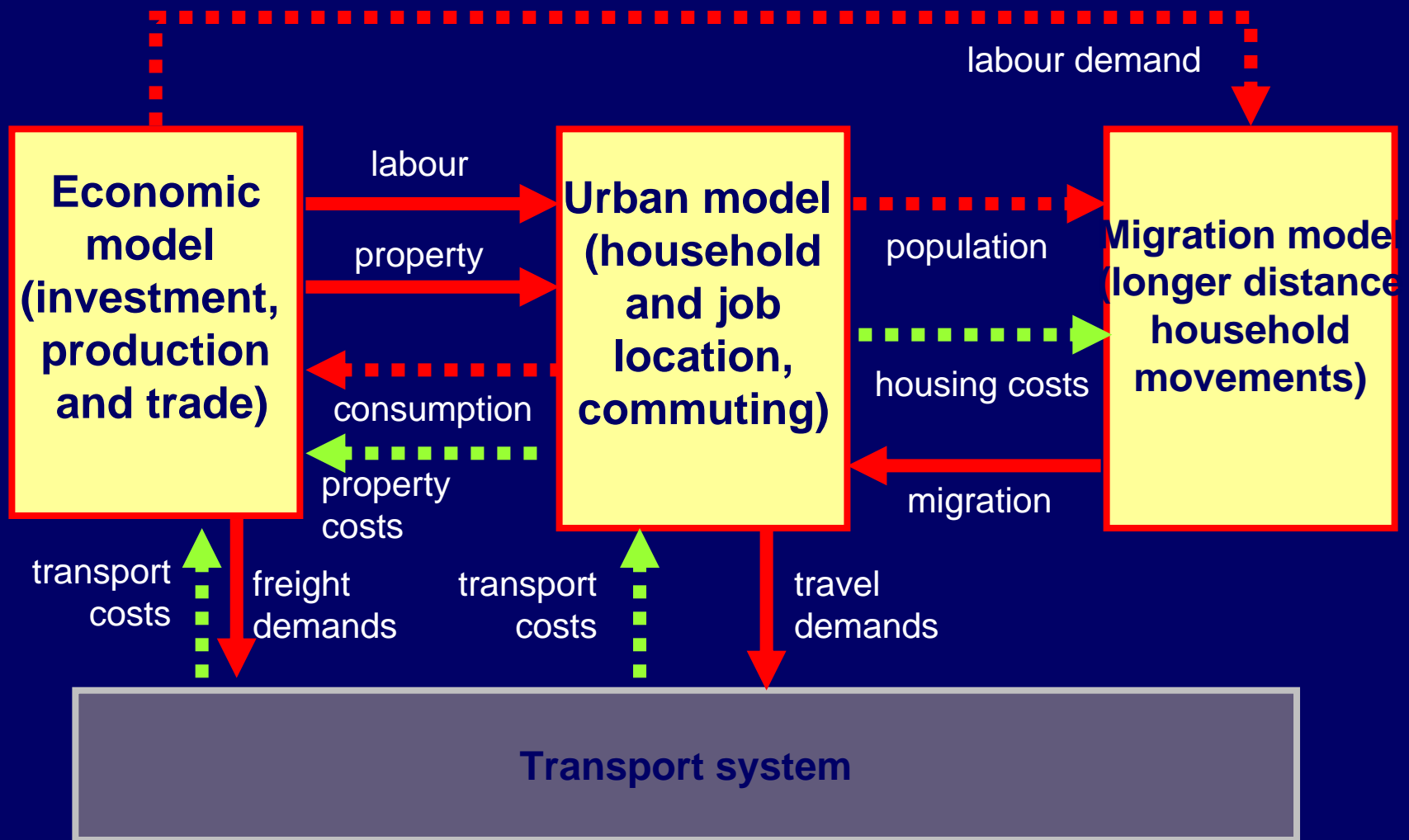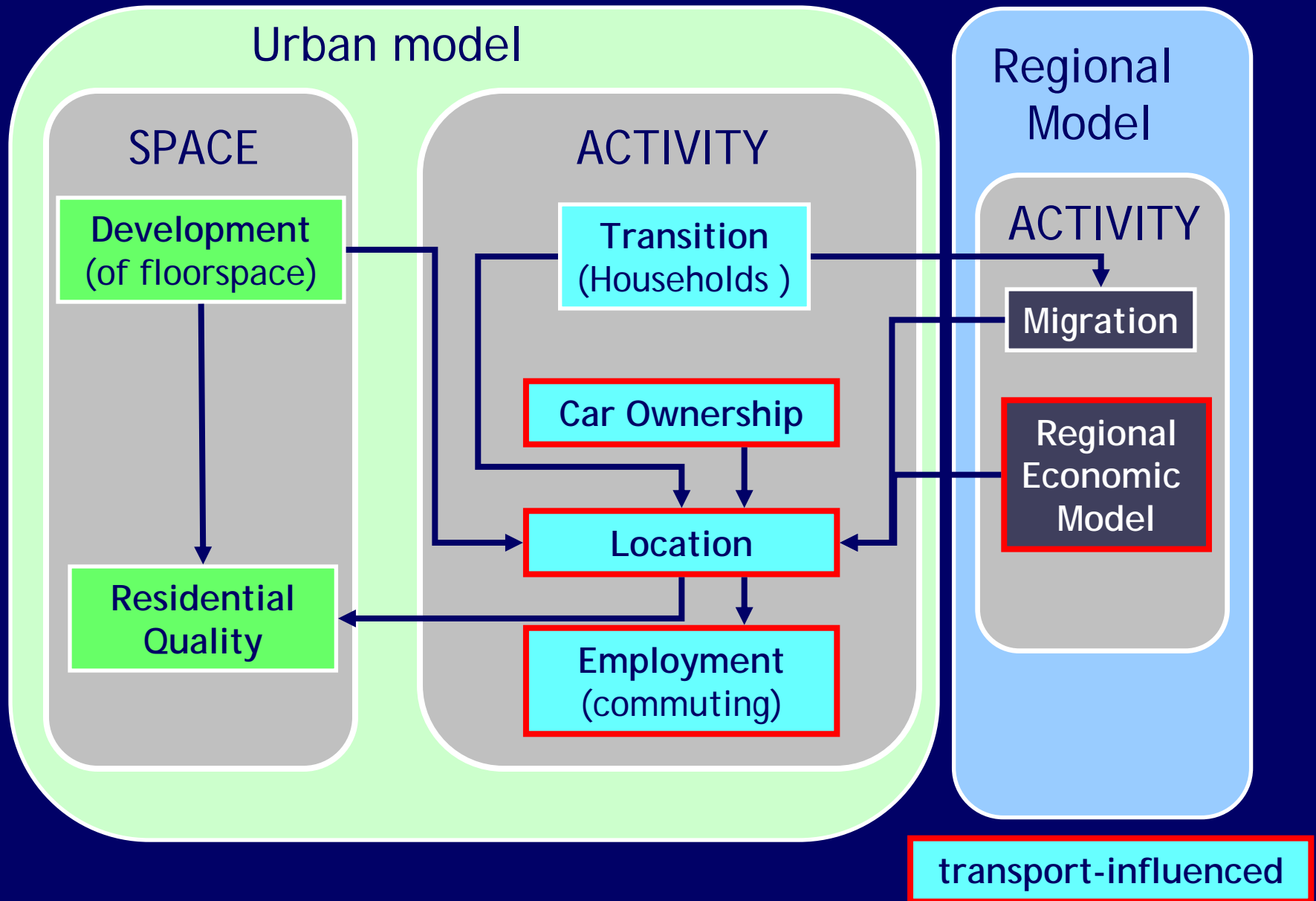fax +44 1223 313893
www.davidsimmonds.com
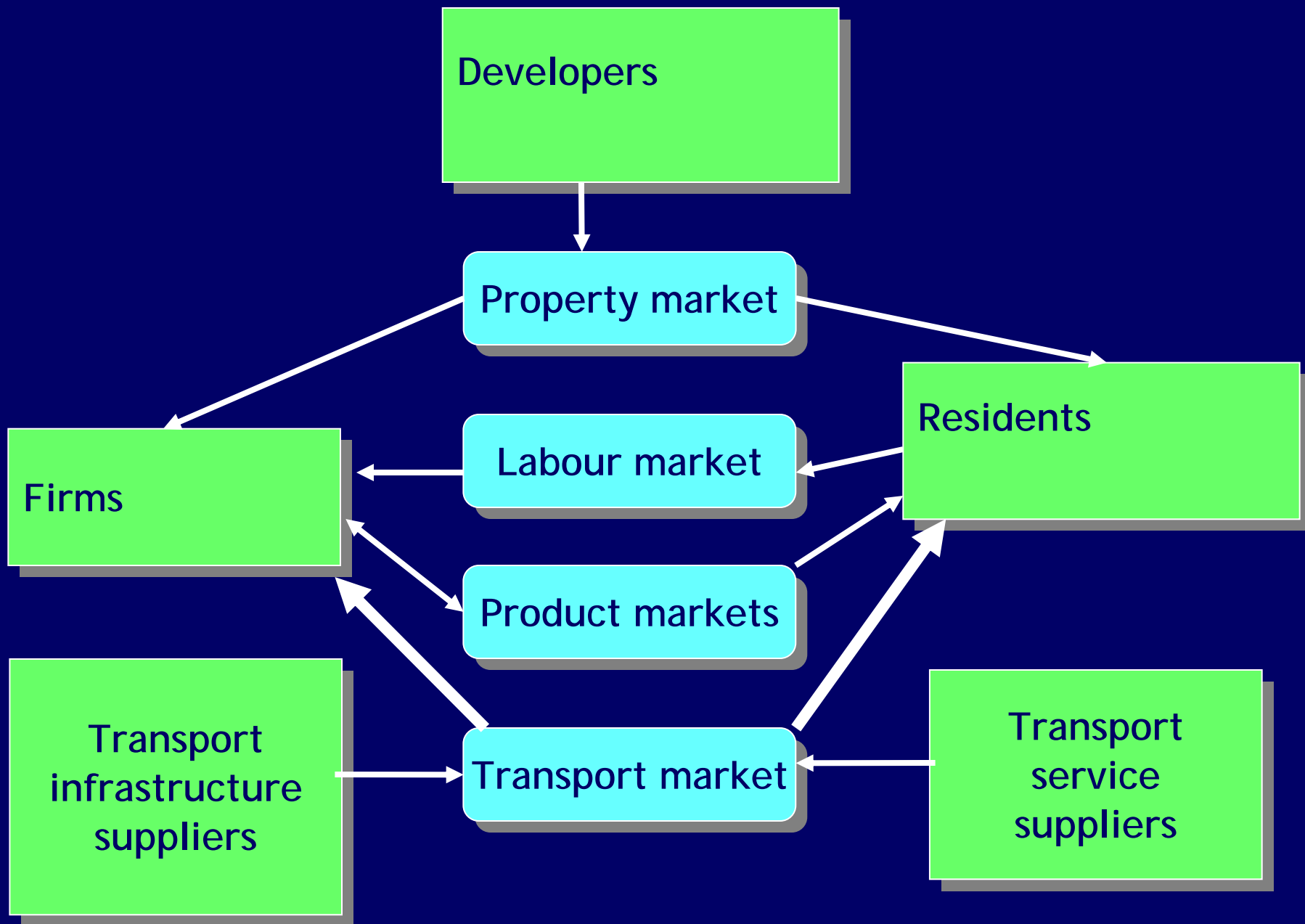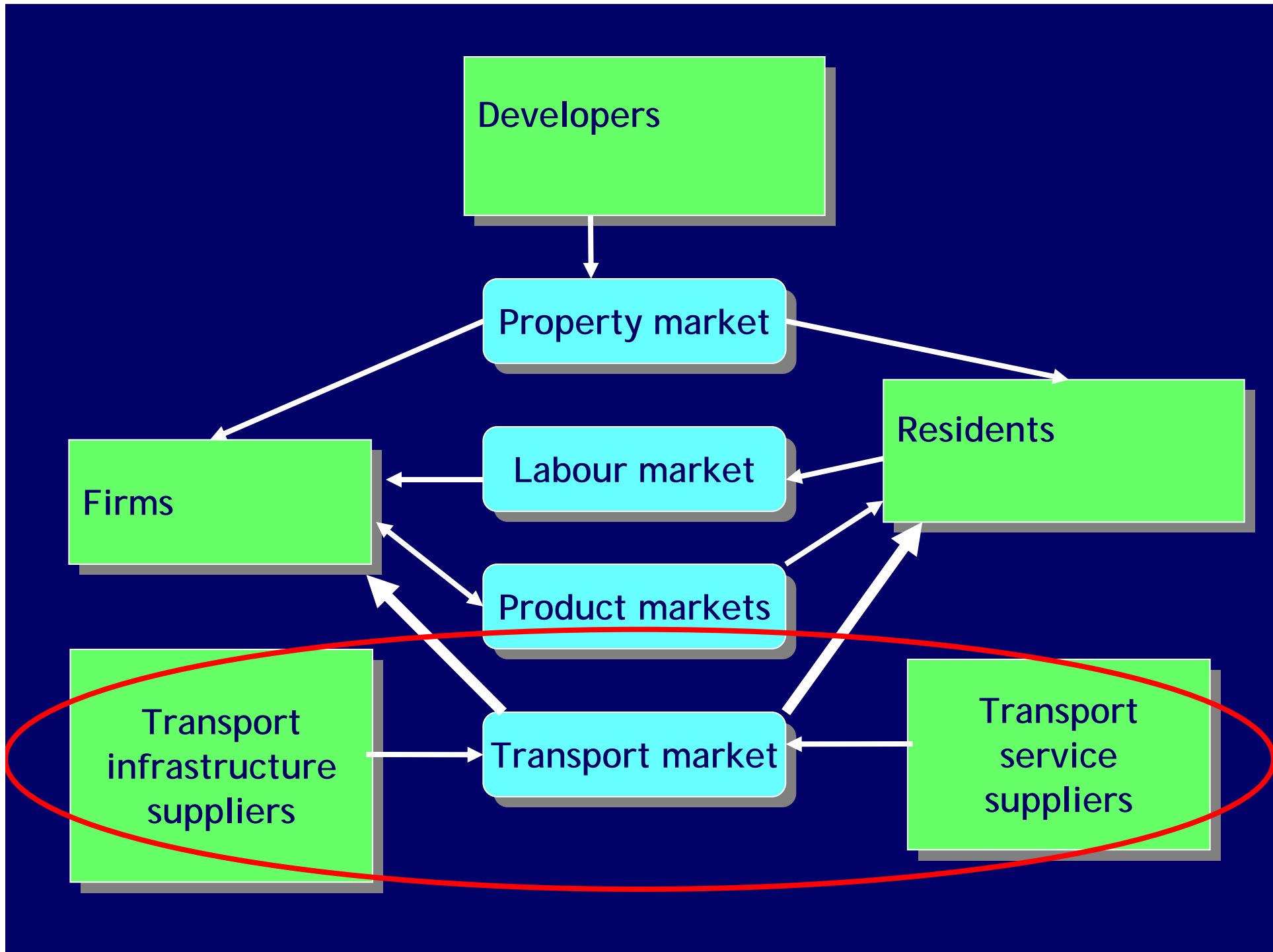
DELTA components within one time period

Urban model

SPACE

- **Development** (of floorspace)
- **Residential Quality**

ACTIVITY

- **Transition** (Households)
- Car Ownership
- Location
- **Employment** (commuting)

Regional Model

ACTIVITY

- Migration
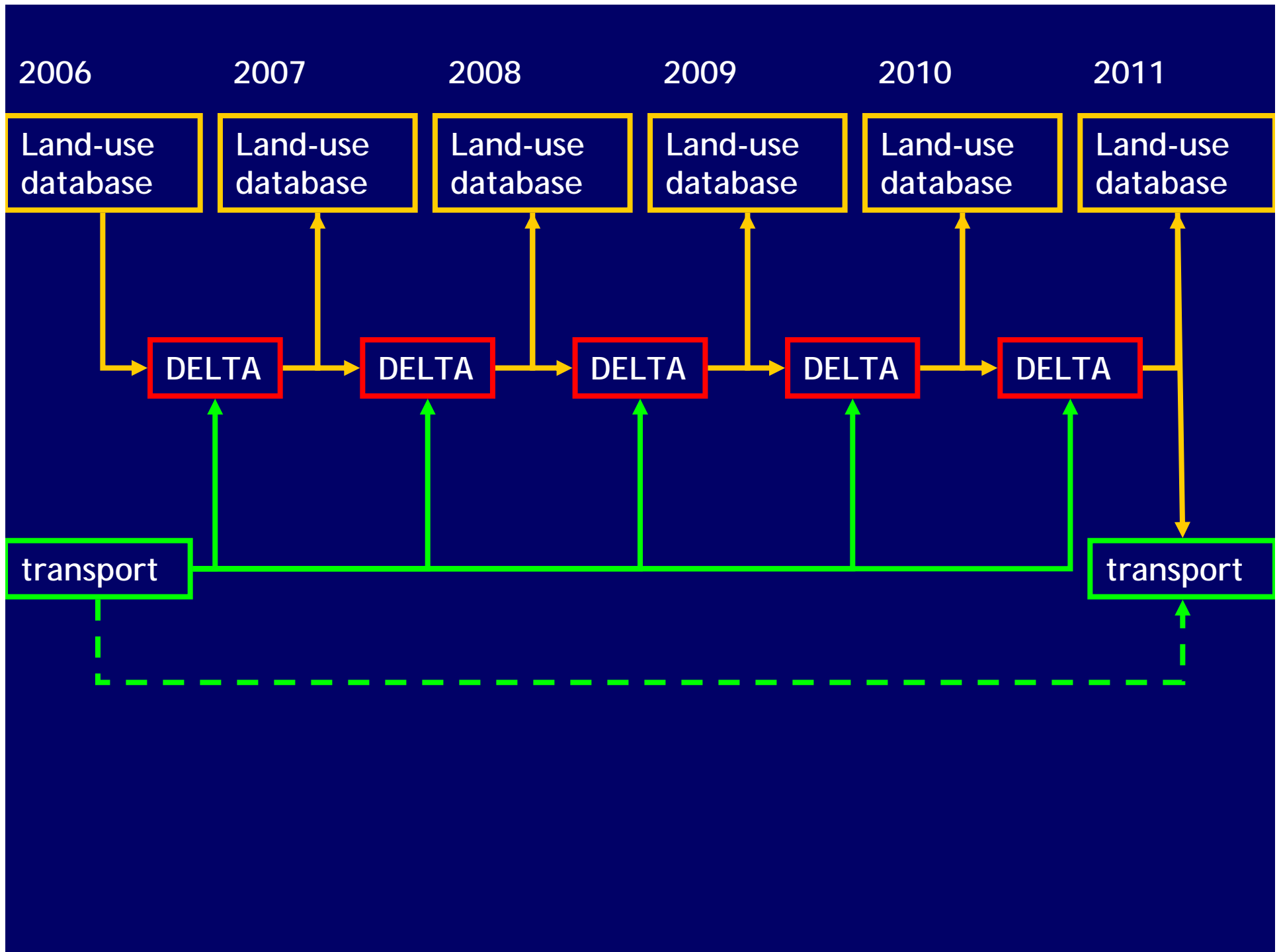- Regional Economic Model

transport-influenced

Dynamics

- Simple sequence of processes within one year
- Complex time-lagged linkages over time

Model is incremental in one year steps so

- starts from an observed database
- produces an updated database for each forecast year.

Area quality model

Main inputs

- average incomes by zone
- vacancy rates
- planning policies

Main outputs

- changes in housing quality due to occupiers' improvements or neglect

Working on applying quality to offices as well as housing

Household transition model

Main inputs

- households by type and zone at beginning of year

Main outputs

- households modified by life-cycle changes and socio-economic trends

- numbers of households needing to locate

Car ownership model

Main inputs

- income by household type
- licence-holding trends
- accessibility (advantage of car ownership)

Main outputs

- probability that a household of type h will own 0/1/2+ cars if locating in zone i
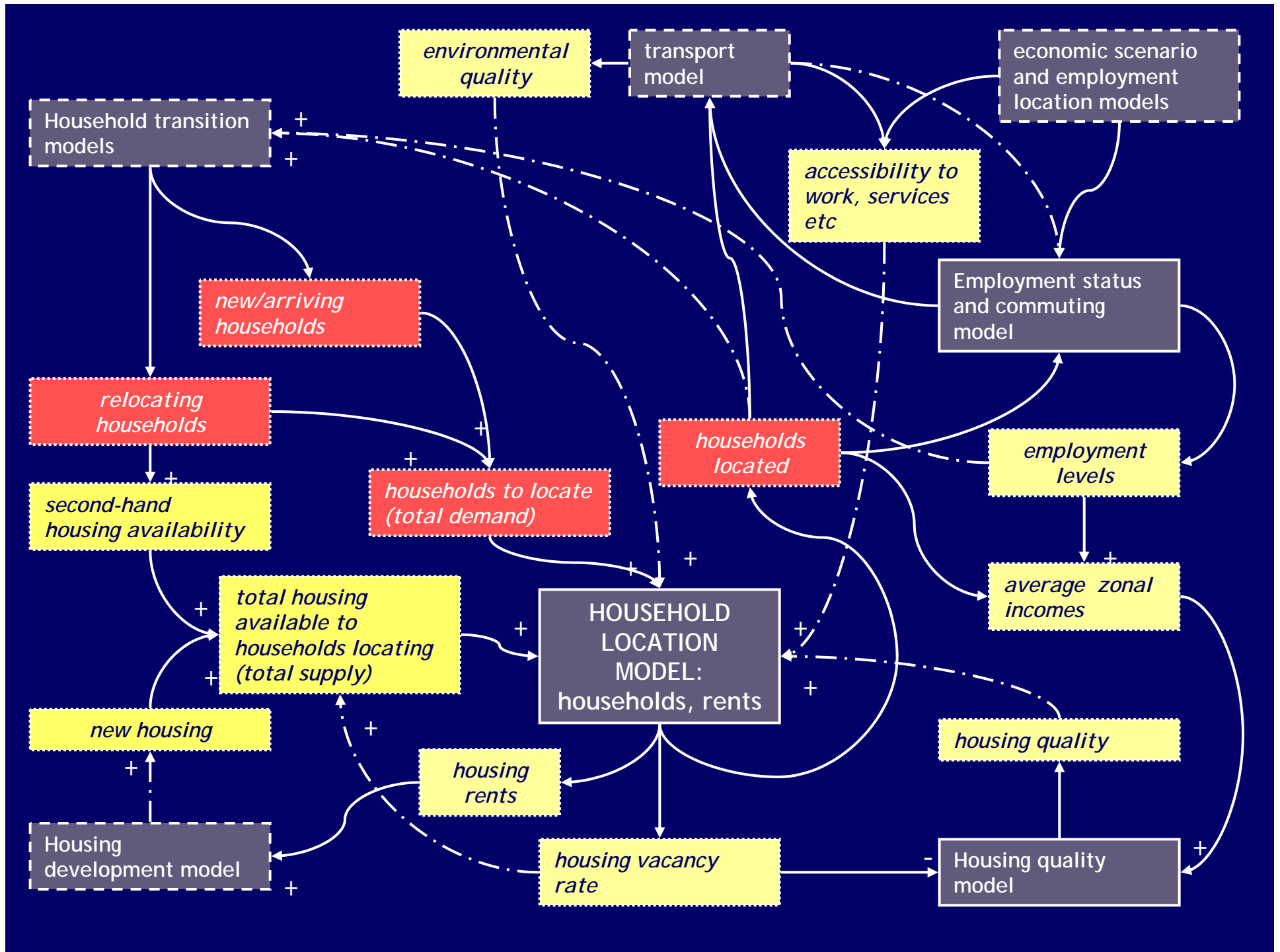
Household location model

Main inputs:

- income by household type
- households to be (re)located
- housing supply
- housing rent
- housing quality
- accessibilities
- environmental quality

Main outputs

- location of those households that are (re)locating in this year
- housing rents by zone
- vacant housing.

Key

Housing quality model	Sub-model
economic scenario and employment location models	Sub-model interacting with other components (outside diagram)
new/arriving households	Household variables
second-hand housing availability	Housing variables
employment levels	Ratio and price/rent variables
→	Immediate linkage
–·–·–·–·→	Time-lagged linkage
+ –	Direction of influence

Employment status model

Main inputs:

- demand for labour (employment location)

- supply of labour

- expected commuting pattern or generalised costs of commuting (from transport model)

Main outputs

- numbers of workers per household (and hence household incomes)

- travel-to-work pattern (adjusted for land-use changes);

- also updates non-working population.

Employment location model

Main inputs:
- jobs to be located
- floorspace supply
- floorspace rent
- (floorspace quality)
- accessibilities
- (environmental quality)

Main outputs
- location of those jobs that are being (re)located in this year
- floorspace rents by zone
- vacant floorspace.

NB separate models by floorspace type.

Regional economic model

Main inputs: changes in

- consumer final demand

- other final demand (economic scenario)

- transport costs

Main outputs

- production and value-added by area

- trade pattern

- investment/disinvestment by area.

The REM incorporates a spatial input-output model which differs from standard applications in being influenced by the investment model.

Migration model

Main inputs:

- numbers of households (potential migrants)
- employment opportunities
- housing costs
- environmental variables

Main outputs

- numbers of households moving between areas.

Land-use – transport linkage

Minimum data passed to transport model:

- population, employment

More complex applications:

- persons by type, household structure and household car-ownership
- employment by sector
- other attractors eg retail floorspace
- travel-to-work and trade (freight) matrices.

All by zone/zone pair for transport model years.

Transport – land-use linkage

Minimum data returned from transport model:

- cost and time matrices

More complex applications:

- cost/time/generalised cost matrices by mode, purpose, time of day

- trip or tour matrices

- environmental impacts of transport.

All by zone/zone-pair for each transport model year.

Accessibilities

Various different measures of accessibility calculated as influences on

- household location (urban level)
- employment location (urban level)
- car ownership (urban level)
- commuting (urban level)
- investment (regional level)
- trade and production (regional level).

Data sources - implementation

- Household/population, TTW and housing from Census

- Employment from Census (plus sectoral estimates in England & Wales)

- Commercial floorspace based on ODPM data.

- Housing prices from Land Registry

- Commercial rents based on VOA and other sources.

Typical dimensions

- 20 household types (10 household compositions * 2 socio-economic groups)
- 4 person types (including non-household population)
- 10-20 employment sectors
- 5 floorspace types (including housing)
- 50-1200 zones
- up to 30 years forecast.

Data sources - calibration

- Existing applications calibrated mainly using results from other research and own professional judgement

- Highly desirable (though not necessary) to make more use of formal (statistical) calibration, which would imply

- new household and business surveys (SP and RP).

Practicalities (1)

- Basic DELTA application takes 3-4 months for simple application, 6-8 months for complex case (new surveys and formal calibration would take longer again)

- Integration with transport model requires care to achieve consistency; most of this can be done in parallel, but

- allow substantial part of any project for model testing and adjustment.

Practicalities (2)

- DELTA typically takes 2-10 minutes per year
- Runs in DOS window; simple commands, all inputs in data files; GUIs for setting up and analysing tests.
- Fully integrated with "fast" transport models for automatic overnight runs
- Manual linkage with "slow" transport models.