



TELMoS: the Transport/Economic/ Land-use Model of Scotland

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Presentation structure

- The DELTA package
- The Scottish context
- The TELMoS (the Transport/Economic/Land-use Model of Scotland) family of models
- Implementing TELMoS
- Calibrating TELMoS
- Applications of TELMoS and related models

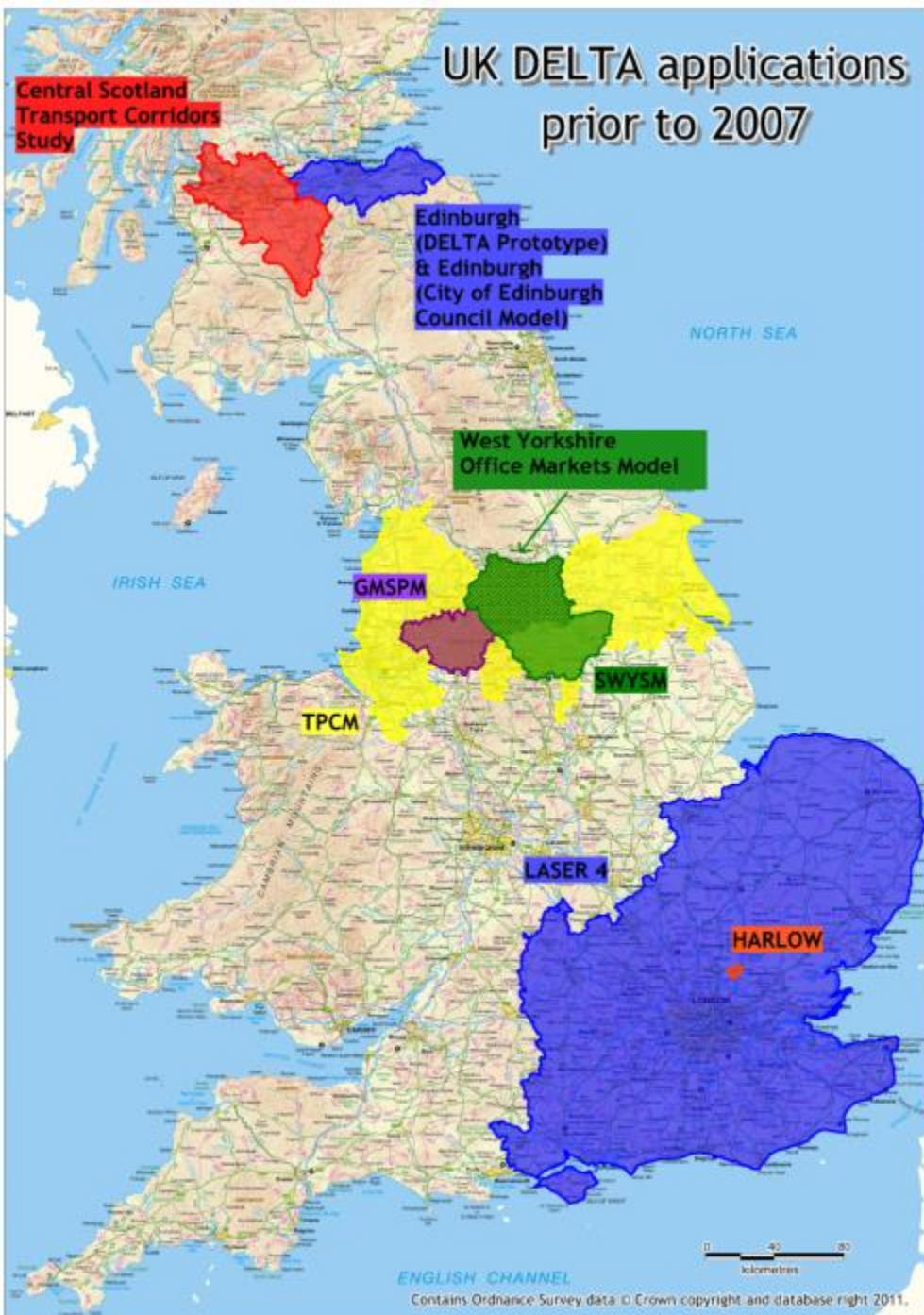


Background - the DELTA package

- Development of DELTA started in 1995, to meet a perceived demand for a land-use modelling system that could be linked to fairly standard transport models
- Prototype was applied to Edinburgh, in collaboration with ITS Leeds, MVA Consultancy and City of Edinburgh Council
- First major consultancy application was for GMPTE, as part of GMSPM
- This was followed by the Trans-Pennine Corridor Model, which involved adding a “regional” level in addition to the “urban” one
- Since then, DELTA has been quite widely used in the UK, plus a major application in New Zealand and several small academic applications elsewhere.

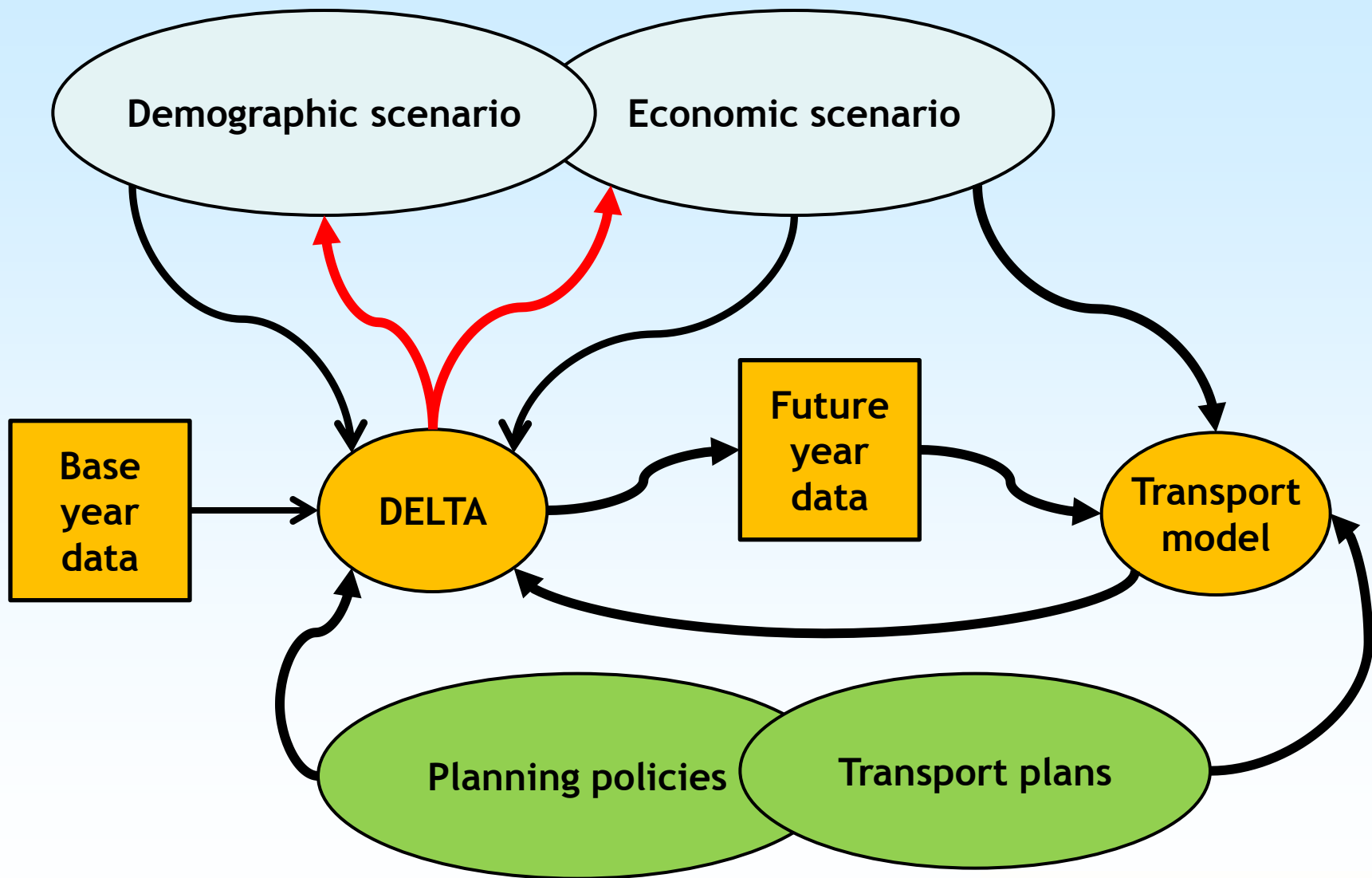


UK DELTA applications prior to 2007



UK DELTA applications in use 2007-2011





LUTI model contents

Main land-use processes:

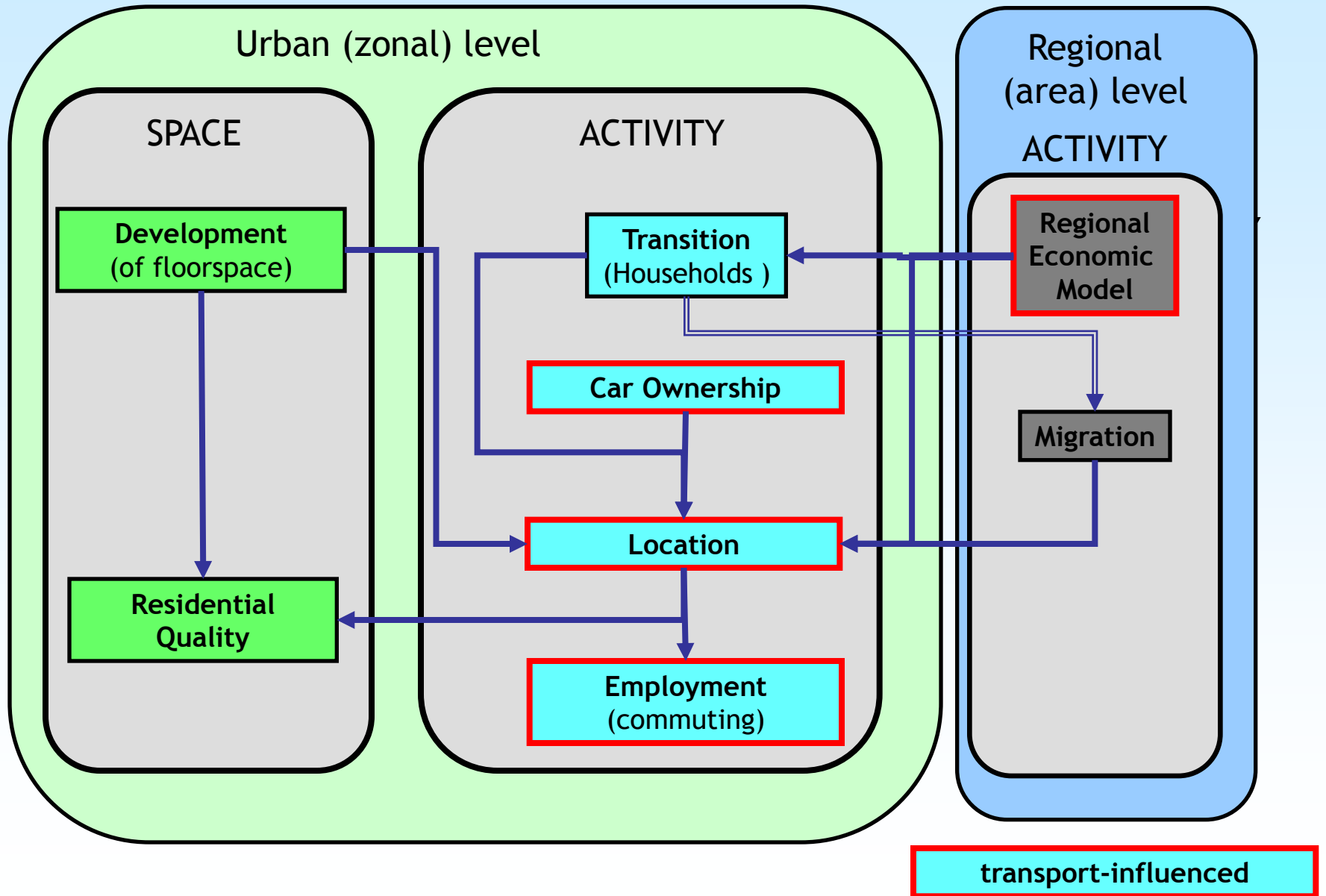
- Demographic change, migration
- Economic output, employment
- Physical development - floorspace, housing
- Car ownership
- Household and job location (in property markets)
- Whether/where to work
- Change in quality of housing

Main transport choices (usually)

- how often to travel
- when to travel
- destination choice
- mode choice
- route choice
- congestion effects (roads, public transport, parking)

[transport model is outside DELTA]

DELTA components: sequence within one time period



Model forms - discrete choices

Discrete choice models use various forms of logit model:

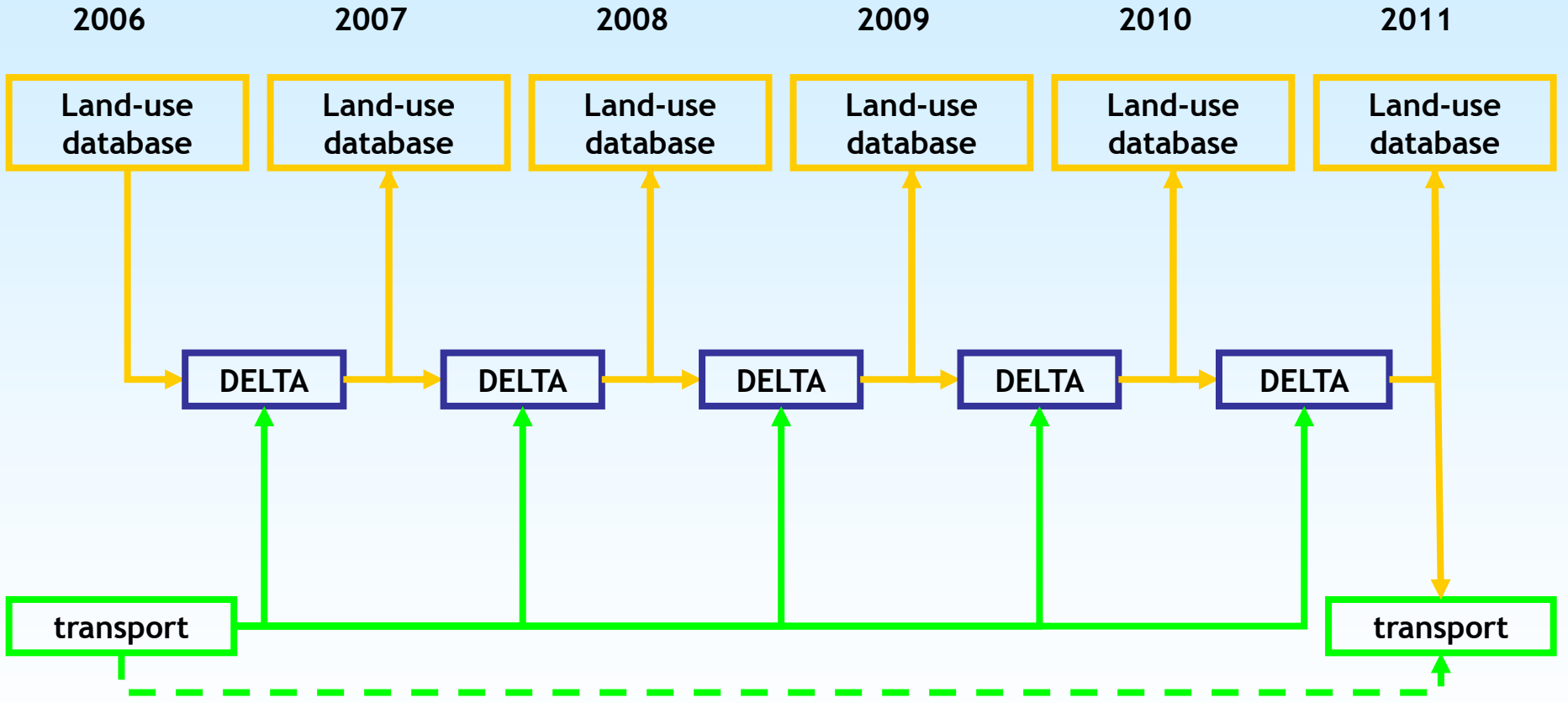
- hierarchical, cross-sectional model of destination and mode use used in calculating accessibilities (we use the resulting logsum values, not the mode and destination shares)
- incremental logit models of location (zone) choice in locating jobs and households
- incremental hierarchical logit (with saturation levels) for car ownership [incremental, zonal application of a Department for Transport model]
- absolute logit model to locate increments of development
- some forms of the model use incremental logit model of whether and where to work
- trade model uses a cross-sectional model of where inputs will be obtained.

Model forms

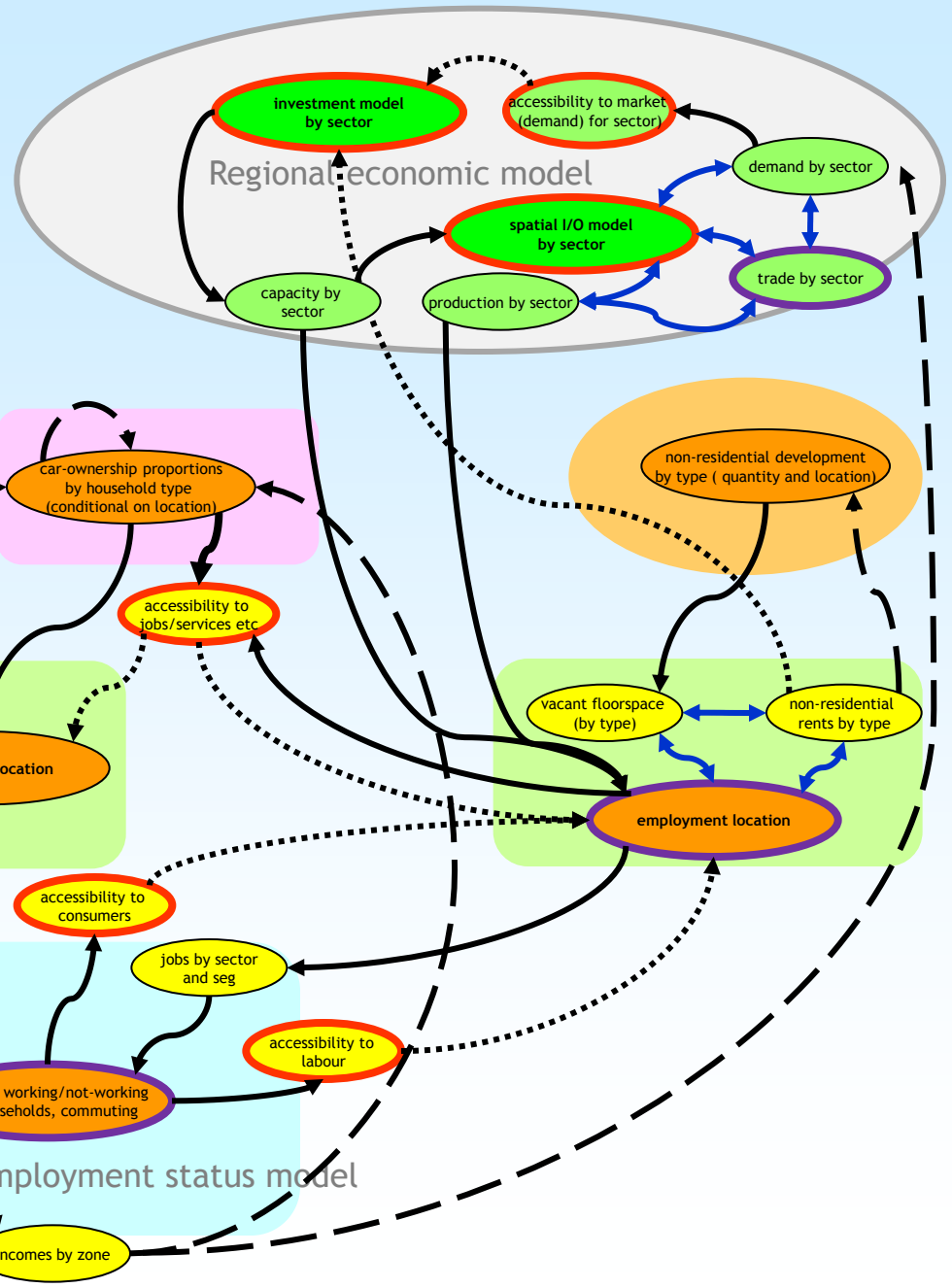
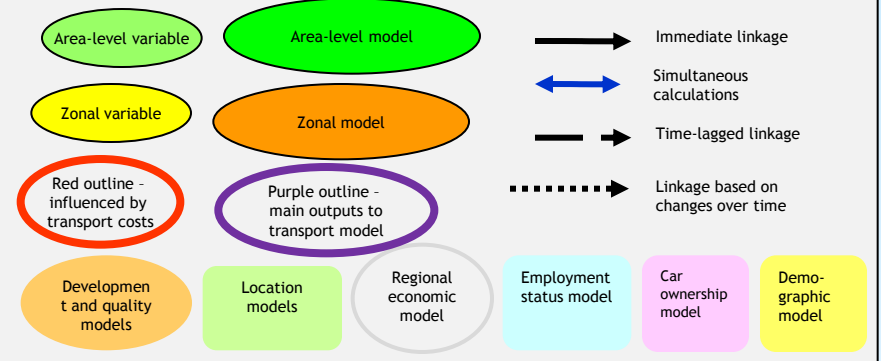
Continuous models are quite diverse:

- Total development of each floorspace type started each year: linear or multiplicative
- Household expenditure: Cobb-Douglas or Stone-Geary functions
- Input-output model: most of the coefficients are fixed, so production is a linear function of demand





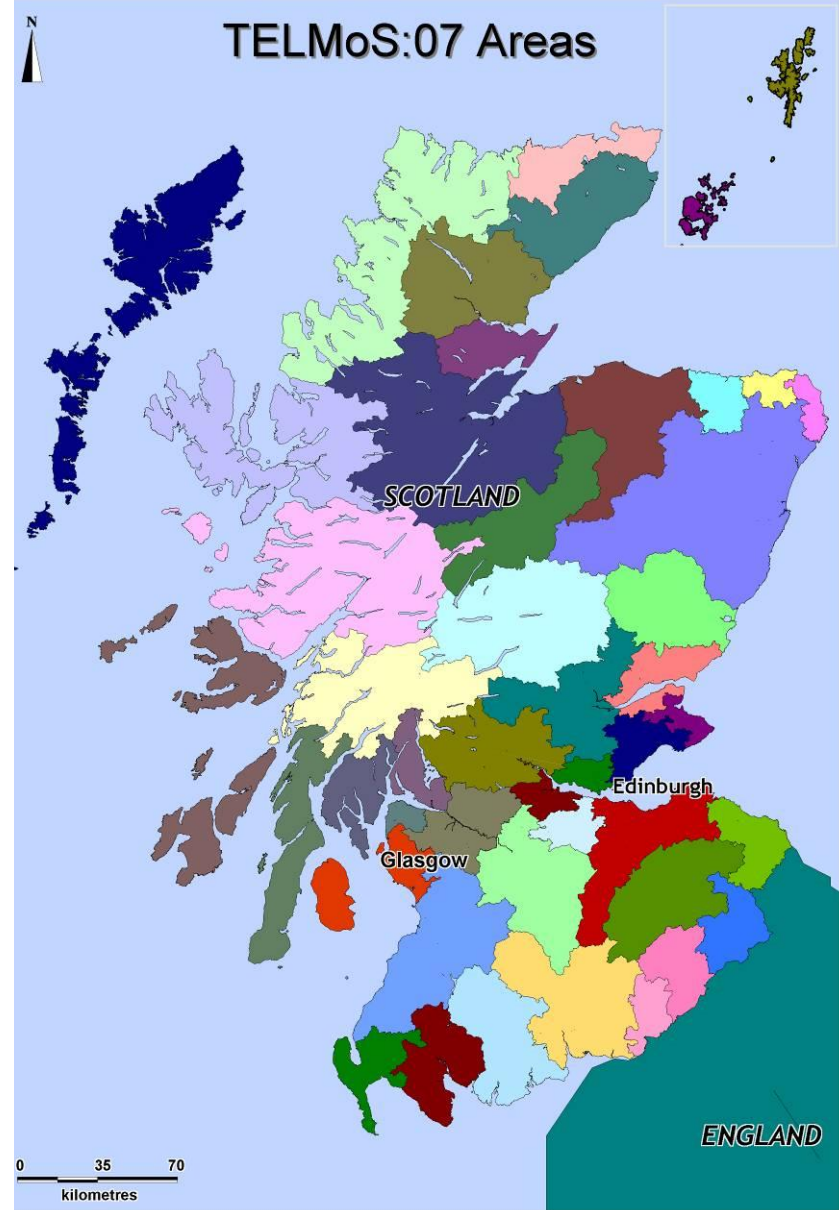
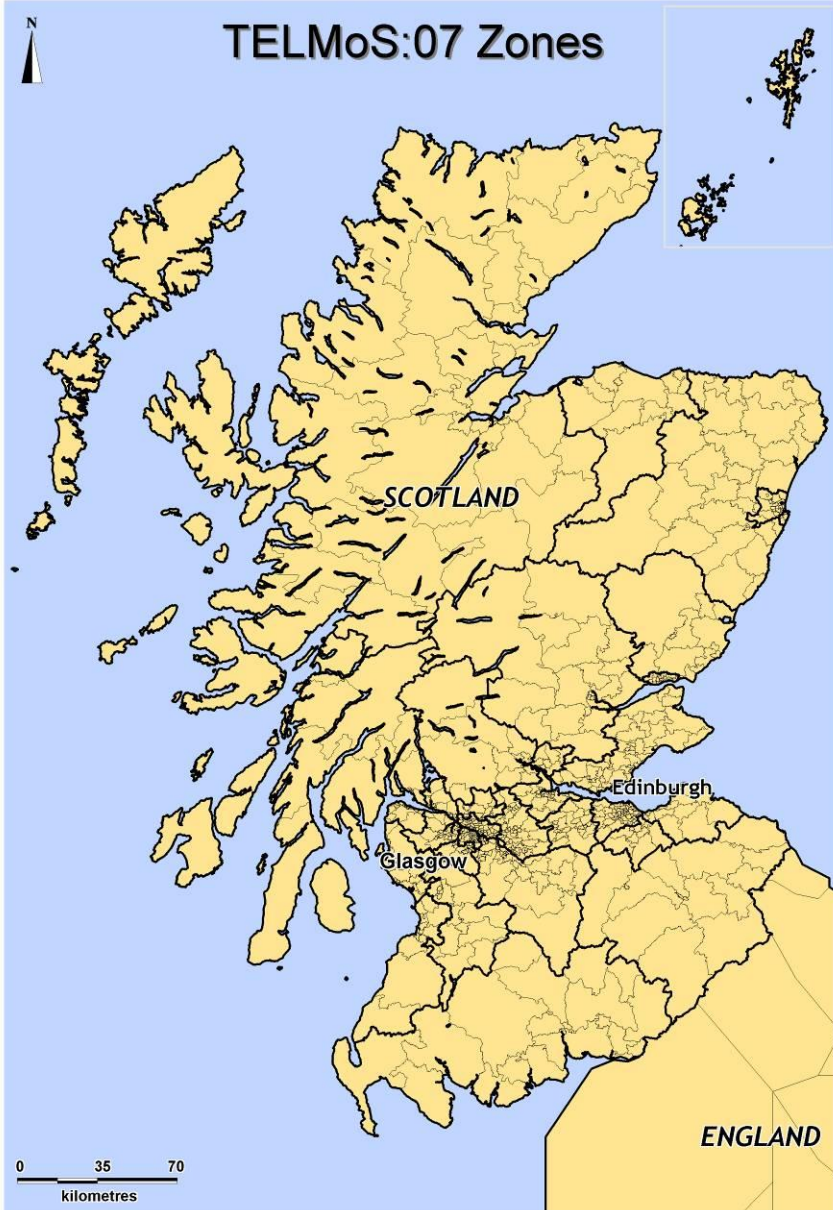
DELTA model linkages (c0.15 PN 22/08)



The Scottish context for modelling

- 1999: restoration of the Scottish Parliament, with a Scottish Executive (renamed Scottish Government in 2007), with devolved powers in planning, transport, environment and economic development
- 2000:
 - Edinburgh: New Transport Initiative - focus on public transport investment supported by road user
 - Glasgow: Central Scotland Transport Corridor Studies - focus on highway investment
- Land-use/transport interaction modelling commissioned in both areas
- The LUTI model developed for the Glasgow sub-region was gradually adopted by Scottish Government (now through Transport Scotland) and extended to cover the whole country as LATIS.





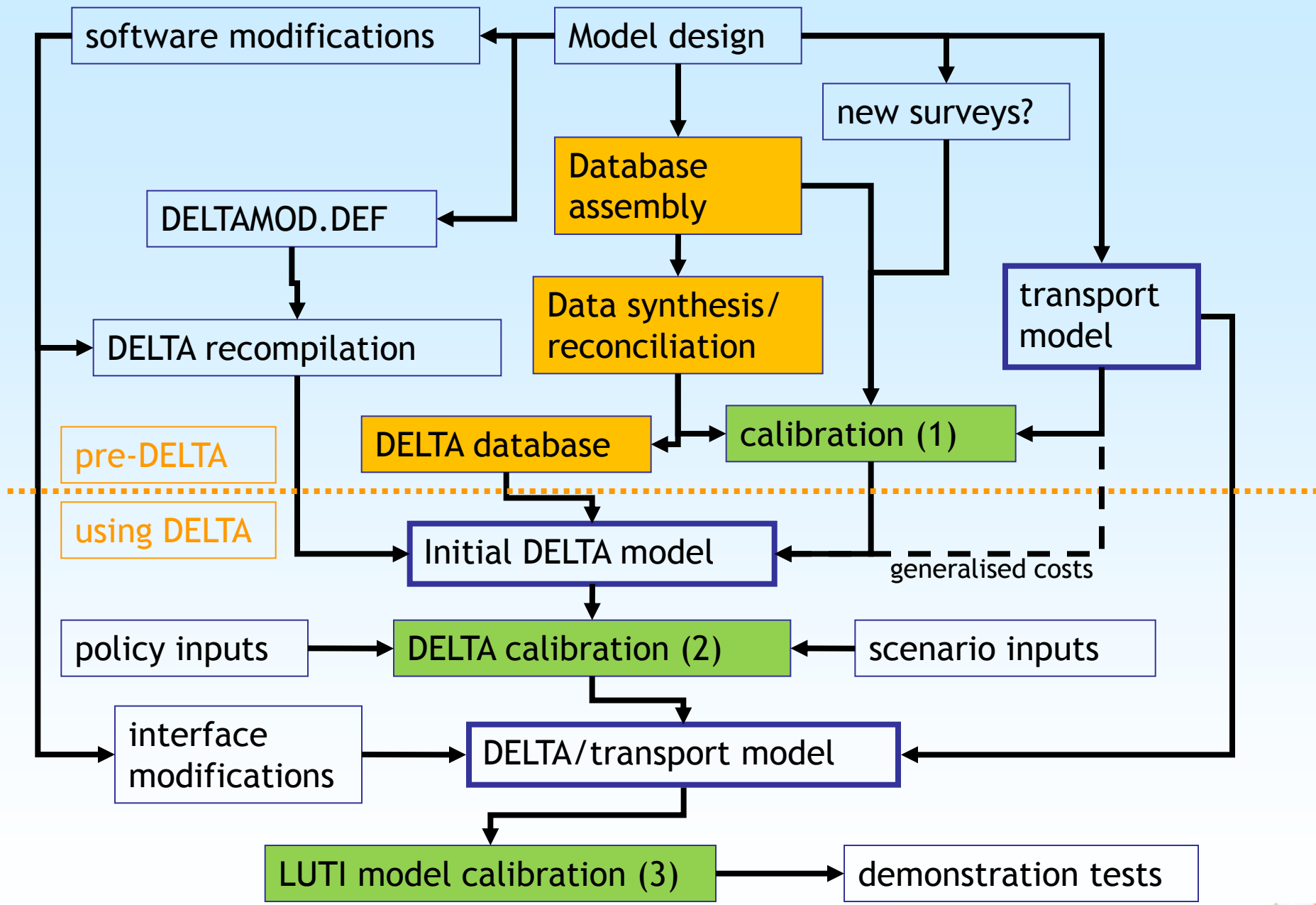
TELMoS:07 definitions/key features

- 720 zones
 - 712 fully-modelled
 - 8 external
- 50 areas
 - 47 areas - based on the 2001 Travel to Work Areas
 - 3 external areas
 - Rest of the UK
 - Rest of the world via UK
 - Rest of the world
- 20 household types * 4 person types, plus persons not in households
- 27 employment activities grouped into 10 economic sectors
- 7 floorspace types
- 5 purposes / 7 measures
- 3 Car-ownership levels
- Transport model every five years



DELTA implementation and calibration





Starting database

- DELTA requires an extensive database for its base year
- Ideally this is a Census year
- Usually it isn't!
- Usual procedure is to create the database in the most recent Census year and to model the changes since then by running the model with constraints to impose observed changes

Scenarios

- Demographic scenario (households and persons) usually taken from official projections
- This has to be reproduced in terms of household changes over time
- Economic/employment scenario also usually taken from official projections
- This has to be reproduced in terms of changes in incomes and exports (or more complex changes)
- [Other DELTA applications for smaller regions are implemented so that a Base run of the model matches the given scenarios, then the totals can vary in Alternative runs]

Calibration approach	Example applications
Own analysis of observed data	LLITM residential relocation model
Analysis of synthetic data (from microsimulation modelling)	Household transition models
Matching data reported by others	Range of floorspace/worker values Household mobility rates
Direct use of coefficients estimated by others	Car-ownership model
Reproducing elasticities (etc) reported by others	Effect of accessibility improvement on residential rents
Reproducing elasticities (etc) implied by the coefficients reported by others	Effect of changing employment opportunities on rates of migration
Matching to “stylized facts”, professional judgement	Choice of variables in migration model Overall “reasonableness” of each component and of the model as a whole



Ways of using coefficients from other research

Independent results may give

- coefficients which we can use directly as inputs [possibly with adjustment over time]
- average coefficients, around which we estimate variations eg by income group
- values we can check analytically eg by examining the ratios of our own coefficients
- values we can check by running part of the model once
- values we can check by comparing two runs of parts of the model
- values we can check by comparing two runs of the full model (ie over several years).

“Check” can mean that anything from “adjusting model coefficients to match the independent result to 3 significant figures”, to “comparing the general trends”.

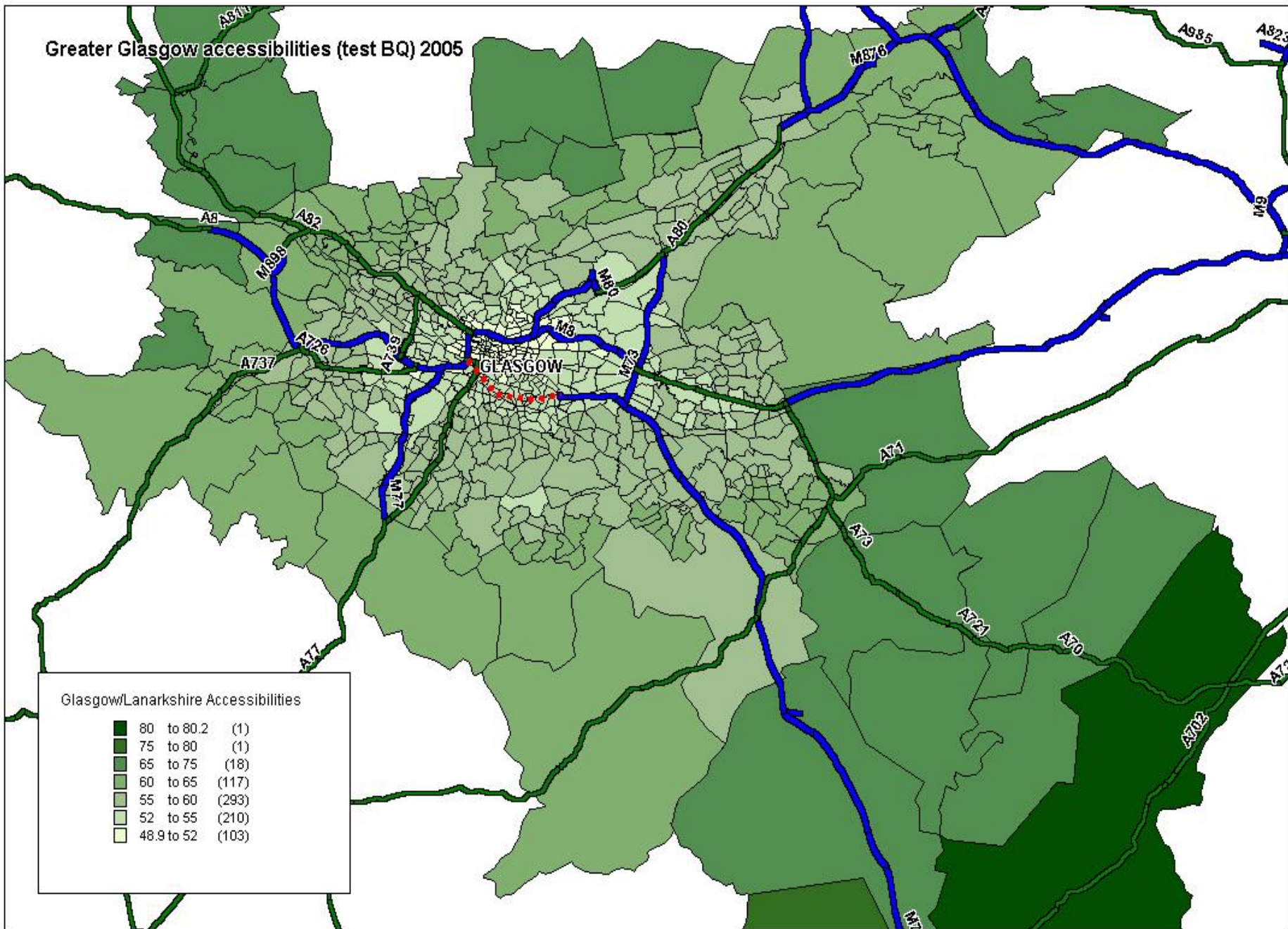


Statistical analysis of results to compare a relationship with an independent coefficient

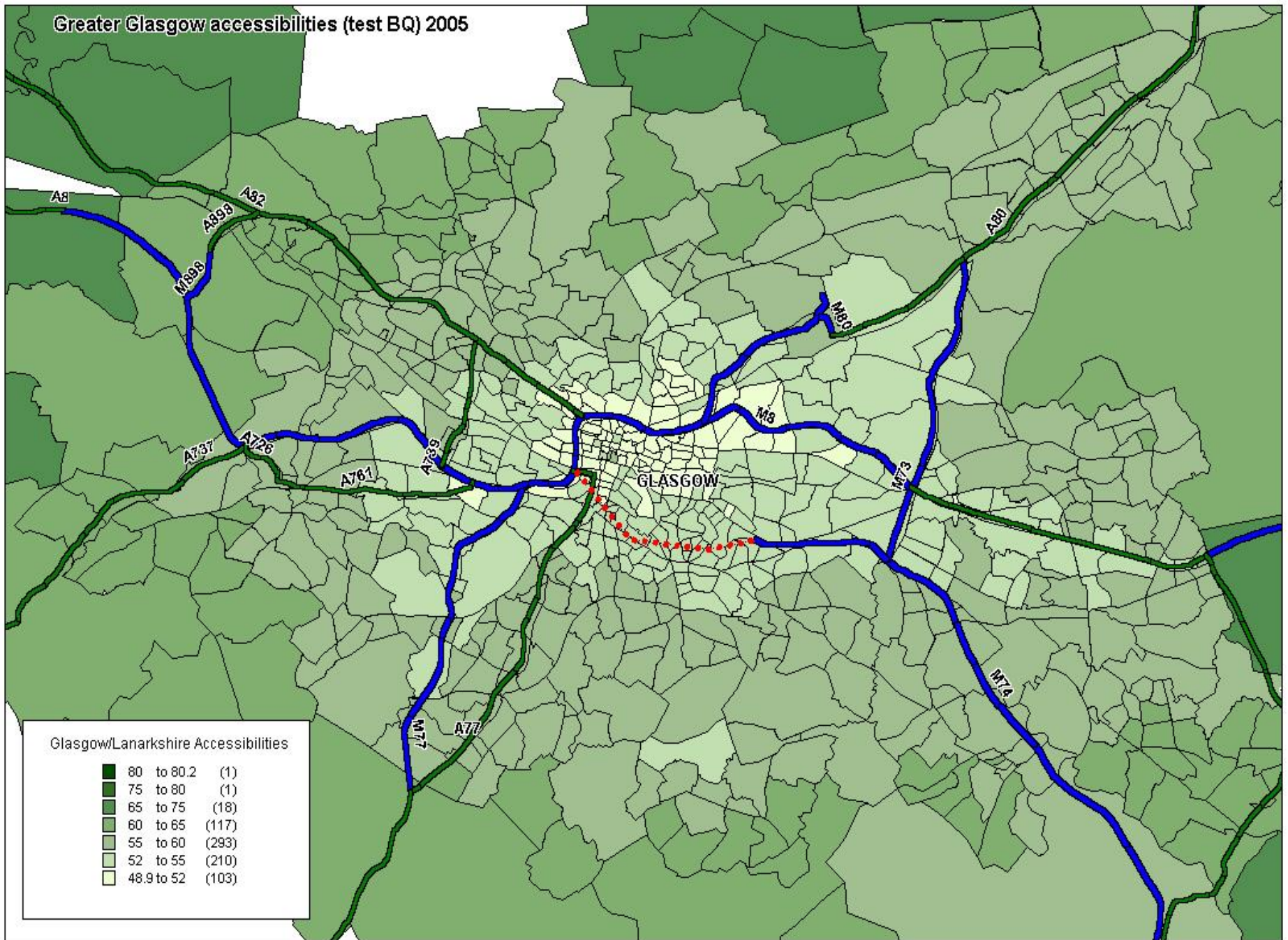
- Suriatini Ismail, for her Aberdeen PhD thesis, carried out a detailed hedonic price analysis on Glasgow housing
- Among her (many) independent variables she included accessibility values which we provided from the Central Scotland model (one of TELMoS' ancestors)
- She found that a one minute worsening in accessibility (ie a one minute increase in expected generalised cost of getting to work) was associated with a reduction of -1.7% to 2.4% in price [range is from different model forms; considering the error of the estimates would widen the range]
- Our models are incremental, so we can't check this in the base data [that would just redo Suriatini's analysis with less data]
- The best way we have found to test this relationship is to run a Reference Case, then make random changes to accessibility in one year, rerun and look at impacts on prices in following year...



Greater Glasgow accessibilities (test BQ) 2005

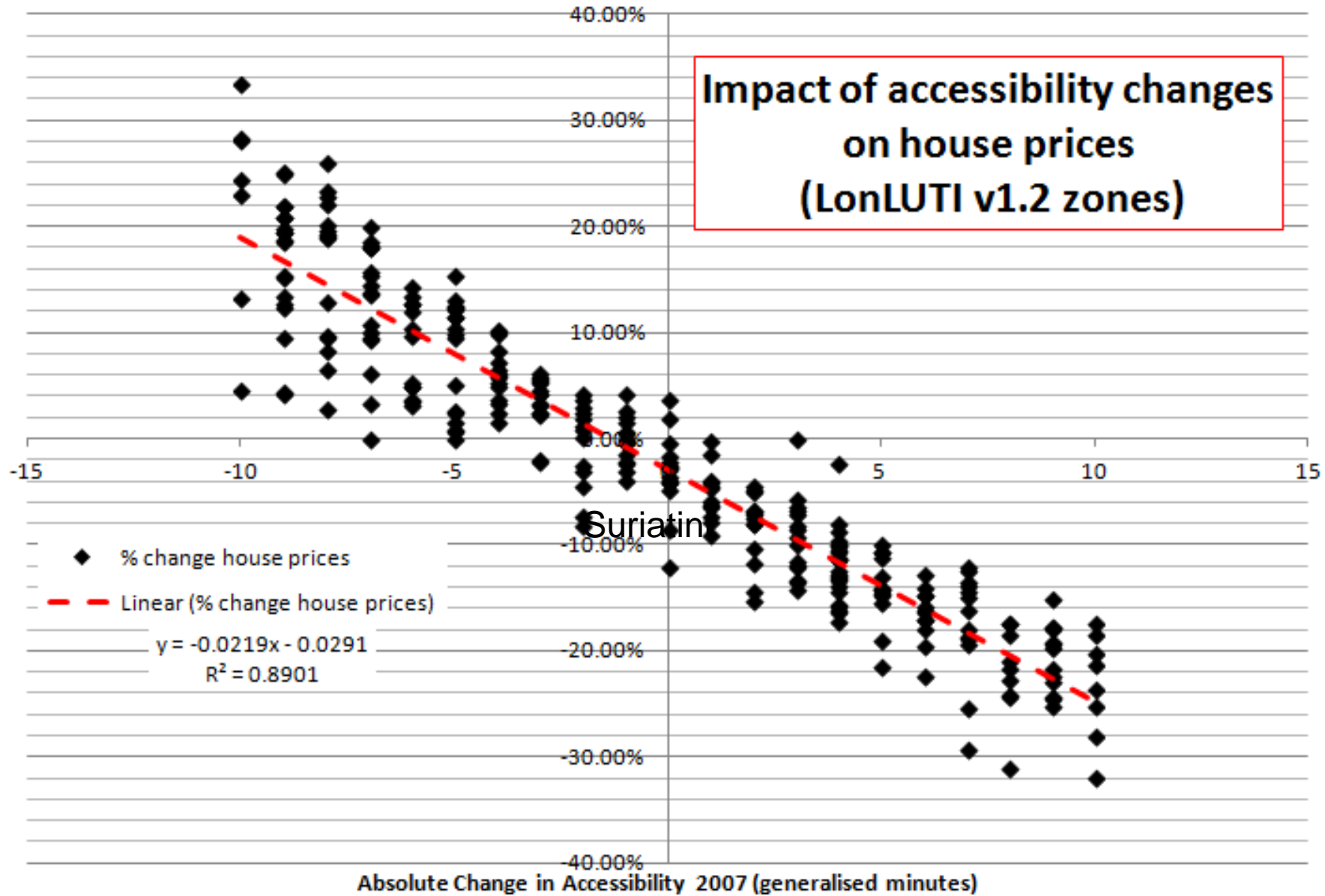


Greater Glasgow accessibilities (test BQ) 2005



**Impact of accessibility changes
on house prices
(LonLUTI v1.2 zones)**

Percentage Change in House Prices 2008 (Houses)



◆ % change house prices
- - - Linear (% change house prices)
 $y = -0.0219x - 0.0291$
 $R^2 = 0.8901$

Suriatin

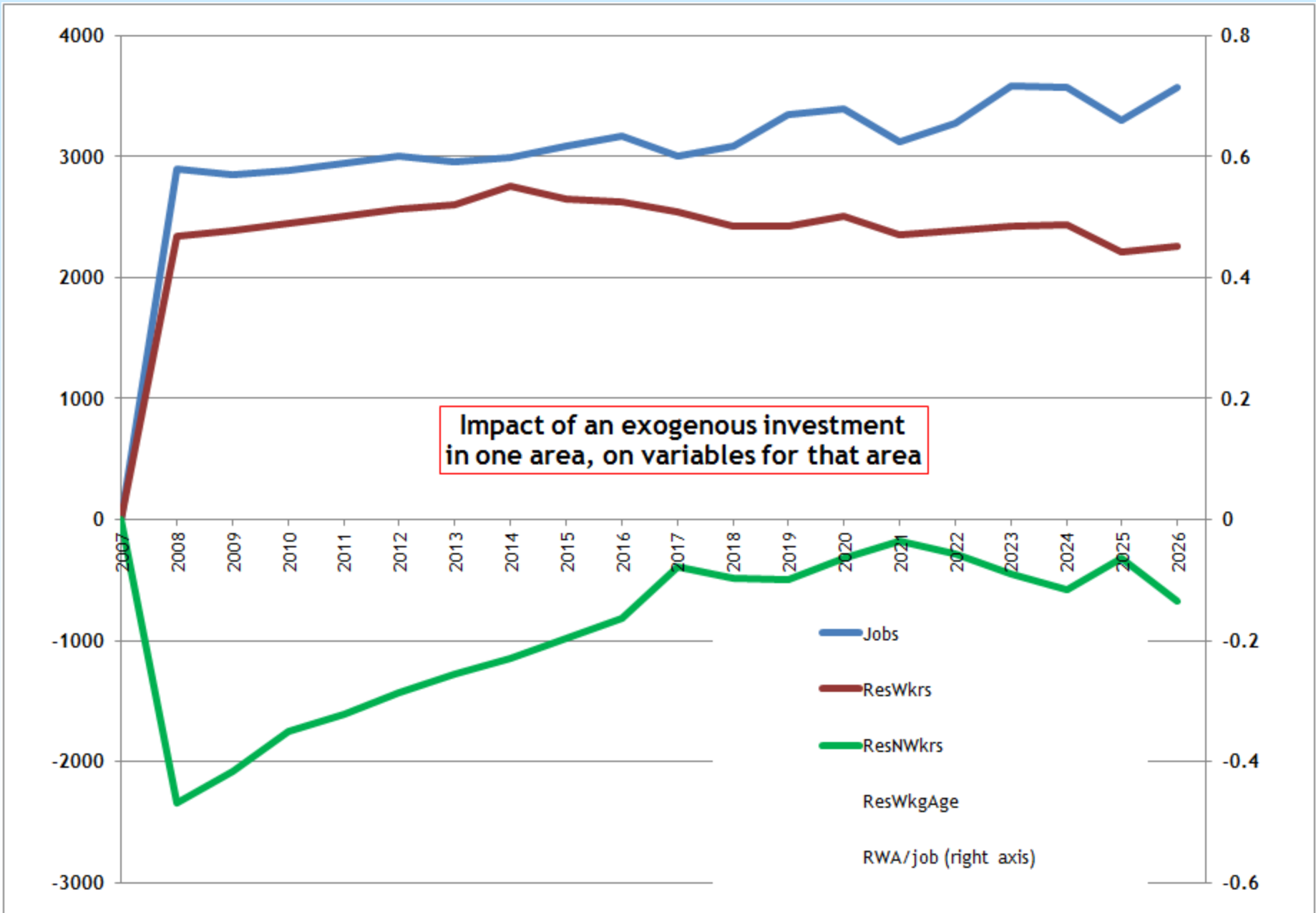


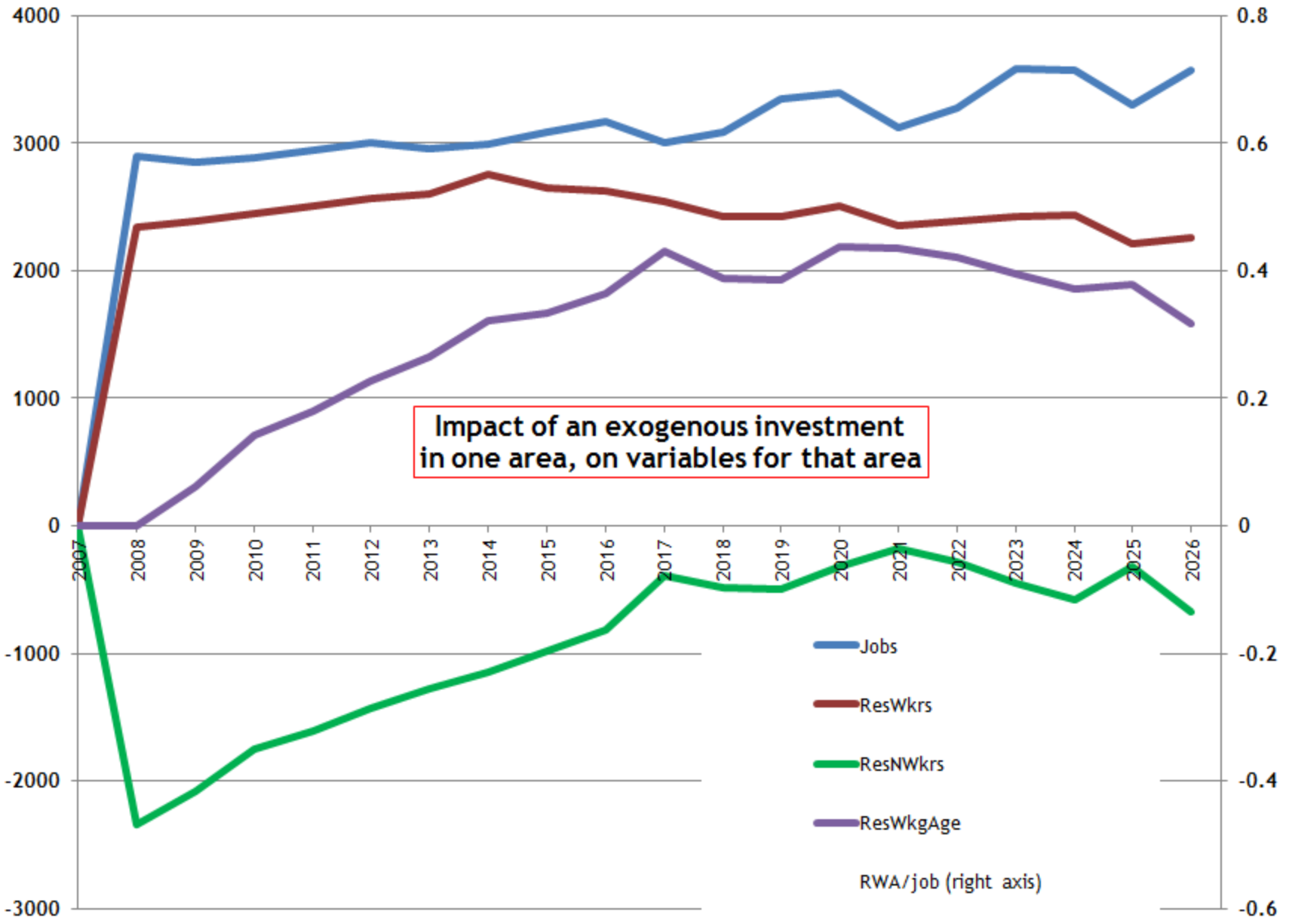
Using independent results to estimate an elasticity-like value

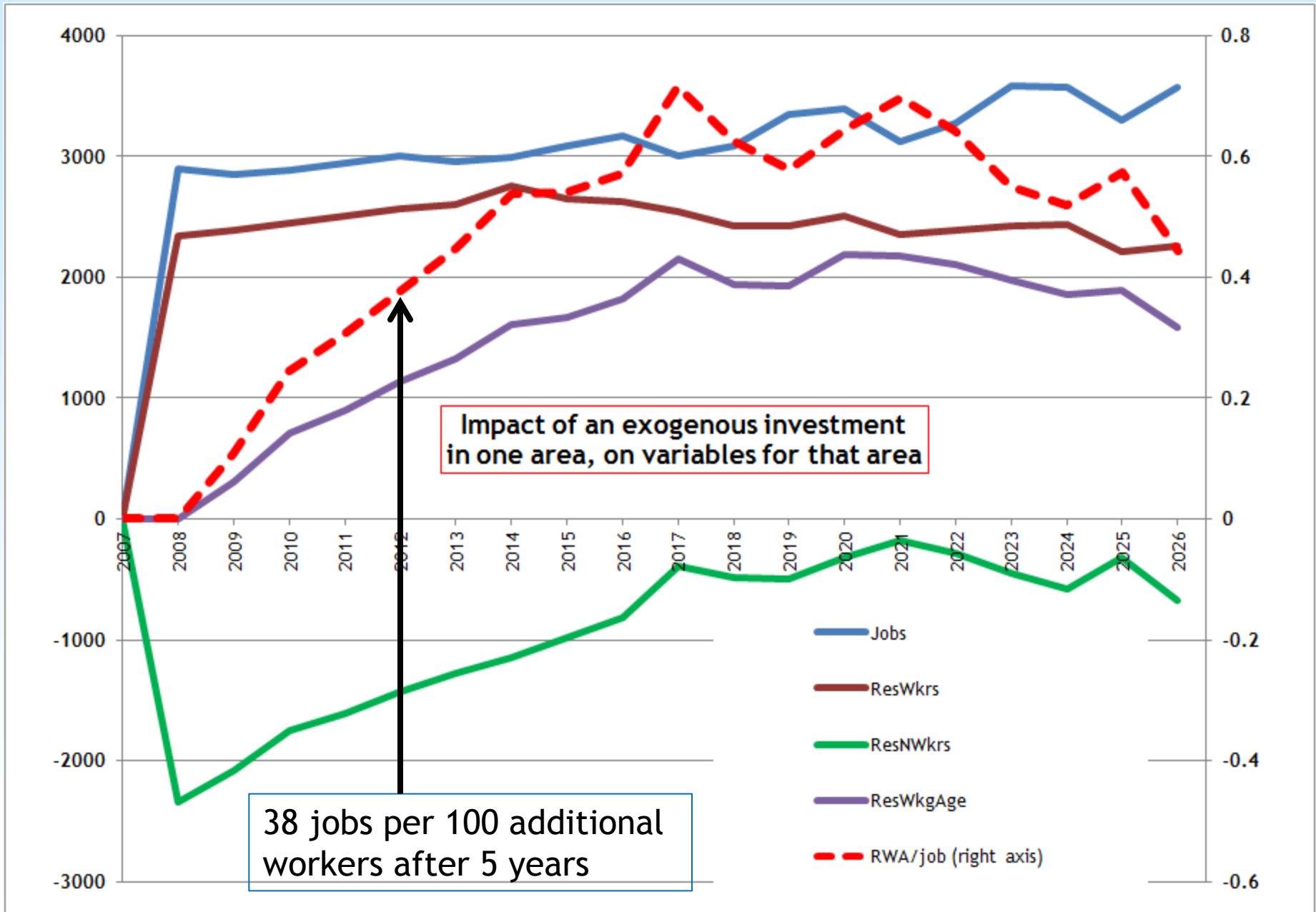
- Bramley and Leishmann used panel data for Health Authority areas to estimate a five equation model for house building, prices, vacancies and gross migration flows
- We identified which variables would change with a “shock” to employment in one area, including impacts of extra jobs on incomes and unemployment rate
- Using the published coefficients, we estimated the impact on annual net migration of 100 extra jobs in an average area
- We made explicit assumptions to get from the age group represented in the migration model to the total working-age population

All this led us to expect that

- 100 extra jobs would draw in a cumulative net total of 25 to 50 working-age persons over slightly more than five years,
- the effects would continue longer than five years
- both +ve and -ve feedback effects could apply.







Comparison of impact on a trend over time

Following two slides show

- our results from a new model of the Greater South-East (London, East, SE), for a test where new housing development is doubled for 10 years, as percentage impacts on average house prices relative to the Reference Case (ie the original rate of housing development)
- results for a similarly-specified test, produced by Meen et al using the CLG Housing Affordability model



**Impact of 50% increase in private construction on regional prices
(3yr moving average)**

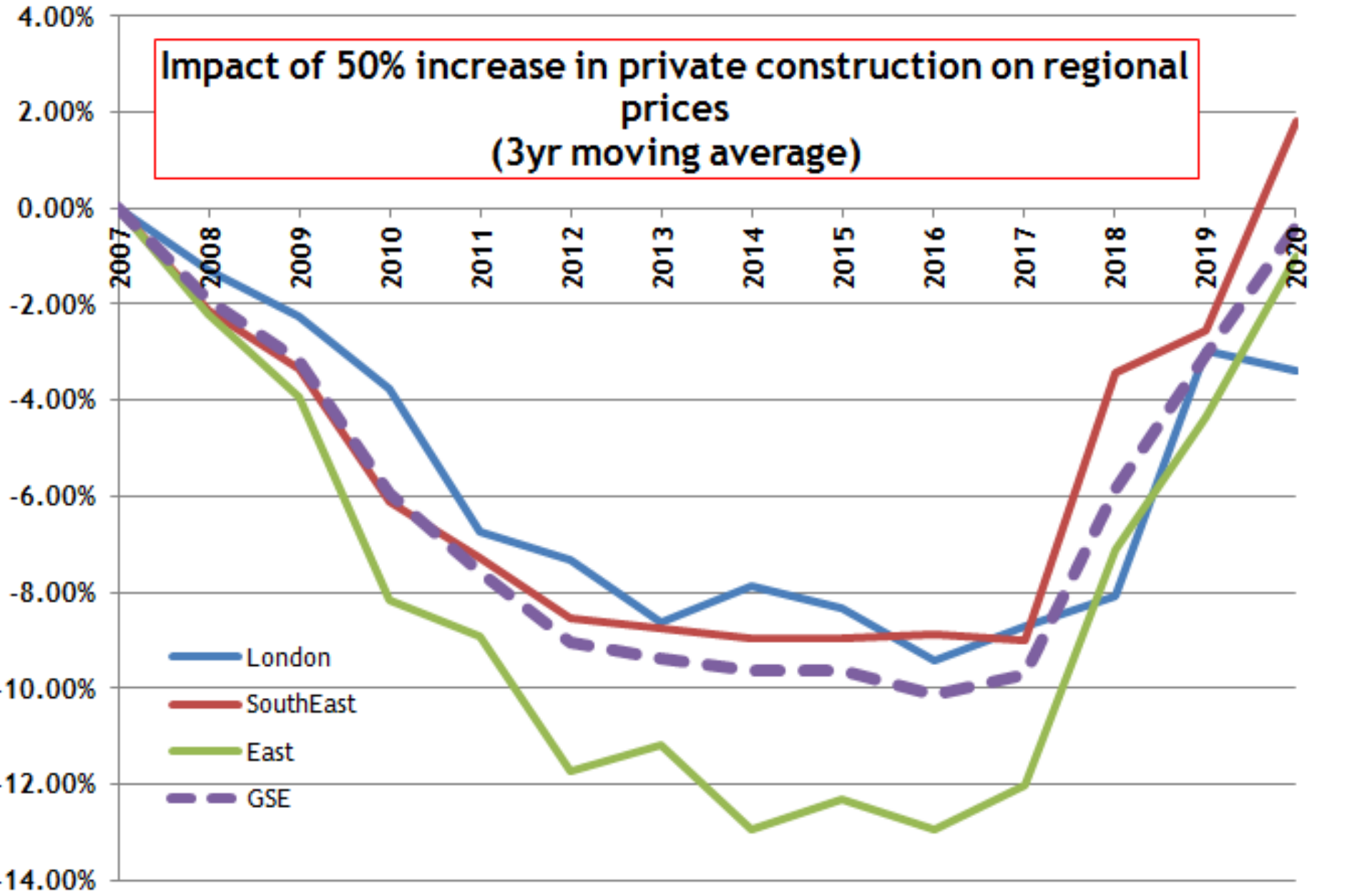
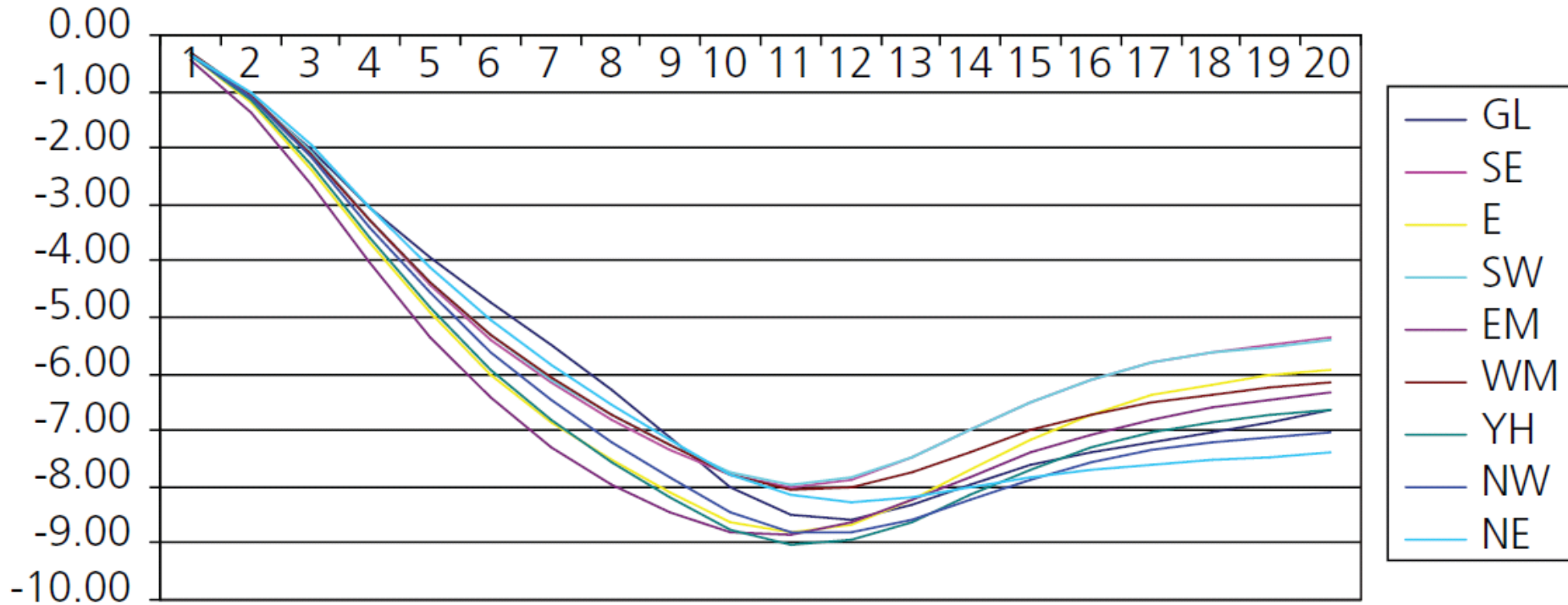


Figure 4 50% Increase in Housing Construction in All Regions – (i) House Prices, (ii) Ratio of Housing Stock to Households



Maximising the value of future urban/regional economic research

- Use of accessibility rather than distance-from-CBD in hedonic price/rent analysis (and elsewhere)
- Express results as elasticities or odds ratios, or quote mean (or median?) values of independent variables
- If showing example runs of a model, express the inputs in explicitly quoted units (not in standard deviations)
- Generally need to represent the whole of each property markets: difficult to use detail researched only for certain segments
- Likewise need to know how many people are moving (etc), not just what influences them.



TELMoS applications

- Multiple rounds of producing “business as usual” land-use forecasts for input to the Transport Model for Scotland, used for conventional transport modelling
- Preparation of alternative scenarios for use in TMfS
- Runs to forecast the impact of major development programmes and plans (eg for Glasgow City Council, South-East Scotland Planning Committee)
- Assessing impact of major public transport schemes, notably the Airdrie-Bathgate reopening
- Assessing impact of major road investments, eg M74 Completion, A8 upgrade, M80 Completion, A9/A96 Upgrades
- Possible future use as testbed for a method of Land-Use Transport Economic Efficiency appraisal, as an advance from Transport Economic Efficiency.

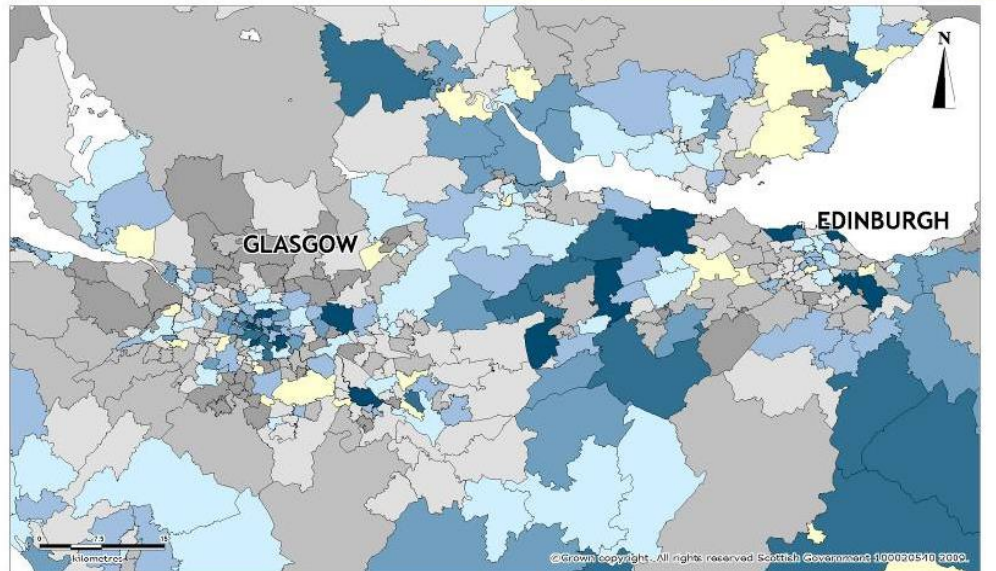
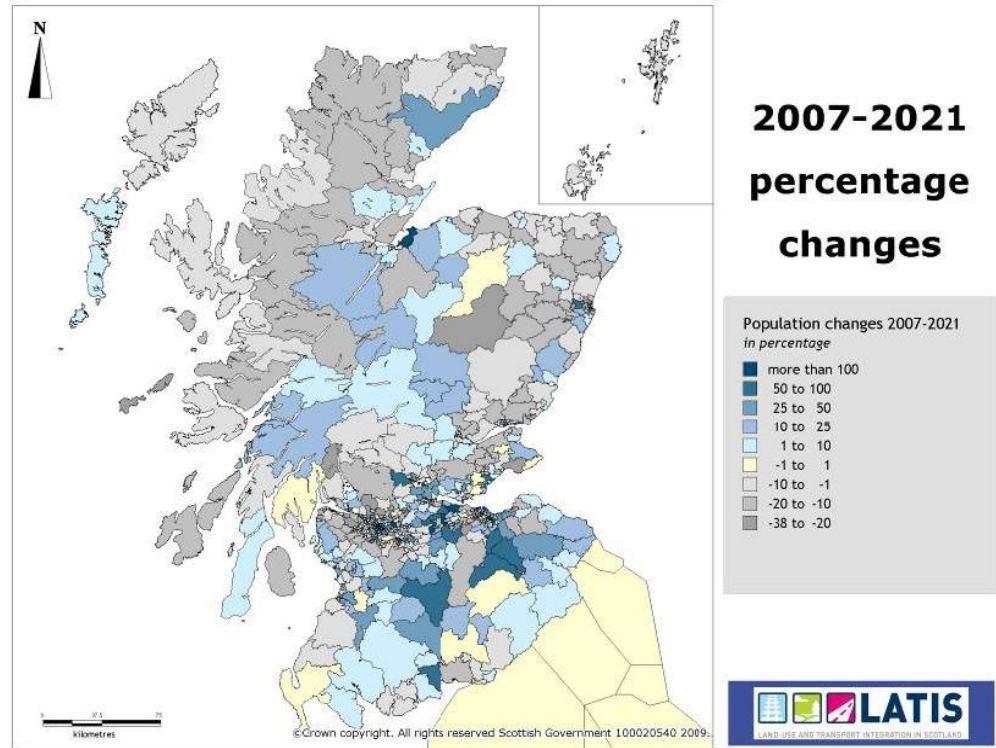


TELMoS:07

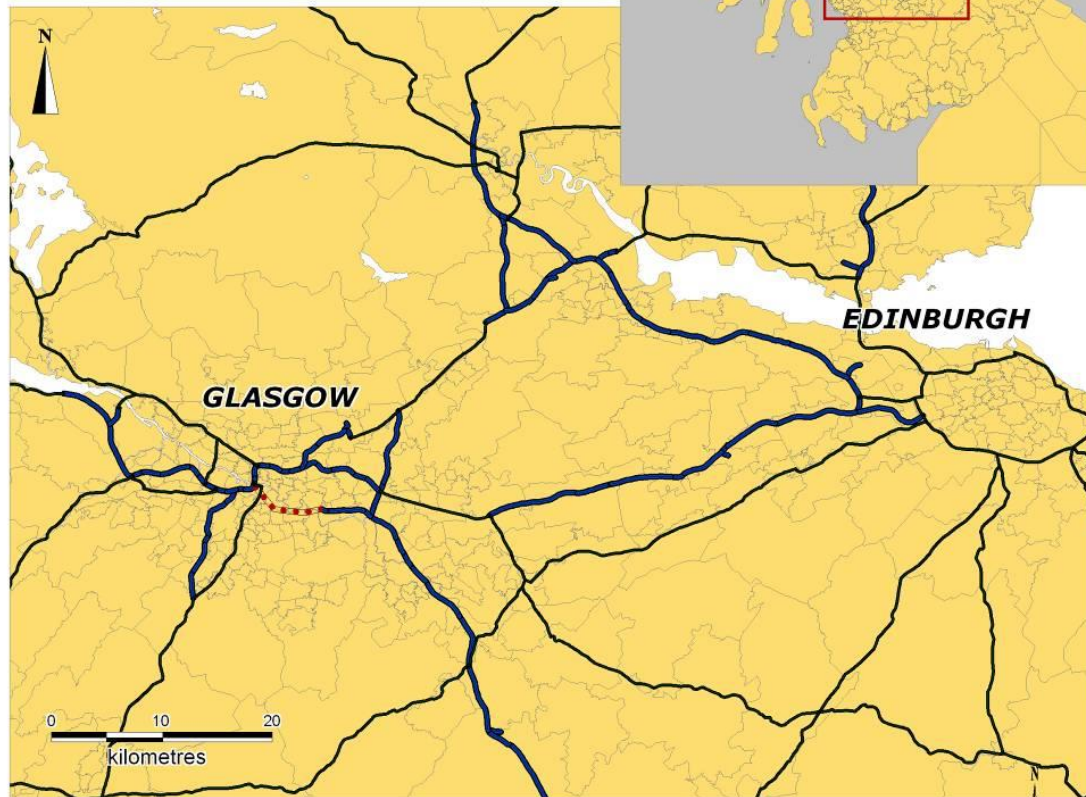
Do-minimum reference case

Population changes

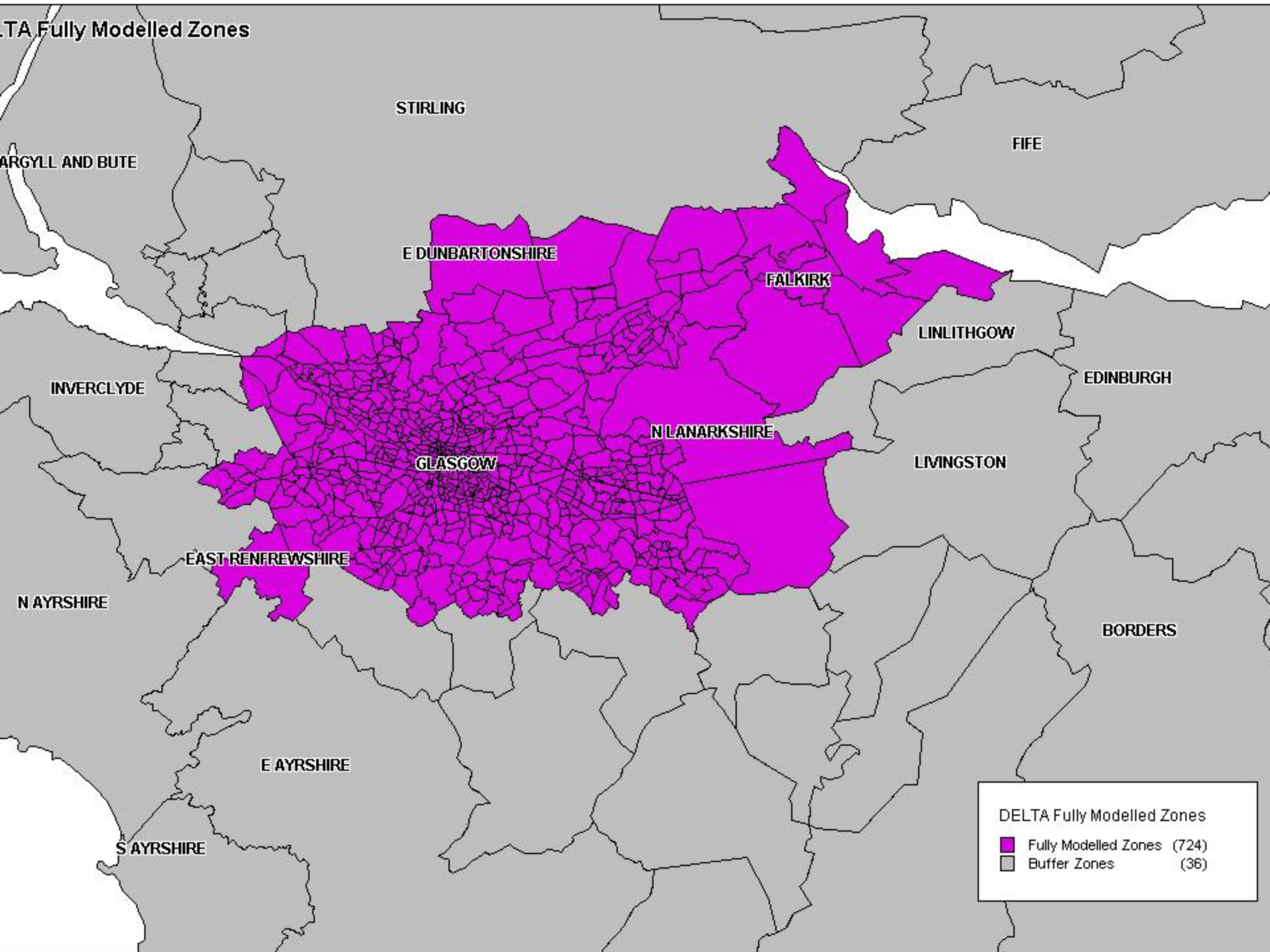
c1.42.07 TELMoS_07
Test HD - 29 January 2009



M74 Completion

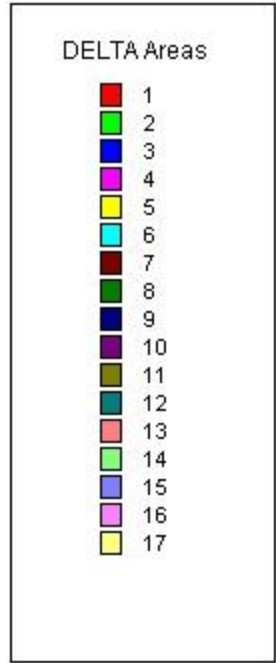
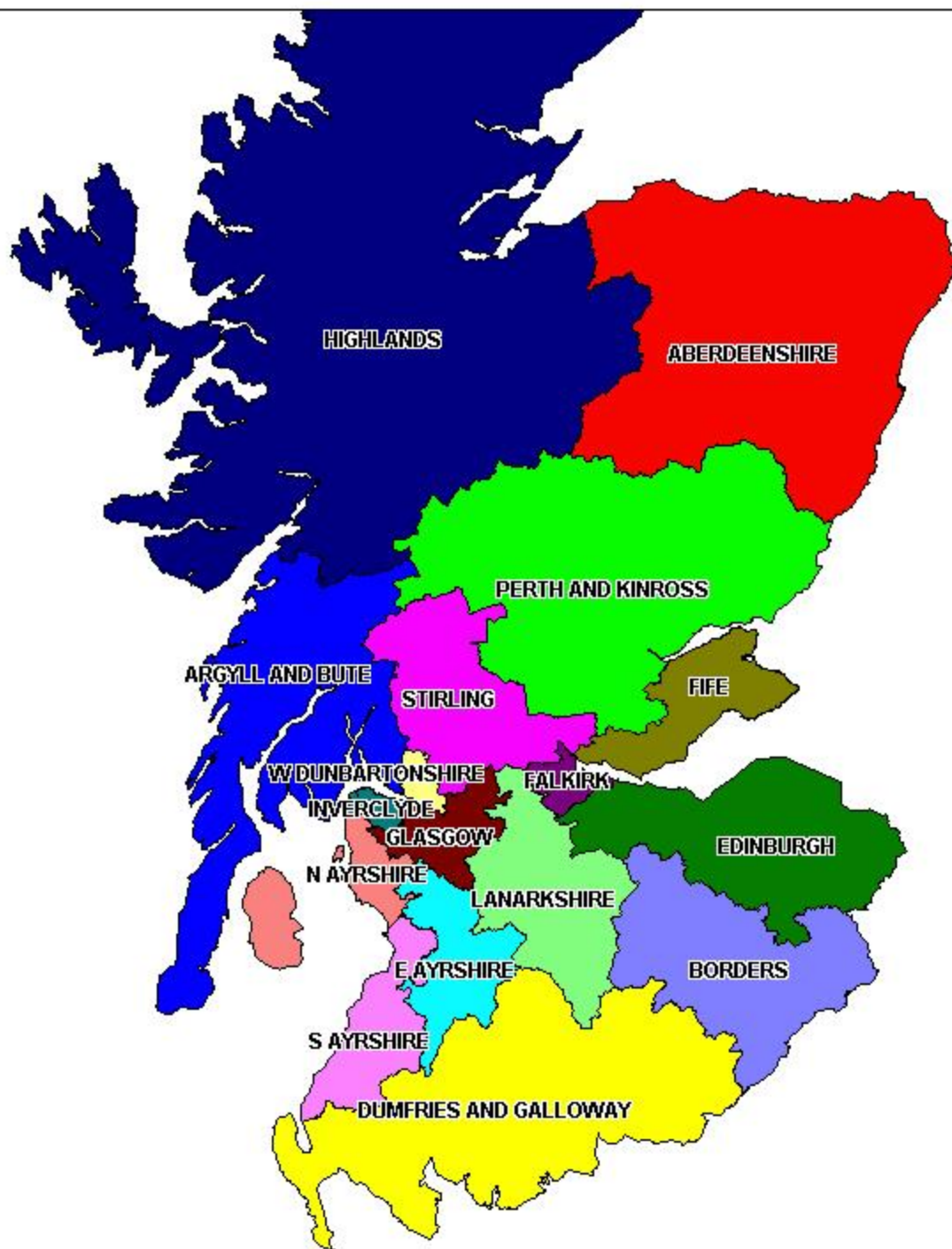


DELTA Fully Modelled Zones



DELTA Fully Modelled Zones

- Fully Modelled Zones (724)
- Buffer Zones (36)

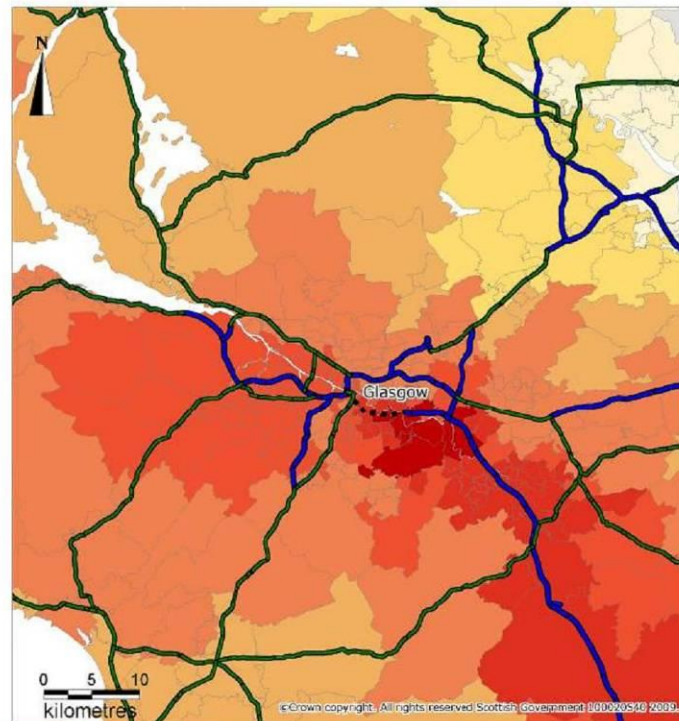


Change in Accessibility in 2017

Test HE - Test HD (Ref Case)

c1.42.07 TELMoS_07
Test HE - 29 January 2009

Access to work non-manual workers 1 car

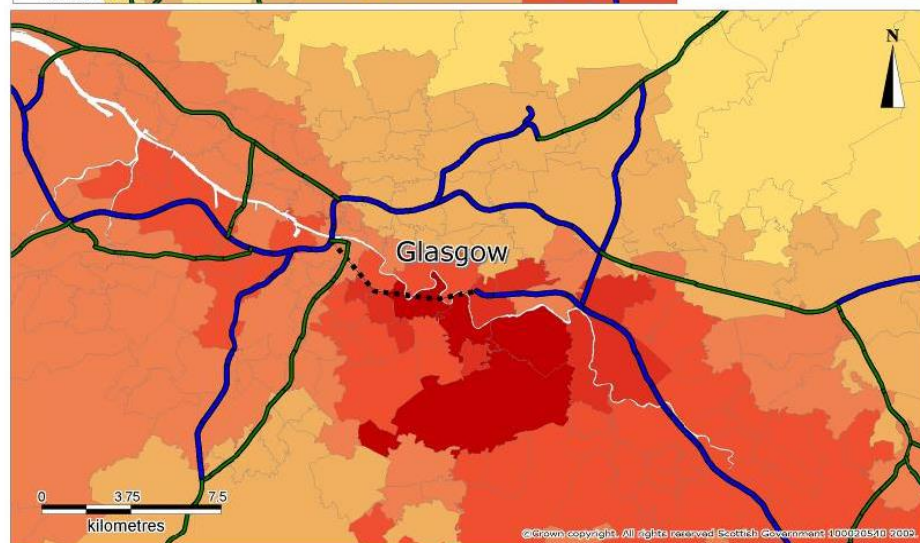
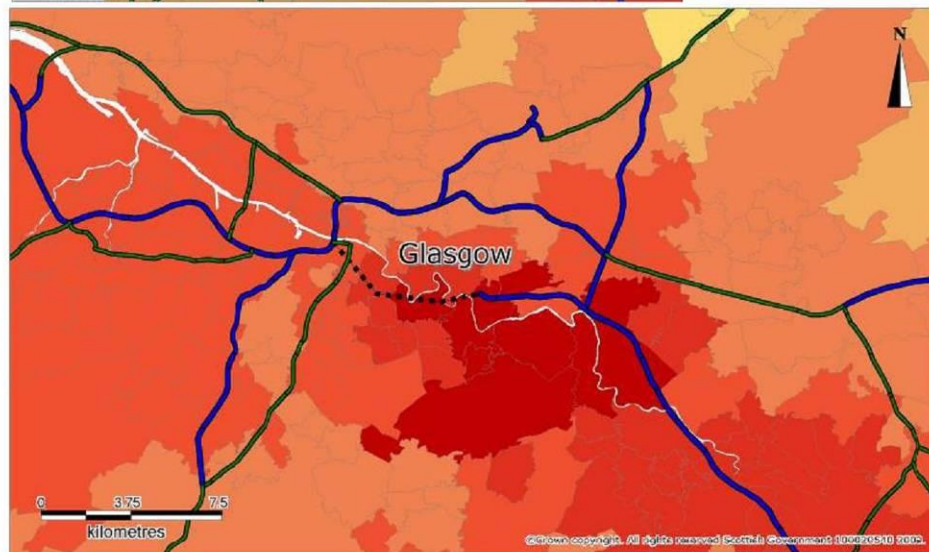
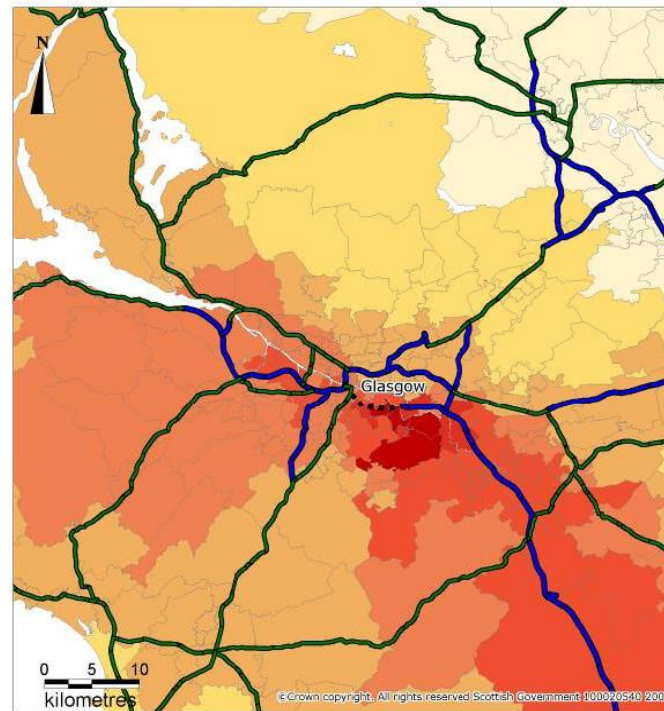


Change in Accessibility in 2017

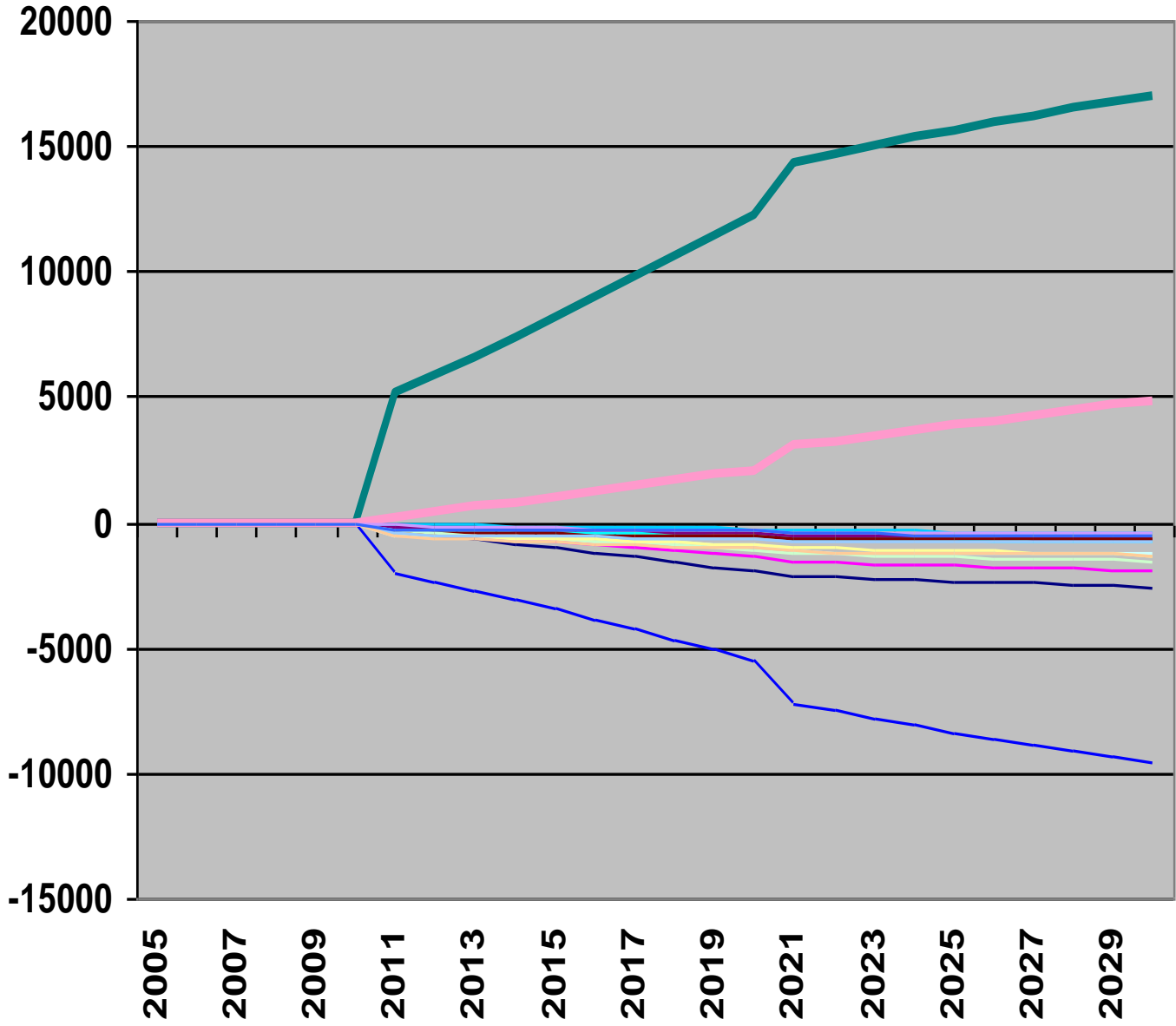
Test HE - Test HD (Ref Case)

c1.42.07 TELMoS_07
Test HE - 29 January 2009

Access to business 1 car

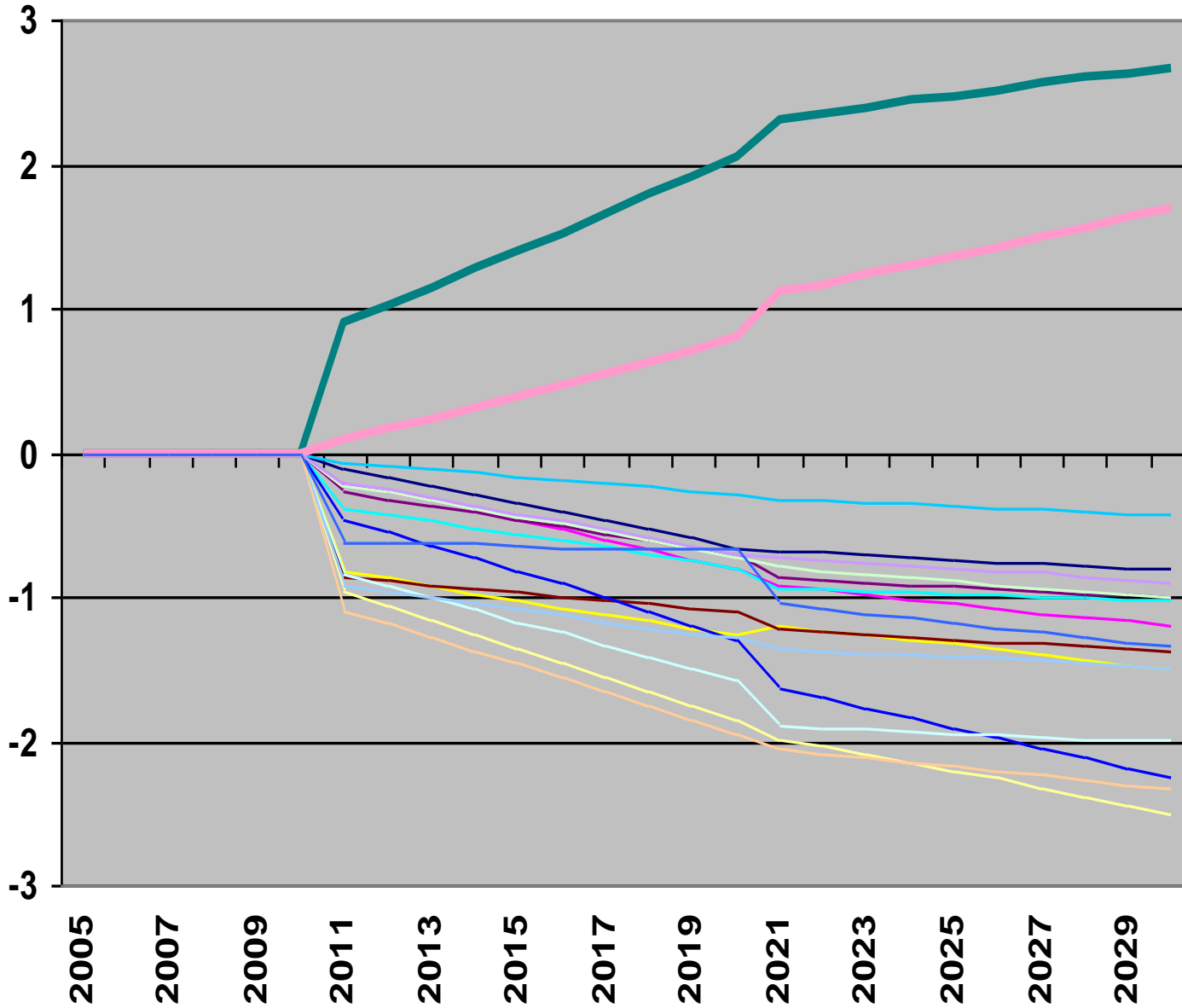


Employment BT-BS



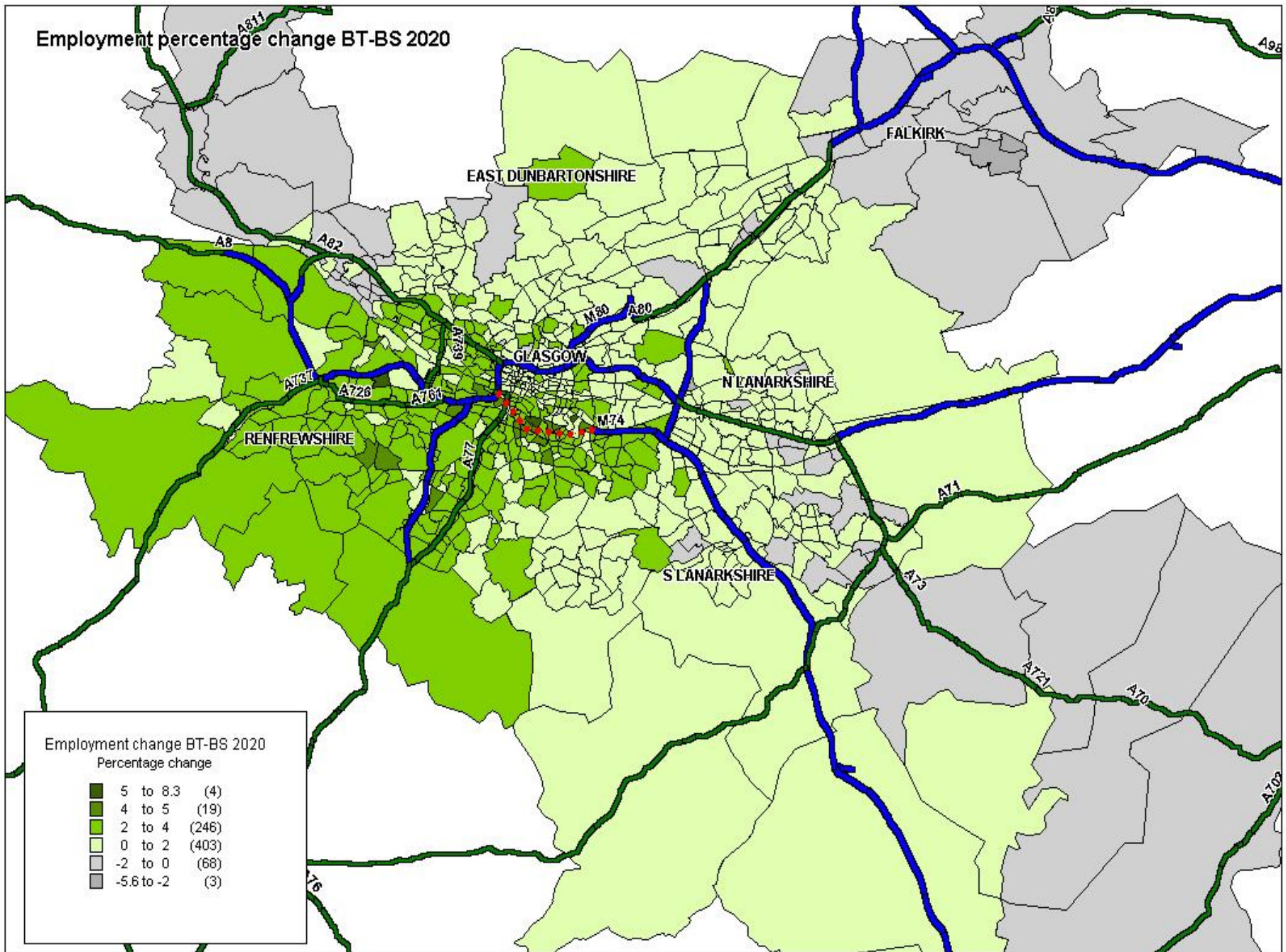
- Aberdeenshire
- Perth and Kinross
- Argyll and Bute
- Stirling
- Dumfries&G
- E Ayrshire
- G.Glasgow
- Lothian
- Highlands
- Falkirk
- Fife
- Inverclyde
- N Ayrshire
- Lanarkshire
- Borders
- S Ayrshire
- W Dunbartonshire

Employment (percentage) BT-BS

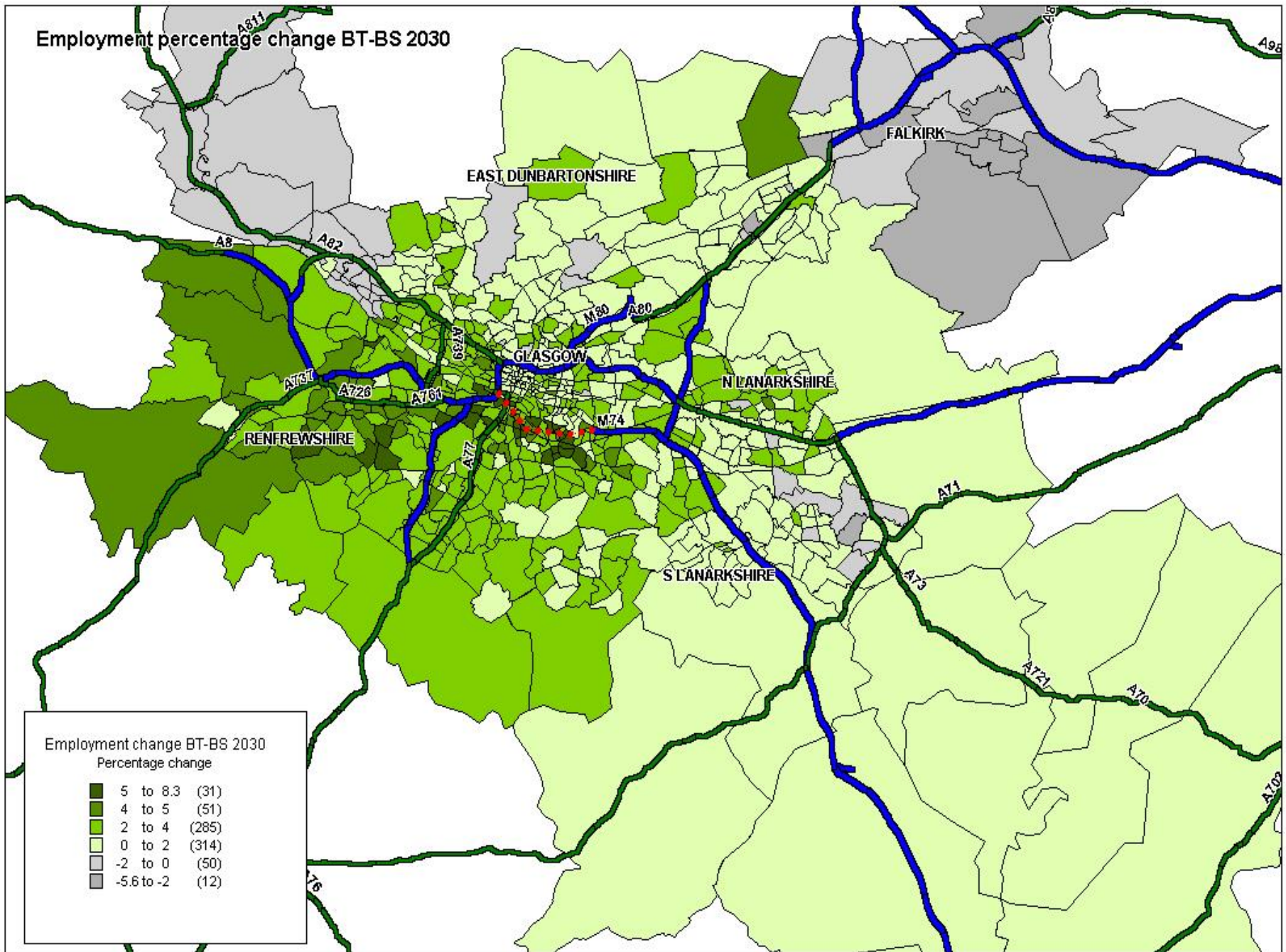


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- Lanarkshire
- Borders
- S Ayrshire
- W Dunbartonshire

Employment percentage change BT-BS 2020



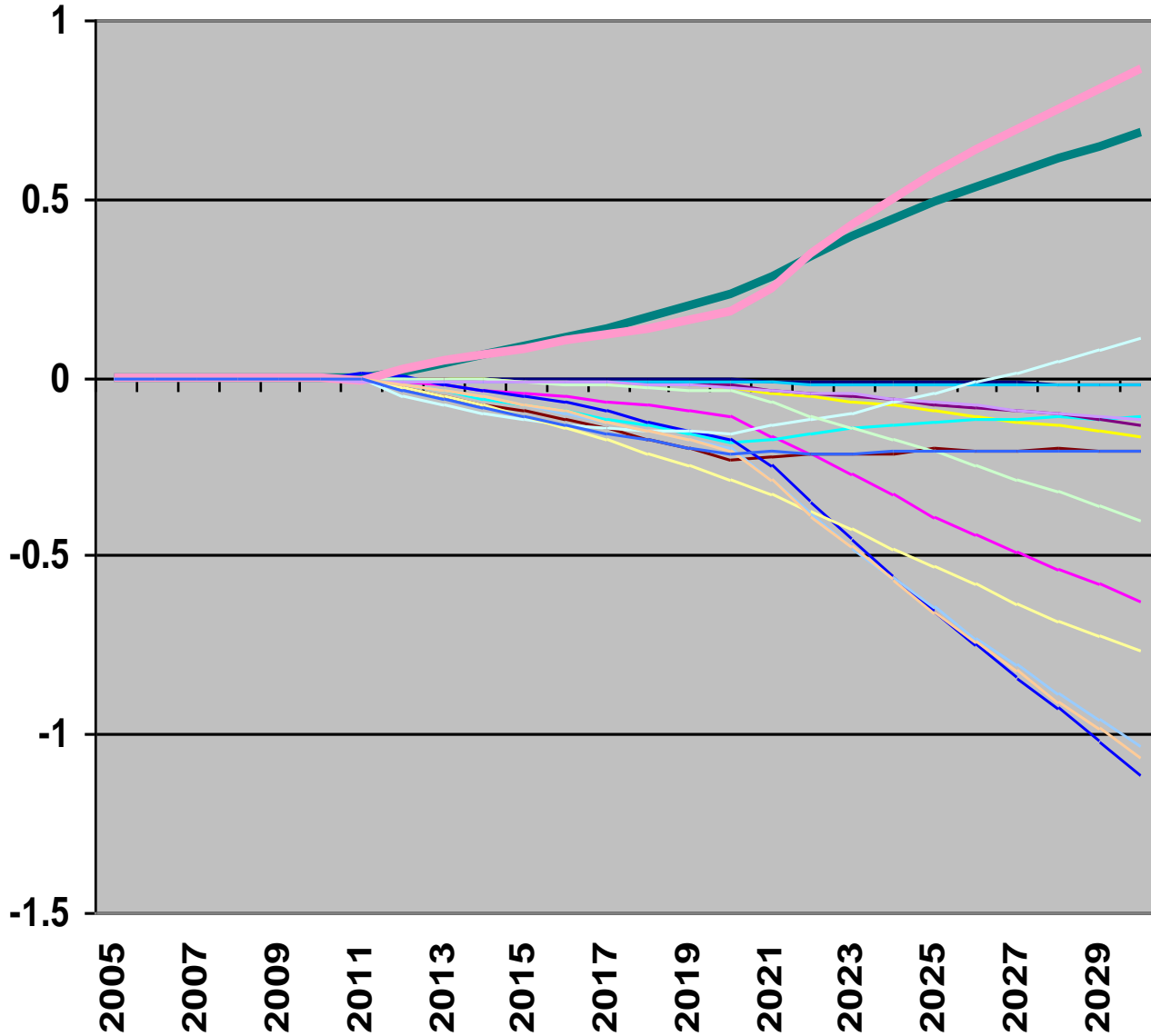
Employment percentage change BT-BS 2030



Employment change BT-BS 2030
Percentage change

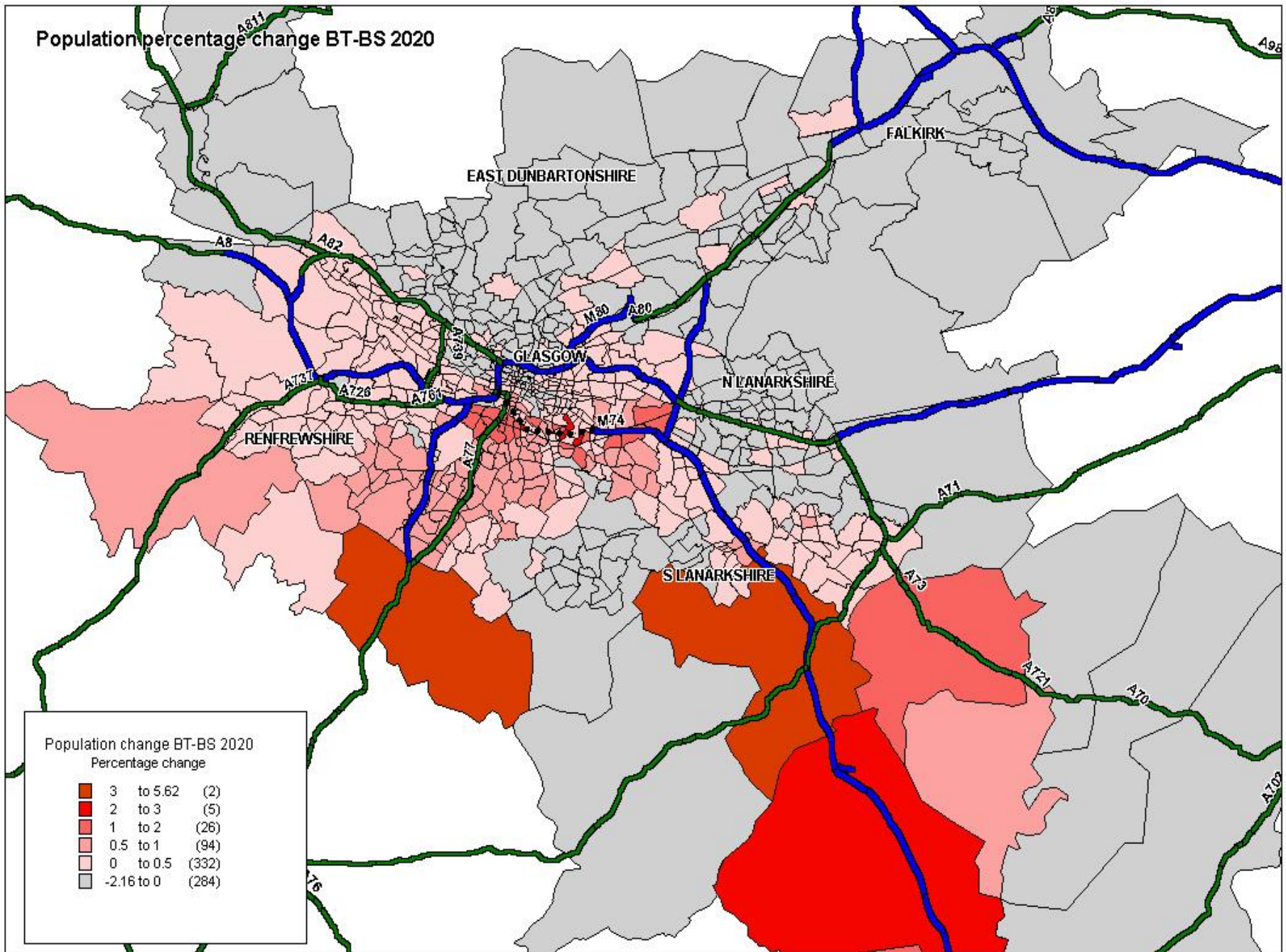
5 to 8.3	(31)
4 to 5	(51)
2 to 4	(285)
0 to 2	(314)
-2 to 0	(50)
-5.6 to -2	(12)

Population (percentage) BT-BS



- Aberdeenshire
- Perth and Kinross
- Argyll and Bute
- Stirling
- Dumfries&G
- E Ayrshire
- G.Glasgow
- Lothian
- Highlands
- Falkirk
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- Borders
- S Ayrshire
- W Dunbartonshire

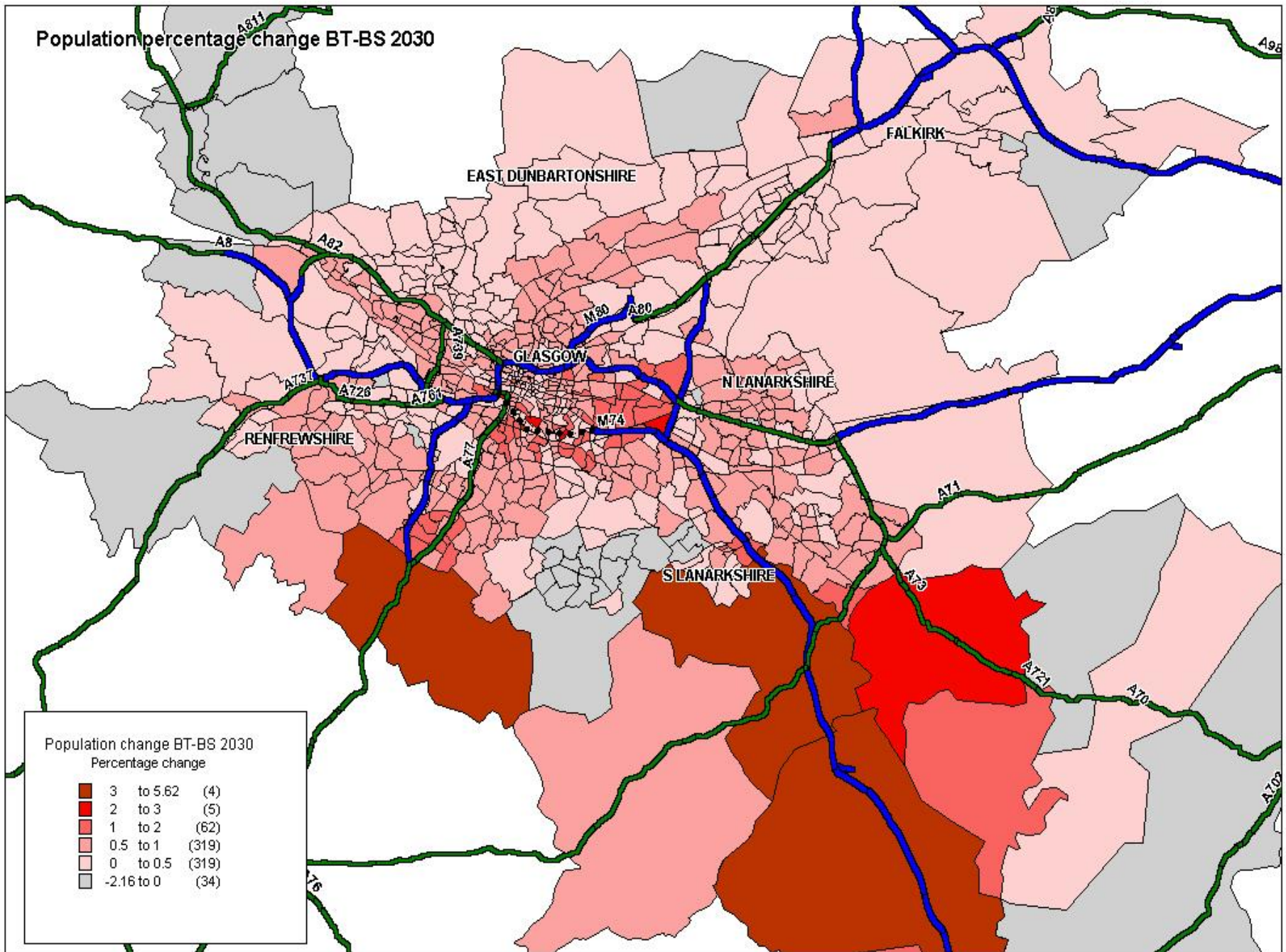
Population percentage change BT-BS 2020



Population change BT-BS 2020 Percentage change

3 to 5.62	(2)
2 to 3	(5)
1 to 2	(26)
0.5 to 1	(94)
0 to 0.5	(332)
-2.16 to 0	(284)

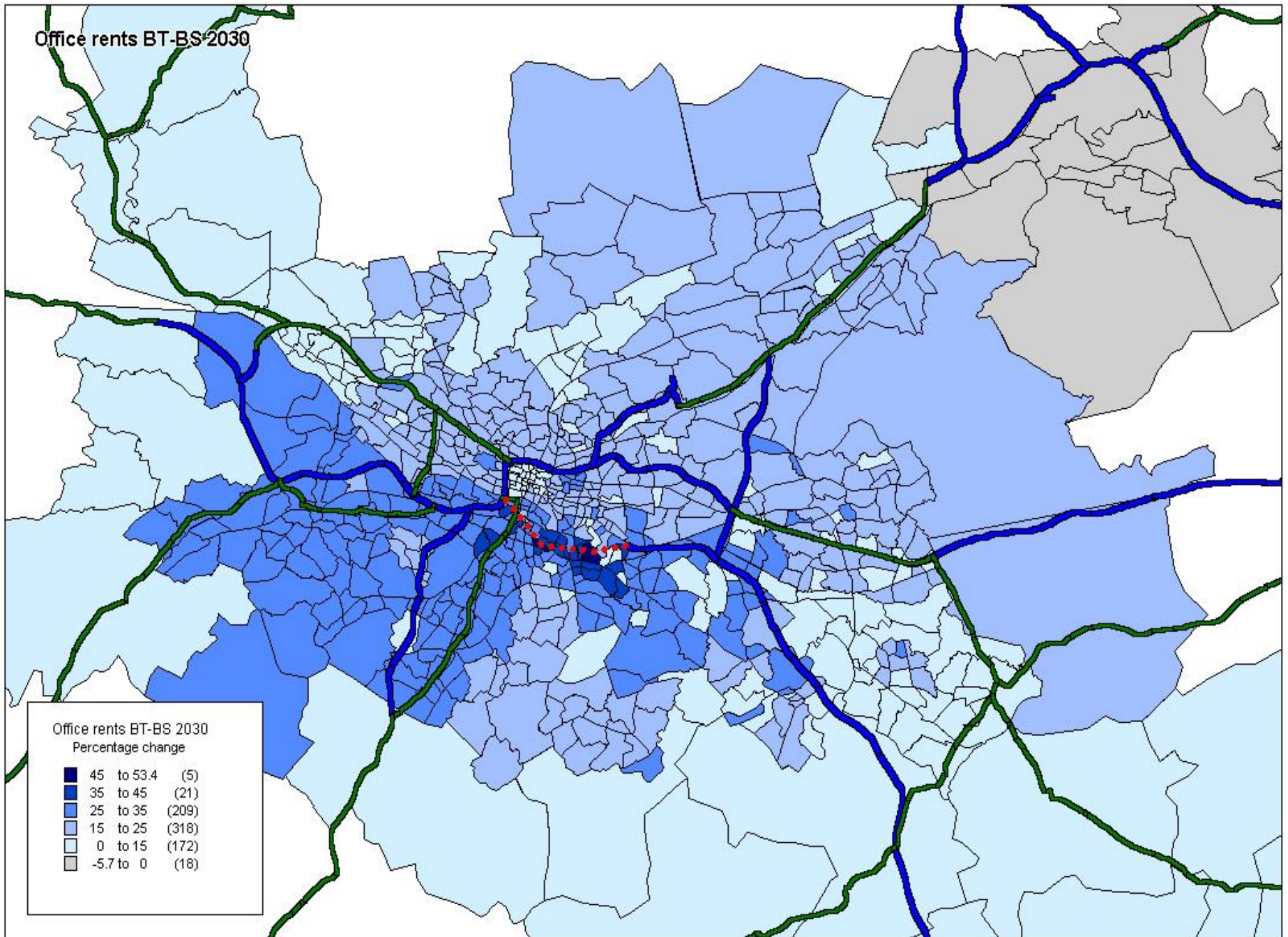
Population percentage change BT-BS 2030

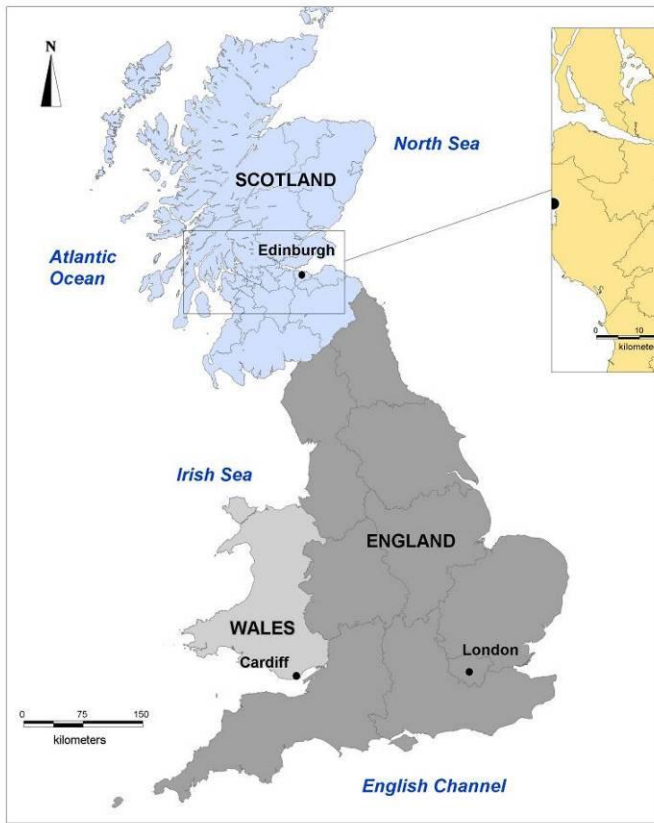


Population change BT-BS 2030 Percentage change

3 to 5.62	(4)
2 to 3	(5)
1 to 2	(62)
0.5 to 1	(319)
0 to 0.5	(319)
-2.16 to 0	(34)

Office rents BT-BS 2030



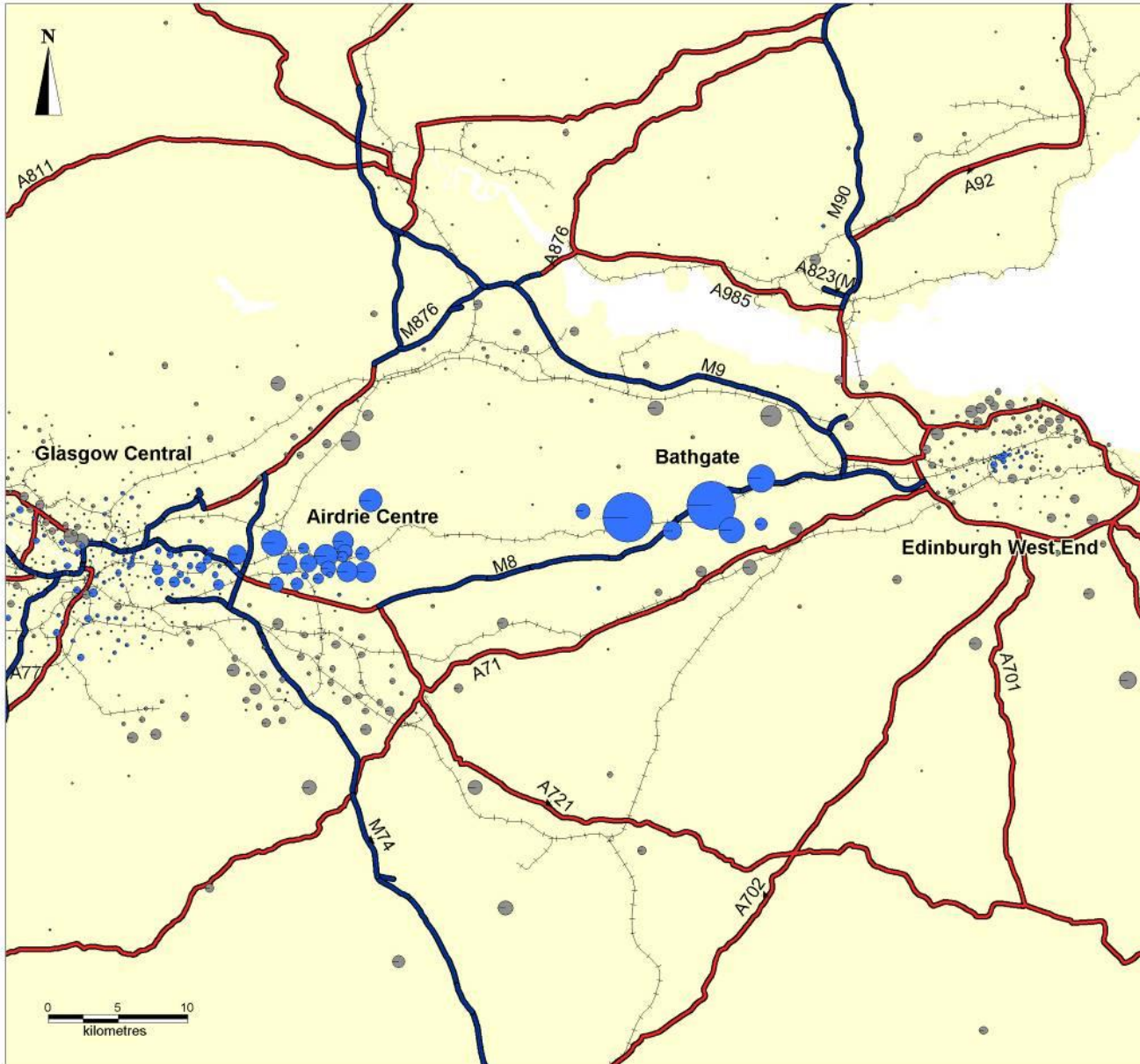


Airdrie-Bathgate Railway Reopening

- The Airdrie - Bathgate rail link is a significant scheme in the context of Scottish passenger transport
- Re-opening was proposed in 2002

- Plan was for a high frequency stopping service linking Glasgow and Edinburgh via Airdrie-Bathgate and intermediate communities
- The model is run twice with the scheme introduced in 2011- different costs
- Comparison of the job and population results in 2021 at different geographic levels

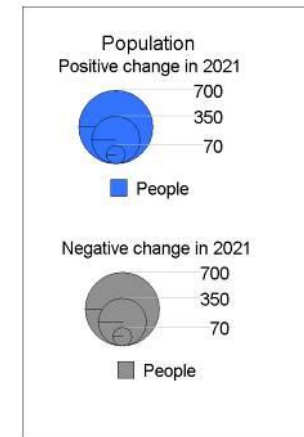
Airdrie-Bathgate - Impacts: testing and results



TELMoS

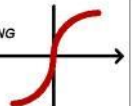
Tests BL-BK - 14 September 2006

Change in Population in 2021

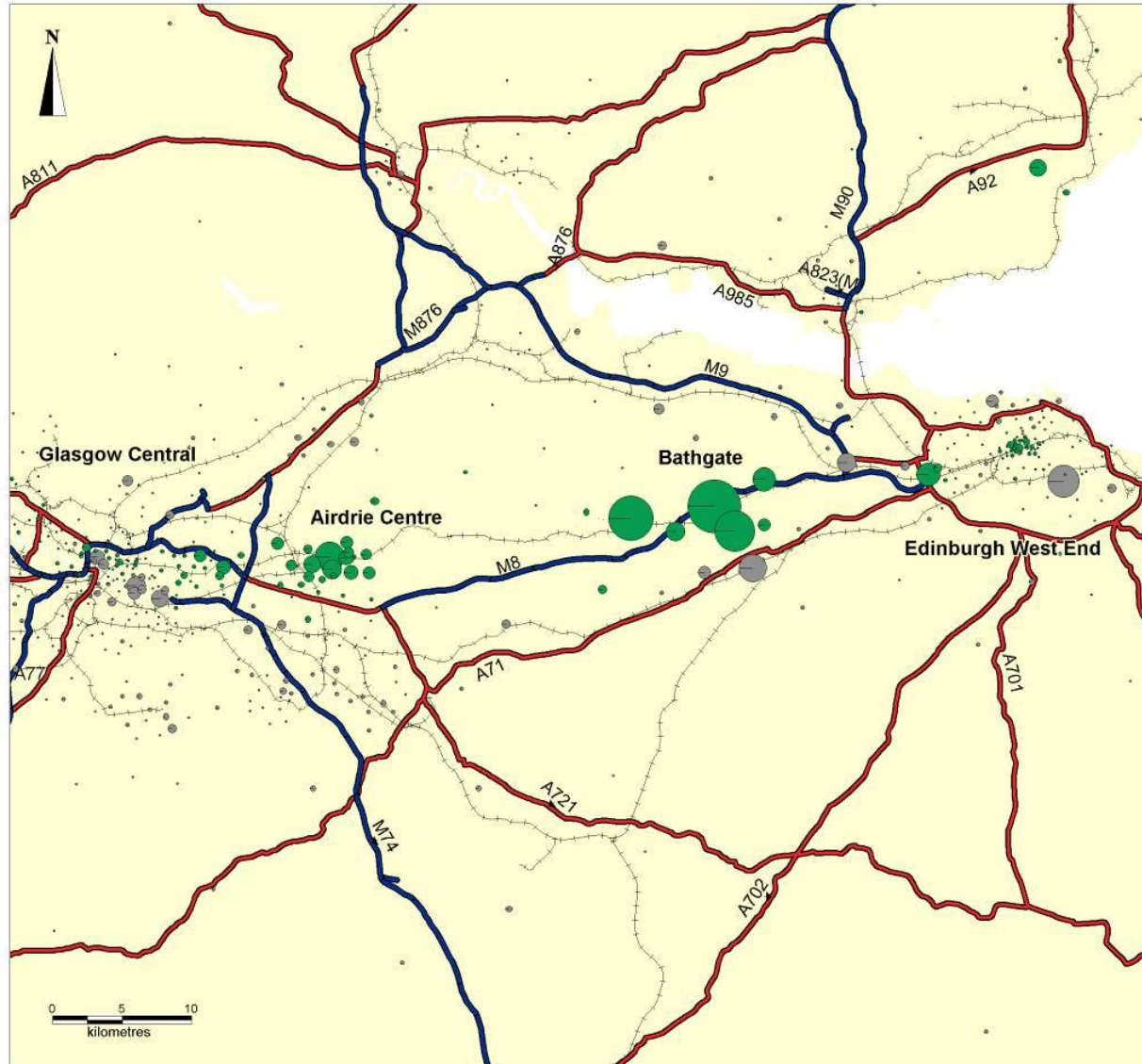


URBAN, REGIONAL AND TRANSPORT PLANNING

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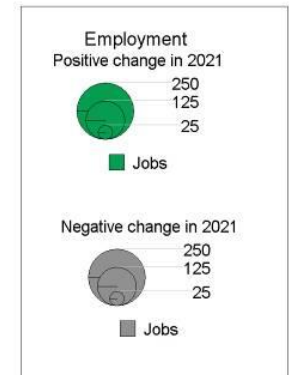
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TELMoS

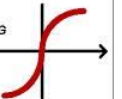
Tests BL-BK - 14 September 2006

Change in Employment in 2021



URBAN, REGIONAL AND TRANSPORT PLANNING

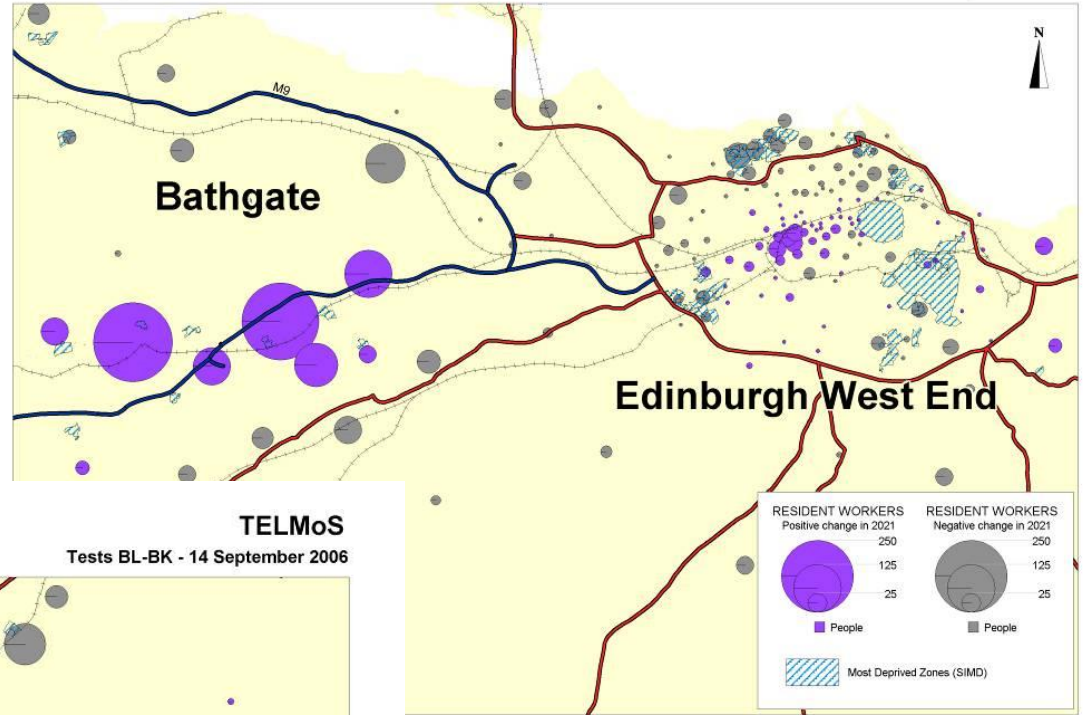
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Airdrie-Bathgate Appraisal

Change in Resident Workers in 2021

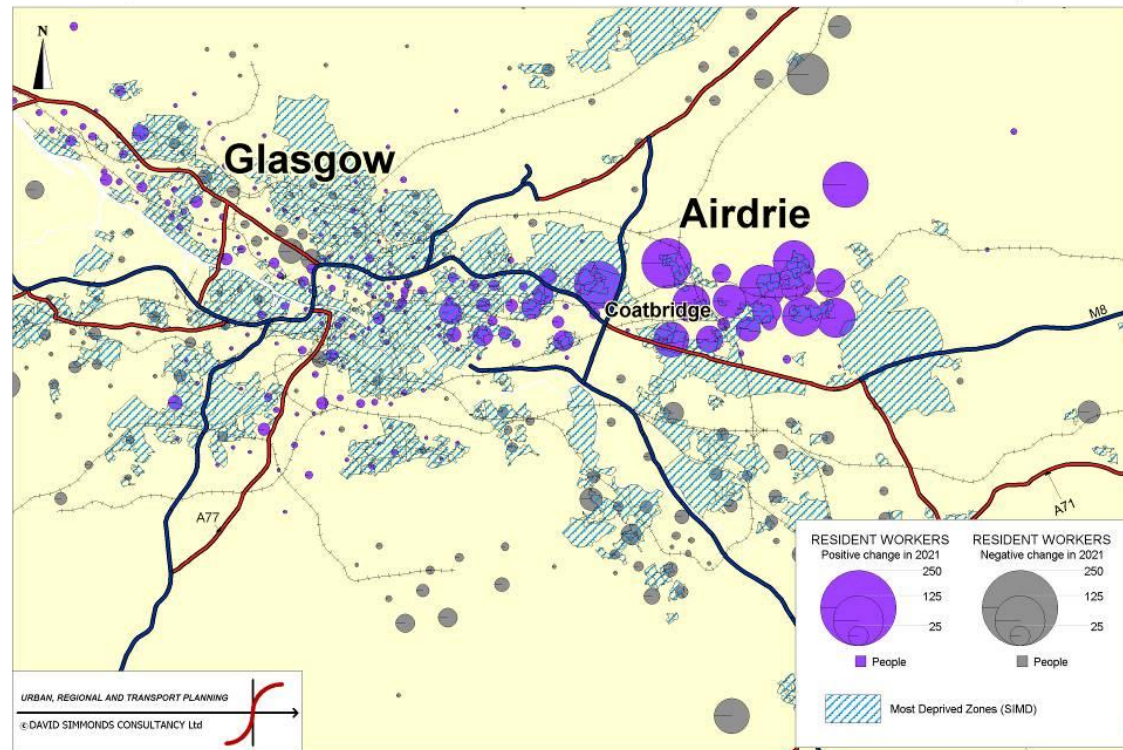
TELMoS
Tests BL-BK - 14 September 2006



Change in Resident Workers in 2021

TELMoS

Tests BL-BK - 14 September 2006



Airdrie-Bathgate - Conclusion

- Positive impacts in the corridor
- Positive impacts in West Lothian and North Lanarkshire
- Some support to deprived zones
- Will help achieve planning goals



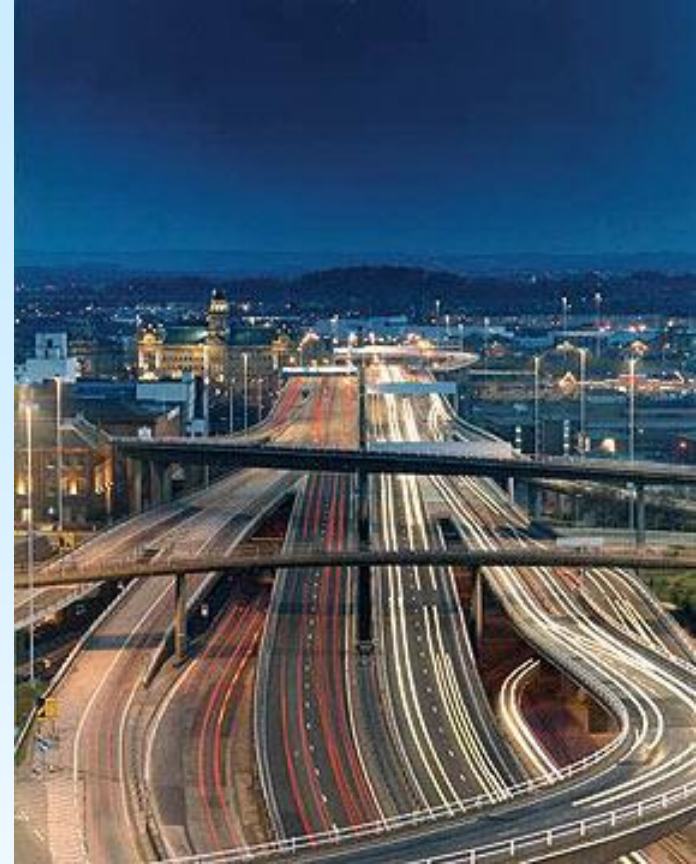
Conclusions

- TELMoS has made a significant contribution to the analysis of major planning and transport decisions in Scotland over the past decade
- Current work indicates that Transport Scotland intends to make further use of TELMoS in future
- LUTI modelling in general is playing a gradually increasing part in UK decision-making
- The development and use of DELTA has been an important part of that trend, and also
- has established new links between LUTI modeling and a range of urban and regional economic research

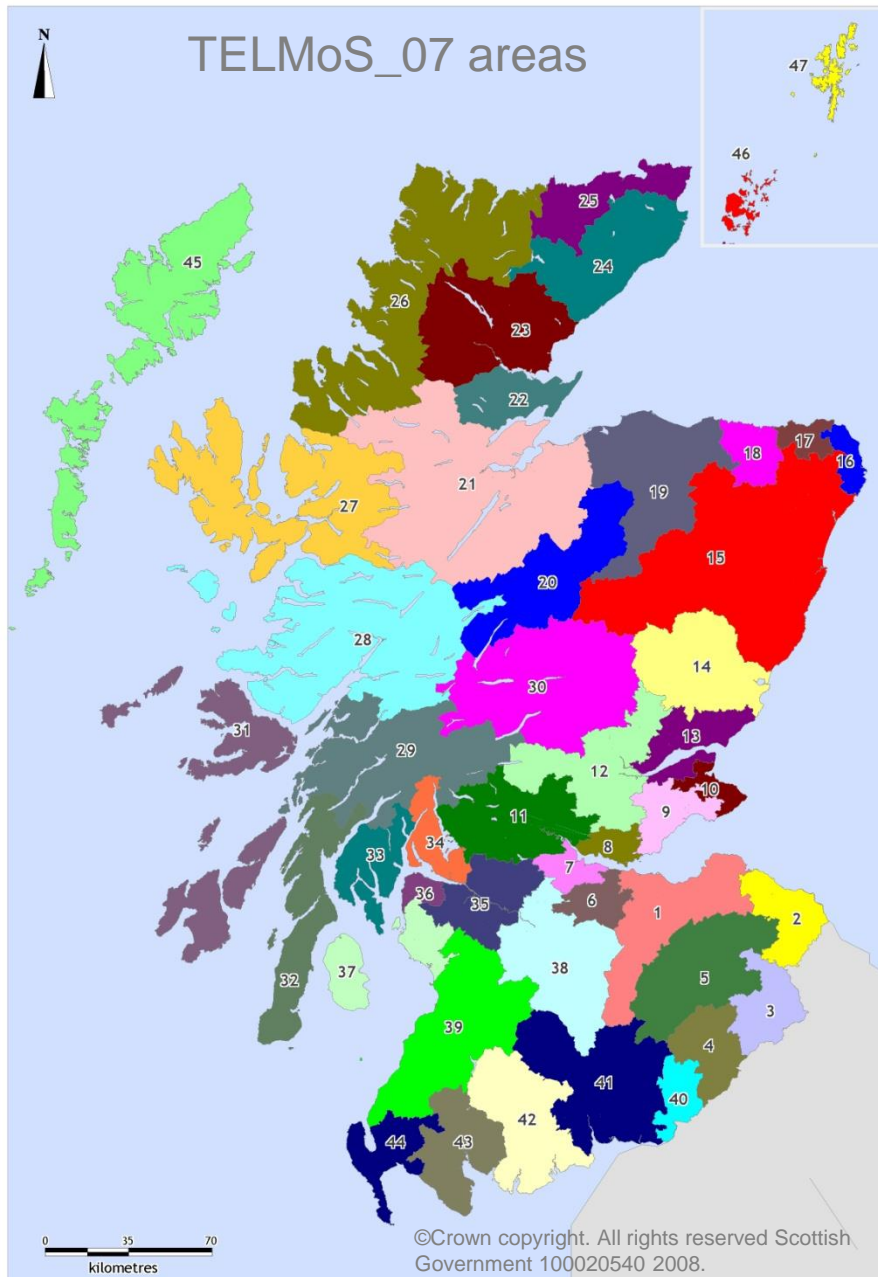
Thank you for your attention!

david.simmonds@davidsimmonds.com

With acknowledgements to our clients, Transport Scotland. Views expressed are not necessarily those of Transport Scotland or the Scottish Ministers.



TELMoS-07 definitions (1)



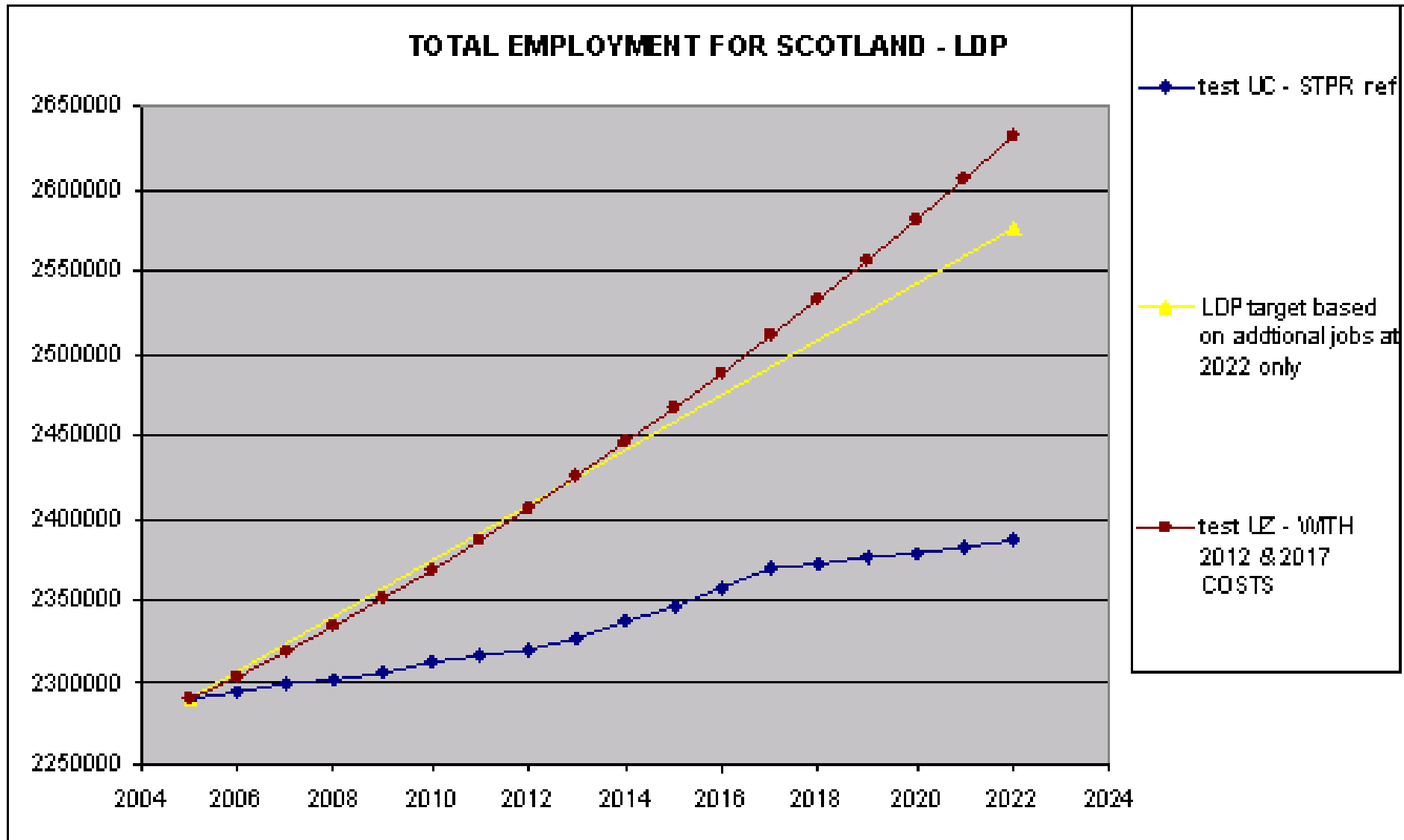
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 - 3 external areas
 - Rest of the UK
 - Rest of the world via UK
 - Rest of the world

Lothian Development Plan

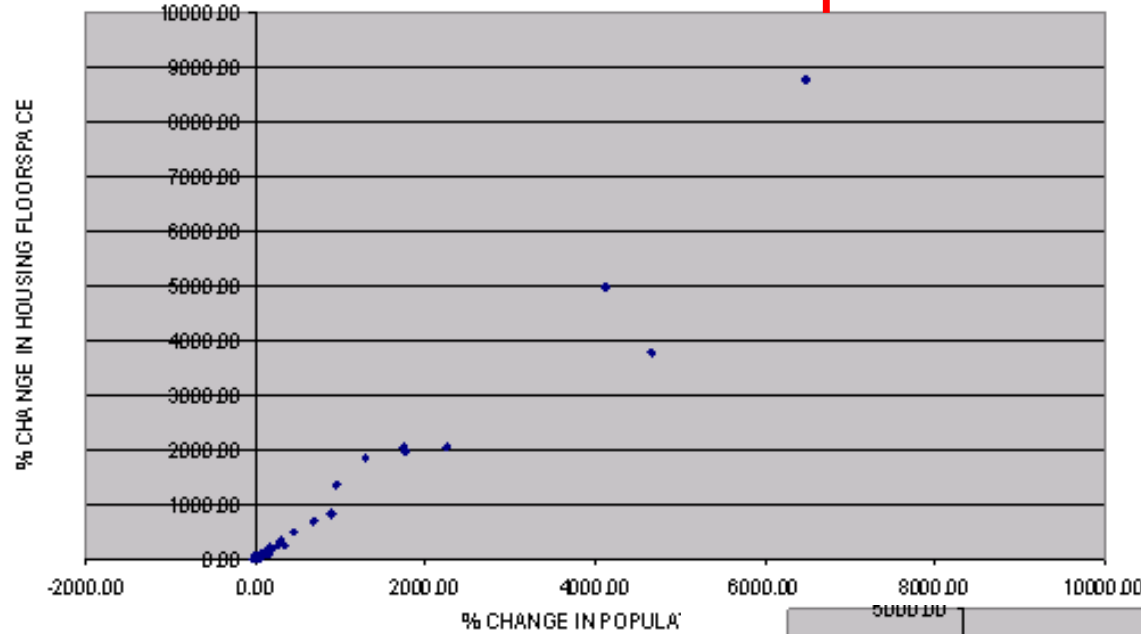
- New planning policy inputs
 - Floorspace inputs taken as exogenous developments
 - Additional floorspace is all occupied
- Economic scenario
 - Extra floorspace converted into employment by sector
- Demographic scenario
 - Young single and couple household types assumed to be the expected takers of the additional employment into the area
- LDP scenario ran as a LUTI model with transport costs in 2005, 2012 and 2017



Lothian Development Plan - Results

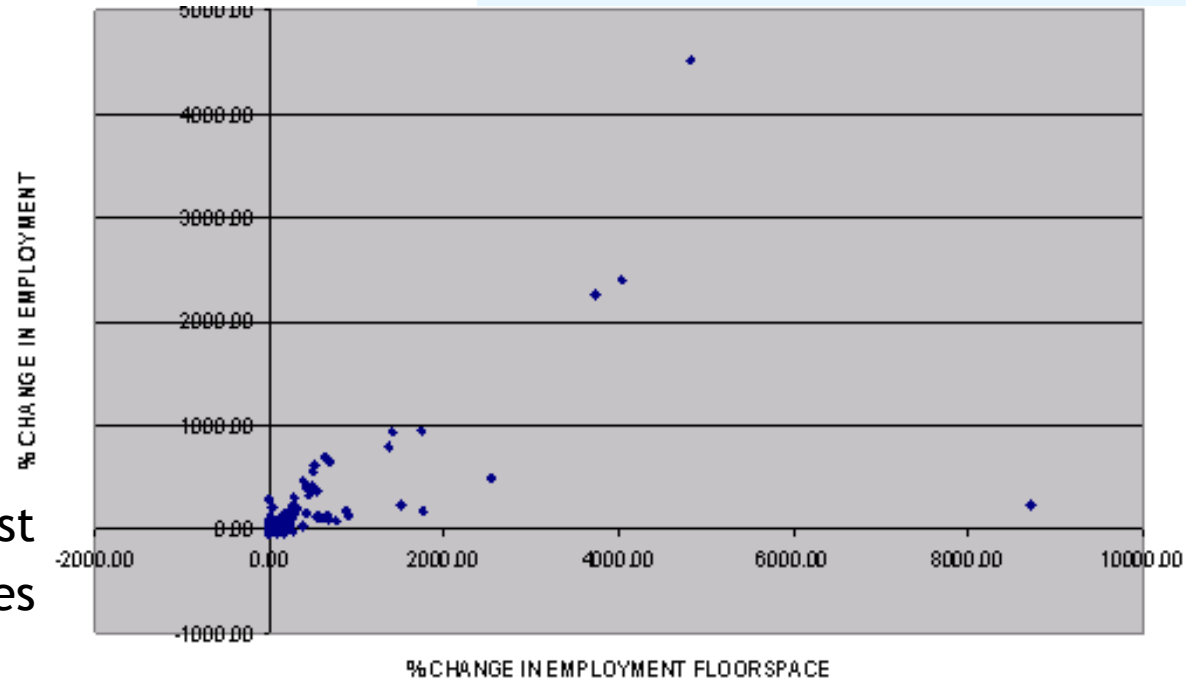


Lothian Development Plan - Results



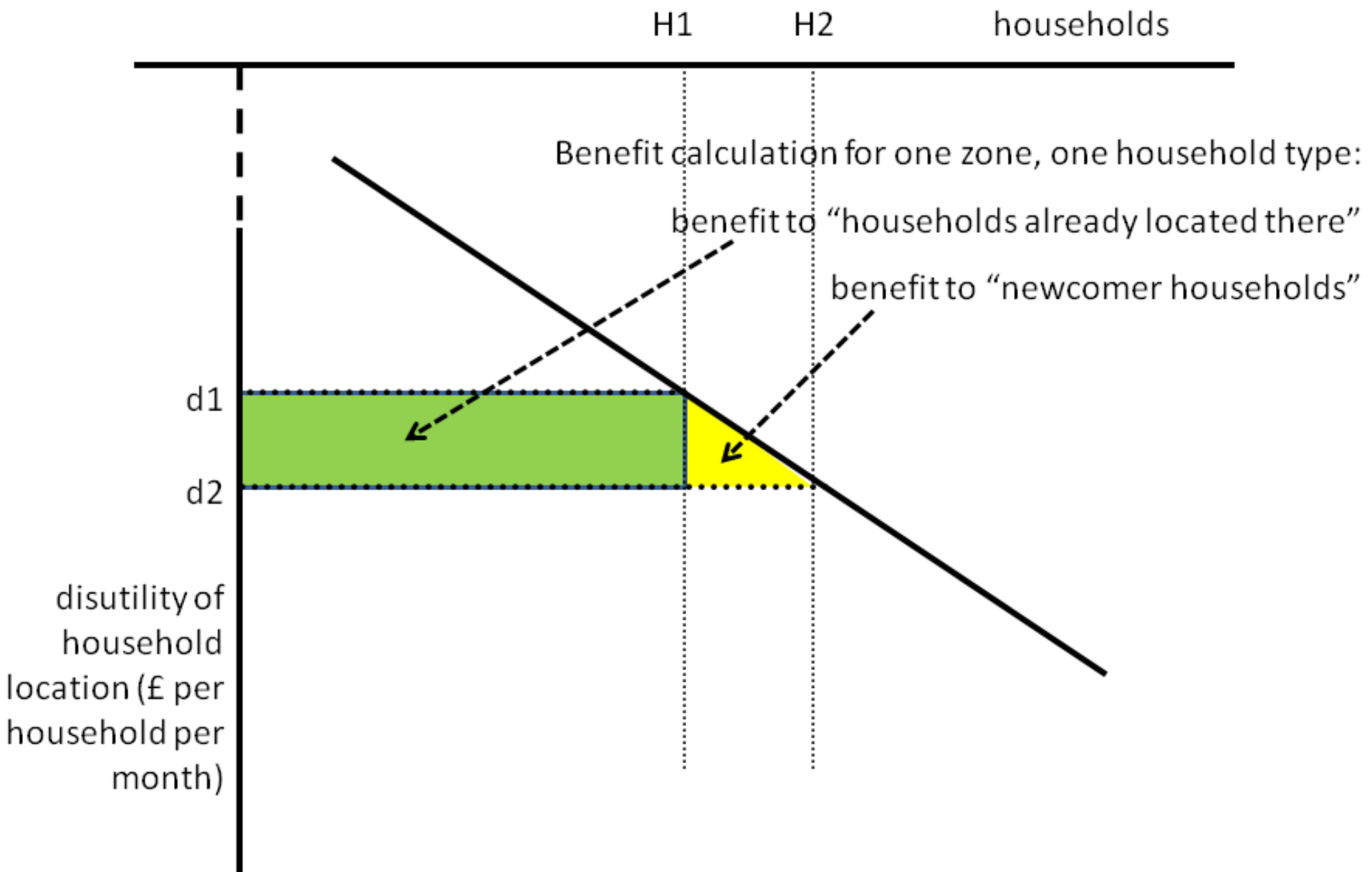
Population changes against residential floorspace changes

Employment changes against commercial floorspace changes



Lothian Development Plan - Conclusion

- Higher employment and full occupancy of newly developed sites
- Extra congestion from the additional people in work and living in the area





LATIS

LAND-USE AND TRANSPORT INTEGRATION IN SCOTLAND

