Institute for Transport Studies
FACULTY OF ENVIRONMENT

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Modelling the Economic Benefits of Inter-city Connectivity

System Dynamics Society Transportation SIG Workshop

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Structure

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- Background to inter-city effects
- Model Structure
  - Mobile Labour and Fixed Capital Case
  - Mobile Labour and Capital Case
- Model Results
- Key Messages
- Future Extensions to Modelling

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Background to Inter-city effects

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Inter-city economy impacts

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- Current inter-city connectivity investment schemes:
  - Northern Transport Strategy, HS2, TEN-T, etc.
- Rationale is improved economic performance
- Appraisal methods focus on direct cost savings and urbanisation effects not trade and specialisation
- There is no complete method currently available for assessing inter-city connectivity benefits which potentially may be significant

Goods, Services, Labour, Investment, Ideas, etc.

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Types of Inter-city effect

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- Direct Effects:
  - Business and Freight Travel Cost Savings
  - Increased Competition in Supplier Market
  - Reductions in Monopoly Power, etc.
- Economy Channels:
  - Gains from Trade
    - Comparative Advantage (Ricardo)
    - Economies of Scale (NEG)
  - Agglomeration Gains (Urbanisation and Localisation)
  - Technology Diffusion
  - Coordination Device and the “Big Push”

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Research Agenda

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- Size of inter-city impacts
- Relative scale of localisation and urbanisation impacts
- Understand the dynamics processes over time
- Determine the length of time for adjustment to a new steady state
- Focus on effects in (business) services sector

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Model Structure

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Model Structure

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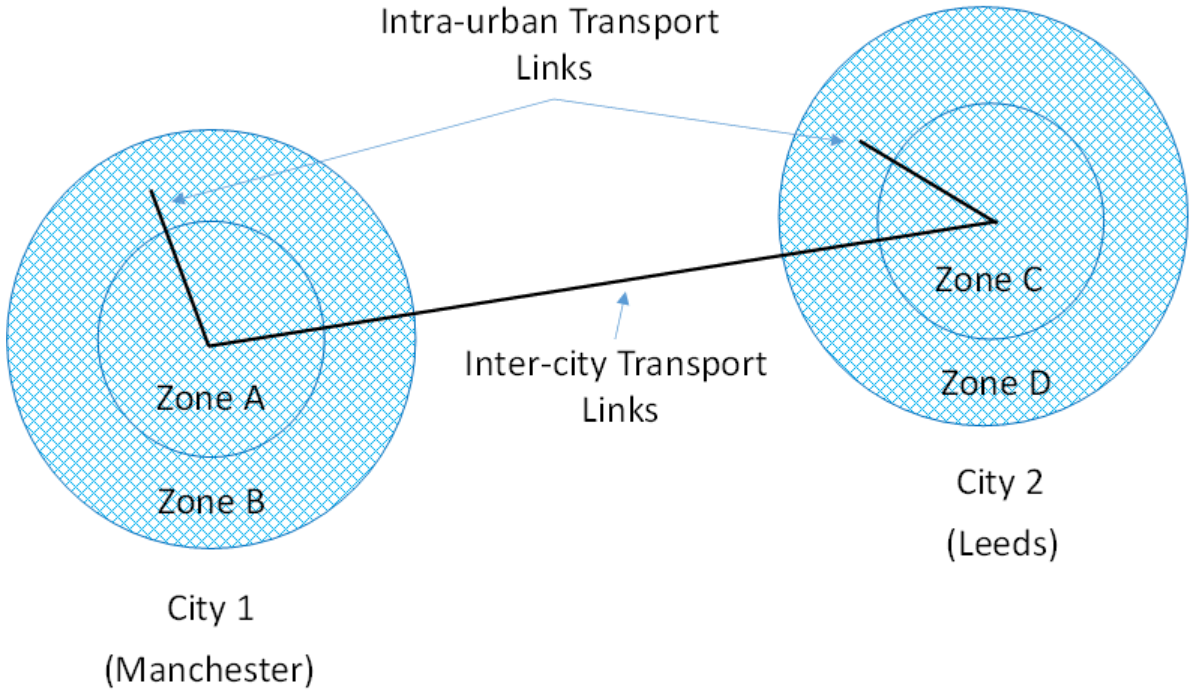
- Stylised four zone model of UK Cities Manchester & Leeds



- Two business service sectors in each zone
- Test impacts of 20-minute reduction in rail journey time

Model Variables

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- Model is based on theories from literature

Variables selected for first-stage model

Endogenous	Exogenous	Excluded
Labour Stock	Transport Scheme	Zonal Migration
Capital Stock (Run 2)	Capital Stock (Run 1)	Vertical Linkages
Wages	Prices	Population Growth
Capital Rents	Income Share of Capital	Labour Skills/Human Capital
Sectoral Migration Within Zones	Labour Supply	Capital Accumulation
Total Factor Productivity		Capital Depreciation
Urbanisation Impacts		Demand for Products
Localisation Impacts		Factor Substitution

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Stock and Flow Model – Fixed Capital Case

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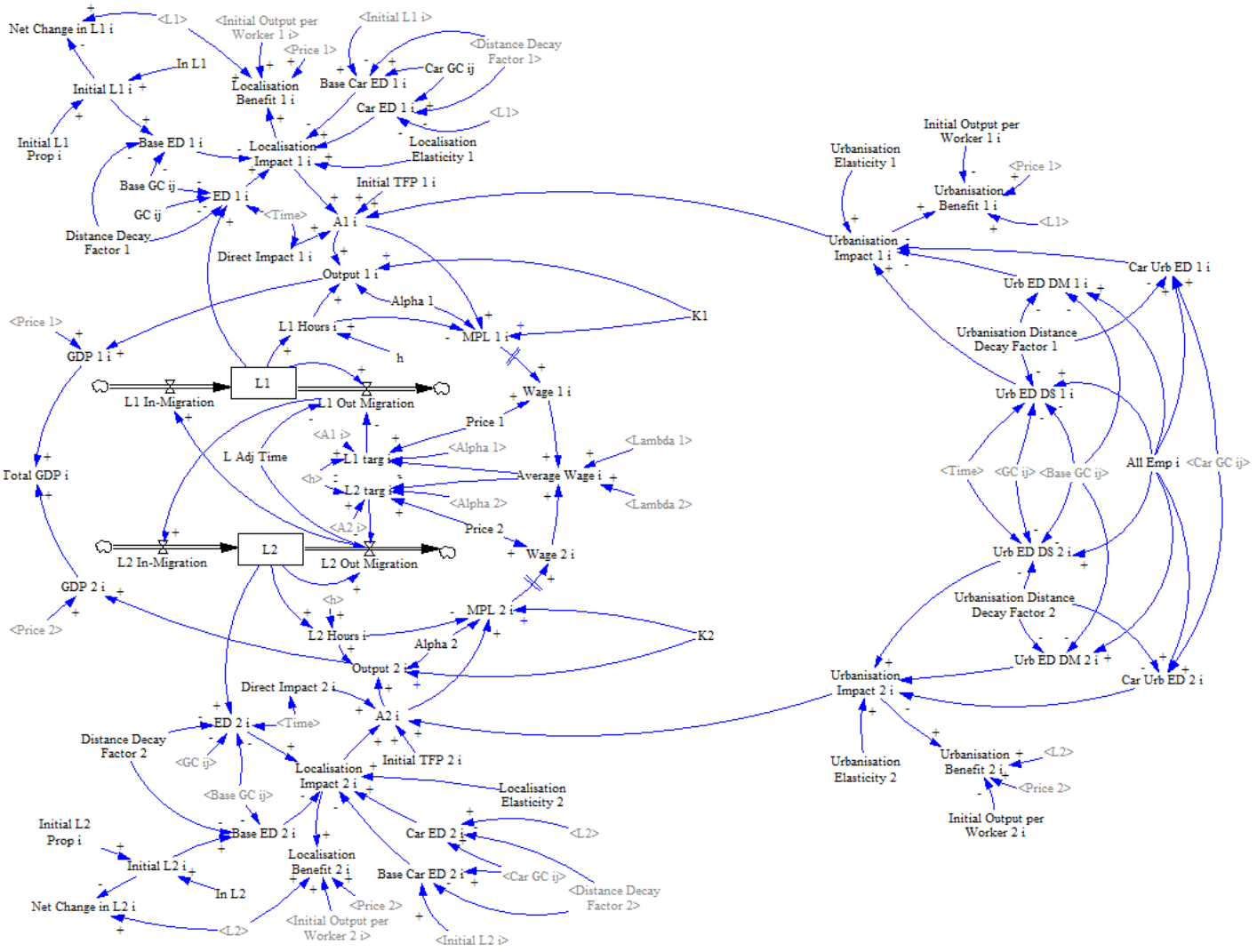

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Labour Reallocation based on Goal-Seeking Archetype

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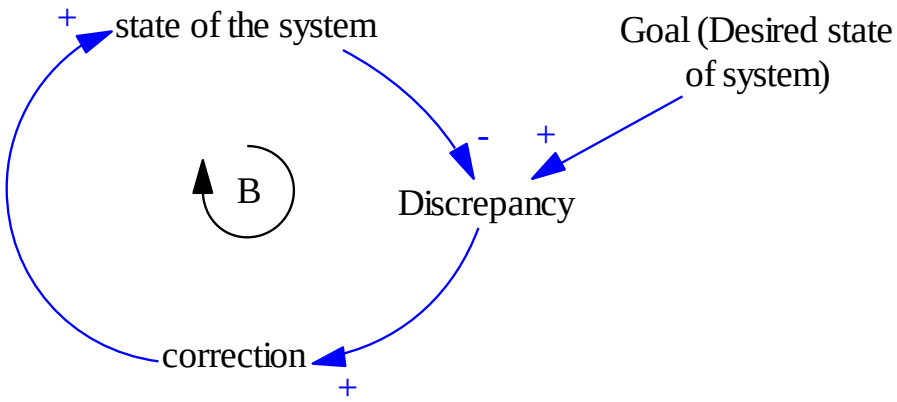
- Discrepancy=

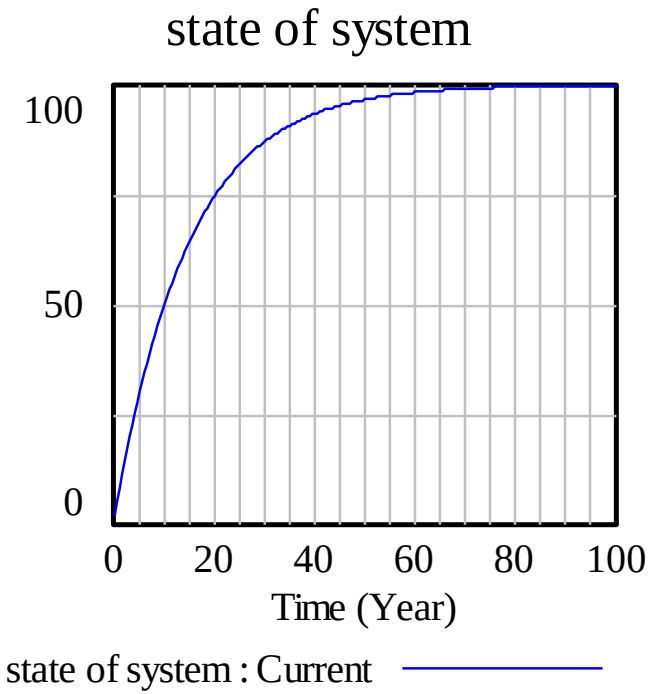
goal – state of system

- Correction =

discrepancy/adjustment time

- Negative feedback loop seeks "balance" or equilibrium





(Note goal = 100)

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Selected Model Equations for the Labour Market

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Labour Stock (e.g. for Sector 1):

$$L1_i(t) = \int_{t_0}^{t} [L1\ In\ Migration_i(s) - L1\ Out\ Migration_i(s)]ds + L1_i(t_0)$$

Wage: $w_i^n = MPL_i^n P^n = (1-\alpha_i^n) A_i^n (K_i^n / hL_i^n)^{\alpha_i^n} P^n$

Target Labour: $(L^*)_i^n = 1/\left((\overline{w_i}/(1-\alpha_i^n) P^n A_i^n)^{1/\alpha_i^n} (h_i^n / K_i^n)\right)$

Labour migration: $\left(\frac{L_1^n - (L^*)_1^n}{TAdjL}\right)$ $if\ w_1 > w_2$

i = zone, *n* = sector, *L* = Labour, *K* = capital, *α* = income share of capital, *w* = wage rate, A is TFP, *P* is Price, *h* is the average annual number of hours worked

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Main Feedback Loops – Fixed Capital Case (Sector 1 - Labour)

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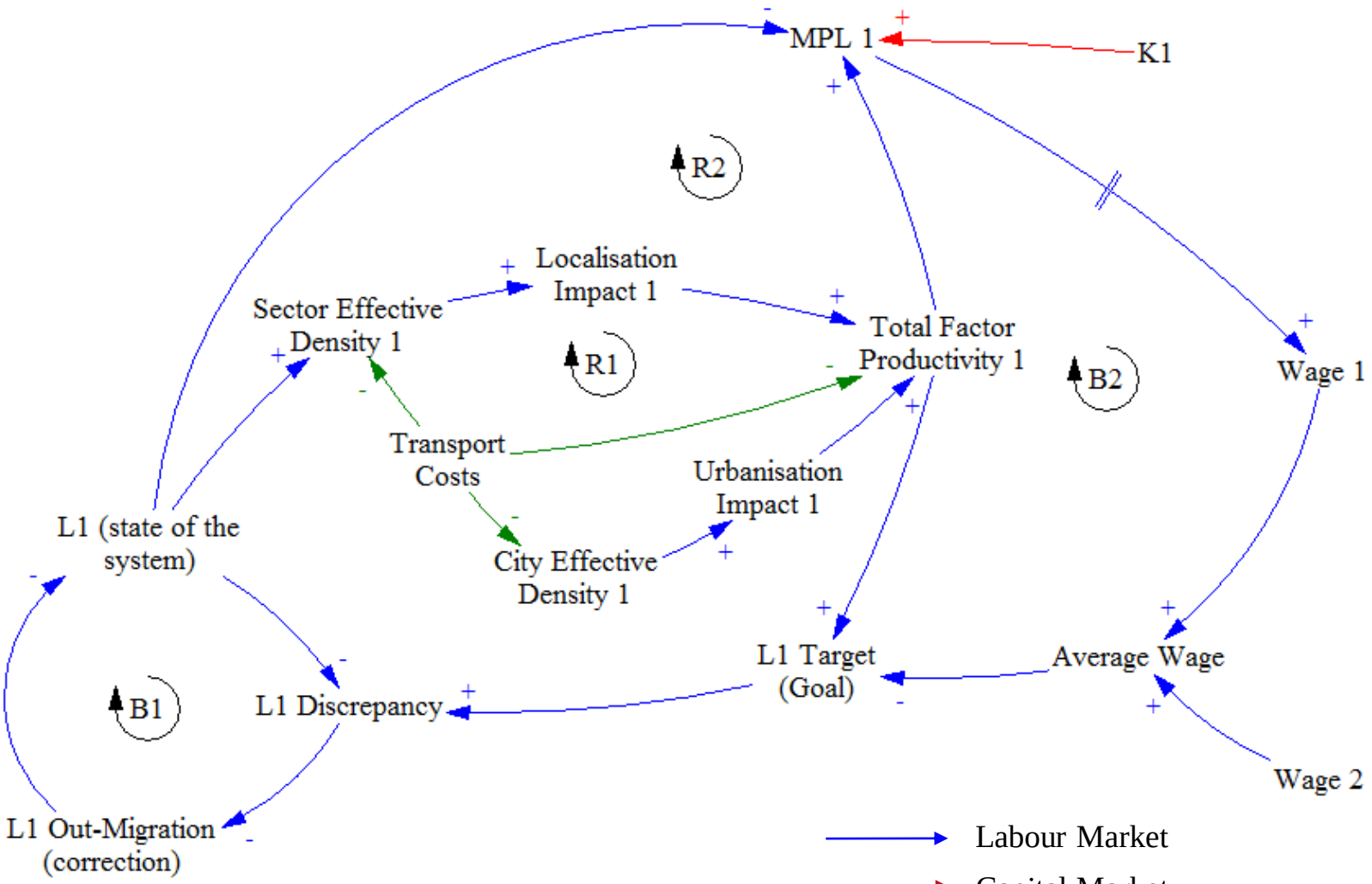

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Stock and Flow Model – Mobile Capital Case

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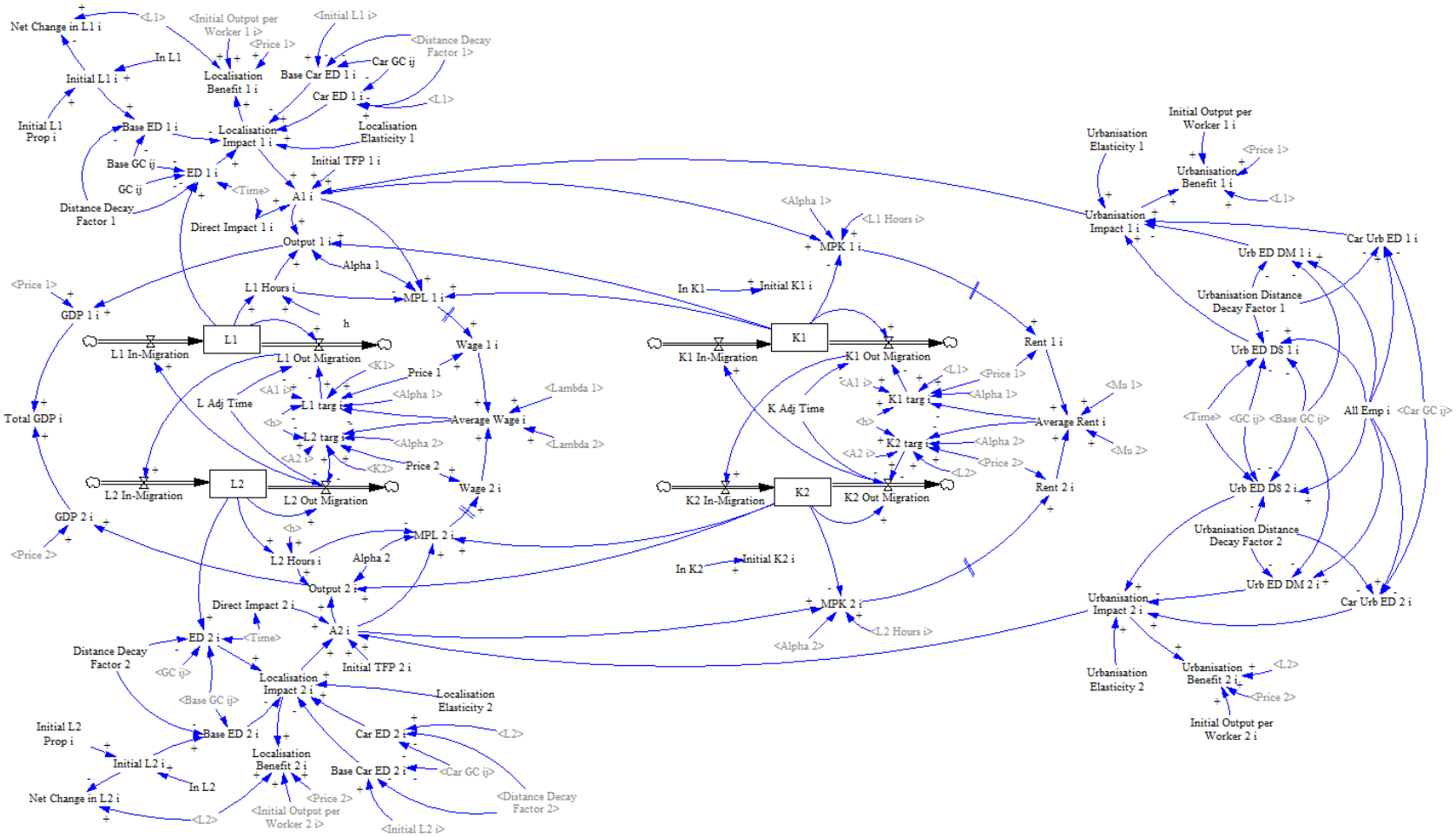

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Main Feedback Loops – Mobile Capital Case (Sector 1 - Labour)

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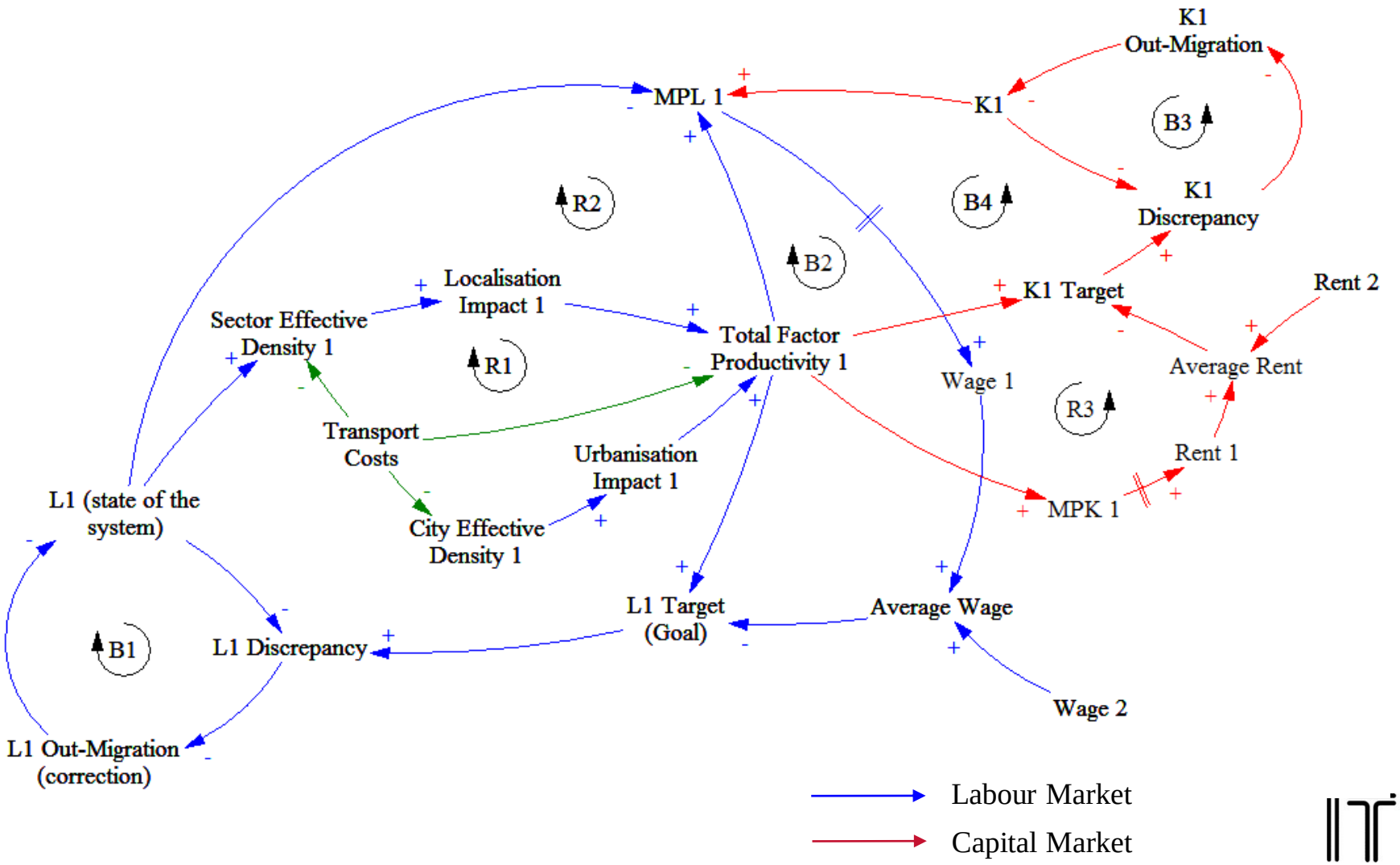

Main Feedback Loops – Mobile Capital Case (Sector 1 - Capital)

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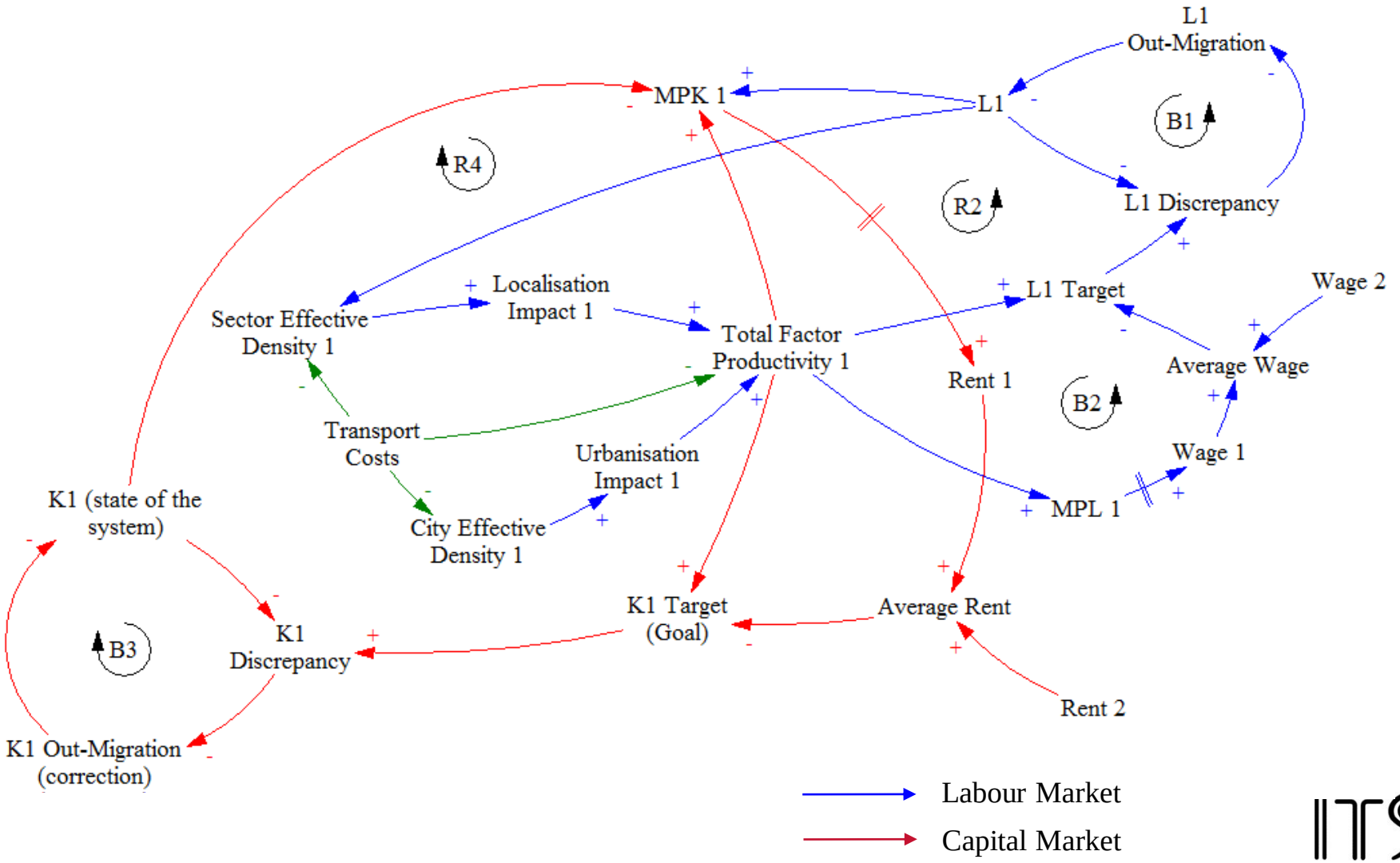

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Model Results

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Mobile Capital Case: Target and Actual Labour in Sector 1

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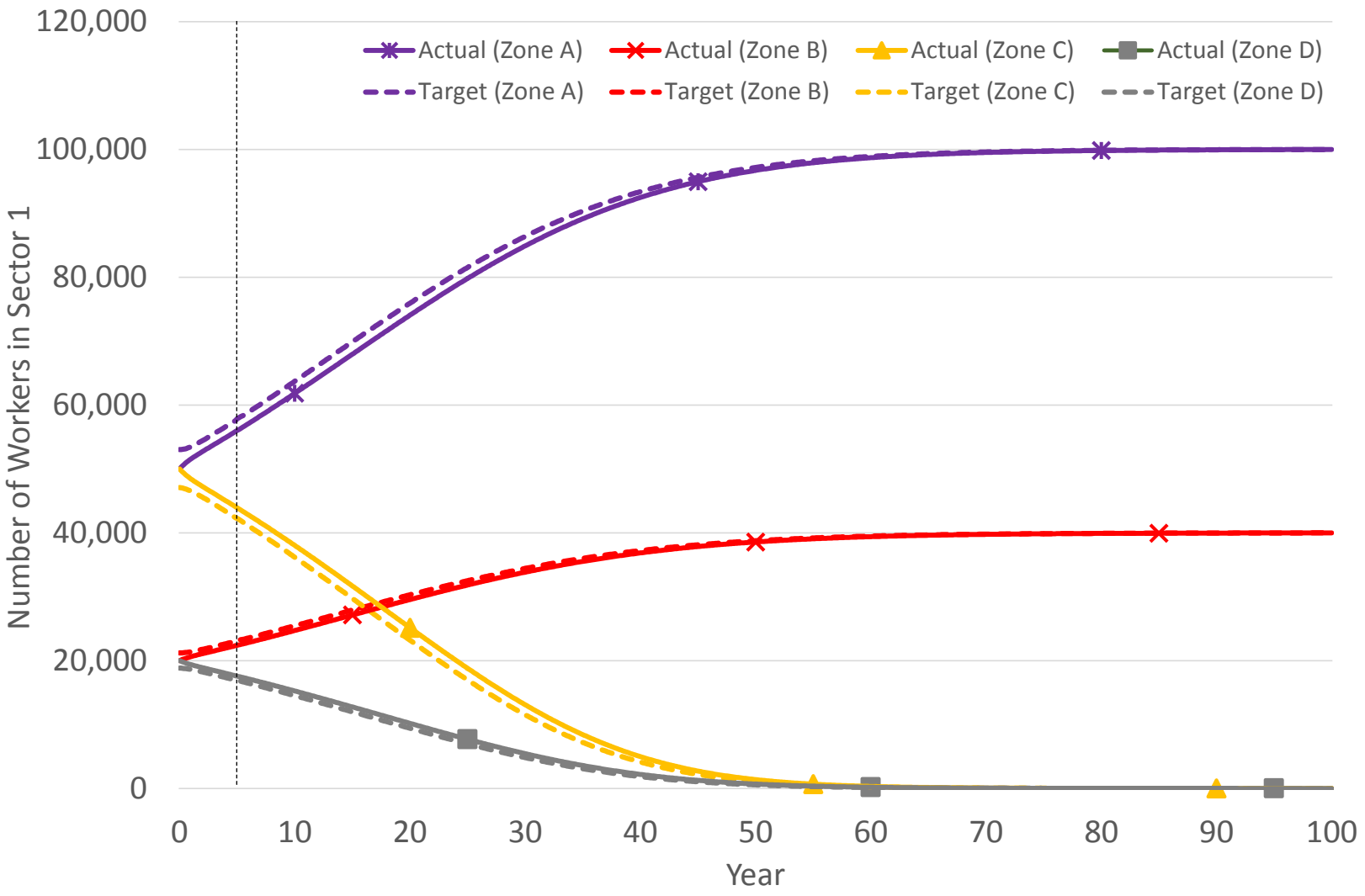

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Mobile Capital Case: Wages (£/hour) in Sector 1

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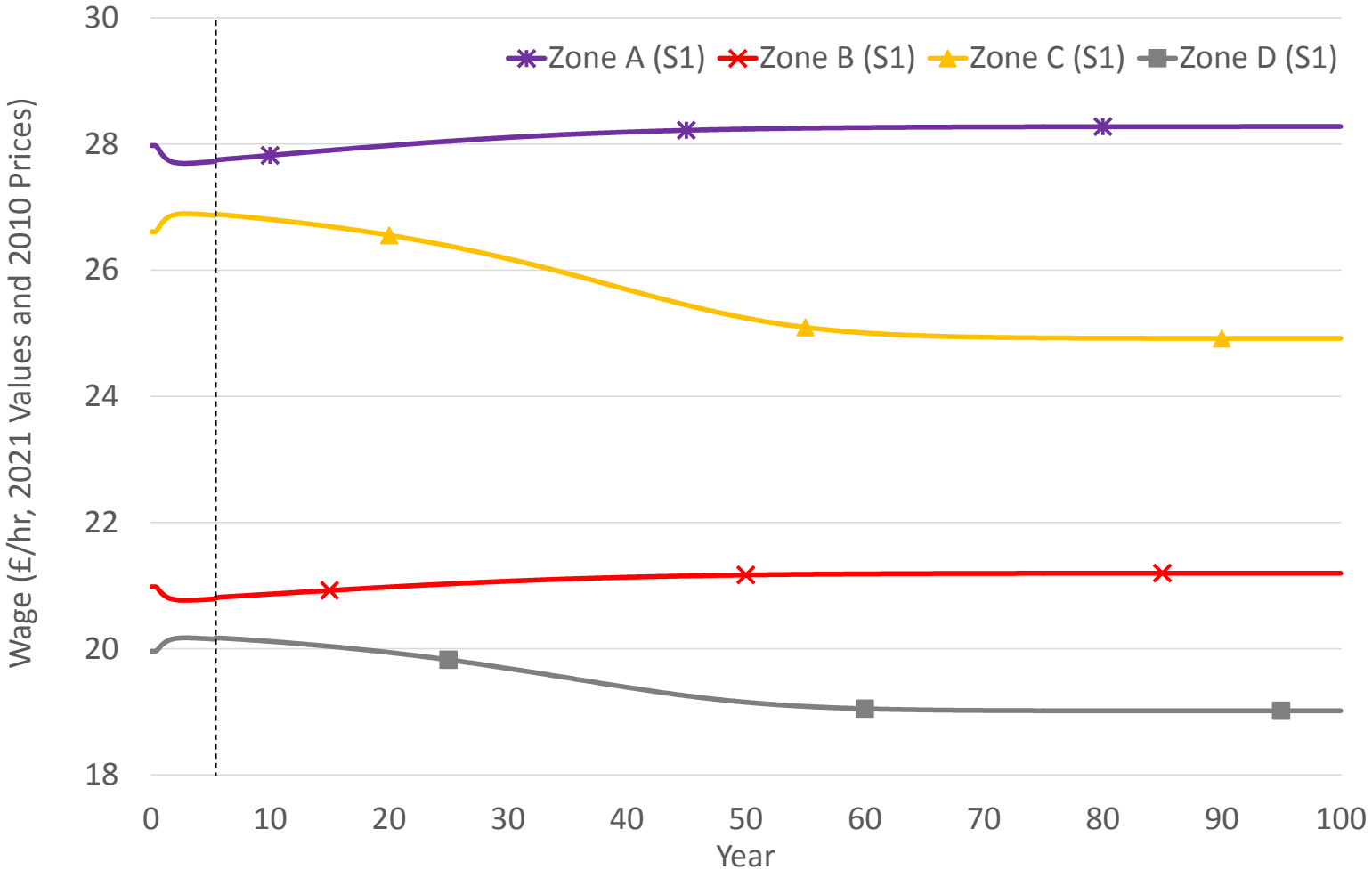

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Mobile Capital Case: Localisation Impact (%) in Sector 1

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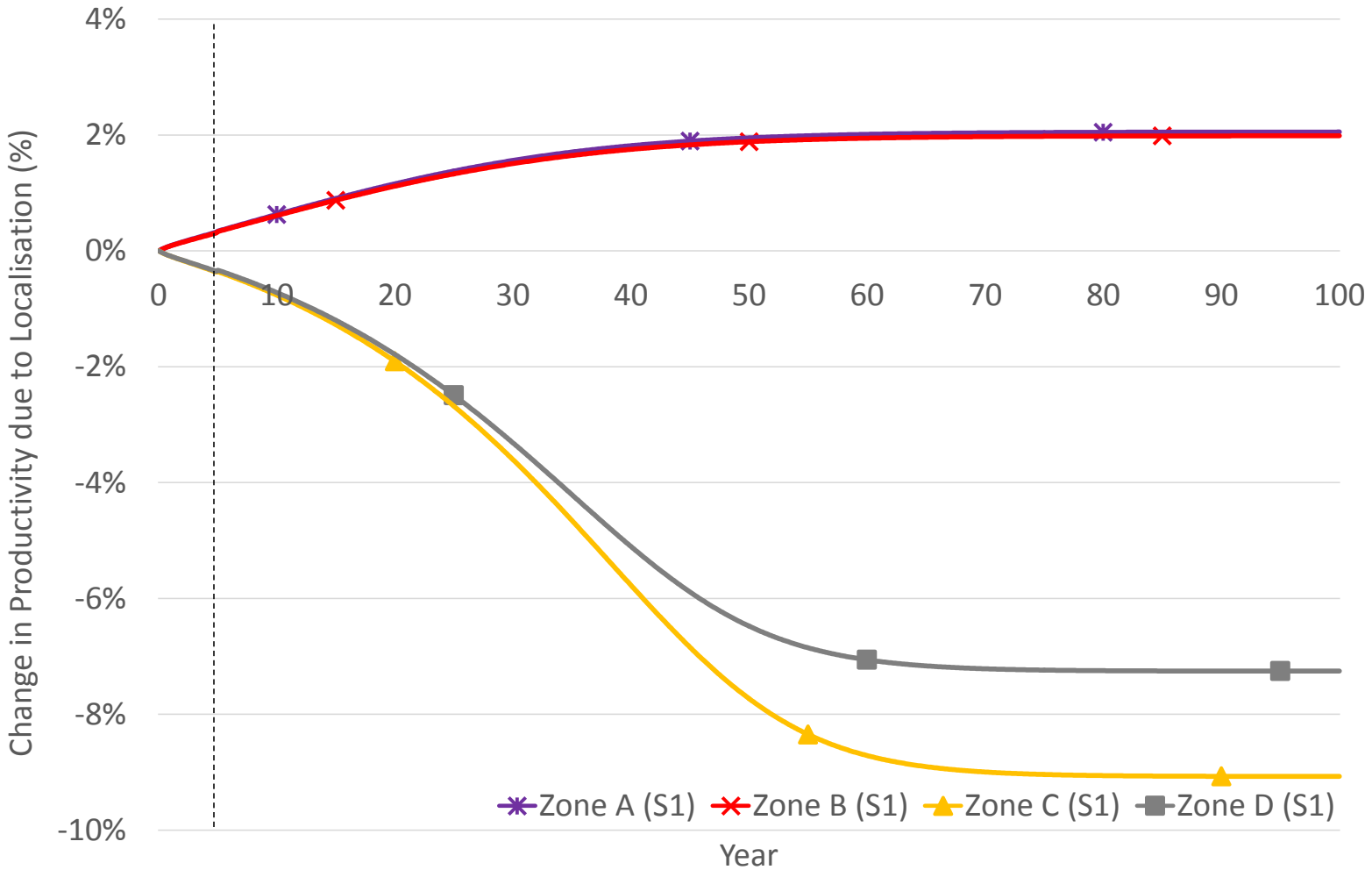

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Mobile Capital Case: Inter-city Scheme Present Value of Benefits (£m)

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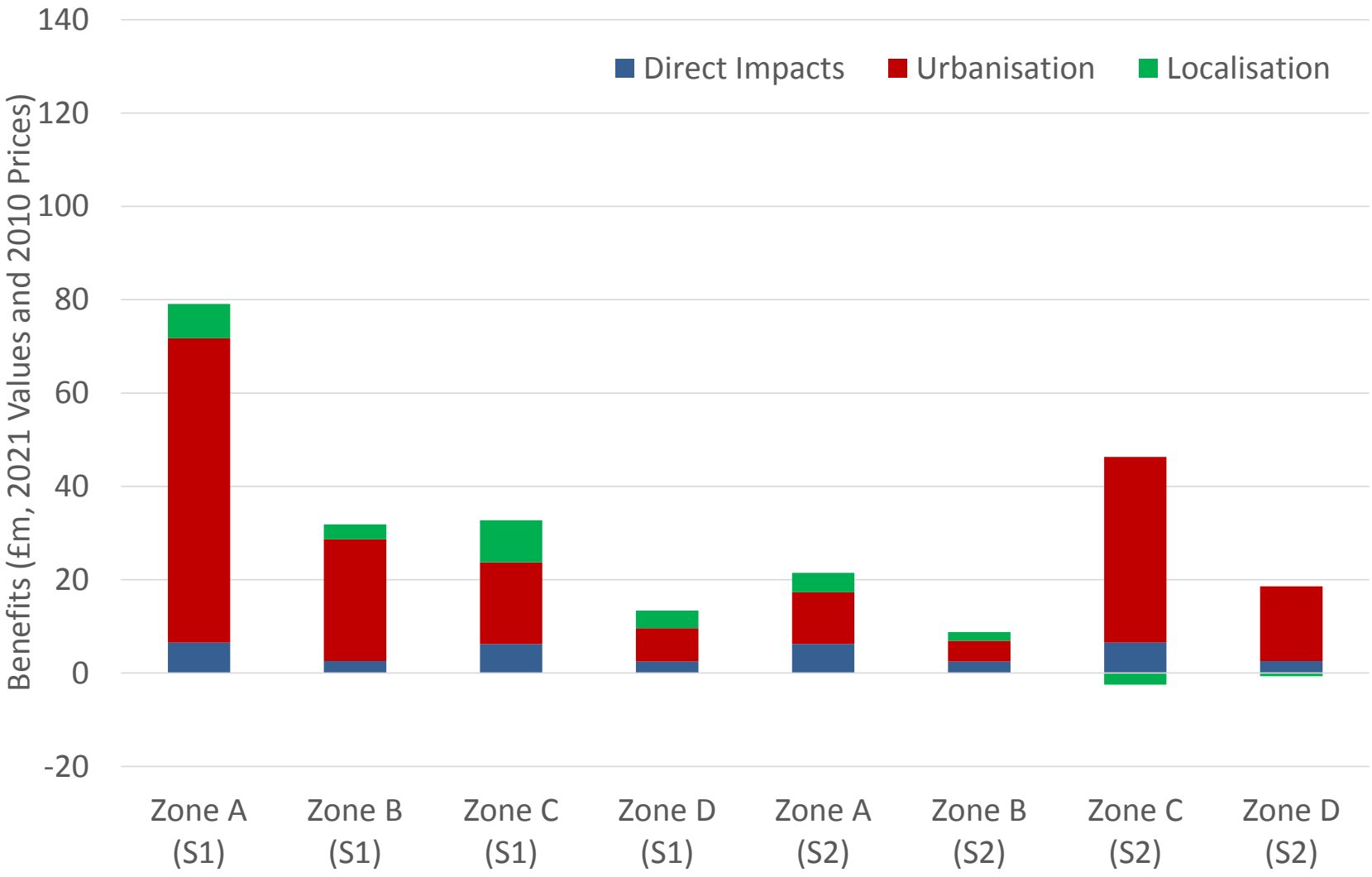

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Mobile Capital Case: Potential Economic Benefits (£m)

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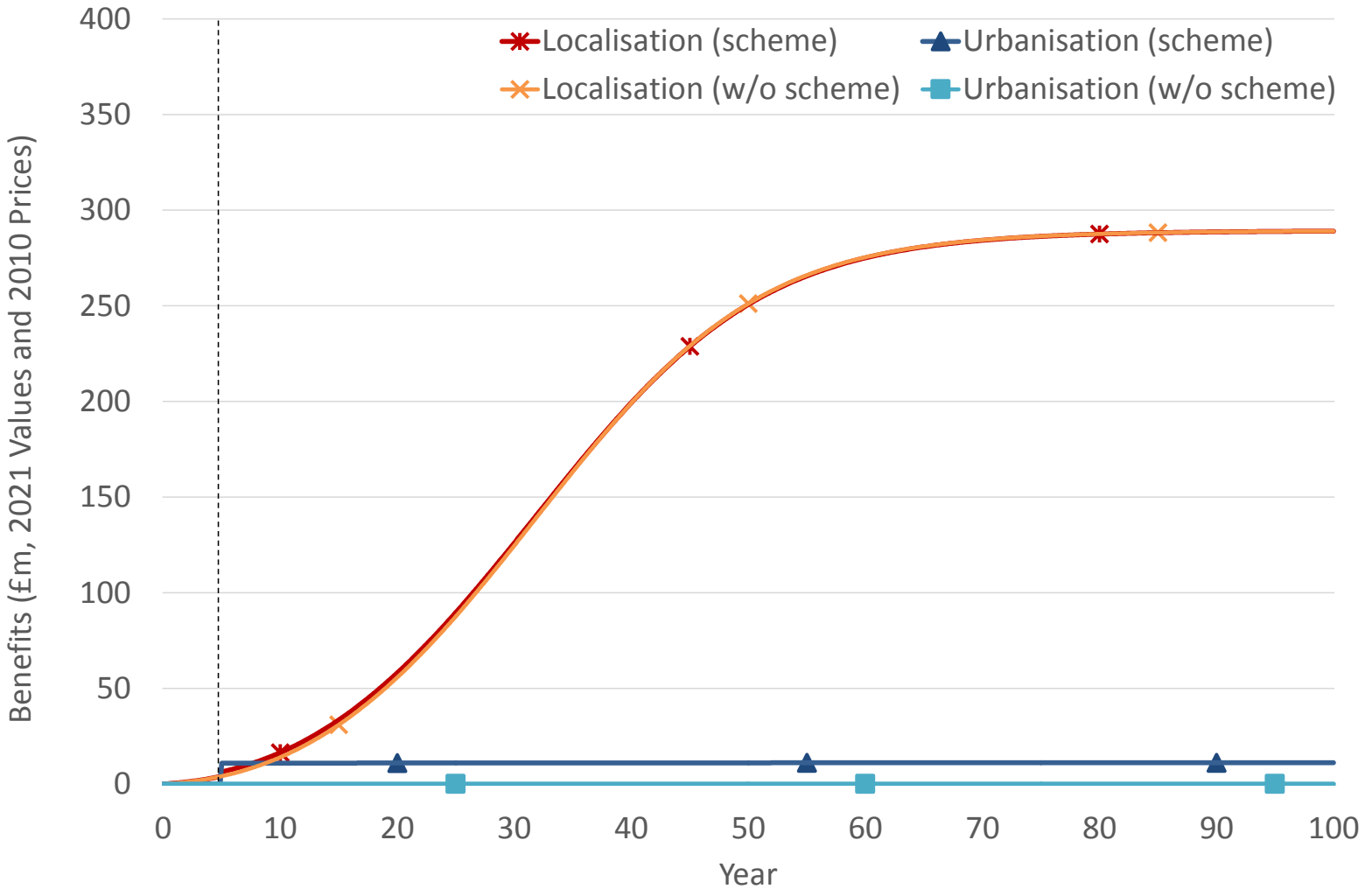

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Fixed Capital Case: Potential Economic Benefits (£m)

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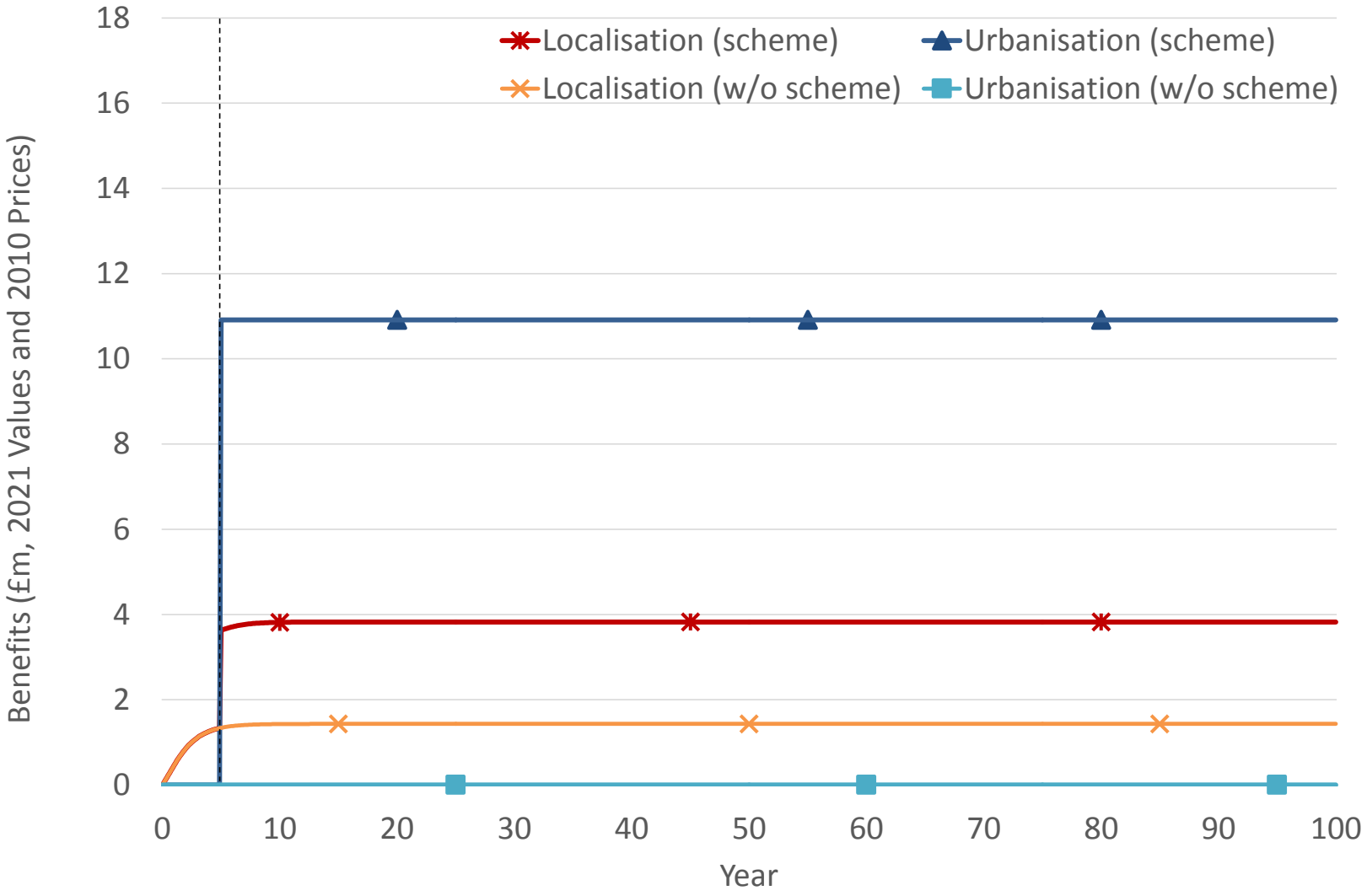

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Present Value of Benefits (£m)

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Present Value of Benefits (£m, 2021 Values and 2010 Prices with a 2010 Discount Base Year)

Benefits	Fixed Capital	Mobile Capital
Business User	35.6	35.6
Urbanisation	185.5	187.2
Localisation	40.5	26.30
Total	261.6	249.2

- Benefits are higher in the Fixed Capital Case

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Key Messages and Research Going Forward

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Key Messages

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- With mobile capital the model tends towards the corner solution with full specialisation (but it takes several decades)
- With fixed capital there are benefits from increased economic density but limited reallocation of labour between sectors but adjustment is quicker (<10 years)
- PV of Benefits of the transport scheme are higher in the fixed capital case (£267m) than with mobile capital (£249m)
- Urbanisation > localisation benefits – suggests other policies may be more effective at generating localisation benefits – e.g. investment in labour skills (but transport can support gains)
- Benefits can be negative in sectors and zones even if positive overall as transport can slow down the transition to further specialisation

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Research Going Forward

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- Future modelling extensions
  - Additional functionality
    - Endogenous pricing, labour skills, vertical linkages, etc.
  - Multiple sectors
  - Cities of different sizes, three cities, polycentric city, etc.
  - Longer distances between cities
  - 2 Case studies using actual data (both ex-ante and ex-post)
- Workshops/interviews with experts to review and finalise models

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Thank you for listening

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Any Questions?

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