The Impossibility of Social Simulation

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Talk Outline

1. *The Pessimistic view* – reasons why social simulation might be impossible
2. *Why it Might Appear Possible* – ways in which we can fool ourselves
3. *Modelling Relations* – a bit about how models relate to what is modelled
4. *Some Different Simulation Goals*
5. *Some Example Simulations*
6. *Conclusion*

Part 1

The Pessimistic View

Why it might *not* be possible – I

- We are trying to model using something of a different nature from what is modelled
  - We are using a formal object (a program) which is syntactic in nature, obeying (at base) fixed rules for inference (running it)
  - We want to model phenomena that is semantic in nature exhibiting a variety of flexible and "fuzzy" behaviour
- It is true that in physics symbols and numbers are used to model the properties of physical phenomena, with the gap bridged by *measurement* but...
  1. This took a long time to develop requiring a lot of effort into developing measurement rather than theory
  2. There are special reasons why numbers work at representing physical phenomena (due to implicit averaging of parts)
  3. The limitations of analytic approaches to physics and the need for modelling that goes beyond numbers to structure is apparent
- *It is not obvious that what worked in physics will work for us* – the gap is much **MUCH** greater!

Why it might *not* be possible – II

- There is an important lack of knowledge about what we are trying to model...
- ...namely what goes on in our heads.
- It is known that in some simulations, exactly which cognitive model is used (with the same inputs, outputs etc.) results in very different outcomes so we know our results are dependent on this
- There is no "off the shelf" model/theory of cognition from AI, ML, cognitive science, economics, etc. that is *anywhere like* reliable
- Thus we don't know how to model a ***crucial*** part of our target phenomena that we know might matter!

Why it might *not* be possible – III

- Different social causes/mechanisms might ***not*** be effectively separable
- That is to say, each time we add in another aspect or mechanism into our models we might get significantly different outcomes
- Whilst in physics it often seems to be the case that some factors are more important than others, so one is safe in ignoring the less important ones...
- ...this is not obviously the case for social phenomena where often the inclusion of a new kind of mechanism/ability in a simulation can completely change the outcomes from...
- The framing of social phenomena – *what is or is not included* can be crucial to any conclusions drawn

Why it might *not* be possible – IV

- Social phenomena might be *extremely* context-dependent
- It is not even true that if one puts the same person in increasingly similar situations that their behaviour converges to a pattern
- Whilst in physics atoms etc. always act in the same way describable by general laws
- People (or other social actors) are not obviously consistent in this way
- It might be that every single observed instance will require its own special simulation model

Why it might *not* be possible – V

- Any simulation that is adequate to what we are modelling might be so complex that we can not understand it
- There might be no "middle ground" where models are somewhat useful but sufficiently comprehensible
- A consequence of the "Anti-anthropocentric Principle" – that the world (including the social world) is not arranged for our convenience (as academics)
- Then we could not even check if our intentions for a simulation were reflected in its implementation!
- Simple simulations would have no relevance, complex simulations no rigour

Summary of the Pessimistic View

  - The semantic/syntactic divide
  - The lack of reliable cognitive models
  - The inseparability of social mechanisms
  - The context-dependency of behaviour
  - The size of the complexity gap
- "*To a man with a hammer, every screw looks like a nail*" – just because we have this flexible and fascinating tool, it does not mean that it will *help* us understand the social phenomena we observe
- What we are trying to do is difficult and open to (justified) criticism if done sloppily

Part 2

Why it may *appear* feasible

Theoretical Spectacles

- Kuhn (1962): when we have adopted a theory we tend to filter what we see:
  - We notice aspects of data/observations that agree with it or are explained by it
  - We don't notice or explain away anything that does not fit with the theory
- We see the world "through" the theory
- This effect is even stronger with agent-based simulation models, because:
  - they are readily interperable in terms of them
  - the act of playing with a model over a period of time involves you in the model and its construction

Thinking Analogically

- In an analogy the referential mappings to the domain of application are flexibly created in a creative fashion each time
- The mapping is not usually specified and is certainly not fixed – it may be different for different people even for the same domain
- This contrasts with “scientific” applications where what the different parts of the model refer to are specified explicitly
- We are *so* adapt at applying ideas in an analogical fashion that we are often unaware of the process
- Analogical thinking is powerful in developing personal understanding, but is different from actually modelling social phenomena

Wishful thinking

- We might *wish* that our simulation project is feasible and thus believe it is possible
- We might not want to keep discarding wrong simulations and starting again
- We might imagine that our simulation is basically right (Kuhn's spectacles) but it just needs some extra details put right/included
- Via analogical thinking we *can imagine* how it could be the case that simple models might represent social phenomena

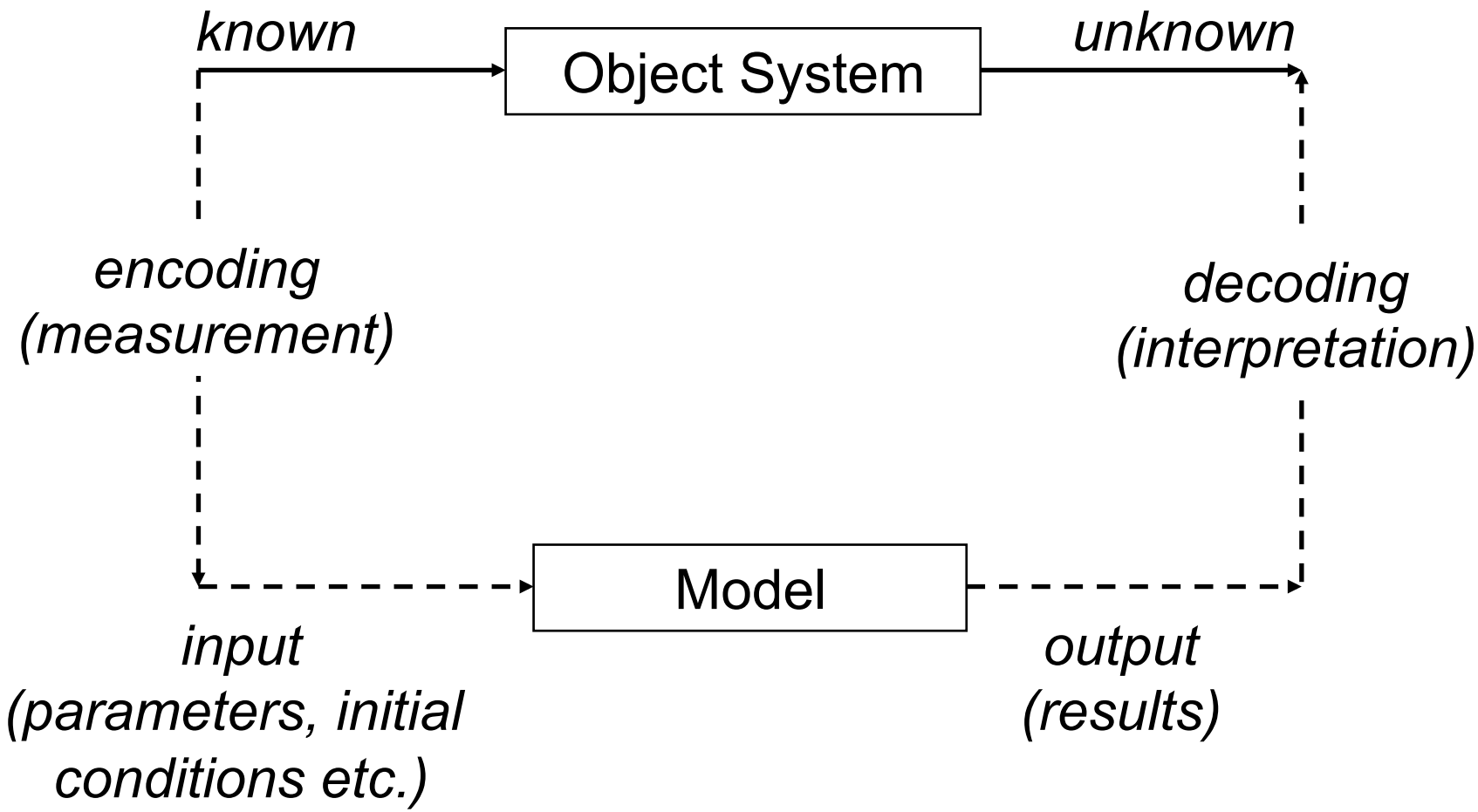
Conflation/Confusion of Aims

- A model that is a good analogy is confused with one that actually describes some phenomena
- A model that presents a candidate explanation is confused with one that predicts what will happen
- A purely conceptual exploration is confused with an explanation of what happens
- An illustration of a phenomena is confused with a demonstration of its existance
- etc. etc.

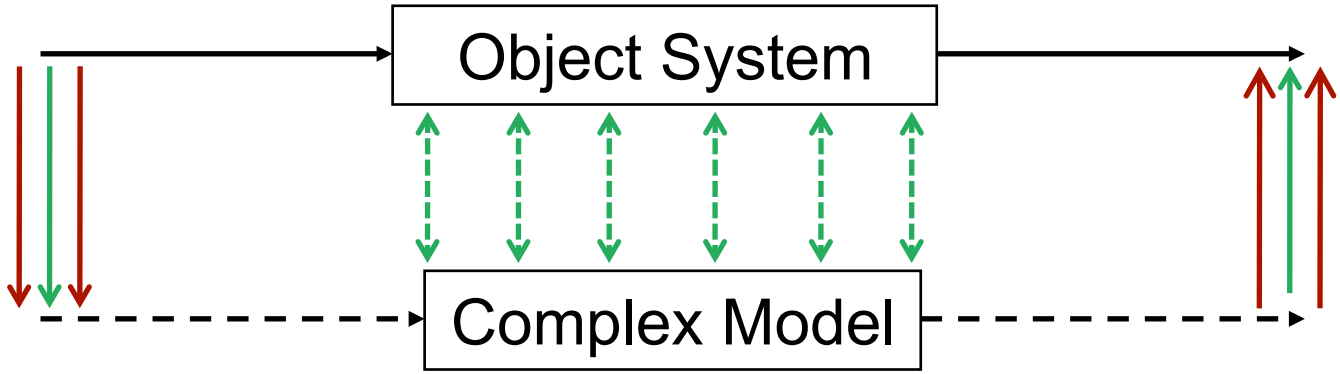
Part 2

Modelling Relations

Modelling parts and relations

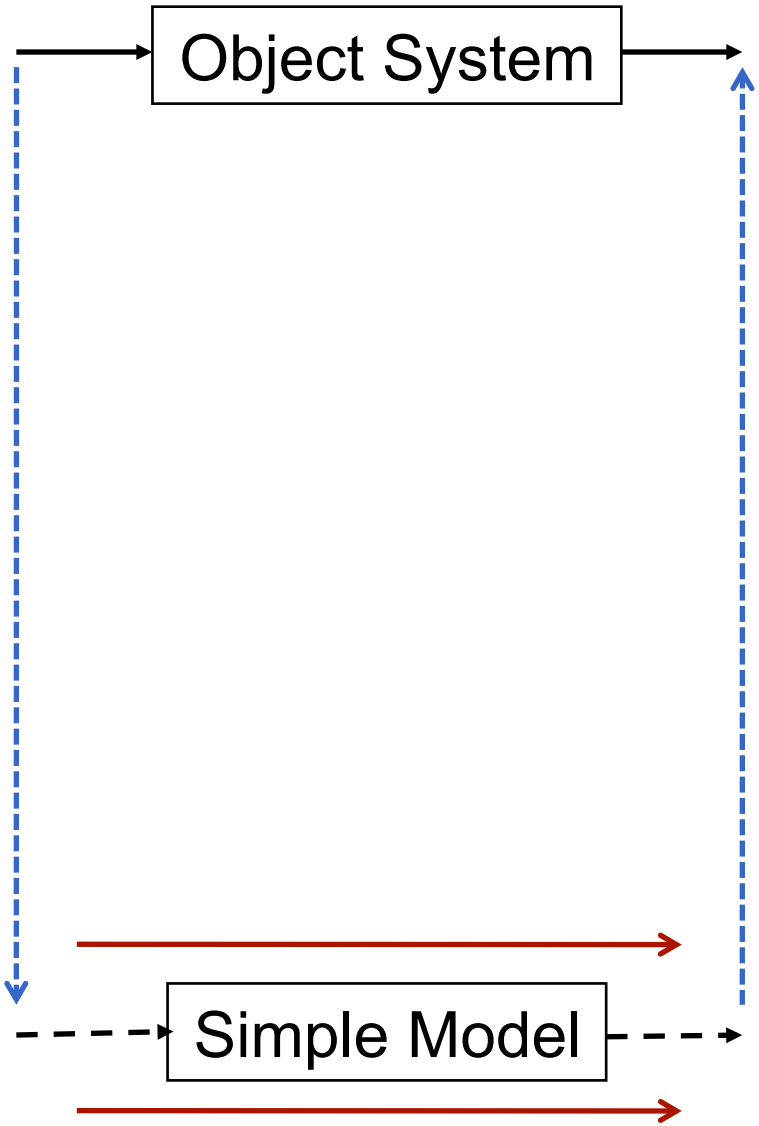


A Descriptive Model



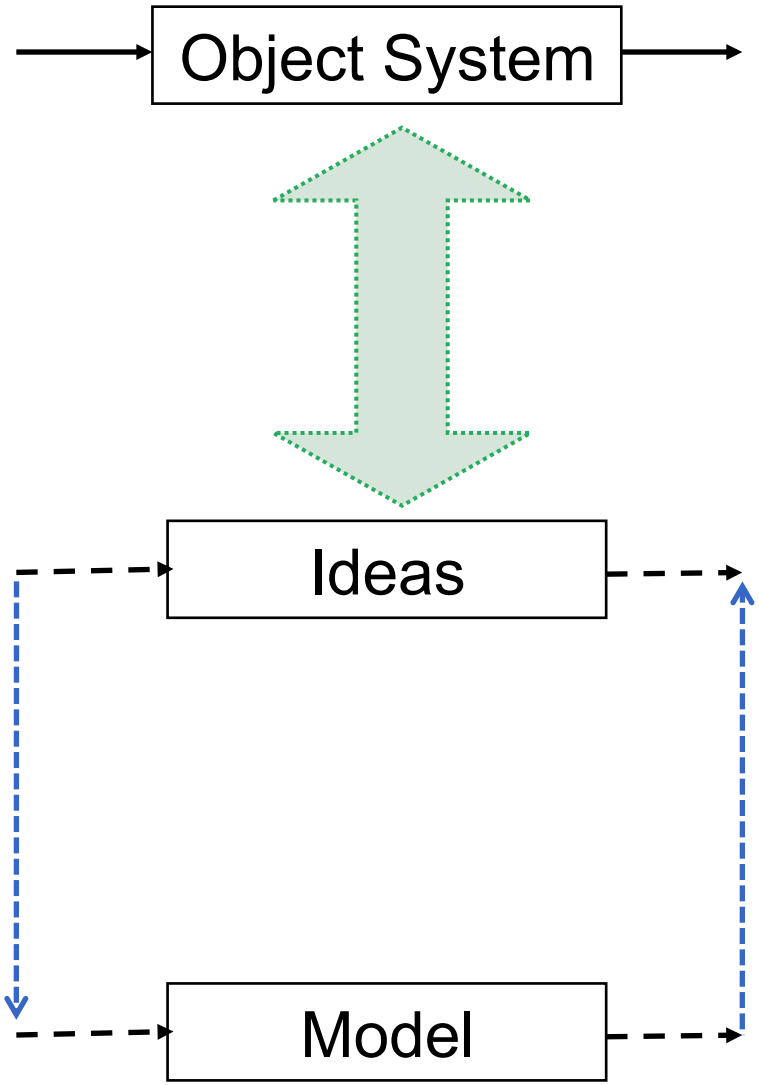
- A model with a detailed and explicit mapping to its target phenomena, not only in terms of in/outputs but also processes
- Strong on *relevance*
- However model might need to be complex and so not fully understood or checked

An Abstract Model



- A simple model with a distant relationship with what is observed
- Strong on *rigour* since the model can be analysed and checked
- However establishing the relevance of such a model may be problematic

Modelling Ideas not Observations



- Here the simulation models a set of ideas
- And the ideas are analogically applied to the subject domain
- There is no strong and direct mapping from model to observations/data
- The ideas *as they are applied to the target phenomena* are not rigourously understood, *only* the model of the ideas

Summary of Modelling Relations

- If we are satisfied with "*yet another way of thinking about stuff*" (YAWOTAS), then modelling is easy, but then we should not claim more of our models than any other story that can be told
- One way of doing this is to model an idea using a simulation where it is the idea which analogically models what we observe
- In this case we can only make very weak claims about what we model
- A central difficulty is that to do otherwise requires *both* rigour and relevance

Part 4

Different Simulation Goals

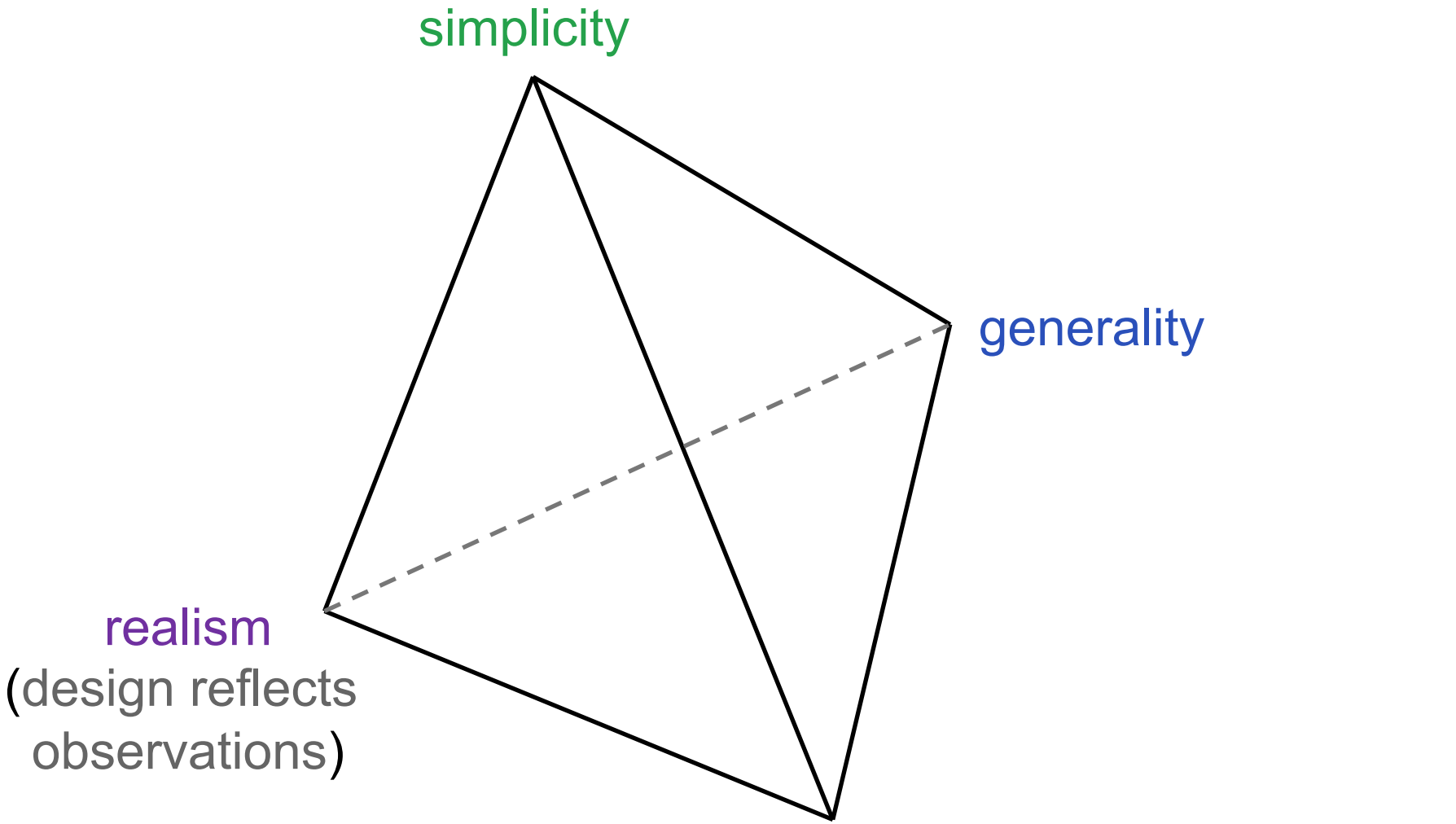
Some Purposes for Simulation

- To entertain
- To illustrate a process
- To help design an artificial system
- To mediate between people
- To provide a way of thinking about stuff
- To critique/clarify some concepts
- To predict aspects of unknown events
- To explain known events/data
- To analyse a mechanism

Some criteria for judging models

- Soundness of design
  - w.r.t. knowledge of how the object works
  - w.r.t. tradition in a field
- Accuracy (lack of error)
- Simplicity (ease in communication, construction, comprehension etc.)
- Generality (when you can safely use it)
- Sensitivity (relates to goals and object)
- Plausibility (of design, process and results)
- Cost (time, space etc.)

Some modelling trade-offs



Decisions about modelling

- Your modelling goal strongly relates to the research question you are tackling
- This is not the same as the criteria for judging models
- Different goals and different methods imply different trade-offs are possible and may rule out some methods...
- ...but the choice of methods and extent of possible success should be related back to your modelling goal/research question

Part 5

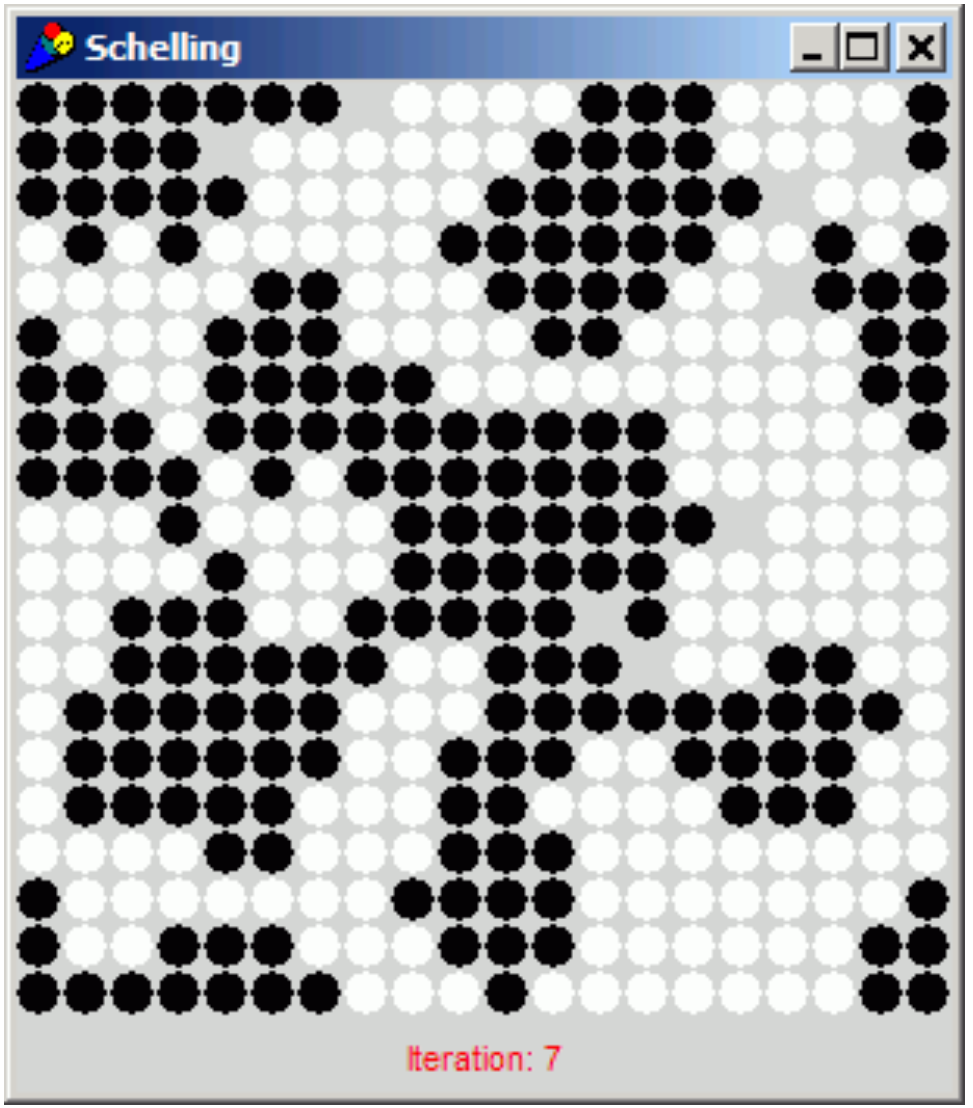
Some Example Simulations

Example 1: *Schelling's Segregation Model*

Schelling, Thomas C. 1971. Dynamic Models of Segregation. *Journal of Mathematical Sociology* **1**:143-186.

Rule: each iteration, each dot looks at its 8 neighbours and if less than 30% are the same colour as itself, it moves to a random empty square

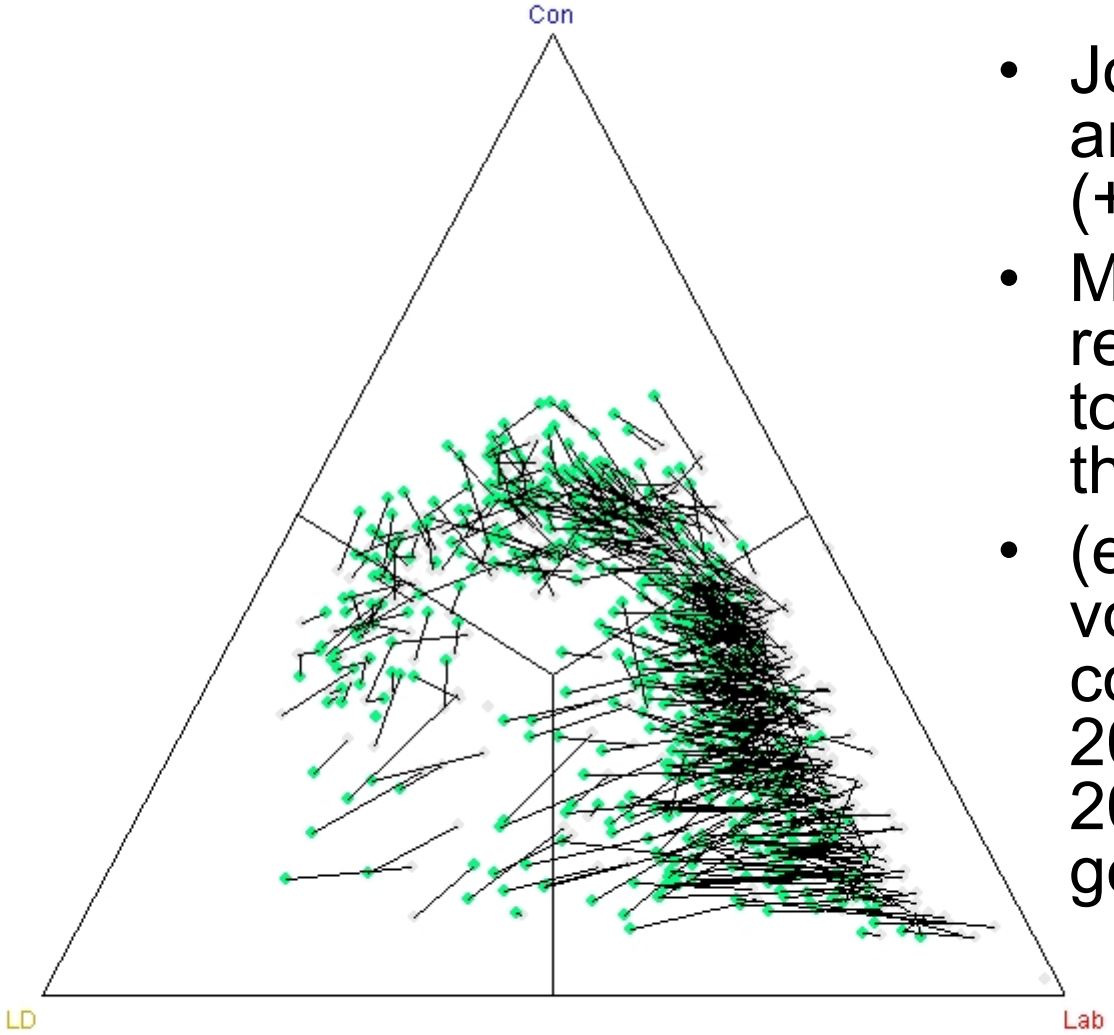
Segregation can result from wanting only a few neighbours of a like colour



About Schelling's Model

- A simple but ground-breaking simulation
- Its purpose is conceptual clarification...
- Namely that *macro-scale segregation can be caused by relatively weak preferences of social actors*
- It does not relate directly to observed social processes
- It does not predict
- Later work analysed the mechanism

Example 2: *General Election Forecasting*

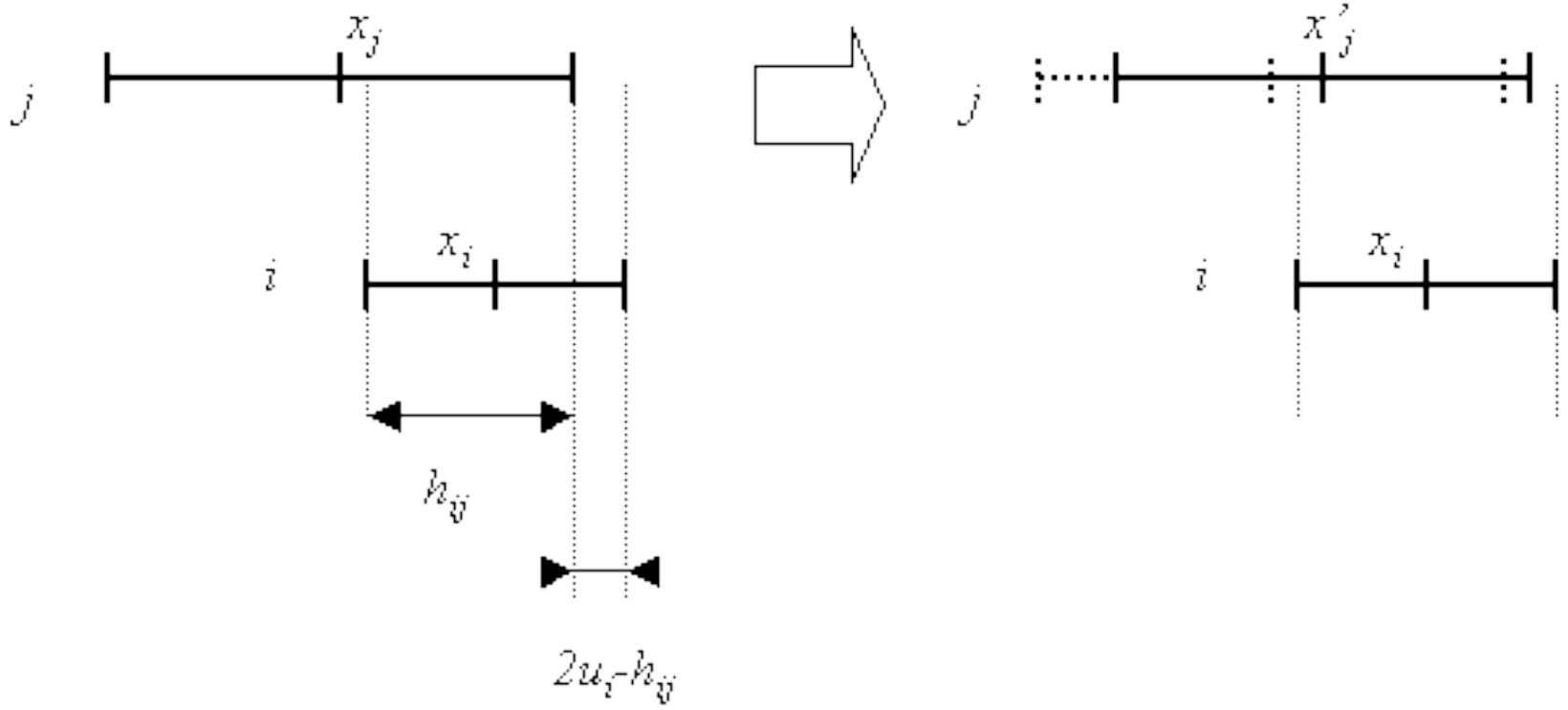


- John Curtice (Strathclyde) and David Firth (Warwick) (+ input from others)
- Micro statistical model requiring a mass of data to condition and initialise the model
- (each line is a the 3-way vote share for each constituency, green spots 2005 shares, tail is the 2001 shares in UK general elections)

About the Election Forecast Model

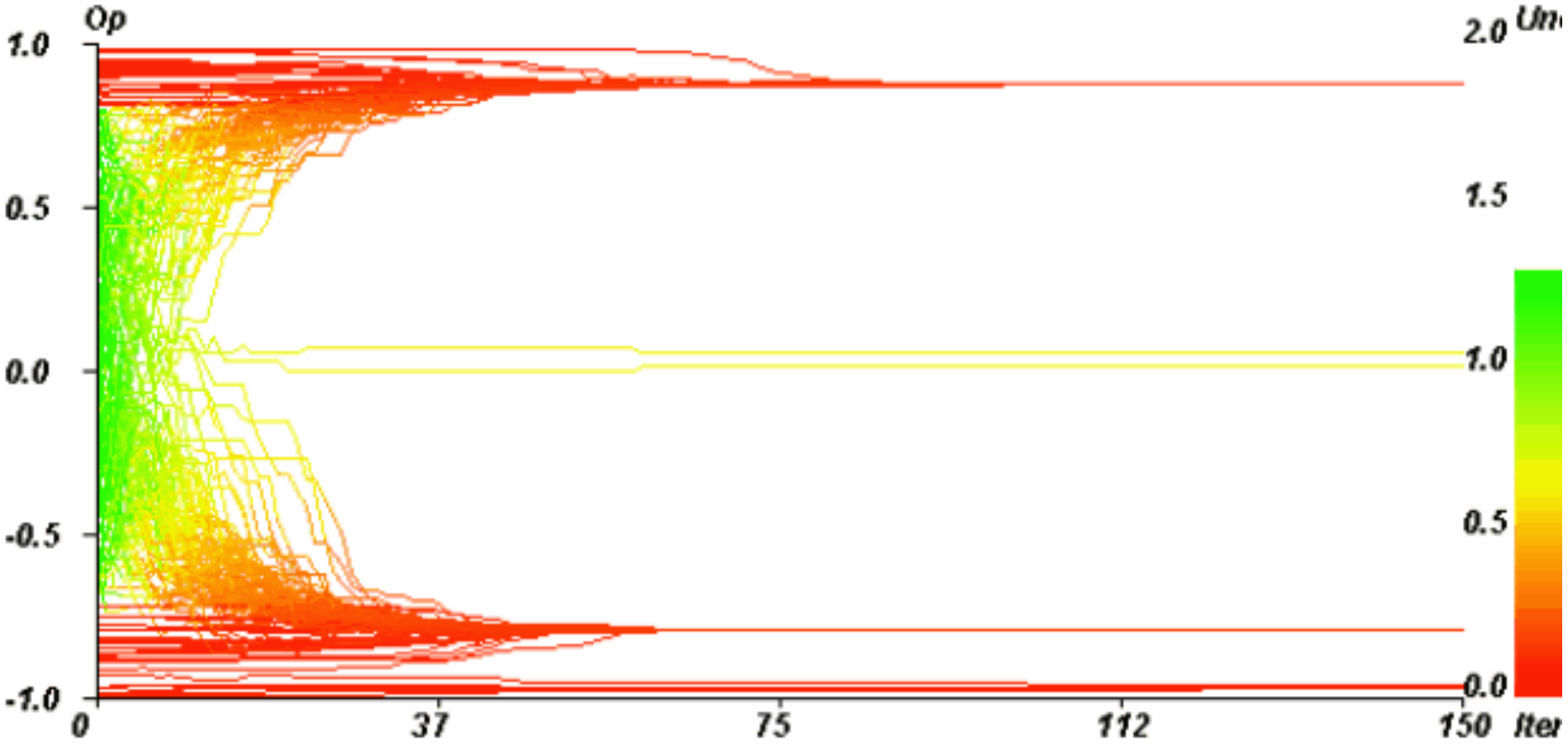
- It does predict
- Once it is conditioned with a lot of data
- It predicts the final result in terms of number of seats for each main party
- When about 30% of the real results are in
- It does not predict individual constituency results well

Example 3: *Opinion Dynamics Models*



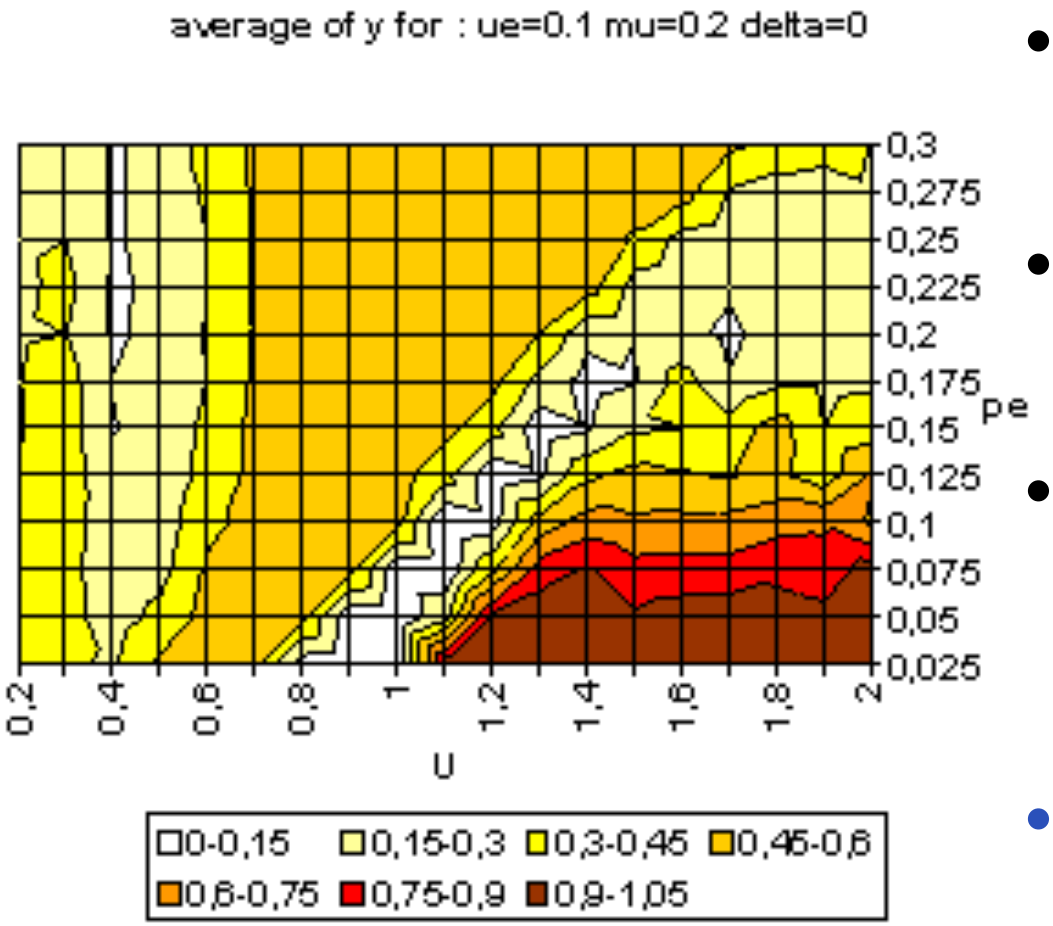
- Deffuant, Amblard, Weisbuch & Faure, JASSS (2002)
- Each agent, *i*, has an opinion (x_i) and uncertainty (u_i)
- Random pairing, when other's opinion, x_j is within u_i then change both x_i and u_i

Example 3: *Typical results*



- A few certain extremists polarise the opinions of the moderates

Example 3: *Analysis*

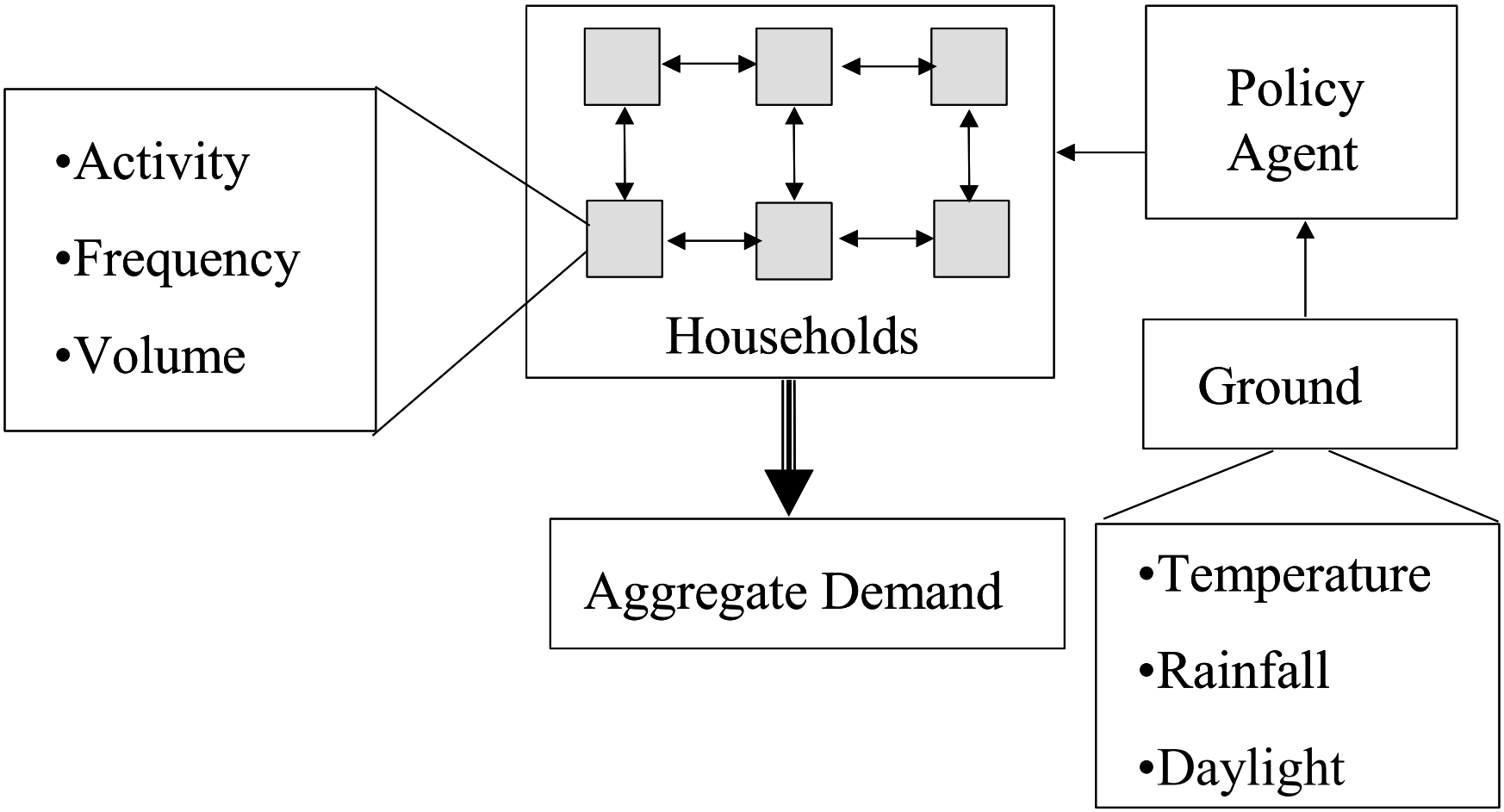


- A large number of variants explored
- Thorough mapping of outcomes
- Analytic generalisations and approximations
- *Purpose to analyse this mechanism*

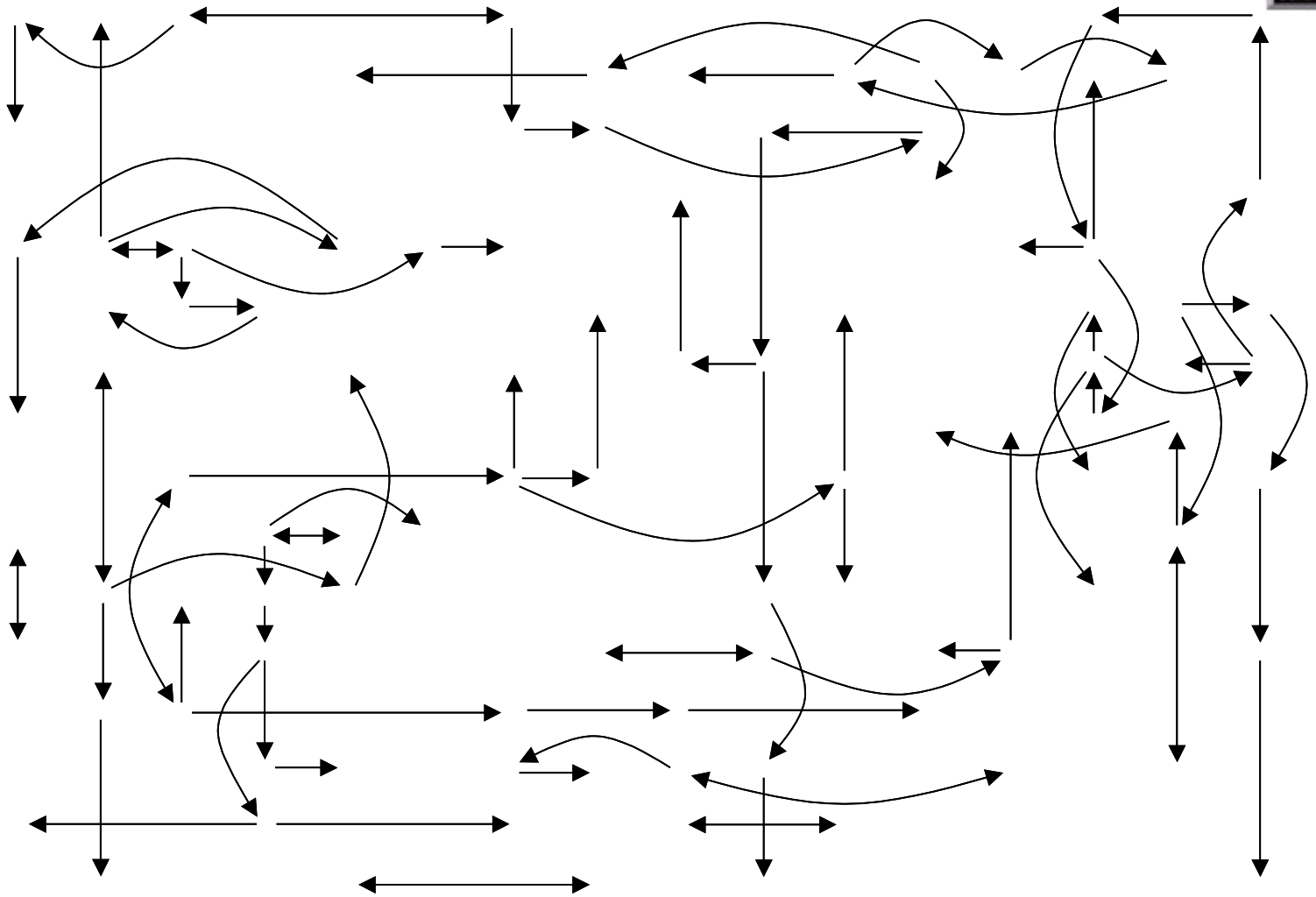
Example 4: *a model of social influence and water demand*

- ***Identify*** ways in which social processes would manifest themselves in consumption outcomes
- ***Explain*** observed deviations from statistical models of domestic water demand
- Investigate the impact of social influence between households on patterns of water consumption
- Micro and Macro behaviour of simulation validated against expert/stakeholder opinion at each stage
- Some of the inputs are real data
- Characteristics of resulting aggregate time series validated against similar real data

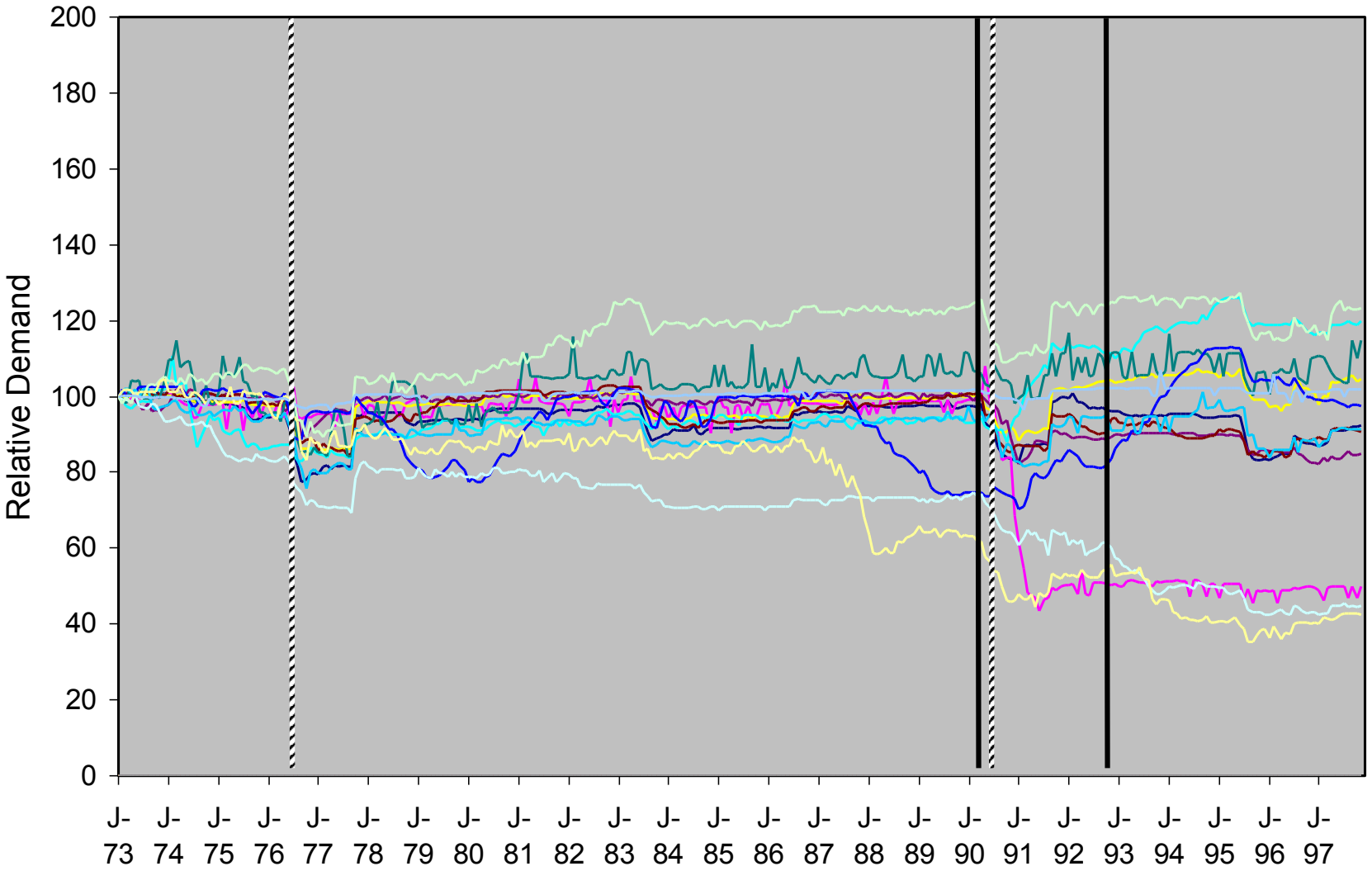
Example 4: *A model of domestic water demand*



Example 4: *some of the household influence structure*



Example 4: *example results*



Example 4: Conclusions

- The inclusion of social influence resulted in aggregate water demand patterns with some of the characteristics of observed demand
- The model established how it *was possible that* processes of mutual social influence could result in widely differing patterns of consumption that were self-reinforcing
- It thus produced a candidate *explanation* of the characterises of patterns of water demand (e.g. clustered volatility, variation among districts, differing results due to shocks)

Part 6

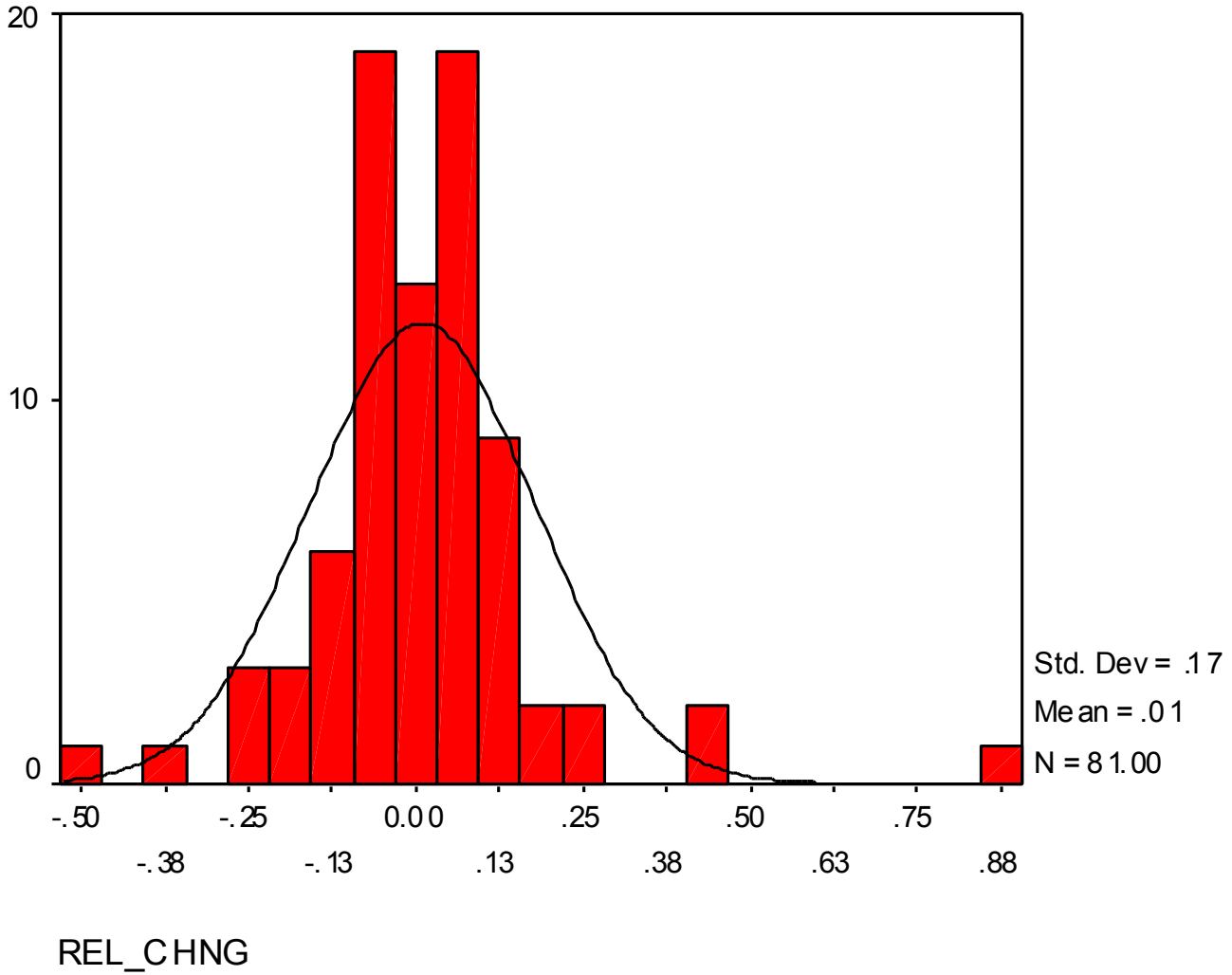
Conclusions

Conclusions

- *If* social simulation is not impossible, then *it is at least very hard to do well*
- There are different reasons for simulating each of which:
  - entail different compromises in approach
  - need to be judged in different ways
- Decide clearly on your reason and don't fudge it later on account of difficulty
- There are many excuses for failure, but beware of using them
- Beware of trying to use the same simulation for different purposes

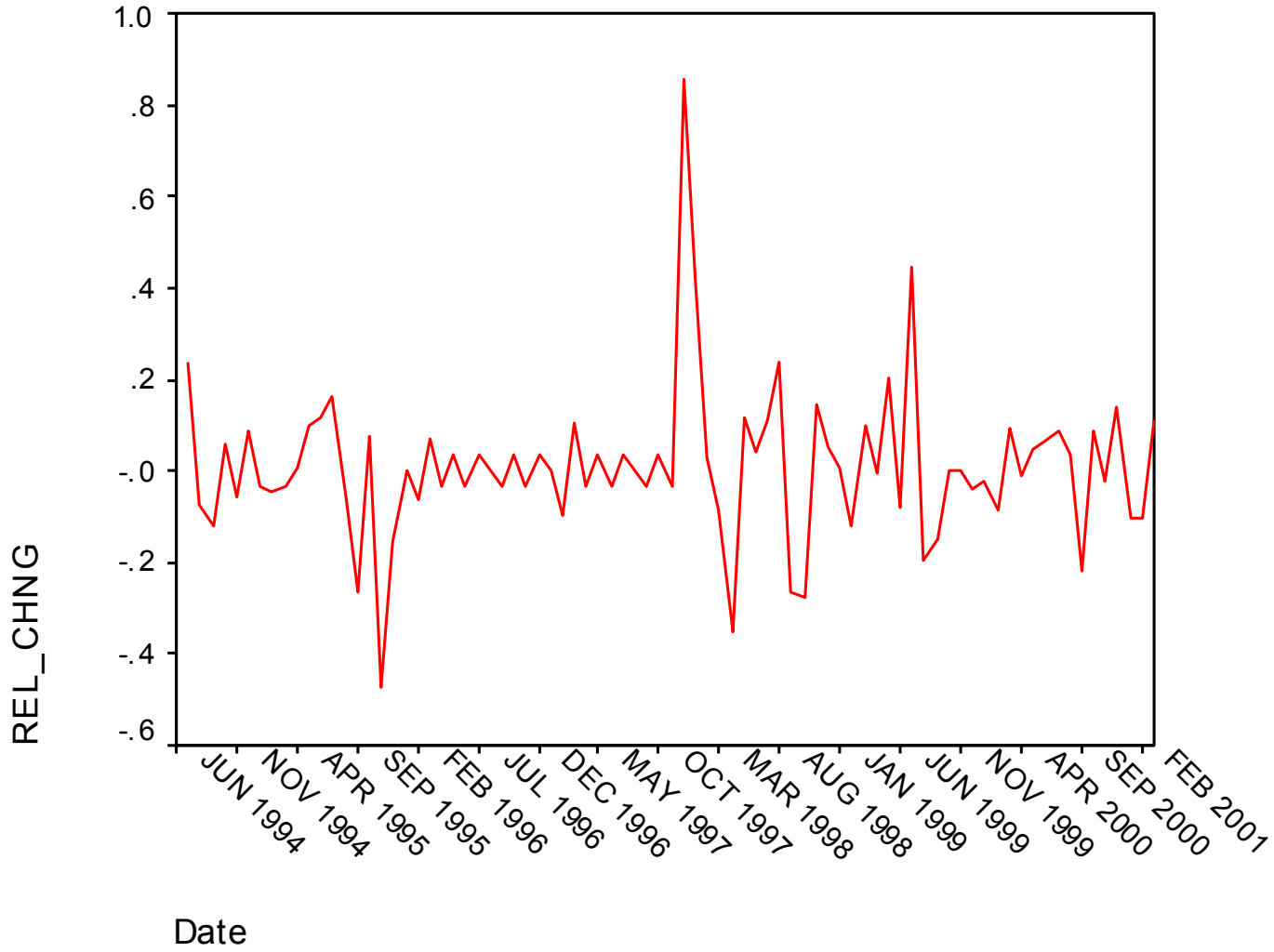
The End

Monthly Water Consumption



Social influence and the domestic demand for water, Aberdeen

Relative Change in Monthly Consumption

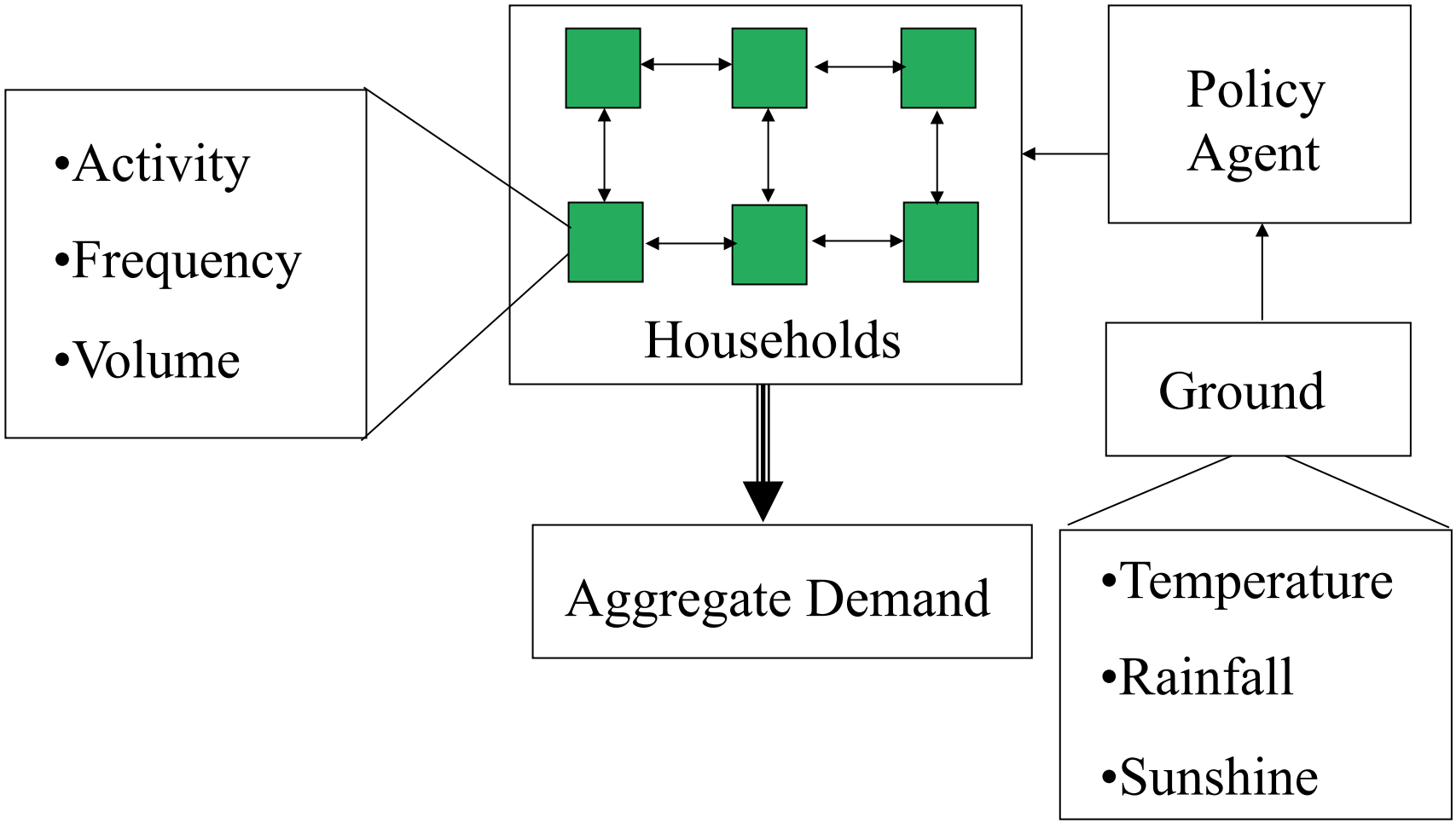


Social influence and the domestic demand for water, Aberdeen

Purpose of the SI&DWD Model

- *Not* long-term prediction
- *But* to begin to understand the relationship of socially-influenced consumer behaviour to patterns of water demand
- *By* producing a representational agent model amenable to fine-grained criticism
- *And hence* to suggest possible interactions
- *So that* these can be investigated/confirmed
- *And* this loop iterated

Model Structure - Overall Structure



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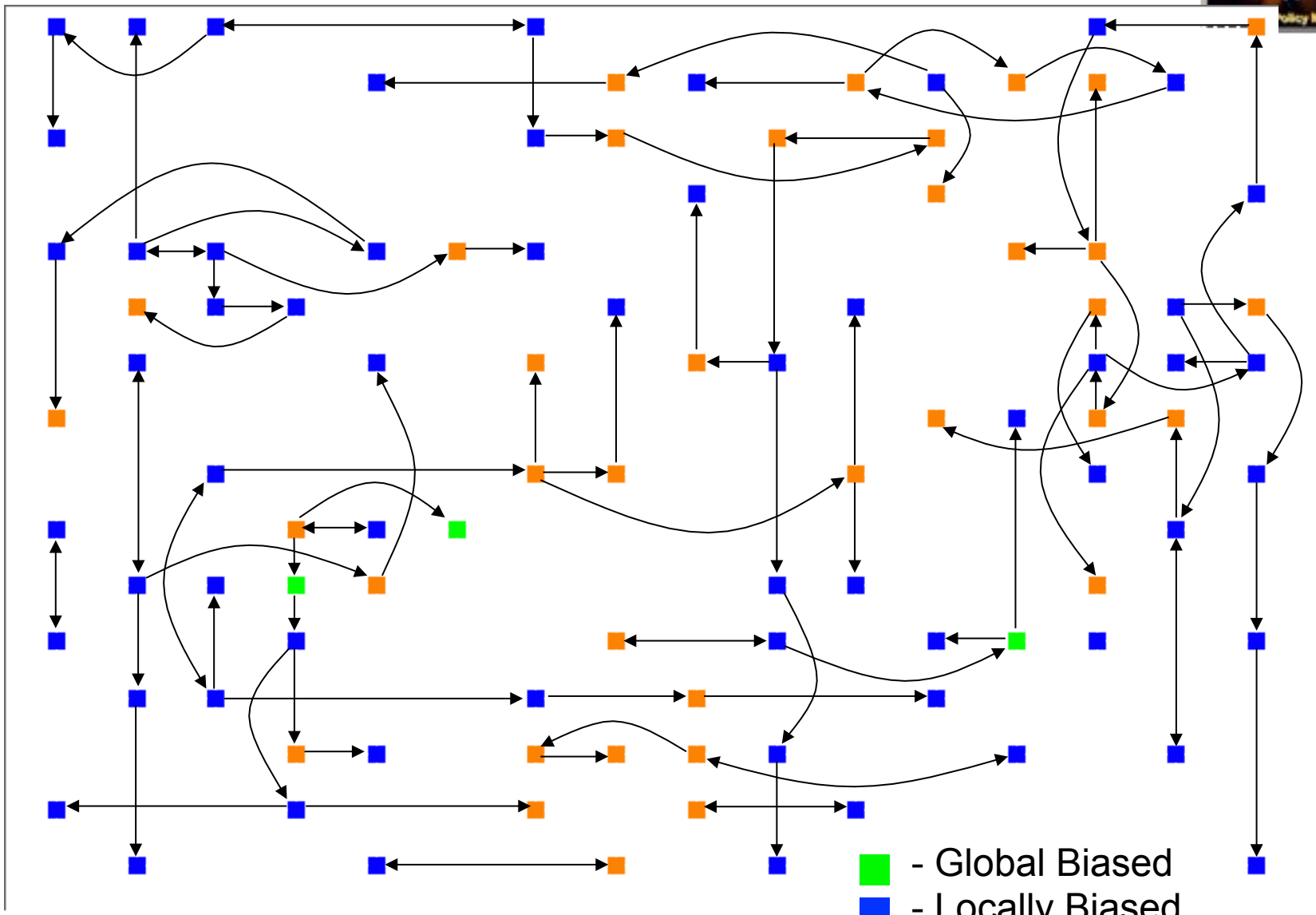
Model Structure - Microcomponents

- Each household has a variable number of micro-components (power showers etc.): bath other_garden_watering shower hand_dishwashing washing_machine sprinkler clothes_hand_washing hand_dishwashing toilets sprinkler power_shower
- Actions are expressed by the frequency and volume of use of each microcomponent
- AVF distribution in model calibrated by data from the Three Valleys

Model Structure - Household Distribution

- Households distributed randomly on a grid
- Each household can copy from a set of neighbours (currently those up to 4 units up, down left and right from them)
- They decide which is the neighbour most similar to themselves – this is the one they are most likely to copy
- Depending on their evaluation of actions they might adopt that neighbour's actions

An Example Social Structure



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Household Behaviour - Endorsements

- Action Endorsements: recentAction neighbourhoodSourced selfSourced globallySourced newAppliance bestEndorsedNeighbourSourced
- 3 Weights moderate effective strengths of neighbourhoodSourced selfSourced globallySourced endorsements and hence the bias of households
- Can be characterised as 3 types of households influenced in different ways: *global*-; *neighbourhood*-; and *self*-sourced depending on the dominant weight

History of a particular action from one agent's point of view

Month 1: used, endorsed as **self sourced**

Month 2: endorsed as **recent** (from personal use) and **neighbour sourced** (used by agent 27) and **self sourced** (remembered)

Month 3: endorsed as **recent** (from personal use) and **neighbour sourced** (agent 27 in month 2).

Month 4: endorsed as **neighbour sourced** twice, used by agents 26 and 27 in month 3, also **recent**

Month 5: endorsed as **neighbour sourced** (agent 26 in month 4), also **recent**

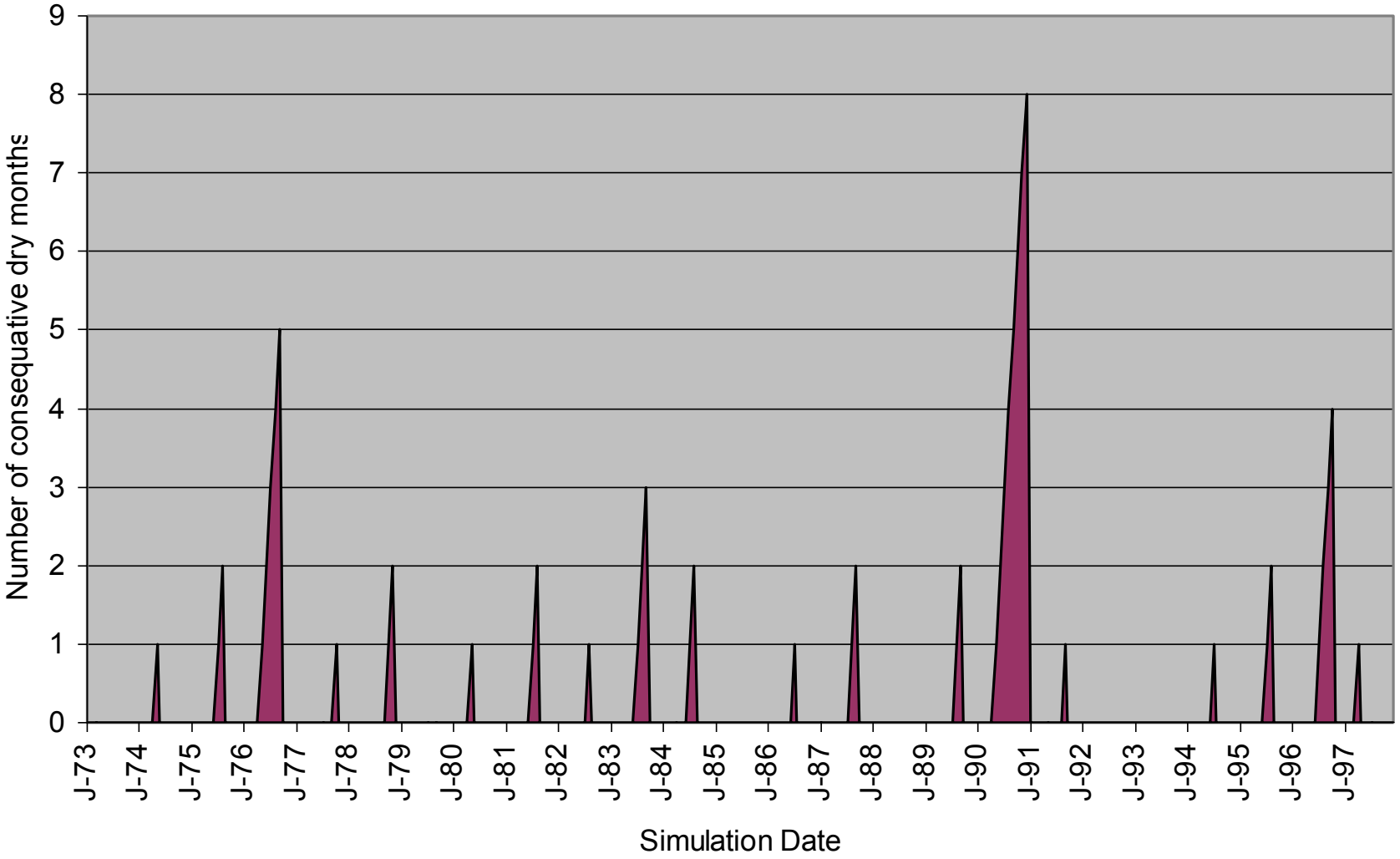
Month 6: endorsed as **neighbour sourced** (agent 26 in month 5)

Month 7: replaced by action 8472 (appeared in month 5 as **neighbour sourced**, now endorsed 4 times, including by the **most alike neighbour** – agent 50)

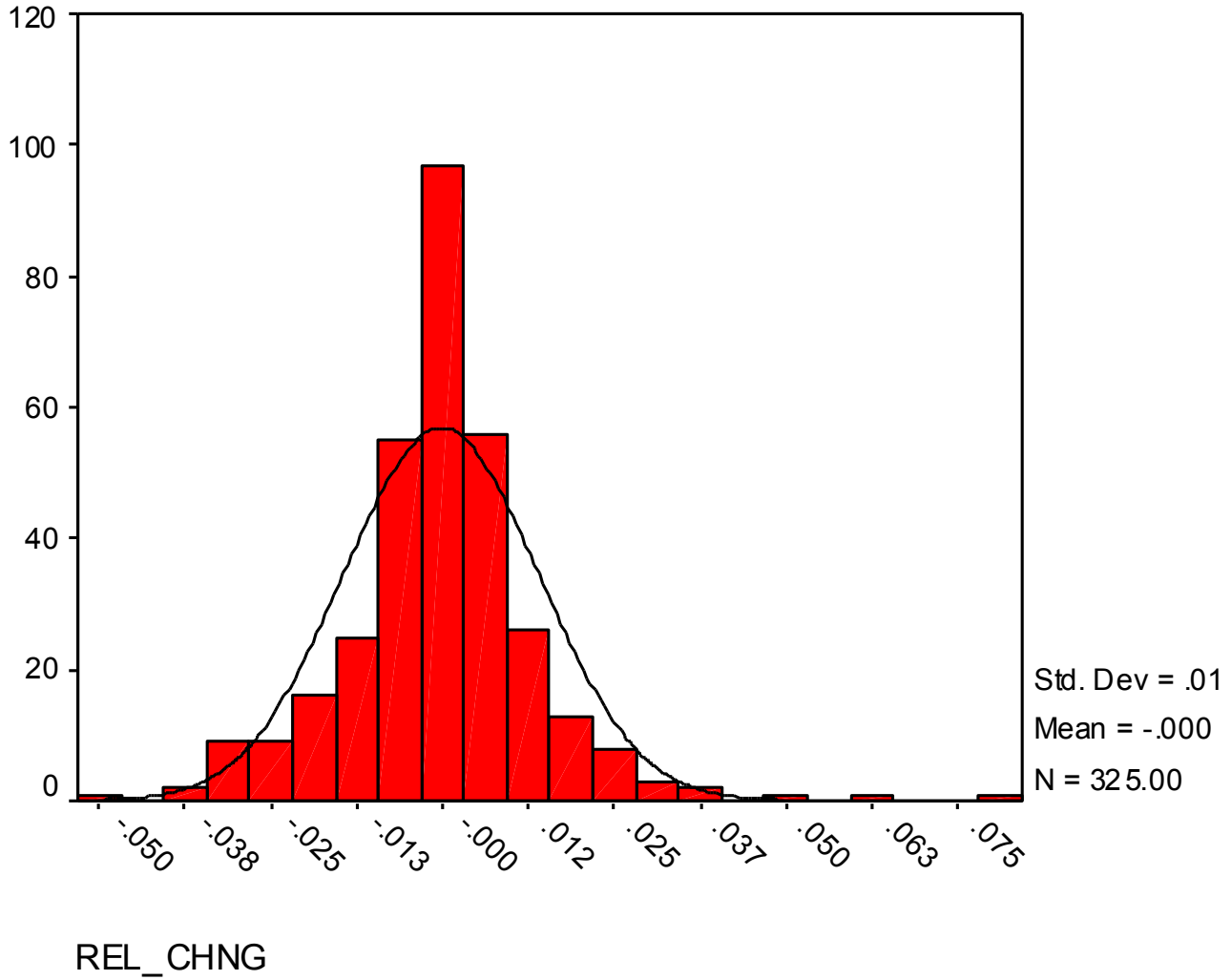
Policy Agent - Behaviour

- After the first month of dry conditions, suggests AFV actions to all households
- These actions are then included in the list of those considered by the households
- If the household's weights predispose it, it may decide to adopt these actions
- Some other neighbours might imitate these actions etc.

Number of consecutive dry months in historical scenario



Simulated Monthly Water Consumption



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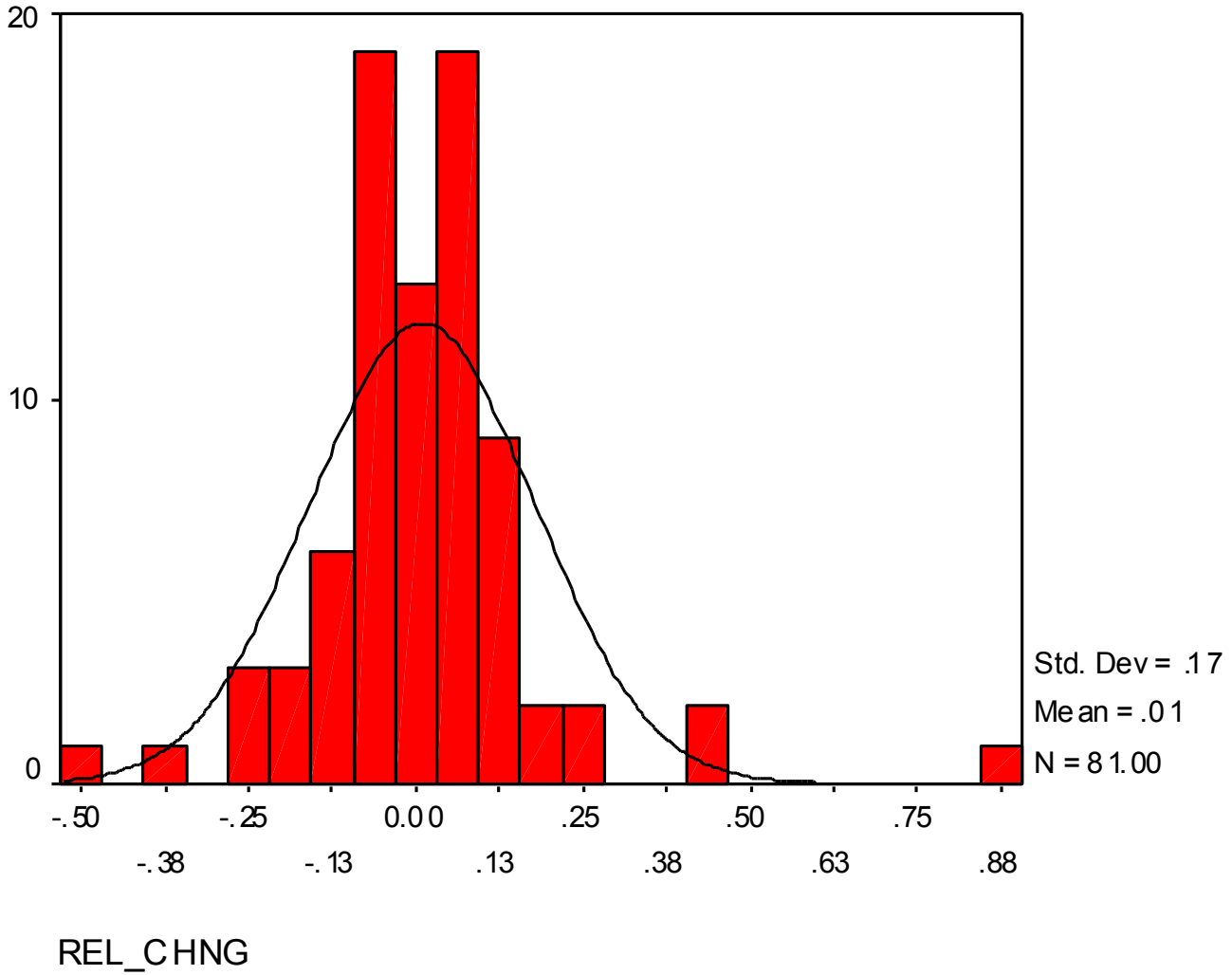
Monthly Water Consumption (again)



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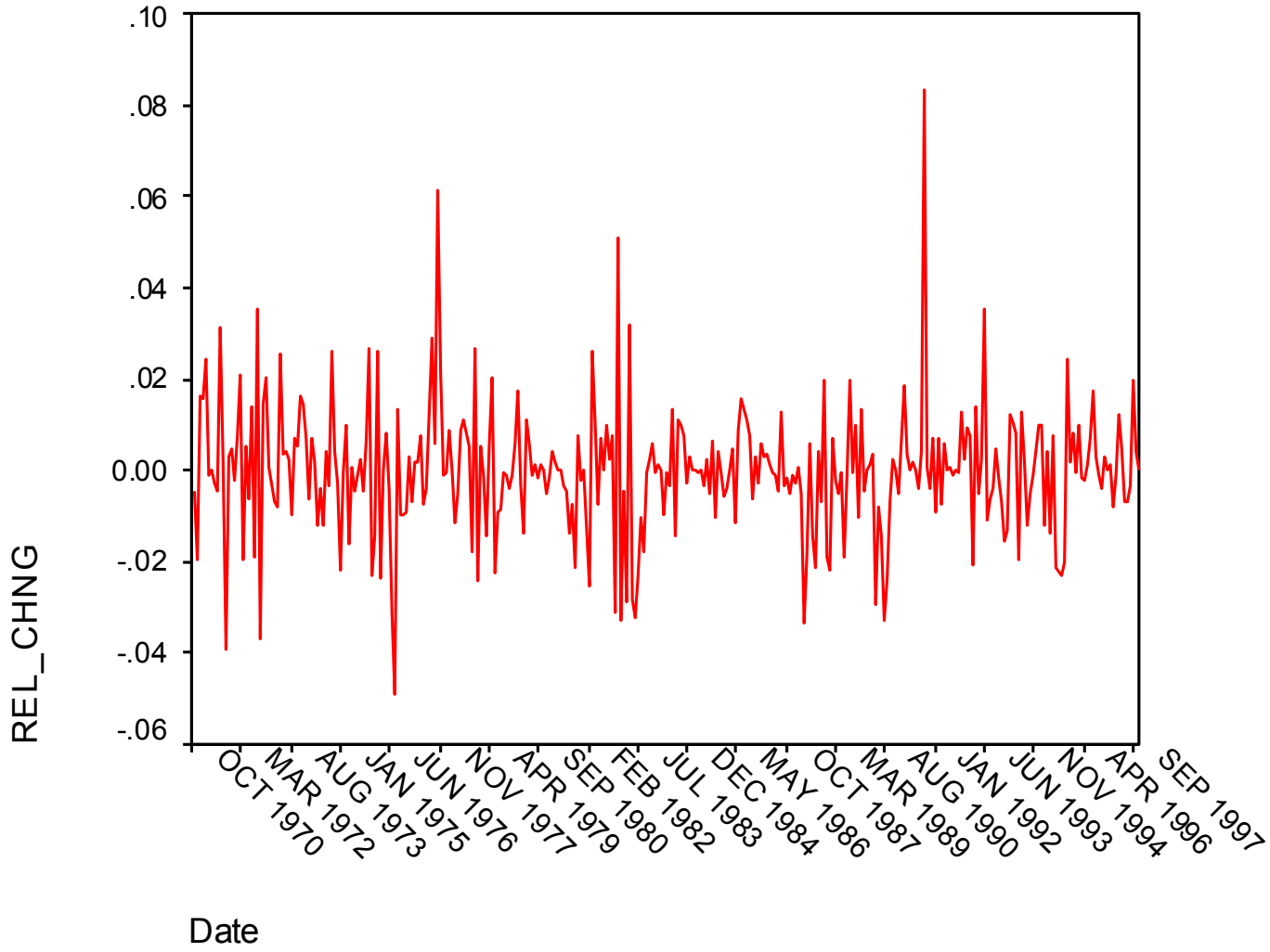
Simulated Change in Monthly Consumption



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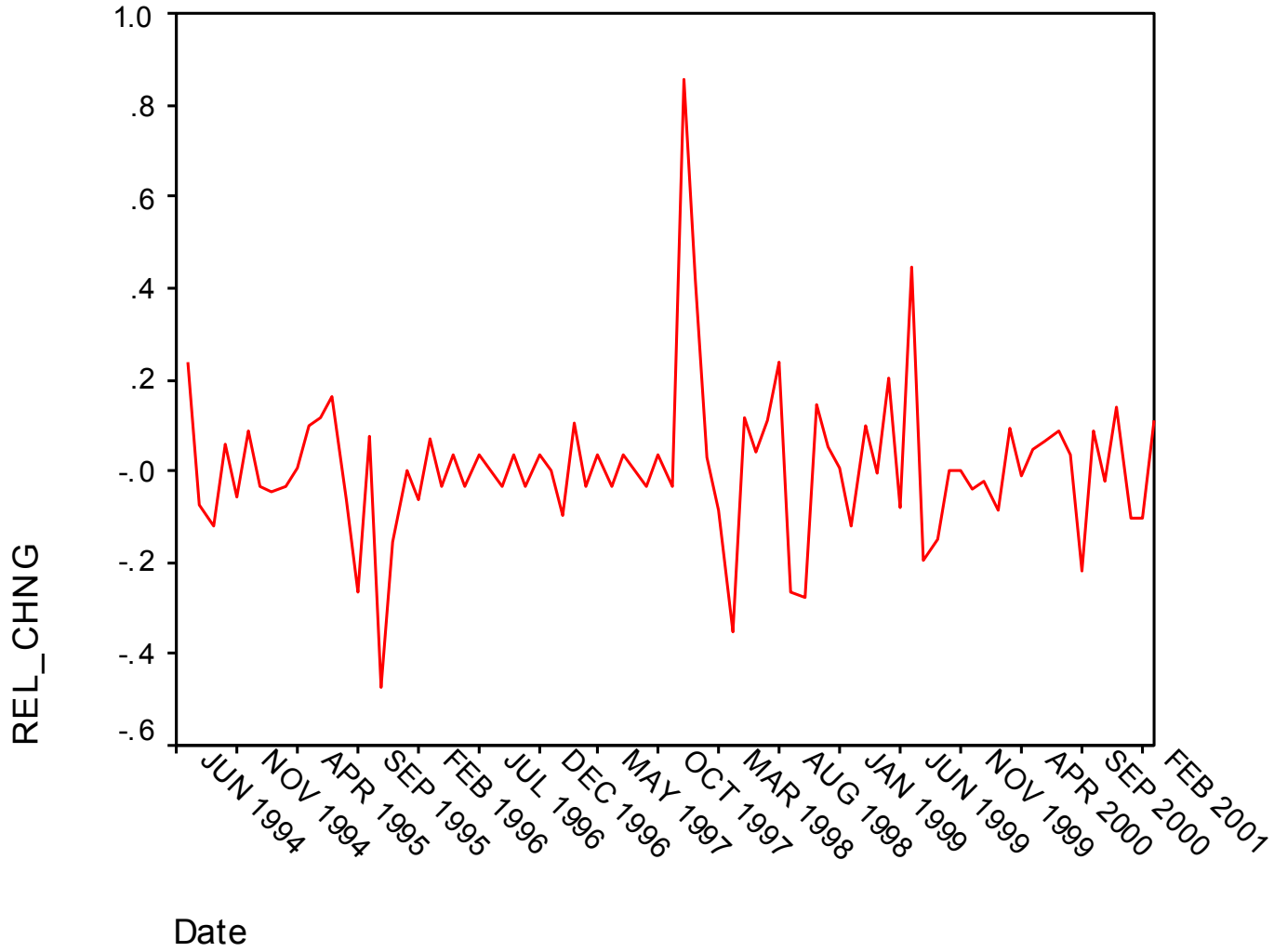
Relative Change in Monthly Consumption (again)



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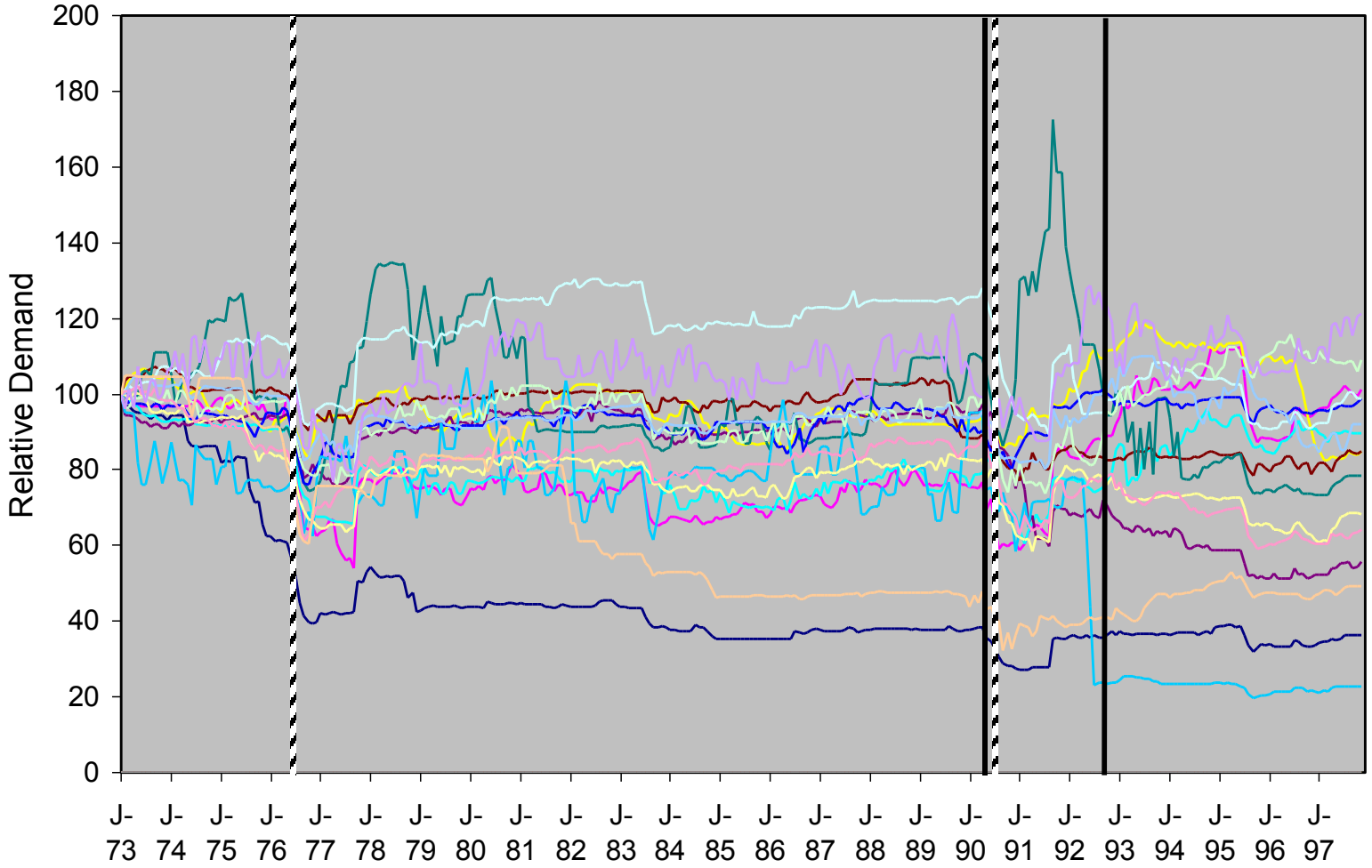
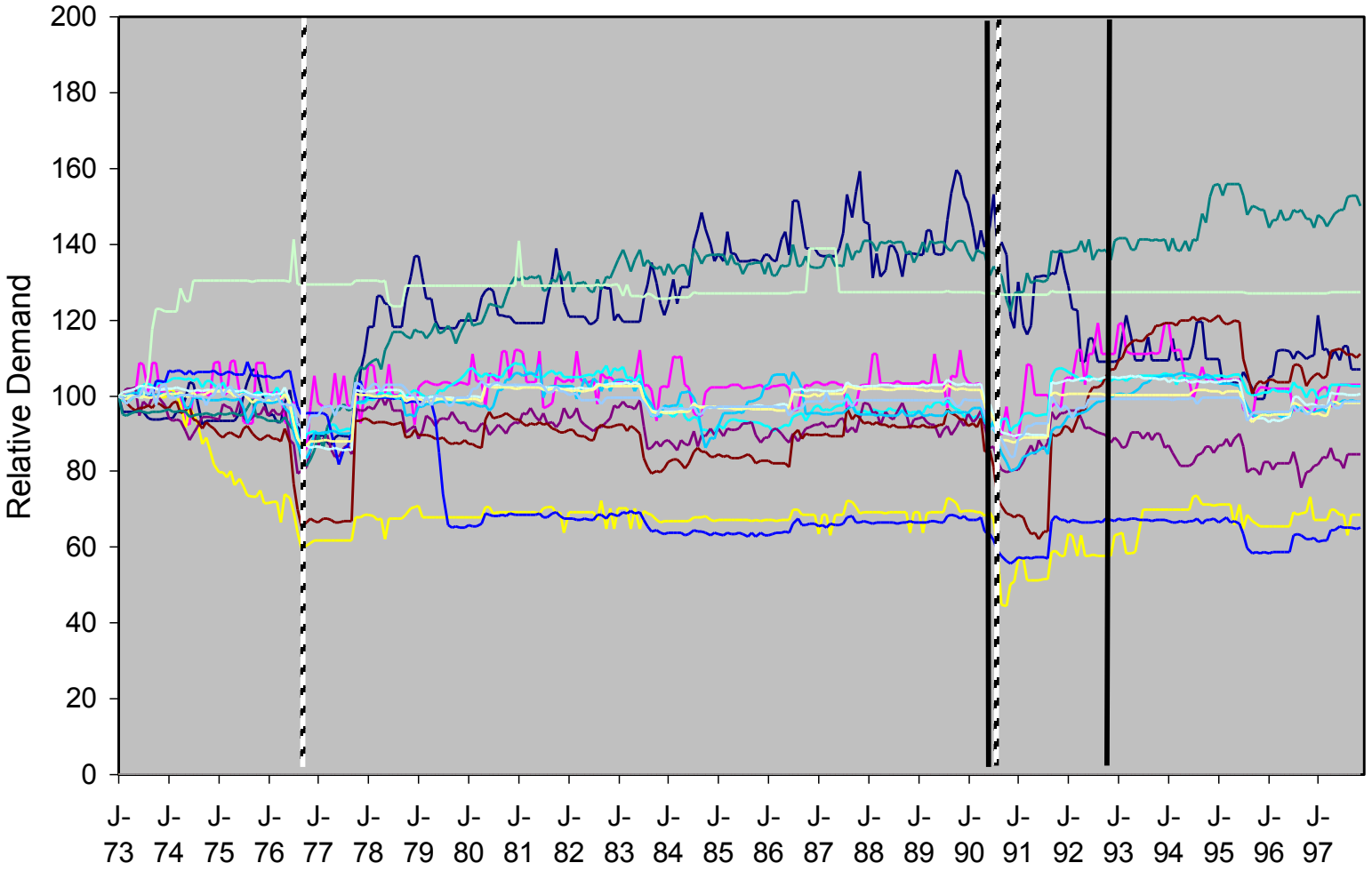
30% Neigh. biased, historical scenario, historical innov. dates



80% Neigh. biased, historical scenario, historical innov. dates



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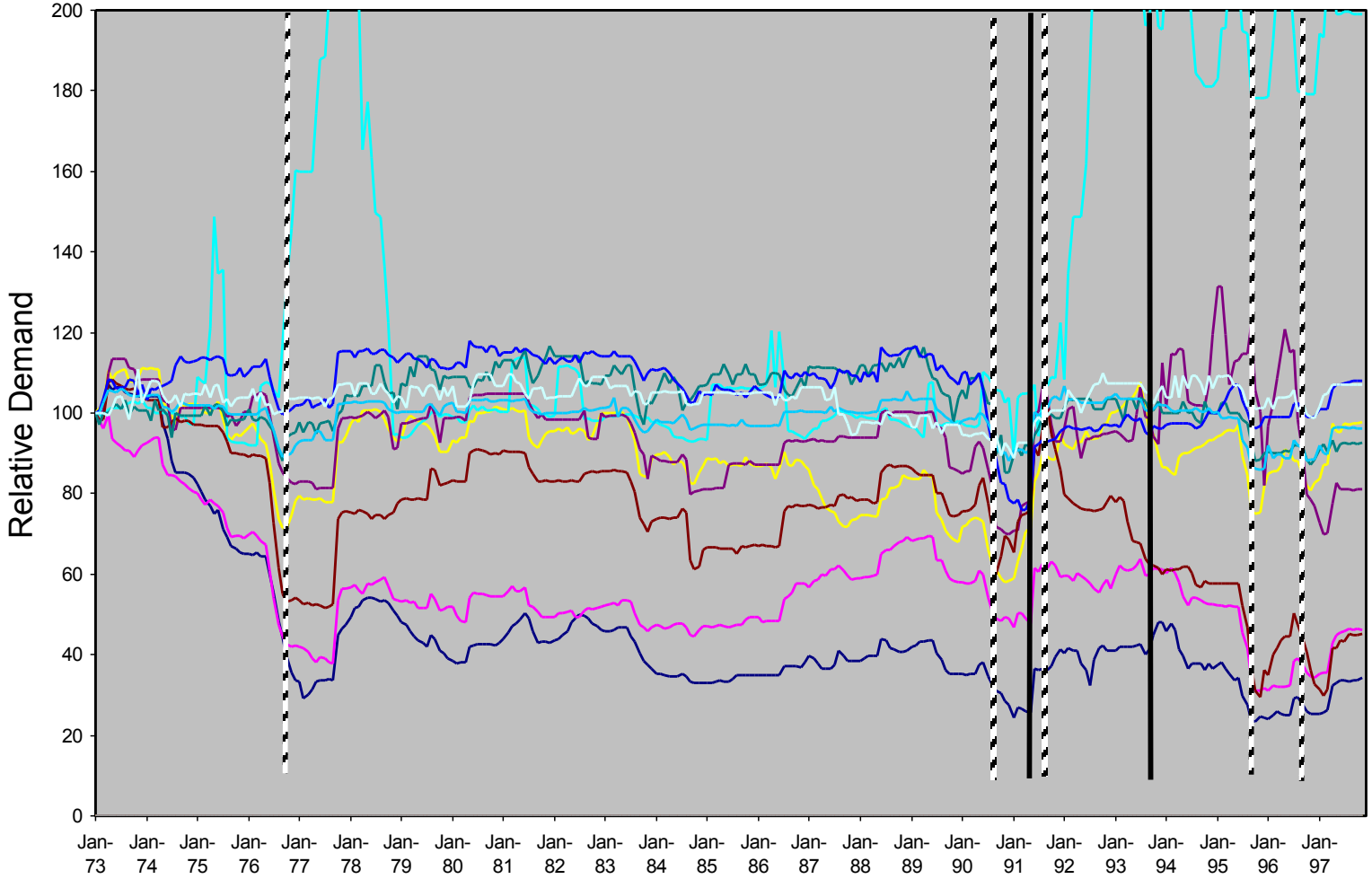
80% Neigh. biased, medium-high scenario, historical innov. Dates



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