Measuring Economic Impact in Disruptive Technologies: use of Agent Based Modelling

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Overview

- Challenges posed by new technologies
- Schema for measuring impact – 3 stages
- Modelling complex systems
- Agent Based Models
- Conceptual Boxology and Data

The Digital Catapult recognises the challenges for evaluating impact.

- High potential for new emerging industries – disruptive to existing industry boundaries but cannot wait for revisions to SIC (see Nesta's Dynamic Mapping of Creative Clusters and Innovation Analytics reports)
- Importance of relational data – networks and digital an important enabling technology that can increase productivity in other sectors
- Time horizon – lags in impact on productivity ('Productivity Paradox' Brynjolfsson (1996)); Limited take up of IoT (Economist June 2016)
- Assigning contribution within multiple influences

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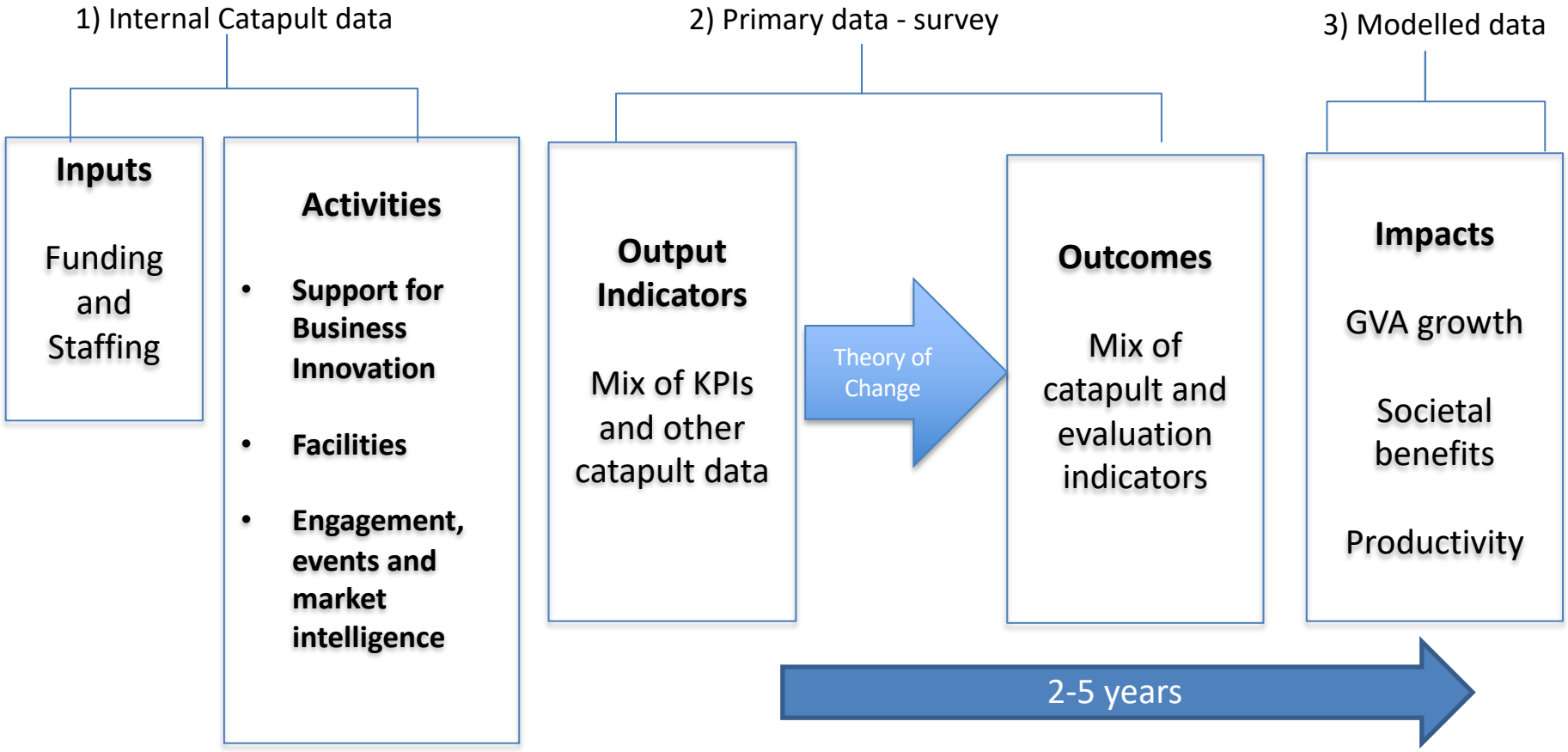
Schema for measuring and evaluating impact



1) Internal Catapult data

2) Primary data - survey

3) Modelled data

Inputs

Funding and Staffing

Activities

- **Support for Business Innovation**
- **Facilities**
- **Engagement, events and market intelligence**

Output Indicators

Mix of KPIs and other catapult data

Theory of Change

Outcomes

Mix of catapult and evaluation indicators

Impacts

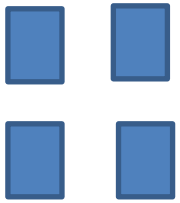
GVA growth

Societal benefits

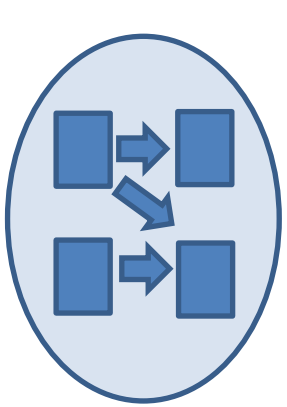
Productivity

2-5 years

Micro



Micro - Meso



Meso - Macro

Attribution of impact?

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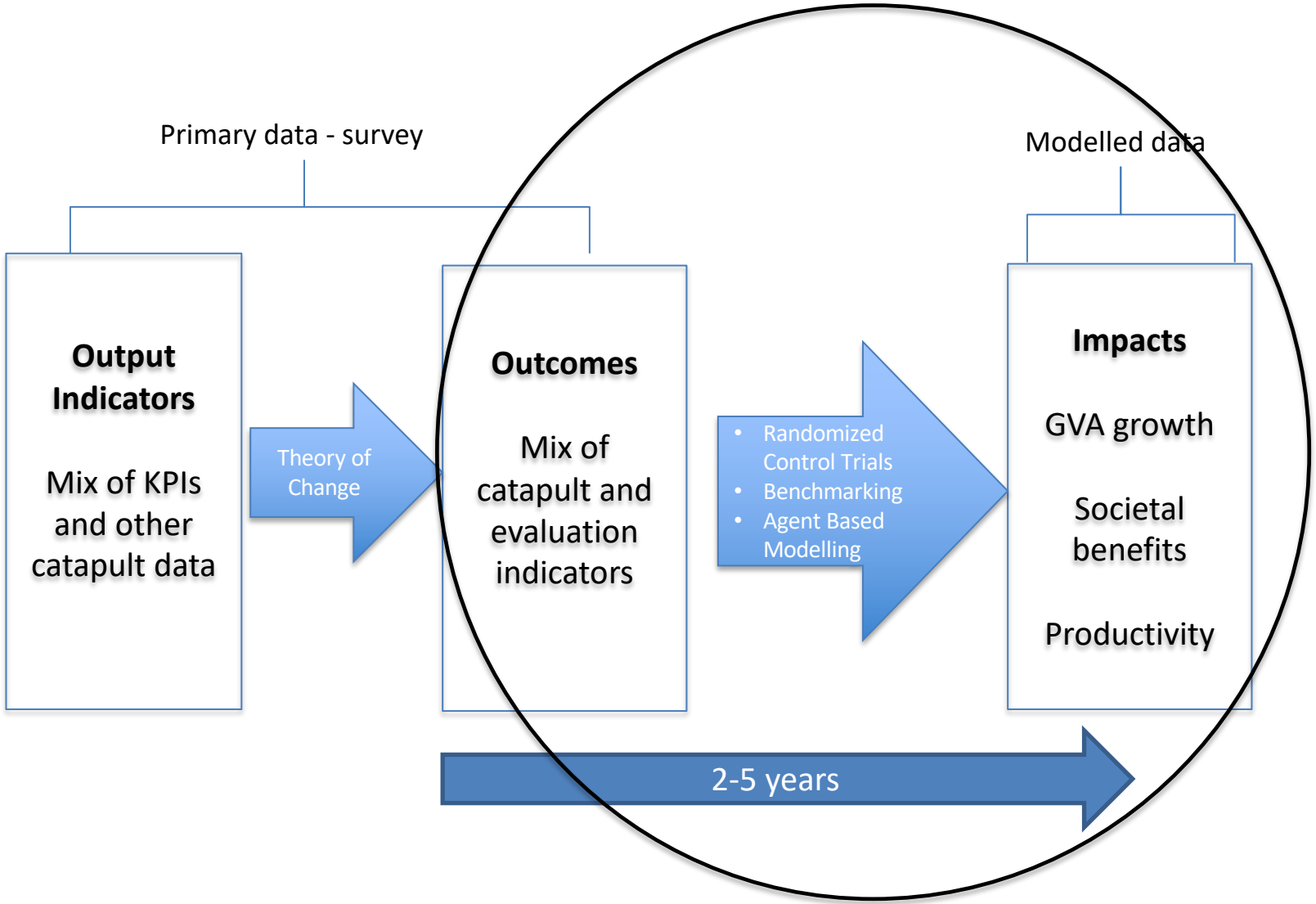
Our focus is on how we capture progress towards outcomes and project potential impact from disruptive technologies



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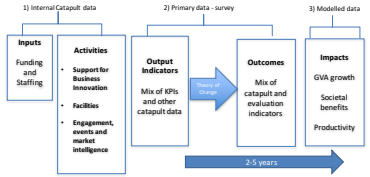

Allen – Evolutionary Complex Systems

The Assumptions Used to Reduce Complexity to Simplicity

- We can define a boundary between the part of the world that we want to 'understand' and the rest.
- We have rules for the classification of objects that lead to a relevant taxonomy for the system components.
- Agents are identical to each other and to the average.
- The overall behaviour of the variables can be described by the smooth average rates of individual interaction events.

Allen P.M (2001) *'Knowledge, ignorance and the evolution of complex systems'* Chapter 10 in 'Frontiers of evolutionary economics : competition, self-organization, and innovation policy' edited John Foster and J. Stanley Metcalfe. Edward Elgar 2001

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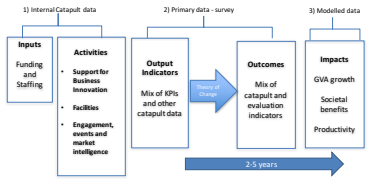

Complexity → Successive Assumptions → Simplicity

Qualitative Research

Boundary Classification

Structural Stability Fixed Variables

Stationarity –
Sand Piles, Rank-Size rules
Cities, Firms…

Stationarity Equilibrium

Attractors

Reality
Practice

Soft Systems

Time

X Y Z

Evolutionary Models
QUALITATIVE CHANGE

X Z Y

Probabilistic Non-linear Dynamics

Quantity

Equilibrium

Price

Average Dynamics

X Z Y

Strategy **Contingency** **Operations**

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“The Michael Fish moment for economists”

Andy Haldane – Chief Economist, Bank of England

“Mr Haldane sees some reason for hope in reformed modelling, and in particular in so-called “Agent Based Models”, which take account not just of the observable environment, but also the behaviour of other agents which interact with it. Big Data promises to give these models even better predictive qualities.”

Telegraph – 4 January 2017

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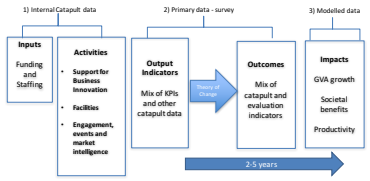

Agent Based Models the answer?

- Computational Irreducibility
  - Unable to reduce behaviour to a mathematical description
- Emergence
  - Aggregate effect of individuals' actions is qualitatively different from what each individual is doing.
- Non-Ergodocity
  - In probability theory, an ergodic dynamical system is one that, broadly speaking, has the same behavior averaged over time as averaged over the space of all the system's states in its phase space.
- Radical Uncertainty/Ignorance
  - 'Don't know what we don't know'

Richard Bookstaber (2017) 'Agent-based models to help economics do a better job' OECD Insights– Debate the Issues, Complexity and Policy Making

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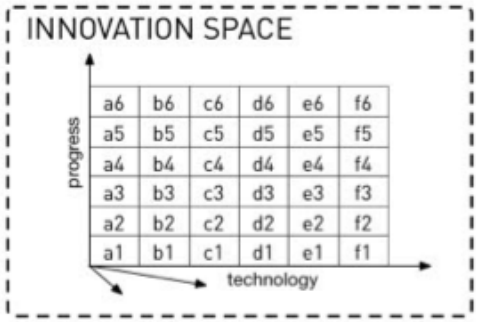
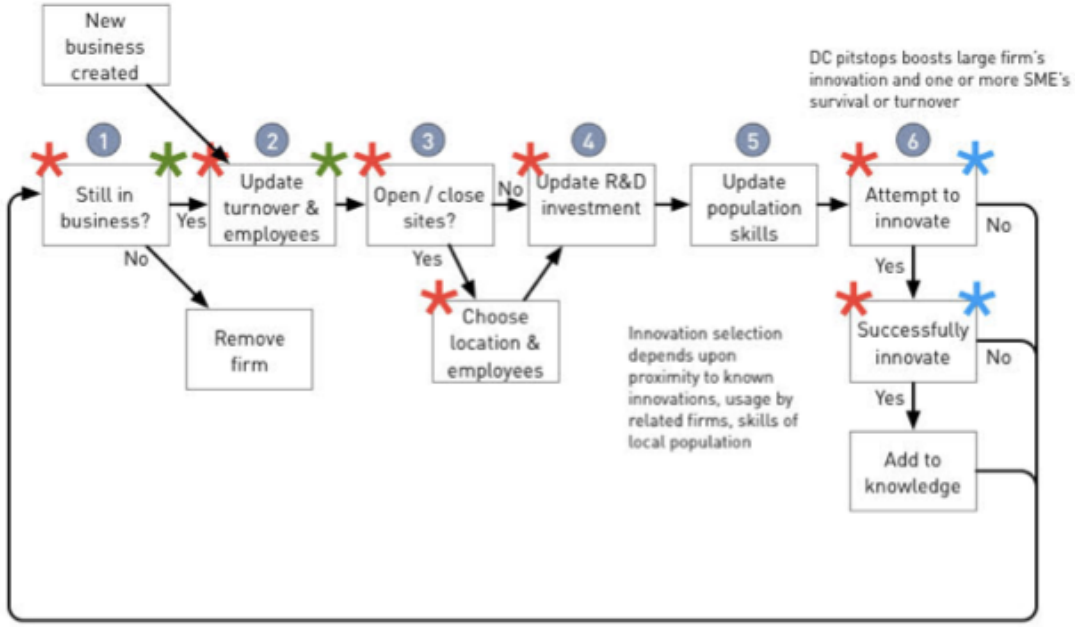
Proposed modelling of diffusion of digital technologies – Conceptual Boxology





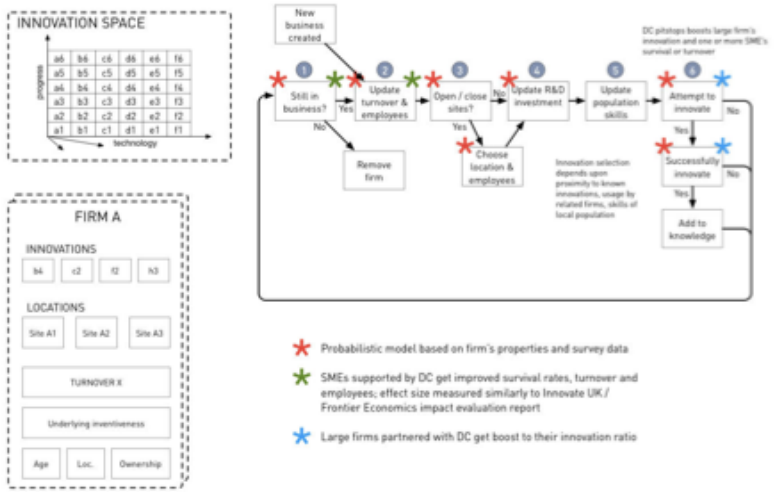
Probabilistic model based on firm's properties and survey data

SMEs supported by DC get improved survival rates, turnover and employees; effect size measured similarly to Innovate UK / Frontier Economics impact evaluation report

Large firms partnered with DC get boost to their innovation ratio

Source: Sandtable/Digital Catapult

Proposed modelling of diffusion of digital technologies – Conceptual Boxology



Data options:

Exploring possible methods

- Access to combined data through ONS's Virtual Micro Lab – build characteristics of firms through statistical paramaterisation.
- Use of Natural Language Processing – Ecosystems mapping and cluster analysis

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Any Questions?

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