

## Abstract

Sustainable finance requires simultaneous optimization of financial returns and sustainability outcomes, creating modeling challenges that traditional financial approaches cannot adequately address. This systematic review examines agent-based modeling (ABM) applications in sustainable finance, analyzing **45 studies** published between 2005 and 2025 following PRISMA guidelines. Environmental dimensions dominate (47% of studies), while social and governance aspects remain underrepresented. Nearly half of all studies (49%) lack clear alignment with EU sustainability frameworks, 93.3% rely on single validation methods, undermining policy credibility. Addressing these gaps is essential for realizing ABM's potential to inform sustainable finance policy and support global sustainability transitions.

## Motivation: The Investment Dilemma

**The Problem:** 'Double Optimization'

**Traditional Models vs. Reality: Key Differences**

### Traditional Models Assume

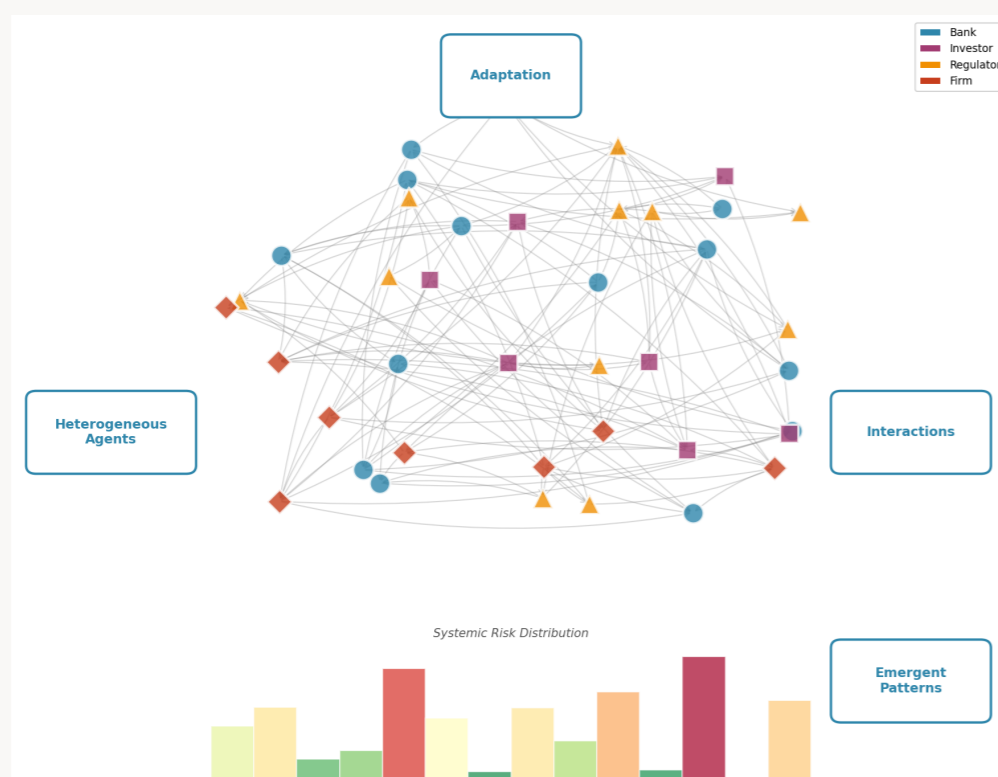
- ❖ Everyone is perfectly rational
- ❖ All investors are identical
- ❖ Markets reach equilibrium
- ❖ Linear relationships

### Reality Shows

- ❖ Bounded rationality & biases
- ❖ Diverse behaviours & goals
- ❖ Constant adaptation
- ❖ Complex feedback loops

## Why Agent-Based Modelling?

ABM offers a fundamentally different approach that aligns naturally with complex adaptive systems:



## Our Research Questions

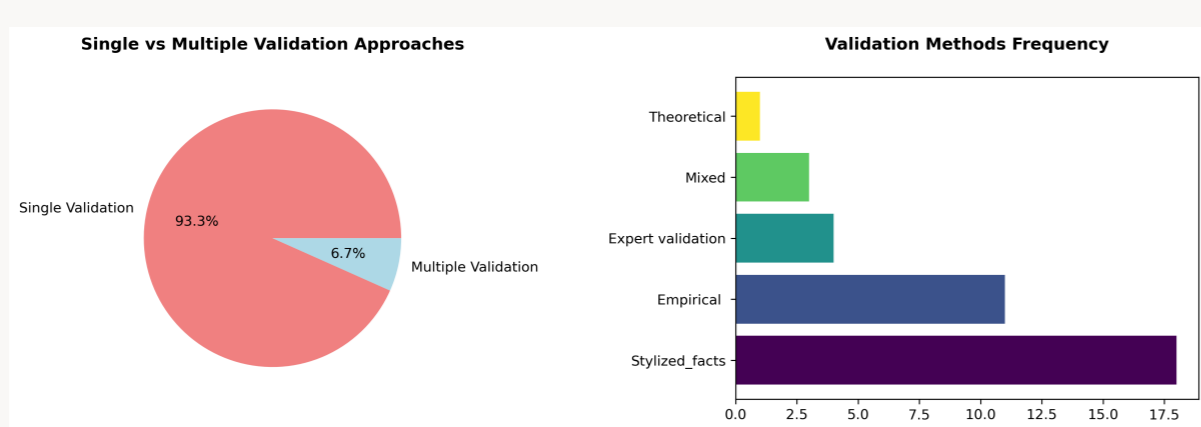
1. What sustainability dimensions are most commonly modelled?
2. What methodological approaches are used?
3. What are the current gaps and limitations?

## Methodology

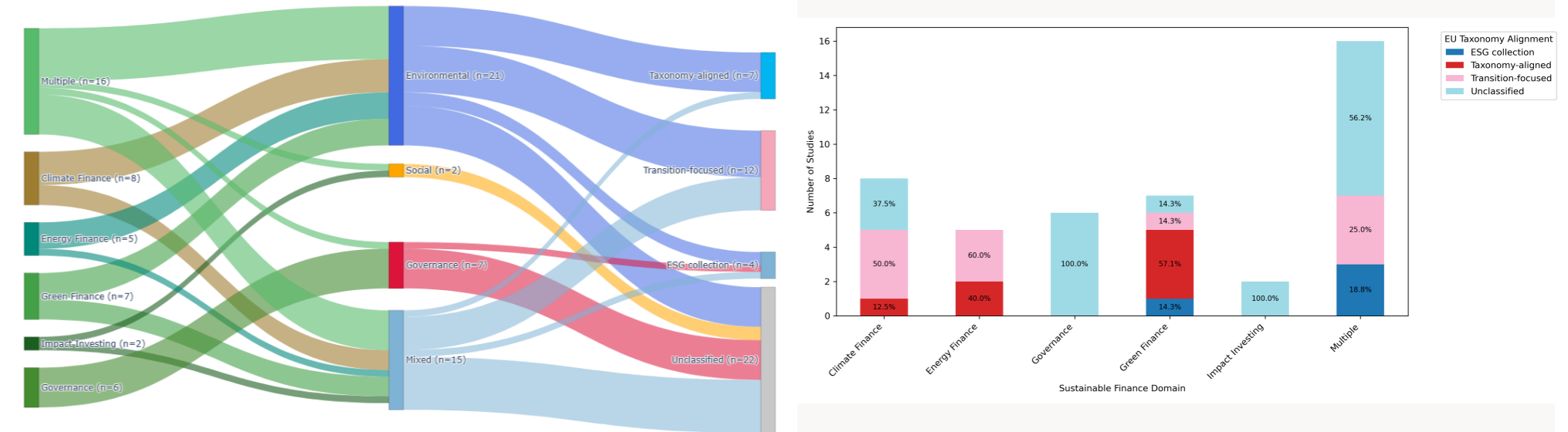
### Systematic Review Protocol (PRISMA 2020):

- ▶ 530 papers identified (Scopus + Web of Science), 200 duplicates removed
- ▶ **Screening:** 330 screened (titles + abstracts), 273 excluded
- ▶ **Eligibility:** 57 full-text reviewed, 12 excluded
- ▶ **Included:** 45 papers in final analysis

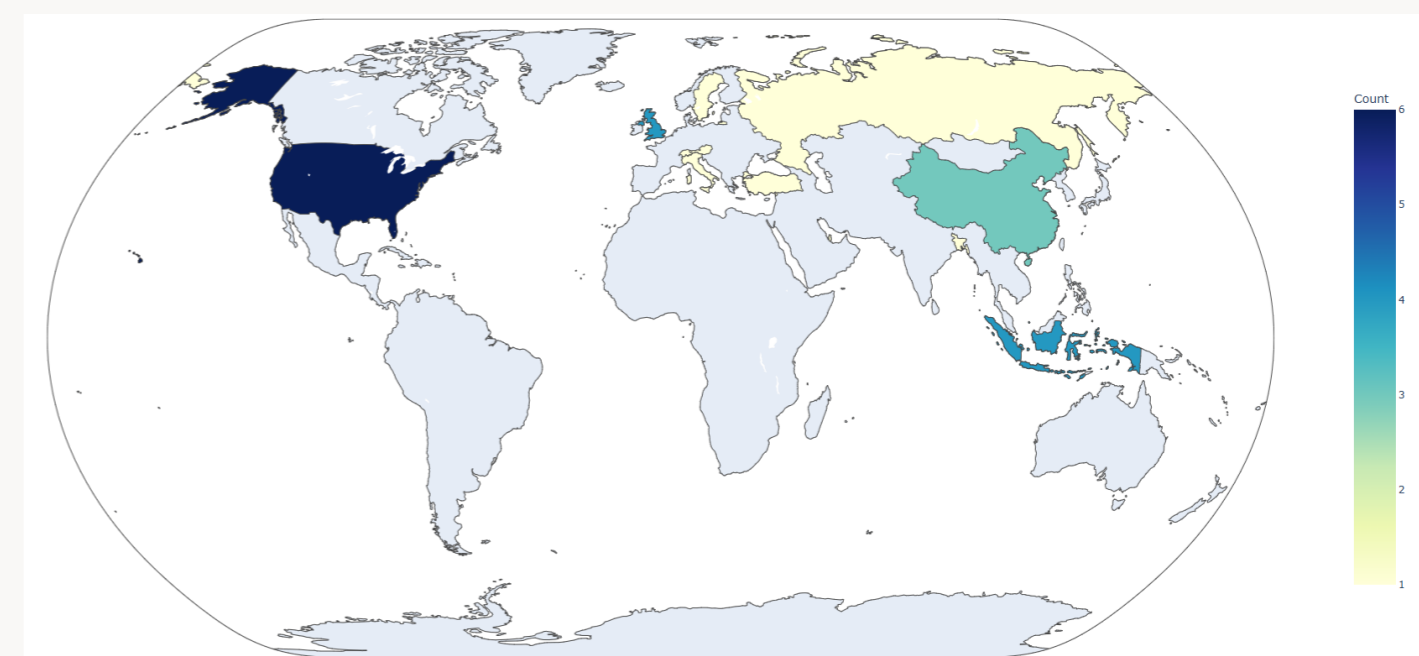
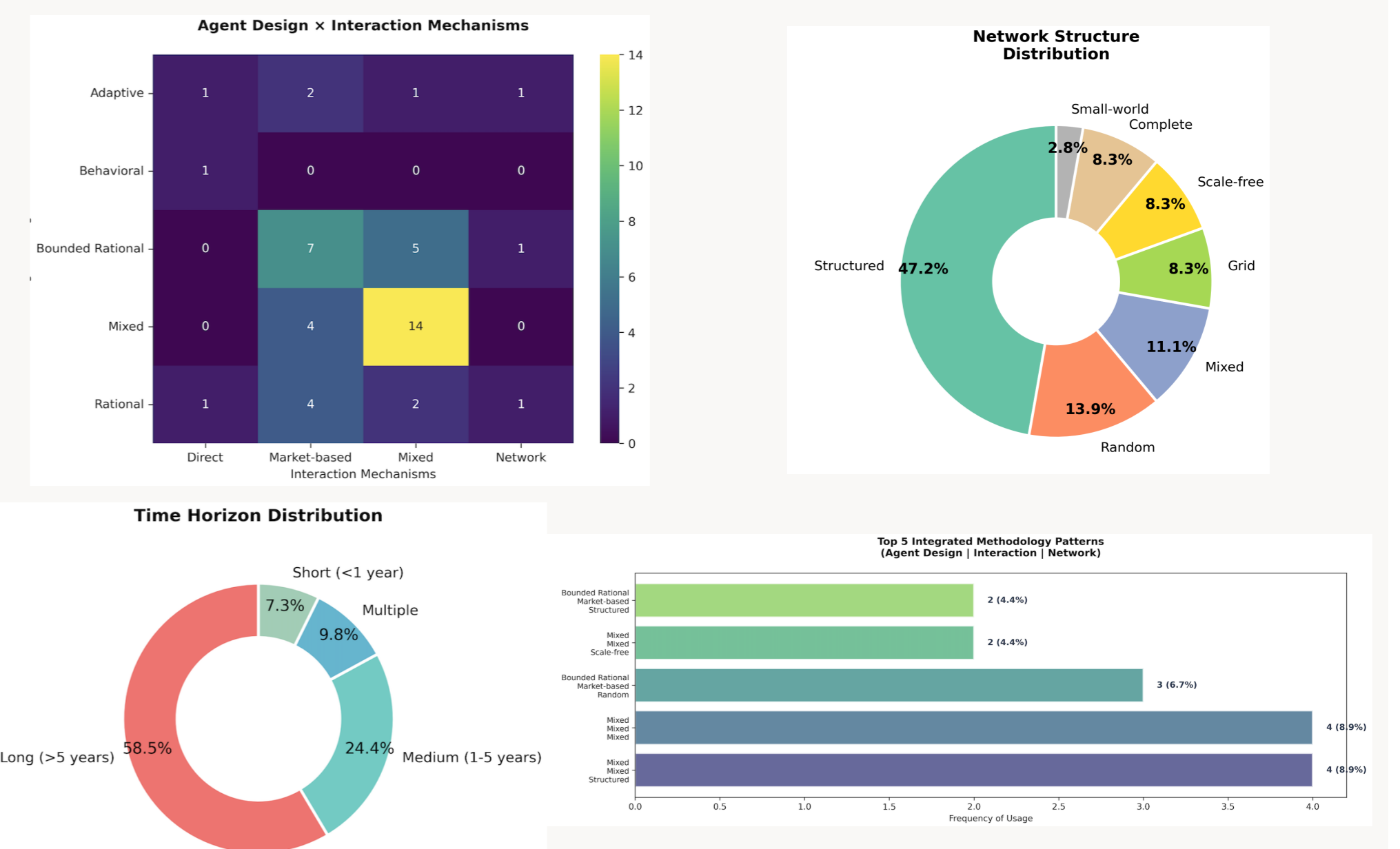
## Finding #1: The Validation Crisis



## Finding #2: Domain & Regulatory Disconnect



## Finding #3: Methodology Landscape & Geographic Imbalance



**Impact:** Models built primarily for developed Western markets may not apply to different financial systems, regulatory environments, or sustainability priorities.

## Research Opportunities

- ▶ Multi-validation standards
- ▶ Geographic expansion
- ▶ Integrated ESG models
- ▶ Taxonomy-aligned tools

## Why This Matters

Because the financial decisions made today:- where capital flows, which projects get funded, which companies attract investment will shape our climate, our communities, and our planet for decades to come. Agent-based modelling gives us a unique window into how these complex systems work. But only if we build models that are globally representative, rigorously validated, and policy-relevant. This review shows we're making progress but have critical gaps to fill.

## More Information



Scan to learn more about the Digital Finance project

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