

CECL Multi-Agent Simulation Framework

Yang Li

Stevens Institute of Technology

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Research Motivation

Problem Statement

CECL introduces discretion and complexity in loss estimation, creating opacity concerns among key stakeholders:

- Regulators
- Auditors
- Financial Analysts

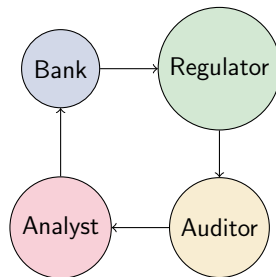
Research Goal

Understand how operational transparency evolves and reduces institutional tension through strategic stakeholder interactions.





Framework Architecture

Core Approach:

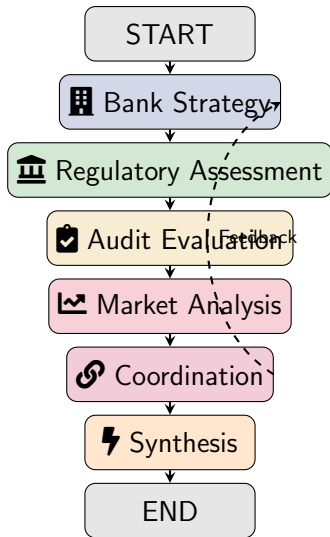
- Agentic framework rooted in institutional and organizational theory
- Multi-agent simulation using LangGraph
- Iterative stakeholder interactions



Agent Configuration

Agent	Role	Objectives
 BankManagementAgent	Controls CECL estimation	<ul style="list-style-type: none">● Minimize regulatory scrutiny● Maintain competitive advantage● Balance transparency vs. proprietary risk
 RegulatoryAgent	Monitors compliance	<ul style="list-style-type: none">● Ensure model validation● Assess systemic risk● Provide improvement guidance
 AuditorAgent	Assesses reliability	<ul style="list-style-type: none">● Evaluate audit trail completeness● Verify methodology● Assess control adequacy
 AnalystAgent	Adjusts market confidence	<ul style="list-style-type: none">● Assess earnings predictability● Evaluate model comparability● Adjust forecast confidence

Simulation Flow



Multi-Round Interaction Protocol

- 1 **Bank issues CECL disclosure** (with transparency level)
- 2 **Regulators, auditors, and analysts evaluate** and respond
- 3 **Bank receives feedback** and adjusts policy
- 4 **Process repeats** → system moves toward stability or conflict

Key Dynamic

Multiple rounds enable learning and adaptation, leading to emergent transparency norms

Key Research Questions

- ① How do strategic interactions among CECL stakeholders evolve transparency norms?
- ② What feedback loops drive institutional convergence in disclosure practices?
- ③ How does operational transparency reduce stakeholder tensions over time?
- ④ What agent configurations optimize transparency and legitimacy outcomes?

Technical Implementation

Infrastructure:

- LangGraph-based multi-agent system
- State Management: Shared ResearchState
- Communication: Structured message passing
- Learning: Adaptive strategies
- Memory: Persistent checkpointing

Analysis Tools:

- `analyze_cecl_transparency`
- `assess_stakeholder_tensions`
- `institutional_theory_analysis`

Implementation Example

```
# Unified Agent base class
@dataclass
class AgentConfig:
    """Agent configuration data class"""
    name: str
    role: str
    system_prompt: str
    objectives: List[str]
    state_key: str

class UnifiedCECLAgent:
    """Unified CECL research Agent"""
    def __init__(self, config: AgentConfig, llm: ChatAnthropic):
        self.config = config
        self.llm = llm

    async def process(self, state: ResearchState,
                     context_data: Dict[str, Any]) -> ResearchState:
        """Unified processing logic"""
        response = await self.llm.ainvoke(...)
        state["research_data"][self.config.state_key] = {...}
        return state
```

Expected Outputs & Insights

Transparency Evolution:

- Audit objections frequency
- Regulatory scrutiny intensity
- Analyst forecast dispersion
- Market confidence metrics

Institutional Dynamics:

- When banks become more transparent
- Convergence toward accepted practices
- Legitimacy building mechanisms
- Isomorphic pressures

Policy Implications

- Optimal transparency frameworks for different environments
- Cost-benefit analysis of increased transparency
- Mechanisms to reduce stakeholder tensions

Research Contributions

- ① **First comprehensive multi-agent analysis** of CECL transparency dynamics
- ② **Novel application of institutional theory** to CECL implementation
- ③ **Practical framework** for improving stakeholder relationships
- ④ **Methodological innovation** through agentic simulation approach

Impact

Bridges theoretical understanding with practical implementation for financial institutions

Usage Instructions

- ➊ **Setup Environment:** Install dependencies and configure API keys
- ➋ **Run Simulation:** Execute `start.ipynb` notebook
- ➌ **Generate Visualizations:** Use `save_graph_as_png()` function
- ➍ **Analyze Results:** Review agent interactions and transparency patterns

Quick Start

```
$ git clone https://github.com/yli397/CECLAgents.git
$ python -m venv .venv && source .venv/bin/activate
$ pip install -r requirements.txt
$ python cecl_simulation.py
```

Next Steps & Extensions

Ongoing Development:

- Integrating empirical feedback loops from real-world data
- Testing scenarios: regulatory shocks, policy interventions, peer effects
- Expanding to include additional stakeholder types (investors, rating agencies)

Framework Ready ✓

All components tested and operational for CECL transparency research

Key Takeaway

This multi-agent simulation framework provides a novel approach to understanding how operational transparency evolves in complex financial reporting environments, offering both theoretical insights and practical applications.