A Dynamic Model for Risk Characterization of Mega-projects and its Impact on Project Financing

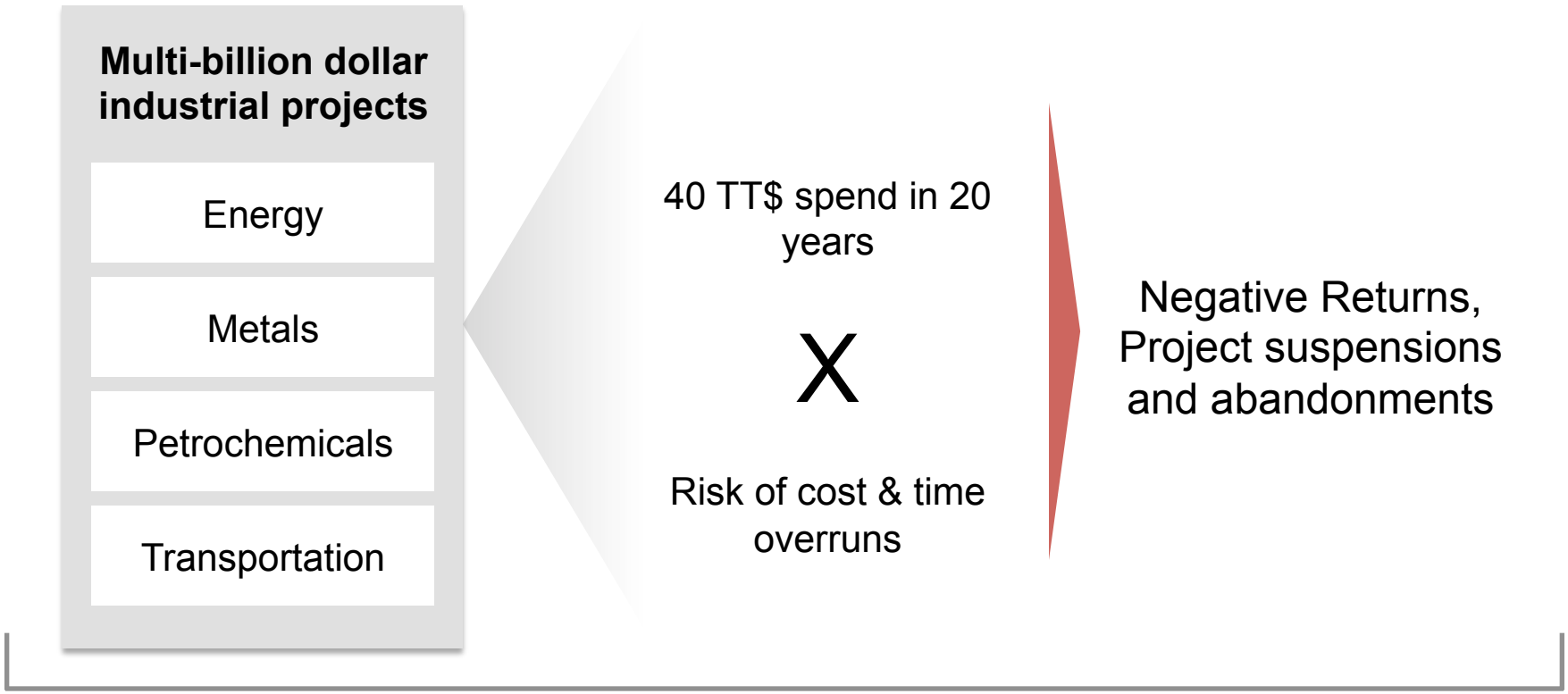
33rd International System Dynamics Conference

Atanu Mukherjee

July 22, 2015

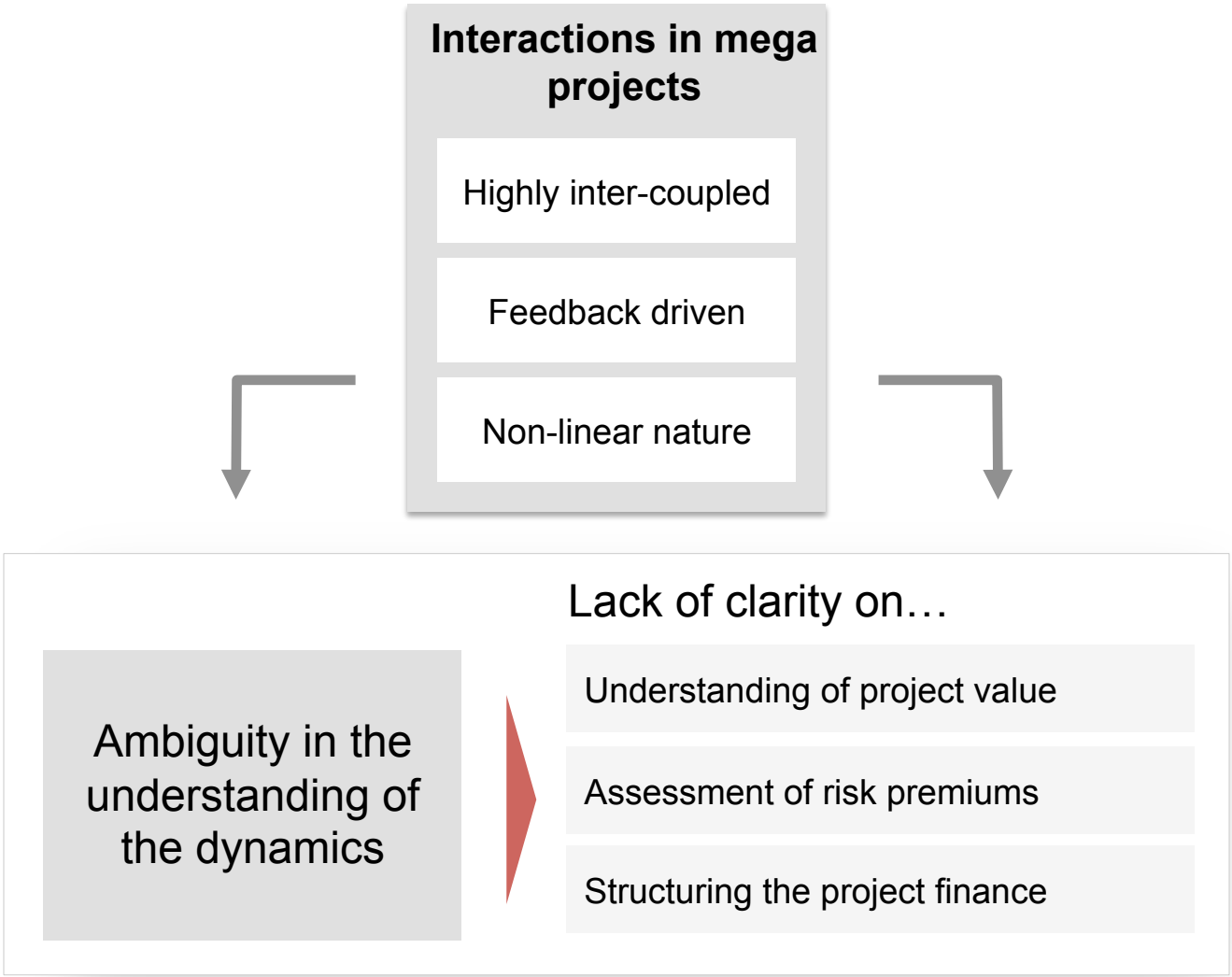
DASTUR | AcuLead

The Mega Project Challenge



Projects need to be **structured**, **organized**, **financed** and **managed** in a way, which accommodates change, characterizes risk while minimizing late cost, functionality and schedule impacts

Understanding Risk based on the Dynamics of Mega Projects is Key



Current Decision Analysis Methods for Understanding Risk is often Inadequate

- Traditional mechanisms used to establish causal relationships are weak
  …they ignore feedback effects, multiple interconnections, non-linearities, time delays, and other elements of dynamic complexities

- Various methods to infer causality is constrained
  ….temporal and spatial proximity of cause and effect, temporal precedence of causes, covariation and similarity of cause and effect

- These methods lead to difficulty in large complex projects where
  ….cause and effect are often distant in time and space, actions have multiple effects, the delayed and distant consequences are different than proximate effects

- The assumptions in the traditional models are at aggregate levels
  ….are at higher levels of aggregation, underestimate the tail behavior and non-stationary effects

A Causality Based Approach to Modeling and Characterizing Risks

- Understand cause-effect relationships in terms of
  …attributions, feedbacks, delays and non-linear & higher order effects
- Understand how
  ….projects are structured, elements interact at project, macro and industrial sector level; change, shocks and delay effects propagate through the project
- Causality estimation based on facts, data and intuition in the context of macro-industry dynamics allows to
  ….understand attributions, feedback effects and time delays in a iterative top-down, bottoms-up manner in a “closed loop” system based approach
- Frame dynamic models of project structures and interactions to
  ….infer patterns of behavior based on hybrid simulations using techniques from system dynamics and traditional Monte-Carlo mechanisms

Progression from Static to Dynamic Modeling of Projects, Shapes Project Markets

Traditional method of statistical risk modeling

Fails to provide meaningful value in risk assessment due to the highly inter-coupled, feedback driven and non-linear nature of interactions in mega-projects

The unique and craft nature of each project limits the extent of reasonable analysis based on correlations of comparative data

Dynamic risk behavior modeling

Associated risks can be characterized, quantified and monitored in a more accurate manner

The transparency and understanding results in meaningful assessment of dynamic risk profiles

Appropriately priced risk premiums

Project finance market expansion

Larger institutional investors for funding (e.g. insurance, pension funds)

Enhanced market liquidity for project finance

Greater financial innovation and opportunity expansion in fully functional project finance markets

Transformative impact on the industry and society

…We need a Framework for Structuring, Organizing, Managing and Financing Industrial Megaprojects for dynamic risk understanding

The Basis for Understanding Complexity in Megaprojects

Large engineering projects are complex because they tend to have

Multiple...

- Shaping phases
- Stages of design
- Procurement
- Construction
- Interacting technical disciplines
- Organizations involved (consultants, contractors, vendors,..)
- Possible sequences for accomplishing the work

Changing...

- Customer requirements
- Performance priorities (schedule, cost, technical)
- Government regulations and standards
- Political Environment
- Work scope
- Technologies
- Resource availability
- Contractor productivity
- Work quality

Delays...

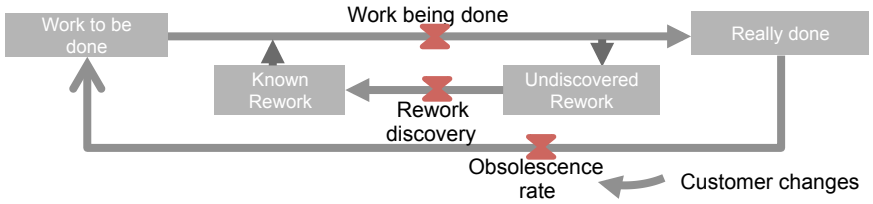
- Effect of macro-economic shocks
- In discovering rework
- In experiencing full effects of events and conditions that impact the project
- In perceiving true project performance
- In implementing management responses
- In project supply chain behavior

A Two-Stage Framework to Model Large Project Dynamics

Market | Feedstock | Investment | Technology | Labor

Structure | Organize | Finance | Manage | Insure

Dynamic Behaviour, Risk and Uncertainty Characterization

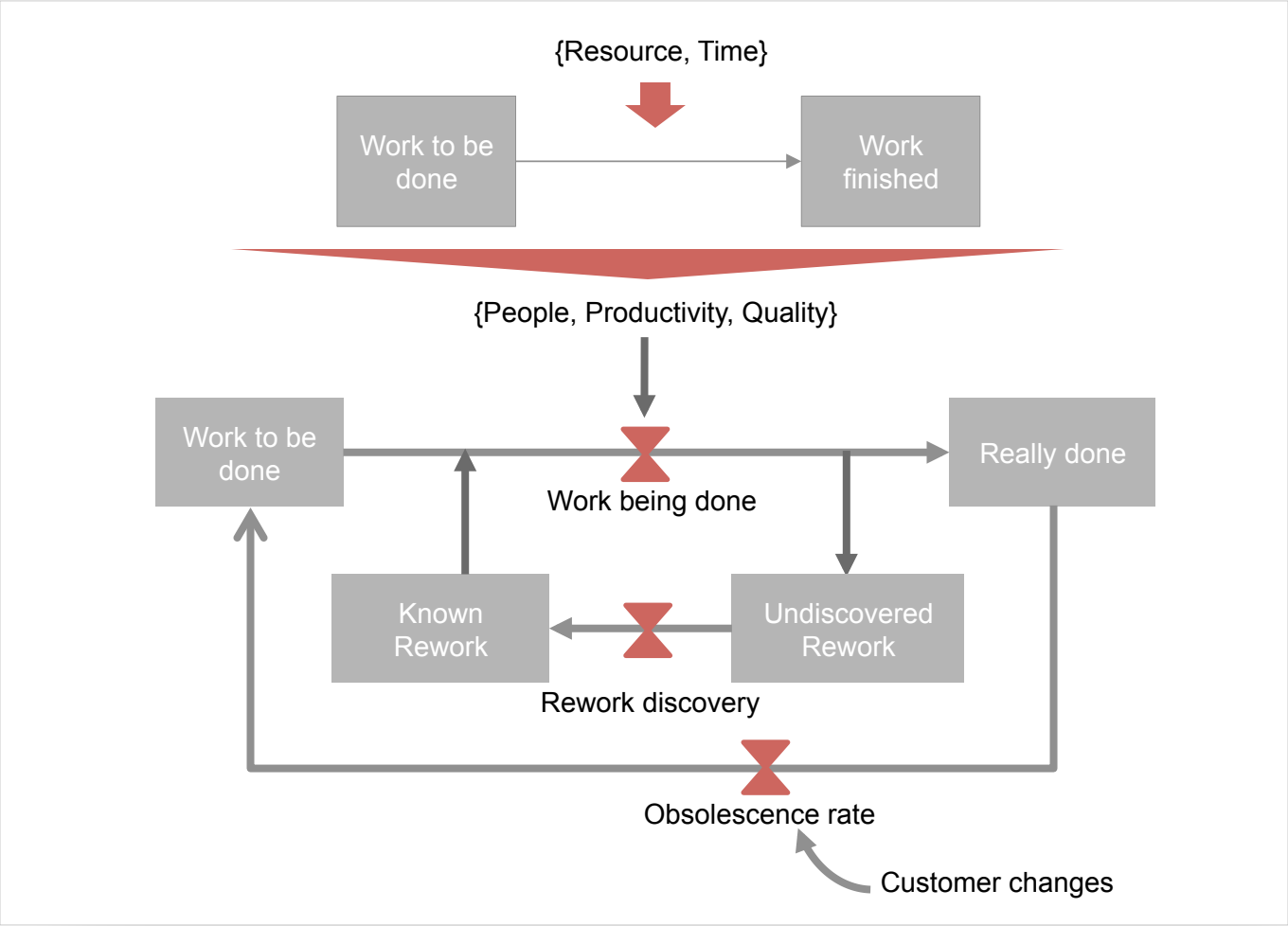


Causal Models | Design Structure Matrix | Hybrid Simulations | Project Supply Chains

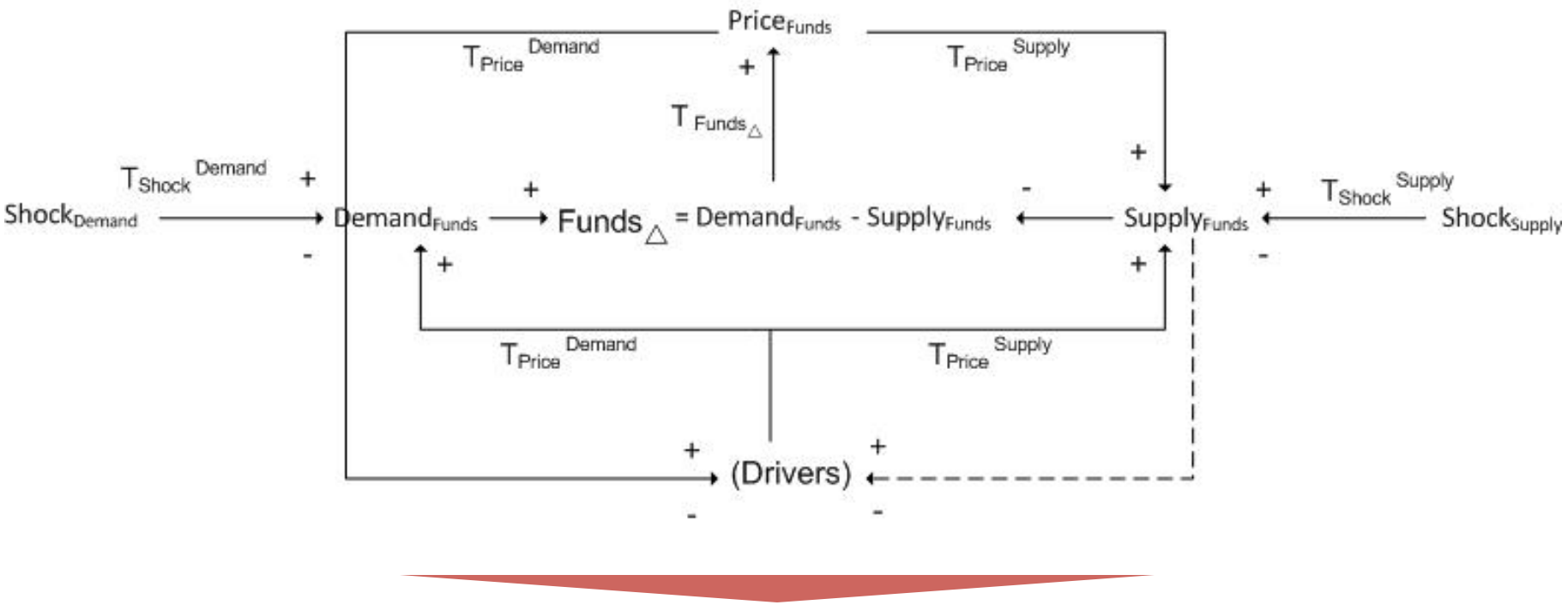
Project Databases | Uncertainty Models | Flexibility and Options

DASTUR | AcuLead

Project Work-Rework Cycle Model

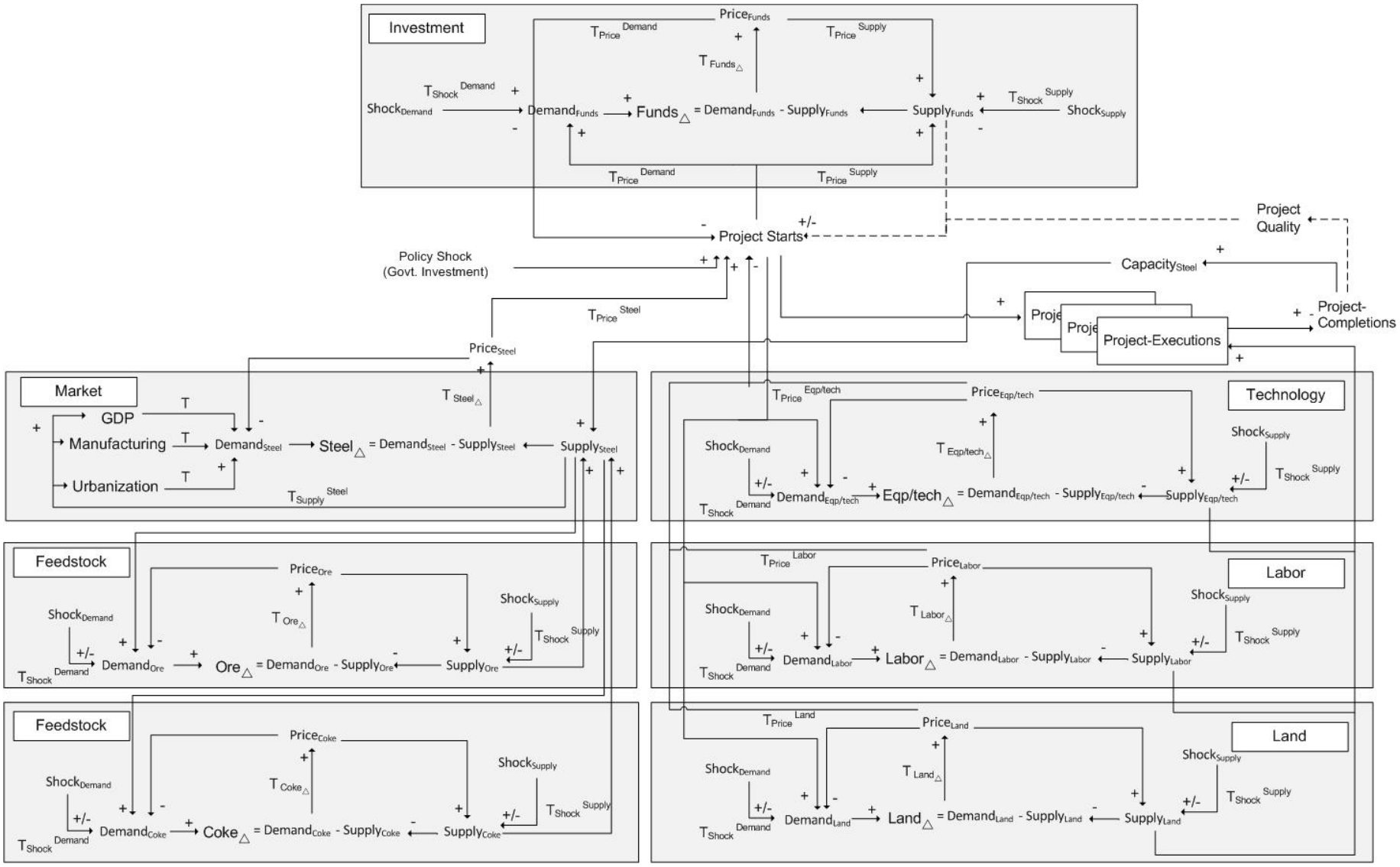


Project Investment Causal Model Archetype

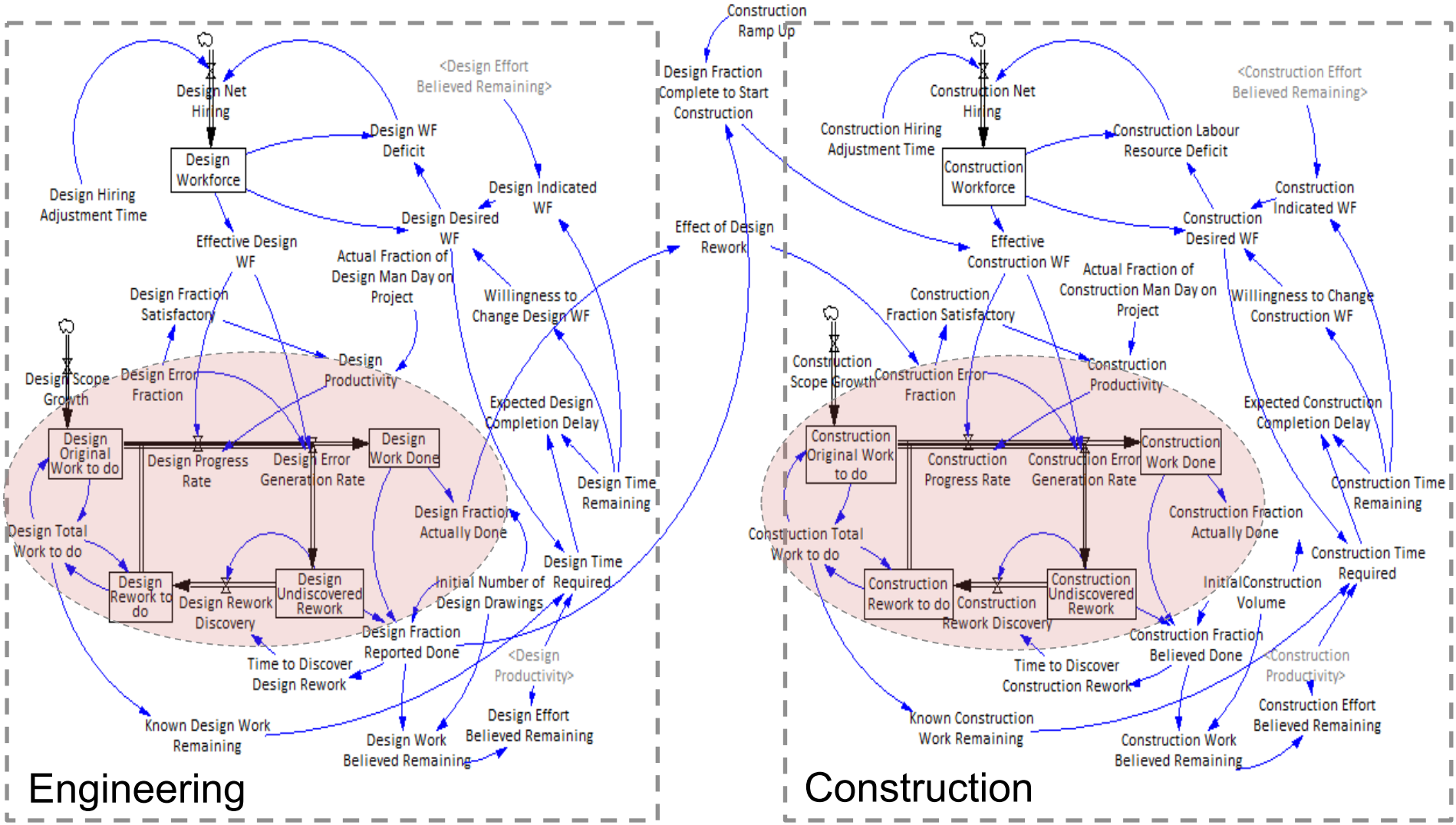


These interacting loops of demand, supply with lags exhibit a stable or unstable dynamic behavior over time

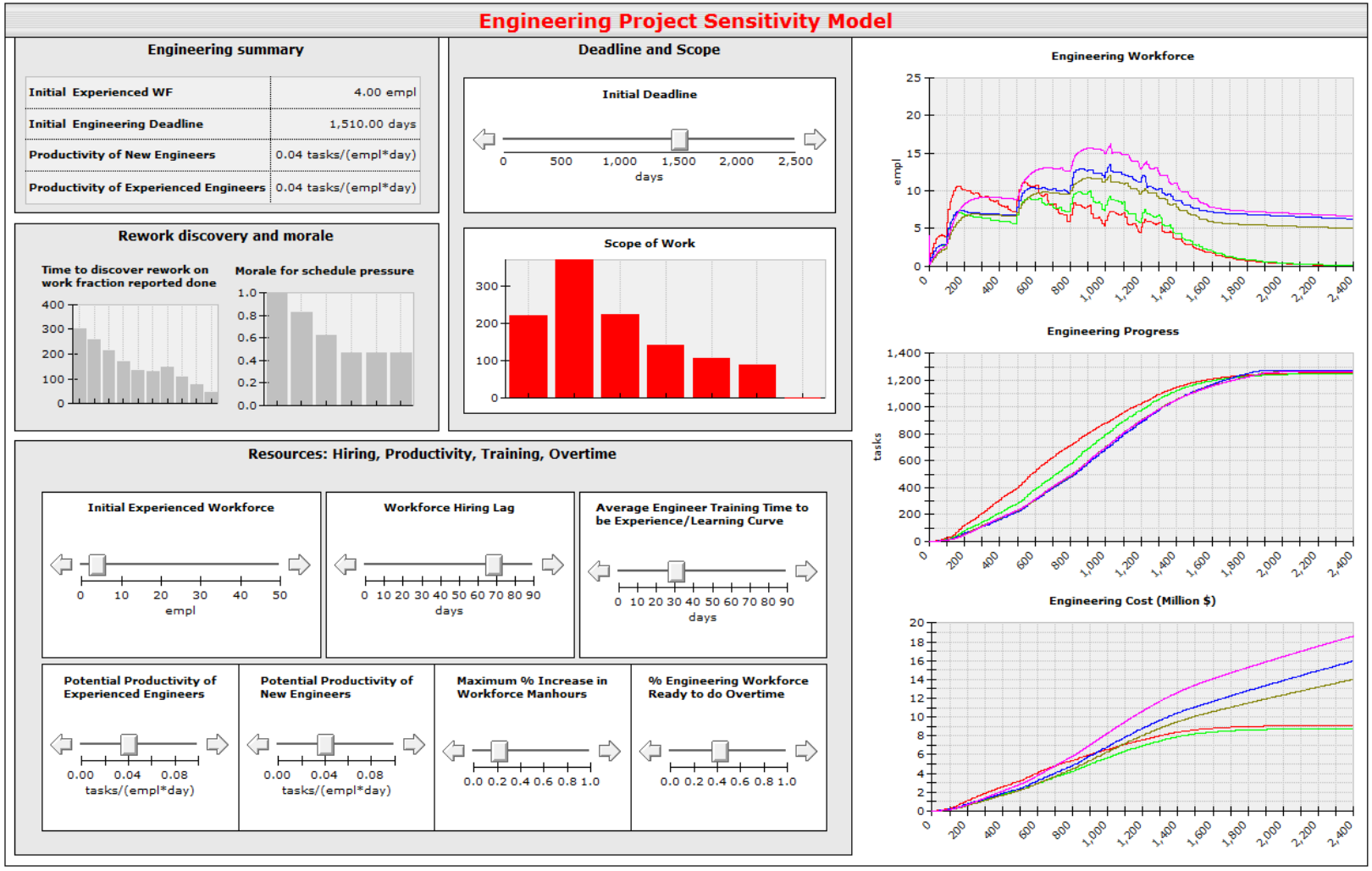
Stage One Dynamic Model



Stage Two Dynamic Model



Project Outcome Sensitivities to Changes



Typical Questions and What If's the Framework Helps Answer

Market Risks		
1	Is there an opportunity for investment in a project in the market?	1. Potential return envelope 2. Capacity bounds 3. Market segments
2	How would the commodity price evolve?	1. Price evolution trajectory 2. Price bounds and sensitivities
3	How would raw material availability and pricing evolve?	1. Raw material supply trajectory 2. Raw material price envelope
4	Impact of availability and pricing of › Land › Equipment & technology › Labor & workforce	1. Impact of returns on project 2. Feasibility of new projects
Execution Risks		
1	How should the project be structured?	1. Complete (EPC) and discrete turnkey option 2. Number of packages 3. Difference in cost between contracting options
2	Impact of › Timing and magnitude of Scope changes › Delays in decision making › Delays in discovering rework/changes	1. Cost impact 2. Schedule impact 3. Workforce impact 4. Trade-off zone
3	Impact of supply chain disruptions	
4	Impact of unavoidable events › Labor strikes › Forces majeure › Inter-contractor dependencies	

Thus Shaping Megaproject Uncertainty through Flexibility Options

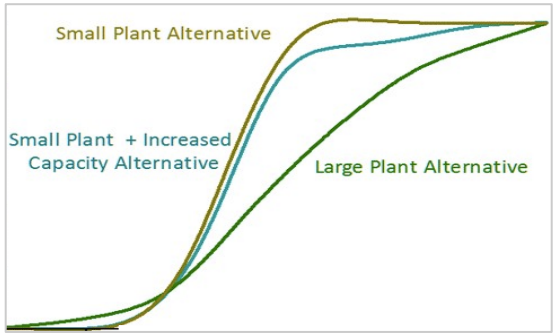
Dynamic Risk & Uncertainty

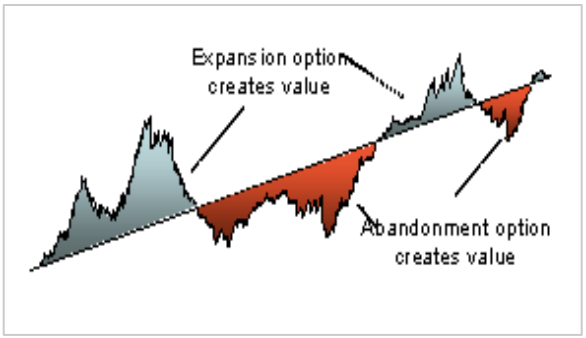
Option to Delay

Option to Expand

Option to Sell Excess

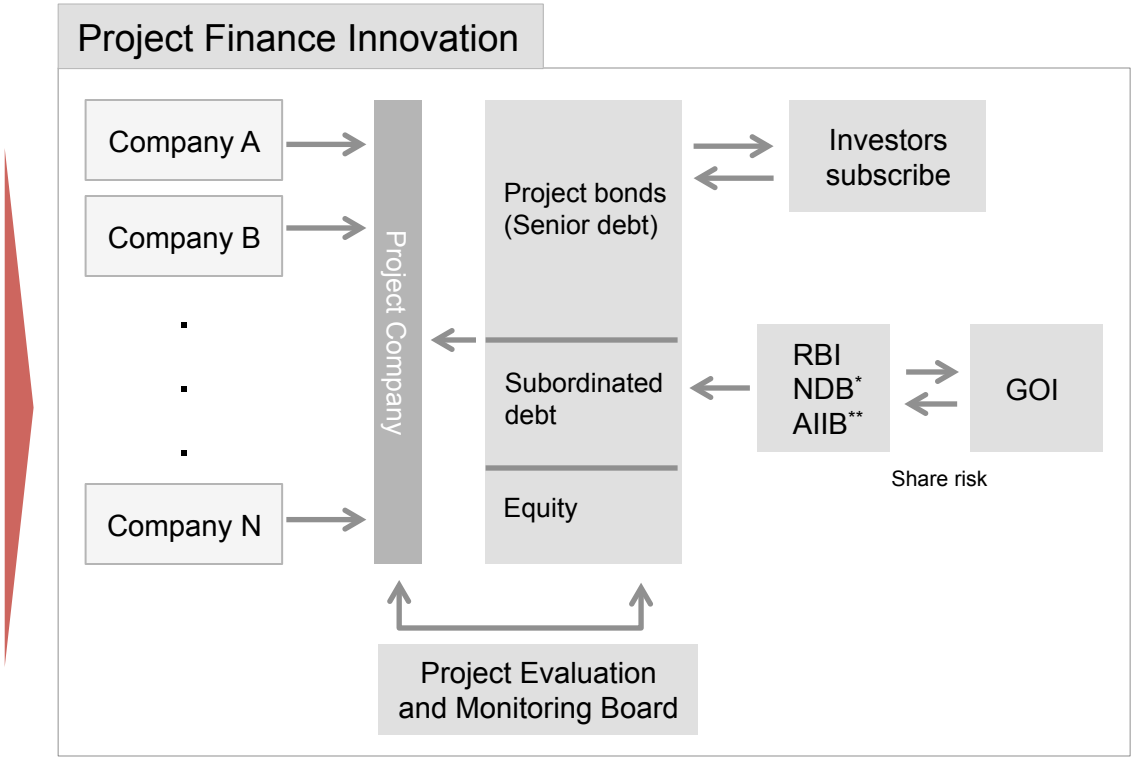
Option to Abandon





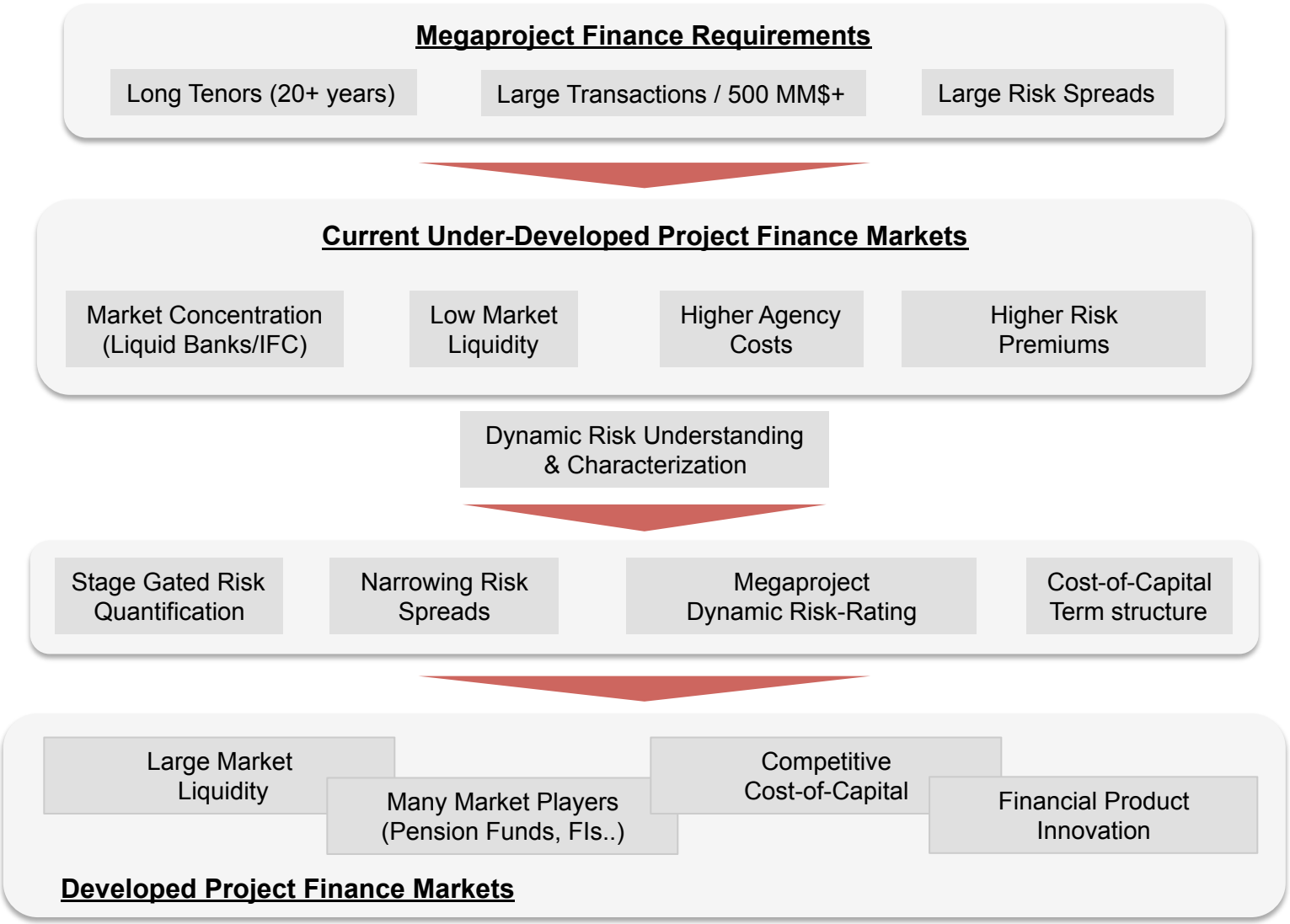
Our Project Dynamics Framework and Platforms Expand the Opportunities for Project Finance

- > Project Shaping & Analysis
- > Project Structuring
- > Project Flexibility and Phasing
- > Project Risk Modeling
- > Project Ratings
- > Project Monitoring
- > Project Restructuring



* New Development Bank
** Asian Infrastructure Investment Bank

Enabling the Creation of Competitive Markets for Project Finance



Conclusion

- Success in Industrial Megaprojects is all about understanding, characterizing, quantifying and managing risk across the project lifecycle
- Understanding dynamic risk behavior and control points is critical in allocation and control of risks
- Understanding the dynamic behavior of projects during execution is critical in understanding uncertainty, risk and change dynamics
- If risk, uncertainty and change impacts can be characterized it can have transformative effect on Megaprojects, including the markets for project financing
- Our framework for project dynamics is a comprehensive mechanism for understanding complexity, uncertainty and change in Industrial Megaprojects

AcuLead

www.dastur.com | www.aculead.com

atanu.m@dastur.com
(91) 983.027.0019