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# **Using System Dynamics to Understand Disruption:** A General Model for Technology and Industry Disruption

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# Steps in the System Dynamics Modeling Process

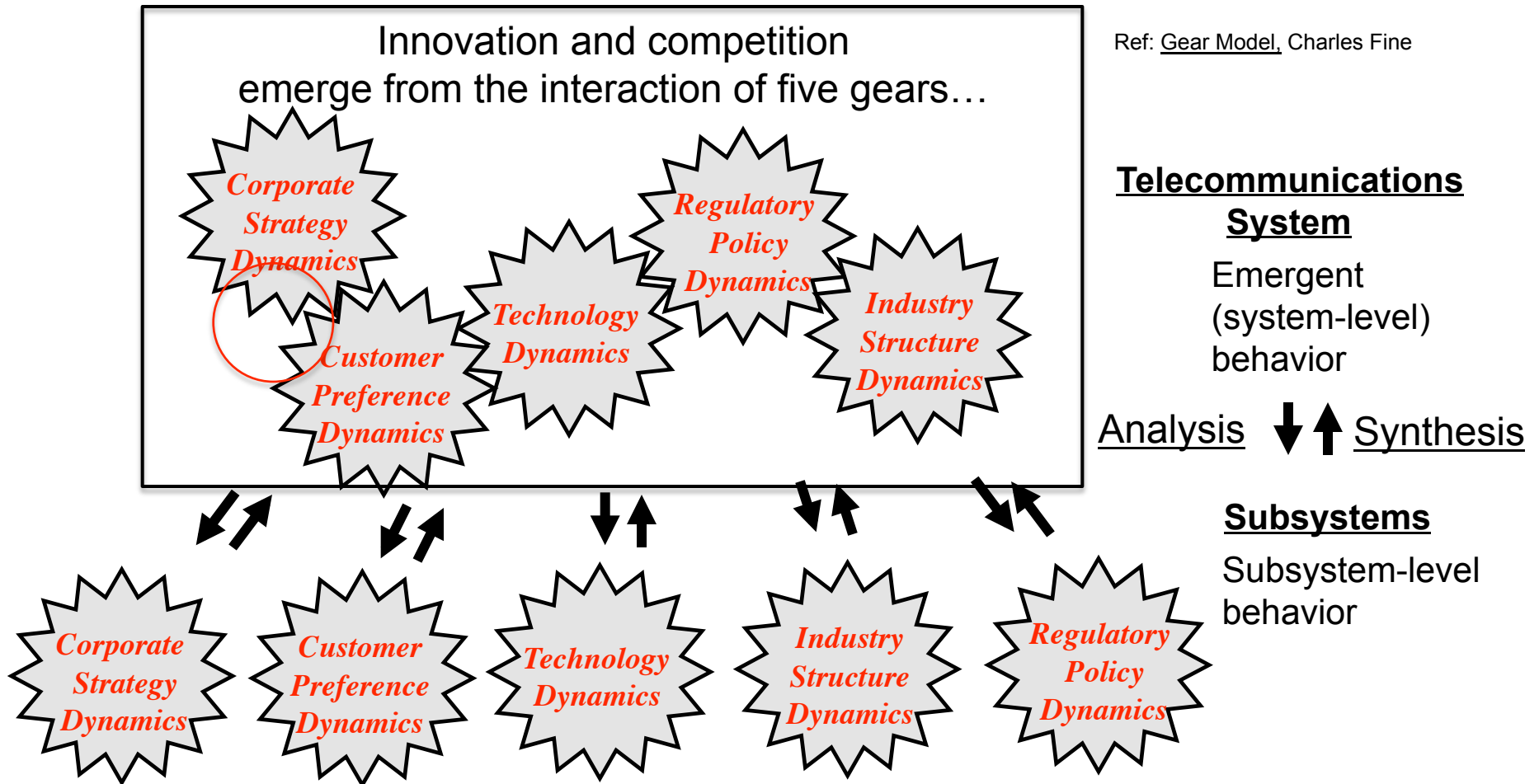
- Problem Articulation
  - What is the problem?
  - Key Variables
  - Time Horizon
- Formulating Dynamic Hypotheses
- Formulation of a Simulation Model
  - Causal Loops, Stocks and Flows
  - Estimation
- Testing and Validation
  - Consistency with the purpose and boundaries
  - Comparison with Expected Behavior
  - Robustness of the Model
  - Sensitivities and other tests
- Policy Evaluations

## Problem/Research Question

**How can we improve decision making amidst technology and industry disruption?**

# Model Formulation, Testing, and Validation

# Model: Philosophy and Principles



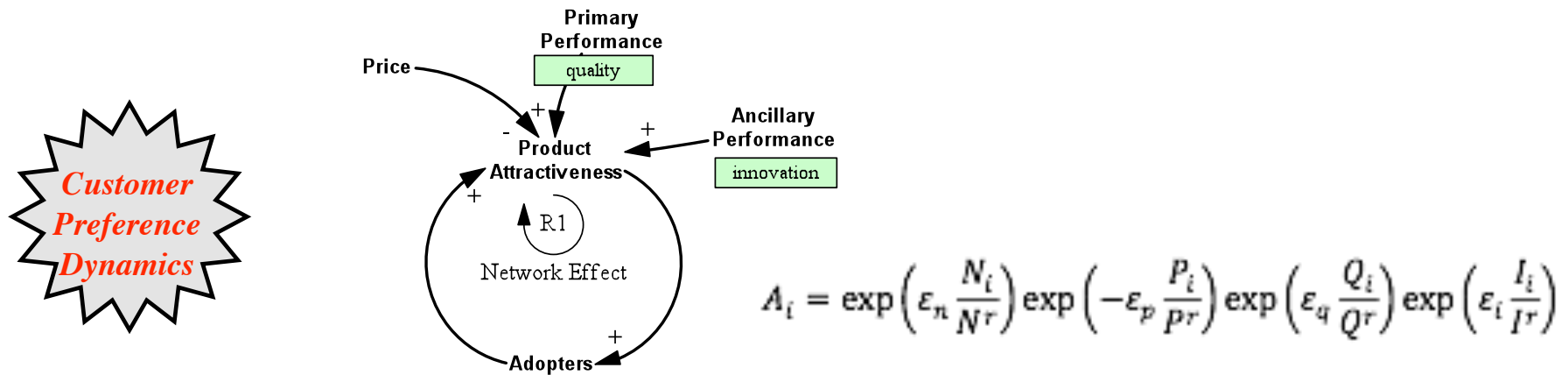
## Model formulations rest upon:

1. Theories of adoption, tech strategy, and innovation
2. Unstructured interviews with stakeholders

# Example: Model based on Theory

## Christensen's Conditions for Disruptive Technology (Christensen 1997)

Firm	Price	Primary Performance (Quality)	Ancillary Performance (Innovation)
Incumbent (e.g. AT&T)	High	High	Low
Entrant (e.g. Skype)	Low	Low	High



Assumptions:

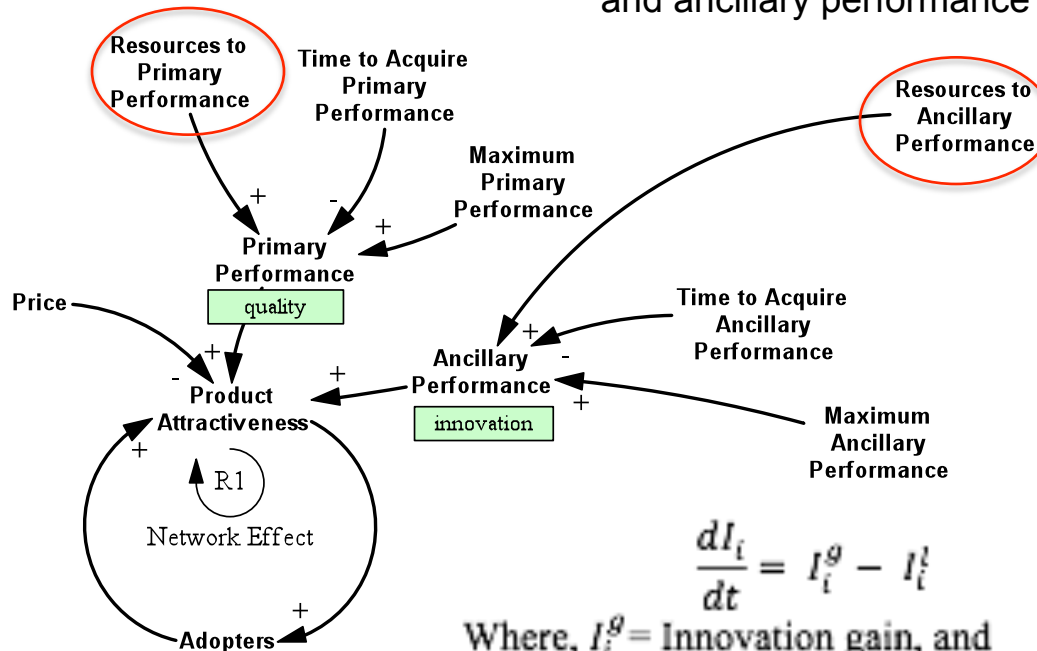
- 2 Firms – Incumbent, Entrant
- Each firm represents a typical firm in their industry

# Example: Model based on Unstructured Interviews



Assumption:

- Features of each service are separable into (identifiable as) primary performance (quality) and ancillary performance (innovation)



$$\frac{dl_i}{dt} = I_i^g - I_i^l$$

Where,  $I_i^g$  = Innovation gain, and  $I_i^l$  = Innovation loss.

$$I_i^g = R_i^i \frac{(I_i^{max} - I_i)}{\tau_i^i}, (I_i^{max} > I_i)$$

$$I_i^l = \frac{(I_i - I_i^{max})}{\tau_i^l}, (I_i > I_i^{max})$$

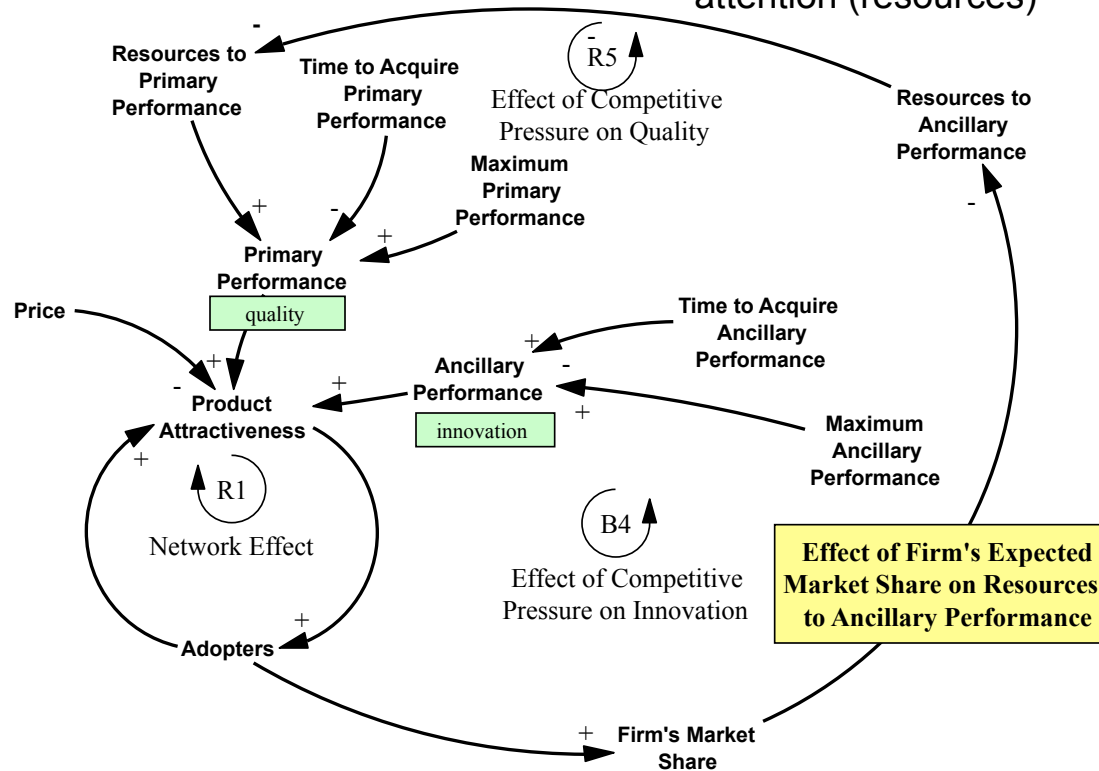
$$I_i^g = I_i^l = 0, (I_i = I_i^{max})$$

# Example: Model based on Unstructured Interviews (Contd.) (making Firm's Strategy endogenous)

*Corporate Strategy Dynamics*

*Customer Preference Dynamics*

Assumption:  
Both firms endowed with equal total attention (resources)



*“The only strategy was that of a monopolist. Incumbent A did not care what other features you want!” Director, CTO Organization, Incumbent A*

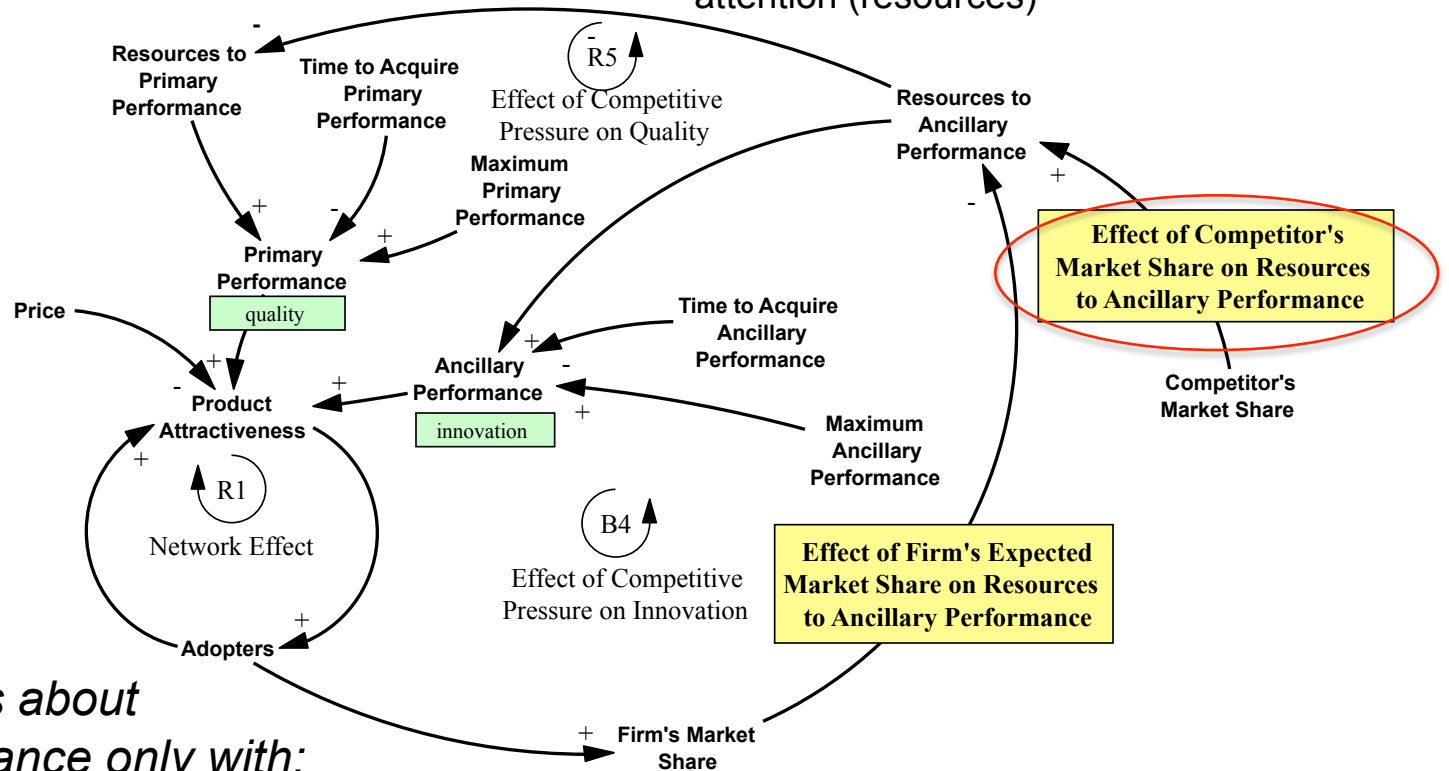


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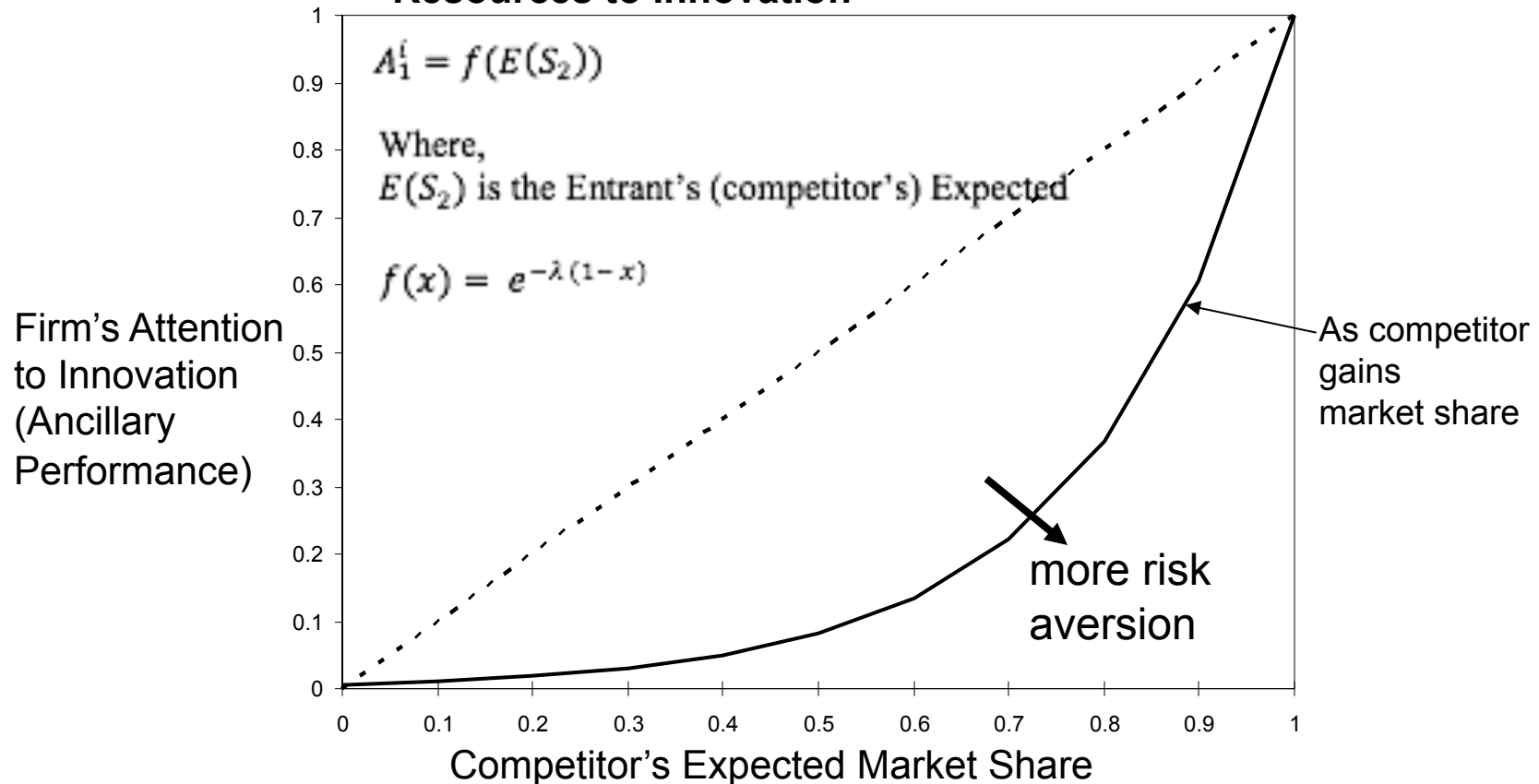


*“Incumbent cares about ancillary performance only with: the entry of the non-traditional competitor, and the growth of its market share.”*  
Director, CTO Organization, Incumbent A

$$R_i = R_i^i + R_i^q + R_i^z$$

## Example: Model based on Unstructured Interviews (Contd.)

### Effect of Competitor's Market Share on Resources to Innovation



*“First [when the entrant enters] the question is whether this is a price game or a performance game. Then, you realize that the future is ancillary.”*  
*Chief Strategist and Architect, Incumbent B*

# Model Testing and Analysis

## Model Verification, Validation

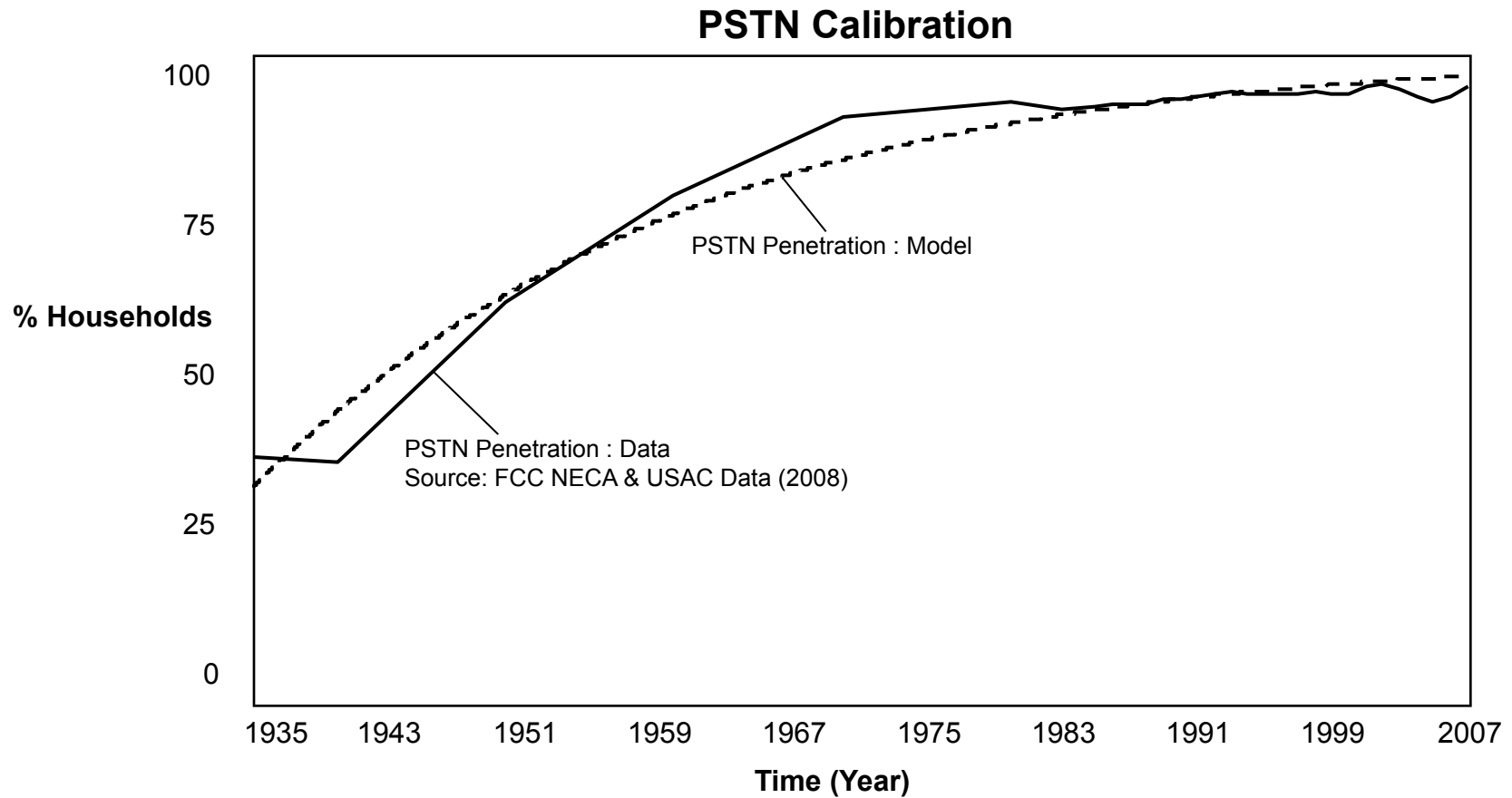
1. Calibration with real-world trends
2. Expert Opinion: Regulators (FCC, MIAC-Japan), Industry Architects and Strategy Experts (Motorola, BT, Nokia, Cisco, Comcast, Verizon), Academics (Primary Sources)

## Testing

1. Sensitivity of each exogenous parameter (including those that were made endogenous later)
2. Analysis of a unit model to understand structural forces and incentives
3. Analysis of calibrated model to understand timing and magnitude of the forces
4. Industry Structure Scenarios
  - Integrated Incumbent Remains Dominant
  - Niche Entrant, modular in technology and industry structure, displaces the Incumbent
  - Erstwhile Entrant (new Incumbent in the modular structure) remains dominant with a new modular entrant present

# Model Validation

Through calibration with data, agreement with shared mental models of stakeholders, and expert opinion



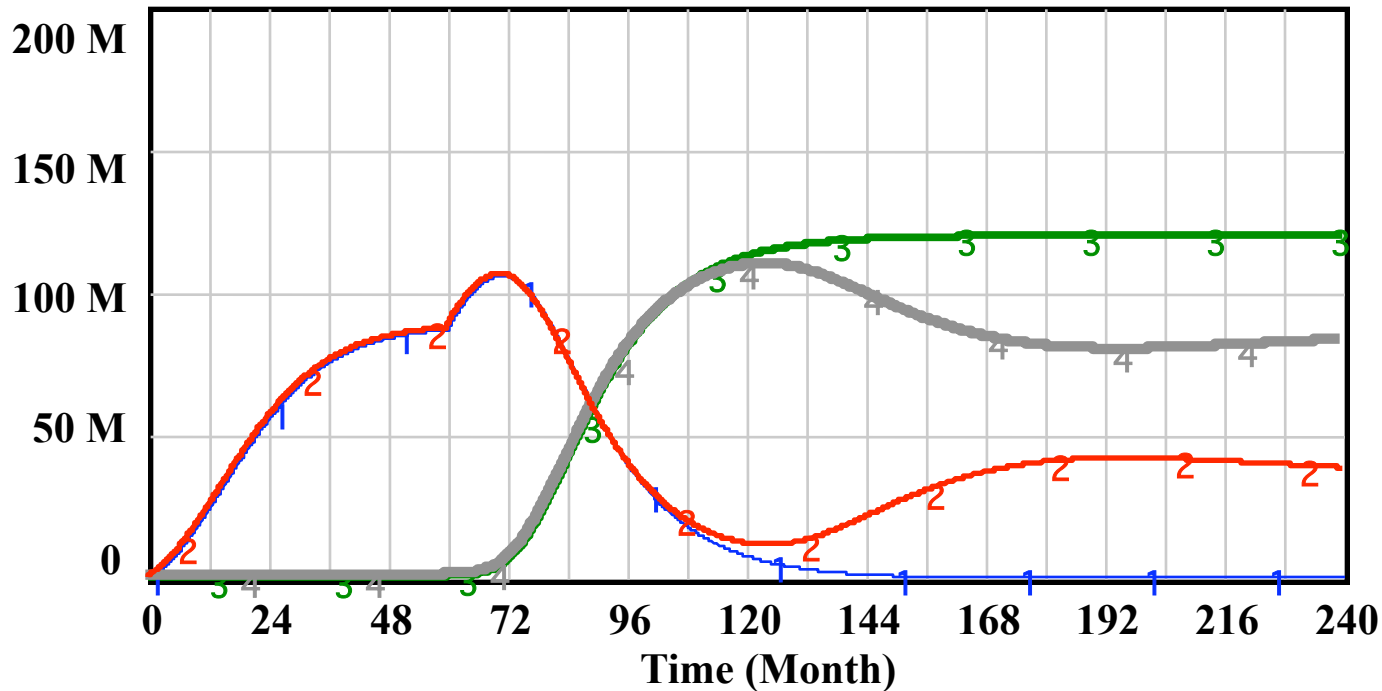
# Results

## Base Case Behavior

Passive Base Case - Incumbent does not respond to threat

Active Base Case - Incumbent responds to threat

### Adopters



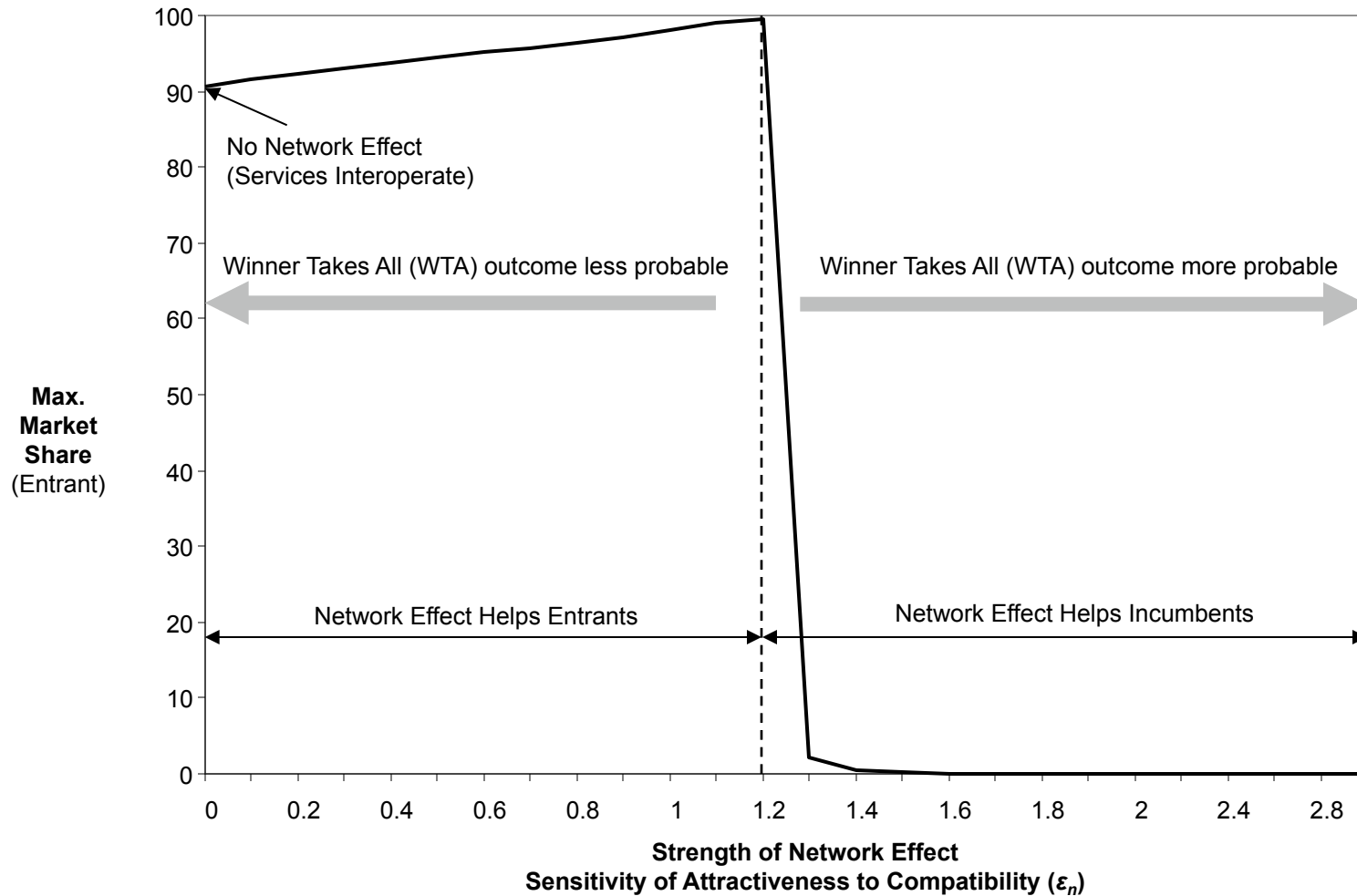
Adopters[Incumbent] : Passive Base Case — 1 — 1 — 1 — 1 — 1

Adopters[Incumbent] : Active Base Case — 2 — 2 — 2 — 2 — 2

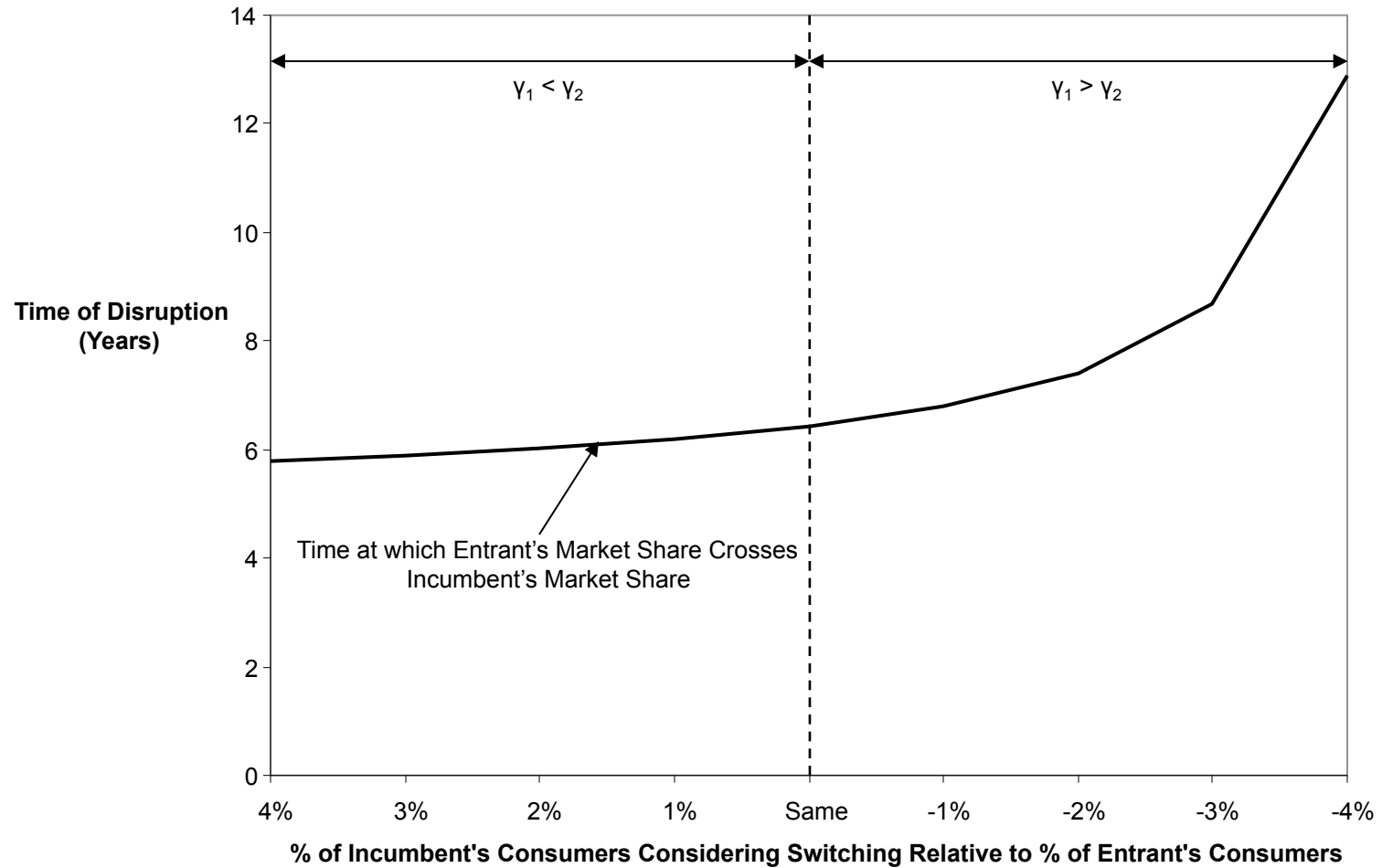
Adopters[Entrants] : Passive Base Case — 3 — 3 — 3 — 3 — 3

Adopters[Entrants] : Active Base Case — 4 — 4 — 4 — 4 — 4

# Market Uncertainty: Network Effect Phase Plot

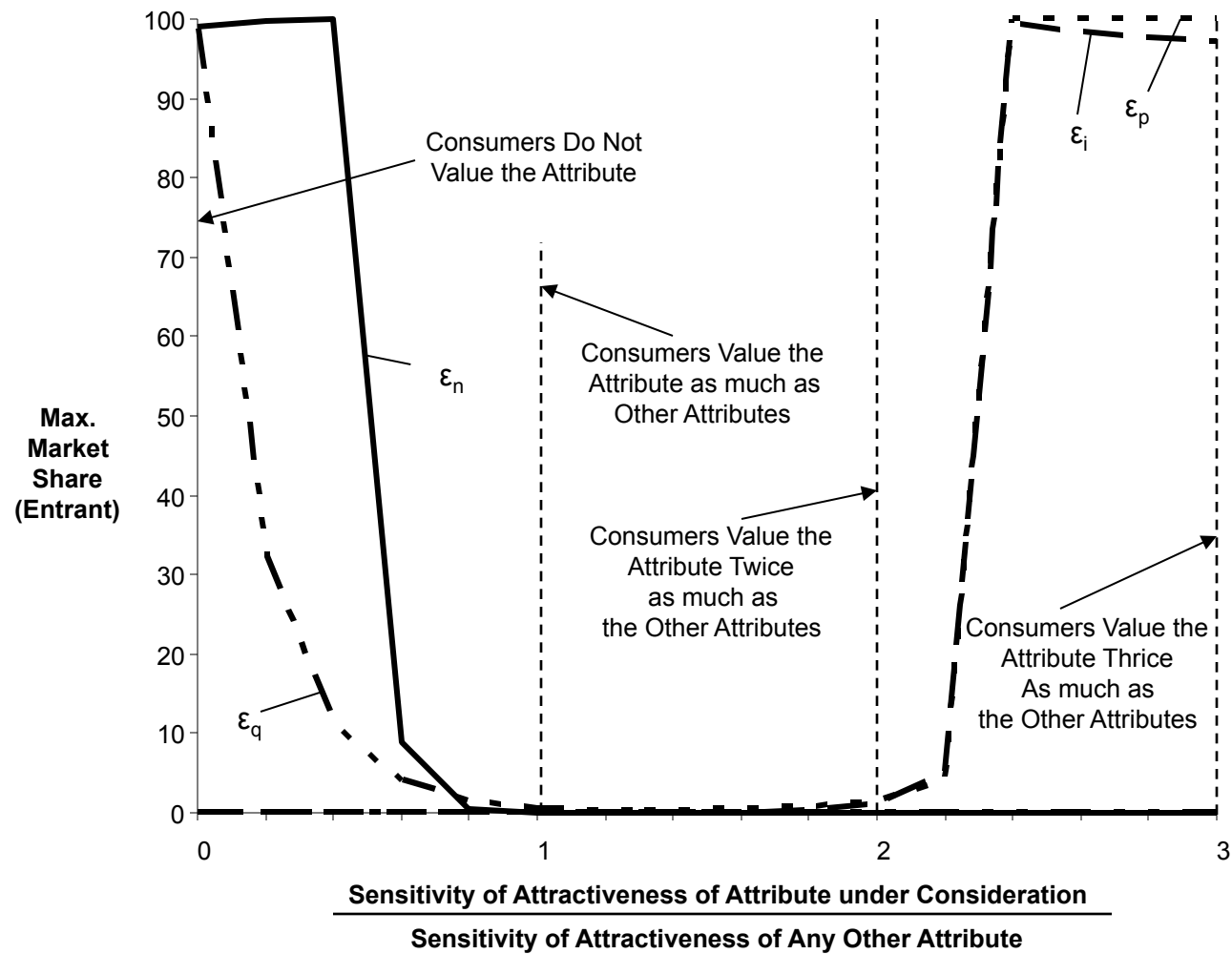


# Market Uncertainty: Switching Cost Phase Plot





# Market Uncertainty: Consumer Choice Phase Plot



# Limits to Technology and Industry Disruption

	Industry Disruption	No Industry Disruption
Technology Disruption	<ul style="list-style-type: none"> <li>• Weak Network Effect</li> <li>• Consumer highly price sensitive and willing to risk adopting innovative service with low quality and compatibility</li> </ul>	<ul style="list-style-type: none"> <li>• Incumbents can affect switching behavior heavily</li> <li>• Incumbents innovate while maintaining quality</li> <li>• Entrants struggle to offer quality due to lack of functional control or market power</li> </ul>
No Technology Disruption	<p><b>Quadrant Not Studied</b></p> <ul style="list-style-type: none"> <li>• General double helix dynamics without technology disruption</li> </ul>	<ul style="list-style-type: none"> <li>• Strong Network Effect</li> <li>• Consumer value quality and compatibility over innovation and low price</li> </ul>

**THANK YOU**