AN INTEGRATED INNOVATION LIFE CYCLE MODEL FOR SUPPLY CHAIN ADAPTION

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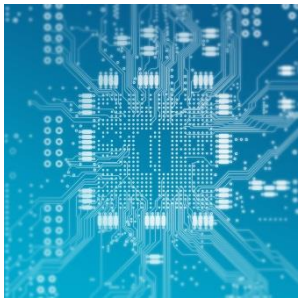
AGENDA

- Introduction
- Previous work and research gap
- Findings
- Conclusion and Outlook

Introduction
Radical Innovations from a Supply Chain Perspective



Radical Product Innovations:

- New to the supply chain and the overall industrial sector
- Differ significantly from previous products

Radical Innovation Supply Chain Challenges

- Disruptive impact on Supply Chains
- High uncertainty (demand and supply)
- Rapid life cycle progress requires quick adaption of supply chain strategy and structure
  - What is the right supply chain strategy in different innovation life cycle phases?
  - Different performance targets in each phase?
  - How to detect the need to change (life cycle phase transitions) timely?

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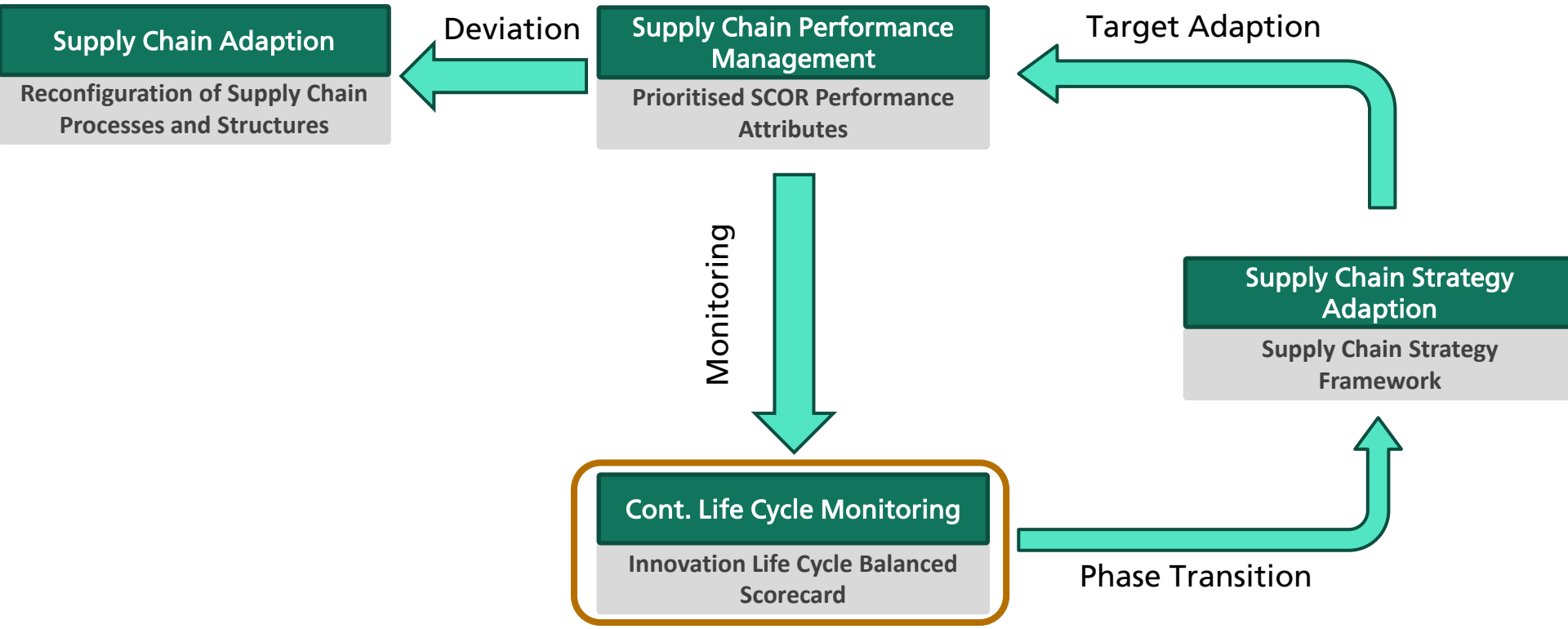
Previous Work

Cycle for Aligning the Supply Chain throughout a Radical Product Innovation's Life Cycle



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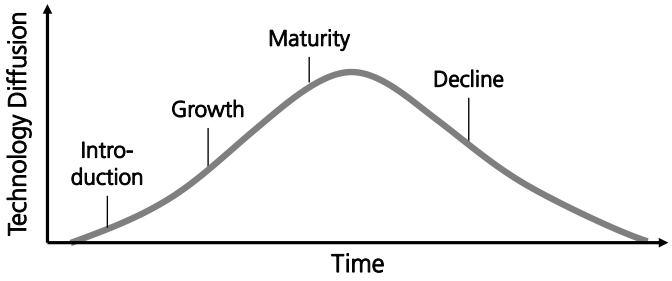
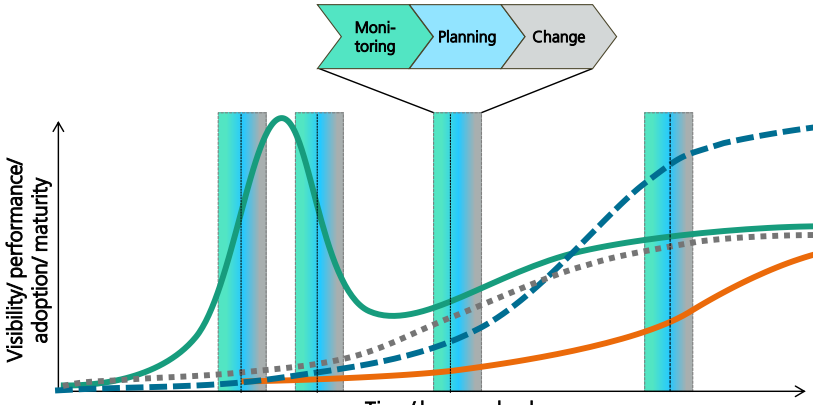
Previous Work
Integrated Product Innovation Life Cycle Model



Standard Product Life Cycle[1]



Integrated Innovation Life Cycle Model[2]

- Product Life Cycle
  - Evolution of volume of sales over time
- Adoption Curve
  - Market penetration of new technologies
- Performance S-Curve
  - Technology's performance over effort expended
- Maturity Curve
  - Technological advance over time
- Hype Cycle
  - Early life cycle as a function of expectations over time

1: Tschirky 1998; 2: Parlings & Klingebiel, 2012

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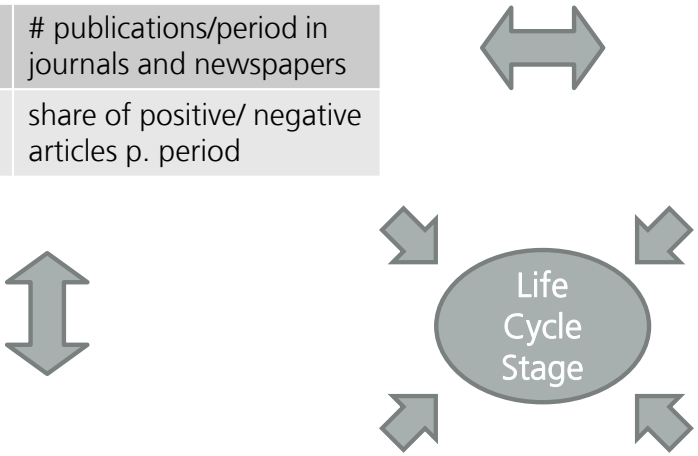
Previous Work
Indicators for Tracking an Innovation's Life Cycle Progress

Hype Indicators	
Visibility (quantitatively)	# publications/period in journals and newspapers
Expectations (qualitatively)	share of positive/ negative articles p. period

Financial Performance Indicators	
Revenue	Income per period
Profitability	Gross margin per e-car
Sales growth	Sales increase p. period
Return on R&D expenses	Ratio of innovation revenue to R&D expenses



Maturity Indicators	
Maturity degree	% of maximum maturity
R&D stage	# publications/period in research/patent databases

Adoption Indicators	
% adoption by target market	Cumulated # customers / # potential customers
Adoption speed	# customers p. period

Parlings et al. 3013

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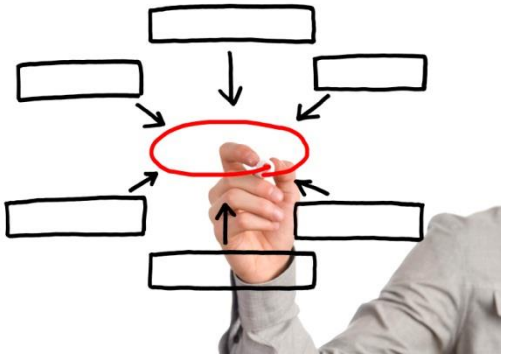
Intermediate Conclusion
Research Gap & Research Task



Research Gap

- Qualitative integrated Life Cycle Model existent
- Early detection of phase transitions by using appropriate monitoring methods is required
- Early detection should be based on objectively assessable facts
- To allow quantitative determination of phase transitions, a mathematical description of the life cycle model is necessary.

Research Task

- Mathematical description of the integrated life cycle curves
- Identification of characteristic points indicating phase transitions
- Demonstrate applicability as an early warning system

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Methodological Approach

Four steps to obtain and validate the results

Mathematical Life Cycle Model Description

Identify parameters for describing the life cycle curves

Identification of characteristic points

Curve sketching of each life cycle curve

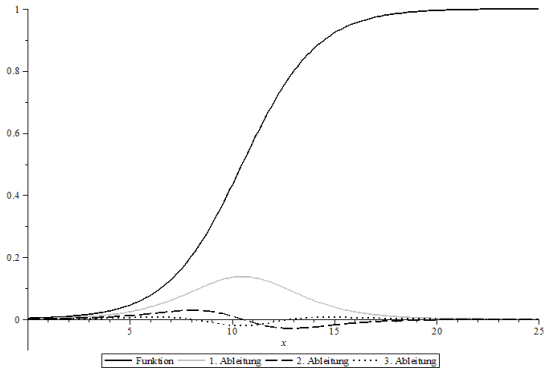
Validation based on historic data

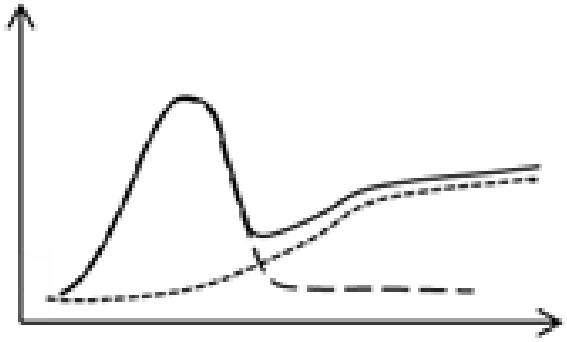
Exemplary parametrization of a life cycle curve

Prospective Application

Life cycle development prediction and early warning

Mathematic Compilation of the Life Cycle Curves





State-of-the-Art:

- Adoption Curve, Technology Life Cycle (TLC) and Performance Curve follow an S-Curve shape
- Based on the Sigmoid Function (Martino 2003):

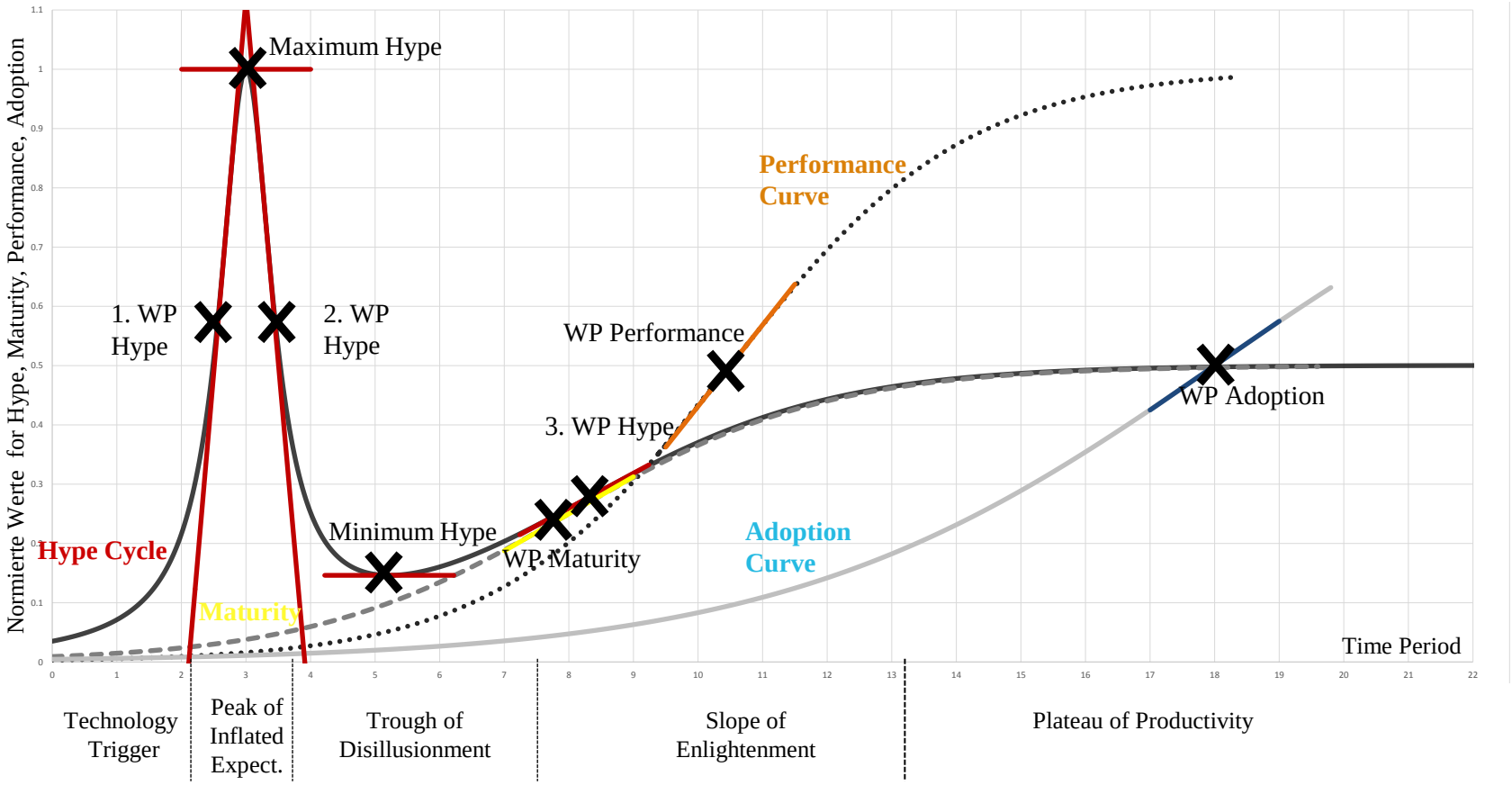
$$f(x) = \frac{\gamma}{(1 + e^{-a(x-T_0)})}$$

Research Gap: Hype Cycle

- Combination of a bell-shaped hype and an S-shaped sustainable development
- Breit-Wigner-Curve (witch of Agnesi, Lorentz Distribution) + Sigmoid Function

$$f(x) = \frac{\kappa}{\left(\left((\varphi x) - T_{0_2}\right)^2 + \omega\right)} + \frac{\gamma}{(1 + e^{-\alpha(x-T_0)})}$$

Findings
Characteristic Points within the Integrated PLC Model



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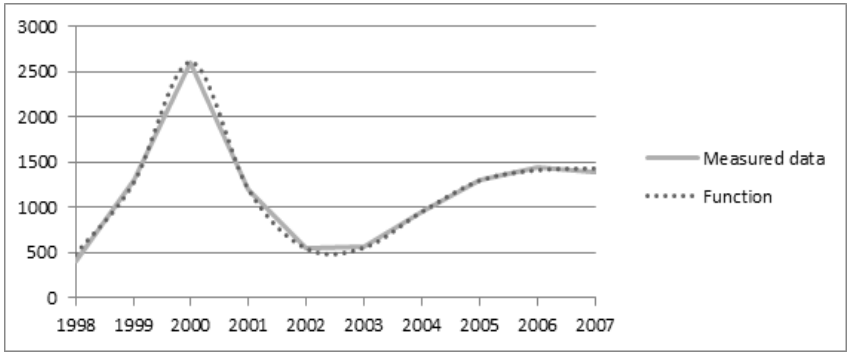
Findings
Verification Example - MP 3 Hype Cycle

Year	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007
# documents	300	1300	2600	1200	550	560	945	1300	1450	1400



Parameter	κ	φ	ω	α	T_0	T_{0_2}
Opt. Value	2852.5893	1.1190	1.0941	1.5207	5.7678	2.1970

- Examplary data set derived from Järvenpää and Mäkinen (2008)
  - # Articles mentioning MP3 in LexisNexis database
- Find optimal parameter value set:
  - Min $\sum_{i=1}^{10} |f(x_i) - V_i|^2$
  - $s.t.\quad f(x_i) = \frac{\kappa}{\left(\left((\varphi x_i) - T_{0_2}\right)^2 + \omega\right)} + \frac{\gamma}{\left(1 + e^{-\alpha(x_i - T_0)}\right)}$
- Sufficient parameter set for this application could be determined

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Findings
Application Case - Autonomous Cars

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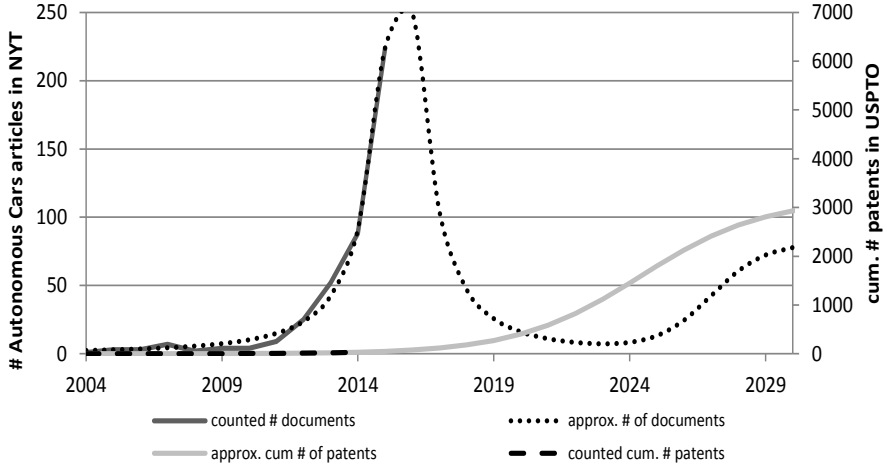

- According to Gartner, autonomous cars are in the ‚peak phase‘
- Data sets for representing the hype cycle and the TLC
  - Hype: #NYT articles on autonomous cars
  - TLC: # patents in USPTO database
- Future development can roughly be predicted:
  - Hype rises for another 1-2 years
  - TLC still at the early phase
- Indicators need to be tracked continuously

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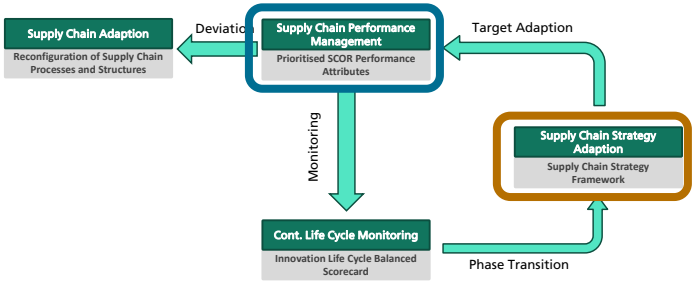
Next Step: Supply Chain Strategies and prioritisation of performance attributes



Hype Cycle Phases		Phase 1: Technology Trigger	Phase 2: Inflated Expectations	Phase 3: Trough of Disillusionmet	Phase 4: Slope of Enlightenment	Phase 5: Plateau of Productivity
Supply Chain Phases		Monitoring and Integration	Supply Chain Setup and Responsiveness	Consolidation and Adaptability	Scale-Up and Agility	Efficiency and Hybrid strategy
Supply Chain Characteristics	SCM Strategy	Monitoring and Awareness	Responsive Supply Chain	Adaptable Supply Chain	Agile Supply Chain	Hybrid, leagile Supply Chain
	SCM Tasks	Design Chain Integration, Risk identification	Resist the hype Highly reliable supplier base	Consolidation of supplier base, Cost-efficiency	Scale-up logistics and supplier capabilities	High-scale production Efficiency
Priority of SCOR Performance Metrics	Agility	High	High	Neutral	High	Neutral
	Responsive-ness	High	High	Neutral	Neutral	Neutral
	Reliability	High	Neutral	Neutral	High	Neutral
	Asset Efficiency	Low	Neutral	High	Low	High
	Cost	Low	Low	High	Low	High

Parlings/Klingebiel (2014)

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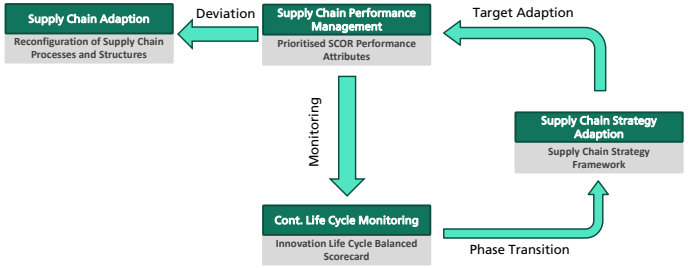
Conclusion and Outlook



Conclusion

- Mathemtical basis for setting up an early warning system
- First step for the operationalisation of an early warning system
- General applicability (proof of concept) could be shown

Outlook

- Integration into a decision support system
- Usage of better optimization algorithms and tools
- Empirical testing of the phase transition detection

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Thank you for your attention!

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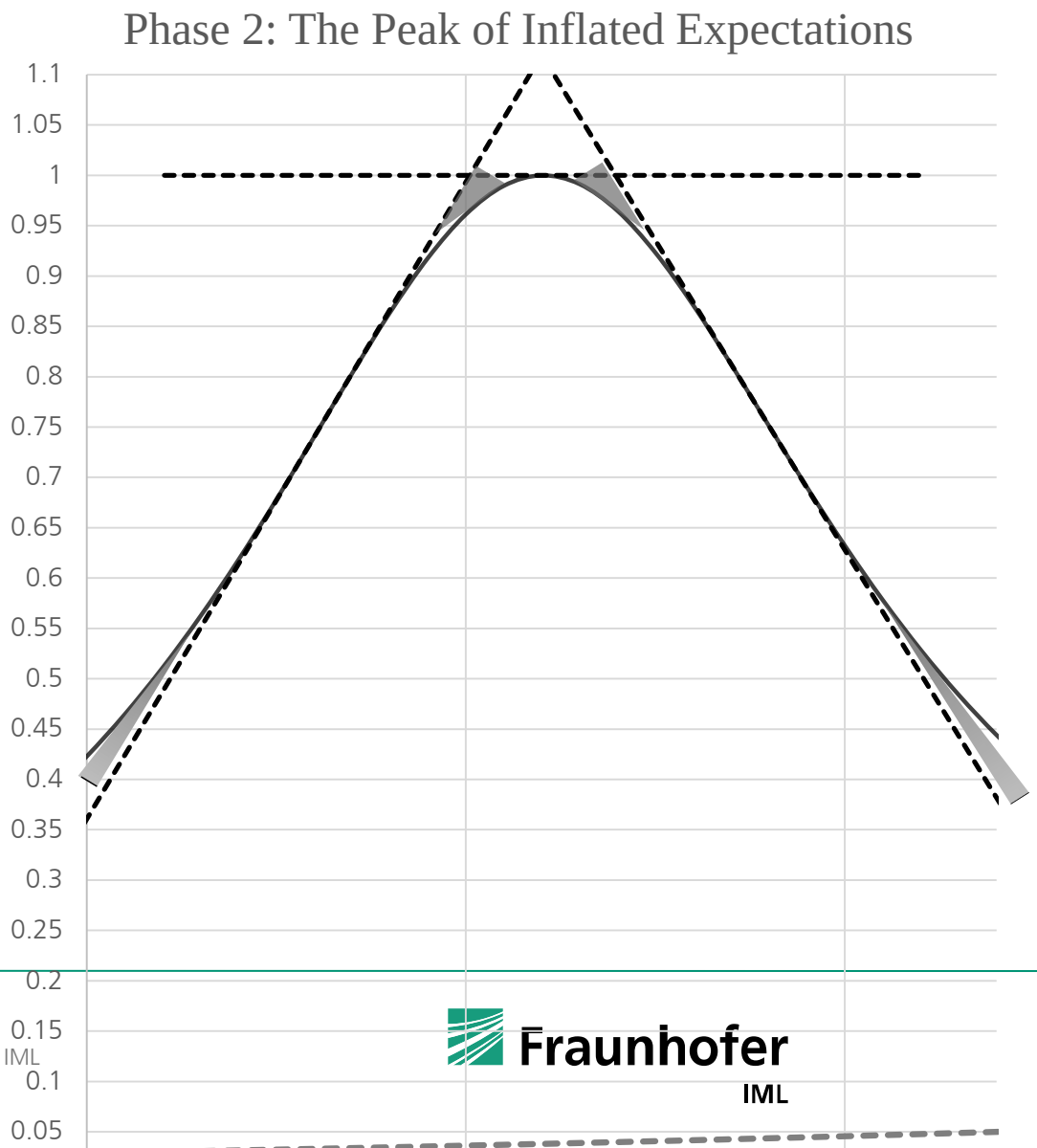
Early Warning Corridors



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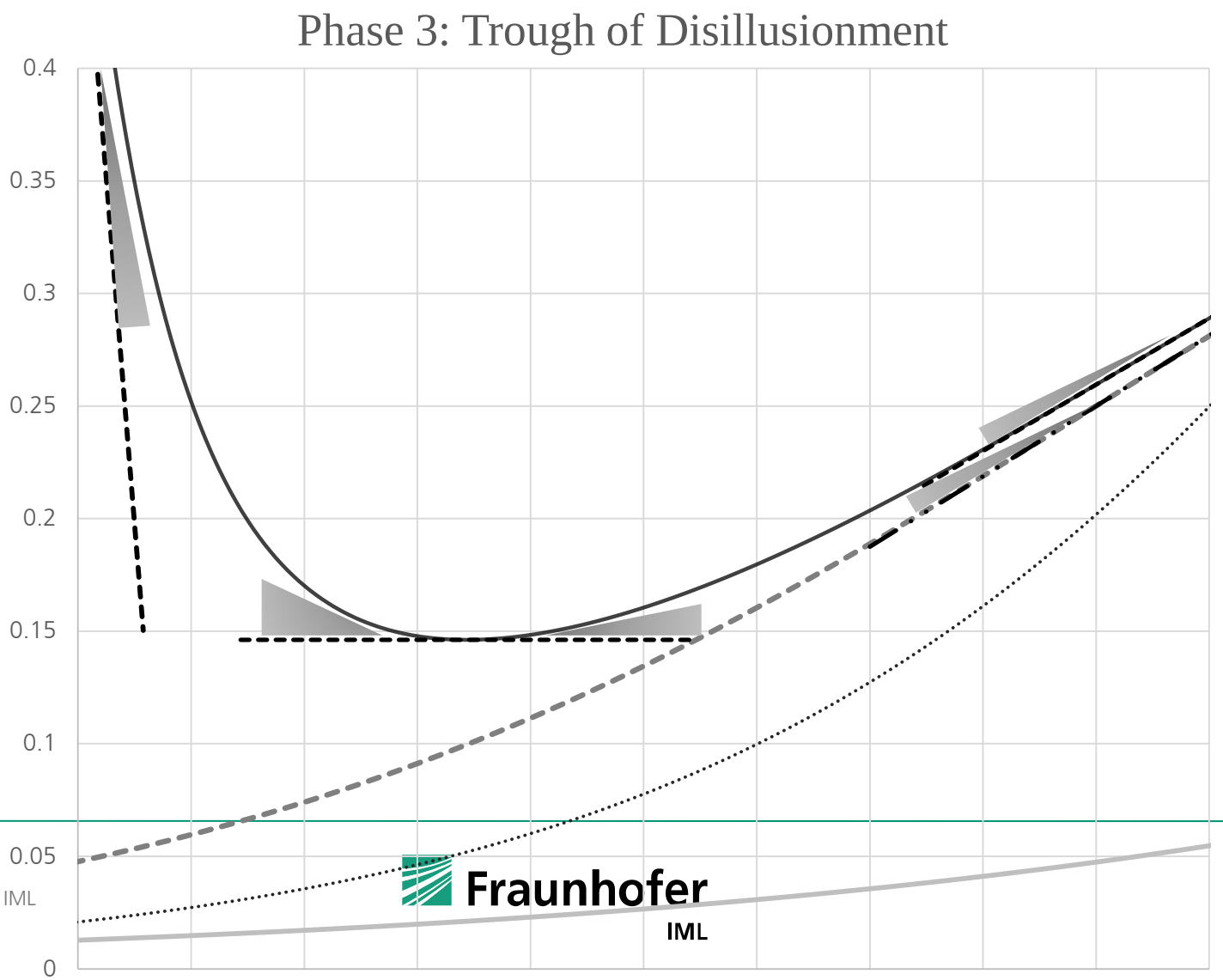
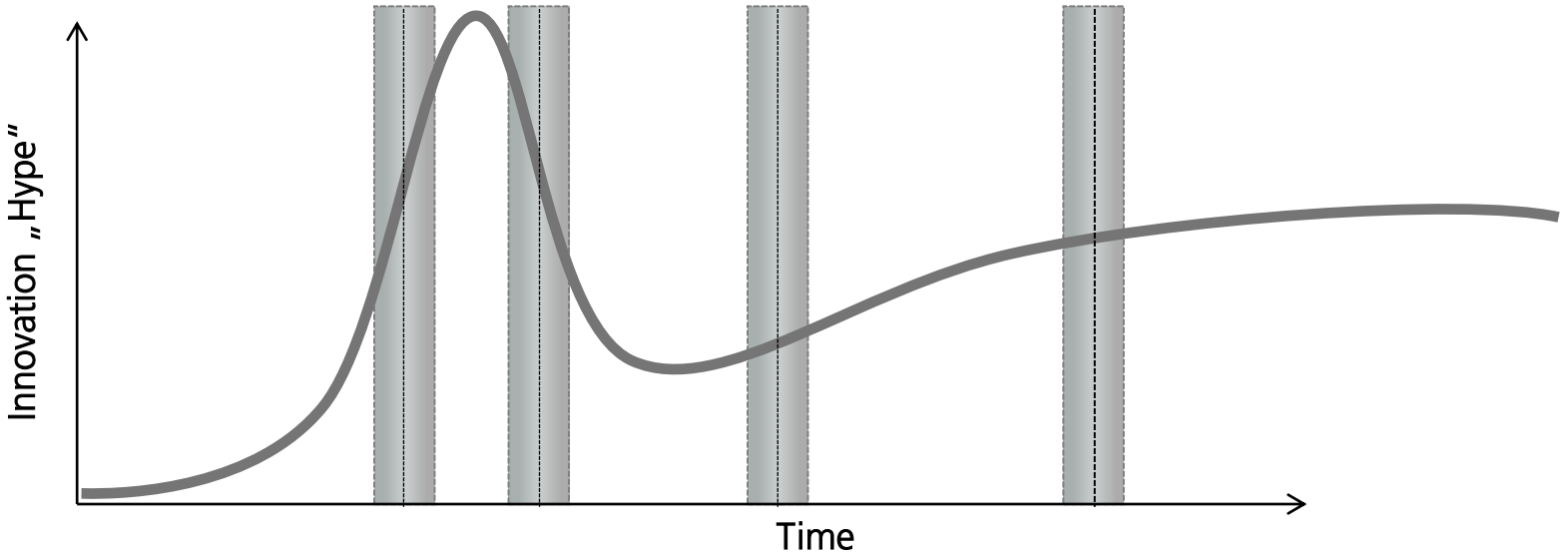
Early Warning Corridors





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