

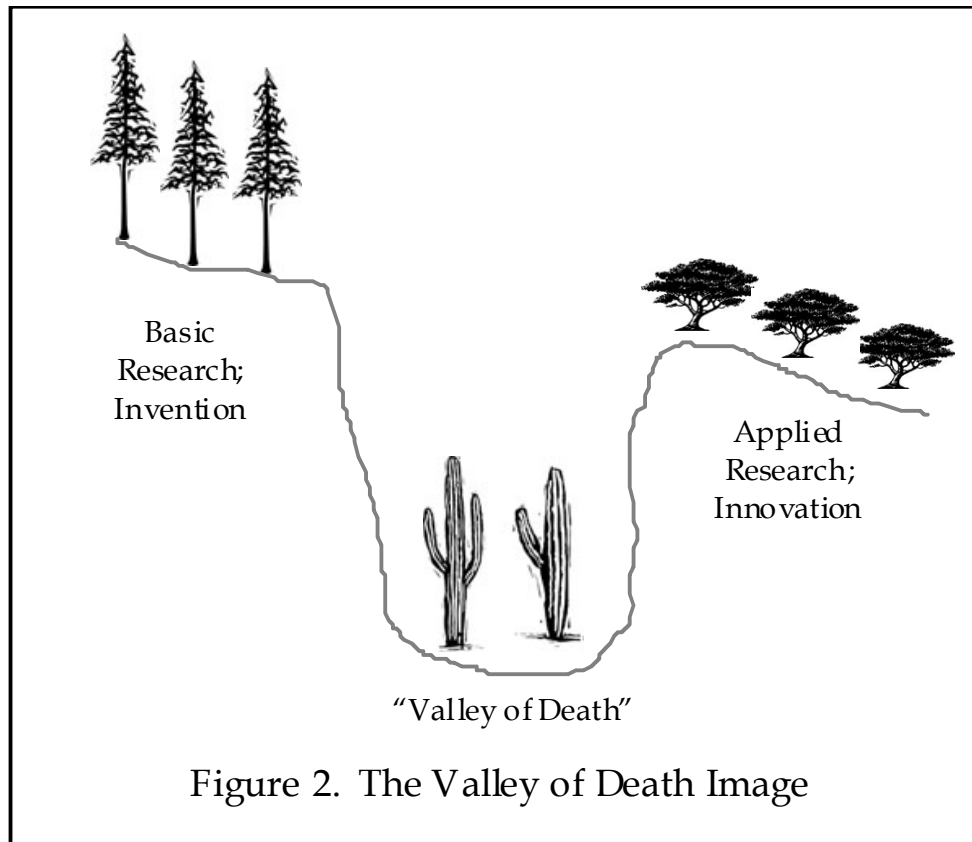
A Valley of Death in the Innovation Sequence: An Economic Investigation



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The Valley of Death



Policy Level
*Should the government be involved?
How do we get that involvement?*

Practical Level
*How do we solve the problem,
government or not?*

Academic Level
*Do we really understand the
problem: causes, consequences, and
solutions?*

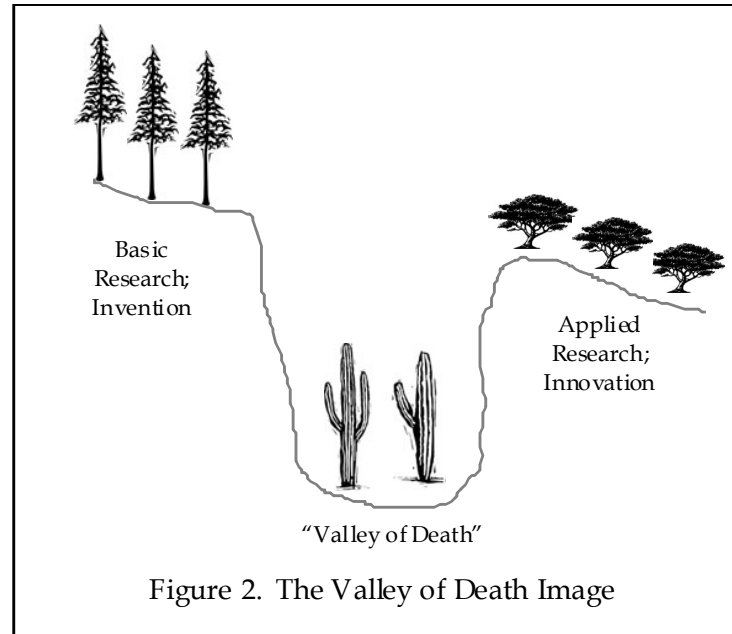
On the Agenda?



Obama will double federal science and research funding for clean energy projects including those that make use of our biomass, solar and wind resources. ... The gap between the lab and the marketplace is sometimes referred to as the ‘**Valley of Death**,’ because many technologies enter but few ever make it out the other side because of the prohibitive costs of building the first commercial-scale facility that processes that energy source. www.barackobama.com

... Senator Obama's campaign has focused on a great deal is the real question of how do we turn the crank on innovation and technology? ... [I]t's not that we haven't had good ideas in this country; it's that we've had good ideas that then get commercialized in other countries. There's this wonderfully romantic notion called the **Valley of Death**, where great technologies basically go and never come out the other side. Jason Grumet, environmental adviser for Barack Obama.

Simple Innovation Sequence



Stage 1.
basic
research
idea

Stage 2.
technical/
economic
feasibility

Stage 3.
commercial
production/
diffusion

Investments in the Innovation Sequence



$$V > \frac{I_1(1+r_1)}{P_1 P_2 P_3} + \frac{I_2(1+r_2)}{P_2 P_3} + \frac{I_3(1+r_3)}{P_3}$$

$$SV > \frac{I(1+r)}{\lambda P}$$

The expected private value of the project, V , exceeds its direct costs, $I(1+r)$, adjusted for the probability of success, P .

No stage, including the intermediate stage, can be evaluated in isolation.

Investments in the Innovation Sequence



$$V > \frac{I_1(1+r_1)}{P_1P_2P_3} + \frac{I_2(1+r_2)}{P_2P_3} + \frac{I_3(1+r_3)}{P_3}$$

Assumption: Investments in research are made with the hope of creating profit.

In this sensible setting, there can be no Valley of Death ...
... absent some non-economic actor at Stage 1.

Simulation to Demonstrate



- 1,000 potential projects
- Choose values for V , I , and P
- Choose values for λ
 - Private Value = $\lambda(\text{Social Value})$
 - Appropriability problem
- $I_3 > I_2 > I_1$
- $P_3 > P_2 > P_1$

All values drawn from χ^2 distribution, then scaled as needed.

Simulation: Projects Funded



	Funded Projects			
	Stage 1	Stage 2	Stage 3	Innovations
Social Welfare Max	834	164	72	53
Profit Max	342	81	38	27
Profit Max, Risk Premium Rise	327	78	36	25
Profit Max, Non-Economic Activity	834	118	52	38

Shocks:

1. Risk Premium rise in Stage 2, funded projects decline.
2. Non-Economic Agent at Stage 1, funded projects rise.

Simulation: Valley of Death



	Probability of Funding for Socially-beneficial Project		
	Stage 1	Stage 2	Stage 3
Social Welfare Max	100%	100%	100%
Profit Max	41%	100%	100%
Profit Max, Risk Premium Rise	39%	100%	100%
Profit Max, Non-Economic Activity	100%	72%	100%

VoD

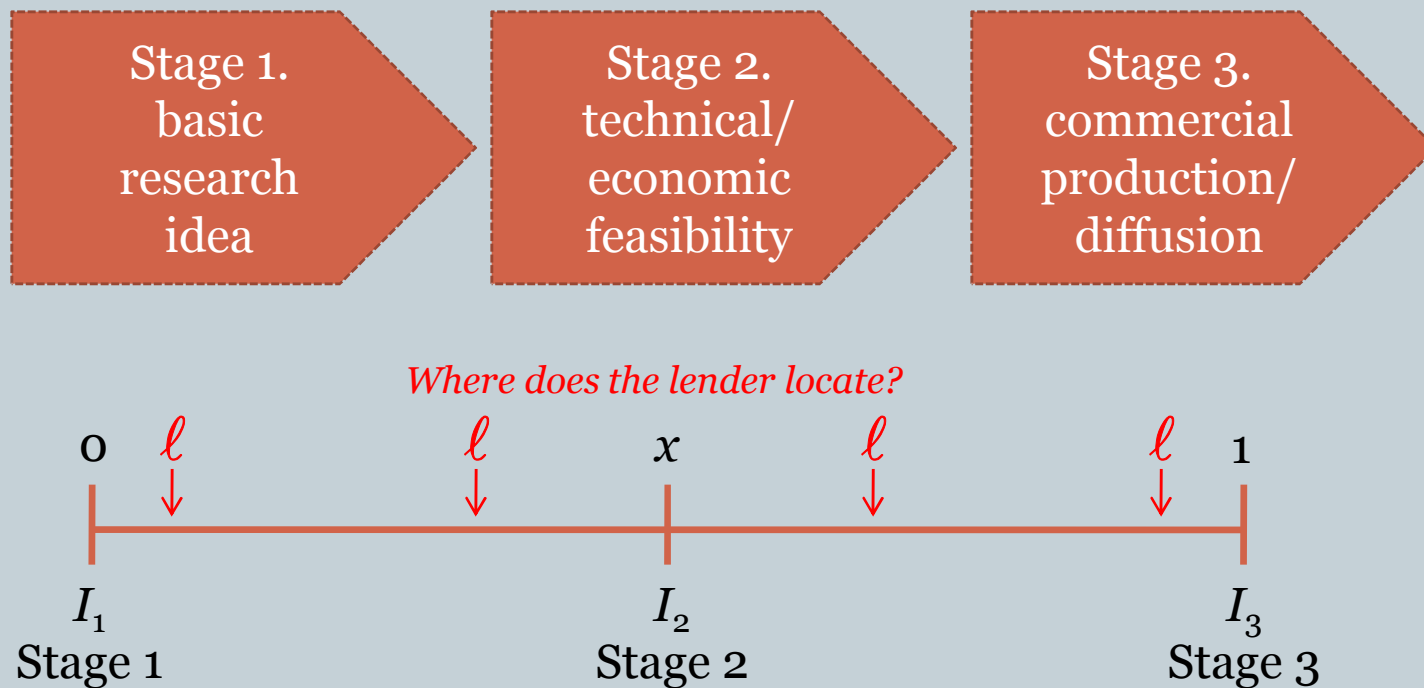
Shocks:

1. Risk Premium rise in Stage 2, projects decline but no VoD.
2. Non-Economic Agent at Stage 1, funded projects rise and VoD.

Non-Economic Funding and Lender Location



- Could non-economic actor at Stage 1 cause more problems at Stage 2?



Simple Location Model



- Average or Typical Project
- Investor chooses to locate at some single point along the innovation sequence $[0, 1]$
- Investor seeks to minimize the cost of funding the project
- Competitive financing industry
- Sunk costs to financing relationship and location choice (due diligence)
- Activities at each stage have characteristics $\theta \sim (0, \sigma^2)$
- Only observe signal $s = \theta + d\varepsilon$, where $\varepsilon \sim (0, \sigma_\varepsilon^2)$ and d is 'distance' from the 'stage project'
- The (non-linear) premium on funds is $k(d^2/2)$, where $k > 0$.

Simple Location Model



$$C = k \left[\frac{\ell^2}{2} I_1 + P_1 \frac{(x - \ell)^2}{2} I_2 + P_1 P_2 \frac{(1 - \ell)^2}{2} I_3 \right]$$

$$\ell^* = \frac{xP_1I_2 + P_1P_2I_3}{I_1 + P_1I_2 + P_1P_2I_3}$$

Size Matters. The bigger is I_3 relative to the others, the greater the pull to Stage 3.

Simple Location Model: Effect of Non-Economic Actor



No Non-Economic Actor

$$\ell^* = \frac{xP_1I_2 + P_1P_2I_3}{I_1 + P_1I_2 + P_1P_2I_3}$$

Non-Economic Actor
funds all Stage 1 projects

$$\ell^* = \frac{xI_2 + P_2I_3}{I_2 + P_2I_3}$$

Stronger
pull to
Stage 3.

Why is this important?



- The Valley of Death is not the consequence of the standard explanations for investment in R&D.
 - Non-economic activity is required at Stage 1.
 - The “profit motive” is not ready for the handoff from the “social motive.”
- The Valley of Death is not a unique problem (in some respects)
 - We need public investment in Stage 2 for the same reasons we invest in Stage 1.
 - The Valley is caused by intense investment at Stage 1.
 - Re-allocation of public funds can shrink the Valley.

Next Step



What is the economically-optimal allocation of a fixed sum of public dollars across the stages of the innovation sequence?

Policy Effort and Implementation



Allocation of federal money to “applied” research.

How much?

What organization manages the funds?

How is success/failure measured?

Research Program for the Valley

