

**Entrepreneurship Returns to the Auto Industry:  
Electric Vehicle Charging as a case study**

**Professor Charles Fine**

**MIT Sloan School of Management**

**MIT Mobility Initiative**

**May 2023**

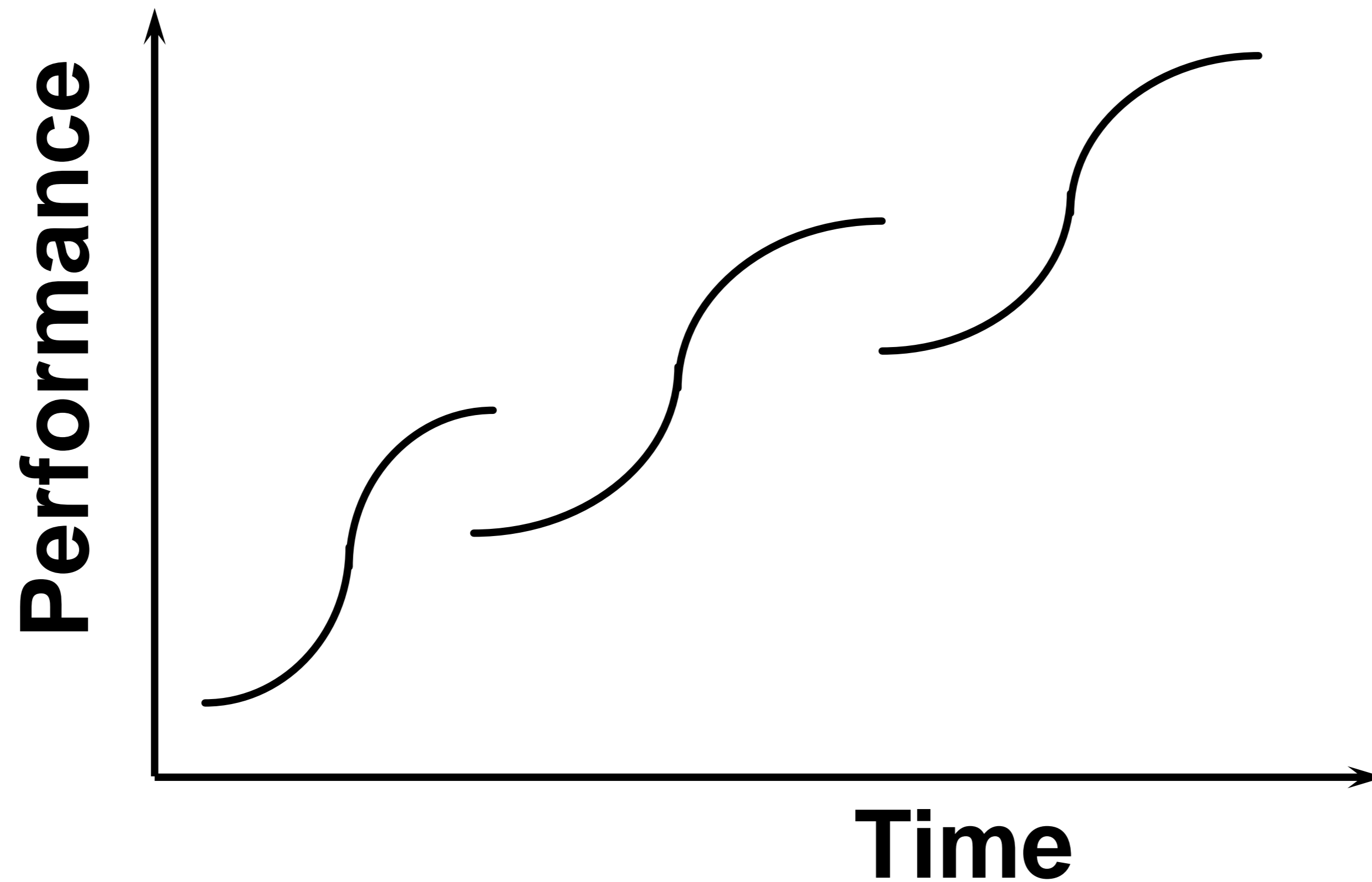
[charley@mit.edu](mailto:charley@mit.edu)

**"All models are wrong,  
but some are useful".  
--George Box**

1.Box, George E. P. (1976), ["Science and statistics"\(PDF\), \*Journal of the American Statistical Association\*, 71\(356\): 791–799, doi:10.1080/01621459.1976.10480949.](#)



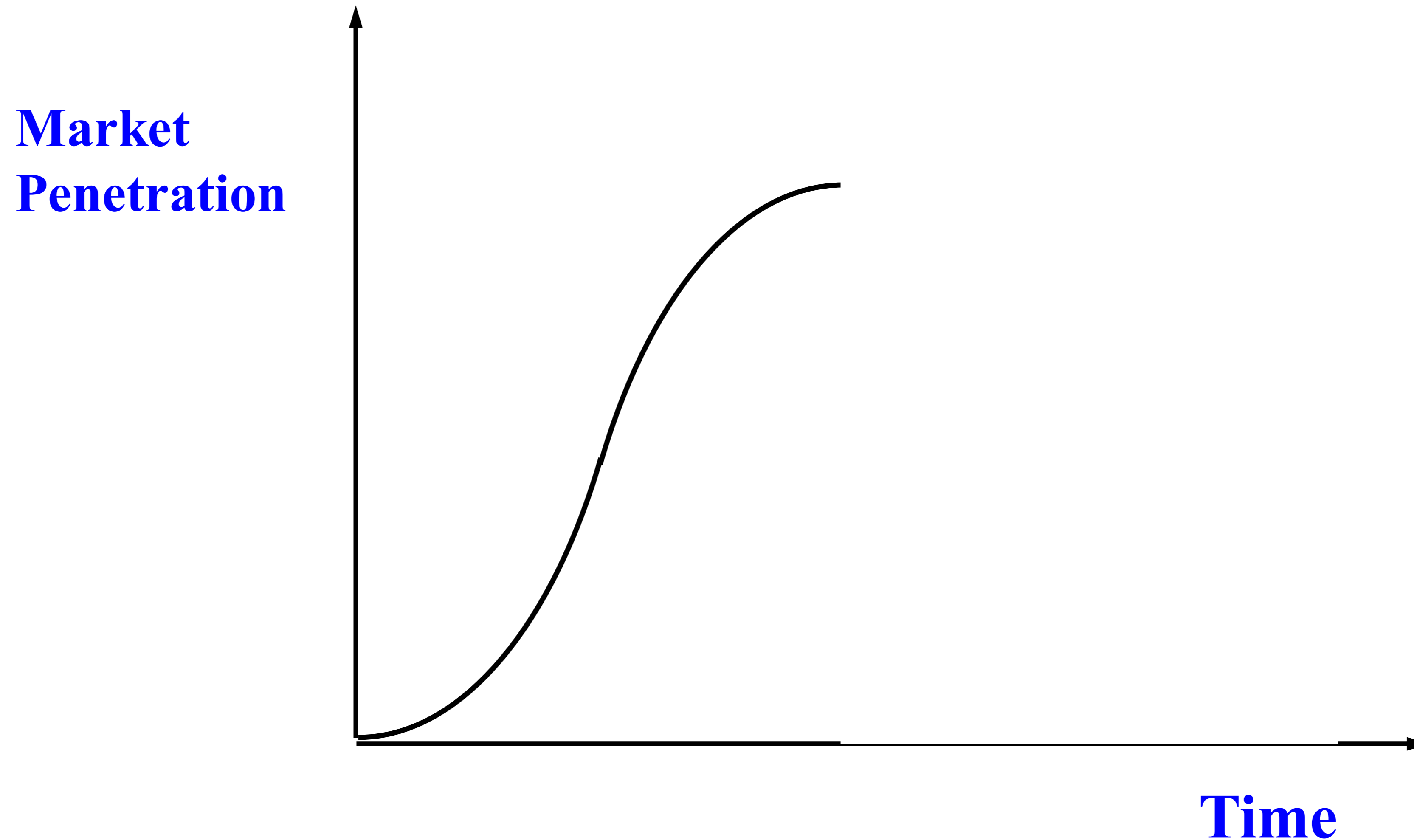
# Innovation “S” curve: Social, Economic, and Technical change does not occur “smoothly”



**“Working The S-Curve: Assessing Technological Threats,” Richard N. Foster,  
*Research Management* Volume 29, 1986 - Issue 4**

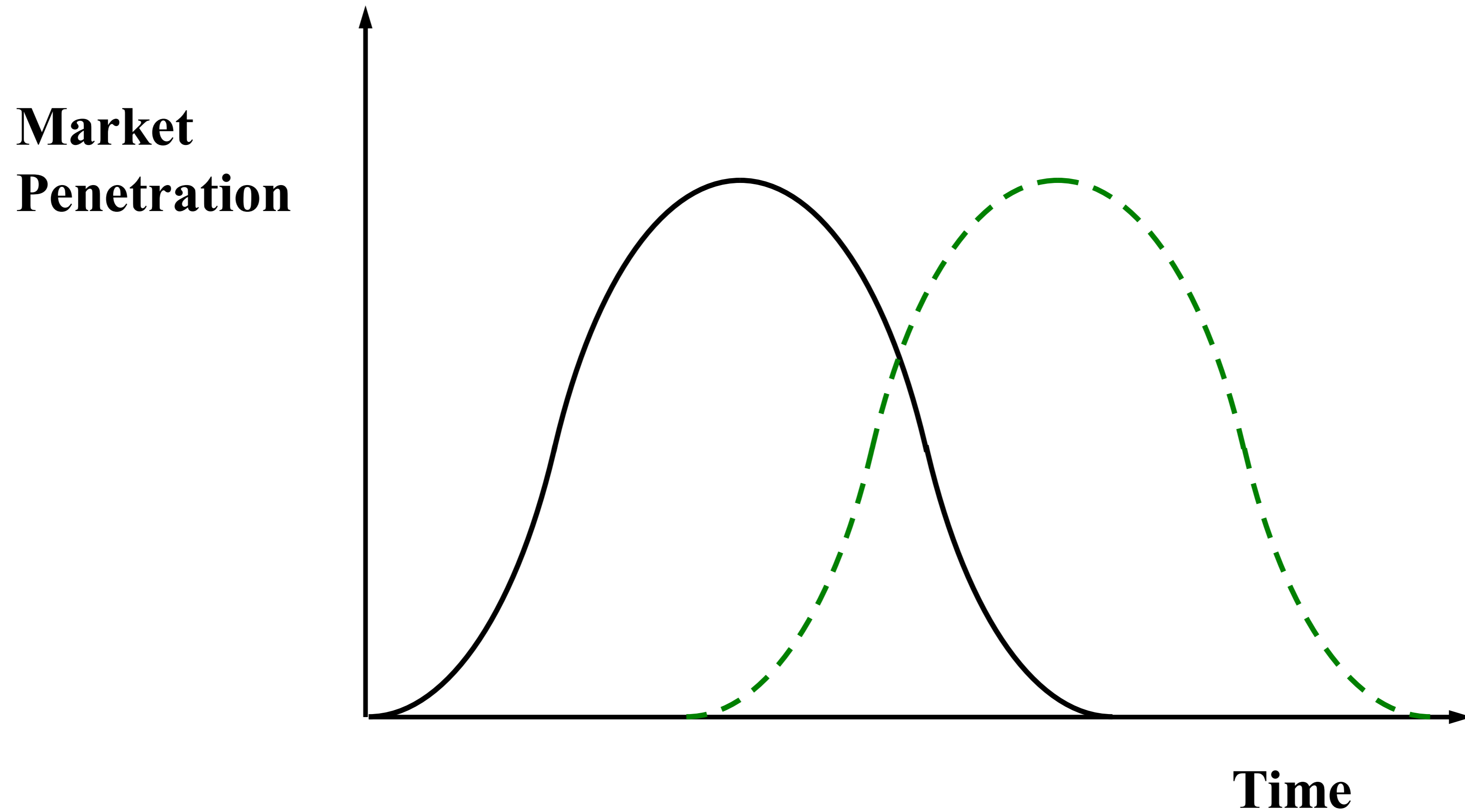
**“A dynamic model of process and product innovation,” J. Utterback & W. Abernathy, *Omega*,  
Volume 3, Issue 6, December 1975, Pages 639-656**

# The Adoption S-curve (Bass Diffusion Model)



**Bass, Frank (1969). "A new product growth model for consumer durables".  
*Management Science* 15 (5): p215–227. doi:10.1287/mnsc.15.5.215.**

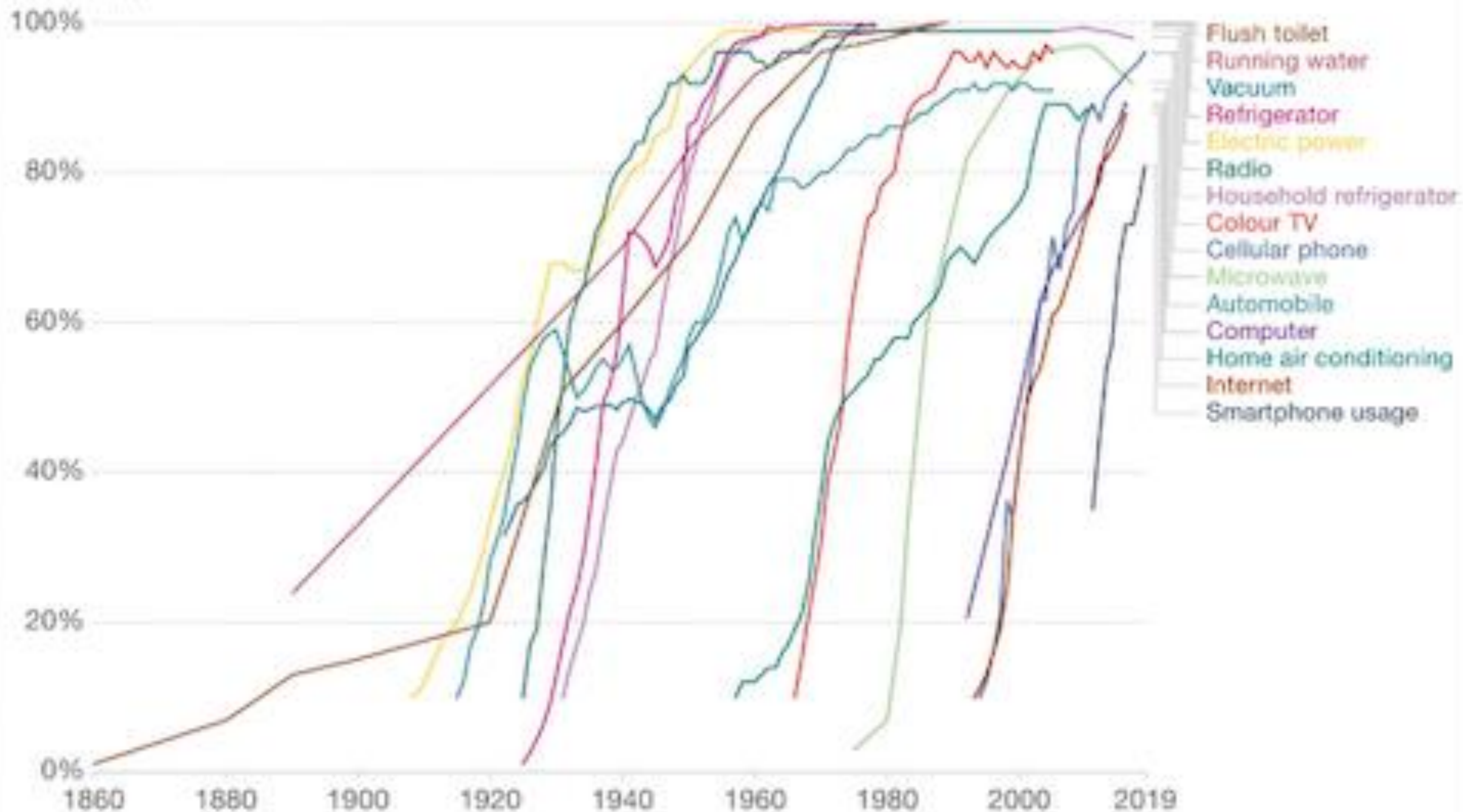
# The Adoption S-curve and The Product Life Cycle





# Technology adoption in US households, 1860 to 2019

Technology adoption rates, measured as the percentage of households in the United States using a particular technology.



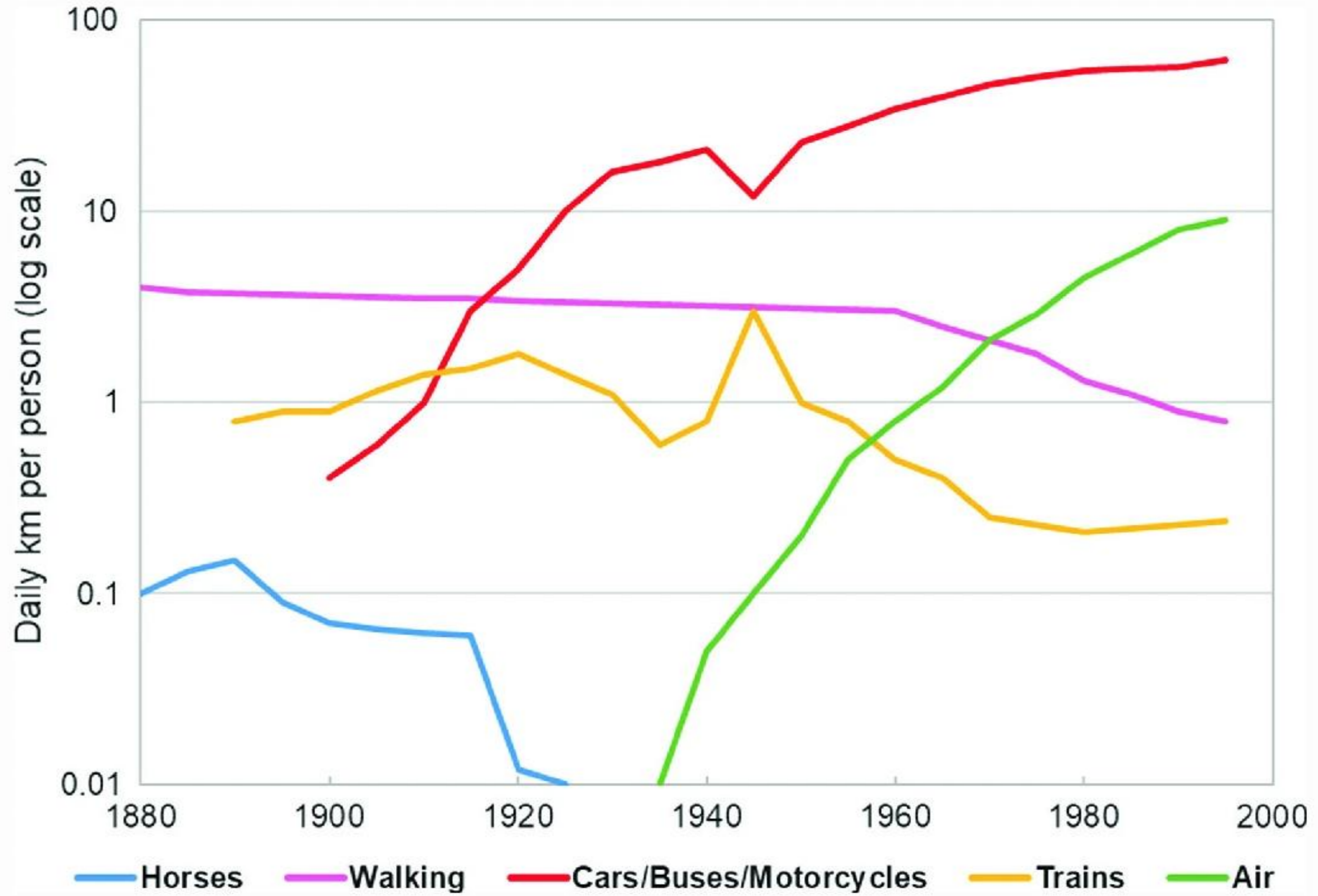
Source: Comin and Hobijn (2004) and others

OurWorldInData.org/technology-adoption/ • CC BY

Note: See the sources tab for definitions of household adoption, or adoption rates, by technology type.



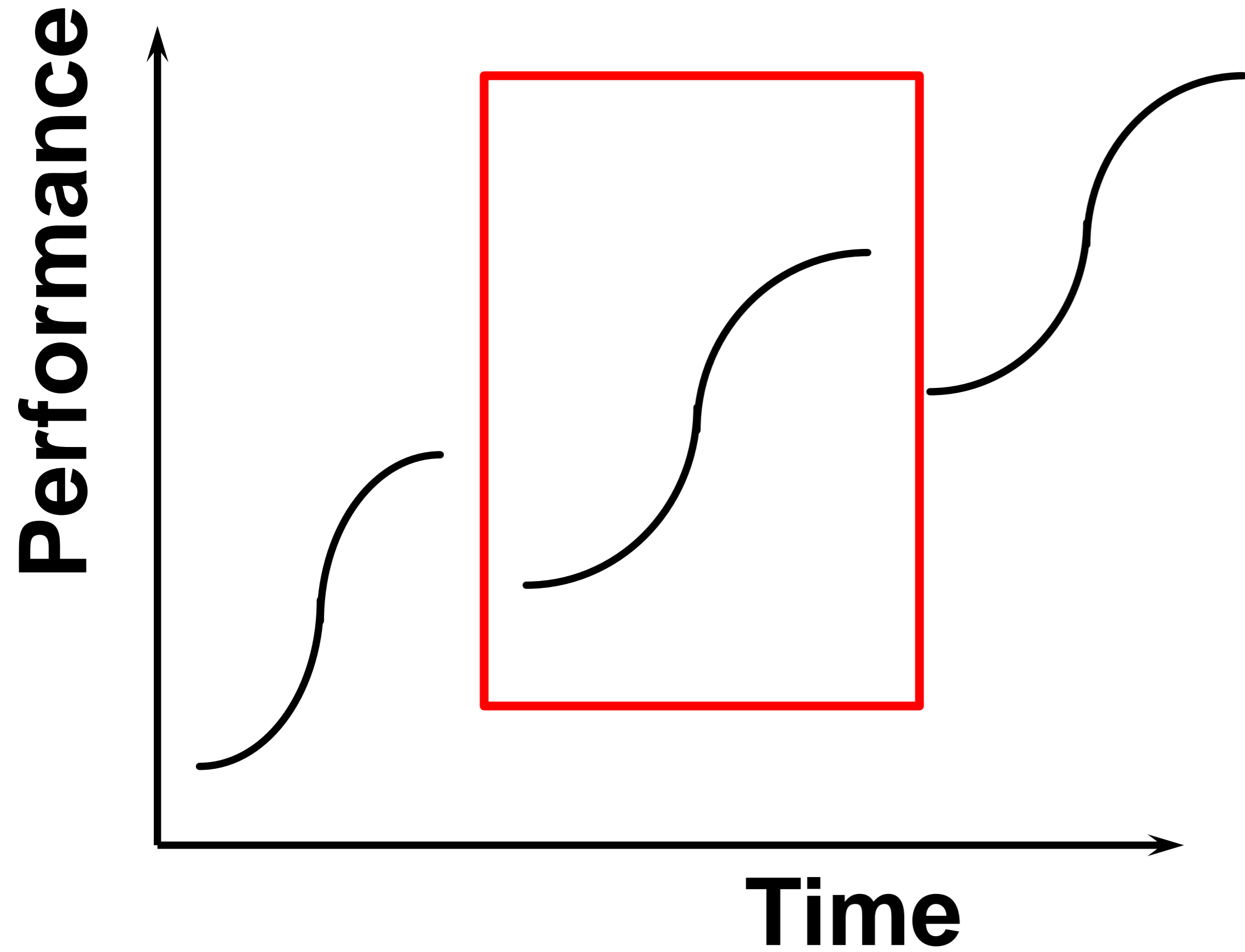
From: [The Evolution of Transport Across World Regions](#)



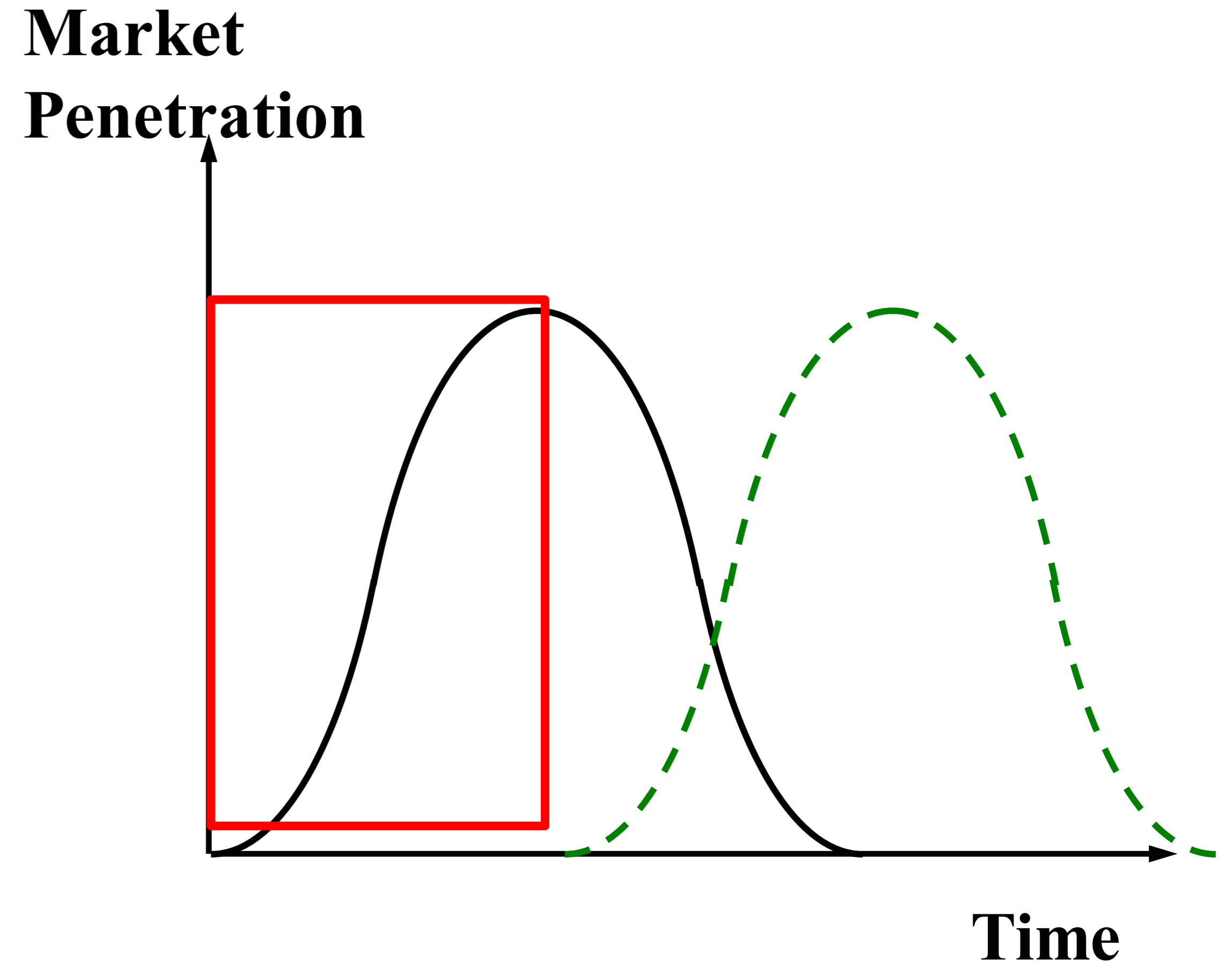
Authors' elaboration from Ausubel, Marchetti, and Meyer (1998)

US travel per capita per day by all modes.

# The Innovation S-curve

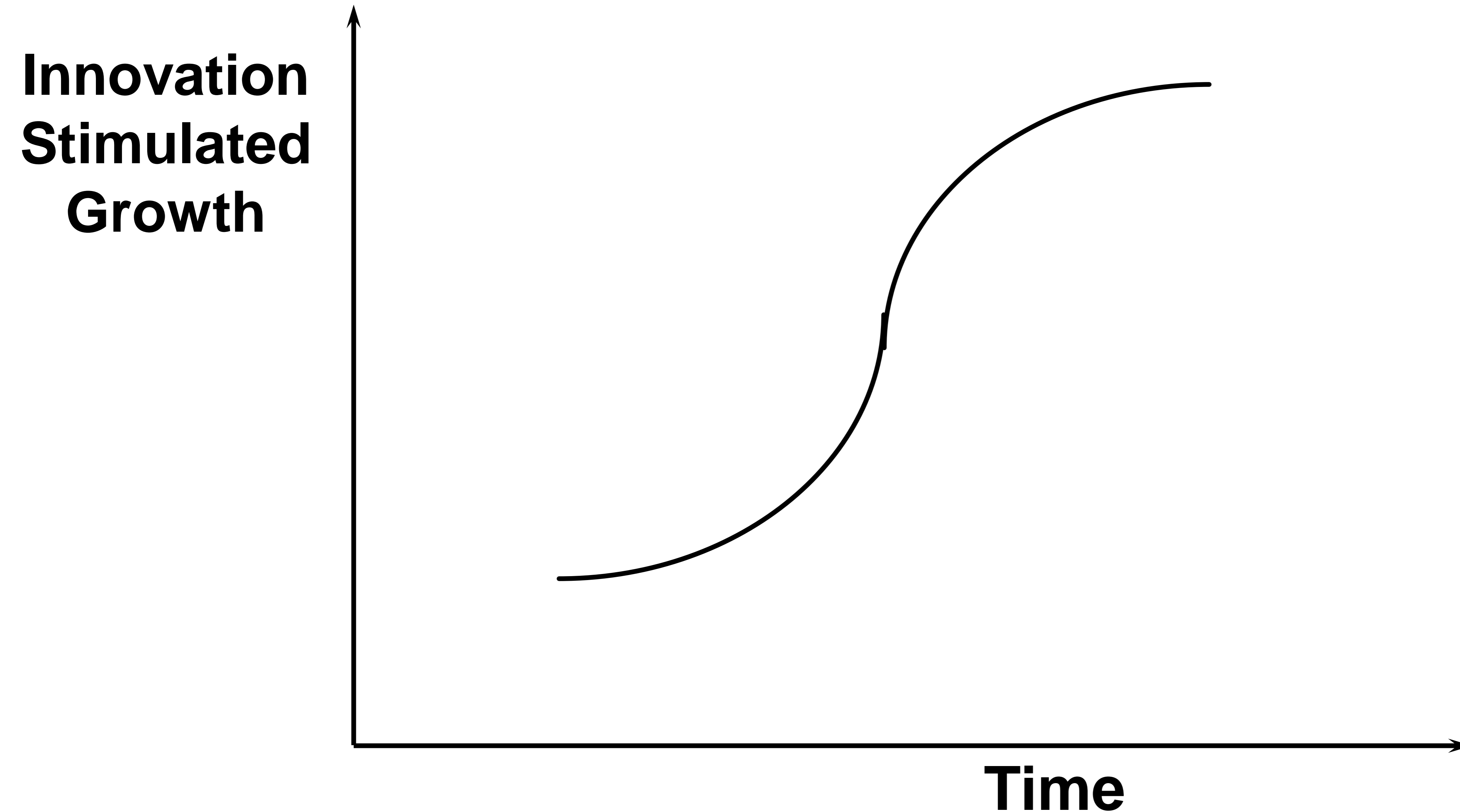


# The Adoption S-curve

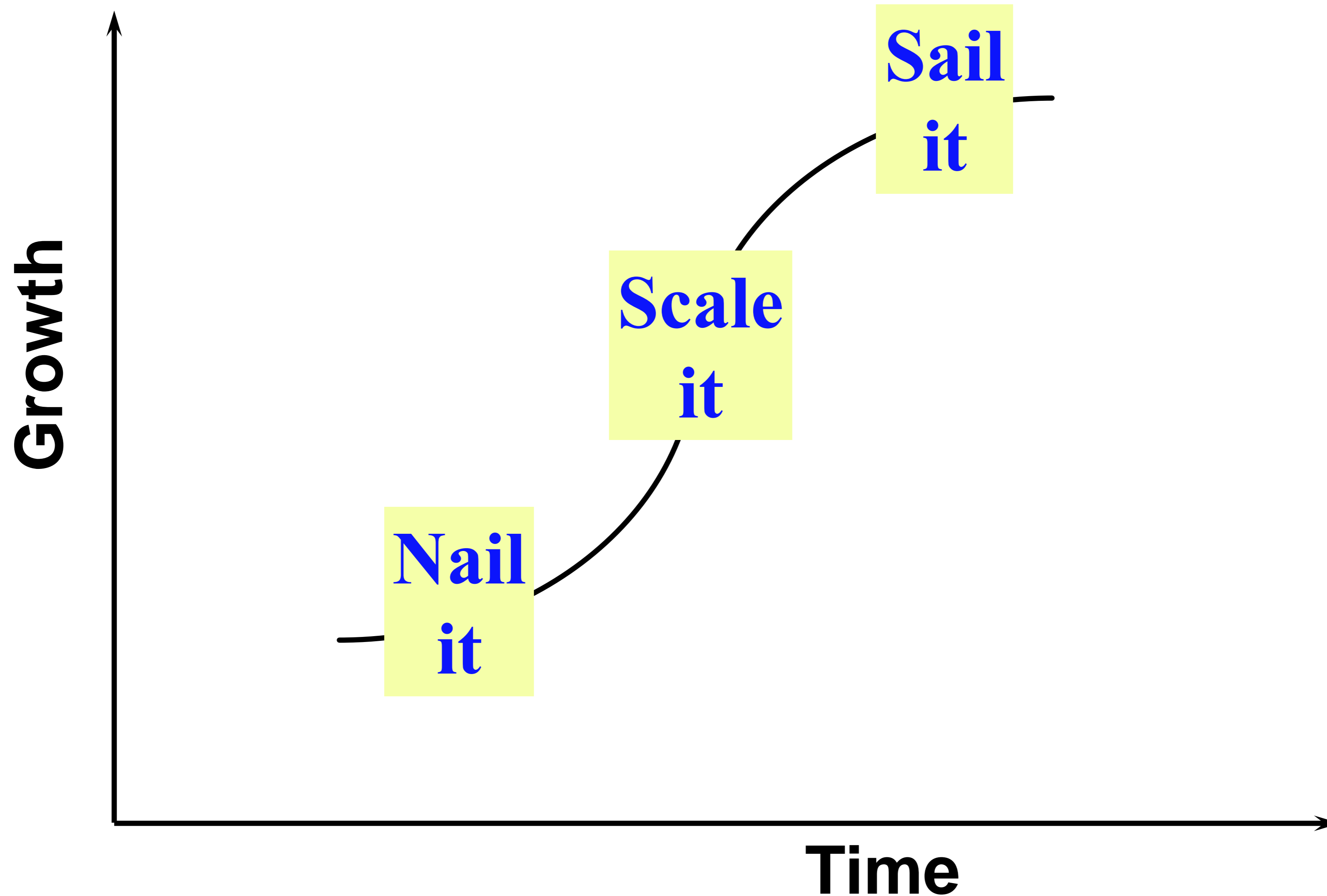




# Innovation Life Cycle: Market Penetration and Performance growth



# Processes and Organizations may look very different over the innovation life cycle



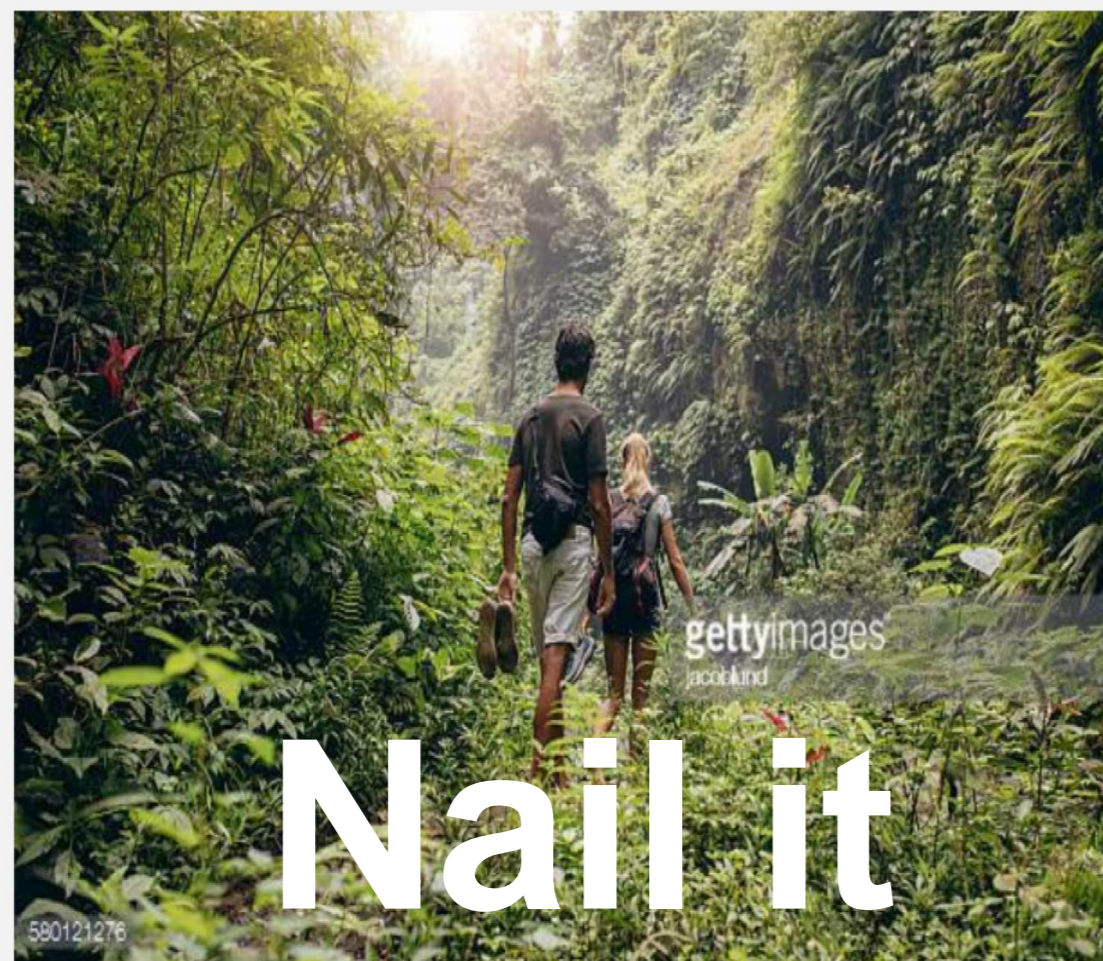


# Nailing, Scaling, Sailing

## An entrepreneurial journey through Jungles, Mountains, Oceans\*

### Jungles

"Carry as little as possible, but choose that little with care!" *E.Shaffer*



### Mountains

"It's time to climb that goddamn mountain!"  
*Jack Kerouac*



### Oceans

"Anyone can hold the helm when the sea is calm."  
*Syrus Publilius*



\*Fine, Padurean & Naumov, "Operations for Entrepreneurs: Can OM make a difference in Entrepreneurial Theory and Practice?" *Production & Operations Management*, 31(12), 4599-4615, 2022.



# Different personalities may be better suited to different stages of the innovation life cycle



ORGANIZER



STABILIZER



# HOW DO YOU NAIL IT?

- **Nail it** = Establish a *validated value proposition* that works simultaneously for all the members in your value chain (customers, employees, suppliers, distributors, investors, etc.)



A woman with blonde hair in a ponytail, wearing a dark sleeveless top and a black armband, is seen from behind. She is holding a large machete in her right hand. The background is a dark, dense jungle with large green leaves. In the distance, a pair of red eyes is visible in the darkness.

Welcome to the jungle!  
WHAT TOOLS DO YOU NEED TO NAIL IT?

Carry as little as possible,  
but Choose that little with care!



# How do you nail it?

## Environment

- Ambiguous
- Uncertain
- Risk prone
- Iteration
- Uncertainty tolerance
- Rapid problem-solving
- Flat structure
- Intense communication
- Trust
- Problem ownership

## Requirements

- Speed & Agility
- Frugality
- Iteration
- Uncertainty tolerance
- Rapid problem-solving
- Willingness to pivot

## People

- Entrepreneurial
  - Risk tolerant
  - Resourceful
  - Generalists
- Solutions Hackers
  - Optimistic
  - Mission driven
- Flexible, prepare to pivot
- “Rule-breakers”

**How do you scale it?**

**Scale it = Grow *in parallel*  
your market size and  
your production and  
delivery capability.**



# Scaling it



*“The very behavior that makes you successful to get a startup from **zero to \$10 million** in revenue is very likely the same that will make you **unsuccessful** when the company gets to be **\$50 million or \$100 million.**”*

***Prof. Bill Aulet, MIT Sloan***

# How do you scale it?

## Environment

- Greater certainty
- Build an Organization
- Build processes
- Build hierarchy
- Committees

## Requirements

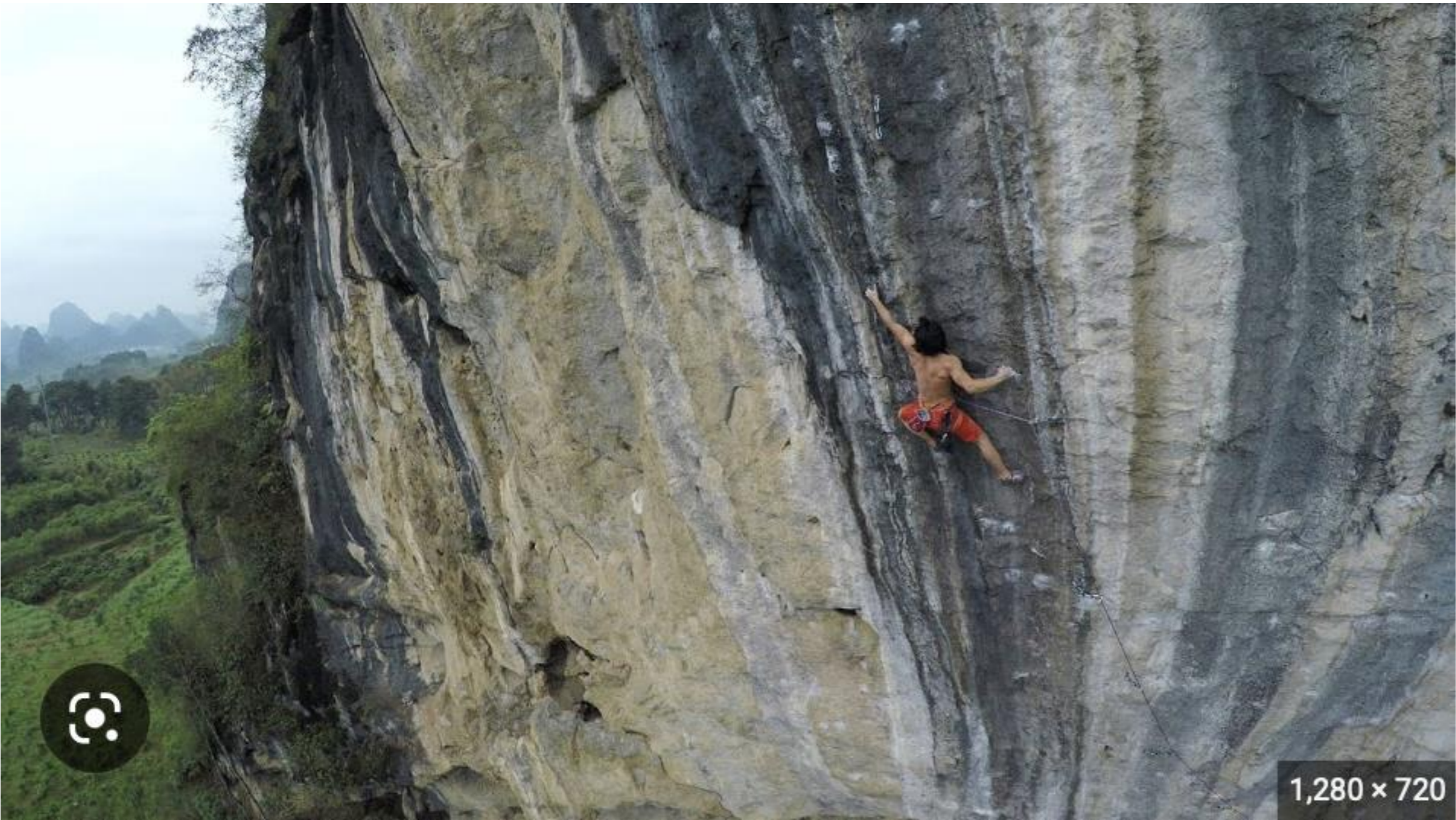
- Marshall Resources
- Professionalization
- Automation
- Process Control
- Reproducibility
- Cultural consistency
- Raise more capital

## People

- Team players
- Systematic
- Specialization
- Group decisions
- Growth driven
- Collective problem solving



# Scaling without Tools: “Naked Scaling”



# Scaling with Tools





# An inveterate nailer: "I don't believe in process."



**Pictured above:  
Entrepreneur who slept in his  
factories for three years**

<https://www.inc.com/larry-kim/50-innovation-amp;-success-quotes-from-spacex-founder-elon-musk.html>



# *Structure “will prevent your company from descending into chaos”*

When you scale an organization, you will need to give ground grudgingly. Specialization, organizational structure, and process all complicate things quite a bit, and implementing them will feel like you are moving away from common knowledge and quality communication. It is very much like the offensive lineman taking a step backwards to protect the quarterback. You will lose ground, but you will prevent your company from descending into chaos.



- Entrepreneur/Investor:  
**Ben Horowitz**
- (CEO & Co-founder,  
**Andreessen Horowitz)**

*Ben Horowitz, "Taking the Mystery Out of Scaling a Company," Ben's Blog, August 2, 2010, <http://bhorowitz.com/2010/08/02/taking-the-mystery-out-of-scaling-a-company/>.*







- **Scale it** = Grow *in parallel* your market size and your production and delivery capability.
- Processification: enables reproducibility, delegation, simplicity, efficiency, but risks **rigidity, misalignment**
- Professionalization: expands skill set and allows task and process focus, but risks **rigidity, misalignment**
- Automation: enables leveraged scale, but requires **balancing freezing processes vs. fluidity and flexibility**
- Platformization: enables leveraged scale for *multi-sided businesses*, but requires **balancing constituent interests**
- Segmentation: enables customer focus and scale, but **increases complexity**
- Acculturation: build cohesiveness and collective purpose, but **hard to get it just right** (*When no one is watching ...*)
- Capitalization: enables growth, capability development, but adds **pressure for financial performance, more overhead and oversight**
- Collaboration: expands capabilities, but adds **managerial complexity**
- Replication: enables growth, reproducibility, but requires **standardization and discipline**
- Evaluation: measures progress, but potentially **reduces innovation**

As the electric vehicle (EV) market continues to heat up, automakers are going all in on electrification. Vehicle manufacturers and battery makers **plan to invest \$860 billion globally by 2030** in the transition to EVs.

Jan 12, 2023 <https://www.atlasevhub.com> › data\_story › 210-billion-o...

**Ford** has been investing in hybrid and electric vehicles, including the Mustang Mach-E and an all-electric F-150 pickup truck, and announced last year that it would boost electric vehicle spending to **\$50 billion through 2026**.

Mar 23, 2023 <https://www.washingtonpost.com> › 2023/03/23 › ford...

The total spending is part of **GM's** previously announced **\$35 billion in EV-related spending**, happening between roughly 2021 and 2025. That total spend should yield about 30 new EV models by 2025. GM stock might not be getting a boost from the announcement since it's part of that larger plan.

Jan 26, 2022 <https://www.barrons.com> › articles › gm-ford-spending-s...

**Toyota's new \$35 billion investment**, announced in December 2021, includes a plan to introduce 30 electric models by 2030. That is just under a quarter of the more than 130 models it currently makes.

Jan 17, 2023 <https://www.cnbc.com> › 2023/01/17 › why-toyota-is-batt...



**Los Angeles Times, April 23, 2023**

**Commentary: I'm ready to trade in my electric car. Here's why**

**(Josh Edelson / For the Times)**

**I love my electric car. I really do.**

**I love how I never have to buy gas.**

**I love how it glides quietly up the street.**

**I love that it has so much pickup that I can easily blow past gas-powered muscle cars if I want to.**

**I love having stickers that allow me to drive solo in the HOV lanes.**

**I love that routine maintenance consists of little more than rotating the tires.**

- But after three years, I am thinking seriously of trading it in for the gas-powered hybrid plug-in version.**
- Why? Because as much as I love my car, I loathe that I can't travel around California, a state that has led the electric car revolution, with confidence that I can get a charge when I need one.**

Los Angeles Times, April 23, 2023

Yes, there are significantly more public charging stations than when I first got behind the wheel of my Kia Niro EV in January 2020. *But there are also significantly more electric vehicles vying to use them — and still vast areas of the state without a single fast charger.*

Chargers are more reliable now, but still not quite good enough.

In 2020, it felt like half the public chargers I tried to use weren't working.

These days, I find only about a quarter are out. This jibes with the [experience of researchers](#) who checked *public fast chargers at 181 charging stations in the Bay Area last year and found that about 23% weren't functional.*

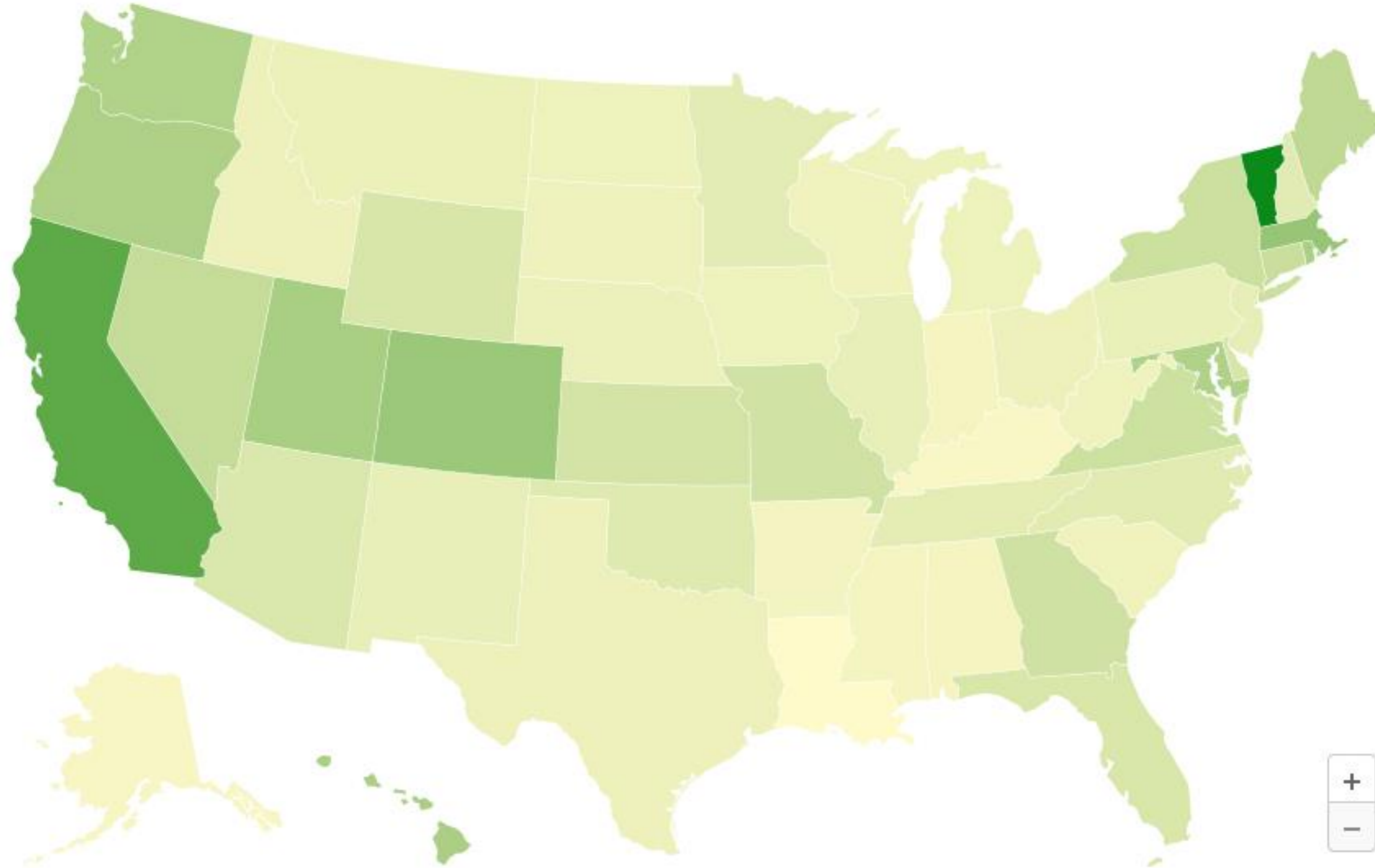


- Even with more chargers, ***they still aren't easy to find***. I have an [app that helps](#), but it only gives me a general location. Public charging stations are often tucked away in remote corners of parking lots or behind buildings with no helpful signage. They may be accessible only during business hours or, if in a hotel, only for paying guests to use.
- ***It's not uncommon to locate a charging station and discover that all the chargers are in use or blocked by cars not charging. Or, most frustratingly, the chargers may be offline or nonfunctional — which you may not discover until you park, plug in and try to start the charger. And even if the stars align and you find an available charger that works, it may shut off mid-charge with no warning or reason.***
- ***When I chose an electrical vehicle, I knew that meant an extra 30 minutes in travel time for each charging stop during a road trip. But I did not count on the time wasted by having to, for example, backtrack to another station or one out of my way because the charging station on my route was not working.***
- ***I did not count on having to wait 60 minutes to charge because the fast charger is not charging very fast today. Or having to spend the wait time baking in the sun because the charging station on the side of a hot freeway has no shade. Honestly, who thought that was a good idea? I didn't count on having to download a half-dozen apps because each charger company has its own.***
- I could fill up a book recounting the many frustrating and absurd experiences I have had charging my car over the last three years and three months — ***and I haven't even hit 23,000 miles on the car yet.***

## Alternative Fueling Station Density Across the U.S.

EV Chargers Per  
100,000 Residents

8.3 139.7



Ranking based upon EV charger density per capita; a rank of 1 is the best, most-dense.

Source: [CoPilot](#) • [Download image](#) • Created with [Datawrapper](#)



**The EV charging network buildout requires collaboration amongst players at different stages of organizational and business model maturity.**

