Challenges in **Energy Innovation and Public Policy**

Prof. Gregory Nemet

January 2016

Robert M. La Follette
School of Public Affairs
UNIVERSITY OF WISCONSIN–MADISON

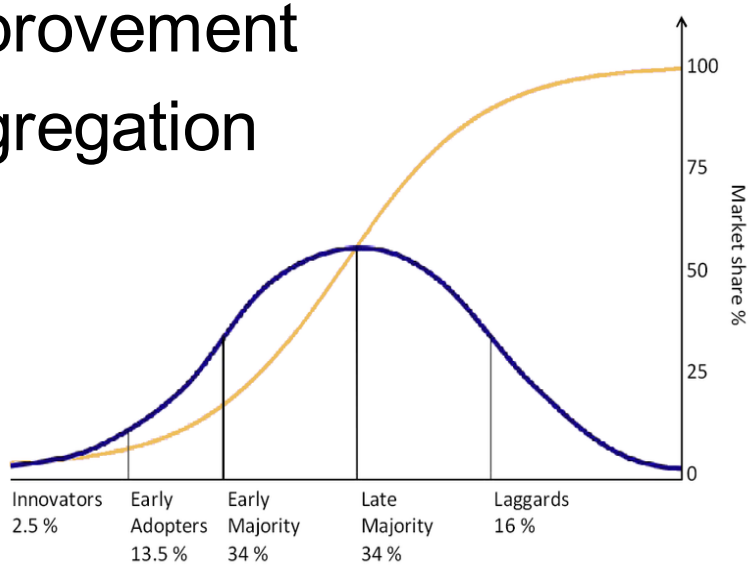
Characteristics of innovation: **surprise and stationarity**

Emergent properties

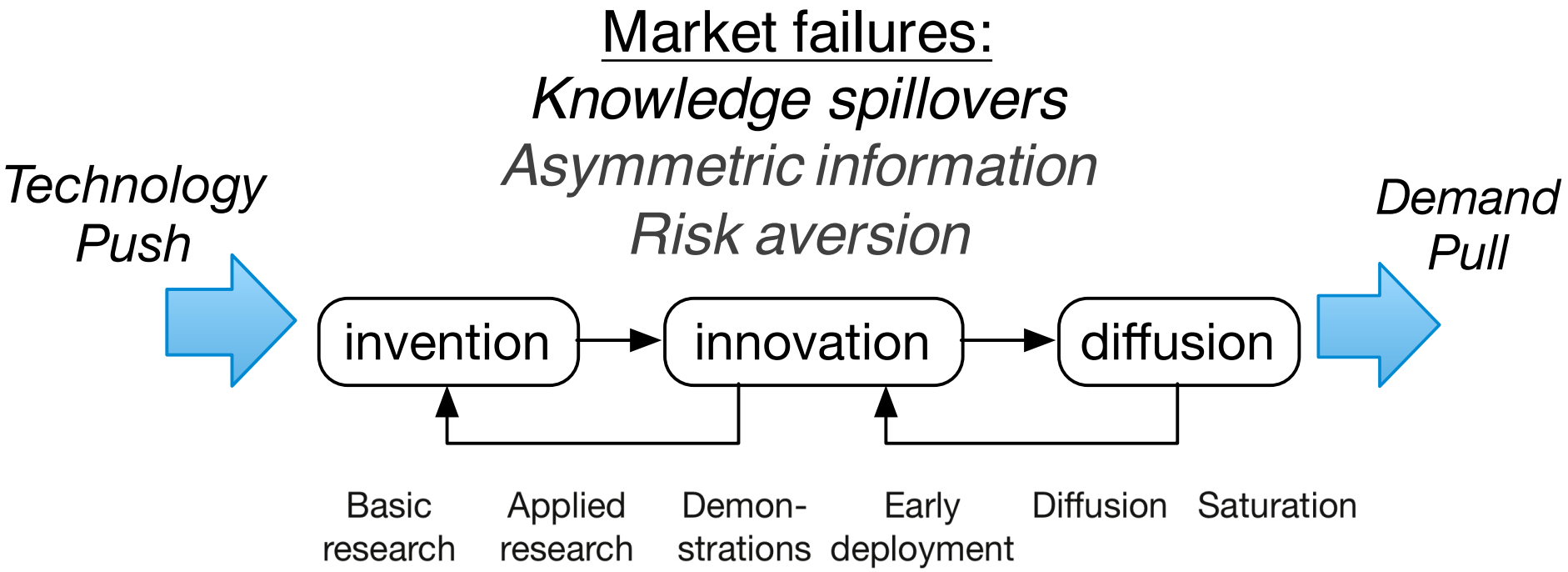
- Ex ante ignorance
- Skewed outcomes
- Pervasive spillovers
- Combinatorial
- Depreciating knowledge
- Interaction w/ production

Drivers of smoothness

- long lifetimes
- risk aversion
- incremental improvement
- aggregation

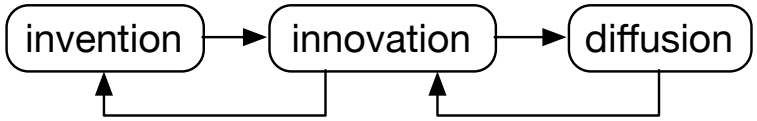


1. Policy and Innovation:
Technology push and demand pull



*Source: Nemet, G. F. (2009). "Demand-pull, technology-push, and government-led incentives for non-incremental technical change." Research Policy **38**(5): 700-709.*

1. Policy and Innovation:



Technology Push		**Demand Pull**
+ knowledge	*GOVT GOAL*	*+ size of market*
Reduces the cost of innovation	FOR PRIVATE ACTORS	*Increases payoffs for success*
• R&D • tax credits • education • Demonstrations • knowledge networks		• IPR • price externalities • subsidize demand • govt. procurement • tech. standards

*Source: Nemet, G. F. (2009). "Demand-pull, technology-push, and government-led incentives for non-incremental technical change." Research Policy **38**(5): 700-709.*

Two Policy Challenges

- ***Fragile*** demand pull

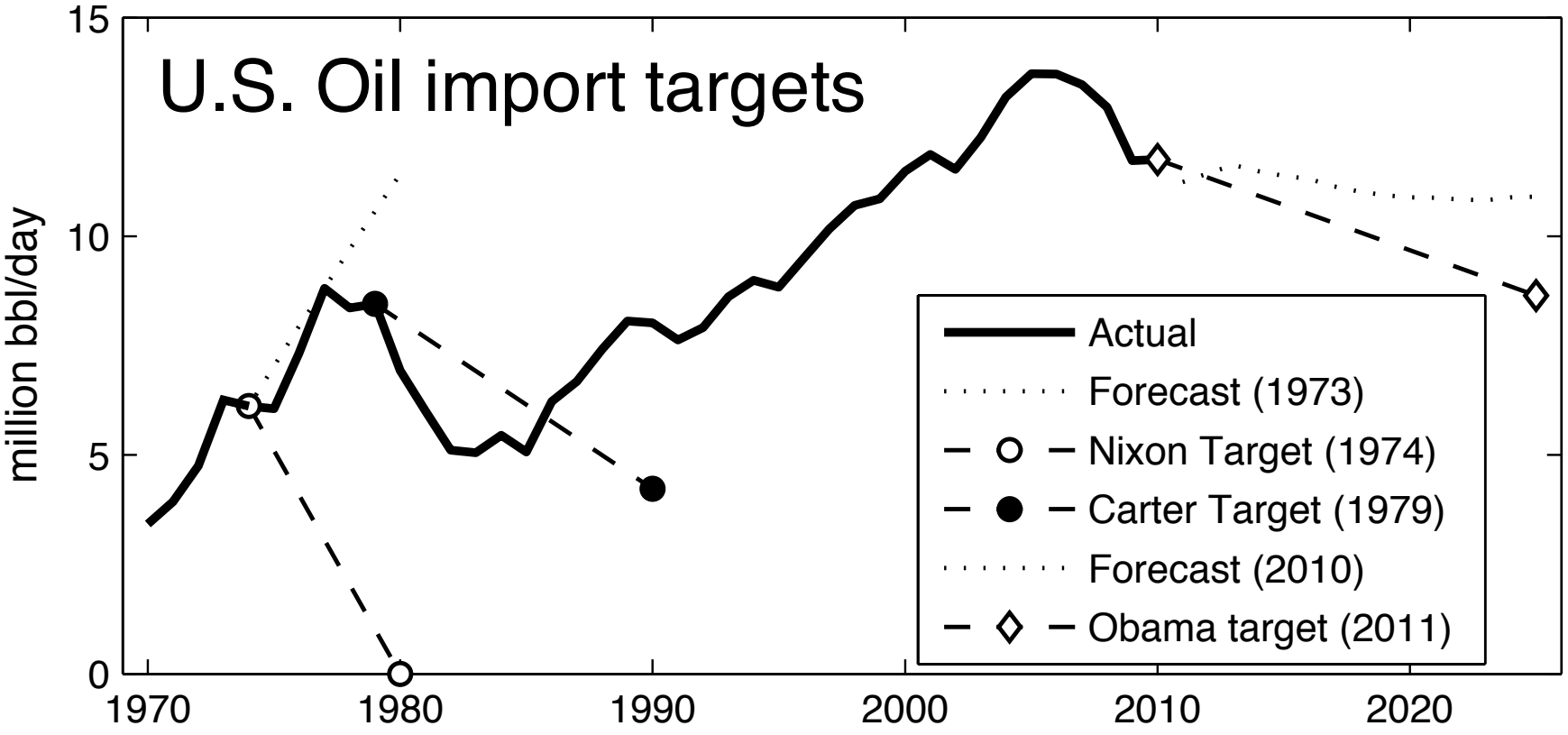
- ***Between*** technology push
  and demand pull

2. Fragile demand pull: **government commitments are not fully credible**

- Investment depends on ***expectations***
- Low-C: expectations about D-Pull ***policy***
- What happens to investment if expectations about policy are ***uncertain***?

Do we need additional measures?

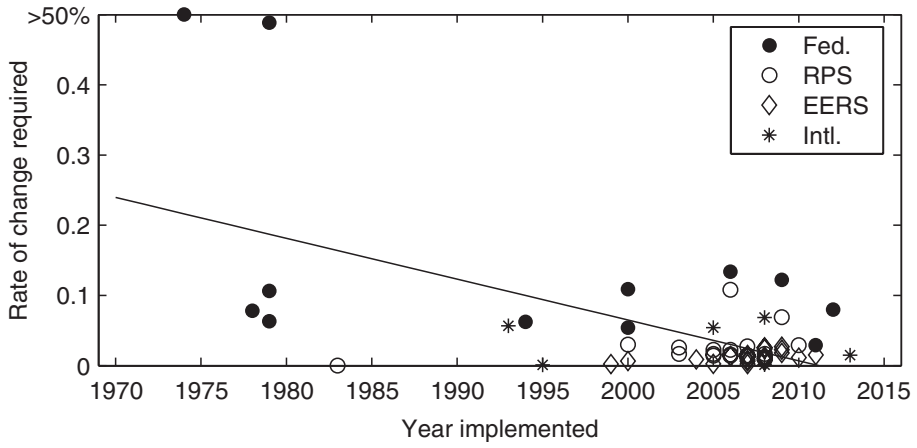
2. Fragile demand pull: **Evidence that commitments are not fully credible**



Source: Nemet, G. F., P. Braden, E. Cubero and B. Rimal (2014). "Four decades of multiyear targets in energy policy: aspirations or credible commitments?" Wiley Interdisciplinary Reviews: Energy and Environment **3**(5): 522-533.

2. Fragile demand pull: **Evidence that commitments are not fully credible**

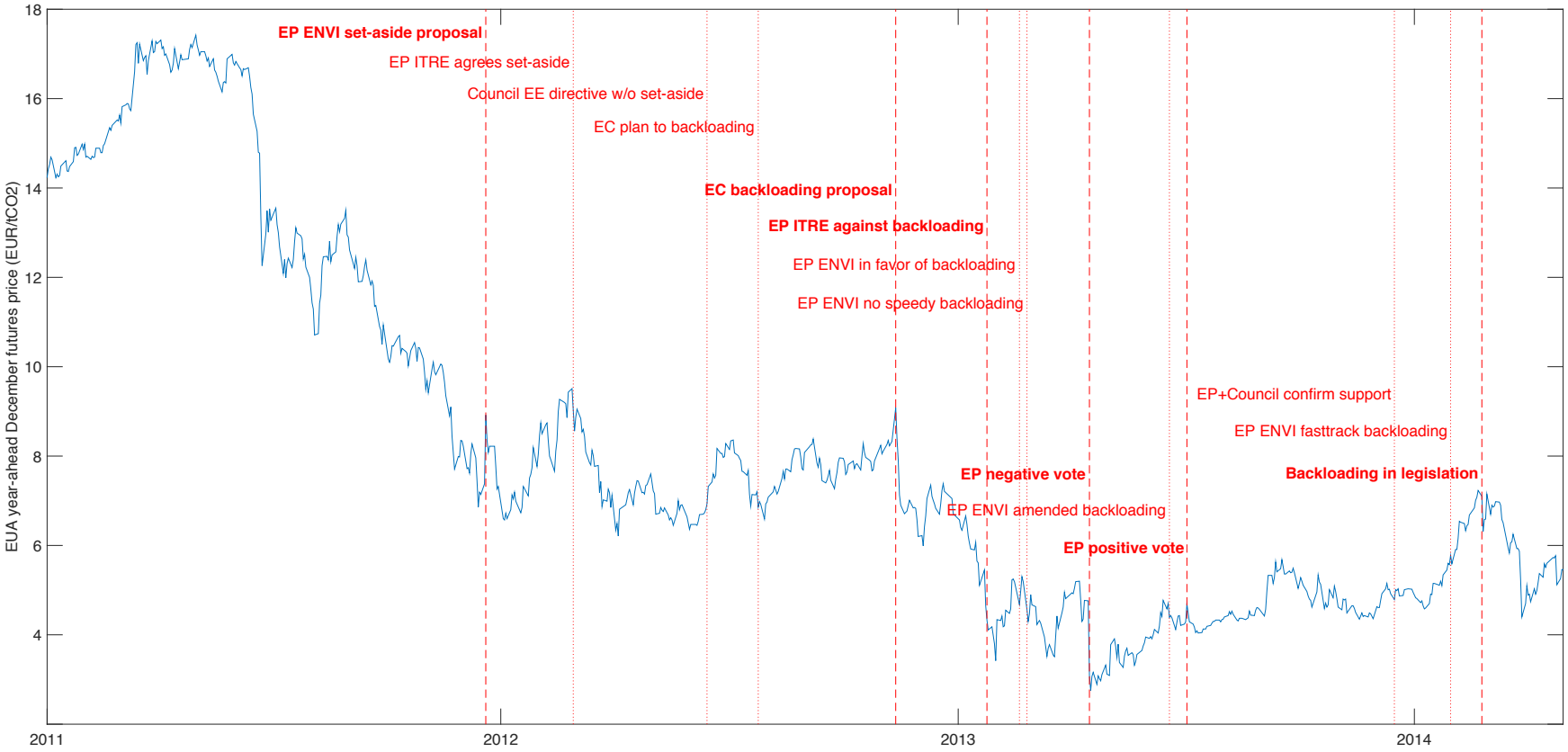
	Nonbinding	Binding	Total
Not met	5	1	6
Met in target year	0	10	10
Met all years	2	11	13
Met latest year	10	11	21
Not met in any year	4	3	7
Not yet	1	5	6
Total	22	41	63



Source: Nemet, G. F., P. Braden, E. Cubero and B. Rimal (2014). "Four decades of multiyear targets in energy policy: aspirations or credible commitments?" Wiley Interdisciplinary Reviews: Energy and Environment **3**(5): 522-533.

2. Fragile demand pull: **Evidence that commitments are not fully credible**

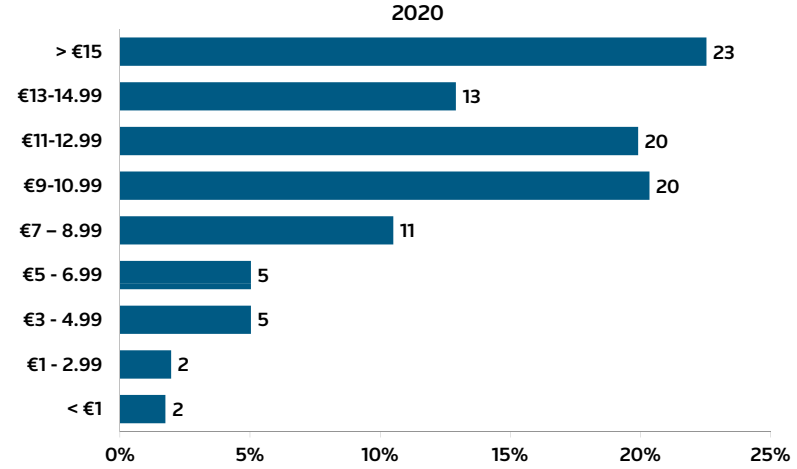
Figure 2: EU Allowance price and news related to backloading



Koch, N., G. Grosjean, S. Fuss and O. Edenhofer (2015). "Politics Matters: Regulatory Events as Catalysts for Price Formation Under Cap-and-Trade." Available at SSRN.

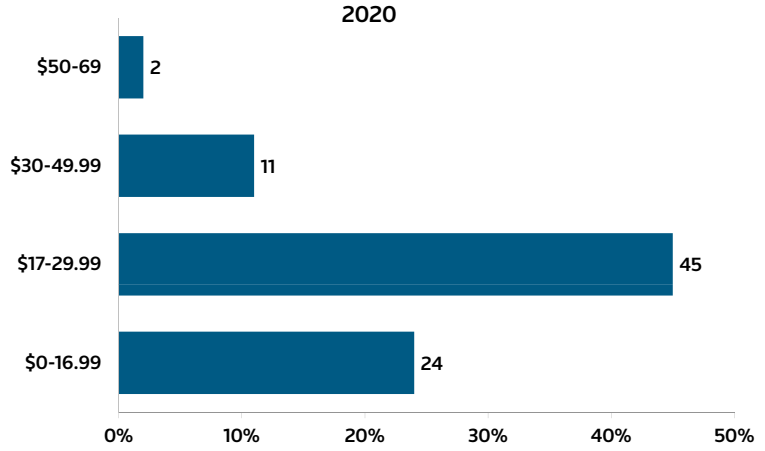
2. Fragile demand pull: **Evidence that commitments are not fully credible**

Figure 4.3b. Price expectations 2020
"What do you think will be the average price of EUAs in 2020?" Asked to all respondents indicating interest in the EU ETS. 'No opionion' not included. N=457



Source: Thomson Reuters Commodities Research and Forecasts

Figure 5.4b. WCI price expectations 2020
"In 2020, what do you think will be the average price of a WCI allowance?" Asked to all participants involved in the WCI.



Source: Thomson Reuters Commodities Research and Forecasts

Thompson Reuters (2015) Carbon Market Survey.

2. Fragile demand pull: **consequences of not fully credible commitments**

Nemet question to venture capitalist:

How do you value the benefits of policy in your decisions to invest in start-up companies?

*"**We ignore it.***
***What the government giveth, it can taketh away.**"*
- venture capitalist in energy sector

"***It does not affect profit projections.***
It goes below the line."
– energy finance professional

2. Fragile demand pull: **importance of credibility to incentives**

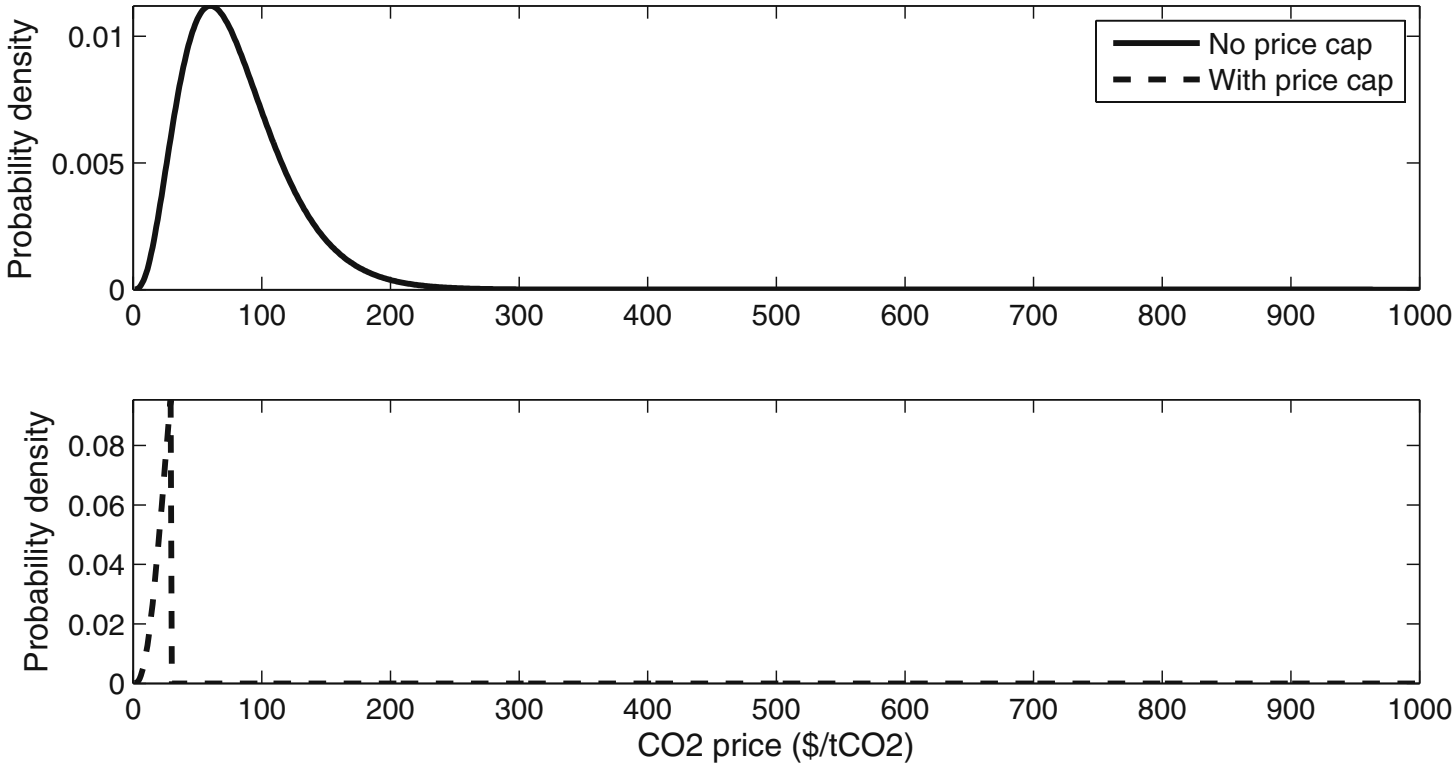


Fig. 7 Assumed distribution of possible CO_2 prices in 2030 with (*lower panel*) and without price caps (*upper panel*)

Nemet, G. (2010). "Cost containment in climate policy and incentives for technology development." Climatic Change 103(3): 423-443.

2. Fragile demand pull: **importance of credibility to incentives**

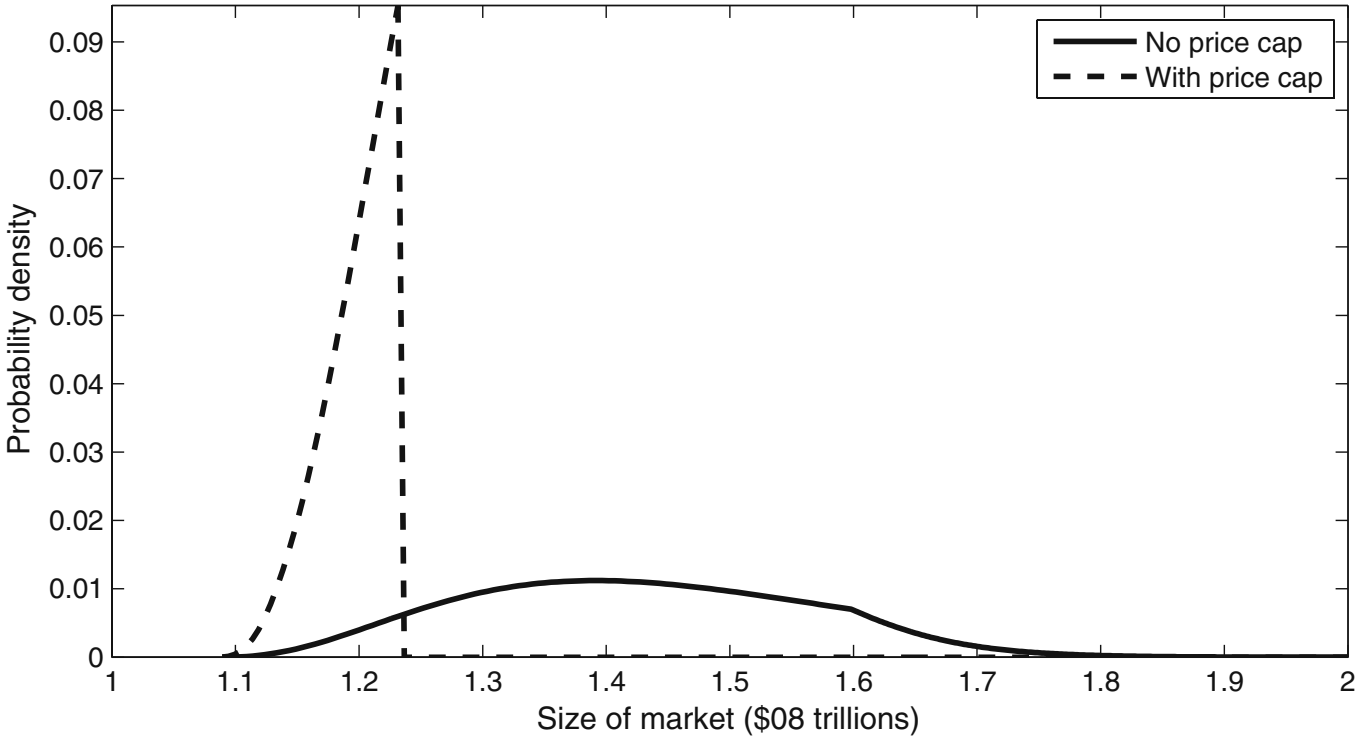


Fig. 3 Probability density function (PDF) showing the size of the market for a zero-carbon technology (trillions of current dollars) assuming a distribution of possible future carbon prices. The *solid line* shows the PDF of market size when no price cap is in place and the *dashed line* shows the PDF of market size with a price cap in place at $\$29/tCO_2$

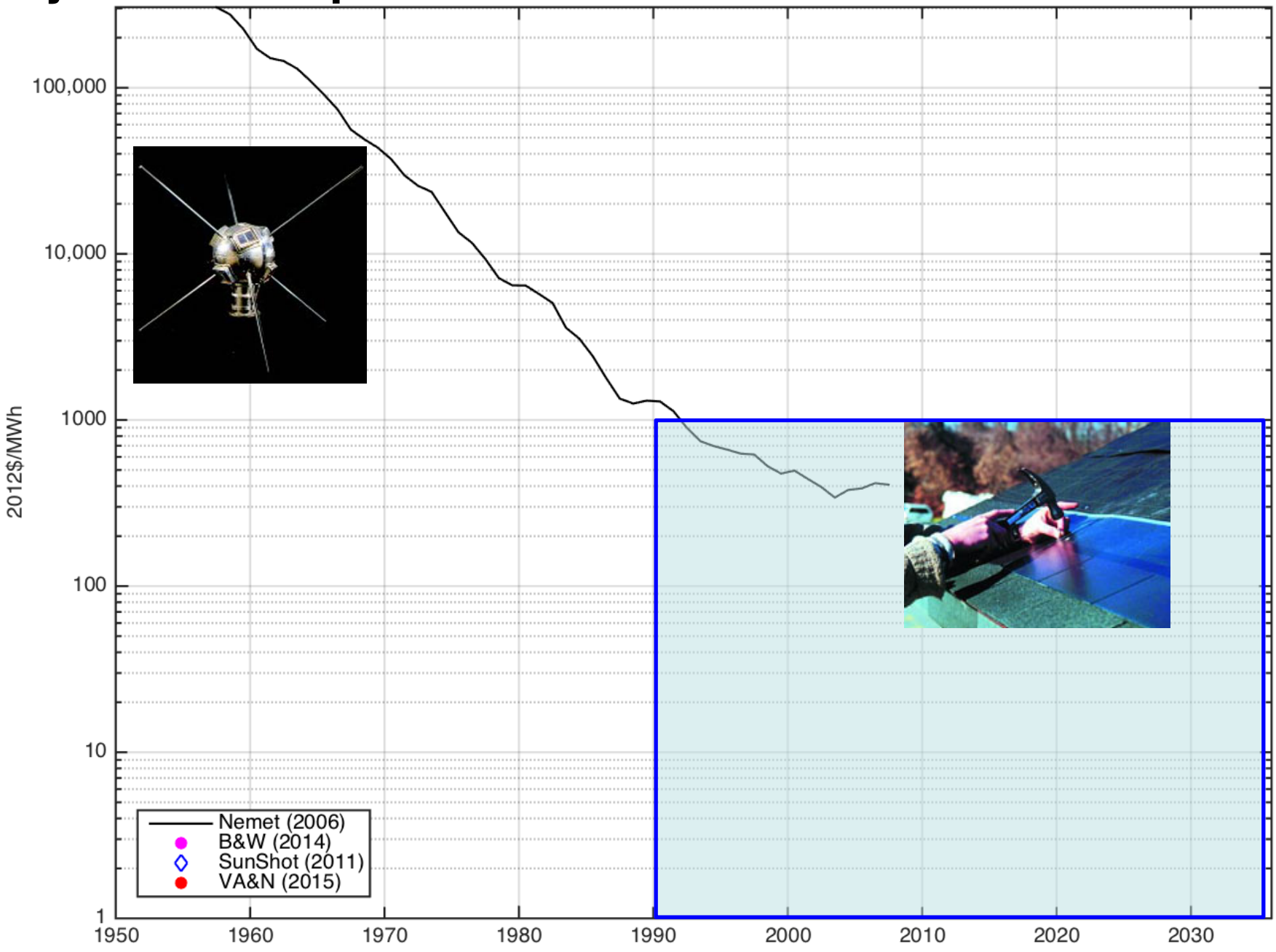
Nemet, G. (2010). "Cost containment in climate policy and incentives for technology development." Climatic Change 103(3): 423-443.

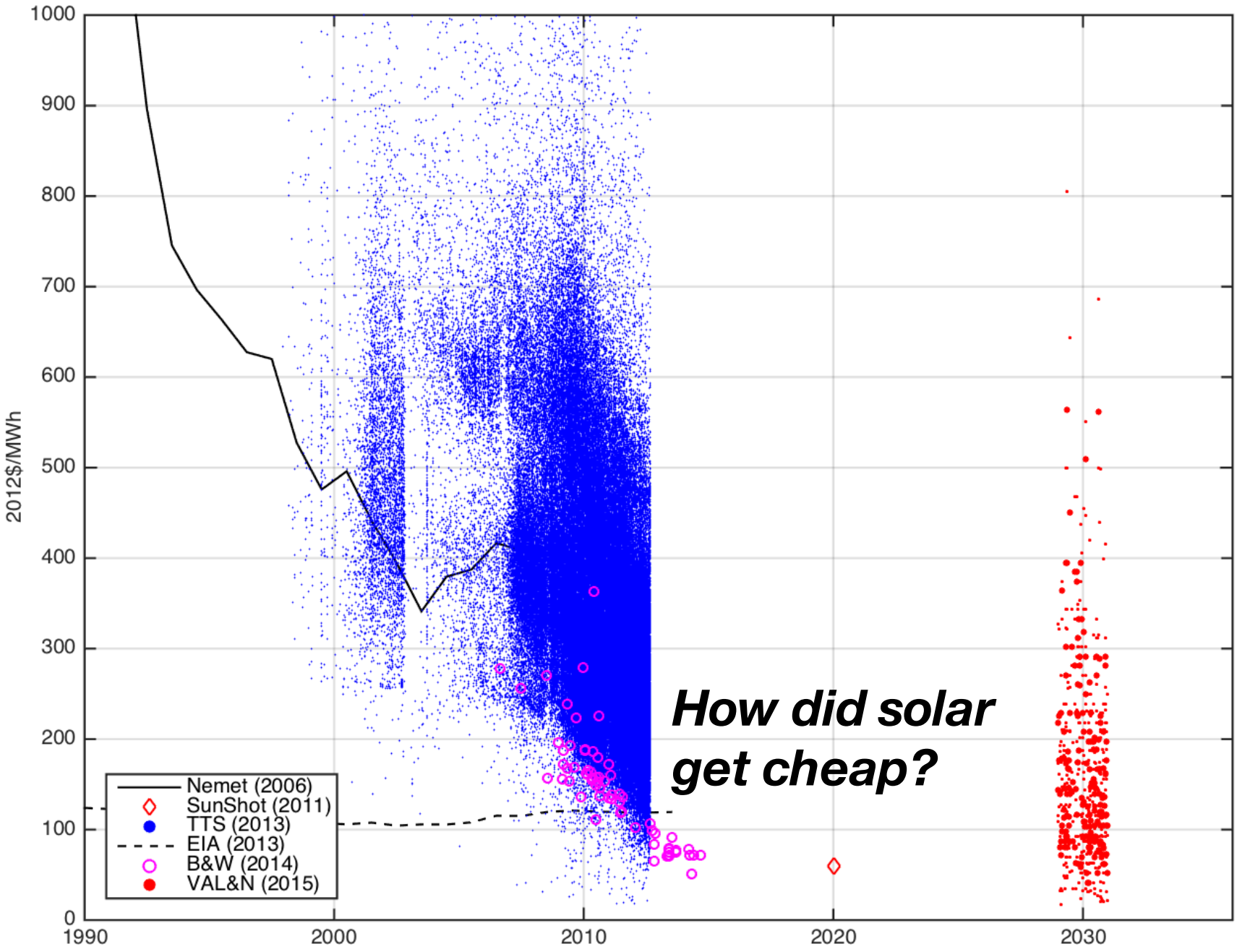
2. Fragile demand pull: **importance of credibility to incentives**

How did solar PV get cheap?

- Full answer: a combination of factors
- Short answer: *expectations*

80 years of PV prices

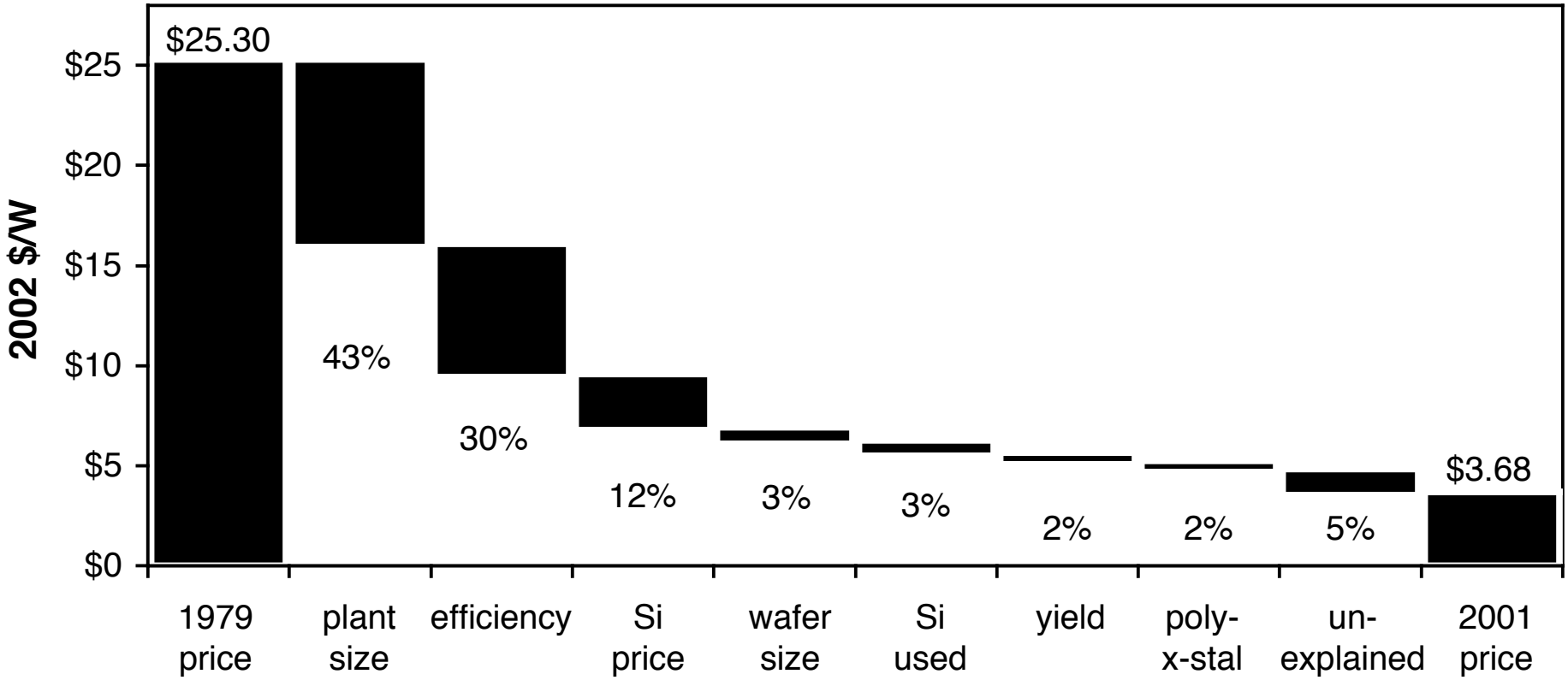



1000
900
800
700
600
500
400
300
200
100
0
2012$/MWh
1990
2000
2010
2020
2030
Nemet (2006)
SunShot (2011)
TTS (2013)
EIA (2013)
B&W (2014)
VAL&N (2015)
How did solar get cheap?

2. Fragile demand pull: **importance**

How did solar get cheap?

Biggest reason: Economies of scale

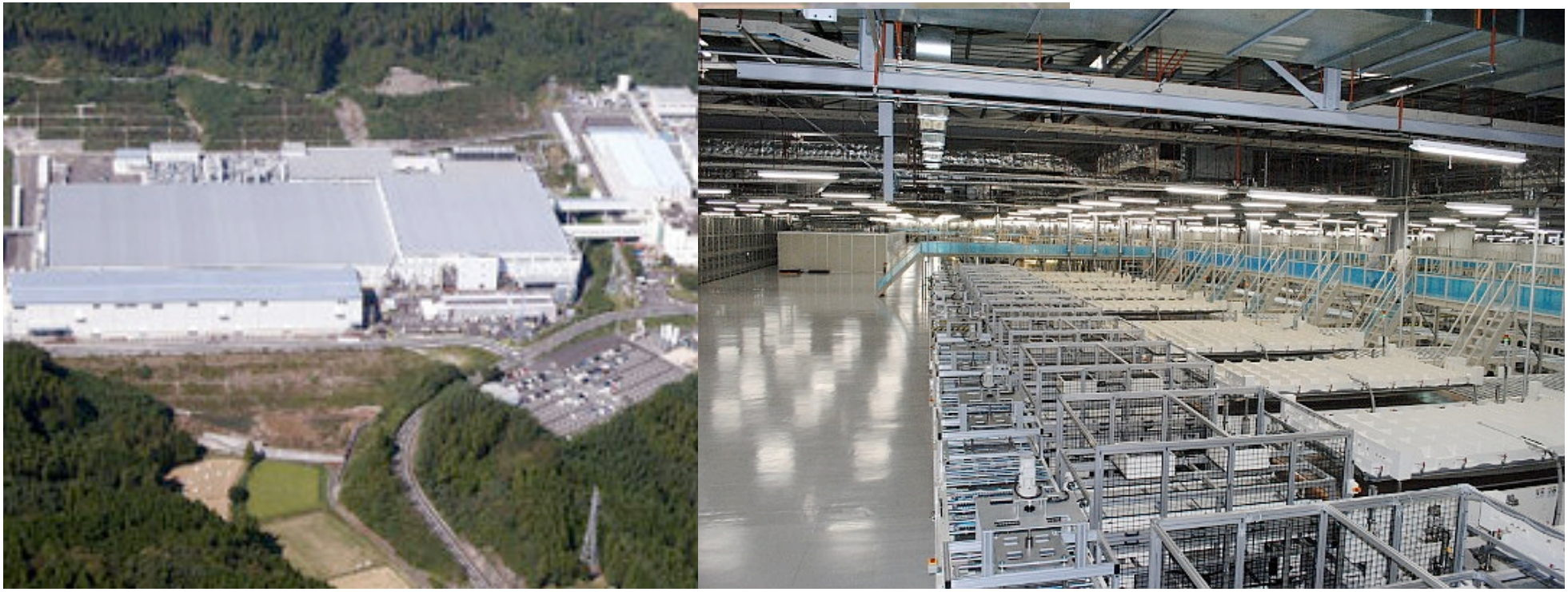


*Nemet, G. F. (2006). "Beyond the learning curve: factors influencing cost reductions in photovoltaics." Energy Policy **34**(17): 3218-3232.*

2. Fragile demand pull: **importance**

How did solar get cheap?

Biggest reason: Economies of scale



…expectations of future demand

*Nemet, G. F. (2006). "Beyond the learning curve: factors influencing cost reductions in photovoltaics." Energy Policy **34**(17): 3218-3232.*

2. Fragile demand pull: **importance**

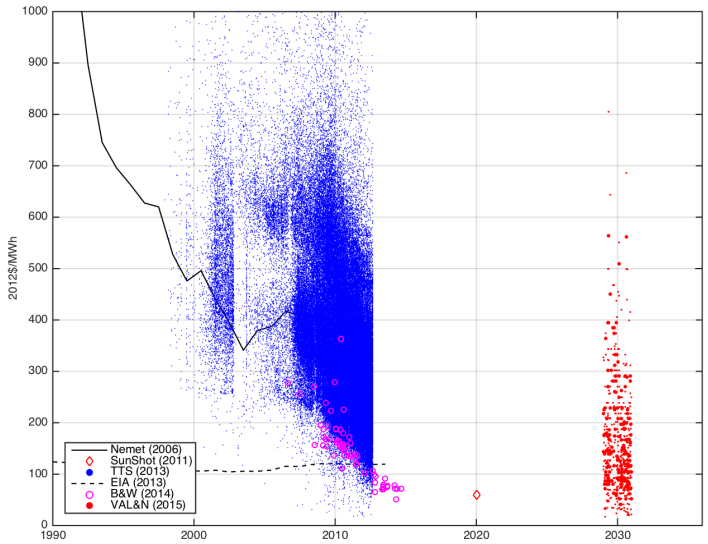
How did solar get cheap?

1. Technology Push in 1970s-80s

2. German FIT, 2004-present
   - pure demand pull
   - high credibility
   - Other countries too.

3. Chinese scale up

4. Cheap PV everywhere.



…expectations of future demand

2. Fragile demand pull: **is there a case for flexibility?**

- allow for policy experimentation
- recover from policy mistakes
- make use of new information
- respond to unexpected events
- account for changes in social priorities

2. Fragile demand pull:

How do we navigate the trade off between commitments and flexibility?

Approach: look at how other poliocy areas have done it:

- monetary policy
- fiscal policy
- trade policy

2. Fragile demand pull:
Addressing credibility problems
Learning from other sectors

		Monetary	Fiscal	Trade	Other	Example
1. Design of rules						
	Rules on future targets	M	F			interest rate targets
	Discretion within rules	M	F			safety valves
	Periodic review of targets				Env	5-year stocktake
	Counter-cyclical mechanisms	M	F			target duration of bus. cycle
2. Transparency and trust						
	Monitoring and verification	M	F			national accounts
	Independent authority	M		T		WTO
	Reputation and experience			T		being tough on inflation
3. Political economy and distribution						
	Compensate losers		F			grandfathering
	Create new winners		F			infant industries
	Two-level game			T		trade liberalization
	Policy windows				Env	ozone treaty
4. Robustness						
	Multiple instruments		F			social insurance
	Decentralized policy making			T		tariff setting

Nemet, G., M. Jakob, J. Steckel and O. Edenhofer (in preparation). "Addressing credibility problems in climate policy."

2. Fragile demand pull: **A taxonomy for improving incentives in climate policy**

		Advantages for credibility	Disadvantages and risks	Climate example
1. Design of rules				
	Rules on future targets	Can be legally binding	Too inflexible for a dynamic environment	Binding emissions limits
	Discretion within rules	Incorporate new information; respond to shocks	Vulnerable to political expediency	Safety valves
	Periodic review of targets	Enables ratchet effect; can revise target on predictable schedule	Possible to weaken; incentive to postpone investment	5-year global stocktake
	Counter-cyclical mechanisms	Avoids amplifying cycles; cyclical opportunities (low	Difficult to implement, e.g. in defining a cycle.	Public investment when energy and/or carbon prices are
2. Transparency and trust				
	Monitoring and verification	Provide accountability; enable cooperation	Conflicts with sovereignty; requires institutional capacity	UNFCCC Paris Agreement: published intended nationally defined
	Independent authority	Can exercise discretion independently of	Authority may be vulnerable to regulatory capture;	Carbon market efficiency board
	Reputation and experience	Can create strong incentives without requiring legislation	Can be reversed without deliberative process	UNFCCC process; leader nations

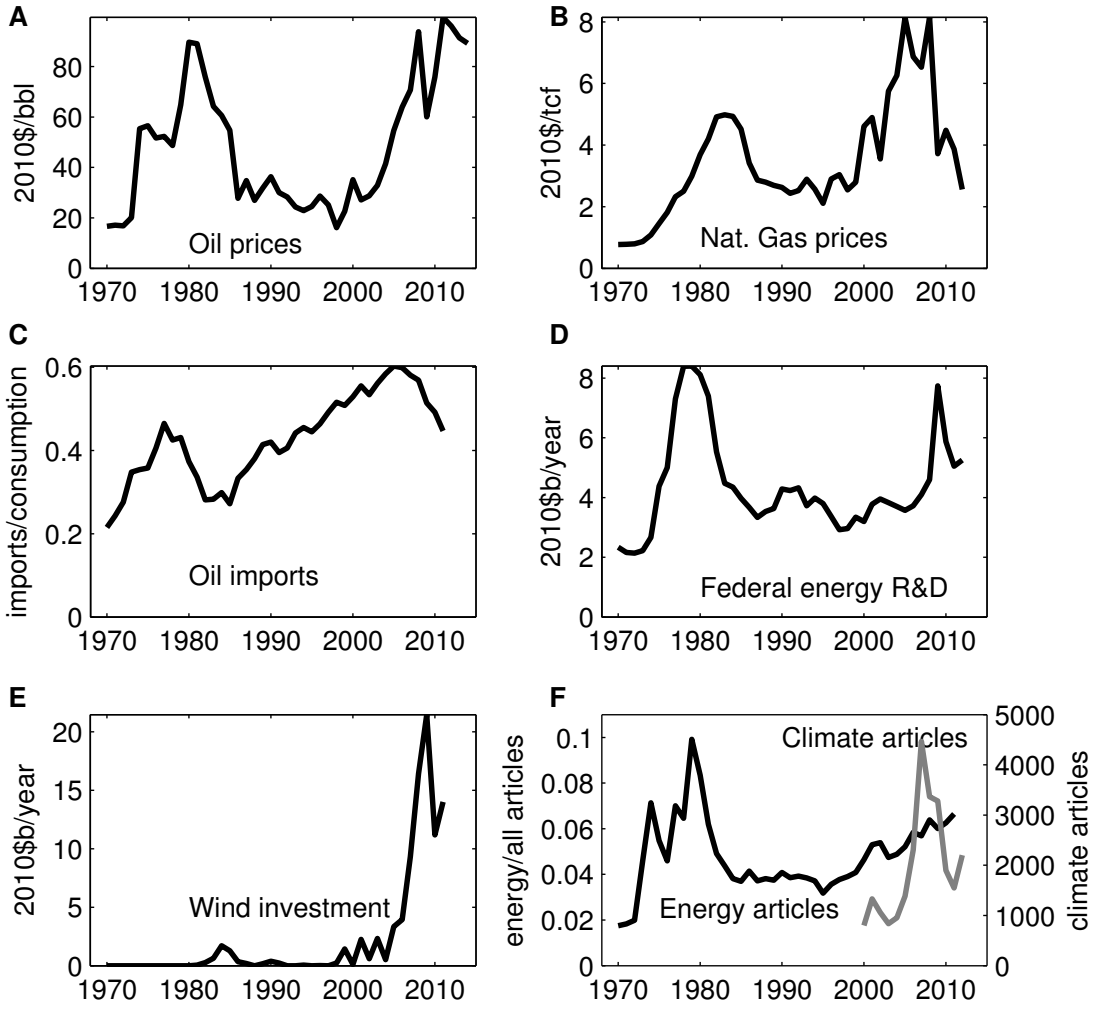
Nemet, G., M. Jakob, J. Steckel and O. Edenhofer (in preparation). "Addressing credibility problems in climate policy."

2. Fragile demand pull: **A taxonomy for improving incentives in climate policy**

		Advantages for credibility	Disadvantages and risks	Climate example
3. Political economy and distribution				
	Compensate losers	Avoid efforts by powerful interest groups to weaken	Inefficient; prone to gaming; hard to know how much to	Grandfathering; free allocation of emissions permits
	Create new winners	Can create support for strong policy	Benefits may be too dispersed; subsidies	Carbon pricing; subsidies for low-
	Two-level game	Mechanism in which international commitments reinforce	Can work in opposite direction if international	UNFCCC in combination with bottom-up
	Policy windows	Poltically infeasible targets may rapidly become feasible	Credibility can be reversed when crisis fades	Pursue efforts to limit to 1.5C as a possible future
4. Robustness				
	Multiple instruments	Incentives for investment maintained if one policy is	Inefficient; complexity may weaken incentives; perverse	Carbon prices and regulations; multi-level governance
	Decentralized policy making	Enables policy innovation; incentives may be robust to	Inefficient; may be poorly coordinated; may not enable	Sub-national climate policies

Nemet, G., M. Jakob, J. Steckel and O. Edenhofer (in preparation). "Addressing credibility problems in climate policy."

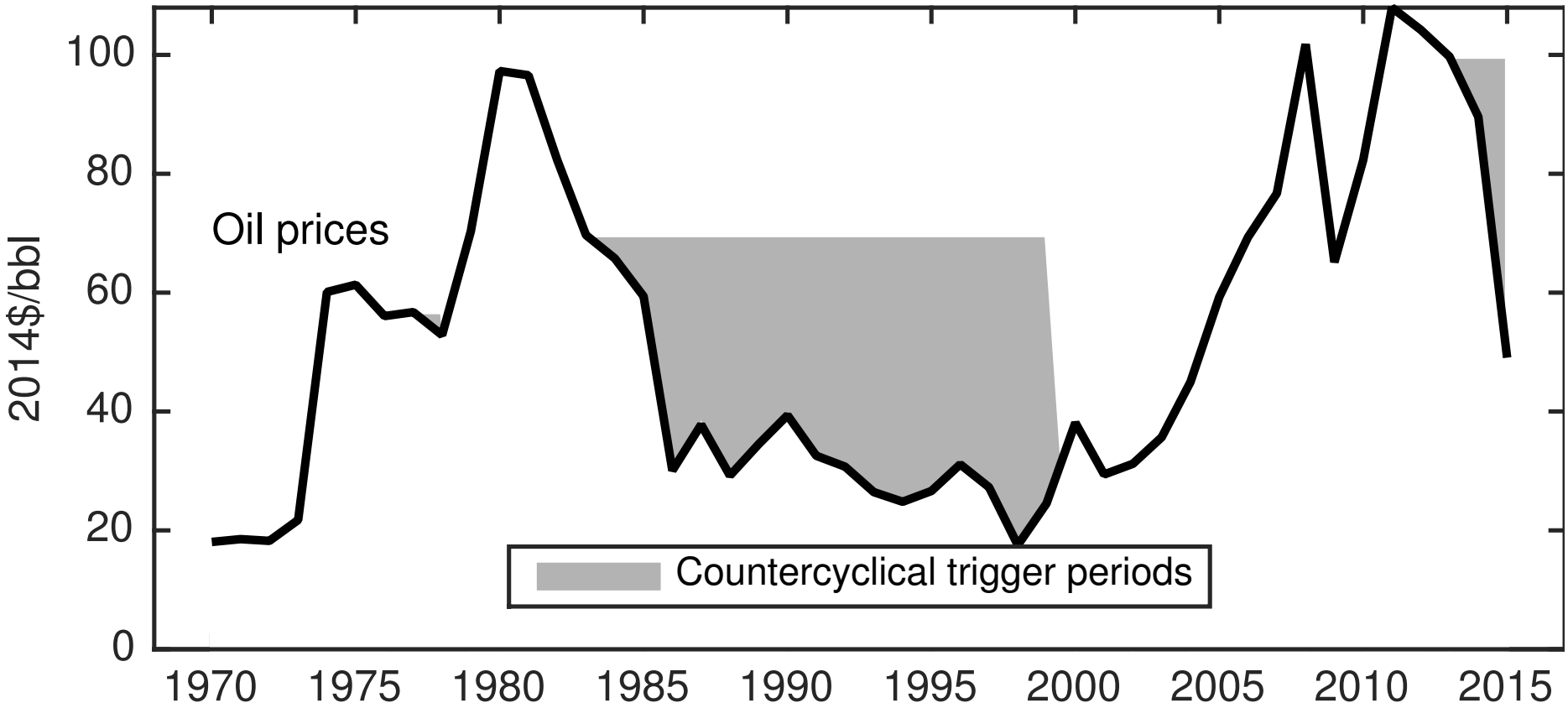
2. Fragile demand pull:
Proposal for counter-cyclical policy



Nemet, G. F., A. Grubler and D. Kammen (2016). "Countercyclical energy and climate policy for the U.S." Wiley Interdisciplinary Reviews: Climate Change **7**(1): 5--12.

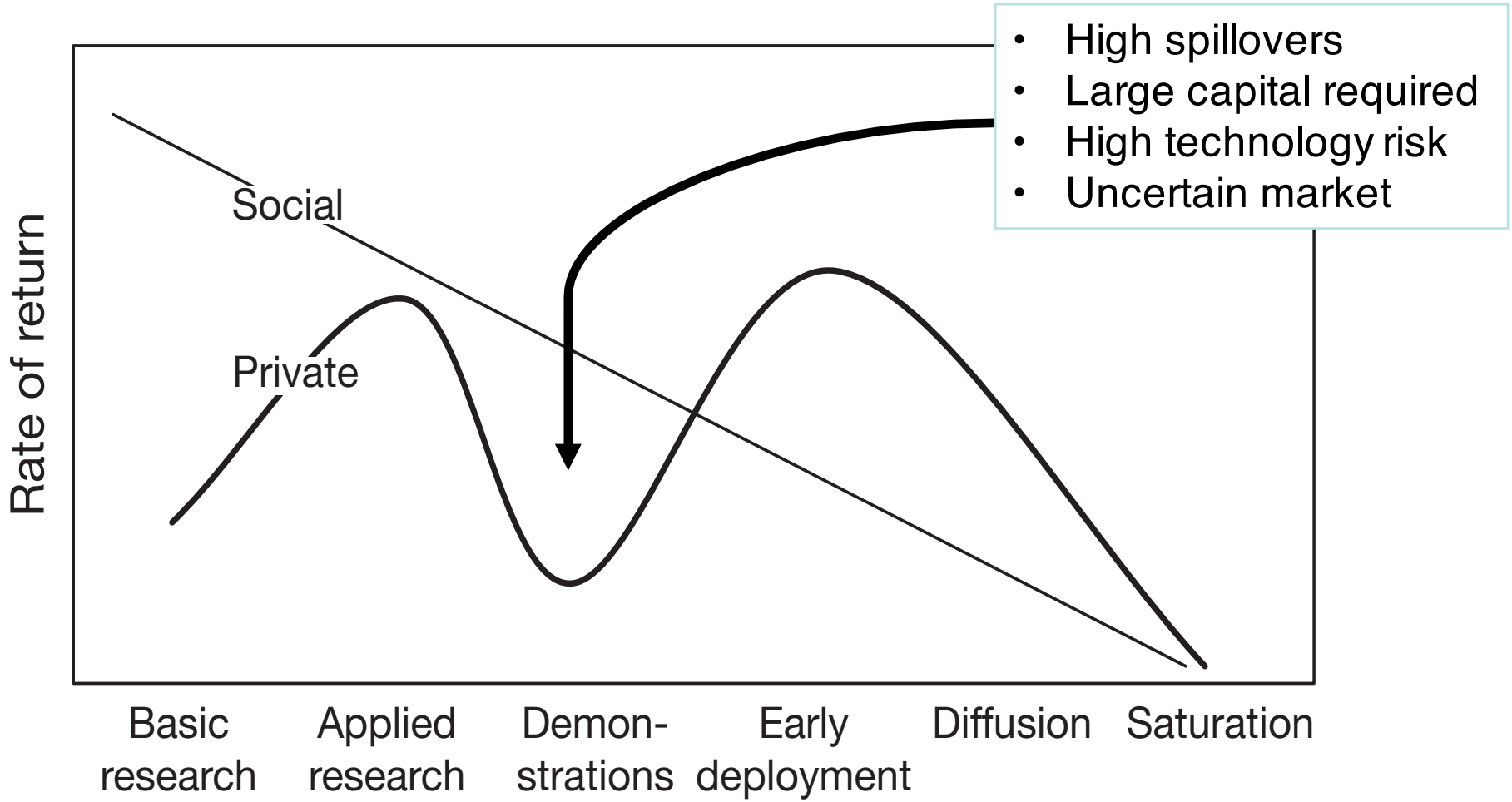
2. Fragile demand pull:
Proposal for counter-cyclical policy

1) Predefined trigger conditions 2) Predefined policies



Nemet, G. F., A. Grubler and D. Kammen (2016). "Countercyclical energy and climate policy for the U.S." Wiley Interdisciplinary Reviews: Climate Change **7**(1): 5--12.

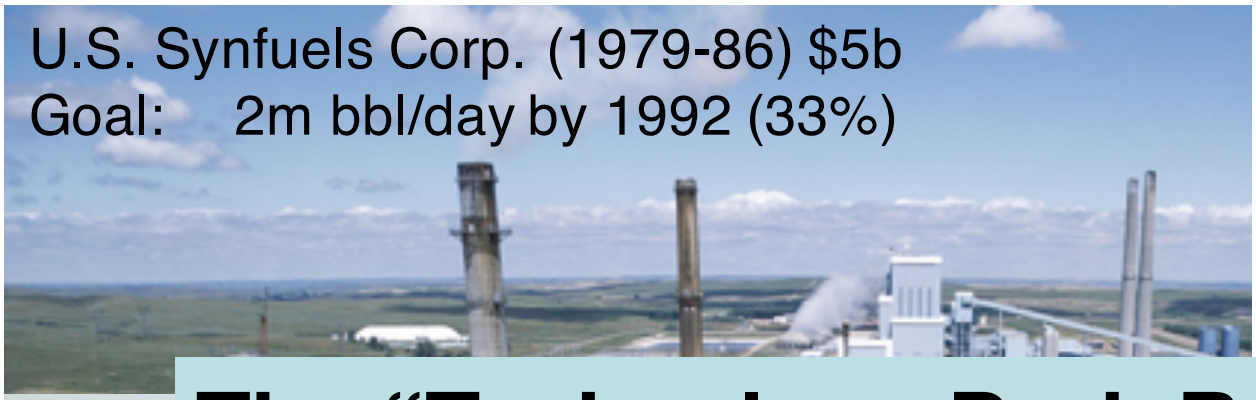
3. In between Tech Push and Demand Pull: **the "Valley of death"**

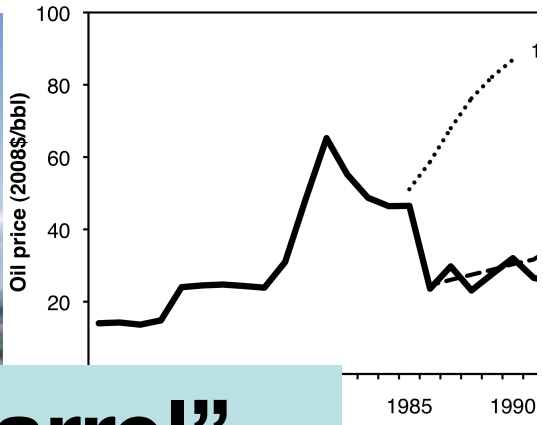


- High spillovers
- Large capital required
- High technology risk
- Uncertain market

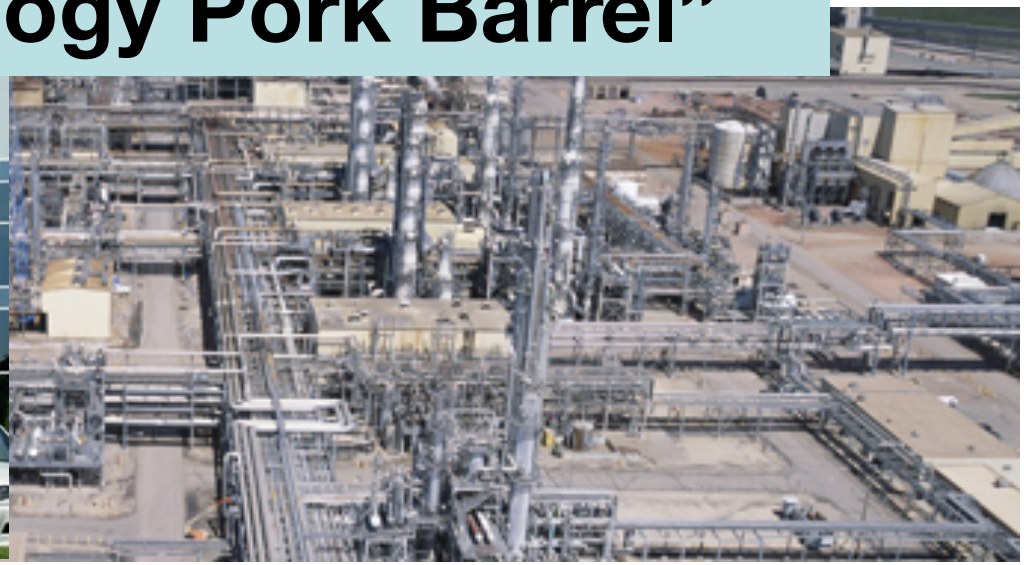
Nemet, G. F. (2013). Technological change and climate-change policy. Encyclopedia of Energy, Natural Resource and Environmental Economics. J. Shogren. Amsterdam, Elsevier: 107--116.

3. In between Tech Push and Demand Pull: **the "Valley of death"**





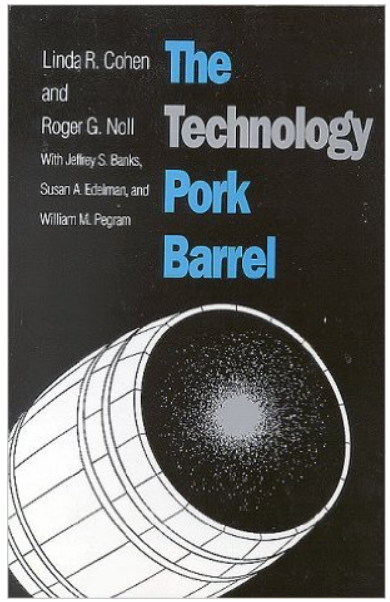
The "Technology Pork Barrel"



Anadon, L. D. and G. F. Nemet (2014). The U.S. Synthetic Fuels Corporation: Policy Consistency, Flexibility, and the Long-Term Consequences of Perceived Failures. Energy Technology Innovation: Learning from Historical Successes and Failures. A. Grubler and C. Wilson. Cambridge, Cambridge University Press: 257—273.

3. In between Tech Push and Demand Pull: **the "Technology Pork Barrel"**

"American political institutions introduce predictable systematic biases to R&D programs so that on balance, government projects will be susceptible to performance underruns and cost overruns." – Cohen and Noll



Cohen, L. R. and R. G. Noll (1991). The Technology Pork Barrel. Washington, Brookings.

"government should not pick winners"

...but what if scale, spillovers, and market uncertainty force a choice?

3. In between Tech Push and Demand Pull: **Bridging the "Valley of death" while avoiding the "Technology Pork Barrel"**

1. On what factors does the case for government intervention rest?

2. How to maximize the effectiveness of government support?

Nemet, G., K. Neuhoff and V. Zipperer (in preparation). "The valley of death and the technology pork barrel: support for radical low-carbon innovation in the materials sector."

3. In between Tech Push and Demand Pull: **Bridging the "Valley of death" while avoiding the "Technology Pork Barrel"**

1. On what factors does the case for government intervention rest?
   - Appropriability
   - Radicalness
   - Scale
   - Markets

Nemet, G., K. Neuhoff and V. Zipperer (in preparation). "The valley of death and the technology pork barrel: support for radical low-carbon innovation in the materials sector."

3. In between Tech Push and Demand Pull: **Bridging the "Valley of death" while avoiding the "Technology Pork Barrel"**

2. How to maximize the effectiveness of government support?

- US Synfuels Corporation
- CCS
- Solar thermal electricity
- Nuclear
- ULCOS

Nemet, G., K. Neuhoff and V. Zipperer (in preparation). "The valley of death and the technology pork barrel: support for radical low-carbon innovation in the materials sector."

In summary...

- ***Technology Push*** and ***Demand Pull***
  - both needed

- Policy ***credibility*** and ***expectations***
  - Crucial for private incentives
  - 2nd best solutions likely needed...many exist

- ***Valley of Death*** and ***Technology Pork Barrel***
  - Public support needed for some technologies
  - But implementation difficult...is it impossible?
  - Decisions coming on this