

Green Growth and Technological Change

What We Know — and Don't Know — About What Drives Improvements in Energy Efficiency

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Green Growth

- First, what's "green growth?"
 - United Nations: *"Green Growth is the process of **greening** a conventional economic system and a strategy to arrive at a **green economy**," ... and ... "Green Economy can be defined as an economy where economic prosperity can go hand-in-hand with ecological **sustainability**."*
 - "Green growth" may be a new phrase for "sustainable development"
- We then need to ask whether green growth is:
 - Nothing more nor less than addressing ordinary "market failures," including environmental externalities? ... or ...
 - An activist call to coordinate growth & environmental policies? ... or ...
 - A conviction that green policy is not only good for broadly-defined welfare, but for narrowly-defined GDP growth?
- Whatever it means, green growth is tightly linked with technological change

For green growth, technological change with regard to *energy efficiency* is very important

- Why? Because global energy consumption is on a path to grow 50% over the next 25 years
 - increased air pollution, greenhouse gas emissions, oil consumption, and energy prices
- And energy efficiency improvements are an important mechanism for decreasing energy consumption
- Important questions:
 - How do people & businesses make energy efficiency decisions?
 - What are the effectiveness, costs, and benefits of energy-efficiency policies?
 - In the context of green-growth, a central issue is the “energy paradox” or “energy efficiency gap”

What is the “energy paradox” or “energy-efficiency gap?”

- It is the *apparent* reality that energy-efficiency technologies that would pay off for adopters ... are nevertheless *not* adopted.
- Let’s be clear about what *adoption* means”
- Three stages of technological change
 - *Invention* – creation of new equipment (in the laboratory)
 - *Innovation* – commercialization, i.e. taking it from the laboratory to the showroom floor
 - *Diffusion* – gradual process of *adoption* (purchase) of product
 - [And, of course, *utilization* – use of the adopted product]
- Energy paradox is mainly about *diffusion*
- So, what can **explain** the existence of the paradox/gap?

Potential Explanations of the Paradox/Gap

- **Market-Failure Explanations**

- Information Problems
 - Principal-agent issues (e.g., renters/landlords)
 - Lack of information, asymmetric information
- Energy Market Failures
 - Externalities – environmental, security
 - Average-cost electricity pricing
- Capital Market Failures (liquidity constraints)
- Innovation Market Failures (R&D spillovers)

- **Behavioral Explanations**

- Inattentiveness/salience issues
- Bounded rationality, heuristic decision-making

- **Model and Measurement Explanations**

- Unobserved costs of adoption
- Product characteristics/attributes
- Heterogeneity in demand across potential adopters
- Uncertainty (real, not informational – e.g., future energy prices)

Some Policy Implications

- What about *subsidies* as a diffusion (adoption) policy?
 - Can provide perverse incentive to *increase* energy use (rebound effect)
 - Require large public *expenditures* per unit of effect (infra-marginal units)
- What about *conventional*, command-and-control regulations?
 - Major effect is to *remove* some technologies from the market (examples: CAFE standards, energy-efficiency standards)
- *Bottom Line*: There are two distinct market failures – environmental *externality* and *public-good* nature of information generated by R&D
 - Pricing of externality is *necessary, but not sufficient*
 - Direct technology policy is *necessary, but not sufficient*
- Conclusion from previous research:
 - Theory & empirical evidence: innovation & diffusion do respond to market incentives
 - But double market failure clarifies the case for broader-based public support for technology innovation (and perhaps diffusion)

More Research is Needed

- Research Problem
 - Bricks
 - Walls
 - House
- What does existing evidence tell us when assembled?
- Where are there inconsistencies?
- What are the most important knowledge gaps?
- A very substantial agenda for research, communication, and action

For More Information

Harvard Environmental Economics Program
www.hks.harvard.edu/m-rcbg/heap/

- Blog: An Economic View of the Environment
 - <http://www.robertstavinsblog.org/>

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Appendix: Alternative notions of the “energy-efficiency gap”

