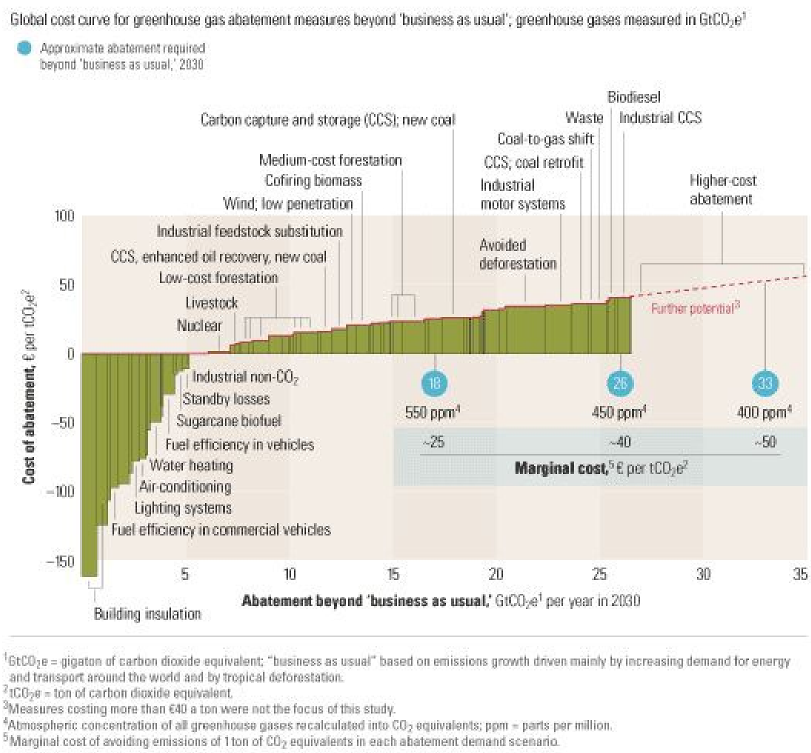
Lecture # 12 – Behavioral Economics and Energy Efficiency

I. Is there an Energy Efficiency Gap?

- Energy efficiency provides an example where government policy plays an important role
  - Many studies find that both consumers and firms underinvest in energy efficiency, even when NPV is positive
  - Energy efficiency is often seen as a low cost way of reducing CO_2 emissions
  - This literature also offers an opportunity to consider lessons from behavioral economics
- Many see energy efficiency as a "win-win" solution.
  - Energy efficiency can save money and reduce pollution.
  - A well-known example in energy policy is McKinsey and Co.'s global abatement cost curve for CO_2.
    - Several suggested technologies have negative costs!



source: [McKinsey (2007)]

- Energy efficiency gap: the gap between the cost-minimizing level of energy efficiency and the amount actually realized
- Is the energy efficiency gap real?
    - People demand high returns (greater than 30%) to invest in energy efficiency.
        - Demand payback periods of 2-3 years
    - Low energy prices help explain the gap
        - Energy is a small portion of the average household's budget
        - Energy efficiency is higher in counties with higher energy prices.
        - In the U.S., energy consumption in a state is about 7% lower for each cent/kWh by which electricity prices exceed the national average.
    - While engineering studies suggest more energy efficiency is possible, might there be rational reasons for not adopting?
        - Hidden costs
            - Administrative costs or time costs of installation
            - Decreased quality (e.g. lower lighting quality)
        - Consumer heterogeneity
            - Different preferences
                - Purchase a lower-efficient appliance if won't use it much
                - A recent study finds conservatives are less likely to use high-efficient light bulbs
        - Uncertainty
            - Will energy prices fall in the future?
        - Rebound effect
            - Engineering estimates may overestimate potential savings
                - Assume perfect installation and maintenance
                - May ignore potential behavioral changes if energy use becomes cheaper
    - Thus, a key question is to what extent market failures matter, versus rational decision making that leads to the "energy efficiency gap"

- Evidence on returns to energy efficiency investments
  - Four types of evidence
    - Engineering estimates of returns to potential investments
      - Calculate NPV of energy efficiency investments assuming capital costs, energy prices, investment horizons, and discount rates
      - Often find negative net costs for many investments
      - Critique
        - Omit opportunity costs or other unobserved factors
          - E.g. Anderson and Newell (2004): small and medium firms do not undergo all recommended changes after DOE energy audits
          - Cite lack of staff, inconvenience, and risk of problems with equipment as reasons.
        - Are estimated energy savings accurate?
    - Cost effectiveness of energy efficiency programs run by electric utilities
      - Costs are usually costs reported by the utility, not by users
      - What is the counterfactual?
    - Estimated demand patterns for energy-using durables
      - Do energy prices change purchase choice?
      - Consumers should be equally responsive to variations in purchase prices and variations in other product costs
      - Examples
        - As gas prices increase, the price of a Prius should go up, and the price of a Hummer should go down
          - Allcot and Wozny (2014) find that consumers value 76 percent of discounted future gas prices, suggesting a small bias
          - Other papers (Busse *et al*. 2013; Sallee *et al*. 2015) find no bias – e.g. 100% valuation
    - Empirical estimates of returns to observed investments
      - Use energy use data to estimate average savings of people that actually adopt energy efficient technologies
      - Potential issues
        - Unobserved costs and benefits
          - E.g. making changes to your home is disruptive
        - Rebound effect – using energy is cheaper, so turn up the heat to be more comfortable
        - Observed over a short time frame
          - Long term benefits will be discounted
        - Heterogeneous effects

- Fowlie *et al*. (2015, 2018) is an example of such a study
    - Use a randomized control trial of the Federal Weatherization Assistance Program (WAP)
        - Program provides assistance to low income households
            - Average value of retrofits about $5,000
        - Included 30,000 households in Michigan who were eligible for WAP
        - Treatment group given information about WAP and efforts were made to reduce barriers to participation
    - Potential barriers to participation in WAP
        - Application process requires much paperwork (to prevent fraud), including utility bills and documentation of earnings
        - Treatment group received assistance with the application
    - Costs of treatment
        - $50 per targeted household
        - $1,000 per weatherized household
    - Results
        - In treatment group, only 15% applied and only 6% received weatherization
            - But only 2% of control applied, and less than 1% received weatherization
        - Suggests non-monetary costs of participation are high!
        - Who participated
            - Encouraged households had larger incomes, more children, and more likely to have an elderly resident.
    - Their 2018 study suggests that the costs of the program outweigh the benefits
        - Retrofits reduced energy consumption by 10-20%. Upfront costs are twice the realized savings

- What are the market failures that affect adoption of energy efficiency?
    - Note that each has different policy solutions, so understanding which market failures matter is important, and is a question of ongoing research
        - Externalities
            - Some of the benefits of improved energy efficiency (e.g. reduced pollution) are benefits to society as a whole, rather than the potential adopter
            - Early adopters may help raise awareness about a product
        - Imperfect information
            - Buyers and sellers may have different information about potential savings
            - Consumers may be unaware of the energy efficiency of goods (e.g. how energy efficient is the home you are buying)
                - Renters are 1-10% less likely to have Energy Star appliances than homeowners
                - Owner-occupied homes have more insulation
            - Lemons model
                - Because difficult to observe energy efficiency, not willing to pay more for goods that are energy efficient
                    - Because unable to verify true energy efficiency
        - Principal-agent
            - The person installing the technology might not be rewarded for doing so (e.g. landlord/tenant relationship)
        - Credit constraints
            - Investments often have high up–front costs
            - Will need to finance initial investment to reap future savings
        - Learning by using
            - Early users provide positive externality of their experience to future users
        - Regulatory failures
            - Electricity market regulation often means electricity not priced at marginal cost
            - Gillingham and Palmer suggest this is less important, since prices are often above efficient levels

II. Behavioral Economics: A Theory of Internalities

- Recent work in behavioral economics suggests behavioral anomalies may also play a role
  - Behavioral economics combines psychology and economics, and notes cases where observed behavior differs from what traditional economic models predict
  - Systematic biases create a difference between <u>decision utility</u> and <u>experienced utility</u>.
    - Decision utility is the utility consumers maximize at the time of choice
    - Experienced utility is the utility consumers later realize as a result of a prior decision
    - Behavioral anomalies that lead to a difference between decision utility and experienced utility are <u>behavioral failures</u>
  - Note that if preferences are not stable over time, using consumer decisions to infer utility will lead to incorrect estimates
- Allcott and Sunstein discuss energy efficiency as example of behaviorally motivated policy
  - Involve large costs
  - Federal agencies suggest substantial net benefits from internality reduction
    - Regulatory Impact Analysis for light duty CAFE standards projects social benefits of $629 billion, versus costs of $153 billion.
      - $61 billion of benefits are net externality reductions
      - $475 billion are private benefits.
    - Note that even without internalities, private benefits will be large because of gasoline cost savings
    - But, there must be a nonexternality market failure for *net* private benefits to be positive.
      - Otherwise, people would choose more efficient vehicles without regulation.
      - RIA cites behavioral economics as justification. Reasons given include:
        - loss aversion
        - inadequate consumer attention to long-term savings
        - lack of salience of relevant benefits when purchasing

- I began this section with example to demonstrate behavioral anomalies and the importance of information. Below are the two types of questionnaires that I distributed. Note that both describe the same vehicles, but only the second tells the reader how to interpret the MPG figures

A town maintains a fleet of vehicles and is considering updating them. They have two types of vehicles:

- Type A vehicles get 15 miles per gallon (MPG)
- Type B vehicles get 34 miles per gallon (MPG)

The town has 100 of each type. Both types are driven 10,000 miles per year.

Because they get a bulk discount, they must replace all of a type at once. Moreover, they can only afford to replace one type of vehicle. They have two options:

- *Option 1*: Replace the 100 vehicles that get 15 MPG with vehicles that get 19 MPG
- *Option 2*: Replace the 100 vehicles that get 34 MPG with vehicles that get 44 MPG

The town's overriding goal is to reduce gas consumption of the fleet and thereby reduce harmful environmental consequences. Which option should they choose?

A town maintains a fleet of vehicles and is considering updating them. They have two types of vehicles:

- Type A vehicles get 15 miles per gallon (MPG)
- Type B vehicles get 34 miles per gallon (MPG)

The town translates miles per gallon into how many gallons are actually used per 100 miles. Type A vehicles use 6.67 gallons per 100 miles (100/15). Type B vehicles use 2.94 gallons per 100 miles (= 100/34).

The town have 100 of each type. Both types are driven 10,000 miles per year.

Because they get a bulk discount, they must replace all of a type at once. Moreover, they can only afford to replace one type of vehicle. They have two options:

- *Option 1*: Replace the 100 vehicles that use 6.67 gallons per 100 miles with vehicles that use 5.26 gallons per 100 miles
- *Option 2*: Replace the 100 vehicles that use 2.94 gallons per 100 miles with vehicles that use 2.27 gallons per 100 miles

The town's overriding goal is to reduce gas consumption of the fleet and thereby reduce harmful environmental consequences. Which option should they choose?

- Allcott and Sustein (2015) present a theory of internalities
    - Internalities are costs individuals impose on themselves by taking actions not in their own self interest.
    - Model
        - Individuals decide whether to take an action with equilibrium price p and a perfectly completive supply curve $S(p)$.
        - Consumers receive true utility v when taking the action.
            - In standard economic model, take action if $v > p$.
        - In behavioral economics, decision utility is $d = v - b$.
            - b is <u>bias</u>, that could be zero, positive, or negative.
            - Thus, v is <u>experienced utility</u>.
    - Figure 1 from Alloctt and Sunstein illustrates
        - Suppose consumers have negative bias against a decision ($d < v$)
            - $D_U(p)$ is demand if unbiased
            - $D_M(p)$ is market demand
                - Bias is the distance between $D_U(p)$ and $D_M(p)$
            - Market equilibrium is point a
            - Inefficiency
                - Consumers between *a* and *k* do not take the action even though true utility, represented by D_U, is greater than cost
                    - Welfare loss is triangle aef.
        - Policy solution
            - A subsidy equal to the bias, *b*, moves the equilibrium to *k*
    - Now, add externalities (e.g. D_2 in figure 1 in Allcott/Sustein)
        - The highest demand curve (D_2) includes social costs
            - This demand assumes no internalities and full social costs.
            - Optimal output moves to point j
            - Pigouvian tax needed to move from D_U to D_2
        - Note the distinction for how each policy works
            - Addressing the internalities affects investment in the energy efficient good, but does not change how the good is used
            - The Pigouvian tax addresses usage – higher gas prices encourage less driving.

- What are examples of behavioral anomalies that might affect energy efficiency?
    - Nonstandard preferences: Preferences that violate standard neoclassical assumptions
        - Self-control problems
            - A behavioral failure
            - Appears as time-inconsistent preferences
                - People often take long-term view for distant outcomes, but use higher discount rates for the near future
        - Reference-dependent preferences
            - Consumer's utility depends on a reference point
            - For example, consumers exhibit loss aversion
                - Decline in utility from a loss is much larger than gain in utility from gaining similar income
                - Consumers will be more concerned with potential bad outcomes (e.g. what if I invest in energy efficiency and fuel prices fall) than in potential savings
            - Not necessarily a behavioral failure (decision utility might not differ from experienced utility)
    - Nonstandard beliefs
        - Systematically incorrect beliefs about the future
        - While people's beliefs about future energy prices may be wrong, it is not clear that they are systematically wrong

- Nonstandard decision making
  - Decision processes that do not follow neoclassical assumptions
  - All could be behavioral failures
    - Limited attention
      - Follows from bounded rationality (Simon, 1955)
        - Consumers simplify complex decisions by focusing on only a subset of available information
      - Salience matters here
        - E.g. sales taxes added at register less salient than taxes added to list price
        - Paying tolls vs. EZPass
      - Regarding energy efficiency, limited attention may be a reason consumers don’t think much about fuel efficiency when buying a car
    - Framing of choices
      - Presentation of information affects choices
      - Important for properly designing energy efficiency labels
    - Suboptimal decision heuristics
      - Use of rules of thumb for decision making
        - E.g. favoring first name on ballot
      - Again, not directly studied in energy efficiency decisions

III. Policy Implications of Behavioral Economics for Energy Efficiency

- Understanding what failures need to be addressed (e.g. market failures, behavioral failures) is important to target policies correctly
    - Market failures
        - Pigouvian tax
            - Addresses environmental externalities from energy usage
        - Subsidies are an alternative
            - But must consider costs of raising funds
            - Other limitations
                - However, by lowering costs, may have rebound effect
                - Benefits may go to higher income households
                - Treat all consumers equally. Taxes make heavy users pay more
                - Doesn't price utilization
        - Providing information
            - Product labeling is an example
        - Financing programs
            - Some communities fund energy efficient investments and let consumers pay it back through utility bills (e.g. from resulting savings)
        - Minimum efficiency standards for energy worse than a tax or subsidy
            - For instance, people that use air conditioners infrequently won't benefit enough from the cost savings to pay more for a more efficient model
            - Efficiency standards may lead to rebound effects – use equipment more because it is cheaper to use
    - Behavioral failures
        - Will information alone be enough?
            - If bias comes from imperfect information or inattention, provide salient information
            - They may benefit more from this information
            - Several studies find that providing information alone does not have a large impact
            - Houde (2013) finds that Energy Star labeling has positive net benefits, but also crowds out other energy-saving activity
        - Social norms
            - Information can also be used to change preferences
                - For example, providing information on the energy consumption of neighbors
                - Has been found to reduce energy consumption
                    - One study found the savings similar to what would happen if prices rose 11-20%
            - Can target heavy users who may be unaware of their heavy usage, whereas energy efficiency subsidies are more likely

    - to be used by environmentalists who may have changed behavior anyway
  - Energy efficiency standards may also be an option
    - Imposes the "correct" choice on a consumer
    - May be inappropriate for some in the case of heterogeneous preferences
- Liberal paternalism (e.g. "Nudges")
  - Give people freedom to make choices, but frame choices in ways to lead to good decisions)
    - For example, make energy efficiency a default option
    - If bias comes from present bias, offer commitment contracts
  - Nudges can help target the distortion
    - Heterogeneity in the internality across users weakens the case for subsidies
      - Thus, *who* is induced to change their behavior matters
    - Most likely to improve welfare if target the largest investment inefficiencies
      - Thus, providing information to heavy energy users (e.g. via smart meters) is more effective
    - Thus, *nudges* may be a better policy instrument
      - If bias comes from imperfect information or inattention, provide salient information
      - If bias comes from present bias, offer commitment contracts
    - Implications for energy efficiency
      - Energy efficiency subsidies may be poorly targeted because well-informed environmentalists most likely to be aware of the subsidy and more likely to be marginal
      - In contrast, mailing home energy reports can target heavy users who may be unaware of their heavy usage
        - They may benefit more from this information
      - Note that nudges alone are not optimal unless nudges remove *all* systematic bias.
        - E.g. 40% of consumers report that they did not think about fuel costs when purchasing their last vehicle, even though information is on the sticker