

Research Statement (1000 words)
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I study energy and environmental economics in developing countries. Energy markets are failing developing countries, to devastating effect, for two main reasons. First, they impose costs on society through externalities like air pollution and global climate change that are caused by energy use. Second, the large firms that operate in energy markets have market power if left unregulated. Developing countries are dependent on energy use for their growth yet disproportionately harmed by these market failures.

My research studies how these energy market failures affect economic efficiency, both in direct costs and indirectly, through the policies that governments adopt to correct them. There are three main branches of my research agenda, on wholesale energy markets, retail energy markets, and environmental regulation.

1 Wholesale energy markets

The first branch of my research agenda studies wholesale energy markets. The animating market failure in wholesale markets is market power. I show that when India opened competition in power generation, the market did not in fact become competitive, because the downstream transmission segment remained a natural monopoly and highly constrained (Ryan, 2021). Market power may be exacerbated by weak contract enforcement. I study the effect of contract enforcement on the efficiency of large power projects in India. Weak contract enforcement favors firms that have stronger negotiating power with government buyers. I find that politically connected firms, anticipating that they can change their bids after the fact, bid low to win projects, despite that they are not the lowest cost suppliers of power (Ryan, 2020). A failure of contract enforcement thereby raises the cost of energy. In ongoing work, I extend this theme by studying how the risk of hold-up by state buyers in procurement auctions affects the prices

that private firms bid to supply solar power. I find that the risk of hold-up increases energy prices and thereby reduces sorely needed investment in green energy.

2 Retail energy markets

The second branch of my research agenda studies retail energy markets. Because energy markets are regulated or altogether state-run, governments often use energy as a means of redistribution—instead of giving welfare in cash, they give it in kind, in lower energy prices. This kind of redistribution can be very costly, both in external costs and because distorted prices undercut the quality of energy supply in developing countries (Burgess et al., 2020). We use a large field experiment to estimate the demand for electricity for households at the boundary of the electricity grid today, who can often choose between grid and off-grid sources of power. We find that households strongly prefer to buy grid electricity, but most of this advantage is due to government subsidies, without which they would buy off-grid solar power instead (Burgess et al., In progress).

If subsidizing energy is so wasteful, why do governments keep doing it? Two projects, joint with Anant Sudarshan, investigate the constraints on moving to more efficient energy pricing (this work is supported by NSF SES-1919076 and US AID 7200AA19FA00008). We study the rationing of electricity, which India uses, in place of efficient pricing, to manage groundwater resources. We find that rationing limits farmers' water use to about the efficient level, on average, despite very low prices for extracting water. Rationing is nonetheless inefficient, due to the misallocation of water from more to less productive farmers. The government likely uses rationing because it enacts a large and progressive redistribution of profits, from rich to poor farmers, whereas a mandate for efficient pricing would make a large number of farmers worse off (Ryan and Sudarshan, 2021). Ongoing field experiments in the Indian states of Punjab and Andhra Pradesh test whether the voluntary adoption of efficient pricing by farmers can nonetheless increase the efficiency of water use.

3 Environmental regulation

The third branch of my research studies environmental regulation. Developing countries today have some of the worst pollution recorded in history and are disproportionately exposed to climate change. This state of environmental crisis leads to calls for new corrective policies, but there is little evidence on whether existing environmental regulations have any bite in poor countries, or on what they cost firms.

Ryan (2018) finds that subsidizing firm energy audits, which are meant to reduce energy use and emissions, paradoxically may increase energy use, in response to higher energy productivity. Duflo, Greenstone, Pande and Ryan (2013*a*; 2013*b*) show that environmental auditors falsify reports of pollution, to appease client firms, but that a reform of the audit system, to make auditors independent, made reports more truthful and lowered pollution. Despite the prospect of corruption, Duflo, Greenstone, Pande and Ryan (2018) find that the state's own inspections have a greater effect on pollution emissions when the regulator is given discretion to target the most polluting firms. This paper was cited by the Nobel Prize Committee as an example of innovation in development economics (Nobel Committee, 2019).

With coauthors, I am conducting several ongoing field experiments in this domain on the benefits and costs of environmental regulations. The most ambitious of these experiments has launched a new cap-and-trade market for particulate matter air pollution in an Indian city and is studying the effect of this emissions market on firm pollution and abatement costs. Preliminary results suggest large environmental gains from the use of market-based regulation. I have also studied regulation in the banking sector, particularly how it mediates the heterogeneous responses of depositors to bank runs (Iyer, Puri and Ryan, 2016).

Several common methodological threads run through my research agenda: a deep understanding of the institutional context that gives rise to market failures, including political economy or informational constraints on corrective policy; novel data, from a combination of administrative sources and field work; and an empirical approach that combines structural

models, field experiments and descriptive data analysis as is appropriate for a given research question. The combination of these elements makes possible the practice of an energy and environmental economics that is grounded in how governments and markets actually work in developing countries.

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