Note

August 14, 2024 Coly Elhai

1 Updates

- Mark Agerton posted a draft of competing work on SSRN in July. Question: anything we should do other than continue trying to finish a draft?
- Working on estimating methane model- have made good progress
- Brainstorming other project ideas

2 Methane modeling progress

2.1 Static cost function estimation

In our model, every period the firm chooses $m_{it} \in [0, q_{it}]$, the quantity of gas extracted that it sends to market (i.e., sells). The remaining gas is flared or vented (at no cost). Firm i's profits in period t is given by

$$\max_{m_{it} \in [0, q_{it}]} p_t m_{it} - c_i(m_{it}; r_t, q_{it}),$$

where $c_i(m_{it}; r_t, q_{it})$ is the marketing cost. This function $c(\cdot)$ captures all costs related to selling the gas (processing the gas, transporting it to market via pipelines, etc.). We assume the firms are price-takers and equate marginal revenue to marginal cost, so marginal cost is identified from prices.

We've struggled to find a functional form for $c()$ that gives reasonable results[1], but we think we've now found a few. One of them assumes that costs take the form:

$$c_i(m_{it}; r_t, q_{it}) = (\gamma_1 r_t)\, m_{it} + \gamma_2 \left[(q_{it} - m_{it}) \log\left(\frac{m_{it}}{q_{it}}\right) + m_{it} \right]$$

where γ_1 captures sensitivity to the spot market for transmission, γ_2 captures the convexity of marketing costs, and γ_3 captures dispersion in costs related to production levels. This cost function yields the (more intuitive-looking) FOC:

$$p_t = \gamma_1 r_t + \gamma_2 \log\left(1 - \frac{m_{it}}{q_{it}}\right)$$

An attractive feature of this FOC is that it essentially matches the shape of the data: net prices are low when the marketed share of gas is low, and net prices increase rapidly as we approach a marketed share of 1 (see Figure 2). We estimate γ terms by running a regression of the FOC.

Question: Do you think this function is defensible? In order to avoid some of the issues we've had with other functions, it imposes a lot of structure on the data.

Next steps:

- Dynamic estimation: a few things to iron out here, including figuring out how best to estimate conditional choice probabilities given a continuous choice variable (number of drilled wells).
- Simulating counterfactuals
- Draft edits

[1] We want costs to be always positive, convex in marketed volume, and increasing in transmission costs.

3 Project proposals

3.1 Emissions in Space: The Case of Manufacturing

- **Purpose:** Quantify differences in the carbon intensity of manufacturing across space. Determine the elasticity of energy demand with respect to prices, including the substitutability of different energy inputs. Analyze the economic and climate impacts of various policies affecting industrial energy consumption via 1) firm location subsidies, 2) electricity transmission infrastructure, and 3) general transport infrastructure.
- **Motivation:** Many policies (place-based industrial policy, local subsidies, transport infrastructure) influence industrial location choices. These policies almost never consider the climate consequences of these impacts. Because industry consumes huge amounts of electricity, and because the carbon intensity of electricity varies tremendously across space, these climate consequences may be of first-order importance. Furthermore, given the challenges of building long-distance electricity transmission infrastructure, it may be worthwhile to consider alternate policies affecting the geography of energy demand rather than of energy supply.
- **Approach:** Use plant-level data on energy use, energy type, and production in the U.S. (Manufacturing Energy Consumption Survey + Economic Census). First, establish patterns in the carbon intensity of manufacturing activity across space. In which places is production most polluting, and to what extent is heterogeneity across space mediated by the carbon intensity of the electric grid? Then, build a model of optimal firm location choice and energy input mix, accounting for input costs, trade costs, and agglomeration. Estimate parameters using variation in electricity prices over time and space induced by the fracking revolution and heterogeneity in natural gas generator prevalence across space. Examine production and emissions under counterfactuals (changes in trade costs, changes in energy costs, place-based subsidies).
- **Contribution:** This project will demonstrate the importance of an as-yet unstudied mechanism in climate change policy: the impact of industry location on the carbon intensity of production. I will explore the scale to which this mechanism affects the social welfare gains/losses from building more transmission, building other transport infrastructure, or using place-based subsidies.

3.2 Data Centers and the Geography of Energy Use

Similar to 3.1, but focusing entirely on data centers. The appeal of data centers is that energy is by far the most important input. Because data centers produce a good that is nearly instantaneously transported, they have potential to substitute for electricity transmission. Data centers have been in the news recently because of rapid growth in their energy use. The policy implications are also clearer: many states offer substantial tax subsidies for data centers.

To do this project, I would need to build a database of data center locations and openings. I am talking to a Berkeley ARE fifth year grad student about collaborating on this data build.

3.3 Emissions in Space: International Trade in Energy-Intensive Goods

Again, similar to proposal 3.1 but focusing on the international dimension. Specifically: to what extent did the fracking boom and resulting decrease in gas costs in the US lead to a global redistribution in the production of gas-intensive goods? This category is dominated by fertilizer, but possibly includes electricity intensive goods such as aluminum as well. What were the climate consequences of this reallocation, and what can we infer about the global gains from reducing energy costs and carbon intensity in only some countries?

3.4 Climate Grants: Fiscal Federalism in a Warming World

I'm working with Simon Essig Aberg to develop a project focusing on state and local government applications for federal funds. Below are hypothetical abstracts for different angles on this project:

Grant crowd-out: On average, transfers from the federal government account for nearly 30% of state and local revenues each year. Though some of these transfers are formula-based (Medicare, for instance), some federal grant programs require states and localities to apply for funding. These applications can be arduous, especially for municipalities that are understaffed and overburdened. In this project, we investigate whether local governments' capacity constraints (staff hours, expertise) reduce their ability to apply for and manage federal funding. We build a novel database of grant-related local government employment for jurisdictions across the country. We find significant crowd-out in federal grant programs for localities we identify as constrained: for these localities, an additional $1 in grants won through a new program corresponds with about an $x decline in grants won through pre-existing programs. For un-constrained localities, we find $y crowd-out. Our results imply that there are equity and efficiency costs to creating new federal grant programs without recognizing the administrative burden this imposes on constrained communities.

Comparing different funding mechanisms : More than X% of the United States federal government's social programming is implemented by states, local governments, and nonprofits. Funding is distributed to these entities through mechanisms including competitive grants and formula allocations. We build a comprehensive database of applications to federal climate grant programs funded through recent legislation. We then relate the funding mechanism to applicant selection, timelines, and the degree of competition. We find that applicants to competitive grants differ in X, Y, Z way from recipients of formula allocations. Funding through competitive grants is distributed with an average delay of X relative to formula allocations. Next, we focus on grant program X, where outcomes and efficiency are measurable and there has been variation in the funding mechanism in recent years. We find that cost-efficiency when funds are distributed via competitive grants is X% higher than when funds are distributed with a formula, but that the same patterns in selection and timeline hold. The social present value of cost efficiency must be X to justify the use of competitive grants.

4 Appendix

4.1 Dynamic model of well drilling

Firms choose the number of wells to drill in each period, $a_{it} \in A = \{0, 1, ..., J\}$, to maximize the stream of future-discounted expected profits. Wells drilled in period t begin producing in period $t+1$. Drilling costs c_t are a function of number of wells drilled and are allowed to vary by period. The firm's dynamic optimization problem is given by

$$V(\Omega_{it}, \varepsilon_{it}) = \max_{a} \bar{\pi}_i(\Omega_{it}) - c(\Omega_{it}, a) \; - \tau f a + \varepsilon_{it}(a) + \beta \mathbb{E}[V(\Omega_{it+1}, \varepsilon_{it+1}) | \Omega_{it}, \varepsilon_{it}, a] \tag{1}$$

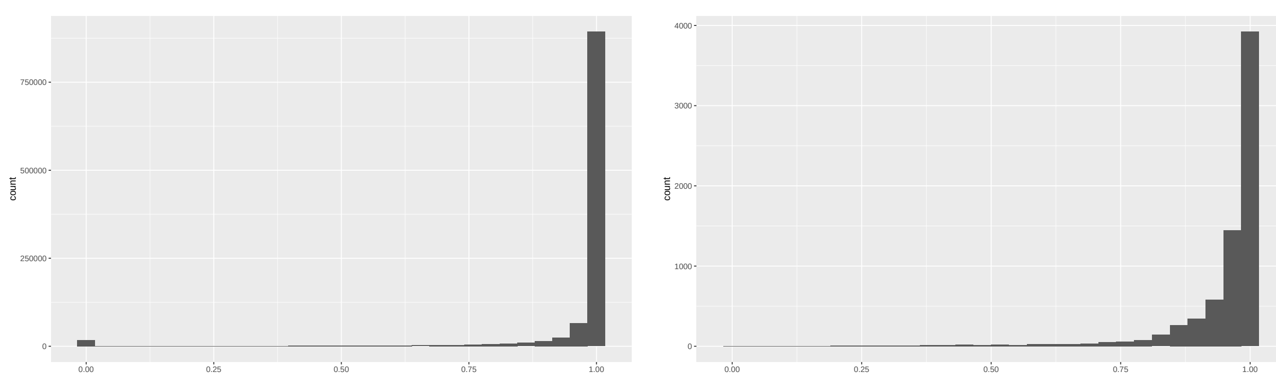
where β is the discount rate, f is the emissions associated with each drilling event, and $\varepsilon_{it}(a)$ is a profit shock which is assumed to be i.i.d. Type 1 Extreme Value with mean zero and scale parameter σ_ε. Profit shocks $\varepsilon_{it}(a)$ are independently distributed over time and across firms.

4.2 Methane figures

Figure 1: Producer-reported un-flared gas

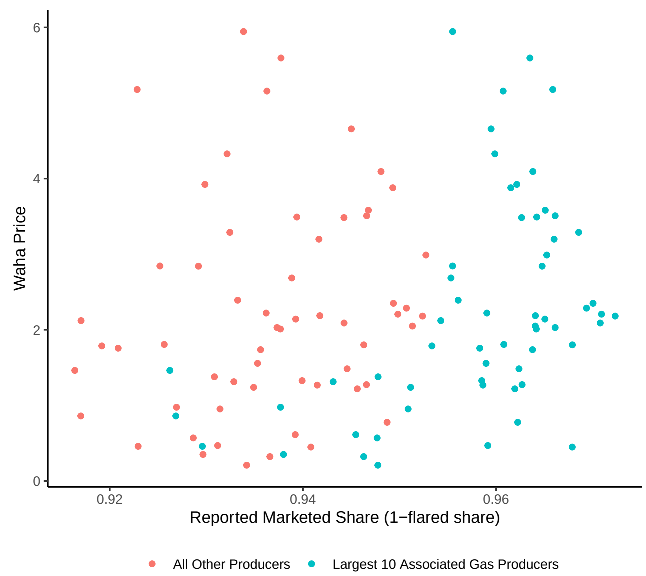
(a) Lease-level

(b) Producer-level



Notes: The x-axis indicates marketed gas share, i.e. the ratio of total gas production net of venting and flaring to total gas production. Each observation is a lease-month or producer-month. Data span January 2017 through January 2023. The sample includes Permian oil leases (RRC districts 7C, 8, 8A) owned by the 100 biggest Permian casinghead gas-producing companies in the sample.

Figure 2: Producer-reported unflared gas vs. Waha basis



Notes: Each observation is a category-month average. Data span January 2018 through January 2023. The sample includes all oil leases in the districts that the Texas Railroad Commission designates as belonging to the Permian Basin (7C, 8, and 8A). "Waha Basis" is the difference between Henry and Waha spot prices, averaged within month. We calculate marketed share to be 1 minus the ratio of vented/flared gas to total gas produced. The largest 10 producers are defined as the operators that accounted for the most casinghead gas (i.e., gas coming from oil wells) produced during this period.