**Some empirical RF findings:**

* Import of coal represents 40% of total coal consumption while imports of other fuels represents close to 0% in selected industries only.
  + However, imported coal prices are on average twice as high as domestic coal prices (inclusive of transportation costs or just about quality?)
* Analysis still holds with while keeping firms that only produce one output, but the number of observations significantly drop when fully balancing the panel. However, the number of outputs produced doesn’t have a statistically significant effect on the probability of switching.

**Prices**

* Districts interacted with years explain 60% of natural gas price variation and 55% of the coal price variation.
* Price of natural gas significantly more disperse than price of coal.

**Preliminary results on Switching**

Almost all following results are consistent across both samples (all manufacturing industries and selected industries). In each regression on productivity, I control for most disaggregated industry level and districts (roughly 488 in the data).

* Plants that switch to natural gas are more productive both in the year of switching and across all years in both samples.
* Plants that switch to any fuel are typically more productive firms overall but this relationship between productivity and switching is more robust when it comes to natural gas only and insignificant when looking at other fuels in isolation.
* Plants that switch off coal tend to be less productive firms across all years in both samples.
* Switching to natural gas is positively correlated with some measure of investment (K-L.K).
* Bigger firms are more likely to switching.
* Plants that switch to natural gas tend to be more **energy efficient** (less energy required per unit of output) 🡪 productivity channel why plants might want to switch.

**Entry and Exit**

* Incumbents tend to use more coal and natural gas but less oil than newcomers and firms exiters in both samples.
* Incumbents represent roughly 80% of energy consumption and GHG emissions across both samples.

**Natural gas structure in India:**

1. State-owned company owns and manages 70% of natural gas pipelines (GAIL), and works jointly with the regulatory board of natural gas (ONGC) to set transportation prices:
   1. Until 2006, GAIL had a monopoly on the transportation networks of natural gas, but after 2006 the government allowed private companies and joint ventures to build and operate more networks.
   2. Divided into zones of length 300km along the path of the pipeline. Each zone covers 50km in width on both sides of the pipeline. Beyond that, private consumers must set up their own transportation infrastructures or jointly with GAIL but it is out of the regulatory scope of ONGC.
2. Pricing in upstream markets (from natural gas production/imports to pipeline) was historically set in majority by the government but has seen recent deregulation to have prices closer to market prices.
3. Mapping existing pipeline networks to zones and districts/states: use [www.gem.wiki](http://www.gem.wiki) as main source

**Alternative policy other than carbon tax**

* 2021: Government of india plans to “equalize” transportation price of natural gas (20-30% more expensive when closer to pipeline and similarly cheaper when further from pipeline) to incentivize consumption from further.
  + Good? Bad? Use model to evaluate this policy, and study optimal relative transportation prices between zones as an incentives to stimulate plants switching to natural gas from more polluting fuels.

**Effect of proximity to gas pipeline on Gas prices and consumption:**

A lot of these effects are more robust and more consistent with priors when including all industries because there may not be enough geographical support of plants that use natural gas across all districts in the selected industries.

* Bulk of the effect (significantly lower prices and higher quantity consumed) is for plants located in a district where a pipeline directly passes and in Zone 1 (that is less than 300km from the source of natural gas).
* Conditional on using natural gas, plants that are not connected to the pipeline system (either directly or indirectly) use on average less natural gas than plants who are connected to the system, and usage almost decreases monotically as plants locate further and further away from the source of gas.
* At the extensive margin, plants that are less than 300km from the source an directly connected to a pipeline are significantly more likely to use natural gas, and this probability decreases as plants locate further apart from the source and become indirectly connected, but always more likely to use natural gas than plants to are not connected to the system.
* In both samples, plants that are not connected to the pipeline system but still use natural gas are more productive and this is statistically significant. Emphasize that plants who cannot access pipelines typically need to purchase natural gas in liquified form and need to compress it themselves into gas form, which require significant capital to do so.

**Goal of model**

* Quantify when it is optimal for a plant to add a new fuel and when it is optimal for a plant to stop using an existing fuel.