Data Mapping Report

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India's Cold Chain: a case study of power grid stability and cold storage capacity in India's wheat markets

Despite a record wheat harvest this year, India has made headlines by enacting two significant export bans: first on wheat last year following a drop in output, and more recently on non-basmati white rice. While the export bans dampen India's potential to capitalize on the spike in global wheat prices triggered by the disruption in Ukraine, they also highlight the importance of building robust domestic infrastructure to manage food security effectively. India continues to suffer significant post-harvest losses (PHLs) for perishables due to inadequate cold storage infrastructure. These losses are estimated to be around 25-30%, which translates to massive economic and nutritional losses.

For context, Indian markets (mandis) have a decades-long network of Agricultural Produce Market Committees (APMCs) established to regulate the buying and selling of agricultural produce. In an effort to diminish the middlemen costs and information asymmetry, trading networks (ETNs) like the National Agricultural Market (e-NAM) are on the rise.

Notably, e-NAM uses warehouses and cold storage as market yards to facilitate warehouse-based trading. Thus, if an Indian state's e-NAM participation could act as a proxy for power grid stability and the adoption of technology in the local wheat markets, we could treat this like a natural experiment on the efficacy of digital networks and APMC regulation on evolving India's cold storage capacity.

Spatial Distributions

Map of Indian APMC participation in e-NAM per state (as a % of APMCs)

I am in the process of grouping APMCs by commodity, through which I only want to keep the ones that specialize in wheat for the sake of my study. However, this is a prototype with all commodities.

Overlayed are the districts within each state. As I am still trying to troubleshoot some errors in creating centroids, the vision is to create an additional map of the states. I would ideally

make a centroid for each district whose size is proportional to its cold storage capacity. I have district-wide cold storage capacity from 2018 to 2022. I would want to see the evolution of the centroids grow or fall depending on e-NAM participation to assess the impact of e-NAM's warehousing efforts.

```
#| include: false
##Add centroid per district. make size proportional to magnitude of cold storage available

indiadistbound <- st_read("geoADM2/geoBoundaries-IND-ADM2_simplified.shp")
```

```
Reading layer `geoBoundaries-IND-ADM2_simplified' from data source
  `C:\Users\rhine\OneDrive\Documents\GitHub\econ429\Projects\geoADM2\geoBoundaries-IND-ADM2_s
  using driver `ESRI Shapefile'
Simple feature collection with 735 features and 5 fields
Geometry type: MULTIPOLYGON
Dimension:     XY
Bounding box:  xmin: 68.17939 ymin: 6.75649 xmax: 97.39744 ymax: 37.0773
Geodetic CRS:  WGS 84
```

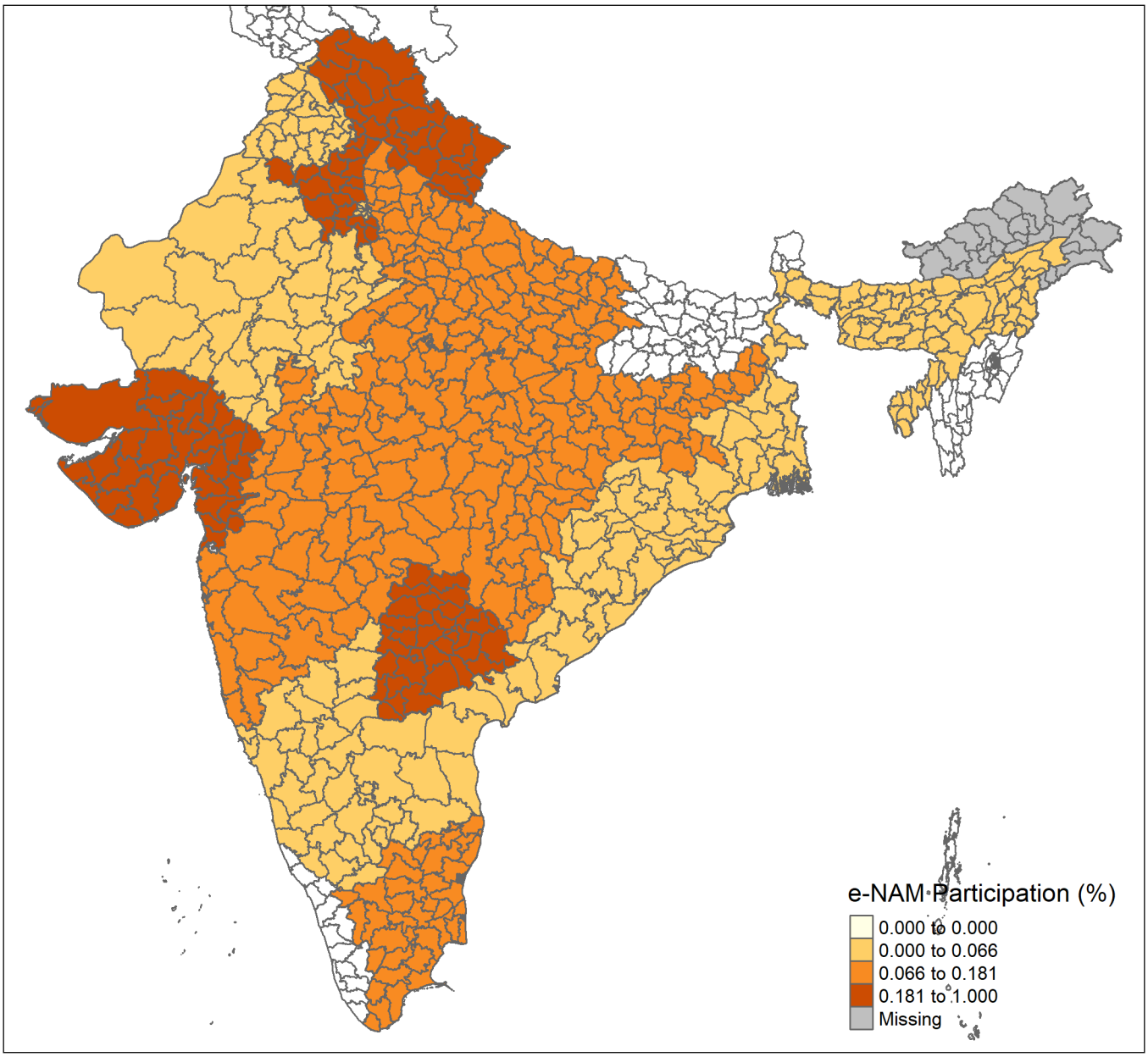
```
#tm_shape(indiabound) + tm_borders() + tm_fill("enam_pct", title = "e-NAM Participation (%
#making centroids
#indiadistcent <- indiadistbound|>
 #st_centroid()
map1 <- tm_shape(indiabound) + tm_borders() + tm_fill("enam_pct", title = "e-NAM Participa
#making centroids
tmap_save(map1,"map1.png")
```

```
Map saved to C:\Users\rhine\OneDrive\Documents\GitHub\econ429\Projects\map1.png

Resolution: 2191.843 by 2012.005 pixels

Size: 7.306143 by 6.706685 inches (300 dpi)
```

```
knitr::include_graphics("map1.png")
```



Summary Statistics

This is a table of the average commodity prices (in lakh rupees) for arrivals of wheat for Feb 13, 2024. This is district-wide data where each district specializes in a particular commodity. The number of districts per state specializing in wheat is displayed under N.

I also wanted to use this for commodities utilizing cold storages (so wheat, rice, amongst others) to analyze whether the issue is wheat specific or not. I would use dates that surround a particular wheat supply shock to confirm whether the volatility is endogenous to my selection of wheat.

```
state_com_prices <- read_csv("state_mandi_commodity_prices_2-13.csv")
```

```
Rows: 9567 Columns: 10
-- Column specification --------------------------------------------------------
Delimiter: ","
chr (7): State, District, Market, Commodity, Variety, Grade, Arrival_Date
dbl (3): Min_x0020_Price, Max_x0020_Price, Modal_x0020_Price

i Use `spec()` to retrieve the full column specification for this data.
i Specify the column types or set `show_col_types = FALSE` to quiet this message.
```

```
com_sum <- state_com_prices |>
  filter(Commodity == "Wheat" ) |>
  group_by(State)|>
  summarize(
    N = n(),
    avgPrice = mean(Modal_x0020_Price)
  ) |>
  kable(booktabs = TRUE, digits = 0) |>
  kableExtra::kable_styling(full_width = TRUE)

com_sum
```

State	N	avgPrice
Bihar	1	2450
Chattisgarh	6	2478
Gujarat	53	2590
Karnataka	6	2866
Madhya Pradesh	73	2397
Maharashtra	40	2548
Rajasthan	23	2434
Uttar Pradesh	103	2483
Uttrakhand	1	2400
West Bengal	2	2800