

# Self-Enforcing Tax Design and Supply Chain Formalization

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# Motivation

- ▶ Developing countries collect far less tax as a share of GDP than rich ones (10–14% vs. 30–40%; Besley and Persson, 2014)
- ▶ Theory: tax structures such as VAT can cascade formalization through supply chains
  - ▶ de Paula and Scheinkman (2010): formal buyers demand invoices to claim credits  $\Rightarrow$  informal suppliers register to keep formal customers
- ▶ Empirics: direct evidence is limited
  - ▶ Pomeranz (2015): Chile RCT, spillovers to downstream clients using VAT credits
  - ▶ Agrawal and Zimmermann (2025): India's staggered state VAT raised firm sales and cut effective tax rates
  - ▶ Agarwal et al. (2024): RD at GST exemption threshold; compliance up overall, cost overreporting at small labor-intensive service firms
  - ▶ Gap: macro evidence on the nationwide GST reform for India

# India's GST Reform

- ▶ July 1, 2017: unified national VAT on goods and services — input tax credits flow across the entire supply chain
- ▶ Replaced a fragmented system:
  - ▶ Central excise on manufacturing
  - ▶ 29 state VATs, no credit across state borders
  - ▶ Central Sales Tax on interstate sales (non-creditable)
  - ▶ Service tax, no credit against goods taxes
  - ▶ Countervailing and special additional duty on imports

# India's GST Reform

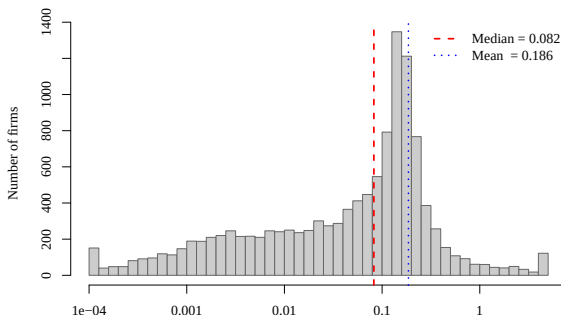
- ▶ Expand the tax base
- ▶ Remove cascading taxes
- ▶ Reduce reliance on monitoring in tax enforcement
- ▶ Remove distortions in firm decisions:
  - ▶ factory location
  - ▶ supplier choices
  - ▶ vertical integration
  - ▶ whether to formalize

## Data: CMIE Prowess

- ▶ **Period:** fiscal years 2013–2022 (4 years pre-, 5 years post-GST)
- ▶ **Sample:** 12,024 firms from the CMIE Prowess panel
  - ▶ exclude financial firms (NIC 64–66)
  - ▶ require positive raw materials reported in the pre-GST window (2014–16) — needed to compute exposure
- ▶ **Main variables:**
  - ▶ raw material expenditures — documented input purchases
  - ▶ indirect taxes paid — excise, state VAT, service tax, GST
- ▶ **Other variables:** sector (NIC), ownership, size tercile (based on pre-GST total assets)

# Treatment: Pre-GST Exposure to Cascading Taxes

$$\text{Exposure}_i = \frac{1}{3} \sum_{t=2014}^{2016} \frac{\text{Indirect Taxes}_{it}}{\text{Raw Materials}_{it}}$$



Exposure (pre-GST indirect taxes / raw materials), log scale

Note: Firm-level pre-GST exposure, winsorized at the 1st and 99th percentiles. Sample of 12,024 firms from CMIE Prowess. Higher exposure indicates more non-creditable cascading per rupee of inputs and a stronger incentive to formalize the supply chain under GST.

# Empirical Strategy

- ▶ Difference-in-differences with continuous treatment intensity:

$$Y_{it} = \alpha_i + \lambda_t + \beta (\text{Post}_t \times \text{Exposure}_i) + \varepsilon_{it}$$

- ▶  $Y_{it}$ : log raw materials or log indirect taxes
- ▶  $\alpha_i$  firm FE absorb permanent firm heterogeneity;  $\lambda_t$  year FE absorb common shocks
- ▶ Standard errors clustered at firm level

# Identification

- ▶ **Identifying assumption:** absent GST, high- and low-exposure firms would have followed parallel trends in log raw materials and log indirect taxes
- ▶ Supporting evidence:
  - ▶ exposure is *predetermined* — constructed from 2014–2016 data, strictly pre-reform
  - ▶ event-study pre-trends flat in the years immediately before GST
  - ▶ simultaneous national rollout  $\Rightarrow$  no firm selection on treatment timing or location
  - ▶ balance on observables across exposure terciles (size, age, sector mix)
- ▶ Year FE absorb common shocks

## Difference-in-Differences Results

|                        | Log Raw Materials<br>(1) | Log Indirect Taxes<br>(2) |
|------------------------|--------------------------|---------------------------|
| Post $\times$ Exposure | 0.297***<br>(0.090)      | -0.407***<br>(0.060)      |
| Observations           | 131,052                  | 131,052                   |

*Notes:* Specifications include firm fixed effects and industry  $\times$  year fixed effects, with standard errors clustered at the firm level in parentheses. The sample is 12,024 firms from the CMIE Prowess panel (excluding financial firms, NIC 64–66) over fiscal years 2013–2022. The dependent variable is log raw material expenditures in column (1) and log indirect taxes paid in column (2). Post is an indicator for fiscal years starting April 2017 or later. Exposure is the firm-level ratio of indirect taxes to raw materials averaged over 2014–2016 and winsorized at the 1st and 99th percentiles. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$ .

Scaled by mean exposure (0.186), the estimates imply effects of +5.5 percent on raw material expenditures and -7.6 percent on indirect taxes paid.

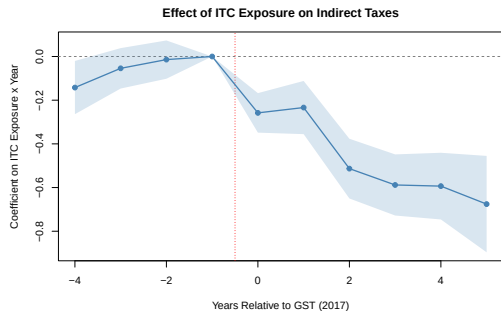
## Event Study Specification

$$Y_{it} = \alpha_i + \lambda_t + \sum_{k \neq -1} \beta_k (\mathbb{1}\{t - 2017 = k\} \times \text{Exposure}_i) + \varepsilon_{it}$$

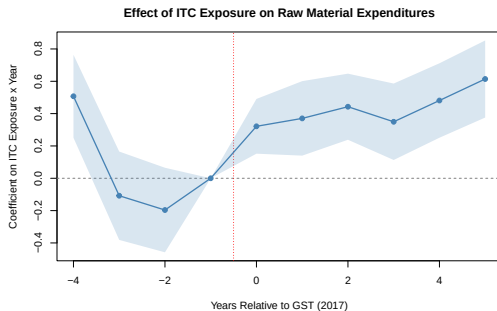
- ▶  $\beta_k$ : effect of exposure at event time  $k$  relative to  $k = -1$  (FY2016, the last pre-GST year)
- ▶  $k = 0$  corresponds to FY2017, the first post-GST year
- ▶ Pre-reform coefficients ( $k < -1$ ) test for differential pre-trends
- ▶ Post-reform coefficients ( $k \geq 0$ ) trace the dynamic path of treatment effects
- ▶ Firm FE, industry  $\times$  year FE; standard errors clustered at firm level

# Event Study: Indirect Taxes and Raw Materials

(a) Indirect Taxes



(b) Raw Materials



*Notes:* Coefficients from event-study regressions interacting exposure with year indicators. Reference period is  $k = -1$  (FY2016, the last pre-GST year);  $k = 0$  is FY2017, the first post-GST year. The sample is 12,024 firms from the CMIE Prowess panel (excluding financial firms, NIC 64–66) over fiscal years 2013–2022. Specifications include firm fixed effects and industry  $\times$  year fixed effects; shaded areas show 95% confidence intervals based on firm-clustered standard errors.

Pre-trends flat in the years immediately before GST; post-reform effects appear on impact and grow over time.

## Dynamic Effects by Year

|                    | Years Since GST Implementation |                      |                      |                      |                      |                      |
|--------------------|--------------------------------|----------------------|----------------------|----------------------|----------------------|----------------------|
|                    | $t = 0$                        | $t = 1$              | $t = 2$              | $t = 3$              | $t = 4$              | $t = 5$              |
| Log Raw Materials  | 0.321***<br>(0.086)            | 0.370***<br>(0.118)  | 0.443***<br>(0.104)  | 0.350***<br>(0.121)  | 0.481***<br>(0.117)  | 0.614***<br>(0.122)  |
| Log Indirect Taxes | -0.258***<br>(0.046)           | -0.234***<br>(0.062) | -0.513***<br>(0.070) | -0.588***<br>(0.071) | -0.593***<br>(0.078) | -0.676***<br>(0.113) |

*Notes:* Year-by-year coefficients on  $\text{Exposure}_i \times \mathbf{1}\{t - 2017 = k\}$  from the event-study specification. Reference period is  $k = -1$  (FY2016). Specifications include firm fixed effects and industry  $\times$  year fixed effects, with standard errors clustered at the firm level in parentheses. The sample is 12,024 firms from the CMIE Prowess panel (excluding financial firms, NIC 64–66) over fiscal years 2013–2022. \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.10$ .

At mean exposure, raw materials rise from +6% at  $t = 0$  to +11% at  $t = 5$ ; indirect taxes fall from -5% to -13% — effects approximately double over five years.

## Tax Base Expands From Below

| Fiscal Year | Prowess Firms | Prowess Total (Rs. Cr) | Prowess Share |
|-------------|---------------|------------------------|---------------|
| 2018–19     | 37,130        | 538,335                | 45.7%         |
| 2019–20     | 37,666        | 493,543                | 40.4%         |
| 2020–21     | 37,394        | 508,438                | 44.8%         |
| 2021–22     | 36,815        | 647,779                | 43.9%         |
| 2022–23     | 35,633        | 695,737                | 38.4%         |
| 2023–24     | 30,651        | 667,601                | 33.1%         |
| 2024–25     | 23,671        | 655,165                | 29.7%         |

*Notes:* Prowess Total is the sum of indirect taxes and GST paid by firms in the CMIE Prowess database, in crores of rupees. Prowess Share is Prowess Total divided by gross national GST collections from government sources. Prowess covers primarily large and medium formal-sector firms.

Prowess total GST rises, but its share of national collections falls from 46% in 2018–19 to 30% in 2024–25 — smaller, previously informal firms are entering the formal tax net.

## Effective Tax Rates Compress

| Period               | Mean   | Variance | IQR    | N      |
|----------------------|--------|----------|--------|--------|
| Pre-GST (2013–2016)  | 0.167  | 0.146    | 0.156  | 54,009 |
| Post-GST (2018–2022) | 0.101  | 0.130    | 0.043  | 76,377 |
| Change               | −0.067 | −0.016   | −0.113 |        |
| Percent change       | −40%   | −11%     | −72%   |        |

*Notes:* The effective input tax rate  $\tau_m$  is defined as indirect taxes paid divided by raw material expenditures, winsorized at the 1st and 99th percentiles. IQR is the interquartile range ( $P75 - P25$ ). The pre-GST sample pools firm-years from 2013–2016 and the post-GST sample pools firm-years from 2018–2022; 2017 is omitted as the transition year. Sample of 12,024 firms from the CMIE Prowess panel.

The mean falls by 40% and the IQR collapses by 72%: heterogeneous cascading replaced by uniform input tax credits.

# Conclusion

- ▶ GST's contribution: reduces the role of direct monitoring and removes cascading distortions in firm optimization
- ▶ Self-enforcement: contingent input tax credits deputize formal buyers to demand invoices from suppliers — formalization propagates upstream through supply chains
- ▶ Reducing distortions: uniform input credits compress the dispersion of effective tax rates and free firm decisions on supplier choice, factory location, vertical integration, and formalization from tax considerations

# Thank you

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