Targeting Winners: Firm Growth, Resource Allocation, and Aggregate Effects of India's PLI Scheme

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Motivation

- Industrial policy has re-emerged as a central macroeconomic tool in developing economies.
- India's Production-Linked Incentive (PLI) schemes:
  - Over $26 billion in subsidies.
  - 14 targeted manufacturing sectors (electronics, pharma, autos, etc.).
- Distinctive feature: **targeting** relatively large, productive, and globally competitive firms ("picking winners").
- **Core question**:
  - *Can industrial policy accelerate manufacturing growth in India by scaling up selected large and productive firms — boosting their productivity and generating broader aggregate gains — while preserving a dynamic, competitive environment?*

Project Overview

- Integrate:
  1. **Reduced-form causal evidence** exploiting the staggered rollout of PLI.
  2. **Dynamic structural model** of heterogeneous firms with PLI-style subsidies.
- Quantify three PLI mechanisms:
  1. Scale expansion among already-productive firms.
  2. Productivity upgrading through technology adoption & capability building.
  3. Reallocation effects for non-beneficiary firms (winners vs. displaced).

Institutional Background: PLI Design

- PLI launched in 2020–21 to:
  - Promote domestic manufacturing and build scale
  - Reduce import dependence and expand exports.
- Eligibility to apply (sector-specific) requires:
  - **Product/sector fit**: firm operates in notified manufacturing segments,
  - **Prior production / revenue track record** above threshold,
  - **Minimum capex commitment plan** for eligible machinery/facilities,
  - **Incremental output plan** over 2019–20 base year,
  - **Financial compliance readiness** (net worth, NPA-free status, tax compliance).

$\rightarrow$ *These criteria allow firms to enter the applicant pool; approval comes later (Slide 5).*

PLI Selection and Assignment in Practice

- **Selection among eligible applicants is based on**:
  - Competitive ranking on proposed incremental production and export commitments,
  - Financial capacity and balance-sheet strength to undertake minimum capex,
  - Past performance on compliance, quality standards, and market presence,
  - Domestic value-addition and technology-upgrading plans,
  - Strategic considerations in some sectors (supplier diversification, GVC integration).

  Approval is not automatic: PLI picks among applicants with credible scale and capability-building potential.

- **Assignment becomes effective only when:**
  - Incremental production/sales exceed the base year threshold,
  - Within a 4–5 year incentive horizon.

PLI Sector Coverage and Rollout

- Staggered sectoral rollout generates quasi-experimental timing variation.

Sector	Rollout Year
Mobile devices & electronics	2020
Pharmaceuticals (KSMs/APIs)	2020
Medical devices	2020
Automobiles & auto components	2021
ACC batteries	2021
Telecom equipment	2021
White goods (ACs, LEDs)	2021
Textiles (MMF/Technical)	2021
Food processing	2021
Specialty steel	2021
Solar PV modules	2021
Drones & components	2022
IT hardware	2022
Semiconductors (design/fabs)	2022

Empirical Exercise: Data Construction

Firm-year panel combining:

- **CMIE Prowess:** audited financial statements for India's organized manufacturing firms,
- **Official PLI beneficiary lists:** matched by sector and firm identity across ministries (Electronics & IT, Pharmaceuticals, Heavy Industries, etc.).

Key Prowess variables used in our analysis:

- *Scale expansion:* Net sales, gross fixed assets (GFA), capex, raw material expenses, Wage bill, export earnings
- *Capability upgrading & GVC integration:* Export earnings (forex), import spending
- *Performance & profitability:* Profit after Tax
- *Productivity measures:* Constructed TFPQ and TFPR from revenue, capital, and input data.
- *Firm-level characteristics as controls:* total assets, leverage, employment, firm age, sector market share.

Baseline Specification

- Staggered rollout across sectors $\Rightarrow$ variation in treatment timing
- Staggered DiD specification:

$$Y_{ist} = \alpha + \beta_1 PLI_i + \beta_2 PLI_{it}^{\text{cum}} + \delta_s + \lambda_t + \varepsilon_{ist}$$

- Augmented with rich pre-treatment controls:

$$Y_{ist} = \alpha + \beta_1 PLI_i + \beta_2 PLI_{it}^{\text{cum}} + X_i^{\text{pre}\top}\gamma + \delta_s + \lambda_t + \varepsilon_{ist}$$

Variables and Controls

Outcomes Y_{ist}:

- Sales, exports, employment, capital stock (GFA),
- Input use, profits (PAT),
- Productivity measures: TFPQ and TFPR.

Treatment variables:

- PLI_i: firm approved under any PLI scheme (time-invariant).
- PLI_{it}^{cum}: $= 1$ from the first approval year onward.

Pre-treatment controls X_i^{pre}:

- 2014–2018 characteristics: total assets, leverage, employment, firm age, sector market share.

Effect of PLI on Net Sales (in Rs. million)

	(1) Net sales No ctrls	(2) Net sales Ctrls 14–18	(3) Net sales Ctrls 15–18	(4) Net sales Ctrls 16–18
PLI firm	41,545***	-8,982***	-9,274***	-11,624***
	(1,765)	(2,335)	(2,353)	(2,420)
PLI firm × Post	20,996***	40,133***	39,466***	38,861***
	(2,708)	(3,410)	(3,430)	(3,527)
Firm controls	No	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	167,259	23,507	22,918	21,983
R^2	0.012	0.905	0.907	0.909

Firm controls: size, assets, debt–equity ratio, employees, age, market share. Columns use pre-PLI averages for 2014–18, 2015–18, 2016–18 respectively. *** p<0.01, ** p<0.05, * p<0.1.

Effect of PLI on Exports (in Rs. million)

	(1) Exports No ctrls	(2) Exports Ctrls 14–18	(3) Exports Ctrls 15–18	(4) Exports Ctrls 16–18
PLI firm	10,987***	10,302***	10,743***	11,216***
	(253)	(884)	(910)	(949)
PLI firm × Post	9,393***	19,131***	19,130***	19,077***
	(593)	(2,082)	(2,136)	(2,220)
Firm controls	No	Yes	Yes	Yes
Sector FE	Yes	Yes	Yes	Yes
Year FE	Yes	Yes	Yes	Yes
Observations	531,671	72,570	70,609	67,673
R^2	0.007	0.207	0.197	0.184

Firm controls: size, assets, debt–equity ratio, employees, age, market share. Columns 2–4 use pre-PLI firm averages for 2014–18, 2015–18, and 2016–18, respectively. *** p<0.01, ** p<0.05, * p<0.1.

Effect of PLI on Imports (in Rs. million)

	(1) Imports No ctrls	(2) Imports Ctrls 14–18	(3) Imports Ctrls 15–18	(4) Imports Ctrls 16–18
PLI firm	12,016***	-1,901	-1,339	-1,068
	(412)	(1,168)	(1,212)	(1,282)
PLI firm × Post	4,724***	9,067***	8,756***	8,328***
	(968)	(2,751)	(2,844)	(3,001)
Firm controls	No	Yes	Yes	Yes
Observations	531,671	72,570	70,609	67,673
R^2	0.003	0.495	0.482	0.458

Firm controls: size, assets, debt–equity ratio, employees, age, market share. Columns 2–4 use pre-PLI firm averages for 2014–18, 2015–18, and 2016–18. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Effect of PLI on Raw Material Expenses (in Rs. million)

	(1) Raw mat. expenses No ctrls	(2) Raw mat. expenses Ctrls 14–18	(3) Raw mat. expenses Ctrls 15–18	(4) Raw mat. expenses Ctrls 16–18
PLI firm	21,823***	5,348***	5,167***	4,437***
	(587)	(1,068)	(1,098)	(1,138)
PLI firm × Post	15,187***	30,281***	30,336***	30,503***
	(1,354)	(2,489)	(2,556)	(2,647)
Firm controls	No	Yes	Yes	Yes
Observations	206,323	40,782	39,614	38,142
R^2	0.014	0.715	0.711	0.706

Firm controls: size, assets, debt–equity ratio, employees, age, market share.
Columns 2–4 use pre-PLI firm averages for 2014–18, 2015–18, and 2016–18, respectively.
Robust standard errors clustered at the firm level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Effect of PLI on Wage Bill (in Rs. million)

	(1) Wage expenses No ctrls	(2) Wage expenses Ctrls 14–18	(3) Wage expenses Ctrls 15–18	(4) Wage expenses Ctrls 16–18
PLI firm	1,802***	-1,365***	-1,509***	-1,626***
	(84)	(164)	(166)	(169)
PLI firm × Post	1,466***	2,224***	2,277***	2,258***
	(194)	(386)	(388)	(394)
Firm controls	No	Yes	Yes	Yes
Observations	408,756	69,435	67,588	64,842
R^2	0.005	0.443	0.450	0.462

Firm controls: size, assets, debt–equity ratio, employees, age, market share.
Columns 2–4 use pre-PLI firm averages for 2014–18, 2015–18, and 2016–18, respectively.
Robust standard errors clustered at the firm level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Effect of PLI on Profits (in Rs. million)

	(1) Profits No ctrls	(2) Profits Ctrls 14–18	(3) Profits Ctrls 15–18	(4) Profits Ctrls 16–18
PLI firm	2,690***	1,931***	1,929***	1,973***
	(77)	(247)	(251)	(259)
PLI firm × Post	2,780***	5,399***	5,441***	5,418***
	(180)	(580)	(589)	(606)
Firm controls	No	Yes	Yes	Yes
Observations	492,933	71,914	69,977	67,072
R^2	0.008	0.264	0.267	0.267

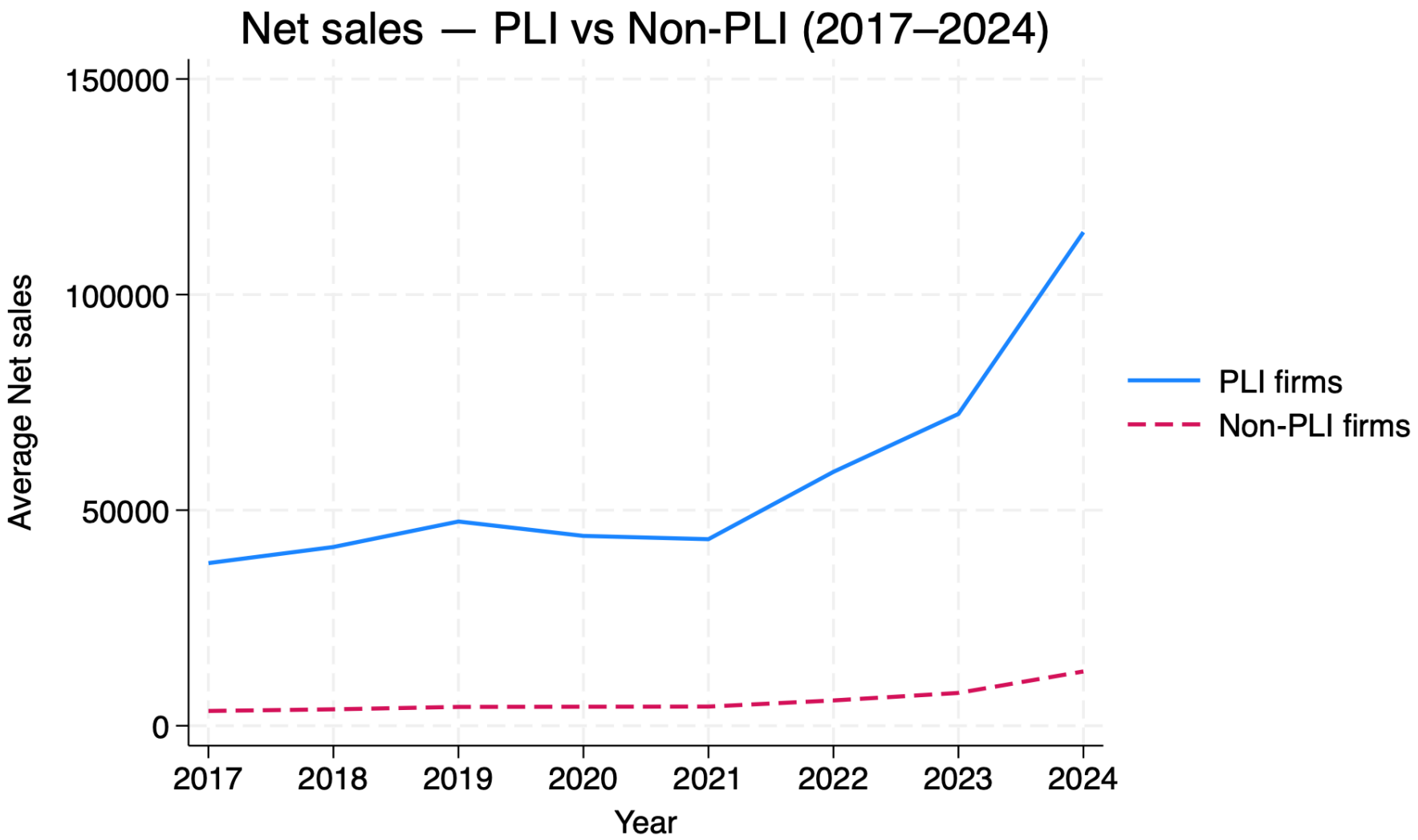
Firm controls: size, assets, debt–equity ratio, employees, age, market share. Columns 2–4 use pre-PLI firm averages for 2014–18, 2015–18, and 2016–18, respectively. Robust standard errors clustered at the firm level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

Effect of PLI on Investments (in Rs. million)

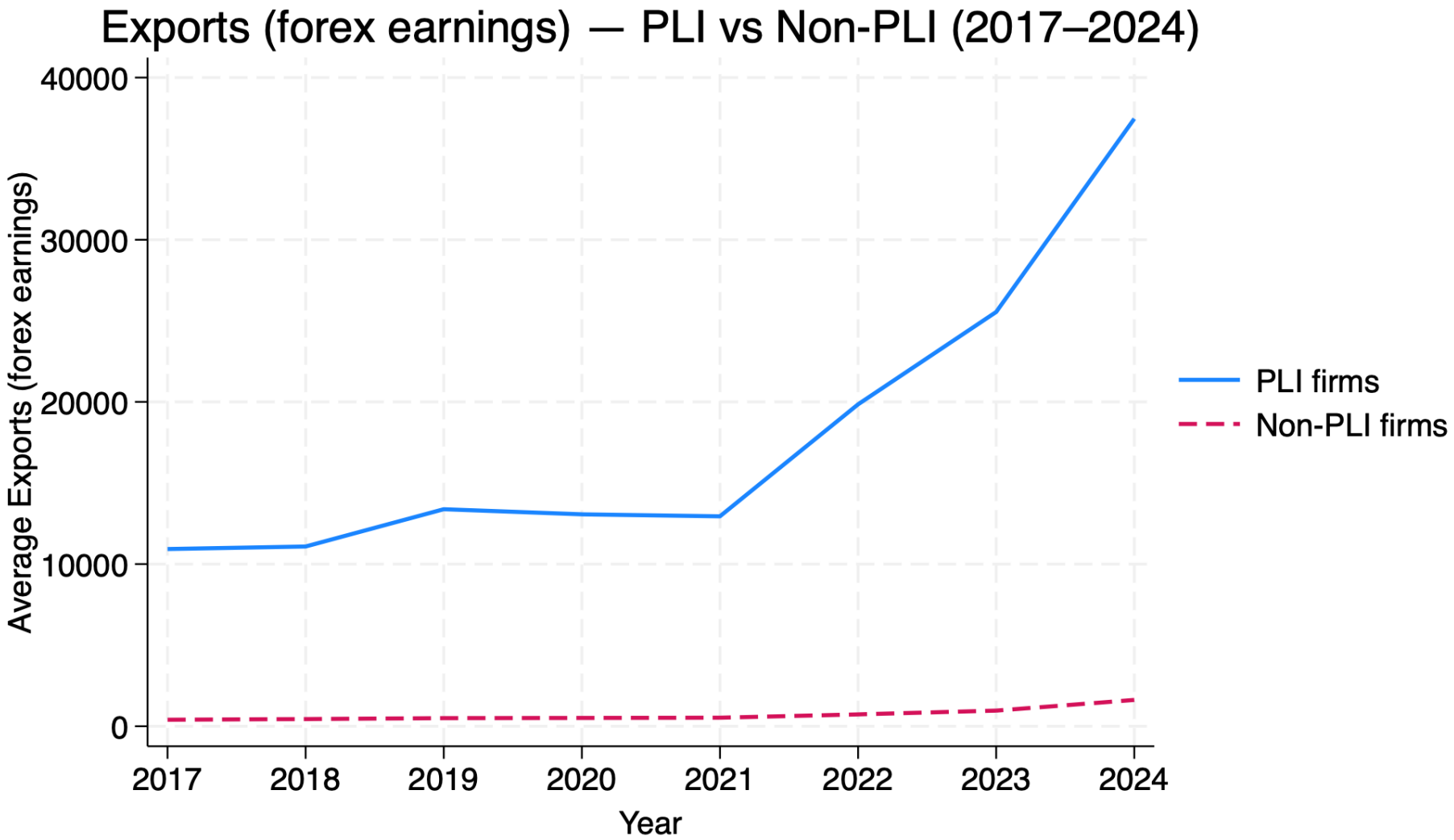
	(1) Investments No ctrls	(2) Investments Ctrls 14–18	(3) Investments Ctrls 15–18	(4) Investments Ctrls 16–18
PLI firm	26,716***	-10,591***	-11,199***	-10,461***
	(754)	(1,279)	(1,304)	(1,334)
PLI firm × Post	20,489***	51,134***	51,790***	52,155***
	(1,770)	(2,966)	(3,014)	(3,084)
Firm controls	No	Yes	Yes	Yes
Observations	151,535	29,687	28,873	27,901
R^2	0.016	0.762	0.764	0.763

Firm controls: size, assets, debt–equity ratio, employees, age, market share. Columns 2–4 use pre-PLI firm averages for 2014–18, 2015–18, and 2016–18, respectively. Robust standard errors clustered at the firm level in parentheses. *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

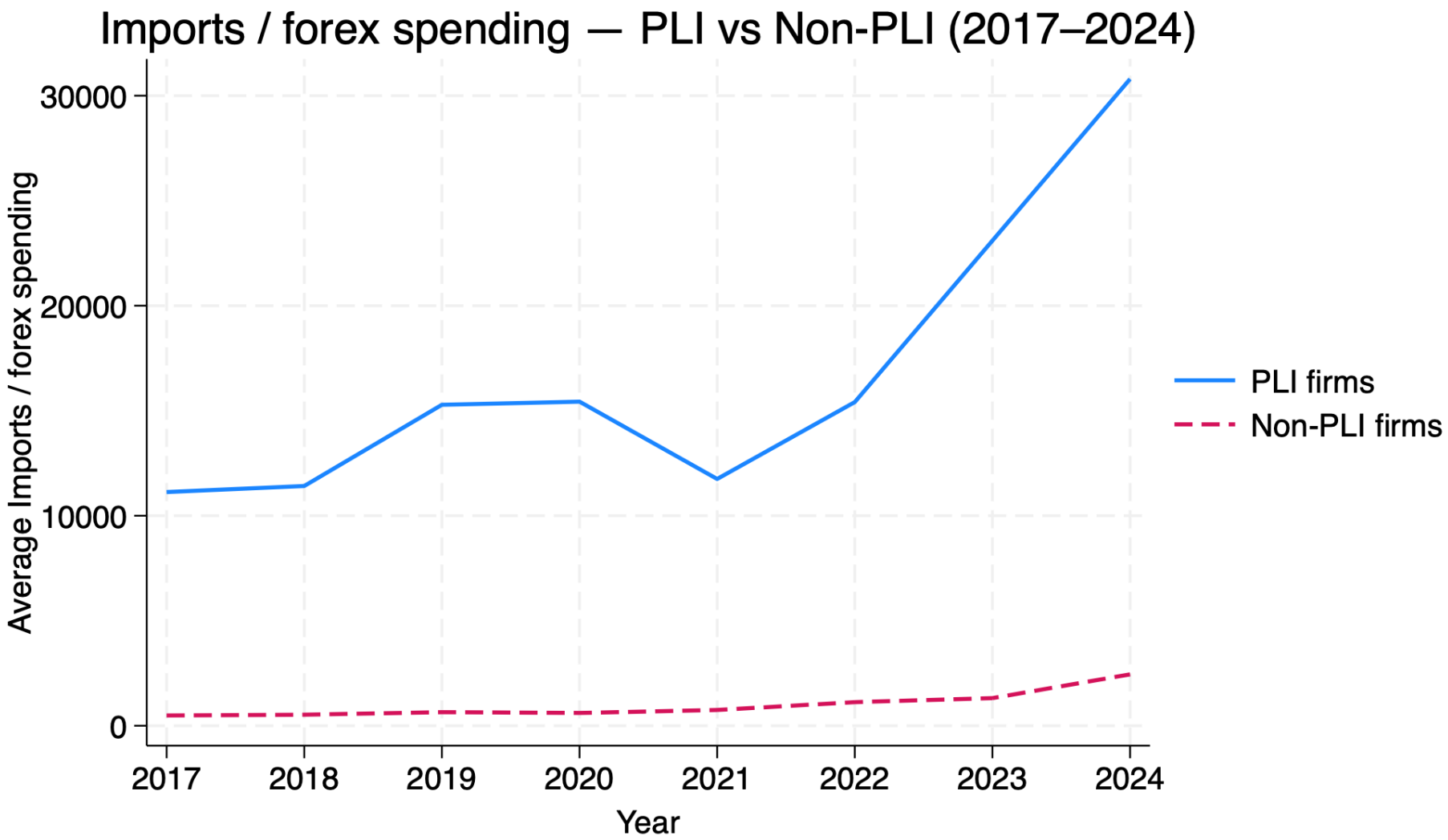
Net sales(in Rs. million) — PLI vs Non-PLI (2017–2024)



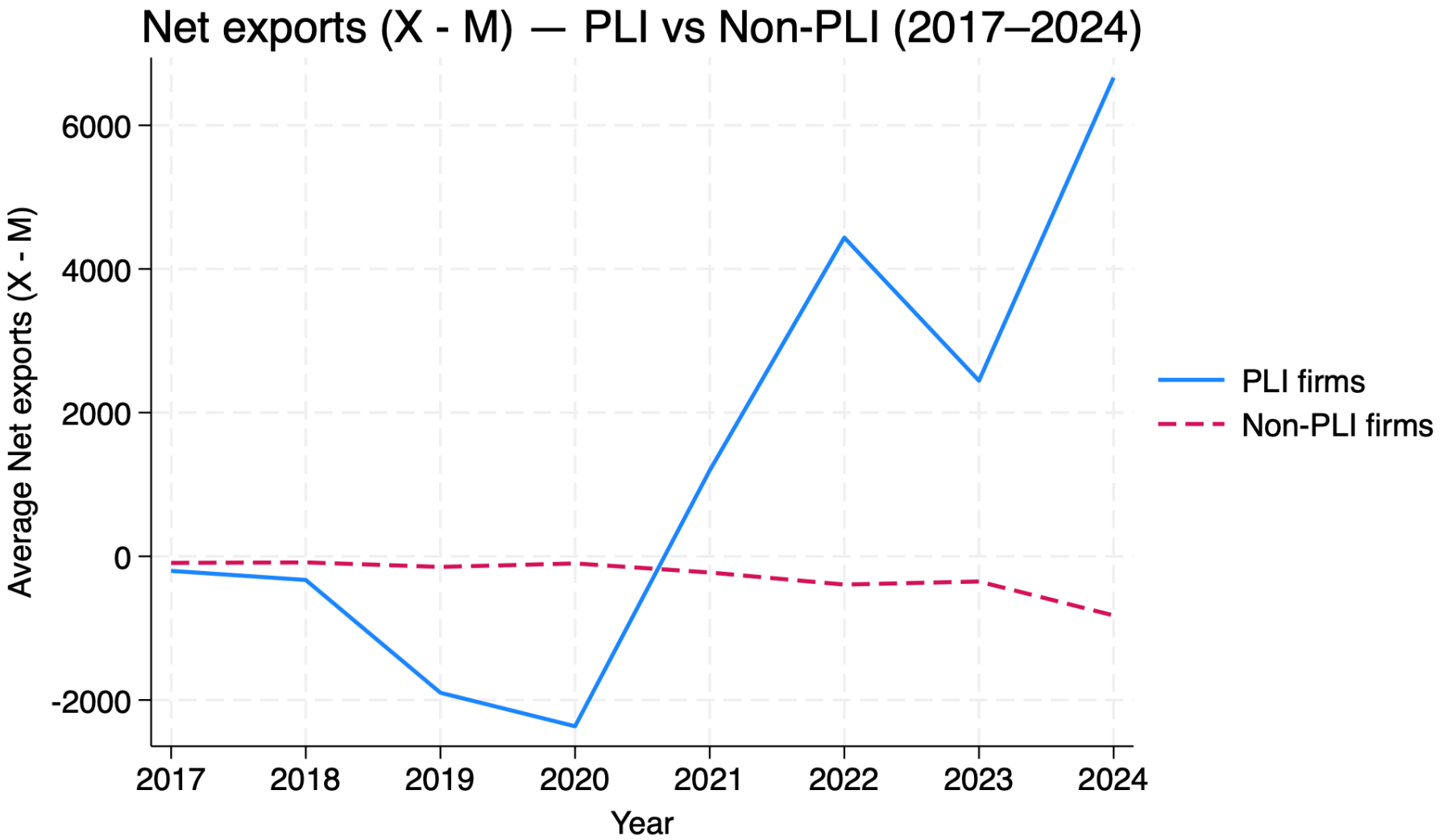
Exports (forex earnings) (in Rs. million) — PLI vs Non-PLI (2017–2024)



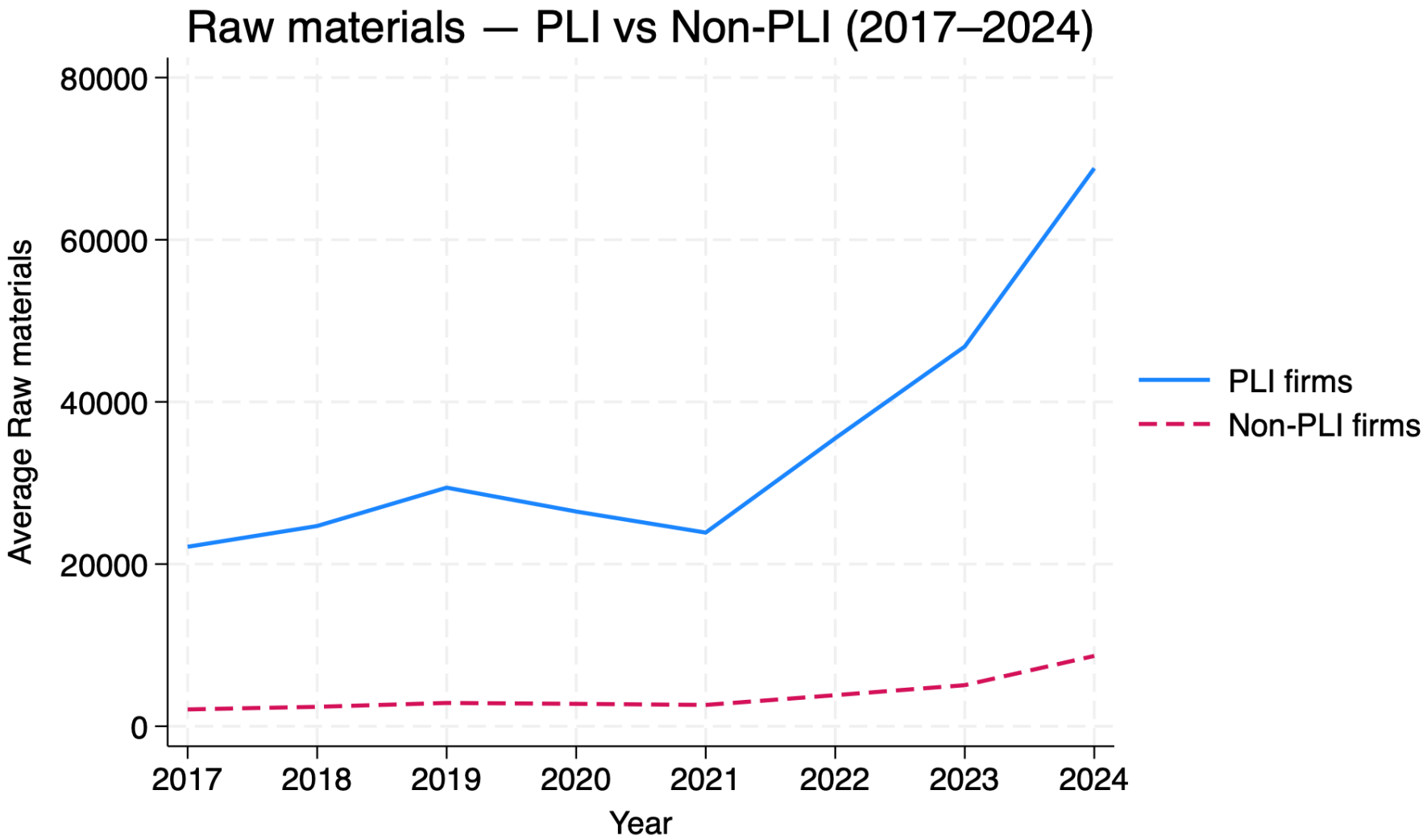
Imports (in Rs. million) — PLI vs Non-PLI (2017–2024)



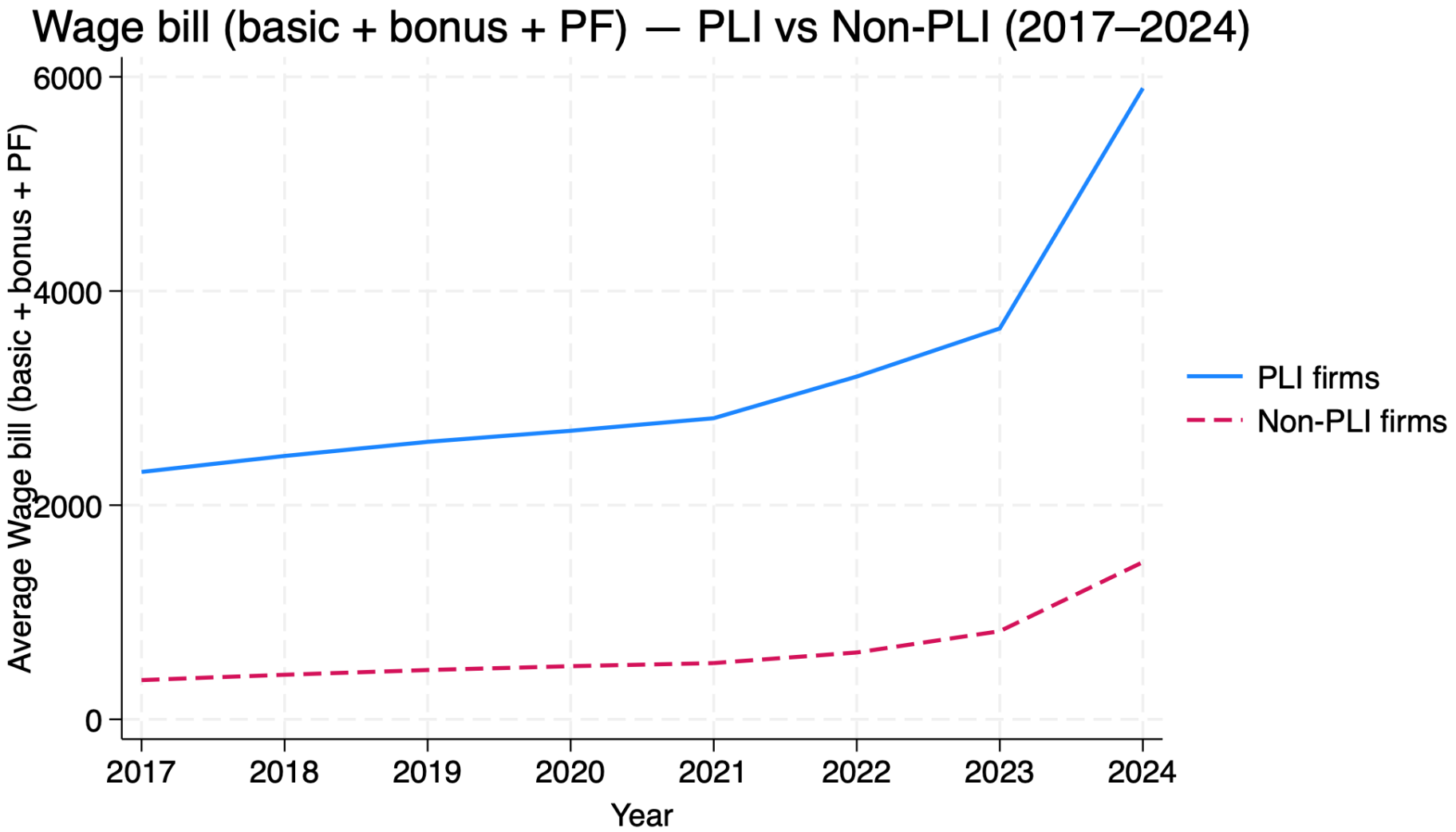
Net exports (XM) (in Rs. million) — PLI vs Non-PLI (2017–2024)



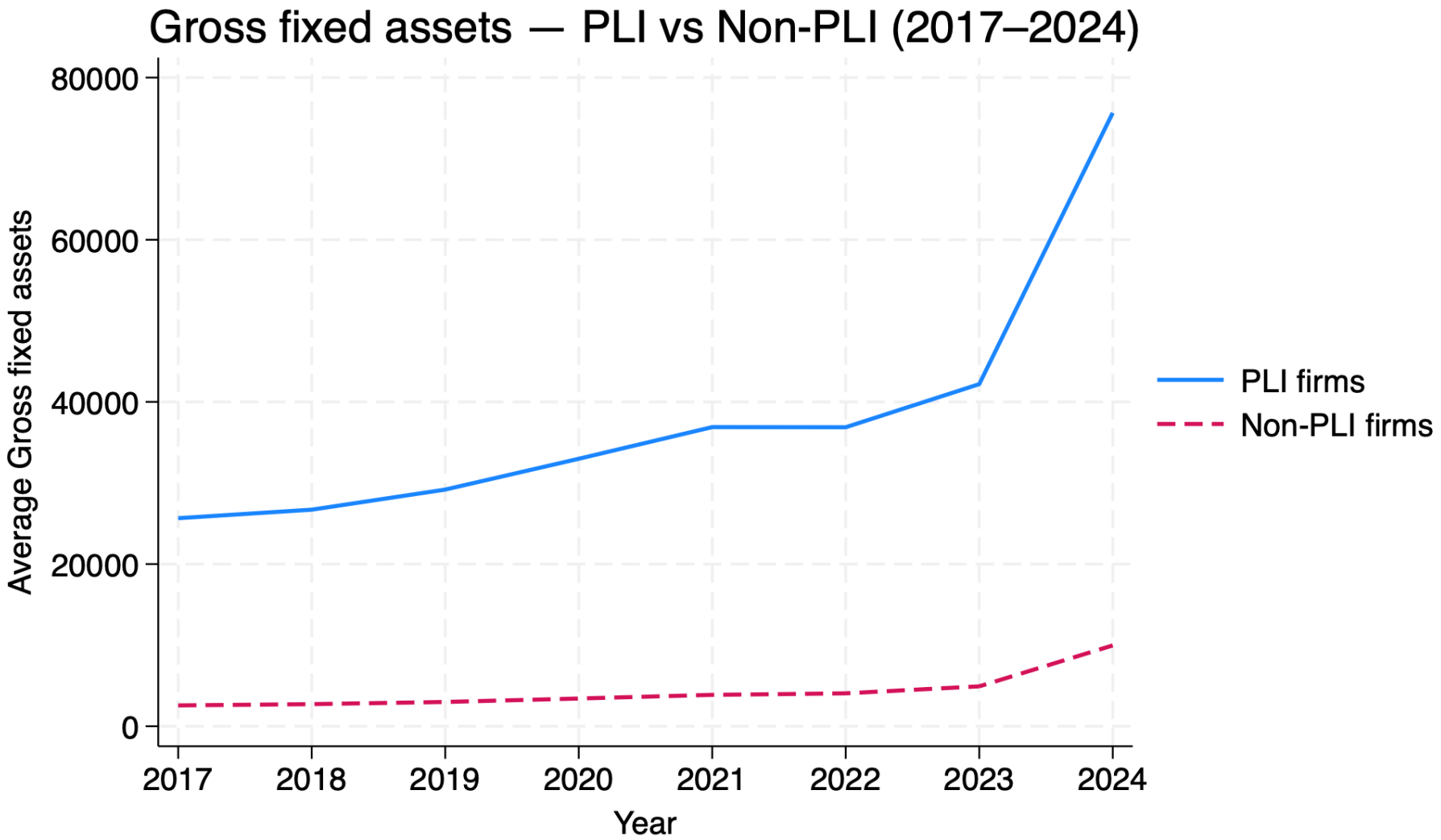
Raw materials (in Rs. million) — PLI vs Non-PLI (2017–2024)



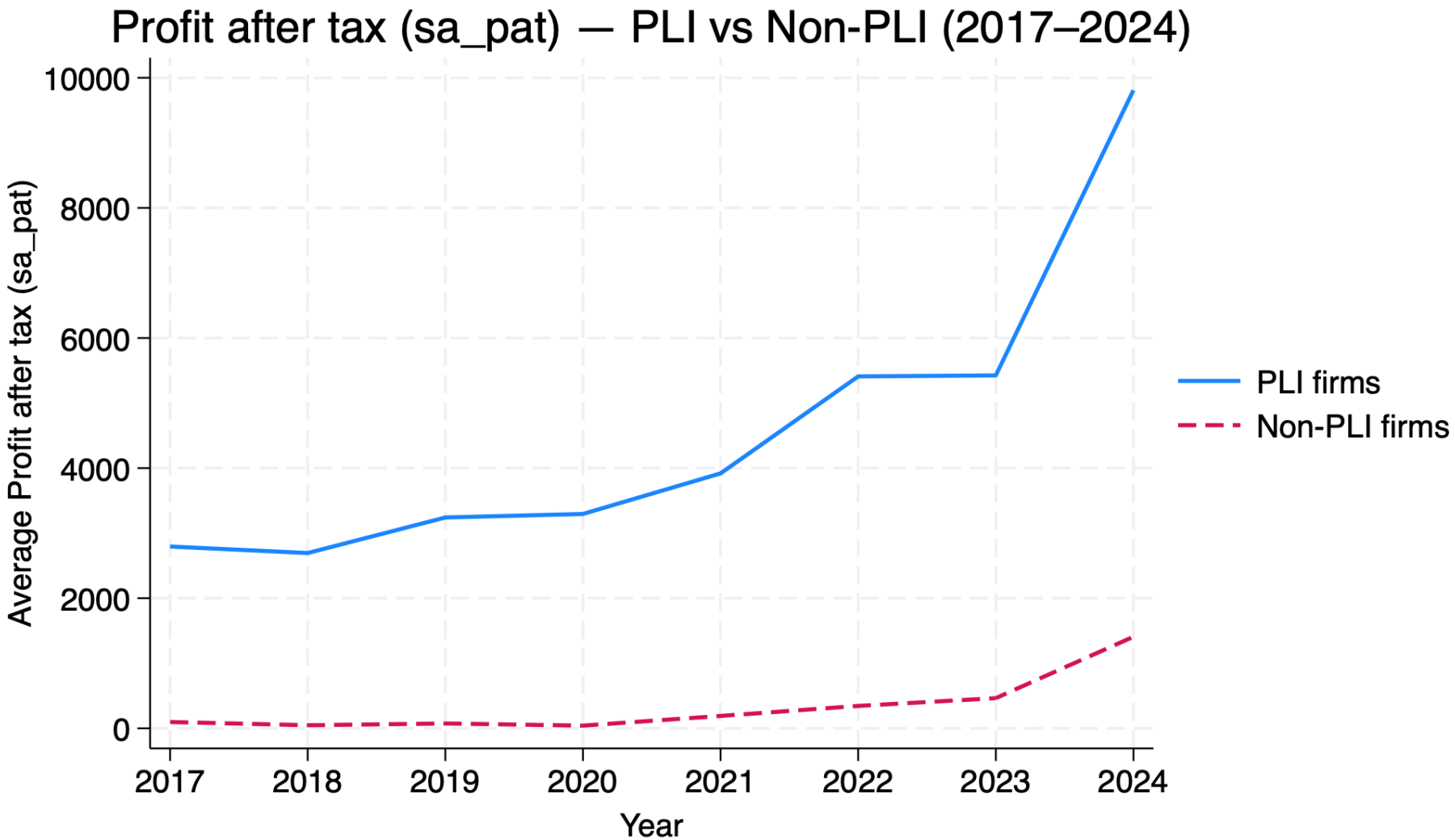
Wage bill (basic + bonus + PF) (in Rs. million) — PLI vs Non-PLI (2017–2024)



Gross fixed assets (in Rs. million) — PLI vs Non-PLI (2017–2024)



Profit after tax (in Rs. million) — PLI vs Non-PLI (2017–2024)



Identification: Placebos and Spillovers

Placebo tests (2017–2019):

- Assign pseudo-treatment in pre-PLI years.
- Estimate DiD with:

$$Y_{ist} = \alpha^{pl} + \beta_1^{pl} PLI_i^{pl} + \beta_2^{pl} PLI_{it}^{pl,\text{cum}} + X_i^{\text{pre}\top} \eta + \delta_s + \lambda_t + \varepsilon_{ist}^{pl}.$$

- Insignificant β_2^{pl} supports parallel pre-trends.

Spillovers to non-beneficiaries:

- For $PLI_i = 0$:

$$Y_{ist} = \alpha^{sp} + \phi_1 S_{st} + X_i^{\text{pre}\top} \gamma^{sp} + \delta_s + \lambda_t + \varepsilon_{ist}^{sp},$$

- S_{st}: sector-year PLI intensity.
- Negative revenue: business-stealing; positive input demand: supply-chain linkages.

Empirical Results (Summary)

- Treated firms show:
  - Strong increases in sales and exports.
  - Higher gross fixed assets (GFA) and wage bills.
  - Increased raw material expenses.

- Ongoing work:
  - Quantify effects on TFPQ and TFPR.
  - Characterize spillovers to non-beneficiary firms.

Structural Model: Environment

- Dynamic general equilibrium model of heterogeneous manufacturing firms.
- Each firm i produces:

$$y = zk^{\alpha} n^{1-\alpha},$$

where z is firm productivity.

- **Without PLI**:

$$\pi_0(z, k, n) = py - wn - rk - f,$$

with fixed operating cost f.

PLI as a Subsidy and Productivity Upgrading

- Let $d_t \in \{0, 1\}$ indicate PLI receipt in period t.
- **With PLI subsidy** at rate τ:

$$\pi(z, k, n; d_t) = (1 + \tau)py - wn - rk - f.$$

- **Productivity dynamics:**
  - Baseline (no policy):

$$z' = g(z, \varepsilon; \theta_0).$$

  - For PLI recipients:

$$z' = g(z, \varepsilon; \theta_0 + \theta_{\text{PLI}}),$$

    where $\theta_{\text{PLI}} > 0$ raises the probability of moving to higher z.
  - Captures export entry, technology adoption, supplier upgrading; gains persist beyond PLI.

PLI Assignment in the Model

- Eligibility depends on sector and initial scale:

$$d_i^{elig} = \mathbf{1}\{s_i \in S^{PLI}\} \cdot \mathbf{1}\{z_i \geq \bar{z}_s,\ k_i \geq \bar{k}_s\}.$$

- Actual subsidy receipt requires meeting incremental production targets:

$$d_t = d_i^{elig} \cdot \mathbf{1}\{\Delta y_t \geq \bar{\Delta}_s\},$$

  where $\bar{\Delta}_s$ is sector-specific.
- **Finite duration** of support:
  - Subsidy available for J periods (about 5 years).
  - After J periods, status reverts to $d_{t+J} = 0$.

Firm Problem and Equilibrium

- State: (z, k, d_t).
- Value function:

$$V(z, k, d_t) = \max_{k', n} \left\{ \pi(z, k, n; d_t) - \psi(k', k) + \frac{1}{1+r} \mathbb{E}[V(z', k', d_{t+1})] \right\}.$$

- Firms exit when $V(z, k, d_t) < 0$; free entry pins down value of entry.
- Stationary/transitional distribution $\mu(z, k, d)$ over productivity, capital, and PLI status.
- Factor market clearing:

$$\int n(z, k, d)\, d\mu = \bar{L}, \quad \int k\, d\mu = \bar{K}.$$

Calibration

- **Technology and firm-dynamics parameters chosen to match:**
  - Firm size distribution
  - Entry and exit rates; investment rate dispersion.
  - Capital and labor shares; wage bill and rental rate ratios.
  - TFPQ and TFPR distributions for non-PLI firms.
- **PLI-specific parameters** (τ, θ_{PLI}, J, $\bar{z}$, $\bar{k}$, $\Delta\bar{y}$) disciplined by:
  - Estimated elasticities ($\hat{\beta}_2$) for scale, exports, and productivity.
  - Pre-PLI characteristics of approved vs. non-approved firms (targeting of "winners").
- **Model used to quantify:**
  - Aggregate gains in output and productivity
  - Winners vs. losers: distributional effects and exit dynamics.
  - Impact of finite subsidy horizon J on investment and long-run outcomes.