WP-2026-001

Firm-Level Trade Responses to Intellectual Property Reforms: Evidence from India

Qayoom Khachoo, Ridwan Ah Sheikh, Pritam Banerjee

INDIRA GANDHI INSTITUTE OF DEVELOPMENT RESEARCH

March 2026

Firm-Level Trade Responses to Intellectual Property Reforms: Evidence from India

Qayoom Khachoo, Ridwan Ah Sheikh, Pritam Banerjee

Email (corresponding author): qayoom_cws@iift.edu

ABSTRACT

This study leverages India's Patents (Amendment) Act, 2002, as a quasi-natural experiment within a difference-in-differences framework to examine how domestic reforms related to patents may affect firms' export behavior and their integration to the global value chains. Exploiting a detailed firm-level database covering the universe of Indian manufacturing firms, we find that heightened patent protection is associated with approximately a 18% increase in exports and a 12% increase in total imports among high-tech firms relative to low-tech firms, even including firm, year, and industry-by-year fixed effects. We further show that stronger enforcement of intellectual property rights (IPRs) has a positive impact on firms' imports of intermediate inputs. Specifically, high-tech firms experienced 20% increase in raw-material imports relative to their low-tech counterparts. In contrast, the reform was associated with a significant reduction in imports of spares and stores. While the average treatment effects on capital and final goods imports remain insignificant, event-study estimates suggest positive and statistically significant effects, albeit with a delay. This study provides policy-relevant evidence that stronger IPRs in emerging market economies such as India enhance firms' trade performance by stimulating innovation, promoting technology transfer and adoption, and enabling access to advanced global inputs.

Keywords: IPRs, Exports, Imports, Global Value Chains, Difference-in-Differences

JEL Code: F13, F14, O30, O33, O34

Firm-Level Trade Responses to Intellectual Property Reforms: Evidence from India

Qayoom Khachoo † Ridwan Ah Sheikh ‡ Pritam Banerjee §

March 6, 2026

Please click here for the latest version

Abstract

This study leverages India's Patents (Amendment) Act, 2002, as a quasi-natural experiment within a difference-in-differences framework to examine how domestic reforms related to patents may affect firms' export behavior and their integration to the global value chains. Exploiting a detailed firm-level database covering the universe of Indian manufacturing firms, we find that heightened patent protection is associated with approximately a 18% increase in exports and a 12% increase in total imports among high-tech firms relative to low-tech firms, even including firm, year, and industry-by-year fixed effects. We further show that stronger enforcement of intellectual property rights (IPRs) has a positive impact on firms' imports of intermediate inputs. Specifically, high-tech firms experienced 20% increase in raw-material imports relative to their low-tech counterparts. In contrast, the reform was associated with a significant reduction in imports of spares and stores. While the average treatment effects on capital and final goods imports remain insignificant, event-study estimates suggest positive and statistically significant effects, albeit with a delay. This study provides policy-relevant evidence that stronger IPRs in emerging market economies such as India enhance firms' trade performance by stimulating innovation, promoting technology transfer and adoption, and enabling access to advanced global inputs.

JEL Codes: F13, F14, O30, O33, O34

Key Words: IPRs, Exports, Imports, Global Value Chains, Difference-in-Differences

†Corresponding author: Centre for WTO Studies (CWS), Centre for Research on International Trade (CRIT), Indian Institute of Foreign Trade (IIFT), New-Delhi. E-mail address: qayoom_cws@iift.edu

‡Indira Gandhi Institute of Development Research (IGIDR), Mumbai. E-mail address: ridwan@igidr.ac.in

§Head Centre for WTO Studies (CWS), Centre for Research on International Trade (CRIT), Indian Institute of Foreign Trade (IIFT), New-Delhi. E-mail address: pbanerjee@iift.edu

1 Introduction

The Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS) entered into force with the establishment of the World Trade Organization (WTO) in 1995. The agreement instituted binding minimum standards for intellectual property (IP) protection across all WTO member states, with the principal objectives of reducing distortions and impediments to international trade, fostering innovation, and facilitating the transfer of technology.

Despite these stated objectives, TRIPS adoption prompted significant opposition from many developing and least-developed countries. Critics argued that its stringent protection standards, particularly for pharmaceuticals, would induce price inflation for critical technologies, restrict access to essential medicines, and constrict the policy autonomy necessary for industrial development and technological catch-up (Helpman 1993; Lai and Qiu 2003; Chaudhuri et al. 2006). In response, the agreement incorporated transition periods and flexibilities, such as delayed implementation and compulsory licensing, to mitigate potential adverse effects on public welfare and health.

India's intellectual property regime was strengthened as a result of the country's commitment to TRIPS-mandated guidelines. These reforms, however, were implemented amid intense political debate involving public-health advocates, industrial lobbies, and pro-reform policymakers. Eventually, in June 2002, the Indian parliament enacted the second amendment to the Patent Act, 1970, which formally came to be known as the Patents (Amendment) Act, 2002.[1] This amendment aligned Indian patent law with core TRIPS obligations by extending the patent term to twenty years, tightening patentability criteria, streamlining examination procedures, and strengthening enforcement mechanism. Therefore, by reducing legal uncertainty, these reforms strengthened firms' incentive to undertake fixed investments in new technologies under a more credible IP regime. Unlike the subsequent 2005 amendment, which introduced pharmaceutical product patents, the 2002 reform

[1]A change in government in 1998 paved the way for the initial round of reforms. The Bharatiya Janata Party (BJP), which had previously opposed patent legislation, assumed power in March 1998. The new Prime Minister, who had earlier led a parliamentary walkout against the 1995 Amendment, conducted nuclear test soon after taking office, straining relations with the Western countries and prompting the imposition of sanctions. In an effort to avoid further foreign policy frictions, the government, despite its earlier position, moved forward with patent reforms. The opposition Congress party, having signed the TRIPS Agreement in 1995, did not obstruct these reforms (Reddy T and Chandrashekaran 2017).

altered the appropriability environment across the entire manufacturing sector, signalling a decisive shift toward more rigorous IP enforcement.[2]

The stringent IPRs, particularly patent laws, protect innovation rents by raising imitation and infringement costs and encourage firms to invest more in R&D, which in turn leads to higher rate of product and process innovation (Kanwar and Evenson 2003; Peters et al. 2022). Moreover, stronger enforcement of IPRs positively affects firms' ability to acquire new external debt, generate more innovation patents, and produce more sales from new products (Ang et al. 2014; Liu et al. 2021). In a related study, Hu and Png (2013) found that stronger patent protection is associated with faster growth in patent-intensive industries, where IPRs play a central role in protecting proprietary knowledge, relative to less patent-intensive industries. The other strands of literature shows that enhanced patent rights protection in host countries encourage technological transfer by multinational corporations (Branstetter et al. 2006). Therefore, with increase in R&D expenditure, domestic patent reforms enable firms to absorb and deploy foreign technical information to improve their product quality and remain competitive, ultimately encouraging entry into export markets. Branstetter et al. (2011) found that, in the years after patent reforms, countries tend to increase the number of commodity categories in which they export. Maskus and Yang (2018) find that countries with stronger patent rights have significantly greater exports in research-intensive sectors, with effects that are relatively stronger in developed countries than in upper-middle-income and lower-income countries. By contrast, Shin et al. (2016) show that stronger IPR laws and enforcement in developed countries acts as a deterrent to exports from emerging economies, as the latter's exports may be blocked if they are found to be too imitative and infringing.

While much of the literature focuses on aggregate trade flows, stronger IPR protection can also affect firms' imports of intermediate inputs. In particular, input customization requires firms to transmit knowledge to their suppliers, which is then embodied in the corresponding intermediate goods. With sequential production, intermediates become increasingly intellectual property (IP) intensive at successive stages of the supply chain. Therefore, the lack of effective (*de facto*)

[2]The 2002 amendment did not introduce pharmaceutical product patents; instead, it standardized a twenty-year patent term, eliminated special distinction for drugs and food products, updated the definition of "invention" in line with TRIPS norms, and streamlined the procedural and enforcement mechanisms. Product patents for pharmaceuticals, foods, and chemicals were subsequently introduced in the *Patents (Amendment) Act, 2005*.

IPR enforcement in the suppliers' locations creates costly repercussions in knowledge transmission along the supply chain, as transmitted knowledge may be vulnerable to dissipation. Utilizing transaction-level trade data on Slovenian firms, Bolatto et al. (2023) found that stronger IPRs in suppliers location increase firms' reliance on *'outsourcing'* rather than *'vertical integration'* when importing intermediate inputs. This effect is particularly pronounced at downstream stages, due to the larger knowledge content embodied in the corresponding intermediates. By contrast, Biancini and Bombarda (2021) found that stringent IP regime disproportionately encourages the imports of intermediate goods through vertical integration rather than from independent suppliers, as latter may involve a risk of imitation and technology expropriation. Canals and Şener (2014) find that high-tech US industries expand their *intra-industry* offshoring activities, defined as the imports of intermediate inputs within the same industry, in response to intellectual property reforms in its trading partners.

The extant literature on the relationship between IPRs and trade highlights multiple channels through which stronger IPR enforcement in destination markets influences host-country firms' decisions to trade. Maskus and Penubarti (1995) find that increasing patent protection is associated with higher export flows from OECD into developing countries, while Rafiquzzaman (2002) find that Canada exports more to countries with stronger (de facto) protection of intellectual property. Ivus (2010) and Delgado et al. (2013) find that trade responses to TRIPS-induced patent reforms were significantly stronger in patent-intensive sectors than in sectors that rely less on intellectual property for rent appropriation. However, a number of other studies either find negative or insignificant effect of IP protection on trade (Smith 1999; Co 2004; and Braga and Fink 2005). Moreover, Palangkaraya et al. (2017) found that bias against foreign firms in obtaining patents in the destination country and their expectation of patent infringement suit, discourages them from exporting to those markets. Brunel and Zylkin (2022) reach similar conclusions.

The existing literature on IPRs and trade has largely focused on advanced countries and has predominately relied on country- or industry-level data on trade flows. By contrast, Lin and Lincoln (2017) match comprehensive information on patenting and exporting behavior at the firm level and find that US firms are more likely to export to jurisdictions that strengthen IP protection. In a related study, De Rassenfosse et al. (2022) find that French firms export more to destination markets where they secure patent protection, a phenomenon they refer to as the 'patent premium'. However, there is relatively little evidence at firm-level, particularly for emerging market economies such as India, which is the focus of this study.

We leverage the India's Patents (Amendment) Act, 2002 as a quasi-natural experiment within a two-way fixed effects (TWFE) difference-in-differences framework to identify the causal effect of stronger intellectual property protection on firm-level trade. Utilizing a comprehensive dataset covering the universe of Indian manufacturing firms, obtained from CMIE Prowess, we classify firms as 'high-tech' if their average expenditure on R&D and royalty payments as a share of gross value added (GVA) in a pre-reform period (1996-2001) exceeds their 2-digit industry median, which is our treatment group, while the remainder are classified as 'low-tech', which is our control group. We first examine how policy reforms related to patents, following the enactment of Patents (Amendment) Act, 2002 affect firms' export growth. We further investigate the impact of reform on firm's imports of intermediate inputs, which we interpret as evidence of deeper integration into global value chains (GVCs). However, the timing of 2002 reform may be endogenous if pressure groups or technologically advanced firms lobbied for stronger patent protection in anticipation of future gains. In that case, firms may have adjusted their export or import behavior prior to the reform, so that any post-2002 increase would reflect a mere continuation of pre-existing trends rather than a causal effect of the reform, posing a potential threat to the "parallel trends assumption" underlying the difference-in-differences framework. We conduct a battery of robustness check and find no significant evidence of anticipatory effects or firm-specific characteristics that could have influenced the 2002 reform.

We find that, on average, following the reform, high-tech firms increased their exports by about 18% more than low-tech firms. Moreover, the event-study estimates indicate that export flows exhibit a sustained positive response that persists for up to four years after reform, suggesting that the impact is long-lasting. We did not find any evidence of differential pre-reform trends, confirming the validity of parallel trend assumption. Moreover, following the enactment of 2002 Act, domestic patent reforms are associated with an average increase of about 12% in total imports among high-tech firms relative to low-tech firms, with effects persisting well into the post-reform period. Furthermore, we find that stronger patent protection has a positive impact on input-sourcing decisions of Indian manufacturing firms, confirming the findings in Canals and Şener (2014), Biancini and Bombarda (2021), and Bolatto et al. (2023). Specifically, high-tech firms experienced 20% rise in raw-material imports relative to control group. The post-reform increase in raw-material imports may be associated with significant productivity gains through improved access to higher quality inputs, a greater variety of intermediate inputs, and a learning effect (Schor 2004; Amiti and Konings 2007; Topalova and Khandelwal 2011), which can strengthen firms' export competitiveness and facilitate their entry into international markets. Although the average treatment effects for capital and final goods imports remain insignificant, the event-study estimates suggest positive and statistically significant effects, albeit with a delay. We identify key mechanisms linking IPR reform to firm-level trade outcomes. Our analysis indicates that the reform resulted in a significant rise in firms' R&D investment, technology adoption expenditures, as well as both inward and outward patenting activity, resulting in improved product quality and technical efficiency, thereby strengthening firms' export competitiveness and expanding their participation in international markets (Chan et al. 2023).

This paper contributes to the literature on intellectual property rights and trade along multiple dimensions: (i) We provide a firm-level evidence on the impact of stronger patent protection on export performance for the universe of Indian manufacturing firms; (ii) We investigate whether patent enforcement laws leads to a systematic shift in the composition of imports away from final goods and toward upstream, knowledge-intensive intermediates, notably raw materials, spares and stores, and capital goods; (iii) To access the validity of the parallel trend assumption and to account for the possibility that trade responses to patent reform may materialize with a delay, as firms may require time to upgrade product-quality, establish new supplier relationships, reconfiguring global procurement networks, and invest in internal absorptive capacity. We estimate a dynamic TWFE event-study specification to examine the causal impact of the 2002 reform at different lengths of exposure to the treatment; (iv) We conduct a series of robustness checks to test the validity of the identifying assumptions underlying difference-in-differences framework. Specifically we test whether the timing of 2002 IPR reforms is exogenous to firm-level characteristics; (v) Finally, we identify key mechanisms through which IPR reforms shape firm-level trade dynamics.

The remainder of the paper is organized as follows: Section 2 discusses the empirical framework. Section 3 discusses data and stylized facts. Section 4 presents our main findings. Section 5 presents the event-study dynamic effects and tests the validity of identifying assumption underlying difference-in-differences. Section 6 examines the mechanisms through which stronger intellectual property protection affects trade. Finally, Section 7 concludes.

2 Empirical framework

This paper leverages the Patents (Amendment) Act, 2002 within a TWFE difference-in-differences framework to examines the impact of domestic patent reform on trade for manufacturing firms in India. Following Branstetter et al. (2006, 2011) and Bhattacharya et al. (2022) and controlling for other firm- and industry-specific characteristics that might confound the outcome of interest, we estimate the following specification using ordinary least squares (OLS):

$$ln\ Y_{is,t} = \beta_i + \gamma_t + \lambda_{s,t} + \delta\ (IPR_{02} \times Htech_{i,96-01}) + \mathbf{X}'_{is,t-1}\boldsymbol{\theta} + \epsilon_{it} \tag{1}$$

where, i indexes an individual firm, s indexes firm's industry group, and t denotes time. $Y_{is,t}$ is the outcome variable (exports, total imports, final good imports, and imports of intermediate inputs); β_i, γ_t, and $\lambda_{s,t}$ denote firm, time, and industry-time fixed effects, respectively [3]; $\mathbf{X}'_{is,t-1}$ controls for other firm- and industry-specific characteristics, and $\boldsymbol{\theta}$ is the corresponding vector of parameters. Note that, to avoid the post-treatment bias, i.e., bias that occurs when control variables are themselves affected by treatment, we use all firm- and industry-specific controls in $(t-1)$ period. In addition, we also test the sensitivity of results by using pre-reform (1996-2001) average of these

[3] It is important to note that the Patents (Amendment) Act, 2002 coincided with the introduction of R&D tax credits scheme by the Government of India in the Union Budget of 1997-1998. This scheme was designed to incentivize in-house R&D investments among firm in selected industries and has undergone several revisions over time. In such a case, any observed increase in private R&D expenditure, exports, or related outcomes could therefore be spuriously attributed to the Patents (Amendment) Act, 2002. To mitigate this concern, we include a rich set of industry-by-time fixed effects ($\lambda_{s,t}$) to control for time-varying shocks common across all industries such as factor productivity, technological progress, and international trade policy measures, including the R&D tax credits scheme of 1998.

controls; and finally, ϵ_{it} is the error term. We cluster standard errors at the firm level to account for serial correlation within the same firm over time (Abadie et al. 2023).

We divide firms into two groups based on their technology adoption expenditure as a share of GVA during the pre-reform period (1996–2001). $Htech_{i,96-01}$ is a dummy that equals 1 for firms whose average expenditure on R&D and royalty payments, expressed as a share of gross value added (GVA) during the pre-reform period (1996–2001), exceeds their corresponding 2-digit industry median. These firms constitute our 'treatment' group. For all remaining firms, $Htech_{i,96-01}$ equals 0, these are classified as 'low-tech' and serve as the control group. IPR_{02} is the post-patent reform dummy variable that takes value of 1 for all years on and after the inception of the Patents (Amendment) Act, 2002 (2002-2007), and takes the value of 0 for all pre-reform years (1996–2001).

Our key parameter of interest is the coefficient on the interaction term, δ, which captures the differential trade response of 'high-tech' firms relative to 'low-tech' firms following the 2002 patent policy reform. We expect this coefficient to be positive.

3 Data and stylized facts

The firm-level data on Indian manufacturing firms are drawn from the Prowess database, maintained by the Centre for Monitoring the Indian Economy (CMIE). Prowess aggregates audited annual financial statements of all publicly listed firms and information collected through annual surveys of unlisted firms. The database provides broad coverage of India's organized manufacturing sector, accounting for approximately 70% of industrial output, 71% of corporate taxes, and 95% of excise-duties, making it a standard source in the empirical work on Indian firms (Goldberg et al. 2010a, 2010b; Topalova and Khandelwal 2011; De Loecker et al. 2016). Unlike other databases, Prowess is panel of firms allowing us to examine dynamic firm responses over time.

We use firm-level data on exports and imports as our outcome variables. The imports are further sub-classified into raw materials, capital goods, stores and spares, and final goods, which is crucial for our study. Additionally, we obtain information on several firm-specific characteristics from the Prowess database, including profits, total assets, debt, and firm age (which is calculated as the difference between the reference year and the year of incorporation). Moreover, under Section 217 of the Companies Act, firms are required to disclose expenditures on R&D and royalty payments for technical know-how. While R&D expenditure captures in-house innovation, royalty payments for technical know-how reflect the licensed use of intellectual property owned by other firms. We aggregate R&D expenditure and royalty payments to construct a measure of total technology adoption expenditure for any given firm. Furthermore, we compute gross value added (GVA) as sales net of the cost of raw materials and other intermediate inputs. The final sample consists of unique 2544 manufacturing firms observed over the period 1996-2007. Table A1 in the appendix gives further details on each variable used in the analysis.

We supplement our firm-level data with data on tariffs, obtained from the UN COMTRADE, accessed via the World Integrated Trade Solution (WITS) interface, to control for industry-level output tariffs that might otherwise confound our outcome variables (exports and imports), unrelated to 2002 reform. We construct India's Most-Favoured-Nation (MFN) tariff series at the four-digit level of the International Standard Industrial Classification (ISIC) Revision 3 and subsequently match them to firm records coded under NIC-2008 using a text-based concordance. For example, ISIC Rev. 3 code 1511 ("production, processing, and preserving of meat products") is manually matched to NIC-2008 subclass 1010, which denotes the same activity. This concordance ensures consistency between international and national industrial classification.

Table 1 reports the summary statistic for the key variables used in the analysis. On average, firms export roughly Rs. 71 million ($e^{4.26}$) and imports Rs. 33 million ($e^{3.51}$) annually, demonstrating their significant participation in international trade. The significant portion of total imports consists of raw materials, reflecting strong integration into global production networks and extensive dependence on foreign inputs in firms' production processes. The average firm age is 22 years ($e^{3.10}$), suggesting the sample is predominantly composed of established incumbents with significant operational experience and stable supply-chain relationships.

On average, firms spend Rs. 5.47 million on technology adoption, comprising Rs. 3.15 million on R&D and Rs. 2.31 million on royalty payments and licensing fees for technical know-how, reflecting their capability to both develop and effectively assimilate advanced technologies from external sources. The mean tech-share in our sample is 0.02, indicating that firms allocate about

2% of their GVA to technology adoption (R&D and royalty payments), with significant variation across firms. Finally, the average MFN applied tariff is approximately 25%, implying non-trivial degree of protection with potential implications for firms' import costs and export competitiveness.

Table 1 Descriptive statistics

	Mean	Std. Dev.	Min	Max	N
Panel A: Outcome variables					
ln Exports	4.26	2.17	0	13.28	9,597
ln Imports	3.51	2.49	0	13.79	13,462
ln Final good imports	3.35	1.95	0	11.95	1,790
ln Raw-material imports	4.15	2.02	0	13.68	9,688
ln Spares and stores imports	2.16	1.76	0	9.64	6,442
ln Capital good imports	2.63	1.83	0	10.22	6,770
Panel B: Firm characteristics					
ln R&D	1.15	1.46	0	8.98	13,462
ln Technology transfer	0.84	1.36	0	8.82	13,462
ln Technology adoption expenditure	1.70	1.59	0	8.98	13,462
Tech-share†	0.02	0.143	0	10.27	13,462
ln Assets	6.73	1.62	0	13.98	13,461
ln Debt	5.47	1.87	0	12.54	13,048
ln Profits	9.76	0.12	0	11.83	13,450
ln Tariff	3.24	0.65	0	5.61	13,228
ln Age	3.10	0.74	0	4.98	13,432
ln Gross value added	6.26	1.71	0	14.21	12,408

Notes: The table presents summary statistics for the firm- and industry-level variables employed in the analysis, with all variables measured in logarithms.
† Tech-share is calculated as the ratio of technology adoption expenditure to the gross value added.

Table 2 compares high-tech and low-tech firms across multiple characteristics in the periods before and after the reform. [4] Prior to the reform, average exports of high-tech firms were approximately 3% higher than those of low-tech firms, and this difference increased to 68% after the reform. Similarly, average imports were about 8% higher for high-tech firms relative to low-tech firms in the pre-reform period, and 191% higher in the post-reform period. Consistent with these patterns, high-tech firms exhibit significantly larger post-reform increases across all other characteristics as well.

[4] Δ^{pre} and Δ^{post} in Table 2 denote the difference in mean log values between high-tech and low-tech firms during the pre- and post-reform periods, respectively. Since the variables are expressed in natural logarithms, the corresponding percentage differences are computed as $(e^{\Delta^{pre}} - 1) \times 100$ for the pre-reform period and $(e^{\Delta^{post}} - 1) \times 100$ for the post-reform period.

Table 2 Pre- and post-reform averages for high- and low-tech firms

Variables	Pre-reform mean (1996–2001)			Post-reform mean (2002–2007)		
	Low-tech	High-tech	Δ^{pre}	Low-tech	High-tech	Δ^{post}
ln Exports	3.94	3.97	0.03	4.26	4.78	0.52
ln Imports	3.41	3.49	0.08	3.12	4.19	1.07
ln Final good imports	3.27	2.96	-0.31	3.67	3.40	-0.27
ln Raw-material imports	3.87	3.90	0.03	4.12	4.65	0.53
ln Spares and stores imports	2.10	2.10	0.00	2.16	2.27	0.11
ln Capital good imports	2.50	2.46	-0.04	2.67	2.89	0.22
ln R&D	0.75	1.36	0.61	0.81	1.74	0.93
ln Technology transfer	0.31	1.13	0.82	0.64	1.22	0.58
ln Technology adoption expenditure	0.94	2.11	1.17	1.28	2.47	1.19

Notes: The table reports the pre- and post-reform mean values of all firm-level outcome variables for high-tech and low-tech firms, with corresponding differences denoted by Δ^{pre} and Δ^{post}.

Moreover, Figure 1 plots the mean technology adoption expenditure (sum of R&D and royalty payments) for high-tech and low-tech firms over the period 1996–2007. Prior to the reform, both groups exhibit broadly similar growth in technology adoption expenditure. Following the reform, however, high-tech firms exhibit a substantially stronger increase in technology adoption expenditure relative to low-tech firms.

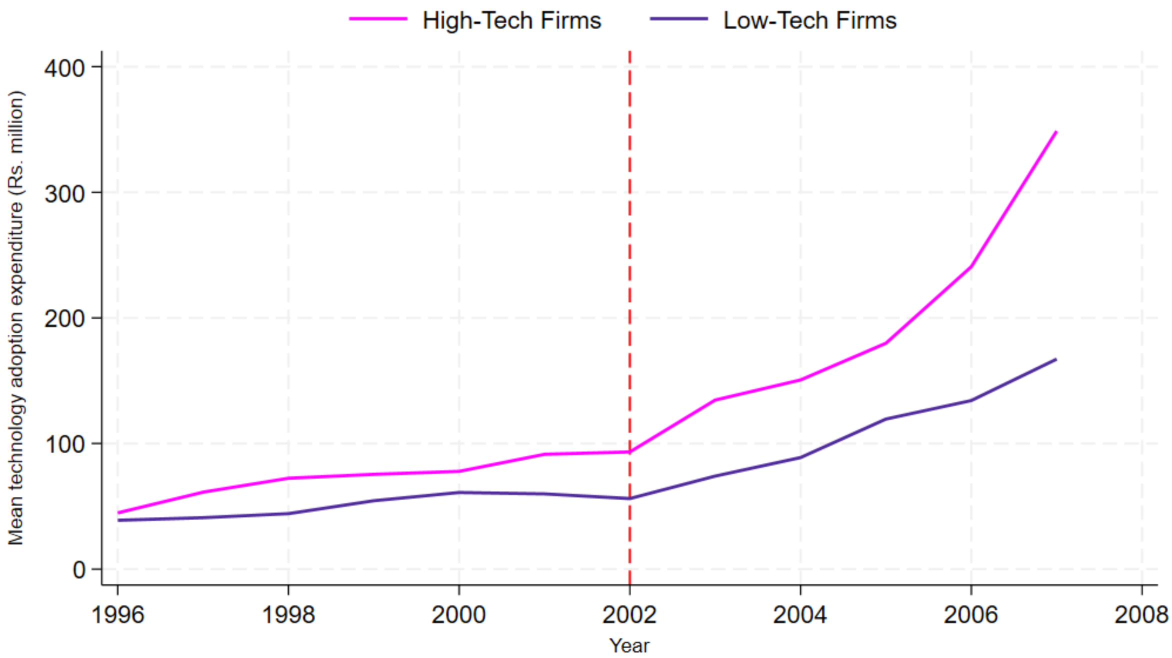
While these descriptive statistics provide useful preliminary insights into how outcome variables and other firm characteristics evolved across high-tech and low-tech firms around the reform, they should not be interpreted as evidence of a causal impact of the reform. In the next section, we present the formal estimation results.

4 Main findings

4.1 Average impact on total exports and imports

The average impact of stronger patent laws and enforcement, exploiting the Patents (Amendment) Act, 2002 as a quasi-natural experiment, on firms exports (Column 1-2) and total imports (Column 3- 4) are reported in Table 3. The estimates are obtained from Eq. (1) using alternative specifications that control for firm, year, and industry-by-year fixed effects, as well as other observable firm-

Figure 1 Technology adoption expenditure of Indian manufacturing firms (1996-2007)



Notes: The figure depicts the average technology adoption expenditure for high-tech and low-tech firms in India over the period 1996–2007.

and industry-specific characteristics measured at $t-1$ period. Robust standard errors are clustered at the firm level to account for serial correlation within the same firm over time. The coefficient on interaction term ($IPR_{02} \times Htech_{i,96-01}$) in Column (2), controlling for firm and industry-by-year fixed effect, is positive and statistically significant. Specifically, following the 2002 reform, stronger patent protection is associated with an average increase of about 18% $\big((e^{0.167}-1)\times 100\big)$ in exports among high-tech firms relative to low-tech firms. In addition to exports, we also estimate the impact of heightened patent protection on firms' total imports, as foreign technology embodied in imports can facilitate learning and stimulates domestic innovation (Keller 2004; Schneider 2005). The results in Column (4) suggest that, after the reform, enhanced patent protection corresponds to an increase of about 12% in total imports among firms in treatment group (high-tech) relative to comparison group (low-tech). Note that Columns (1) and (3) report estimates without firm- and industry-specific controls and fixed effects, whereas Columns (2) and (4) incorporate the full set of firm- and industry-specific controls and fixed effects. The relatively larger coefficients in Columns

(1) and (3) likely reflect omitted variable bias. Accordingly, in the subsequent analysis, we employ a specification that include full set of firm- and industry-specific controls and fixed effects.

Table 3 Patent reform impact on exports and imports of Indian manufacturing firms

	Exports		Imports	
	(1)	(2)	(3)	(4)
$IPR_{02} \times Htech_{i,96\text{–}01}$	0.483***	0.167**	0.993***	0.113*
	(0.106)	(0.081)	(0.101)	(0.067)
Firm controls$_{t-1}$	No	Yes	No	Yes
Firm FE's	No	Yes	No	Yes
Year FE's	No	Yes	No	Yes
Industry × Year FE's	No	Yes	No	Yes
N	9,597	6,959	13,462	9,287
R^2	0.02	0.85	0.02	0.87

Notes: The table reports the estimated effects of the Patents (Amendment) Act, 2002 on firms' exports and imports based on Eq. (1), with both variables expressed in their natural logarithm. Standard errors, reported in parentheses, are clustered at firm level. In specifications (2) and (4) all firm- and industry-specific controls - age, debt, profits, total assets, R&D expenditure, royalty and licensing expenditures, and tariffs - all measured in their natural logarithm form, are used in $t-1$ period. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Our findings are consistent with the cross-country evidence linking stronger IPR protection to trade in IPR-intensive industries (Ivus 2010; Branstetter et al. 2011; Delgado et al. 2013; Maskus and Yang 2018; and Sheikh and Kanwar 2025). One plausible explanation for the observed increase in exports and imports among high-tech firms following the Patents (Amendment) Act, 2002 is that stronger IPRs facilitate innovation and technology upgrading by domestic firms while providing a safer environment for foreign firms to deploy technology, which in turn is conducive to international trade in technology-intensive goods. Our results are in line with Gupta and Stiebale (2024), who document post-reform increases in patenting and R&D expenditure among Indian manufacturing firms more exposed to patent protection. Section 6 provides supporting evidence for these mechanisms.

4.2 Average impact across import categories

The evidence based on aggregate imports is rather extensive. In addition, stronger IPR protection may also affects firms' imports of intermediate inputs, either through 'vertical integration' or 'outsourcing', as discussed in the introductory section. In this section, we decompose total imports into raw-materials, spares and stores, capital goods, and final goods to examine how enhanced patent protection affect firms' imports across these distinct input categories. Results reported in Table 4 indicate that, in the post-reform period, high-tech firms responded by increasing imports of raw materials by 20% relative to low-tech firms.

Table 4 Patent reform impact across different import categories

	(1) Raw-Materials	(2) Spares and Stores	(3) Capital Goods	(4) Final Goods
$IPR_{02} \times Htech_{i,96-01}$	0.180**	-0.169**	-0.041	0.186
	(0.079)	(0.084)	(0.109)	(0.236)
Firm controls$_{t-1}$	Yes	Yes	Yes	Yes
Firm FE's	Yes	Yes	Yes	Yes
Year FE's	Yes	Yes	Yes	Yes
Industry × Year FE's	Yes	Yes	Yes	Yes
N	6,935	4,741	4,827	1,230
R^2	0.85	0.85	0.63	0.75

Notes: The table reports the estimated effects of the Patents (Amendment) Act, 2002 across different import categories based on Eq. (1), with all variables expressed in their natural logarithm. Standard errors, reported in parentheses, are clustered at firm level. The firm- and industry-specific controls - age, debt, profits, total assets, R&D expenditure, royalty and licensing expenditures, and tariffs - all measured in their natural logarithm form, are used in $t-1$ period. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

We provide two potential explanations for these findings. First, the stronger IP regime reduces the threat of imitation by local firms, thereby making foreign firms more inclined to supply technology-intensive inputs to countries with stronger IPR protection. This finding aligns with Branstetter et al. (2006) who document that knowledge transmission by US multinationals to their affiliates increases following IPR reforms in host countries. Second, the reform enhances incentives for innovation and induces firms to invest more in R&D, which raises expected future profits and further encourages firm to engage in cost-saving activities such as importation of intermediate inputs, providing evidence of complementarity between R&D and outsourcing (Bøler et al. 2015). Therefore, domestic reforms related to patents not only promote innovation but also encourage international sourcing.

The average treatment effects of the reform on imports of capital goods and final goods are not statistically significant. Specifically, the insignificant response of capital-goods imports indicates that firms initially relied on existing production capacity instead of investing in new machinery. Nonetheless, the positive and statistically significant effects emerges with a lag. Therefore, the results suggest that patent reform reoriented firms' import composition away from final goods and toward more upstream intermediate inputs.

5 Event study and dynamic effects

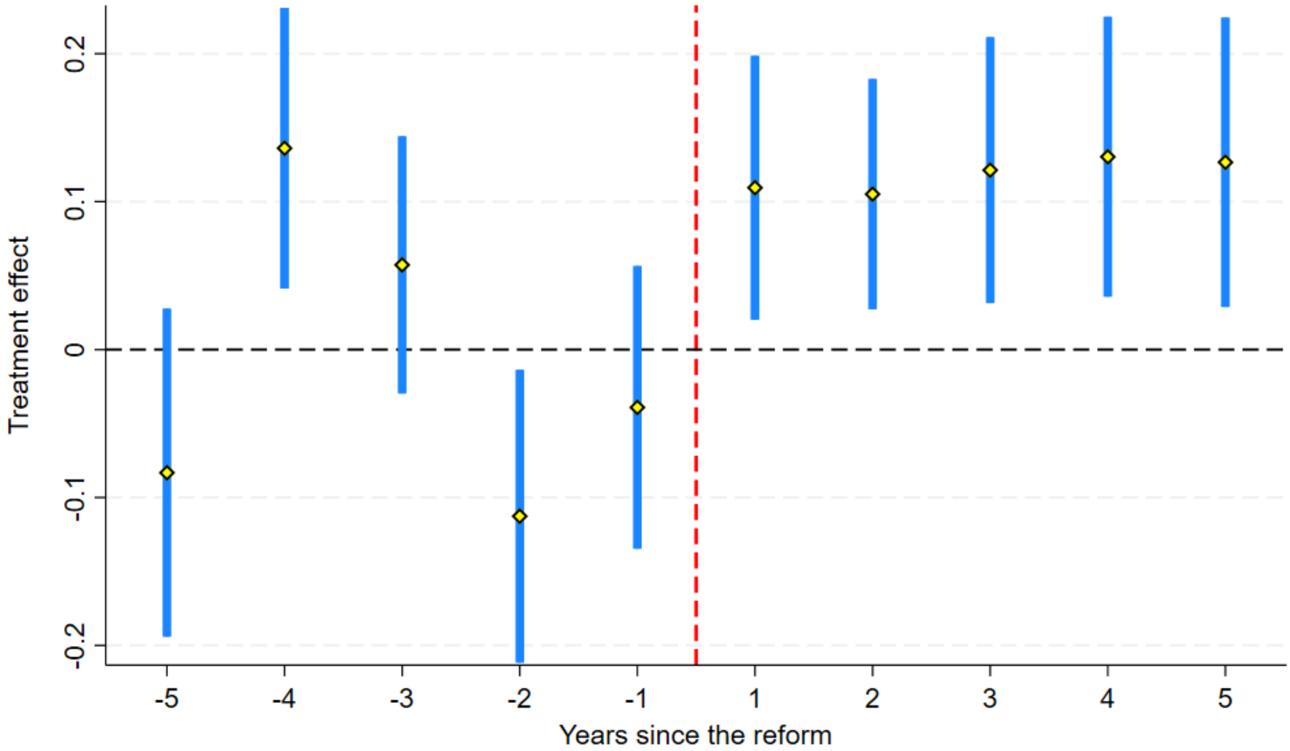
A key identifying assumption underlying the difference-in-differences requires that, in the absence of the treatment, the average outcome for the high-tech firms (treatment) and the low-tech firms (comparison) would have followed the same trend over time, commonly referred a parallel trend assumption (PTA). To test the validity of PTA, we estimate the following dynamic TWFE event-study regression:

$$\ln Y_{is,t} = \beta_i + \gamma_t + \lambda_{st} + \sum_{\substack{k=-6 \\ k\neq 0}}^{5} \delta_k \left(IPR_{t+k} \times Htech_{i,96\text{–}01} \right) + \mathbf{X}'_{is,t-1}\boldsymbol{\theta} + \varepsilon_{it}. \tag{2}$$

where, t indexes calendar years, while k indexes event time relative to the 2002 reform ($k = t-2002$). $IPR_{t-6} = \mathbb{1}\{t \leq 1996\}$ is an event-time indicator that equals one for all year that pre-date the Patent (Amendment) Act 2002 by six or more years, and zero otherwise. Similarly, $IPR_{t+5} = \mathbb{1}\{t \geq 2007\}$ is a dummy that equals to one for all years at least five year after the 2002 reform. The coefficients on pre-reform dummies, $\delta_k \ \forall \ k < 0$, either capture anticipation effects or, in their absence, are interpreted as placebo coefficients used in testing the validity of PTA, whereas, $\delta_k \ \forall \ k > 0$, enables us to estimate dynamic effects post-reform. The reform year $k = 0$ is omitted for normalization which serves as a reference period, and all coefficients are measured relative to it.

Figure 2 presents the event-study estimates of the effect of the reform on exports. First, we find that average treatment effects prior to the reform are statistically indistinguishable from zero, providing evidence in favor of the parallel trends assumption. Second, export flows exhibit modest growth in the post-reform periods. Specifically, in the first year following the reform, average exports for high-tech firms are about 12% higher than low-tech firms, with effects of comparable magnitude observed in the subsequent years. This pattern may reflect the gradual evolution of enforcement mechanisms, whereby IPR protection became effective only over time, resulting in a lagged export response to the reform (Delgado et al. 2013; Sheikh and Kanwar 2025).

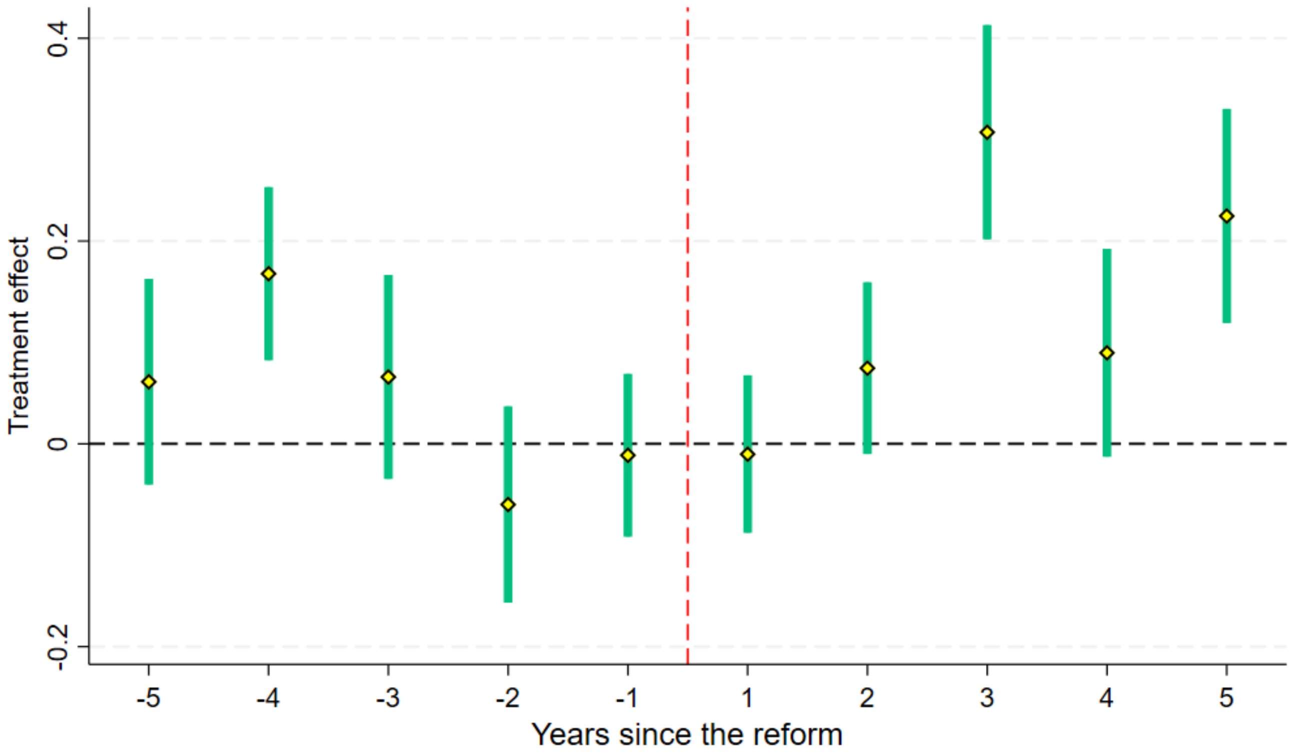
Figure 2 Event-study estimates of reform impact on exports



Notes: The figure presents the dynamic event-study estimates of the reform's effect on firm exports across different durations of exposure to the treatment. The whiskers denote 95% confidence intervals with standard errors clustered at the firm level.

Figure 3 presents the dynamic effects of the reform on firms' total imports. Similar to exports, we find no evidence of differential pre-trends between high-tech and low-tech firms, while imports of high-tech firms increase only after the 2002 reform. We did not find the instantaneous impact of the reform on imports, any discernible effects were observed to occur with delay. Specifically, two years after the reform, the imports of high-tech firms are estimated to be 8% higher than low-tech firms, in the third year by 35%, in the fourth year by 9%, and in the fifth year by 25%. Taken together, these estimates indicate a persistent positive effect of the reform on firms' total imports.

Figure 3 Event-study estimates of reform impact on imports

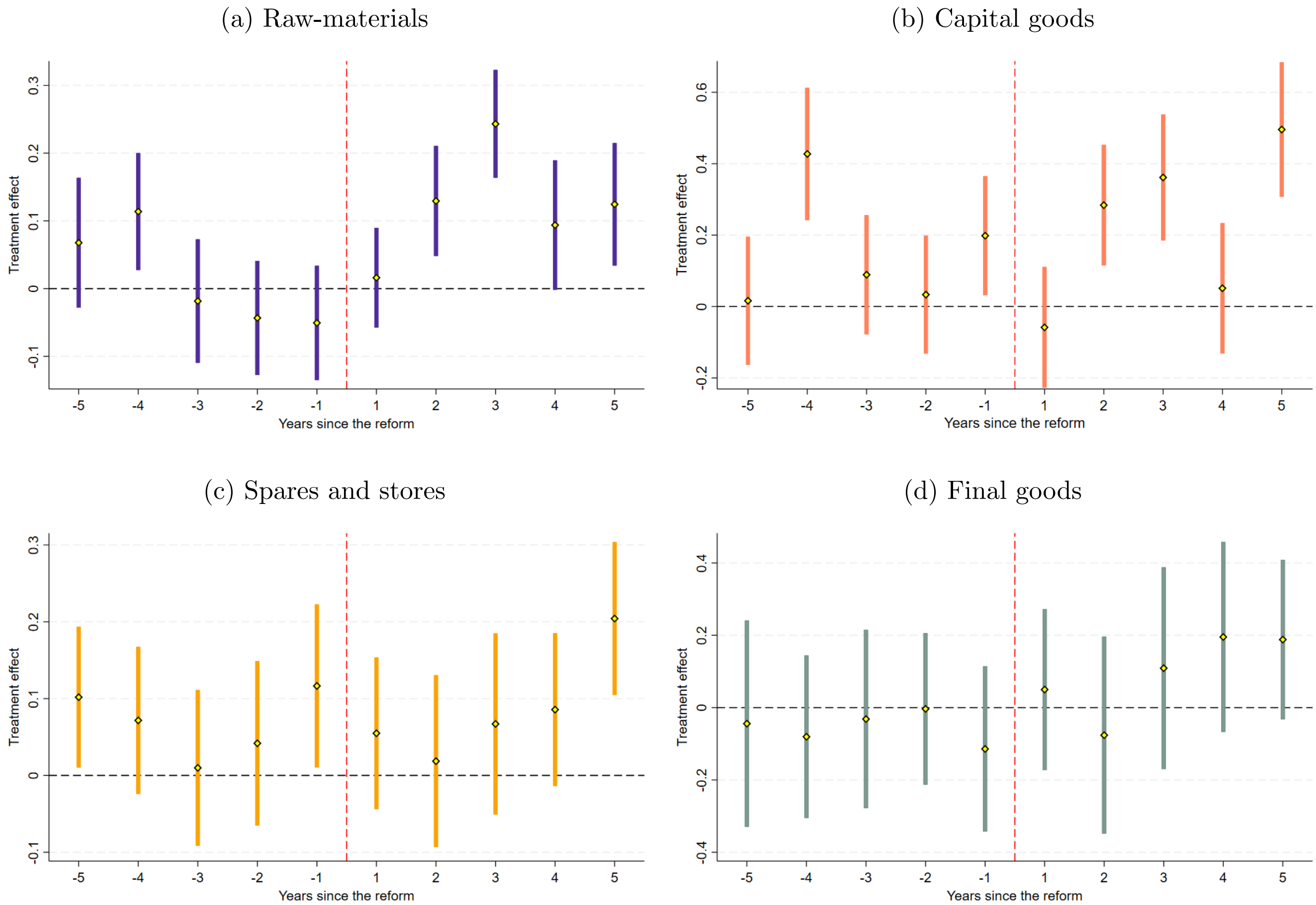


Notes: The figure presents the dynamic event-study estimates of the reform's effect on firm imports across different durations of exposure to the treatment. The whiskers denote 95% confidence intervals with standard errors clustered at the firm level.

Next, Figure 4 presents the effects of the reform across different import categories, including raw materials, spares and stores, capital goods, and final goods, at different durations of treatment exposure. Several results stand out: First, imports of raw materials exhibit a strong positive response to the reform, with effects that persist even five years after its inception. Second, the reform effects on imports of capital goods increase over time throughout the period of investigation. Third, while we find no significant effects of the reform on imports of final goods at different lengths of event-horizon, the phasing-in estimates for spares and stores emerge with a delay. A possible interpretation of these results is that, over time, the reform induced a reallocation of firms' import composition away from final goods and toward raw materials and capital goods.

Therefore, stronger IPR reforms facilitated firms' access to superior, often proprietary, inputs through international sourcing, which may have lowered input costs while simultaneously improving product quality (Bøler et al. 2015).

Figure 4 Event-study estimates of reform impact across different import categories



Notes: The figure presents the dynamic event-study estimates of the reform's impact across different import categories. The whiskers denote 95% confidence intervals with standard errors clustered at the firm level.

5.1 Sensitivity analysis

5.1.1 Were the treatment and control firms on different pre-reform time trends

To further test for the validity of identifying assumptions, we use pre-reform data from 1996-2001. Following Abramitzky and Lavy (2014), we estimate a constant linear time trend model while allowing for an interaction of the constant linear trend with the treatment indicator ($Htech_{i,96-01}$). We also estimate an alternative specification where we replace the linear time trend variable with a series of year dummies, each interacted with the treatment indicator. The results are presented in Table 5 for exports, imports, and raw-materials imports, which we estimate to exhibit a stronger response to the reform. The estimates in Columns (1) and (2) indicate the presence of a time trend in exports, however, this trend is identical for high-tech and low-tech firms in the pre-reform period. Specifically, the coefficients on the interaction term of the treatment indicator with the year dummies are all economically small and statistically insignificant. Therefore, we conclude that high-tech and low-tech firms followed similar export trends in the six years preceding the reform. The results based on total imports and imports of raw-materials reveal similar conclusions.

Table 5 Differences in pre-reform time trends in exports, imports, and raw-material imports

	Exports		Imports		Raw-Materials Imports	
	(1)	(2)	(3)	(4)	(5)	(6)
$Time\ Trend$	-0.038		-0.027		-0.053	
	(0.114)		(0.086)		(0.093)	
$Htech_{i,96\text{–}01} \times Time\ Trend$	0.027		0.009		0.008	
	(0.018)		(0.015)		(0.119)	
$Htech_{i,96\text{–}01} \times 1997$		-0.135		-0.076		-0.004
		(0.128)		(0.115)		(0.111)
$Htech_{i,96\text{–}01} \times 1998$		0.038		0.031		0.126
		(0.116)		(0.099)		(0.102)
$Htech_{i,96\text{–}01} \times 1999$		-0.003		0.012		0.020
		(0.098)		(0.091)		(0.086)
$Htech_{i,96\text{–}01} \times 2000$		-0.014		0.008		-0.008
		(0.079)		(0.077)		(0.068)
Firm controls$_{t-1}$	Yes	Yes	Yes	Yes	Yes	Yes
Firm FE's	Yes	Yes	Yes	Yes	Yes	Yes
Year FE's	Yes	Yes	Yes	Yes	Yes	Yes
Industry FE's	Yes	No	Yes	No	Yes	No
Industry × Year FE's	No	Yes	No	Yes	No	Yes
N	5,682	2,701	5,644	2,695	7,330	3,556
R^2	0.86	0.88	0.86	0.88	0.88	0.87

Notes: The table presents estimates assessing whether the treatment group (high-tech firms) and the control group (low-tech firms) followed differential pre-reform time trends in exports, imports, and raw-material imports. The firm- and industry-specific controls - age, debt, profits, total assets, R&D expenditure, royalty and licensing expenditures, and tariffs - all measured in their natural logarithm form, are used in $t-1$ period. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

5.1.2 Exogeneity of the Patents (Amendment) Act, 2002

A remaining threat for identification is that the timing of the 2002 reform may not be exogenous with respect to the activities of high-tech firms. In particular, if technologically advanced firms actively lobbied for enhanced patent protection to secure disproportionate gains, the estimated treatment effects may partly reflect endogenous policy timing and strategic selection, rather than the causal impact of the reform.

Following Topalova and Khandelwal (2011), we test whether the interaction of the high-tech dummy and the post-reform dummy ($IPR_{02} \times Htech_{i,96-01}$) is systematically correlated with pre-reform firm characteristics that may proxy for lobbying capacity or political influence. These characteristics include exports (firms with higher export intensity have stronger incentive and resources to lobby for patent protection), imports (firms with greater reliance on imported inputs and foreign technology may benefit more from stronger IPR protection and therefore have stronger incentives to influence policy reform), R&D (returns to R&D depend on strength of intellectual property regime, thereby strengthening firms' incentives to lobby), total sales (larger firms are typically more politically connected). Therefore, our estimating equation becomes:

$$IPR_{02} \times Htech_{i,96-01} = \beta_i + \gamma_t + \lambda_{s,t} + \delta_1 \overline{\pi}_{i,96-01} + \mathbf{X}'_{is,t-1} + \epsilon_{it} \tag{3}$$

The pre-reform firm characteristics, $\overline{\pi}_{i,96-01}$, are measured as an average of 1996-2001 period. All other firm- and industry-specific controls ($\mathbf{X}'_{is,t-1}$) are used in $t-1$ period.[5] Table 6 presents the results based on Eq. (3). We find that the coefficients on all pre-reform firm characteristic are statistically indistinguishable from zero, suggesting that treatment assignment does not appear to be predicted by observable pre-reform firm characteristics that proxy for lobbying power. These finding mitigate concerns that the timing of the IPR reform was endogenous to the political influence of high-tech firms. Instead, the 2002 reform appears more plausibly attributable to external obligations under the WTO's Agreement on Trade-Related Aspects of Intellectual Property Rights (TRIPS), or to coercive pressures from developed countries, as documented in prior studies (Deere 2009; Ivus 2010; Kanwar 2012; Delgado et al. 2013; Sheikh and Kanwar 2025).

[5] The results are qualitatively unchanged when we instead employ pre-reform averages of these control variables.

Table 6 Exogeneity of the Patents (Amendment) Act, 2002

	$IPR_{02} \times Htech_{i,96\text{–}01}$				
	(1)	(2)	(3)	(4)	(5)
ln Exports	0.010				
	(0.006)				
ln Imports		0.006			
		(0.004)			
ln R&D			0.005		
			(0.008)		
ln Total assets				0.012	
				(0.018)	
ln Sales					0.018
					(0.013)
Other controls$_{t-1}$	Yes	Yes	Yes	Yes	Yes
Firm FE's	Yes	Yes	Yes	Yes	Yes
Year FE's	Yes	Yes	Yes	Yes	Yes
Industry × Year FE's	Yes	Yes	Yes	Yes	Yes
N	6,961	9,287	6,891	9,295	9,280
R^2	0.76	0.75	0.77	0.75	0.75

Notes: The table presents the estimates from a regression of $IPR_{02} \times Htech_{i,96\text{–}01}$ on pre-reform firm characteristics, computed as an average of 1996-2001 period. Standard errors, reported in parentheses, are clustered at firm level. All additional firm- and industry-specific controls are used in $t-1$ period. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

6 Mechanism

Domestic reforms related to patents increase the costs of imitation while enhancing the expected returns to innovation, thereby incentivizing in-house R&D and facilitating technology transfer by multinational corporations (Kanwar and Evenson 2003; Branstetter et al. 2006).

We begin by examining the first-order effects of the Patents (Amendment) Act, 2002 on firms R&D expenditure, technology transfer expenditure (measured as the sum of royalty payments and licensing fee for technical know-how), technology adoption expenditure (defined as the sum of expenditure on R&D and technology transfer), and tech-share (calculated as the ratio of technology adoption expenditure to gross value added). We sequentially replace the dependent variable in Eq. (1) with these measures of innovation and technology oriented expenditures. The regression results reported in Table 7 indicate that the patent reform led to significant increase in R&D, technology transfer, technology adoption, and tech-share among high-tech firms relative to low-tech firms.

Together with our earlier finding of increased raw-material imports, the positive effect of reform on R&D provides evidence of complementarity between in-house R&D and imports of intermediate inputs, consistent with Bøler et al. (2015). Furthermore, the increase in technology transfer and technology adoption expenditures suggests that the reform enabled firms to absorb and effectively assimilate foreign technology to enhance their product quality and remain competitive, which in turn may have contributed to the rise in exports reported in the preceding analysis.

Table 7 Patent reform impact on R&D, technology transfer, and technology adoption expenditure

	(1) R&D	(2) Royalty & Licensing	(3) Technology Adoption	(4) Tech-Share
$IPR_{02} \times Htech_{i,96\text{–}01}$	0.533***	0.508***	0.811***	1.188***
	(0.060)	(0.069)	(0.055)	(0.067)
Firm controls$_{t-1}$	Yes	Yes	Yes	Yes
Year FE's	Yes	Yes	Yes	Yes
Industry × Year FE's	Yes	Yes	Yes	Yes
N	9,706	9,706	9,706	9,629
R^2	0.48	0.25	0.55	0.24

Notes: The dependent variable in columns (1), (2), (3) and (4) is the natural logarithm of R&D expenditure, technology transfer expenditure, technology adoption expenditure, and tech-share, respectively. The firm- and industry-specific controls - age, age-square, debt, profits, and tariffs - all measured in their natural logarithm form, are used in $t-1$ period. Standard errors, reported in parentheses, are clustered at firm level. Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

Second, we utilize the "International Patent and Citations across Sectors (INPACT-S)" database by LaBelle et al. (2024), which tracks international and domestic patent flows and citations in 213 countries of origin and 91 patent application authorities over 1980-2019 period across 31 sectors. For the purposes of this study, we restrict the sample to India both as a country of origin, capturing patents filed abroad by Indian residents, and as a patent application authority, covering patents filed in India, focusing on 12 sectors over the 1996–2007 period. We follow Delgado et al. (2013) and Ivus (2010) in classifying 2-digit ISIC Rev. 3 industries into high–IPR-intensive sectors (treatment group) and low–IPR-intensive sectors (control group), and estimate the following specification:

$$Y^i_{s,t} = exp\left\{\gamma_t + \lambda_{s,t} + \chi_{c,t} + \delta^i(IPR_{02} \times Htech)\right\} \times \epsilon_{it}\ ,\ i \in \{O, D\} \tag{4}$$

We estimate two separate models. The dependent variable Y_{st}^{O} measures patents filed abroad by Indian residents (India as origin), while Y_{st}^{D} captures patents filed in India (India as destination), respectively in sector s at time t. The specification includes country–time fixed effects (χ_{ct}), which correspond to *destination–time* fixed effects in the origin model (χ_{dt}) with standard errors clustered at destination level and *origin–time* fixed effects (χ_{ot}) in the destination model with standard errors clustered at origin level. These fixed effects control for the general equilibrium effects operating via multilateral resistances (Yotov et al. 2016). Consistent with the baseline specification, we include year (γ_t) and industry-by-year (λ_{st}) fixed effects as well. $Htech$ is a dummy that takes the value of 1 for high-IPR intensive sectors and 0 for low-IPR intensive sectors. Finally, IPR_{02} is the post-reform dummy that takes the vale of 1 on and after the inception of Patents (Amendment) Act, 2002 and 0 otherwise. The coefficient δ^i is our key parameter of interest that captures the differential effect of the reform on patenting activity in high-IPR intensive sectors relative to and low-IPR sectors. We estimate Eq. (4) using Poisson pseudo-maximum likelihood (PPML) estimator, which is robust to heteroskedasticity and accommodates the presence of zero patenting flows (Silva and Tenreyro 2006).

Table 8 presents the PPML estimates of the reform's impact on patenting activity. Column (1) reports estimates for the specification in which India is the origin, while Column (2) reports estimates for the specification in which India is the destination. The estimate in Column (1) implies that the reform is associated with an approximate 73% $\big((e^{0.549} - 1) \times 100\big)$ increase in patent filings by Indian residents in high-IPR-intensive sectors relative to low-IPR-intensive sectors. In Column (2), the estimates suggest an approximately 24% $\big((e^{0.214} - 1) \times 100\big)$ increase in patent filings by foreign residents in India in high-IPR-intensive sectors relative to low-IPR-intensive sectors. Taken together, these findings suggest that the reform is associated with an increase in innovation activity, particularly in high-IPR-intensive sectors, and has contributed to strengthening India's position as a preferred destination for international knowledge dissemination. These effects may in turn have contributed to increased trade by promoting innovation and facilitating international knowledge diffusion.

Table 8 Patent reform impact on patenting activity

	(1) Foreign filings	(2) Domestic filings
$IPR_{02} \times Htech$	0.549***	0.214***
	(0.179)	(0.082)
Destination × Year FE's	Yes	No
Origin × Year FE's	No	Yes
Industry FE's	Yes	Yes
Year FE's	Yes	Yes
N	2,756	1404
R^2	0.85	0.83

Notes: The table reports the reform's impact on patents filed by Indian residents abroad (Column 1) and those filed by foreign nationals in India (Column 2), with standard errors clustered at destination- and origin-level, respectively . Statistical significance at the 1%, 5%, and 10% levels is denoted by ***, **, and *, respectively.

7 Conclusion

The existing literature on the relationship between intellectual property rights (IPRs) and trade has predominantly focused on developed economies, relying primarily on country level data on aggregate trade flows. In contrast, there is only a limited body of work that examines these questions in the context of emerging market economies using firm-level data. Using a difference-in-difference framework, we exploit the India's Patents (Amendment) Act, 2002 as a quasi-natural experiment to provide firm-level evidence on the effects of stronger intellectual property protection on trade.

Our results indicate that, following the reform, high-tech firms experienced statistically significant increases in both exports and imports relative to low-tech firms. We also find that the patent policy reform led to a significant positive impact on firms' imports of intermediate inputs. The dynamic event-study results demonstrate that the policy generated economically and statistically significant increases in exports, total imports, intermediate inputs, and capital goods, with effects that persist over time. We further document that the trade response to intellectual property reforms operates primarily through increase in firms' R&D investments and enhanced capacity to assimilate and deploy foreign technology via learning effects. Overall, this study provides policy-relevant evidence that stronger IPRs in emerging market economies such as India enhance firms' trade performance by stimulating R&D investment, promoting technology transfer and adoption, and expanding access to imported intermediate inputs and capital goods.

References

Abadie, A., S. Athey, G. W. Imbens, and J. M. Wooldridge (2023). When should you adjust standard errors for clustering? *The Quarterly Journal of Economics 138*(1), 1–35.

Abramitzky, R. and V. Lavy (2014). How responsive is investment in schooling to changes in redistributive policies and in returns? *Econometrica 82*(4), 1241–1272.

Amiti, M. and J. Konings (2007). Trade liberalization, intermediate inputs, and productivity: Evidence from Indonesia. *American Economic Review 97*(5), 1611–1638.

Ang, J. S., Y. Cheng, and C. Wu (2014). Does enforcement of intellectual property rights matter in China? Evidence from financing and investment choices in the high-tech industry. *Review of Economics and Statistics 96*(2), 332–348.

Bhattacharya, S., P. Chakraborty, and C. Chatterjee (2022). Intellectual property regimes and wage inequality. *Journal of Development Economics 154*, 102709.

Biancini, S. and P. Bombarda (2021). Intellectual property rights, multinational firms and technology transfers. *Journal of Economic Behavior & Organization 185*, 191–210.

Bolatto, S., A. Naghavi, G. Ottaviano, and K. Zajc Kejžar (2023). Intellectual property and the organization of the global value chain. *Economica 90*(359), 707–745.

Braga, C. P. P. and C. Fink (2005). 'How stronger protection of intellectual property rights affect international trade flows'. In *Intellectual Property and Development: Lessons From Recent Economic Research.* Washington, DC, The World Bank.

Branstetter, L., R. Fisman, C. F. Foley, and K. Saggi (2011). Does intellectual property rights reform spur industrial development? *Journal of International Economics 83*(1), 27–36.

Branstetter, L. G., R. Fisman, and C. F. Foley (2006). Do stronger intellectual property rights increase international technology transfer? Empirical evidence from US firm-level panel data. *The Quarterly Journal of Economics 121*(1), 321–349.

Brunel, C. and T. Zylkin (2022). Do cross-border patents promote trade? *Canadian Journal of Economics/Revue canadienne d'économique 55*(1), 379–418.

Bøler, E. A., A. Moxnes, and K. H. Ulltveit-Moe (2015). R&d, international sourcing, and the joint impact on firm performance. *American Economic Review 105*(12), 3704–39.

Canals, C. and F. Şener (2014). Offshoring and intellectual property rights reform. *Journal of Development Economics 108*, 17–31.

Chan, M., A. Petrin, and F. Warzynski (2023). The effect of R&D on quality, productivity, and welfare. Working Paper No. 30950, National Bureau of Economic Research.

Chaudhuri, S., P. K. Goldberg, and P. Jia (2006). Estimating the effects of global patent protection in pharmaceuticals: A case study of quinolones in India. *American Economic Review 96*(5), 1477–1514.

Co, C. Y. (2004). Do patent rights regimes matter? *Review of International Economics 12*(3), 359–373.

De Loecker, J., P. K. Goldberg, A. K. Khandelwal, and N. Pavcnik (2016). Prices, markups, and trade reform. *Econometrica 84*(2), 445–510.

De Rassenfosse, G., M. Grazzi, D. Moschella, and G. Pellegrino (2022). International patent protection and trade: Transaction-level evidence. *European Economic Review 147*, 104160.

Deere, C. (2009). *The Implementation Game: The TRIPS Agreement, and the Global Politics of Intellectual Property Reform in Developing Countries.* Oxford University Press.

Delgado, M., M. Kyle, and A. M. McGahan (2013). Intellectual property protection and the geography of trade. *The Journal of Industrial Economics 61*(3), 733–762.

Goldberg, P. K., A. K. Khandelwal, N. Pavcnik, and P. Topalova (2010a). Imported intermediate inputs and domestic product growth: Evidence from India. *The Quarterly Journal of Economics 125*(4), 1727–1767.

Goldberg, P. K., A. K. Khandelwal, N. Pavcnik, and P. Topalova (2010b). Multiproduct firms and product turnover in the developing world: Evidence from India. *The Review of Economics and Statistics 92*(4), 1042–1049.

Gupta, A. and J. Stiebale (2024). Gains from patent protection: Innovation, market power and cost savings in India. DICE Discussion Paper, No. 414, Heinrich Heine University Düsseldorf, Düsseldorf Institute for Competition Economics (DICE), Düsseldorf.

Helpman, E. (1993). Innovation, imitation, and intellectual property rights. *Econometrica 61*(6), 1247–1280.

Hu, A. G. and I. P. Png (2013). Patent rights and economic growth: Evidence from cross-country panels of manufacturing industries. *Oxford Economic Papers 65*(3), 675–698.

Ivus, O. (2010). 'Do stronger patent rights raise high-tech exports to the developing world?'. *Journal of International Economics 81*(1), 38–47.

Kanwar, S. (2012). Intellectual property protection and technology licensing: The case of developing countries. *The Journal of Law and Economics 55*(3), 539–564.

Kanwar, S. and R. Evenson (2003). Does intellectual property protection spur technological change? *Oxford Economic Papers 55*(2), 235–264.

Keller, W. (2004). International technology diffusion. *Journal of Economic Literature 42*(3), 752–782.

LaBelle, J., I. Martinez-Zarzoso, A. M. Santacreu, and Y. V. Yotov (2024). Cross-border patenting, globalization, and development. Working paper 2023-031c, Federal Reserve Bank of St. Louis.

Lai, E. L.-C. and L. D. Qiu (2003). The North's intellectual property rights standard for the South? *Journal of International Economics 59*(1), 183–209.

Lin, J. X. and W. F. Lincoln (2017). Pirate's treasure. *Journal of International Economics 109*, 235–245.

Liu, Y., W. G. Park, and D. Fu (2021). Export quality and patent protection: Stage-dependent effects in development. *Review of Development Economics 25*(2), 601–629.

Maskus, K. E. and M. Penubarti (1995). How trade-related are intellectual property rights? *Journal of International Economics 39*(3-4), 227–248.

Maskus, K. E. and L. Yang (2018). Domestic patent rights, access to technologies and the structure of exports. *Canadian Journal of Economics/Revue canadienne d'économique 51*(2), 483–509.

Palangkaraya, A., P. H. Jensen, and E. Webster (2017). The effect of patents on trade. *Journal of International Economics 105*, 1–9.

Peters, B., M. J. Roberts, and V. A. Vuong (2022). Firm R&D investment and export market exposure. *Research Policy 51*(10), 104601.

Rafiquzzaman, M. (2002). The impact of patent rights on international trade: Evidence from Canada. *Canadian Journal of Economics/Revue canadienne d'économique 35*(2), 307–330.

Reddy T, P. and S. Chandrashekaran (2017). *Create, copy, disrupt: India's intellectual property dilemmas*. Oxford University Press.

Schneider, P. H. (2005). International trade, economic growth and intellectual property rights: A panel data study of developed and developing countries. *Journal of Development Economics 78*(2), 529–547.

Schor, A. (2004). Heterogeneous productivity response to tariff reduction: Evidence from Brazilian manufacturing firms. *Journal of Development Economics 75*(2), 373–396.

Sheikh, R. A. and S. Kanwar (2025). Revisiting the impact of TRIPS on trade: Evidence from staggered difference-in-differences. WP-2025-025 , Indira Gandi Institute of Development Research, Mumbai.

Shin, W., K. Lee, and W. G. Park (2016). When an importer's protection of IPR interacts with an exporter's level of technology: Comparing the impacts on the exports of the North and South. *The World Economy 39*(6), 772–802.

Silva, J. S. and S. Tenreyro (2006). The log of gravity. *The Review of Economics and Statistics 88*(4), 641–658.

Smith, P. J. (1999). Are weak patent rights a barrier to U.S. exports? *Journal of International Economics 48*(1), 151–177.

Topalova, P. and A. Khandelwal (2011). Trade liberalization and firm productivity: The case of India. *Review of Economics and Statistics 93*(3), 995–1009.

Yotov, Y. V., R. Piermartini, M. Larch, et al. (2016). *An Advanced Guide to Trade Policy Analysis: The Structural Gravity Model*. Geneva: UNCTAD and WTO.

A Appendix

Table A1 Variable definitions

Variable	**Definition**
Exports	FOB value of goods exported, as disclosed in firms' annual reports.
Import of raw materials	CIF value of imported raw materials from financial statements.
Import of spares & stores	CIF value of imported spares and stores (Prowess field).
Import of finished goods	CIF value of imported finished goods (Prowess field).
Import of capital goods	CIF value of imported capital goods (plant & machinery, furniture & fixtures, transport equipment, intangible assets, and other equipment/accessories used directly or indirectly in production or services).
Total imports	Sum of the import of raw-materials, spares & stores, finished goods, and capital goods (CIF basis).
Age	Firm age in years (= reference year − year of incorporation).
Debt	Total borrowings (short- and long-term): loans, bonds, and other interest-bearing liabilities reported in Prowess.
Profit	Net profit after interest and taxes.
R&D	Total research & development outlays, including capitalized R&D (capital account) and expensed R&D (current account).
Technology Transfer	Annual payments for royalties, technical know-how, and license fees to access IP/technology not owned by the firm.
Technology Adoption	Sum of R&D and technology transfer expenditures.
Gross value added (GVA)	Sales minus cost of raw materials and other intermediate inputs (e.g., fuel, spares, stores).
Tech-share	Ratio of technology adoption expenditure to GVA.
Tariffs	MFN import tariffs at the ISIC Rev. 3 four-digit level (obtained from WITS interface).

Note: FOB: Free on Board; and CIF: Cost, Insurance, and Freight.