Innovation, Productivity and IPRs in an Emerging Market Economy

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Emerging Market Economies

- sustained growth performance

  * amongst the fastest growing
  * largest outside OECD
  * increasingly intertwined with r-o-w
  * largest holders of foreign exchange

Perhaps no coincidence that this period also witnessed stronger IPRs post-TRIPs agreement of 1994

Question:

Has this spectacular performance been accompanied by greater innovation and productivity, associated with the strengthening of IPRs post-TRIPs?

Positive association appears consistent with the literature, which predicts greater inflow of technology and superior inputs in response to stronger IPRs.

Stronger IPRs may spur
* domestic innovation (Kanwar-Evenson 2003, Chen- Puttitanum 2005)
* technology licensing (Yang-Maskus 2001, Park-Lippoldt 2005, Branstetter et.al 2006, Kanwar 2012a)
* Xs/high-tech Xs from N to S (Ferrantino 1993, Smith 2001, Ivus 2010
* FDI (Ferrantino 1993, Lee-Mansfield 1996, Javorcik 2004
* overseas R&D (Branstetter et al 2006)

Contrary evidence as well
* Domestic innovation (Sakakibara-Branstetter 2001, Lerner 2002, Qian 2007);
* technology licensing (Ferrantino 1993, Fosfuri 2002);
* overseas R&D (Kanwar 2012b).

We contribute by focusing directly on the relationship between IP reform in India and its influence on the TF and TFP in Indian manufacturing. To our knowledge, the first attempt at this issue.

Second, using the fact that the post-TRIPs strengthening of IPRs in LDCs was largely exogenous, we attempt to correct for endogeneity bias.

Exogeneity of IP variable:

Presumably true in the post-TRIPs period, when strengthening of IPRs by developing countries was forced by developed countries.

Drahos (2002) observes that "... developing countries have comparatively little influence ..." in the negotiations, the major cause of which "lies in the continued use of webs of coercion by the US and EU, both ... united on the need for strong global standards of intellectual property protection".

Deere (2009), Drahos (2002), and Watal (2001) argue that certain developed countries used strong economic and diplomatic pressures to make the developing countries cede their position. US used 'Section 301' of the US Trade Act, and GSP programme to deny trade benefits to noncomplying nations

Used 'Special 301' to place on the 'Watch List' and 'Priority Watch List', those opposed to the US IP agenda..

Similar laws enacted by the EU (eg. Council Regulation 264/84), but sparingly used for lack of consensus. EU rallied behind the US.

IP Reform in India – more a process than an event

Patents Ordinance 1995 – bill defeated in Parliament, but > 1300 product patent applications filed till early-1997

Patents (Amendment) Act 1999 - 'mailbox facility' for product patent applications in drugs, pharmaceuticals and chemicals. EMRs for applications satisfying certain conditions. 9000 applications filed.

Patents (Amendment) Act 2003 - rendered Indian patents laws TRIPs compliant.

Patents (Amendment) Act 2005 - product patents in drugs, pharmaceuticals and chemicals.

Diff-in-diff analysis and Event analysis not feasible –
* no single year as threshold
* short window around threshold not enough to capture effects of IP reform
* Presence or absence of reform (i.e. reform dummy) not enough; efficacy of enforcement also important

So IP-variable treated as a continuous variable

Start with Ginarte-Park patent index (Ginarte-Park 1997; Park 2008), which allows for Coverage, Duration, Membership, measures against Revocation, and Enforcement.

We augment these by Efficacy of Enforcement, using the 'Area 2' index of Gwartney, Lawson, Hall 2014.

The modified Ginarte-Park index (IPGP) varies between 0 and 6, with larger values signifying stronger protection

Total factor productivity (TFP) measured using Färe-Primont productivity index

Technical frontier (TF) approximated by maximum possible TFP

Production efficiency (PE) is then difference between firm's actual TFP and the technical frontier, such that
$$TFP_{it} = (TF_t)(PE_{it})$$

TFP and its components derived using Data Envelopment Analysis (O'Donnell 2011a, 2011b), using data on sales, raw materials, net fixed assets, and salaries, each deflated by industry-specific WPIs

Data:

Firm-level data for the Indian manufacturing sector ('Prowess'; CMIE)

Sample 15084 observations - 838 firms over 1994-2011, covering 17 industries (mostly 2-digit, some 3-digit levels):

Auto ancillaries, automobiles, cement, chemicals, domestic appliances, drugs and pharmaceuticals, electrical machinery, electronics, food and agro-products, leather and leather products, metals, non-electrical machinery, personal care, petroleum, plastics and plastic products, rubber and rubber products, and textiles and textile products.

Unlikely that IP reform had same effect on all firms/industries

Can distinguish these effects on the basis of IP-intensity of industries/firms
i.e. factors $D^1 * IPGP$ and $D^3 * IPGP$
where $D^1 = 1$ for IP-intensive firms, and $D^3 = 1$ for non-IP-intensive firms (determined using Cohen et al. 2000)

The estimation equation is:
$$Y_{ijt} = \theta_2\, IPGP_t + \theta_1\, D^1_{ij} * IPGP_t + \theta_3\, D^3_{ij} * IPGP_t + \beta_1\, X1_{ijt} + \beta_2\, X2_{jt} + \gamma\, t + \alpha_i + \varepsilon_{ijt}$$

where X1, X2 and α_i are possible confounders (SALES, CRATIO, PRIVATE, FOREIGN), and t is the time trend

Table 1
Sample Statistics: 1994-2011

Variable	Mean	Median	Standard Deviation	Minimum	Maximum
TF	0.523	0.413	0.271	0.187	1.182
TFP	0.178	0.119	0.153	0.0001	1.182
PE	0.325	0.300	0.163	0.001	1.000
IPGP	3.355	3.568	1.024	1.569	4.457
SALES	52.398	9.372	282.501	0.002	8507.490
CRATIO	0.442	0.406	0.158	0.217	0.991
PRIVATE	0.607	1.000	0.488	0.000	1.000
FOREIGN	0.103	0.000	0.303	0.000	1.000

Correlation Matrix for Regressors

	IPGP	SALES	CRATIO	PRIVATE	FOREIGN
IPGP	1.000				
SALES	0.062	1.000			
CRATIO	0.030	0.251	1.000		
PRIVATE	0.034	–0.003	0.026	1.000	
FOREIGN	–0.029	0.007	0.097	0.114	1.000

Growth. Rate p.a.

TF	1.17
TFP	0.67
PE	–0.50

Notes: *TF, TFP, PE, IPGP* – indices; *SALES* – Rs. million; *CRATIO* – ratio; *PRIVATE, FOREIGN* – dummies; Growth rate – percent per annum over the sample period

Table 2
The Effect of Intellectual Property Reform:
Dependent Variable – Technical Frontier Index (TF)

Regressor	Results with Firm Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
$IPGP$	0.022***	0.021***	0.021***	0.020***	0.020***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$D_{ij}^1 * IPGP_t$	0.026***	0.025***	0.030***	0.031***	0.032***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$D_{ij}^3 * IPGP_t$	−0.014***	−0.014***	−0.002*	−0.003**	−0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
$TREND$	0.001***	0.001***	0.001***	0.001***	0.001***
	(0.0001)	(0.0001)	(0.0002)	(0.0002)	(0.0002)
$SALES * 10^{-3}$		−0.014***	−0.011***	−0.012***	−0.012***
		(0.005)	(0.004)	(0.004)	(0.004)
$CRATIO$			−0.354***	−0.343***	−0.343***
			(0.027)	(0.026)	(0.025)
$PRIVATE$				0.041***	0.041***
				(0.006)	(0.006)
$FOREIGN$					0.043***
					(0.012)
$Intercept$	−1.178***	−1.370***	−0.798**	−0.907***	−0.873**
	(0.255)	(0.265)	(0.346)	(0.347)	(0.347)
N	15084	15084	15084	15084	15084
$P (slopes\ 0)$	0.000	0.000	0.000	0.000	0.000
$Robust\ SEs$	Yes	Yes	Yes	Yes	Yes
R^2	0.289	0.289	0.322	0.332	0.338

Notes: Standard error in parentheses below coefficient;
    ***, **, * denote significance at 1%, 5% and 10% levels, two-tail test.

Table 3
The Effect of Intellectual Property Reform:
Dependent Variable – Total Factor Productivity Index (TFP)

Regressor	Results with Firm Fixed Effects				
	(1)	(2)	(3)	(4)	(5)
IPGP	0.0002	0.0004	0.0003	0.0001	0.0001
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$D_{ij}^1 * IPGP_t$	−0.004*	−0.004*	−0.002	−0.002	−0.002
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
$D_{ij}^3 * IPGP_t$	−0.008**	−0.008**	−0.004	−0.004	−0.004
	(0.003)	(0.003)	(0.003)	(0.004)	(0.004)
TREND	0.002***	0.001***	0.001***	0.001***	0.001***
	(0.0004)	(0.0004)	(0.0004)	(0.0004)	(0.0004)
$SALES * 10^{-3}$		0.020	0.021*	0.020*	0.021*
		(0.012)	(0.012)	(0.012)	(0.012)
CRATIO			−0.101***	−0.100***	−0.100***
			(0.021)	(0.021)	(0.021)
PRIVATE				0.005	0.005
				(0.006)	(0.006)
FOREIGN					0.003
					(0.009)
Intercept	−3.000***	−2.733***	−2.569***	−2.583***	−2.581***
	(0.765)	(0.785)	(0.790)	(0.791)	(0.791)
N	15084	15084	15084	15084	15084
P (slopes 0)	0.000	0.000	0.000	0.000	0.000
Robust SEs	Yes	Yes	Yes	Yes	Yes
R^2	0.022	0.024	0.028	0.029	0.029

Notes: Standard error in parentheses below coefficient;
    ***, **, * denote significance at 1%, 5% and 10% levels, two-tail test.

Table 4
The Effect of Intellectual Property Reform:
Dependent Variable – Production Efficiency Index (PE)

	Results with Firm Fixed Effects				
Regressor	(1)	(2)	(3)	(4)	(5)
$IPGP$	–0.019***	–0.021***	–0.021***	–0.021***	–0.021***
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$D_{ij}^1 IPGP_t$	–0.008*	–0.007*	–0.008*	–0.008*	–0.009**
	(0.004)	(0.004)	(0.004)	(0.004)	(0.004)
$D_{ij}^3 IPGP_t$	0.009*	0.010*	0.007	0.007	0.007
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
$TREND$	0.002***	0.002***	0.002***	0.002***	0.002***
	(0.0007)	(0.0007)	(0.0007)	(0.0007)	(0.0007)
$SALES * 10^{-3}$		0.040*	0.040*	0.040*	0.040*
		(0.023)	(0.022)	(0.023)	(0.022)
$CRATIO$			0.069*	0.067*	0.067*
			(0.038)	(0.039)	(0.039)
$PRIVATE$				–0.007	–0.007
				(0.010)	(0.010)
$FOREIGN$					–0.019
					(0.017)
$Intercept$	–4.251***	–3.710***	–3.821***	–3.803***	–3.818***
	(1.353)	(1.398)	(1.396)	(1.396)	(1.396)
N	15084	15084	15084	15084	15084
P ($slopes$ 0)	0.000	0.000	0.000	0.000	0.000
$Robust SEs$	Yes	Yes	Yes	Yes	Yes
R^2	0.022	0.024	0.024	0.024	0.025

Notes: Standard error in parentheses below coefficient;
     ***, **, * denote significance at 1%, 5% and 10% levels, two-tail test.

Conclusion:

Statistically significant outward shift in the Technical Frontier during sample period, in response to IP reform – shift of 0.052 units for treatment group, compared to 0.017 for control group; significantly different.

However, TFP does not appear to have increased as a result - both overall and for the treatment and control groups.

One factor behind this appears to be that many firms have not yet adopted the improved technology. As more firms catch up over time, TFP may also respond to the IP reform.