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**Strategic Positioning after TRIPS: Evidence from the Indian Pharmaceutical Industry**

Shinjinnee Chattopadhyay  
*University of Illinois at Urbana Champaign*  
Management  
schattop@illinois.edu

Janet Bercovitz  
*University of Illinois at Urbana Champaign*  
Management  
jbercov@illinois.edu

**Abstract**

Firms’ strategy selection and positioning choices are contextually dependent. When there is a radical shift in the institutional context, firms are forced to reevaluate the viability of their current strategies. From 1970 to 1995 the Indian pharmaceutical industry operated under a process-focused intellectual property (IP) regime and enjoyed the legal protection to reverse engineer the chemical composition of brand name drugs to produce cheaper generic versions. In 1995 this protection was taken away through the introduction of the TRIPS Act. In this paper we examine the strategic response of Indian pharmaceutical firms to this shift in the IP regime. The central questions we study in this paper are which innovation strategies different firms choose and what underlying factors dictate these repositioning choices. We find that the scope and specialization of the firm’s extant knowledge base, which set capabilities and influence cognitive framing, dictate firms’ innovative behavior in response to the regime change. We further find that firms’ strategic choices in response to institutional change have significant implications for the industry structure and contribute to the reshaping of both the Indian pharmaceutical industry and the broader global pharmaceutical industry.

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Key words: TRIPS, disruptive change, cognitive emphasis of firm, strategic repositioning, recombination, specialization, Indian pharmaceutical industry, generics manufacturing

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1. Introduction

Firms’ strategy selection and positioning choices are contextually dependent. When there is a significant shift in the institutional, competitive or technological environment (Meyer, 1982; King and Tucci, 2002; Li and Tallman 2011), firms may be forced to reevaluate the viability and appropriateness of their current strategies. Such re-evaluation catalyzes an endogenous change process – as firms respond to environmental and institutional disturbances through the selection of and movement toward new strategic positions, the competitive landscape itself undergoes substantial reconfiguration.

Most of the existing literature on organizational transformation has examined the response of firms to shifts in their individual external technological contexts. For instance, past work has theorized that firms respond to external shifts in technology trajectories by reconfiguring and transforming resources (Helfat and Peteraf, 2003), embarking on search processes (Cyert and March, 1963, Barnett and Burgelmann, 1996), and learning (Zollo and Winter, 2002). Lavie et al (2010) point out, however, that there is a dearth of work that looks at underlying factors that determine firms’ strategic innovation choices in the face of disruptive contextual jolts that affect an entire industry. Uhlenbruck et al (2003) also call for research on factors that bring about organizational transformation in response to institutional changes. This paper seeks to inform this gap. We contribute to the literature on organizational evolution by first illuminating the dimensions of firms’ existing resources and cognitive capabilities that shape innovation-based repositioning choices, and second examining the effect of these choices on firm performance and industry structure.

We study the effect of a significant institutional change – the introduction of product patent protection in the Indian pharmaceutical industry, the Trade Related Aspects of Intellectual
Property (TRIPS) Act (introduced in 1995, with full enactment in 2005 by the Indian pharmaceutical industry) which required migration from a process-patent intellectual property (IP) regime to a product-patent IP regime. This radical institutional shift made the then dominant reverse engineering strategy of Indian pharmaceutical firms unfeasible as a future strategy.

During a contextual shift, the set of feasible strategic alternatives open to firms will differ as this set is determined by the firms’ existing resources (Argyres, Bigelow, and Nickerson, 2015), integrative capabilities (Moeen, 2016), and cognitive lenses (Kaplan and Tripsas, 2008). Helfat and Lieberman (2002) have shown that firms enter new markets when their existing resources and the resources needed to exploit the new opportunity are in alignment. Adding to this literature, we study how firms’ knowledge capabilities shape their innovation decisions in the period following the implementation of the TRIPS. We find that knowledge base scope determines the range of recombination-worthy elements the firm possesses, but ultimately the firm’s ability to recombine, and hence its repositioning strategy, is shaped by the firm’s degree of specialization in certain key elements. We argue that firms’ past specialization influences managerial attention and decision-making. Thus firms’ responses to exogenous technological changes are shaped dually by the knowledge assets and the cognitive emphasis of the firms.

In this study of Indian Pharmaceutical firms, we consider four mutually inclusive potential repositioning strategies based on the degree of recombination involved: (1) Novel innovation strategy which entails new active pharmaceutical ingredients (API), new drug formulation and new delivery methods; (2) Focused or close-in innovation strategy which entails fast-entry into newly off-patent drugs; (3) Limited innovation or status quo strategy—continuation of a traditional reverse-engineering based strategy concentrated on established generics or (4) Innovation in drugs for neglected diseases. We find that competencies and
balance across a broad knowledge set is associated with firms embarking on the ambitious innovation strategy of developing new delivery formulations – injectables, suppositories, lotions, etc. A specialized set of process knowledge corresponding to market opportunities that emerge as key patents expire is associated with firms pursuing a “new-generics” strategy. Narrow and shallow sets of process knowledge is associated with firms remaining followers, re-engineering older, off-patent, generic drugs. Surprisingly, but consistent with prior literature (Lanjouw and Cockburn, 2001; Kyle and McGahan, 2012) we find that there is no significant move towards producing drugs for neglected diseases by any of the Indian pharmaceutical firms in our sample which may indicate that potential gains of such a strategy do not outweigh required adjustment costs in the short-run.

We also document that the size and structure of the pharmaceutical industry is reshaped in the period following TRIPS. We find that pharmaceutical exports from Indian pharmaceutical firms grew exponentially between 1995 and 2010. There was a sharp increase in strategic alliances as well as acquisitions. Moreover, we observe an expansion of performance distribution across Indian pharmaceutical firms. Firms that respond to the TRIPS Act by engaging in delivery formulation innovation are more likely to break away from the pack and move into higher income quintiles in 2010 relative to their quintile in 1995. Firms that remain engaged in traditional reengineering activities for established generics are less likely to move into higher income quintiles and are more likely to remain in the same, lower-tier, income quintile.

The paper proceeds as follows. We provide a contextual description of the Indian Pharmaceutical industry and the institutional change it faced in Section 2. We construct our hypotheses in Section 3, and present the data, methodology and results in Section 4. We
augment our econometric analysis with descriptive statistics to provide an overview of industry evolution and firm performance in Section 5. We conclude with a discussion in Section 6.

2. Environmental Context: Pharmaceutical industry of India and the introduction of the TRIPS Act

India adopted its first patent law in 1856. This initial policy, which was strongly influenced by the country’s British colonial status, supported the patenting of products, including pharmaceuticals products. India’s stance towards intellectual property (IP) was dramatically revised in the 1970s with the passage of the 1970 Indian Patents Act (which took effect in 1972). Under this Act, a product of lobbying by key players from India’s nascent domestic pharmaceutical industry, Indian law was changed so that patents for pharmaceutical products were no longer recognized. Instead, the Act acknowledged only process patents, with these process patents in force for a seven-year period.

There were two key objectives behind this dramatic IP shift. The first was to provide a legal environment conducive to the development of a competitive domestic pharmaceutical industry. The second aim was to better serve the Indian consumers by ensuring the availability of low-cost, affordable drugs (Chaudhuri, Goldberg, & Jia, 2003). It is clear that the first objective was successfully met. Following the passage of the 1970 Indian Patents Act, the Indian pharmaceutical industry grew rapidly. Central to this growth was the newly viable option to pursue a “reverse-engineering” strategy. Specifically, since product patents were no longer recognized in the Indian market, domestic firms could legally replicate the chemical formulations of branded drugs, drugs developed and patented by global pharmaceutical companies in their home countries, as long as the Indian firm produced these drugs via new
processes developed domestically. This “reverse-engineering” strategy was widely adopted by domestic pharmaceutical companies resulting in Indian companies moving from holding a 20% share of the domestic market in 1970 to claiming a 95% share in 2006 (Haley & Haley, 2012). Likewise, it appears that significant progress was made towards fulfilling the second, socially-focused, objective of providing affordable drugs to Indian consumers. Again, this success is tied, in part, to the “reverse-engineering” strategy as the cost-advantages of this strategy – minimal R&D costs combined with low production costs in India (estimated to be 50% US or EU production costs) – enabled the domestic pharmaceutical firms to produce generic drugs of comparable quality to branded drugs, and profitably sell these drugs at significantly lower prices (Ramani, 2002). For example, in 1987 the US firm Burroughs Wellcome introduced Zidovudine, also known as AZT as the first antiretroviral drug designed to combat the progression of AIDS. The drug was priced at nearly $10,000 for a year’s dosage or $28 a day. In contrast Cipla, the Indian drug manufacturer launched a generic version of this drug in 2001 in India, priced at $1 a day.3

The process-patent IP regime held sway in India until 1995 when India sought membership in the World Trade Organization (WTO). The WTO was established in 1994 with the goal of liberalizing trade by providing member countries with trade privileges based on negotiated rules of trade that streamlined administrative procedures. Commitment to comply with the Trade-Related Intellectual Property Rights (TRIPS) policy was necessary to gain entry into the WTO, though the required timing of implementation varied across countries based on development status (Hamdan-Livramento, 2009). India became a member of the WTO in 1995.

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2 The product mix supplied by these domestic pharmaceutical companies changed as well. Following the passage of the Act in 1970, the domestic industry has evolved from primarily producing bulk pharmaceuticals to an industry roughly balanced between bulk pharmaceuticals (45%) and formulations (55%) (Haley & Haley, 2012).

However, as a low-income developing country, India was granted a 10-year grace period and was not expected to reach full compliance with TRIPS until 2005. A key element of the TRIPS agreement is the obligation to provide and enforce product patents in all technological fields including pharmaceuticals.  

Thus, for the Indian pharmaceutical industry, India’s decision to join the WTO signified a major shift in the country’s IP policy – moving from a process-patent regime to a product-patent regime. The 10-year grace period, 1995-2005, can be considered an “incubation” or re-positioning period – the period between country-level commitment to new institutional rules and the required firm-level commercial response to these new rules (Moeen and Agarwal, 2016).

For Indian pharmaceutical companies, a central fall-out of this regime shift is the foreclosure of the continued employment of the traditional “reverse-engineering” strategy. Firms had to reevaluate their existing strategies and draw upon their existing resources to chart a new course that would ensure competitive success, or at a minimum survival, under the new IP regime. Initial strategies chosen had significant ramifications for future viability of Indian drugs manufacturers. Thus, at first glance the adoption of TRIPS appeared to represent a shrinking of market opportunities for Indian pharmaceutical firms and the short-term prognosis was grim. Simultaneously, however, several international firms were facing a sharp patent cliff as between 2005 and 2013 a number of important patents held by the large pharmaceutical companies were due to expire. These patents represent large markets both in developing as well as developed countries and the expiration of these patents represented an expansion of opportunities for the Indian pharmaceutical firms. It is this “shock-driven” multi-level change process that we study in this paper.

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4 This element of the TRIPS agreement was quite contentious. During the Uruguay round of negotiations, India led the opposition to TRIPS articles mandating pharmaceutical product patents (Chaudhuri, Goldberg, & Jia, 2003)
3. Hypothesis Development

Tushman and Romanelli (1985) classify disruptive changes into ‘convergence’ which are characterized by the process of incremental change, congruous with existing processes and activities, and ‘reorientation’ which is a process of discontinuous shift that transforms a system’s structures and control mechanisms. Using this classification, the radical shift of the Indian intellectual property regime is best categorized as a reorientation due to the collapse of old institutional structures governing firm activities and the establishment of a new order. Under ‘reorientation’ the industry landscape a firm faces is characterized by “major changes in competitive, technological, social and legal conditions of the environment that render a prior strategic orientation, regardless of its prior success, no longer effective” (Tushman and Romanelli, 1985:180). Past literature has examined the effects of reorientation on diversification and firm performance (Li and Tallman, 2011), organizational learning (Meyer, 1982) and ability to adapt (Afuah and Utterback, 1997). While the literature finds that firms’ existing capabilities determine their success in adapting to disruptive changes (Afuah and Utterback, 1997; Helfat and Eisenhardt, 2004), there have been relatively few systematic enquiries into the key dimensions of firm resources and capabilities that influence innovation-based repositioning choices, the cognitive capabilities that underlie the repositioning process, and the subsequent effect of these firm-level repositioning choices on firm performance, industry structure, and the competitive landscape. We seek to address this gap.

Strategic Repositioning

The WTO-driven discontinuous change in India’s institutional and environmental context severely undercut the viability of the traditional reverse-engineering strategy of Indian
pharmaceutical firms raising a pressing need for strategic repositioning. Indian firms’ strategic innovation choices vary according to the degree of innovation involved. Based on our conversations with industry leaders such as Gautam Swaroop, Vice President of Strategic Planning at Dr. Reddy’s Laboratories, four main repositioning options were identified: (1) Innovation-driven strategic repositioning: Innovation via the development of novel delivery formulations and active pharmaceutical ingredients (API); (2) Close-in repositioning: Fast-entry into newly off-patent drugs; (3) Status quo positioning: Production of established generics or (4) Specialization in drugs for neglected diseases. Given institutional reorientation, firms will necessarily evaluate the potential of alternative strategic options choosing to adapt to the changing environment by moving to the new strategic position that is most feasible – in terms of cost/benefit trade-offs, existing capabilities, and related adjustment costs – for their particular firm (Argyres et al, 2015).5

Though the existing stocks of technical knowledge set the firm’s starting point, attaining a new strategic position often requires additional, and at times costly, investments in new knowledge as well as the integrative capabilities to leverage these investments in concert with existing technical assets (Argyres, et. al., 2015; Moeen, 2017). These later investment and integrative decisions are shaped by the strategic beliefs of the firm’s management (Tripsas and Gavetti, 2000; Kaplan, Murray, Henderson, 2003). In sum, the level of adjustment costs faced by a firm is a function of the distance, in terms of degree of fit, between the firm’s existing capability set, the capabilities needed to successfully compete from a new strategic position, and

5 The potential value accruing to the four alternative positions is a function of the offering’s associated price-cost margin, the competitive sustainability of these margins, and the expected market segment size.
the cognitive preconditions within the firm that underlie decision-making processes (March and Simon, 1958; Kaplan and Tripsas, 2008; Ocasio, 1997, 2011).

Consider first the influence of scope on a firm’s repositioning activities. Firms draw upon existing knowledge bases to assimilate new (Cohen and Levinthal, 1990) and existing (Katila and Ahuja, 2002) information for the purpose of innovation and the pursuit of new commercial opportunities. Broadly, it is the recombination of knowledge component blocks that enable the firm to generate new knowledge and new products (Schumpeter, 1939; Kogut and Zander, 1992). Innovation can take place through recombination of existing knowledge components that are familiar to the organization (Fleming, 2001). Most directly, greater scope provides the firm with a larger set of familiar technologies that they might recombine which, in turn, increases their innovation potential (Fleming and Sorenson, 2001; Rosenkopf and Nerkar, 2001; Ahuja and Katila, 2001; Ahuja and Lampert, 2004). Relatedly, existing internal knowledge assets may have a secondary benefit stemming from the past learning investments the firm has made in these areas and the resultant asset mass efficiencies (Dierickx and Cool, 1989). The scope or breadth of the knowledge base provides combinative knowledge components as well as contributing combinative capabilities that enable innovation and repositioning activities. Further, a broader base of knowledge can facilitate the absorption and assimilation of a more diverse set of external knowledge (Cohen and Levinthal, 1990). The scope of the knowledge base therefore measures not only the recombinant components necessary for innovation, but also the potential to capture value from these components.

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6 Schumpeter (1939, p88) says: “innovation combines components in a new way, or that it consists in carrying out New Combinations”. Nelson and Winter (1982, p130) state that “the creation of any sort of novelty in art, science or practical life consists to a substantial extent of a recombination of conceptual and physical materials that were previously in existence”.
But while the existence of scope in technological knowledge is necessary, scope alone is not sufficient to prompt re-combinatorial innovative activity in support of strategic repositioning. The salience of the various knowledge elements, as evidenced by the specialization across technological knowledge assets, is also expected to matter. A firm’s strategic response to environmental changes is influenced by cognitive factors underlying managerial decision-making (Adner and Helfat, 2003; Prahalad and Bettis, 1986, 1995). Three related elements are pertinent: (1) organizational identity (Tripsas, 2009; Kaplan, 2008) (2) managerial attention (Simon, 1947; Ocasio, 1997, 2011; Eggers and Kaplan, 2009) and (3) decision-making routines and heuristics (Simon, 1947; Tversky & Kahneman, 1973). First, organizational identity, associated with senior managers’ mental model of their firm and its traditional behaviors can restrict or bound search and recombination activities to specific, often historic, trajectories (Tripsas & Gavetti, 2000). Second, limits to managerial resources result in the selective allocation of managerial attention, which in turn shapes strategic choices and organizational adaptation (Ocasio, 1997; Cho & Hambrick, 2006; Helfat & Peteraf, 2015). Finally, breadth of search and recombination activities are often subject to an “availability heuristic”, where managers/scientists over draw on information that is “top-of-mind” and easily retrieved (Tversky & Kahneman, 1973; Prahalad & Bettis, 1986; Leiponen & Helfat, 2010). This cognitive influence can be traced, in part, through the past specialization choices of the firm. Specifically, where, and the degree with which, firms tend to specialize reflect the existing organizational identity of the firm, reveal patterns of managerial attention, and suggest salient information flows.

In sum, if the scope of existing knowledge assets set a range for what a firm can do, specialization of existing knowledge assets influence what a firm will choose to do within this
range.\textsuperscript{7} We develop our hypotheses regarding choices in firm strategic repositioning based on this combination of scope and specialization, with an eye to how the distribution of capabilities may trigger specific cognitive processes.

First, consider a firm having broad scope but limited specialization. That is, a firm in which activities are relatively equally distributed across the numerous technological and product areas in which they participate. As noted above, one benefit of broad scope is the related wide range of recombination possibilities scope provides. Scope, in this sense is a necessary, but not sufficient condition for innovation. We submit that when scope is paired with less specialization significant innovation is more likely for three reasons. First, such a combination indicates a fluid, more encompassing organizational identity. Rather than being anchored to a small number of product areas, these firms exhibit an identity tied to a tradition of “innovation” via movement to new areas and commitment to develop these new areas. These are likely the firms that perceive themselves as “explorers” and are thus less likely to be constrained by narrow mental models and strategic beliefs (Tripsas & Gavetti, 2000; Gavetti, 2012). Second, a history of limited specialization implies expansiveness in management attention where equal salience is given to alternative technologies and product areas. Such balance would indicate an organization where managers across different areas have relatively equal power and input in strategic decision-making. Having all the technological areas at the table allows the benefits of scope to be exploited. Third, and relatedly, such equitable distribution of attention would arguably give rise to broad awareness of the firm’s ongoing activities in the management team. A firm with recent innovation activities across a wide set of areas would catalyze a positive “availability

\textsuperscript{7} The relationship between capabilities (i.e., the firm knowledge assets) and managerial cognition is clearly recursive, rather than linear. Initial capabilities influence strategic decision-making processes which in turn influence capability development and deployment (Eggers and Kaplan, 2013). While we acknowledge this dynamic, our study leverages the WTO “shock” to investigate how a firm’s existing (or pre-TRIPS) capabilities influence subsequent strategic repositioning decisions.
heuristic” where multiple knowledge components are “top of mind” and in play for recombinant and repositioning activities. Thus, we submit:

**Hypothesis 1:** *Firms with a broader knowledge base and less process specialization within this knowledge base are most likely to engage in innovation-driven strategic repositioning.*

When broad scope is paired with high specialization a different dynamic is anticipated. Though, as above, the firm has an extensive set of knowledge components it may draw upon for strategic repositioning, the cursory investment in some knowledge areas may limit the potential gains to recombination. Further, the cognitive framing associated with specialization serves to constrain the options considered and pursued (Eggers & Kaplan, 2013). A specialized firm is likely to assert and operate under a more narrow organizational identity. In turn, such a specific identity may restrict the viable search activities perceived by the firm (Tripsas, 2009). Rather than explore new areas, such firms are conditioned to continue on historical trajectories and deepen their specialization (Leonard-Barton, 1992). Likewise, specialization points to the selective attention of management, where certain technological or product areas are elevated and prioritized above others. Specifically, managerial resource cognition – the identification of firm resources and the assessment of the potential redeployability of these resources – may be inaccurate or constrained under conditions of high specialization (Danneels, 2011). Even though the broad scope firm may have activities across numerous areas, they may not consistently leverage the knowledge assets underlying these activities. Rather, the potential value of existing resources and capabilities is subject to interpretation and repositioning discussions are likely to be dominated by the more powerful managers from the leading divisions or technology areas.
Finally, specialized firms are also more likely to suffer from a negative availability heuristic where, given easy recall, the subset of areas with recent activity will exert greater influence as compared to those smaller divisions with marginal contributions. Sparse experience with specific knowledge assets decreases the likelihood that they are well-understood which in turn reduces the probability that these assets will be redeployed and/or recombined to solve new problems (Miner, Gong, Baker & O’Toole, 2011).

In sum, even against a backdrop of broad scope, specialization will narrow both the viability and span of recombination activities. As such, we submit:

**Hypothesis 2:** Firms with a broader knowledge base and higher process specialization will more likely pursue close-in repositioning strategies.

The final combination considered – narrow scope and high specialization firms – are expected to be greatly disadvantaged with respect to repositioning options. Focused firms are limited in the internal knowledge components they can access for innovative recombination. Similarly, such focused firms are not well-positioned to access and assimilate external knowledge (Cohen and Levinthal, 1990). In addition, cognitive factors are not likely to be conducive for supporting movement to a new strategic position. Operating under a tight organizational identity, focused managerial attention, and an availability bias given limited activities, create strong barriers to change. Lacking the necessary capabilities and operating under weak incentives, we propose:
**H3:** Firms with a narrower knowledge base and higher process specialization will continue with the status quo rather than undergo significant strategic repositioning.

**Data, Methods and Results**

**Data**

We start our data collection with the names and annual financial information of all Indian pharmaceutical firms in the Prowess database of the Center for Monitoring of the Indian Economy (CMIE): this amounts to over 600 firms\(^8\). The Prowess database includes all public and established private firms, and financial information provided by these firms are partly voluntary and partly required disclosures. We then hand-collect data on all patents filed by each of these firms between the years 1990 to 2010 from the Indian Patent Office. We drop firms that do not patent from our sample. Our final sample therefore consists of the universe of patenting pharmaceutical firms from the Prowess database.

We manually classify these patents into types based on the Title, Abstract and Description (TAD) sections of the application filed. We classify a patent as a process patent if the patent is said to be for a process in the TAD sections of the application. We do the same for a product patent. In the TAD if the patent application lists as an indicator one of the ‘neglected’ diseases, then the patent is designated as a Neglected patent, or one for neglected diseases. If one of the diseases for which key drug patents are expiring in the USA between 2005 and 2013 are listed in the TAD of the application, then the patent is classified as an Expiring patent. The list of diseases for which patents are expiring was obtained from Ganguli (2003) and the Generic Drugs Supplement (2009) of the Generic Pharmaceutical Association. This generates a unique panel dataset of microdata on Indian patent filings organized at the firm-year level. We then combine

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\(^8\) Haley & Haley (2012) estimate over 20K pharma firms in 2000; but include entities they call “pharmaceutical units”.
the patent data with Merger and Acquisition data from SDC Platinum database to get all M&A events of Indian pharmaceutical firms within the same years.

**Variables**

**Dependent Variables**

Our unit of observation is the firm-year in the years 1995 to 2010. Our hypotheses are centered on firm strategy choices, which we operationalize using the nature of innovation carried out by a firm. We use different kinds of patents to designate different innovation strategies adopted by firms. We distinguish between process and product patenting to indicate the nature of innovation associated with each. Process patents are associated with innovation in production processes while product patents are associated with innovation in drug composition, API and delivery formulations.

**API and Novel Delivery Formulation:** Firms that reformulate new drugs or devise new methods of use through product innovations are able to obtain product patents, which protect the new composition. During the time covered by our study, the immediate post-TRIPS period, new drug development was rarely pursued by Indian Pharmaceutical firms. Product innovation occurred mainly through reformulation activities. Therefore, the strategy of novel delivery formulation is operationalized by the number of product patents filed by, or granted to, a particular firm (#product patents) in each year.

**Fast entry into newly-off patent drugs:** The strategy of fast entry into production of newly-off patent drugs is measured by the number of process patents filed by or granted to a firm that is associated with a drug targeted to diseases in which a major patent was soon to expire. (#newly off-patent-drug patents).
Production of established generics: Analogously, the strategy of continuing to do what the firm had been doing in the past, which is production of established generics is measured by the number of process patents, exclusive of those targeted to newly off-patent drugs, filed by the firm (#process patents).

Specialization of drugs for neglected diseases: The strategy of patenting in neglected diseases is quantified by the number of product and process patents associated with neglected diseases (#neglected patents).

Independent Variables and Controls

Although we cannot directly observe combinative capabilities, we are able to observe patent classes, which give us insight into the scope of the existing knowledge embedded in the firm. Prior to 1995 Indian pharmaceutical firms had little patentable knowledge on products or composition of drugs, as they were mostly engaging in reverse engineering and the subsequent generics manufacturing of branded drugs. Thus, the existing knowledge base largely reflected the process expertise that these firms possessed. After 1995 firms were able to quickly patent their process expertise. Measures of knowledge base are therefore based on prior process patents. We create two variables to measure the breadth of the knowledge base. Knowledge Breadth measures the existing breadth of knowledge in processes, and is the number of unique classes associated with process patents filed by or granted to the firm over the three years prior to the post-TRIPS focal year. Thus Knowledge Breadth in year t is the average of the number of unique classes firms patented in year t, t-1 and t-2.

To measure the specialization of the knowledge base or cognitive influence we create a Herfindahl index (HHI) based on the square of share of patents filed in each class (Hall, Jaffe
and Trajtenberg, 2001; Hall, 2005) over the past three year period. Assuming that a firm has N patents falling into J classes with $N_j$ patents in class j, the HHI is constructed as

$$\text{HHI} = \sum_{j=1}^{J} \left( \frac{N_j}{N} \right)^2$$

The HHI gives heavier weight to firms with larger shares of patents in one class. If a firm has a higher share of patents in one particular class, the HHI will be higher, reflecting the idea that greater the concentration of patents in a smaller number of classes, the higher is the specialization of the firm within that particular class. On the other hand, lower share of patents in many different classes reflects the idea that the firm is less concentrated in one particular class and therefore less specialized. A high value of HHI therefore is to be interpreted as the firm having higher specialization of knowledge and a narrower cognitive frame. A lower HHI is to be interpreted as the firm having knowledge that is diversified among many different classes and therefore a broader cognitive frame. We create the HHI based on process patents over a prior three year period and name it \textit{Specialization}.

We control for a number of firm-year specific measures, namely the R&D investment ($R&D$) and the total income of firms ($Total\ Income$). We also control for the total number of patents filed or held by the firm in a year ($Total\ Patents$).

\textbf{Methods}

As we have a panel of firms through the years 1995-2010 we are able to account for time-invariant firm characteristics with firm fixed effects and year specific unobservable effects with year fixed effects. We use robust standard errors in our estimation clustered at the firm level.

We use a poisson maximum likelihood estimation (MLE) with conditional firm and year fixed effects and robust standard errors. To test Hypothesis 1 we measure the association
between the number of product patents (#product patents) with the existing breadth of the knowledge base taken over the past three years (Knowledge Breadth), and the specialization of the firm (Specialization). The coefficients on the two variables of interest indicate the association of knowledge breadth and attention with the strategy of novel delivery and formulation. We control for the total number of patents held by the firm in that year, the total income of the firm and the firm’s R&D expenditure.

To test Hypothesis 2 we measure the association between the number of process patents filed on diseases for which major drug patents are expiring between 2005 and 2010 (#newly off-patent drugs) and the breadth of knowledge base (Knowledge Breadth) and the specialization (Specialization). We use the same controls. To test Hypothesis 3 we measure the association between the number of process patents, exclusive of those targeted to newly off-patent drugs, (#process patents) and the breadth of the knowledge base and the specialization. We use the same controls.

**Empirical Results**

Table 1 presents the correlations and summary statistics of our sample of firms. There are 611 pharmaceutical firms that are listed in the Prowess database of Indian firms. The number of Indian firms that hold any type of patent in any year across the 1995-2010 time period is 202. Of these 62 percent are publicly-held firms while the rest are privately-held. Two percent of these patenting firms were the target of an M&A event between the years 1995 and 2012 and the average value of the equity transferred was Rs.290 million or $5 million. Financial data is not available on about half of the sample: of the remaining half the average profit is approximately Rs.155 million, or 3.5 million USD. The firms have a mean age of 32 years as of 2014, and range
between being 4 to 117 years old. The firms hold between 1 and 214 patents in total. The mean number of product patents granted to a firm is .4 patents per year while the maximum number of was 8 in a year. The mean number of process patents granted to a firm in one year is 1.6 and the maximum number of process patents, is 26. The maximum number of patents on neglected diseases granted for by any one firm is 4. The mean number of process patents associated with drugs for which patents are expiring between 2005 and 2013 is 1.4 while the maximum is 13.

In Column 1 of Table 2 we show the results of a poisson regression where the dependent variable is the number of product patents filed for a specific firm-year between 1995 and 2012. The positive and significant coefficient on the variable *Knowledge Breadth* indicates that higher scope of absorptive capacity or breadth of pre-existing knowledge is associated with a higher number of product patents filed or granted. A negative and significant coefficient on the variable *Specialization* shows that higher efficiency or lower specialization is associated with the same. Together, these results suggest that firms with higher recombination potential due to existing knowledge breadth and lower cognitive limits associated with less specialization are engaging in novel delivery and formulation, or innovation-based repositioning. As such, we find evidence in support of H1: firms with a broader knowledge base and less process specialization within this knowledge base are most likely to engage in innovation-driven strategies.

In Column 2 of Table 2 we present support for H2 showing that firms with a broader knowledge base and higher process specialization will be more likely to pursue close-in strategies. We show the results of a poisson regression where the dependent variable is the number of patents filed or granted between 1995 and 2012 on drugs for which patents are expiring between 2005 and 2013. The positive and significant coefficients on *Knowledge
Breadth and Specialization indicate that a close-in, expiring drug, strategy is positively associated with higher scope (breadth of pre-existing knowledge) and concentrated activities. That is, firms with broader knowledge bases and higher specialization are likely to be pursuing a strategy of producing generic versions of drugs that are losing patent protection in the United States. In essence, this close-in strategy is viable when there is overlap of a firm’s existing capabilities with market needs and the opportunity is easily recognized given the more focused attention of the firm’s decision-makers.

In Column 3 of Table 2 we present evidence in support of H3 showing that firms with a narrower knowledge base and higher process specialization will continue with the status quo rather than undergo significant strategic repositioning. We show the results of a poisson regression where the dependent variable is the number of process patents, exclusive of those for expiring drugs, filed or granted between the years 1995 and 2012. The negative coefficients on Knowledge Breadth and Specialization indicate that the number of such process patents filed by a firm is negatively associated with the breadth of the existing knowledge base (and recombination potential) and the specialization within the classes (or a tightly bounded identity). This indicates that firms with lower breadth of knowledge and lower specialized knowledge were likely reduced to operating under a traditional reverse-engineering strategy given disadvantages in terms of innovation capability and cognitive outlook.

Industry Performance

Following the enforcement of TRIPS, the Indian pharmaceutical industry underwent significant changes. Chittoor et al. (2009) comment that the enforcement of TRIPS led to the emergence of the pharmaceutical industry as spearheading the growth of India’s trade in the global market.
Along with access to the global pharmaceutical market we find an increase in innovative activity as well as knowledge sharing. In this section we document the shift in industry characteristics.

[Figure 1 goes here]

Prior to 1995 we do not find much evidence of patenting by Indian firms, as shown in Figure 1. After 1995 that firms begin to file for patents, with an exponential increase in patent granting and filing in the year of 2000. The figure shows that firms first filed for process patents, then followed by product patents and patents on drugs for which patents were expiring. There was a peak in patenting in 2006, reflecting expectations of full compliance with TRIPS requirements. The graph on patents filed on neglected diseases shows that there was no perceptible increase in such patenting during the 1995-2010 conversion period, or in the post-TRIPS period that follows. Simultaneously, there was a sharp increase in pharmaceutical exports, as shown in Figure 2, presumably from the access to the global market for generics of newly off-patent drugs and established generics.

[Figure 2 goes here]

Figure 3 shows that there was also a dramatic increase in the number of acquisitions within the sector; these were carried out both by Indian firms and firms outside India, leading to significant consolidation in the global pharmaceutical industry. Figure 4 shows that the number of strategic alliances within the industry also increased following 1995. We found\(^9\) that the strategy of novel innovation (filing product patents) is positively and significantly associated with the likelihood of engaging in strategic alliances. This finding is consistent with the argument (Cohen and Klepper, 1996) that firms engaging in product patenting appropriate rents

\(^9\) Results with authors for brevity.
on their patents through licensing: part of the increase in strategic alliances is associated with an increase in licensing.

[Figures 3 and 4 go here]

Figure 5 shows alliances of Indian pharmaceutical firms with each other as well as international firms. Between 1991 and 1995 half of the alliances of Indian pharmaceutical firms were based on manufacturing agreements. Licensing agreements formed only 5% of the total number of alliances while R&D agreements constituted 9%. After 1995 the picture changes: manufacturing agreements now form only 29 percent of the total alliances while licensing agreements constitute 10%. R&D agreements now form 25% of the total number. Marketing alliances remain more or less constant as a fraction of the total both before and after TRIPS. The increase in R&D alliances shows the increased demand for knowledge sharing following the enforcement of the stricter patent regime. This suggests that firms are more likely to engage in sharing of tacit knowledge when there are IP protections in place, thereby strengthening the case for a stronger protection regime in order to facilitate higher innovative activity. This also presents an alternative hypothesis that the sharing of tacit knowledge from international firms has an impact on firms’ drug formulation capabilities. This is a topic that can potentially be explored in future research.

[Figure 5 goes here]

Figure 6 shows the distribution of strategic alliances based on regions. Prior to TRIPS 61% of the alliances of Indian firms were with firms based in the USA, while 23% were with other Indian firms and the remaining (around 17%) were with firms in the Asia-Pacific and Middle Eastern regions. After TRIPS, however, Indian firms have access to European markets: more than 30 percent of the total number of alliances is with firms in Western and Eastern
Europe and African countries. This finding also represents a potential direction for future research.

In subsidiary analysis not shown in the paper\textsuperscript{10} we find that firms with a greater number of patents and higher specialization in their knowledge assets were more likely to be acquired. This suggests that highly productive but narrowly specialized firms constitute more attractive targets for acquisition. We found that firms with broader scope were positively associated with the likelihood of exporting. We next examine relative firm performance following TRIPS by examining the reordering of Indian pharmaceutical firms with respect to their income. We create quintiles of firms based on their income in 1995 and then in 2010, and create two categories of firms: those who moved to a higher quintile (\textit{Moved to Higher Quintile}) from 1995 to 2010, and those who either remained in the same quintile or moved to a lower quintile (omitted category). Our independent variables are the change in product (\textit{Δproduct patents}), process patents (\textit{Δprocess patents}), newly off-patent drug patents (\textit{Δ newly off patent drug patents}), breadth (\textit{Δ Knowledge Breadth}) and specialization (\textit{Δ Specialization}) of firms between 1995 and 2010.

Firm strategy is the mediating variable through which the dimensions of the knowledge base are associated with firm performance; this is illustrated in Figure 6. Paths A1 and A2 show the direct effect of knowledge breadth and specialization on firm performance outcome while paths D1, D2 and D3 show the indirect effect of knowledge dimensions through firm strategies. Paths S1, S2 and S3 show the direct effects of firm strategies on performance. Since the firm strategies can change knowledge breadth and specialization in the next time period, there may be a bi-directional effect and so, in our model we include a non-recursive loop between their errors.

\textsuperscript{10} The results are with authors.
of the firm strategies $\epsilon_1$, $\epsilon_2$, $\epsilon_3$, with that of the knowledge dimensions of the firms $\epsilon_4$. These errors have not been shown in Figure 6 for ease of comprehension. Estimation of firm performance calls for a modified three-regression mediation model based on the method proposed by Baron and Kenny (1986). We modify the Barron and Kenny (1986) approach by choosing a generalized structural equation modeling (GSEM) method with robust standard errors, which has been suggested as a preferred approach in the literature (Shaver, 2005; MacKinnon et al. 2007; Hayes, 2009; Zhao, Lynch and Chen, 2011) as it gives the following specific advantages: (1) that we can denote strategy chosen to be a mediating variable without having to assume any temporal ordering of strategy and resources. (2) Our assumptions do not have to preclude reverse causal effects. (3) The GSEM also allows us to disentangle the mediating effect of strategy chosen from the error. We manually examined our sample set for firms who patented in 1995 but became bankrupt by 2010 and found that only one such firm, Rolex Pharmaceuticals, existed. Therefore, we do not believe attrition to be causing a bias and do not employ bias correcting solutions. The three structural equations as shown in paths D1, D2 and D3 in Figure 6 are specified as poisson equations relating knowledge characteristics with firm strategies, as the latter are operationalized by the count variable of number of patents. Thus $\Delta\text{Knowledge Breadth}$ and $\Delta\text{Specialization}$ are specified to be related to the three strategies through a poisson model. The corresponding paths from respective strategies to firm performance, namely, S1, S2 and S3 are specified as logit. The direct paths (A1 and A2) between knowledge dimensions and firm performance is also specified as a logit equation.

Table 3 presents the association between firm strategy and performance. The outcome variable is the likelihood of moving to a higher performance quintile, and the omitted categories are that for staying in the same quintile or moving to a lower quintile. Model 1 shows that firm
strategies have a significant association with the likelihood of moving to a higher performance quintile, while the knowledge scope and specialization are insignificant. This suggests that firm strategies play a key role. Moreover, paths S1 and S3 are insignificant while path S2 is significant. This indicates that firms that choose the close-in strategy of pursuing generics manufacturing of newly off-patent drugs are likely to experience performance gains relative to other strategies. As we stated above, firms that pursue the close-in strategy are also more likely to be exporting. Together these findings suggest that these firms are able to leverage the economies of scale in manufacturing of generics for which there is an established demand a large global market and therefore experience performance gains. Firms that choose the innovation strategy, on the other hand, do not seem to realize their performance gains by 2010 but may do so at a later date.

[Table 3 inserted here]

**Robustness Checks**

A concern with our estimation methodology is that we make the tacit assumption that firms’ choice of which innovation strategy to choose is independent; that is, the choice to pursue product innovations is independent of the choice to pursue process innovations on generics of diseases for whom patents have just expired. This is potentially a strong assumption, which may not be upheld. Ideally, our estimation should involve a system of simultaneous equations with a correlated error structure. As a robustness check we therefore conduct a seemingly unrelated OLS regression on the three dependent variables \(#\text{product patents}, #\text{process patents} \text{ and } #\text{newly off patent drug patents}\) with the independent variables that have been specified in the regressions.
above. We find that while the magnitudes of the coefficients change, our broad conclusions remain unchanged\textsuperscript{11}.

Our data spans 2005-2010 but firms continue to patent after 2010. As a robustness check we follow up our analysis with a censored poisson model to account for the right-censored nature of our data\textsuperscript{12} and our results are largely unchanged. The limitation of this paper is that we cannot conclude which strategic choices represent repositioning versus which choices are mere continuation.

Discussion

The results in this paper shed light on the strategic repositioning of pharmaceutical firms and the structure of the global pharmaceutical industry following the announcement of the TRIPS Act in 1995. We find that broad but non-specialized knowledge bases are associated with more product innovations, while broad and specialized knowledge bases are associated with process based innovation in areas with newly expired drugs. Consistent with past work (Kyle and McGahan, 2012) we do not find evidence of a marked increased patenting in neglected diseases. Other work in the area (Vakili and McGahan, 2016) has suggested that basic research in neglected diseases has been increasing in South Asia. Since patenting lags basic research, we may therefore expect to see neglected disease patenting increases in later years.

This paper follows the body of work that studies the impact of institutional changes on firm strategy (Ingram and Silverman, 2002; Peng 2003; Xia, Boal and Delios 2010) with a particular focus on the recent patent regime changes in India (Chittoor et al, 2008; Bhaskarbhatla and Chatterjee, 2012; Kyle and McGahan, 2012; Delgado, Kyle and McGahan, 2013). It also makes a contribution to our understanding of what resources firms draw upon when struck with a

\textsuperscript{11} Results are not included due to considerations on brevity and are available on request.
\textsuperscript{12} Results are not included due to considerations on brevity and are available on request.
disruptive shift in the institutional context and contributes broadly to the literature on organizational adaptation and repositioning (Li and Tallman, 2011; Meyer, 1982; Afuah and Utterback, 1999; Agyres et. al.). Much of the literature in this area has examined firm response to gradual changes in technological trajectories, while we study response to a relatively sudden reorientation in context that rendered firm strategies dominant in the past redundant. Observing firm innovation strategies in this unique setting provides us with the insight that firms’ knowledge scope while being a determinant of its ability to recombine, can be most effectively leveraged through its cognitive emphasis of more balanced firms.

Our paper connects to past work that has studied cognitive responses of firms to technological changes. Organizational cognitive capabilities have been studied in the context of explaining industry life cycles (Kaplan and Tripsas, 2008) but much of the work has focused on individual managerial or CEO-level cognition rather than organizational cognitive emphasis. The key findings of this literature are that managerial and CEO cognitive responses constitute a core component of firm strategy during periods of uncertainty (Cho and Hambrick, 2006; Tripsas and Gavetti, 2000) and market entry (Eggers and Kaplan, 2009). In times of uncertainty CEO cognitive responses interact with capabilities to steer firms and can compensate for the absence of other capabilities (Kaplan, 2008). Our findings constitute a natural extension of this literature: cognitive emphasis constitutes an organizational capability that supplements knowledge scope to shape innovative repositioning. Lastly, we connect peripherally with the dynamic capabilities literature that has examined the role of experience, organizational resources and managerial roles in driving firm response to changing contexts (Penrose, 1959; Tushman and Anderson, 1986; Helfat, 1997; King and Tucci, 2002; Adner and Helfat, 2003; Helfat and Perteraf, 2015).

\footnote{While countries were given ten years to adjust to the new regime, firms did not know for certain that the TRIPS agreement would be reached in the WTO and therefore the shift in regime was relatively sudden.}
Our paper has a number of limitations. First, due to the absence of patenting activity prior to 1995 we do not have any observable metrics of innovative activity prior to 1995. Thus we cannot directly observe firms’ prior, pre-commercial, innovative pursuits. This limits us in the kind of questions we can answer: we cannot, for instance, observe the change in firms’ innovative activity; we can only observe their ex-post response. Moreover, empirically we do not have an easily quantifiable measure of knowledge base prior to 1995. We proxy for this using several measures such as yearly R&D expenditure and asset base size. We additionally use firm and year fixed effects that control for time-invariant firm capabilities in the year 1995. Nevertheless, due to the absence of a conventional before and after setting in our empirical methodology we refrain from making any claims on causal identification of the treatment effect of an IP regime change. Similarly, the estimation of firm strategy on relative performance should be interpreted as associations. Second, our paper studies firm repositioning in a particular industry following one unique shift in institutional context; external validity of this study should therefore be extended with caution. Thirdly we are limited in our ability to distinguish between firms that do not report their financial data to the Prowess database and those that actually become bankrupt by the end of our sample. However, we believe this to be a very small problem. Our sample consists of the universe of all patenting firms in India. A manual examination of the data bolstered by web searches verified that while some firms did not report financial data in some years (particularly between 1995 and 2000) only one patenting firm went bankrupt. This gives us confidence that attrition is a very small problem in our sample and is unlikely to bias our results.

TRIPS spelled a radical shift in the IP regime in India; between 1994 and 2005 there were widespread concerns related to the introduction of TRIPS voiced by Indian media and the
academic community. The chief concern was related to consumer welfare; there were widespread predictions of higher drug prices following TRIPS (Agarwal and Saibaba, 2001; Chaudhuri, 2002). There were additional concerns related to biodiversity (Sahai, 1993), firm competition (Chaudhuri, 2002), firm growth and increasing inequality (Sen 1993) among others. On the other hand, there was widespread anticipation that TRIPS would spur R&D in neglected diseases (Agawal and Saibaba, 2001; Mishra, 2001). Focusing on the competitive impact of TRIPS, the evidence uncovered in our study does indeed suggest that firms are more widely dispersed in their income following the introduction of TRIPS. Clearly, there have been winners and losers in the repositioning process. Moreover, while firms on average are generating higher income, they are not engaging in R&D on neglected diseases. We speculate, that while the TRIPS Act could have foreshadowed the collapse of the middle section among Indian firms, the simultaneous onset of significant patent cliffs for a number of large multinational pharmaceutical firms have prevented this from happening as a significant subset of Indian firms was well-positioned to profitably reengineer brand name drugs. Finally, post-TRIPs Indian firms have developed a larger global presence as seen through a higher number of alliances with international firms, acquisitions and exports.

Reference


Table 1: Summary Statistics and Correlation Table of patenting firms sample

<table>
<thead>
<tr>
<th></th>
<th>Mean</th>
<th>S.D.</th>
<th>Min</th>
<th>Max</th>
<th>#Process patents applied</th>
<th>#Product patents applied</th>
<th>#Patents applied on diseases with newly expired patents</th>
<th>#Patents applied on neglected diseases</th>
<th>Total income in billions of Rs.</th>
<th>R&amp;D expenditure in millions of Rs.</th>
</tr>
</thead>
<tbody>
<tr>
<td>#Process patents granted</td>
<td>1.6</td>
<td>2.824</td>
<td>0</td>
<td>26</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Product patents granted</td>
<td>.394</td>
<td>1.078</td>
<td>0</td>
<td>8</td>
<td>.787</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Newly off patent drug patents</td>
<td>1.476</td>
<td>1.839</td>
<td>0</td>
<td>13</td>
<td>0.794</td>
<td>0.861</td>
<td>1</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>#Patents applied on neglected diseases</td>
<td>0.219</td>
<td>0.736</td>
<td>0</td>
<td>4</td>
<td>0.541</td>
<td>0.545</td>
<td>0.576</td>
<td>1</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total income in billions of Rs.</td>
<td>7.754</td>
<td>12.548</td>
<td>1</td>
<td>184</td>
<td>0.412</td>
<td>0.339</td>
<td>0.276</td>
<td>0.237</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>R&amp;D expenditure in millions of Rs.</td>
<td>472.112</td>
<td>892.55</td>
<td>0.4</td>
<td>5457</td>
<td>0.547</td>
<td>0.501</td>
<td>0.379</td>
<td>0.391</td>
<td>0.693</td>
<td>1</td>
</tr>
</tbody>
</table>
Table 2: Table showing association between number of patents, likelihood of being an acquisition target and knowledge breadth and specialization

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>(1) # product patents</th>
<th>(2) # newly off patent drug patents</th>
<th>(3) # process patents</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Breadth</td>
<td>0.00315***</td>
<td>0.00633***</td>
<td>-0.00156**</td>
</tr>
<tr>
<td></td>
<td>(0.000662)</td>
<td>(0.000782)</td>
<td>(0.000656)</td>
</tr>
<tr>
<td>Specialization</td>
<td>-1.593***</td>
<td>0.932***</td>
<td>1.259***</td>
</tr>
<tr>
<td></td>
<td>(0.194)</td>
<td>(0.156)</td>
<td>(0.0797)</td>
</tr>
<tr>
<td>Total Patents</td>
<td>0.0189***</td>
<td>0.0171***</td>
<td>0.0146***</td>
</tr>
<tr>
<td></td>
<td>(0.000682)</td>
<td>(0.000779)</td>
<td>(0.000616)</td>
</tr>
<tr>
<td>Log of Total Income</td>
<td>0.600***</td>
<td>0.593***</td>
<td>0.476***</td>
</tr>
<tr>
<td></td>
<td>(0.0408)</td>
<td>(0.0661)</td>
<td>(0.0596)</td>
</tr>
<tr>
<td>Target</td>
<td>-0.0515</td>
<td>-0.0424</td>
<td>-0.115**</td>
</tr>
<tr>
<td></td>
<td>(0.0651)</td>
<td>(0.0841)</td>
<td>(0.0478)</td>
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<tr>
<td>Observations</td>
<td>1,033</td>
<td>760</td>
<td>1,345</td>
</tr>
<tr>
<td>Number of Firms</td>
<td>76</td>
<td>50</td>
<td>100</td>
</tr>
<tr>
<td>Firm FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Year FE</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Table 3: GSEM estimation on relative performance showing mediating effect of strategy and direct effect of resource base***

<table>
<thead>
<tr>
<th>Independent Variables</th>
<th>DV=Moved to Higher Quintile</th>
<th>Product Stock (D1)</th>
<th>Process Stock (D3)</th>
<th>Expired Stock (D2)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Knowledge Breadth (A1)</td>
<td>.002 .007 0.26</td>
<td>.053 .050 10.70</td>
<td>1.162 .069 16.80</td>
<td>.462 .033 13.81</td>
</tr>
<tr>
<td>Specialization (A2)</td>
<td>-.546 .451 -1.21</td>
<td>-.16.312 4.620 -3.53</td>
<td>5.597 6.341 0.88</td>
<td>-3.455 3.070 -1.13</td>
</tr>
<tr>
<td>Product Stock (S1)</td>
<td>.003 .004 0.71</td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>Process Stock (S3)</td>
<td>.448 .369 1.22</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Expired Patent Stock (S2)</td>
<td>.020 .010 1.99</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Income in 1995</td>
<td>.000 .000 1.31</td>
<td>.017 .001 12.82</td>
<td>.019 .001 10.48</td>
<td>.008 .001 9.67</td>
</tr>
</tbody>
</table>
Figure 1: Mean number of patents of each category by year

Figure 2: Exports in millions of Indian Rupees by Indian Pharmaceutical firms between 1985 to 2010

Figure 3: Number of acquisitions of Indian pharmaceutical firms between 1985 and 2010
Figure 4: Number of Strategic Alliances with Indian pharmaceutical firms

![Figure 4](image)

Figure 5: Strategic Alliances by type (patenting firms only)

![Figure 5](image)
Figure 5: Strategic Alliances by Region (patenting firms only)

Figure 6: Structural Equation Model showing the mediating association of strategy