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Toward resource independence – *Why* state-owned entities become multinationals: An empirical study of India's public R&D laboratories

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Abstract
In this paper, we build on the standard resource dependence theory (RDT) and its departure suggested by Vernon to offer a novel explanation for *why* state-owned entities (SOEs) might seek a global footprint and global cash flows: to achieve resource independence from other state actors. In the context of SOEs, the power use hypothesis of standard RDT can be used to analyze the dependence of SOEs on other state actors, such as government ministries and government agencies that have ownership and control rights in the SOE. Building on Vernon, we argue that the SOE can break free from this power imbalance and establish resource independence from other state actors by becoming a multinational firm and/or by generating global cash flows. We leverage a natural experiment in India and outline both quantitative and qualitative evidence from 42 Indian state-owned laboratories to support this argument.
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INTRODUCTION

In this paper, we build on standard resource dependence theory (RDT) (Pfeffer & Salancik, 1978) and its departure suggested by Vernon (1979) to offer a novel explanation for *why* state-owned entities (SOEs) might seek a global footprint and global cash flows: *to achieve resource independence from other state actors*. We leverage a natural experiment in India and outline both quantitative and qualitative evidence from 42 Indian state-owned laboratories to support this argument.

One of the key tenets of standard RDT is the "power use" hypothesis. This broadly states that in interorganizational relationships, a power imbalance enables the dominant actor to influence the power-disadvantaged actor and extract a higher share of the exchange surplus (Casciaro & Piskorski, 2005). In the context of SOEs, RDT could be used to analyze the power imbalance between SOEs and other state actors, such as government ministries and

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government agencies that have ownership and control rights in the SOE. International business scholars have utilized the power use hypothesis to study the relationship between SOEs and other state actors on issues like foreign direct investment (FDI) decisions (e.g., Cui & Jiang, 2012; Wang, Hong, Kafouros, & Wright, 2012). However, a relatively open question in the field of international business is how an SOE can break free from this power imbalance and establish *resource independence* from other state actors by becoming a multinational firm and/or by generating global cash flows. This question has become more important over the past two decades given the "reinvention" of state capitalism, as documented by Musacchio and Lazzarini (2012).

This line of questioning in international business dates back to Vernon (1979), who proposed that SOEs create resource independence from home-country governments by creating independent cash flow streams. Vernon also suggested that engaging with multinational corporations (MNCs) was one way to establish such resource independence. However, there are no empirical studies that build on Vernon's (1979) theoretical propositions.

In this paper, we build on standard RDT and Vernon's (1979) idea, and we posit that R&D-oriented SOEs can achieve resource independence and launch a global footprint by licensing high-quality foreign patents to multinationals. In other words, we explore an important motive for *why* SOEs might license intellectual property (IP) to multinationals and might seek a global footprint. We argue that the underlying motive for doing so might be to seek resource independence from other state actors who exert control over the SOE in question.

The recent literature on SOEs has been focused on the theme of privatization as a mechanism to achieve resource independence; we argue that creating an independent cash flow stream by licensing high-quality foreign patents to multinationals might be an alternative/complementary mechanism to privatization that allows SOEs to achieve resource independence.

We explore this proposition in the context of 42 premier state-owned laboratories in India employing more than 10,000 scientists and technical staffers. This empirical context offers us a natural experiment to test our core proposition. At a time when the Indian government faced severe resource constraints, was launching an ambitious privatization program for state-owned entities, and was reforming the Indian patent law, the 42 labs were granted a large number of US patents. The labs then licensed several of these US patents to multinational firms such as General Electric (GE), and revenue from multinationals increased from 3 to 15% as a proportion of government budgetary support. Over time, the patent mix of these labs moved toward a United States Patent and Trademark Office (USPTO)-based patent portfolio and this strategy of leveraging global patents helped the labs launch a global footprint involving R&D partnerships with multinational firms.

Our choice of India as a context to conduct our research is motivated by the fact that a common economic shock – the fiscal and economic crisis of 1991 – triggered: (i) domestic patent reform, influenced by the International Monetary Fund (IMF) and the World Trade Organization (WTO); (ii) severe resource constraints for SOEs; and (iii) an ambitious SOE privatization program. Gupta (2005) documents details of the SOE privatization program in India and outlines that several SOEs, including public R&D labs, were kept outside the ambit of the privatization program. Given that the state-owned R&D labs *could not be privatized* (as they were part of the "strategic sector"), they had to seek alternate mechanisms to generate cash flows and seek resource independence. Our empirical analysis documents that the Indian state-owned R&D labs leveraged an important aspect of the patent reform (the "Patent Cooperation Treaty" or PCT clause), filed high-quality foreign patents, and licensed foreign patents to multinationals to achieve partial resource independence. In other words, licensing patents to MNCs could be an alternative/complementary mechanism to privatization for SOEs to achieve resource independence.

A major challenge in conducting research on SOEs in emerging markets is finding the right data set. Publicly available data sets, including those focused on emerging markets, do not track microdata on emerging market SOEs.[1] To address this issue, we worked closely with one of the largest emerging market research entities comprising multiple national laboratories, "The Council of Scientific and Industrial Research" (CSIR) in India, and we collected data for 42 labs over a 14-year period (1993–2006). In 2002, collectively these labs had become the single-largest emerging market PCT applicant. We find that over 1993–2006, Indian state-owned laboratories increased both Indian and foreign patent filings; however, the patent mix aggressively moved toward United States and other foreign patents. Also, while government budgetary support either declined year on year or remained flat from 1995 to 2005, revenue from multinationals increased fivefold from 1995

to 2005. In addition, an increase in licensing revenue from multinationals is related to an increase in foreign patents, but not to an increase in domestic patents. We conducted a counterfactual test and compared foreign patent filing of the CSIR labs with other SOEs and other private entities in India, and we document that the CSIR labs were unique in their move toward foreign patent filing.

To summarize, our central research question is whether SOEs can leverage IP to create an independent cash flow stream and launch a global footprint, even in the absence of privatization, thus achieving resource independence from other state actors. Here, we are also motivated by insights from the innovation and public R&D literature. In this literature, several papers have looked at the impact of incentive and organizational reform on IP creation at public R&D entities. Key contributions in this literature include Henderson, Jaffe, and Trajtenberg (1998), Jaffe and Lerner (2001), Jensen and Thursby (2001), and Lach and Schankerman (2008). Henderson et al. (1998) studied the effect of the Bayh–Dole Act that allowed universities and nonprofit institutions to retain titles to patents derived from federally funded R&D. This reform also allowed government-owned labs to grant exclusive licenses on government-owned patents. Jaffe and Lerner (2001) studied the impact of the initiatives since 1980 to encourage patenting and technology transfer at the US national laboratories. Their analysis is based on 23 federally funded research and development centers from 1977 to 1997. Specifically, they studied the effect of the 1986 reform that encouraged patenting and technology transfer by labs, and they report that patenting post-1986 was 50% greater than patenting prior to 1986. Lach and Schankerman (2008) study incentives and invention in US universities and document that faculty members respond to royalties both in the form of cash and research lab support, indicating pecuniary *and* intrinsic research motivations. Collectively this literature documents that state-owned R&D entities exhibit higher IP creation and commercialization in response to incentive and organizational reform.

THEORETICAL FOUNDATION – RDT

Our theoretical arguments are based on standard RDT and its departure in the context of SOEs, as suggested by Vernon.

RDT owes its origins to the work by Aldrich and Pfeffer (1976) and Pfeffer and Salancik (1978). A recent essay on the theory by Wry, Cobb, and Aldrich (2013: 442) summarizes the key two original tenets of the theory: (i) an organization's external environment comprises other organizations, each with their own objectives and interests and (ii) organizations hold power over a focal firm and may constrain its behavior if they control resources vital to the operations of the firm. These resources include monetary or physical resources, information, and social legitimacy.

Pfeffer and Salancik (1978) also discuss symbolic approaches for managing conflicts with the environment; these include restricting information flows, hiding controversial actions, or actively working to shape the perceptions of external actors. The authors also outline strategies that change the organizational boundaries and thereby absorb external constraints. These strategies include horizontal and vertical mergers. Finally, the authors outline strategies where firms establish bridging ties to other organizations to obtain information or establish legitimacy, and/or as a means of co-optation.

One of the central tenets of the RDT is the relation that Pfeffer and Salancik (1978) outline between resource dependence and power for a dyad of organizations. They build on Emerson (1962) and the exchange-based theory of power to surmise that power and dependence are the obverse of each other. In other words, if A is dependent on B, then B has power over A.

As Casciaro and Piskorski (2005) state, this relationship between resource dependence and power has led RDT scholars to develop the power use hypothesis. This hypothesis broadly states that in interorganizational relationships, power imbalance enables the dominant actor to influence the power-disadvantaged actor and extract a higher share of the exchange surplus. Casciaro and Piskorski (2005) also cite several empirical studies (including Burt, 1983, and Pfeffer & Leong, 1977) that provide support for the power use hypothesis. Extending this hypothesis, RDT scholars have posited that managers act to reduce their dependence on other organizations by trying to control vital resources. Ulrich and Barney (1984) frame the concept of power as control over vital resources.

The organizational literature that builds on RDT has studied the relationship between ownership and control. Ownership affects firms in two ways: (i) through the extent of ownership or (ii) by getting involved in the decision-making process. Demsetz and Lehn (1985) note that greater ownership leads to more centralized power. Also, owners who are more involved in the decision-making processes of a firm exert greater influence on firm outcomes (Wry et al., 2013). In the context of SOEs, other state

actors, such as government departments with ownership and control rights over the SOE, might exert power over SOE managers.

The issue of SOE resource dependence on other state actors has been revisited in recent studies on SOE's FDI decisions. Cui and Jiang (2012) argue that state ownership creates a linkage between a company and its home government, which makes the SOE resource dependent on home-country institutions. This particularly affects SOE's FDI decisions. In situations where the SOE chooses a strategy that is not aligned with government objectives, the home-country government can exert influence to either cancel or delay the project. But, if SOE managers concur with government internationalization strategies, they have strong home-country support, which reduces the risks of internationalization. Wang et al. (2012) analyzed how governments of emerging market enterprises impact the internationalization strategy of these companies. They found that the level of the government official involved and the type of involvement can influence a company's decision to invest abroad. Wang et al. (2012) state that the SOE's strategic choice is affected by being in a hybrid state of neither market nor hierarchy. The authors suggest that emerging market governments exert power over their MNCs through informal or formal channels. The influence, however, is determined based on the degree of state ownership and the level of government affiliation. The former refers to state ownership and the latter to the rank of the government official the company is connected to through relationships.

Resource Independence and Privatization

Privatization might enable SOEs to seek resource independence from other state actors. The SOE privatization literature, starting with Shapiro and Willig (1990), has identified several "costs" related to public ownership of firms. Inefficiencies of state-owned firms – for example, principal–agent issues, lack of residual claimant, absence of motivation and monitoring, soft budget constraints and so on – have been documented in the agency theory and property rights literature. Given this background, recent theory, starting with Shleifer (1998) points out that private ownership is better than state ownership in most contexts; a key reason being that government employees have very weak incentives with respect to both cost reduction and innovation. The recent empirical literature also overwhelmingly supports privatization. In the context of emerging markets such as India, Majumdar (1998) documents a significant performance shortfall for government-owned firms compared with private firms for the period 1973–1989.

However, privatization may not be a feasible policy option for all SOEs. In India, for example, as Kapur and Ramamurti (2002) point out, the government had a stated objective of not privatizing the strategic sector. In other cases, only partial privatization may have been implemented. One particular study by Jones, Megginson, Nash, and Netter (1999) documents that in a sample of share-issue privatizations from 59 countries, just 11.5% of the firms sold all of their capital and less than 30% sold more than half of their capital in the initial public offering. As Dastidar, Fisman, and Khanna (2008) point out, governments may not privatize firms due to unprofitability or because of political interests.[2]

A nascent empirical literature looks at policy alternatives and complements to privatization and, in the case of Chinese SOEs, studies by Groves, Hong, McMillan, and Naughton (1994, 1995) have shown that incentives and other organizational changes (e.g., selecting managers by auctions) are positively related to worker incomes and investment. However, an important white space in this literature is studying whether and how SOEs can leverage intellectual property to craft a turnaround and launch a global footprint.

Alternative Mechanism to Achieving Resource Independence – Seek Global Cash Flows

Vernon (1979) lays out an important mechanism for SOEs to achieve resource independence. In the context of SOEs, this mechanism could be an alternative/complementary mechanism to privatization.

In an article titled *The International Aspects of State-Owned Enterprises*, the author outlines the "multiplicity of roles" of the SOE and outlines the following roles for the SOE in the eyes of the home-country government: (i) the SOE as a "fiscal agent", where the state-owned firm often ends up being a device to collect monopoly taxes on behalf of the government; (ii) the SOE as the "national champion", where the SOE is seen as a means of "developing or maintaining an industry that the private sector seems unwilling to enter or unable to defend" (Vernon, 1979: 8); (iii) the SOE as a mobilizer of national monopoly or monopsony power; (iv) the SOE as an agent in bilateral trade agreements; and (v) the SOE as an agent of industrial policy, where the government might employ the SOE to develop a lagging section of the country.

Vernon (1979) then argues that this multiplicity of SOE goals leads to potential conflict between the SOE manager and the home government. The SOE manager has to respond to multiple signals from the government in relation to the multiple goals the government sets for the SOE. Responding to multiple and often conflicting goals is further complicated by two issues – the presence of coalitions and the short tenure of government ministers. On the issue of coalitions, Vernon (1979: 10) says that "governments are characteristically composed of a coalition of forces, each of which places rather different weights on conflicting goals. One ministry, therefore, may stress inflation goals, another employment goals, another budgetary goals; one politician will favor his area of the country, another politician his. And any of these elements in the coalition could easily have some voice in determining the rewards and punishments meted out to the manager". Vernon (1979: 10) also outlines the potential conflict between the long-term career goals of the SOE manager and the short-term tenure of the politician: "The tenure of ministers in most governments is short – shorter in many cases than the tenure of professional managers in state-owned enterprises. By responding faithfully to the goals of one administration, therefore, the manager will not necessarily contribute to his career goals; the preoccupation of one administration to achieve budgetary balance, for instance, could easily be succeeded by the preoccupation of the next administration to maintain employment".

As a solution to this conflict between the SOE manager and the politician, Vernon (1979) suggests that SOEs should become *resource independent* from other related state actors. He describes the tendency of SOE managers to seek independence from their "government apparatus" using three different labels – "desire for autonomy", "discretion", or "increased bargaining power". This forms the core theoretical foundation of our study – the desire of SOEs facing power imbalance to seek resource independence from other government actors. He concludes that managers of SOEs should try to enter partnerships with MNCs in order to increase "their autonomy in relations with their home governments" (Vernon, 1979: 14).

In subsequent research on SOEs in international business, we could not find studies *directly* related to Vernon's resource independence hypothesis, that is, studies that document SOEs leveraging multinationals and global cash flows to seek resource independence from other state actors. This is a gap we seek to fill.

Motivating Case Study – The National Chemical Laboratory (NCL)–GE Alliance and Broader Impact

Prior to outlining our detailed hypotheses, we document a motivating example that highlights the theoretical reasoning of Vernon. This stylized case study suggests that foreign patenting at CSIR was instrumental in creating an independent cash flow stream at CSIR labs and in formulating long-term partnerships with multinationals such as GE.[3] In 1989, Dr Raghunath Mashelkar took over as director of the NCL, one of the CSIR labs. Prior to this, CSIR filed for less than five foreign patents every year. Around 1989, NCL scientists (under the new leadership) prioritized research in the area of polymer preparation, condensation, and poly carbonates and filed for the first US patents in this area.[4] Around 1991, NCL started interacting with GE, a large purchaser of a special compound, THPE.[5] NCL's idea was to enter the THPE market as, at the time, Hoechst Celanese, USA was the only player. In interviews, CSIR scientists involved recounted that it took "several trips to the US and several face-to-face meetings with the GE scientists to even initiate the conversations. Initially, there was a lot of skepticism around whether a state-owned laboratories in India could develop a novel process to generate a complex compound."

In 1994, NCL initiated a program funded by GE that aimed to develop a proprietary process for THPE. CSIR scientists noted that several batch experiments were conducted on a pilot scale in a 50-liter batch reactor to try out alternative purification strategies. The outcome was the development of a new color removal and purification process. In parallel, NCL started aggressively patenting in the USPTO system and filed several US patents in the area of polymers from 1994 to 2000.[6] In interviews, Dr Mashelkar and other NCL scientists stressed the role played by the first few USPTO patents on polymers in "getting a foot in the door at GE". The NCL–GE alliance worked successfully for 9 years and broke Hoechst's global THPE monopoly. NCL earned revenues of around US$8.5 million from GE over this period.

We also conducted several interviews with CSIR employees to understand how the NCL–GE alliance motivated other CSIR labs to license foreign patents to multinationals. Following the 1991 economic shock, CSIR declared a formal "Intellectual Property Management Policy" in 1996. The policy stated its objectives as the following: "To maximize the benefits to CSIR from its intellectual capital by stimulating higher levels of innovation through a judicious

system of rewards, ensuring timely and effective legal protection for its IP and leveraging and forging strategic alliances for enhancing the value of and from its IP" (CSIR Profile, 2005: 295).

The filing of foreign patents for the different CSIR labs was coordinated by a central team known as the "Intellectual Property Management Division". With India joining the PCT in 1998, CSIR extensively leveraged the PCT mechanism to file foreign patents to save on patent filings costs. In a 2007 document, The World Intellectual Property Organization (WIPO) outlined the benefits of leveraging the PCT mechanism to file foreign patents: "The PCT establishes a procedure for the filing and processing of a single application for a patent which has legal effect in the countries which are Treaty members" (WIPO, 2007: 4). In other words, the PCT enabled CSIR and other patentees to save costs associated with filing separate foreign patents across multiple countries. These included the cost of translating patent applications into local languages across the world, the costs of local filing fees, and the costs of local legal experts. As of 1 March 2007, the PCT had 137 contracting states. Interviews with CSIR employees indicate that in 2002, CSIR filed 129 US patents, more than any other Indian entity, and filed 184 PCT applications, higher than Samsung and LG Electronics. CSIR was featured in the WIPO's top PCT filers' annual rankings in 2001, 2002, and 2003, with a second, first, and third rank, respectively. Several of these patents were licensed to multinationals. The list of multinational firms that licensed technologies and/or conducted contract research at CSIR include GE, PepsiCo, Du Pont Merck, L'Oreal, Mitsui, Pfizer, Novo Nordisk, Unilever, P&G, ICI, SmithKline Beecham, and Mitsubishi. This was a dramatic transformation for a SOE that had no multinational firms licensing its patents prior to 1994.

As a precursor of filing foreign patents and licensing these patents to MNCs, several CSIR labs made investments in new infrastructure and developed new capabilities. Interviews with CSIR employees indicate that the Center for Cellular and Molecular Biology in Hyderabad developed capabilities in X-ray crystallography and proteomics and focused on an ambitious drug discovery program related to cancer. NCL made investments in new technologies such as xylofining and polymer condensation. As a result of these investments, NCL developed capabilities in polymers and licensed several technologies related to this capability, including THPE, fiber reinforced plastics for making two-wheeler components, polyurethane-based water proofing compounds, polyethylene cable compounds, super-absorbing polymers for immobilization of enzymes and so on.

HYPOTHESIS DEVELOPMENT

India – Macroeconomic Shock of 1991

In 1991, India was deep in an economic crisis triggered by both political and economic factors. The economy was in the doldrums – inflation was at an annual rate of 17% and there was an unsustainably large fiscal deficit. A major concern was the unprecedented possibility that India would default on its external debt. The government entered talks with the IMF to seek emergency aid. India needed more than $5 billion from the IMF to meet the emergency. Among the IMF's demands was reducing the budget deficit, decreasing the licensing requirements for companies, opening doors for foreign companies, and liberalizing investment.

The central theme of the economic crisis was an unsustainably high fiscal deficit. As Ghosh (2006) outlines, the antecedents of this unprecedented high fiscal deficit were gradually building up in the late 1970s and 1980s. The oil shock of 1979, high agricultural subsidies, increased defense spending, and a reduction of direct taxes all led to a fiscal deficit in the range of 9.4% in 1990–1991.

As a result of the deficit, the Indian government faced an unprecedented resource crunch. Ghosh (2006) documents that the Indian government had sent informal bailout proposals to the IMF as early as September 1989. The author also quotes then Finance Minister Madhu Dandavate who, in his budget speech in February 1990, declared that "the fiscal imbalance [was] the root cause of the twin problems of inflation and the difficult [BOP] position" (Ghosh, 2006: 418). From July to September 1990, India accessed $660 million from its reserve tranche in the IMF. By the end of 1990, when reserves could cover only 3 weeks of imports, India negotiated $1.8 billion from the IMF under the Compensatory and Contingency Financing Facility.

Indian Domestic Patent Reform

The IMF-led reforms of the 1990s led to a major change in India's domestic patent system. For several decades since her independence, India had a conservative national patent system and refused to join the Paris Convention (1883), which acts as a common agency for national patent systems.[7] Under the Indian Patents Act (1970), only process, not product, patents were allowed in medicines,

food, and agrochemicals. The term of patents was 14 years and 5–7 years in chemicals and drugs. There was compulsory licensing and license of right,[8] and the government was allowed to use patented inventions to "prevent scarcity". For several years, despite pressure from the WTO, India did not reform its patent laws in accordance to the Trade Related Aspects of Intellectual Property Rights agreement, which required India to allow product patents in pharmaceuticals and agrochemicals.[9]

However, triggered by the IMF and the WTO in 1999, there was a major reform to the Indian Patent Act.[10] Applications were allowed for product patents in medicines, food, and agrochemicals, and exclusive marketing rights were introduced. Patent terms were increased to 20 years. There were no licenses of right; compulsory licensing was allowed, but was more restricted. Finally, the government was restricted to selling on a noncommercial basis (Ramanna, 2003). In parallel, there was a major investment in new patenting centers and training patent examiners. India also joined the Paris Convention and the PCT in 1998.[11] One could argue that the reforms made India a more attractive location for filing patents and created a level playing field for patenting in India *vis-à-vis* patenting in foreign locations.

We compared the Indian patent system (before and after the reform) with the USPTO. In doing this, we spoke to the IP management team within CSIR and also to several patent lawyers in India. In summary, post reform India matched the United States on several aspects, such as allowing product patents, equalizing the term of patents, and joining the PCT. Details are in Table 1.

Implications for SOEs

The economic crisis of 1991 had far-reaching implications for SOEs. The economic crisis led to the Industrial Policy Resolution of 1991, which stated an ambitious SOE privatization goal – the government intended to reduce government ownership to 26% of equity, the minimum equity holding necessary for certain voting powers in all state-owned firms, except for the defense, atomic energy, railway, and other strategic sectors (Gupta, 2005).

The economic crisis also led to resource constraints for India's SOEs, including India's premier state-owned R&D labs. These premier R&D labs could not be privatized, as they were part of the "strategic sector"; however, they were now forced to seek resource independence given the uncertainty of increases in government budgetary support. Given this, we build hypotheses on how R&D-focused SOEs could react to the domestic patent reform.

Domestic entities' reactions to patent reforms in emerging markets have long been studied in the international business and economics literature. Most studies have reported either a null or negative result of patent reform on local patenting by domestic entities. In a recent study, Allred and Park (2007) outline theoretical antecedents for how domestic entities might react to such reform in terms of domestic patent filings. They outline two possible reasons why domestic entities could reduce domestic patent applications in response to patent reform in emerging markets. The first reason relates to a lesser ability to imitate technologies in the face of a stronger domestic patent regime; the second reason relates to the fact that traditional knowledge is likely to be patented in the face of a stronger domestic patent regime. They also provide empirical

Table 1 Comparison of patent systems in the United States and India (pre and post reform)

Criteria	USPTO	India pre-1999	India post-1999
Type of patent allowed	Design, utility, plant patents	Only process patents in medicines, food, and agrochemicals	Product patents in medicines, food, and agrochemicals
Term of patent	Either 20 years from the earliest claimed filing date or 17 years from the issue date; for design patents, 14 years	14 years and 5–7 years in chemicals, drugs	20 years
Jurisdiction	United States	India	India+PCT applications allowed
Cost of filing	Filing cost around $3500; total cost around $7000–$20,000	Around 60–70% cheaper	Around 60–70% cheaper
Time needed	Around 3–5 years	Around 8–9 years	Around 3–5 years
Patent right granted to	First to invent	First to file	First to file

Source: Interviews with CSIR IP management team and Indian patent lawyers.

evidence that in emerging markets, patent strength negatively affects domestic patent fillings.

In addition to the arguments and results presented by Allred and Park (2007), there are several studies in economics that document a null or negative result of domestic patent filing by residents in response to patent reform. These studies include Sakakibara and Branstetter (2001), Branstetter, Fisman, and Foley (2006), and Lerner (2002), and they report that patenting by domestic residents either declines or remains stagnant post patent reform. Lerner (2002) studies 177 events of patent reforms in 51 countries over a 150-year period and finds that residential patent filings did not react to domestic patent reform. Sakakibara and Branstetter (2001) study the Japanese patent reform of 1988 and report a negative shift in domestic patent applications. They also look at Japanese firm patenting in the United States and report that there is no sign of a shift or acceleration around the time of patent reform. Branstetter et al. (2006) look at the impact of intellectual property rights (IPR) reform on resident vs nonresident patenting across 16 countries over 1982–1999. They report that relative to the pre-reform period, patenting grows for nonresidents after reform, but remains flat for domestic residents. Lo (2011) also found, when researching the impact of the Taiwanese patent reform in 1986, that the reform stimulated R&D, but that R&D-intensive industries increased their patenting in the United States, not in Taiwan. This leads us to our first hypothesis:

Hypothesis 1: Post domestic patent reform, premier state-owned R&D entities in India do not move their patent mix toward filing more domestic patents.

A Unique "Seeking Resource Independence" Explanation for the Null/Negative Result

Given that the majority of prior studies in both the international business and economics literature have reported a negative or null result of domestic patent filing in response to patent reform in emerging markets (Allred & Park, 2007; Branstetter et al., 2006; Lerner, 2002; Sakakibara & Branstetter, 2001), we now provide unique theoretical reasoning to explain the result. Here, we leverage Vernon's (1979) resource independence hypothesis. To recap, Vernon suggests that SOE managers try and secure resource independence from other related state actors. This helps managers of SOEs better navigate the challenges related to the multiplicity of the SOE role.

Seeking resource independence entails creating a cash flow stream independent of government budgetary support. To quote Vernon (1979: 10), "Maneuvers of this kind include efforts to develop a cash flow that is independent of the control of their supervising ministries, as well as efforts to link up with foreign partners who are capable of providing resources that lie beyond national controls." Vernon also suggests SOEs seek resource independence by creating a cash flow stream linked to MNCs. He also provides more details of this SOE–MNC arrangement and, to quote the author (Vernon, 1979: 12), "These are embodied in licensing agreements, joint ventures, and management contracts which often assign to the private multinational partner a considerable role in the operation of the facilities of the state-owned enterprise."

Recent studies in international business have looked at how domestic entities in emerging markets can create cash flow streams by leveraging MNCs. Singh (2007) used patent citation data as a proxy for examining the knowledge flows between MNCs and host-country organizations. He found that MNCs gain more from host-country knowledge than they contribute, especially in countries where domestic organizations are more technologically advanced. This knowledge outflow from domestic organizations can benefit the domestic organizations in terms of payments, royalties, or license fees. In summary, Singh (2007) shows that domestic entities in emerging markets can create independent cash flow streams by licensing technologies to MNCs. Extending this logic to SOEs, one can argue that SOEs can achieve resource independence and satisfy Vernon's recommendation by licensing technologies to MNCs.

However, it is not clear *ex ante* why SOEs would need *foreign* and not *domestic* patents for such MNC licensing deals. In other words, it is not clear *ex ante* why we might observe a null/negative result with regard to domestic patents and why SOEs might need foreign patents to create independent cash flow streams of licensing technologies to MNCs.

Here we turn to the signaling model in economics, first outlined by Spence (1973). Spence used a hiring situation to show how signaling worked. An individual who, for example, got an education would use this to obtain a higher wage. Spence (1973) found that if an individual did not invest in an education, he or she would get a lower wage and the loss would exceed the gain from not obtaining a degree. In the hiring situation, the signal lies in a feedback loop where the employer's expectations lead to wages

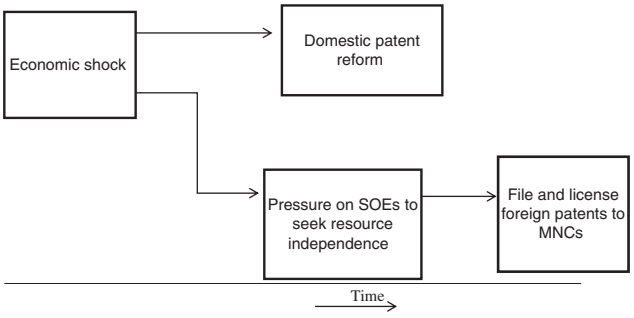

Figure 1 Theoretical explanation for domestic patent reform result in context of SOEs.

offered for various levels of education, which leads to job seekers investing in education. In the same way, an emerging market SOE that files for foreign patents is making an investment by incurring a higher patent filing cost, given the cost differentials of filing a patent in an emerging vs a developed country. Here the assumption is that MNCs are willing to offer higher licensing fees when the patent is from a developed patent system. MNCs might be willing to pay higher licensing fees for foreign patents filed in a developed country, as the underlying patent might be of better "quality", might have legal jurisdiction in the larger Western markets of the MNC, or might be less affected by concerns of patent law violations given the stronger IPR regime in the developed country patent system where the patent is filed. This leads to our second hypothesis:

> **Hypothesis 2:** For premier state-owned R&D labs, revenue from MNCs is correlated to an increase in the number of foreign patents, but not to an increase in the number of domestic patents.

Also, as Figure 1 indicates, if the domestic patent reform and the need for resource independence of SOEs are both triggered by a common economic shock, then despite domestic patent reform, R&D-focused SOEs could move their patenting focus to foreign patents in an attempt to license such foreign patents to MNCs. This could offer a unique "seeking resource independence" explanation for the negative/null result in the domestic patent reform literature in the context of SOEs.

DATA AND METHODS

The CSIR is a major government-owned research organization in India, comprising 42 national laboratories and around 10,000 scientific and technical employees.[12] As outlined earlier, in response to the Indian economic crisis of 1991 and the resulting constraints in securing government budgetary resources, the CSIR labs started a major transformation process around 1996 under the leadership of a new director general, Dr Mashelkar. The *CSIR 2001 Vision Document* published in January 1996 outlined ambitious goals for 2001.[13] As a result of this reform process, the labs started from a base of negligible foreign patents and ended up with more patents than all domestic private firms combined. The labs were then able to license several of these patents to multinational firms, and revenue from multinationals increased from 3 to 15% as a fraction of government budgetary support. In 2002, CSIR emerged as the single-largest PCT applicant from emerging markets. Summary statistics and the correlation matrix are reported in Tables 2a and 2b.

Domestic and Foreign Patenting Before and After Patent Reform

We first analyzed what happened to domestic and foreign patenting by the CSIR laboratories before and after the 1999 patent law reform. Using the methodology employed by prior empirical papers focused on patent law reform – including Sakakibara and Branstetter (2001) and Branstetter et al. (2006) – and a similar methodology used by Jaffe and Lerner (2001), we used a (post_reform) dummy variable and ran the following fixed effects regressions:[14]

$$\begin{aligned}\text{ln\_pat\_filed\_abr}_{it} = {} & \beta_0 + \beta_1 \text{*post\_reform} \\ & + \beta_2 \text{*govt\_budget}_{it} + \beta_3 \text{*pub}_{it} \\ & + Z_i + Y + \varepsilon_{it} \end{aligned} \quad (1)$$

$$\begin{aligned}\text{ln\_pat\_filed\_ind}_{it} = {} & \beta_0 + \beta_1 \text{*post\_reform} \\ & + \beta_2 \text{*govt\_budget}_{it} + \beta_3 \text{*pub}_{it} \\ & + Z_i + Y + \varepsilon_{it} \end{aligned} \quad (2)$$

The dependent variables in these two regressions measure the number of patents filed abroad (pat_filed_abr) and in India (pat_filed-ind) by each individual CSIR laboratory. Based on the logic articulated by several prior papers, including Jaffe and Lerner (2001), that the patent production function is multiplicative and the fact that certain labs do not have patents in certain years, we used the logarithm of one plus the number of patents as the dependent variable.

The key independent variable of interest is the post reform dummy variable (post_reform). The two main time-variant control variables measure the year-wise number of publications (publications_{it}) and the level of government budgetary support (govt_budget); the inclusion of these two variables allowed us to control for the size and scale of individual lab's R&D

Table 2a Summary statistics for CSIR

Variable	Description	Observation	Mean	Standard deviation	Minimum	Maximum
Year	Year	504	2000	4.04	1993	2006
pat_filed_abr$_{it}$	Number of foreign patents filed by lab *i* in year *t*	432	12.0	21.4	0.0	160
pat_filed_ind$_{it}$	Number of Indian patents filed by lab *i* in year *t*	432	9.1	14.8	0.0	122
revenue_MNC$_{it}$	Revenue from multinationals to lab *i* in year *t*	305	10.6	18.7	0.0	131
govt_budget$_{it}$	Budgetary support from government to lab *i* in year *t*	430	50.6	69.7	4.1	693.5
publications$_{it}$	Publications for lab *i* in year *t*	428	60.3	74.5	0	552

Table 2b Correlation matrix

	pat_filed_abr	pat_filed_ind	revenue_MNC	govt_budget	publications
pat_filed_abr	1.00	—	—	—	—
pat_filed_ind	0.61	1.00	—	—	—
revenue_MNC	0.33	0.29	1.00	—	—
govt_budget	0.12	0.04	0.20	1.00	—
publications	0.58	0.51	0.51	0.26	1.00

Notes: The variable revenue_MNC represents revenue earnings from multinational firms. The variable govt_budget represents the government budgetary support received by a lab. All monetary variables are in Rs. million. For most of the variables, the data was collected for 1995–2006; for a few variables, we have additional data for 1993 and 1994.
Source: CSIR.

operations. We also controlled for the age of the lab and added dummies for location and type of science pursued[15] and year dummies Y_i.

In addition, we used data from 593 scientist CVs and added several time-invariant control variables. These include the percentage of scientists who have PhDs (fraction_PhD); average number of countries visited by scientists (avg_countries_visited); percentage of scientists who have traveled to the United States (fraction_visited_US); average number of awards received by scientists (avg_awards); average number of books (avg_books), articles (avg_articles), and reports (avg_reports) published by scientists and so on. Also, in line with Jaffe and Lerner (2001), we construct a measure of technological focus (focus) on individual labs by computing the Herfindahl index of patent classes for patents granted to a lab.

In the base case, when we first ran the fixed effects model, the time-invariant variables like location, type of science dummies, and average scientist quality measures drop out. However, we then ran a random effects model and conducted a Hausman test. Next, we explored the effect of the patent reform on the patent mix of CSIR and ran similar fixed and random effects regressions, using patent mix as a dependent variable. The control variables for this regression were similar to the prior two regressions. In our base model, the dependent variable is defined as log(1+US patents)/(1+Indian patents) and the specification is:[16]

$$\begin{aligned}\text{ln\_patent\_mix}_{it} = {} & \beta_0 + \beta_1\text{*post\_reform} \\ & + \beta_2\text{*govt\_budget}_{it} \\ & + \beta_3\text{*pub}_{it} + Z_i + Y + \varepsilon_{\text{it}} \end{aligned} \quad (3)$$

Domestic and Foreign Patents and Revenue from MNCs

Here, our main specification is:

$$\begin{aligned}\text{ln\_revenue\_MNC}_{it} = {} & \beta_0 + \beta_1\text{*govt\_budget}_{it} \\ & + \beta_2\text{*ln\_pat\_filed\_abr}_{it} \\ & + \beta_3\text{*ln\_pat\_filed\_ind}_{it} \\ & + \beta_4\text{*pub}_{it} + Z_i + Y + \varepsilon_{\text{it}} \end{aligned} \quad (4)$$

The dependent variable (revenue_MNC) measures revenue from multinationals to CSIR, and the main independent variables of interest are the levels of domestic and foreign patents. We use the cumulative stock of domestic and foreign patents as the independent variables, as any of the patents "held in stock" could be licensed to MNCs to generate revenue. The two main control variables are the level of publications generated by individual labs and the level of government budgetary support; other controls include laboratory age, dummies for lab, year dummies and so on.

Comparison with Other SOE and Private Entities

Next, we compared US patenting at CSIR labs with other public R&D labs in India, state-owned firms in India, and private firms in India to establish whether or not US patenting trends at CSIR labs were dictated by broader and potentially confounding factors.

We coded 1640 USPTO patents granted to Indian entities from 1994 to 2003 and assigned each patent an "ownership" value. The ownership variable can take the following values: CSIR, Indian private, other public R&D (includes university), or state-owned firm. In this analysis, we used firm ownership information from the Prowess database that is distributed by the Centre of Monitoring Indian Economy (CMIE). This data set is widely used in studies focused on India.[17] Here we used both fixed effects and random effects difference in difference regressions to test whether the number of US patents granted (US_patents_granted) to CSIR labs was systematically higher than the number granted to other Indian entities in the same period. We had to use granted and not filed patents (unlike the prior specifications), as we knew only the granted patents for non-CSIR entities. We used three panels (CSIR labs compared with other Indian public R&D/universities, private Indian firms, and state-owned firms) and used 1996 (the first full year of Dr Mashelkar's tenure as director general of CSIR) as the baseline year.[18] Here the specification was:

$$\begin{aligned}\text{ln\_US\_patents\_granted}_{it} &= \beta_0 + \beta_1 * \text{entity\_isCSIRlab}_t + \beta_2 * \text{post1996}_{it} \\ &\quad + \beta_3 * \text{entity\_isCSIRlab}_t * \text{post1996} + \varepsilon_{\text{it}} \qquad (5)\end{aligned}$$

In this specification, the key coefficient of interest is β_3: if CSIR labs show a disproportionate increase in US patents compared with other Indian public and private entities, the coefficient on β_3 should be positive and significant.

RESULTS

Summary Trends – Patenting and Revenue from Multinational Firms

We first investigated the effect of the 1999 reform on overall patent filings in India. Figure 2 shows a spike in patent applications in India around 1997–1998 in anticipation of the 1999 reform. Next, we analyzed the trend of patenting at CSIR around the reform year and looked at both domestic and foreign patent filings. Figure 3 indicates that there was an increase in Indian patents filed by CSIR around 2 years prior the reform; however, this trend flattened out around the reform year of 1999. In contrast, foreign patents continued to increase for 5 years after the reform. Foreign patenting, which was one-third of domestic patenting 4 years prior to the reform, exceeded domestic patent filings 1 year after the reform. In summary, while the Indian domestic patent system was being reformed, the CSIR laboratories disproportionately increased their focus on the US patent system. Figure 4 outlines the trend of revenue from multinationals and government budgetary support from 1995 to 2005 and indicates that while government budgetary support declined or remained roughly equal in this period (e.g., year on year it declines between 1995 and 1996; 1996 and 1997; 1997 and 1998 and so on), revenue from multinationals increased fivefold from 1995 to 2005.

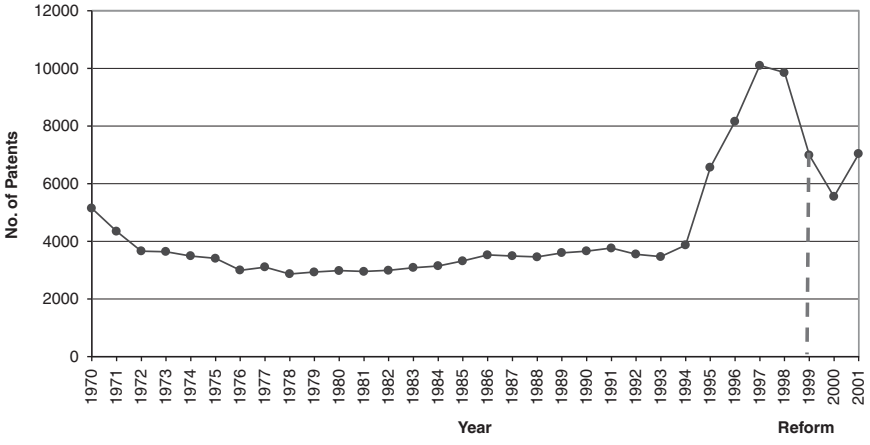

Figure 2 Patent filings in India (1970–2001).
Note: This figure shows the trend in patent filings in India and shows a clear spike around 1997 in anticipation of the 1999 reforms.
Source: Ganguli (1998) and TIFAC.

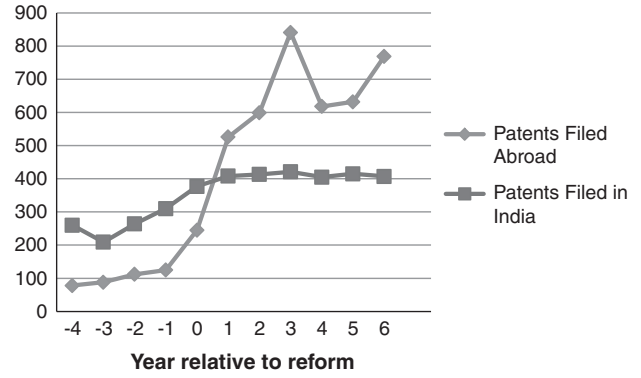

Figure 3 Foreign and Indian patent filings by CSIR around reform year of 1999.
Notes: Here, we trace foreign and Indian patent filings by CSIR around the reform year of 1999. Foreign patent filings, starting out at about one-third of domestic filings, exceed domestic filings 1 year after the reform. Foreign patent filings include filings on the USPTO, EPO, and other global patent systems.
Source: CSIR.

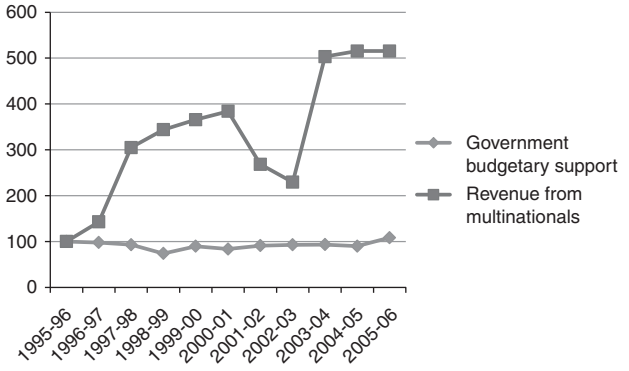

Figure 4 Trend of revenue from multinationals and government budgetary support.
Notes: Here, we trace revenue from multinationals and government budgetary support from 1995 to 1996 and 2005 to 2006. We scale the trend of both revenue from multinationals and government budgetary support to their respective levels in 1995; in other words, the 1995 levels are treated as 100 and the subsequent figures are scaled to the 1995 levels.
Source: CSIR.

Table 3 Panel regression results – Impact of patent reform on patent filings and patent mix

	Dependent variable					
	(1) ln_pat_fil_abr	(2) ln_pat_fil_abr	(3) ln_pat_fil_ind	(4) ln_pat_fil_ind	(5) ln_patent_mix	(6) ln_patent_mix
post_reform	1.57*** (0.23)	1.57*** (0.23)	0.43*** (0.16)	–0.18 (0.16)	0.15*** (0.05)	0.28*** (0.05)
ln_govt_budget	0.18* (0.10)	0.19** (0.09)	0.08 (0.06)	0.07 (0.06)	0.00 (0.02)	–0.02 (0.02)
ln_publications	0.28** (0.12)	0.25** (0.12)	0.17** (0.08)	0.17** (0.08)	0.12*** (0.03)	0.11*** (0.03)
Focus	—	–3.66***(0.75)	—	0.26(0.51)	—	–0.27(0.19)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
State dummies	—	Yes	—	Yes	—	Yes
Type of science dummies	—	Yes	—	Yes	—	Yes
Scientist-level controls	—	Yes	—	Yes	—	Yes
Method	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects
N	380	380	380	380	310	310

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.
Notes: These regressions measure the impact of the reform on foreign patents filed by CSIR (ln_pat_filed_abr), domestic patents filed (ln_pat_filed_ind), and patent mix (ln_patent_mix). ln_patent_mix is log(1+US patents)/(1+Indian patents). The variable govt_budget represents budgetary support from the government and the variable publicationsit measures year-wise number of publications. The post reform dummy is an indicator for years after 1999. We run both fixed effects and random effects models and then conduct a Hausman test to verify that the Random estimator cannot be ruled out as inconsistent.

Regression Results – Patenting and Revenue from MNCs Post Reform

Our first major finding from the regression analyses is that after the Indian patent system reform, CSIR labs increased both foreign and Indian patent filings, but disproportionately increased foreign patent filings, moving their patent mix toward US patents. Results are reported in Table 3 and indicate support for Hypothesis 1.

Using Eq. 1, 2, and 3, we regressed foreign and Indian patent filings and measures of patent mix on the post reform dummy variable. Columns 1 and 2 indicate that foreign patent filings increase after 1999, and the result is robust to specification (fixed or random effects). Though Indian patent filings increase after 1999 in a fixed effects model (Column 3), this result does not hold for a random effects model (Column 4). Columns 5 and 6 indicate that the patent mix of CSIR moved toward US patents after 1999.

Next, we tested whether revenue from multinationals to CSIR labs responds to domestic and/or

Table 4 Panel regression results – Impact of domestic and foreign patents on revenue from multinationals

Independent variable	Dependent variable		
	1 ln_revenue_MNCs	2 ln_revenue_MNCs	3 ln_revenue_MNCs
ln_pat_uscum	43.10***	85.50**	46.28**
	(14.79)	(41.80)	(23.49)
ln_pat_indcum	8.33	11.14	46.84
	(22.59)	(36.96)	(52.18)
ln_govt_budget	–25.04	–67.90	–17.71
	(16.02)	(30.83)	(22.84)
ln_publications	36.62* (20.35)	51.31 (38.13)	27.87 (30.93)
Year dummies	Yes	Yes	Yes
Lab covariates	Yes	Yes	Yes
Method	Fixed effects	Fixed effects	Fixed effects
Years	1995–2006	1995–1999	2000–2006
N	304	96	208

*Significant at the 10% level; **significant at the 5% level; ***significant at the 1% level.
Notes: The regressions measure the impact of the cumulative stock of domestic and foreign patents on revenue from foreign companies to CSIR (ln_revenue_MNCs). We use the cumulative stock of patents and not contemporaneous filings of patents, as licensing can be assumed to have a lead time of searching for the buyer and structuring the licensing deal and licensing could involve any patent in stock. ln_revenue_MNC is defined as ln(1+revenue_MNC). The variable govt_budget_support represents budgetary support from the government and the variable $publications_{it}$ measures year-wise number of publications. Lab covariates include age.

Table 5 Comparison of CSIR labs to other Indian SOEs and private entities

Independent variable	Dependent variable: ln_US_patents_granted					
	Sample: CSIR labs, all other public R&D labs and public universities		Sample: CSIR labs and all private Indian firms		Sample: CSIR labs and all state-owned firms	
	(1)	(2)	(3)	(4)	(5)	(6)
entity_is_CSIRlab	—	1.75** (0.81)	—	1.75* (1.02)	—	1.71** (0.87)
post96*entity_CSIRlab	1.84*** (0.02)	1.84** (0.89)	1.83*** (0.02)	1.83** (0.89)	1.73*** (0.10)	1.73** (0.82)
Year dummies	Yes	Yes	Yes	Yes	Yes	Yes
N	533	533	2041	2041	117	117
Model	Fixed effects	Random effects	Fixed effects	Random effects	Fixed effects	Random effects

*Significant at the 10% level; **significant at the 5% level;***significant at the 1% level.
Notes: This table reports results of difference in difference regressions that compare US patents granted with CSIR labs with other Indian entities. We had to use patents granted and not patents filed (unlike Table 3), as we know only the patents granted to non-CSIR entities. Models 1 and 2 compare CSIR labs with other Indian public R&D labs and universities; Models 3 and 4 compare CSIR labs with Indian private firms; Models 5 and 6 compare CSIR labs with Indian state-owned enterprise. The analysis is done for baseline year 1996 (first full year of Mashelkar's tenure as the director general of CSIR). Similar results, not reported here are obtained for dummy year 1999 (midpoint of Mashelkar's regime). Models 1, 3, and 5 are fixed effects and Models 2, 4, and 6 are random effects/difference in difference models. For each patent, we code the variable "ownership", and we code 1640 US patents (1994–2005). Heteroskedasticity-consistent standard errors reported within parentheses.

foreign patents; results are reported in Table 4 and indicate support for Hypothesis 2. Columns 1–3 indicate that licensing revenue from multinationals is positively related to the stock of foreign patents filed, but not to the stock of domestic patents filed. Column 1 conducts this analysis for 1995–2006, while Columns 2 and 3 break the sample into two time periods – 1995–1999 and 2000–2006 – and confirm this result. Based on back of the envelope estimates, we find that in the post reform period, every unit increase in log of cumulative US patent stock leads to an approximately $13 million increase in revenue from multinationals.

Regression Results – Comparison with Other Indian Entities

Table 5 summarizes the panel regressions comparing US patenting at CSIR with similar patenting at other

public R&D labs and universities in India (Columns 1 and 2); private firms in India (Columns 3 and 4); and state-owned firms in India (Columns 5 and 6). We used both fixed effects models (Columns 1, 3, and 5) and random effects difference in difference models (Columns 2, 4, and 6). As summarized earlier, we used 1996 as the baseline, and the key coefficient of interest is the interaction term (post96*entity_CSIRlab). For all regressions, this coefficient turns out positive and significant, indicating that post 1996, CSIR labs disproportionately increased US patenting compared with other public R&D labs in India, other state-owned firms in India, and Indian private firms.[19] This indicates that only the *premier* state-owned R&D labs employ the strategy of seeking resource independence by filing and licensing foreign patents.

Robustness Checks

In addition to the robustness checks reported earlier, we conducted additional robustness checks. We considered a more flexible interpretation of the reform year itself. Given that the new patent law was legislated in one of the two Parliament Houses (the "Lok Sabha") in December 1998, we repeated the analyses with 1998 (instead of 1999) marked as the patent reform year; results remain consistent.

Prior studies have also indicated that the reform was not a single-year event and that there were several key events that happened prior to and post the reform year. To take care of these issues, we repeated all the tests by breaking the data into three periods: 1995–1999, 2000–2004, and 2005–2006. Here we find that for all key variables (Indian and foreign patent filing, patent mix, revenue from multinationals and so on), there is a progressive increase in values from Phase 1 (1995–1999) to Phase 2 (2000–2004) and, finally, to Phase 3 (2005–2006).

We also find that there is a positive and significant relation between ln_share (delta_ ln_share) of US patent stocks and ln_share (delta_ln_share) of revenue from multinationals in both the overall panel and in the post reform period. The results are robust to first differencing and choice of method (GMM or fixed effects). We also conducted robustness checks of our random effects estimators using the corrections suggested by Bell and Jones (2012).

DISCUSSION

Main Theoretical Contribution

Our main theoretical contribution is that we provide a novel explanation for *why* SOEs might seek global cash flows and a global footprint: *to seek resource independence from other state actors*. We build on the power use hypothesis of the standard RDT (Pfeffer & Salancik, 1978) and its departure in the context of SOEs suggested by Vernon (1979) to posit that in the absence of privatization, SOEs could leverage global cash flows and their global footprint to seek resource independence from other state actors.

Our choice of Indian state-owned laboratories in the 1990s offers a convenient natural experiment to conduct our research. India's 1991 economic crisis led to an IMF-mandated reform process, and India's domestic patent system was reformed starting in 1999 under pressure from the IMF and the WTO. But, the economic crisis of 1991 concurrently created resource constraints for India's state-owned entities. Several SOEs were partially privatized; however, privatization was not an option for R&D labs such as the CSIR. As a result, CSIR labs tried to achieve resource independence by licensing foreign patents to MNCs. As a result, while India's domestic patent system was being reformed, India's premier R&D labs leveraged the PCT option of domestic patent reform and moved their patent filing to foreign patents; licensing revenue from MNCs reacted positively to foreign, but not domestic, patent filings.

Our results also have implications for the SOE efficiency improvement and privatization literature. Earlier in the paper, we outlined the ambitious Indian SOE privatization program studied by Gupta (2005). This program intended to reduce government ownership to a bare minimum of 26% in all applicable Indian SOEs. However, to quote Gupta (2005: 991), "In the decade following the launch of the privatization program, the government sold minority shares through a variety of methods including auctions and public offerings in domestic markets, and through global depository receipts in international markets. However, through 1999 the federal government sold an average of just 19.2% of equity in 40 of 258 industrial, financial, and service sector firms and majority stakes in none. Euphemistically referred to as 'disinvestment', privatization has proven to be very difficult to implement". In this context, we offer an alternative/complementary mechanism to privatization – for R&D-oriented SOEs, filing foreign patents and licensing the same to MNCs might create a cash flow stream independent of government budgetary support. In India and across emerging markets, SOEs continue to comprise a large proportion of industrial sales, yet lag private counterparts on performance measures. Analysis

included in the Appendix suggests that in 2007, 30% of firm sales in India were with state-owned firms; this was, in fact, an increase from the 27% share of sales that SOEs had in 1991, the year the ambitious privatization program was initiated. Our analysis also suggests that state-owned firms continue to lag their private counterparts in performance (Tobin's *q*) and R&D investment (R&D to sales ratio).

Other Contributions

We also provide a theoretical explanation for why R&D-focused SOEs, in an attempt to secure resource independence from government budgetary support, might not react positively to a domestic patent reform and may not disproportionately file more domestic patents. Instead of increasing domestic patent filings post reform, such SOEs might increase foreign patent filings in an attempt to license high-quality foreign patents to MNCs and, thus, secure resource independence from government budgetary support. Seeking resource independence from other state actors may help explain the long-standing null or negative result of domestic patent reform in emerging markets (Allred & Park, 2007; Branstetter et al., 2006; Lerner, 2002; Sakakibara & Branstetter, 2001). If the domestic patent reform and the need for resource independence of SOEs are both triggered by a common economic shock, then despite domestic patent reform, R&D-focused SOEs could move their patenting focus to foreign patents in an attempt to license such foreign patents to MNCs.

Our results have implications for the globalization of resources and markets of emerging market entities (Khanna et al., 2010). In this literature, Chittoor, Sarkar, Ray, and Aulakh (2009) document how Indian pharmaceutical companies went through a global transformation led by resource and market globalization. Similar to our findings, the authors find that the Indian pharmaceutical firms moved from a phase of imitation to developing products that were patentable; filing global patents, in turn, increased their need for more innovative technology to assist them in product discovery. Our results also relate to the emerging literature in international business that focuses on the disaggregated nature of the state. In our context, while the bureaucrats responsible for the Indian domestic patent reform intended more domestic patent filings, the managers of the CSIR labs were concurrently filing higher numbers of foreign patents in an attempt to create a cash flow stream independent of government budgetary support. This is in line with Henisz and Zelner (2010), who outline the disaggregated structure of political actors in emerging markets. The core-periphery framework in Choudhury, Geraghty, and Khanna (2012) also outlines the disaggregated nature of state actors in emerging markets; the framework documents how different "core" state actors might differ in their incentives toward a focal policy and how MNCs engaging with peripheral actors such as state R&D labs might help core state actors align their incentives.

In conclusion, we believe our findings are relevant to SOEs around the world, which are dependent on varying degrees of government budgetary support and government control. Our findings are directly relevant to state-owned R&D entities across emerging markets – a few examples of such entities being Embrapa and Fiocruz in Brazil, the Indian Council of Medical Research, and the CSIR in South Africa. Our findings are also widely relevant to SOEs that have IP that could be licensed to create a cash flow stream independent of government budgetary support. In a more general way, our main theoretical proposition is also relevant for SOEs that acquire/create assets in foreign countries to create a cash flow stream independent of their home-country government control. A case in point here is Petróleos de Venezuela S.A. (PVDSA), a Venezuelan SOE acquiring ownership of Houston-based CITGO. PVDSA acquired 50% ownership in CITGO in 1986 and acquired the remaining half of CITGO in January 1990; arguably this acquisition created a cash flow stream for PVDSA independent of other state actors in Venezuela.

NOTES

[1]Examples include CMIE Prowess for India or FinAsia for China.

[2]A similar result is reported by Gupta, Ham, and Svejnar (2000), who report that governments sequence privatization by selecting the most profitable firms first. Bardhan (2003) mentions yet another difficulty of privatization in India and highlights that organized labor is opposed to privatization.

[3]The case study is based on interviews with Dr Mashelkar and other CSIR executives.

[4]For example, patent number 5,080,121 filed in August 1990 claimed to create a novel polymer useful for drag reduction in hydrocarbon fluids in exceptionally dilute polymer solutions.

[5]THPE is a branching agent used in the synthesis of high-grade polycarbonates with properties of high transparency, good mechanical strength, and high parison strength. 1,1′,1″-Tris(4′-hydroxyphenyl) ethane; a branching agent used in the synthesis of high-grade polycarbonates.

[6]For example, the following US patents: 5,780,578; 5,851,546; 6,379,599; 6,420,487; 6,605,714; 6,689,836; 6,794,467; and 6,867,268.

[7]In the area of patents, India and countries under the New International Economic Order tried to push for free flow of technological information, arguing that it was owned as part of a common heritage (Braithwaite & Drahos, 2000).

[8]These provisions allow governments to issue licenses to allow other companies to make patented products or use patented processes without the consent of the patent owners under certain circumstances.

[9]The government tried to pass an ordinance in 1994 reforming India's law to conform to TRIPS, but this attempt failed in the Upper House of Parliament. The pharmaceutical industry argued that drug prices would rise if TRIPS was adhered to and NGOs argued that farmers would be hit severely if the patent system was reformed.

[10]The reformed bill was passed in the Upper House of Parliament in December 1998 and in the Lower House in March 1999.

[11]The patent reform process continued until 2002.

[12]The list of CSIR labs along with their locations is available from the authors.

[13](1) Move toward the path of self-financing by generating more than Rs. 7 billion from external sources vs Rs. 1.35 billion in 1994–1995, of which at least 50% will be from industrial customers (up from 15% in 1994–1995); (2) Develop at least 10 exclusive and globally competitive technologies in niche areas; (3) Hold a patent bank of 500 foreign patents (up from 50); (4) Realize 10% of operational expenditure from intellectual property licensing (up from<1%); and (5) Derive annual earnings of $40 million from overseas R&D work and services (up from<$2 million). Note: the figures here are in Indian rupees and US dollars, as the text is reproduced from the original.

[14]Here, *i* indicates an individual laboratory and *t* indicates the individual year.

[15]We have five dummy variables for the "type of science" pursued, one each for "biological sciences", "chemical sciences", "physical sciences", "engineering sciences", and "informational sciences". We also have 19 dummy variables for the lab location based on the 19 Indian states in which CSIR labs are located.

[16]We also used alternate specifications like log(1+US patents)/(1+Indian patents).

[17]The Prowess data set is the Indian counterpart of DataStream, and researchers have used it extensively in studies on India.

[18]We also repeated the analysis using 1999 as the baseline year. The year 1999 is the beginning of Dr Mashelkar's second tenure as the director general of CSIR.

[19]We repeat the analysis with 1999 as the baseline year. This is the midpoint of Dr Mashelkar's regime. We get similar results in this case. Results are available from the authors.

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APPENDIX

Table A1 Comparison of Indian SOEs and domestic private firms, 1991 and 2007

	1991		2007	
	SOE	Private domestic	SOE	Private domestic
Number of firms	176	2630	244	5074
Percentage of total sales(%)	27	73	30	70
Percentage of total assets(%)	34	66	31	69
R&D to sales ratio(%)	0.02	0.02	0.18	0.52
q ratio	0.25	0.7	2.12	14.44

Notes: This table compares number of firms, R&D with sales ratio, and Tobin's (*q*-ratio) for Indian SOEs and domestic private firms in year 1991 and year 2007. The table also compares the percentage of total industry sales (Percentage of total sales) and percentage of total industry assets (Percentage of total assets) in the SOE and domestic private sector in years 1991 and 2007. The year 1991 is chosen to indicate the beginning of the Indian government disinvestment/privatization program. Year 2007 indicates the end of the time period of the current study.

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