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From Produce and Protect to Promoting Private Industry: The Indian State's Role in Creating a Domestic Software Industry

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Abstract

The software industry is one of the hallmarks of the Indian growth story. It is a key contributor to the country's economy, and has remained robust despite laggardness in other sectors. Initially, India's electronics policy followed the standard "license raj" procedures which empowered state enterprises over private industry. As with other sectors, the protectionist, statist policies hampered the growth of the industry. However, radical changes came about in 1984. The newly elected Prime Minister, Rajiv Gandhi, was quite a westernized man who took a keen interest in reforms. Computer policy, consequently, went from a protectionist, statist establishment to a private sector oriented model. Industries related to computing also saw government promotion. While many claim that the software industry boomed due to a lack of government involvement, the government's private sector promotion policy played a critical role in setting up one of India's most successful industries.

Acknowledgements

I. Introduction

Government policies have historically hampered innovation and economic growth in India. From Independence in 1947 through the 1970s, the Indian government sought to foster a planned economy where state-owned enterprises and a small set of private-sector business groups would receive market protections.[1] But unlike the developmental states in East Asia where state-led initiatives resulted in industrialization and new possibilities for innovation, the

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[1] India suffered slow growth rates from its Independence in 1947 until 1980. Slow growth during this time period is widely considered to be the result of poor government policies brought about through centralized planning. For a review, see Dani Rodrik and Arvind Subramanian, "From 'Hindu Growth' to Productivity Surge: The Mystery of the Indian Growth Transition," *IMF Staff Papers* 52(2): 2005.

Indian state ultimately proved unable to direct such an economic transformation.[2] Beginning in the early 1980s the government started to dismantle the "license raj," culminating with economic liberalization in 1991. Since that time, the Indian economy has grown fast on balance, yet in an uneven manner. India's working population is mostly employed in an agricultural sector that has experienced anemic growth over this time period, in no small part due to government institutions that continue to discourage market reforms and policies that suppress technological innovation. As a result, the percentage of value added to the economy from agriculture has been going down since 1980, with agriculture being responsible for less than twenty percent of the value added to the economy as of 2012 (see Figure 1). The industrial sector has done slightly better as it has generally kept pace with overall economic growth, but it only contributes about thirty percent of the value added to the economy. Instead of relying on agriculture or industry, however, India has become a service sector economy, with more than fifty percent of the value added to its growing economy coming from services.

Why has India's services' sector flourished? In this chapter, I will examine the crown jewel of this sector: India's software industry. As with other Indian industries, innovation and growth in the software industry suffered under government control from the 1960s to the 1980s. When reforms came to the industry in 1984, however, private companies in the software industry—including several independent startups that were not affiliated with India's business groups—did not want the state to adopt a *laissez faire* approach. While they celebrated the end of *protective regulations* that were designed to aid state-owned enterprises, the private software industry successfully pushed for government policies that would *promote* industry-wide innovation and growth. Among these promotional policies, the central government expanded its already considerable investment in technical higher education and developed telecommunications infrastructure that would enable software export services, while state and local governments created technology parks that would provide office space, constant electricity, and clean water. Some of these parks—like Electronic City in Bangalore—also became model innovation clusters along the lines of those described by Lee and Kim later in this volume.

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[2] Many excellent studies have examined the developmental state miracles in South Korea and Taiwan. For Korea, see Alice Amsden, *Asia's Next Giant: South Korea and Late Industrialization*, (New York: Oxford University Press, 1989) and Peter Evans, *Embedded Autonomy: States and Industrial Transformation* (Princeton, NJ: Princeton University Press, 1995). On Taiwan, see Robert Wade *Governing the Market: Economic Theory and the Role of Government in East Asian Industrialization*, (Princeton, NJ: Princeton University Press, 1990). For an insightful comparative perspective between Korea and India, see Atul Kohli, *State Directed Development: Political Power and Industrialization in the Global Periphery* (New York: Cambridge University Press, 2004).

Following the shift in government policy in the 1980s, the growth of the software industry has been profound. Software exports have grown at a blistering 33 percent annual compounded rate from 1990 to 2015 (see Table 1). Today several of India's largest companies are software exporters, including India's largest publicly traded company by market capitalization in Tata Consultancy Services (TCS). Within software exports, the information technology/business process management segment contributes between 8 to 10 percent of the entire country's GDP.[3] Apart from software exports, almost every leading technology company in the world has at least one research and development facility in India. Put simply, a technology services ecosystem has emerged that will probably determine the course of India's economic future in the twenty-first century.

[Table 1 somewhere here]

The development of India's software industry is an economic miracle in a country not known for such success stories. What explains it comparative success? I argue that the industry's growth is partly due to the government's decision to shift from a state-led "produce and protect" model to a pattern of broad-based industry promotion. Following the decision to abandon its "produce and protect" model, the government could have struck a different path: it could have adopted a laissez-faire approach to the industry or it could have identified a few private sector firms to become national champions. Instead, government policies aided the industry as a whole rather than privileging national champions. As a result, the Indian software industry is a vibrant and innovative ecosystem that potentially provides important lessons for other industries in India and elsewhere.

This chapter proceeds as follows. In the next section, I present the history of the software industry from its beginnings to 1984. During this time, the Indian government sought to centrally plan the economy. For the electronics sector (of which the software industry was a part), this meant that the government sought to throttle foreign competition and competition from the private sector in favor of new state-owned enterprises. In Section III, I present the causes and consequences of the 1984 Computer Policy. This policy essentially signaled that the government was abandoning "produce and protect." Over the next several years, the government would adopt an industry promotion approach. I conclude in Section IV with a discussion of why the software industry succeeded. Other scholars have suggested that the

[3] NASSCOM India, various years, compiled by *Statista*.

success of the industry is due to the retreat of the government from policymaking. Even though ending the "produce and promote" model was certainly healthy for the software industry, the government's promotional policies clearly played an important role in the industry's success. Similar kinds of promotional policies could aid other innovation-driven industries in India and elsewhere.

II. The 1960s to 1984: The "Produce and Protect" Regime

At a high level, states can pursue any of four strategies for fostering an infant industry. They can directly **produce** by creating a state-owned enterprise or they can pick winners, usually by creating **protective regulations** that privilege a specific player or a few players or they can **promote** the industry as a whole, usually by reducing the costs on input materials or by waiving taxes or they can simply do nothing (*laissez-faire*).[4] Post-war industrialization has usually involved government protection. In this volume, Moon and Lee examine the relationship between firm size and innovation across six East Asian countries. Economies with planned capitalist models like Taiwan, South Korea, and Japan saw their states protect a few key private sector players as they pursued industrialization. By contrast, successful free market economies like Hong Kong and Singapore tend to focus on service sectors like finance and trade. These different starting points carry important implications for firm size and innovation policy.

Government officials in India initially pursued the first two strategies of production and protection in the country's pursuit of economic development. Production and protection manifested in centralized planning, and this centralized planning approach was initially beneficial to the computing sector as government resources could be steered toward expensive start-up investments. Indeed, it was two technocrats who initially recognized the importance of computing for the future course of the country. In Calcutta (today called Kolkata), the Indian Statistical Institute under the direction of P.C. Mahalanobis built an analogue computer in 1953 and acquired a digital computer from Britain in 1956, along with another digital computer from the Soviet Union in 1958.[5] These computers would be used for processing government data related to economic planning. In 1960, the Tata Institute for Fundamental Research (TIFR) in Bombay (today called Mumbai) formally commissioned India's first digital computer under

[4] This framework is adapted from Evans 1992. Evans used slightly different terms and argues that the Indian state never adopted a *laissez faire* approach to the electronics sector, but instead shifted from producing and protecting to promoting private industry.
[5] See Nikhil Menon (2018), "'Fancy Calculating Machine': Computers and Planning in Independent India, *Modern Asian Studies* 52(2): 421-457.

the direction of Homi Bhabha, a leading atomic scientist working within the Indian government.[6]

At around the same time, the central government also decided to partner with UNESCO, the Soviet Union, West Germany, the United States, and the United Kingdom to build five Indian Institutes of Technology (IITs) across India. At IIT-Kanpur—the campus that was founded with US support—the US government and the Ford Foundation worked with local academics to create the first educational programs in computing. IIT-Kanpur imported the IBM 1620 in August 1963, becoming the first campus in the country to use a computer with a FORTRAN compiler.[7] Professor Harry Husky of California-Berkeley, along with Professors Forman Acton and Irving Rabinowitz from Princeton, came along for the first two years to set up the computer and establish the first programming classes at Kanpur, which were made mandatory for all engineering students. By 1965, there were at least 15 digital computers spread across the country, mostly at central government research agencies and technical institutes.

Because of initiatives like the one at IIT-Kanpur, a growing number of Indians were learning to program computers. An even larger number of Indians were quickly recognizing the potential promise of computing. Among this latter group was Lalit Kanodia, a 1963 graduate of IIT-Bombay. Following his graduation, Kanodia enrolled in an MBA program at MIT. After completing his MBA in 1965, Kanodia went home for the summer before starting the PhD program at MIT. During his break, he fell in love and sought to get married. The priest informed the couple that there were no auspicious dates for marriage in the summer and so Kanodia decided to defer his studies for a term. While waiting in India, he approached P.M. Agerwala, the Managing Director of Tata Electric Companies, who suggested he write some papers on how the Tata Group could utilize computers. Kanodia made three suggestions. First, he suggested that the Electric Companies should automate their Load Despatch System. Second, he encouraged them to computerize their billing system by buying computer time from TIFR. Third, he suggested that they launch an enterprise that he called Tata Computer Centre. After making these suggestions, Kanodia returned to MIT in January 1966.

The Tata Group decided to act on all three suggestions and recruited Kanodia to start the Tata Computer Centre. Kanodia convinced two of his Indian classmates from MIT to join

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[6] After building its first computer, TIFR decided to buy computers from the foreign private sector instead. See Vaidyeswaran Rajamaran (2015), "History of Computing in India: 1955-2010," *IEEE Annals of the History of Computing* 37(1): 24-35.

[7] See Rajamaran 2015. Because Indian programmers learned FORTRAN, subsequent mainstream computer languages including C were much easier to learn.

and together they started the company in 1967 by leasing two IBM computers. In 1968, this company was renamed Tata Consultancy Services (TCS).[8]

TCS would become one of the first indigenous, privately owned companies to operate in the computing space in India, but while other Indian business groups were avoiding the computer sector, foreign companies were also establishing themselves.[9] By the mid-1960s, IBM already had a thriving hardware computer business in the country and was consolidating its position as an industry leader. To get around restrictions on foreign production, IBM and a British company named International Computers Limited applied to the Indian government to produce computers in India. After striking a deal with the Indian government, IBM would import used computers, refurbish them in Mumbai, and then rent them to Indian customers for as much as $190,000 USD per year.[10] As the computers that they were providing were of lower quality than what was available in the United States, IBM was soon accused of profiteering by some government officials. IBM responded by arguing that in the US they merely sold computers whereas a customer in India would get computing services as well: IBM provided regular maintenance services as well as systems engineers who could analyze data processing and would even assist in programming. IBM recruited and trained Indians to fill these technical roles, generating what would become the first generation of Indian IT consultants.

As a foreign firm, IBM would have to continuously pay close attention to the government officials in charge of centralized planning for the emerging computing industry. As IBM's refurbished computers and domestic IT consultants spread across India, the central government was seeking to craft a comprehensive industrial policy for electronics. There were many factors to consider. Chief among these was whether India should produce computer hardware domestically or import the hardware and focus on software development. In 1963, the central government formed a committee with Homi Bhabha as its chairman to craft a government plan for electronics. A subcommittee led by R. Narasimhan was tasked with making a plan for computers; this subcommittee recommended to the government that large computers should be imported, but smaller computers should be manufactured locally. After

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[8] See Lalit Kanodia (2012), "The Software Journey of Indian and the Road Going Forward," *Indo-American Chamber of Commerce*. Available online: https://iaccindia.wordpress.com/2012/10/12/the-software-journey-of-india-and-the-road-going-forward/ (last accessed May 13, 2018). Kanodia suggests that government officials have found it difficult to control software exports, discussing how several Customs' Collectors have come to his office to understand how software is exported, presumably so that they could interfere in its operations, but were unable to do so.

[9] Another private company, Hinditron, was founded by Hemant Sonawala in 1966. Sonawala used to work for DEC in the United States and his company sold their equipment.

[10] Rajaraman 2015, 30.

taking into account the views of academics, military officials, leaders at government labs, and a small number of leaders in the private sector, this decision became government policy.[11]

Official planning reports take time as a variety of constituents have to be consulted, and the Bhabha Committee on Electronics would not complete its report until 1966. But Bhabha was killed in a plane crash before formally submitting the report, delaying the implementation of some recommendations. Apart from shaping a policy on computer imports, the Committee also called for the establishment of a new state-owned enterprise, the Electronics Corporation of India Limited (ECIL). A new Department of Electronics (DOE) would oversee ECIL, which would broadly be in charge of planning the development of the computer industry.[12]

As a result of Bhabha Committee's report, India's electronics policy largely followed the import substitution model that was taking place in many other Indian industries at the time. The DOE and the central government placed high tariffs on computers and computer parts and enacted cumbersome strictures on the release of foreign exchange for acquiring computers or software. But unlike typical import substitution models, the DOE also put into place policies that hampered private domestic development. Private domestic computer manufacturers faced foreign exchange and capital restrictions, caps on production quotas (to protect against any one player gaining too much market share), government bans on producing the best computers (for instance, private manufacturers were banned from producing 32 bit machines, which could only be manufactured by ECIL until 1984), and private manufacturers were unfavorably considered for government contracts.

This strong preference for state-owned enterprises over the private sector was unique from other sectors where privately owned business groups like Tata, Birla, and Godrej were oftentimes the beneficiaries of such restrictive policies. Such business groups would often be given individual exceptions, enabling them to monopolize certain markets. In the computing industry, on the other hand, the protectionist policies that the government imposed were mostly designed to aid state-owned electronics companies.[13]

There were at least two reasons why business groups did not hold the same sway in the computing industry as they enjoyed in the rest of the economy. First, most business groups had not recognized the importance of computing by the 1970s. The only major business group with

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[11] Rajamaran 2015.

[12] Richard Heeks, *India's Software Industry: State Policy, Liberalisation, and Industrial Development*, (New Delhi: Sage Publications, 1996).

[13] See Tarun Khanna and Krishna G. Palepu (2005), "The Evolution of Concentrated Ownership in India: Broad Patterns and a History of the Indian Software Industry," in *A History of Corporate Governance around the World: Family Business Groups to Professional Managers*, Randall Morck (ed.), Chicago: University of Chicago Press.

an electronics company in the 1960s and 1970s was Tata. In the early years of TCS, the company could sustain itself by focusing on computerizing Tata's other companies and was not interested in manufacturing hardware. It relied on IBM machines and eventually partnered with Burroughs, a British computer-manufacturing firm. As a result, TCS was not focused on computer manufacturing so much as it was focused on services. Second and related, the government's main policymakers came from a close and well-connected academic and government network, not from industry. They did not privilege domestic business groups because they did not come from domestic business groups. Instead, they understood and believed in government research agencies like TIFR, academic institutions like the Indian Institutes of Technology (IITs), and state-owned enterprises like ECIL.

Unfortunately for India's central planners, coordinating production and promotion efforts across so many different levels of government and across so many different ministries is often difficult. Even though ECIL was intended to be the flagship state-owned enterprise in the computing space, several other central government ministries and departments also sought to create computer companies.[14] By the mid-1980s there were more than a dozen different central government enterprises in this space. Further complicating matters, a number of state governments also set up their own SOEs. For instance, Kerala formed Keltron in 1973—which was supposed to develop semiconductors—and the state of Uttar Pradesh created a data processing company known as Uptron Powertronics in 1977. State-level initiatives like these drew talented workers and government resources away from companies like ECIL and CMC, while also bringing more competition to what was supposed to be a protected industry.

In typical developmental states like South Korea or Taiwan, a regulatory policy that was set by a high-level committee would be followed closely. Coordination between governmental agencies was virtually assured, as there was usually a clear hierarchy of power. As other scholars have noted about state planning in India, however, disparate groups with their own power bases have frequently complicated regulatory policy in India.[15] State-led development of the electronics sector was no different. The plans for supporting state-led computer manufacturing would fall prey to the same problems that afflicted much of the rest of the "license raj." At the same time as the Bhabha Committee was enacting its report, another government committee initially chaired by R. Venkataraman and then by V.M. Dandekar warned that automation brought on by computers would threaten employment and the central

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14 Heeks 1996.

15 Kohli 2004.

government. In 1972, this committee introduced strict controls on public or private computer adoption, including a policy requiring labor to approve the introduction of computers in any organization. Such restrictions made the adoption of computers much more difficult, which further reduced the domestic market for computing. It is unlikely that such restrictions would have been implemented in a state with a more coordinated government.

The decisions of the Dandekar Committee reveal how the nascent software industry was unable to check other powerful interests. A simple lack of coordination among government actors clearly affected the infant computing sector. By the early 1970s, computer technology outside of India was progressing rapidly. The Indian central planning approach, with its cumbersome procedures and internal political divisions, was already causing a constant stream of problems. For instance, computer prices outside of India were dramatically reducing with the development of large-scale integrated circuits, which are enabled by semiconductors. Government and industry leaders decided that a domestic semiconductor industry would first have to be developed before a hardware computing industry could form. They immediately announced restrictions on the import of semiconductors or integrated circuits. Building an industry would take time, however. The DOE formed a committee to create a semiconductor industry in 1971 and a report was issued two years later, in 1973. Progress on implementing the semiconductor policy was slow, and ground to a halt when Indira Gandhi suspended democracy and declared Emergency for 19 months, beginning in 1975. As a result, the DOE made no serious step toward fostering a semiconductor industry until 1978.[16] With government protections in place to create a semiconductor industry—but with no movement toward creating such an industry—private domestic manufacturers could not get integrated circuits. ECIL was given an exception and could use foreign integrated circuits, but it never scaled its production volume. As a result, from 1971 to 1978 ECIL sold 98 computers, with all but four machines being sold to government departments and universities who were required to purchase ECIL machines. Today, India is an international leader in semiconductor research and design, but semiconductor manufacturing is dominated by companies operating in East Asia.

Apart from its own internal failings, international headwinds also hampered the formation of the Indian computing industry in the 1970s. In 1971, India and Pakistan went to war. For a variety of geostrategic reasons that are beyond the scope of this chapter, the United

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[16] C.R. Subramanian, *India and the Computer: A Study of Planned Development* (New York: Oxford University Press, 1992).

States aligned with Pakistan instead of India. India was already limiting computer imports, but the Nixon administration placed embargoes on electronics and computer imports from the US. Also, the cooperative relationship that India had enjoyed with American technology experts was dramatically affected. For instance, the Kanpur Indo-American Programme that brought American technology experts to IIT-Kanpur was supposed to be renewed in early 1972, but was instead canceled. India conducted its first nuclear tests in 1974, leading to further embargoes on high-end computers and software.[17]

India also faced a huge currency problem during the 1970s owing to a poorly managed domestic economy, combined with a spike in global oil prices. Indira Gandhi nationalized the country's banks in 1969, which restricted the flow of domestic capital; at the beginning of 1974, the Foreign Exchange Regulation Act also came into effect, basically enabling the government to acquire all foreign exchange in the country (including foreign exchange owned by residents) and requiring the Reserve Bank of India to sign off on all transactions involving foreign exchange. Acquiring computers or computer parts from abroad became almost impossible, although companies did try. Patni Computers, for instance, had partnered with an American firm called Data General to sell that company's minicomputers in India. To get around the foreign exchange restrictions, in the late 1970s Patni hired twelve programmers to add value by writing software on top of Data General's systems. The company's focus shifted from the onerous business of selling minicomputers to software development services and in 1980, eight of these programmers split off from Patni to form Infosys, one of India's biggest software consulting companies (Yost 2017).

Also according to the 1974 Act, all international companies that were not considered "essential" by the central government would have to dilute their equity to 40% and take an Indian partner. This condition would have a huge impact on IBM.[18] IBM thought that it would be able to secure "essential" status as its installations were spread across several important public and private sector locations. IBM also conveyed to the central government that it would set up exporting operations and would use 26% of its in-country profits to develop a research and development center in India (Subramanian 1992). IBM began what it thought would be quick negotiations with the central government in 1974; of course, Indira Gandhi declared Emergency from 1975-77 and subsequently lost the 1977 election. An opposition government

[17] The United Nations Development Programme continued to fund technology initiatives with the central government. This money was used to create the National Centre for Software Development and Computing Techniques in 1972 and the National Informatics Centre in 1975, for instance.
[18] Khanna and Palepu, 2005.

led by Morarji Desai came into power, derailing IBM's negotiations with the government. By 1978, it became clear to IBM that they would have to accede to dilution or leave the Indian market. Figuring that problems like these would continue, IBM decided to leave the Indian market.

IBM sold its in-country computers to Indian customers at cut-rate prices. Just as important, the company left behind its maintenance workers and programming consultants as well. Many of IBM's ex-computer maintenance workers went to work for a government company called the Computer Maintenance Corporation (CMC), but ex-IBMers also started their own software companies or went to work for other domestic computer companies.

III. 1984 to the Present: The Promotion Era

The Indian government had sought to create a centrally planned electronics industry, one where state-owned enterprises would drive growth for the entire industry. To help these SOEs, the government stifled the domestic private sector and all but eliminated any foreign competition. These policies were ultimately disastrous as the government was unable to effectively coordinate its production and protection policies. Yet poor policies can only be changed when there is political appetite for such reforms. For the electronics sector as a whole—and the software sector in particular—reforms began in 1984, seven years before the rest of the economy would be liberalized. In this section, I present the political circumstances that led to this transition.

Indira Gandhi and the Congress Party came back to power in 1980, this time with her son, Rajiv, prepared to play a prominent role in government, and it turns out in the growth of the computer industry. In 1982, Rajiv Gandhi oversaw the organization of the Asian Games in Delhi, and he reached out to various technology advisors for help, including several of the leaders of the DOE. The Games—and the computer programs that the organizers utilized—proved to be highly successful, and by the time Rajiv ascended to the prime ministership in October of 1984, he was simultaneously aware of the enormous potential of computers as well as the government-generated challenges that the industry was facing.

Rajiv came to power committed to ending centralized economic planning. Unlike many other Indian politicians of the time, Rajiv had traveled extensively through the west. He studied in Great Britain and had an Italian wife. In 1970, he announced to his family that he would make a career as a commercial pilot for Indian Airlines. For the next ten years, Rajiv would explore the world. This international exposure shaped his economic orientation.

Just as important, when he came to power, Rajiv was only beholden to his family's legacy. Rajiv was never supposed to enter politics. Instead, his younger brother Sanjay was being groomed to inherit the family's political legacy. When Sanjay died in an aircraft accident in 1980, however, Rajiv was thrust into the family business. In 1981, he was given a reliable Congress Party seat and three short years later he found himself the prime minister of India.

Rajiv's quick rise to power was the result of being born to Indira Gandhi, not from shrewd political alignments or even a charismatic ability to move crowds. Riding a wave of sympathy following the assassination of his mother, Rajiv's Congress Party won 404 of the 543 seats in Parliament, more than Indira Gandhi or Jawaharlal Nehru had ever managed to win. Kohli eloquently describes the political environment following Rajiv's ascendancy:

> "The considerable sense of power, and the hurry in which it had been acquired, must have created a sense among the new rulers that they had hijacked the state. The state suddenly stood quite autonomously, free of societal constraints, ready to be used as a tool for imposing economic rationality on society. Situations of state autonomy like this always encourage the powerful to pursue their ideological whims."[19]

Less than a month after coming to power, Rajiv's government announced a new Computer Policy that would end central planning for the industry. Instead of seeking to protect SOEs, the government would now seek to promote private manufacturers and software developers. Private hardware manufacturers would now be able to make 32 bit machines and would no longer be subject to manufacturing limits. Crucially, the new government policy also allowed the importation of assembled boards with microprocessors and boards with interface electronics.

This decision essentially got the Indian state out of "produce and protect" mode and into private sector promotion. But the government would now be promoting two industries. In addition to computer hardware, the 1984 Computer Policy sought to support private companies that were in allied fields, specifically assembly, system integration, and 'software development and services,' the latter officially becoming a recognized industry. This recognition allowed private companies to get loans from banks and claim duty exemptions; it also exempted software from excise duties. Engineers who went abroad to develop and maintain software for

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[19] Atul Kohli (1999), "Politics of Economic Liberalization in India, *World Development* 17(3) 305-328. See pg. 312.

clients, along with the profits they earned, were considered "software exports" and were exempted from duties as well.

Rajiv installed new leaders at the DOE who were much more friendly to the private sector, including foreign firms. From the late 1970s, Indian expats were serving in executive ranks at various US multinational firms and were debating whether to locate computer operations in India. Many of these expats had come from the IITs and knew about the talented workforce in the country, but they also knew the inhospitable political environment that foreign companies faced, especially after IBM's hasty exit from the country in 1978. These political considerations kept American foreign firms out. With the new regime, American firms sought to test Rajiv's appetite for openness. In 1985, Citibank approached the Indian government with a proposal to set up a private satellite link between its US operations and its office in the Santa Cruz Export Processing Zone in Mumbai. The satellite link would be used to help Indian software engineers work remotely with their American counterparts, essentially enabling software outsourcing. The government agreed and Citibank's software sales began to skyrocket. Shortly afterward, Texas Instruments asked for permission to establish a satellite link between its headquarters in Dallas and a new offshore software development center in Bangalore; again the government agreed. N. Seshagiri, one of the original Bhabha Committee members who had ultimately become Rajiv's main advisor on electronics would subsequently boast that: "[w]e broke 26 separate rules to accommodate TI's [Texas Instruments'] Bangalore subsidiary and are willing to break more!"[20] Dozens of other multinationals would soon strike similar arrangements.

In 1986, the Department of Electronics announced the "Computer Software Export, Software Development and Training Policy." Export-oriented software companies could now import computers duty free provided that the computer could generate 250% of the cost of the computer within four years, while regulations on domestic-oriented use of imported hardware were also lightened. Software imports went from a system of quotas to tariff protection, enabling anyone to import if they paid a 60 percent import duty. Such a move maintained some protections on domestic markets, but was probably designed to simultaneously enable software exporters to buy and build on foreign software packages. Foreign exchange was made available via annual rather than individual permitting, reducing the amount of licensing processing that an export-oriented software company would have to undergo. Just as important, the central government allowed software developed in India to be exported using satellite and cable

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[20] *SIPA News* (1988) p. 2, quoted in Evans (1989) p. 7.

communication systems. Foreign firms had their own dedicated satellite links and the government decided to build a system to provide domestic firms with satellite access as well. The government also gave software exporters access to "Indonet," a network of IBM mainframes across the country that the government would maintain and expand. Almost overnight, the government had switched from strangling private software firms to embracing them.[21]

At least three important factors made these reforms easier to implement, or at least minimized the forces of resistance that derailed reforms in other industries. First and foremost, private software companies sought to remove protections across the board. No individual company or business group wanted protection; indeed, no major business group had a company in computer hardware and only Tata had a stake in the software industry, in TCS and Tata Unisys Ltd. But Tata's software companies had never relied from government concessions to the extent that its parent business group had benefited in other industries.[22]

By 1984, leaders in the software industry also recognized that the domestic demand for software services was miniscule compared to the enormous potential of foreign markets. Software providers in the domestic market lacked serious piracy or IP protections. Anti-piracy software laws did not exist until 1984 and were likely to go unenforced. At the same time, software firms had experimented with exporting services. When government restrictions were minimized, Indian firms knew that they could offer cheaper services compared to their competitors. Keeping foreign entrants out of the Indian market was not a huge priority for Tata or other software players: the domestic market was simply not that appealing compared to foreign markets. The private sector wanted the government to reduce protective regulations. Rather than substituting an SOE national champion for one from the private sector, they wanted the government to pursue policies that would benefit the industry and the ecosystem as a whole.

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[21] Perhaps the only area where the central government showed any continuity with the past was its commitment to educating a growing class of software developers. In 1986, new computer science programs were forming all over the country and the government was training teachers and professors who could instruct in software development. The central government was also continuing to fund academic research, usually in partnership with the UNDP. To provide just a few examples, between 1984 and 1986, they funded programs in computer aided design, computer assisted management programming, advanced computing, knowledge-based computer system development, and several research initiatives were taking place in parallel computing and computer networking, which would position Indian software engineers for the meteoric rise of the Internet and the World Wide Web.

[22] For the most part, DOE practices sought to privilege government enterprises at the expense of all private actors, large and small. One such legacy example comes in 1989, after the initial liberalization reforms. TCS and a state-owned enterprise named CMC Limited were both competing for a bid to computerize the Bombay Stock Exchange. TCS's bid was weakened when the DOE refused to approve the import of the computer hardware that TCS had proposed using and CMC won the bid. This action was met with some surprise by Indian industry, but was standard practice before 1984. Indeed, perhaps the only true "loser" from these reforms were state-owned companies like CMC and ECIL who had previously benefited the most from market protections.

For the government's part, there was sincere high-level political commitment to reforming the computing sector. A second factor that led to these reforms was a small set of technocrats within the government who believed that things needed to change. The same DOE that had previously taken nearly nine years to come up with a plan for the semiconductor industry was now run by leaders who would present a new software policy three weeks after Rajiv Gandhi came to power. In Rajiv, these reformers found a politician who was as eager to reform the sector as they were.

Many politicians have come to power promising reform only to be stymied by larger political forces. However in his early years, Rajiv was able to pursue a series of reforms because of his strong popularity. Following his mother's assassination, Rajiv won a huge majority in the 1984 national elections and did not have to make many political compromises to rise to power. This allowed him to pursue an ideological agenda that was broadly supportive of economic reform.

Rajiv's eagerness for reform was widely known, but ideological whims had to give way to political exigencies a few short years into his rule. During his tenure as prime minister, Rajiv tried to end central planning in other industries—and even spoke of dismantling India's "license raj" altogether—but he was otherwise unable to translate desires into policy. The old guard within his own Congress Party would be skeptical and Rajiv would soon find out that the trade unions—an important Congress ally—would also take a strong anti-computerization stance.[23] In the first years of his administration, Rajiv had the popular support and the political power to check these challengers.[24] But following its commanding victory in 1984, Rajiv's Congress Party subsequently lost a series of state elections, including the Haryana elections in May 1987. Additionally, several corruption scandals weakened Rajiv's political standing, including the Bofors' Scandal that implicated Rajiv and many members of his inner circle for accepting kickbacks on military equipment. At the time, Haryana was a Congress stronghold and this loss returned India to a "'muddle through' model of economic policymaking" (Kohli 1989: 311). Following this loss, Rajiv and his advisors had to adopt a more populist outlook that was tolerant of central planning. Rajiv increasingly had to rely on political support of his

[23] This decision was made by the Rangarajan Committee, which also recommended that banks adopt UNIX as the standard operating system. Many software companies developed their UNIX skills because of this recommendation, which was fortuitous as the UNIX market would become very large. By 1994 UNIX work was estimated to make up between 15 to 20 percent of India's software exports.

[24] The computer industry also received broad public support as well. The galvanizing moment came in 1986 when the Indian Railways computerized their ticket reservation systems. The new program was tremendously popular with voters. As a result, popular political support for computers—and for the computer industry—was high.

party, including the old guard in the Congress Party who mostly supported central planning. Pragmatic political considerations would have to trump ideology.

By 1987, Rajiv's focus was on winning elections, but in 1989, the Congress Party lost its majority and was unable to form a government. For just the second time in India's history, the Congress Party was relegated to the Opposition. No one political party was able to maintain control despite several attempts, and national elections were called in 1991.

Software industry policymaking from 1987 to 1991 has been likened to "the headless chicken" (Heeks, 1996, 331). Because of the larger political circumstances, Rajiv and other politicians would not give the industry much attention. Also for political reasons, the technocrats who oversaw the DOE were removed and replaced with generalist bureaucrats who had limited understanding of the software space. As a result, policy directives were formed by the strongest coalition of interests with no larger vision or planned direction. Software companies quickly figured out how to successfully navigate this new landscape. In addition to direct lobbying, a coalition of large software firms also created an industry lobby in 1988 called the National Association of Software and Services Companies (NASSCOM). An industry elite would soon start to emerge in the private sector.

After decades of government policies that had inhibited the industry's growth, the software industry would now use government to promote its interests. The industry started by turning the DOE into an almost unwitting handmaiden. Following private sector cues, the DOE set up foreign promotional boards and organized marketing conferences in different countries to promote the Indian companies; they developed certain insurance schemes to protect computer companies; they also ensured that India's domestic banks as well as the Export Import Bank gave preferential treatment to computer firms. Another big win for the software lobbying industry came in late 1990. At a time when the Indian government was facing a balance of payments crisis that made it desperate for capital and foreign exchange, the central government somehow decided that the software industry would not have to pay taxes on export profits.

In 1991, Rajiv was assassinated while campaigning in the national elections. The Congress Party was able to form a minority government with the aid of several leftist parties. P.V. Narasimha Rao was able to navigate the Congress Party infighting to become the prime minister. Rao was a polymath who had personally been influenced by the 1984 Computer Policy. As Rajiv's Home Minister, he had been present on the day that Rajiv had initially

spoken about liberalizing the computer industry in 1984.[25] Wanting to learn more, Rao immediately acquired a personal computer that he would learn to love. Over the next several years not only kept a diary on his computer, but also learned two computer languages.

Despite the fact that both Rajiv and Rao came to power following assassinations, the political circumstances that Rao encountered on his ascension were far different than the situation that had greeted Rajiv. Rao was in charge of a party that was divided, with many others in Congress having sought the top position following Rajiv's death. Rao also had to rely on a coalitional government to stay in power.

Apart from the political realities, India was also facing a looming economic crisis. When Rao came to power in 1991, India had almost completely exhausted its foreign exchange and was in trouble of defaulting. In response to this crisis, most economists encouraged liberalization of the economy. Rao listened to his experts and in the 1991 budget speech by Rao's Minister of Finance, Manmohan Singh, the Indian government announced it was going to end central planning. Buried within this speech, Singh promised to indefinitely extend the tax elimination for software exports, which would hold for much of the rest of the 1990s.

The period following the 1991 liberalization announcement was kind to the Indian software industry, but liberalization should not be mistaken for *laissez faire*. Far from leaving the industry to its own devices, the central government sought to aid the software industry's growth such that by the 1990s the DOE started to resemble industry "handmaiden" government agencies in other developmental states: South Korea's Ministry of Communications, which sought to develop the country's indigenous computer industry, or for more typical industrial handmaidens like the Industrial Development Bureau in Taiwan or Japan's Ministry of International Trade and Industry. In addition to overturning regulations and granting favorable tax concessions, the DOE and allied sectors within the government also made several proactive moves for the private sector (Evans 1992). By this point, the DOE was regularly meeting with software industry lobbyists, sponsoring industry marketing events in India and abroad, recruiting domestic and foreign investors, providing discounted physical infrastructural services, especially in telecommunications, and offering other important benefits to the software sector. And instead of competing with the private sector like they previously had done, state-owned enterprises like ECIL and CMC either focused on supplying government software services or on providing government infrastructure that could help the private players.

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[25] Vinay Sitapati, *Half-Lion: How P.V. Narasimha Rao Transformed India* (Delhi: Penguin Press, 2017).

In contrast to handmaiden agencies in other countries, however, the DOE and the central government did not seek to pick winners. By the early 1990s, companies like TCS, Infosys, HCL, and WIPRO were an emerging class of heavyweights that had special relationships with the DOE, but some of India's biggest contemporary software firms were not formed until the late 1990s. These include companies like MphasIS, Mindtree, and Larsen and Toubro's Infotech. Yet despite the emergence of industry leaders, the Indian software industry has remained relatively fragmented and competitive. As a result, the industry has historically been supportive of startups as well as small and medium sized firms. With some exceptions, the leading companies have sought promotional benefits that are good for the industry as a whole, not protectionist measures that would give them control over a specific market.

Apart from central government policies, various state and local governments have also pursued promotional policies designed to support the software industry. Perhaps the most successful example is the Electronic City in Bangalore. In 1976, a state-level bureaucrat named R.K. Baliga incorporated the Karnataka State Electronics Development Corporation (KEONICS). KEONICS would ultimately build an industrial park that provided an array of free and subsidized infrastructural benefits to public and private electronics firms operating within its campus. The state government of Karnataka constructed office buildings, provided discounted and reliable 24 hour electricity, set up clean water systems, and by the late 1980s provided firms with access to Indonet and the government-maintained satellite network. Officials who oversaw Electronic City also offered a single government window to make all requests. A foreign software company could register itself with the state government in an afternoon; otherwise properly registering a business usually takes several months. Local government officials—and even some customs officials—would also be kept at bay. This state-level promotion is perhaps the main reason why five of the ten largest software export firms are based in Bangalore and why so many international firms have been drawn to the city. 26

With favorable central and state government policies, growth followed for the Indian software industry. The spread of computing and the Internet during the 1990s and 2000s aided the global demand for new software. There was also a strong demand to "fix" existing software. In 1995, the European Union decided to develop a common currency, requiring all banks to change their denomination systems in their software. This problem required low-level computer fixes and Indian software firms came to the rescue. Software officials in many parts of the world were also warning of a Y2k problem: essentially most programs had been coded

26 Further aiding matters, Karnataka is also known to have a closely connected political and economic elite class.

in a DD/MM/YY format; with 2000 fast approaching, officials warned that software systems could potentially crash if this formatting was not fixed. Indian software firms again came to the rescue. These kinds of stories have continued until today, with the software industry well positioned for future growth.

IV. Why Did Software Succeed?

The success of the Indian software industry is due in no small part to the promotional policies that the government adopted, however this reality often goes overlooked, or is altogether undermined by those who suggest that the industry prospered because of government non-involvement. For instance, Khanna and Palepu (2005) suggest that the software industry succeeded not because of good government involvement, but instead because of minimal government involvement. They point out that because software involves technology that officials did not fully understand, it was able to slip under "the discerning bureaucrat's otherwise omnipresent proverbial radar screen." Also, they claim that because the software industry is not capital intensive nor does it involve tangible assets, government entanglement is less likely.

But we should be skeptical that the software industry has thrived simply because of ignorant government officials, low capital requirements, and a business that sells intangible assets. After all, infant software industries in other developing countries share these same features, yet many have been unable to achieve the same success that we observe in India.

It is perhaps more accurate to instead say that the industry succeeded because ideologically committed technocratic reformers came in who ended "produce and protect" policies and sought to promote the private sector. Even though these reformers were soon removed in favor of generalist bureaucrats, these bureaucrats also sought to do what was best for the private sector. They turned to the industry's leaders for instruction.[27] If a singular player dominated the software industry—or if the foreign markets were not so much more attractive than the domestic market—then these officials might have implemented a "national champion" strategy to protect a private sector leader. Indeed, domestic business groups in other areas of the economy were able to secure such concessions. But the software industry at the time was made up of multiple private firms who mostly had their sights set on foreign markets. Software industry leaders did not seek protectionist policies, but instead sought policies that would promote the entire industry. As a result, the government continued to make substantial outlays

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[27] Evans 1992.

for technical education, reduced barriers to registering new startups, provided subsidized and reliable physical and communications infrastructure to all companies, promoted the industry to potential customers and investors at home and abroad, and so forth. India's software industry is a success story in large part because of the promotional strategies that the government has been effectively able to execute. The political origins and the economic effects of these policies deserve greater attention.

Table 1: Gross Indian Software Export Earnings

Year	Total Exports (US$m)	Compounded Annual Growth Rate (percent)
1980	4	--
1985	27.7	47.26
1989-90	105.4	30.64
1994-95	480.9	35.47
1999-2000	4,000	52.76
2004-05	17,700	34.64
2009-10	50,000	23.08
2014-15	98,000	14.41
2017-18	125,000 (projected)	8.45 (projected)

Source: pre-1995: Heeks 1996, which he compiled from Interviews and Sharma (1995). Post-1995 comes from DOE annual reports.

Figure 1: Value Added to the Indian Economy, 1960-2012