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JULY 1995

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WORKING PAPER #9504-15

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September, 1994
Revised July, 1995

Research on this paper was undertaken while I was visiting the Indira Gandhi Institute of Development Research, Bombay, India, and I am grateful for the Institute's support of this research. I am also grateful to seminar participants at the Institute and two anonymous referees for their helpful comments, and to R. D. Banker, P. K. Chhibber, N. J. Jhaveri, D. Mazumdar, K. Parikh and K. Sen for discussions. The usual caveat applies.

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ABSTRACT

The study examines the impact that different industrial policy regimes have had on the economic performance of Indian industry between the period 1950-1951 and 1988-1989. Economic performance is assessed as the ability to achieve dynamic efficiencies, and is measured using a linear-programming based technique called data envelopment analysis. From the late 1950s onwards, to the early 1980s, the industrial policy regimes in India are characterized as one of increasingly stringent regulation and detailed administrative control. The results show that in the decade of the 1950s, industrial efficiency was relatively high; however, in the 1960s and 1970s there was severe regression in efficiency patterns as a result of the policy regimes in place. These patterns began reversing themselves only in the 1980s as the policy regimes became progressive; however, efficiency in the 1980s was no better than it had been in the 1950s. In addition, there was misutilization of physical capital relative to working capital, and of managerial human resources relative to production labor. The policy regimes in India are demonstrated, at best, to have contributed to no progress in the development of industrial capabilities over a forty-year period, and during the two critical decades of the 1960s and the 1970s, when other economies in Asia started developing their now superior industrial capabilities, ninduced severe retrogression in these capabilities for India.

1. INTRODUCTION

In 1994 India witnessed the 50th anniversary of modern industrial planning. In 1944 the "Bombay" plan, urging significant government intervention to cope with the task of implementing rapid large-scale industrialization, was formulated. Subsequently, in the next half-century several state-led measures were undertaken to spur industrial progress. Yet, Indian industrial performance has been lack-lustre.[1] However, as Amsden [1989] and Wade [1990] demonstrate, in two of the most successful newly-industrialized countries, namely South Korea and Taiwan, the State has been, if anything, strongly interventionist, with outcomes which are well-known.[2]

With respect to how policy regimes impact on industrial performance, there has also been a significant change in attitudes. As Nayyar [1994, 9] remarks "We appear to have moved from a widespread belief, prevalent in the 1950s that the State could do nothing wrong to a gathering conviction, fashionable in the 1990s, that the State can do nothing right." Yet, in respect of South Korea and Taiwan that is not the case. Patently, the State can do things right. It can, therefore, be argued that how government policies impact on industrial progress depends critically on the nature of the policies chosen, and the way they have been implemented.[3]

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[1] Economic growth is the result of the interaction of two key factors: investment in capabilities, which is a function of savings, and the productivity with which these capabilities are utilized. In searching for explanations of India's lack-lustre growth, a low savings rate is not responsible, since that grew from 10 percent to almost 25 percent between 1950 and 1984. Therefore, one possible reason can be the productivity of the investments which were made.

[2] See Pack [1992] for a detailed review of how total factor productivity growth of Indian industry compares with U.S.A., Japan, Korea and other developing countries. In most of the industries listed in the review India has been unable to attain positive growth rates in total factor productivity in the 1960s and 1970s, especially when compared to Japan and Korea.

[3] While writers (Ahluwalia [1985], [1991]; Bardhan [1984]; Bhagwati [1993]; Datta-Chaudhuri [1990]; Marathe [1989]; Weiner [1986]) have attributed India's industrial performance trends to the policy regimes in place, systematic empirical evidence of their impact is sketchy. A decline in research on industrial economics in India may have arisen partly as a result of a

This paper empirically evaluates the impact that different policy regimes have had on one aspect of Indian industrial performance, namely the efficiency of the industrial sector.[4] Comparative evidence about the efficiency of the industrial sector of India is presented for the period 1950-51 to 1988-89,[5] and the paper unfolds as follows. In section 2 the theoretical

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shift towards research on agricultural economics. Prior to the mid-1960s, the important agricultural sector had been ignored in economic research. However, the take-off of the "green revolution" stimulated research on the agriculture sector, which thereby replaced the industrial sector as a focus of interest. Nevertheless, empirical works by Ahluwalia [1985], [1991] and Goldar [1986] do exist. Ahluwalia examines productivity patterns in Indian industry during the period between 1959-1960 and 1984-1985, while Goldar examines productivity in the period 1951-1952 to 1979-1980. In this study data coverage is for the most recent four decades in the post-independence industrial history of India. The results that emerge use the most contemporary data feasible.

[4] Inefficiency in resource usage is well-recognized as leading to substantial welfare losses (Harberger [1959]), and for a state like India, with a multiplicity of socio-economic demands on its capital, how such limited resources are utilized assumes fundamental importance. While substantial investments can be a pre-condition for economic transformation, it is only the productivity of such investments which yields further re-investible resources. These generate surpluses, which then motivate entrepreneurs toward further industrial activity. In a dynamic context, a static investment approach, where focus is on output rather than on the efficiency in generating such output, also ignores a basic concept: that capital has an opportunity cost; if it does not yield a minimum return as a result of good utilization, it is better used elsewhere. That efficiency in resource utilization has to be given a center-stage role in policy analysis cannot be denied, since dynamic efficiencies are critical in ensuring the industrial performance of a nation. Within the mainstream literature in India, there is now belated recognition that efficiency has a major role to play in ensuring industrial success. Nayyar [1994, 3] writes that "Success at industrialization is not only about resource allocation. It is as much, if not more, about resource utilization and resource creation. The mode of utilization of resources is a critical determinant of economic efficiency. The process of creation of resources is a crucial determinant of economic growth."

[5] Industrial policy was formally codified as law by the Industries (Development and Regulation) Act of 1951 (IDR Act [1951]). In 1951 systematic planning was launched in India, with the inauguration of the first five-year plan, and setting up of the Planning Commission as a superior policy-making body. 1950-51 is an apposite year with which to commence analysis. The analysis of the impact of different policy regimes on Indian industrial efficiency is conducted up to 1988-1989, which is the last year for which systematic data have been collected and released to the public by India's Central Statistical Organization. 1988-1989 is also a year in

framework and institutional issues connected with the Indian industrial scenario are discussed. Section 3 describes the empirical procedures, and the paper goes into the description of data envelopment analysis in some detail, while section 4 contains a discussion of the results that emerge, and section 5 sums up the paper.

2. THEORY AND INSTITUTIONAL ISSUES

The framework used is that of x-efficiency (Leibenstein, [1966]), based on the hypothesis that neither individuals, nor firms, or industries are as productive as they can be. The difference between maximum possible utilization and the actual utilization of given resources is the degree of x-inefficiency. As a result of either a lack of, or the wrong types of, incentives emanating from their environments,[6] firms do not minimize costs or maximize possible outputs. Hence, x-inefficiencies are observed.[7]

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which the impact of various liberalization moves, commenced by Mr. Rajiv Gandhi's government (1984-89), would have made themselves felt. In subsequent years, from the latter part of 1989 to mid-1991, the political stability in existence unraveled. It was not until 1991 that the present government commenced mass-scale "reform by storm" that is currently in progress. However, the unavailability of data does not permit the empirical study to include the impact of such fundamental liberalization.

[6] Where pressures are low, as in monopoly situations, there is no need for owners and managers to pressurize employees to be efficient. Even without monopolies in existence, autarkic situations can also create x-inefficiencies. Domestic firms may not grow up to be competent, because implicit response mechanisms are not built in to tackle challenges that foreign ideas and competition may generate. The impediments to flow of ideas and information caused by policy barriers then create a pool of entrepreneurs whose firms' performance recedes, because they do not have modern technology or knowledge, or face any other incentives to produce at lowest cost, or seek rents.

[7] Guha [1990] has noted that the balance of opinion on the relative success of market mechanisms versus control over economic activities has rested on the ability of one system to mobilize incentives. Whether Indian policy regimes have marshalled the right sorts of incentives which influence economic agents to maximize firm-level x-efficiencies is an empirical issue, but

The way policy is administered can also lead to x-inefficiencies. Even when there is significant government control over industrial progress x-inefficiencies may not result, as South Korean productivity growth shows. Provided entrepreneurs are given targets, reasonable time to meet them in and then are monitored, they can decide what their operational objectives ought to be and utilize their organizational capabilities in meeting targets. On the other hand, policy administration can be ad-hoc and dilatory. Lack of monitoring and follow-through, or political factors, can be mediating influences in how policy is actually administered. At the level of the firm, long-range views of strategic decisions disappear; at an individual level, motivations to be innovative are also absent because of uncertainties that policy regimes may foster (Leibenstein, [1969]), and is replaced by rent-seeking behavior (Krueger, [1974]).[8]

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one the evaluation of which can be grounded in the assumptions of the theory. The issue of whether free-markets, or command and control systems, generate the right incentives so as to reduce x-inefficiencies becomes an empirical issue which depends on the nature of policies in place, and the way they are implemented. Studies, for example, by Carlsson [1972] for Sweden, Gillis [1982] for Bolivia and Indonesia, and Page [1980] for Ghana, have shown how competitive environments do lead to observed x-efficiencies because micro-level capabilities are impacted on. There is a limited amount of evidence on the Indian experience. Jacobsson [1991] and Mazumdar [1991] both demonstrate how government policies skewed businesses into undertaking actions inconsistent with ensuring growth of firms and improvements in their operational performance. The policies were such that firms had incentives to either adopt inappropriate technologies, or build plants of the wrong economic size, thus leading to low performance, in the engineering and textile industries respectively. These observations were valid even after the various liberalization moves commenced by Mr. Rajiv Gandhi's government were put into effect.

[8] Pieces by Balassa [1971], Little, Scitovsky and Scott [1970], Krueger [1978] and Posner [1975] contain detailed exposition of similar and allied ideas. With regard to the Indian experience, Bhagwati [1993, 60] writes, "I should also add that the deadly combination of industrial licensing and controls at home with import and exchange controls externally, effectively cut off the rigorous of competition and made the creation of a *rentier*, as against an entrepreneurial, economy more likely. X-inefficiency was certainly to follow, with only the exceptional escaping from the wrong set of incentives." In a sense, this captures the nature of malaise likely to have been inflicted by the policy regimes, and makes the estimation and

Following Jalan [1991], Marathe [1989] and Rudolph and Rudolph [1987], the overall period 1950 to 1988 can be broken up into four regimes. The first regime is from 1950-1951 to 1960-1961. Excluding 1950-1951 which is a year before formal planning commenced in India, the years 1951-1952 to 1960-1961 include the first and second five-year plan years. The second regime runs from 1961-1962 to 1973-1974. This includes the third five-year plan years (1961-1962 to 1965-66), "plan holiday" years when planning was in disarray (1966-1967, 1967-1968, 1968-69), and the fourth five-year plan years (1969-70 to 1973-1974).

The third regime includes the fifth five-year plan years (1974-1975 to 1979-1980). It is a period composed of significant political landscape changes. In 1974 severe political unrest commenced, leading to the emergency of 1975-1977, the removal of Mrs. Gandhi from power by the electorate, and two short-lived prime ministerial regimes (Mr. Morarji Desai: [1977-1979]; Mr. Charan Singh: [1979-1980]). There is broad policy continuity in regimes 2 and 3, between 1961-1962 and 1979-1980. However, the political economy of regimes 2 and 3 are substantially different so as to warrant disaggregation of the overall period into two sub-periods: 1961-1962 to 1973-1974, and 1974-1975 to 1979-1980.

The fourth regime commences in 1980-1981. It is marked by Mrs. Gandhi's return to power, when she commenced "reforms by stealth" as Bhagwati [1993] puts it. It includes a year of no planning [1980-1981], the sixth five-year plan years [1981-1982 to 1985-1986], and three years of the seventh five-year plan [1986-1987 to 1988-89]. In a political sense, the fourth

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evaluation of x-inefficiencies in Indian industry particularly apposite.

regime includes the regimes of Mrs. Gandhi, as well as that of Mr. Rajiv Gandhi, who continued "reforms with reluctance" (Bhagwati [1993]).

To understand whether India's industrial policy regimes have impacted on observed x-inefficiencies, their salient features are described.[9] Two mechanisms to implement industrial policy have been systems of industrial licensing, and import licensing,[10] to foster import-substituting indigenous industrial development. The 1948 Industrial Policy Resolution sought government control of industrialization,[11] operationalized through the IDR Act, 1951.

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[9] Issues which figure in industrial policy lists can be macro-oriented: as to the role and weightage assigned to light, medium and heavy industries, ownership patterns desired, the roles of foreign capital, foreign technology and institutional finance, and location guidelines. At micro-levels, where impact on efficiency patterns are critically felt, issues relate to: the operating size of units and scale, maximum production possible given market-demand factor-supply conditions, and choice of operating technologies permissible to firms. In addition, the third major element includes an appraisal mechanism to monitor progress according to the stated objectives (Marathe [1989]).

[10] Bhagwati and Srinivasan [1975] have extensively analyzed the trade policy regime in India, the origins of which lie in two laws passed in the late 1940s and mid 1950s: the Imports and Exports (Control) Act of 1947 and the Import Trade Control Order of 1955. The order of 1955 brought imports under the control of bureaucratic discretionary licensing, particularly those items for which a "domestic angle" and infant industry protection argument could be made (Ahluwalia [1985]). The scope of quantitative imports licensing via the Import Trade Control Order of 1955 increased, particularly in the 1960s, and rules were designed to allocate imports by specific product type and by product user category. Along with these quantitative import restrictions, there were price restrictions in many key industries: coal, drugs, edible oils, fertilizer, steel and sugar, and restrictions on foreign investments with promulgation of the Foreign Exchange Regulation Act in 1973 (FERA).

[11] It explicitly stated that the role of government was to create industrial wealth, rather than develop guidelines for devolving industrial assets into dispersed hands as a means of redistribution. Thus, the role of the state as an important industrial entrepreneur and manager was clearly articulated. However, if private firms existed in certain industries where the state was to assume a dominant role, these had freedom for efficient production and expansion. The ethos underlying policy was the development of national capabilities; the state's role was both primary, to step in where private capital was not forthcoming in actual quantity, and secondarily also to correct regional lop-sidedness in location.

In 1956 a second Industrial Policy Resolution was enunciated. This resolution guided industrial policy-making in India for over 20 years. The principle that the state was to be the dominant industrializer was maintained. However, the resolution went further and operationalized precisely the nature of public ownership. While private firms were likely to be occasionally authorized to produce items which were reserved for the state sector, the state sector could enter at will into sectors where private firms were dominant players.[12]

In the late 1950s, there was an abandonment of indicative planning for the industrial sector. Industries were given explicit directions as to the areas that they could enter, and the amount of investments possible in each sector. Particularly from the second-plan onwards, there were increasing concerns with quantity controls and capacity management. Rather than provide macro-level incentives to participants in product and factor markets, that were progressively becoming competitive, control over resources became the policy premise, [13] and the focus of strategic and operational decisions began to be taken away from the hands of industrial

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[12] The resolution also specifically mentioned that industrial undertakings ought to behave in constraints with the social and economic policy objectives of the state, howsoever defined. The mid-1950s is also the period when the second five-year plan was launched. This plan was heavy-industry oriented, and priority was given to the development of steel, heavy engineering, machine tool and heavy chemical industries. Panagariya [1990] has noted the reliance on creation of a large capital-goods sector suddenly transformed the capital intensity of production, and detracted from the development of labor-intensive manufacturing, in which India perhaps had a comparative advantage at that stage of her development.

[13] For instance, the second plan document explicitly stated that "a comprehensive plan cannot be seen through as the basis of merely overall fiscal and monetary controls" [1956, 38].

enterprises, with an impact on efficiency since explanations for poor performance could be laid at someone else's door.[14]

The regimes that existed in India in the 1960s and 1970s were "more of the same" 1950s approach (Ahluwalia [1985]).[15] Coupled with a foreign-exchange crisis arising after the 1962 China war, at the start of the third-plan, 1961, there was realization that lack of monitoring allowed entrepreneurs to exploit the system, and the administrative burden of expanding industrial activity created such delays that criticisms of the system could no longer be avoided.[16] However,

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[14] Also, there were little or no incentives for enlarging production as a result of emergent competitive product and factor market pressures. Raw material inputs, foreign exchange, foreign technology purchases, types of collaborations to be undertaken, and the amount of domestic capital to be made available to any industrial unit, were all decision items the dispensation of which the state began to control, apart from controlling capacity dispensations themselves.

[15] Mohan and Aggarwal [1990] comprehensively list how, in the decades of the 1960s and 1970s, control over resources got operationalized into a number of steps that had to be gone through by an entrepreneur before production could commence. There were many major and comprehensive controls which had been negotiated by any industrial unit. These included, inter-alia, procedures relating to acquiring: a letter of intent to start an industrial firm, capital goods imports clearances, foreign-technology collaboration clearances, capital issue clearances, raw materials import clearances, essentiality clearances, indigenous non-availability of equipment and materials clearances, monopolies clearances, small-scale sector clearances and clearances for locating in non-municipal areas. The multiplicity of administrative hurdles not only reduced flexibility in launching projects, but inevitably tended to increase both project and production costs.

[16] In the 1960s several review committees were set up; the first inquiry (chaired by Mr. T. Swaminathan) into procedural issues reported in 1964, and a major and comprehensive inquiry (chaired by Dr. R.K. Hazari) into the role of industrial policy as an instrument for development reported in 1967. The 1967 report concluded that whether industrial licensing served to channelize investment into desired directions appeared extremely doubtful. There was very little follow-up of licensing to see that approved projects were completed on time. Also, in attempting to cover almost the whole range of large-scale industrial development licensing, the act (IDR Act 1951) inevitably lost sight of the relative importance of different projects and products; i.e., whether critical to the economy or otherwise, all applications under went similar processing. The conclusions of Bhagwati and Desai [1970], thereafter, were also similar. Concomitantly, during the 1960s two key bodies were appointed to study the concentration of economic power in Indian

in spite of conclusions that the industrial policy had failed, and concentration was a result of licensing, the status-quo continued.

The policy framework starting from the late 1960s is characterized as one of detailed administrative day-to-day direction (Jalan [1991]; Marathe [1989]).[17] Controls over all facets of operations of firms,[18] became detailed and all-pervasive, not just control over strategic issues such as whether particular industrial houses could enter certain sectors of industry. Because the license specified the maximum capacity of any undertaking, over time these limits became the maximum actual production permissible. Production beyond these limits were deemed to be contravention of law, even though demand shortfalls might exist. Also, enterprises desiring to merely alter product-mixes at their plants, even with existing capital equipment, had to seek approval. In the approval process, the judgment of the policy makers prevailed in all areas,

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industry, and evaluate whether the licensing regime had a role to play in fostering such concentration. These committees were the Monopolies Inquiry Commission of 1965 (chaired by Justice K.C. Dasgupta), and the Industrial Licensing Policy Inquiry Committee (ILPIC) of 1969 (chaired by Mr. S. Dutt). Paranjape [1988, 2343], who was a member of the ILPIC, has paraphrased some key findings of the ILPIC: "in respect of licensing, the system had failed practically on all counts.....Licenses were issued in excess of capacity targets even in nonessential industries.....Influential parties and large houses were permitted to pre-empt capacities." Also, increased capacity reservations for the small-scale sector ensured a preponderance of plants in Indian industry operating at significantly less than efficient scale (Mazumdar [1991]).

[17] The mood and intent of the government is best captured by the setting up in 1964 of a short-lived Department of Economic and Defence Coordination, within the Ministry of Finance, similar to George Brown's short-lived Department of Economics Affairs in the U.K.

[18] For example, on activities such as pricing and acquisition of raw materials, distribution of the final product, and how to allocate foreign exchange within a project.

including areas such as the size, nature of the equipment, process used and physical plant location, over that of entrepreneurs.[19]

In spite of lacunae, the system continued well into the 1970s. Regime 2 easily transited into regime 3 in which administrative direction-giving was the primary task of policy makers. Which such administrative procedures were ostensibly democratically-oriented, with a great deal of checks and balances, these checks showed the process of development and, more important, each administrative agency attempted to broker power by delaying the whole chain. In the 1970s, particularly after the 1975 "emergency," various licensing policy liberalizations were announced. But none of these measures had any impact because no measures were automatically implemented (Marathe [1989]), and every liberalization measure was treated as a new policy instrument, rather than as a negation of past policy. Firms had to go back to the policy makers to have these liberalization measures enforced.[20]

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[19] That the industrial policy system permitted administrative excesses to take place, which in turn fostered patronage and rent-seeking, has been earlier commented on, inter-alia, by Bardhan [1984], Bhagwati and Desai [1970] and Bhagwati and Srinivasan [1975]. Bhagwati [1993, 49] has written "Few outside India can appreciate in full measure the extent and nature of India's controls until recently. The Indian planners and bureaucrats sought to regulate both domestic entry and export competition, to eliminate product diversification beyond what was licensed, to penalize unauthorized expansion of capacity, to allocate and prevent the reallocation of imported inputs, and indeed define and eliminate virtually all aspects of investment and production through a maze of kafkaesque controls. This all-encompassing bureaucratic intrusiveness and omnipotence has no rationale in economic or social logic; it is therefore hard for anyone who is not a victim of it even to begin to understand what is means."

[20] Because there were a substantial number of government agencies to implement many parts of the system, not only did a nexus of industrialists and managers develop who wanted to see the system stay, but an equally large nexus of bureaucrats developed. Among the large number of agencies within the government each sought to control the idiosyncratic aspects of control they possessed over industry, so that they too could enjoy bureaucratic rents. Each agency and its supporting interest group could have liberalization measures stalled if they served against their

The industrial policy regimes moved in the decades from the 1950s to the 1970s from being development-oriented to being regulation-oriented.[21] After the installation of the short-lived [1977 to 1979], coalition-based government of Morarji Desai initial attempts were made at liberalization, but they miserably floundered. In the even more short-lived [1979-1980] Charan Singh regime all economic policy was made subservient towards agricultural development. With the return of Mrs. Indira Gandhi to power after the elections in 1980, the aim of industrial policy as being one which would engender progress and development, through enhancement of the competitive process, began.[22] The seventh-plan (1985-1990) document is unique among plan documents in spelling out the role of firm-level, micro-economic factors which would drive

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specific interests. Marathe [1989, 100] has written "the system seemed to have acquired a momentum of its own; any attempts to reduce its procedural rigors or to make peripheral improvements were rejected by the system like an unwanted transplant. Over the years a formidable and pervasive vested interest had been built up in the continued operation of an elaborate system of regulation in which different agencies within the government and at different levels of responsibility had to be involved."

[21] While the role of the state as an investor had grown, the role of government as continuously influencing micro-level decisions also widened considerably. The late 1970s were characterized by the presence of contradictory policies. IBM and Coca-Cola, as multinational corporations, were given marching orders out of India; at the same time, Siemens was welcomed into India as a major supplier for power generation equipment projects by the administration.

[22] In the early 1980s the ratification of surplus capacity as part of actual capacity commenced. While no radical departures from existing policy mind-sets were forthcoming in regime 4, the need to use existing capacity in place was well-recognized by her senior advisers. 1982 was declared as the Productivity Year, and in that year a scheme of re-endorsement of capacity was introduced. Till then, existing capacity in place could not be used to meet production quotas, even if market demand existed, if such capacity was in excess of authorized limits (Ahluwalia [1985]). Now, such excesses were allowed to be used for productive purposes. Subsequently, the seventh-plan document recognized the important role of technological modernization and the upgrading of manufacturing capabilities.

industrial progress, and in laying out the appropriate policy regimes which would foster the development of firm-level capabilities.[23]

3. EMPIRICAL ANALYSIS

DATA DESCRIPTION: To calculate the relative observed x-inefficiencies in Indian industry for the period 1950-1951 to 1988-1989, data from 1959 onwards generated by the Annual Survey of Industries (ASI), and data prior to 1959 collated from the Census of Manufacturing Industries (CMI), publicly available in data-sets constructed by Chandhok [1990] supplemented by new ASI reports, are used. The summary results for the factory sector are used as the principal data-source for the purposes of this study. From the data set available, labor and capital inputs as well as data on various output measures can be identified.[24]

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[23] For example, product development was thought to be a significant area for industries. In their abilities to introduce new products, at competitive costs, industries would show their mettle. However, to do so needed the articulation of policy regimes which encouraged adoption of new foreign technologies and the establishment of plants with globally-competitive scale parameters, as opposed to fragmentation of capacity among numerous firms. That empirical realities were being recognized, and evidence that a major change of heart was taking place is reflected in a statement in the seventh-plan document: that the approach of government bodies lay "not in the extensive powers to control and regulate, but in their efforts to provide technical and administrative guidance to industries. The performance of these tasks will be informed less by legal or procedural codes but by better access to data and knowledge" [1985, 7.42]. Presumably, data and knowledge would enable the government to enhance the market process, which would then generate competition.

[24] Disaggregation at the industry level is feasible only for the period 1979-1980 onwards, and a lengthy time-series of forty years can be prepared using only the summary results for the factory sector. The ASI and CMI data relate to the organized sector of manufacturing, and the ASI data have been used by Ahluwalia [1985], [1991] in studies of growth and productivity in the Indian manufacturing sector. However, empirical studies using CMI data are few (Goldar [1986]; Little, Mazumdar and Page [1987]). There are some minor differences between CMI and ASI data. CMI data collection did not cover small scale plant, a lacuna rectified by the ASI. However, given that the thrust towards the small-scale sector commenced seriously only in the second plan (1956-1961), the CMI incorporated data on almost all the relevant units that

Four inputs and one output are used. The inputs used are rupee values of fixed and working capital, actual number of workers and actual number of administrative and support staff employed. The output variable is: gross production, expressed in crores of rupees. Capital inputs, both physical and working capital, are also expressed in crores of rupees. Labor inputs are expressed in thousands of employees. To deflate variables expressed in rupees the wholesale price index is used; the capital inputs and the output values are then expressed in constant rupees.

Proper measurement of output and capital is important, and Ahluwalia [1985] is followed in using gross output value as the output variable. Capital inputs can be actual book-values of physical capital given in CMI and ASI data. In measuring capital input, the use of undeflated book-values amounts is inaccurate and the book value series is deflated by a price index. The weakness of using deflated data alone is that it does not take into account assets of different vintages bought at different points of time. Therefore, following Goldsmith [1962] and Hulten [1990] the perpetual inventory method is used. That involves assuming for some base year an amount as beginning capital stock, and an annual rate of capital consumption. However, it is the preferred mode of measuring capital inputs. The data on Indian industries include capital stock data at net book value and depreciation. Combining these yields the gross capital stock. A real capital stock series is constructed using a perpetual inventory capital adjustment method, given by the equation:

$$K_t = (1 - \Omega)K_{t-1} + \textit{deflated gross investment} \qquad (1)$$

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comprised organized manufacturing industry. I am grateful to Dipak Mazumdar for extensive discussion on this issue.

where K_t is the capital stock to be used for each year, gross investment is the change in the firms undepreciated capital stock since the preceding year, and Ω is the rate of depreciation taken at 10 percent, which is suggested by Hulten and Wyckoff [1981] to be consistent as a representation of the weighted average over asset categories of the economic depreciation. The initial capital stock, K_0, equals the net book value of the capital stock for 1950.[25] Data for each year are used and there are 38 observations over the period 1950-1951 to 1988-1989.[26] The extensive cross-section coverage of the entire industrial sector as captured by the ASI and CMI data, coupled with the almost four decades of time-series coverage,[27] yields a data set which can be used for comprehensive assessment of the impact of economic policies on industrial performance.

EFFICIENCY ESTIMATION PROCEDURES: Data envelopment analysis, DEA, is used to measure the relative efficiency of the Indian industrial sector for the annual observations between the years 1950-1951 and 1988-1989. Thereafter, DEA technical efficiency scores are used as dependent variables in a regression model to estimate efficiency growth rates. DEA is a performance assessment tool useful for uncovering patterns of dynamic efficiencies. Using only observed output and input data for observations, the DEA algorithm calculates an ex-post

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[25] The approach is similar to that adopted by Lieberman, Lau and Williams [1990].

[26] The Annual Survey of Industries has been carried out since 1959 under the Collection of Statistics Act of 1953. It is the principal source of industrial statistics in India. Prior to 1959, a Census of Manufacturing Industries was carried out under the Industrial Statistics Act of 1942. The ASI extends to every part of the country, except some industrially-marginal states, and covers all factories registered under the Indian Factories Act of 1948. Essentially, all factories employing more than 10 workers and using power, or more than 20 workers and not using power have to report data. Hence, the data coverage is that of a census.

[27] The ASI was not carried out for 1972-1973. Hence, there is a gap in the time-series of one year.

measure of how efficient each observation was in converting inputs to outputs, accomplished by the construction of an empirically-based production frontier, and by evaluating each observation against all the others which are included in the data set.[28]

DEA has two properties which are relevant for the present study. First, it is a technique for comparative efficiency measurement. Each observation is evaluated against itself and all other observations. Thus, the efficiency of each observation, relative to all others in the data-set, can be estimated.[29] Second, for each observation, a single efficiency statistic is calculated. This is a ratio measure of performance as to how efficient each observation was with regard to converting a set of inputs jointly and simultaneously into a set of outputs.

As developed by Charnes, Cooper and Rhodes [1978] (CCR) and extended by Banker, Charnes and Cooper [1984] (BCC), the Farrell output-input measure is generalized to a multiple

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[28] Following Farrell [1957], two main paradigms have evolved in the construction of frontier production functions. There is the parametric approach, based on estimating regression-based production functions, and the non-parametric approach, DEA, based on estimating linear programming models of relative efficiency. The advantage of the non-parametric approach is that no explicit functional form, or assumptions relating to technology needs to be incorporated, and it can handle multiple outputs and multiple inputs which no parametric technique can handle. The data need not all be quantitative, and qualitative measures can be used as outputs or inputs. Concomitantly, both nominal and physical values can be simultaneously used as outputs or inputs, because the aim is not to estimate functional parameters, per-se, but relative measures of efficiency among observations. DEA is similar to other newly-developed techniques for performance assessment, one of which is demonstrated in Banker, Chang and Majumdar [1993].

[29] Therefore, the results that are arrived at relate explicitly to the observations in the data-set. In the present case, x-efficiency is evaluated only with respect to observations for Indian industry over time. No conclusions can be drawn about whether Indian industry is equally efficient, or inefficient, compared to the industrial sector of some other country. Comparative analysis, using data for India in conjunction with data for other countries, can help evaluate how x-inefficient India is compared to other countries and remains an agenda item to be covered in future empirical research.

output-input case using a fractional mathematical program developed by Charnes and Cooper [1962], where the ratio of the weighted outputs to weighted inputs of each observation is maximized.[30] In the CCR model, constant returns to scale are assumed and the CCR efficiency score is a total efficiency score for each observation. Banker, Charnes and Cooper [1984] show that the CCR score confounds the effects of technical and scale efficiency, and can be broken up into a pure technical efficiency component and a scale efficiency component, with the pure technical efficiency component of the BCC model capturing the resource-conversion efficiencies feasible by observations irrespective of scale considerations.[31]

A generalized DEA model can be presented by means of the following formulation:[32]

Max $e_{0,0}$ (2)

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[30] Unlike in the parametric approach, where an explicit functional form for the production relationship is assumed, and a measure of technology can be incorporated as a variable in the overall regression, no assumptions about the underlying functional form or technology are made in DEA, since the objective of estimation is to measure the relative ability of each observation to convert a multiple set of inputs into a multiple set of outputs. If some observations are indeed efficient because of superior technology employed then an explicit measure of technology quality has to be introduced in subsequent regression models where the dependent variable is the efficiency measure generated by a DEA model. This approach has been used in prior research (Majumdar [1995a]) to explain how the adoption of new technology, superior to the installed-base of the existing older technology, has positively impacted on the performance of firms in the U.S. telecommunications industry. A measure of technology quality, the proportion of electronic switches to total switches, was used as one of the regressors in a model explaining inter-firm variations in technical efficiency, which was calculated using DEA. In the case where aggregate data are used, as in the present study, time can be treated as a measure of technical change, as is often done in studies of aggregate productivity, but deriving an explicit measure of technical change, intuitively acceptable, for the economy as a whole is very difficult.

[31] Since there is writing on the technique, detail are not gone into here. Readers wishing to learn more should read Bauer [1990], Banker [1993], Charnes, Cooper, Lewin and Seiford [1995], Majumdar [1995b], or Seiford and Thrall [1990].

[32] For a detailed model see Majumdar [1995b].

subject to

$e_{j,0} \leq 1, \forall j$

$\mu_{r0} \geq \epsilon, \forall r$

$v_{i0} \geq \epsilon, \forall i$

where $e_{o,o}$ is an efficiency index for the observation being evaluated, and where $j > 1,....n$ is the index for observations, 0, as mentioned, being used as the index for the being observation being specifically evaluated, $r = 1,....R$ is the index for the outputs, ($y_{rj} \geq 0$ is output r of observation j), $i = 1,....I$ is the index for the inputs, ($x_{ij} \geq 0$ is input i of observation j), $e_{j,0}$ is the relative efficiency of observation j, when observation 0 is evaluated, μ_{r0}, v_{i0} are the output and input weights, respectively, associated with the evaluation of observation 0, ϵ is a non-Archimedean infinitesimal quantity. In (2), the input (x_{ij}) and output (y_{rj}) factors are known quantities observed from the activities of the observations and the factor weights (μ_{r0} and v_{i0}) are the decision variables. Defining,

$$e_{j,0} = \sum_{r=1}^{R} \mu_{r0} \cdot y_{rj} \,/\, \sum_{i=1}^{I} v_{i0} \cdot x_{ij} \qquad (3)$$

yields the CCR model. Similarly, defining the relative efficiency measure as,

$$e_{j,0} = \sum_{r=1}^{R} \mu_{r0} \cdot y_{r_j} - u_0 \,/\, \sum_{i=1}^{I} v_{i0} \cdot x_{ij} \qquad (4)$$

where u_0 is an unconstrained decision variable yields the BCC model. Dividing the efficiency score resulting from the CCR model by the efficiency score resulting from the use of the BCC model yields a measure of scale efficiency, which is the ability of each observation to operate as close as possible to its most productive scale size (Banker, Charnes and Cooper [1984]).

DEA is useful in estimating x-inefficiencies. Since x-inefficiency is the manifestation of inability to extract maximal output from the given inputs, in a DEA sense those observations which define the frontier, attaining a score of 1 on a scale of 0 to 1, are x-efficient. These are the observations which have utilized their full potential. Therefore, observations which score less than 1 are x-inefficient, and the efficiency rating for each observation denotes a precise estimate of the empirically-assessed x-inefficiency present that may be present.[33]

DEA procedures are used to generate CCR, BCC scores and scale efficiency scores.[34] An efficiency score for each observation is computed relative to the efficiency of all other observations and itself. In other words, the efficiency of industry in 1950-1951 is computed relative to the efficiency characteristics for all the other 37 observations up to 1988-1989, and so on. A set of relative efficiency scores for almost all of Indian industry is available for the

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[33] See Leibenstein and Maital [1992] and Majumdar [1995b] for a discussion of this issue. The advantage of DEA lies in its approach. DEA optimizes for each individual observation, in place of the overall aggregation, and single optimization thereafter, performed in statistical regressions. Instead of trying to fit a regression plane through the center of the data, DEA floats a piece-wise linear surface to rest on top of observations. This is empirically-driven by the data, rather than by assumptions as to functional forms. The only assumption made is that the piece-wise linear envelopment surface is convex. Next, the efficiency score is a bounded efficiency measure in that a score of 1 represents optimal attainment. Hence, any observation with a score of less than 1 has measurable potential for improvement. Also, traditionally certain assumptions underlie statistically-driven regressions, and in parametric production frontier analysis. Banker and Maindiratta [1988] show that behavioral assumptions can be incorporated within DEA models, and that also the analytical properties of DEA and non-parametric production frontier analysis in econometrics are equivalent.

[34] Within the CCR and BCC models either an input-conservation or an output-maximization orientation can be incorporated. The CCR and BBC models were estimated under both orientations, and the correlation between the CCR input-conservation and output-augmentation scores was 0.99, while the correlation between the BCC input-conservation and output-augmentation scores was 0.98.

entire period: 1950-1951 to 1988-1989. These scores help gauge whether x-inefficiency persists in Indian industry for the time-period studied, which periods are more x-inefficient than others, what are the dynamic patterns of improvement or reversals in x-efficiency patterns, and what policy regimes are particular x-inefficiency scores associated with.

ASSESSING EFFICIENCY GROWTH: To calculate efficiency growth rates and evaluate the impact of policy regimes on efficiency, an exponential efficiency-time relation is specified as follows: $E_t = x\ (1+r)^t\ \mu\ t$ (5)

which is linearized as: $Ln\ E_t = a + bt + ut$ (6)

where E_t = the technical efficiency score generated by the BCC DEA algorithm for each time-period, t = time in discrete years (t=1.....38), a = 1n x = a constant, r = annual compound growth rate, b = 1n (1+r) and ut = 1n μt ~ ind $(0,\sigma^2)$. The exponential form is chosen because if industrial progress is dynamic, then efficiency in a given year is likely to be at least a constant increasing percentage of efficiency in the previous year and not a constantly diminishing percentage of it. The coefficient on time, b, is the continuous rate of growth, but given the range of values it closely approximates the annual compound growth rate, and following convention, the estimates of b are taken as the growth rates.

A problem arising in the fitting of equation (6) to the full time-series data is that the growth rate in a given period can markedly differ from the growth rates of efficiency in the sub-periods. The estimated growth rate in efficiency in each period can be higher or lower than the entire period. These sub-period growth rates inefficiency are a function of the policy regimes that existed in each sub-period. Thus, following the earlier discussion of the institutional structure of

Indian industrial policy regimes, sub-period growth rates in efficiency are estimated for the years: 1950-1960, 1961-1973, 1974-1979 and 1980-1988 separately.

The variations in growth rates shown by estimates of equation (5) raises an issue as to whether these rates are indeed constant. Efficiency growth rates can accelerate or decelerate. To incorporate these possibilities and evaluate the rate of change in efficiency for the full period as well as for the four sub-periods, a log-quadratic equation is estimated, as follows:

$$ln\ E_t = a + bt + ct^2 + ut \qquad (7).$$

A significantly positive value of c indicates an acceleration in the growth rate of efficiency; a significantly negative value indicates deceleration.[35]

4. DISCUSSION OF RESULTS

EFFICIENCY GROWTH RATES: The CCR, BCC and scale efficiency scores are listed in Appendix 1 and displayed in Figure 1. Details of the growth rates in the BCC technical efficiency score are given in Table 1. From figure 1 it is noted that Indian industry has not progressed in becoming efficient over time. The CCR total efficiency score has fallen from the 1950s to the 1980s, and only started picking up in the 1980s. The fall in efficiency is

[35] See Boyce [1987] for a discussion of growth-rate estimation. The inclusion of time squares on the right-hand side in (7) introduces a multi-collinearity problem. This is solved by normalizing time in mean deviation form. That is, it is set to zero on the mid-point of the time series. This procedure is followed for the full series as well as for each of the four sub-periods. This normalization makes time and its square orthogonal. The normalization of time only affects b. The estimate of c and its standard error are invariant with respect to the normalization. In the log-quadratic estimation, the value of b is the same as in the log-linear model. The standard error of b is the measure of instability of the growth rate of efficiency. If it is assumed that the log-quadratic form is a better estimator of the true trends in the growth rate of efficiency, the instability measure of b is also improved, since systematic specification errors are somewhat cleansed from the data.

primarily as a result of a decline in technical efficiency, or productivity in the utilization of resources, as the pattern of the BCC technical efficiency measure shows, and not as a result of being unable to reap scale efficiencies. If there has been a process of new technology adoption, learning, training, use of improved work practices and better utilization of physical and human capital taking place, then efficiency scores are expected to rise monotonically during the entire period, from the 1950s to the 1980s. The data reveal quite the opposite trend.

From Table 1 it is seen that efficiency declined between 1950 and 1988 at a rate of 0.34 percent per annum, and this decline was significant. While figure 1 and table 1 does indicate that the overall trend is one of decline, there is significant heterogeneity visible in the efficiency patterns within each of the four regimes. Therefore, the overall decline noted can be disaggregated into periods of no decline, sharp declines, and recovery. These trends are visible from figure 1. Efficiency trends are assessed for each of the sub-periods. Also, as table 1 shows, there was significant acceleration in the rate of decline of industrial efficiency over the four decades studied. The values of *b* and *c* are significant for the overall period 1950 to 1988.

A regime-specific analysis shows that through the 1950s Indian industrial efficiency was high[36] compared to its performance in the 1960s, 1970s and most of the 1980s. Efficiency

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[36] The evidence shows that through the duration of the first and much of the second five-year plans, the years 1951 to 1960, Indian industrial efficiency was high. The dips that occurred between 1950 and 1961 were marginal. They took place in the second plan period, and could reflect the making of initial adjustments on part of the industrial sector to a new planning ethos. Nevertheless, the trend is one of high efficiency. Policy regimes during this period were development-oriented, and planning was indicative. While capacity controls were being undertaken, they were not yet critical enough to foster rent-seeking activities and lead to subsequent x-inefficiencies in the industrial sector. Indian industry exploited almost its full potential.

patterns only showed a resurgence in the late-1980s. Recollect, that the 38 observations are being compared to each other. The observations which are frontier definers or the most efficient years were: 1950-1951, 1951-1952, 1952-1953, 1953-1954, 1959-1960, and 1988-1989 in efficiency in output generation is assessed. However, for over a quarter of a century, between 1961-1962 and 1987-1988, efficiency was grossly low compared to what Indian industry had been capable of attaining. Between 1954-1955 and 1959-1960 there were small dips in efficiency, but the efficiency scores for these years were always over 0.95. Similarly, table 1 shows that while efficiency did decline during regime 1: 1950-1960, the rate was 0.29 percent per annum. Also, an evaluation of the rate of this decline does not indicate an accelerative or decelerative pattern.

Table 1 shows that the largest drop in efficiency took place during regime 2. Efficiency declined at over 2 percent per annum between 1961 and 1973.[37] This decline was statistically

[37] The 1960s are years when macro-economic factors were unfavorable to India (Joshi and Little [1994]). Foreign exchange crunches worsened, with an import-substituting autarkic regime going into place. During the 1960s there were growing shortfalls in agricultural production, leading to demand-side imbalances for the industrial sector. There was a severe drought in 1964, with spillover effects of its impact into the years 1965, 1966 and 1967, as a result of which demand shortfalls were likely to constrain industrial growth and productivity. Arguments have been advanced that it does not serve much purpose to consider high inefficiency as a performance criteria if capacities are under utilized, since unfavorable efficiency scores will follow as a statistical result (Nayyar [1994]). Capacity utilization is likely to be low when there is a demand shortfall, but that assumes shortfalls in both domestic and export markets. If only the domestic market is targeted, then it is well possible that demand shortages will exacerbate x-inefficiencies. But, the non-targeting of external markets, so as to gain volume, learning and associated economies of scale which are the hallmarks of South Korean, Taiwanese and even modern Chinese industrial growth, is a policy failure which has arisen in the Indian context because of the external export pessimism of the Indian government (Mohan and Aggarwal [1990]). Coupled with purely looking at the internal market as the driver of volume, and then limiting participation in this market to incumbents, who, thereafter, faced no entry threats, reduced incentives to be efficient. It is, well-known that the industrial policy regimes in place in the 1960s is characterized by the perfecting of the "license raj" (Ahluwalia [1985]; Bardhan [1984]; Bhagwati and Desai [1970]; Bhagwati and Srinivasan [1975]; Marathe [1989]; Rudolph and Rudolph [1987]) which

significant, as the estimate of the standard error of *b* shows. Not only was there a large decline, but this decline showed a significant accelerative trend. The estimate for c is the largest for any of the four regimes and is statistically significant.[38] Similarly, during regime 3 efficiency continued declining, albeit at a lower rate. Now, the rate of efficiency decline was at the rate of 1.31 percent per annum. Again, the decline is statistically significant, and the trend in the decline

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allowed incumbent industrialists to make hay even in a cloudy environment. As the administration of the "license raj" was being perfected in the 1960s, there was a major drop in efficiency (see the scores in Appendix 1) from 1961-1962 to 1966-1967. The drop is extremely significant. From an efficient position, with a score of almost 1 (0.999) in 1961-1962, industrial efficiency dropped dramatically to a score of 0.68. This is the lowest noted efficiency score in the entire study. There were marginal improvements up to 1968-1969, but significant drops thereafter. The evidence points not only to a major regression away from the scores that were achieved in the 1950s, but an inability to catch up.

[38] The premise of x-efficiency theory is that environmental forces change the nature of incentives facing industry and permit slack-causing behavior. These forces either enhance or retard motivations for performance improvements. Negative macro-economic forces notwithstanding, the policy regimes in place in the 1960s and 1970s must account for a large share of the x-inefficiencies noted. Because every major strategic and operational decision was relegated to the bureaucracy in New Delhi, even if a license had been obtained, there were no factors over which entrepreneurs had control. Licensing allowed a finite market size to be made available to each entrepreneur who succeeded in acquiring a license. Hence, there were no incentives for survival in a competitive battle-ground. How the officially-sanctioned market was to be served was also dictated to by the authorities. Thus, there were no incentives left for industrialists to display any creative or craftsmanship skills, for example in product differentiation. Since the government dictated all strategic and operational decisions, firms merely had to go through the motions of undertaking industrial activity (Bhoothalingam [1993]). That Indian industry got away with exerting minimal effort seems evident, living the "quiet life" (Hicks [1935]), because there were no reasons to minimize costs or strive for superior performance. The impact of legitimized market pre-emption and day-to-day interference by government, on the other, are reflected in the patterns of low efficiency. Bhagwati [1993, 54] has noted the following, in his evaluation of the intent of and actual outcomes from industrial policy "The Indian embrace of bureaucratic controls was also encouraged by additional objectives, none of them served well by the control system in practice. One was the prevention of the concentration of economic power, by licensing the creation and expansion of capacity. But, if monopoly power was to be reduced, the virtual elimination of domestic and foreign competition (i.e. the elimination of the "contestability" of the market) was hardly the way to do it."

is one of acceleration. The value of c for regime 3 is positive and significant; however, it is slightly lower than that for regime 2 and relatively unstable, as its larger standard error indicates.

The policy regimes of the 1960s continued well into the 1970s. Regimes 2 and 3 display policy continuity, though the political scenario were different, and in regime 3 there was an exacerbation of the role of government as an influencer of micro-level decisions. Table 1 shows that regime 3 is characterized by declining rates of efficiency which show an accelerating trend. Between 1965-1966 and 1980-1981, when a structural up-swing in efficiency began, as also noted by Ahluwalia [1991], patterns of efficiency moved up and down.[39] Two rising peaks of rising efficiency are, however, noted in 1968-1969 and for the period 1974-1975 to 1976-1977.[40]

The 1980s have been referred to as the years in which micro-level forces were recognized as being important to industrial and economic progress (Marathe [1989]). After falling between

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[39] Because the capital input need for calculations is actually the book value of capital, in years when additional write-offs were given to industry the capital input variable would be much lower than for other comparable years and the year being evaluated would have a higher efficiency score. In fact, investment allowance reserves which would reduce the value of capital inputs were given to industry in the early and mid-1970s. A lower capital input would result in greater efficiency being noted. Yet efficiency scores calculated are low during that period.

[40] During the late 1960s there was a threat to industry of possible stringent monitoring, following from the recommendations of the ILPIC. In early 1969 Mrs. Indira Gandhi nationalized a significant portion of the banking industry. There was a clear threat that other industries or sectors of the economy could follow suit. The administration could turn authoritarian. The years 1975-1977 saw the presence of an "emergency" situation which did provide micro-level incentives, certainly fear, to industry to become more efficient. Following major political unrest, which was put down firmly by the government, the administrative regime did turn authoritarian. During these time-periods (in the early parts of regime 3) policy pressures seemed to be devolving on industry to behave less profligately, with concomitant internal pressures engendering efficiencies. Nevertheless, in spite of such "positive" blips, if the results for regimes 2 and 3 are taken together, Indian industry has gone through almost two decades of retrogression in capabilities in the period 1961-1962 to 1979-1980.

1976-1977 and 1979-1980, from 1980 onwards x-efficiency patterns began to show an upward-rising trend, culminating in the final year of the study, 1988-1989, being a frontier-defining or an x-efficient year. During the 1980s efficiency increased at the rate of almost 2 percent per annum, as Table 1 shows. The standard error of the efficiency growth rate was the lowest noted for any regime, indicating that the upward trend in efficiency was stable. There was a slight deceleration in the trend of the efficiency growth rate; however, that was not significant. A review of figure 1 has to be carried out simultaneously. During the 1980s efficiency clearly increased. Figure 1 reveals almost a monotonic increase in the technical efficiency scores. Between 1980-1981 and 1988-1989, the annual scores rose from 0.82 to 1.00. Such a rise was steady, and there were no major dips in the score between any pairs of years.[41]

At a micro-level, there were many firms which had pre-empted capacity. This meant that large quantities of capacity were installed, both legally and in contravention of license provisions in the 1960s and 1970s. Hence, surplus capacity abounded. In the early 1980s, the existence of surplus capacity was ratified. The existence of such surplus capacity may have had some impact on the drop in x-efficiency in the 1960s, and particularly the 1970s, since capacity in place was

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[41] Opening up of the market to foreign technology purchases, allowing plants with sufficient economic scale to be established, and encouraging the establishment of "sunrise" industries characteristics of the policy environment from the early 1980s (Marathe [1989]). In import licensing, particularly with respect to capital goods, the realization that India had to learn skills and adapt new technology from abroad led to significant lessening of import restrictions. This occurred from the early 1980s, after a Committee on Imports-Exports Policies and Procedures, (headed by Dr. P.C. Alexander), had reported. After Mrs. Gandhi's return to power in 1980, Dr. P.C. Alexander became the principal secretary to the Prime Minister. The realization that industry faced was business practices "as usual" in managing the labyrynthines of bureaucracy were less critical than prowess needed in managing operations, production processes, marketing strategies, and the onslaught of potential competition. Changing incentives, and the alteration of factors which guaranteed industrial survival, meant that an efficiency orientation carried a high premium.

not utilized to generate output as there were penalties for doing so. Thus, another reason for the x-efficiency catch-up in the early 1980s, along with the changed policy scenario, is the utilizing of existing capacity in place for actual production.

While the efficiency growth rate of the 1980s looks relatively high, the 1980s are being compared to the three prior decades: 1950s, 1960s, and 1970s. Relative to the performance achieved in the 1950s, performance in the 1980s is lackluster. For instance, the average efficiency score in regime 1 (1950-1951 to 1960-1961) was 0.989, while in regime 4 (1980-1981 to 1988-1989) it was 0.918. Hence, though there has been an efficiency spurt in the 1980s, it has only been to catch up with what was once attained in the 1950s. Indian industry has shown a decade of relative progress in the 1950s, two decades of several structural retrogression, the 1960s and 1970s, and a decade of catch-up in the 1980s.

INPUT UTILIZATION AND OUTPUT SHORTFALLS:: For each input an optimal quantity of that input which should have been consumed is computed as a by-product of the DEA program. In a year when the technical efficiency score is 1, then actual and optimal input consumption data are equal, and the ratio of optimal to actual consumption is 1, since there is no x-inefficiency present in utilizing the inputs. Where the observation for any year turns out to be inefficient, then for that year a ratio of the optimal input to actual input consumed, for each of the four inputs, is calculated. These ratios indicate where the sources of x-inefficiencies lie in Indian industry and are given in Appendix 2.

Data in Appendix 2 show that the primary sources of x-inefficiency arose in the utilization of physical capital and managerial resources. Because x-inefficiency is a behaviorally-driven concept, the manifestation of x-inefficiencies should be reviewed through an analysis of human

resource utilization patterns. Actual quantities of production workers and managerial staff are two separate inputs. Ratios of optimal to actual inputs for each of these input categories are plotted in Figure 2, which indicates trends in the utilization of human resources by Indian industry.

The results are striking. In the non-efficient years for which the results ought to be analyzed, the management of the productive capacity of workers is relatively better, while the utilization of managerial staff is worse. As Indian industry became inefficient in the 1960s and 1970s, utilization rates of managerial staff dropped more rapidly than that of production workers. The utilization of managerial staff remained at low levels through a major part of the 1960s, 1970s and 1980s. Managerial utilizations rates declined markedly after the mid-sixties and started rising only after the mid-eighties, when it started surpassing the rate of worker utilization.[42]

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[42] X-inefficiencies are often caused by an inadequacy of monitoring devices in a firm's environment. Policy-makers may lay down rules, but follow-through may be tardy. As a result, less-than-optimal effort is expended by individuals. Such factors can lead to intra-firm rent-seeking and collective action problems (Olson [1965]) where small groups, such as managers, exploit rent-streams at the expense of the larger mass, comprising production employees. The Indian industrial policy regimes in the 1960s and 1970s were administratively oriented, and the nexus of industrialist and managers with bureaucrats that developed (Marathe [1989]) permitted the former to burden firms with surplus staff in managerial categories. These administrative staff, once in position, had no incentives to expend effort. The 1960s, and particularly the 1970s, strongly suggest the abuse of privileged positions of managerial staff, seeking personal rents in the form of low on-the-job effort, at the expense of production employees. The 1960s and 1970s are characterized by policy regimes which did not reward intra-firm entrepreneurship, primarily because government bodies took on the roles of entrepreneur and operational decision-maker. Such a situation could also act as a demotivating factor for managerial staff. Conversely, in the early 1980s, when micro-level decisions began to be relegated back to the level of the firm, it can be noted that efficiency in the use of managerial staff started rising, but only after a lag. With a micro-oriented policy regime in place, where rewards for efforts went back to the firms and there was also the threat of new-firm entry which could dislodge internal rent-seeking, the necessity to use capabilities to the fullest seemed to have been felt by managerial staff in Indian industry, but not rapidly enough.

Economic historians such as Bagchi [1972] and Ray [1979] have pointed to the trading origins of Indian industrial houses. Even British industrial houses which stayed on after independence owed their origins as managing agency houses. For Indian and foreign firms the capability to manage short-term transactions and controlling liquid assets effectively were the primary competencies that were important. Such capabilities were visible in Indian industry in the 1960s and 1970s, and the ratios of optimal working capital to actual working capital used were consistently higher than the equivalent ratios for physical capital.

Managing physical capital requires distinctly different capabilities, as compared to managing working-capital and day-to-day transactions. The data show that since industrial efficiency first started declining, the efficiency with physical capital was managed dropped much faster up to the mid-1970s compared to working capital utilization. Ray [1979, 283] has remarked about entrepreneurs in Indian industry that: "they had no technological experience, which they merely regarded as a commodity to buy, like any other factor of production." To regard technology, as embodied in plant and machinery, as any other commodity type factor fails to recognize the critical role of scientific progress in enhancing output and productivity by a factor much greater than the sum of actual physical units consumed. Such behavioral predilections of Indian industry are brought out in Figure 3.[43]

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[43] It is also feasible that a decline in the efficiency of physical utilization is due to one other key factor. The import-substituting policies of the early 1960s may have closed off opportunities to Indian industry to use the latest technology and knowledge that were likely to be embodied in the purchase of imported know-how and plant. These would have impacted on the ability of industry to be x-efficient. The combined effects of existing behavioral attitudes towards capital usage, and autarky seem to have yielded an empirical pattern of physical capital utilization which is not affordable by any developing country.

DEA procedures also generate the virtual output that are attainable by any observation, or the maximum output feasible by any observation if it was efficient. A calculation, of the target output that ought to have been attained minus the actual output attained in the inefficient years can be carried out to assess the quantum of losses in saleable output resulting from the inefficiency of the industrial sector. The calculations that are carried out with the data show that over Rupees 1,500 billion, in current values, in potential output was lost between the 1950s and the 1980s as a result of x-inefficiencies perpetrated in Indian industry during those years.

6. CONCLUDING REMARKS

In this paper the magnitude of x-inefficiencies existing in Indian industry was analyzed for the period 1950-1951 to 1988-1989. The analysis of efficiency is important in shedding light on whether economic progress is taking place, since efficiency patterns are a reflection of the micro-capabilities of the industrial sector of any nation. In countries where government policies have a strong impact on industrial behavior, the impact policy regimes have on observed efficiency patterns yields major insights into the success of these regimes. The efficiency results show that as the Indian industrial policy regime changed from a development orientation in the 1950s to one of regulation in the 1960s efficiency dropped steeply. As the regulation and control regimes turned authoritarian in the late part of the 1960s and mid 1970s, there were occasional rises in the efficiency scores. Such rises were notable when the threat of stringent monitoring by government agencies was felt in the industrial sector, notably in the period 1968-1970 and in 1974-1977. Nevertheless, throughout most of the 1960s and 1970s the locus of decision-making

was taken away from the hands of Indian industry and efficiency patterns suffered.[44] Motivations to be efficient re-emerged in the 1980s, when micro-level forces were recognized to be key to industrial progress, and the policy regime became more hands-off.

The input-specific analyses of x-efficiency reveals two trends. First, efficiency trends for managerial resource usage shows intra-firm rent-seeking taking place in the 1960s and 1970s. Coupled with regimes that placed barriers to exit for existing firms, and guaranteed employment continuity at all levels, the environmental forces did not promote the use of managerial capabilities. Conversely, labor, which is much-maligned, was relatively better utilized. Second, as technological autarky increased, efficiency in capital use plummeted for almost a decade in the 1960s, then started rising in a larger measure only from the early 1980s, when technological autarky was abandoned. Finally, x-inefficiencies caused over Rs. 1,500 billion in lost output.

The overall pattern over four decades is one of retrogression in the capabilities of Indian industry, if rising efficiency patterns are to be taken as a pattern of progress. Concomitantly, with dynamic learning assumed to take place in a nation's industry, the industrial sector also grows in competence. As policy regimes progress through time, an expectation is that the industrial

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[44] Administrative hurdles, barriers to entry for domestic competition, protection from foreign competition and allowing of uneconomic scale sizes to exist interacted with each other to generate an environment for industry where efficiency was not a criteria that mattered at all. On one hand, the industrial policy regime legitimized market pre-emption to a given set of players. For these players a market of finite size was guaranteed. Protection from internal and foreign competition was provided. On the other, how these players could serve such pre-empted markets: with what types of resources, to be acquired in what quantities, and at what prices, were all decisions which the policy regime prescribed. This was coupled with autarky with respect to foreign technology purchases. Such factors combined to sap the motivation of Indian industry to be frugal in the use of resources, and two decades of structural retrogression in efficiency patterns ensured.

sector will simultaneously progress. One indication of such progress can be evidence of a monotonic increase in efficiency patterns. By that count, Indian industry has not progressed, and has been let down by the policy regimes of the government, which were to ostensibly support industrial development. The spurt in efficiency that took place between 1979-1980 and 1988-1989 reflects only the process of catching up with what capabilities industry once possessed in the 1950s. The score of 1.00 was attained in 1959-1960 and, thereafter, re-attained only in 1988-1989. Between these years the efficiency drop was substantial, and even in the 1980s a relative score of 0.95 was attained only in 1985-1986.

Efficiency and productivity growth is a reflection on the innate capabilities and dynamism of a country's industrial sector. At a micro-economic level, such efficiency growth is critical if industrial expansion and development is to take place. With respect to late-19th century industrial growth in the United States, Chandler [1990] shows how important the attainments of functional and strategic efficiencies were in the growth of industrial enterprises which catapulted the United States into being the major industrial power in the world. Amsden [1989] recounts a similar story in respect of the South Korean experience in the 20th century, where functional efficiency-attainment has been the key driver in enabling Korean firms to acquire global market share. The results presented in this paper, therefore, raises an important issue with respect to Indian industrial performance: can India ever be a major industrial power if the noted progress of the 1980s is merely a correction of the regress of the 1960s and 1970s?

The comments made thus far apply only with respect to the data used in this study, and the results are valid for understanding what has happened internally in India between 1950-1951 and 1988-1989. If the fundamental change that took place in industrial policy in July 1991 is

truly a "policy switch" (Flood [1992]), it can destroy the path-dependencies and inertia engendered in Indian industrial behavior in the past four decades. When recent data are introduced into empirical analysis, it is hoped that latter-year observations (1991 onwards) will define the frontier. Some of the frontier-defining observations in the present study, which belong to the 1950s anyway, may turn out to no longer be the most efficient. This will be prima-facie evidence that the recent reforms are working, and Indian industry is actually making progress.[45]

There are several questions that need to be answered in the Indian context, to assess if micro-level capabilities are the key to economic progress and two come to mind. The first is: how are particular capability sets, to manage physical or working capital, utilized within an industry, given the existence of industry-specific policy regimes? The second is: how do different types of resources yield these different capability sets, and what incentives do policy regimes provide so as to acquire relevant types of resources and capabilities?[46] Thus, future industry-specific research can highlight whether particular regimes have led to the enhancement of capabilities and efficiency within specific industry settings.

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[45] The study has a limitation which has to be spelt out. Indian industrial efficiency has not been compared with respect to that of other countries but only with respect to itself over time. Cross-country comparison may reveal an even worse picture for India.

[46] Prior work using x-efficiency as the underlying theory has shown how changing policy regimes led to the enhancement of firm-level technological capabilities in the U.S. telecommunications industry (Majumdar and Venkataraman [1993]). Policy regimes can also provide firms with incentives to be skilled and efficient in certain areas; for example, Korea acquired efficient large-project implementation capacity and allied production skills, via targeting of the shipbuilding sector as strategic (Amsden [1989]).

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TABLE 1

Log-Quadratic Estimates of Growth Rates and Acceleration/Deceleration Trends in Indian Industrial Efficiency

	Efficiency growth rate [percent per annum] *(b)*	Acceleration/ deceleration rate *(c)*
Overall Period:	-0.34	0.09
1950-1988	(0.12)	(0.01)
Regime 1:	-0.29	0.00
1950-1960	(0.14)	(0.00)
Regime 2:	-2.10	0.53
1961-1973	(0.69)	(0.23)
Regime 3:	-1.31	0.50
1974-1979	(0.42)	(0.28)
Regime 4:	1.97	-0.14
1980-1988	(0.25)	(0.11)

Standard errors in parentheses

APPENDIX 1

Efficiency Scores for Indian Industry

Regime 1		Regime 2		Regime 3		Regime 4	
1950-1951	1.000	*1961-1962*	.999	*1974-1975*	.846	*1980-1981*	.822
1951-1952	1.000	*1962-1963*	.878	*1975-1976*	.788	*1981-1982*	.880
1952-1953	1.000	*1963-1964*	.850	*1976-1977*	.793	*1982-1983*	.879
1953-1954	1.000	*1964-1965*	.732	*1977-1978*	.785	*1983-1984*	.915
1954-1955	.994	*1965-1966*	.681	*1978-1979*	.781	*1984-1985*	.918
1955-1956	.996	*1966-1967*	.670	*1979-1980*	.777	*1985-1986*	.951
1956-1957	.989	*1967-1968*	.694			*1986-1987*	.949
1957-1958	.951	*1968-1969*	.804			*1987-1988*	.944
1958-1959	.984	*1969-1970*	.776			*1988-1989*	1.000
1959-1960	1.000	*1970-1971*	.753				
1960-1961	.967	*1971-1972*	.713				
		1973-1974	.690				
Mean:	**.989**	*Mean:*	**.770**	*Mean:*	**.795**	*Mean:*	**.918**
S.D.:	**.015**	*S.D.:*	**.094**	*S.D.:*	**.023**	*S.D.:*	**.049**

Mean Score for the overall period: **.873**

Standard Deviation: **.110**

Appendix 2: Target Input Use As Proportion of Actual Input Use

Years	Production Human Resources	Managerial Human Resources	Fixed Capital	Working Capital
1950-51	1.000	1.000	1.000	1.000
1951-52	1.000	1.000	1.000	1.000
1952-53	1.000	1.000	1.000	1.000
1953-54	1.000	1.000	1.000	1.000
1954-55	0.994	0.938	0.903	0.918
1955-56	0.991	0.963	0.997	0.865
1956-57	0.941	0.865	0.990	0.849
1957-58	0.951	0.884	0.924	0.802
1958-59	0.985	0.847	0.764	0.839
1959-60	1.000	1.000	1.000	1.000
1960-61	0.722	0.911	0.967	0.967
1961-62	0.711	1.000	1.000	0.918
1962-63	0.698	0.879	0.707	0.815
1963-64	0.688	0.850	0.665	0.786
1964-65	0.665	0.733	0.635	0.733
1965-66	0.682	0.672	0.610	0.682
1966-67	0.670	0.606	0.556	0.670
1967-68	0.695	0.625	0.547	0.694
1968-69	0.804	0.681	0.556	0.804
1969-70	0.776	0.683	0.591	0.776
1970-71	0.753	0.671	0.616	0.753
1971-72	0.714	0.650	0.674	0.714
1973-74	0.682	0.563	0.690	0.690
1974-75	0.666	0.535	0.846	0.715
1975-76	0.692	0.567	0.788	0.766
1976-77	0.711	0.590	0.793	0.751
1977-78	0.709	0.601	0.786	0.786
1978-79	0.758	0.684	0.782	0.782
1979-80	0.721	0.624	0.777	0.711
1980-81	0.710	0.580	0.822	0.685
1981-82	0.765	0.658	0.880	0.727
1982-83	0.808	0.727	0.880	0.773
1983-84	0.742	0.730	0.915	0.774
1984-85	0.780	0.718	0.918	0.720
1985-86	0.859	0.695	0.951	0.758
1986-87	0.899	0.881	0.949	0.917
1987-88	0.912	0.896	0.944	0.834
1988-89	1.000	1.000	1.000	1.000

Figure 1: INDUSTRIAL EFFICIENCY TRENDS

PATTERNS FOR INDIA: 1950 to 1988

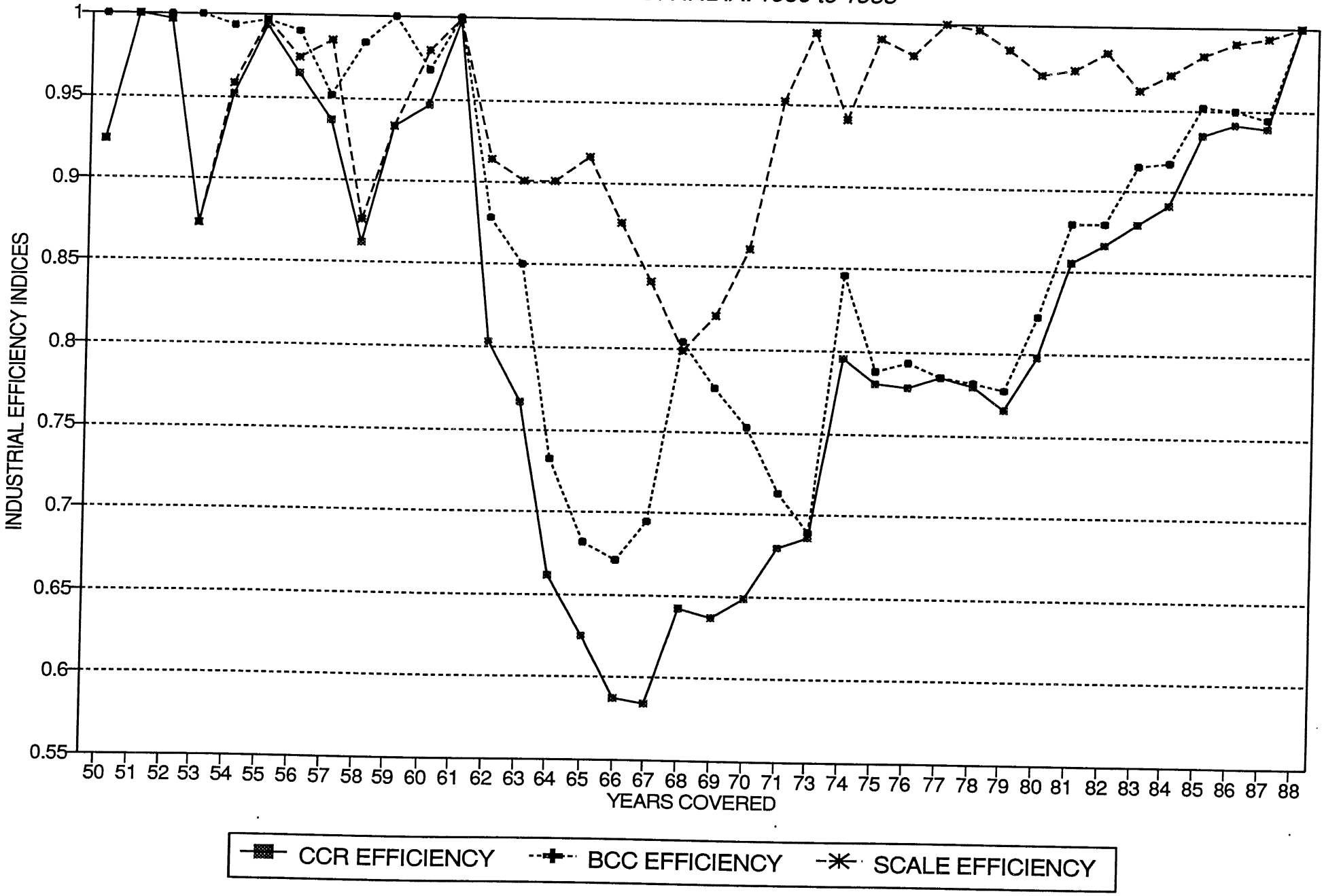

Figure 2: INPUT UTILIZATION PATTERNS

HUMAN CAPITAL USE IN INDIA

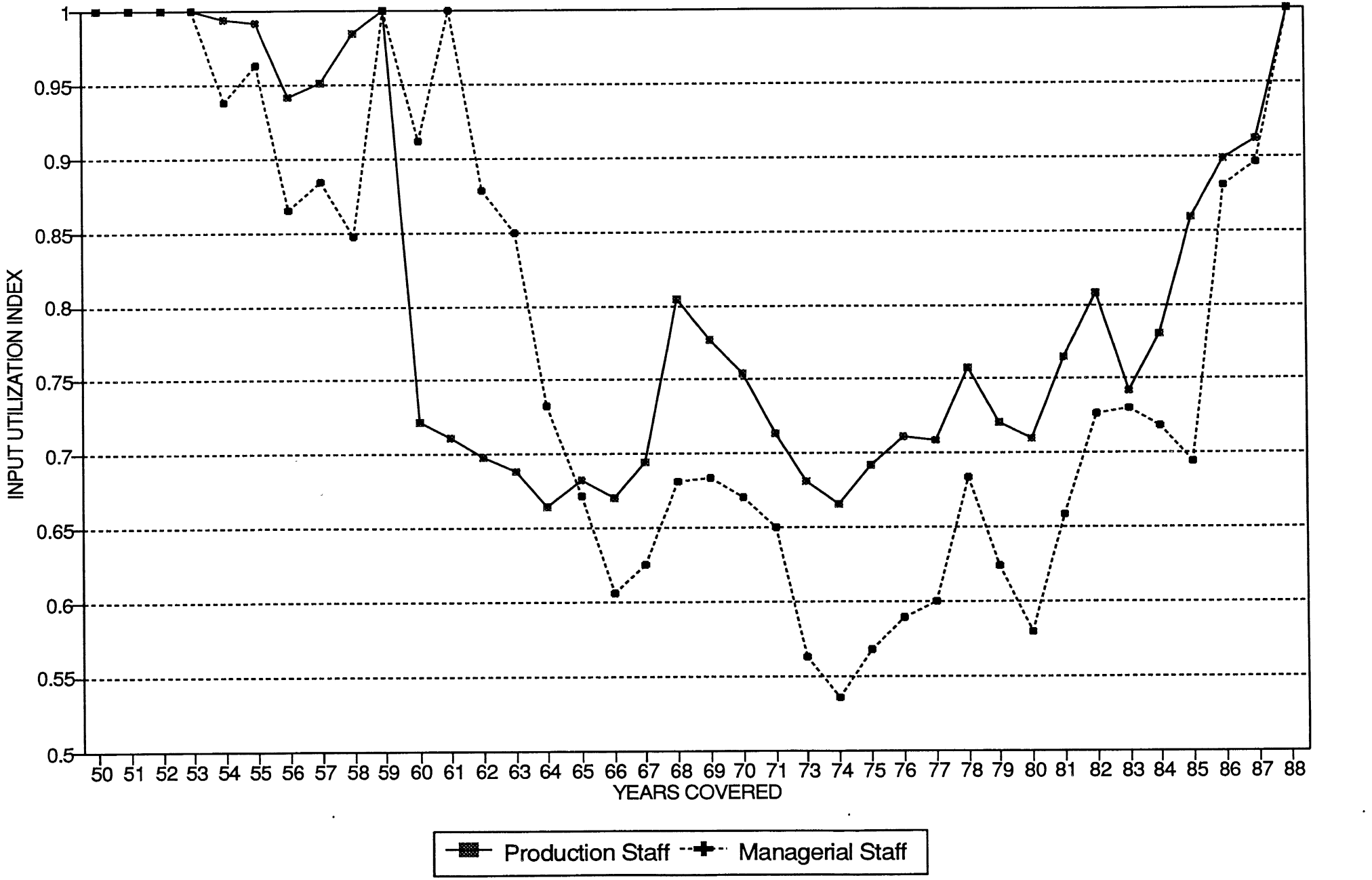

Figure 3: INPUT UTILIZATION PATTERNS

FIXED AND WORKING CAPITAL USE IN INDIA