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UNDERSTANDING THE EXPANSION AND QUALITY OF ENGINEERING EDUCATION IN INDIA

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This is a study of higher education and quality in one of the world's largest developing economies. India. India is already an important global economic player, and, unusual for developing countries, its success is due in part to exports of information technology services. By mid-century, India could be an economic powerhouse, but one factor influencing whether it reaches this level will be how successfully it creates quality higher education to put its labor force at the cutting edge of the information society. It is difficult to imagine large economies reaching higher stages of development in the 21st century without high levels of innovative, well-trained, politically savvy professionals.

India's potential success in developing highly skilled professionals is not the only reason to study its higher education. The way governments go about organizing higher education can tell us a lot about their implicit economic, social, and political goals, and their capacity to reach them. Our study therefore puts a lot of emphasis on the role of the State—that is, the political system and the way it is reflected in government organization and policies. The State, in our view, is crucial to how higher education develops everywhere, but certainly in a country such as India, where the State (nationally and regionally) has always played a central role in economic and education policies. Because university level technical education—namely, various types of electronic/ communications engineering and computer science—is essential to new information industries and new information industries are, in turn, important to economic development in the information age, we also place special focus on how the State and these university departments are responding the growing demand for innovative technical education graduates.

Indian colleges and universities produce more engineers than any other country in the world, except China, and engineering enrollment is increasing in India faster than anywhere else, at almost 10 percent per year. Given the importance of high technology products and services in the growth of the global economy, many believe that those countries and regions able to create a stock of high quality technically skilled human

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capital are more likely to flourish in the coming decades. In India's (and China's) case, this seems to be already occurring. So it is important to understand whether or not India is becoming better positioned to go beyond its present stage of lower end technical product and service development through its rapid expansion of engineering and computer science higher education.

In this paper, we take an innovative approach to analyzing the nature of this expansion. We summarize the available general data on the growth of higher education in India and conditions in the labor market for engineers and other higher education graduates. But we are also able to draw on an extensive survey of colleges and universities we carried out in four Indian states that produce and employ close to the majority of Indian technical higher education graduates—Karnataka, Delhi, Maharashtra, and Tamil Nadu. In that survey, we interviewed about 6,000 electronic engineering and computer science students in their final year of study in about 40 government and private higher education institutions. We also conducted administrator surveys in those institutions and were successful in getting information from more than 75 percent of them. Our final set of data is ten videotapes of electrical engineering classes in ten institutions in three states.

On the basis of these data sources, we have been able to assemble a comprehensive picture of Indian engineering education, to analyze the current quality of graduates, and to assess the prospects for quality improvement. Our analysis suggests that there is, indeed, considerable demand for entering an engineering career, and as a result, India has found a logical "low public cost" formula for expanding its stock of technically trained human capital and done so in a way that is fairly equitable. The government has promoted the growth of private unaided technical colleges and affirmative action for disadvantaged castes. Thanks to high average private labor market rates of return to studying and pursuing engineering and computer science professions, many young people are motivated to get a technical degree, and they are willing to pay to achieve that goal.

The students graduating as engineers and computer scientists are generally from highly educated, rather well off families and they have high scores on India's college entrance exams. This suggests that technical fields are attracting academically very capable young people.

However, the education they receive varies considerable in quality. While financially efficient and rather equitable, we find that the current strategy of expanding technical education appears to sacrifice quality. The top of the technical higher education pyramid is the group of Indian Institutes of Technology—central government funded universities with extremely high admissions requirements, which send a high fraction of their graduates to study for advanced degrees abroad. Yet they produce only about 5000 BA degrees annually out of the estimated 300 thousand students receiving a technical graduate degree system wide.

More than 90 percent of engineering/computer science students today are trained in private colleges. The cost of this education is substantially funded by families rather than at public expense. The highest scoring university entrance test students are admitted to both government and private colleges, all at government mandated lower levels of tuition. In addition, the government requires all colleges and universities to admit specified percentages of disadvantaged students, as defined by caste, also at government mandated lower tuition rates. Thus, private colleges are motivated to attract their quota of high scoring students but also to admit as many additional (higher social class) students as possible scoring lower on college entrance tests but willing to pay much higher tuition. At the same time, most private colleges have no more than a handful of professors with PhDs, no research to speak of, only simple lab equipment, large class sizes, and no access or motivation to engage in research. That said, our survey suggests that private colleges do compete for students, making quality claims for themselves mainly on the grounds of job placement, peer examination scores, and program availability. They also make arrangements for some professors to obtain PhDs part time, usually at a nearby government university. Competition and some of these teacher training efforts may tend to increase quality, but magnitude of these factors is small compared to the overriding impact of the private colleges' business model of keeping costs low and maximizing revenues under conditions of government tuition regulations.

We will show that the results of the Indian government's "low public cost" strategy appear to be fourfold:

- The Indian government is focusing its efforts to raise quality on a limited group of institutions producing very few graduates. Even this strategy faces difficulties because of a lack of PhDs produced by the overall system, and limited government resources spent on R & D in universities.

- A relatively small percentage of colleges and universities in each state produce reasonably well-trained engineers and computer software professionals. These are mostly, but not exclusively, state-owned institutions. The state-owned institutions have a higher proportion of Ph.D. faculty and produce a higher proportion of graduate students compared with private institutions.

- A few higher-paying firms are able to recruit these graduates, and generally like what they get, but smaller, less well-placed firms are generally dissatisfied with what is available to them.

- Students are, however, generally satisfied with the results of their education, suggesting that the Indian State's legitimacy objectives associated with this type of "low public cost" expansion are also satisfied.

BACKGROUND[2]

The Indian economy has expanded at a steady and rapid rate in the past fifteen years (Figure 1). Economic growth has increased demand for university graduates,

[2] Beteille (2008) provided much of the data for this background section. Assistance of Pradeep Choudhury and Pumsaran Tongliemnak in the collection and analysis of secondary data is also acknowledged.

particularly for those in technical fields. This growth in demand is driven largely by the globalization of information technology industries, with India as a center of relatively low cost skilled (university educated and English speaking) technical labor, hence an attractive location for outsourcing software production and other IT-related services, including call centers. As of 2008, India was the largest producer and exporter of IT enabled services in the developing world, with $47.3 billion in annual export sales and 1.7 million people employed in the sector (Nasscom, 2009). India's exports of software services amounted to US$31 billion in 2006-07, forming 41 per cent of all total service exports (RBI Bulletin 2008). With higher economic growth over this long period of time (per capita gross domestic product doubled in 1995-2008) and somewhat increased income inequality, there has also probably been disproportionately increasing demand for more human capital-intensive goods and services.

[Figure 1 here]

At the same time, Indian higher education has also expanded rapidly, both in the number of institutions and the number of students enrolled (Bhushan, Malhotra, and Gopalakrishnan, 2009). In 1985, there were less than 6 thousand colleges with about 4.5 million students; by 2008, there were more than 20 thousand colleges with more than 12.4 million students. The number of universities (including 'institutions deemed to be universities and institutions of national importance) more than doubled from about 200 to 415. The number of universities and colleges (or higher educational institutions (HEIs)) in India is four times the number in the United States and Europe. China, with the highest enrolment in HEIs in the world, has only 2500 HEIs (Agarwal, 2006). In 2007-08, higher education in India employed approximately 522,000 teachers (UGC, 2009). Although all this represents massive growth in India's higher education system, the proportion of the age cohort attending higher education remained quite low, reaching only about 12-13 percent in 2008. Even so, this gross enrollment rate varies greatly among states from almost 40 percent in Nagaland and 25 percent in Kerala to 10 percent in West Bengal, Bihar and Rajastan to an even lower rate (7 percent) in Assam (Thorat, 2006). This is partly related to the proportion of the population living in rural areas, since estimates place the gross higher education enrollment ratio at about 8 percent in rural areas and 25 percent in urban (Thorat, 2006).

Other statistics worth noting: the gross enrollment ratio for women is much lower than for men, 14.5 percent for men versus 10 for women in 2006-07. Only 9.4 percent of scheduled caste young people are enrolled, and 7.5 percent of scheduled tribes. (SES, 2006-07).

In 2007/08, almost two-thirds of students were enrolled in arts and sciences, and about another 18 percent in business (commerce/management) courses, only 7 percent in engineering/technology, and an even lower 3 percent in medicine (Table 1).

Despite the low percentage of enrollment in engineering/technology, that proportion has been increasing steadily over the past fifty years, and the sheer numbers of those enrolled in and graduating from engineering institutions is growing rapidly In

2007-08, there were more than 900 thousand students enrolled in engineering institutions, almost double the number seven years earlier (Figure 2).. In fifteen years, from 1990 to 2005, the stock of graduate engineers in India more than doubled, from 500 thousand to 1.2 million (Figure 3). At current enrollment rates, the figure today should be approaching almost two million. The number of engineering graduates per one million population is as high or higher than in developed countries, but since only a fraction of these works as engineers, other measures of the number of engineers per million population shows India as lower than China and considerably lower than many countries, particularly Japan and South Korea (cite).

[Figures 2 and 3 here]

One of the most important features of the enrollment growth pattern in recent years is the rapidly increasing number of new private colleges offering accredited courses in engineering, management, and medicine, as well as private vocational courses preparing young people for work in the IT sector. Ninety-three percent of the engineering colleges were private in 2006-07. They also account for 92 percent of the student intake.

[Table 1 here]

The growth of private colleges in technical and business fields is an important feature of India's higher education expansion, but it needs to be interpreted carefully. According to Agarwal (2006), in the year 2005/2006, the approximate breakdown of college enrollment according to financing, was still largely (70 percent) public or publicly aided (salaries of staff paid by government, subject to government recruitment policies), but the most rapidly growing type of college is unaided private, which, unlike private aided colleges, pay their staff out of collected revenue (Table 2).[3] Nevertheless, as we show below, in almost all cases, private unaided colleges are still subject to government directives on affirmative action hiring policies and student admissions. Indeed, the only way for colleges to get out from such direct government controls over course curricula and examinations is to become a Deemed University.

[Table 2 here]

Thus, the 70 percent figure misestimates the extent of public financial and other significant involvement in higher education, for four important reasons (see Tilak, 2003):

- In the Indian system, universities are distinguished from colleges in that universities as educators mostly provide only graduate (generally known as post-graduate) education (some also provide limited undergraduate education), university faculty teach and do research, and universities have autonomy to organize their own curriculum for each course of study and to set their own course examinations. The more important university function is to be the affiliating body for independent member colleges. Colleges are mostly undergraduate institutions, although many offer post-graduate degrees as well. To be accredited and to issue

[3] Enrollment figures in Table 2 are Agarwal's guess-estimates.

their graduates government certified degrees, colleges must be affiliated with a university. All aided and unaided colleges are necessarily affiliated with public universities, hence even though not financed directly by the government, they are subject to public university controls over curriculum and the tests students must pass to get credit for the courses. In the case of engineering studies, the public universities obtain considerable oversight from a national public body, the All India Council of Technical Education (AICTE), which regulates curricula.

- Private affiliated (aided and unaided) and public colleges and universities are subject to *central/state* government controls over their admissions policies. They must admit certain percentages of disadvantaged students by category of student. The tuition paid by these disadvantaged students is, in turn, controlled by *state* governments, whether the student attends public or private college. In varying degrees, depending on their disadvantage designation and the state's policy for tuition subsidies and affirmative action policies, students' tuition is subsidized wherever they attend. Therefore, even private unaided colleges receive a certain percentage of their students under the same tuition arrangements as public colleges and universities and receive income from the state. The private institutions are also subject to accreditation by the National Board of Accreditation (a body of AICTE), which sets minimum infrastructure requirements and reviews curricula and teaching standards.

- Colleges and universities in each state accept students based on a state government administered college entrance examination system, with higher scoring students getting more choice on a number of grounds, including higher "ranked" colleges, more desirable courses of study at the college, and access to lower tuition fees. Such students mostly prefer government institutions. This is particularly applicable to professional education. National institutions (all public), such as the Indian Institutes of Technology and the Indian Institutes of Management, give a separate examination.

- On the other hand, unlike public colleges and universities, both private aided and unaided colleges and private deemed universities can accept non-designated group students at much higher tuition fees than the fees charged by government colleges and universities. The highest scoring students not in designated disadvantage groups pay the state-approved (often set by private colleges in consortia) private college fees (which is higher than the public college fee). Furthermore, depending on the state, private colleges and universities can accept up to 25 percent of students at even higher fees. These students are lower-scoring and have little bargaining power besides the tuition fees they are willing to pay.

In sum, the fee structure in Indian higher education is complicated. Students are ranked based on common entrance tests conducted by state governments. The students with high ranks (set by the number of admissions available set by each state government), whether they join government or private colleges, pay a low fee, which is also fixed by each state government. Government colleges admit from the high rank students only, and charge the (lower) government fee, which varies from state to state. The private aided and unaided colleges also admit a large number of students from this high rank, and they pay the fixed government fee. Students whose ranks are below the benchmark have to pay a higher level of fee approved separately for each college in some states. Such students join either private aided or unaided colleges. Both government and private colleges are required to admit "designated" students from lower castes. These students get a fee subsidy, ranging from 50 to 100 percent, depending on the designated category. The fee subsidy takes the form of a direct payment to the college by the government.

Essentially all private colleges are non-profit charitable trusts, so cannot make profits. However, as we shall show, many of these charitable trusts can and do accumulate considerable surplus based on the difference between the total tuition fees they collect and their spending for faculty and other services. Most use this surplus to expand enrollment and therefore to accumulate more surplus and to expand further. This complex public-private relation that governs more than 60 percent of the higher education sector makes it extremely difficult to define the meaning of private in Indian higher education. "Private" includes a high degree of government control over the content of the curriculum and the standards used to measure learning, hence what takes place in higher education classroom, but also includes the freedom for private unaided colleges to accumulate surplus and expand operations by charging at least a fraction of students higher than public tuition.

The rapid expansion of unaided colleges affiliated with universities is gradually transforming not only the landscape of where students choose to go to post-secondary education, particularly in certain fields, but also seems to be gradually transforming the role of public universities into regulating, degree-granting institutions and away from teaching or research (Kapur, 2009). They are also act as a strong pressure group against giving autonomy (deemed university status) to private colleges.

In the words of one writer, "These private institutions are helping to meet the growing demand that the public sector cannot. Private institutions are less subject to political instabilities and day-to-day political pressures that often bedevil public institutions in developing countries. They are also more nimble and able to respond to changes in demands from employers and labor markets. Yet despite these positives, these institutions are of highly variable – and often dubious – quality" (Kapur, 2009).

Evidence of this market responsiveness is that the expansion of private colleges has been greatest in those fields of study that are most in demand and in those localities where the demand for graduates in these fields is expanding most rapidly. For example, whereas government and government-aided institutions saw an increase of barely 3.5 percent in 2000-2005, private unaided colleges expanded almost 109 percent. In 2002, 78 percent of all engineering and technology colleges were private (Tilak, 2003). In 2006, the percentage had increased to 85 percent, and in 2007 to nearly 95 per cent. The southern states dominate in private engineering and technology education. Andhra Pradesh, Karnataka, Tamil Nadu and Kerala (in descending order) have the highest percentage of private engineering and technology colleges (Beteille, 2008). The only other major state where a large number of private colleges exist is Maharashtra in the western region.

There are indications that State policy may be changing in simultaneous and opposite directions. Our interviews in Maharashtra, Delhi, Karnataka and Tamil Nadu, sites of considerable growth in private unaided technical colleges, suggest that the rapid growth of Deemed Universities is supported by apparently increasing willingness of state authorities to grant support for private unaided colleges to become autonomous (Deemed) universities. One path to towards this goal is for private colleges to begin post graduate programs at least in a minimum number of fields. These can be older more established private colleges as well as newly established colleges, but, nevertheless, the movement in this direction will greatly loosen the regulatory power over private institutions' decision making.

At the same time, there are many signals and events that point toward considerable expansion of public universities and colleges over the next 4-5 years. The Indian government has set a higher education gross enrollment target of 15 percent of the age cohort—approximately 21 million students—by 2012. The government announced plans to establish and fund 30 new central universities across the country and to support states financially to open colleges in the 340 districts that have low college enrollments In addition, the central government has begun to increase the number of IITs, IIMs, India Institutes of Science and Engineering Research (IISERs), National Institutes of Technology (NIT), and India Institutes of Information Technology (IIIT) (Planning Commission, 2008). These are all "elite," relatively expensive, and highly selective and autonomous technical universities designed to greatly increase the high end of the Indian engineering and science cadre. The total number of students in all these institutions together, however, will be small compared to the total output of India's technical colleges.

Given this background and some preliminary data we have from student and institutional surveys and interviews in Indian technical colleges and universities, we try to address several important issues in Indian higher education:

1. What are the driving forces shaping higher education and where they are likely to take it?

2. What is the essence of the higher education financing system established by government policies and what can we infer from that financing system about government goals for higher education?

3. How are colleges, their faculty, and their students reacting to these policies?

4. What can be said about the current quality of Indian technical/engineering education and its prospects for the future?

MODELING CHANGE IN INDIAN HIGHER EDUCATION

We situate higher education expansion and quality in the context of a politics of education that in turn reflects much broader struggles over social goals and the distribution of national resources. There is a distinct paucity of research on *how* States in developing countries try to reorganize access to and the delivery of university education to create new knowledge. We know little about how effectively countries are developing the scientific and managerial cadres that will lead the economy into science-based development.

Figure 4 summarizes our State-centered model. The model represented in this figure puts the national State at the center of four key factors influencing the way it develops its higher education system:

1. Economic globalization, changing economic payoffs to higher education graduates, and the structure of payoffs to various programs of study/professions

Globalization together with new information technology and the innovative processes they promote are driving a revolution in the organization of work, the production of goods and services, relations among nations, and even local culture. No community is immune from the effects of this revolution. It is changing the very fundamentals of human relations and social life.

Two of the main bases of globalization are information and innovation, and they, in turn, are highly knowledge intensive. Internationalized and fast-growing information industries produce knowledge goods and services. Today's massive movements of capital depend on information, communication, and *knowledge* in global markets. And because knowledge is highly portable, it lends itself easily to globalization.

If knowledge is fundamental to globalization, globalization should also have a profound impact on the transmission of knowledge. Its effects are particularly great on higher education. Why is this the case? The answer has three parts. Rising payoffs to university training in a global, science based, knowledge intensive economy makes university education more of a "necessity" to get "good" jobs. Demographics and democratic ideals increase pressure on universities to provide access to groups that traditionally have not attended university. The growing power of "externally defined" global market values (in which universities themselves play an important role) increases pressure on universities to reinvent local communities and culture.

Governments in a global economy need to attract foreign and generate local capital, and this capital needs to be increasingly knowledge intensive. This translates into pressure to increase the average level of education in the labor force. The payoff to higher levels of education is rising worldwide as a result of the shifts of economic production to knowledge-intensive products and processes, as well as because governments implement policies that increase income inequality. Rising relative incomes for higher educated labor increases the demand for university education, pushing governments to expand their higher education, and, correspondingly, to increase the number of secondary school graduates ready to attend post-secondary. In countries that were previously resistant to providing equal access to education for young women, the need for more highly educated low-cost labor tends to expand women's educational opportunities.

Governments have responded directly or created the conditions whereby private providers have greatly increased university places, but given the bias of global demand for the higher educated, the tendency is rates of return to investment in higher education to continue rising or stay high relative to the payoffs to investing in primary and secondary schooling. Estimate of rates of return show that the payoffs to university education are now often as high or higher than to either secondary or primary (World Bank, 2000). Furthermore, some of these same studies were able to measure rates of return for several different years in the 1970s, 1980s, and 1990s. They suggest that rates of return to university have risen *relative* to primary and secondary rates. Rising rates of return to higher education relative to lower levels of schooling also characterize many countries where measured rates to investment in university remain lower than to investment in primary and secondary.

Rates of return to higher levels of schooling increase not necessarily because the real incomes of university graduates are rising in *absolute* terms. Real incomes of university graduates could stay constant or even fall, but if the incomes of secondary and primary graduates fall more than those of workers with higher education, the rate of return to higher education rises and pressure on the higher education system increases.

Many years ago, Mark Blaug, Richard Layard, and Maureen Woodhall, studied the paradox of Indian universities. Graduates seemed to suffer high rates of unemployment, yet the demand for university education continued unabated (Blaug, Layard, and Woodhall, 1969). They found that although the rate of unemployment was, indeed, high among university graduates, it was even higher among secondary school graduates. This helped push secondary school graduates to go on to university. In the past 25 years in the United States, the real incomes of male college graduates have risen very slowly, but the real incomes of male high school graduates have fallen sharply, again raising the college income premium and increasing enrollment in higher education.

Globalization may therefore benefit university graduates only in *relative* terms, but the implications for general educational investment strategies are the same as if university graduates' incomes were rising more rapidly than incomes of those young people with less schooling. By increasing the *relative* demand for university graduates more rapidly than universities can expand their supply, globalization puts continuous pressure on the educational system to expand.

Not all programs of study are equally affected by the increased demand being generated in the globalized information economy. In most countries, the payoff to business/economics education has risen considerably since the 1980s. In many countries—Brazil, China, and India, for example—the earnings of engineers, computer scientists, and physical scientists have also been positively affected by than new structure of economic growth. As result, the demand for university places to study these subjects has increased even more rapidly than for university places more generally, and many of the brightest students in the country choose to study in those programs. This is not true everywhere, however. We will show that, among the countries we study, Russia is an exception to the rule: engineering is not a demanded profession, but the government continues to allot many university places to engineering and science, with a resulting decline in the average quality of students entering such programs.

Higher rates of return (both private and social) to higher education have important effects on the rest of the educational system and on income inequality. Rising rates to higher levels of schooling mean that those who get that education are benefited relatively more for their investment in education than those who stop at lower levels of schooling. Those who get to higher levels of schooling are also those from higher social class background. This is acutely so in societies such as Brazil's, which are already highly unequal and in which less than 15 percent of the age cohort attends university.

So not only do families with higher social class background have more capital to start with, under these circumstances, they get a higher return to their investments. This is a sure formula for increased inequality in already highly unequal societies. In addition, higher socio-economic status (SES) students are those who get access to "better" schools, in regions that are more likely to spend more per pupil for education, particularly in those schools attended by higher socio-economic class pupils, and enter programs with higher payoffs, such as engineering, business/economics, and medicine. Competition for such higher-payoff education also increases as the payoff to higher education increases, because the stakes get higher. Higher SES parents become increasingly conscious of where their children attend school, what those schools are like, and whether they provide access to higher levels of education. The total result is therefore that schooling becomes more stratified at lower levels rather than less stratified, especially under conditions of scarce public resources. National economic competition on a global scale gets translated into sub-national competition in social class access to educational resources.

If rates of return to university are pushed up by globalization, intensifying the competition for access to higher education, higher-educated, higher income parents tend to step up the amount they spend on primary and secondary school to assure their children's university enrollment. Even in the public system, wherever possible, parents with more motivation and resources will seek "selective" public schools that serve higher social class clientele. These same parents, willing to spend on the "best" (often private) primary and secondary schools for their children, end up fighting for high quality, highly subsidized (or essentially free), public universities and many of them do everything they can to get their children into the most highly subsidized part of the system.

Thus, the State's higher education strategies should be (and are) influenced by relative economic payoffs to education and by the relative payoffs to different professions. Furthermore, the State needs to be concerned with the distribution of access to higher education by different socio-economic groups for both efficiency and equity reasons. Whom the State chooses to represent politically and how it assesses the trade offs between “efficiency” and equity affects the higher educational financing system and who gets the major benefits from State spending.

2. State legitimation through HE expansion

Pressures on the higher education system generated by a combination of increasing payoffs to investment in university, population growth, and higher completion rates of secondary education have important political implications for the State. The central government and, to a lesser extent, state governments, in all these countries are closely identified with providing access to higher education places and controlling who gets access through examination systems, tuition setting, public subsidies, scholarships, and loan programs. Various groups in society, from those who have relatively high levels of family resources and fight for higher educational subsidies so that their children get an even better “deal,” to those highly motivated lower-income families whose children are excluded from higher education and therefore feel frustrated, have a vested political interest in the State’s expansion strategies. How the State handles expansion, access, and the “quality” of higher education can seriously affect the national State’s political legitimacy and, often, local state’s legitimacy as well.

Beyond this possible direct relation between State higher education policies and State legitimacy, State strategies can also impact legitimacy indirectly. State legitimacy is closely related to families’ material wellbeing and employment, which, in turn, depends on economic growth. If the effectiveness of educational policies is related to the rate of economic growth, the State’s political legitimacy may be considerably raised or diminished by the quality of its educational strategies. This applies even to non-democratic regimes such as China’s. Indeed, in terms of the fundamental organization of the State (as compared to regime change), China’s or Russia’s form of State organization is probably more dependent on high rates of economic growth for legitimacy than Brazil or India’s. Thus, the current Chinese and Russian governments may have to be more concerned, in this sense, about effective higher education strategies.

3. The ideology of globalization and the push for “world class” universities

There is also an important ideological component to globalization. That ideological component is rooted in the notion that the quality of national culture (and by implication, the national State) is measured in terms of the quality of its educational system, particularly its universities. The notion itself is rooted in the ideology of Western conceptions of progress, but the more important characteristic of this ideology of globalization is that the arbiters of such educational quality, and hence of the national culture, are international organizations, such as the Organization of Economic Cooperation and Development (OECD), he World Bank, UNESCO, the International Education Association (IEA), and because of the “quality” of its universities (measured in these terms), the United States and Europe.

This ideology has been characterized in the recent globalization literature as the “as [a] world-wide field of power in which research-intensive universities in the United

States exercise a global hegemony" (Marginson and Ordorika, 2008, p. 1). It is symbolized by the Jiao Tong University "Shanghai List" of the world's top universities and the impact its existence (and that of other world rankings) has on national State decisions regarding higher education. Universities in the English-speaking nations constitute 71 percent of the top 100 research universities. To the extent that nations are concerned with getting their universities into that top 100, the implication is that they need to copy the U.S.-U.K. model of the university. That model is the standard of quality, and indeed, the model is being strongly promoted by the international organizations. Accepting this notion suggests that university programs and organization should be rethought around training students to much higher "global knowledge" standards. The movement to emulate U.S. and European universities is evident in a number of policy pronouncements across the developing countries and, in part, reflects ideological component of globalization.

The more direct impacts of globalization on knowledge production can also be considered as having an ideological component, strongly related to the ideology of educational quality discussed above. As we have argued, globalization and information technology are driving profound changes worldwide in the way we work, use our leisure time, and think about our place in the world. We have suggested that much of the effect is transmitted from the global economy to universities through the generally rising economic payoffs to university graduates and particularly to certain fields of post-secondary study. It is also transmitted through other manifestations of globalization: highly skilled professional labor is increasingly mobile, and its mobility is facilitated by the needs of research universities in the developed countries for postgraduate labor, especially in technical fields (Carnoy, 1998); and, increasingly, many fields of research are becoming trans-national because many of the world's problems are global—environment, health, education, security, and even culture.

These are "objective" phenomena, in the sense that as they are manifested nationally, they produce real material incentives. Yet how they are interpreted and how States respond to them is shaped by ideology, and a powerful element of that ideology comes from outside the BRIC nation-states. For example, the global conception of knowledge to which all university (and, more generally, all formal) education must adhere to promote sustained economic development has a significant ideological component rooted almost entirely in U.S. and European standards of knowledge.

Thanks to the Internet, international cooperation in research is also made easier, so it is likely that dominant elite research universities in the United States and Europe will increasingly shape research agendas in developing countries. Universities in developed countries are also pushing into developing countries with programs and even campuses to exploit developed country university brands.

Our analysis argues that this external ideology primarily influences universities through the State. This differs substantially from the mainstream literature on higher education and globalization. For example, Altbach explicitly assumes that the response to globalization—the international research networks, internationalizing student bodies, university extensions into other countries, and the quest for world-class quality—is situated in higher education institutions themselves. In other words, it is higher education institutions that initiate the response to globalization and shape the dynamic of the new internationalization. "… globalization is something that happens to universities and internationalization is how universities respond" (Cantwell and Maldonado-Maldonado, 2009 discussing Altbach's definitions of globalization and internationalization).

This approach has some empirical validity. Seen from on high, it is universities (faculty members) in developed countries that seek out faculty in universities abroad, and seek to install branch campuses in developing countries. It is universities that develop exchange programs, and developing country students who seek to study in the United States, Europe, and Japan, looking for the best opportunities to advance their careers. Developed country universities try to attract such students because, as graduate students, they serve as valuable assistants on large scale research projects, especially in engineering and science (Carnoy, 1998), and, as undergraduates, they pay much higher fees than locals. In some countries, universities also compete for faculty members to develop more prestigious departments and become more attractive for the best students—that is, to improve their quality as institutions.

However, this analysis also has serious limitations. We recognize the relative autonomy of higher education institutions and that many of them do initiate responses to the ideological components of globalization. Yet, most institutions depend on the State for funding and State sanctioned initiatives to pursue internationalization. Professors may be able to establish international research networks but cannot engage in international research on even a moderate scale without State funding. The major movements of students internationally takes place because of State funding, often with developing country channeled funding.

We hypothesize that the movement to develop "world class" universities is also State led. The State needs the active involvement of universities willing and able over time to become more like U.S. and European research universities. But without explicit support of the State, State research funding, and State funding to hire new faculty, no university in the BRIC countries can begin to look like a U.S. or European research university. Assuming that universities in developing countries are the main responders to globalization ideology is therefore a misreading of the process of change—whatever change takes place first and foremost involves the State, with universities playing active but subordinate roles.

4. Higher education institutions' responses to state policies and to each others' policies

Universities in all the BRIC countries do have a great deal of autonomy, and, in many cases, have some funding and support from provincial authorities. Many universities have more active and entrepreneurial leadership. Many others do not. This is why it is not farfetched to accept the analysis of those that put the university itself at the center of change. Indeed, some economics-based analysis sees competition among universities, similar to competition among private firms, as the driving force behind innovation and improvement (World Bank, 2000).

Our model of change would be remiss if we did not study differences in the responses of universities to the national and global contexts, given State higher education policies. Burton Clark argued that the most conservative institutions in democratic societies were universities (Clark, 1964). We will show that Clark's observation is true in most cases, but not entirely. Moreover, universities may appear conservative because they are the product of earlier State reforms that have "trained" university faculty to behave effectively within that earlier context. Such institutions and particularly their faculty try to preserve the conditions under which they know how to be effective. Most older faculty are also just trying to preserve their jobs. Further, universities may appear to be conservative because the State has implicitly assigned them a fundamentally conservative role—to absorb increasing numbers of secondary school graduates and train them into bachelors and professional degree graduates. This role does not require innovative techniques or quality improvements; to the contrary, doing research and being at the cutting edge of the field could help faculty become more knowledgeable in their subject but could also interfere with teaching increasing numbers of students as universities expand.

One of the interesting questions we will examine is whether students are "satisfied" with the education they received and whether this satisfaction is lower in mass, lower cost, second tier institutions. We hypothesize that, in general, students feel the education they get in whatever college or university they attend is rather satisfactory. Such mass universities may also be training students for jobs that are not cutting edge, and most students may, when all is said and done, be satisfied with the jobs they get with the education they received at these undistinguished, conservative institutions.

1. STATE POLICY AND THE PAYOFF TO INDIAN HIGHER EDUCATION

The form of India's higher education expansion in the 2000s does not appear to be accidental. It is a conscious decision by the central State to reduce its role in financing public expansion of undergraduate education (see Tilak, 2005, 2008; Bhushan, Malhotra, and Gopalakrishnan, 2009, Table 8) and to put more pressure on the states to take on this task. The states, in turn, are allowing expansion to be carried by the private sector, relying less on direct state involvement through the expansion of wholly public or privately aided institutions and more on indirect state influence through regulation of curriculum, examination standards, and how much tuition private institutions can charge. The state's motivation in encouraging private expansion may be in part the need to shift its education rupees to primary and secondary education. This shift from direct control to regulation is especially true in high payoff fields such as business and engineering/computer science.

Spending on Technical Higher Education. Overall, the result in the early 2000s has been a steady reduction in public spending per student in higher education (Table 3; Figure 5; Figure 6). Although these are approximate figures, they suggest that the spending per student in higher education fell about 12-14 percent in purchasing power parity dollars. Of course, in current dollars at current exchange rates, public spending per student is much lower, at about $US500 in 2007-2008, using UNESCO data. Tilak (2004) and CABE (2005) come up with another set of figures that show somewhat similar trends, but much lower absolute spending for higher education. Their figures indicate average public spending per student in 2003-04 of Rs.10,000, or about $US220 at then exchange rates. Since 2004, it appears that public spending per student has fallen (see Table 3). It is likely that our higher number is overestimated and represents the pubic spending per student in the richer states. For example, our survey in Maharashtra and Karnataka suggests that the public sector spends about $500 per student in those states. Public spending per student is also much higher for technical education. By allowing enrollment growth to be absorbed by increasing numbers of private colleges, the public sector is reducing the amount it spends per student. Families take up the slack with tuition payments (see Table 3)

[Table 3 here]

[Figure 5 here]

[Figure 6 here]

Thus, Indian government public spending per student in higher education in current US dollars is quite low, at about $US300-500. This low spending is made possible because Indian higher education is partially financed through tuition fees. Furthermore, popular, high payoff fields of study, such as business and engineering, are largely financed through tuition fees since most of the colleges providing education in these fields are private. And because of high demand, even public colleges have been allowed to charge higher fees for these courses than for courses in humanities and sciences.

According to Agarwal (2006), full costs are recovered for most professional programs, regardless of whether they are offered by private or public colleges. Tuition fees remain low in central universities (usually attended by the highest scoring students), but they are quite high in many state universities, particularly in Tamil Nadu, Karnataka, Kerala, Haryana, Punjab and Rajasthan. In 2004-05, nearly 50 per cent or more of the operating budget of many state universities, such as Madras University (50.4 percent), Bangalore University (63.7 percent), and Punjab University (50.4 percent) came from student fees (Agarwal, 2006; Beteille, 2008; Tilak and Rani, 2003).

We have three sources of data on fees. The first is the All India Council of Technical Education (AICTE). Table 4 shows AICTE's estimates of average fees paid for engineering courses in 2006 in several states (only two of which are in our survey--.Maharastra and Tamil Nadu). These are set by the states and apply to students who are *not* disadvantaged. But since more than 85 percent of engineering students attend private unaided colleges, at least 25 percent of them pay higher fees than these—sometimes much higher.

[Table 4 here]

Second, our survey of electronic engineering/computer science students in Delhi, Karnataka, Maharashtra, and Tamil Nadu in 2008-2009, asked students to report the tuition fees they paid. Consistent with what we would expect, average tuition fees in government and private aided colleges are much lower than in private unaided colleges, even though the fees are regulated even in these unaided colleges. Students reported paying about 10-20 (30 in one outlier) thousand rupees in tuition fees in government and PA colleges, and 40-55 thousand rupees in private unaided colleges (85 in one outlier). Overall, in our sample, which over sampled government and PA colleges relative to PUA colleges, the average tuition paid was about 42 thousand rupees per year, or about $US870. Total fees paid were somewhat higher, over 50 thousand rupees, or about $US1,200 annually (Figures 7a-7d). Although we do not show the total fees in the figures, they vary greatly from institution to institution. In many cases, they are 3-5 thousand rupees in addition to tuition, but in some cases they are much more, thus reaching the relatively high average figure reported.

[Figures 7a-7d here]

The fees as reported by students are confirmed by the third source of data on fees—our administrative survey of and interviews in 2008-2009 in private and public colleges and universities, which also showed total fees in the 50,000-80,000 rupee range in private institutions, and about 25,000 rupees in public and private aided institutions.

Rates of Return to Technical Education. A main reason why students are willing to pay fees in public colleges and are willing to pay the much higher fees charged by private institutions is the relatively high rate or return to a degree. There are a number of rates of return studies for India, and these show that since the late 1970s up to the late 1990s, the private rates of return to the investment in higher education were about 11-13 percent per year of higher education (Table 4a). This is not as high as in some developing countries, such as Brazil, but it is much higher than in mature, developed economies, such as in Europe and the United States. Private rates are estimated in two ways:

- Mincer rates, estimated from a regression model of log earnings as a function of age and education, in which only the foregone income as taken as a cost of attending further schooling, with the foregone income taken as the earnings of students with the next lower level of schooling at the ages of investing in the higher level. Log of earnings at each level of schooling are often estimated controlling for other factors that might influence earnings but are not associated with schooling itself.

- Calculated rates, in which age-income profiles are estimated and income foregone and other private costs are included. In some estimates, incomes at each level of schooling are adjusted for other variables and adjusted for income taxes.

Table 5a also suggests that the rates of return to secondary education were higher for women than for men, but the opposite was true for investment in higher education, and the rates of return to taking a technical diploma (a three-year degree at a technical college) was a better investment than a university education in terms of payoff per dollar of income foregone for men but not for women.

Once the Indian economy began growing rapidly in the late 1990s and into the 2000s, we would expect that the payoff to university and to technical or engineering degrees would have risen.

To bring these estimates up to date and to test whether rates of return to technical education are higher than to those for university education as a whole, we estimated Mincer and "calculated" rates using 2006 earnings, estimated tuition and public spending per student data, and added a focus on those in the labor force with engineering degrees, both at the diploma (three year degree) and graduate (four year degree) levels.

Mincer rates for 2006 are comparable with previous estimates, so we report them in Table 5a. They suggest that the payoffs to secondary schooling and university remained similar to those in the 1990s, except that for women, the payoff to secondary education may have declined somewhat and their payoff to a university degree increased substantially. Indeed, in 2006, it appears that rates of return to both a diploma (3 year) and a graduate (4 year) degree were higher for women then for men. Table 5a also shows that the returns to an engineering graduate degree are much higher for men than to investing in a non-technical college education. It should be stressed that these rates of return are not corrected for labor force participation, and that may bias them, especially for women. Nevertheless, they strongly suggest that the payoff to engineering education is very high.

The calculated rates take account of tuition costs as well as income foregone. It is key to keep in mind that technical higher education students pay a higher fraction of the costs of their education with fees, so we estimate their private rates of return using higher fees than for diploma and graduate degree students as a whole. Further, we estimate two sets of private rates using a lower estimate of total fees in 2006 for engineering students (25,000 rupees and 40,000 rupees, using the range in the Table 6 estimates for Maharashtra and Tamil Nadu) since tuition fees in technical colleges vary among public and private institutions. The higher fees are in the more expensive private institutions. We also estimate social rates of return, which include costs per student borne by the public sector in addition to private costs. The results of these estimates are shown in Table 5b. They confirm that the private and social (including public spending per student above and beyond tuition and other fees) rates of return to graduate degrees in engineering are extremely high for males, even when tuition and other fees are included. There were too few females with engineering four-year degrees in the India national household survey to compute a reasonably accurate calculated rate of return. Even the social rate of return based on private earnings differences is 16-18 percent per year of technical college.

These results suggests that getting students to pay a significant fraction of the costs of a graduate degree in engineering is an effective way to increase enrollment, and public investments in engineering education are also a good investment. When tuition is not included, we can observe that the rates of return are extremely high even for non-technical higher education at both the diploma and four-year degree levels. It also makes sense, as the RORs with tuition included show, to charge higher tuition for technical education—even with this higher tuition, the private RORs to technical education remain high.

[Table 5a, Table 5b, and Table 6 here]

Figures 8a and 8b show the age-earnings profiles for the various levels of schooling and gender. For the sake of illustration, we include the age-earnings profile for post-graduate education. It is lower for males than engineering education at the graduate level.

[Figures 8a and 8b here]

Expected Earnings of Fourth Year Graduate Degree Students in Technical Colleges and Universities. Our survey of almost six thousand electrical engineering and computer science students in about 40 colleges and universities in four Indian states gives us a good picture of student expected first year earnings and the variables that influence those expectations. A principal question is whether students attending private colleges expect higher earnings than those in public colleges, controlling for their socio-economic background, because they pay higher fees.

Our estimated average expected salaries varied greatly across colleges. Even salaries for students who had already received and accepted job offers varied across colleges. The average expected first year earnings for those who had offers were 3-6 lakhs, or 300 to 600 thousand Rupees annually (US$6,400 – 12,800), depending on the state, with the lowest average in Maharashtra, and the highest in Karnataka. Expected first year earnings were higher for those who had not accepted a job, with the highest in Maharastra (8 lakhs) and the lowest in Karnataka, at about 5 lakhs), Students at the IITs had higher than average expected earnings, and so did those at other government colleges, but students at some private colleges had even higher expectations.

We estimated a structural model of students' estimated first year salary as a function of entrance examination scores, students' socioeconomic background, caste, and type of college attended for those students who had and had not accepted job offers (a majority had not). Since a variable of interest is whether students attending public colleges expected higher earnings controlling for their socio-economic background, the structural model is estimated in the following two stages (based on our sample of final year students): (1) we estimated the probability of attending a public college as a function os gender, test score, caste, and socio-economic background (Table 7, column 1); and (2) we estimated students' expected income as a function of test score, gender, socio-economic background, and attending a public/private college (Table 7, column 2).

The results show that males are about 18 percent more likely than females with similar college entrance scores and similar socioeconomic background to attend public colleges. Those with higher test scores and higher mother's education are also more likely to attend, regardless of gender. But students in our sample come from families where the average percentage of mothers with higher education is almost 60 percent (and fathers with higher education, almost 80 percent). So perhaps the relevant way to put our results is that the 40 percent of students with mothers who have less than higher education are 26 percent less likely to attend a government college.

In addition, those who attend public colleges, are male, have higher entrance test score, and are from a higher socioeconomic background expect higher first year salaries, and that those who come from lower income families and those who attend private colleges expect lower first year earnings even when controlling for socioeconomic background and entrance test score (Table 7, column 2). A male student attending a public college expects to earn about 14 percent more than a student completing a private college. Given that the average student in private unaided colleges also scores lower on the entrance test than students in government colleges, these results strongly suggest that on both these grounds engineering and computer science students attending government colleges expect and actually earn higher incomes than the vast majority that get their degrees from government administered public colleges. Middle and lower income male and particularly female students expect to earn much less in the first year, and this is somewhat correlated with caste. Those male students from families in the lowest half of incomes expect to earn 15 percent less than those in the highest quartile. Yet, since lower-middle income students (who represent the vast majority in our sample—see Figure 9) are more likely to attend a government college, on those grounds, they are somewhat more. In affirmative action terms, therefore, we can say that others things equal, lower and lower middle income students (correlated with lower caste) students expect to earn 15 percent less in first year salary than students from higher income families, but since they are 56 more likely to attend a government college, they would earn (0.56 X 0.145) = 8 percent more on that score. We ran estimates for men and women separately and found that the relation between expectations and family income is even greater for women in technical colleges than for men. Women are less likely to attend government colleges and, controlling for test score and other factors, expect lower incomes even when controlling for private/public college attendance.

[Table 7 here]

[Figure 9 here]

Is the higher education financing system socially efficient and equitable? The almost ubiquitous national government affirmative action program, which requires colleges and universities to admit certain percentages of each level of disadvantaged group (see Thorat, 2006 for estimates of the percentages enrolled nationwide of each group) and subsidizes the tuition of these groups, certainly has had the effect of increasing access to higher education for some students from poorer families and has reduced their cost of attending substantially. Many of these students are not adequately prepared to succeed in higher education despite being unusually successful academically in their social class group (Kochar, 2009), Even so, Comer found that in one highly ranked technical college, 75 percent of Scheduled Caste students graduated, albeit with relatively lower grades than their fellow students from less disadvantaged groups or Brahmins (Kochar, 2009).

As we discuss below, private technical colleges finance essentially their entire budget from tuition and other fees (many make a surplus). With spending per student in the US$1,000-US$1,500 range in 2009, private technical colleges average a minimum of 45,000-68,000 rupees. More than one-half of students are supposed to be admitted under some sort of controlled tuition scheme, either through affirmative action or as a high scoring student (whom private colleges desire to admit to raise their status), and their tuition is fixed in the 25,000-40,000 rupee range (see Table XX). This suggests that many students who do not fall into these categories pay 70,000-100,000 rupees tuition.

At the other end of the spectrum, students attending elite, high cost technical institutions are heavily subsidized even if they are from the highest castes. For example, the cost per student in an IIT is over US$4,000 annually, compared to about US$1,000 - $1,500 annually in a high quality unaided private technical college. Regular tuition at an IIT is only one eighth of the $4,000 cost. The assumption in this level of subsidy is that the Indian government should be promoting the development of the best and the brightest because of possibly high social externalities associated with these individuals when they go into the labor market, even if they go into the U.S. labor market. As their supply increases with the opening of many more elite technical universities, it might be argued that increased numbers will stay in India, teach, do research, and contribute much more than they earnings through their creativity and innovation.

If tuition fees cover a significant part of costs in the Indian system, how are these fees applied in terms of social efficiency and equity? Are those students who are more likely to get high private payoffs to their investments made to pay more? Are those who can most afford university studies made to pay a higher share of the costs of their education than those who come from lower income families?

We have indicated that the higher fees charged to students who pursue technical education do answer some of the questions above positively. Students who pursue high payoff technical education are made to pay a higher fraction of the total cost of that education. That makes sense from an equity standpoint and from the standpoint of social efficiency, particularly because the social rate of return is high even when we include the public costs of technical education.

With the data from our technical student survey we can go further to examine whether the educational system is rewarding mainly higher social class students with the high payoffs to engineering education or whether the government has been able to provide more equal access to these high returns.

Given the regulations regarding how much students pay—whether in a government, PA, or PUA college—according to how well they do on the college entrance examination and their caste (affirmative action), it may be obvious that examination score and caste are strongly related to tuition fees. However, our student sample provides the possibility to test to what degree students pay less because of higher test score or because of caste. Table 8 shows the results of estimating tuition fees as a function of caste, college entrance test scores, and type of college. The results suggest that, indeed, students with higher test scores and those from disadvantaged castes pay lower tuition, and pay even lower tuition when their test scores are higher. Higher socioeconomic background students, where socioeconomic background is measured by mother's and father's education education, pay higher tuition. As expected, controlling for the caste and test scores, those students attending private colleges pay higher fees. These results suggest that government affirmative action policies do result in disadvantaged castes paying less to take technical education, and do result in those of higher socioeconomic background paying higher fees, controlling for caste and test score. It appears, therefore, that from an equity standpoint, government policy regarding lower caste access at lower fees does offset at least part of the advantage going to higher social class students in terms of their likely scoring higher on entrance tests. A ten percentage point higher entrance test score is associated with 6000 rupees less tuition, but disadvantaged castes pay about 20,000 rupees less, on average, with the most disadvantaged paying about 30 thousand rupees less.

Problem is, a much smaller percentage of disadvantaged groups attend technical colleges, at least be the final year before graduation (our student sample) than the affirmative action policy officially requires. In our sample, 8 percent are scheduled castes; 2 percent are scheduled tribes, and 19.6 are OBC, for a total of 29.7 percent. A disproportionately high number of disadvantaged groups are in our Tamil Nadu sample, and a disproportionately small are in our Delhi sample.

[Table 8 here]

In sum, the current financing of the Indian higher education system seems to be generally efficient (those who pay the highest fees, on average, are in the fields that have the highest private payoffs), and generally provides for considerable equity—some say too much equity (Kochar, 2009)—except at the upper end of the test score distribution, where the government heavily subsidizes very high scoring students to attend highly selective technical (IITs), business/public management (IIMs), and other institutions, such as the Delhi School of Economics.

What, then, can we infer from a pattern of financing that increasingly has Indian students and their families paying for higher education, particularly in higher payoff fields of study, by promoting the expansion of private unaided colleges as a response to increased student demand? What can we infer from a pattern of public investment that seems to be largely focused on expanding central government public high cost, highly selective universities (although there is talk of expanding state universities in certain regions), while lowering public spending per student in the higher education system as a whole?

We need to keep in mind that this opening from the Indian State to the private sector to move heavily into high payoff fields in higher education is getting a large response from politicians and other investors with land holdings who find opening universities is a "profitable" use of assets (Tilak, 1999) Furthermore, such investment has a "feel good" aspect of contributing to the social welfare by increasing access to higher education. Thus, there are many actors creating new institutions who have their own ideas about what higher education institutions should be like. Many of the larger institutions are seeking autonomy from the tight controls imposed by affiliation with a public university. This was the gist of a number of conversations with directors of private, unaided colleges in Mumbai, Bangalore, and Chennai.

On one side, then, the Indian national state has an implicit policy regarding the shape of Indian education—this could be called the national structural condition of Indian higher education—and, on the other, the independent actors in the higher education sector—mainly the newly unleashed private education sector—have their own view of how they want to move within and respond to that structure.

In the implicit policy, the Indian national state appears to be reacting to two quite different forces. The first of these is the more vague: a "pressure" from international economic competition and international elite notions of what is a world class university to develop institutions of excellence, where academically very select students are taught by research-oriented professors with high quality PhDs, and the institutions themselves are heavily involved in producing innovative research. The second is quite "real": as the economy grows and the demand for higher education graduates increases (especially in certain fields of study—see Figure 3) and "higher order" economic activity and the number of secondary school graduates increases, the demand for places in higher education also increases rapidly. This is particularly true in a country where compared to the size of the college age cohort, the number of available places is small. Furthermore, there is "real" political pressure from so called "disadvantaged" groups, which the way they define themselves, now constitute about half the population, to get preferred access to higher education place and jobs to make up for years of discrimination.

So, a good argument can be made that the Indian state is dealing with both these forces, but doing so in a very different way. In response to the vague force, the central state is stepping up and spending considerable public resources, and in response to the "real" force for increased mass expansion, the central state is responding by putting more resources into subsidizing disadvantaged groups (or pushing the states to subsidize these groups) and as for the others students, is giving more financial responsibility to families and more administrative responsibility to the private sector. In other words, the central state is focusing its financial energy on taking care of globalized higher education issues, where national "prestige" and the long term "economic position" of India is at stake, and is generally "farming out" the financing of the mass of higher education training to states, families and, increasingly, privately run, government-regulated higher education institutions.

THE INSTITUTIONAL REACTION

Introduction

Ownership of Indian colleges vests either with private groups or the State. The public (State-owned) colleges, which were the primary form of instructional provider till the 1990 reforms, constitute the oldest type. This type is still expanding, though relatively slowly at the level of undergraduate instruction to lower-tier students. Most of the expansion of public colleges is in undergraduate teaching in a few institutes of excellence, and in postgraduate instruction.

Privately owned colleges are organized as societies or trusts, both of which are non-profit entities. They are of two types, aided and unaided. The private-aided colleges predate the 1990 reforms. They are allowed to charge the same tuition fee as comparable state colleges. Salaries of teachers and other staff are required to be identically structured to that of state colleges. Private-aided colleges receive almost their entire operating budget, net of tuition, from the state. The programs and courses that they teach are mandated by the state. Thus, they look very similar to state colleges in their sources and uses of funds, programs, student composition and instruction. The difference between them and state colleges in instruction and quality of student intake is very little for those colleges that primarily deliver undergraduate education to lower-tier students.

However, due to the 'center of excellence' mission of the elite State colleges since the 1990 reforms, there is a divergence of mission between these and the best run privately aided institutions. Unlike the elite state colleges, which have been funded heavily by the state to develop graduate education, the best private-aided colleges continue to focus primarily on undergraduate education. In the field of undergraduate education, they are expanding faster than the state colleges, but at a much slower rate than the third category, the private unaided colleges.

This last category, the private unaided college now provides over 90% of undergraduate engineering instruction and overwhelmingly focuses on undergraduate education. Due to the mandate to these colleges to charge fees to a portion of unsubsidized students that will recover all costs, their tuition fees are higher than the state/aided colleges.

Unaided colleges are more nimble in what they teach as they tend to pick degree programs that meet market needs. For example, during the global economic during 2008-

2010, several private colleges reported in our interviews that they faced a reduction in demand for computer science programs (whose graduates mostly enter the Indian software exporting industry) and had switched to an emerging field with strong domestic demand, civil engineering. Such flexibility is not possible in the typical state/aided college due to the need for cumbersome approvals and concerns about losses of faculty jobs.

Unaided colleges are allowed to pay salaries to faculty at what the market will bear. In practice, their salary structures tend to mimic that of state/aided institutions, since these institutions attract the best faculty due to higher job stability. Average salaries are lower at unaided colleges, though, since they attract a poorer quality of faculty and have a higher proportion of visiting and junior faculty than state/aided colleges. We show this in more detail below.

The data from our institutional interviews allows us to develop a detailed picture of how public and the mainly private technical colleges are responding to the massive increase in demand for technical higher education in India. We interviewed in four types of institutions: public national universities (IITs), public technical colleges, private aided colleges, and private unaided colleges. Recall that 92 percent of Indian engineering students are in private aided and unaided colleges, and that the enrollment in the unaided colleges is growing most rapidly.

Costs

We were able to obtain budget data from 21 institutions. This allowed us to check the average fees paid at those institutions, the total spending per student, and the relationship that spending per student might have to whether the institution was private or public and the percent graduate students enrolled in the institution. Total spending per student among the 21 institutions varied enormously, from about US$200 to US$10,000. The three highest cost institutions were are central government institutions, two of them IITs (see Figure 8). The spending per student in most private colleges was considerably less, as we have already noted.

[Figure 10]

However, the private-public dichotomy may be less important to spending per student than another factor that drives up costs, namely the percentage of graduate students attending the university. Graduate education is more expensive everywhere in the world because it requires more professors per student body and devoting more time to research. Institutions with larger numbers of graduate students also have to recruit professors with higher degrees. When we estimate spending per student for these 21 institutions as a function of private/public and the percent of the student body in graduate students, we get the following result:

$$\underset{}{\text{Spending/Student}} = \underset{(2.65)}{901.4} + \underset{(1.01)}{632.3}\ \text{Public} + \underset{(7.64)}{93.0}\ (\%\ \text{grad students}) + e \quad R^2 = 0.81$$

Where Public is a dummy variable in which government colleges equal 1 and private = 0; and % grad students is the number of graduate students enrolled as a percentage of total enrollment. The t-value is in parentheses. The dummy for public is not statistically significant. The result suggests that a private college in our sample with only undergraduate student spends about US$900 per student, whereas a college with 12 percent graduate students (the mean in the sample) spends about US$900 + US$1,100, or about US$2,000 per student.

Interestingly, there was little variation in the cost per student across different ownership structures. The median tuition fee was Rs.48,027. This lack of variation is perhaps due in part to some offsetting factors: the unaided schools are newer and were likely constructed at significantly higher costs; however, as offsetting factors, their salary burdens are lower and student to faculty ratios relatively high. This was supported by the finding that the share of salary to total costs is lowest for the unaided colleges.

Autonomy

Autonomy is generally understood as autonomy from the state. As we have noted, state/aided colleges have limited operational autonomy. All colleges, including unaided colleges, need to abide by the regulatory standards of the All India Council of Technical Education and its accrediting arm, the National Board of Accreditation. These standards cover minimum requirements of physical infrastructure, the list of courses to be taught in each degree program and learning outcomes of each course.

The unaided colleges are also subject to significant control from trustees, who represent the ownership of the college. Our interviews with colleges revealed that such control can be significant, as the following table shows.

Autonomy of Departments within Engineering Colleges

College owner =>	Public	Aided	Unaided vis-à-vis state	Unaided vis-à-vis trustees
Disciplinary choices	Low	Low	High	Low
Faculty Recruitment	Low	Low	High	Low
Syllabus	High	High	High	High
Textbooks	High	High	High	High

Source: Authors' Interviews

The table above indicates that unaided colleges have significant autonomy from the state; however, that autonomy in the case of disciplinary choices, specializations within disciplines (not shown in the above table) and faculty recruitment is exercised by trustees rather than by departments. Such power is used to respond to market conditions and enables the college to quickly change faculty and courses in response to market demand.

Later, we discuss how this might be influencing the quality of instruction at unaided colleges.

Effect of Ownership and State Support

As noted above, private schools, both aided and unaided, tend to focus more on undergraduate education, while public schools, which are older and have a mandate to develop graduate education, do more graduate education. The average share of undergraduate students to the total was 76% for state colleges and 94% for unaided colleges. This is shown in more detail in the table below.

Public schools are also able to attract better-qualified faculty, a feature of higher job stability and salary parity. The quality of faculty was assessed by us by observing the share of part-timers. As the table below shows, it is lower for public and aided schools than for unaided schools.

Another measure of faculty quality is the share of faculty with Ph.D.s. The share is lower for private unaided schools, averaging 13% in our sample, versus 49% for state and aided schools.

As noted earlier, despite no restrictions on faculty pay, the salaries of faculty are lower in private unaided schools. The government sets salaries for public and aided schools and these are viewed as the benchmark for private unaided schools to meet. Because their faculty is less qualified, faculty salaries in unaided schools tend to be lower.

	Public	Aided	Unaided
Ratio of Ph.D.s in faculty	High	High	Low
Ratio of part-time faculty	Low	Low	High
Ratio of undergraduates	Low	Medium	High
Ratio of students/faculty	Low	Medium	High
Cost/Student	Medium	Medium	Medium
Share of tuition/Total costs	Low	Low	High
Salaries/Total costs	High	Medium	Low

Source: Authors' interviews

The quality of instruction is also likely to be influenced by the student to faculty ratio. The AICTE imposes a ceiling ratio of 15. In our interviews, this ratio was largely met by all schools, and the median was 14.62. However, the ratio was higher for unaided than for aided colleges, which in turn was higher than for state colleges.

In our interviews, we definitely got the sense that unaided private colleges—many of them quite young—are anxious to expand their enrollment, and are interested in attracting more students by improving their reputation. Their main competition for better students are established older aided private and public technical colleges in the same city. In theory, such competition should improve quality as colleges strive to produce better-prepared, more employable students. Private colleges tend to pay professors at all ranks more than public, but professors in private colleges have no tenure, so can be removed at any time. This should theoretically lead to greater motivation on the part of professors in private colleges to teach better.

Education trusts of unaided colleges, according to our interviews, tend to hire management that may have less academic prestige than directors at public colleges, but appear to be more dynamic in terms of developing new programs, marketing their universities, and motivating teachers to be successful deliverers of state university regulated curricula so that students will pass state university regulated examinations. Colleges are also motivated to place their students in jobs upon graduation. Yet, so are established public and aided private colleges. Together, all these types of higher education institutions lobby the states to raise allowable general tuition levels (for higher scoring students).

The private unaided colleges also lobby the states to raise allowable tuition fees for those students who constitute the group who cannot qualify academically for the fixed proportion of lower priced places. The proportion who can be charged the higher fees also vary from state to state and can be negotiated—another bargaining point for private unaided colleges. So in Karnataka, 35 percent of students can be admitted charging the highest allowable fee--$2,500 annually. Fifteen percent of students who score high enough on the entrance test get to enter at a much lower fee, $500 annually, and the 50 percent of students who qualify as designated lower caste, also pay $500. In Maharashtra, the top 25 percent of students pay about $660, and so to the designated castes, but the difference there is that the state pays the tuition of the designated castes at all colleges, private and public. The remaining 25 percent of students pays $1,400-$1,800 annual fees.

The $2,500 figure for fees in Karnataka and the $1,600 figure in Maharashtra are supposed to represent the tuition fee that when paid by 25% or 35% of the students would make the college meet the average costs per student in each of these states (interview with State Secretary of Higher Education, Maharashtra). However, our interviews suggest that the costs of running an engineering college are considerably lower than total revenues. One large engineering college estimated that management ran the college at a cost of $1,250 per student but collected revenues of about $1,900 per student.

Besides raising the amount of revenue they can collect by negotiating fees collectively with state governments, the other main concern of private colleges is to work toward a situation of autonomy from state regulation by the Universities Grants Commission (UGC). The only way to do this and remain a legitimate higher education institution is to obtain autonomous status—that is, become a (deemed) university. The dream of many of the rapidly expanding private unaided technical colleges is to shed the curricular and examination controls of the universities to which they are necessarily affiliated.

Will creating increasing numbers of autonomous deemed universities improve the quality of higher technical education? Possibly yes, if there are sufficient highly skilled professors to develop and deliver a more high-powered curriculum, more demanding (and creative) examinations, and more participative, problem solving teaching and learning. This is a big question mark, since simply getting more freedom will not produce better results unless the current courses and exams are far below current faculty and student capacity and would become more effective just as soon someone changes the curriculum and the tests.

To summarize, Indian technical higher education is marked by considerable competition and considerable opportunities for social entrepreneurs to enter the market for producing college graduates and accumulate surplus that could be used for expansion and improvement. It appears that the main use of the surplus in private unaided colleges is expansion rather than improvement, mainly because it is not easy to increase higher education effectiveness without entering into a risky policy of attracting better full time professors, providing research opportunities, and so forth. In addition, the supply of better professors is limited, particular with 85 percent of students already in private colleges. Private schools would have to continue raiding public colleges and universities, but there are simply too few PhDs to go around.

In order to grant more autonomy to private colleges, the State also has to be convinced that capacity is there to develop high quality graduate programs, come up with a reasonably effective curriculum, and can come up with evaluation instruments that are as good or better than the ones provided by the universities. In any case, there is little doubt that in the Indian technical higher education system, institutional forces are pressing hard for such autonomy and that they constitute a force for changing the present system, for better or not.

ASSESSING THE QUALITY OF INDIA'S ENGINEERING EDUCATION

The concept of an adequately trained engineer may differ due to the different contexts within which an engineer works, such as from country to country, or with time or due to the nature of work. For instance, we may expect that civil engineers would be more spatially constrained than computer engineers because the regulatory and business environment differs more for the construction industry across countries than computing. Differences also arise due to differences in infrastructure and styles of education. For example, according to Downey, et. al. (2006), European engineers tend to stress first-best solutions while British engineers focus on design and practical knowledge. According to some college recruiters for Computer Science Ph.D. programs in the United States, applicants trained in India were better at design conceptualization relative to process conceptualization, relative to applicants from east Asian countries (Harandi, 2006). Other differences may lie in soft skills, such as teamwork.

Nevertheless, the globalization of some engineering professions, notably computer engineers, has led to an expectation that technical competence achieved through the higher education system of a country must meet certain global standards. Thanks perhaps to the size of its market, the American paradigm of core science competence, fundamentals of engineering and specialization has evolved to become the dominant standard – even though there is great variation even within the United States in operationalizing this paradigm.

The Internet has made it easier for standardization of the U.S. model to happen. For instance, MIT's Open Courseware Initiative is an important resource for syllabus development in India (Dossani, 2009). Open Courseware's most downloaded courses are in engineering and related courses in physics and mathematics. Although, in India, a standard national curriculum for engineering does not exist, our interviews indicate that most Indian colleges' computer engineering curricula attempt to approximate the American curriculum.

Even if nations accept that an adequately trained engineer should be defined by the American definition, it does not follow that nations that aspire to train such an engineer will succeed. There may be systemic differences that matter, as mentioned earlier, arising from differences in styles. For instance, our analysis below shows that an engineer trained at Stanford University will have done less coursework on her major (as a percentage of total study) than an engineer from an elite institution in India, and, comparably, more on her minors and general educational courses. This appears to be primarily an outcome of the fundamental differences in the system: the Indian system is modeled on the British pre-colonial system, in which specializations are chosen at the beginning of the higher educational stream and focused on, to the exclusion of non-major courses. In America, majors are often declared only near the end of the second (sophomore) year.

Assuming that the courses are taught similarly and that the Indian engineer (having done more coursework in the major, as noted above) is trained to at least acceptable American standards, is he or she of equally good, if not better, quality? Clearly, there are many other factors that make an unambiguous answer difficult. For instance, do the non-major courses matter a great deal even for technical work? If they do, then the Indian training may be deficient. Other concerns making comparability difficult are: if the educational system prior to entering college is different in the two countries, how much does that matter? If the educational system makes it difficult to pay faculty adequately or incentivizes them differently in one or the other country, how much does that matter? If an educational system is primarily publicly driven (as in China and the U.S.) versus private (in the case of engineering in India), does this matter?

It should be clear, from the above discussion that, just as intra-country variation is a reality, we should expect no less variation across countries in the quality of student produced. Finally, the market, i.e., the goals of the recruiter, matters. An American university looking to recruit for a Ph.D. program in computer science will have different conceptions about the adequacy of, say, the Indian undergraduate engineer than an

American corporate recruiter. Among corporate recruiters, variations in the products and markets they cater to are likely to lead to differences in what they look for. It may well be that the Asian engineer offers advantages, such as a knowledge of design for local markets, that the American engineer would not be able to supply even if the value-added in undergraduate education is the same. On the other hand, the American engineer may be better suited in other areas, such as design, or small-team projects, because the pedagogical style and pre-tertiary education make this possible.

Examining the Differences

We use primary data from a survey of Indian colleges we conducted in 2008-2009 to dig deeper into the notion of quality. Our student results are for about 5600 final undergraduate year students in 35 colleges in the states of Delhi, Karnataka, Maharastra, and Tamil Nadu in 2008-2009, and interviews with the directors of about 30 colleges and three IITs in Delhi, Mumbai, and Karnataka in 2009.

Our quality assessment of Indian engineering and computer science education is based on a number of direct and indirect measures:

- Assessments by institutions and employers of the quality of graduates from the institutions.
- Student time use and assessments.
- Quality of faculty in terms of attaining PhD.
- Assessments of classroom videotapes.

Assessments by Institutions. We asked the heads of departments of the colleges to make an assessment of their graduates on various parameters of competence. Such self-assessment raises questions of bias. However, we also asked recruiters to provide their assessment of the average recruit, who is primarily a fresh graduate of an unaided college. The results are shown in the table below.

Competence of students in	*Public*	*Aided*	*Unaided*	*Firm 1*	*Firm 2*	*Firm 3*
Core S&E	High	High	Medium	High	High	High
S&E knowledge in Major	High	High	Medium	High	High	High
English	High	High	Medium	High	High	High
Basic Computer Use	High	High	High	High	High	High
Programming	High	High	Medium	High	High	Medium
Communication	High	High	Medium	High	High	High
Management	High	High	Medium	High	High	High
Sales	Medium	Medium	Medium	High	Medium	High
Organization	High	Medium	Medium	High	High	Low
Teamwork	High	Medium	Low	High	High	High
Local networks	Medium	Medium	Medium	High	High	High
Global Networks	Medium	Medium	Medium	High	High	High
Problem solving	High	High	Medium	Medium	High	Low

Innovativeness	High	High	High	Medium	High	High
Multi-cultural awareness	Medium	Medium	Medium	Medium	High	Medium

Source: Authors' Interviews. The last three columns are from three IT firms in India, which together employ 235,000 persons as of April 2010. Firm 1 is a product company in IC design, while firms 2 and 3 are IT services firms.

It appears that there is a remarkable similarity between the attributes of students assessed by recruiters and between recruiters' assessments and unaided colleges' assessments. However, we need to keep in mind that these three firms were large employers and therefore had the "pick of the crop" from both public, private unaided, and private aided colleges, so the opinion of smaller firms that can offer lower salaries and hire more average students, might be quite different. Yet, at least as far as the larger firms are concerned, it appears that the objective of engineering colleges to produce an employment-worthy graduate is being met.

"Quality" as Reflected in Student Practices. Course taking in India seems to be quite different from course-taking by students in the United States and England. In our 2008 and 2009 interviews in Delhi, Tamil Nadu, Maharashtra, and Karnataka, we found that engineering and computer science undergraduate students take 4-6 courses and 2-3 laboratories (practical training) every semester for four years—a total of 36-40 courses and 16-18 labs in their undergraduate training. Students are in class/lab about 32 hours per week. According to interviews with students, they spend relatively little time working on their courses at home. This contrasts sharply with engineering/computer science training in the United States, where typical students will be in class or laboratories 15-18 hours per week and spends about 2.5 to 3 times that number of hours working on class assignments on their own.

Table 9 compares course taking at the Imperial College London, Stanford University, and universities/colleges in India. A second difference is between the US and the other two—Stanford students are required to take fewer science and engineering/computer science courses compared to students in England and India.

[Table 9 here]

For example, in the Stanford computer science department, the core science requirement consists of 2 physics classes and 4 math classes, while at IIT Madras, it consists of 2 physics classes, 2 chemistry classes and 4 math classes. A review of the PCM syllabi indicated substantial similarity of topics covered (Sahami, 2009). In Imperial College, the core science course is focused entirely on mathematics (2 classes) and one statistics course. While, at Stanford and ICL, the core classes are completed in the first two years, they are spread out over three years in IITM. Among engineering courses, there is some noticeable difference in course content. IIT Madras begins its programming sequence with training in Pascal, a language no longer taught at most American universities. The introductory course on computer engineering focuses on numerical analysis, such as Gaussian eliminations or Euler's method, whereas the comparable course at Stanford emphasizes modeling (Sahami, 2009).

There is also variation in the post-core engineering courses and in non-major studies. At Stanford, out of 180 units done during the 4 year period, a typical CS major would cover 93 units over 21 courses counting towards her major. During the first two years, the student would complete about 40% of those units and expect to spend about the same percentage of time (inside and outside class) on her likely major, i.e., about 60% of her class hours and non-class working hours would be spent on other subjects. In the second two years, the student would complete the remaining 60% of the major requirements, but would likely spend 80% or more of her time on the major, mostly outside class.

By contrast, in IIT Madras, all the classes in the first year are in core sciences or the major. In year 2, the student takes one humanities class (out of 6) in each semester, and one more in the final year. The range of courses described under the term 'humanities' is wide, and includes the social sciences. While the class time for the humanities accounts for about 6%, the share of total time spent is less. Most students at Stanford would have taken at least one foreign language course, whereas this is not the case at IITM, although foreign languages are offered. In most Indian engineering colleges, however, foreign languages are not offered.

In Imperial College, London, which is a three-year program, one course in humanities is offered in each year, although these courses are electives and compete with engineering courses. In other words, it is possible to graduate from ICL without taking a single humanities course.

Table 10 shows the lecture course to laboratory ratio, lectures to group work, and time in classes/laboratories versus work outside of class by students in India and the United States, with some limited information on England. In Stanford, the ratio of classes to supervised labs is 3:1, which is the same as in the Chennai/Bangalore sample; however, the ratio of unsupervised work (outside class hours) to supervised hours (lectures and labs) is 1:3 in India, whereas it is it is the opposite at Stanford (Sahami, 2009). Within supervised teaching, in India, the lecture method dominates, whereas in Stanford, small group work is the most common activity. While all CS students at Stanford would have done at least one summer internship, this is not the case at most engineering colleges in India, though it is true for about 80% of students at IITM (Simon, 2008).

[Table 10 here]

Comparing Fresh Graduate and University Faculty Salaries Across Countries. The effect of higher educational reforms in India is reflected in the differences between salaries of graduates from IIT Bombay and the average Indian college. Given that the $6,000 earned by the average graduate in our sample is the same as the average annual wage paid by global firms such as TCS, Infosys and Wipro, reforms have apparently succeeded in producing a student of acceptable quality and scale through the largely private second tier system (or that the private second tier system is able to attract students of high enough ability so that they can be trained after graduation quickly and cheaply by Indian employers). For students and their families, the cost of education is also reasonable, considering that cost recovery happens in 8-12 months, compared with 1.5 years at Stanford University**,** assuming that the graduates entire salary goes to paying off his or her schooling.

Faculty salaries are lower in India relative to the United States and China (Table 11). However, compared to commercial wages, the disparity disappears. At IIT Bombay, the starting wage for an assistant professor is 1.2 times the wage of a fresh graduate, compared with 0.9 at Stanford University. Private colleges in India pay even more. Progressions seem at least comparable, with a full professor earning 1.4 times the wage of the assistant professor at IIT Bombay, versus 1.3 times at Stanford University. The figures on cost indicate that the unsubsidized private college, which covers costs, has improved the cost efficiency of the system.

[Table 11 here]

In Table 12, we show how Indian students spend their time. These data support the data in Table 9 showing that a much higher fraction of student time on academic work in India than in the United States is spent on attending courses rather than studying at home. As noted above, an average Indian engineering/computer science student spends about 27 hours per week in lectures and laboratories and only about 10 hours per week studying their subject matter outside of class. This is the inverse of the ratio for engineering/computer science students in the United States, who are in classes and labs less each week, but report working on their own a lot more.

[Table 12 here]

Faculty degrees and research orientation. We have videotaped ten electrical engineering course lessons in ten different colleges/universities in three Indian states. However, we have not yet analyzed those videos. We intend to compare the pedagogy and content of the teaching in these lessons to videotapes of similar EE classes in the United States, China, and Russia.

In this paper, we limit ourselves to analyzing the formal preparation of the teachers teaching in engineering and computer science departments in the Indian colleges and universities we surveyed. At this point, we will only focus on one dimension—the fraction of PhDs among the faculty.

In Table 13 we show that, except in the three IIT we surveyed, of the 30 technical colleges and universities, the proportion of PhDs teaching varied between 4 and 26 percent. However, these figures represent the percentages in the entire college, not in the electrical engineering and computer science departments, which generally have much lower proportions of PhDs compared to more traditional fields such as civil and mechanical engineering. For example, in one private unaided college, of the 70 professors with PhDs, only 5 (7 percent) were in electrical engineering, even though 17 percent of total students were in that field of study. In a public technical college, of the 68 faculty members, 15 (22 percent) were in electrical engineering and computer science, whereas 40 percent of total students were in those two fields.

[Table 13 here]

A major reason that there are relatively few PhDs teaching in technical colleges in India is the more general shortage of technical PhDs. PhDs are formed in public universities and colleges—for technical PhDs, almost all in IITs. But IIT annual production is small. According to one administrator at an IIT, the current number is 700 PhD degrees annually from all the IITs, and most of these are faculty members already teaching at technical colleges, in essence upgrading themselves with the help of the college administrations and a recent World Bank loan aimed at improving the quality of technical education in India.[4]

The Indian technical PhD problem is shown in Table 14 and Figure 11. Although there are now more than 800 thousand undergraduate engineering students in Indian colleges, India produces about 1,000 engineering PhDs per year. The United States has only one half the enrollment in undergraduate engineering, but produces 6,000 PhDs annually, and China, with more than 2 million undergraduate students in engineering (in 2005), produced about 10,000 PhDs that year.

We have not charted the figures for Russia because we only were able to find data separated by field of study, including "technical" PhDs, for the past few years. In 2003-2006, Russia produced between 306-355 "technical" PhDs annually. In 2006, 341 PhDs graduated in "technical" fields out of a total of 1,385 PhDs graduated that year.[5] Considering that Russia's population is one-tenth the Chinese population, the equivalent PhD production in Russia in 2006 would be about 3,500 technical PhDs, about one-third the Chinese level

[Table 14 here]

[Figure 11 here]

Although having a PhD does not necessarily imply that a professor will be a more competent teacher, there should be some connection between completion of a research degree and being able to teach a subject more competently even at the undergraduate level. If this is the case, India will have difficulty in the future to increase the quality of its undergraduate education, other things being equal.

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[4] The World Bank loan, run through state governments, was $20 million for the period 2004-2009 in Maharashtra alone and was awarded to a number of institutions and included paying extra salary to approved positions and offsetting the costs of faculty taking time off to complete PhD degrees (upgrading).
[5] For these statistics, see
<http://stat.edu.ru/scr/db.cgi?act=listDB&t=20_6&ttype=2&Field=All>http://stat.edu.ru/scr/db.cgi?act=listDB&t=20_6&ttype=2&Field=All)

One major issue, of course, is that Indian college professors are not particularly well paid, so there is little incentive to invest in getting a PhD, particularly in technical fields, where the high payoff is to a first degree or an MA. Secondly, India, like China, and probably Russia, does not have the option to import PhDs or students who want to study for the PhD (and teach in India) from abroad, as do the developed countries. Third, India invests little in basic research in universities, a *sina qua non* of stimulating PhD production.

The availability of R&D to do research in India is relatively low, compared to developed countries, but that is to be expected. What is telling is the level of India's R&D spending in universities per university student relative to other developing countries, such as those in Latin America or even China. Russia's R&D spending per university student is also very low (Figure 12).. Naturally, it would be more relevant to ask how much the R&D spending comes out per graduate student, but if the number of graduate students is small because overall R&D spending in universities is relatively low in terms of all students, the ratios would rise, but for the wrong reason.

Given the very low R&D spending for university researchers per university student in India, it is highly likely that graduate student production is relatively low—thus the low number of PhDs.

Neither is R&D spending distributed equally over universities, but the less there is, the less likely that research will spread down very far into even first tier universities, and this will assure that research culture will be limited to very few institutions, This is indeed the case in India. If research activity is a measure of quality, then the quality of universities in India is lower than in most other developing countries. The offset, of course, is that such a small percentage of the age group associated with tertiary education actually attends

[Figure 12 here]

How do students feel about the quality of their technical education? One of the most interesting results of our student survey is that students are largely satisfied with their engineering and computer science education, even if we, as outsiders, might think that in many institutions, it is not of very high quality. We can show two examples of this point. In the first, students were asked how much technical know how they felt they had compared to when they entered (Figure 13a). Most answered that it was stronger or much stronger. Similarly, when asked about their academic confidence compared to when they entered, they also felt stronger or much stronger, on average (Figure 13b).

The areas in which they felt about the same as when they entered were in foreign language skills and entrepreneurial skills.

Furthermore, we asked whether they agreed with the statement "I am well prepared for a career in engineering," the majority answered that they agreed, with somewhat more answering that they strongly agree than those who had no opinion one way or the other. When asked whether if they were to do it all over again that they would study engineering, the majority agreed, with somewhat fewer saying that the strongly agree compared to those who had no opinion. And most were optimistic about the job future for engineers in India.

The overall story, then, is that engineering and computer science students awe interviewed in a wide range of institutions, including many private unaided ones, ppear quite satisfied with their education and with their choice of profession. This is largely the case whether they are in high level IITs or in less notable private institutions. As far as these students are concerned, the higher education system has done "right" by them.

WHAT DO THESE RESULTS IN INDIA IMPLY FOR A THEORY OF HIGHER EDUCATIONAL CHANGE?

We can now try to summarize these components as spelled out in the broad model we proposed to describe the dynamic of India's (and other countries') higher education systems (see Figure 4). What are the weights we should assign to each of the multiple forces shaping the expansion and quality of higher education in India?

Certainly one major force is economic growth and increased demand for higher education workers. India is an urbanizing economy increasingly oriented toward business and financial services and the production of IT goods and services for export. This has had the effect of at least maintaining and possibly increasing the payoff to higher educated labor relative to those with lower levels of education, as we showed above. Not only is the private payoff to higher education reasonably high in India, it has remained high despite a rapid increase in the number of graduates from universities in the period 1993-2006. Engineering graduates seem to do particularly well in the labor market, with very high private rates of return even when considering the higher tuition they pay, on average, to obtain their degree. We can call this force *the influence of economic globalization on the returns to higher education*, and it has helped to create a large demand for higher education and particularly for technical higher education.

We have shown that a second important force shaping Indian higher education is the political pressure placed on the Indian State regarding higher education expansion. *The Indian State—like all national political systems in today's world—needs to deliver educational access as port of legitimizing itself as a State.* It could be argued that mass education—including the massification of higher education—is important to State legitimation only because of globalization (the spread of the "knowledge society"), but history suggests otherwise. The United States and, the Soviet Union (two very different political systems) responded to mass demand by greatly increasing access to higher education in 1930-1950—a period of relatively nationalistic self-centeredness.

Some global convergence analysts' claims that mass-education "spreads in a world organized politically as nation-states and candidate states," (Meyer, Ramirez, and Soysal, 1992, p. 128) have a persuasive logic. They argue that mass education was endemic to the worldwide spread of an *ideology* of the meaning of nationhood, *not* because mass State-run education has real "value." They reject as "functionalist" the argument that States in capitalist and post-capitalist economies expand access to education mainly because such education serves as a valuable labor market signal or because, by serving to sort individuals into economic roles "objectively," it effectively reproduces inequality and the State power structure that derives from that inequality.

> We thus argue that the expansion of mass education around the world is dependent on the formation of unified sovereign projects that are linked to and recognized by the wider world society of nation-states and the formation of internal principles of nationhood within countries ((Meyer, Ramirez, and Soysal, 1992, p. 132).

However, the proof offered in this argument is largely dependent on the authors' own classification of nations in various states of formation between 1870 and 1940. And it is difficult to separate the "formation of sovereign projects" from the notion that dominant elites in some societies would copy from elites in others the idea of using mass education to reproduce their power or make their classed-based economic systems more efficient.

We see it a different way. There are (and have been all the way back to the mid-nineteenth century) real political benefits to the dominant economic/political classes from expanding educational access, and that these benefits have less to do with persuading world society that they are constructing a legitimate nation-state than with giving the masses the sense that they are acquiring valuable assets in the form of years of schooling because what they learn in school (like literacy and numeracy) may result in some degree of social and economic mobility. This means that what has been accepted worldwide is the notion that States can expand education, reap political and economic benefits from it, and all this can occur without the economic dominant class (in capitalist economies) or the political dominant class (in communist or religious authoritarian) or the political-economic dominant class (post-communist state capitalism) necessarily giving up the real advantages derived from being dominant and controlling State power.

This is not legitimation based on mass false consciousness. After all, mass education could and probably does contribute to economic growth and increases in the standard of living at least for those who get enough of it. Education can provide access to more choices in work, and the educational system emphasizes meritocracy—that each individual is treated "equally" on the basis of merit, not social origin, ethnicity, or gender.

In India, the political legitimation argument can explain a great deal about what is happening to higher education. For example, the State's decision to expand lower levels of schooling can have the effect of increasing the payoff to those with higher education, as the payoff to lower levels fall in relative terms. When the State expands secondary education, it creates much more demand for higher education as more students finish secondary schooling. The State's decision to implement affirmative action access to higher education and to promote the regulated privatization of technical and business education certainly seem to be conscious State strategies meant to provide greater access, on the one hand, to lower caste groups to get their political support, but, on the other, to allow the new middle class to "buy into" high payoff types of higher education.

We suggest that a third force impinging on the shape of higher education in India is *the response to the increased pressure for expansion of public and private higher education coming from institutions themselves.* The public technical college staff we interviewed seemed content to rest on their historically preferred position in the higher education structure. The private aided technical colleges we interviewed were in a position, by dint of their age and reputation, to seek autonomy (and one was about to get it), which meant greater control of curriculum, testing, program development, and staffing decisions. Whether autonomy delivers greater quality is questionable. The most dynamic (although not necessarily the highest quality) institutions we visited were private unaided colleges and their management was largely focused on expansion, competing for better and higher paying students, but limited in their ability to improve the quality of their offerings without spending more per student. Yet, both aided and unaided private colleges are constantly negotiating their financial and decision-making relationship with the State.

The fourth significant force affecting higher education in India is the *ideology of globalization*. This ideology has been characterized in the recent globalization literature as the "as [a] world-wide field of power in which research-intensive universities in the United States exercise a global hegemony" (Marginson and Ordorika, 2008, p. 1). It is symbolized by the Jiao Tong University "Shanghai List" of the world's top universities and the impact its existence (and that of other world rankings) has on national State decisions regarding higher education. Universities in the English-speaking nations constitute 71 percent of the top 100 research universities. To the extent that nations are concerned with getting their universities into that top 100, the implication is that they need to copy the U.S.-U.K. model of the university. That model is the standard of quality.

In India, the central State appears to be impacted by this global ideology. It is investing heavily in the expansion of its already highly rated Indian Institutes of Technology and its Indian Institutes of Management, as well as other highly selective, research-based higher education institutions even though it is much less sanguine in helping Indian state governments garner the resources needed to build high quality colleges at the state level. The spending per student in the IITs is about three times the spending per student in the state level technical colleges. Engineering and computer science research funds administered by the University Grants Council (UGC) are highly concentrated in the national technical institutions.

According to our interviews, despite a large pool of highly talented youth ready to enter these quite well resourced autonomous universities, the expansion of national "world-class" universities at the current level of quality will not be easy. First, because the State is trying to duplicate the US-UK model, the expansion of the IITs and IIMs depends on importing large numbers of (Indian) PhDs from the developed countries. There are simply too few high quality PhDs in technical fields produced locally (see

Figure 4). Second, and intertwined with point one, they depend on the State greatly expanding basic research funds for faculty working in these institutions. As we showed, India has farther to go than any of the BRIC countries in making research funds broadly available to universities so that, in turn, graduate programs can expand and produce more PhDs. Any serious effort to significantly increase the quality of higher education will require a preceding investment in large numbers of PhDs that can improve the staffing of at leas the better private colleges.

Yet, if the State can achieve this goal—and at some price, it can succeed—the result could be a much higher local production of technical PhDs, hence the potential of improving the quality of many of the higher second tier technical colleges. It is true that this would probably not reproduce the US-UK model further down into the university system, but purely in terms of producing high quality labor, it would enhance the State's political legitimation and might contribute to the pressure on the State to stimulate the economic growth process,

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Table 1. ***India: Enrollment by field of study, 2007-08***

Field of Study	Enrollment	% Total Enrollment
Arts	5,508,877	45.51
Science	2,543,416	20.55
Commerce/Management	2,243,899	18.13
Education	188,126	1.52
Engineering/Technology	914,639	7.39
Medicine	404,719	3.27
Agriculture	73,023	0.59
Veterinary Services	19,802	0.16
Law	379,965	3.07
Other	100,252	0.81
Total	**12,376,718**	**100**

Source: UGC Annual Report 2007-08

Table 2a. ***India: Typology and Growth Trends of Higher Education Institutions, 2005-2006***

Type	Ownership	Financing	Number of Institutions	Number of Students	Percent Enrollment	Growth Trends
Government Universities	Public	Public	240	1,000,000	9.6	Not Growing
Private Universities	Private	Private	7	10,000	0.1	Emerging
Deemed Universities (Aided)	Public or Private	Public	38	40,000	0.4	Growing slowly
Deemed Universities (Unaided)	Private	Private	63	60,000	0.6	Growing rapidly
Government Colleges	Public	Public	4,225	2,750,000	26.3	Not growing
Private Colleges (Aided)	Private	Public	5,750	3,450,000	33.0	Not growing
Private Colleges (Unaided)	Private	Private	7,650	3,150,000	30.1	Growing rapidly
Foreign Institutions	Private	Private	150	8,000	0.1	Emerging
Total			***18,123***	***10,468,000***	100.0	

Table 2b. India: Number of Techinical Institutions and Intakes, by Region and Type of Management, (2006-07)

Regions	*Government Institutions*	*Private Inst,*	*Total Institutions*	*% Govt. Inst.*	*% Pvt. Inst.*	*Govt. Intake*	*Private Intake*	*Total Intake*	*% Govt. Intake*	*% Pvt. Intake*
Southern	10	875	885	1.1	98.9	2358	359700	362058	0.65	99.35
Northern	25	216	241	10.4	89.6	5704	80264	85968	6.64	93.36
Eastern	22	122	144	15.3	84.7	4371	50318	54689	7.99	92.01
Western	13	216	229	5.7	94.3	4986	80185	85171	5.85	94.15
Central	32	216	248	12.9	87.1	10109	82205	92314	10.95	89.05
North West	23	255	278	8.3	91.7	10724	94498	105222	10.19	89.81
South West	40	199	239	16.7	83.3	9549	86111	95660	9.98	90.02
Total India	165	2099	2264	7.3	92.7	47801	833281	881082	5.43	94.57

Note: Pvt = Private, Govt = Government, Instns = Institutions
Source: Author's Calculation from the available information from AICTE Website.

Table 3 : India: Per Student Public Expenditures (in Rupees) for Higher and Technical Education

Year	**Higher Education**		**Technical Education**	
	Current	Constant Prices	Current Prices	Constant Prices
1991-92	4224.91	7815.22	21413.8	39611.24
1992-93	4877.98	8288.84	34480.2	58589.98
1993-94	5335.22	8243.54	37688.3	58232.92
1994-95	1945.16	2737.74	40888.7	57549.14
1995-96	6024.84	7769.97	40684.6	52469.13
1996-97	6347.26	7594.23	44153.8	52828.23
1997-98	6864.92	7704.74	47290.6	53075.87
1998-99	8245.88	8564.48	66289.3	68850.50
1999-00	10665.68	10665.68	67611.7	67611.74
2000-01	11492.14	11130.40	60451.1	58548.30
2001-02	9168.61	8621.98	48791.6	45882.60
2002-03	9600.99	8696.55	39801.6	36052.17
2003-04	9102.46	7971.33	36654.1	32101.48
2004-05	9067.05	7527.02	45164.8	37493.61
2005-06	9986.70	7960.06	21921.4	17472.83
2006-07RE	8415.80	6393.52	24702.3	18766.43

Note: National income deflators were used to convert current expenditure into constant expenditure and refer to the year 1999-2000.
Source: Calculated from the Analysis of Budget Expenditure on Education and the UGC Annual Reports (various years).

Table 4. ***India: Annual State-set Fees for Undergraduate Programs in Engineering, by State, 2006***

State	**Average/Range (in Rupees)**
Madhya Pradesh	23,300-26,000
Chhattisgarh	20,000-31,900
Gujarat	30,000-36,000
Chandigarh	72,000
Haryana	45,000
Himachal Pradesh	41,000
Jammu and Kashmir	32,000
Maharashtra	25,000
Punjab	51,500
Rajasthan	41,000
Andhra Pradesh	22,000
Tamil Nadu	25,500-40,000

Source: AICTE

Table 5a. ***India: Rates of Return to Secondary and Higher Education, by Gender, 1965-2006 (percent return per year of schooling at each level).***

	Secondary			University			Technical/Engineering	
Year	*All*	*Men*	*Women*	*All*	*Men*	*Women*	*Men*	*Women*
1965[a]	18.8			16.2				
1978[a]	19.8			13.2				
1983[b]	13.7	13.2/6.0*	23.8	11.6	12.2/10.0*	9.5	13.9	12.8
1993/94[b]	13.8	12.6/5.4*	25.5	11.7	12.2/10.9*	10.3	15.6	12.3
1999[b]		6.1			12.3			
2006[b]		10.5	15-18.5**		12.0	16/13***	12/24***	16/13***

Source: 1965, 1978: Psacharopoulos, 1985; 1983, 1993/94: Doussami, 2000; 1999: ; 2004: Indian Survey, 2004 (see Table 5 for estimates).
Notes: a: Calculated rates. b: Mincer rates. *: Second figure is recalculation by xxxx. **: First figure is for last two years of secondary school; second figure is for all four years of secondary school. a: First figure is for diploma degree; second figure is for graduate (four year) degree.

Table 5b. ***India: Calculated Private and Social Rates of Return to Higher Education, by Gender, 2006 (percent return per year of schooling at each level).***

	Men			Women		
Level of Education	*Earnings Forgone*	*Earnings Foregone + Tuition*	*Private + Public Costs (Social ROR)*	*Earnings Foregone*	*Earnings Foregone + Tuition*	*Private + Public Costs (Social ROR)*
Diploma (All)	19.0	13.7	12.0	18.6	12.6	10.7
Graduate (All)	19.5	14.1	12.3	18.0	12.4	10.6
Diploma (Technical)	21.0	11.0-13.2	8.7-10.0	30.0	12.1-16.0	7.8-10.2
Graduate (Engineer)	36.8	20.4-24.1	16.0-18.6	---	---	---

Source: India National Household Survey, 2006

Table 6: ***India: Estimates of Mincer Rates of Return, by Gender and Technical Education, 2004***

	Model I		Model II	
Variable	***Male***	***Female***	***Male***	***Female***
Age	0.07***	0.05***	0.07***	0.05***
	(0.00)	(0.00)	(0.00)	(0.00)
Age squared	-0.00***	-0.00***	-0.00***	-0.00***
	(0.00)	(0.00)	(0.00)	(0.00)
General Education (Left out = higher secondary)				
Not literate	-0.96***	-1.24***	-0.95***	-1.24***
	(0.01)	(0.03)	(0.01)	(0.03)
Literate without formal schooling (EGS/NFEC/AEC)	-0.81***	-1.16***	-0.80***	-1.16***
	(0.05)	(0.13)	(0.05)	(0.13)
Literate without formal schooling (TLC)	-0.85***	-0.99***	-0.84***	-0.99***
	(0.06)	(0.12)	(0.06)	(0.12)
Literate without formal schooling (Others)	-0.71***	-0.61***	-0.70***	-0.61***
	(0.05)	(0.11)	(0.05)	(0.11)
Below Primary	-0.75***	-1.00***	-0.74***	-1.00***
	(0.02)	(0.04)	(0.02)	(0.04)
Primary	-0.61***	-0.99***	-0.60***	-0.98***
	(0.01)	(0.04)	(0.01)	(0.04)
Middle	-0.43***	-0.74***	-0.42***	-0.74***
	(0.01)	(0.04)	(0.01)	(0.04)
Secondary	-0.21***	-0.30***	-0.21***	-0.30***
	(0.01)	(0.04)	(0.01)	(0.04)
Diploma/certificate course	0.36***	0.48***	0.14***	0.36***
	(0.02)	(0.06)	(0.03)	(0.07)
Graduate	0.48***	0.52***	0.41***	0.46***
	(0.02)	(0.04)	(0.02)	(0.04)
Postgraduate and above	0.75***	0.66***	0.69***	0.61***
Technical Education (Left out = no technical education)				
Technical Degrees (all fields) & Diploma or certificate (below graduate level) in other technical fields			0.34***	0.15***
			(0.03)	(0.05)
Diploma or certificate (below graduate level) in Engineering/Technology			0.23***	0.11
			(0.03)	(0.09)
Diploma or certificate (below graduate level) in Medicine			0.27***	0.19**
			(0.08)	(0.09)
Diploma or certificate (graduate level) in other tech fields			0.18***	0.22***
			(0.05)	(0.07)
Diploma or certificate (graduate level) in Engineering/Technology			0.55***	0.12
			(0.04)	(0.11)
Diploma or certificate (graduate level) in Medicine			0.69***	0.76***
			(0.09)	(0.12)
Constant	5.08***	5.32***	5.07***	5.32***
	(0.03)	(0.06)	(0.03)	(0.06)
Observations	49351	13266	49198	13244
R-squared	0.39	0.43	0.40	0.44

Source: National Household Survey, 2006

Notes: Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1

Table 7. ***Estimates of Structural Model--Probability of Attending Public Technical College and Log of Earnings, Four Indian States, 2008-09***

Variable	*Probability of Attending Public Technical College (probit)*	*Log of Expected Earnings in First Year of Work*
Public college	---	0.145***
Gender	-0.718***	-0.207***
Entrance score	0.024***	0.013***
Mother w/ higher education	0.264***	0.164***
Lower middle income SES	0.567***	0.048
High income SES	0.073	0.154***
Other variables included	Y (caste)	Y (college internships; ability)
Constant	-1.831***	0.375***
Observations	5073	3593
R-squared	---	0.103

Source: Sample of final year engineering and computer science students.
Notes: reference variables: gender (male=0); low income (family income < 10,000 rupees/month. *** = statistically significant at .01 level of significance.

Table 8. ***Estimated Tuition Fees Reported Paid by Students as a Function of Student Characteristics and Type of Institution Attended (dependent variable is thousands of current rupees)***

Variable	*Model 1*	*Model 2*	*Model 3*	*Model 4*
% Marks on entrance exam	-0.61***	-0.66***	-0.69***	-0.37***
Scheduled caste	-26.50***	-23.28***	-31.52**	-43.48***
Scheduled tribes	-33.19***	-29.34***	-81.17***	-49.29***
Other backward class	-17.02***	-13.39***	-0.40	-15.00
Female	-1.62	-2.30	-2.30*	-3.64***
Mother higher general education		9.06***	8.98***	7.17***
Mother higher professional educ		8.46***	8.41***	7.43***
Father higher general education		3.28	3.43*	4.26**
Father higher professional educ		3.64	3.90*	5.15**
Scheduled caste*test score			0.11	0.38*
Scheduled tribes*test score			0.72**	0.47
OBC*test score			-0.16	0..06
State college				-28.79***
Intercept	96.71***	92.26***	94.03***	75.65***
Number of observations	4117	4097	4097	4097
R-squared	0.08	0.09	0.10	0.17

Source: Sample of final year engineering and computer science students.
Notes: reference variables: gender (male=0); parents' education, secondary school; caste, other; college, private. *** = statistically significant at .01 level of significance; ** = .05 sig. level; * = .10 sig. level

Table 9: ***Computer Science Subject Course-Taking in India, England, and the United States***

Courses	**ICL**	**IITM**	**Stanford**

Engineering Fundamentals	0	5	2
Computer Science classes	23-26	16	11
Senior Project	1	1	1
Minor (Engg)	0	3	0
Math	3	4	4
Physics	0	2	2
Chemistry	0	2	0
Humanities & Social Sciences	0-3	3	22
Total	30 (3 years)	36 (8 semesters)	42 (12 quarters)

Sources: ICL (Imperial College, London) and some IITM (Indian Institute of Technology, Madras) data from website: www3.imperial.ac.uk; Stanford and some IITM data are from authors' survey

Note: Many of the technical subject courses have laboratories associated with them—in the Indian case, there is one lab for every two-three courses, depending on the college (see Table 5)

Table 10. ***Comparing Coursework Structure and Student Study Patterns in India, England, and the United States.***

Category	Imperial College	India	Stanford
Lecture: Lab	4:1	3:1	3:1
Supervised to Unsupervised	NA	3:1	1:3 (Years 1 and 2) 1:4 (Years 3 and 4 - CS) 1:2 (Years 3 and 4 – other)
Total hours/week on major	NA	40	24 (Years 1 and 2) 50 (Years 3 and 4)
Total hours/week on other subjects	NA	3	36 (Years 1 and 2) 15 (Years 3 and 4)
Lecture to Small Group Work	NA	2.3:1	1:3
Summer Internship	NA	<10%	100%
Total units in major (including prerequisites)	92%	88%	52%

Sources: As in Table 4 plus authors' survey of 7 colleges in Chennai, 5 colleges in Mumbai, and 3 colleges in Bangalore.

Table 11. ***Faculty Salary and Tuition Fees/State Subsidies Across Countries (US dollars)***

	IIT Bombay+	**India**	**Stanford**	**Tsinghua**
Assistant Professor	10,600-16,000	12,000-15,000^	99,500-103,000*	20,000
Associate Professor	14,500-17,600	15,000-20,000^	110,000-121,000*	25,000
Professor	16,200-19,700	20,000-48,000^	132,000-166,000*	25,000-100,000
Fresh Graduate	9,000	6,000	110,000	15,000
Tuition	800	500-700 – public/pvt. aided 1,600-2,500 – private unaided	39,000 + 16,000 on campus living	
State tuition subsidy	4,000	500 – public 500-700 – private unaided (for designated castes)	0	
Job placement rate by Semester 7	85%	57%	90%	
No. of job years to recover tuition from full salary	0.35	0.67-1.67 (private unaided)	1.5	
Ratio Asst.Prof Min/ Grad salary	1.2	2.0	0.9	1.3
Ratio Full Prof/ Asst Prof @ 33 percentile	1.4	NA	1.3	

Source: China data:http://fangzhouzi-xys.blogspot.com/2009/02/talking-about-shi-yigongs-salary.html, http://www.chinadaily.com.cn/china/2008-01/02/content_6365215.htm
India data: Authors' interviews; Joshi (2008); Banerjee, et.al. (2008), http://www.indiaedunews.net/IIT/Many_IIT_aspirants_fail_to_prove_OBC_non-creamy_layer_status_4749/
Notes: Salary converted at USD 1 = Rs.50; USD 1 = Rs.6.8 Yuan
+ IIT salaries are augmented by sizable housing subsidies for faculty living on campus.
^ = private unaided school averages
* = 33 & 66 Percentiles

Table 12. ***How Indian Engineering Students Spend Their Time (hours/week)***

	Time Spent per Week (hours)				
Category of Activity	*Delhi*	*Karnataka*	*Maharashtra*	*Tamil Nadu*	*Total*
Attending classes / labs	17.9	29.8	27.4	33.4	27.0
Studying / homework	9.2	10.1	9.3	9.3	9.6
Socializing with friends	12.3	13.1	11.8	10.5	12.4
Talking with teachers outside of class	2.5	2.4	1.8	3.0	2.3
Computer work	13.6	13.7	12.3	12	13.2
Volunteer work	2.9	3.4	2.7	4.4	3.3
Student clubs / groups	3.9	3.6	4.1	4.6	3.9
Exercise / sports	6.2	6.7	6.0	6.2	6.4
Entertainment (movies, games, going out, etc.)	9.2	12.4	10.0	13.0	11.3
Paid Work	2.3	1.4	1.4	1.5	1.6
Transport	8.3	6.9	8.0	7	7.6
Total	95	113	106	112	108

Source: Authors' Student Survey in four states

Table 13. ***India: Percent of PhDs Teaching in Technical Colleges and Universities, 2009***

Technical Institution	Total Faculty	Total Students	Number of PhDs	Student/ Faculty	% PhDs
Karnataka (private unaided)	348	4473	48	12.9	13.8
Karnataka (private unaided)	381	5465	94	14.3	24.7
Karnataka (private unaided)	107	1584		14.8	0.0
Karnataka (private unaided)	91	1440	7	15.8	7.7
Karnataka (private unaided)	106	1600	10	15.1	9.4
Maharashtra (public)	520	6000	470	11.5	90.4
Maharashtra (public)	165	3700	38	22.4	23.0
Maharashtra public)	55	860		15.6	0.0
Maharashtra (private unaided)	113	1671	9	14.8	8.0
Maharashtra (public)	141	1902	14	13.5	9.9
Maharashtra (public)	46	458	33	10.0	71.7
Maharashtra (public)	222	3082	38	13.9	17.1
Maharashtra (private unaided)	222	3112		14.0	0.0
Delhi (public)	28	1384	14	49.4	50.0
Delhi (private unaided)	64	960	5	15.0	7.8
Delhi (private unaided)	97	1440	5	14.8	5.2
Delhi (private unaided)	137	1880		13.7	0.0
Delhi (public)	251	3500	129	13.9	51.4
Delhi (public)	136	2050	18	15.1	13.2
Delhi private unaided)	86	1386	11	16.1	12.8
Delhi (public)	357	4382	351	12.3	98.3

Source: Authors' Survey of Colleges, 2009

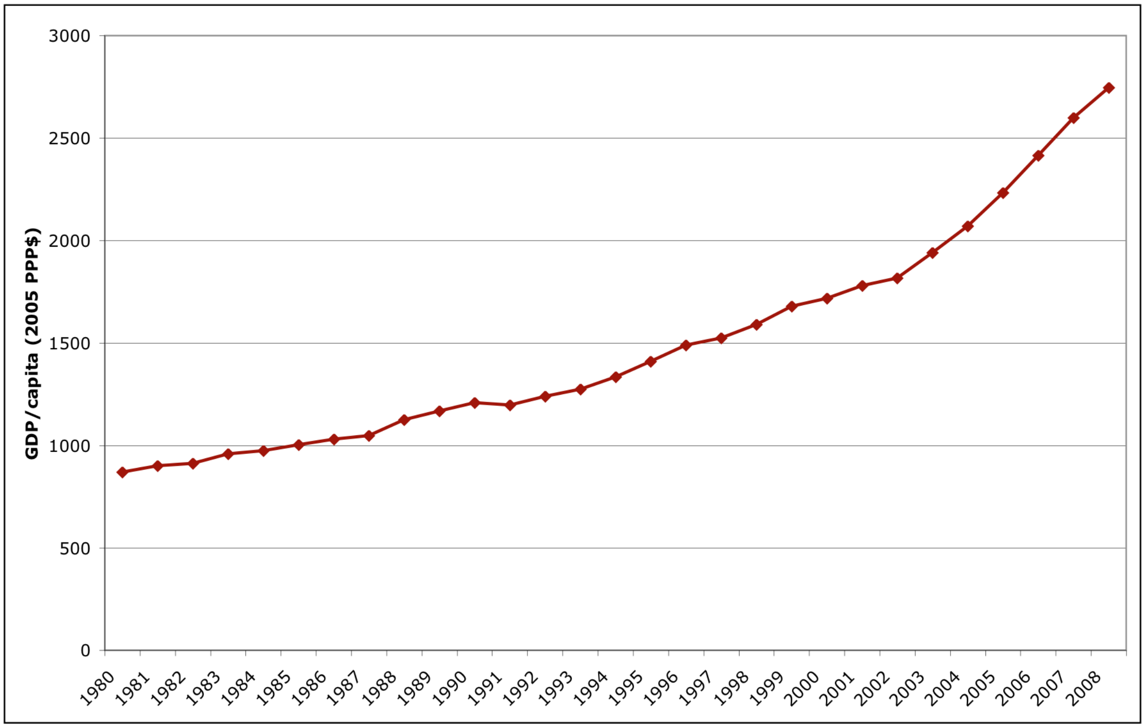
Table 14. ***India: PhDs Awarded in Engineering Education and Their Share of Total PhDs in Higher Education, 1973-74 to 2004-05***

Year	No. of PhDs in Engineering	No. PhDs in HE	% of Engineering PhD to total HE
1980-81	139	6080	2.29
1981-82	190	6404	2.97
1982-83	160	6597	2.43
1983-84	192	6934	2.77
1984-85	210	7139	2.94
1985-86	194	7346	2.64
1986-87	224	7219	3.10
1987-88	225	7934	2.84
1988-89	238	8238	2.89
1989-90	252	8052	3.13
1990-91	262	8016	3.27
1991-92	299	8743	3.42
1992-93	277	10136	2.73
1993-94	329	9923	3.32
1994-95	337	9851	3.42
1995-96	374	10397	3.60
1996-97	298	10408	2.86
1997-98	696	11107	6.27
1998-99	682	11067	6.16
1999-00	723	11296	6.40
2000-01	778	11534	6.75
2001-02	734	11974	6.13
2002-03	833	15328	5.43
2003-04	882	17853	4.94
2004-05	968	17898	5.41

Note: HE = Higher Education

Source: Calculated from the UGC Annual Reports (Various Years).

Figure 1. ***India: Gross Domestic Product per Capita, 1980-2008 (constant 2005 PPP dollars).***



Source: World Bank (n.d.). *World Development Indicators.* Washington, DC: World Bank.

Figure 2. ***India: Enrollment in Engineering Institutions and Engineering Enrollment as a Fraction of Total Higher Education Enrollment, 1960-2007***

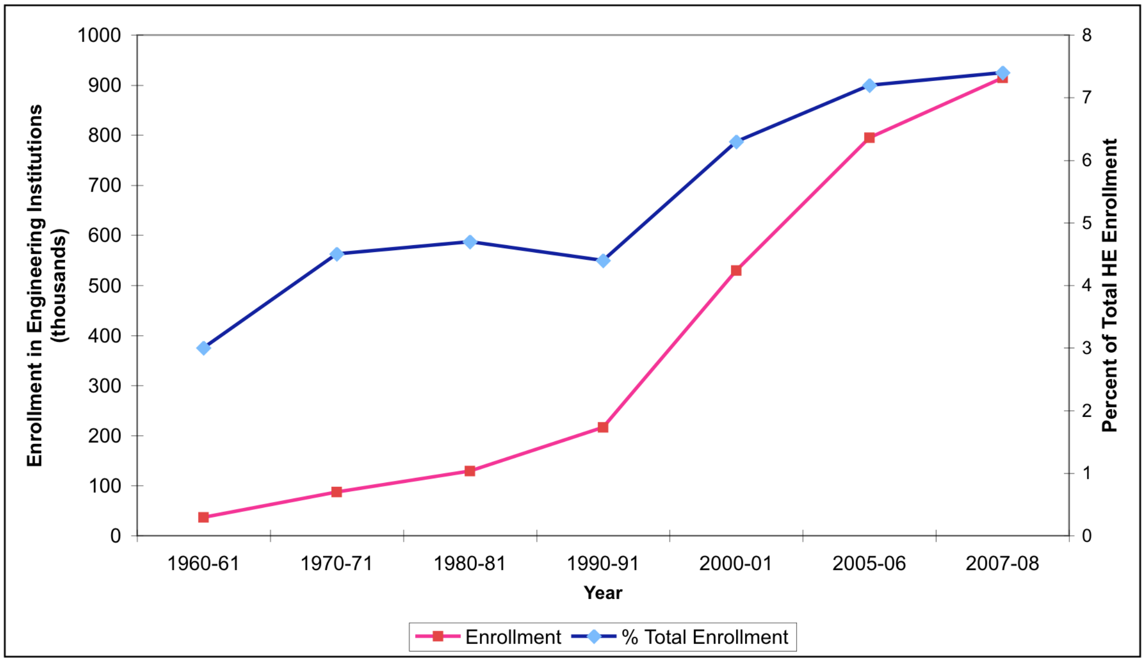


Figure 3. ***India: Stock of Engineering Graduates (degree holders) and Stock of Engineering Graduates per Million Population, 1970-2005.***

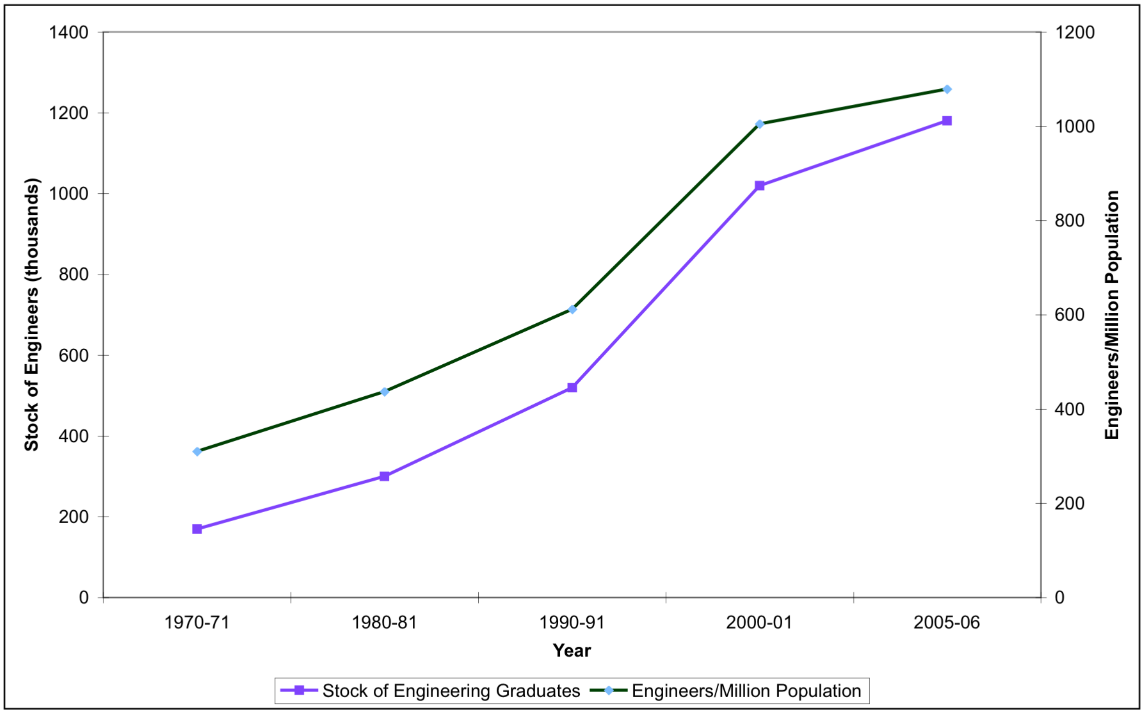


Figure 4. ***India: A Model of Forces Impacting on the Shape of Change in Higher Education***

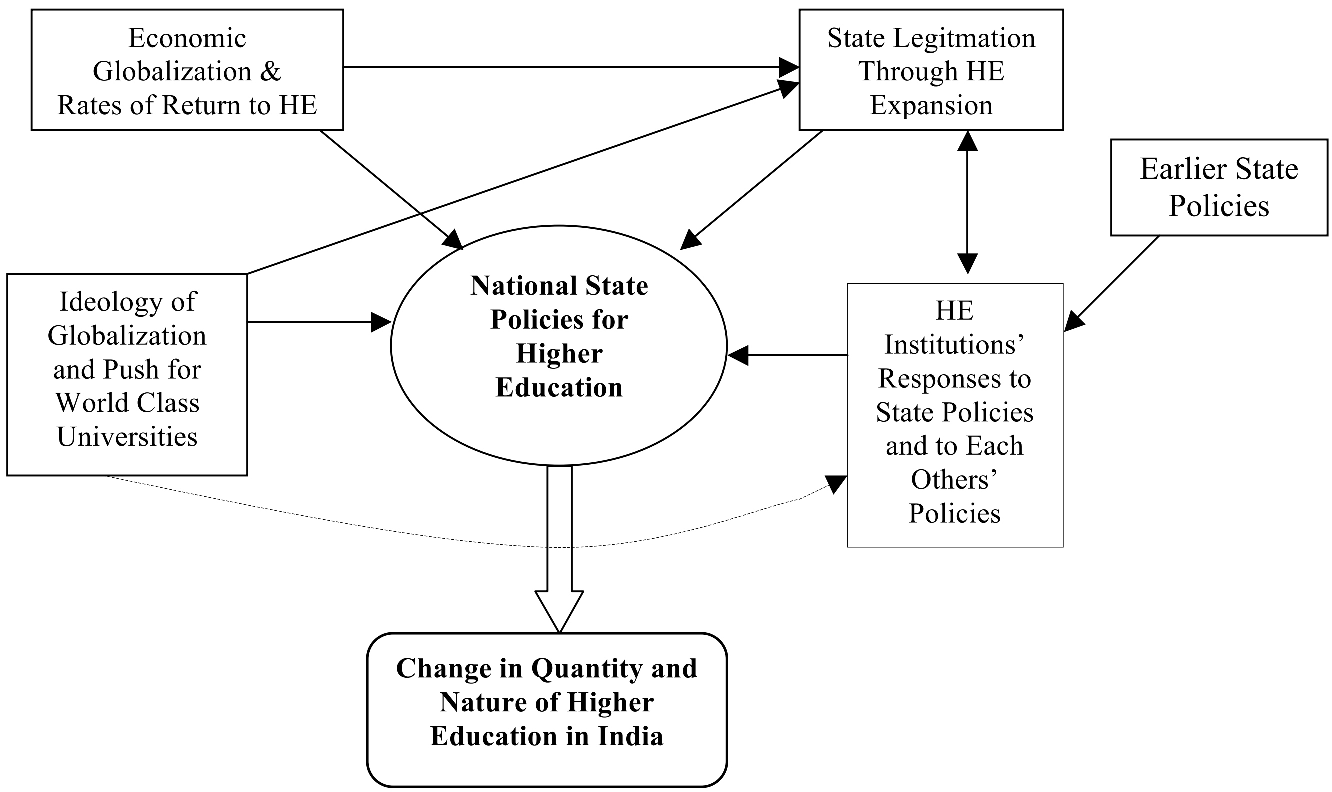
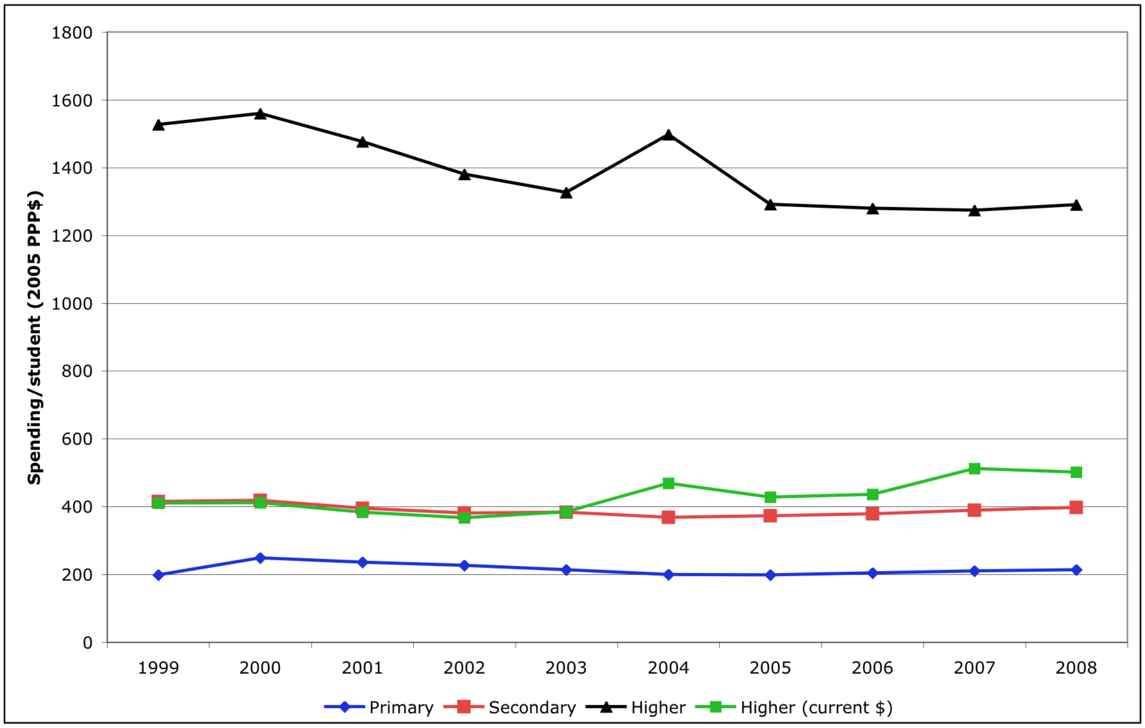
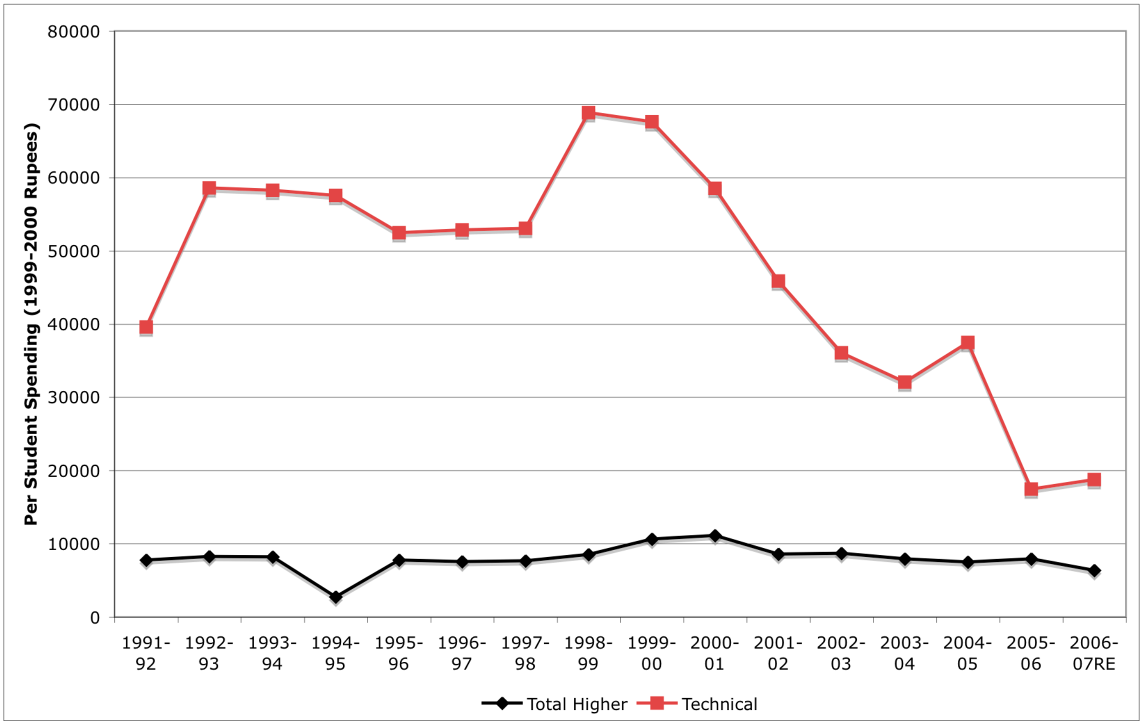


Figure 5. ***India: Public Expenditures per Student, 1999-2008, by Level of Schooling (2005 PPP dollars).***



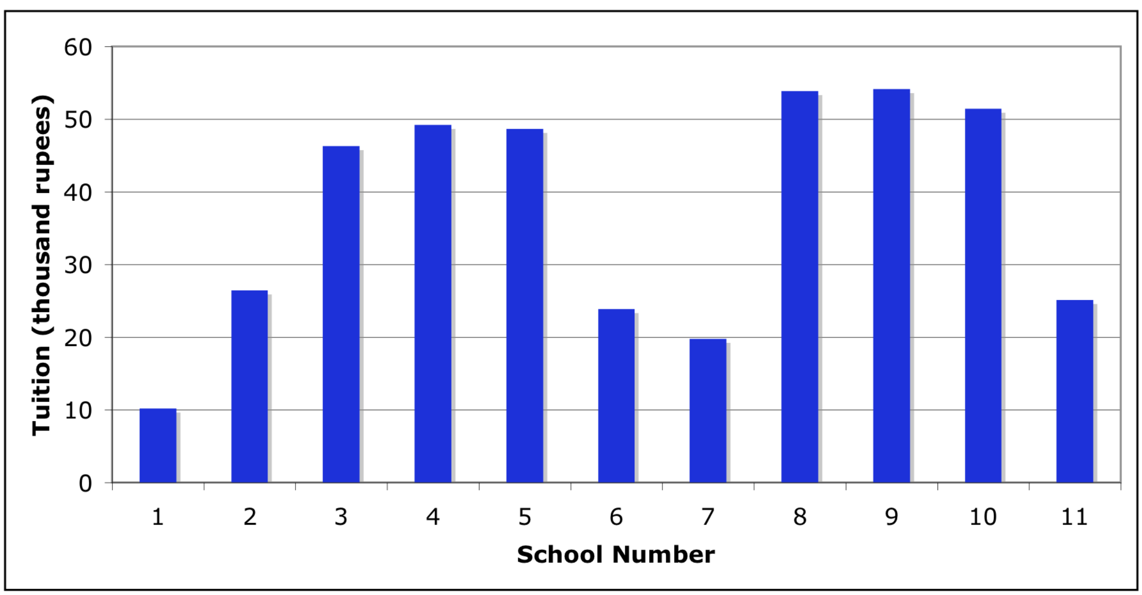
Source: Authors' estimates from World Bank (n.d.), *World Development Indicators*, using figures for spending per student as a percentage of GDP/capita times GDP/capita.
Note: India Spending Data suggest lower figures (see Table 3 above):
Total Public Expenditure on Higher Education in 2007-08: Rs.155770 million
Technical Education: Rs.70203 million
Total : Rs.225973 million = US$ 4519 million (Rs 50 per 1 US$)
No. of Students: 12.4 million
Per Student Expenditure: US$ 364.

Figure 6: ***India: Public Spending per Student in Technical and All Higher Education, 1991-2006.***



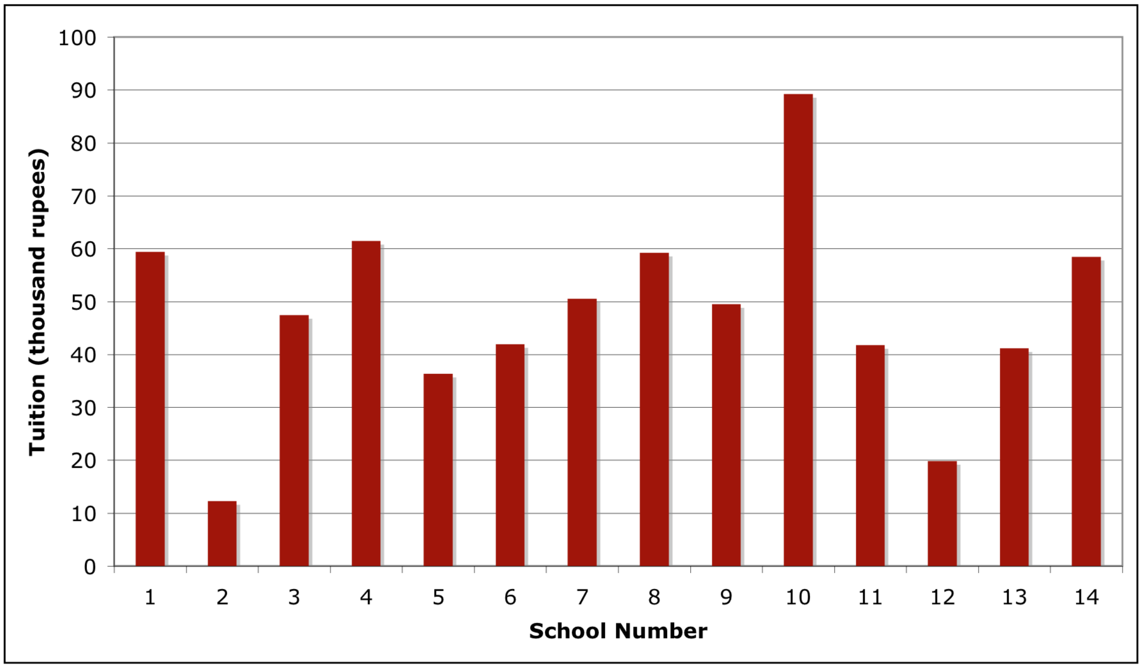
Source: Table 3.

Figure 7a. ***Delhi: Average Tuition Fees Reported Paid by Students, by College Number, 2008-09 (thousands of current rupees).***



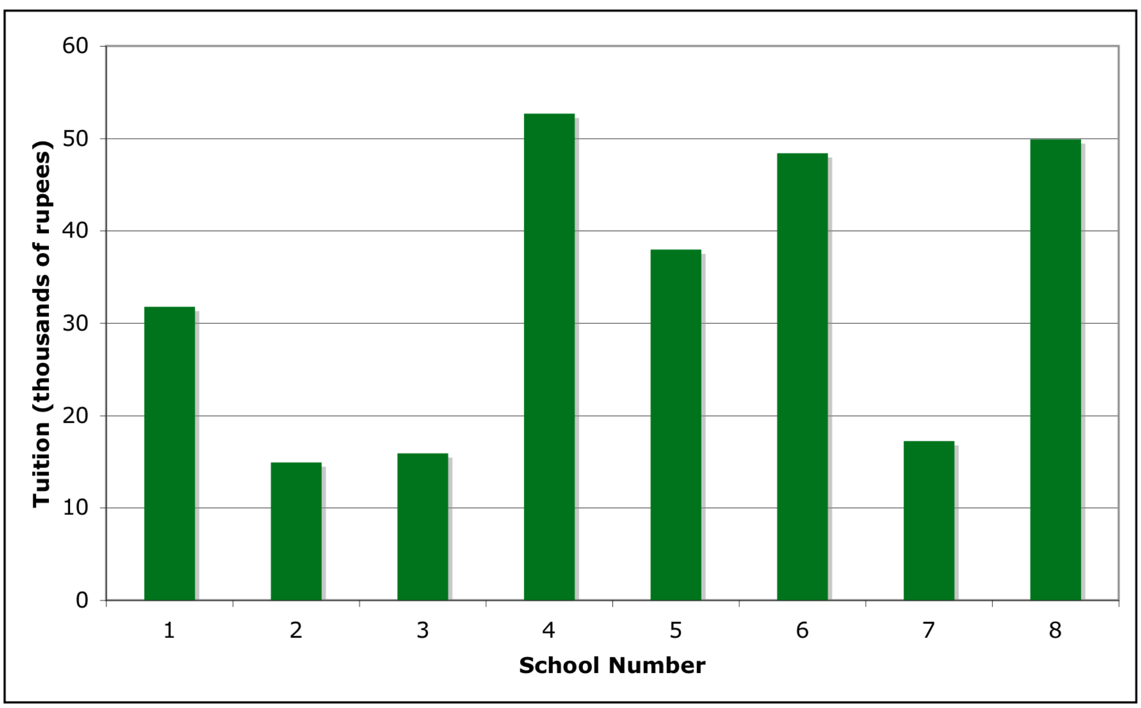
Source: Technical College Student Sample

Figure 7b. ***Karnataka: Average Tuition Fees Reported Paid by Students, by College Number, 2008-09 (thousands of current rupees).***



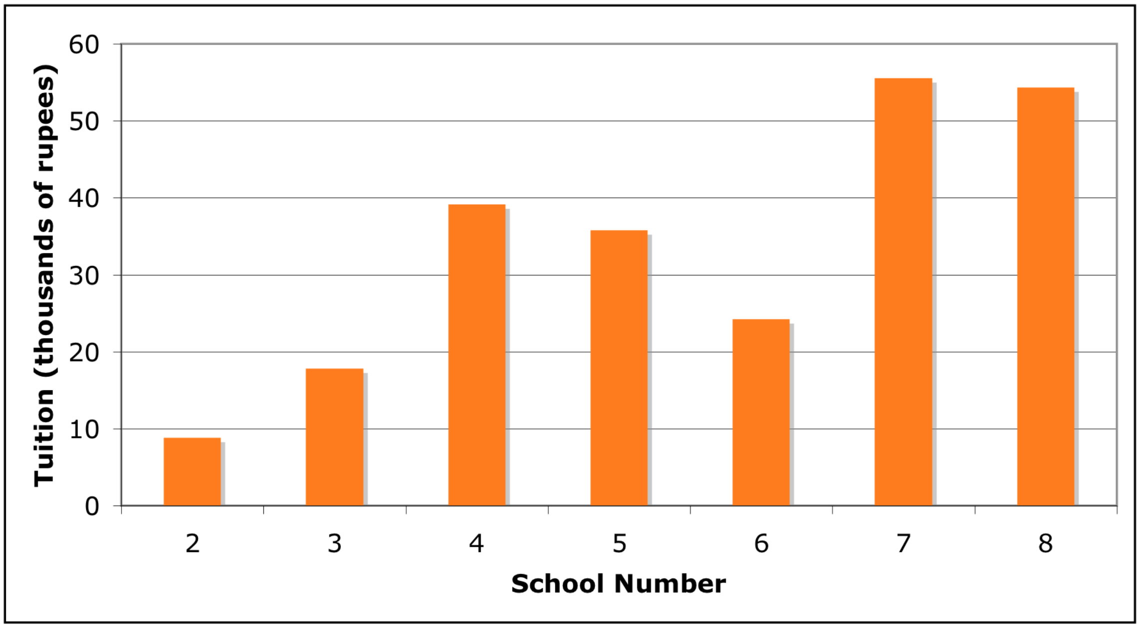
Source: See Figure 7a

Figure 7c. ***Maharashtra: Average Tuition Fees Reported Paid by Students, by College Number, 2008-09 (thousands of current rupees).***



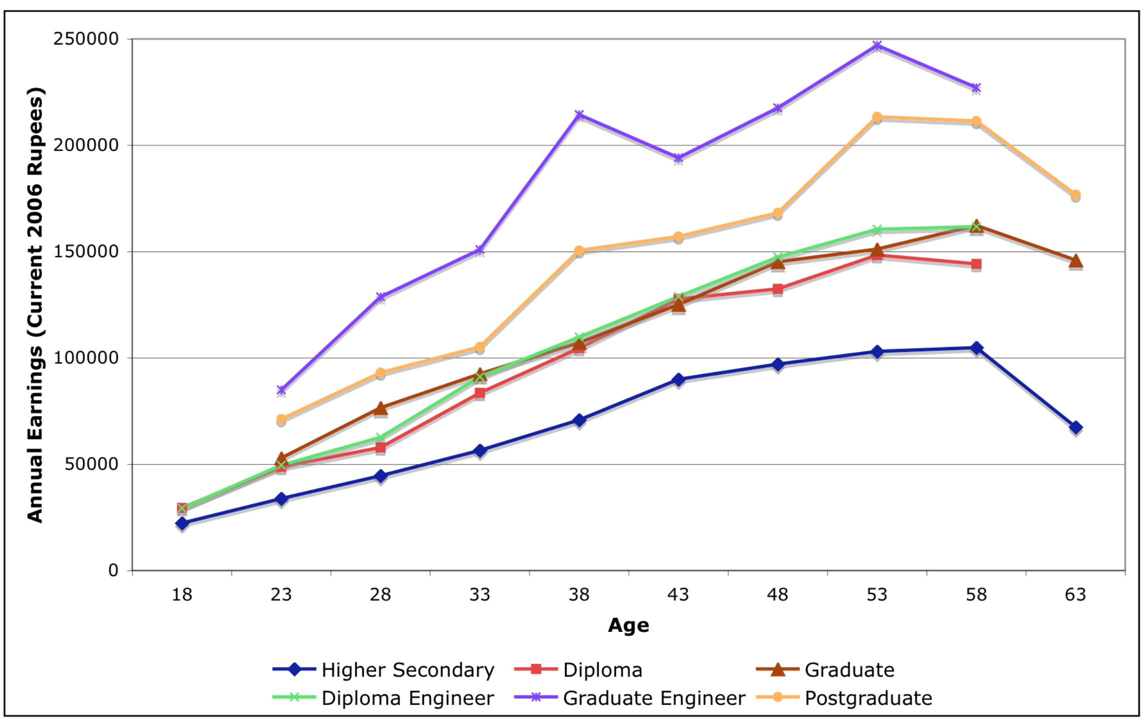
Source: See Figure 7a

Figure 7d. ***Tamil Nadu: Average Tuition Fees Reported Paid by Students, by College Number, 2008-09 (thousands of current rupees).***



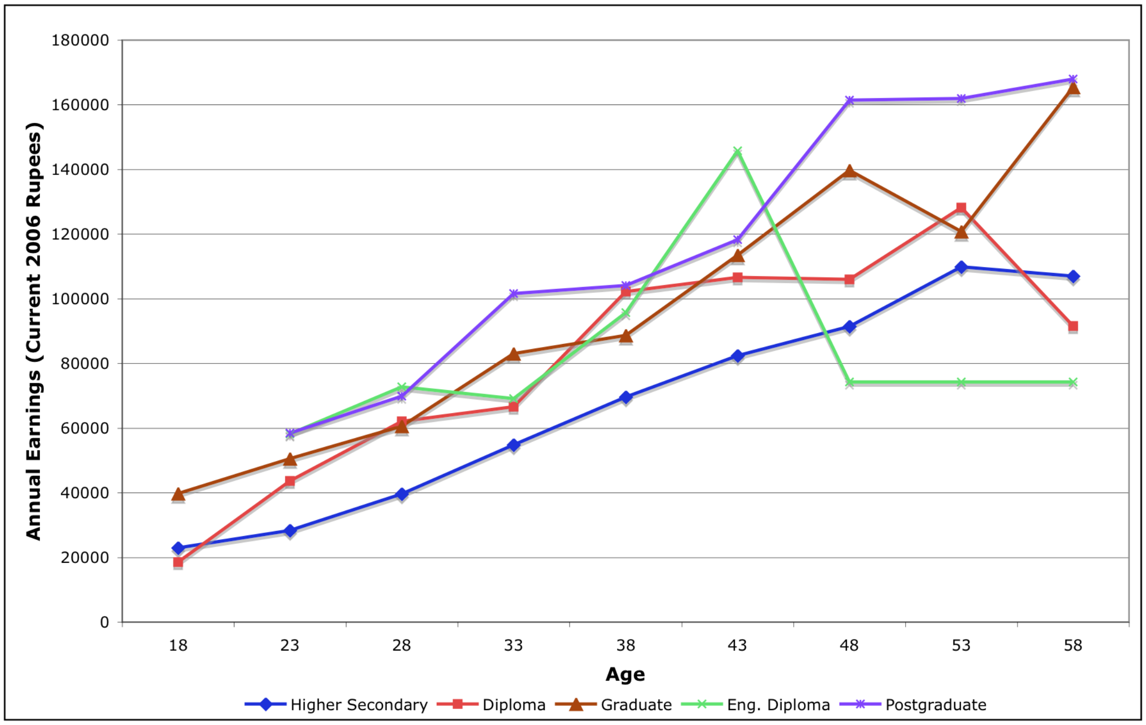
Source: See Figure 7a

Figure 8a. ***India: Males' Annual Earnings, Secondary Schooling Complete, Bachelors' Degree, and Bachelor's Degree in Engineering, 2006 (current Rupees/year).***



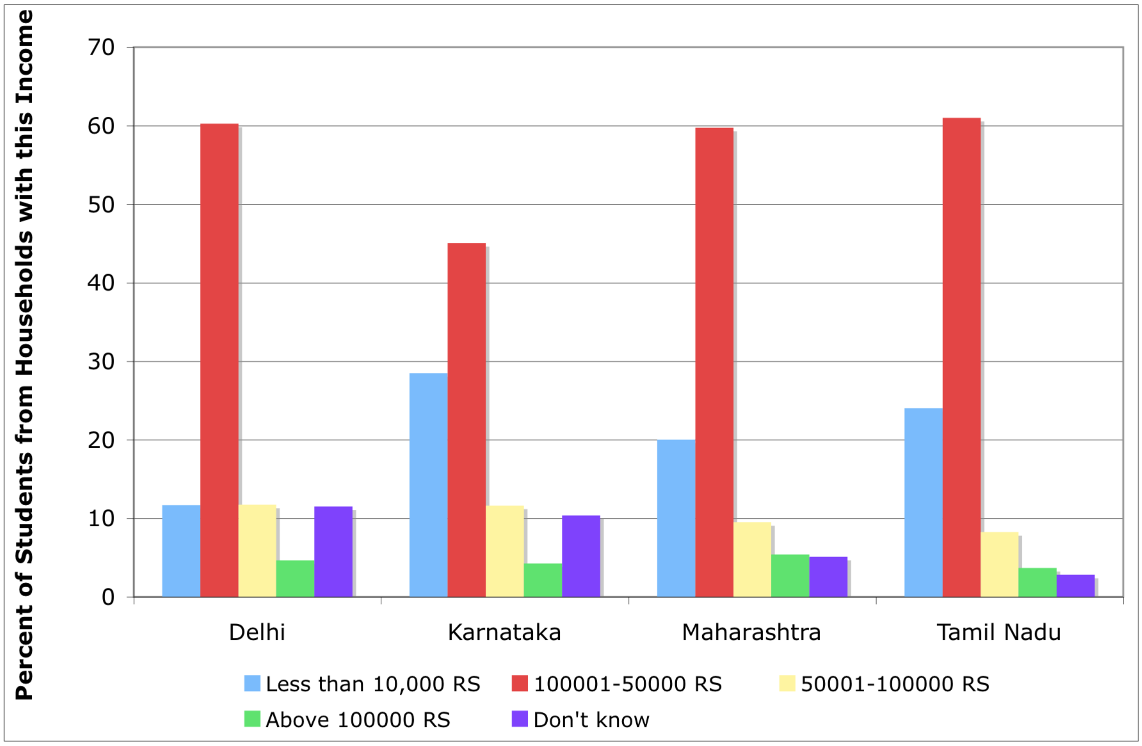
Source: NSS Survey 62nd round

Figure 8b. ***India: Females' Annual Earnings, Secondary Schooling Complete and Bachelor's Degree, 2006 (current Rupees/year).***



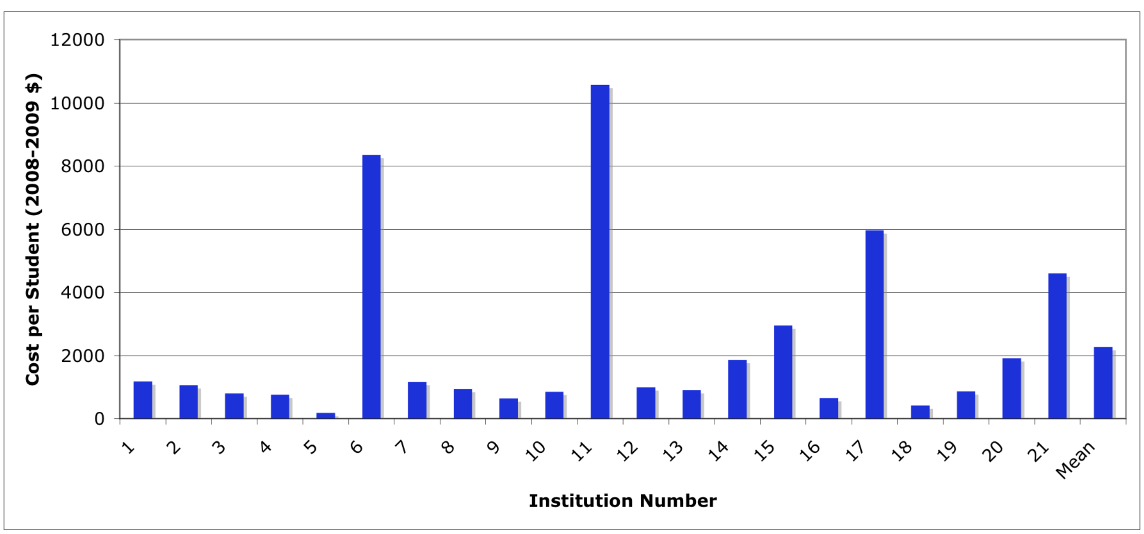
Source: NSS Survey, 62nd round.

Figure 9. ***Distribution of Technical Students' Family Income, by State, 2008-2009 (percent in each category)***



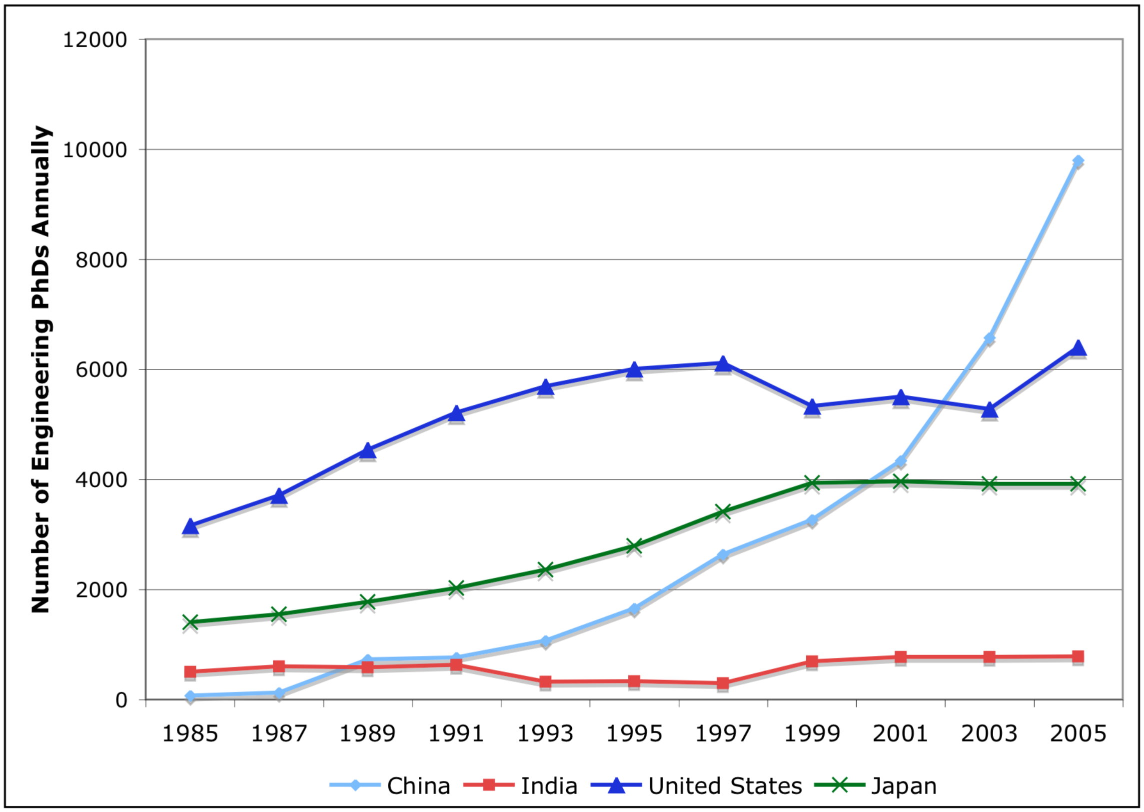
Source: Student Sample, 2008-2009

Figure 10. ***India: Spending per Student in Technical Colleges, 2008-2009, by College (current US dollars)***.



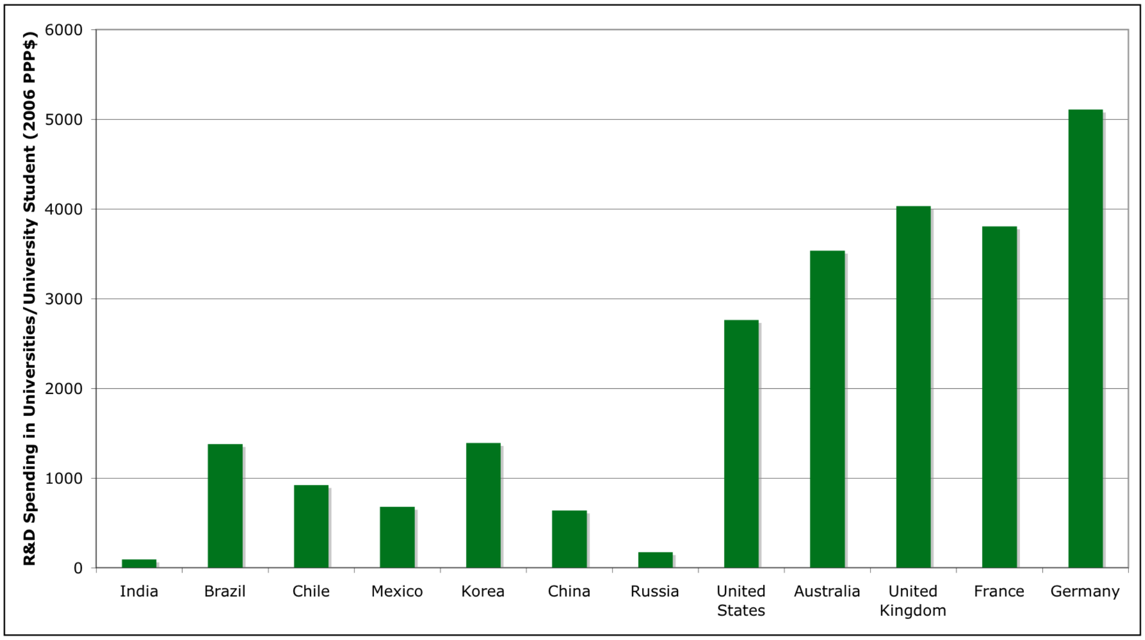
Source: Survey by authors.

Figure 11. ***Engineering PhDs Graduated Annually, by Country, 1985-2005***



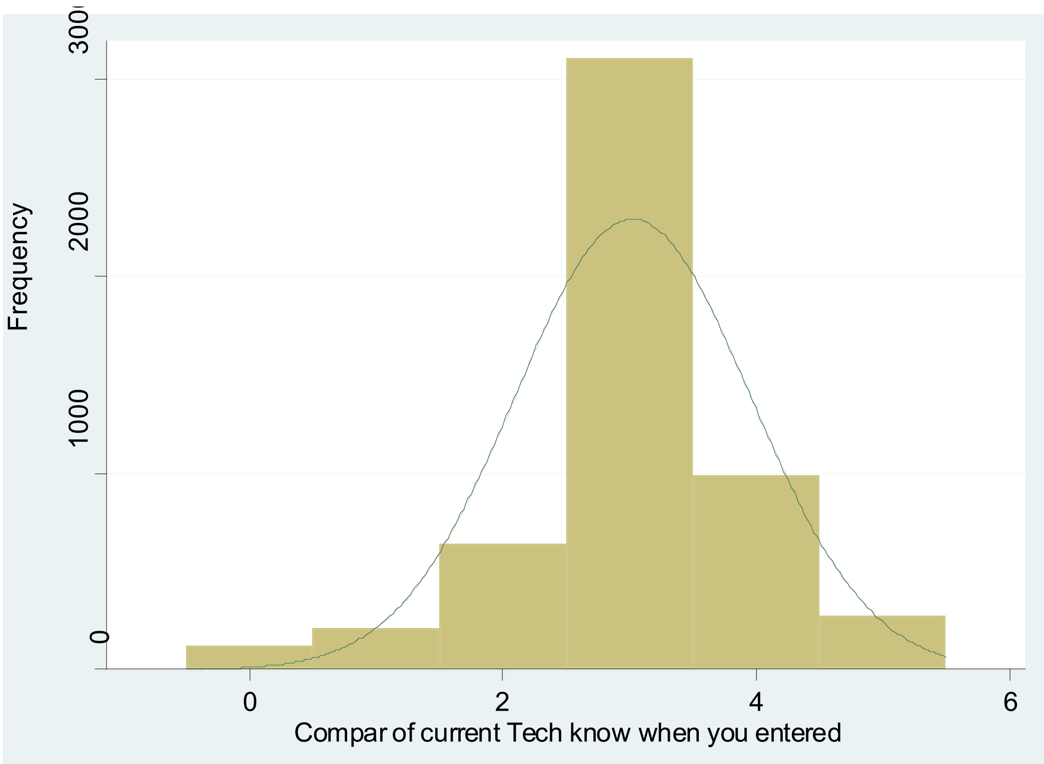
Source: National Science Foundation (2008*). Science and Engineering Indicators, 2008,* Appendix Tables 2-42 and 2-43.Note: India: 2005-06: 1058; 2006-07: 1079

Figure 12. ***R&D Spending Performed in Universities per University Student, by Country, 2006 (PPP $)***



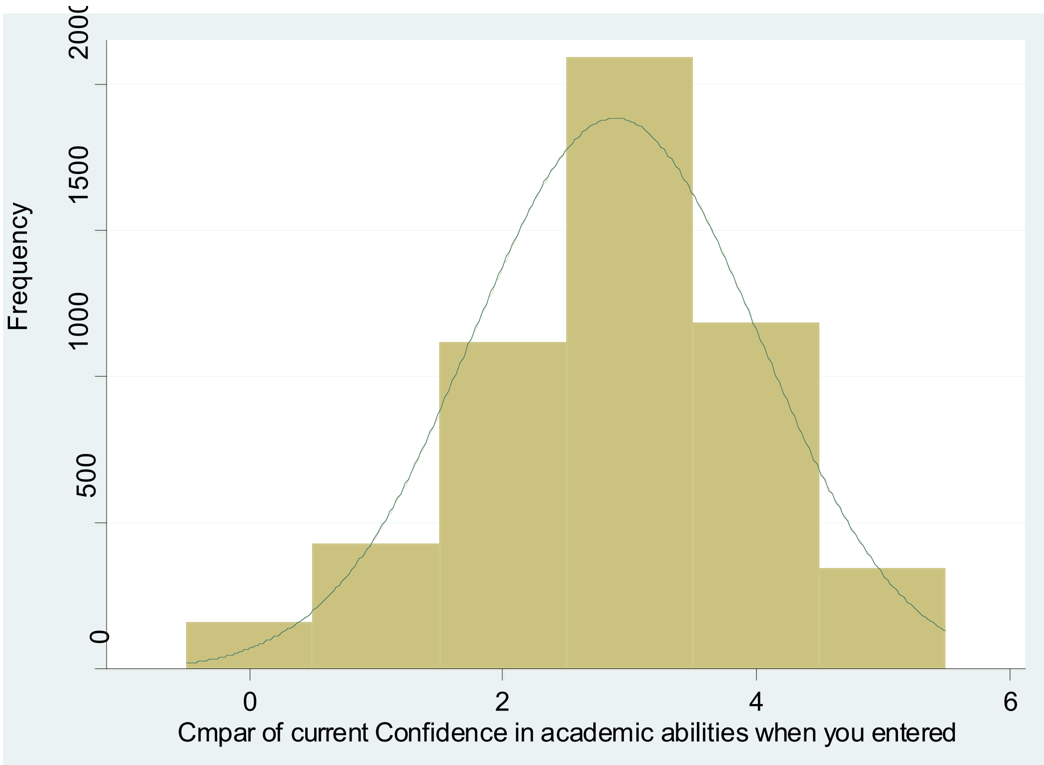
Source: UNESCO \ Institute for Statistics.
http://stats.uis.unesco.org/unesco/TableViewer/document.aspx?ReportId=143&IF_Language=eng

Figure 13a. ***Student Opinion of Current Technical Knowledge Compared to When they Entered This Institution (distribution of frequency).***



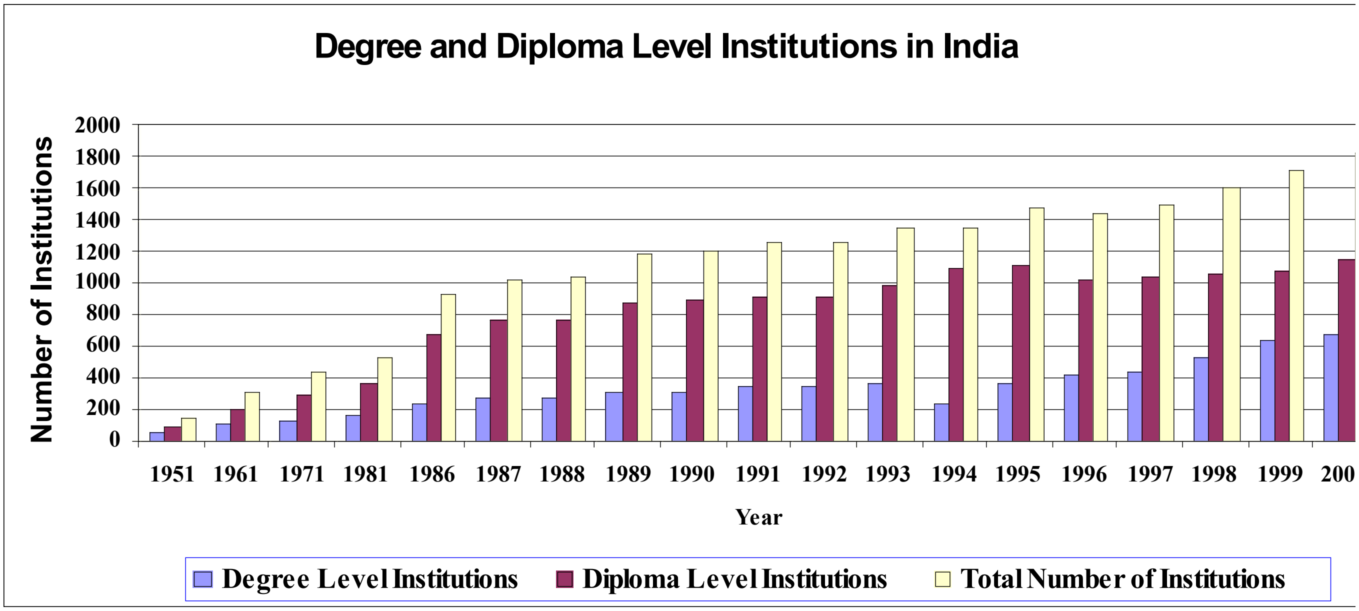
0=much weaker; 1 = weaker; 2 = same; 3 = stronger; 4 = much stronger; 5 = don’t know

Figure 13b. ***Student Opinion of Confidence in Academic Abilities Compared to When they Entered This Institution (distribution of frequency).***



APPENDIX FIGURES AND TABLES

Figure A1: Growth of Technical Institutions in India (1951-2000)



Source: IAMR year book, 2008.

Table A1: Share of Engineering Education to Total Higher Education in India (1970-71 to 2005-06)

Year	Enrolment in HE	Enrolment in Eng. Edn	% of Eng. Enrolment to Total HE
1970-71	1953700	87257	4.46
1971-72	2065041	82804	4.00
1972-73	2168107	82674	3.81
1973-74	2234385	86665	3.87
1974-75	2366541	90685	3.83
1975-76	2426109	96067	3.95
1976-77	2431563	100040	4.11
1977-78	2564972	103706	4.04
1978-79	2618228	111659	4.26
1979-80	2648579	118607	4.47
1980-81	2752437	128937	4.68
1981-82	2952066	130189	4.41
1982-83	3133093	142440	4.54
1983-84	3307649	153131	4.62
1984-85	3404096	159046	4.67
1985-86	3605029	176540	4.89
1986-87	3757158	183966	4.89
1987-88	4020159	192148	4.77
1988-89	4285489	201289	4.69
1989-90	4602680	209371	4.54
1990-91	4924868	216837	4.40
1991-92	5265886	258028	4.89
1992-93	5534966	271213	4.89
1993-94	5817249	285045	4.89
1994-95	6113929	299583	4.90
1995-96	6574005	315720	4.80
1996-97	6842598	331017	4.83
1997-98	7260418	346833	4.77
1998-99	7705520	363481	4.71
1999-00	8050607	389001	4.83
2000-01	8399443	529469	6.30
2001-02	8964680	605597	6.75
2002-03	9516773	692087	7.27
2003-04	9953506	716652	7.199
2004-05	10481042	754635	7.19
2005-06	11028020	795120	7.20

Source: UGC, Annual reports (Various Years).

Table A2: India: Availability of Engineering Graduates per 100,0000 (lakh) Population ,1970-71 to 2005-06

Year	Eng. graduates per lakh Population	Year	Eng. graduates per lakh Population
1970-71	16.12883549	1988-89	25.00
1971-72	14.9465704	1989-90	25.47
1972-73	14.58095238	1990-91	25.84
1973-74	14.94224138	1991-92	30.14
1974-75	15.2925801	1992-93	31.10
1975-76	15.82652389	1993-94	31.95
1976-77	16.13548387	1994-95	32.92
1977-78	16.35741325	1995-96	34.02
1978-79	17.23132716	1996-97	34.99
1979-80	17.8625	1997-98	35.97
1980-81	18.9892489	1998-99	36.97
1981-82	18.81343931	1999-00	38.86
1982-83	20.11864407	2000-01	51.95
1983-84	21.17994467	2001-02	58.34
1984-85	21.5217862	2002-03	65.60
1985-86	23.38278146	2003-04	66.78
1986-87	23.86070039	2004-05	69.23
1987-88	24.38426396	2005-06	71.82

Source: UGC, Annual reports (Various Years).

Table A3. ***India: Estimated Stock of Engineers, 1971 to 2003***

Year	Degree Holders	Diploma Holders	Total
1971	1745	2304	4049
1981	3049	4258	7307
1986	3908	6014	9922
1990	4922	7978	12900
1991	5196	8593	13789
1992	5558	9111	14669
1993	5977	9701	15678
1994	6449	10260	16709
1995	6981	10978	17959
1996	7533	11731	19264
1997	8065	12422	20487
1998	8591	13123	21714
1999	9137	13795	22932
200	9695	14560	24255
2001	10244	15317	25561
2002	10783	16067	26850
2003	11832	17205	29037

Source: IAMR year book, 2007.

Note: Stock is taken at the beginning of the year & in the working age group