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Jandhyala B. G. Tilak
Council for Social Development, New Delhi, India

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Corresponding Author: Jandhyala B. G. Tilak, jtilak2017@gmail.com

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Engineering Graduates in India: Determinants of their Employment and Earnings

Jandhyala B. G. Tilak[1*]
Council for Social Development, New Delhi, India

Abstract

In terms of enrolments and number of higher education institutions, engineering education has expanded fast in India during the last three decades. The expansion has been clearly in response to labour market conditions – growing demand for engineering manpower and higher wages relative to others. However labour market conditions are changing fast, and the growth in the field of engineering education has also slowed down in the most recent years. Using the data collected through a survey of about 7,000 students enrolled in 40 engineering institutions in four different states in India, an attempt has been made in this paper to analyse two specific aspects relating to labour market for engineering graduates: determinants of employment probabilities of engineering graduates and determinants of their earnings. Multi-variate logistic regression and ordinary least squares (OLS) techniques have been used to examine respectively these two aspects. Among the hypothesized factors, education and related factors seem to be the main predictors of employment, while education related factors, job related factors and gender seem to influence the earnings of the engineering graduates. The paper contributes to the extensive research on labour market research on higher education, and to the limited research on economic aspects of employment and earnings of engineering graduates in India. The results have important implications for policy making relating to engineering education and employment in India and other countries.

Keywords: Earnings/wages, employment, engineering education, higher education, India, labour market

Introduction

Eighty percent of engineers are not employable for any job in the knowledge economy.
(Aspiring Minds: *National Employability Report, 2019*, p. 5)

Only forty nine percent of engineering graduates have 'employable talent'.
(Wheebox: *India Skill Report, 2020*, p. 13)

Higher education in India has expanded very fast, particularly since the mid-1980s. Compared to 3.6 million students enrolled in 5,227 institutions of higher education in the academic calendar year 1985-86 (UGC, 1987), the system has grown to 993 universities, 40 thousand colleges with 37.4 million students in 2018-19 (MHRD, 2019). Almost all branches of higher education have experienced high growth. Among the many branches, engineering education as a specific field of study in higher education has grown relatively very fast. In 1985-86 the enrolments in engineering and technology were of the order of 180,000, constituting 3.4 percent of the total enrolments in higher education. By 2017-18, the student numbers increased to 4.8 million and the share of students enrolled in engineering education in the total increased more than four-fold, to 16 percent (UGC, 2018).[1] The outturn of graduates in engineering and technology was of the order of 838,000 in 2018-19 (MHRD, 2019, p. 24). Among major disciplines, the employability of graduates in engineering seems to be the highest: 57 percent in 2019,

[1] In 2018-19, these numbers seemed to have respectively declined to 3.9 million and 13.5 percent (MHRD, 2019).

[*] **Corresponding Author:** Jandhyala B. G. Tilak, jtilak2017@gmail.com
ORCID: 0000-0002-2560-3508

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which has slidden down to 49 percent in 2020, as shown in Figure 1. The private rate of return to first degree in engineering education in India was above 20 percent in 2006; even the social rate of return was above 16 percent (Carnoy et al., 2012, p. 23). Perhaps this is still the reason why there still exists huge demand for engineering education in India[2], even though quite a few cracks are being noted both with respect to employment and also associated earnings of engineering graduates in the markets: employment opportunities begin to be not so good, or salaries as attractive as they were about 1-2 decades ago. In this paper we wish to explore the factors that predict employment of engineering graduates, and determinants of their earnings.

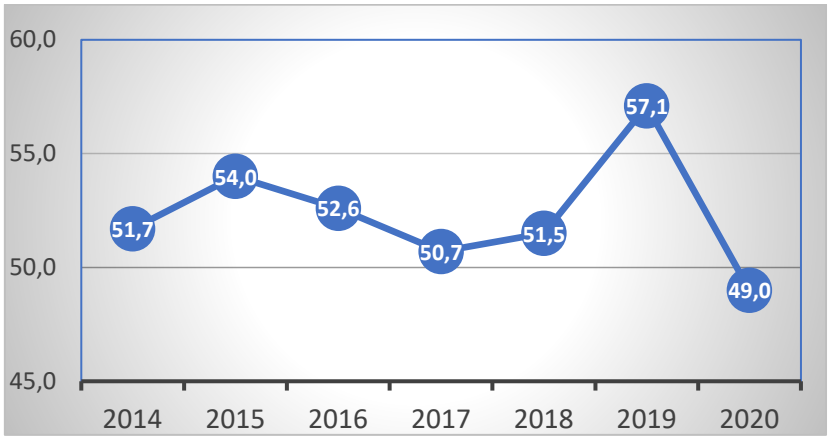

Figure 1. Fluctuating employability of engineering (%) graduates (B.Engg./B.Tech.)
Source: *India Skills Report 2020* (Wheebox, 2020, p. 13)

It is widely held that the massive expansion of higher education and of engineering education in particular has come at the cost of quality of education (Carnoy et al., 2013; Loyalka et al., 2014; MHRD, 2015). The result being production of large numbers of engineering graduates who are unemployable. Various reports point out that 80-90 percent of the graduates are not fit for employment. According to the NASSCOM-McKinsey report (2005) only one-fourth of the total engineering graduates in India are employable in appropriate fields. At the same time there are critical shortages of engineering manpower in various sectors of the economy. Thus, there seem to be major mismatches between demand and supply of engineering manpower.

The problem owes also to the unbridled growth of private sector in engineering education in India (MHRD, 2003). In 1970, India had a total of 139 engineering institutions, and only four of these were private, while currently the private institutions account for more than 80 percent of the total and in some southern states it has crossed 95 percent. Experts (e.g., MHRD, 2003) have condemned these private institutions for producing "IT coolies" – graduates with no skills, and glut in the labour market. It is often argued and also evident that with poor quality teachers and highly inadequate infrastructure, these private institutions are not capable of producing competent engineers from the system which ultimately leads to the problem of massive unemployment and underemployment. They have often contributed to the lowering of standard of the educational programmes offered by the engineering colleges in India and thereby in their employment and earnings (Biswas et al., 2010). On the whole, the quality of engineering graduates is generally observed to be very poor and this is regarded as the main reason for unemployment and low wages of engineering graduates. For instance, only 2.5% of the engineering graduates possess the skills in artificial intelligence (i.e., machine learning and data science – considered as very important for employment in the changing labour market), 1.5% to 4.5% possess the necessary skills in data engineering, and only 2.8% to 5.3% are qualified in wireless technologies that industry requires (Aspiring Minds, 2019).

Based upon the data collected through a primary survey, an attempt has been made in this paper to analyse the employment and related aspects of engineering graduates in India. The database and the

[2] In a pioneering study in India, Blaug et al. (1969) attributed graduate unemployment in India to high private rates of return.

methodology are briefly described in the following section. After describing the labour market profile of engineering graduates based on the primary survey in Section 3, Section 4 examines the determinants of employment probabilities of engineering graduates. This is done with the help of logistic regression, considering 'whether the engineering graduates have been employed or not' as the dependent variable. In Section 5, we examine the determinants of earnings of engineering graduates, using the ordinary least squares (OLS) technique. The paper ends with presenting a short summary of the study and its implications for public policy on engineering education.

Database and Methodology

The paper examines the possible determinants of employment and earnings of engineering graduates in India, based on data collected from a survey of 6,623 students studying in 40 engineering institutions in four major states in India, namely, (the National Capital Region of) Delhi, Maharashtra, Karnataka, and Tamil Nadu, where demand for engineering education has been very high. Karnataka and Tamil Nadu are in South India, Delhi in the north and Maharashtra in the west. Engineering education has not expanded much in the eastern states or in the central parts of India. Thus, the survey can be considered as fairly representing all the geographical regions of India. The survey covers Indian Institutes of Technology (IITs), National Institutes of Technology (NITs) (known earlier as Regional Colleges of Engineering), central and state universities, private universities and government and private colleges – government aided private, and private institutions that do not receive significant government support and rely mostly on student fee. The later are familiarly known as unaided private colleges/universities. The IITs, NITs and central universities are funded by the union (central) government and the others by state (provincial) governments. Thus, the survey can be regarded as representative of the variety of engineering institutions in the country. The survey was conducted by the National University of Educational Planning and Administration in the context of a larger international comparative study of BRIC countries (Brazil, Russia, India and China) (Carnoy et al., 2013), of which the author is a part. The larger study focused on examining the massive expansion of higher education – essentially technical – engineering, in the four BRIC countries. Through a student questionnaire, a huge amount of quantitative data, apart from a small amount of qualitative data are collected in India on a variety of dimensions of engineering education, including those relating to family background, educational and occupational background of parents, caste, religion, features of current education of students – public or private institution, the stream of engineering they are enrolled in, expenditure on engineering degree studies, job offers received and the starting salaries offered, and students' perceptions on the quality education they received. Considerations of the wider study determined the choice of the states; states and institutions were chosen based on purposive random sampling; institutions have been chosen based on availability of major streams of engineering education at first degree level; and all the students in the final (fourth) year enrolled in the selected departments were surveyed. One of the reasons for selecting fourth year students as our respondents in the survey is the students in the final year of study already get employment (or failed to get employment) offers, along with details on starting salaries, in campus recruitments which are conducted in most engineering institutions in India.

It is important to note here that we do not have the data on actual employment of the graduates or on their earnings. Students in the final year of the studies were the respondents in our survey. They are yet to enter the job market. Campus recruitment is a very common practice in many higher education institutions in India.[3] Recruitment of undergraduate engineering students through campus recruitment drives by engineering companies has become very popular, in which a variety of companies – foreign, domestic, and joint ventures participate.[4] Students are recruited by prospective employers before the

[3] While a majority of the institutions invite or allow campus recruitment, and some, particularly the private institutions use the 'placement record' to boast of their quality and popularity in their approach to attract students, some institutions might ban on-campus recruitment, fearing that students would become money-minded and lose interest in studies as they get job offers prior to their completion of their studies. It might also disorient students from pursuing further higher studies. But such institutions are very few in the country. On the whole, placement record has also become an important consideration in national assessment and accreditation and national ranking framework.

[4] Major companies that visited different engineering institutions for campus placement in our survey, as per the statements of the institutions, include: Tata Consultancy Services, Microsoft, Samsung, Infosys, Hindustan Computers Limited, McKinsey, Birlasoft, International Business Machines, Computer Science Corporation, Syntel, Maruti Automobiles, Tata Motors, Bharat

students complete their studies. Generally, the recruitment takes place through placement cells of the institution, when the students are in the final year/semester of studies. A variety of firms, companies or organizations interested in recruiting engineering graduates belonging to different disciplines, visit institutions for on-campus recruitment of graduates as per their needs. They use face-to-face interviews, group discussions or some other selection method. They consider it as the best method of catching the talent early. Selected students are given a job offer that describes conditions relating to the job, including starting annual salary. So, in our survey, students were asked a question, 'whether she/he has got job offer' in the on-campus recruitment. Students who have received job offers are considered here as 'employed' and who have not as 'unemployed'. Similarly, the annual salary offered to the students (by the employers) is taken as the actual earnings from their jobs in the first year, or as starting salaries. It would have been ideal to use information on graduates who are actually employed, but the survey has not considered employed graduates. Consideration of the variables for the econometric analysis is seriously constrained by the availability of data. We could consider only those variables that could be generated from the survey data. The survey did not include many relevant variables. There are several other probable determinants of employment and earnings of engineering graduates that could not be considered.

After providing a brief discussion on the employment and earnings profiles of the graduates surveyed in the next section, we examine predictors of employment, and determinants of earnings of engineering graduates, using standard quantitative tools of modern economic analysis and STATA software.

The following logit regression equation is estimated to find the factors that predict the probability of securing employment by the engineering graduates:

$$Prob\ (\text{EMPLOYMENT}=1) = f(X_i) \qquad \text{(Eqn. 1)}$$

i.e., probability of a graduate getting employment (variable employment taking the value of one, as against 0 – not getting employment) is a function of a set of variables X_i. Logit regression is one of the most commonly used statistical tool in applied statistics for discrete statistical analysis. The dependent variable, EMPLOYMRNT is also known as binomial response variable, as it takes the value of only 1 or 0. Odds ratios, calculated using regression coefficients, help us to know the probability of happening the event, i.e., getting employment is high or low, given a change in the independent variable. If the odds ratio is greater than one, then it is more likely to occur and if the ratios is less than one, it is less likely to occur. Note that if the reference event is more likely to happen, it means that given the values of co-variates, the other option is less likely and if the reference event is less likely, then the other option is more likely. Marginal effects describe the average effect of changes in predictor variables on the change in the probability of securing employment.

The determinants of earnings are estimated with the help of the following OLS log-linear regression equation:

$$\ln(\text{EARNINGS}) = f(X_i) \qquad \text{(Eqn. 2)}$$

The dependent variable EARNINGS used here is natural logarithm of annual earnings of the graduates, as widely used in the literature. The variations in earnings are explained by a set of explanatory variables X_i. The regression coefficients of the variables indicate the extent of influence of each variable on the earnings. A regression coefficient describes the size and direction of the relationship between the independent and dependent variable, after controlling for other variables.

The two econometric tools are extensively used in the literature in economics under such circumstances. The respective specifications used are described in detail in the later sections of the paper, along with the variables chosen.

Heavy Electrical Limited (BhEL), National Thermal Power Corporation (NTPC), and Defence Research and Development Organisation (DRDO) of Government of India, Accenture, Convergys, I-Flex, Sapient, and Tata Tele Services and a few others.

Employment and Earnings Profile of Engineering Graduates[5]

Employment Profile

As Sudipto Sarkar (2019) highlighted, every year on an average 1.5 million students get their degree in engineering education in India, but due to lack of skills required to perform technical jobs less than 20 percent get employment in their core domain. This is a huge loss in terms of manpower and economy. As per our survey, only 26 percent of the graduates succeed in getting employment offers through on-campus recruitment, as shown in Table 1; others could not make it.[6] There may be many reasons for such a low rate of 'employment.' A good number of firms/organisations/companies/industries visit universities, colleges and other institutions of engineering education in search of talent and select students as per their requirements. Job offers are conditioned by the requirements of the organisations – number and nature. It is also possible that some students might not like the jobs and associated conditions offered by the companies, including pay, location and job profile or the goodwill of the company; or they may have some preference to go for further studies, and they may not finally take up those jobs. But quite probably in such cases also the students take the offers but may not finally join the given job. On the whole, since a large number of engineering institutions are visited by prospective employers, and a majority of students participate in the recruitment process, it may not be far from correct to assume that the results of campus recruitment reflect employment and unemployment (including voluntary unemployment) conditions of engineering graduates in the country. As noted, the employment rate at national level is also close to our estimate.

Table 1. Employment profile of engineering graduates in India

(Engineering students who have got job offer in campus recruitment)

Category	*Percentage*	*Field of Employment*		*Region of Placement*		*Type of Enterprise*		
		Engineering	*Non-Engineering*	*Within state*	*Outside state*	*Foreign*	*Joint venture*	*Domestic*
GENDER								
Male	25.35	88.92	11.08	59.60	40.40	34.65	37.36	27.99
Female	26.69	90.17	9.83	50.58	49.42	30.56	44.84	24.60
*NATIVITY**								
Native of the state	23.88	85.08	14.92	51.41	48.59	37.33	35.08	27.59
Outside state	21.53	88.56	11.44	59.45	40.55	31.16	42.15	26.69
TYPE OF EDUCATIONAL INSTITUTION								
Government	37.12	88.99	11.01	56.35	43.65	33.77	33.08	33.15
Private	20.03	89.62	10.38	57.37	42.63	33.38	42.31	24.31
STREAM OF ENGINEERING STUDY								
Traditional	16.68	81.00	19.00	56.27	43.73	27.46	41.98	30.56
IT-related	29.77	91.35	8.65	57.37	42.63	36.07	38.40	25.53
Total	25.74 (1657)	89.31	10.69	57.03	42.97	33.50	39.47	27.03

* Whether the student belongs to the same state where the education institution is located, or s/he is a native of some other state in India.

Gender discrimination in the job market is a matter of concern in many countries, including in India. Further, the problem of gender discrimination in the job market is predominately visible in the engineering sector, where men are traditionally preferred to female graduates (Duraisamy & Duraisamy, 1999). According to our survey, gender differences are very marginal: around 25 percent of male students have got job offers, compared to 27 percent among females. However, we find noticeable gender differences when it comes to employment by different types of organisations – foreign, joint ventures and domestic.

[5] For a general profile of the engineering students based on our sample survey, see Tilak (2020b).

[6] The employment status of engineering graduates is as at the time of the survey (in the fourth year of the engineering studies); some more might get employed after completion of the final year of engineering studies, or even before. After all, graduates also try for employment through many other methods, particularly after completing the studies. Thus, our estimates may have to be seen as under-estimates.

A student's choice of enrolment in an engineering institution depends *inter alia* on the job placement record of the institution. Engineering institutions which have higher placement records in recent years obviously attract more students than the institutions which have performed poorly in the campus placement/recruitment. This is more true in case of private engineering institutions than public universities/engineering institutions. While students mostly prefer government institutions to private ones for various reasons (see Tilak, 2020b), between the several private universities and colleges, students prefer enrolling in those institutions which have better campus placement records to others. As the numbers of private universities and colleges of engineering in India are very high, students have more options among these institutions as institutions compete with each other in attracting students. Private institutions, therefore, use various methods to attract companies to recruit their students and to have a record of high campus placement. On the other hand, as the public engineering institutions are small in number, their quality is high and tuition low, students face fierce competition for admission in these institutions. Hence the record of campus placement (records) does not matter much in the enrolment in the public institutions, though generally these institutions are considered to be faring better than private ones in placement records as well.

We note that in our survey, the number of students who have got a job offer is nearly two times higher in government institutions than in private institutions (Table 1). The employers may obviously be concerned with quality of the institutions and the graduates. Public institutions, with better trained and qualified faculty and good academic infrastructure, could produce better trained graduates than private universities and colleges. The latter are known to be having poor quality teachers and in small numbers than required, and not necessarily good infrastructure in terms of libraries and laboratories. The facilities and structures provided for campus recruitment in government institutions may also be more transparent and on the whole better than in private institutions. As a result, government institutions have a better placement record than private institutions. That a higher proportion of students studying in public institutions secure job offers than students enrolled in private institutions, confirms the quality advantage that public institutions have over private institutions, and the employer's recognition of the same.

The stream/department of engineering that one is enrolled carries a high weight in the labour market. Jobs in the engineering and technical areas are highly specialized and the scope for substitution between different specialisations or streams of study in the recruitment market is to some extent restricted, as the job requirements and the area of specialisation in engineering education are somewhat closely related. For example, the requirement of a company for a graduate in electronics engineering cannot be substituted with a graduate in civil or mechanical engineering, or vice versa. Hence it can be stated that employment of engineering graduates also depends upon the stream of study one is graduated in and the level of employment might depend upon the jobs available under each category. As the electronics and IT-related firms seemed to be growing fast, higher number of graduates in these disciplines might get employment than those specialised in other engineering disciplines. That rates of employment vary widely by discipline of engineering and that they also change overtime is well documented. For example, according to *India Skill Report 2020*, the employability of graduates in electronics and communications engineering is the highest—about 60 percent, compared to 50 percent among graduates of civil engineering in 2019 (Figure 2).

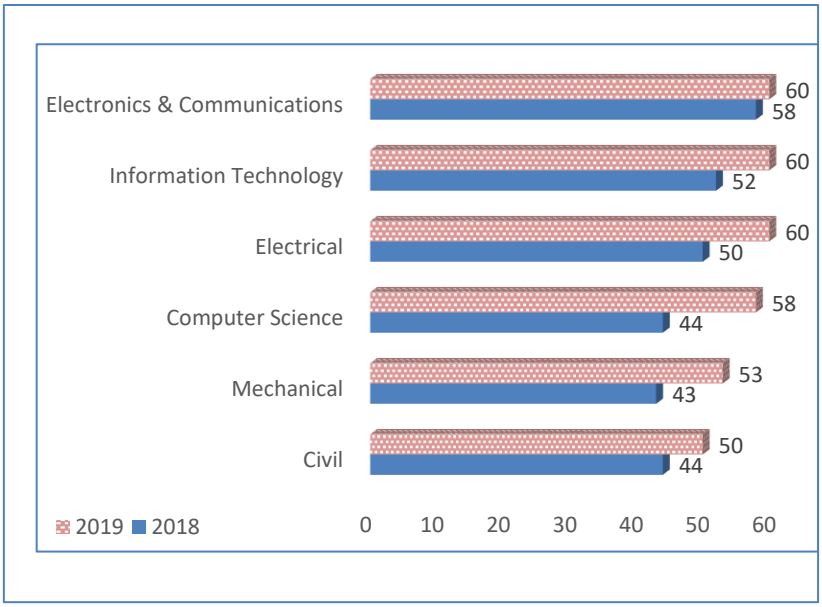

Figure 2. Employability of engineering (%) graduates by Stream of Study, 2018 and 2019
Source: *India Skills Report 2020* (Wheebox, 2020, p. 29)

We also find similar significant differences in rates of employment between the graduates of various disciplines of engineering. In our survey, we have classified engineering streams (which can be called 'majors' as in some western universities) into two major categories: 'traditional' or conventional that includes civil, mechanical, and electrical engineering, and 'modern' consisting of disciplines like electronics, computers, information technology etc. We note that 17 percent of the graduates in traditional disciplines have got job offers, while the corresponding figure is almost double – 30 percent in case of those pursuing studies in IT and related departments.

Coinciding with popular perceptions, employment conditions seem to favour graduates in modern streams of engineering as against those graduating in traditional areas, though domestic and joint ventures recruit higher proportions of graduates in traditional disciplines of engineering. Joint ventures seem to have a higher demand for graduates in both IT-related and traditional disciplines.

Nearly one-fourth, i.e., 24 percent of the 'native' students[7] have got job offers in their native states and 22 percent of the non-natives have got their job offers in 'other states'. Surprisingly, more male students have got jobs within their state of domicile as compared to females, the shares being 60 percent for males and 51 percent for females. There is not much difference in this between the graduates of private and public institutions, or between those who graduated in traditional and modern streams of engineering. Surprisingly, only half of the engineering students (51 percent) belonging to 'within state' have got their job offer in the same state. The other half has to migrate to other states for employment. This also depends on the employment conditions in various state, which widely vary in India.

Different kinds of engineering firms go to the educational institutions for campus recruitment for some jobs in engineering and some jobs in non-engineering activities like administration and management in engineering and non-engineering firms. The jobs in the engineering category includes engineers—civil, mechanical, electrical, electronics, computers, information technology etc., while jobs of non-engineering category include executive posts in human resources, marketing, and jobs in management, finances, administration, planning, development, etc. Graduates, who are not successful (or uninterested) in getting a suitable job in their parent discipline of engineering, may choose different jobs in non-engineering categories. Firms that come for campus recruitment to engineering institutions might offer the students jobs in either engineering or non-engineering trades, as per their requirements. If

[7] 'Native' students refer to the students who are studying in an institution located in the state of which they are the natives. Non-natives are those who went from home state to another state for studies.

engineers are employed in non-engineering jobs, including in civil services and public administration, this, generally known as 'mal-employment' is considered by some as a waste of resources – financial and human. This is also considered as a mismatch between education and qualifications. We find that nine out of every ten of the students who got jobs on-campus recruitment have taken jobs in areas of engineering and closely related areas, and the rest have gone for non-engineering jobs. Those who leave engineering in favour of jobs in non-engineering activities are very few in number. In contrast to general perceptions, relatively a higher number of female students have taken engineering related jobs than male students. There is not much variation in this between students from government and private engineering institutions. But we find some difference in the pattern between students in conventional disciplines of engineering and IT-related modern disciplines. As high as 91 percent of the students in modern disciplines who have got their job offer have taken up (or selected for) the engineering related jobs whereas only 81 percent students enrolled in traditional departments of engineering (mechanical engineering and electrical engineering) have done the same. That is, nearly 20 percent of students in traditional disciplines chose non-engineering jobs for their employment.

Among the several companies that go for campus recruitment drive, domestic companies do not seem to perform so well. Foreign companies attracted as many as 43 percent of the students, and joint venture companies another 40 percent. This is the same pattern in case of male students who received job offers. But in case of female graduates, joint ventures recruited them more than others. Joint ventures also attracted students from private educational institutions more than foreign and domestic companies. Hence, a higher number of students from private universities/colleges have got job offers in joint venture companies, whereas the students from government institutions received offers mostly from domestic companies. Joint ventures and foreign firms together account for 70 percent of the employment of graduates in traditional areas of engineering and 75 percent in IT-related modern areas, the rest being accounted by domestic enterprises.

Earnings Profile of the Graduates

Graduates in engineering earn substantially higher than other graduates, and even other post (master's degree) graduates in India. Based on National Sample Survey 2006, Carnoy et al. (2012) estimated that the annual earnings of male graduates in engineering earn consistently higher than post (master degree) graduates for the entire life time, as shown in Figure 3. But they are not the same for all. They differ by gender, by the type of institution they studied, by the nature of organisation they are employed and so on. Based on our survey, we present some such details on how they differ by different characteristics of the graduates.

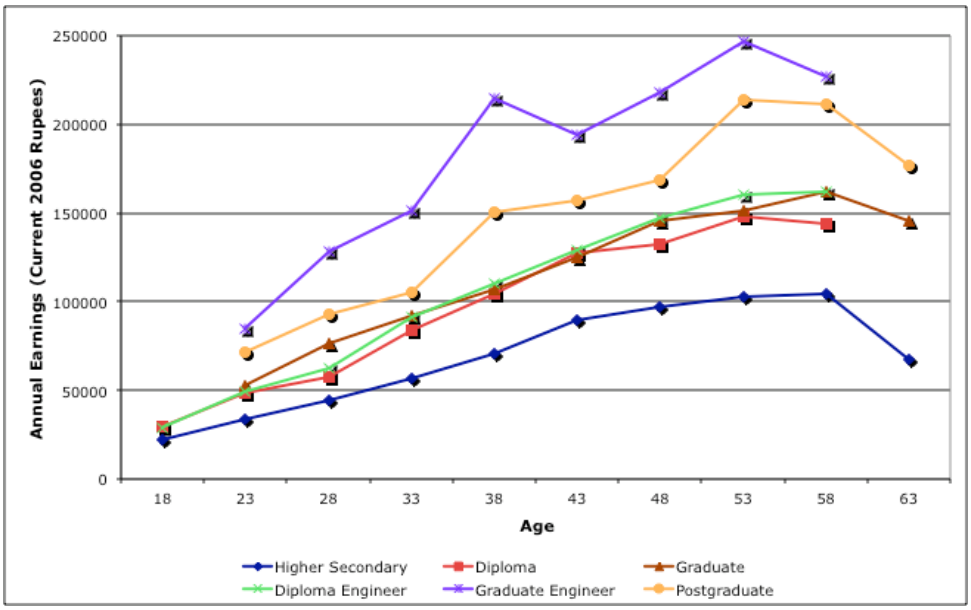

Figure 3. Annual earnings of males in India by educational level, 2006
Source: Carnoy et al. (2012, p. 22)

As stated earlier we use here in this paper, the wages/salaries offered for the first year of employment at the time of on-campus recruitment, as the earnings of the graduates. Though they are not actual earnings, nor of course are they lifetime earnings that are used by many scholars in such contexts, they can be considered as starting salaries of the graduates. On average, such earnings amounted to Rs. 387 thousand per annum per person.[8] There is not much gender difference in the earnings; both men and women receive more or less the same.[9] Graduates from public institutions of higher education seem to receive better treatment with an offer of higher earnings than graduates from private institutions, which is partly reflective of the differences in quality of education the graduates received. Annual earnings offered to graduates of public institutions was of the order of Rs. 410 thousand, compared to Rs. 356 thousand offered to graduates of private institutions. As stated earlier this reflects partly the employers' acknowledgement of the quality of public institutions. Generally, it is observed that students are better trained in government institutions, and hence come out better skilled and more competent, than the students of private institutions and hence, they may even be able to bargain for higher wages. Availability of trained faculty, better physical infrastructure such as laboratories, classrooms, hostels, and overall academic atmosphere are often cited as major reasons for superior quality of education provided in government institutions in India.[10]

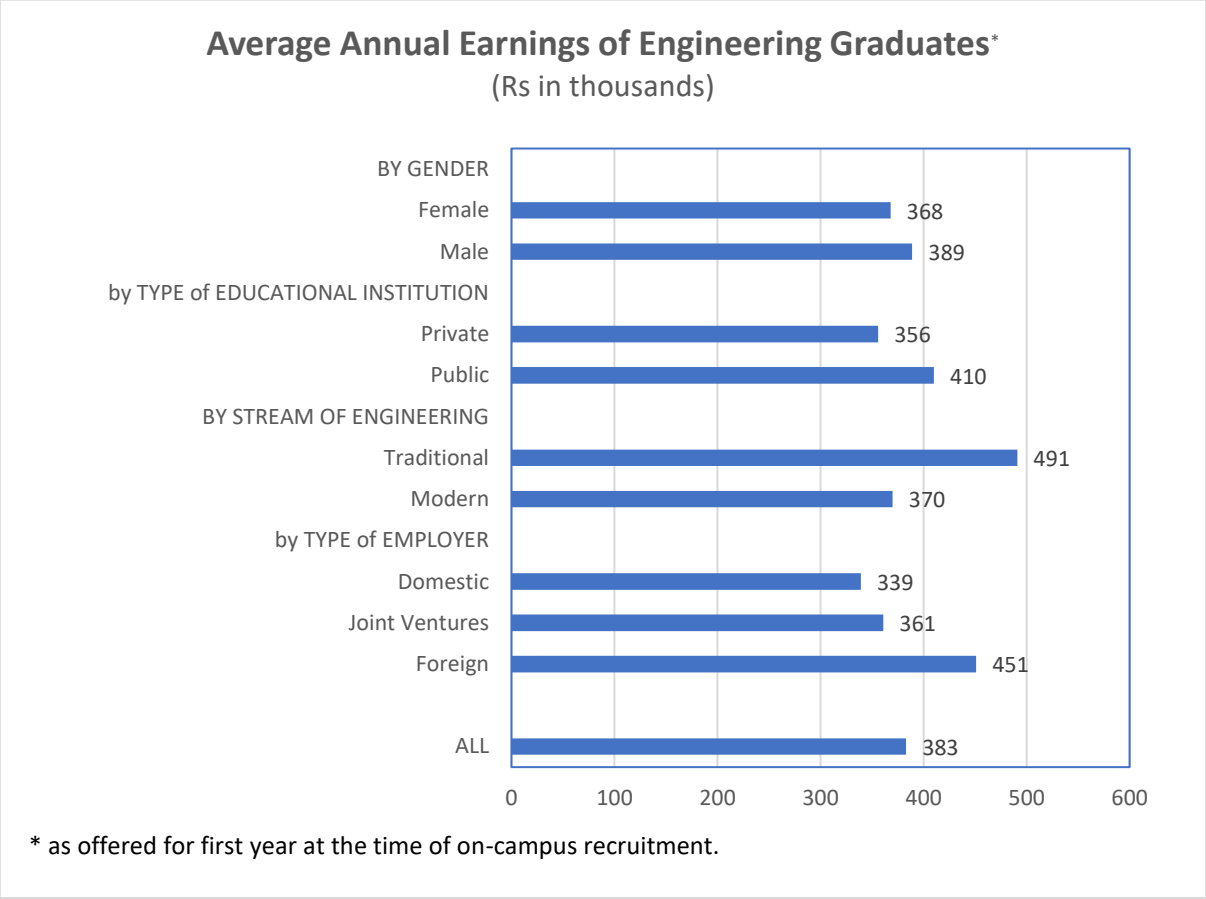

Figure 4. Starting average annual salaries of engineering graduates in India

Further, somewhat contrary to general opinion, graduates in traditional streams of engineering like mechanical, civil, and electrical, are offered higher wages – about 33 percent higher -- than those who graduated in modern – IT related streams, as shown in Figure 4. While graduates of modern disciplines

[8] At the current exchange rate, US$1 = Rs. 70 (approximate).
[9] In the study on Delhi, which was based on sub-sample of the database of the present study, Choudhury (2015); however, found that women are offered salaries which are about 54 percent less than that of men.
[10] See Rao (2007) and Biswas *et al* (2010) for details on quality related aspects of technical education in India. See also Loyalka et al (2014) on the quality related aspects in BRIC countries.

get better treatment in terms of employment, in case of pay-checks graduates in traditional disciplines get a better deal. Students seem to have strong preference in favour of modern disciplines expecting quick employment and high wages (Tilak, 2020a). Foreign companies obviously pay higher levels of salaries than joint ventures and domestic companies. The pay in foreign companies is 33 percent higher than the pay offered by domestic organisations, which, in turn, is seven percent less than what joint ventures offer.

Determinants of Graduate Employment

Which individual traits and social, economic, and institutional factors predict graduate employment? The literature on determinants of unemployment/employment is dominated by studies at macro level, wherein rates of unemployment or employment are considered as a function of economic growth, level of technology, structural and other factors. Drawing from 21 case studies of developing and developed countries, sponsored by UNESCO-IIEP, Sanyal (1987a; 1987b) concluded that the stagnant economic growth is the most dominant factor that explains graduate unemployment. There are also of course a good number of studies based on graduate surveys which analysed individual employment as a function of household factors -- social, economic, etc., individual factors, academic background of the students, etc. As Atkinson and Pennington (2012) found, analysing unemployment of engineering graduates in UK, there is no single reason for unemployment. A multitude of factors explain why graduates are employed or unemployed. Macmillan et al. (2013) highlighted the importance of several factors in access to good employment in UK that include family background, networks, and the pubic/private school the graduates attended. They have also shown that graduates from private schools are more likely to enter 'high status' occupations.

Several studies observed that the subject or the major the students choose in their studies matter a lot in employment market. For example, Kong (2011) analysed employment of graduates in Beijing, China and finds that employment of graduates is considerably influenced by the 'major' chosen by the student during their studies, apart from reputation of the college and gender of the graduate; and that women find jobs more easily. On the other hand, in a study on Korea, Park (2015) concluded based on a hierarchical liner regression model that the curriculum – the major subject chosen was not statistically significant, nor were the household income, club activities and employment preparation activities. In a study of a small township in South Africa, Dunga (2014) found that education level, age, marital status, household labour force and total government grants were significant determinants of employment status. As one would expect, university scores are used by the employers as a selection criterion to filter through the competition among job applicants in many cases (Boissiere et al., 1985). After all, the students with good academic records are viewed more productive and as being better prepared for their first jobs (Jones & Jackson, 1990). Preference for employment in public sector also keeps many graduates unemployed, as employment in public sector is reactively limited, as Panchamukhi (1987) has shown in case of India. Analysing educated unemployment in India, researchers (e.g., Bairagya, 2015) identified socioeconomic, regional and other factors and used probit or logit regression technique. Choudhury (2012) in a study of engineering graduates in Delhi that used a sub sample of the database of the present research study, concluded that while the type of the institution (public or private), caste, academic merit of the student, and the loan status of the student were significant determinants of employment, and the major stream of engineering, parental occupation or education etc., were not having any influence on the employment probabilities of the graduates.

While there is a good number of studies on employment of the graduates in India, many were conducted in the 1970s and 1980s, when the economic and educational conditions were altogether different. While many studies tend to explain employment and unemployment with the help of national economic factors, including industrial production, growth in gross domestic product, few concentrated on graduates' traits, the quality of education they received, and related aspects. Some research has focused on some specific disciplines like economics. There is need to examine the determinants separately for each major discipline. There are practically no studies focussing on engineering education in India. Hence the present study may be seen as a modest contribution in this direction. Based on a quick review of the literature, largely following the framework adopted in Choudhury (2013) apart from others, we identify a set of predictors of employment of engineering graduates. The set includes 15 variables grouped into

three categories, (i) personal attributes (individual factors) – gender and cate, (ii) household factors that include household income, parental occupation, and parental schooling, and (iii) academic aspects – academic performance at the senior secondary level (before entering undergraduate engineering studies), the medium of instruction at secondary level, the type of education institution currently attending (public or private), and the 'major' – the main stream of engineering: modern or traditional. We have also included in category (iii) a variable that reflects the student's educational loan status – whether she/he has taken any educational loan for the engineering studies.

We hypothesise that factors relating to educational background of the students are the most important determinants of employment of engineering graduates in India; and socio-economic background of the students including individual factors such as gender and caste, and household conditions do not influence much the employment probabilities of graduates. To examine this, the following specification of logistic regression equation is used, and predictors of employment probabilities of the graduates are estimated:

$$\text{EMPLOYMENT} = \alpha + \beta_1 \text{GENDER} + \beta_2 \text{SC} + \beta_3 \text{ST} + \beta_4 \text{OBC} + \beta_5 \textit{ln}\text{HHY} + \beta_6 \text{FATHOCP\_PROF} + \beta_7 \text{FATHOCP\_BUS} + \beta_8 \text{FATHER\_ED} + \beta_9 \text{ENRL\_PVT} + \beta_{10} \text{STREAM\_STUDY} + \beta_{11} \text{SEC\_MARKS} + \beta_{12} \text{SEC\_MEDIUM} + \beta_{13} \text{LOAN} + \varepsilon \quad \text{(Eqn. 3)}$$

where,

EMPLOYMENT = 1, if the graduate is employed (got a job offer), and 0 otherwise; α = constant; βi = respective coefficients of the explanatory variables and ε = error term.

Table A.1 in the Appendix gives a description and definition of the variables. Table 2.2 gives summary statistics of the variables. The statistical results are given in Table 2.

Table 2. Logit estimates of the employment probabilities of engineering graduates

Variables	***Coefficient***	***Odds Ratio***	***Standard Error***	***Marginal Effect (dy/dx)***
Individual Characteristics				
GENDER	-0.0985	0.9062	0.080	-0.020
SC	0.1675	1.1824	0.168	0.030
ST	0.3409	1.4062	0.320	0.050
OBC	-0.0037	0.9964	0.108	0.000
OTHERS	Reference category			
Household Factors				
*ln*HHY	-0.0847*	0.9189	0.045	-0.010
FATHOCP_PROF	-0.1143	0.8920	0.092	-0.020
FATHOCP_BUS	-0.1025	0.9026	0.094	-0.020
FATHOCP_OTHERS	Reference category			
FATH_ED	-0.0373***	0.9634	0.013	-0.010
Educational Background				
ENRL_PVT	0.3511***	1.4207	0.082	0.060
STREAM_STUDY	-0.2662***	0.7662	0.087	-0.440
SEC_MARKS	-0.0642***	0.9378	0.004	-0.010
SEC_MEDIUM	-0.1873*	0.8292	0.111	-0.030
LOAN	-0.3052**	0.7370	0.118	-0.060
Intercept	7.9395**		0.634	
Log-Likelihood	-2283.79			
Pseudo R^2	0.0808			
Number of Observations	4,432			

Significance level: *** p < 0.01; ** p < 0.05; * p < 0.1

Results and discussion

Given the general gender preferences and discrimination in labour market, it is generally presumed that employers coming for on-campus recruitment will have a bias against female candidates and accordingly prefer recruiting male graduates. They might presume rightly or wrongly that male employees would not mind staying in office and work for longer hours, while females having family obligations, would

not do so. The problem of gender discrimination in the job market is said to be predominant particularly in the engineering sector, where male applicants get better treatment than female graduates. The popular perception is that engineering and technical education is a masculine domain (Goel, 2007). But it was also found that women perform better in campus-recruitment drive in engineering colleges in India (Gokuldas, 2011). Given some of these popular views, some of which were supported by research, one can hypothesise that *ceteris pari bus*, companies coming for on-campus recruitment prefer hiring male graduates to women. We find here that the probability of getting employment for a woman is less than that for a male student, but the difference is statistically not significant. We have already noted that the absolute difference in employment rates is also very small.

Caste is included as an explanatory variable to see whether employers have any preference towards or bias against students belonging to lower social background (e.g., scheduled castes [SC], scheduled tribes [ST] and other backward castes [OBC]) in providing jobs.[11] When caste is included in the equation in the form of binary variables for SC, ST and OBC, with general population as a reference category, the results show that caste does not matter, as it turns out to be statistically not significant. Generally, it seems that majority of the companies going for on-campus recruitment belongs to private sector which does not necessarily provide the Constitutionally guaranteed reservations (quotas) to the students belonging to disadvantaged sections of population such as SCs, STs and OBCs. The employers may not give any preference or discriminate against these caste groups of graduates.

We consider three important dimensions relating to socioeconomic conditions of households – household income, father's occupation, and father's education. Household income is measured in logarithmic form, to even out extreme differences. Father's occupation is defined in three categories: (a) professional or technical worker; (b) businessmen; and (c) others; [12] and years of schooling of the father is taken for father's education. It is hoped that these three dimensions reflect economic and some kind of 'social capital' that the students possess. Household income represents household's economic status. The higher the economic status of a household, the greater could be the chances of getting employment by a graduate, as rich households might be able to invest additional resources on improving English language, skills on computers etc., which seem to have been highly valued by the employers in the job selection processes, besides the formal education and training one receives. Similarly, parental occupation and education can be expected to be of help for the student to access better information on labour market, and to make a wise decision in selecting the jobs. So, one may expect all the three dimensions on household factors to have a positive effect on employment of graduates. Surprisingly, the results show the other way. The coefficients of all the variables are negative in value: higher family income, parents' higher occupational status or parent's education reduce the probability of employment. While the coefficient of occupation is not statistically significant, the other two – lnHHY and FATHER_ED are statistically significant.

The third group of variables that can be expected to have considerable influence on graduate employment relates to the educational background of the students. We do not have information on the quality of engineering education that the students receive, or the quality of the institution, though they are generally found to be very important. Instead, we use two indicators of academic performance of the students at senior secondary level, which are highly related to admission, and may also be related to the performance in undergraduate engineering studies. They are: the marks secured in the senior secondary

[11] The *Constitution of India* provides for reservation of 15 percent of employment in public sector for SCs, 7.5 percent for STs and 27 percent for OBCs. The proportions are based on the estimated shares of respective groups in the total population. The reservation for OBCs was added in 1993, and it is based on the criterion of social and educational backwardness with a creamy layer cap of Rs. 800,000 annual income of the household.

[12] In the survey, information was collected on occupation of the parents in sixteen occupational categories, which are re-grouped here into three: (a) professional or technical workers; (b) businessmen/women; and (c) others. Mainly due to small numbers of observations in many of the occupation categories such as skilled works (foreman, craftsman etc.), unskilled workers (mostly ordinary labourers working for daily wages), clerical and related workers, service workers, farmers, fishermen and workers in related activities, skilled/unskilled retired workers, and workers who were not classified by occupation (athletes, actors, musicians, unemployed, partially employed), etc., are included in the category of 'others'. The category of 'professional or technical workers' includes both junior and senior professional workers/salaried employees like doctors, professors, lawyers, architects, engineers, nurses, teachers, editors, photographers and bank employees.

examination (SEC_MARKS) and the medium of instruction (English/non-English) at senior secondary level (SEC_MEDIUM). It can be argued that graduates having higher scores in senior secondary examination may have better chance in job market than the students scoring comparatively lower percentage of marks. Prospective employers obviously consider the previous academic background of the graduates in their selection process. In the absence of information on performance of graduates in degree level examination, they might consider records at school level. Similarly, it is widely felt that communication skills in English carries a premium in employment market (see also Gokuldas, 2011). It is assumed that school graduates with English as a medium of instruction will have a good command over English language and will be able to perform better compared to those with Hindi or regional language as their medium of study. Hence employers may favour those who had English as the medium of instruction than others. Graduates may also feel that proficiency in English language is acquired better when English is used as a medium of instruction, rather than if it is merely a subject. Proficiency in speaking English is considered as a good qualification for good employment. This has been the view for a long period (Allen, 1854), and still continues to be so, supported by robust research as well (Azam et al., 2013; Pandey & Pandey, 2014).

Both the explanatory variables included in the equation to represent academic background of the student, viz., percentage of marks scored in the senior secondary examination (SEC_MARKS) and medium of instruction at senior secondary school, are found to be statistically significant in determining the probability of getting employment, confirming our view that firms going for on-campus recruitment consider the performance of the prospective employees at higher secondary school level and they assign a positive value to the same; but they seem to be not necessarily bothered much about the medium of instruction in which the student studied at school level. Perhaps they would be content with the knowledge and skills in English language, as displayed in the interview/group discussions. The variable SEC_MEDIUM has a negative value and is statistically significant at ten percent level. It is also possible that command over English can be acquired not necessarily when it is used as a medium of instruction, but when it is taught and learnt properly. In fact, apart from this, firms also seem to be interested in non-technical knowledge of the graduates, including their attitudes and values (Gokuladas, 2010).

We have also considered two aspects relating to current education, the type of engineering institution the student is studying in -- public or private, and the stream of engineering -- traditional or modern -- the student is enrolled in. While many earlier studies have considered the prestige or reputation of the college in this context, but we do not have data on the same. We simply consider whether the institution is public or private. Note that in general, public institutions in engineering education in India are generally regarded to be better and high in reputation than private ones. Second, as already described, as employment varies widely by stream of engineering, the stream is also included in the model. Another important variable that is considered here is the loan status of the student -- whether the student has taken any educational loan or not. Employer may either favour or discriminate against those carrying a debt owing to the educational loan taken for the studies. Employer may feel that employees with student loan debts would have financial stress which might interfere with their job performance and finally their productivity at work might get affected, as they might spend considerable time worrying about repayment of their loans; and that in the process they might also continuously look for a better job. Or alternatively employer may feel that employees with such debts cannot risk even frictional unemployment, or pay-cuts for inefficiency, and hence will be loyal to the organisation and work sincerely so as to earn and repay the loan fast (Mercer Survey, 2017).

According to the logit estimates in Table 2, the stream of engineering the graduates have enrolled in (STREAM_STUDY) has the strongest influence on their employment probabilities. Contrary to general perceptions, as revealed from the estimates of marginal effects (given in the last column in Table 2), graduates of IT-related streams – computer science engineering, electronics & communication engineering, and information technology engineering have 44 percentage points less chance of getting employment than the graduates of traditional disciplines. Similarly, the results show that students of private engineering institutions have higher likelihood of getting jobs compared to the students enrolled in government engineering institutions, though the private advantage is not very high: the advantage the graduates in private institutions have is only by six percent points. Both these aspects need further

examination, as they also contradict common perceptions as well as the inferences from the descriptive statistics given in Table 1.

The other important variable that turns out to be statistically significant is the loan status of the students. The results show that students who availed educational loan are at a disadvantage in the labour market; they are less likely to get employment than the students who have no debt obligations. As per the estimate of marginal effect, students taking educational loan have 6 percentage points less chance to get employment than the students who have not taken educational loan.

Determinants of Earnings

There may be many more factors than what we noted here to explain the individual differences in earnings of graduates. In fact, the literature on Economics of Education is abundantly rich with studies on earnings function. Typical or standard earnings function also known as Mincerian equation (Mincer, 1974) included schooling and job experience as the only explanatory variables and both were found to be important in a large number of studies (see e.g., Psacharopoulos & Tilak, 1992). Extended or augmented Mincerian earnings functions include a variety of factors—personal, market, and environmental. They cover individual, social, household characteristics, education variables, factors relating to job, the organisation and many more. Researchers used essentially OLS technique in such contexts, including stepwise repression analysis (e.g., Tilak, 1980). The applications of human capital earnings function have grown many-fold over the years (Willis, 2016).

Some recent research has guided us to identify a few important possible determinants of earnings. The relationship between academic performance and starting salary has been examined by a number of researchers in various experimental settings. A few of the earlier studies in context include James et al. (1989), Weisbrod and Karpoff (1968), and Murnane et al. (1995). Apart from Choudhury (2012), quite a few researchers identified in such context's variables like, knowledge of English, academic performance, quality of college, subjects of study etc., apart from individual, social, economic, and household factors. Chevalier (2011) found significant differences in earrings by the subject studied by the UK graduates. Earnings of graduates in Canada are reported to vary very widely by field of study (Frennet & Frank, 2016); the differences are also marked between several streams of engineering, general engineering, civil and mechanical engineering graduates earning higher than electronics, computer engineering etc. The majors chosen seem to explain a large part of the gender gap in earnings in US (Daymont & Andrisani, 1984). That female graduates earn less than male graduates are well documented in the literature. Ramsey (2008) highlighted this in case of UK. Ramsey (2008) also found that earnings vary by type of university. In India, Duraisamy and Duraisamy (1999) found that women graduates of professional and technical higher education were discriminated in the labour market with respect to wages and the magnitude of discrimination ranged between 55 and 70 percent, depending on the level of education and sector of employment (public/private sector). Madheswaran and Shroff (2000) also found that women graduates with scientific and technical education face discrimination in labour market. Parikh and Sukhatme (2004) reported that women engineers in India encounter hindrances in wages, and career promotions. Focusing on starting salaries of the fresh engineering graduates in IT-related majors in India, Singh (2016) found that the academic performance in school and college, college reputation, school affiliation and engineering major are key predictors of starting salaries. Using the *India Human Development Survey* (of the National Council of Applied Economic Research), Azam et al. (2013) attempted to quantify the effects of English-language skills on wages in terms of rates of return and concluded that returns to English language skills in Indian labour market were very high. After controlling for age, social group, schooling, geography, and proxies for ability, they found that hourly wages are on average 34 percent higher for men who speak fluent English and 13 percent higher for men who speak a little English relative to men who do not speak English. Earnings are not only different for graduates of different subjects, but they are also determined differently for graduates of different subjects (Dolton & Makepece, 1990). Jack Britton et al. (2016) found, based on data on 260,000 graduates in UK, the subjects one studied and the university one attended have strong influence on earnings of graduates. Then comes the finding that the individual variables such as socioeconomic class, region and ethnicity matter, even after controlling for academic-related variables. Chakravarty and Somanathan (2008), using data of 242 final-year students of IIM-Ahmedabad, have also found that

academic performance of the students is an important determinant of salary offered to them. An increase of one grade point in the performance during the first year (measured in terms of Grade Point Average GPA) is estimated to raise the wages by more than 40 percent. Academic performance was found to be the most important determinant of starting salaries in Australia (Chia & Miller, 2008). In the same study it was also found that science graduates earn less than general graduates. According to Panchamukhi (1987), about one-third of variation in graduate earnings in India could be explained by family characteristics.

Taking clue from available research, incorporating some of these variables, an attempt has been made here to find out the determinants of annual earnings of graduates using OLS technique. In such a context, a typical Mincerian (Mincer, 1974) log earnings function is extensively used by a majority of the researchers including those cited above. We also use the same, the augmented Mincerian equation. The selection of the variables is subject to same constraints as in case of the employment equation estimated in the previous section. Variables on gender, and parental occupation and education as household background factors, education related factors that include current and past education, and factors relating to the job – the field of employment (engineering or non-engineering), and type of employment organisation – foreign, joint venture or domestic one, are regressed on earnings. Other variables like caste and household income have been tested and are found to be not relevant, being statistically not significant and having no effect on the explanatory power of the equation. So, the actual OLS regression specification empirically estimated is as follows:

$$ln\ \text{EARNINGS} = \alpha + \beta_1\,\text{GENDER} + \beta_2\,\text{FATHOCP\_PROF} + \beta_3\,\text{FATHOCP\_BUS} + \beta_4\,\text{FATHER\_ED} + \beta_5\,\text{ENRL\_PVT} + \beta_6\,\text{STREAM\_STUDY} + \beta_7\,\text{SEC\_MARKS} + \beta_8\,\text{SEC\_MEDIUM} + \beta_9\,\text{FIELD\_EMPLOYMENT} + \beta_{10}\,\text{TYPE\_FOREIGN} + \beta_{11}\,\text{TYPE\_JOINT} + \varepsilon \quad \text{(Eqn. 4)}$$

where, *ln*EARNINGS = annual earnings of engineering graduates (in logarithmic form); α = constant, β_i = respective coefficient of the explanatory variables, and ε = the random disturbance term capturing unobserved characteristics or simply known as error term. The variables are as described and defined earlier (see Tables A.1 and A.2 in the Appendix).

Results and discussion

The results of the earnings functions are given in Table 3. Some are similar to the results obtained in the logit regressions on employment, while some contradict.

Table 3. OLS Estimate of the annual earnings of engineering graduates

Variables	Coefficient	Standard Error
Individual and Household Factors		
GENDER	-0.0861**	0.0319
FATHOCP_PROF	-0.0467	0.0347
FATHOCP_BUS	-0.0387	0.0367
FATHOCP_OTHERS	Reference	
FATHER_ED	0.0005	0.0053
Past and Current Educational Background of Students		
ENRL_PVT	-0.1484***	0.0310
STREAM_STUDY	0.0268	0.0350
SEC_MARKS	0.0069***	0.0018
SEC_MEDIUM	-0.0811*	0.0428
Job Characteristics		
FIELD_EMPLOYMENT	0.1427**	0.0438
TYPE_JOINT	-0.1232***	0.0383
TYPE_DOME	-0.1242***	0.0326
TYPE_FOREIGN	Reference	
Intercept	0.8466*	0.1713
R Square	0.0912	
Adjusted R Square	0.0804	
F-Value	8.4600***	
Number of Observations	940	

Note: *** significant at 99 percent level; ** significant at 95 percent level; * significant at 90 per cent level.

Gender is not an important predictor of employment, as we have already seen, but it turns out to be a significant factor in the OLS estimation of earnings equation and it works adversely for women. Parent's occupation or education does not have any significant effect on the earnings of the graduates, though father's education has a small positive effect. The higher the level of occupation (professional, or business), lower would be the earnings.

Among the variables chosen to refer to current and past education background of the students, the OLS results show that the type of institution (public or private) is the most significant factor in the determination of earnings of graduates. The coefficient of the variable (ENRL_PVT) is negative and significant at 99 percent level of confidence. Being a graduate from a private institution pushes down the wages by about 15 percent below the earnings of the graduates of government institutions. It may be pertinent to note here that the students at private universities/colleges make higher investments (in terms of household expenditure) than the students of government institutions in their engineering education (Tilak, 2020c), and their probability of getting employment through on-campus recruitment is comparatively high. But more important to note is the fact that the graduates of private institutions earn less than the graduates of public institutions, though it can be the other way in other countries (e.g., Crawford & Vignoles, 2014). Macmillan et al. (2013) have found that graduates form private schools earn higher than those from public institutions. It may depend upon the quality of education a graduate receives.

Almost similar to the estimates of logit equation on employment, English medium has a small value negatively influencing the earnings; the coefficient is significant at ten percent level. While most literature suggests that communication skills in English language matter a lot in employment and earnings, we found here in both the equations that the coefficient of the variable SEC_MEDIUM is negative in value. Perhaps the medium of instruction at secondary level does not matter, as long as the students have good domain knowledge in the subject (reflected in SEC_MARKS), good analytical and quantitative skills and good communication abilities in English. Perhaps none of them is related to the medium of instruction. Possibly it is not the medium of instruction that improves the student's knowledge and skills in a language, but it is how a language is taught and learnt as a subject. After all, English is highly valued by the employers, and it is English that is found to explain a substantial part of the gap in employability of engineering graduates (AspringMinds, 2020, p. 36). It is generally observed by pedagogues that English when taught as a subject, the grammar, the syntax, the linguistics, etc., besides the literature, are much better valued, than when it is merely a medium of instruction.

The stream of study in engineering – modern or conventional also does not matter in earnings, though it matters in case of employment. The regression coefficient is positive in value but not statistically significant. The percentage of marks scored by the student in higher secondary examination (taken as a proxy of quality of the graduates) is positively related with the probability of employment as well as the annual earnings of graduates. More clearly, with the increase in higher secondary examination marks by one percent, the annual earnings of graduates increase by one percent.

Though the common tendency is one to accept a job that offers higher earnings (in fact higher lifetime earnings), in some cases graduates may have overriding preferences relating to the nature and field of job, place of occupation, type and reputation of the firm etc. For example, one might take up a job, even if earnings are relatively less, but if it is a foreign company with a high brand value, or if the location of work is their native city or state than a job with higher earnings in a faraway place. Hence, it is expected that the earnings of the graduates vary significantly with the nature and field of employment. Considering this, in our OLS estimation we have included two factors related to job market namely, field of employment – engineering or non-engineering, and type of enterprise that offers a job. One can expect that the students employed in engineering related fields to make higher earnings than those in non-engineering related jobs. The underlying hypothesis in including the 'type of enterprise' as an explanatory variable in the earnings function is that the graduates employed in foreign firms will earn high wages, followed by the employees of joint-venture companies and then those in domestic companies.

Our results show that these two factors matter most in explaining earnings of the graduates. After controlling for other factors, jobs in engineering activities give one 15 percent higher earnings than if employed in non-engineering activities. Or in other words, engineering graduates employed in non-engineering firms earn 15 percent less than the graduates employed in engineering fields. It supports the general presumption that the earnings in engineering related jobs are higher than non-engineering related jobs. Secondly, if one chooses a domestic unit or a joint venture for employment, she/he would receive about 12 percent less earnings than those employed in foreign establishments.

Summary Conclusions and Implications

Using a survey of about seven thousand students in engineering education in about 40 institutions located in four different states in India, this paper investigates determinants of employment and separately determination of earnings of engineering graduates. The students in the final year of the undergraduate studies have gone through campus recruitment. The job offers and the starting salaries offered in the on-campus recruitment are used as employment and earnings of the graduates in the present study, though they are not the perfect measures. Logistic and OLS regression equations are estimated to examine respectively the probabilities of employment and the determinants of earnings. We have hypothesized that academic performance and related educational variables are the most import predictors of graduate employment, and similar variables and employer/job related characteristics together account for most of the variance in earnings of engineering graduates. To briefly sum up, our results confirm our hypotheses: educational characteristics of graduates, and their fathers' education are the most important predictors of employment; and job characteristics, and secondly education characteristics explain the variance in earnings. Interestingly, factors such as caste and gender, or even family characteristics like father's occupation have no significant role in employment, and caste and parental occupation have no significant influence on earnings.

As a limitation it must be noted that quite a few important factors could not be considered in this exercise due to constraints on data availability. Further research with a larger set of variables, with data on actual employment earnings of those who are already in employment with varying duration of experience may give more robust results. Yet the results arrived here have important implications for further research and policy making relating to engineering education, private education, and employment of engineering graduates. With respect to further research, the study highlights the need to recognise the difference between public and private institutions, and if possible, elite and mass institutions. Second, a survey of employers going for campus recruitment, may yield interesting insights into the criteria that they actually focus on recruitment.

The analysis made here will inform public policy. One can draw quite a few important implications. First, mushrooming of a large number of low-quality private institutions of engineering education will not help employment or economic growth. There needs to be strong checks on the growth of low quality of institutions. AICTE has closed as many as 778 private institutions during 2012-13 to 2019-20. This measure and the number do not seem to be enough. Effective mechanisms of quality control are necessary. Curricular and pedagogical arrangements need to be strengthened and restructured to prepare better quality graduates. The quality of engineering education has to be substantially raised, so that the graduates become immediately employable. The graduates should be equipped with a variety of 21st century skills (beyond core academic subjects), such as artificial intelligence, cloud computing, 3-D machining, data analytics, data engineering, data sciences, machine learning, robotic process automation, etc., along with professional engineering knowledge. Modern engineering problems require students to master engineering knowledge, while the ability to work with others across contexts requires professional skills. Both are interdependent and important for success in labour market (Winberg et al., 2020). Otherwise, there will be a huge wastage of investment made in engineering education from public as well as private, including household, sources.

Interestingly, though most private institutions in India are found to be offering very poor-quality education, probability of getting employment is higher for graduates of private institutions, but they get very low starting salaries compared to those who graduate from public institutions. It is possible that

many engineering graduates from low quality institutions, though prefer engineering jobs, end up in non-engineering jobs, and/or low paying jobs, which reflects yet another form of wastage of resources. Private colleges also focus on their records of campus recruitment, but not much on salaries the graduates would receive, i.e., the quality of employment might be less cared for. Similarly, graduates in modern streams of engineering like electronics and computer science, if employed, are likely to earn more than those who graduated in traditional streams of engineering; but they are at a disadvantage in employment market, compared to the graduates in traditional streams. This may partly reflect the gluts in the labour market. There is overproduction of graduates in modern streams of engineering. Institutions that concentrate on modern streams have to note this and rethink their plans and strategies in this regard. As the AICTE (2018) suggested, institutions have to continuously monitor the future skill requirements and make accordingly suitable changes in the streams of engineering they offer, and even think of new and emerging areas. Though manpower planning has lost its gleam, it may be useful to have a continuous exercise of manpower analysis, including estimation of requirements of manpower of various levels and types for the short and medium terms. This will be useful for efficient monitoring of the system and to adopt necessary policy changes and new policy initiatives. Third, it appears that employers tend to discriminate against those who come with a burden of educational loans. Some mechanisms have to be thought of, in such a way that such discrimination does not take place. A better mechanism is to reduce the reliance of students on loans, and to ensure students instead to depend upon scholarships. A publicly subsidised higher education system would reduce the need for loans.

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Appendix

Table A.1. Description of variables used in the regression analysis: Their definitions and notation

EMPLOYMENT	= 1, if the student got a job offer, =0 otherwise
FIELD_EMPLOYMENT	= 1 if the job offered is in engineering sector, =0 otherwise
TYPE OF ENTERPRISE	Nature of the firm/company/organisation where job is offered
TYPE_DOMESTIC	= 1 if domestic, = 0 otherwise
TYPE_FOREIGN	= 1 if foreign, = 0 otherwise
TYPE_JOINT	= 1 if it is a joint venture, =0 otherwise
***ln*EARNNGS**	Annual salary/wages (Rs.) offered at the time of campus recruitment (logarithmic form)
Individual characteristics	
GENDER	Gender of the student: = 1 if female, 0 otherwise
Caste	Caste of the student
SC	=1 if SC, 0 otherwise
ST	= 1 if ST, 0 otherwise
OBC	= 1, if other backward classes, 0 otherwise
GENERAL	= 1, if general (non-reserved) category, = 0 otherwise (reference category)
Household factors	
lnHHY	Annual income of the household (in Rs.) (logarithmic form)
Father's occupation	
FATHOCP_PROF	= 1, if professional/technical worker, 0 otherwise
FATHOCP_BUS	= 1, if businessman, 0 otherwise
FATHOCP_OTHERS	= 1 if belonging to other occupations, 0 otherwise
Father's Education:	FATHER_ED: actual years of schooling of father
Student's Academic Background (at School level)	
SEC_MARKS:	% of marks secured in the board (school-end) examination
SEC_MEDIUM:	medium of instruction at the school = 1 if English, =0 otherwise
Student's current education	
ENRL_PVT	Type of institution the student is currently studying = 1, if the student is enrolled in a private institution; = 0, otherwise, i.e., if the student is enrolled in a government institution.
STREAM_STUDY	Stream of Engineering Discipline in which the student is enrolled =1 if enrolled in modern/IT-related courses, =0 otherwise
LOAN	Availing of Education Loan (from a commercial bank) =1, if the student has taken any loan, =0 otherwise

Table A.2. Summary statistics of variables used in regression analysis

	Mean	***Standard Deviation***	***Minimum***	***Maximum***
EMPLOYMENT	0.7426	4372	0	1
*ln*EARNINGS	1.2405	0.4592	1.6094	3.912
ENRL_PVT	0.6599	0.4738	0	1
STREAM_STUDY	0.6896	0.4627	0	1
SEC_MARKS	78.89	11.19	30.39	100
SEC_MEDIUM	0.1477	0.3549	0	1
LOAN	0.1034	0.3045	0	1
GENDER	0.2861	0.452	0	1
SC	0.0738	0.2615	0	1
ST	0.0187	0.1356	0	1
OBC	0.194	0.3954	0	1
OTHERS	0.7134	0.4522	0	1
*ln*HHY	12.3298	0.9623	10.8198	14.0387
FATHOCP_PROF	0.2	0.4	0	1
FATHOCP_BUS	0.2036	0.4027	0	1
FATHOCP_OTHERS	0.6	0.49	0	1
FATH_ED	14.5684	3.913	0	17
FIELD_EMPLOYMENT	0.1069	0.3091	0	1
TYPE_JOINT	0.3947	0.4888	0	1
TYPE_DOME	0.2703	0.4442	0	1
TYPE_FOREIGN	0.3825	0.4862	0	1