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Assessing the impact of higher education expansion on economic restructuring, occupational change and access to opportunities in Brazil and India

Employment and Education: An Exploration of the Demand Side Story

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Employment and Education: An Exploration of the Demand Side Story[1]

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India has seen a rapid growth in knowledge intensive industries. At the same time there appears to be a major surge in the demand for higher education, both technical and non-technical. There is now an understanding among the youth that unless they acquire relevant skills, they will not be able to gain from the current growth of knowledge and technology intensive industries. This is a challenge for India today, to match the education/skills and relevant jobs for its youth.

In the standard human capital theory the causal relationship of education and earnings is seen through productivity augmenting effects. Education is seen as a signaling device for employers in the face of imperfect market information. This model's characterization of the demand side is crude. It acknowledges the role of physical capital, but no other variable is used to characterize jobs (apart from wages and prices). Job or occupation has no role in production theory. The human capital model ignores the demand side, except to include dummy variables for occupation/industry or employ fixed effect models to capture the effect. It assumes that mismatch of education and occupation is a temporary status in a worker's career development arising from inadequate information, omitted human capital components. The literature on over-education attempts to analyze the mis-match between educations and jobs (Hertog, 2000). This paper takes a small step to fill in the gap in the literature on the demand side of the relation between education and occupation or jobs.

We address three questions: 1. Is the demand for higher education increasing rapidly in certain occupations? 2. To what extent technology and knowledge intensive industries absorb (demand) workers in occupations requiring higher education? 3. Whether the effect of having a graduate degree on the probability of being in high-tech/knowledge intensive Industry (manufacturing plus services) differs between occupations?

The paper begins with a brief review of policy concerns and research on higher education in India. In the second section we discuss changes in graduate education and occupations and construct categories of graduate density of occupations. In the third section we develop a classification of knowledge intensive industries and discuss the growth of employment in knowledge intensive industries. In the fourth section we explore thickening and deepening of the graduate occupations in knowledge intensive industries. In section five we discuss the determinants of participation in high tech knowledge industries and compare the entry of

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graduates in occupation categories into manufacturing and service industries. In the final section we present the conclusions of the paper.

A Brief Review

Given India's age pyramid with more than one third of its population below the age of 14 years and given its low literacy levels, the major debates in education have concentrated on elementary education. The arena of higher education is relatively under-researched. As India grows rapidly into a knowledge economy, concerns with regard to whether its higher education system can match up to the challenge of producing the kind of skilled workforce necessary for this growth has arisen. A recent University Grants Commission report on higher education (UGC, 2003) discussed the issues and concerns in higher education in India today. Two eminent reports have been brought out in recent years, the National Knowledge Commission headed by Sam Pitroda (GOIa, 2009) and the Committee on Renovation and Rejuvenation of Higher Education headed by Yashpal (GOIb, 2009). Four Bills have been introduced in Parliament: Foreign Educational Institutions (Regulation of Entry Operation) Bill, 2010; Prohibition of Unfair Practices in Technical, Medical Educational Institutions and Universities Bill; the Educational Tribunal Bill and the National Accreditation Authority Bill. The Foreign Educational Bill is the most controversial, but the basic premise is that every foreign educational service in India, existing or planning in future, should register with a designated authority. The other Bills propose to make accreditation mandatory, prevent malpractices in higher education and help speedy disposal of disputes through a special tribunal (Anandakrishnan, 2010). All this point to the more recent concerns in policy circles with issues in higher education.

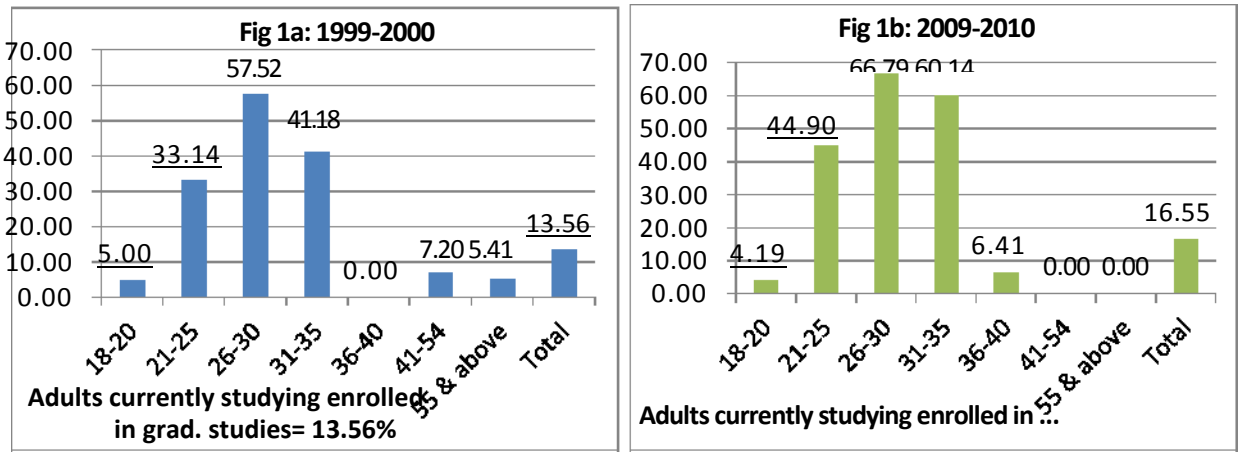
There has been an increasing skill premium in the labour market in India. This has been attributed to skill biased technical change which allows a rapid increase in supply of workers with graduation and above degrees or diplomas to co-exist with increasing skill premium (Unni and Rani, 2008). However, others argue that this rapid increase in skill premium exposes a paradox in India's labour market, in the sense that this enormous pool of skilled workers is relatively shallow (Kapoor and Mehta, 2007). They argue that the higher education system produces poor quality graduates and neither serves as a screening or signaling device, nor prepares students to be productive and responsible citizens. A study of the links between higher education and high technology industries argues that there is indeed a robust link between the two, though the quality of students from this system leaves much to be desired (Basant and Mukhopadhyay, 2008).

It has been argued that the IT labour market has been deepening and thickening (Basant and Rani 2004). Labour market deepening occurs through extension and penetration into new areas, when diversity in the demand and supply of skills is enhanced. With increasing specialization and expanding scale, the demand for skills in specific segments grow, which is referred to as thickening. This paper discusses to what extent these processes can be found in the knowledge intensive industries?

Graduate education and occupations

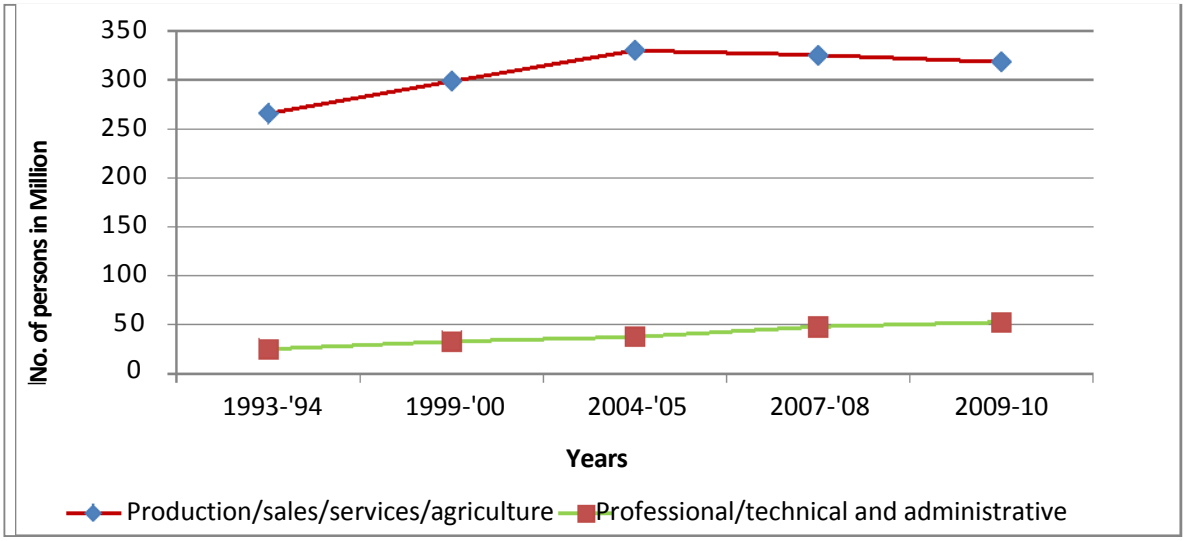
To get an idea of the current interest in education among adults in each age group, we look at the percentage of population currently studying at level of education graduate and above. Nearly 17 percent of adults aged 18 years and above were enrolled in graduate studies in 2000- 10 and this had risen from little less than 14 percent in 1999-00 (Figures 1 a and b). There was about10 percentage point increase in graduate enrolments in the age group 21-25 years and 26-30 year olds during the decade. Enrolments in graduate education increased by 20 percentage points among 31-35 yrs old. This is indeed very encouraging for the growth of higher education.

Figure 1 a-b: Percentage of adult students enrolled in graduate studies by each age group



Among the employed, there was a rapid increase in the number of better qualified occupations such as professional, technical, administrative and clerical jobs since 1999-00 (Figure 2), whereas, production, sales, service and agricultural occupations grew steadily upto 2004-05 and started falling after that.

Figure 2: **Employment trends by broad occupational groups, 1993-94 to 2009-10 (in millions)**



Higher Education and Occupational Structure: The question we ask ourselves here is to what extent various occupations require highly qualified labour and how has this been changing over the past decade? Using graduate education as a measure of higher education we divide the occupations into graduate and non-graduate occupations. Occupation where less than 7 percent of the work force was graduate was noted as non-graduate occupations. Next we observe changes in these occupations over time in two ways: by comparing among the age cohorts 21-35 years and 40-54 years for the year 2009-10 and the same age cohorts between 1999-00 and 2009-10 using NSSO Employment and Unemployment Survey data.

Occupational groups classified by graduate intensity, that is, the percentage of graduates in each 2-digit occupational group was as follows:

Very High, >= 60%: The proportion of employed people holding a first degree is greater than 60 percent in each age cohort in each occupation.

High, 40-59%: The occupation group has not been classified as above and the proportion of employed people holding a first degree is 40 to 59 percent in each age cohorts.

Medium, 15-39%: The proportion of employed people holding a first degree is 15 to 39 percent in each age cohort and the occupation group has not been classified as above.

Low, 7-14%: The proportion of employed people holding a first degree is 7 to 14 percent in either age cohort and the occupation is not classified in any above.

Non-graduates, < 7 %: All other occupation groups not classified above and with the proportion of employed graduates of < 7 percent.

India's Graduated Occupations: Overall nearly 71 percent of the occupied population 21 years old and above were in non-graduate occupation in 2009-10, having declined from 78 percent a decade earlier (Table 1, column 5). The corollary, nearly 30 percent of the occupied persons were in graduate occupations. Among the graduate occupation categories, about 3 percent each were in very high and high graduate intensity; medium intensity category had 13 percent and low intensity constituted above 10 percent of the occupied population in 2009-10. It was the medium graduate intensity occupations which registered the largest (around 10 percentage point) increase in occupied population over the decade (Table 1, column 5).

The very high graduate intensity occupations, by definition had the highest percentage of graduate occupations, about 63 to 73 percent in both years and both age cohorts. The high intensity category was the only group that saw a classic 10 percentage point higher graduated occupations among the younger cohort compared to the older one, more or less sustained over the decade, 1999-00 to 2009-10. The medium occupations which had registered a 10 percentage point increase in occupied population, had a 10 percentage point decline in graduate intensity in the younger cohort in 1999-00 to 20 percent, but retained the same in both cohorts in 2009-10. The low intensity occupations which had between 7 to 10 percent of graduates saw nearly 3 percentage point higher graduate density among the younger age cohort in 1999-00.

To sum, the **very high graduate intensity occupations** retained its need for higher educated workers. These consisted of occupations that have always had requirement for highly qualified people, for example solicitors, medical practitioners, higher education and secondary education teachers and biological scientists, architects/engineers, accountant, auditors, mathematicians/ statisticians and senior administrators, Directors, managerial executives, IT professionals and surprisingly poets, authors and journalists.

It was the **high graduate intensity occupations** that appeared to increase their demand for higher education in both the cohorts in India during this decade. High graduate density occupations were mainly associate professionals, technicians, health professionals, clerks, technical salesmen, and primary and middle school teachers. There was definitely a change in the demand for better and highly qualified people among these occupations. We can say that with the advent of the knowledge economy in India these jobs were being upgraded in terms of their need for better qualified personnel.

Low graduate intensity occupations were, merchants, shopkeepers, salesmen, chemical processors, rubber, plastic product and paper and paper board workers. It also included farm plantation and metal processors, occupations that actually saw the opposite of a decline in the graduate density in the younger cohort. It is possible that while the first set were occupations that required new skill sets in the new economy, the latter were occupations from which the young and better educated were moving out.

Only a few occupations, two in the two digit classification of nearly 27 occupation groups, actually showed a decline in graduate density over the decade.

Table 1: Summary Graduate Intensity Occupational Classification, 1999-00 and 2009-10 (Average percentage of graduates in each group)

Occupations by Graduate Intensity (1)	Cohort 1 (21-35 years) (2)	Cohort 2 (40-54 years) (3)	21years and above (4)	Percentage Distribution (5)	Cumulative percentage (6)
1999- 00					
Very High >=60%	73.2	71.7	71.9	**1.4**	1.4
High 40-59%	48.7	41.2	44.0	**5.4**	6.7
Medium 15-39%	20.6	27.6	23.0	**3.8**	10.6
Low 7-14%	10.3	7.7	8.9	**11.3**	21.8
Sub-Total Classes	*24.0*	*25.6*	*24.1*	21.9	
Non-graduate	1.9	1.0	***1.5***	***78.1***	100.0
Total	6.7	6.9	6.4	100.0	
2009-10					
Very High >=60%	71.7	63.9	72.1	**2.7**	2.7
High 40-59%	53.2	44.1	47.4	**3.0**	5.7
Medium 15-39%	20.8	20.1	19.6	**13.1**	18.7
Low 7-14%	7.6	7.0	7.0	**10.6**	29.3
Sub-Total Classes	*27.2*	*24.6*	*22.7*	***29.3***	
Non-graduate	2.4	1.5	***1.8***	***70.7***	100.0
Total	10.4	8.6	8.0	100.0	

Source: Computed from unit records of NSSO Employment and Unemployment Survey, 1999-00 and 2009-10 by NCO 2004 classification in both years.

Employment in knowledge intensive industries

Knowledge Intensive Industry Classification: Manufacturing industries and more so service industries in India, are seen as increasingly technology and knowledge intensive. Here we address the issue of whether growth of knowledge intensive industries has led to a demand for higher educated graduates.

We use the Eurostat/OECD Classifications to categorize the industries into various levels of knowledge intensity. For classifying manufacturing industries the OECD classification is based on the ratio of R&D expenditure to GDP or R&D intensity (Bernard, 2006). Both direct and indirect expenditure on R&D are considered, including purchase of machinery, equipment and intermediary inputs. This is a proxy to capture the technological intensity of the manufacturing industry.

The service industries are classified based on the OECD proposal for knowledge intensive services (Eurostat, 2007a and b). The knowledge intensity reflects the integration of a generic or

service specific science and technology base, it can be seen as a combination of knowledge embedded in new equipment, personnel and R&D intensity (Bernard, 2006). The service industries have been classified broadly as knowledge intensive based on this OECD classification and has been further split based on types of services following Torres-Freire and Abdel (2010).

Using these classifications we have grouped the non-agricultural industries using the National Industrial Classification (NIC, 1998 for 1999-00 and NIC, 2004 for 2009-10) into eight knowledge and technology intensive groups, four each in manufacturing and services. Further, two other non-agricultural industries, construction and mining and quarrying, were retained separately. (See Appendix Table A1 for a detailed listing of the industries in each group). The primary activities, agriculture, dairy, fishing, forestry etc. were excluded from this classification.

Growth of Employment in Knowledge Intensive industries: Of total non-agricultural employment about 48 percent was in the less knowledge intensive services (trade, transport, public administration) and 16.5 percent was in the low technology manufacturing industries (mainly primary products) in 1999-00 (Table 1). Both these low knowledge intensive industry groups registered a small decline in employment share of 6 and 2 percentage points respectively over the decade 1999-00 to 2009-10 and accordingly registered lower annual growth in employment. Only about one fifth of total employment was in high/medium technology intensive manufacturing and knowledge intensive service industry.

Manufacturing: The overall average annual growth of total non-agricultural employment was 2.7 percent during 1999-00 and 2009-10 (Table 2). In manufacturing, all the industry groups had shown less than 2.5 percentage annual growth of employment.

Services: Among all the industry groups, the highest annual growth, about 7.2 percent, in employment was registered in high technology knowledge intensive service industries. These included telecommunication, computer services and R&D, whose share was quite small but increasing over the decade. The next highest growth was registered in knowledge intensive services (KIS), 4.5 percent, with the share increasing from 3.5 to 4.2 percent over the decade. These included financial services, real estate, and other business, recreational and sporting services. This was followed by the social knowledge service industries, with 2.8 percent growth and share remaining at 7.2 percent. This was mainly the education and medical services industry.

Overall, there was rapid growth of employment in the knowledge intensive service industries, whereas the technology intensive manufacturing industries recorded very slow growth in employment. This is understandable in that technology intensive manufacturing industries were likely to be more capital intensive and therefore likely to absorb less employment. It also reflects the nature of high growth in the service sector, being very knowledge intensive. This is important to our study as it probably implies absorption of more educated workers, which is what we shall investigate in the rest of the paper.

Table 2: Share and Growth of Employment in the Knowledge Industries, 1999-00 and 2009-10

Knowledge Industry Groups (KII)	Share of Employment (%)		CAGR (%)	% of Graduates 2009-'10
OECD classification	1999-'00	2009-'10	CAGR	
High-tech manufacturing	0.8	0.7	1.4	29.7
Medium-High-tech manufacturing	3.0	2.8	2.3	22.2
Medium-low-tech manufacturing	7.3	6.1	1.1	7.0
Low-tech manufacturing	16.5	13.9	1.1	4.9
Knowledge Intensive Services(KIS)	3.5	4.2	4.5	49.2
Social Knowledge Intensive Services	7.2	7.2	2.8	57.3
High-tech Knowledge Intensive Services	1.1	1.7	7.2	52.1
Less KIS	47.6	41.8	1.5	11.8
Construction	11.6	20.1	8.0	2.8
Mining & Quarrying	1.5	1.4	2.2	14.2
Total	100.0	100.0	2.7	14.7

Note: 1.CAGR-compound annual growth rate.
2. Figures in parentheses are percentage of graduates in each knowledge industry group
Source: Computed from unit records of the Employment and Unemployment Surveys, National Sample Survey Organization, 1999-00 and 2009-10

Thickening and Deepening of graduate occupations in knowledge intensive industries

The simplest way of studying graduate intensity in industries is the percentage of graduates in each industry group. This is presented in the last column of Table 2. About 60 percent of occupied persons in the Social KI services are graduates, followed by about 50 percent in the KIS and 52 percent of graduates in the high-tech. KIS. The next most graduate intensive industries are the high tech and medium high tech manufacturing industries with about thirty percent and one fifth of workers in them being graduates. However, this does not tell us what types of graduate occupations are concentrated in each of these knowledge intensive industries (KII).

The distribution of graduate intensity in occupations tells us which industry groups have a greater demand for higher educated/graduate workers. This also tells us about the demand for higher education in knowledge intensive industries (KII) through the distribution of occupied graduates in each of the KII. This distribution is presented for occupied population, by age cohorts, 21-35 and 40-54 years (Tables 3a and b). This distribution helps us to understand the deepening of knowledge intensity in each KII group.

Table 3a: Distribution of workers in Knowledge Industries by graduate intensity in Occupation (21-35 years), 2009-10 (percentage)

Knowledge Industry Groups	Graduate Intensity in Occupations					
	Very High >=60 %	High 40- 59 %	Medium 15- 39 %	Low 7- 14 %	Non-Graduate < 7 %	Total
High-tech manufacturing	19.0	13.6	14.7	27.6	25.1	100
Medium-High-tech manufacturing	12.5	9.6	10.0	50.0	17.8	100
Medium-low-tech manufacturing	2.3	2.0	14.3	26.6	54.8	100
Low-tech manufacturing	1.0	2.1	12.5	10.4	74.1	100
Knowledge Intensive Services (KIS)	15.4	37.5	30.8	9.6	6.7	100
Social Knowledge Intensive Services	76.9	3.9	10.8	5.5	3.0	100
High-tech Knowledge Intensive Services	51.6	15.7	19.4	9.3	4.0	100
Less KIS	1.9	4.8	45.4	28.8	19.1	100
Construction	0.8	0.5	2.4	2.4	93.9	100
Mining & Quarrying	1.9	4.0	12.0	14.4	67.8	100
Total	9.7	5.2	24.2	18.0	42.9	100

Table 3b: Distribution of workers in Knowledge Industries by graduate intensity in Occupation (40-54 years), 2009-10 (percentage)

Knowledge Industry Groups	Graduate Intensity in Occupations					
	Very High >=60 %	High 40- 59 %	Medium 15- 39 %	Low 7- 14 %	Non-Graduate < 7 %	Total
High-tech manufacturing	12.3	15.9	9.0	40.4	22.4	100.0
Medium-High-tech manufacturing	10.7	7.4	21.5	41.3	19.1	100.0
Medium-low-tech manufacturing	2.9	2.8	15.9	25.1	53.3	100.0
Low-tech manufacturing	1.0	2.6	17.4	10.2	68.8	100.0
Knowledge Intensive Services (KIS)	10.9	32.7	41.9	7.0	7.4	100.0
Social Knowledge Intensive Services (SKIS)	68.4	6.4	8.7	11.7	4.8	100.0
High-tech Knowledge Intensive Services	24.3	34.3	16.1	20.2	5.1	100.0
Less KIS	3.3	9.0	42.7	22.9	22.1	100.0
Construction	0.8	0.4	4.3	1.4	93.1	100.0
Mining & Quarrying	3.4	4.7	7.9	23.3	60.8	100.0
Total	8.8	7.4	26.6	16.5	40.7	100.0

We had observed that more than half the occupied persons in the social KIS and 49 percent in KIS were graduates (Table 1). Has there been deepening of graduate intensity in the younger age cohort? In the services with a high concentration of graduates (KIS, social KIS and High tech KIS) there was clearly a move towards more graduate intensive occupations among the younger cohort (21-35 years, Table 3a and b). However, subtle differences were noted.

KIS, business services, showed increase in very high and high graduate intensity occupations among the younger cohort. This implied a deepening of graduate intensive occupations in these service industries, that is, the nature of jobs in the industry had changed to allow for persons with lower graduate intensity to enter. Financial services, banks, accounting services now perhaps produce products/services that are more technical, such as insurance products, that require a variety of persons with varying graduate intensity to produce and market. Soft skills such as knowledge of English, etiquette and style are also important in the various occupations on this sector.

In social KIS and high tech KIS there was a concentration in very high (>60 percent) graduate intensity occupations among the younger cohort compared to the older one. These occupations were generally educational and medical professionals, administrative/ managerial, senior officers and technical engineers, computer programmes and scientists. This could be termed as labour market thickening or specialization, when graduate intensity increases sharply in certain occupations and there is a greater absorption of such workers in these jobs. In these industries, education, medical, software, hardware and R and D, the jobs are getting more specialized and require a larger proportion of highly qualified people.

We had observed that growth in employment was the highest in the high technology KIS followed by social KIS and KIS industry groups. These industries groups also witnessed the increasing demand for higher educated graduates. This is clearly the impact of the demand for workers with higher education in the knowledge economy.

The deepening of knowledge intensity was witnessed in KIS, while social and high-tech KIS groups could be said to have more specialization or thickening of knowledge intensity. In the manufacturing sector, there was no real deepening or thickening of knowledge intensity. In medium-low and low tech manufacturing a status quo was maintained with more than 50 percent non-graduates among the younger and older cohorts.

One caveat however needs mentioning regarding changes observed in the service sector. There has been a decline in the quality of education delivered by the institutions of higher education. The deepening of knowledge intensity may also occur if employers perceive this deteriorating quality of workers and in certain occupations use graduate education as a screening device. This might actually imply over-education of workers in these occupation groups. That is, the occupation does not require graduation but employers prefer to employ them as there is a increasing supply of them and it becomes a convenient method to get better workers.

Participation in High Tech Knowledge Intensive Industry

The question we address here is whether the effect of having a graduate degree on the probability of being in high-tech(HT) and knowledge intensive(KI) Industry (manufacturing plus services) differs between occupation groups and our model is:

$E(HT\_dummy) = Probability\ (HT\_dummy=1) = \Phi(\alpha + \beta_1 edu\_dummy + \beta_2 occupation\_category + \beta_3 edu\_dummy\#occupation\_category + \beta_4 sex + \beta_5 social\_grp\_dummy + \beta_6 region + \beta_7 age)$

Where HT_dummy takes the value 1 for high tech or knowledge intensive manufacturing + service industries the rest is 0. We also run the same model for HT manufacturing and HT/knowledge intensive service industry separately. Here age is the only continuous variable.

Our main variable of interest is *edu_dummy* which takes value 1 if the person has a graduate degree, takes the value 0 otherwise. The nine occupational categories are coded as follows:

0-Elementary; 1- Legislators, Senior Officials and Managers; 2-Professionals; 3- Technicians and Associate Professionals; 4-Clerical; 5- Service Workers and Shop & Market Sales; 6-Skilled Agricultural; 7- Craft and Related Trades Workers; 8- Plant and Machine Operators and Assemblers. We have excluded category 6, farmers and other agricultural occupations from the analysis.

To study the effect of a graduate degree on participation in HT/KI industry in different occupations an interaction variable is constructed by interacting the graduate dummy variable with each of the 8 occupation category dummies (as there are 9 categories of occupations), and this is summarized by the term *edu_dummy#occupation_category*. The coefficient β_3 thus comprises of eight coefficients for eight interaction terms in the model. We are interested in calculating the marginal effect of each explanatory variable.

In a non-linear model like probit, this marginal effect is an approximation of how much the dependent variable (probability of being in HT/KI industry in this case) is expected to change for a unit change in the independent/explanatory variable. For a continuous independent variable, marginal effect is nothing but the first derivative of the dependent variable (y) with respect to the independent variable (say x_1). But the problem occurs when we want to compute the change of the effect of x_1 (an explanatory variable) on E(y) (y being HT_dummy) for a unit change in x_2 (another explanatory variable), i.e. the interaction effect of x_1 and x_2. This effect is actually the cross partial derivative of E(y) with respect to x_1 and x_2, not the first derivative of E(y) with respect to the multiplicative term ($x_1 x_2$) (For details on the model see *Appendix 1*).

Overall there is a 17.4 percent increase in probability on participation in HT/KI industry (manufacturing + service) if the worker is a graduate rather than non-graduate (Table 4). The effect of higher education is more than double on knowledge intensive service industry than that on high technology manufacturing industry.

Within occupations alone, the probability of participation in the high tech industry was nearly 27 and 60 percent higher among professional and technical occupations respectively compare to

elementary. This was followed by clerical occupations (32 parcent higher probalibity). All these results were particularly true for the high tech service industry compared to manufacturing.

Among the control variables age and the social group (caste/tribe) to which the worker belonged made no difference to overall participation in HT/KI industry (Table 4). But the workers in the knowledge intensive service had a higher probability of being younger, male and of the upper social groups compared to their peers in the manufacturing industry. Gender has an impact on industry participation. Women have a greater probability (.021 or 5.5 percent) of participation in KI service industry as well as in HT/KI industry (3.3 percent) than men. Women are more likely to participate in service industry, whereas men are likely to participate in HT manufacturing industry (2.3 percent higher probability than female). Further, probability of participation in knowledge intensive service industry is more likely in South Indian states, while participation in high tech manufacturing is more so in West Indian states. This is intuitively correct, wherein the main knowledge intensive IT service sector centers are the cities of Bangalore, Hyderabad and Chennai in the South, while the Western states of Maharashtra and Gujarat are known to be manufacturing hubs.

Table 4: Determinants of Participation in HT Manufacturing and HT/KI Service Industries: Marginal effects (dy/dx) of all explanatory variables except interaction term, 2009-10

VARIABLES	Probability of being in HT (Manu + Service) Industry	Probability of being in HT/KI Service Industry	Probability of being in HT Manu Industry
Education dummy (Graduate or above=1)	0.174*** [0.000]	0.119*** [0.000]	0.0530*** [0.000]
Occupation category (Reference group: 0-Elementary occupation)			
1- Legislators, Senior Officials and Ma	0.019 [0.122]	0.048*** [0.000]	-0.028*** [0.000]
2-Professionals	0.273*** [0.000]	0.303*** [0.000]	-0.029*** [0.000]
3- Technicians and Associate Profession	0.609*** [0.000]	0.629*** [0.000]	-0.026*** [0.000]
4-Clerks	0.320*** [0.000]	0.311*** [0.000]	0.001 [0.348]
5-Service Workers and Shop & Market Sal	-0.035*** [0.000]	0.0138 [0.118]	-0.049*** [0.000]
7-Craft and Related Trades Workers	0.008 [0.539]	-0.029*** [0.000]	0.036*** [0.000]
8-Plant and Machine Operators and Assem	0.0002 [0.988]	-0.032*** [0.000]	0.025** [0.010]
Age	-0.0006*** [0.000]	-0.0003** [0.038]	-0.0003** [0.020]
Feamle dummy	0.034*** [0.000]	0.055*** [0.000]	-0.023*** [0.000]
SC/ST dummy	0.006 [0.240]	0.016*** [0.001]	-0.008** [0.014]
Region (Reference group: 0-Central)			
North	0.0251*** [0.000]	0.009 [0.212]	0.013** [0.030]
South	0.038*** [0.000]	0.033*** [0.000]	0.007 [0.240]
West	0.049*** [0.000]	0.023*** [0.000]	0.025*** [0.000]
East	-0.0154* [0.081]	-0.002 [0.745]	-0.014*** [0.008]
Observations	82,319	82,319	82,319

pval in brackets

*** p<0.01, ** p<0.05, * p<0.1

Note: Figures in parentheses denote the level of significance (p>|z|).

The effect of graduate degree (*edu_dummy=1*) for different occupational categories on participation in high tech and knowledge intensive manufacturing and service industries are presented in Table 5. The marginal effects for the interaction terms are computed from the probabilities of being in HT/KI industry for every combination of education and occupation category (*edu_dummy & occupation_category*) (For details see Appendix 1, Table A2).

Table 5: Effect of Graduate Degree on Industry Participation (HT Manufacturing, HT and KI Service) for Each Occupation Category, 2009-10

Marginal effect of education (i.e. non-graduate to graduate) for different occupational categories	HT/KI industry (Manufacturing + service) participation	HT/KI service industry participation	HT Manufacturing industry participation
graduate#0-Elementary – non-grad# 0-Elementary	0.149 [0.005]***	0.090 [0.033]**	0.057 [0.067]*
graduate#1- Legislators, Senior Officials and Ma– non-grad# 1- Legislators, Senior Officials and Ma	0.253 [0.000]***	0.212 [0.000]***	0.045 [0.000]***
graduate#2-Professionals – non-graduate# 2Professionals	0.503 [0.000]***	0.483 [0.000]***	0.018 [0.056]*
graduate#3-Technicians and Associate Profession – non-grad# 3 Technicians and Associate Profession	0.102 [0.000]***	0.089 [0.000]***	0.016 [0.066]*
graduate#4-Clerical– non-grad#4-Clerical	0.060 [0.022]**	0.071 [0.006]***	-0.012 [0.340]
graduate#5-Service and Sales– non-graduate#5-Service and sales	0.019 [0.252]	0.007 [0.584]	0.015 [0.263]
graduate#6-Craft and Related – non-graduate#6-Craft and Related	0.197 [0.000]***	0.063 [0.001]***	0.122 [0.000]***
graduate#8-Plant and Machine Operators and Assem – non-graduate#8-Plant and Machine Operators and Assem	0.156 [0.000]***	0.054 [0.007]***	0.094 [0.003]***

Note: Figures in parentheses denote the level of significance.

The probability of being in high-tech manufacturing/service industry is higher by 50 percent for graduates compared to non-graduates for professional workers (occupation category 2) which is 25 percent for legislators, senior officials and managers. This is perhaps because such workers are those who necessarily have a graduate degree. Having a graduate degree has no impact on participation in high tech manufacturing as well as service industry for service and sales workers Overall, the effect of graduate degree is comparatively small on participation in high-tech

manufacturing, specially for legislators, senior officials, managers and professionals, 4.5 percent and 1.8 percent, than in high-tech/knowledge intensive service industry, being 21 percent and 48 percent. It implies that graduates in professionals, administrative, executive and managerial occupations are more likely to participate in high-tech/ knowledge intensive service industry. In the case of sales workers we had noted earlier that the products of various business and financial services were more sophisticated and required more technical knowledge. Among administrators and managers, service industry was the new growth sector with perhaps more challenging jobs and also offered more remuneration.

Being a graduate created no advantage in industry participation for occupation such as merchants, service workers.

Conclusions

India has seen a rapid increase in higher education in the recent decade. The question we ask is whether there is demand for higher educated persons, graduates and above, or are we facing a situation of over-education in employment? This issue is addressed innovatively in terms of changes in nature of jobs and in occupations within knowledge intensive industries.

All, but two out of thirty occupations have had an increase in graduate intensity. Occupations with high intensity of graduates, mainly engineering, medical and scientific technicians, social scientists and economists, technical salesmen and primary and middle school teachers showed an increased demand for better and highly qualified people, we could say with the advent of the knowledge economy. The medium graduate intensity occupations were nurses, working proprietors (self employed enterprises), village officials, artists and composers, transport conductors, who showed a smaller increase in graduates among the younger cohort. The low graduate intensity occupations saw a large increase in the percentage of graduates in the younger cohort in 2009-10, for example, ticket collectors and checkers, merchants, shopkeepers, salesmen, and service workers. The nature of activities in these occupations may have changed so as to require a more qualified workforce. This definitely indicates an increase in demand for better educated work force in many occupations in recent years.

The industry groups, manufacturing and services, were reclassified based on high tech and knowledge intensity. We found that the service industries showed a greater demand for graduates. Within it, knowledge intensive services (KIS), financial and business services, showed a deepening of graduate intensity, meaning the nature of jobs changed to allow for occupations with lower graduate intensity as well. The social KIS, education and medical services, and high tech KIS, R&D and computer services, showed a thickening or specialization of occupations, reflected in sharp increase in very high graduate intensity occupations.

Finally having a graduate degree had a greater impact overall on participation in service industry compared to manufacturing. Senior managerial officials and professionals with graduate and above degrees had a higher chance of being employed in knowledge intensive industry, mainly services. All this points to an increase in demand for higher educated workers in particular occupations and within the knowledge intensive industries, more so in the service sector.

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Appendix Table 1: OECD Classification of Knowledge Intensive Manufacturing and Service Industry

Knowledge Intensive Industry Classification	Industry Groups (NIC,1998 and 1987)
High-tech manufacturing	Manufacture of office machinery and computers; radio, television and communication equipment and apparatus; medical, precision and optical instruments, watches and clocks
Medium-High-tech manufacturing	Manufacture of chemicals and chemical products; machinery and equipment n.e.c.; electrical machinery and apparatus; transport equipment
Medium-low-tech manufacturing	Manufacture of coke, refined petroleum products and nuclear fuel; rubber and plastic products; basic metals and fabricated metal products; other nonmetallic mineral products; manufacturing n.e.c.
Low-tech manufacturing	Manufacture of food products, beverages and tobacco; textiles and textile products; leather and leather products; wood and wood products; pulp, paper and paper products, publishing and printing;
Knowledge Intensive Services(KIS)	financial intermediation; real estate, renting and business activities; recreational, cultural and sporting activities; Water Transport; air transport ;
Social Knowledge Intensive Services	Education; Health & social work
High-tech Knowledge Intensive Services	Post and telecommunications; Computer and related activities; Research and development
Less Knowledge Intensive Services	Wholesale and retail trade; hotels and restaurants; land transport; transport via pipelines, Supporting and auxiliary transport activities; activities of travel agencies Public administration and defense; compulsory social security; Sewage and refuse disposal, sanitation and similar activities; activities of membership organization n.e.c.; Other service activities; activities of households as employers of domestic staff; Extra-territorial organizations and bodies
Construction Industry	
Mining and Quarrying	

Appendix 1: Model and Interpretation of results

The purpose of the model is to study whether the effect of having a graduate degree (x_1) on the probability of being in High-Tech Industry (y) (both manufacturing and services) differs between occupation groups (x_2). And to do so we use an interaction term of graduate dummy and occupation category $_{(x1.}$ x_2) dummy. We are interested in calculating the marginal effect of each explanatory variable which, in a non-linear model like Probit, is an approximation of how much the dependent variable is expected to change for a unit change in that explanatory variable. For a continuous independent variable, marginal effect is nothing but the first derivative of the dependent variable with respect to the independent variable (say x_1). But the problem occurs when we want to compute the change of the effect of x_1 on E(y) for a unit change in x_2 (another explanatory variable). This effect is actually the cross partial derivative of E(y) with respect to x_1 and x_2.

Linear Model: In linear models the coefficient of the interaction term between x_1 and x_2 gives exactly this cross partial derivative. So if we consider the interaction term $_{(x1.}$ x_2) to be another variable q, and compute the marginal effect of q, then it is same as the cross-partial derivative (coefficient of interaction term) of E(y) with respect to $_{(x1.}$ x_2),

i.e., $3E(y)/3q = 3^2E(y)/3\ x_1 3\ x_2$

Non-linear Model: In non-linear models (Probit or Logit) since the functional form is not linear, the coefficient is not equal to the marginal effect,

i.e., $3^2E(y)/3\ x_1 3\ x_2 \neq 3E(y)/3(\ x_1.\ x_2)$.

So far this illustration is given for continuous independent variables, but the same holds true (i.e., the coefficient **≠** marginal effect) with differences instead of differentials (partial derivatives) of the independent variables in case they are discrete or dummy in nature. Hence computation of marginal effects in Probit or Logit models which include interaction terms (with discrete values) requires different kind of methodology as compared to those followed in general.

Generally STATA commands *"mfx"* and *"dprobit"* are useful to estimate the marginal effects. But these commands do not give the correct marginal effects when interaction terms are included in the model. The command *"margins, dy/dx(*)"* (which is a post command, run after probit) can give us the marginal effects of all other independent variables except the interaction terms. Marginal effects of the interaction terms can be obtained from the command *"margins".*

Instead of taking the derivative of the expected probabilities of any occupational category with respect to *edu_dummy,* we will calculate the marginal effect as the difference between the expected probabilities (which are called margins) of any occupation group with and without graduate degree since the *edu_dummy* is a categorical variable which takes values 0 or 1. The command *"margins"* gives us the estimated probabilities in STATA. The results copied from the STATA output on running the command *"margins edu_dummy#occupation_category"* are presented in Appendix Table 2.

Appendix Table 2: Margins of Interaction Terms

	Margin	Std. Err.	Z	P>z
Education*occupation (0- Non-grad, 1-Grad)				
0 0	0.089	0.005	18.26	0
0 1	0.090	0.007	12.68	0
0 2	0.300	0.015	20.66	0
0 3	0.708	0.014	50.92	0
0 4	0.426	0.018	24.08	0
0 5	0.078	0.004	19.07	0
0 7	0.089	0.005	18.27	0
0 8	0.088	0.006	13.88	0
1 0	0.238	0.052	4.55	0
1 1	0.342	0.018	19.56	0
1 2	0.803	0.011	71.73	0
1 3	0.809	0.012	68.32	0
1 4	0.486	0.019	25.37	0
1 5	0.097	0.017	5.89	0
1 7	0.285	0.038	7.57	0
1 8	0.244	0.037	6.69	0

The margins command shows the probabilities of being in high-tech industry of every combination of occupational category and education (*occupation_category & edu_dummy*). The probability of being in HT industry of elementary workers (occupation code 0) without a graduate degree is 0.089, while that probability for workers with graduate degree is 0.238. The marginal effect of having graduate degree (*edu_dummy)* for production workers is thus 0.149 (see Table 5 in the text).