

Technological Capability, Employment Growth and Industrial Development: A Quantitative Anatomy of Indian Scenario

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Abstract:

Industrial development is the dynamic process responsible for structural transformation of the economy and generating gainful employment opportunities for growing workforce. The post-reform spurt of economic growth in India has been described as 'jobless growth'. In this paper an attempt has been made to examine the question of when industrial development provides required dynamism for generating desired employment opportunities for labour force and when it does not. An industrial technological capability based approach has been adopted to analyse the Indian Industrial development experience during the period 1980 to 2005, which is a quarter century time period. The main finding that emerged from the empirical evidence is that the medium-high-tech industries have shown dynamism in terms of generating employment growth. The labour market regulation view put forward by various scholars supporting the liberalisation policies could not stand the scrutiny of clear demarcation among job creating and job destroying industries under the same circumstances. The relationship between industrial technological capabilities and employment growth turns out to be ambiguous. This implies that weak technological capabilities adversely affect employment growth and heavy dependence on imported technological know-how from the developed countries is labour displacing. It is thus suggested that developing countries should invest both in institutions and industrial firms to develop technological development that suits to resource endowment, specificities of local conditions and suitable to the stage of industrial development. There is a dire need to explore alternative paths of industrial and technological capability development to sustain economic transformation process for achieving prosperity and reducing the time for catch-up development.

Key words: Industrial development, jobless growth, technological capabilities, employment elasticities, India.

Introduction:

Post-reform spurt in Indian economic growth has been described as ‘jobless growth’. The phenomenon of jobless growth during the period of late 20th century and early years of 21st century was not India specific, but was observed across developed and developing countries alike except newly industrialising South East Asian countries including China (Van der Hoeven and Taylor, 2000; and Audretsch and Thurik, 1999). The industrial development of the developing economies including India except Asian newly industrialising countries has also recorded very slow growth in employment. The industrial sector has been considered as the most dynamic sector of an economy and therefore, it is expected that this sector should absorb the growing labour force and provide decent livelihood to the growing work force. Many scholars working in the area of industrial development and its implications for employment have observed dismal scenario so far as employment outcomes of industrial development is concerned (Morawetz, 1974; Edquist, Hommen and McKeley, 2001; Amsden and Van der Hoeven, 1996; Papola, 2009; Kannan and Raveendran, 2009; Goldar, 2009; and Sen, 2008). Economic reforms initiated in the early eighties and more vigorously since July 1991, both national and international, failed to effect manufacturing employment in the face of excess supply of unskilled labour force in the Indian economy. Indian development strategy has underlined the importance of industrial development with regard to its dynamic characteristics such as capital accumulation and technological capabilities. It is widely held view that the technological advancement, since industrial revolution, has been concentrated in manufacturing sector and the diffusion of technology takes place from this sector to other economic activities and sectors (Szirmai, 2009). The diffusion of technology across manufacturing and other sectors not only raised productivity but also generated backward and forward linkages. This process has a capacity to generate special opportunities for catch-up. Large-scale mass production of manufactured products essentially creates dynamic comparative advantage and triggers change in the industrial structure that generates economic activities based on new knowledge provides greater employment opportunities and explodes demand for improved variety of products (Audretsch and Thurik, 1999). Rapid industrial development experience of both developed countries and newly industrialised (East Asian) countries have supported the view that growth can solve the problem of unemployment. However, there has been growing realisation that the gap between the speed, at which technological progress is taking place, and the capacity to provide new job opportunities has widened dramatically (Rifkin, 1995 and Commission of the European Communities, 1994). Policy makers are expected to address the growth-employment dilemma, while understanding

the relationship between growth and employment, with a broad spectrum of policy approaches. The mainstream policy response favoured higher dose of market until recent financial meltdown and recession that has engulfed the global economy. Therefore, it is high time to understand and examine the question of industrial output growth implications for employment generation. In this paper an attempt has been made to examine the question of when industrial development provides required dynamism for generating desired employment opportunities for labour force and when it does not. An industrial technological capability based approach has been adopted to analyse the Indian Industrial development experience during the period 1980 to 2005, which covers the rapid growth period of industrial economy of India and also represents the pre and post-reform period. Quantitative assessment of industrial employment growth has been made while making use of semi-logarithms regression analysis and panel databased models. The discussion is organised into the nine sections. Apart from section one, the section two presents the analytical framework of the paper. Data sources and methodology is discussed in section three. The changes in the structure of industrial employment are presented in section four. Section five analyses the employment, output and wage trends across manufacturing industries. The estimates of employment elasticity are presented in section six and section seven discusses the determinants of employment elasticity. The employment growth and technological capabilities relationship is examined in section eight. In the final section, concluding remarks and policy implications for other developing countries, which result from the paper, are presented.

Framework for Analysis:

Industrial development, technological capabilities and employment growth are intimately connected. Industrial development generates opportunities for faster capital accumulation and technological capability building that spurs structural transformation in the economy. Historical experiences of industrial development of the advanced countries shows that spurt of industrial activities not only engineered the process of structural transformation but also have generated gainful employment opportunities for the work force. This has led to the shortage of desired work force in desired skills initiated the process of either immigration or innovations that has been addressing the problem of labour shortages. Therefore, the evolution of industrial structure in the developed countries has been accompanied by the evolution of technological capabilities addressing the problems encountered by the industrial development process. This co-evolution process remained in operation in the developed countries for a long time and recent wave of technological revolution further raised the skill

requirement of the work force and raised wage costs along with reduced possibilities of capital-labour substitution. Towards the last quarter of 20th century, the emergence of new lower cost production locations has reduced the competitiveness of European and North American firms. The threat of erosion of traditional comparative advantage has resulted into shifting of production to cheaper locations, laying off workers and reduction of wage cost, which soared the unemployment rates during the 1980s and the 1990s (Audretsch and Thurik, 1999). The continuously rising unemployment rates in the developed countries with moderate growth rates of output have triggered policy debate on inevitable trade-off between employment and wage cost. The recent studies conducted to examine the relationship between innovations, industry evolution and employment suggested that the debate on trade-off between employment and wage cost actually diverted the main issue, that is, alternative to it. The alternative lies in the continuous evolution of the industrial structure reflects in the shifting of industrial activities from moderate technology industries to newly emerging knowledge-based industries. Thus, the technological capability building approach is path dependent and has a capacity to connect innovation, industry evolution and employment generation.

When India began her march towards modern economic growth after achieving independence, industrial development assumed to play central role for rapid economic growth and structural transformation of the economy. The central emphasis of the Indian government was to lay foundations for faster growth of industrial sector and building technological capabilities that can self sustain rapid industrialisation. It was also envisaged that heavy industrial development strategy will inherently be capital intensive, therefore, special emphasis was made to develop small scale labour intensive industries for providing gainful employment to the growing work force. The catch-up growth model chosen by India strive to develop technological capabilities while doing R&D expenditure in public sector enterprises and institutions. Substantial efforts were made to fulfil the needs of technological requirements through the process of adapting imported technologies and further create technological capabilities to generate new technologies and eventually catching up with the advanced countries (Ray, 2009). The domestic efforts in terms of R&D expenditure were stepped up from 0.17 per cent in 1958-59 to 0.98 per cent in 1987-88. However, it declined thereafter and hovered around 0.8 per cent. The emphasis has shifted from self-reliant technological capabilities to liberal import of technology. The structure of R&D expenditure has undergone some changes but still remained highly public sector dominated and firm level capabilities except some industries usually remained low. The industrial economy of India

could not catch-up to the frontier of technological knowledge and industrial productivity still remained quite low not only compared with the developed countries but also with East Asian countries especially far behind from China (Papola, 2009). It is significant to know that despite achieving reasonably faster rate of output growth why Indian organised manufacturing industry could not able to generate desired level of employment growth. The discussion on slow employment growth in the Indian organised manufacturing industries has been revolved around the inevitable trade-off between output growth and labour cost

The slow absorption of the labour force in industrial sector even during the liberalisation experience put a question mark on industrial development strategy adopted by the Indian policy makers. However, several scholars have investigated and argued that stagnation in employment of labour force in the organised industrial sector of the economy can essentially be attributed to labour security provided by the labour laws. Labour market rigidity was mainly held responsible for decline in the employment elasticity of organised manufacturing industries (Fallon and Lucas, 1993, Hasan, et al 2007 and Goldar, 2009). The industrial employment stagnation has been resulted from falling employment in some set of industries and rising employment in other set of industries under the same policy regime have resulted into overall jobless growth gives credence to the view that supporters of liberalisation may not be right to find out factors that has not allowed job creation in the industrial sector. Therefore, some alternative approaches have been put forward to find out plausible underlined explanation so that right kind of public policy can be formulated to overcome joblessness in the Indian economy (Kannan and Raveendran, 2009; Papola, 1994; Nagraj, 2000 and Singh and Gill, 2002). Alternative to labour market rigidity, the reduction of capital cost and changing pattern of demand of the manufactured products both nationally and internationally put forward as a dominant explanation for decline in the elasticity of employment in the organised Indian manufacturing industry. It is pertinent to argue that the last quarter of 20th century has witnessed technological revolution, which has introduced automation processes and hence substantially reduced capacity to generate direct employment by the manufacturing sector. Indian industry witnessed structural transformation from primary raw-material and metal based to processed intermediates and inputs, that is, high-tech processes, which has increased labour productivity and consequently may have reduced the employment potential of output growth (Papola, 1991). The phenomenon of jobless growth of Indian industrial development can be attributed to the pattern of technological change rather than Labour market rigidities. The objective of this study is to provide alternative explanation of near stagnation of employment growth and unravelling the factors

that have led to the jobless growth of the organised manufacturing sector of the Indian economy. To accomplish the above said objective, we have followed technological capability impacted evolution of industrial structure approach and accordingly classified manufacturing industries into four groups. These are low technology, medium-low-technology, medium-high technology and high technology manufacturing industries.

Data Base and Methodology:

The purpose of this study is to analyze the long-term pattern of growth and structure of employment at disaggregative level of three-digit manufacturing industries. The study covers the period from 1980-81 to 2004-05, which is a quarter century time period and data was collected from Annual Survey of Industry (ASI) published by the Central Statistical Organisation. An attempt has been made to develop a consistent data set related to 44 three-digit industries (Names of industries and industrial codes are given in appendix I). While developing consistent data set one faces a problem of frequently changes introduced in the National Industrial Classification (NIC) used by the ASI. The NIC 1970 was remained in operation up to the year 1988-89, NIC 1987 up to the year 1997-98 and thereafter industries were classified on the basis of NIC 1998. Therefore, it is important to construct concordance of the changed NIC 1998 with the earlier two changes introduced in the classifications (NIC70 and NIC87) for developing a consistent data set. After constructing consistent data set for 44 three-digit industries, we have classified industries into four groups based on technological characteristics as low-tech, medium-low-tech, medium-high-tech and high-tech industry groups. The variables other than employment have been corrected with 1993-94 base year wholesale price indices and cost of living indices appropriate for each industry. The whole period from 1980-81 to 2004-05 has been divided into two sub periods, that is, pre-reform period from 1980-81 to 1991-92 and post-reform period from 1992-93 to 2004-05. To ascertain the long-term trends of the variables, we have estimated trend growth rates based on semi-logarithmic regression equation. The employment elasticity for each industry has been estimated on the basis of percentage change in employment growth for a percentage change in output growth. To estimate the major determinants of employment elasticity, a decomposition analysis, which allows us to compare the trade-off between employment growth and wage growth, has been done. The panel data regression models have been used to obtain the empirical evidence with regard the impact of technological capabilities on Indian industrial employment growth.

Changing Structure of Employment in India's Organised Manufacturing

Indian industrial development experience, during the import substitution regime, has undergone substantial structural transformation. During this period, the industrial sector accumulated technological capabilities nurtured and supported by the Indian government while investing in both research and development and tertiary education. While drawing benefits from the capabilities developed during the period of import substitution, the industrial structure has been substantially altered in favour of high tech industries. According to one estimate, the high-tech Indian industries generated more than 33 per cent of the value added as early as in the year 1980 (Amsden, 2004). This evidence of higher share in value added originated from high-tech industries has been provided India a unique place among the late industrialising countries who's manufacturing industrial sector is dominated by high-tech activities.

The relative shares of employment generation of India's organised manufacturing industries classified on the basis of technological categories are presented in Table 1. The analysis of the Table 1 revealed that the twelve low-tech industries in the year 1980-81 had been providing 53.66 per cent of employment of the organised manufacturing industries. Within the low-tech group of industries, there were a very high degree of concentration of employment and two industries (that is textiles and food products) predominantly provided large proportion (34 per cent) of employment. Thereafter diversification in low-tech industries in terms of employment generation has occurred during the fast pace of liberalisation. The overall shares of employment of the low-tech industrial sector have declined from 48.79 per cent in 1992-93 to 41.49 per cent in the year 2004-05. It is important to note here that during the period of analysis there was a sharp decline in terms of relative shares of employment provided by low-tech manufacturing industries of the order of more than 12 percentage points. The medium-tech manufacturing sector employment shares during the period under consideration have shown marginal improvement from 1980-81 to 1992-93, but declined in 2004-05. On the whole, the medium-tech industry continues to maintain its position so far as the shares of employment are concerned. The relative share of labour force employment in high-tech industries has also remained stagnant during the period of analysis. It is quite counter intuitive result in the sense that in the post-reform period, it is expected that the structure of manufacturing sector should have been driven by domestic and international demand for high-tech products. More so the growing importance of the operation of multinational corporations are expected to trade both domestically and internationally in high-tech products. The employment outcome of this process tends to show jobless growth of

this sector. However, the perusal of Table 1 reveals that medium-high-tech Indian manufacturing industries have substantially increased its relative shares of employment. It is significant to note that in the year 1980-81 the medium-high-tech industries have generated 25.98 per cent of the total industrial sector employment. But the relative share of employment increased to 27.16 per cent in 1992-93. In the post-reform period, there was a dramatic rise in the relative shares of employment of the medium-high-tech industries. The relative share of employment has improved to 36.34 per cent, which is more than 9 percentage points. If we combine medium-high-tech and high-tech group of Indian manufacturing industries, the relative share of employment turns out to be 34.38 per cent in the year 1980-81, which is quite close to the value addition done by these industries (Amsden, 2004). The combined share for the year 2004-05 comes out to be 44.68, which is more than 10 percentage points higher than the initial period. The rising relative importance of high-tech industries in terms of changing proportions of employment sufficiently provide support to the argument that the Indian manufacturing sector has been undergoing a dramatic structural transformation from low-tech manufacturing industries to medium-high-tech industries.

Employment Growth across Manufacturing Industries in the Pre- and Post-Reform Period:

The overall employment growth in organised manufacturing sector, both in the pre- and post-reform period, remained quite dismal. The trend growth rate of employment in the pre-reform period (1980-81 to 1991-92) was 0.40 per cent. However, it has marginally improved in the post-reform period (1992-93 to 2004-05) and was 0.63 per cent. The employment elasticity of the overall manufacturing sector also improved marginally. It was 0.06 in the pre-reform period and in the post-reform period it was 0.09 (Kannan and Raveendran, 2009). In sharp contrast to this, Goldar (2009) has shown that the estimated labour demand elasticity during the period 1970-71 to 1990-91 was 0.41, which was declined to 0.27 in the post-reform period (1991-92 to 2003-04). On the basis of labour demand elasticity estimates, the author has argued that despite dramatic reduction of the tariff rates and dismantling of quantitative restrictions in the post reform period, the employment demand elasticity results for the organised manufacturing industrial sector are counter intuitive. Therefore, it is instructive to analyse the pattern of growth of industrial employment across manufacturing industries for understanding the employment growth enhancing and employment destroying industries. The employment, value added, output and emoluments growth rates across four groups of industries based on technological categories over the period of quarter century are presented in Table 2.

The perusal of Table 2 brings out the fact that in the category of low-tech industries, majority of industries recorded negative trends of growth both in the pre- and post-reform period. This clearly shows that the employment growth creating industries were small in number compared with employment growth reducing industries. That is why the relative share of low-tech industries declined more sharply in the post-reform period compared with the pre-reform period. The value added and output growth rates remained not only positive but quite high in the low-tech industries except wood products and publishing. The high growth rates recorded in majority of low-tech industries provides evidence enough to argue that low-tech industries were partly responsible for jobless growth in the Indian organised manufacturing industries. The medium-low-tech industries have not only showed stagnation in the relative shares of employment but also have half the number of industries generated employment which resulting into positive growth rates and equal number of industries recorded negative employment growth rates. The medium-high-tech industries have recorded positive employment growth rates in as many as eight industries in the pre-reform period. However, the employment growth rates have been positive only in five industries in the post-reform period. The job creating industries in the category of medium-high-tech industries were outnumbered by the job destroying industries in the post-reform period. The output (that is, value added and output) growth rates in the medium-high-tech industries remained quite high compared with the employment growth. The growth rate of emoluments also has shown higher growth rates in the pre-reform period compared with the post-reform period. The deceleration in the growth of emoluments is quite obvious from the pattern of growth of emoluments in the post-reform period (Table 2). It is important to note that the high-tech industries have recorded positive employment growth rates in five out of the seven industries in the pre-reform period. Among the five high-tech employments creating industries, four industries recorded very high growth rates in the pre-reform period. However, in the post-reform period not only the number of employment creating industries declined but the growth rates of job creating industries also observed deceleration during the post-reform period (Table 2). The high-tech industries have also recorded higher growth rates of value added and output compared to the other industries. The high-tech industries were also high wage growth industries in the pre-reform period but deceleration in the growth of emoluments have clearly been occurred in the post-reform period.

Employment Elasticities across Indian Organised Manufacturing Industries:

The employment elasticity helps us in understanding the relationship between employment growth and expansion of output in the manufacturing sector. The low

employment elasticity with respect to output signifies that the economic development concentrates in a particular sector and higher growth of manufacturing sector can affect in a limited way the rest of the sectors of the economy (Mazumdar, 2003). On the other hand, higher employment elasticity can generate Hirschman type of linkages with rest of the economy that creates opportunities for economic transformation. The low elasticity of employment results into jobless growth especially after undertaking economic reforms raises serious question with regard to the sharing of benefits of rapid economic development. The enclave type development reduces opportunities for the labour force in the high wage sector of the economy and pushes the surplus labour force to find out jobs in low wage informal sector of the economy. This process not only generates income gaps but also perpetuate the prevailing disguised unemployment. The employment elasticities with respect to value added for the Indian manufacturing industries during the period 1980-81 to 2004-05 are presented in Table 3. During the period 1980-81 to 2004-05, there are four low-tech industries recorded negative employment elasticity. However, the majority of the low tech manufacturing industries showed positive but low degree of employment elasticity of output. The values of employment elasticity ranged between 0.01 and 0.53. This shows that capacity to create employment in the low-tech industries during the overall period of analysis remained quite low. When we divide the whole period into two-sub periods, that is, pre-reform and post-reform period, there were eight industries that have observed negative employment elasticities in the pre-reform period. But in the post reform period the low-tech manufacturing employment elasticities were recorded negative sign in as many as seven industries. This implies that the employment scenario remained quite grim so far as low-tech manufacturing industries were concerned. It is significant to mention here that there were at least two low-tech industries which were declining in the pre-reform period but the number of declining industries increased to three in the post-reform period.

The perusal of the elasticity of employment in medium-low-tech manufacturing industries presented in Table 3 shows that there were three declining industries during the overall period under consideration. However, the high negative employment elasticity was noticed in one industry. But the magnitude of positive employment elasticities was quite low during the overall period of analysis. A comparative analysis of pre- and post-reform employment elasticities of the medium-low-tech manufacturing industries clearly brings out the fact that there was a low magnitude of employment elasticities. However, the declining industries increased from two in the pre-reform period to three in the post-reform period. The low employment elasticities of the medium-low-tech manufacturing industries imply that the

share of employment has declined contrary to the widely held belief that low-tech industries are less capital intensive and more labour absorbing. It is significant to note that among the medium-high-tech manufacturing industries, the incidence of declining industries was very low. The elasticity of employment in some of the industries was very high in the overall period and also in the two sub-periods. There were wide variations in the employment elasticities in the medium-high-tech manufacturing industries in the pre and post-reform period. However, there was a rise in employment elasticity in the post-reform period in some industries compared with the pre-reform period. In the pre-reform period, the number of positive employment elasticities was much higher compared with the number of positive employment elasticities in the post-reform period. It is important to notice here that this group of industry has increased substantially the share of employment in the overall manufacturing sector of the Indian economy. But this group of industries contained both employment creating and employment destroying industries. The variations in estimated employment elasticities in the high-tech manufacturing were quite large (Table 3). The employment creating industries in the high-tech manufacturing sector was more in number compared with the labour displacing industries. This provided evidence in supports of the argument that employment share remained intact in the post-reform period in the high-tech manufacturing industries.

Determinants of Employment Elasticity across Manufacturing Industries in the Pre- and Post-Reform Period:

There is a considerable economic literature on the trade-off between wage growth and employment growth (Mazumdar, 2003). In this literature, it has been argued that expansion of employment is constrained by the expansion of output growth. This implies that when employment increases it has an adverse impact on growth of wages. On the other hand rise in wage rate dampen the possibilities of rise in employment. However, this relationship does not work independently from the impact of price rise on wage bill. It needs to pointed out here that the rise in wage bill do fall behind due to wage setting rigidities in the face of rise in prices. It is widely held view that wage setting usually lags far behind the inflationary pressures. The three factors that determine the value of employment elasticity at a given rate of growth of output are the rate of growth of emoluments relative to value of output in current prices, the relative rates of increase in the producer and consumer prices that actually determines the value of emoluments for the labour force and the trade-off between employment expansion and growth in real wages. The decomposition exercise, which

segregated the impact of output growth in real wage growth and employment growth along with price effect, has been done to ascertain the actual magnitude of the trade-off between wage growth and employment growth across Indian manufacturing industries and the results are presented in Table 4. The analysis of the employment elasticity determinants clearly brings out the fact that price effect is negative in majority of the industries across the board during the period 1980-81 to 2004-05. However, the intensity of the negative price effect varies widely across industries and seems to have wiped out moderate growth of output. It is important to note that during the pre-reform period the price effect was highly positive across the board except few industries signifies that the output growth was more favourably inclined towards real wage growth. Thus, given the output growth, the trade-off between real wage growth and employment expansion seems to have been working but varies substantially across industries. The low-tech industries have lost in terms of real wage growth. The medium-high-tech industries have gained in terms of expansion of employment during the pre-liberalisation period. The analysis of the decomposition exercise in the post-liberalisation period shows that there were wide variations of price effect across industries. The negative price effect was substantial in the case of low-tech industries. The medium-high-tech and high-tech industries recorded positive price effect except three industries in the medium-high-tech industries where price effect turn out to be negative (Table 4). The distribution of output growth among the medium-high-tech industries more favourably inclined towards real wage growth and employment effects largely turns out to be negative. However, the fall in the real wage growth in the medium-high-tech industries seems to have positive employment effects. This shows that there has occurred a trade-off between real wage growth and employment expansion. In the case of high-tech industries, the magnitude of the trade-off differs across industries. But the real wage growth has positive gains in majority of industries except two industries where real wage growth has actually declined. It needs to be mentioned here that the moderation of the trade-off between real wage growth and employment has been done by the other factors such as price effects. Thus, the decomposition procedure adopted has allowed us to quantify the relative importance of the factors determining the share of wages and price effects and enables us in understanding the labour market outcomes. There are other alternative factors in operation that has played significant role in deviating the interests of employment growth and real wage growth. Therefore, it is important to understand employment outcomes of the economic growth process beyond the inevitable trade-off between employment growth and wage growth explanation.

Industrial Technological Capability, Industrial Structure and Employment:

It is widely recognized fact that industrial development and technological capabilities are highly correlated. The evolution of industrial structure in the developed countries show that innovative capabilities have played an important role in stimulating change in the industrial structure. Employment outcomes of industrial development have remained highly dependent on the technological capabilities. It has been argued in the literature on economics of innovation that product innovation are employment creating, but the process innovations are employment destroying (Edquist, Hommen and McKeley, 2001). The net increase or decrease in employment outcomes of industrial development will largely be determined by the relative strength of the effects of product versus process innovations. It important to note here that the technological capabilities of most of the developing countries are either very weak or are related to adaptation of the innovations generated in the developed countries. Therefore, the technological capabilities of the developing countries are generally related to the process innovations and improvements in the technologies imported from the developed countries. Consequently, the employment implications of industrial development of the developing countries are quite dismal.

According to the UNCTAD innovation capability index, which consists of technological activity index and human capability index, India has been ranked among the low technological capability developing countries. In the year 1995, the ranking of India with regard to innovation capability index was 81 with the index score point 0.287. However, India's global position declined to 83 with score point 0.285 in the year 2001 (UNCTAD, 2005). It is pertinent to point out here that among the Indian industries only pharmaceutical and ICT industries have consider to be possessing substantial technological capabilities, but majority of industries are having weak technological capabilities and are highly dependent on technology imports (Ray, 2009). Therefore, the relationship between technological capabilities and employment growth of the industrial development is expected to be quite weak. The estimates of this relationship are presented in Table 5. The analysis of the Table 5 reveals that the coefficient of research and development expenditure turns out to be negative but non-significant during the period 1980-81 to 2004-05. However, the elasticity of technological capability with respect to employment was negative but statistically significant for both the pre and post-reform period. This implies that employment growth and technological capability measured in terms of research and development expenditure incurred during the period of liberalization. The output and employment elasticity has been positive and significant but the magnitude was quite low. However, the value of the magnitude has

declined substantially in the post-reform period and also turned insignificant. The relationship between employment and output turned out to be positive and significant during the period of analysis (Table 5).

To ascertain the relationship between the technological capability index and employment growth, we have estimated correlation across industries classified on the basis of technological characteristics and are presented in Table 6. The coefficient of correlation turn out to be positive in the case of low-technology industries. Since the employment growth rates and technological capability indices were negative in majority of cases, therefore, the positive correlation is just because of mathematical relationship. It is important to mention here that in majority of industries the technological capabilities has declined during the period of post-reform period and import content of technology has gone up dramatically. The correlation across three industrial categories, that is, medium-technology, medium-high-technology and high-technology industries, between employment growth rates and technological capability index turns out to be negative and magnitude of the correlations were very low. It needs to be noted here that Indian industrial technological capabilities remained quite weak therefore implications of this relationship for employment needs to be interpreted with some cautions. The South Korean industrial technological capability development experience is quite instructive. As the technological capabilities have increased at a faster rate during the period of eighties and nineties in the South Korean industrial sector (Lee, 2009), the employment growth slowed down in the eighties and turned negative in the nineties (Singh, 2004).

Concluding Remarks:

In this paper an attempt has been made to analyse the long-term trends of employment growth across Indian manufacturing industries classified on the basis of technological categories over the period of quarter century. The phenomenon of jobless growth of the organized manufacturing have put to test at disaggregative level and for this purpose a consistent data set for 44 three-digit industries based on Annual Survey of Industries have been constructed. The analysis of the changing structure of industrial employment brings out the fact that low-tech industries have shown signs of fatigue and majority of low-tech industries have lost their relative importance in the industrial economy of India. The changing pattern of employment structure have allowed us to identify the medium-high-tech industries, which have shown dynamism in terms of increasing their relative share in total employment of the organized manufacturing industries. However, the relative shares of employment in the medium-low-tech and high-tech industries have remained stable over the quarter century. The

pattern of employment growth has shown that some industries have generated employment and others have destroyed jobs and wide variations across industries and over time have been observed. The employment elasticities across technological groups of industries have also shown wide variations. The positive employment elasticities have shown ability of industries to create new jobs, but majority of industries have shown negative elasticities implies jobless growth. In the post-reform period estimates of employment elasticities across industries have shown rise in the number of industries recorded positive employment elasticities compared with pre-reform period. These results imply that the employment creating industries in the high-tech manufacturing sector was more in number compared with the labour displacing industries. The changing structure of employment elasticities underlined the importance of emerging dynamic high-tech industries in the Indian industrial sector. The labour market regulation view put forward by various scholars supporting the liberalisation policies could not stand the scrutiny of clear demarcation among job creating and job destroying industries under the same circumstances over the quarter century period examined here. The decomposition of the determinants of the employment elasticity procedure clearly brings out the fact that the labour market outcomes have shown the importance of the factors such as wage shares and price effects in leaning out the interests of employment growth and wage growth. The relationship between industrial technological capabilities and employment growth turns out to be ambiguous. This implies that weak technological capabilities adversely affect employment growth and heavy dependence on imported technological know-how from the developed countries is labour displacing. Therefore, it is suggested that developing countries should invest both in institutions and industrial firms to develop technological development that suits to resource endowment, specificities of local conditions and suitable to the stage of industrial development. There is a dire need to explore alternative paths of industrial and technological capability development to sustain economic transformation process for achieving prosperity and reducing the time for catch-up development.

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Table 1: Changing Structure of Employment across Indian Industries- 1980-81 to 2004-05

Industry code	LOW- TECHNOLOGY				MEDIUM- HIGH -TECHNOLOGY		
	1980-81	1992-93	2004-05		1980-81	1992-93	2004-05
151	3.12	1.96	1.79	241	1.17	2.91	2.10
152	0.49	0.88	0.87	252	1.41	1.21	1.97
153	2.27	3.71	3.49	311	2.00	2.25	2.51
154	10.94	9.14	6.86	261	0.92	0.75	0.54
155	3.12	1.96	1.79	290	2.43	3.13	2.10
160	5.12	6.40	4.94	271	7.02	6.35	4.13
171	23.09	19.84	17.87	319 to 323	2.03	1.61	4.70
201	0.37	0.28	0.11	292	2.60	2.54	5.81
202	1.33	0.55	0.41	293	1.07	0.67	0.27
210	1.67	2.02	1.86	313	0.47	0.52	4.92
221	2.00	1.97	1.18	314	0.26	0.19	4.13
361	0.13	0.09	0.32	315	1.33	0.66	0.83
	53.66	48.79	41.49	341	2.30	2.59	0.83
MEDIUM-LOW-TECHNOLOGY				333	0.17	0.28	0.11
182+191	0.45	0.80	0.55	359	0.80	1.50	1.37
192	1.38	0.89	1.03		25.98	27.16	36.34
251	1.65	1.36	1.20		HIGH-TECHNOLOGY		
231	0.67	0.49	0.33	223	2.03	1.34	0.02
269	4.00	5.29	4.92	232	2.05	0.39	0.50
272-273	0.65	2.19	1.89	233	0.52	0.00	
281	2.64	3.11	3.33	242	1.17	5.39	5.81
351	3.96	2.48	0.24	300	2.12	0.54	1.20
369	0.39	0.63	1.51	331	0.33	0.40	0.47
371+372	0.08	0.09	0.02	332	0.03	0.04	0.07
	15.86	17.33	15.03	243	0.15	0.36	0.27
					8.40	8.46	8.34

Source: Calculations are based on Annual Survey of Industry, Various Issues.

Table 2: Patterns of growth in employment, value added, output and emoluments across Indian industries.

Industry code	EMPLOYMENT GROWTH			VALUE ADDED			OUTPUT GROWTH			EMOLUMENTS		
	1980-2005	1980-1992	1992-2005	1980-2005	1980-1992	1992-2005	1980-2005	1980-1992	1992-2005	1980-2005	1980-1992	1992-2005
Low-technology												
151	-1.72	-4.58	-0.47	1.60	2.98	3.10	4.24	5.88	8.65	10.22	18.61	2.96
152	3.60	4.60	1.19	10.19	13.98	11.47	7.53	8.75	6.31	16.06	29.70	4.67
153	0.80	-4.14	1.43	6.41	8.14	7.80	5.86	8.46	10.59	15.04	24.92	5.96
154	0.49	-2.30	-0.43	6.74	12.78	1.05	6.75	10.73	3.15	13.67	27.42	2.59
155	3.66	3.55	4.21	6.91	8.69	3.31	7.80	8.24	7.15	16.16	28.31	8.48
160	1.47	1.40	-0.27	6.66	9.12	6.08	3.21	4.61	2.14	12.01	23.06	2.80
171 to 181	0.08	-1.43	-0.36	5.55	4.94	3.25	7.53	6.55	6.32	9.85	19.55	1.64
201	-6.95	-9.88	-7.19	-9.21	-2.49	-6.83	-4.26	-0.06	4.36	2.18	14.58	-5.24
202	-0.85	-5.02	-1.44	1.95	8.08	-1.15	3.56	7.66	4.93	12.51	22.15	2.82
210	1.63	0.66	0.77	4.94	6.00	2.81	5.40	6.64	4.78	12.63	22.46	3.80
221 to 222	-1.49	-1.03	-3.88	0.61	-0.47	-2.73	1.80	1.72	-0.70	10.53	21.26	0.32
361	5.50	-2.30	17.05	14.86	1.08	36.96	16.60	1.83	41.55	20.62	19.93	29.65
Medium-low-technology												
182 to 191	1.85	5.92	-2.81	5.45	11.80	-3.56	6.01	8.78	2.12	12.54	27.46	-0.15
192	-0.83	-3.87	2.79	-3.03	-9.67	3.04	-3.38	-10.38	5.33	4.36	9.45	5.21
251	-0.02	-1.76	-0.17	4.59	1.75	5.16	4.81	2.29	5.12	8.56	16.00	2.90
231	-3.48	-3.83	-3.43	0.39	-3.32	1.43	3.30	3.71	3.46	8.65	18.32	1.60
269	1.20	2.11	1.17	7.33	9.74	5.71	7.78	10.63	6.19	12.45	23.21	4.00
272 to 273	6.41	9.96	0.18	15.74	23.14	9.91	11.97	13.57	11.32	18.14	33.97	4.86
281 to 289	1.98	1.56	6.38	6.46	4.02	12.27	7.95	5.50	14.85	13.37	23.25	9.95
351	-11.04	-4.44	-22.03	-6.21	1.10	-16.00	-2.22	2.40	-11.40	-1.10	17.65	-19.47
369	3.56	6.95	-0.24	12.10	12.36	10.20	11.86	15.26	10.86	16.31	31.61	5.94
371 to 372	-6.77	-0.28	-17.60	-7.24	3.98	-20.72	-2.62	4.37	-15.12	0.74	19.56	-17.69
Medium-high-technology												
241	5.37	8.32	-1.12	15.97	23.79	2.49	16.21	24.22	6.40	20.14	36.06	3.13
252	0.03	-2.35	2.06	6.50	-1.86	12.81	7.16	3.56	9.75	8.52	10.43	9.02
311+312	-0.47	1.54	-2.95	5.05	7.55	1.57	6.92	7.73	5.52	10.14	25.21	-2.04
261	-0.95	-1.44	-1.33	6.65	8.59	6.99	7.50	9.11	7.53	12.09	23.68	4.06
290	0.31	1.60	-2.44	6.28	5.44	6.79	7.32	7.21	9.40	11.97	24.09	2.85
271	-1.88	-2.13	-2.63	5.95	-0.60	8.44	6.21	4.42	8.56	10.51	18.36	2.80
319 to 323	9.79	9.14	3.66	16.08	24.26	6.64	20.65	30.06	12.13	22.64	41.49	7.78
292	0.87	-0.91	3.53	7.97	4.60	12.38	8.76	5.92	12.95	13.18	21.24	8.39
293	-4.86	-2.27	-6.65	0.37	7.13	-1.93	2.43	6.58	2.02	5.38	19.81	-2.06
313	3.01	0.75	7.41	5.95	6.11	2.75	7.12	5.99	9.55	12.87	22.43	8.44
314	3.60	-1.52	13.23	9.69	4.10	19.56	8.93	4.61	21.18	14.57	19.55	16.86
315	-6.83	-6.49	-5.83	-1.44	0.23	4.59	-1.07	0.00	4.92	2.73	11.53	-0.51
341	-4.05	0.57	-11.63	4.53	6.45	0.52	8.72	7.79	8.34	9.29	23.81	-3.33
333	0.26	4.67	-5.65	2.98	8.29	-0.70	4.75	12.15	0.04	12.77	28.84	-0.26
359	3.56	6.95	-0.24	12.10	12.36	10.20	11.86	15.26	10.86	16.31	31.61	5.94
High-technology												
223	-11.62	6.89	-36.61	-7.86	22.87	-37.43	-3.77	28.44	-32.84	-1.02	39.00	-33.85
232	-6.53	-14.74	3.51	11.03	9.18	13.12	13.24	12.87	17.03	10.40	12.45	11.12
242	9.47	14.12	1.93	13.09	29.70	5.73	5.44	12.89	5.74	21.34	41.08	4.50
300	-1.73	-2.78	-4.34	6.94	10.33	2.85	10.21	19.46	2.18	10.61	23.10	4.20
331	2.96	1.13	3.11	10.41	7.81	11.45	11.74	8.17	13.65	15.89	22.42	9.43
332	5.73	3.97	3.93	12.42	2.09	13.47	12.68	5.41	6.83	18.81	26.27	8.21
243	3.70	5.07	-2.15				7.70	8.67	-0.36	18.01	37.07	-0.04

Table 3: Employment Elasticity across Organized Manufacturing Industry Groups

Industry code	1980-2005	1980-1992	1992-2005	Industry code	1980-2005	1980-1992	1992-2005
LOW- TECHNOLOGY				MEDIUM- HIGH -TECHNOLOGY			
151	-1.07	-1.54	-0.15	241	0.34	0.35	-0.45
152	0.35	0.33	0.10	252	0.00	1.26*	0.16
153	0.13	-0.51	0.18	311+312	-0.09	0.20	-1.88
154	0.07	-0.18	-0.41	261	-0.14	-0.17	-0.19
155	0.53	0.41	1.27	290	0.05	0.29	-0.36
160	0.22	0.15	-0.04	271	-0.32	3.54*	-0.31
171 to 181	0.01	-0.29	-0.11	319 to 323	0.61	0.38	0.55
201	0.75*	3.97*	1.05*	292	0.11	-0.20	0.29
202	-0.44	-0.62	1.26*	293	-13.03	-0.32	3.45*
210	0.33	0.11	0.27	313	0.51	0.12	2.70
221 to 222	-2.43	2.22*	1.42*	314	0.37	-0.37	0.68
361	0.37	-2.12	0.46	315	4.76*	-27.96	-1.27
MEDIUM-LOW-TECHNOLOGY				341	-0.89	0.09	-22.39
	1980-2005	1980-1992	1992-2005	333	0.09	0.56	8.11*
182 to 191	0.34	0.50	0.79*	359	0.29	0.56	-0.02
192	0.27*	0.40*	0.92	HIGH-TECHNOLOGY			
251	0.00	-1.01	-0.03	223	1.48*	0.30	0.98*
231	-8.90	1.15*	-2.40	232	-0.59	-1.61	0.27
269	0.16	0.22	0.21	233	-	-	-
272 to 273	0.41	0.43	0.02	242	0.72	0.48	0.34
281 to 289	0.31	0.39	0.52	300	-0.25	-0.27	-1.52
351	1.78*	-4.04	1.38*	331	0.28	0.14	0.27
369	0.29	0.56	-0.02	332	0.46	1.89	0.29
371 to 372	0.93*	-0.07	0.85*	243	0.00	0.16	0.03

Note: * Represents the negative growth of employment and value added turns out to be positive elasticity signifies declining industry.

Table 4: Decomposition of Effects on the Growth of Real Wages 1980-81 to 2004-05

Industry code	1980-81 to 2004-05				1980-81 to 1991-92				1992-93 to 2004-05			
	Real wage growth	Output effect	Employment effect	Price effect	Real wage growth	Output effect	Employment effect	Price effect	Real wage growth	Output effect	Employment effect	Price effect
Low-Technology												
151	-1.00	-0.01	0.74	-3.63	2.54	-0.43	-1.18	12.60	-0.16	0.06	0.11	1.14
152	-0.96	-0.20	-0.60	-3.13	2.59	0.26	-1.06	10.45	-0.23	-0.21	-1.58	-1.49
153	3.29	0.02	1.42	-2.20	2.92	0.05	6.86	15.22	0.56	-0.30	-0.77	0.23
154	-2.15	-23.02	0.72	27.12	-2.20	-0.22	4.82	12.06	-0.19	-22.53	-1.09	27.01
155	-0.92	0.02	0.28	-3.80	1.51	-0.20	0.78	14.23	-0.01	0.24	0.51	-3.06
160	-0.69	-0.08	-0.04	11.31	0.67	0.07	2.07	29.62	0.19	-0.12	-0.56	15.09
171 to 181	-0.70	0.01	0.39	-5.26	2.23	0.62	0.70	4.51	0.40	-0.22	-0.41	4.48
201	-2.25	0.09	2.52	-5.66	-10.95	0.10	1.78	-3.21	0.03	-0.89	1.47	1.99
202	-1.99	0.08	2.83	-2.77	-3.44	0.16	1.28	11.66	0.02	0.99	-1.86	-0.44
210	-0.55	-0.10	-0.09	11.13	3.57	-0.33	0.24	14.14	0.31	0.04	-0.83	22.84
221 to 222	-0.56	0.01	-0.52	11.32	2.64	-0.37	-0.84	15.50	0.04	-0.66	-0.75	16.14
361	-0.38	0.12	1.86	-3.39	1.47	0.28	1.64	10.10	0.30	-0.18	2.26	7.19
Medium-Low-Technology												
182 to 191	-0.42	-0.07	-0.92	-3.69	4.55	0.30	1.14	9.29	0.17	-0.28	-0.10	0.67
192	-0.20	-0.10	1.03	-1.07	-3.51	-0.63	-5.55	15.27	0.99	0.39	-0.10	-6.61
251	-0.59	0.11	0.29	-2.58	-1.50	0.02	-0.65	9.11	0.01	-0.16	-1.47	3.33
231	-0.74	-0.20	0.65	1.53	3.52	-0.35	-6.32	15.13	-1.20	-0.22	0.80	5.48
269	-0.57	0.00	-0.37	-3.58	3.34	-0.01	-1.21	12.54	-1.12	-0.04	0.17	-0.61
272TO273	5.24	-0.13	4.01	-2.60	21.90	0.22	16.78	14.12	0.67	0.06	-0.01	4.78
281TO289	-0.57	-0.23	0.05	-0.74	1.69	1.48	0.90	17.07	-0.71	1.28	26.24	2.30
351	-1.01	0.05	-5.67	-4.47	0.12	6.59	2.01	13.13	0.12	0.32	-0.18	-3.60
369	-0.21	0.11	0.83	-4.26	2.47	0.25	2.71	9.81	0.39	-0.14	-0.08	2.89
371TO372	-1.29	-0.60	-17.07	-1.09	0.35	-0.38	-0.91	14.55	0.35	-0.04	-13.48	6.32
Medium-High-Technology												
241	-0.31	-0.02	-0.96	-4.99	6.27	0.36	3.36	15.95	0.42	-0.04	-2.50	-1.32
252	-28.46	0.12	-20.69	-2.84	-4.76	-0.70	-4.24	12.08	-52.98	-0.13	-33.05	2.82
311+312	-3.24	0.04	-0.86	-6.49	1.60	0.31	2.35	1.61	-7.06	-0.08	1.52	2.23
261	-1.23	-0.22	0.40	2.31	0.23	-0.70	3.62	36.09	-0.23	0.03	1.66	1.27
290	-0.27	0.02	-1.64	-2.32	1.71	-0.22	-1.46	12.03	2.51	0.11	-2.13	1.57
271	-0.51	-0.09	-0.11	-2.27	-1.57	-0.68	-3.12	15.31	-2.59	-0.30	-0.64	1.41
319TO323	-3.62	0.17	17.17	-5.13	-9.99	0.87	11.03	8.92	-3.05	0.17	4.23	0.95
292	-1.06	0.19	1.46	-2.19	2.36	-0.04	-0.20	12.17	-1.71	0.47	4.87	2.19
293	0.20	-0.03	-0.90	-2.88	2.40	-0.26	-5.36	12.28	4.37	0.32	-1.61	-0.45
313	-2.37	0.52	1.64	-4.79	1.65	-0.03	0.32	12.31	-4.97	1.89	5.27	-6.65
314	-0.34	0.62	2.91	-2.68	-0.15	-0.40	1.01	17.59	1.71	1.95	7.04	1.74
315	0.59	0.42	0.99	-3.08	0.90	-0.83	-11.92	12.77	3.57	1.89	4.14	1.69
341	-0.35	-0.36	-2.54	-2.69	1.76	-0.42	-0.66	11.45	0.84	0.00	-0.65	1.06
333	-1.37	-0.07	-1.88	-3.37	1.13	0.12	1.12	10.94	-2.92	-0.70	-2.90	1.55
359	-0.30	0.12	-1.35	-2.61	2.69	-1.16	-0.68	20.55	1.41	0.05	-1.84	0.58
High-Technology												
223	-2.95	-0.46	-63.15	-4.15	-9.71	0.77	108.77	8.94	0.19	-0.41	-10.16	1.44
232	-0.89	0.05	4.27	4.29	5.87	4.10	-29.31	43.92	0.47	-0.11	-1.54	0.87
233												
242	-0.74	-0.19	-0.72	-2.25	1.51	0.03	3.68	7.12	0.72	0.03	-0.78	1.85
300	-3.71	0.20	10.72	-3.41	-9.83	0.01	65.57	10.47	-2.86	0.43	8.74	3.21
331	-0.05	0.05	-0.01	-2.52	3.60	-0.06	-1.70	12.85	-0.34	-0.37	-2.20	2.88
332	0.02	-0.22	-0.29	2.20	9.29	0.16	3.17	30.15	1.26	-0.06	-0.26	1.69
243	-0.84	-0.25	-1.42	-2.79	7.18	0.53	-0.66	13.98	0.88	-0.47	-2.09	3.28

Table 5: Estimated Fixed Effects Models (Dependent Variable is log of Employment)

Name of the Variables	1980-81 to 2004-05	1980-81 to 1991-92	1992-93 to 2004-05
R&D Expenditure	-0.019 (0.651)	-0.240* (-3.60)	-0.180* (-3.64)
Value added	0.014* (3.25)	0.062*** (1.35)	0.0005 (-0.004)
Wages	0.068** (1.49)	0.263* (4.212)	0.619* (2.804)
AIC	-2.675	-3.165	-3.330
Adjusted R square	0.961	0.982	0.976
Autocorrelation	0.000	0.000	0.000

Note: * Represents statistically significant at 1 per cent level; ** Represents statistically significant at 15 per cent level and *** statistically significant at 20 per cent level.

Table 6: Correlation Coefficients between Growth rates of Technology Capability Index and Employment (1992-93 to 2004-05).

Name of Industrial Groups	Correlation Coefficient
Low-Technology Industries	0.21
Medium-Technology Industries	-0.35
Medium-High Technology Industries	-0.40
High-Technology Industries	-0.29
All Industries	-0.21

Appendix I: Names of Industries Classified on the Basis of Technology Characteristics and Industrial Codes.

LOW- TECHNOLOGY	INDUSTRY CODE	MEDIUM- HIGH -TECHNOLOGY	INDUSTRY CODE
Production, processing and preservation of meat, fish, fruit vegetables, oil & fats	151	Manufacture of basic chemicals, fertilizers and nitrogen compounds	241
Manufacture of dairy product	152	Manufacture of plastic products	252
Manufacture of grain mill products, etc. and animal feeds	153	Manufacture of electric motors, generators, transformers and control apparatus	311+312
Manufacture of other food products	154	Manufacture of glass and glass products	261
Manufacture of beverages	155	Machinery	290
Manufacture of tobacco products	160	Metal	271
Spinning, weaving and finishing of textile+other textiles+knitted and crocheted fabrics and articles, Wearing Apparel, except fur apparel and tailoring	171 To 181	TV, Radio and Video	319TO323
Saw milling and planning of wood	201	Special purpose machinery	292
Manufacture of products of wood, cork, straw and plaiting materials	202	Domestic appliances	293
Manufacture of paper and paper products	210	Insulated wire and cables	313
Publishing and printing and service activities related to printing	221 To 222	Manufacture of accumulator, primary cells and battery	314
Manufacture of furniture	361	Manufacture of electrical lamps and lighting equipment	315
MEDIUM-LOW-TECHNOLOGY	INDUSTRY CODE	Manufacture of motor vehicles	341
Dressing and dyeing of fur; manufacture of articles of fur, tanning and dressing of leather, manufacture of luggage handbags, saddlery& harness	182 To 191	Manufacture of watches and clocks	333
Manufacture of footwear	192	Manufacture of transport equipment n.e.c.	359
Manufacture rubber products	251	HIGH-TECHNOLOGY	INDUSTRY CODE
Manufacture of coke oven products	231	Reproduction of recorded media	223
Manufacture of non-metallic mineral products n.e.c.	269	Manufacture of refined petroleum products	232
Manufacture of basic precious and non ferrous metals and casting of metals	272 To 273	Manufacture of pesticides, paints, varnishes and similar coating and pharmaceuticals and other chemicals	242
Manufacture of structural metal products, tanks, reservoirs and steam generators	281To 289	Manufacture of office, accounting and computing machinery	300
Building and repairing of Ships, Rails	351	Manufacture of medical instruments	331
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Recycling of metal waste and scrap and recycling of non-metal waste and scrap	371 To 372	Manufacture of man-made fibers	243