World Economics Association
(WEA)

Conferences

Inequalities in Asia:
The interaction with growth, structural change, economic openness and social and political structures

Conference n. 3, 2013: 12th May- 8th June

Title of paper

Impact of Technology on Wage Inequality

Evidence from Indian Manufacturing under Globalisation

Abstract

The policy reforms in India initiated in the early 1990s have brought phenomenal changes in the economy's growth and development process. The economy during this period has experienced high growth rates on the one hand and increased inequalities on the other hand. A prominent strand of literature argues that income inequalities are aggravated due to an increase in the earning opportunities of skilled workers over unskilled workers due to increased technology. Hence, the present paper is an attempt to examine the impact of various components of technology accessed through external as well as internal sources on changing wage structure in the era of globalization. The present study has been carried out using two data sources ASI and CMIE prowess during 1992-93 to 2005-06. From an analysis of the trends and patterns of employment and wages, it is observed that the wage share of skilled workers has been increasing during liberalisation period across all the manufacturing industries. Hence, to examine the wage inequality empirically, an econometric analysis of panel data has been carried out using a cost function framework. The results showed that technology intensity in general has a positive and significant effect on wage inequality in total manufacturing, high-tech and medium-tech industries. Further, it is found that while domestic technology elements have a positive effect on wage inequality in total manufacturing and high-tech industries; imported technology is significant in low-tech industries. While imported capital goods are significantly affecting the demand for skilled workers in low tech industries, domestic capital goods are contributing for the rise in skill demand in total manufacturing and high-tech industries. Thus, the study infers that domestic technology in general has been biased towards skilled workers there by contributing to increase in their wages.

Key words: Wage Inequality, Technology

Author's name

Kiran Kumar Kakarlapudi
PhD Scholar
Centre for Development Studies

Prasanth Nagar, Ullor,
Trivandrum, Kerala
India-695011
Email: kiran20uohyd@gmail.com
Mobile: +919037172425

1. Introduction

India has entered the phase of globalisation in the early 1990s with a policy shift towards free market economy. Since the liberalisation, the economy has undergone phenomenal changes in its growth and development process. It has grown at over 6 per cent per annum during 1990-91 to 2004-05 (Agarwal, 2008). On the other hand, the evidences show that, during the period of rapid economic growth, the inequalities have been widening, posing major challenge to inclusive growth (Deaton and Dreze, 2003; Sen and Himanshu, 2005; Sundaram and Tendulkar, 2003). One strand of literature has observed that, there has been persistent rise in wage inequalities between skilled and unskilled workers in the manufacturing sector particularly after liberalisation (Berman et al. 2005; Ramaswamy, 2008 and Abraham, 2009). The phenomenon of increasing wage inequalities in the light of globalisation contradicts with the conventional neo-clssical trade theories of Hecksher-Ohlin. Nonetheless, the recent trade theories argue that, trade liberalisation leads to improved access to technology from developed countries, which leads to technology transfer from developed countries to the developing countries (Robbins, 1995, 1996; Mayer, 2000). The other strand of theretical literature argues that globalisation gives rise to increased international competition. Therefore, firms adopt technological innovation is key strategy in order to withstand the rising competition (Lall, 2001; Thoenig and Verdier, 2003). The studies which have have argued that increased technology at the work places in the light of globalisation has led to increased demand for skilled workers over unskilled workers, leading to increased wages of the former over the unskilled workers (Gorg and Strobl, 2002; Pavcnik, 2003; Meschi and Vivarelli, 2008). In this context, this paper tries to analyse the impact of technological change on increasing wage inequality in the era of globalisation.

The paper is organised in six sections. The second section provides a breif overview of literature on technological change and its impact on wage inequality and provides a frame work for analysing technology. Section 3 discusses data used and method of aggregation. Following data, section four provides the trends and patterns of employment, wages and technology. Section 5 elaborates on econometric model, wherein hypothesis and variable construction followed by methodology for estimation and results have been discussed. The last section provides concluding remarks.

2. Engagement with Theory and Empirics

The effects of technical change on labour market in general and employment and wage in particular have fascinated scholars and alarmed the general public down through the ages. However, the issue has not received scholarly attention until 1980s where studies found the widening wage inequalities between skilled and unskilled workers (Bound and Johnson, 1992). It was then the effect of technological change on the welfare of workers received academic attention. This section provides a brief review of studies on this issue

Increased Technology: Theory and Evidence

It was Griliches (1969), who formulated the hypothesis of capital-skill complementarity and proved that capital demands more of skilled workers than unskilled workers. The hypothesis was further supported and a group of scholars argued that it is due to recent changes in technology due to the introduction of information technology, particularly usage of computers at workplace, which is biased towards skill workers has led to increasing demand for skilled workers, in turn led to wage inequality (Bound and Johnson 1992; Katz and Murphy 1992; Berman, Bound, and Griliches 1994). A study by Goldin and Katz (1998) shows that the technology skill complementarity is not a recent phenomenon and existed in the manufacturing from early 1900's. In the similar framework, a wealth of quantitative and case evidences documents a definite relation between computer related technologies and the use of skilled labour within detailed industries, within firms and across plants within industries. Among all, Autor, Levy, and Murnane (2003) have developed an economic model to show how demand for workplace tasks responds to an economy wide decline in the price of computer capital. They show that there has been increasing demand for skilled workers since the beginning of 1970's and the increase seems to be high where there is rapid computerization in the industry and concludes that the change in technology seems to be the underlying factor contributing recent demand shifts towards more skilled and educated labour. While number of studies empirically examined using econometric tools and found that relative utilization of more-skilled workers is positively correlated with capital intensity and the implementation of new technologies (see Doms, Levy and Murnane 1996). Autor, Katz, and Krueger (1998), investigated skill biased technological change using a framework that incorporates both relative demand and relative supply of skills. They found that computers at workplace play a significant role in stimulating demand for skilled workers and concluded that SBTC is basic underlying factor. While much of the studies have reached a general consensus that change in skill and wage structure in the United States stems from impact of new technology, Machin and Van Reenen (1998) and Berman, Bound, and Machin (1998) have tried to examine whether the changes in wage structure is similar to that of US in other developing world. While, the former examines the skill wage structure in OECD countries and compared with US economy using R&D intensity as direct observed change as technological change, the latter has examined the same in ten developed countries. The analysis shows that, there have been shifts in relative demand that have favored skilled workers in all the seven countries. As in the United States, most of this shift has occurred within, rather than between industries and also skilled labour is complemented with new technologies in all seven countries.

Trade Induced Technology Transfer: Theory and Evidence

In the light of globalisation, where all the economies are integrated, results in increased competition which leads firms to engage in more technology intensive production (Thoenig and Verdier, 2003) and developing countries would depend on technology imports from developed countries. Hence, globalisation leads to technology transfer from developed countries to developing countries (Coe and Helpman (1995). Accelerated transfer of production technology to developing countries becomes crucial as the technology in developed countries is proven to be skill-biased (Katz and Autor, 2000). In this context, Berman and Machin (2000 and 2004) studied the role of SBTC in increasing the demand for skills, trying to determine to what extent SBTC moves across international borders, thereby altering the skill structure of labour markets. They analysed the changes in the non-production wage-bill share in 37 countries for the 1970-80 and 1980-90 time periods and found that in the 1970s high-income countries experienced a great increase in skilled wages in their total manufacturing wage bill (most of which was due to within-industry skill upgrading). In the 1980s the skilled wage bill share increased in middle-income countries as well, to a similar extent as in high-income countries. They then showed that the US industry pattern of skill upgrading during the 1970s was a good predictor of industry skill upgrading in middle income countries in the 1980s, suggesting that the same industries had increased their proportion of skilled workers. Moreover, it appeared that the patterns in middle-income countries were due to the adoption of the same kinds of skill-biased technologies that had permeated into industries in the developed. Thus, their results suggested that SBTC had been transferred rapidly from the developed world to middle income countries and emphasised the pervasive nature of SBTC.

In contrast with the standard models, he shows that trade opening would lead to induced technological change in developing countries and may affect the wage structure. Mayer (2000) empirically shows that globalisation has led to increased access to technology in developing countries, hence technology imports in developing has witnessed a rapid increased which in turn increased demand for skilled workers. Similarly, Pavcnik (2003), probes into sources of wage inequality in Chile by examining the impact of skill biased technology. In the light of liberalisation, there has been substantial rise in imports of technology such as import of capital goods, patented technology and he attributes that increasing wage inequality is result of increasing technology imports. Hanson and Harrison (1999), using data on Mexican manufacturing plants, found that firms that receive FDI, acquire technology through licensing agreements or import materials, tend to hire more skilled workers. However, they found insignificant relationships for other measures of technological change. A similar result was obtained by Feenstra and Hanson (1997) studied the increasing wage inequality using 3-digit data in Mexican industries for the period 1975 to 1988. Gorg and Strobl's paper (2002) is the only work in this field focusing on a low-income country. They analysed a panel of manufacturing firms in Ghana over the 1990s in order to determine whether imports of technology-intensive capital goods or export activities might provide an explanation for the increase in the relative wages of skilled workers in Ghana. Their results suggested that while the purchase of foreign machinery for technological purposes had significantly raised the relative demand for skilled labour, a greater participation in the world output market via exporting activities did not play a direct role in the skill composition of manufacturing firms in Ghana. Meschi et al. (2008) presented the relationship between trade openness, technology adoption and relative demand for skilled labour in the Turkish manufacturing sector using firm level data. The results suggests that both trade openness and technology variables such as R&D and also the technology imports found to be significant with skilled wages. Araújo et al. (2009) observed the role of trade liberalisation on skill enhancement in Brazilian manufacturing using micro data on firms. The focus was to see how have trade liberalisation led to technology transfer and its impact on the changing employment composition. Then they show that the increase in the relative demand for skilled labour was mainly driven by the within-industry variation, supporting factor bias, while domestic capital is a complement is a complement of the skilled workers, imported component clearly act as a skill enhancing component of trade.

Indian Context

In the recent past, there have been studies which argued that the wage inequality between skilled and unskilled workers has been widening in Indian manufacturing since liberalisation (Banga, 2005; Berman et al. 2005; Ramaswamy, 2008; Abraham, 2009). Nonetheless, Berman et al. (2005) and Ramaswamy (2008), using capital intensity as a measure of technology, argue that changing wage structure in favour of skilled workers over unskilled workers is due to the increased technological access during liberalisation period. This argument does not seem to be convincing to scholars as the nature of production and development of technology is complex. Moreover, technology is used in various forms (embodied and disembodied) in the production process which is acquired both from internal and external sources. Hence, using the 'black box' measure of capital intensity as an indicator of technology, which is much complex in nature, does not hold strong. Therefore the study tries to give a comprehensive picture of various elements of technology which can affect wages.

A Framework for Analyzing Technology

From the various strands of literature on the issue of changing wage structure, it can be inferred that technology either imported or domestically produced is the main contributing factor. Studies examined the issue in various developing countries (see for instance, Hanson and Harrison, 1999; Pavcnik, 2003; Meschi et al. 2008) argued that imported technology is the significant factor, others argued that technological change in the form R&D significantly related to changing wage structure (see Doms et al. 1994; Machin and Van Reenen, 1998; Adams, 1999; among others). However in order to examine the effect of technology, a broader understanding on the ways in which technology is produced and developed is essential. Therefore, a framework is developed to understand the modes in which a firm can acquire technology in order to analyse the impact of various elements of technology on changing wage structure.

Figure 1 Modes of Technology Acquisition

Source: Own Compilation

To elaborate on the modes of technology acquisition, two main ways can be specified they are *In-house development of technology* and *purchase of technology*. In-house development means R&D for new product and process development, reverse engineering or absorbing and assimilating imported foreign technologies. Purchase of technology could be from domestic sources and foreign sources. Purchasing of technology from other countries is considered as technology imports. Further, purchase can be of two types one is purchase of embodied technology through investment in acquiring new vintages of machinery and equipments. The assumption here is that novel ideas are embedded in these new capital goods. Depending upon the source of location, the embodied mode can be further divided into procuring capital goods domestically or importing from overseas. Second is technology in disembodied form, which includes investment in acquiring technology in the form of licenses, patents, knowhow, trademarks, designs, etc. This can be accessed either through collaboration with foreign firms, what is known as import of disembodied technology, or by purchasing from other domestic firms, which is called as domestic disembodied technology.

3. Data and Methods

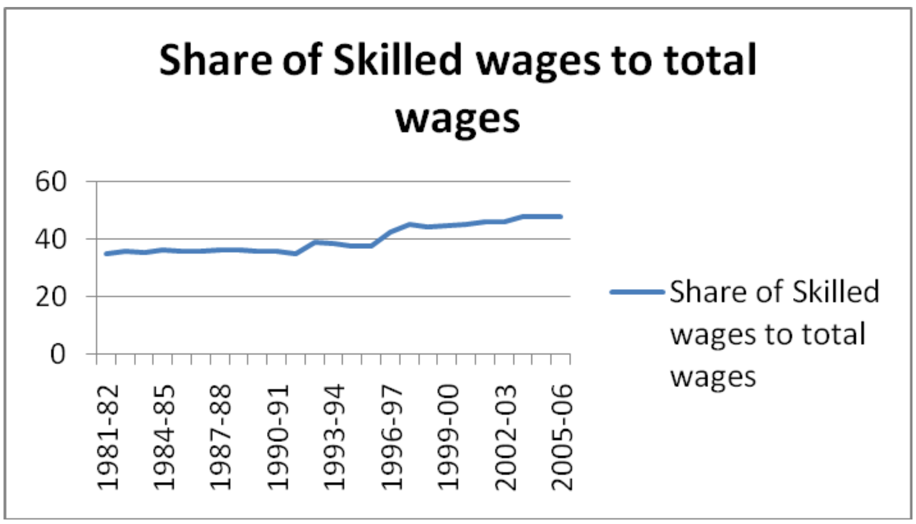
As there is no single data source to analyse the issue. Hence, this study draws data from two main data sources, Annual survey of Industries (ASI) and data published by the Centre for Monitoring Indian Economy (PROWESS). ASI is the principal principle source of industrial statistics in India conducted every year (since 1959) by the National Sample Survey Organization (NSSO) and processed by the Central Statistical Organization (CSO), publishes data for all important characteristics of manufacturing sector at till five level of National Industrial Classification (NIC). Whereas, PROWESS provides data on firms which, are listed in BSE. The period of study for our analysis is 1992-93 to 2005-06. For this analysis, we have taken data on employment skilled workers, unskilled workers and contract workers and wages of skilled and unskilled workers are taken from ASI. Other technology variables which, includes both domestic and foreign technology such as Gross Fixed Assets, R&D expenditure, Import of capital goods, expenditure on purchases of foreign technology (import of disembodied technology) and sales (which is proxy for value of output) are drawn from PROWESS.

It is to be noted that, all ASI frame industries are classified in their appropriate National Industrial Classification (NIC) groups on the basis of the principle product manufactured, which follows the and NIC classification is subject to changes over a period of time, the latest NIC is classification is NIC 2004. Since our time period falls under different NIC classifications (followed NIC 1987 till the year 1997 and NIC 1998 from 1998 to 2003 and NIC 2004 afterwards), we have done a concordance between NIC 1987 and NIC 1998 for the years between 1992-93 to 1997-98 and used NIC 1998 for the analysis. On the other hand, the firm level data from CMIE is aggregated to three digit level and concorded with NIC 1998. Since data is provided in nominal values, we have obtained Wholesale Price Index (WPI) data on manufacturing products from Reserve Bank of India and eaindustry and matched with three digit industries (NIC 1998) and deflated the values to the 1993-94 constant prices. To deflate, fixed capital and Import of capital goods, the WPI of plant and machinery which, is an indicator of capital being used. The nominal wages reported in the ASI is deflated using the Consumer Price Index for Industrial Workers at 1993-94 constant prices provided by RBI for the respective years to arrive at real wages.

4. Employment, Wages and Changes in Technology: Trends and Patterns

The figure 1 shows the share of wages of non-production workers (skilled workers) to total wages. From the figure it is clear that the wage share of skilled workers had more or less remained stagnant during the pre liberalisation period at 35.17 percent to 35.92 percent despite. Interestingly, the share of skilled wages to total wages increased significantly during post liberalisation period. From 35.92 per cent to 42.77 per cent during 1990-91 to 1996-97 and it further inccreased from 42.77 to 48.88 during 1996-97 to 2005-06.

Figure 1 Share of Wages of Non-production Workers to Total Wages



Source: Own calculation from ASI, Various years

As it is observed from the trends, the share of skilled worker wages in total wages are increasing during post reform period, it becomes interesting to examine whether similar trends of manufacturing are followed at the industrial level as well. Hence, it is worth examining the trends and patterns of employment and wage composition at 2 digit industries and identify the industries which had undergone drastic changes interms of employment and wage composition.

Table 1 Industry wise Trends in Share of Skilled Employment and Wages

	Share of Skilled Employment			Share of Skilled Wages		
Industry	**1992-93**	**1997-98**	**2002-03**	**1992-93**	**1997-98**	**2002-03**
Food	23.28	21.01	21.95	36.31	38.90	40.92
Tobacco	2.22	4.23	4.71	9.27	14.54	17.60
Textile	12.40	14.85	14.54	19.09	24.13	26.98
Garment	9.97	14.93	14.46	21.00	31.62	31.87
Leather	17.27	17.90	17.88	28.90	31.87	35.00
Wood	14.43	19.22	20.53	24.73	30.34	37.09
Paper	21.96	22.63	21.27	32.97	33.91	39.07
Printing	25.94	29.95	35.41	34.14	41.84	58.05
Petroleum	28.90	27.66	25.50	35.94	38.65	44.14
Chemical	29.25	30.30	31.83	43.20	47.74	55.52
Rubber	24.39	26.15	24.00	35.49	40.78	43.43
Non- Metallic	23.07	20.37	14.43	35.30	37.85	35.50
Metals	24.95	24.63	24.77	33.32	35.87	39.89
Metal Pro	30.61	28.16	24.91	42.27	44.24	43.43
Machinery	27.64	29.70	33.13	37.39	41.63	52.26
Computing	37.23	40.03	45.02	51.19	66.23	76.64
Electrical Machinery	35.91	34.01	30.24	44.26	48.39	50.43
Radio, TV	41.71	36.76	35.83	49.46	53.96	61.99
Medical instruments	27.50	31.00	35.40	37.08	46.91	60.58
Motor vehicle	30.89	28.80	25.71	39.50	40.49	45.77
Transport	28.27	24.51	23.17	37.09	38.89	43.58
Furniture	22.27	22.67	22.63	27.78	32.13	37.64
Total	21.39	22.23	21.66	34.16	38.48	43.29

Source: Own calculation from ASI, Various years

In order to check for inter industry changes in the shares of employment and wages of skilled workers, we have taken three time points at five year lag (1992-93, 1997-98 and 2002-03) during the liberalisation period. From the Table 1 it can be understood that most of the industries followed the overall manufacturing trend i.e. decreasing share of skilled employment during the liberalisation period and increasing share of skilled wages in total wages. As we have seen earlier, there is a significant rise in the share of wages of skilled workers from 34.16 percent in 1992-93 to 43.29 percent in 2002-03 in total manufacturing industries. This trend is uniform across all industries. It is apparent that the industries with relatively high skilled employment share has high skilled worker wage share. Among others, the computer machinery has the highest wage share of skilled workers of 76.64 percent with the highest skilled employment share of 45.02 followed by other industries like Radio TV and Medical instruments, chemical and printing industries etc has undergone significant rise in the share of wages of skilled workers and also the share constitutes more than fifty per cent in these industries. However, the trends reveal that the rise in the share of skilled worker wages in total wages is widespread across all industries. Given these trends, one can infer that the increasing wage inequality between skilled and unskilled workers is prevalent across all the manufacturing industries.

The existing empirical evidences show that technological changes are the contributing factors in the increasing demand for skilled workers. Hence, in order to compare the trends in technology and wages, we have taken average technology intensities and skilled worker wage intensity across all industries during 1992-93 to 2005-06. Since industries behavior towards technology capabilities is according to the structure of the industries, following OECD classification, industries are divided into high tech, medium tech, and low tech industries. From the table 2, t is evident that the wage share of skilled workers is high in all high tech industries as compared to the other industries as well as total manufacturing average. Contradicting the evidences, imported technologies intensities such as import of capital goods and disembodied technologies are too small to affect wages of skilled workers. Further, the imported intermediate technology intensity in high tech industries is higher than the other industries. Hence, it can be inferred that relatively high intermediate technology intensity is positively correlated with the share on wages of skilled workers. By and large, the increasing share of skilled workers wages can be related to high domestic capital goods intensity as compared to other technologies. Interestingly, the domestic capital goods intensity is lower than the total manufacturing in all high tech industries except in chemical industry. Nevertheless, it is clear that domestic technologies per se seem to have contributed increasing demand for skilled workers.

Table 2 Average Shares of Imported, Domestic Technologies and Wage Share During 1992-93 to 2005-06 According to OECD Technology Classification

Industry	**Imported Technology**			**Domestic Technology**			**Skilled Wage Share**
	ICG	**IDT**	**IIT**	**R&D**	**DCG**	**DDT**	
High Tech Industries							
Chemical	1.38	0.23	0.39	0.76	67.82	0.06	54.12
Machinery	0.87	0.25	3.51	0.60	30.58	0.25	49.49
Computing	5.77	1.35	2.16	0.28	19.35	0.67	70.05
Electrical Machinery	1.11	0.20	2.04	0.36	34.02	0.17	51.38
Radio, TV	1.62	0.30	1.78	0.99	36.99	0.38	58.90
Medical instruments	1.20	0.18	2.04	0.28	36.85	0.25	53.70
Motor vehicle	2.72	0.56	1.32	0.76	39.32	0.46	46.04
Transport	1.50	0.66	3.86	1.83	23.60	1.05	37.73
Medium Tech Industries							
Wood	1.37	0.01	0.36	0.06	76.51	0.02	35.19
Petroleum	1.09	0.23	0.26	0.06	25.94	0.03	50.12
Rubber	2.06	0.13	0.28	0.24	49.98	0.16	44.94
Non- Metallic	1.67	0.14	1.07	0.23	93.14	0.53	39.47
Metals	1.89	0.27	0.87	0.13	90.78	0.30	40.58
Metal Pro	1.10	0.13	0.65	0.13	44.70	0.10	43.27
Low Tech Industries							
Food	3.20	0.07	0.10	0.15	33.54	0.33	41.48
Tobacco	0.87	0.04	0.21	0.15	15.75	0.05	17.97
Textile	2.83	0.07	0.56	0.06	56.48	0.04	26.55
Garment	1.90	0.19	0.65	0.05	20.77	0.24	34.23
Leather	2.01	0.15	1.88	0.11	25.99	0.22	34.57
Paper	2.13	0.04	0.83	0.09	104.29	0.02	38.25
Printing	2.05	0.10	0.62	0.00	48.11	0.25	51.58
Furniture	0.40	0.01	0.17	0.03	7.29	0.05	38.13
Total	**1.64**	**0.24**	**0.83**	**0.34**	**47.79**	**0.37**	**42.71**

Note: ICG: Import of Capital Goods, IDT: Import of Disembodied Technology, IIT: Import of Intermediate Technology, DCG: Domestic Capital Goods, DDT: Domestic Disembodied Technology

Source: PROWESS, various years

In medium tech industries, the share of wages to skilled workers is higher than the total average in petroleum, rubber and metal products industry. It can be observed from the table that none of the imported technologies have any better share. Similarly, the R&D and domestic disembodied technology intensity is relatively less as compared to total manufacturing average. The domestic capital goods intensity is very high in most of the medium tech industries except in petroleum industry. It is very evident that domestic capital goods is playing important role in skill enhancement among medium tech industries. Similarly, in low tech industries, it should be noticed that the share of wages of skilled workers is low in most of the low tech industries compared to the total average except in printing industry. However, from the table it can be inferred that import of capital goods and domestic capital goods seem to have contributed for increasing wages while other technologies have negligible effect.

5. The Model

From the analysis of trends and patterns, it has been observed that the phenomenon of increasing share of wages of skilled workers is prevalent in all the industries. Further, in order to understand the effect of each element of technology on the increasing share of wages of skilled workers, an econometric analysis is required. Therefore, this section deals with the variables considered for the analysis, the specification of the model and results.

The table 3 presents a summary of all the variables used for the analysis.

Table 3 Construction of Variables

Variable Name	Description	Construction
SSW	Share of Skilled Workers Wages	Total wages to skilled/ Total wages
CI	Capital Intensity	Gross Fixed Assets/Total Employment
ICG	Import of Capital goods intensity	ICG/sales
IDT	Import of Disembodied Technology intensity	Royalties to foreign firms/sales
IIT	Import of Intermediate Technology intensity	Import of spare parts/sales
DCG	Domestic Capital Goods intensity	Plant and Machinery minus ICG/Sales
DDT	Domestic disembodied technology intensity	Royalty payments/ sales
RDI	R&D intensity	R&D expenditure/sales
ITI	Imported Technology Intensity	ICG+IDT+IIT/sales
DTI	Domestic Technology Intensity	DCG+DDT+R&D/sales
TI	Total Technology Intensity	IT+DT/sales
OUTPUT	Value of output	sales
CONTRACT	Contract worker intensity	Number of contract workers/Total employment

Methodology for Econometric Model: A Cost Function Approach

This section is an empirical investigation of the elements of technology that are affecting the wage structure in the post-liberalisation period. In order to examine this empirically, the cost function approach is extensively used in the literature. In this section we bring out the technology factors (domestic and foreign) and its impact on raising demand for skilled workers using a cost function approach. The advantage of using cost function is that, in cost function, technology enters as a separate input and in which changes in technology over time have a non-neutral effect on labor inputs as classified by skill type. Following Pavcnik (2003), in this analysis we used restricted variable cost function as shown in equation one.

$$C = f(Ws, Wu, K, Y, T) \qquad (1)$$

Where C is the restricted variable cost function, which we measure as total labor costs; W_s is the wage of non-production workers, which we measure as the share wages of skilled workers;

W_u is the wage of production workers, which we measure as the share wages of unskilled workers in total wages; K is the stock of quasi-fixed plant and equipment; Y is value of output; and T is technology, which we assume is a function of time. Later, we separate out technology into domestic technology and foreign technology, further into elements of domestic and imported technology.

$$\begin{aligned}\text{Log}TVC = {} & \alpha_o + a_s\log w^s + a_u\log w^u + a_y\log Y + a_k\log K + a_t T \\ & + 0.5\{y_{su}(\log w^s)(\log w^u) + y_{ss}(\log w^s)^2 \\ & + y_{us}(\log w^u)(\log w^s) + y_{uu}(\log w^u)^2\} \\ & + 0.5\{y(\log Y)^2 + y_{kk}(\log K)^2 + y(T^2) + y_{ys}(\log Y)(\log w^s) \\ & + y(\log Y)(\log w^u) + y(\log K)(\log w^s) + y_{ku}(\log K)(\log w^u)\} \\ & + y_{ts}T(\log w^s) + y_{tu}T(w^u) + y_{yt}(Y)T + y_{kt}(\log K)T \qquad (2)\end{aligned}$$

This framework differs from the general cost function specification because it assumes that capital and other technology measures T are fixed while skilled and unskilled labor are variable factors in the considered time period. Using cost minimization, cost share equations of variable inputs is obtained by partially differentiating (2) with respect to input prices. After imposing homogeneity of degree one in prices to ensure that the cost function corresponds to some well-behaved production function, the wage bill share equation for skilled labor can be written as:

$$\text{Share}_s = \alpha + \gamma\log W_s/W_u + \gamma_k\log K/\log L + \beta_1\log Y + \beta_2\text{Tech} + \varepsilon \qquad (3)$$

If γ_k is positive, implies capital-skill complementarity. β_1 represents scale effect of production. β_2 represents our coefficient of interest and captures the impact of different technology-related variables. In this context, 'technology' has to be interpreted in a wider sense; we will use different variables which are potentially channels of technological upgrading: besides the usual proxies of technological change such as R&D expenditures. The term ε represents unobserved component in the analysis.

We run OLS regression based on three different equations on the share of skilled wages. Equation 4 estimates the impact of capital intensity, total technology intensity, output and contract intensity on the share of skilled workers. Moreover, in equation 4 we drop the endogenously determined relative wages since it is directly involved in the construction of dependent variable. We instead include time dummies and industry dummies, which should capture the movements in the wage bill share due to supply shifts as well as other economy-wide mechanisms.

$$SSW_{it} = \alpha + \gamma_k\log CI_{it} + \gamma\log TI_{it} + \beta_1\log OUTPUT_{it} + \beta_2\log CONTRACT_{it} + \eta_t + \varepsilon_{it} \qquad (4)$$

Similarly, leaving other variables same, we decompose technology into domestic technology and imported technology in equation 5 to investigate which technology is actually augmenting skills. This exercise primarily focuses on the issue of skill enhancing trade to test it empirically.

$$SSW_{it} = \alpha + \gamma_k\log CI_{it} + \gamma_i\log ITI_{it} + \gamma_d\log DTI_{it} + \beta_1\log OUTPUT_{it} + \beta_2\log CONTRACT_{it} + \eta_t + \varepsilon_{it} \qquad (5)$$

Further, we dissect both imported and domestic technologies in order find out which element in domestic and imported technology is complementing skills (see equation 6).

$$SSW_{it} = \alpha + \gamma_k\log CI_{it} + \varrho_1\log ICG_{it} + \varrho_2\log IDT_{it} + \varrho_3\log IIT_{it} + \Omega_1\log DCG_{it} + \Omega_2\log DDT_{it} + \Omega_3\log RDI_{it} + \beta_1\log OUTPUT_{it} + \beta_2\log CONTRACT_{it} + \eta_t + \varepsilon_{it} \qquad (6)$$

Before we move on to the main econometric results, it is worth to take a look at descriptive statistics which provides a preliminary idea on the characteristics of the dataset. Table 2 provides the summary results for all the variables.

Table 4 Descriptive Statistics of the Variables

Variables	Number of observations	Mean	Standard Deviation	Minimum	Maximum
SSW	731	42.01	10.88	9.27	76.64

CI	731	4.36	9.06	0.08	121.67
TI	730	0.53	0.35	0	2.25
ITI	730	0.04	0.08	0	1.04
DTI	730	0.49	0.35	-0.72	2.19
ICG	731	0.03	0.08	0	1.02
IDT	731	0.00	0.00	0	0.03
IIT	731	0.01	0.03	0	0.29
DCG	731	0.48	0.36	-0.72	2.19
DDT	731	0.02	0.34	0	9.09
RDI	731	0.00	0.01	0	0.08
OUTPUT	731	9548.01	24883.91	0	305130.40
CONTRACT	731	0.19	0.17	0	2.95

Often, studies with econometric modeling suffer from the problem of multicollinearity, which misleads the results. Hence, we check for correlation between the variables selected for the analysis. Correlation matrix shows that there is no muticollinearity problem among the variables as the values turned to be less than 0.45 except for output and capital intensity which is significantly related capital intensity. Otherwise, there is prevalence of muticollinearity among variables.

Table 5 Correlation Matrix for the Variables

	SSW	CI	ICG	IDT	IIT	DCG	DDT	RDI	OUTPUT	CON
SSW	1									
CI	0.43*	1								
ICG	-0.12*	0.09*	1							
IDT	0.24*	0.14*	0.29*	1						
IIT	0.18*	0.02	0.23*	0.39*	1					
DCG	0.00	0.37*	0.09*	-0.02	0.03	1				
DDT	0.38*	0.08*	0.07*	0.41*	0.30*	-0.00	1			
RDI	0.40*	0.11*	0.06*	0.34*	0.37*	-0.03	0.25*	1		
OUTPUT	0.16*	0.45*	-0.13*	0.00	-0.05	-0.04	-0.00	0.15*	1	
CON	0.00	0.19*	-0.13*	-0.14*	-0.22*	0.06*	-0.10*	-0.17*	0.33*	1

Note: * indicates significance at 1 % level.

Estimation Results

Scholars have analysed panel data using the Ordinary Least Square (OLS) for estimation. However, pooled regression biases the estimated results upwards if significant cross-section or time fixed-effect are present. Hence, the present study started panel analysis with fixed effect and random effect regression of equation which takes care of unobserved elements in the model. The estimated results of equation 4 i.e. share of skilled workers wages on technology during 1992-93 to 2005-06 is presented in table 6.

Table 6 Estimation of Impact of Technology on Wages of Skilled Workers during 1992-93 to 2005-06		
Dependent variable: Share of Skilled Wages		
Regressor	(1)	(2)
	Fixed Effects	**Random Effects**

	Coefficients (t values)	Coefficients (z values)
Log CI	3.946*** (8.69)	4.290*** (9.78)
Log TI	2.103*** (4.72)	1.80*** (4.05)
Log OUTPUT	2.281*** (5.63)	1.68*** (4.59)
Log CONTRACT	0.79*** (3.38)	.79*** (3.37)
Constant	23.88*** (7.78)	28.15*** (9.32)
Observations	710	710
NIC group	53	53
Hausman specification test	c^2=168.28 (p = 0.000)	
R squared	0.09	0.11
F-Test	110.47	-
Wald	-	422.93
Prob>F	0.00	0.00

Note: Robust t statistics in parentheses

** indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1% level.*

Column 1 and 2 in the table shows the estimated results of fixed effect and random effect model. We can observe from the table that the co-efficient values of fixed effects model and random effects model differ from each other. However, they show same signs as well as significance level. In order to check which model is reliable in our estimation, we have estimated Hausman Specification test, which informs whether fixed-effects or random-effects model is reliable. The test yields statistically significant result (c^2=168.28) which indicates that fixed effects is preferable to the random effect model. Thus, hereafter we interpret results of fixed effect model. Estimated values of F and Wald chi2 values are significant at 1 per cent level. Overall, the regression model employed is robust to examine the causal relationship between technology and skilled wages.

Having confirmed that the model is suitable for fixed effect estimation, table 7 presents the results of fixed effect estimation according to technology classification. Columns 1, 2, 3, 4, present the estimated results of total manufacturing, high tech, medium tech, and low tech industries. From the table, it can be observed that the constant term is high and significant across all the industrial groups except in low tech industries. Capital intensity is positively and significant at 1 percent level across all the industry classifications except in medium tech industry where it is significant only at 5 percent level. This result is consistent with hypothesis is of capital skill complementarity by Griliches (1969), argues that increased capital labour ratio complements skilled labour and substitutes unskilled labour. Similarly, Krusell et al. (2000) argue that capital account for larger proportion of skill changes. It can be observed that the coefficient value of capital intensity is higher in high tech industries at 4.77 compare to other industries as well as total manufacturing which is at 3.94 percent. This implies that one percent increase in capital intensity leads to 4.77 percent increase in wages of skilled wages which is much higher compare to other industries such as medium tech and low tech industries where one percent increase leads to 1.8 and 3.7 percent increase in wages of skilled workers respectively.

Table 7 Estimation of Impact of Technology on Wages of Skilled Workers according to Technology Classification during 1992-93 to 2005-06				
Dependent variable: Share of Skilled Wages				
	Fixed Effect Model			
	(1)	(2)	(3)	(4)

Regressor	Manufacturing Coefficients (t values)	High Tech Coefficients (t values)	Medium Tech Coefficients (t values)	Low Tech Coefficients (t values)
Log CI	3.946*** (8.69)	4.775*** (6.78)	1.844** (2.27)	3.773*** (3.11)
Log TI	2.103*** (4.72)	3.137*** (4.25)	1.378* (1.89)	1.212 (1.11)
Log OUTPUT	2.281*** (5.63)	2.004*** (2.98)	2.750*** (2.82)	4.168*** (4.81)
Log CONTRACT	0.79*** (3.38)	.937*** (2.88)	.499 (.70)	-.271 (-0.43)
Constant	23.88*** (7.78)	32.14*** (6.43)	14.89* (1.86)	4.02 (0.61)
Year dummy	Yes	Yes	Yes	Yes
Observations	710	322	160	236
NIC group	53	24	12	17
R squared	0.09	0.07	0.18	0.05
F-Test	110.47	46.66	19.29	34.56
Prob>F	0.00	0.00	0.00	0.00

Note: Robust t statistics in parentheses

** indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1% level.*

It is clear that the capital used in High tech industries have a much larger capacity to create relative demand for skilled workers than in other types of technology based industries. Similarly, total technology intensity is found to be highly significant at 1 percent level in total manufacturing and high tech industries and significant at 10 percent level in medium tech industries where as low tech industries does not show any significance level. Among all, the coefficient of technology intensity is highest in high tech industries (3.13) imply that technology skill complementarities are highest in high tech industries. High tech industries by their structure are highly technology intensive compared to the other medium tech industries and low tech industries hence demands high skilled labour. Our findings are unambiguous with arguments in the literature. For instance, Bound and Johnson (1992), Krueger (1993), Berman et al (1994), Autor et al. (1997) and Goldin and Katz (1998) argued that introduction of advanced technologies in the form of computers and machineries complements technology. Further, this argument is stronger in our estimation as the results show that technology intensity is insignificant in low tech industries.

Output which represents the scale effect on skilled wages is highly significant at 1 percent level in total manufacturing as well as high tech, medium tech and low tech industries. However, the coefficient of output is high in low tech industries, 4.16; indicate that the scale effect on share of skilled wages is high in low tech industries compare to other coefficients such as capital intensity, and medium tech industry also follows similar trend. This implies that the scale effect explains much of the changes in skilled wages in low and medium tech industries while in high tech industries, much of the changes is explained by capital intensity and technology intensity with high coefficients of 4.77 and 3.13 respectively compare to low scale effect due to coefficient output being low at 2.00. It should be noted that the output coefficient is lowest in high tech industries. Our finding, significant scale effect on wages of skilled workers is consistent with the findings of Berman et al. (2005) and Ramaswamy (2008) that also showed the positive and significant scale effect. Our proxy for labour market flexibility i.e. contract worker intensity is turned out significant at one percent level in total manufacturing as well as high tech industries. This can be interpreted as, if there are costs of labour regulations and they are not offset by strong scale-economies then industries have an incentive to hire relatively more skilled labour increasing skill-wage inequality. This is consistent with the reported fact that both contract-intensity and skill-intensity go up with employment size of factories in India (Ramaswamy, 2006).

The estimated results of equation 5 are provided in table 8 where, we dissect technology into imported and domestic technology in order to estimate impact of domestic and imported technology separately on wages of skilled workers.

Table 8 Estimation of Impact of Domestic and Imported Technology on Wages of Skilled Workers According to Technology Classification During 1992-93 to 2005-06				
Dependent variable: Share of Skilled Wages				
	(1)	(2)	(3)	(4)
	Manufacturing	**High Tech**	**Medium Tech**	**Low Tech**
Regressor	**Coefficients (t values)**	**Coefficients (t values)**	**Coefficients (t values)**	**Coefficients (t values)**
Log CI	4.326*** (9.07)	4.344*** (6.13)	3.861*** (3.83)	3.999*** (3.39)
Log ITI	0.95 (0.43)	-.383 (-1.03)	-.632 (-1.58)	1.651*** (3.38)
Log DTI	1.073*** (3.30)	2.060*** (3.77)	-.177 (-1.58)	1.131* (1.70)
Log OUTPUT	2.739 *** (5.78)	3.890 *** (4.25)	1.194 (1.09)	4.453*** (4.94)
Log CONTRACT	.658*** (2.78)	.809*** (2.52)	.583 (0.83)	-.544 (-0.82)
Constant	19.29*** (5.40)	15.58** (2.26)	22.07*** (2.66)	8.12 (1.19)
Observations	710	322	158	230
NIC group	53	24	12	17
R squared	0.09	0.07	0.13	0.03
F-Test	110.47	40.85	17.31	29.18
Prob >F	0.00	0.00	0.00	0.00

Note: Robust t statistics in parentheses

** indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1% level.*

The results show that capital intensity is significant at 1 percent level across all industrial groups. Import of technology intensity is insignificant in total manufacturing, high tech and medium tech industries whereas, it is significant in low tech industries. Our results are in contrast with the literature in the context of other developing countries which argue that globalisation facilitated technology transfer from developed countries and the technologies imported from outside are the main contributing factors in increasing skilled wages (Robbins, 1995, 1996; Hanson and Harrison, 1999; Mayer, 2000, Pavcnik, 2003; among others). However, this prediction seems to be valid only in low tech industries.

On the other hand, domestic technology intensity is highly significant at 1 percent level in total manufacturing with the coefficient value of 1.07, high tech industries at 2.06 and in low tech industries it is significant at 10 percent level with the coefficient of 1.13. Interestingly, both the technology indicators turned insignificant in medium tech industries when we split the technology variable. However, as against the predictions of literature, domestic technology seems to contribute for increasing skilled wages than the imported technology. This could be probably due to the emphasis on the development of capital good base since independence, which led industries to depend on domestic technology even after liberalisation. However, in low tech industries, the coefficient of imported technology is higher than the domestic technology i.e. 1.65 and 1.13 respectively, implying that imported technology is contributing to increasing demand for skilled workers.

Similarly, output is significant across all industrial groups except in medium tech industries. Interestingly, after dividing technology into domestic and imported, the output coefficient which was significant in the previous regression (see table 7) turned insignificant in this regression (see table 8 column 3) in medium tech industries. In the same way, in the previous regression (see table 7), contract intensity is significant in total manufacturing and high tech industries, insignificant in medium tech and low tech industries. Moreover the coefficient sign is negative in low tech industries which implies contracting intensity is negatively related with share of skilled wages implies that more flexibility in labour market leads to decrease in skilled wages.

Having examined the impact of imported and domestic technology separately on the share of skilled wages, as highlighted in equation 5, we now explore what are the elements in both domestic and imported technology that are significantly, affecting wages of skilled workers. The estimated results of equation 6 are presented in table 9 The regression results show that capital intensity is highly significant at 1 percent level in all industrial groups except in medium tech industries. Among the elements of imported technology, literature shows that the transfer of technology embedded in capital goods to developing countries demand high skilled labour thus increased wages of skilled labour (Connor and Lunati, 1999; Gorg and Strobl's, 2002; Conte and Vivarelli, 2007; Meschi et al. 2008).

Table 7 Estimation of Impact of Elements of Domestic and Imported Technology on Wages of Skilled Workers According to Technology Classification During 1992-93 to 2005-06

Dependent variable: Share of Skilled Wages

	(1)	(2)	(3)	(4)
	Manufacturing	**High Tech**	**Medium Tech**	**Low Tech**
Regressor	**Coefficients (t values)**	**Coefficients (t values)**	**Coefficients (t values)**	**Coefficients (t values)**
Log CI	3.254*** (5.63)	3.219*** (3.65)	1.559 (1.40)	3.122*** (3.64)
Log ICG	.0634 (0.27)	.093 (0.26)	-.480 (-1.30)	.769*** (2.95)
Log IDT	.102 (0.57)	-.530 (-1.26)	-.325 (-0.78)	.157 (1.20)
Log IIT	-.884*** (-3.50)	-1.074*** (-2.77)	1.016* (1.88)	-.106 (-0.30)
Log DCG	2.062*** (3.71)	2.862*** (3.27)	.156 (0.15)	.843 (1.16)
Log DDT	-.0740 (-0.37)	.160 (0.36)	-.274 (-0.80)	-.030 (-0.18)
Log RDI	-.154 (-0.69)	-.390 (-0.93)	-.721 (-1.63)	-.287* (-1.93)
Log OUTPUT	2.598*** (4.15)	4.243*** (3.74)	3.942*** (2.93)	2.374*** (3.55)
Log CONTRACT	.856*** (2.91)	.894** (2.19)	-.248 (-0.34)	.044 (0.10)
Constant	16.08*** (3.04)	6.58 (0.67)	-3.02 (-0.28)	16.27*** (2.93)
Observations	547	260	137	153
NIC group	48	24	11	14
R squared	0.02	0.02	0.08	0.1
F-Test	37.11	21.55	10.58	16.39
Prob>F	0.00	0.00	0.00	0.00

Note: Robust t statistics in parentheses

** indicates significance at 10%; **indicates significance at 5%; *** indicates significance at 1% level.*

However, contrary to the predictions of this literature, our findings show that import of capital goods is insignificant in total manufacturing, high tech and medium tech industries. Nevertheless, import of capital goods is highly significant in low tech industries with the coefficient of 0.76. In the previous model we have noted that imported technology has significant impact on wages of skilled workers in the low tech industries. From the table it is clear that among imported technologies it is import of capital goods that has significant impact on skilled wages. One can otherwise explain this result as; after liberalisation low tech industries sought technology from outside which resulted in significant impact on skilled wages.

Import of disembodied technology is insignificant across all industrial groups which are similar to the result that is reported in Banga (2005). Similarly, import of intermediate technology is found to be significant but negatively related to the share of skilled wages in the total manufacturing and in high tech industries where as significantly (at 10 percent) and positively related in medium tech industries. The negative relation between intermediate technology and skilled wages is in contrast with the international literature which argues that globalisation leads to outsourcing which complements skills (see Feenstra and Hanson, 1996, 2001; and Hanson and Harrison, 1999). However, the negative relation could be probably due to two reasons. First, our import of intermediate technology such as spare parts and others are probably semi-skilled or unskilled augmenting than skilled labour augmenting. Second, our imports of intermediate technology could be very much processed that it needs very less skilled man power to assemble

On the other hand, among the elements of domestic technology, domestic capital goods are found to be highly significant in total manufacturing and high tech industries and insignificant in medium and low tech industries. Among all elements of technology, it is basically domestic capital goods that are complementing skills in manufacturing sector during the liberalisation period. All other domestic technology elements such as domestic disembodied technology and R&D intensity is insignificant across all industrial groups except in low tech industry where R&D is significant at 10 percent level but negatively related to share of skilled wages with the coefficient of -0.28. There is positive and significant scale effect with output being significant across all industrial groups.

6. Conclusion

The empirical estimates show that, capital intensity, technology intensity and output are significantly related to share of skilled wages across all industrial groups except in low tech industries. While in high tech industries, much of the changes are explained by the capital intensity and technology intensity, in medium and low tech industries much of the changes is explained by scale effect. Further, when we divide technology into domestic and imported, imported technology turned to be significant only in low tech industries and insignificant in all other industrial groups indicating that, skills changes in low tech industries are due to the imported technologies during liberalisation period. On the other hand, domestic technology is highly significant in manufacturing sector, high tech industries and as well as low tech industries. From these results, we could infer that, much of the skill changes in the post liberalisation period are due to domestic technology than the imported technology. In order to investigate the element of technology that is complementing skills and leading to wage inequality, we have run another regression model. The estimated results show that import of capital goods is significantly affecting skilled wages in low tech industries and domestic capital goods is contributing to the changes in skilled wages in total manufacturing and high tech industries. Our indicator of labour market rigidities i.e. contract worker intensity is significant in total manufacturing and in high tech industries and insignificant in medium and low tech industries. Thus, we infer that, the changes in wages of skilled workers could be primarily contributed by the domestic technology rather than the imported technology. The impact of domestic technology is high on wages of skilled workers is found to be high as compared to other industries.

References

Abraham, V (2009): ‘The Effect of Information Technology on Wage Inequality: Evidence from Indian Manufacturing Sector’, Mimeo, Centre for Development Studies, Kerala

Acemoglu, D (1998): ‘Why Do New Technologies Complement Skills? Directed Technical Change and Wage Inequality,’ *Quarterly Journal of Economics*, Vol.113, No.4, pp. 1055-90.

Adams, J.D (1999): ‘The Structure of Firm R&D, the Factor Intensity of Production, and Skill Bias’, *Review of Economics and Statistics*, Vol. 81, No. 3, pp. 499-510.

Agarwal, R N and B Goldar (1995), ‘Economic Reforms and Employment in India: Projections for the Year 2001-02’, *Indian Journal of Labour Economics*, Vol.38, No. 4, pp. 577-95.

Agarwal, M (2008): Changing Economic Power in the World Economy", RIS Discussion Paper, RIS-DP-143, September.

Aghion, P and Howitt (1992) 'A Model of Growth through Creative Destruction' *Econometrica,* Vol. 60, No. 2, pp. 323-351.

Aghion, P. Stephen Redding, and Robin, B., Fabrizio, Z (2005): 'Entry Liberalization and Inequality in Industrial Performance', *Journal of the European Economic Association*, Vol. 3, No. 2/3, pp. 291-302.

Araújo, B., Bogliacino, F., and Vivarelli, M (2009): 'The Role of "Skill Enhancing Trade" in Brazil: Some Evidence from Microdata', IZA Discussion Paper Series, No. 4213.

Autor, David H., Lawrence F. Katz, and Alan B. Krueger (1998): 'Computing Inequality: Have Computers Changed the Labor Market?', *Quarterly Journal of Economics*, Vol. 63, pp. 1169-213.

Autor, D., F. Levy, and R. Murnane (2003): 'The Skill Content of Recent Technical Change: An Empirical Exploration', *Quarterly Journal of Economics,* Vol. 118, No.4, pp. 1279-1334.

Banga R (2005): 'Liberalisation and Wage Inequality in India', Working Paper No. 156, Indian Council for Research in International Economic Relations, New Delhi.

Basant, R. and Fikkert, B (1996): 'The Effects of R&D, Foreign Technology Purchase, and Domestic and International Spillovers on Productivity in Indian Firms' *Review of Economics and Statistics*, Vol. 78, No. 2 (May, 1996), pp. 187-199.

Berman, E, Bound, J, and Griliches, Z (1994): 'Changes in the Demand for Skilled Labor within Manufacturing Industries: Evidence from the Annual Survey of Manufacturing', *Quarterly Journal of Economics*, Vol.109, No. 2, pp. 367-398.

Bernard, B.B and Jenson, J.B (1995): 'Exporters, Skill upgrading and the Wage gap', *Journal of International Economics*, Vol. 42, No.2, pp. 3-31.

Berman, E., Bound, J., and Stephen, M (1998): 'Implications of Skill-Biased Technological Change: International Evidence', *Quarterly Journal of Economics*, Vol. 113, No. 4, pp. 1245-1279.

Berman, E, and Stephen, Machin. (2000): 'Skill-Biased Technology Transfer around the World,' *Oxford Review of Economic Policy*, Vol. 16, No.3.

Berman, E, and Stephen, M (2004): Globalisation, Skill-Biased Technology and Labour Demand, in Lee, Eddy and Vivarelli, Marco (Ed.*), Understanding Globalization, Employment and Poverty Reduction*, Palgrave Macmillan, New York.

Berman, E, Somanathan, R, and Tan, H (2005): 'Is Skill-Biased Technological Change Here Yet? Evidence from Indian Manufacturing in the 1990s', World Bank Working Paper, No.37 16, World Bank, Washington DC.

Bhalotra, S. R (1998): 'The Puzzle of Jobless Growth in Indian Manufacturing', *Oxford Bulletin of Economics and Statistics*, Vol. 60, No. 1, pp. 5-32.

Bound, J, and Johnson, G (1992): 'Changes in the Structure of Wages in the 1980s: An Evaluation of Alternative Explanations', *American Economic Review*, Vol. 82, No.3, pp. 371-92.

Choragudi, S (2008):'Technology Strategies under Globalisation: A Study of Indian Manufacturing', M.Phil. Unpublished Dissertation, Jawaharlal Nehru University, New Delhi.

Coe, D.T and Helpman E (1995): 'International R&D spillovers', *European Economic Review*, Vol. 39, pp. 859–887.

Coe D.T, Helpman, E. and Hoffmaister, A.W (1997): 'North-South R&D spillovers', *The Economic Journal*, Vol. 107, No.1, pp. 134–149.

Connor, D and Lunati, M.R (1999): 'Economic Opening and the Demand for Skills in Developing Countries: A Review of Theory and Evidence', Working Paper No. 149, OECD Development Centre.

Deaton, A and Dreze, J (2002): 'Poverty and Inequality in India: A Re-Examination, *Economic and Political Weekly*, Vol. 37, No. 36, pp. 3729-3748.

Deshpande, L, A. N. Sharma, A. Karan and S Sarkar (2004): 'Liberalisation and Labour: Labour Flexibility in Indian Manufacturing', Institute for Human Development, New Delhi.

Doms, M, Timothy Dunne, Kenneth R. Troske (1997): 'Workers, Wages, and Technology' *Quarterly Journal of Economics*, Vol. 112, No. 1, pp. 253-290.

Evenson, R.E and Joseph, K.J (1999) 'Foreign Technology Licensing in Indian Industry: An Econometric Analysis of the Choice of Partners, Terms of Contract and the Effect on Licensees' Performance', *Economic and Political Weekly*, Vol. 34, No. 27, pp. 1801-1809.

Feenstra, R., and Gordon Hanson (1995): 'Foreign Investment, outsourcing, and relative wages', Working Paper 5121, National Bureau of Economic Research, 1050, Massachussets Avenue. Cambridge MA.

Feenstra, R., and Gordon Hanson (1996): 'Globalization, Outsourcing, and Wage Inequality', *American Economic Review*, Vol. 86, No. 2, pp. 240-245.

Feenstra, R., and Gordon Hanson (1997): 'Foreign Direct Investment and relative wages: Evidence from Mexico's maquiladoras', *Journal of International Economics*, Vol. 42, No. 3-4, pp. 371-393.

Feenstra, R., and Gordon Hanson (2001): 'Global Production Sharing and Rising Inequality: A Survey of Trade and Wages', Paper 8372, National Bureau of Economic Research, 1050, Massachussets Avenue. Cambridge MA.

Freeman, R. B (1991): 'How mach has De-Unionization contributed to the Rise in Male Earnings Inequality', Working Paper 3826, National Bureau of Economic Research, 1050, Massachussets Avenue. Cambridge MA.

Harrison, A, and Gordon Hanson (1999): 'Who Gains from Trade Reform? Some Remaining Puzzles' Working Paper 6915, National Bureau of Economic Research, 1050, Massachussets Avenue. Cambridge MA.

Hatzichronoglou, T. (1997): 'Revision of the High-Technology Sector and Product Classification', OECD Science, Technology and Industry Working Papers, 1997/2, OECD Publishing.

Goldin, C. and Lawrence F. Katz (1998): 'The Origins of Technology-Skill Complementarity', *Quarterly Journal of Economics*, Vol. 113, No. 3, pp. 693-732.

Gorg, H. and Strobl, G. (2002): 'Relative wages, openness, and skill-biased technological change in Ghana', IZA Discussion Paper No. 596.

Griliches, Z. (1969): 'Capital-Skill Complementarity', *Review of Economics and Statistics*, Vol. 51, No. 4, pp. 465-468.

Grossman, G. M., and E. Helpman (1991): 'Innovation and Growth in the Global Economy', MIT Press, Cambridge MA.

Joseph, K.J. and Abrol, D (2009): 'Science, Technology and Innovation Polices in India: Achievements and Limits', in Cassiolato and Vitorino (eds), BRICS and Development Alternatives: Innovation Systems and Policies, The Anthem Press, London.

Kambhampati, U. and Howell, J (1998): 'Liberalization and Labour: The Effect on Formal Sector Employment', *Journal of International Development*, Vol. 10, pp. 439-452.

Katz, Lawrence F. and Kevin M. Murphy (1992): 'Changes in Relative Wages, 1963-1987: Supply and Demand Factors', *Quarterly Journal of Economics*, Vol. 107, No. 1, pp. 35-78.

Katz, L., and D. Autor (2000): 'Changes in the wage structure and earning inequality', *Handbook of Labor Economics*, Vol. 3, pp. 1-25.

Krueger, A.B (1993): 'How Computers Have Changed the Wage Structure: Evidence from

Microdata, 1984-1989', *Quarterly Journal of Economics*, Vol. 108, No. 1, pp. 33-60.

Krussell, P., Ohanian, L.E, Rios Rull, J., Violante, G. (2000): 'Capital-Skill Complementarity and Inequality: A Macroeconomic Analysis', *Econometrica*, Vol. 68, No. 5, pp. 1029-1053.

Kundu, A (1997): 'Trends and Structure of Employment in the 1990s: Implications for Urban Growth', *Economic and Political Weekly*, Vol. 32, No. 4, pp. 1399-1405.

Lall, S (2001): 'C*ompetitiveness, Technology and Skills*', Edwards Elgar, Cheltenham, U.K.

Lucas, Robert E., Jr (1998): 'On the Mechanics of Economic Development', *Journal of Monetary Economics*, Vol. 22, pp. 3-42.

Machin, S and Van Raneen, J (1998): 'Technology and Changes in Skill Structure: Evidence from Seven OECD Countries', *Quarterly Journal of Economics*, Vol. 113, No. 4, pp. 1215-44.

Mayer, J (2000): 'Globalisation, Technology Transfer and Skill Accumulation in Low-Income Countries', Paper prepared for WIDER, No. 150.

Meschi, E., Taymaz, E., and Vivarelli, M (2008): 'Trade Openness and the Demand for Skills: Evidence from Turkish Micro data', IZA Discussion Paper Series, No. 3887.

Pavcnik, N. (2003): 'What explains skill upgrading in less developed countries?', *Journal of Development Economics*, Vol. 71, No. 2, pp. 140-160.

Pradhan, J.P., and Puttaswamaiah, S (2005): 'Trends and Patterns of Technology Acquisition in Indian Organized Manufacturing: An Inter-industry Exploration' Working Paper, No.157, Gujarat Institute of Development Research, Ahmadabad.

Ramaswamy, K.V (1999): 'The Search for Flexibility in Indian Manufacturing: New Evidence on Outsourcing Activities', *Economic and Political Weekly*, February 6, pp.363-368.

Ramaswamy, K.V. (2008): 'Wage Inequality in Indian Manufacturing: Is it Trade, Technology or Labour Regulations?' WP-2008-021 Indira Gandhi Institute of Development Research, Mumbai.

Rani, U and Jeemol U (2004), 'Unorganised and Organized Manufacturing in India: Potential for Employment Generating Growth', *Economic and Political Weekly*, Vol. 34, No. 41, pp. 4568-4580.

Robbins, Donald J., (1995): 'Trade, Trade Liberalization and Inequality in Latin America and East Asia—Synthesis of Seven Country Studies', Harvard University, mimeo.

Robbins, Donald J (1996): 'Evidence on Trade and Wages in the Developing World', Working Paper, No. 119, OECD Development Centre.

Robbins, Donald J (2003): 'The Impact of Trade Liberalization upon Inequality in Developing Countries: A Review of Theory and Evidence' International Labour Organisation International Policy Group, Working Paper No. 13.

Romer, P (1990): 'Endogenous Technological Change' *Journal of Political Economy*, Vol. 98, No. 5, Part 2, pp. S71-S102.

Sanders, M and Weel, B (2000): 'Skill-Biased Technical Change: Theoretical Concepts, Empirical Problems and a Survey of the Evidence', DRUID Working Paper No 00-8.

Sen, A. and Himanshu (2005): 'Poverty and Inequality in India: Getting Closer to the Truth, in Angus Deaton and Valerie Kozel (eds.) (2005), *Data and Dogma: The Great Indian Poverty Debate*, Macmillan, New Delhi, pp. 306-370.

Sen K and Rajesh Raj (2009): 'Did International Trade destroy or create jobs in Indian Manufacturing?,' Paper for BNUIF conference, Centre for Development Studies, Trivandrum.

Sharma, A. N (2005): 'Flexibility Employment and Labour Market reforms in India', *Economic and Political Weekly*' May 27, pp. 2078 to 2085.

Solow, R (1956): 'A Contribution to the Theory of Economic Growth', *Quarterly Journal of Economics*, Vol. 70, No. 1, pp. 65-94.

Sundaram, K. and Tendulkar, Suresh. D (2003): Poverty in India in the 1990s: An Analysis of Changes in Major 15 States, *Economic and Political Weekly*, Vol. 23, pp. 1385-1393.

Thoenig, M and Verdier, Thierry (2003): 'A Theory of Defensive Skill-Biased Innovation and Globalization', *American Economic Review*, Vol. 93, No. 3, pp. 709-728.