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Abstract

This paper investigates the question of wage inequality in Indian manufacturing in the years of trade and investment liberalization. The objective is to test the hypothesis of skill biased technological change (SBTC) due to capital-skill complementarity and the impact of labour regulations on wage inequality between skilled and unskilled labour. The skill-wage bill share equation is estimated for a panel of 46 three-digit industries spanning the period 1981-2004 followed by 113 four-digit industries panel covering the period 1993 to 2004.The econometric results suggest the positive contribution of change in output (scale effect), capital-output ratio and contract-worker intensity to wage inequality in Indian manufacturing.

Key words: wages inequality, skill technological change labour manufacturing

JEL Codes: F16, J31, O12

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K.V.Ramaswamy

I. Introduction:

Studies of globalization and wage inequality in developing countries consistently point to an increase in inequality (Goldberg and Pavenik, 2007). This contradicts the conventional wisdom that predicts favourable effects of trade exposure on demand for unskilled labour. According to the conventional wisdom based on Hecksher-Ohlin and Stolper-Samuelson theory (H-O-S), trade induced increase in the price of unskilled intensive (exported) products should increase the wages of unskilled workers and the expected decrease in the price of skilled labour intensive (imported) products should lead to a decline in wages of skilled workers. Empirical evidence has turned against this benign prediction and drawn attention to the alternative mechanisms through which trade openness affected wage inequality. The increase in skill premium (skill-unskilled wage differential) driven by an increase in the demand for skilled workers has been identified as the key factor contributing to rising inequality. What are the factors that have caused an increase in the relative demand for skilled workers in developing countries? First factor in the list is new technology that flows in from industrialized countries through Foreign Direct Investment (FDI) and import of advanced capital goods. The technology that originates in the developed countries is assumed to be skill-biased or unskilled–labour saving as they are not unskilled-labour abundant economies[2]. Inflow of skill-biased technology can induce increases in the relative productivity of skilled-labour raising relative demand and

[2] SBTC argument was proposed in the industrialized country (read the US) context as an alternative channel for rising wage inequality as against trade with low-wage countries. Therefore, it emphasized technological innovations, use of computers and R&D investment.

wages for skilled labour increasing wage inequality. Robbins (1996) called this source of wage inequality generation following trade liberalization as 'skill-enhancing trade hypothesis'. Second factor is trade in intermediate goods. It is argued that if traded goods are inputs into further production, unlike the H-O theory that assumes traded goods are final goods, the implications of trade on inequality would be different (Feenstra and Hanson, 1996,1997 and 2001). The production of final goods can be split into intermediate stages and that intermediate inputs differ in their skill intensities. As a result, firms find it optimal to "”outsource" some of the production stages to cost-minimizing locations in developing countries. The products shifted to developing countries, through Foreign Direct Investment (FDI), that would be unskilled-labour intensive in a developed country turn out to be skilled-labour-intensive in a developing country when compared with its existing production activities. In brief, outsourcing or slicing up of the value chain is likely to increase the average skill intensity of production in developing countries. Using this insight, Zhu and Trefler (2005) argue that technological catch-up (more broadly defined than mere greater use of physical capital) in the developing countries results in a shift in favour of skill intensive exports (that is skill-intensive relative to developing country endowments) and this raises the demand for skill and wage inequality.[3] Third possible factor is the 'defensive innovations' strategy of developing country firms in response to import competition due to trade openness (Wood 1995). The threat of external

[3] It is also argued that trade reforms in developing countries leads to an increase in capital inflows and this may require greater use of skilled labour, if capital and skilled labour are complementary (Behrman, Birdsall, and Szekey, 2000). This is similar to Feenstra and Hanson argument. A lower price of intermediate inputs (capital goods) would shift the demand for other inputs, increasing that of complementary production factors and reducing the demand for substitutes. If unskilled labour were more substitutable for intermediate goods than skilled labour, cheaper intermediate goods would increase the relative demand for skills within industries raising the skill premium

competition could induce an increase in R&D or incentive to adopt new technologies that was absent under trade protection. By implication incentive to adopt skill-biased technologies would greater in those industries that are subject to relatively large tariff cuts. Fourth mechanism is suggested buy the model of endogenous technological change (Acemoglu 2003). In this model increasing supply of skilled labour in the US induces SBTC through the market-size effect. That is greater demand for skill-intensive goods by consumers (educated labour) increasing the profitability of skill-intensive goods, thus encouraging SBTC. The Less Developed Countries (LDCs) are technology followers that use the US technology. In other words, the drivers of technological change in developing countries may be embodied in 'imported capital good', for example, machines, office equipment and other capital goods that are complementary to skilled labour. Trade liberalization affects the demand for skilled labour by reducing the relative price of these capital goods and increasing their imports. SBTC may be an endogenous response to trade openness. In other words, instead of trade-openness and SBTC as alternative explanations of increasing wage inequality, globalization is indirectly held as the source of observed inequality.

Domestic institutions like the Job Security Regulations (JSR) is also argued to be important as a determinant of industry performance like productivity, profits and employment during economic liberalization (Aghion, Burgess, Redding and Zillbotti, 2005). The impact on wage inequality in the presence of restrictive domestic institutional rules has not been addressed[4]. Domestic labour regulations could restrict firm ability to adjust skill mix in response to trade openness. The JSR may be defined to include all those legal provisions that increase the cost of workforce adjustment by

[4] Aghion et al (2003) point out that restrictive domestic regulations will have adverse distributional consequences but do not attempt empirical estimation of income distribution effects in their paper.

retrenchment of workers. They are supposed to constrain adjustment response of firms to competitive conditions and inhibit firing decisions (labour market inflexibility). Firms are reported to have responded by hiring more temporary or contract workers and outsourcing production to firms in the informal sector (Ramaswamy 1999, 2003). Firms will have an incentive to set up a dual structure within the firm by employing unskilled-contract workers (so called tier-II workers, who could be fired without cost) instead of unskilled-regular workers. Restriction on firing is not applicable to skilled/managerial/supervisory personnel. I had observed in my earlier study large firms with above 300 workers employ a larger share of both contract workers and managers (Ramaswamy 2006). Labour regulations perhaps induce substitution of skilled workers for unskilled workers raising skill premium[5]. This can be easily explained. Assume that JSR raises the expected cost of hiring regular workers then the firms has incentive to increase the *fraction of skilled workers* employed at each level of production[6].

Disentangling the effects of different factors has turned out to be a challenge and the empirical evidence is mixed and inconclusive. In the Indian context, two studies have used the individual worker wage-premium approach to measure the impact of trade liberalization. Dutta (2004) finds a positive relationship between inter-industry wage premium and tariffs. This suggests that trade liberalization has accentuated wage inequalities. Using similar methodologies, Kumar and Mishra (2008) report a negative relationship wage-premium and tariffs leading to the argument that trade reforms in India has reduced skill-wage premium and wage inequalities. In contrast, Berman, Somanathan and Tan (2005) investigate whether

[5] Currie and Harrison (1997) had observed the employment of temporary workers to increase in Morocco in response to trade liberalization.

[6] Recall skilled and unskilled labour are substitutes.

SBTC has taken place in India after the trade reforms in the 1990s using data on industry level skill wage-bill shares. Their analysis covers the period 1984-1998 and uses the method of OLS on period averages of 76 three-digit manufacturing industries based on Annual Survey of Industries (ASI). They estimate cross-sectional variation in growth rates of skill-wage shares in two sub-periods, namely, 1984-1989 (pre-reform) and 1990-1998 (post-reform). Data on two sub-periods are pooled and time dummies are introduced to account for post-reform change in skill-wage shares. They find that the skill wage-bill share accelerated in the 1990s but the change in capital-skill complementarity alone explained very little of the acceleration. Output growth explained about half of the acceleration in wage-bill share in the 1990s suggesting that fast growing industries are upgrading their skill mix faster than slow growing industries. Comparing the estimates for India with the comparable estimates for the US (Berman, Bound and Griliches, 1994) Berman et al suggest that capital-skill complementarity in Indian manufacturing increased in the 1990s to a level comparable to the US level in the 1960s and 1970s (Berman et al 2005, page 32). Overall they interpreted their results as providing some evidence of SBTC but largely uncertain[7]. Their estimates of capital-skill complementarity seem to be an overestimate as the two contributory factors, namely FDI inflows into Indian manufacturing and the import of capital goods (machinery) as percent of fixed capital formation experienced a sharp upturn only after 1997-98, the last year of their study. Further, their method focuses on aggregate effects using weighted average of change in skill-wage shares and does not address situations of industry specific heterogeneity

[7] They are cautious in their interpretation and do point out that the role of SBTC is uncertain due to several other factors. One of them is that the set of Indian industries undergoing skill upgrading does not match the international pattern of the US or the middle-income countries.

unobserved by the econometrician. Third, their analysis does not consider any institutional variable that may impact wage inequalities.

The present study following the similar framework in the tradition of Berman, Bound and Griliches (1994), Berman and Machin (2000) and Berman et al (2005), attempts an empirical examination of the problem of wage inequality in Indian manufacturing industries. I focus on the wage gap between skilled and unskilled workers. The skill wage gap refers to the wage differential between production (blue-collar) and non-manual (white-collar) workers reported in the annual survey of manufacturing factories in India. The manufacturing survey data unlike the household surveys do not give data on education level of the workers. However, the non-production workers are categorized as those in the supervisory and managerial level indicating higher educational attainment. International evidence indicates a close relationship between the production/non-manual status of workers and their education level (Goldberg and Pavenik 2007).[8]. Therefore, the wage gap between manual and non-manual worker is considered as suitable for analyzing the impact of globalization on wage inequality. An added advantage is the availability of data on capital stock and investment that would be absent in household survey data, enabling a direct test of capital-skill complementarity hypothesis. In this paper I provide evidence of increasing wage-gap between skilled and unskilled gap in Indian manufacturing in the years since trade and investment liberalization. These years may be characterized as years of 'catching-up' and 'upgrading' of Indian industry. I make two specific contributions. First I show that skill-wage inequality has risen across industries encompassing both import-competing and export-oriented industries. Second I utilize panel data to estimate skill-wage share equations using time differencing and fixed

[8] Evidence from household survey in India suggests an increasing return to education in recent years

effect models that control for unobserved industry specific heterogeneity. My estimate of skill-wage share equation shows a statistically significant impact of change in scale of output (scale-upgrading) and capital-skill complementarity on skill-wage shares, the two skilled-labor demand shifters suggested in the literature. Some indirect evidence of the impact of restrictive labour regulations is also provided. To begin with I will report the results from a panel of 46 3-digit industries covering the period 1981 to 2004. This uses a consistent data series based on NIC-1998.Then I will present results based on a panel of 113 4-digit industries between 1993 and 2004.

II. Policy Reform and Background Facts:

Trade and Investment Liberalization

India liberalized its trade and foreign investment policies beginning in July 1991.The major areas of reform included the removal of reduction of tariff levels and their dispersion, the removal of licensing and other non-tariff barriers on all imports of intermediate and capital goods, the elimination of trade monopolies of the state trading agencies and the simplification of trading regime. The mean tariff was reduced from 128% before July 1991 to 94% in February 1992 55% in February 1994 and to 35% by 1997-98 (Hasan, Mitra and Ramaswamy, 2007). Later it was reduced to 30 percent in 2001. The share of products subject to quantitative restrictions decreased from 87 percent in 1987/88 to 45 percent 94/95. However, 95 percent of the tariff lines were freed from Non Tariff barriers (NTBs) in 2001. Restrictions on foreign direct investment (FDI) were relaxed in 1991. In the years prior to 1991, FDI was permitted only up to 40 percent in certain industries, known as ‘Appendix I Industries’ subject to the discretionary approval by the government. In 1991, FDI was allowed up to 51 percent equity in these industries under the ‘automatic route’. This was later liberalized to enable setting up of 100 percent subsidiaries in the manufacturing sector in 1997. In absolute terms, manufactured exports have reached close to $ 50 billion in 2004 compared to $24 billion in 1996. The structure of exports has undergone changes during this period in favour of relatively skilled-labour intensive products (Ramaswamy, 2006). Two key product groups that have emerged as prominent are engineering goods and chemicals that include drugs and pharmaceuticals. Engineering goods include passenger cars and automotive components. Liberalization of capacity licensing and entry regulations for large domestic and foreign firms led to high rates of capital formation in 'import competing' industries like consumer durables. India further liberalized the access to foreign technology in the 1990s.Royalty payment by all companies with foreign technology collaboration agreements is permitted without any restriction on the extent of foreign equity participation. In brief following economic liberalization in the 1990s Indian manufacturing industry has greater access to capital and intermediate goods and technology. This provided incentive for technological upgrading and modernization of manufacturing industries. How has trade and investment openness impacted the inequality in wages between skilled and unskilled labour is the focus of this paper.

Background Facts:

What has been the aggregate trend in employment share of skilled-labour in Indian manufacturing in recent years? Figure 1 shows that skilled-labour share (share of non-manual employees in total employment) has increased continuously in the 1990s. Leaving out the year 1998-99 that shows an abnormal rise, the trend is clearly in favour of employment of skilled-labor. The years since 1991 as we noted earlier are years of trade and investment liberalization. Foreign Direct Investment (FDI) in Indian manufacturing showed a rising but fluctuating trend since 1995-96 (Figure 2).

In absolute terms FDI into Indian manufacturing is estimated to be more than $US 12 billion since 1992-93[9]. Import of machinery and equipment by India has risen sharply since 1998-99 (Figure 3)[10]. This is reflected in the share of imported capital goods as percent of fixed capital formation in manufacturing (Table-1). Consistent with this the capital-output ratio has gone up across industry groups encompassing both export-oriented and import-competing industries (Figure-4). I have followed Ghose (2000) in classifying three-digit industries into import-competing and export-oriented categories (Ramaswamy, 2006). Relative wages of skilled-labour (ratio of wages per non-manual employee to wages per worker) or the skill premium has increased through out the 1990s particularly after 1997-98. (Figure-5). The rise in skill premium has taken place both in export-oriented and import-competing industries. As shown in Figure-6, the increase in relative wages of skilled-labour in the 1990s is accompanied by an increase in the share of skilled-workers in total employment. This suggests an aggregate demand shift in favour of skilled-workers represented by the share of non-manual employees in total employment[11]. Another key statistic in this context is the share of contract workers in total manual workers (Figure 7)[12]. This indicates an increase in the share of workers not subject to job security and severance payment rules under Indian labour laws (Ramaswamy 2006).

[9] FDI data is based on Government of India(2002) and updated using the Annual Reports of the Reserve Bank of India for the years 2001 to 2005.
[10] The source of data for machinery imports is the India-stat data base available at http://www.Indiastat.com. Import data excludes import of project goods and metals.
[11] Figures 5 to 7 are based on selected set of 46 three-digit industries having continuous time-series data since 1980-81 after using the concordance tables (EPWRF, 2007).
[12] Data on contract workers is based on Annual Survey of Industries, Summary reports of various years. For details see Ramaswamy (2002)

Figure-1

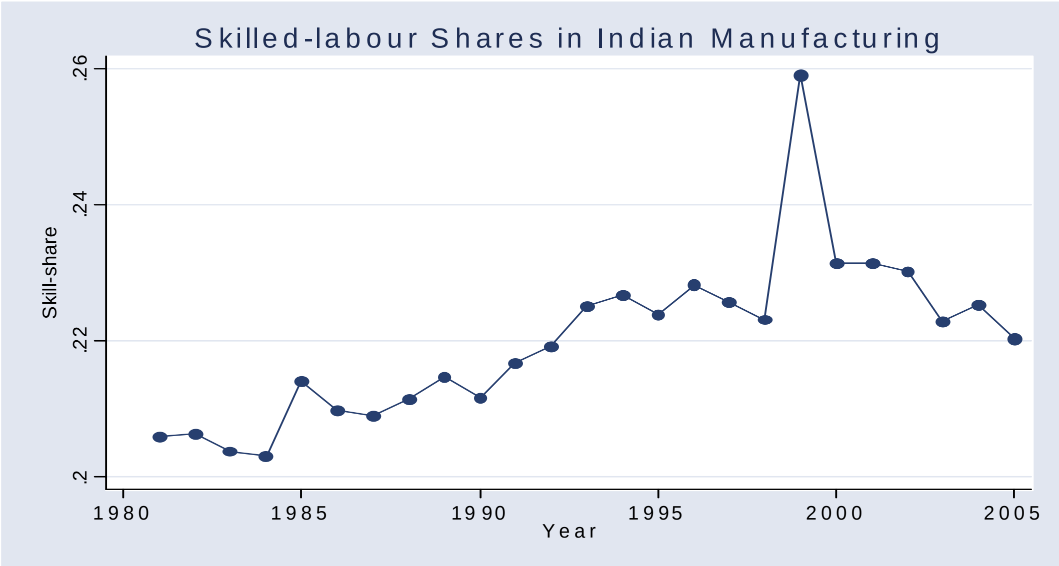

Figure-2

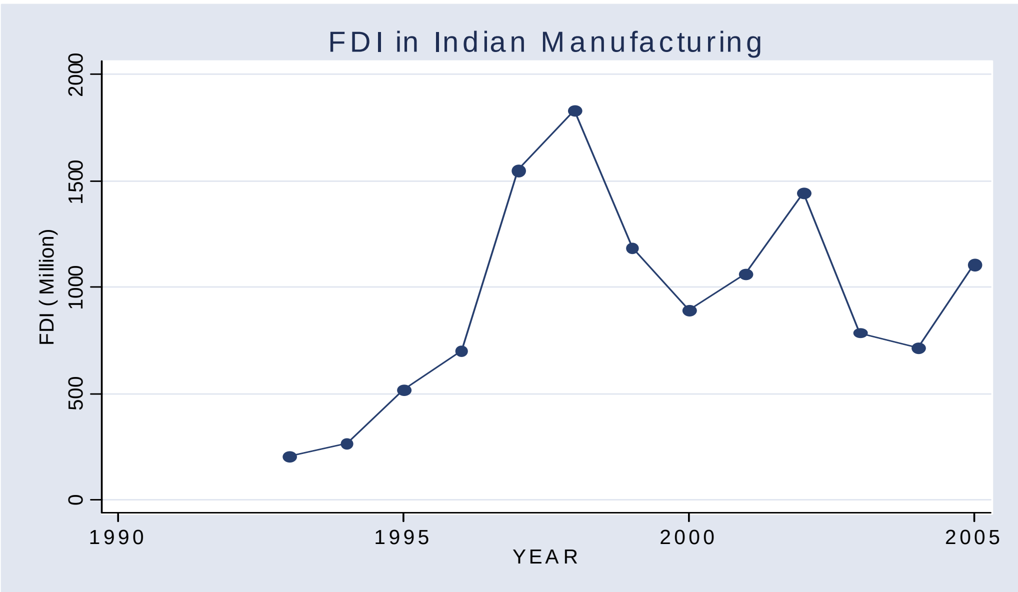

Figure-3

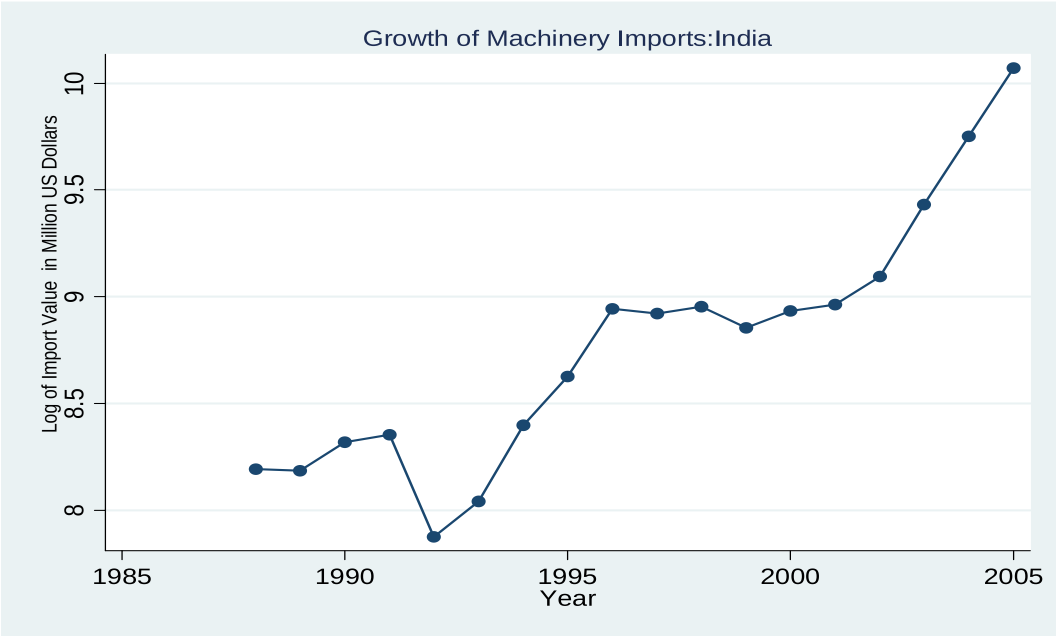

Table 1:Import of Capital Goods as percent of change in Gross Fixed Assets*

1989-90	7.4
1990-91	8.4
1991-92	9.8
1992-93	11.1
1993-94	12.2
1994-95	15.6
1995-96	20.6
1996-97	20.5
1997-98	17
1998-99	22
1999-00	18.3
2000-01	18
2001-02	13
2002-03	31.3
2003-04	25.6
2004-05	21.2

*Estimates based on the sample of Manufacturing Companies covered in the CMIE report.
Source: CMIE, July 1997,May 1999, May 2002,June 2007

Figure-4

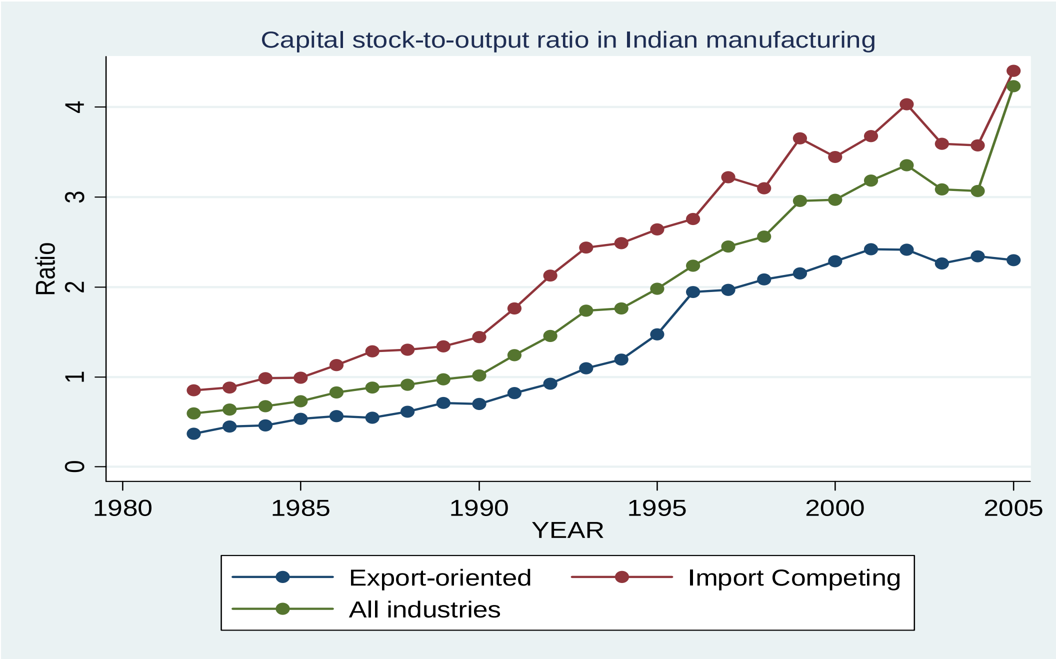

Figure-5

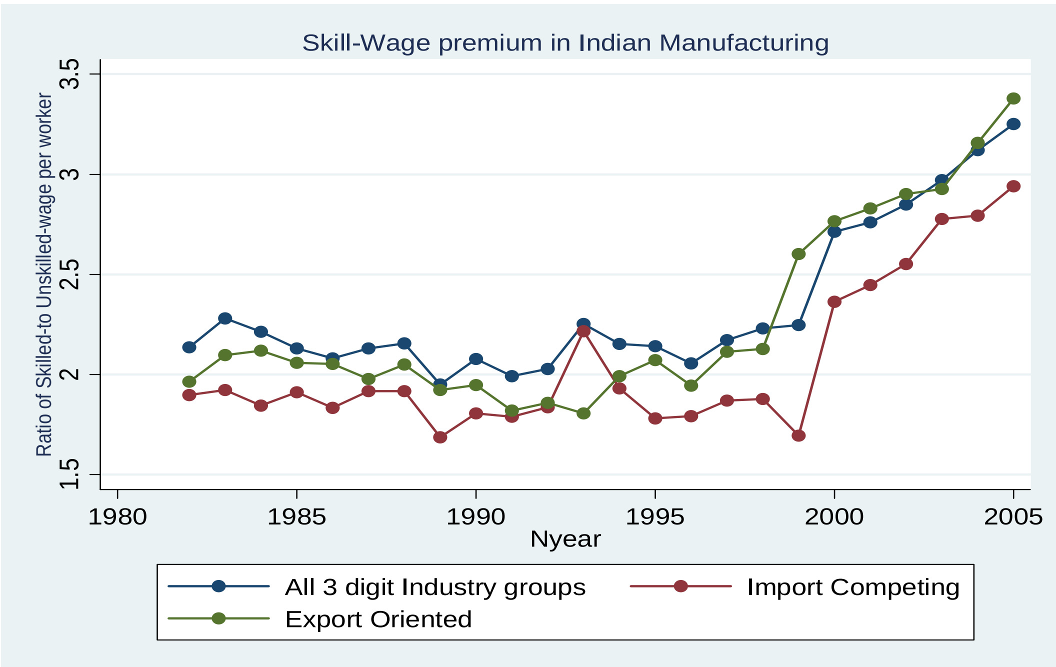

Figure-6

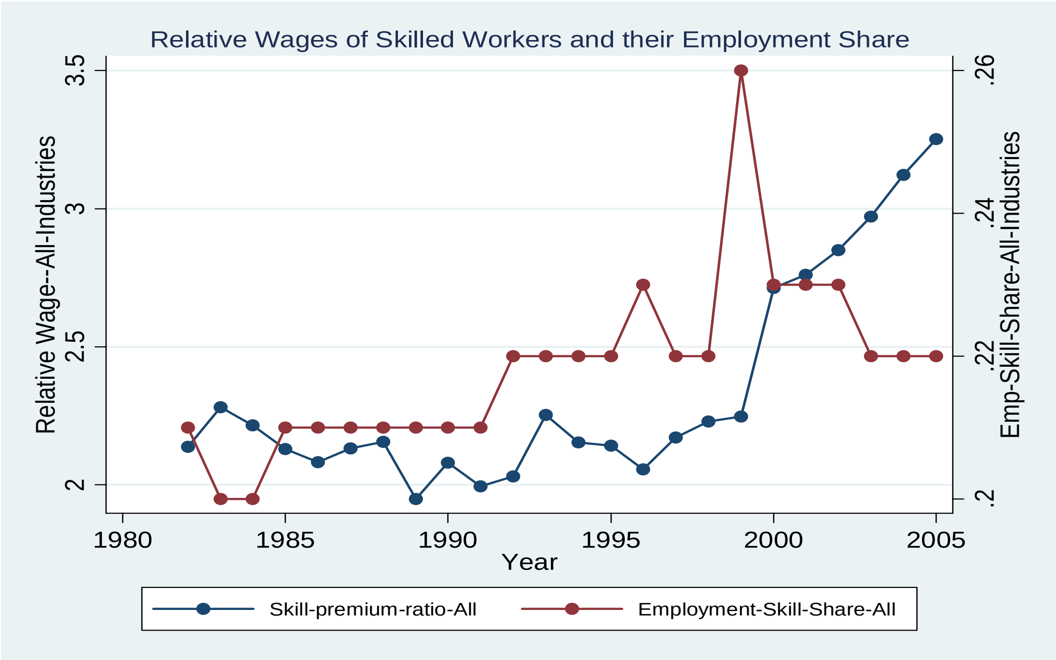

Figure-7

III. Analytical Framework and Data:

The key empirical development reported in many developing countries has been the increase in the ratio of skilled to unskilled wages (W_s/W_u=relative price of labour) accompanied by a rising ratio skilled to unskilled employment (L_s/L_u= relative quantity of employment). This suggests an outward shift in the relative demand curve for skilled labour. What has caused this shift in relative demand for skill? One school of thought attributes this shift to skill-biased technological change (SBTC). SBTC improves the relative productivity of skilled labour within industries and firms within industries causing their wages to go up. A straightforward test of this proposition is to examine whether the aggregate skilled-unskilled wage ratios have gone up due to increase in wage gaps *within* industries or due to greater expansion of skilled-labour intensive industries raising their share in aggregate employment. It is important to recall that according to the traditional approach of H-O-S theory, trade affects labour by a process of inter-industry allocation. As relative output prices change due to openness relative factor demand change inducing re-allocation of labour. Trade impacts labour markets in developing countries by shifting the derived demand for labour *between* industries from those intensive in skilled labour to those intensive in unskilled labour. Many empirical studies have used simple decomposition exercise that decomposes the increase in the skill-wage fraction of total wage bill into shifts that occur within and between industries as an important indicator of sources of change in labour demand (Berman, Bound and Griliches 1994, Berman and Machin 2000).

A standards method is to estimate the following decomposition formula for a change in S (wage-bill share of skilled-labour) in industries i….n.

$$\Delta S_t = S_i - S_\tau = \sum \Delta s_{it} .E_i + \sum \Delta E_{it}. s_i$$

Where, E_{it} is the share of industry i's employment in total employment at time t, s_{it} is the share of skilled-labour wage-bill in total wage-bill in industry i,

$E_i = ½(E_{it} + E_{i\tau})$ and $s_i = ½(s_{it} + s_{i\tau})$

The first term on the RHS represents the within industry change as weighted sum of change in skill-wage shares within industries with weights given by mean employment shares measuring the relative importance of each industry in the aggregate and the second term represents the between industry change, attributing the skill-wage share to changes in the employment shares of different industries. If the proportion of total change in skill-wage-bill share (S) is dominated by within industry change then it is taken as evidence in support of SBTC. However, one needs to recognize that other factors could also possibly cause within industry change in S as pointed out by others (Feenstra 2003).

The within-industry variation in skill-wage shares is further analyzed using an econometric approach (Berman, Bound and Griliches (1994). The econometric approach is based on the quasi-fixed cost function approach to factor demand. The cost function is used to derive equations for shares of skilled and unskilled labour payments in total factor payments for all variable factors assuming that some of the inputs are fixed and the quantities of variable inputs are chosen to minimize costs. Consider the variable cost function, in two variable inputs, namely, skilled-labour and unskilled-labour with capital and output considered as fixed:

$$C = f(W_s, W_u, K, Q) \quad (1)$$

Where C is total variable cost, W_s and W_u are the prices of variable inputs, namely, skilled and unskilled labour, K is the stock of plant and equipment and Q is real output.

The equation in (1) is assumed to take the translog function:

$$\ln C= \alpha_0 + \beta_s \ln (W_s) + \beta_u \ln (W_u) + \beta_q \ln (Q) + \beta_k \ln (K)+ ½ \{\beta_{su} \ln (W_s) \ln (W_u) + \beta_{ss} \ln (W_s)^2 + \beta_{us} \ln (W_u) \ln (W_s) + \beta_{uu} \ln (W_u)^2\} + ½ \{\beta_{qq} \ln (Q)^2 + \beta_{kk} \ln (K)^2 \} + \beta_{qs} \ln (Q) \ln (W_s) + \beta_{qu} \ln (Q) \ln (W_u) + \beta_{ks} \ln (K)\ln (W_s)+ + \beta_{ku}\ln(K) \ln (W_u) + \lambda\ln (K) \ln (Q) + \epsilon \quad (2)$$

Where ϵ is the disturbance term. Shephard's lemma implies the following necessary condition for cost-minimization[13]:

$$\partial \ln C/\partial \ln W_i = S_i \quad (i = s, u) \quad (3)$$

Where S_i = share of ith factor input in total variable cost. Differentiating (2) with respect to ln (W_i), imposing the standard restrictions of symmetry and homogeneity of degree one in prices, and using the equilibrium condition (3), I obtain the cost share equation for each factor[14]. The wage-bill share equation for skilled-labour can be written as:

$$S_s = \alpha + \beta_1 \ln (W_s/W_u) + \beta_2 \ln (K/Q) + \beta_3 \ln (Q) + \epsilon \quad (4)$$

If $\beta_2 >0$, then capital is complementary to skilled-labour. The scale effect of production operations is measured by β_3. If relative factor demand is independent of scale at each relative factor price ratio, then $\beta_3 =0$ otherwise $\beta_3 >0$[15]. Note that the estimation of equation (4) is based on several assumptions. First, it is assumed that

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[13] Note that $\partial\ln C/\partial\ln W_i = \partial C/\partial W_i.W_i/C = W_i.E_i/C=S_i$. Where $\Sigma W_iE_i =C$. And $\Sigma S_i=1$. The cost shares sum to one.

[14] The cost share equations take the following form:

$$S_i = \alpha_i + \beta_{qi} \ln (Q) + \Sigma_j \beta_{ij} \ln Wj + \beta_{ki} \ln (K)$$

Given that $\Sigma S_i=1$ and the symmetry and homogeneity restrictions, only one of the two share equations required to be estimated. The parameters of the remaining equation can be retrieved from the parameters of the estimated equation. Using the restrictions and the constant returns to scale assumption of one can write the skill-wage share equation for econometric estimation as in equation (4 in the text. See Berman et al (1993)

[15] If the production function is non-homogenous then optimal factor-proportion is function of relative factor prices as well as the level of output. See Hamermesh (2000) page 32.

capital and value added can be treated as variables not affected by the current-wage share skilled-labour. Second, the R.H.S of the estimating equation includes a term that is a ratio of relative wage (W_s/W_u). However, it is pointed out that the price of quality-adjusted skilled-labour and unskilled-labour does not differ between industries. Once the wages are adjusted for quality then over-time, the change in relative wage will be a constant. Further, given the relationship between the dependent variable ($S_s=W_s/\Sigma W_i$) and the wages per skilled worker (W_s/E_s), estimates are likely to suffer from spurious correlation. Following this the relative wage term ln (W_s/W_u) is dropped from equation (4). This yields the actual panel estimation equation:

$$S_{it} = \alpha + \beta_1 \ln (K_{it} /Q_{it}) + \beta_2 \ln (Q_{it}) + \delta Y_t + \lambda_i + \varepsilon_{it} \quad (5)$$

Where, S_{it} is the wage bill share of skilled-labour in industry i in year t, ln (K_{it} /Q_{it}) is the log of capital to output ratio in industry i in year t and ln (Q_{it}) is the output level in industry i in year t, Y represents YEAR dummies and λ_i is the industry-specific effect and

ε_{it} is a white noise error term. The variable λ_i captures all unobserved time-constant industry-specific factors that affect S_{it} (unobserved by the econometrician). Y_t captures shocks to S_{it} that vary over time. It is often useful to weight the observations used to estimate equation (5) by the share of each industry's wage-bill in total manufacturing wage-bill. I do follow this practice such that large industries receive more weight in the regression.

Equation (5) can be estimated using both the fixed effects (FE) and time differencing (TD). They are alternative methods for controlling unobserved heterogeneity. I focus on TD with longer time differences like eight-year and six-year differences of the underlying data. By taking differences over a relatively long period, I am in effect allowing industries (firms) to have reasonable time to adjust skilled labour demand to a given shock. The long difference estimators are shown to be less sensitive to measurement errors than the fixed effects estimator (Griliches and Hausman 1986; Westbrook and Tybout 1993). For purposes of comparison I do present the FE estimates for the three-period panel of 4-digit industries. The econometric issue of correlation between the error term and the explanatory variables, say value added, may still be a matter of concern. The use of time differencing and year dummies should largely alleviate the problem. Other variables of direct interest like the import penetration ratio and indicators of labour regulation can be introduced into the regression equation (5).

Data:

The 3-digit and 4-digit industry level data is based on the published results of the Annual Survey of Industries (ASI) that covers all registered factories with more than 10 workers (ASI-EPW 2007 Volume-II). India's National Industrial Classification (NIC) changed in 1989-90 and 1998-99. ASI-EPW volume II presents a consistent series based on NIC-1998 at the 2-digit and 3-digit level of aggregation. I use the data for 46 3-digit industries for which consistent data is available covering the period 1981-82 to 2003-04. Then I update the series using the ASI factory sector results for the year 2004-05. More detailed data on employment and wages is published in the published volumes of the ASI-factory sector results that present data at both 3-digit and 4-digit level[16]. This is available for only selected years. I have constructed the data on output, employment and wages for 3 selected years at the 4-digit level for 1993-94, 1998-99 and 2004-05 using the concordance tables to convert NIC-1987 (for 1993-94) into NIC-1998 such that I can estimate regression (3) based on three time

[16] Annual Survey of Industries 2004-2005, Factory Sector, Summary Results, Volume-I, Central Statistical Organization, New Delhi

periods. For these 3 years I have used the UNIDO demand and supply data base (UNIDO, 2008) to estimate trade data by industry (exports and imports) based on International Standard Industrial Classification (ISIC-revision-3) that is consistent with NIC-1998. This study will cover the period 1981 to 2004. This will have two important advantages:(1) this period includes the years in which FDI inflow into Indian manufacturing underwent a structural break. Imports of machinery and capital goods by the Indian manufacturing firms substantially increased (2) this longer time-span that enables me to use long differencing in terms of 4-year or more than 4-years. Output is measured by gross value added deflated by industry-specific prices based on the Whole-sale Price Index (WPI) for manufactures with the base year 1993-94.Capital by the gross value of fixed assets deflated by price index of machinery at 1993-94 prices. The price index of machinery is weighted average of electrical and non-electrical machinery price indices[17]. The other variables are defined as follows:

Wage-bill-Share of Skilled Workers =(Total Wage-bill minus Wage-bill of Workers) / (Total Wage-bill) Employment share of Skilled Workers = (Total Employees minus Total Production Workers)/(Total Employees)

The ASI reports the total number of employees and total persons engaged separately till 1997-98 at the 3-digit level. The latter includes unpaid family workers and owner-proprietors and 'others' not directly engaged in production activity. Since 1998-99 only the total persons engaged are reported for 3-digit industries. However, since 2001-02 the ASI published reports provide the figures for number of employees and persons engaged separately. A careful examination of the data for the years 2001 and 2002 revealed that employment share of category "Unpaid family members/proprietors etc" is less than one percent of the total employment (all

[17] The source of data for WPI is the India-stat data base available at http://www.indiastat.com

industries). This implies an insignificant share at the level of individual industries. Therefore, for the period 1998-99 to 2004-2005, at the 3-digit level total persons engaged is taken as an estimate of total employees. Total emoluments paid out (our estimate of Total Wage-bill) includes bonus paid in addition to wages. Total wages paid for workers excludes bonus. This overestimates the wage-bill of skilled workers. Bonus is estimated to constitute about 9%-10% of total emoluments with hardly much variation over the period under study. Therefore this should not pose serious problems for my study. Further this problem disappears at the 4-digit level as bonus is excluded in the data on wages paid out to workers and other employees available in the published volumes cited above for the years 1998-99 to 2004-05. The explanatory variables include variables that will capture the capital-skill complentarity effect, scale effect, import competition effect and labour regulation effect. The econometric analysis will be preceded by decomposition analysis of wage inequalities. The decomposition analysis will investigate the within- and between effects of skilled and unskilled wage-bill ratio in the selected set of 46 three-digit industries.

IV Results

The results of decomposition of skill-wage share change for different time periods are presented in Table-2. In the pre-reform period of 1981-89 the skill-wage share declined by 0.08 percentage points per year. In the two post-reform sub-periods, it increased by 0.37 percentage points per year. The proportion of the total change in skill-wage share is accounted for by "within" industry changes in all the three periods under consideration. In other words, the skill-wage share change is driven by within industry change as the between industry allocations are insignificant. This supports the proposition of SBTC. A shortcoming of the decomposition approach is that the measurement of the within-industry is component is sensitive to the level of aggregation used in the analysis. At each level of industry aggregation the mix of constituent heterogeneous industries with different skill-intensities will vary. As a result the decomposition may fail to pick up the within industry effects that could be taking place within more disaggregated industries, say, within 4-digit industry in a 3-digit level analysis.

Table-2: **Decomposition of Δ Share of Skilled-Labour in Wage-bill**			
	1981-89	1991-98	1998-2004
Δ Skill-Wage Share x 100*	-0.08	0.37	0.37
Within Industry (%)**	123.7	116.5	110.4

* Based on 46 3-digit industries in the ASI. Average annual change for the over the relevant period.
* Percentage "within" is the percentage of the change due to increases within industry following the decomposition formula in the text.

In Table 3 the results of OLS estimation of equation 3 for a set of 46 three-digit industries is presented. The regression estimates in the first column represent the pre-reform period, that is, 1981-1989. This is a two-period panel data with a time difference of 8 years. This is followed by followed by three-period (8-year and 7-year differences) and four-period (8-year, 7-year, and 6-year differences) panel data estimates in the third and fourth columns. Estimate for the pre-reform period (column 1) indicates the decline in skill-wage share, as the constant term is negative and significant. The coefficients of log output-change is weakly significant and the log of change in capital-output ratio is insignificant. R-square is very low (0.02) and not significant. This supports the hypothesis of absence of SBTC in the pre-reform period. In contrast, the estimates of coefficients of output and capital-output in column 2 and 3 are statistically significant, after allowing for secular change (captured by time dummies-estimates are not shown) and unobserved industry-specific heterogeneity. We may recall that time differencing has been used to sweep out the time-constant industry specific factors impacting the wage share of skilled-labour. R -square is significant in both panels[18]. These results support the hypothesis of SBTC due to capital-skill complementarity in production captured by increasing capital-output ratio. The significant output change coefficient indicates that skilled-unskilled ratio is positively related scale of output. My estimates of capital-skill complementarity based on 3-digit industries are directly comparable with that of Berman et al (Berman et al 2005). My results for the pre-reform period are similar. However, my estimate (0.123) for the period 1981-1998 seems to be substantially higher than their estimate (0.04) for 1990-1998 (0.04, Berman et al (2005), Table 8,page 25).

However my estimate using three period panel data is 0.08 and somewhat closer to their estimate of capital-skill complementarity. This may be attributed to differences in data and estimation method. I observed that data for the year 1998-99 showed large increases in the employment and wage shares of skilled-labour. In that year the new industrial classification (NIC) was first adopted for the annual survey of industries. The sampling design used was the one first introduced in 1997-98. A careful examination of the 4-digit level data revealed a large increase in the reported skill-wage bill shares in non-electrical equipment industries. I have re-estimated the

[18] I have estimated the equation for three-period and four-period panels with change in log of output and log of capital-output ratio as the single explanatory variable. Both are statistically significant at conventional levels

regression after dropping the year 1998-99. My results do not change and the estimate of capital-skill complementarity effect is higher than that reported in Table 3[19].

Table-3: Skill-Wage Share Regressions: Panel Data Estimates Estimates for 46 Three-digit Industries			
Dependent variable: Δ Share of Skilled-Labour in Wage-bill			
0	1	2	3
Explanatory Variables	1981-1989 T=2	1981-1998 T=3	1981-2004 T=4
Δ ln (Output)	0.0194* (1.69)	0.2038*** (4.12)	0.1795*** (3.91)
Δ ln (Capital/Output)	0.0237 (1.45)	0.1227** (2.09)	0.0794** (2.80)
Constant	-0.0276** (-1.90)		
Year Dummies	NO	YES	YES
Observations	45	90	136
R-Squared	0.02	0.328	0.289
Absolute value of robust t-*statistics* in parentheses. (*) Significant at 10% level. (**) Significant at 5% level. (***) Significant at 1* level. They are based on Huber-White standard errors robust to within panel serial correlation and heteroskedasticity. Estimates for constant are not reported for column 2 and 3.			

In Table 4 the estimate of equation (3) based on 113 four-digit industries is presented. This set of estimates is based on three two-period panels covering the years 1993-94 to 2004-05 with 4-year, 5-year and 10-year differences respectively. I will be referring to as panel-1, panel-2 and panel-3 respectively. As I noted earlier more

[19] I estimated the first differenced model with 1981, 1990 and 2004 as panel years. The coefficient of log output change is 0.183 and the coefficient of capital/output ratio is 0.222.Both are highly significant.

detailed data for employment is available for four-digit industries for selected years. The data on number of workers is further subdivided into regular workers and contract workers. Similarly, the data on wages and salaries paid is separately available for workers and non-manual employees. Data on Non-manual employees is an aggregate of managers, supervisors plus others not belonging to manual workers/supervisory positions. Consequently, the wage differential between skilled and unskilled labour is more accurately measured[20]. In addition to output and capital-output ratio, I have introduced contract intensity, measured as share of contract workers in total workers and import to output ratio as additional variables. The first is a measure of the impact of restrictive labour regulations (Ramaswamy 2005). Contract intensity is a firm level response to India's labour market rigidity. If labour regulations raise the expected cost of hiring unskilled workers it should create more incentive for the industry to hire skilled labour who are substitutes for unskilled labour. The expected sign for the coefficient of contract intensity is positive. Imports-to-output ratio is a trade variable that is a measure of import penetration whose expected sign is positive.

In Table 4A two columns for each panel is separately shown. The first includes all the 4 variables and the second column assumes constant returns to scale (CRS) and thus excludes output variable. The estimated coefficient of output is consistently positive and significant in all three-time periods. However, capital-output ratio is positive but not significant in the first and third panel (column 1 and column 5) and in the CRS specification in the second panel (column 2). The CRS specification in panel-2 is in fact problematic as R-square is very low and none of the

[20] I have plotted the wage differential between workers and supervisors as well as workers and other non-manual employees for two selected years, namely 1998 and 2003, for 122 four-digit industries in Figures A1 and A2 respectively in the appendix.

estimated parameters except the constant term are significant. Import-output ratio is insignificant in all the three panels. In brief the widely used direct measure of international trade variable does not have any significant impact. The interesting parameter is the contract-intensity whose coefficient is positive and significant in the CRS specification in panel-1 and panel-3 (column 2 and column 6 of Table 4A). It is positive and not significant in the first and in the third panel (column 1 and column 5). This may be interpreted as follows. 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).

In Table 4B, estimate of equation (3) using the three-period panel of four-digit industries is presented. I have presented the parameter estimates based on First Differenced (FD) and Fixed Effect (FE) models for the three-period panel as they are alternative approaches to control unobserved industry specific heterogeneity when T>2[21]. The estimated coefficients based on FD and FE methods are very close that provides greater confidence in the estimates. The estimated coefficient of capital-output ratio is found to be similar with a value equal to 0.0027-0.0040 for the three-period panel. This is substantially smaller than the reported estimate (0.04) of Bound et al (2005). As we noted earlier the parameter estimate for the US for the period 1959-86 is 0.038 (Berman, Bound, Griliches 1994). My estimate of capital-skill complementarity is therefore 7 to 10 percent of US estimate. This may be interpreted

[21] A comparison for each model between the standard OLS t-statistics and the robust t-statistics were also carried out. They are not presented to save space. Estimated coefficients do not change but the robust estimates have large standard errors and therefore the statistical significance of estimated coefficients differ relative to standard OLS t-statistics.

as much weaker capital-skill complementarity effects in Indian manufacturing in the years of trade and investment liberalization and production structure upgrading. However, the direction of change in skill-wage share due to capital-skill complementarity is clearly positive.

Table 4A: Skill-Wage Share Regressions: Two Period Panels

Estimates for 113 four-digit Industries

Dependent variable: Δ Share of Skilled-Labour in Wage-bill

	1993-1998 T=2		1998-2004 T=2		1993-2004 T=2	
Δln (Output)	0.0042*** (2,81)		0.0004*** (7.08)		0.0027*** (4.81)	
Δln (Capital/Output)	0.0016 (0.74)	0.0050** (2.22)	0.0004** (2.25)	0.0003 (0.17)	0.0029 (1.39)	0.0043** (2.17)
Δln (Contract Intensity)	0.0010 (0.85)	0.0034** (2.20)	0.0000 (0.18)	-0.0000 (-0.06)	0.0031 (1.24)	0.0058** (2.30)
Δln (Import/Output)	-0.0005 (-1.28)	-0.0001 (-0.45)	0.0002 (0.10)	-0.0007 (-0.47)	-0.0005 (-1.23)	0.0002 (0.34)
Constant	-0.0016 (-1.06)	-0.0025 (-1.56)	0.0006** (2.22)	0.0007** (2.49)	-0.0030 (-1.16)	-0.0038 (-1.44)
Observations	95	95	100	100	96	96
R-squared	0.478	0.352	0.138	0.002	0.561	0.336

Absolute value of robust t-*statistics* in parentheses. (*) Significant at 10% level. (**) Significant at 5% level. (***) Significant at 1* level. They are based on Huber-White standard errors robust to within panel serial correlation and heteroskedasticity.

Table 4B: **Skill-Wage Regressions: Three Period Panel (1993-2004)** **Comparison of First Differenced and Fixed Effect Estimates** **Dependent variable: Share of Skilled-Labour in Wage-bill**				
	First Differenced (FD)		Fixed Effect (FE)	
ln(Output)	0.0025** (2.32)		0.0027*** (5.99)	
ln(Capital/Output)	0.0027* (1.84)	.0037** (2.22)	0.0027* (1.68)	0.0040** (2.27)
ln(Contract Intensity)	0.0018 (1.59)	0.0029** (2.08)	0.0021 (1.46)	0.0038** (2.16)
ln (Import/Output)	0.0000 (0.08)	0.0004 (1.17	-0.0001 (-0.54)	0.0003 (0.84)
Observations	195	195	310	310
R-squared	0.411	0.268	0.481	0.300
Year Dummies	YES	YES	YES	YES
Absolute value of robust t-*statistics* in parentheses. (*) significant at 10% level.(**) significant at 5% level.(***) significant at 1* level. They are based on Huber-White standard errors robust to within panel serial correlation and heteroskedasticity				

A final set of estimate comparison is presented in Table 4C that further support the robustness of my results. Here I compare the FD and FE estimates with and without year dummies. It may be argued that additional inclusion of time dummy may not be required as long as the included variable (output) is picking up the time-varying effects. Note that the regression estimates in Table 4C (column1 and column 3) contain both output as well as year dummies. In columns 2 and 4 the estimates are shown after dropping the year dummies. In the FD model one can immediately notice that the statistical significance of capital-output ration and contract-intensity improves relative to estimates with time dummies. Output, capital-output ratio and contract intensity are positive and statistically significant at conventional levels (Column 3). The FE model results do not show much change. This is supportive of the positive impact of capital-skill complementarity and contract-intensity on skill-wage inequality in Indian manufacturing.

Table 4C: **Skill-Wage Regressions: Three Period Panel (1993-2004) Comparison of First Differenced and Fixed Effect Estimates Dependent variable: Share of Skilled-Labour in Wage-bill**				
	First Differenced (FD)		Fixed Effect (FE)	
ln (Output)	0.0025** (2.32)	0.0026** (2.35)	0.0027*** (5.99)	0.0027*** (5.92)
ln (Capital/Output)	0.0027* (1.84)	.0027** (1.90)	0.0027* (1.68)	0.0032** (1.74)
ln (Contract Intensity)	0.0018 (1.59)	0.0016** (1.66)	0.0021 (1.46)	0.0015 (1.50)
ln (Import/Output)	0.0000 (0.08)	-0.0002 (0.08)	-0.0001 (-0.54)	-0.0004 (-1.63)
Observations	195	195	310	310
R-squared	0.411	0.394	0.481	0.466
Year Dummies	YES	NO	YES	NO
Absolute value of robust t-*statistics* in parentheses. (*) Significant at 10% level. (**) Significant at 5% level. (***) Significant at 1* level. They are based on Huber-White standard errors robust to within panel serial correlation and heteroskedasticity				

V Summary and Concluding Remarks

Wage inequality between skilled and unskilled labour is one important component of income inequality. This paper examined the question of wage inequality in Indian manufacturing in the years of trade and investment liberalization. A first look at the aggregate data suggested an increase in relative employment and relative wages of skilled-labour in the 1990s continuing up to 2004-05, compared to the trend in the 1980s. This fact suggested that shift in aggregate demand in favour of skilled-labour is responsible for the increase in wage inequality. An examination of changes in FDI inflow into manufacturing, share of imported capital goods in fixed capital formation and changes in capital-output ratio, the key sources of technological change, clearly indicated that these were the years of upgrading production structure in Indian manufacturing. I estimated the wage share equation based on translog variable cost function to test the hypothesis of capital-skill complementarity and skill-biased technological change. The skill-wage share equation is estimated for a panel of 46 three-digit industries spanning the period 1981-2004.followed by 113 four-digit industries panel covering the period 1993 to 2004.The coefficient of change in the log of output (scale effect) is estimated to be positive and highly significant. This suggests that in Indian manufacturing skilled/unskilled labour ratio is not invariant to scale of output. Contract-worker intensity of production worker is found to positively impact skill-wage shares. This is interpreted to suggest that restrictive domestic labour regulations applied to manual workers encourages greater skilled-labour demand. The estimates of coefficient of log change in capital-output ratio after accounting for year effect and unobserved industry specific heterogeneity is found to be 0.004. This estimate is substantially lower than 0.038, the estimate for the US manufacturing industries for the 1960s and 1970s by Berman, Bound and Griliches (1994). This is not surprising as the extent of capital deepening in Indian manufacturing is substantially lower than that of the US. However, the direction of change is found to be clearly in favour of skill-biased labour demand towards non-manual labour in the years of trade openness in India. This is in line with the proposition that skill bias in labour demand is an endogenous response to trade openness (Acemoglu 2003). My results are consistent with the other studies in developing countries supporting hypothesis of skill-biased technological change (Pavenik 2003: Goldberg and Pavenik 2007).

My results support the proposition that trade openness has changed the relative skill-wage by shifting out the demand for skilled labour. In another study of labour demand in Indian manufacturing (Hasan, Mitra and Ramaswamy,2007) we had found support for the Rodrik (1997) hypothesis that trade liberalization adversely affect unskilled labour by making labour demand more elastic (flatter labour demand curves). This puts greater pressure on unskilled labour by weakening their bargaining power. Taking these results together one may conclude that trade openness will not be a bowl of cherries for unskilled labour in Indian manufacturing. What should be the appropriate policy response is a difficult question that certainly demands more research.

Appendix

Figure A1

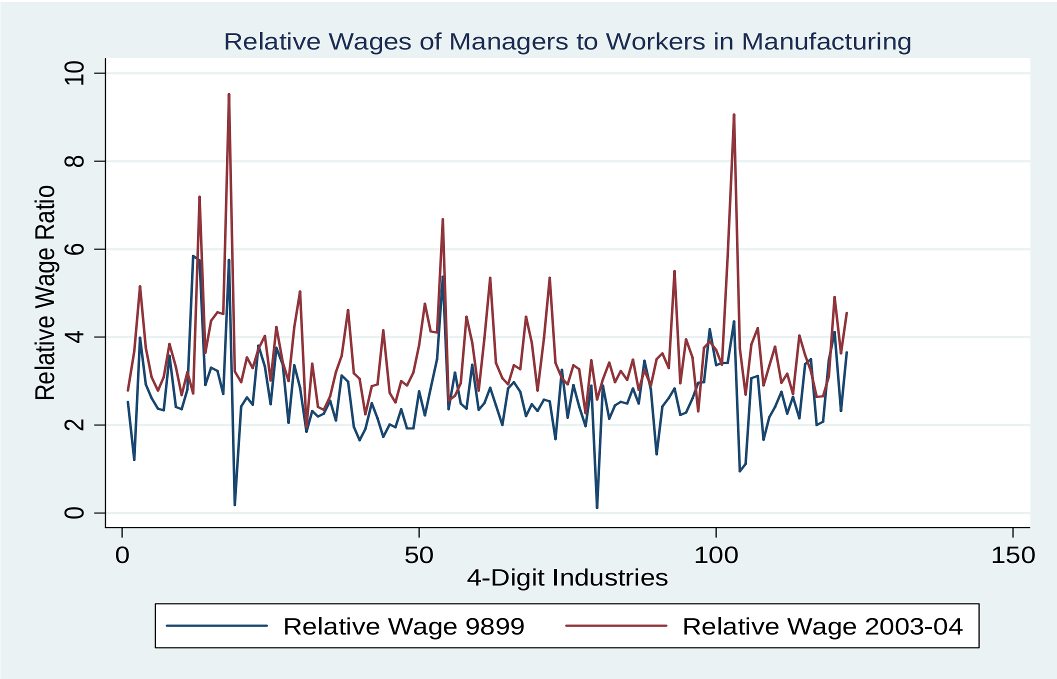
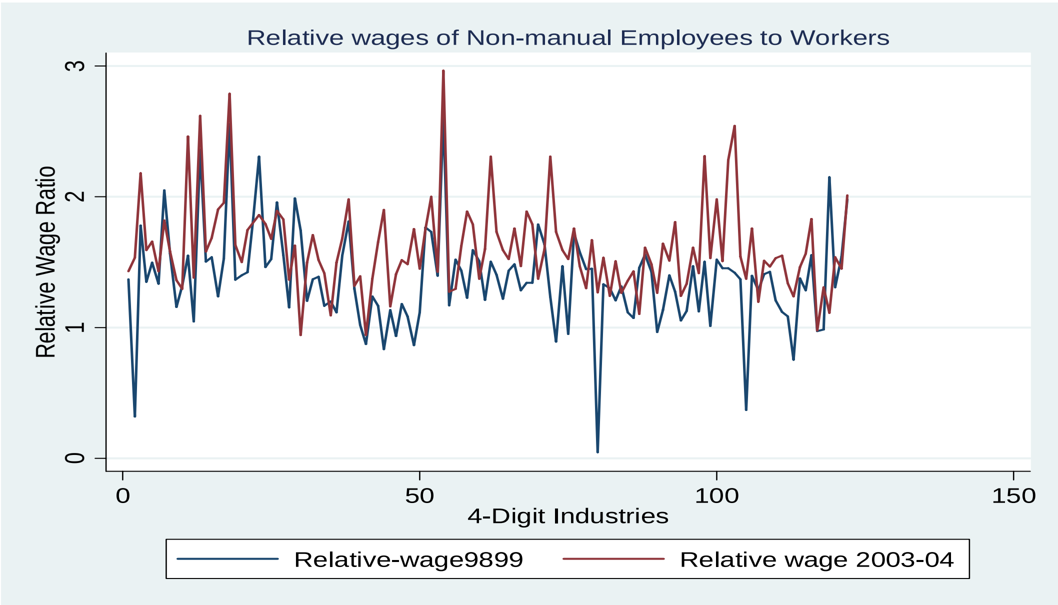


Figure A2



Appendix B: List of 46 3-digit Industries

151	Production, processing and preservation of meat, fish, fruit vegetables, oils and fats
152	Dairy products
153	Grain mill products, starches and starch products, and prepared animal feeds
154	Other food products
155	Beverages
160	Tobacco products
171	Spinning, weaving and finishing of textiles
172	Other textiles
173	Knitted and crocheted fabrics and articles
181	Wearing apparel, except fur apparel
191	Tanning and dressing of leather, luggage etc
192	Footwear
201	Saw milling and planing of wood
202	Products of wood, cork, straw and plaiting materials
210	Paper and paper product
221	Publishing
222	Printing and service activities related to printing
241	Basic chemicals
242	Other chemical products
251	Rubber products
252	Plastic products
261	Glass and glass products
269	Non-metallic mineral products n.e.c.
271	Basic Iron & Steel
272	Basic precious and non-ferrous metals
281	Structural metal products, tanks, reservoirs and steam generators
289	Other fabricated metal products; metal working service activities
291	General purpose machinery
292	Special purpose machinery
293	Domestic appliances, n.e.c.
300	Office, accounting and computing machinery
311	Electric motors, generators and transformers
312	Electricity distribution and control apparatus
313	Insulated wire and cable
314	Accumulators, primary cells and primary batteries
319	Other electrical equipment n.e.c.
321	Electronic valves and tubes and other electronic components
323	Television and radio receivers, sound or video recording apparatus
331	Medical appliances and instruments and appliances
332	Optical instruments and photographic equipment
333	Watches and clocks
341	Motor vehicles
342	Bodies (coach work) for motor vehicles, trailers and semi-trailers
351	Building and repair of ships & boats
352	Manufacture of railway and tramway locomotives and rolling stock
361	Manufacture of furniture

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