Trade, Technology, and Institutions: How Do They Affect Wage Inequality? Evidence from Indian Manufacturing

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(*Draft version*)

Abstract

The phenomenon of rising income/wage inequality observed in many developing countries is one of the major concerns that economists and policy-makers have been facing over last two decades of rapid globalization. Rising wage inequality in developing country is *paradoxical* of what the Heckscher-Ohlin and Stolper-Samuelson models predict. This paper explains the changing pattern of wage inequality in Indian manufacturing sector in the period of its greater participation in the globalization process through India's economic and trade liberalization over last two decades. Using five different wage inequality measures such as skilled-unskilled wage ratio, Gini Coefficient, 90-50 wage ratio, 90-10 wage ratio, and 50-10 wage ratio, this paper explains how trade, technology, and institutional factors have impacted on these wage inequality measures. Each of these factors has differential outcomes across these five wage inequality measures.

I. Introduction

Over last two decades, many developing countries have adopted major liberalization policies through opening up their markets for international trade, foreign capital flows, and promoting flexible labour market. Empirical evidence show that rising wage inequality and economic liberalization have been observed simultaneously in many developing countries.

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Mexico observed the rise in wage inequality in the period 1987 to 1993, Columbia in 1986-1998, Argentina in 1992-1998, India in 1987-1999; moreover, these are the periods of major trade liberalizations in these countries respectively (Goldberg and Pavcnik, 2006).

The trade theories, especially the Heckscher-Ohlin (H-O) and Stolper-Samuelson (S-S) theories predict a reduction in wage inequality between skilled and unskilled labour for the developing countries once they increasingly open up their market for international trade. As developing countries are presumed to be unskilled labour abundant, so they have comparative advantage in unskilled labour intensive goods, and therefore, they specialize on it. An opening up of international trade leads to an increase in the exports and the prices of unskilled labour intensive products. As a result, the unskilled labour demand and their wages increase relative to the skilled labour demand and skilled wages. This should lead to a decrease in the wage inequality between skilled and unskilled labour in the developing country. But the empirical evidences from the most developing countries are completely opposite of what these two trade theories predicts. It is now a highly debatable topic for trade theorist and applied trade economists both to explain this seemingly contradictory phenomenon that is being observed in the developing world. So to find out the linkages between trade liberalization and wage inequality, one need to research on other plausible channels which might have impacted on the rising wage inequality. Section II presents a short review of the relevant literature; Section III describes the sources of the data used in this study; Section IV analyzes the estimates of five wage inequality measures; Section V analyzes the estimates of the trade liberalization indicators; In Section VI, we discuss the estimation results of five wage inequality functions. And Section VII gives the summary of this paper.

II. Literature Review

Empirical evidences suggest that the predictions of the H-O and S-S theory have not been observed in the real world. The general equilibrium H-O model is based on extremely restrictive assumptions such as perfect competition, perfect labour and capital mobility, trade in final goods, and fixed technology. These restrictive assumptions are making it extremely unmatched with real world; moreover, it is sometime hard to empirically test these models. On the other hand in case of S-S model relates trade-induced change in relative prices and factor prices. The prices of products are sometime determined endogenously, and may change for reasons unrelated to trade. For this reasons a direct link between product prices and factor prices - as suggested by general equilibrium trade model - has been empirically elusive. For

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example in the USA, since 1980s there was no clear decline in the relative prices of the unskilled labour intensive products although there was a rising wage inequality between skill and unskilled labour. Contrary to the factor endowment based trade theories where trade liberalization would involve labour reallocation from contracting sector to expanding sector, it has been seen for developing countries that lack of labour relocation/mobility across sectors lead to the market adjustment through changing relative wages and profit margins (Revenga, (1997), Hanson and Harrison, (1999), Topalova, (2004)).

Another line of explanation of rising wage inequality focuses on the pattern of trade protection prior to trade liberalization in developing countries. It is seen that the unskilled labour intensive sector in developing countries was more protected, and due to trade liberalization, the unskilled wage was impacted (declined relative the skilled wage) the most by tariff cuts in unskilled labour intensive goods (Hanson and Harrison, 1999; Currie and Harrison, (1997), Attanasio, Goldberg, and Pavcnik (2004)).

Apart from the standard trade theories which are highly stylized vis a vis the real world, it is possible to reconcile the evidences on wage inequality by considering various extension of the original model. One most important aspect of recent trade pattern is that it no longer keeps the technology *fixed*, i.e. technology is not exogenously given for a country. A country's technological orientation in production may change due to diminishing trade protectionism and increasing international trade (Wood, 1997; Robbinson, 1995). The trade liberalization in developing countries provide an opportunity to augment their existing technology with advanced imported technology which becomes cheaply available through trade liberalization and increasing capital inflows (Acemoglu, 2003).

Now the question is how such trade-induced technological change increases wage inequality. It is seen that the trade-induced technological changes is mostly skilled-biased, i.e. trade-induced technological change demands more skilled labour replacing the unskilled labour - this is called skill-biased technological change (SBTC). Due to the SBTC, the skilled wage should increase relative to their unskilled counterpart, and this would lead to an increase in wage inequality. It is well recognized now that most credible explanation of changes in wage inequality would be how trade liberalization changes the SBTC.

Another deviation from the conventional trade theories in recent years is the increasing importance of trade in intermediate products or the 'outsourcing'. Feenstra and Hanson (1997) argue that the rapid expansion of 'outsourcing' or 'global production sharing' explains a part of the observed decrease in demand for unskilled labour in developed countries. The developed countries outsource the unskilled labour intensive segment of

production to the developing countries where unskilled labour is comparatively cheap. This leads to a decrease in unskilled labour demand in home country, and an increase in wage inequality. On the other hand, developed countries outsource the segment of production work which are done by the so called skilled labour in developing countries (for example, the India's IT & ES industry, China's hardware industry), in this case, the increasing demand for the skilled labour in developing countries increase the wage inequalities in these countries.

The conventional North-South trade is the dominating explanation of the economic inequality in the literature. The recent globalization no longer follows the North-South trade only. The South-South trade comprises slightly more than half of the world trade today, moreover, it is increasing. So it is important to see the implication of the South-South trade in the wage inequality particularly for developing countries. As the countries in the South are unskilled labour abundant, the trade in unskilled labour intensive goods within the South does not benefit the unskilled labour, which would have been better off if the South trades with the North. It is observed that an increasing wage inequality in developing countries is more due to the South-South trade liberalization than to the classical trade liberalization with northern countries (Julien, 2007).

Inequality may have occurred through the growth channel, but the evidence on the causal link between trade openness and growth has been controversial and inconclusive to date. This channel is potentially important because trade liberalization is presumed to be expediting economic growth and growth has its effects on distribution. Moreover, in all most every country, the macroeconomic policies are being followed to maximize the growth of the GDP. How does economic growth affect economic inequality? A set of literature say economic growth initially increases economic inequality because of costly restructuring of the economy and thereafter it reduces economic inequality once the restructuring of the economy gets over - the *Kuznets Curve*. But most of the empirical studies reject the Kuznets curve hypothesis (Ravallion, 1995; Deininger, K., & Squire, L. 1998; Majid, 2011). So the effect of economic growth on economic inequality is an empirical question for any country.

III. The Data

The unit of our observation is the manufacturing industry at the 3 digit level of National Industrial Classification in 1998 (NIC 98). The industry data is obtained from Annual survey of Industries (ASI) for the period 1989-2007. The ASI data covers the organized segment of the manufacturing sector. The wage inequality measure, namely, the skilled-unskilled wage ratio has been measured from the ASI data. The wage inequality

measures, namely, the Gini coefficient, the ratio of 90 percentile to median, the ratio of 90 percentile to 10 percentile, and the ratio of median to 10 percentile are calculated from the unit level data of the National Sample Survey's (NSS) Employment and Unemployment, which covers the total manufacturing sector, i.e. the organized and unorganized segments both. Four rounds of the Employment and Unemployment Surveys have been used; they are 50th round (1993-94), 55th round (1999-00), 61st round (2004-05), and the latest is 66th round (2009-10).

We have built a concordance between ISIC Rev. 3 (NIC 98) and SITC Rev. 3 from United Nations Statistical Division (UNSD) database to match the Indian industry data base with the trade data base. After building the concordance between ISIC Rev.3 (i.e. NIC 98) and SITC Rev 3, we used UN's COMTRADE database for getting the trade statistics required for our estimations. While constructing the variable South-South trade we defined 'South' as non-OECD countries.

IV. Wage Inequality for Indian Manufacturing Labour

Indian manufacturing sector contributes around 16 percent of India's GDP and 11 percent of total employment as of 2009. This sector has significant duality between organized and unorganized sectors within the total manufacturing. Unorganized manufacturing are mostly run by the self-employed entrepreneur with less than twenty wage labor and/or family labour. The unorganized manufacturing accounts for around 81 percent of total manufacturing employment, but have share of only 33 percent of total manufacturing output. In the following section we presented the graphical presentation of the wages and wage inequalities changed over time since 1989. We have taken the all manufacturing industries at the 3 digit NIC 98. We plotted the real wages and inequalities for these manufacturing industries over time.

From Figure 1, we observe a widening gap between per-capita skilled and unskilled wage over the period of 1989-2007. The estimated values (or fitted values) are calculated from the OLS regression of time on the real wages for the skilled and unskilled labour separately for 54 manufacturing industries. Subsequent graphs present the different measures of inequality. Figure 2 presents the wage inequality measured by the skilled-unskilled wage ratio which shows an increasing trend in our data. Figure 3 presents Gini coefficients for different industry groups in various time periods. This graph shows that the wage inequality is highest in high tech industry whereas lowest in medium-low tech industries. We observe that the Gini coefficient decreased for all industry groups in 1999 from the earlier period 1994, and it

started increasing in post 1999 period for all industry groups. Interestingly the increase in the Gini coefficient in post 1999 period was high in high tech industry relative to the other industries.

Figure 1. Trends in the Annual Per-Capita Real Wages for Skilled and Unskilled Labour in 55 Manufacturing Product Groups in 1989-2007 (in INR, at 2001 prices)
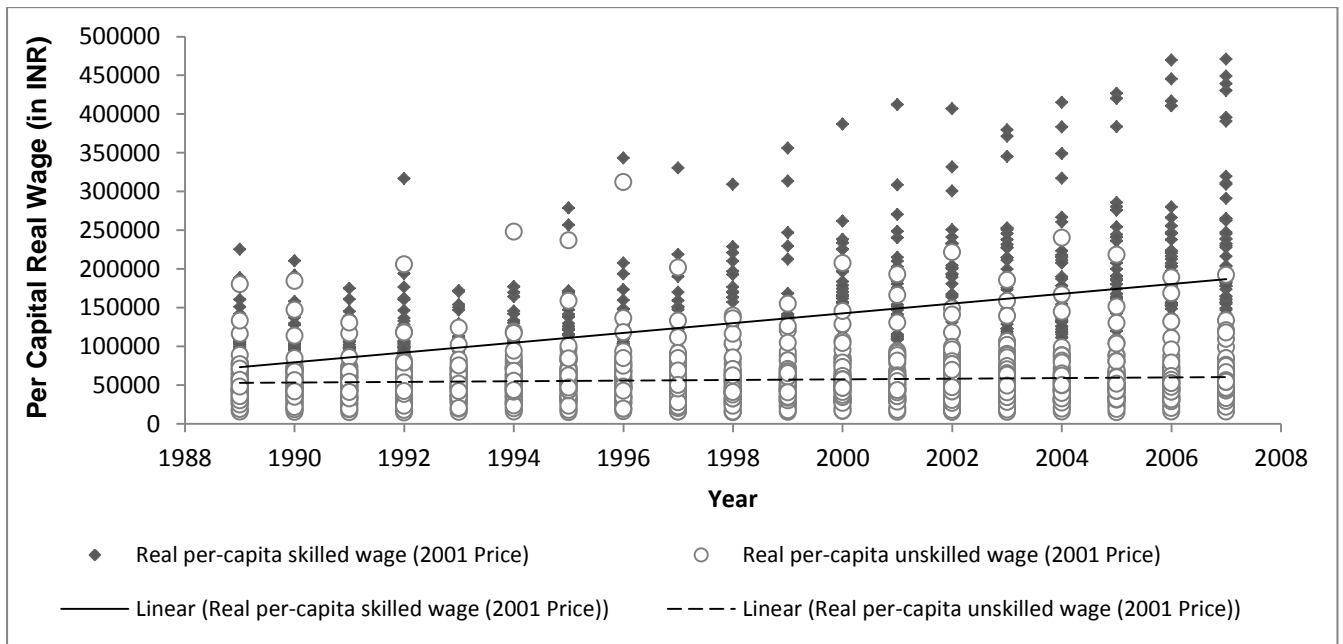

Figure 2: Trend in the Skilled-Unskilled Wage Ratios for 55 Industries in 1989-2007
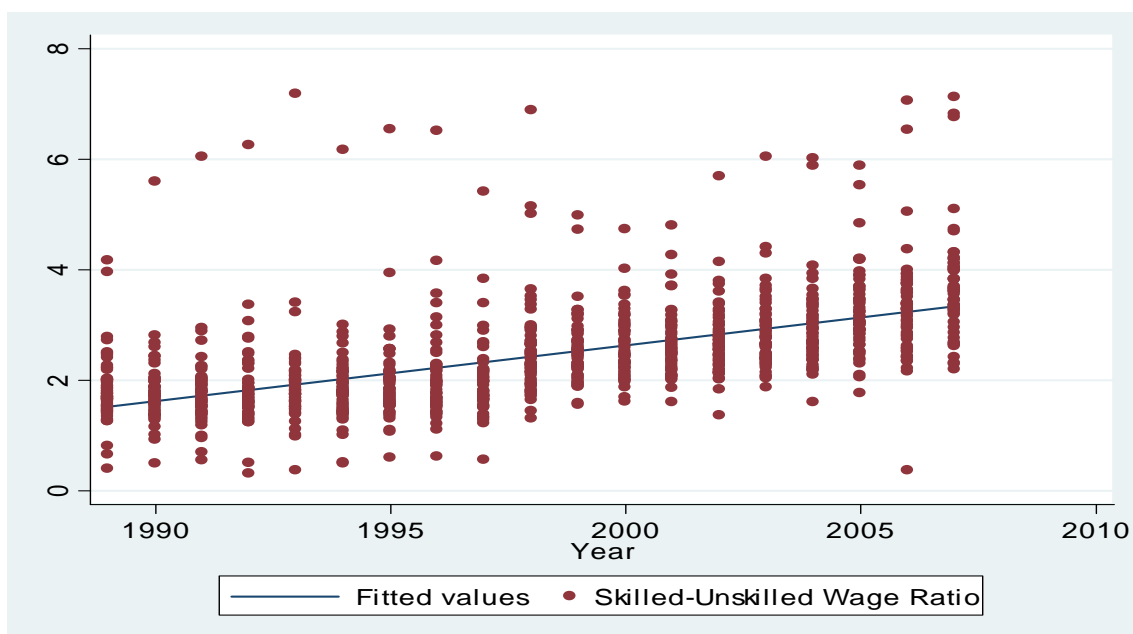
Figure 3: Gini coefficients for various manufacturing industries with different technology sophistications
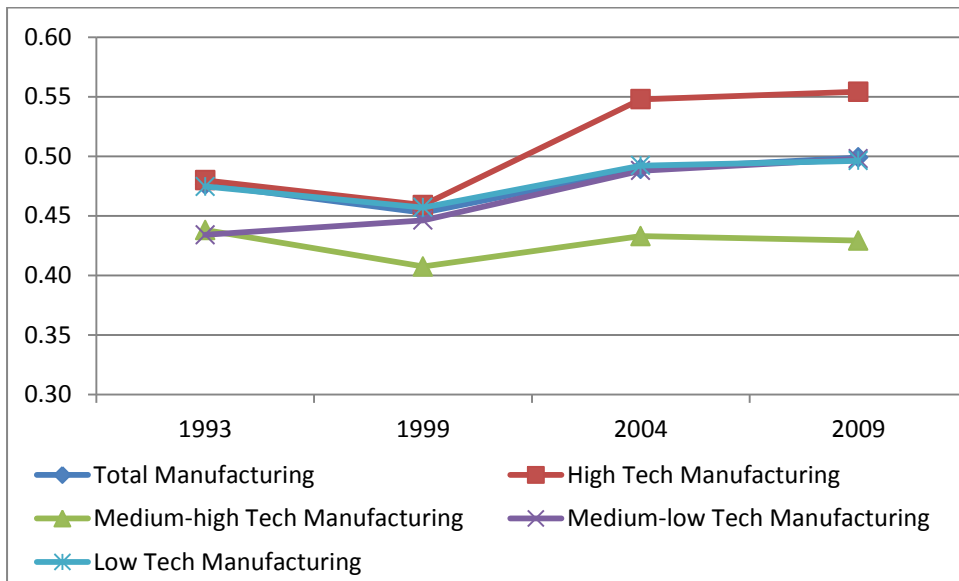

Figure 4: Trend in the Ratios of 90 Percentile to Median income for 36 Industries in 1994-2007
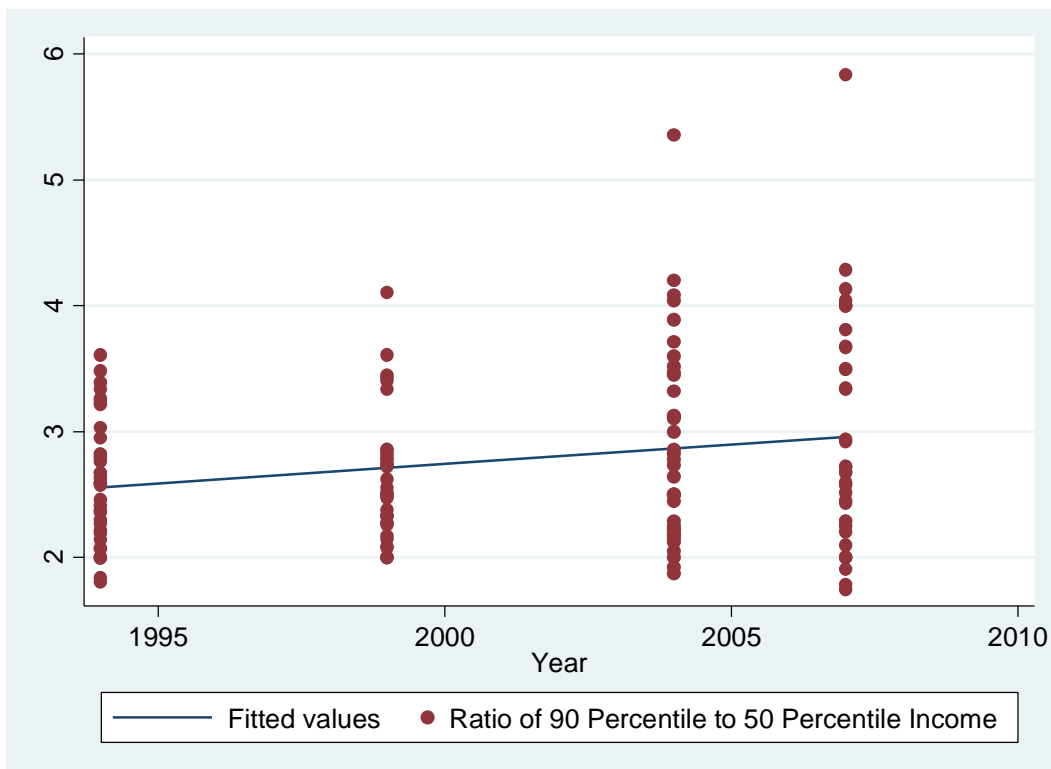
Figure 4 presents the trend of the ratio of 90th percentile to median wage, which shows and increasing trend, this implies that the middle income group (median wage earners) are worsen off relative to high income group (90th percentile).It is interesting to note from the Graph 5 where we plotted the wage inequality measured by the ratio of 90 percentile to 10 percentile wage income shows almost no changes over the period of 1993-2009. This tells us the two extreme poles of the wage distribution do not change relative to each other; so, we see no polarization in the wage distribution *per se*. The Graph 6 which presents the ratio of the median to the 10th percentile income shows a declined trend in this wage inequality measures. If we assume the downward wage rigidity of wages lower wage earners, at least for the 10 percentile wage income groups, there must be a decline in the wages for the median wage earners to support the decline trend of the wage inequality measured by the ratio of median income to 10th percentile income. This argument is supported by the regression analysis in the next section.

Figure 5: Trend in the Ratios of 90 Percentile to 10 Percentile incomes for 36 Industries in 1994-2007
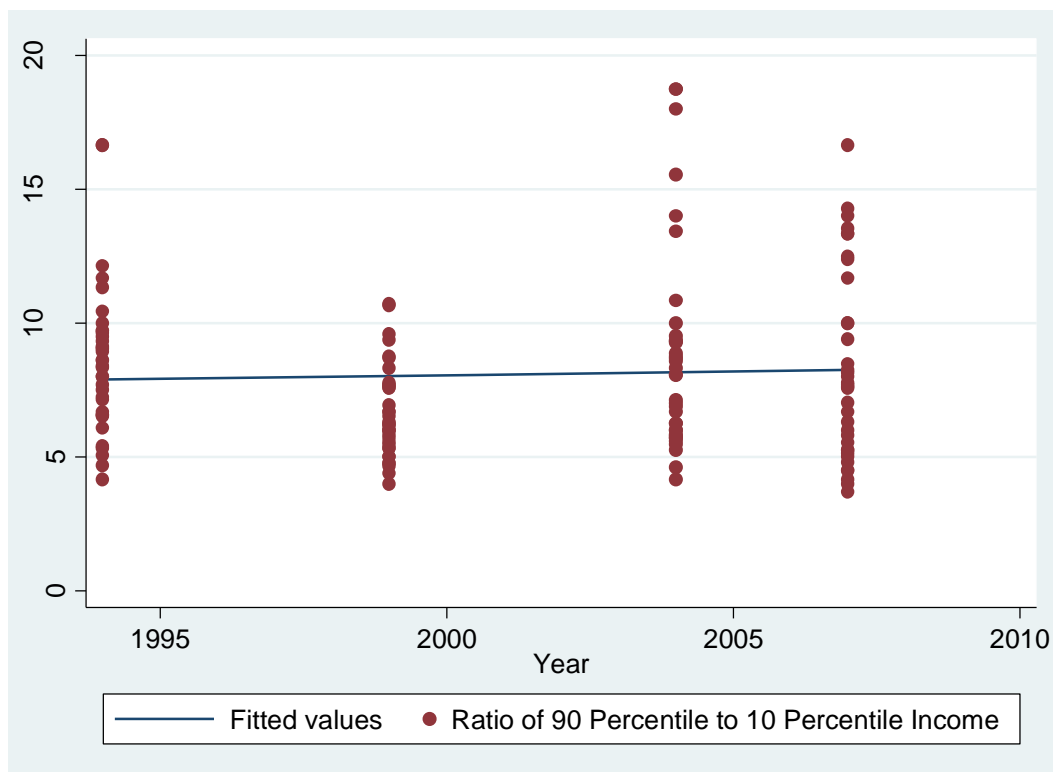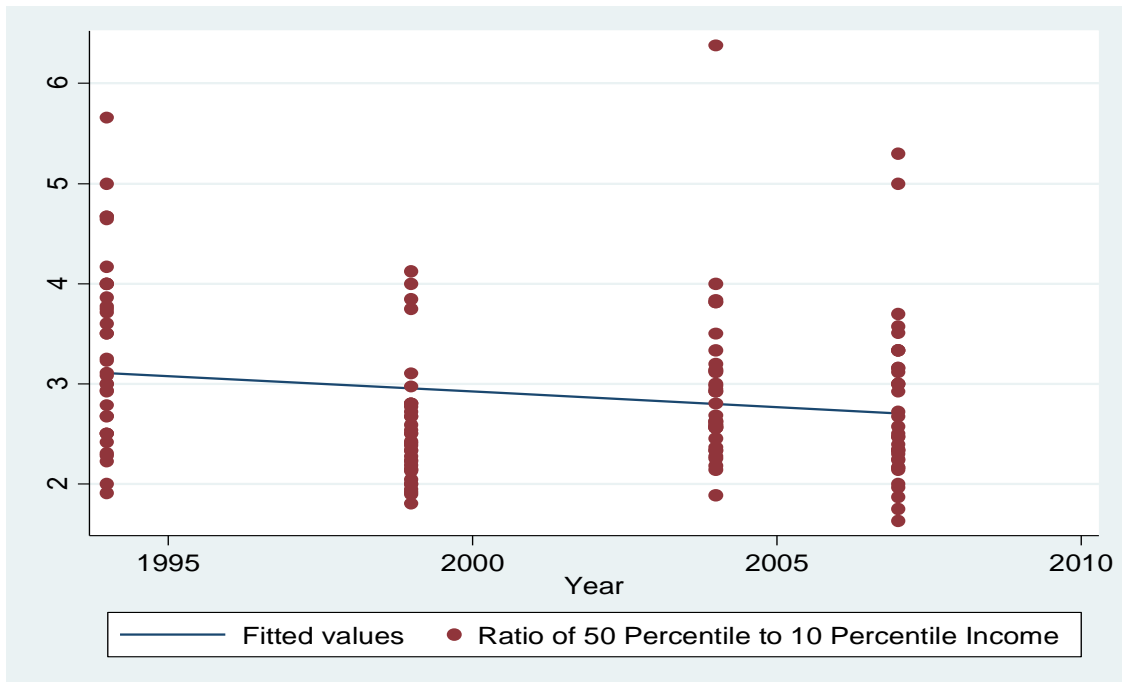
Figure 6: Trend in the Ratios of Median income to 10 percentile Income for 36 Industries in 1994-2007

V. Estimates of trade liberalization in manufacturing sector

This section presents the trade liberalization in the manufacturing sector with the help of some 'outcome based' measures such as the export-orientation and import-penetration. One of the main aims for trade liberalization for any sector is to change the trade volume from its existing level. The trade liberalization is expected to bring about an increase in imports because of the reduction in trade barriers; similarly, the exports are also expected to increase if the trade liberalization policies are aimed at promoting exports and to fulfill the reciprocity of the trade liberalization policy by the partner country which raises imports by its trade liberalization policy. The simplest way of measuring the changes in exports and imports are 'exports-orientation' and 'import-penetration' respectively. The export-orientation of an industry can be measured by many ways, but the way it is measured here is the 'share of export in gross output' for that industry. Similarly, the import-penetration is measured by the 'share of import in gross output'.

From Figure 7 it is observed that the high-tech and medium-high-tech manufacturing groups have import penetration more than the other two groups, i.e. the medium-low-tech and low-tech groups. Notwithstanding, the import-penetration of the high-tech manufacturing group increased sharply vis a vis the other groups from 1999 onwards. For the total

manufacturing sector, the import-penetration increased from 9 percent in 1989 to 20 percent in 2007. So, it is clear from this figure that the India, being a developing country, much depends upon the high-tech and medium-high-tech manufacturing products from the foreign countries and manufacturing imports are increasing over its domestic production in the years of economic-reform period.

In Figure 8, the export-orientation of different manufacturing groups has been presented. It is observed that the low-tech manufacturing group has the highest export-orientation which was 22 percent in 1989, and it increased to 37 percent in 2005 before it came down to 31 in 2007. For other three manufacturing groups, in 2007, the export-orientation was 18 percent, 16 percent, and 8 percent for the high-tech, medium-high-tech, and medium-low-tech manufacturing groups respectively. Throughout the post-reform period, the export-orientation of the high-tech and medium-high-tech industry was higher than the medium-low-tech manufacturing group. For the total manufacturing, the export-orientation increased from in percent in 1989 to the highest 19 percent in 2003 before it reached to 17 percent in 2007. Comparing the export-orientation and the import-penetration of the total manufacturing industry, it seems that the former increased more than the later.

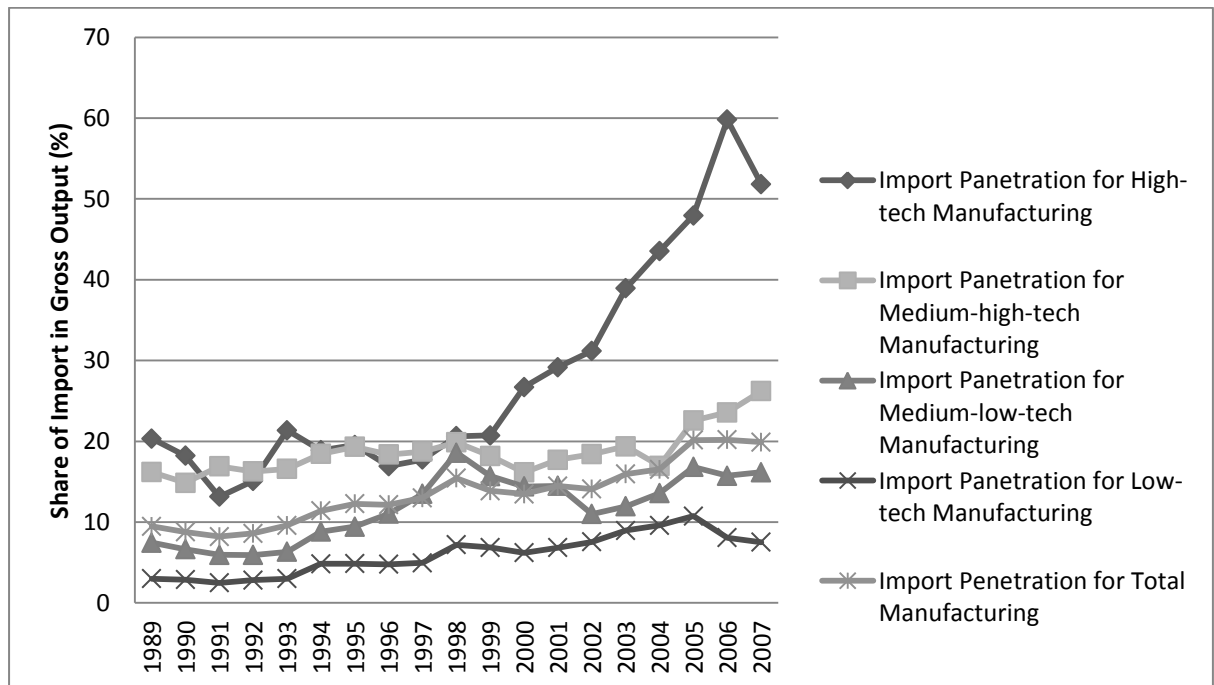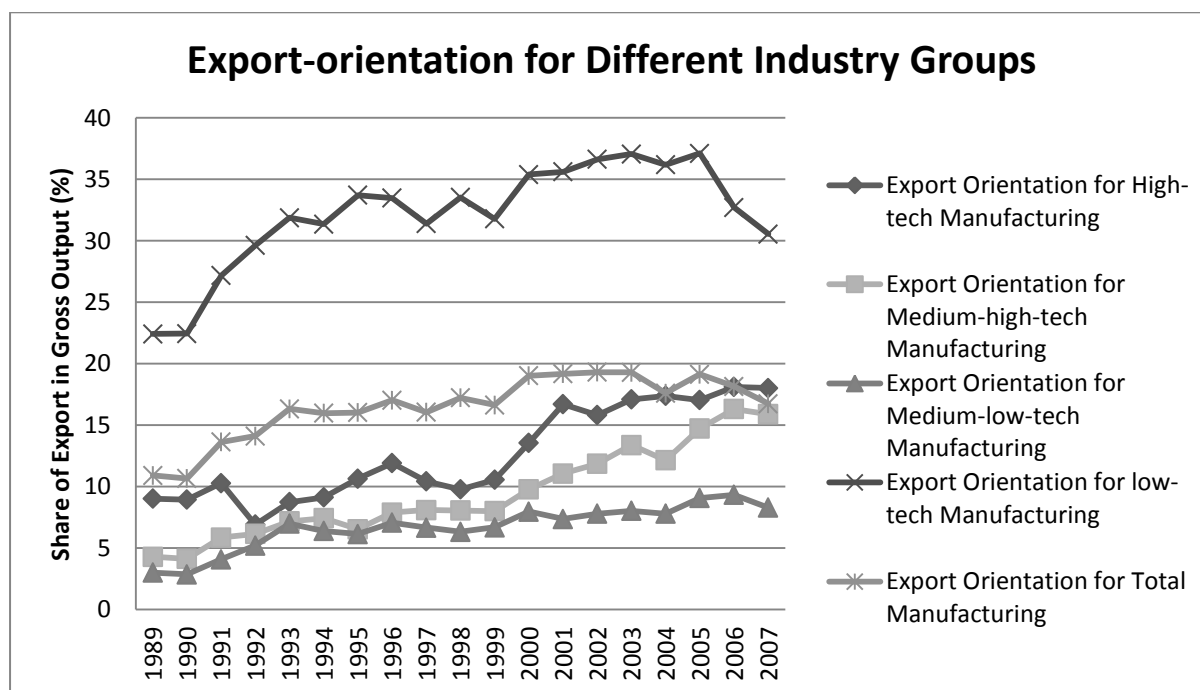**Figure 7: Import-penetration for different manufacturing groups**

Figure 8: Export-orientation for different manufacturing groups

Export-orientation for Different Industry Groups

VI. *Econometric Estimations of wage inequality functions*

This section analyses the econometric results of five wage inequality functions for five wage inequality measures, namely, skilled-unskilled wage ratio (W_S/W_U), Gini coefficient (G), 90-50 percentile wage ratio (W_{90}/W_{50}), 50-10 percentile wage ratio (W_{50}/W_{10}), and 90-10 percentile wage ratio (W_{90}/W_{10}) separately. The wage inequality measured by skilled-unskilled wage ratio (W_S/W_U) is obtained from the ASI database, which represents the 'organized' manufacturing sector only, and therefore, the wage inequality function that uses the skilled-unskilled wage ratio as a dependent variable, represents the wage inequality function for organized manufacturing. The rest four wage inequality measures, i.e. the Gini coefficient, 90-50 wage ratio, 50-10 wage ratio, and 90-10 wage ratio, are obtained from the wage distribution of total manufacturing labour using the unit level data from the NSSO's Employment and Unemployment Survey databases; therefore, the wage inequality function that uses any of these four measures of wage inequality as the dependent variable, represents the wage inequality function for total manufacturing sector.

The wage inequality function, used in this study, is a testable relationship between wage inequality and trade liberalization variables, along with other plausible controls variables that affect wage inequality. These determinants are based on standard theories on wage inequality and India specific factors, particularly in its manufacturing sector over the

period of economic reform since the early 1990s. A range of robustness checks have been carried out to substantiate our econometric findings; these findings have been compared with those from some comparable studies that are available for India and other developing countries. The regression estimates of these five wage inequality equations are presented through Tables 1 to 5.

VI.A. Descriptive Statistics

Although the various estimates of wage inequality and trade liberaization indicators have been discussed in detail in earlier sections IV and V respectively, here we present some key statistics of the variables used in wage inequality functions. These descriptive statistics would be relevant for analysing the regression results presented in this section. Since this study estimates two sets of wage inequality functions – the wage inequality functions for organized and for total manufacturing industry – two sets of statistics are presented in the following subsection and in the Appendix Table A.1.

VI.A.1 Key Statistics for Variables Used in Skilled-Unskilled Wage Ratio Function for Organized Manufacturing

The average skilled-unskilled wage ratio for 55 industries at 3-digit level of NIC-98 is estimated at 1.83 in 1989 and 3.7 in 2007. Three trade liberalization variables, i.e., the export-orientation, import-penetration, and the ratio of South-South trade in total trade have increased over the same period. Export-orientation has increased from an average of 11 per cent in 1989 to 20 per cent in 2007. The average of import-penetration has increased from 21 per cent in 1989 to 33 per cent in 2007. Therefore, the rise in import-penetration was more than the rise in export-orientation. The ratio of South-South trade has increased marginally from an average of 51 per cent in 1989 to 53 per cent in 2007.

Average capital-labour ratio for same number of industries has increased substantially from 1.15 in 1989 to 9.04 in 2007. Labour market institutions variable, i.e., the ratio of contract unskilled labour to total unskilled labour, has increased from an average of 11 per cent in 1989 to 32 per cent in 2007. Hence, all the variables, dependent and independent, appearing in the skilled-unskilled wage ratio function have increased from their initial levels over the period of 19 years from 1989 to 2007.

VI.A.2 Key Statistics for Variables Used in Wage Inequality Functions for Total Manufacturing

Wage inequality measures for total manufacturing sector, i.e. the organized and unorganized manufacturing, cover 36 manufacturing industries at 3-digit level of NIC-98 for four years in 1994, 1999, 2004, and 2009.

Average Gini coefficient for 36 industries was 0.42 in 1994 and 0.43 in 2009; the ratio of 90 percentile to median wage has increased from an average of 2.59 to 2.96 over the same period. However, the average ratio of median to 10 percentile wage and average ratio of 90 percentile to 10 percentile wage have declined in the period 1994-2009. The average ratio of median to 10 percentile wage has declined from 3.33 in 1994 to 2.76 in 2009, while the 90 percentile to 10 percentile ratio, has declined from an average of 8.59 in 1994 to 8.28 in 2009.

Three trade liberalization variables, i.e., the export-orientation, import-penetration, and the ratio of South-South trade have shown an increase in their values over the period 1994 to 2007. Export-orientation has increased from an average of 0.12 in 1994 to 0.21 in 2007. The average import-penetration has increased from 0.12 in 1994 to 0.19 in 2007. The ratio of South-South trade in total has increased from an average of 0.47 in 1994 to 0.52 in 2007. These results reflect the expected positive outcomes of trade liberalization.

Average capital-labour ratio for same number of industries has increased from 2.45 in 1994 to 9.29 in 2007 indicating large increase in capital intensity of the production structure. Labour market institution variable, i.e., the ratio of contract unskilled labour to total unskilled labour, has increased from an average of 0.14 in 1994 to 0.31 in 2007, reflecting the much-talked about casualization of labour.

VI.B. Regression Strategy for Analysing the Impact of Trade Liberalization on Wage Inequality

It is important to use specific wage inequality equation for examining the impact of trade liberalization on wage inequality that exists in India's manufacturing sector, especially in the period of economic reform since early 1990s. However, we need to make some necessary changes in the wage inequality equation to accommodate two different sets of wage inequality measures that come from two different data sources and represent for the organized and total manufacturing sector separately.

VI.B.1 Wage Inequality Function for Organized Manufacturing

The wage inequality function for the skilled-unskilled wage ratio (W_S/W_U), which represents for the organized manufacturing sector is as follows:

$$\left(\frac{W_S}{W_U}\right)_{it} = \alpha + \beta_1 \left(\frac{X}{Y}\right)_{it} + \beta_2 \left(\frac{M}{Y}\right)_{it} + \beta_3 \left(\frac{SS}{TT}\right)_{it} + \beta_4 \left(\frac{K}{L}\right)_{it} + \beta_5 \left(\frac{L_C}{L_U}\right)_{it} + \beta_6 (D\ Growth) + \beta_7 (D\ Tech) + u_{it}$$

$$\ldots\ldots\ldots(A.1)$$

where $(W_S/W_U)_{it}$ is the wage inequality measured by the skilled-unskilled wage ratio for the ith manufacturing industry in year t. Data for 19 years (1989 to 2007) for 55 manufacturing industries have been used for estimating this wage inequality equation. The variables that capture trade liberalization are: (a) the ratio of export to output (X/Y) is the measure of export-orientation or export exposure in an industry; (b) the ratio of import to output (M/Y) is the measure of import-penetration or import competition in an industry; and (c) the ratio of trade with the South in total trade (SS/TT), which captures the rising competition within the South. The control variables are: (a) the capital-labour ratio (K/L), which captures the capital intensity of a production process; (b) the ratio of contract unskilled labour in total unskilled labour (L_C/L_U), which is taken as a proxy of labour market institutions; (c) '$D\ Growth$' is a set of two dummy variables for different growth periods that the Indian economy has experienced since the early 1990s; and (d) '$D\ Tech$' is a set of three dummy variables that indicate the level of technology sophistication in an industry. The u_{it} is the remainder stochastic disturbance term.

The *D Growth* variable in (A.1) is a vector of two dummy variables that distinguishes between the three sub-periods of India's GDP growth. The period of 1994 to 2000 is considered here as the *moderate growth period*, when the average annual growth of GDP was 6.3 per cent; the dummy variable for this moderate growth period is defined by '*D Growth Moderate* (1994-2000)'. The dummy variable for the *period of high growth* of GDP, i.e. the period from 2000 to 2007 when the growth of GDP was 8 per cent per-annum, is defined by '*D Growth High* (2001-2007)'. The period of 1989 to 1993 is considered as a *period of low growth*, when the average annual growth of GDP was 4.3 per cent. The period of 1989-1993 was the initial period of India's economic reform, and is taken as the base[2] period for dummy variable *D Growth*, and therefore, has not been considered in the estimation.

The *D Tech* variable is a vector of three dummy variables that represent three industry

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[2] The initial period of India's economic reform (i.e. 1989-1993) has not been used as a dummy variable for different growth of GDPs to avoid 'dummy variable trap'.

groups based on their technology sophistication and R&D expenditure.[3]The dummy variable for medium-low tech industry is defined by '*D Tech Medium-low*'; for medium-high tech industries, the dummy variable is '*D Tech Medium-high*'; the '*D Tech High*' is the dummy variable for high tech industries. The low-tech industry has been taken as the base industry group, and therefore, has not been considered in the estimation.

VI.B.2 Wage Inequality Function for Total Manufacturing

The four wage inequality measures, namely, the Gini coefficient (G), 90-50 wage ratio (W_{90}/W_{50}), 50-10 wage ratio (W_{50}/W_{10}), and 90-10 wage ratio (W_{90}/W_{10}) are obtained from the unit level data from the Employment Unemployment Surveys of the NSSO and relate to wage inequality in the total manufacturing sector, i.e. both organized and unorganized manufacturing combined. Unlike the skilled-unskilled wage ratio, which is available for the period 1989 to 2007, the Gini coefficient, 90-50 wage ratio, 50-10 wage ratio, and the 90-10 wage ratio are available only for four years, i.e. 1993, 1999, 2004, and 2009. These four different years fall under two different growth periods of India's GDP: the years 1993 and 1999 fall under the period of *moderate growth*, and the years 2004 and 2009 fall under the period of *high growth*. Hence, the wage inequality equation that considers any of these four wage inequality measures as a dependent variable, uses one dummy for *D Growth* variable, i.e. the '*D Growth High' 2004 & 2009*. Since, the years 1993 and 1999 fall under the period of *moderate growth* of the Indian economy, we do not have a dummy for this period in the estimation to avoid the *dummy variable trap*.

The following is the wage inequality function for the total manufacturing sector:

$$(WI)_{it} = \alpha + \beta_1 \left(\frac{X}{Y}\right)_{it} + \beta_2 \left(\frac{M}{Y}\right)_{it} + \beta_3 \left(\frac{SS}{TT}\right)_{it} + \beta_4 \left(\frac{K}{L}\right)_{it} + \beta_5 \left(\frac{L_C}{L_U}\right)_{it} + \beta_6 (D\ Growth\ High)$$
$$+ \beta_7\ (D\ Tech) + u_{it}$$

…………..(A.2)

where WI_{it} is the wage inequality measured by any of the four wage inequality measures, namely, the Gini coefficient (G), the 90-50 wage ratio (W_{90}/W_{50}), the 50-10 wage ratio (W_{50}/W_{10}), and the 90-10 wage ratio (W_{90}/W_{10}) for the ith manufacturing industry in year *t*. The $i = 1, 2,…, 36$; and t= 1 (1993), 2 (1999), 3 (2004, 4(2009). All independent variables

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[3] Detailed list of products for the four groups of industries based on technology sophistication and R&D expenditure is available on request.

are the same as to those used in the wage inequality equation A.1, except the *D Growth* variable, which is replaced by the '*D Growth High*'.

VI.B.3 Regression Strategy for Estimating the Wage Inequality Functions

The regression estimates of the five different wage inequality functions for the five different wage inequality measures are presented in Table 1 to Table 5 separately. A range of regression specifications have been examined and presented through Column 1 to Column 4 in each Table; this strategy allows us to compare the estimated coefficients of each explanatory variable across different regression specifications and to assess the robustness of the results. For each specification, between fixed-effect and random-effect regressions, the one supported by the Hausman test is included in the table of regressions.

The regression specification used in Column 1 in each table presents the wage inequality equation for which the explanatory variables are export-orientation (X/Y), import-penetration (M/Y), the share of the South in total trade (SS/TT), the capital-labour ratio (K/L), the ratio of contract unskilled labour in total unskilled labour (L_C/L_U).

In column 2, we introduce dummy variables for different periods of India's GDP, i.e. the '*D Growth*'. Two growth dummies, i.e. the '*D Growth High (2001-2007)*' and '*D Growth Moderate (1994-2000)*', have been used in Table 1 which presents regression results for the wage inequality function for skilled-unskilled ratio; but for other wage inequality functions, presented in the Table 2 to Table 5, only one growth dummy, i.e. '*D Growth High (2004 & 2009)*' has been used because only two growth periods are compared for the Gini, 90-50 wage ratio, 50-10 wage ratio, and 90-10 wage ratio in the *low growth* period 1989-1993. The *D Growth* variable presumably controls the effects of growth-oriented macroeconomic policies on wage inequality.

In Column 3, we introduce the *D Tech* variable, which is a vector of three dummy variables given that there are four industry groups based on their level of technological sophistication and R&D expenditure. These three *D Tech* variables are the '*D Tech Medium-low*' for medium-low tech industries, the '*D Tech Medium-high*' medium-high tech industries, and the '*D Tech High*' is the dummy variable for high tech industries. These *D Tech* variables are supposed to control for the time invariant technology effects of an industry on wage inequality. For example, it is quite possible that wage inequality is relatively high in high-tech industry than in low technology intensive industries – since these industries employ differently skilled people, the skilled wages are different across industries relative to their common unskilled counterpart. Moreover, it is evident from that the wage inequality,

measured by skilled-unskilled wage ratio and Gini coefficient, are higher in high-tech industry groups than that in other industry groups – at least in the post-1999 period.

In Column 4, we drop[4] the *D Tech* variables, and introduce three *interaction* dummy variables such as interaction between capital-labour ratio ($\frac{K}{L}$) and technology dummy for medium-low tech industry ($\frac{K}{L}$ *D Tech Medium-low*), interaction between capital-labour ratio ($\frac{K}{L}$) and technology dummy for medium-high tech industry ($\frac{K}{L}$ *D Tech Medium-high*), and interaction between capital-labour ratio ($\frac{K}{L}$) and technology dummy for high tech industry ($\frac{K}{L}$ *D Tech High*). Since, the levels of the capital-labour ratio ($\frac{K}{L}$) varies across industries[5], the effects of capital-labour ratio ($\frac{K}{L}$) on wage inequality would be different across industries – possibly because of capital-skill complementarities. These interaction variables control for such industry specific effects of capital-labour ratio ($\frac{K}{L}$) on wage inequality, and therefore, it corrects for the possible *omitted* variable bias estimates of the capital-labour ratio ($\frac{K}{L}$). Hence, the estimated coefficient of the capital-labour ratio ($\frac{K}{L}$) in Column 4 indicate the effect of capital-labour ratio ($\frac{K}{L}$) on wage inequality independent of any industry specific concentration of capital-labour ratio ($\frac{K}{L}$). The econometric specification presented in Column 4 is taken as the *most preferred* regression estimate for our wage inequality model, because it controls for major factors that explain the wage inequality. The standard errors of the coefficients reported in Table 1 to Table 5 are 'robust standard errors'[6], which are consistent estimates taking into account possible serial-correlation and heteroscedasticity of errors in the panel data model (Angrist and Pischke, 2009)[7]. We have assessed multicollinearity between main explanatory variables, through the correlations, and they are found to be small (Appendix Table A.2). To choose between the 'fixed-effect' and 'random-effect' models, the 'Hausman-test'[8] has been carried out. If the null hypothesis of the 'Hausman-test' is rejected, the fixed-effect model is chosen as the preferred panel data

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[4] We finally dropped three *D Tech* dummy variables in column 4, because the estimated coefficient of these *D Tech* dummy variables became statistically insignificant once these dummy variables were incorporated in regression specification presented in column 4.

[5] In 1990, the capital-labour ratio in high-tech, medium-high tech, medium-low tech, and low-tech industries was 1.1, 1.7, 2.1, and 0.5 respectively; and these increased to 8.5 for high-tech, 9.5 for medium-high tech, 10.4 for medium-low tech, and 3.9 for low-tech industry in 2007.

[6] In STATA, the panel data regression estimates with 'robust standard error' and 'clustered standard error' give the same results.

[7] Chapter 8 of the book *Mostly Harmless Econometrics: An Empiricist's Companion*, Angrist, J. D. and J. S. Pischke (2009), Princeton University Press.

[8] The Hausman-test statistic is estimated for each regression specification with 'conventional standard error' estimates, because panel data regression with 'robust standard errors' do not allow to calculate the Hausman-test statistic in STATA.

model; otherwise the random-effect model is preferred. However, the random-effect model is chosen compulsorily for the regression specification presented in column 3, which uses technology dummy variables (*D Tech*) for different industries, and does not allow for the estimating of the fixed-effect model.

VI.C Econometric Results for Organized Manufacturing

One of the widely used wage inequality measures is 'skilled-unskilled wage ratio' (W_S/W_U), and this is the only wage inequality measure available for organized manufacturing sector in this study. Table 1 presents the panel regression estimates of the 'skilled-unskilled wage ratio' function (A.1) in section VI.B.1.

The 'skilled-unskilled wage ratio' function is estimated here from a panel data set of 55 industries at the 3-digit level of NIC-98 and a period of 19 years (1989-2007). In interpreting the regression results, we discuss first the explanatory variables that represent trade liberalization, followed by an analysis of other control variables. Table 1 is presented in the next page, followed by an analysis of the econometrics results.

Table 1. Panel Regressions for 55 industries in organized manufacturing and years 1989 to 2007

Dependent variable: Skilled-unskilled wage ratio				
	(1)	(2)	(3)	(4)
Model Specification / **Independent Variables**	Fixed industry-effects regression	Random industry-effects regression	Random industry-effects regression	Fixed industry-effects regression
Export Orientation $(\frac{X}{Y})$	0.0046 (0.03)	0.0473 (0.61)	0.0343 (0.41)	0.0654 (0.86)
Import penetration $(\frac{M}{Y})$	0.0187** (2.09)	-0.0031 (-0.61)	-0.0102** (-2.38)	-0.021*** (-3.34)
South-South Trade $(\frac{SS}{TT})$	1.0727** (2.42)	0.5376* (1.81)	0.5419** (1.82)	0.2442 (0.82)
Capital-labour Ratio $(\frac{K}{L})$	0.0185 (1.33)	0.0044 (0.69)	0.0041 (0.69)	0.1304*** (3.33)
Labour Market Institutions $(\frac{L_C}{L_U})$	2.611*** (3.31)	1.0203** (1.96)	1.123** (2.09)	0.8301# (1.49)
D Growth Moderate (1994-00)		0.3299*** (4.41)	0.3264*** (4.31)	0.161* (1.91)
D Growth High (2001-07)		1.016*** (9.30)	1.0053*** (9.15)	0.7267*** (5.76)
D Tech Medium-low			-0.2431 (-1.23)	
D Tech Medium-high			-0.131 (-0.83)	
D Tech High			0.4063** (2.1)	
$\frac{K}{L}$ *D Tech Medium-low				-0.1057*** (-2.7)
$\frac{K}{L}$ *D Tech Medium-high				-0.1259*** (-3.28)
$\frac{K}{L}$ *D Tech High				0.0114 (0.27)
Constant	1.4611*** (6.66)	1.4637*** (7.48)	1.4732*** (6.76)	1.5984*** (8.53)
R^2	Within = 0.2615 Between =0.0237 Overall = 0.1005	Within = 0.4255 Between =0.0527 Overall = 0.2803	Within = 0.4229 Between = 0.1868 Overall = 0.3442	Within = 0.4884 Between = 0.0647 Overall = 0.3228
Test Statistic for Joint Significance Slope Coefficients	$F_{(5,54)}$ =9.36***	Wald chi2 (7) =173.9***	Wald chi2 (10) = 185.07***	$F_{(10, 54)}$ = 32.74***
Hausman Test Statistic	chi2(5) = 39.68*** Prob>chi2 = 0.000	chi2(7) = 10.8# Prob>chi2 = 0.1475		chi2(7) = 34.19*** Prob>chi2 = 0.0002
Number of Observations	770	770	770	770
Number of Industries	55	55	55	55

Note: The numbers in the parentheses are the 't' statistic if the regression is estimated with fixed-effects, or 'Z' statistic if the regression is estimated with the random-effects, corresponding to robust standard errors; '***', '**', '*', and # imply 1 per cent, 5 per cent, 10 per cent, and 15 per cent levels of significance respectively.

Trade liberalization in an unskilled labour abundant developing country, like India, is expected to increase export-orientation ($\frac{X}{Y}$) of unskilled-labour intensive goods. Hence, the demand for unskilled labour, and consequently the unskilled wage, should go up relative to that of the skilled-labour. The opposite result is also possible when export-orientation rises in skill-intensive sectors, which demands more skilled labour relative to demand for unskilled labour, and therefore, increases skilled-unskilled wage ratio. Hence, rising export-orientation leads to change skilled-unskilled wage ratio depending upon which industry has higher change in export-orientation than others. Earlier in Section V, we have observed that the export-orientation is higher in low-tech industry compared to other industries, but the rise in export-orientations is similar in high-tech, medium-high tech, and low-tech industry in the Indian manufacturing sector. The similar level of increase in export orientation in these three different sectors should have increased the demand for both skilled and unskilled labour, and therefore, expected to have only a small effect on the skilled-unskilled wage ratio.

Although there was an increase in the average export-orientation of 55 industries, statistically insignificant coefficients of export-orientation in all four regression specifications in column 1 to column 4 imply that export-orientation does not have any significant impact on skilled-unskilled wage ratio. Interestingly, a similar kind of result was observed by Sen (2008), who found that export-orientation did not have a statistically significant effect on skilled-unskilled wage ratio for a set of 56 industries at the 3-digit level.

The other most important indicator of trade liberalization is import-penetration ($\frac{M}{Y}$). For developing countries, an increase in import-penetration is expected to reduce the skilled-unskilled wage ratio, because the trade liberalization raises the imports of skilled-labour intensive goods, and hurts skilled labour by lowering demand and wages relative to unskilled labour. Therefore, in the case of rising import penetration in developing countries, the wage inequality measured by skilled-unskilled wage ratio should fall.

It is observed that import-penetration in high-tech and medium-high tech manufacturing is higher than in the medium-low tech and low-tech manufacturing sector in India. Although, there is an overall increase in import-penetration in the manufacturing sector from 9.5 in 1989 to 19.9 in 2007, it is seen that this increase is more prominent in the high-tech and medium-high tech manufacturing than in the medium-low tech and low-tech manufacturing. The rise in import-penetration in the high-tech and medium-high tech sector relative to the other two sectors should reduce the demand for skilled labour relative to

unskilled labour, and therefore, is expected to have a negative effect on the skilled-unskilled wage ratio.

The statistically significant negative coefficients of import-penetration (-0.01 and -0.02 in columns 3 and 4, respectively) corroborate the expected outcome of the import-penetration on skilled-unskilled wage ratio. However, the coefficient of import-penetration in column 1 is positive (0.018). As the regression specifications in columns 3 and 4 control industry-specific effects, the estimates in these regression specifications are to be preferred over the estimates in columns 1 and 2. The negative coefficients of import-penetration $\left(\frac{M}{Y}\right)$ found in columns 3 and 4 give results corroborating the theoretical prediction. Therefore, the rise in import-penetration has reduced wage inequality between skilled and unskilled labour. This result seems to support the SS theorem in the Indian context. An increase in imports reduces price of the imported good, and hence, the return to the factor which is intensively employed in the importable sector.

Rising South-South trade is expected to have a positive effect on the skilled-unskilled wage ratio in a developing country like India where a number of capital/skill-intensive industries are present vis-à-vis other developing countries and rising competition among the unskilled labour within the South. The estimated positive coefficient of $\frac{SS}{TT}$ is in accord with the expected outcome that the rising share of South-South trade in total trade $\left(\frac{SS}{TT}\right)$ leads to an increase in skilled-unskilled wage ratio – at least in regression specifications presented in columns 1, 2, and 3. However, in column 4, which presents the regression results for the most preferred regression specification, the coefficient is positive but statistically insignificant (t-statistic = 0.82) for $\frac{SS}{TT}$. In this case, since the coefficients of $\frac{SS}{TT}$ are positive in all four regression specification, though statistically insignificant in the regression specification presented in column 4, rising South-South trade can be considered a significant factor contributing to rising the skilled-unskilled wage ratio in the Indian manufacturing sector.

The coefficient of labour market institution $\left(\frac{L_C}{L_U}\right)$ is positive and statistically significant across all four regression specifications in column 1 to column 4. The positive effects of the 'labour market institution' $\left(\frac{L_C}{L_U}\right)$ on skilled-unskilled wage ratio $\left(\frac{W_S}{W_U}\right)$ implies that the increasing contractualization/informalization of unskilled labour has led to an increase in skilled-unskilled wage ratio, $\left(\frac{W_S}{W_U}\right)$. Since the literature shows that there has been an increase in contractualization in the Indian manufacturing sector, and in fact, the average $\left(\frac{L_C}{L_U}\right)$ for 55 manufacturing industries has increased from 0.11 in 1989 to 0.32 in 2007, the positive

coefficient for $(\frac{L_C}{L_U})$ corroborates the fact that rising contractualization is one of reasons for rising skilled-unskilled wage ratio $(\frac{W_S}{W_U})$ in the Indian manufacturing sector.

An increase in contractualization of unskilled labour reduces the average wage for unskilled labour due to the non-payment of the higher regular wage and non-wage benefits to contractual unskilled labour. For example, unlike in the case of regular labour, the contract labour are deprived of benefits like pensions, insurance, paid leave, etc., and therefore, rising contractualization of unskilled labour reduces the average unskilled wage, and increases skilled-unskilled wage ratio.

The coefficient of dummy variables for the period of moderate growth of GDP in 1994-2000 (*D Growth Moderate*, 1994-2000) and high growth of GDP in 2001-2007 (*D Growth High*, 2001-2007) are positive and statistically significant in all four regression specifications. This implies that the skilled-unskilled wage ratio function has shifted upward in both periods − the periods of moderate growth of GDP in 1994-2000 and high growth of GDP in 2001-2007 − compared to the period of low growth of GDP in 1989-1993.[9] Moreover, the coefficient of the '*D Growth High*, 2001-2007' is more than three times[10] higher than the coefficient of '*D Growth Moderate*, 1994-2000'; this implies, after controlling for other factors, the effect of high growth period (2001-07) in raising the skilled-unskilled wage ratio is three times higher than that of the moderate growth period (1994-2000). Therefore, in the period of high growth, wage inequality becomes higher than the moderate growth period; similarly, in the period of moderate growth, wage inequality is higher than in the low growth period.

In India, the average capital per employee for 55 manufacturing industries has increased from INR 1.27 lakh in 1990 to INR 9 lakh in 2007 − i.e. the $\frac{K}{L}$ has increased seven times in the period of 1990-2007. The literature suggest that capital-labour ratio $(\frac{K}{L})$ should have a positive impact on skilled-unskilled wage ratio, since an increase in capital intensity or $\frac{K}{L}$ raises demand for skilled labour due to capital-skill complementarity. Therefore, an increase in $\frac{K}{L}$ should raise the wages for skilled labour relative to unskilled labour, and so, it should raise the skilled-unskilled wage ratio. The estimated coefficient of $\frac{K}{L}$ has the expected

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[9] It is important to note that as the period of low growth of GDP in 1989-1993 is taken as the base period without a dummy variable to avoid *dummy variable trap*.

[10] The estimated coefficients of *D Growth Moderate (1994-2000)* are 0.3299, 0.3264, and 0.161 in column 2, 3, and 4 respectively; on the other hand, the estimated coefficients of *D Growth High (2001-2007)* are 1.016, 1.005, 0.727 in column 2, 3, and 4 respectively.

positive sign with a statistically significant test statistic (i.e. t is 3.33) only in the regression specification presented in column 4 – which is the most preferred regression specification. The regression specification in column 4 uses the interaction variables $\frac{K}{L} * D\ Tech$ that control the industry-specific effect of $\frac{K}{L}$ on skilled-unskilled wage ratio. Hence, the positive and statistically significant coefficient (0.13) of the capital-labour ratio ($\frac{K}{L}$) signifies an independent positive effect of capital-labour ratio ($\frac{K}{L}$) on skilled-unskilled wage ratio ($\frac{W_S}{W_U}$) for Indian organized manufacturing industry as a whole, irrespective of the technology intensity of the industry. Therefore, the observed rise in capital intensity has contributed to a rise in the wage inequality measured by the skilled-unskilled wage ratio.

The statistically insignificant coefficients of $\frac{K}{L}$ in regression specifications presented in Columns 1, 2, and 3 are possibly because of the omitted variable bias that arises from not controlling for industry-specific capital intensities. To examine such biases, the interaction variables ($\frac{K}{L} * D\ Tech$) are introduced in the regression specification presented in Column 4. Compared to the coefficients of $\frac{K}{L}$ in columns 1 to 3, the coefficient of $\frac{K}{L}$ has increased and become statistically significant in column 4. Moreover, the negative and significant coefficients of $\frac{K}{L} * D\ Tech\ Medium-high$ and $\frac{K}{L} * D\ Tech\ Medium-low$ implies that within the medium-high and medium-low tech industry, an increase in capital-labour ratio leads to a decline in skilled-unskilled wage ratio; for other two industry groups, these effects are insignificant. Therefore, the effects of $\frac{K}{L}$ for the organized manufacturing as a whole become insignificant, which is revealed by the insignificant coefficients of $\frac{K}{L}$ in columns 1, 2, and 3. Hence, once we control for industry group specific effects of $\frac{K}{L}$ on skilled-unskilled wage ratio, we uncover an independent and positive effect of $\frac{K}{L}$ on skilled-unskilled wage ratio for all organized manufacturing industries irrespective of technology intensities of these industries.

The last important observation from Table 1 is that the skilled-unskilled wage ratio is higher in high-tech industry compared to low technology intensive industries. This phenomenon is evident from the positive and statistically significant coefficient (0.41) of *'D Tech High'* variable, i.e. the dummy variable for high-tech industry in column 3. The coefficients of dummy variables for medium-low tech and medium-high tech industries, i.e. *D Tech Medium-low* and *D Tech Medium-low* are statistically insignificant, which indicate

that the skilled-unskilled wage ratio in these industries are not significantly different from that in low-tech[11] industry. Therefore, there exists industry-specific heterogeneity in skilled-unskilled wage ratio; the skilled-unskilled wage ratio is higher *within* high-tech industry compared to the other three industries groups.

The overall explanatory power of the skilled-unskilled wage ratio function can be judged by the estimated R^2. The econometric result shows that the 'overall R^2' is 0.32 and the 'within R^2' is 0.49 in Column 4 – the most preferred regression specification – which presents the fixed industry effect estimates in this case.

The main findings from the estimated 'skilled-unskilled wage ratio equation' in Table 1 may be summarized as follows:

- While rising export-orientation ($\frac{X}{Y}$) has no significant effect on skilled-unskilled wage ratio, rising import-penetration ($\frac{M}{Y}$) has a negative impact on the skilled-unskilled wage ratio.

- The rising share of South-South trade in total trade ($\frac{SS}{TT}$) can be considered a significant factor that has contributed to the rising skilled-unskilled wage ratio.

- The rise in contractualization of the unskilled labour ($\frac{Lc}{L_U}$) has led to an increase in the skilled-unskilled wage ratio.

- The coefficient of the dummy for *moderate growth* period (1994-2000) is about 0.33 and that for the *high growth* period (2001-2007) is much higher about 1.02 and both are statistically significant indicating significant upward shifts in the skilled-unskilled wage ratio function, particularly during the high growth period.

- The capital intensity measured by the capital-labour ratio ($\frac{K}{L}$) has a positive effect on the skilled-unskilled wage ratio, independent of the industry-specific technology intensity.

- The skilled-unskilled wage ratio is higher within the high-tech industry group than in the low-tech, medium-low tech, and medium-high tech industry groups, after accounting for the influence of other factors.

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[11] There is no dummy variable for the low-tech industry (*D Tech Low*) in the regression to avoid the 'dummy variable trap.'

VI.D. Econometric Results for Total Manufacturing

The following subsection presents the regression estimates of four wage inequality measures, namely, the Gini coefficient (G), ratio of 90 percentile to median wage (W_{90}/W_{50}), ratio of median to 10 percentile wage (W_{50}/W_{10}), and ratio of 90 percentile to 10 percentile wage (W_{90}/W_{10}). These four wage inequality measures are obtained for the total manufacturing sector that combines the organized and unorganized manufacturing segments.

VI.D.1 Estimates of Gini Coefficient Function

The Gini coefficient (G) is one of the widely used measures of income inequality. Here, it is calculated from the wage distribution of manufacturing labour for each of the 36 manufacturing industries at the 3-digit level of the NIC 98 for each of the four years 1993, 1999, 2004, and 2009 using the NSSO data set for total manufacturing. The regression equation presented in section VI.B.2 by the equation (A.2) is the wage inequality function for the Gini coefficient (G). The G_{it} indicates the Gini coefficient of the ith industry in year t.

Although the Gini coefficient has been widely used as a measure of inequality, its use has been limited in trade liberalization and wage inequality literature. To fill up this gap, the following section analyses the relation between trade liberalization and wage inequality with the Gini coefficient as a measure of wage inequality. Unlike the skilled-unskilled wage ratio which compares the wages for two categories of labour based on their relative skills and involvement in the production process, the Gini coefficient covers the entire wage distribution of labour in a given industry.

The interpretation of the coefficients of different explanatory variables in the Gini coefficient function would be different from that in the skilled-unskilled wage ratio function, because these two wage inequality measures are fundamentally different[12] from each other because of the way they are constructed.

Table 2 presents the estimates of the following Gini coefficient equation:

$$(G)_{it} = \alpha + \beta_1 \left(\frac{X}{Y}\right)_{it} + \beta_2 \left(\frac{M}{Y}\right)_{it} + \beta_3 \left(\frac{SS}{TT}\right)_{it} + \beta_4 \left(\frac{K}{L}\right)_{it} + \beta_5 \left(\frac{L_C}{L_U}\right)_{it} + \beta_6 (D\ Growth\ High) +$$
$$\beta_7 (D\ Tech) + u_{it} \qquad\qquad \ldots\ldots\ldots(A.2.1)$$

 Here, the dependent variable is the wage inequality measured by 'Gini coefficient' (G_{it}) for industry i (i = 1, 2, 3, ..., 36) and in time t (t = 1993, 1999, 2004, and 2009); the definitions of

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[12] For example, any wage/income transfer within skilled or unskilled labour would not change skilled-unskilled wage ratio (because the average wages for skilled and unskilled labour remain unchanged) but it would change the Gini coefficient because of the changes in wage/income distribution.

the independent variables and the regression specification are similar to that of the wage inequality function for skilled-unskilled wage ratio. The only exception is that the Gini coefficient function has only one dummy for *D Growth*, i.e. the *D Growth High* that represent the period of *high growth* of India's GDP in 2004 and 2009; the years 1994 and 1999 are considered as the period of *moderate growth* of India's GDP.   Since, the required data for calculating Gini coefficient for manufacturing wages is available only for four years (i.e. 1994, 1999, 2004, and 2007), we can consider only two growth periods here, i.e. *moderate growth* period (1994 and 1999) and *high growth* period (2004 and 2009). For these two growth periods, we use one dummy variable for *D Growth*, i.e. the dummy for high growth period '*D Growth High*' for 2004 and 2009. However, with the exception of the intercept and slope dummy variables, all the regressions are proxied for the true regressor, because they are constructed from the ASI data which covers the organized sector and the UN-COMTRADE data which covers the total manufacturing sector.

      As the *range* of Gini coefficient is 0 to 1, the predicted Gini coefficients from the regression equation must lie between [0, 1]. In fact, the estimated Gini coefficients for all four regression specifications in Table 2 are found to be within the range [0.36, 0.51]. This is an additional robustness check. Since the Hausman test has supported the random-effect model in all the four regression specifications, estimates of the random-effect model are presented in all the four columns of Table 2.

Table 2: Panel Regressions for 36 industries in total manufacturing and years 1994, 1999, 2004, and 2009

	(1)	(2)	(3)	(4)
Dependent Variable: Gini Coefficient				
Model Specification / Independent Variables	Random industry-effects regression	Random industry-effects regression	Random industry-effects regression	Random industry-effects regression
Export Orientation ($\frac{X}{Y}$)	0.0023 (0.26)	0.0016 (0.18)	0.0076 (0.73)	0.0017 (0.2)
Import penetration ($\frac{M}{Y}$)	0.0763*** (3.38)	0.0663*** (3.37)	0.039 (1.24)	0.0499* (1.88)
South-South Trade ($\frac{SS}{TT}$)	0.026 (0.9)	0.0222 (0.78)	0.0233 (0.95)	0.0171 (0.62)
Capital-labour Ratio ($\frac{K}{L}$)	0.001*** (3.33)	0.001*** (3.44)	0.001*** (3.57)	0.0021 (0.52)
Labour Market Institutions ($\frac{L_C}{L_U}$)	0.045 (1.01)	0.0034 (0.06)	0.0106 (0.19)	0.0008 (0.01)
D Growth High (2004 & 2009)		0.0162* (1.81)	0.0171* (1.87)	0.0132* (1.67)
D Tech Med-low			0.0108 (0.73)	
D Tech Med-high			0.0501*** (4.25)	
D Tech High			0.0665* (1.74)	
$\frac{K}{L}$ *D Tech Med-low				-0.0011 (-0.29)
$\frac{K}{L}$ *D Tech Med-high				0.0012 (0.31)
$\frac{K}{L}$ *D Tech High				0.0104* (1.69)
Constant	0.3785*** (25.98)	0.3834*** (24.31)	0.3688*** (26.37)	0.3834*** (23.98)
R^2	Within = 0.0983 Between = 0.2893 Overall = 0.1956	Within = 0.1348 Between = 0.2746 Overall = 0.2023	Within = 0.1452 Between = 0.4659 Overall = 0.3211	Within = 0.1594 Between = 0.3688 Overall = 0.2695
Test Statistic for Joint Significance Slope Coefficients	Wald chi2 (5) =45.12***	Wald chi2 (6) = 50.3***	Wald chi2 (9) = 124.62***	Wald chi2 (9) = 107.17***
Hausman Test Statistic	chi2(5) = 6.48 Prob>chi2 = 0.2625	chi2(6) = 8.2 Prob>chi2 = 0.2238		chi2(6) = 7.23 Prob>chi2 =0.613
Number of Observations	143	143	143	143
Number of Industry Groups	36	36	36	36

Note: The numbers in the parentheses are the 't' statistic if the regression is estimated with fixed-effects, or 'Z' statistic if the regression is estimated with the random-effects, corresponding to robust standard errors; '***', '**', '*', and # imply 1 percent, 5 per cent, 10 per cent, and 15 per cent levels of significance respectively.

From Table 2, it is observed that among the trade liberalization variables, import-penetration ($\frac{M}{Y}$) is the only variable with statistically significant coefficients in the regression specifications presented in columns 1, 2 and 4. Since these coefficients are positive, it implies that rising import-penetration has increased the Gini coefficient. The rising Gini coefficient in this case is opposite of what a developing country should experience. A developing country's trade liberalization should increase the imports (or import-penetration) of skilled-labour intensive goods; this would reduce the demand for skilled labour and their wages relative to that of the unskilled-labour. Hence, wage inequality is expected to decrease. But, here we see that effect of import penetration on the Gini coefficient is positive and hence perverse. The other two trade liberalization variables, i.e. the South-South trade ($\frac{SS}{TT}$) and the export-orientation ($\frac{X}{Y}$) seem to have no effect on the Gini coefficient.

The effect of capital-labour ratio ($\frac{K}{L}$) – a measure of capital intensity – is positively significant in regression specifications presented in columns 1, 2, and 3; however, it becomes statistically insignificant in column 4, where the industry-specific effect of capital intensity is controlled by the interaction variable by $\frac{K}{L}$ *D Tech. Among the three interaction terms, the only statistically significant term is $\frac{K}{L}$ *D Tech High. Therefore, the positively significant interaction term between the capital-labour ratio and high-tech industry ($\frac{K}{L}$ *D Tech High) supports the hypothesis that a rising capital-labour ratio ($\frac{K}{L}$) has led to an increase in the Gini coefficient only in the high-tech industry. The statistically insignificant coefficient (0.002 with a Z statistics of 0.52) of the capital-labour ratio ($\frac{K}{L}$), in column 4, implies that the $\frac{K}{L}$ does not have any *independent* effect on the Gini coefficient for the manufacturing sector as a whole. However, the positively significant coefficients for $\frac{K}{L}$ in columns 1, 2, and 3 are because of possible omitted variable bias.

The labour market institution variable or the contractualization of unskilled labour ($\frac{L_C}{L_U}$) has no significant effect on Gini coefficient in any of the four regression specifications. Unlike the earlier wage inequality measure, i.e. the skilled-unskilled ratio, the Gini coefficient has not been affected significantly by the deteriorating labour market institutions observed in Indian manufacturing industry.

The estimated coefficient of the dummy variable for the period of high growth (*D Growth 2004 &2009*) is positive and statistically significant for regression specifications presented in columns 2, 3 and 4. Therefore, in the period of high growth (2004 and 2009) the

inequality function shifted upward, indicating a significant rise in wage inequality in the *high growth* period, 2004 and 2009, compared to the *moderate growth* period, 1994 and 1999.

The dummy variables for the medium-high tech and high-tech industries are positive and statistically significant. Therefore, the Gini coefficient inequality functions for the high-tech and medium-high tech industries are above those for the medium-low and low-tech industries, with that for the high-tech groups at the higher level.

In regard to goodness of fit, the 'overall R^2' is 0.27 and the 'between R^2' is 0.37 in Column 4 – the most preferred regression specification – the random industry effect regression in this case.

The main findings from the estimated 'Gini coefficient inequality' function may be summarized as follows:

- An increase in import-penetration has raised the Gini coefficient. This indicates an adverse effect of trade liberalization on wage inequality. The other two trade related variables, namely, export-orientation and South-South trade have no significant effect on the Gini coefficient.

- The positive effect of capital-labour ratio or capital intensity ($\frac{K}{L}$) on Gini coefficient is confined to the high-tech industry. The capital-labour ratio ($\frac{K}{L}$) does not have any independent effect on the Gini coefficient for overall manufacturing indusry once we control for industry-specific technology intensities.

- Deteriorating labour market institution or increasing contractualization of unskilled labour ($\frac{L_C}{L_U}$) has no significant effect on the Gini coefficient.

- In the period of high growth (years 2004 and 2009 in our data set), the Gini coefficient function shifted upward, which indicates a significant rise in wage inequality in the *high growth* period (2004 and 2009) compared to the period of *moderate growth* period (1994 and 1999).

- The Gini coefficient inequality functions for the medium-high tech and high-tech industry groups are above those for the medium-low tech and the low-tech industry groups.

VI.D.2 Estimates of '90-50 Wage Ratio' Function

The rationale for using various wage inequality measures lies in the fact that different wage inequality measures help us to understand the wage inequalities between different labour groups based on their skills or wages etc. The ratio of 90th percentile wage to 50th

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percentile wage $\left(\frac{W_{90}}{W_{50}}\right)$ captures the extent of wage inequality within the upper-half of the wage distribution. Here, it is calculated from the wage distribution of manufacturing labour for each of 36 manufacturing industries at the 3-digit level of NIC 98 for the four years 1994, 1999, 2004, and 2009 using the NSSO data set for the total manufacturing.

Table 3 presents the regression estimates of the following '90-50 wage ratio' equation:

$$\left(\frac{W_{90}}{W_{50}}\right)_{it} = \alpha + \beta_1 \left(\frac{X}{Y}\right)_{it} + \beta_2 \left(\frac{M}{Y}\right)_{it} + \beta_3 \left(\frac{SS}{TT}\right)_{it} + \beta_4 \left(\frac{K}{L}\right)_{it} + \beta_5 \left(\frac{L_C}{L_U}\right)_{it} + \beta_6 (D\ Growth\ High) + \beta_7\ (D\ Tech) + u_{it}$$

$$\ldots\ldots\ldots\ldots..(A.2.2)$$

Here, the $\left(\frac{W_{90}}{W_{50}}\right)_{it}$ indicates the ratio of the 90 percentile to the 50 percentile wage for industry *í*, in year *t*. The independent variables and the regression specification used in this 90-50 wage ratio function are the same as for the Gini inequality function presented in section VI.D.1.

Table 3. Panel Regressions for 36 industries in total manufacturing and years 1994, 1999, 2004, and 2009

Model Specification / Independent Variables	Dependent Variables: 90-50 Wage Ratio			
	(1)	(2)	(3)	(4)
	Fixed industry-effects regression	Random industry-effects regression	Random industry-effects regression	Random industry-effects regression
Export Orientation ($\frac{X}{Y}$)	0.2547** (2.18)	-0.1932* (-1.86)	-0.1188 (-1.33)	-0.1858* (-1.71)
Import penetration ($\frac{M}{Y}$)	0.2686 (0.46)	0.4378 (2.09)	0.1039 (0.34)	0.148 (0.49)
South-South Trade ($\frac{SS}{TT}$)	0.0101 (0.01)	-0.3497 (-0.66)	-0.2205 (-0.5)	-0.4254 (-0.85)
Capital-labour Ratio ($\frac{K}{L}$)	0.0324*** (3.52)	0.024*** (4.81)	0.0213*** (6.09)	0.0227 (0.59)
Labour Market Institutions ($\frac{Lc}{Lu}$)	0.6504 (0.56)	-0.0577 (-0.09)	-0.0604 (-0.11)	-0.1227 (-0.2)
D Growth High (2004 & 2009)		0.1942* (1.61)	0.2191* (1.75)	0.1687# (1.38)
D Tech Med-low			0.1253 (0.75)	
D Tech Med-high			0.7543*** (5.78)	
D Tech High			0.6504* (1.58)	
$\frac{K}{L}$ *D Tech Med-low				-0.0006 (-0.02)
$\frac{K}{L}$ *D Tech Med-high				0.052# (1.38)
$\frac{K}{L}$ *D Tech High				0.1316*** (2.64)
Constant	2.308*** (6.67)	2.6926*** (14.31)	2.4731*** (13.81)	2.7158*** (15.18)
R^2	Within = 0.2391 Between = 0.0997 Overall = 0.1328	Within = 0.2185 Between = 0.2889 Overall = 0.2444	Within = 0.222 Between = 0.5882 Overall = 0.3931	Within = 0.2849 Between = 0.4224 Overall = 0.3395
Test Statistic for Joint Significance Slope Coefficients	$F(5, 35)$ =19.79***	Wald chi2 (6) = 90.8***	Wald chi2 (9) = 204.77***	Wald chi2 (9) = 204.3***
Hausman Test Statistic	chi2(5) = 10.05 Prob>chi2 = 0.0737	chi2(6) = 8.03 Prob>chi2 = 0.2361		chi2(9) = 8.23 Prob>chi2 =0.5115
Number of Observations	143	143	143	143
Number of Industry Groups	36	36	36	36

Note: The numbers in the parentheses are the 't' statistic if the regression is estimated with fixed-effects, or 'Z' statistic if the regression is estimated with the random-effects, corresponding to robust standard errors; '***', '**', '*', and # imply 1 per cent, 5 per cent, 10 per cent, and 15 per cent levels of significance respectively.

The regression estimation presented in Table 3 shows that export orientation ($\frac{X}{Y}$) has a negative effect on 90-50 wage ratio – the estimated coefficients are negative in columns 2, 3, and especially in column 4 which is the most preferred regression specification (although the coefficient is statistically insignificant in column 3). This implies that median wage earners (expected to be unskilled labour) are better off relative to the 90th percentile wage earners (expected to be skilled labour) because of the rise in export orientation observed in the Indian manufacturing sector. This result is quite convincing for developing countries such as India where trade liberalization is expected to increase the export orientation of unskilled-labour intensive industries; hence, the demand for unskilled-labour (50th percentile wage earners) and their wage (50th percentile wage) should rise relative to the wage for skilled labour (90th percentile wage).

The other two trade liberalization variables – i.e. the share of South-South trade in total trade ($\frac{SS}{TT}$) and import penetration ($\frac{M}{Y}$) – and labour market institutions do not have significant impacts on the 90-50 wage ratio.

An increase in capital-labour ratio should increase the demand for skilled labour and their wages (say, labour at 90 percentile wage) relatively more than the demand for unskilled labour and their wages (say, labour at median wage) respectively – because of the capital-skill complementarity. Hence, the 90-50 wage ratio should rise due to an increase in capital-labour ratio.

As in the regression estimates of the Gini coefficient equation, the effect of rising capital-labour ratio ($\frac{K}{L}$) on the 90-50 wage ratio is positive (in columns 1, 2, and 3) only when the industry specific capital intensities are not controlled. Once the industry specific technology intensities are controlled in column 4 by the interaction terms between capital-labour ratio and dummies for industry for their technology intensities ($\frac{K}{L}*D\ Tech$), the effect of capital-labour ratio ($\frac{K}{L}$) on the 90-50 wage ratio becomes statistically insignificant. Therefore, we do not observe an independent effect of $\frac{K}{L}$ on the 90-50 wage ratio; moreover, the statistically significant and positive coefficient of $\frac{K}{L}*D\ Tech\ High$ implies that the capital intensity in high-tech industry has contributed to raising the 90-50 wage ratio. For other industry groups, namely, medium-high, medium-low, and low-tech industries, we do not observe such effects.

The estimated coefficient of the dummy variable for the period of high growth (*D Growth 2004 &2009*) is positive and statistically significant for regression specifications presented in columns 2, 3 and 4. Therefore, in the period of high growth in 2004 and 2009,

the wage inequality function shifted upward, which indicates a significant rise in wage inequality in the *high growth* periods, 2004 and 2009, compared to the periods of *moderate growth* in 1994 and 1999.

Within the high-tech and medium-high tech industry, the 90-50 wage ratio functions are above those for the medium-low and the low-tech industry.[13] The statistically significant and positive coefficients of dummy variables for high-tech (*D Tech High)* and medium-high tech industry (*D Tech Medium-high)* in column 3 imply this. It seems that the high-tech and medium-high tech industries employ *highly-skilled*[14] labour with high wages at the top decile wage groups compared to that of the medium-low tech and low tech industries, which do not employ such highly-skilled labour. Therefore, the 90th percentile wage relative to the 50th percentile wage function for high-tech and medium-high tech industry groups are above those for medium-low tech and low-tech industry groups.

The 'overall R^2' is 0.34 and the 'between R^2' is 0.42 in Column 4 – the most preferred regression specification – which is the random industry effect regression in this case.

The main findings from the estimated 90-50 wage ratio function may be summarized as follows:

- Export orientation ($\frac{X}{Y}$) has a negative effect on the 90-50 wage ratio; i.e. after controlling for other factors, the rise in export-orientation increases the median wage more than the 90 percentile wage.

- Increasing import-penetration and South-South trade seemed to have no significant effect on the 90-50 wage ratio.

- The positive effect of the capital-labour ratio or capital intensity ($\frac{K}{L}$) on the 90-50 wage ratio is confined to the high-tech industry. The capital-labour ratio ($\frac{K}{L}$) does not have any independent effect on the 90-50 wage ratio for overall industry, once we control for industry-specific technology intensities.

- Deteriorating labour market institutions or the increasing contractualization of unskilled labour ($\frac{L_C}{L_U}$) has no significant effect on the 90-50 wage ratio.

- In the period of high growth in 2004 and 2009, the 90-50 wage ratio function shifted upward, which indicates a significant rise in wage inequality in the *high growth*

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[13] In 2009, the 90-50 wage ratios for high-tech, medium-high tech, medium-low tech, and low-tech industries were 4.15, 4, 3.68, and 3.42 respectively.

[14] Highly-skilled labour is assumed as labour that belongs to skilled labour force, but with more specialized skills than average skilled labour. So, it is expected that the wage for highly-skilled labour would be higher than the wage for average skilled labour.

period in 2004 and 2009 as compared to the period of *moderate growth* in 1994 and 1999.

- The 90-50 wage ratio functions for the medium-high tech and high tech industry groups lie above those for the medium-low tech and low-tech industry groups.

VI.D.3 Estimates of '50-10 Wage Ratio' Function

Wage inequality measured by 50-10 wage ratio is supposed to measure the extent of wage inequality that exists within the lower-half of a wage distribution. These wage earners are likely to be unskilled labour relative to the upper-half of the wage earners. Since the 90-50 wage ratio measures the wage inequality within the upper-half of the wage earners, the 50-10 wage ratio complements that measure by looking at wage inequality in the bottom half of the wage distribution.

Like the earlier two measures of wage inequality, i.e. the Gini coefficient and 90-50 wage ratio, the 50-10 wage ratio is obtained from the wage distribution of manufacturing labour for each of 36 manufacturing industries at 3-digit level of NIC 98 for four years 1993, 1999, 2004, and 2009 using the NSSO data set for total manufacturing.

Table 4 presents the regression estimates of the following 50-10 wage ratio equation:

$$\left(\frac{W_{50}}{W_{10}}\right)_{it} = \alpha + \beta_1 \left(\frac{X}{Y}\right)_{it} + \beta_2 \left(\frac{M}{Y}\right)_{it} + \beta_3 \left(\frac{SS}{TT}\right)_{it} + \beta_4 \left(\frac{K}{L}\right)_{it} + \beta_5 \left(\frac{L_C}{L_U}\right)_{it} + \beta_6 (D\ Growth\ High)$$
$$ + \beta_7 (D\ Tech) + u_{it}$$

…………(A.2.3)

Here, the $\left(\frac{W_{50}}{W_{10}}\right)_{it}$ indicates the ratio of the 50 percentile to the 10 percentile wage for industry *í*, in year *t*. The independent variables and the regression specification used in this 50-10 wage ratio function are the same as those for the Gini coefficient and 90-10 wage ratio functions.

Table 4. Panel Regressions for 36 industries in total manufacturing and years 1994, 1999, 2004, and 2009

	(1)	(2)	(3)	(4)
		Dependent Variables: 50-10 Wage Ratio		
Model Specification / Independent Variables	Fixed industry-effects regression	Fixed industry-effects regression	Random industry-effects regression	Fixed industry-effects regression
Export Orientation $(\frac{X}{Y})$	0.5215** (2.44)	0.5737*** (2.58)	0.2725*** (2.72)	0.6288*** (2.62)
Import penetration $(\frac{M}{Y})$	0.0848 (0.1)	-0.4639 (-0.77)	-0.2576 (-1.01)	-0.2711 (-0.31)
South-South Trade $(\frac{SS}{TT})$	1.0356 (1.26)	0.2407 (0.23)	0.4151 (0.68)	0.23 (0.28)
Capital-labour Ratio $(\frac{K}{L})$	-0.0101 (-1.44)	-0.012# (-1.61)	0.0044** (2.03)	-0.1471* (-1.86)
Labour Market Institutions $(\frac{L_C}{L_U})$	-2.2909** (-2.02)	-3.8351** (-2.17)	-1.4788** (-2.08)	-3.4628** (-1.96)
D Growth High (2004 & 2009)		0.4249# (1.5)	0.0524 (0.31)	0.5881** (2.08)
D Tech Med-low			0.1217 (0.62)	
D Tech Med-high			0.5183# (1.48)	
D Tech High			1.3357*** (6.6)	
$\frac{K}{L}$*D Tech Med-low				0.1357* (1.74)
$\frac{K}{L}$*D Tech Med-high				0.0697 (0.89)
$\frac{K}{L}$*D Tech High				-0.1585* (-1.87)
Constant	2.8166*** (7.35)	3.4109*** (5.34)	2.7403*** (9.38)	3.5367*** (5.46)
R^2	Within = 0.143 Between = 0.0021 Overall = 0.0132	Within = 0.1909 Between = 0.0009 Overall = 0.0102	Within = 0.125 Between = 0.2875 Overall = 0.1719	Within = 0.2711 Between = 0.0731 Overall = 0.0002
Test Statistic for Joint Significance Slope Coefficients	$F_{(5, 35)}$ =12.04***	$F_{(5, 35)}$ =7.08***	Wald chi2 (9) = 79.56***	$F_{(9, 35)}$ = 24.52***
Hausman Test Statistic	chi2(5) = 13.29 Prob>chi2 = 0.0208	chi2(6) = 22.62 Prob>chi2 = 0.0009		chi2(9) = 55.23 Prob>chi2 =0.0000
Number of Observations	143	143	143	143
Number of Industry Groups	36	36	36	36

Note: The numbers in the parentheses are the 't' statistic if the regression is estimated with fixed-effects, or 'Z' statistic if the regression is estimated with the random-effects, corresponding to robust standard errors; '***', '**', '*', and # imply 1 per cent, 5 per cent, 10 per cent, and 15 per cent levels of significance respectively.

Among the trade liberalization variables, export-orientation ($\frac{x}{Y}$) has a significantly positive impact on the 50-10 wage ratio across all regression specifications; whereas the other two variables, i.e. South-South trade ($\frac{SS}{TT}$) and import-penetration ($\frac{M}{Y}$) have no significant impact. The positive effect of export orientation seems to be coming from the rise in the demand for middle skilled labour (whose wages are around median wage) relative to unskilled labour (around the 10 percentile wage) due to a rise in export-orientation observed in the Indian manufacturing sector. A study using cross-section data for 2531 plants in Mexico shows a similar positive impact of the share of exports on the 50-10 wage ratio (Frias, *et al.*, 2012).

The negative and statistically significant coefficients of the $\frac{L_C}{L_U}$ across all four regression specifications suggest that the rise in contractualization has led to a reduction in the 50-10 wage ratio. This implies that a rise in contractualization within unskilled labour has reduced the wage inequality measured by the 50-10 wage ratio. This result can be explained by the 'wage rigidity' assumption at very low wage levels (say at 10th percentile wage or below). In fact, because of the low levels, the average growth of the 10th percentile wage was 3.93 per cent annually in 1993-2009, whereas the growth of 50th percentile wage was 1.7 per cent annually in the same period for all industries. As the growth of 50th percentile wage was lower than the growth of 10th percentile wage; so, the wage for 50th percentile wage earners decreased relative to the 10th percentile wage earners. Given the wage rigidity assumption at the 10 percentile wage, the negative impact of contractualization on the 50-10 wage ratio would mean that an increase in contractualization has led to a decline in the median wage. Therefore, the rise in contractualization hurts the middle wage earners more than the low wage earners.

The statistically significant and negative coefficients of capital-labour ratio ($\frac{K}{L}$) (particularly in column 4 which controls for the industry specific technology intensities) can be explained by similar logic given in case of the effect of labour market institution on 50-10 wage ratio. Given the assumption of downward wage rigidity or upward mobility of 10th percentile wage, a negative and statistically significant coefficient of capital-labour ratio signifies that it has led to a decline in the median wage. The statistically significant and negative coefficient of the $\frac{K}{L}$ *D Tech High implies that, within high-tech industry, a rise in the capital-labour ratio has led to a decrease in the 50-10 wage ratio. However, the statistically significant and positive coefficient of the $\frac{K}{L}$ *D Tech Medium-low implies that, within medium-low tech industry, the rise in capital-labour ratio has led to an increase in the 50-10 wage

ratio. These outcomes can be explained by the fact that the rise in capital intensity in high-tech industry increases the demand for high-skilled labour (say, 90 percentile wage earners) relative to the medium-skilled labour (say, median wage earners); therefore, the relative wage for medium-skilled labour decreases relative to high-skilled and low-skilled labour (say, 10 percentile wage earners, whose wages are downward rigid). Thus, a rise in the capital-labour ratio in high-tech industry reduces the 50-10 wage ratio. Unlike the high-tech industry, the medium-low tech industry employs middle-skilled labour as the skilled labour. Therefore, a rise in the capital-labour ratio in medium-low tech industry leads to an increase in the demand for middle-skilled labour (whose wages are around median wage) relative to unskilled labour (whose wages are around 10 percentile wage), and that increases the 50-10 wage ratio.

The statistically significant and positive coefficient of the dummy variable for the high growth period in 2004 and 2007 (*D Growth High, 2004 and 2007)* in column 4 implies that during this period, the 50-10 wage ratio function shifted upward indicating a significant rise in wage inequality between the median and 10 percentile wage earners in the *high growth* period in 2004 and 2009 compared to the period of *moderate growth* period in 1994 and 1999.

However, the 'overall R^2' is negligibly low, but the 'within R^2' is 0.27 in Column 4, which presents the fixed industry effect estimate in this case.

The main findings from the estimated 50-10 wage ratio equation may be summarized as follows:

- Export-orientation ($\frac{X}{Y}$) has a positive impact on the 50-10 wage ratio. The increase in export orientation of unskilled labour intensive goods has probably improved the wages for unskilled labour that are around the median wage than that of very low skilled labour around the 10th percentile wage.

- We find evidence that a rise in contractualization in the unskilled labour ($\frac{L_C}{L_U}$) leads to a decrease in the 50-10 wage ratio. The deterioration in labour market institutions or increasing contractualization of unskilled labour has led to a reduction in unskilled wage around the median wage of the wage distribution relative to the wage at 10th percentile.

- The capital intensity measured by the capital-labour ratio ($\frac{K}{L}$) has a negative effect on the 50-10 wage ratio, independent of any industry-specific technology intensities.

- In the period of high growth in 2004 and 2009, the 50-10 wage ratio function shifted upward, which indicates a significant rise in wage inequality between the median and 10 percentile wage earners in the *high growth* period in 2004 and 2009 compared to the period of *moderate growth* period in 1994 and 1999.

- The 50-10 wage ratio function for the high-tech industry lies above those for the medium-high, medium-low tech and low-tech industry groups.

VI.D.4 Estimates of '90-10' Wage Ratio' Function

The 90-10 wage ratio measures the wage inequality between two extreme deciles of the wage distribution – i.e. the wage inequality between the top and bottom deciles of wage earners. The labour at the 90th percentile wage can be treated as the highly-skilled segment within the skilled-labour segment. On the other hand, labour at the 10th percentile wage is unskilled labour, whose wage is supposed to be downward rigid at this low level of wage.

Table 5 presents the regression estimates of the following 90-10 wage ratio equation:

$$\left(\frac{W_{90}}{W_{10}}\right)_{it} = \alpha + \beta_1 \left(\frac{X}{Y}\right)_{it} + \beta_2 \left(\frac{M}{Y}\right)_{it} + \beta_3 \left(\frac{SS}{TT}\right)_{it} + \beta_4 \left(\frac{K}{L}\right)_{it} + \beta_5 \left(\frac{L_C}{L_U}\right)_{it} + \beta_6 (D\ Growth\ High)$$
$$+ \beta_7 (D\ Tech) + u_{it}$$

………….   (A.2.4)

Here, the $\left(\frac{W_{90}}{W_{10}}\right)_{it}$ indicates the ratio of 90 percentile to 10 percentile wage for industry *í*, in year *t*. The independent variables and the regression specification used in this wage inequality function are the same as those for the 50-10 wage ratio function.

Table 5. Panel Regressions for 36 industries in total manufacturing and years 1994, 1999, 2004, and 2009

	(1)	(2)	(3)	(4)
Dependent Variable: 90-10 Wage Ratio				
Model Specification / **Independent Variables**	Fixed industry-effects regression	Fixed industry-effects regression	Random industry-effects regression	Fixed industry-effects regression
Export Orientation $(\frac{X}{Y})$	1.9635[***] (2.8)	2.2048[***] (3.24)	0.2675 (0.68)	2.1723[***] (3.08)
Import penetration $(\frac{M}{Y})$	-3.2275 (-0.61)	-5.7609 (-1.18)	0.4026 (0.29)	-5.6013 (-1.11)
South-South Trade $(\frac{SS}{TT})$	4.8551[*] (1.82)	1.1849 (0.38)	0.3392 (0.29)	0.7687 (0.24)
Capital-labour Ratio $(\frac{K}{L})$	0.0821[***] (3.68)	0.0731[***] (4.41)	0.0737[***] (4.83)	-0.1243 (-0.33)
Labour Market Institutions $(\frac{L_C}{L_U})$	-3.6002 (-0.83)	-10.73[*] (-1.74)	-4.193[*] (-1.87)	-10.5038[*] (-1.68)
D Growth High (2004 & 2009)		1.9616[**] (2.17)	0.9724[*] (1.9)	2.1584[**] (2.29)
D Tech Med-low			0.7443 (1.08)	
D Tech Med-high			3.354[***] (3.47)	
D Tech High			5.4825[***] (4.11)	
$\frac{K}{L}$ *D Tech Med-low				0.1944 (0.52)
$\frac{K}{L}$ *D Tech Med-high				0.2328 (0.63)
$\frac{K}{L}$ *D Tech High				-0.1585 (-0.26)
Constant	5.9842[***] (4.83)	8.7279[***] (4.59)	6.7269[***] (8.74)	9.0904[***] (4.41)
R^2	Within = 0.0982 Between = 0.0098 Overall = 0.0006	Within = 0.1825 Between = 0.0576 Overall = 0.0008	Within = 0.1075 Between = 0.5857 Overall = 0.3718	Within = 0.192 Between = 0.0576 Overall = 0.0007
Test Statistic for Joint Significance Slope Coefficients	$F_{(5, 35)}$ =6.14[***]	$F_{(6, 35)}$ =9.99[***]	Wald chi2 (9) = 78.39[***]	$F_{(9, 35)}$ = 12.09[***]
Hausman Test Statistic	chi2(5) = 9.82 Prob>chi2 = 0.0804	chi2(6) = 16.84 Prob>chi2 = 0.0099		chi2(9) = 20.39 Prob>chi2 =0.0156
Number of Observations	143	143	143	143
Number of Industry Groups	36	36	36	36

Note: The numbers in the parentheses are the 't' statistic if the regression is estimated with fixed-effects, or 'Z' statistic if the regression is estimated with the random-effects, corresponding to robust standard errors; '***', '**', '*', and # imply 1 per cent, 5 per cent, 10 per cent, and 15 per cent levels of significance respectively.

Among the trade liberalization variables, export orientation ($\frac{X}{Y}$) seems to have a significant positive effect on the 90-10 wage ratio, and that is evident from the statistically significant positive coefficients of $\frac{X}{Y}$ in columns 1, 2, and 4. Therefore, the 90th percentile wage earner has gained more relative to the 10th percentile wage earners from an increase in export-orientation observed in the Indian manufacturing sector. Frias, *et al.* (2012) observed similar results for 2531 plants in Mexico. The other two trade liberalization variables seem to have no significant effect on the 90-10 wage ratio.

Labour market institution or the contractualization of unskilled labour ($\frac{L_C}{L_U}$) shows a negative effect on the 90-10 wage ratio. This phenomenon is explained by the statistically significant negative coefficients of $\frac{L_C}{L_U}$ in regression specifications presented in columns 2, 3, and 4. The contractualization of unskilled labour should not reduce wage for skilled labour – particularly for those who are at the top decile. Therefore, the fall in the 90-10 wage ratio due to rise in contractualization is possible only when there is an increase in the 10th percentile wage relative to 90th percentile wage. In fact, the descriptive statistics show that the annual average growth of the 10th percentile wage was 3.9 per cent in 1993-2009 period, whereas the annual average growth of 90th percentile wage was only 1.9 per cent in the same period for all industries. Therefore, the rise in contractualization within unskilled labour has not reduced the wages for the bottom decile wage earners *per se*. The capital-labour ratio ($\frac{K}{L}$) has a statistically significant positive effect on the 90-10 wage ratio in columns 1, 2, and 3, but it is statistically insignificant in column 4, which controls for industry-specific technology intensities. Moreover, unlike the earlier regression estimates of various wage inequality functions, none of the interaction variables ($\frac{K}{L}$*D Tech) shows statistically significant results in column 4. Hence, the effectiveness of industry specific capital-labour ratio and its independent effect on the 90-10 wage ratio remains inconclusive.

Finally, like all earlier estimates, in the period of high growth in 2004 and 2009, the 90-10 wage ratio function has shifted upward, which indicates a significant rise in wage inequality between the 90 and 10 percentile wage earners in the *high growth* period compared to the period of *moderate growth,* 1994 and 1999.

The positively significant coefficients of the dummy variables for high-tech (*D Tech High*) and medium-high tech industry (*D Tech Medium-high*) imply that for the high-tech and medium-high tech industries, the 90-10 wage ratio functions lie above the functions for the medium-low tech and low-tech industries.

Although the 'overall R^2' is very low, the 'within R^2' is 0.19 in Column 4, which presents the fixed industry effect estimate in this case.

The main findings from the estimated '90-10 wage ratio' function may be summarized as follows:

- Export orientation ($\frac{X}{Y}$) seems to have a statistically significant positive effect on the 90-10 wage ratio.

- The effect of capital-labour ratio ($\frac{K}{L}$) is inconclusive because the estimated coefficients of $\frac{K}{L}$ are positively significant in column 1, 2, and 3 but insignificant in column 4, which controls for industries-specific technology intensities.

- Labour market institutions or the contractualization of unskilled labour ($\frac{L_C}{L_U}$) has a negative effect on the 90-10 wage ratio. Since the wage for skilled labour (wage earners at 90th percentile wage) is not affected by the contractualization of unskilled labour ($\frac{L_C}{L_U}$), therefore, a fall in the 90-10 wage ratio, due to rise in contractualization, is possible only when there is an increase in the 10th percentile wage relative to the 90 percentile wage. Hence, the rise in contractualization within unskilled labour has not reduced the wages for bottom decile wage earners; rather it has increased wages relative to the 90th percentile wage.

- During the period of high growth in 2004 and 2009, the 90-10 wage ratio function has shifted upward, which indicates a significant rise in wage inequality between the 90 and 10 percentile wage earners in the *high growth* period in 2004 and 2009 compared to the period of *moderate growth* in 1994 and 1999.

- The 90-10 wage ratio for the high-tech and medium-high tech industries lies above that for the medium-low tech and low-tech industries.

VII. Conclusions from the Estimates of Wage Inequality Functions

The following Table 6 summarizes the directions of impact of the different regressors on the five wage inequality measures, as revealed by the regression results presented in Tables 1 to 5. The five wage inequality measures are, the skilled-unskilled wage ratio, the Gini coefficient, the 90-50 wage ratio, the 50-10 wage ratio, and the 90-10 wage ratio. Among these five measures of wage inequality, the skilled-unskilled wage ratio is measured for the organized manufacturing sector only; therefore, the regression estimates that arise

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from the skilled-unskilled wage ratio function relate to organized manufacturing only. Since the other four wage inequality measures, i.e., the Gini coefficient, the 90-50 wage ratio, the 50-10 wage ratio, and the 90-10 wage ratio are measured for the total manufacturing (i.e. organized and unorganized segments combined), the wage inequality functions that use any of these four measures refer to the total manufacturing sector.

It is quite clear from the table that the wage inequality outcomes, with respect to various explanatory factors, are different from each other depending upon the wage inequality measure we take. It is not surprising to obtain such differential outcomes – because the economic mechanisms are different from each other for these wage inequality measures. Although this study is possibly a first attempt to test the impacts of a range of factors such as trade liberalization, technological change, labour market institutions and economic growth on various wage inequality measures for Indian manufacturing sector, some of the results obtained in this study show similarities with existing studies for India and other developing countries.

Table 6: Comparison of the effects of different explanatory variables on different wage inequality measures

	Organized Manufacturing	Total Manufacturing Sector			
	(1)	(2)	(3)	(4)	(5)
Wage Inequality Measures / Independent Variables	Skilled-unskilled wage ratio ($\frac{W_S}{W_U}$)	Gini coefficient (G)	The 90-50 wage ratio ($\frac{W_{90}}{W_{50}}$)	The 50-10 wage ratio ($\frac{W_{50}}{W_{10}}$)	The 90-10 wage ratio ($\frac{W_{90}}{W_{10}}$)
Export Orientation ($\frac{X}{Y}$)	Not significant	Not significant	Negative	Positive	Positive
Import penetration ($\frac{M}{Y}$)	Negative	Positive	Not significant	Not significant	Not significant
South-South Trade ($\frac{SS}{TT}$)	Positive	Not significant	Not significant	Not significant	Not significant
Capital-labour Ratio ($\frac{K}{L}$)	Positive	Not significant	Not significant	Negative	Not significant
Labour Market Institutions (($\frac{L_C}{L_U}$))	Positive	Not significant	Not significant	Negative	Negative
D Growth Moderate (1994-2000)	Positive	NA	NA	NA	NA
D Growth High (2001-2007)	Positive	NA	NA	NA	NA
D Growth High (2004 & 2007)	NA	Positive	Positive	Positive	Positive
D Tech Med-low	Not significant	Not significant	Not significant	Not significant	Not significant
D Tech Med-high	Not significant	Positive	Positive	Not significant	Positive
D Tech High	Positive	Positive	Positive	Positive	Positive

Note: NA means 'not applicable'.

VII.A Trade-related Factors

For the organized manufacturing sector, the only wage inequality measure available in this study is the skilled-unskilled wage ratio. The variables related to trade liberalization, namely, the export-orientation, import-penetration, and South-South trade show that the skilled-unskilled wage ratio is affected negatively by the import-penetration, positively by the South-South trade, however, not affected by the export-orientation. The observed impacts of trade liberalization variables on the skilled-unskilled wage ratio can be explained as follows.

The negative effect of import penetration on skilled-unskilled wage ratio is expected from a developing country's point of view. As trade liberalization in developing countries increases imports of skill-intensive products, which is also observed in Indian manufacturing sector through higher rise in import-penetration in high-tech and medium-high tech industries than in the medium-low and low tech industries, this in turn reduces the demand for skilled labour and skilled wage relative to that for their unskilled counterparts. Therefore, such negative effect of import-penetration on skilled-unskilled wage ratio seems to have worked for Indian manufacturing sector. The export-orientation has shown an insignificant impact on the skilled-unskilled wage ratio, and this result is consistent with the results obtained by other study on India.

Rising share of South-South trade in total trade has led to an increase in the skilled-unskilled wage ratio. Unlike the North-South trade, the South-South trade leads to more competition for the unskilled labour in the South. Therefore, the observed positive effect of South-South trade on skilled-unskilled wage ratio can be explained through the plausible increase in competition among unskilled labour between developing countries, and it leads to a reduction in unskilled wage relative to skilled wage. However, the skilled-unskilled wage ratio has not been affected by the rising export-penetration. This result appears plausible because of the rise in export-orientation in high-tech, medium-high tech and low-tech manufacturing industries, seems to have increased the demand for both skilled and unskilled labour and their wages, leaving their relative wages unaffected.

The effects of three trade liberalization variables on the four wage inequality measures for total manufacturing are the following. Export orientation has a negative effect on 90-50 wage ratio, but its effect is positive on the 50-10 wage ratio and the 90-10 wage ratio, and it has no significant effect on the Gini coefficient. Hence, a rise in export orientation leads to a decline in the 90 percentile wage relative to the median wage; on the other hand, it raises the 90 percentile wage and median wage relative to the 10 percentile wage. This result is quite plausible because of India's high export-orientation in low-tech manufacturing goods, which are unskilled labour intensive. Given the wage rigidity at the bottom deciles, an increase in demand for unskilled labour – due to an increase in export-orientation – leads to an increase in the median wage relative to the 90 percentile wage and 10 percentile wage. Therefore, the negative effect of export-orientation on 90-50 wage ratio, and positive effect on the 50-10 wage ratio and 90-10 wage ratio seems to be consistent with our predicted outcomes. A similar kind of result is observed in a study on Mexican industries by Frias *et al.* (2012). Import-penetration affects positively the Gini coefficient, but not the

other three measures. South-South trade has no significant effect on any of the four wage inequality measures for the total manufacturing.

VII.B Non-trade Factors

For all five wage inequality measures, the period of high growth of GDP (2001-2007) has shifted wage inequality function upward, which indicates a significant rise in wage inequality in the period of *high growth* in the post-2000 period compared to the earlier period of *moderate growth.*

The capital-labour ratio ($\frac{K}{L}$), a measure of capital intensity, has a positive effect on the skilled-unskilled wage ratio, but not on other inequality measures. This result shows that a rise in capital intensity leads to an increase in skilled wage relative to unskilled wage. Moreover, the negative effect of capital-labour ratio on the 50-10 wage ratio indicates that a rise in capital intensity has led to an increase in the 10 percentile wage more than the median wage in the wage distribution. The remaining three wage inequality measures, namely, Gini coefficient, 90-50 wage ratio, and 90-10 wage ratio have not been significantly affected by increasing capital-labour ratio.

Labour market institution, measured by the ratio of contract unskilled labour in total unskilled labour ($\frac{L_C}{L_U}$), has a positive effect on the skilled-unskilled wage ratio. As contractualization reduces wage for contract labour vis-à-vis regular labour, therefore, increasing contractualization of unskilled labour has led to a fall in unskilled wage relative to the skilled wage, and consequently led to an increase in skilled-unskilled wage ratio. However, the negative effects of the contractualization on 50-10 wage ratio and the 90-10 wage ratio suggest that rising contractualization has reduced the median wage and the 90 percentile wage relative to the 10 percentile wage. Assuming downward wage rigidity at the 10 percentile level, the fall in 50-10 wage ratio and 90-10 wage ratio are possible only when there is a decline in the median and 90 percentile wages relative to the 10 percentile wage. Therefore, rising contractualization has reduced the wages for middle wage earners and top decile wage earners relative to the bottom decile wage earners.

The evidence shows inter-industry heterogeneity in the wage inequality outcomes. Controlling for other factors, wage inequality – by any wage inequality measure – is high within the high-tech industry compared to other categories of industries.

Finally, we conclude this study with the observation that trade liberalization, labour market institution, technological factors, and economic growth have played important roles in

determining the wage inequalities in the Indian manufacturing sector in the post economic reform period of two decades. The impacts of these factors vary across wage inequality measures analysed for organized and total manufacturing in India.

Appendix Table A. 1: Descriptive Statistics for Major Variables used in econometric estimations

Variables	Number of Observations	Mean	Standard Deviation	Minimum Value	Maximum Value
Organized manufacturing					
Skilled-unskilled wage ratio ($\frac{W_S}{W_U}$)	1064	2.43	0.96	0.30	7.18
Export Orientation ($\frac{X}{Y}$)	1044	0.25	0.54	0.00	5.54
Import penetration ($\frac{M}{Y}$)	1045	0.36	1.66	0.00	41.47
Ratio of South-South Trade ($\frac{SS}{TT}$)	1045	0.46	0.20	0.01	1.00
Capital-labour Ratio ($\frac{K}{L}$)	1064	4.80	10.06	0.04	115.40
Labour Market Institutions ($\frac{L_C}{L_U}$)	779	0.21	0.15	0.00	1.00
Total manufacturing					
Gini coefficient (G)	144	0.42	0.06	0.30	0.59
The 90-50 wage ratio ($\frac{W_{90}}{W_{50}}$)	144	2.77	0.71	1.75	5.83
The 90-10 wage ratio ($\frac{W_{90}}{W_{10}}$)	144	8.08	3.18	3.67	18.75
The 50-10 wage ratio ($\frac{W_{50}}{W_{10}}$)	144	2.89	0.82	1.63	6.38
Export Orientation ($\frac{X}{Y}$)	144	0.27	0.50	0.00	3.81
Import penetration ($\frac{M}{Y}$)	144	0.15	1.66	0.22	1.26
Ratio of South-South Trade ($\frac{SS}{TT}$)	144	0.48	0.20	0.09	1.00
Capital-labour Ratio ($\frac{K}{L}$)	144	6.42	13.20	0.11	112.54
Labour Market Institutions ($\frac{L_C}{L_U}$)	144	0.15	0.22	0.00	1.26

Source: Author's calculation from the Annual Survey of Industries and unit level data from the Employment Unemployment Surveys, NSSO, 50th Round (1993-94), 55th Round (1999-00), 61st Round (2004-05), and 66th Round (2009-10)

Appendix Table A.2: Correlation Matrix for Major Explanatory Variables

	Capital-labour Ratio ($\frac{K}{L}$)	Labour Market Institution ($\frac{L_C}{L_U}$)	Export Orientation ($\frac{X}{Y}$)	Import penetration ($\frac{M}{Y}$)	South-South Trade ($\frac{SS}{TT}$)
Organized Manufacturing (770 observations)					
Capital-labour Ratio ($\frac{K}{L}$)	1.00				
Labour Market Institutions ($\frac{L_C}{L_U}$)	0.27	1.00			
Export Orientation ($\frac{X}{Y}$)	-0.11	-0.14	1.00		
Import penetration ($\frac{M}{Y}$)	0.03	-0.06	0.12	1.00	
Ratio of South-South Trade ($\frac{SS}{TT}$)	0.31	0.31	-0.28	-0.16	1.00
Total Manufacturing (144 observations)					
Capital-labour Ratio ($\frac{K}{L}$)	1.00				
Labour Market Institutions ($\frac{L_C}{L_U}$)	0.37	1.00			
Export Orientation ($\frac{X}{Y}$)	-0.14	-0.22	1.00		
Import penetration ($\frac{M}{Y}$)	0.10	-0.02	0.03	1.00	
Ratio of South-South Trade ($\frac{SS}{TT}$)	0.35	0.44	-0.35	-0.19	1.00

Source: Same as the Appendix Table A.1.

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Appendix A.2: Correlation Matrix for Major Explanatory Variables

	Capital-labour	Labour Market	Export Orientation	Import penetration	South-South

	Ratio ($\frac{K}{L}$)	Institution ($\frac{CW}{W}$)	($\frac{X}{Y}$)	($\frac{M}{Y}$)	Trade ($\frac{SS}{TT}$)
Capital-labour Ratio ($\frac{K}{L}$)	1.00				
Labour Market Institution ($\frac{CW}{W}$)	0.27	1.00			
Export Orientation ($\frac{X}{Y}$)	-0.11	-0.14	1.00		
Import penetration ($\frac{M}{Y}$)	0.03	-0.06	0.12	1.00	
South-South Trade ($\frac{SS}{TT}$)	0.31	0.31	-0.28	-0.16	1.00