Rising Wage Inequality in India and Liberalization Phase: A Translog Cost Function Analysis

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Abstract

The paper attempts to investigate the various determinants of rising wage inequality in India since 1980s. A translog cost function along with the share equations is used to evaluate the impact of various factors such as trade, technology, liberalization phase, efficiency (technical, allocative and cost) and inflation on rising wage inequality between the skilled and unskilled labour. Seemingly unrelated regressions (SUR) procedure by Zellner is used for the estimation purpose. Annual Survey of Industries data at the two digit level from the year 1973-74 to 2007-08, has been used for the study. The findings reveal that trade and technology both tend to increase the wage inequality. Further, elasticity results reveal that capital, skilled labour, unskilled labour etc have turned out to be, substitutes since 1989, although few of them were complementary before the liberalisation phase.

Keywords: Translog Cost Function, Seemingly Unrelated Regressions, Wage Inequality, Trade, Efficiency

Introduction:

There has been a remarkable shift in the India's foreign trade structure during the last few decades. India has been an exporter of agricultural raw materials and agro based manufactured products during the initial years after independence. From the 70s the transformation started because of the government's policy of heavy industrialisation. There has been a continuous decline in the share of agricultural raw materials and allied products.

Indian exports now comprises of mainly engineering and textile products, precious stones, petroleum products, jewellery, sugar, steel chemicals, zinc and leather products.

India also exports services to several countries, primarily to the US. In fact, India is among the world's largest exporters of services related to information and communication technology (ICT). It is also the key destination for business process outsourcing (BPO). India's major imports comprise of crude oil, machinery, military products, fertilizers, chemicals, gems, antiques and artworks.

The economic and trade reforms undertaken in the early 1990s and early 2000s, stimulated a large increase in India's merchandise trade. India's Merchandise Trade Turnover increased from US$95 billion in 2002 to US$ 391 billion in 2008. Most of the increase in trade came from non-agricultural trade as agriculture's share of total trade shrunk from 19.5 percent to 7 percent. Merchandise imports and exports grew proportionately with total merchandise trade, increasing from 51 to 251 billion dollars and 44 to nearly 163 billion dollars respectively. Again most of the growth in total merchandise imports and exports came from growth in non-agricultural goods.

The acceleration of trade would suggest reforms had a major effect on India's pattern of trade. India's export share of Asia has increased from 38.7% in 2001 to 51.7% in 2008. While the share of North America has gone down to 13.5% in 2008 from 22.4% in 2001. This proves that the direction of exports is moving towards southern countries. The leading export markets for India are USA, UAE, China, Singapore and UK while the leading import sources are China, USA, Saudi Arabia, UAE and Iran.

But on the other side of this glorious picture, one can see a particular trend in wage inequality since 1980s. The pertinent question is whether one can attribute this rising wage inequality to liberalization.[1] This paper looks into the later.

Following graph, prepared taking the data from Annual Survey of Industries shows the increased wage inequality since 1980s:

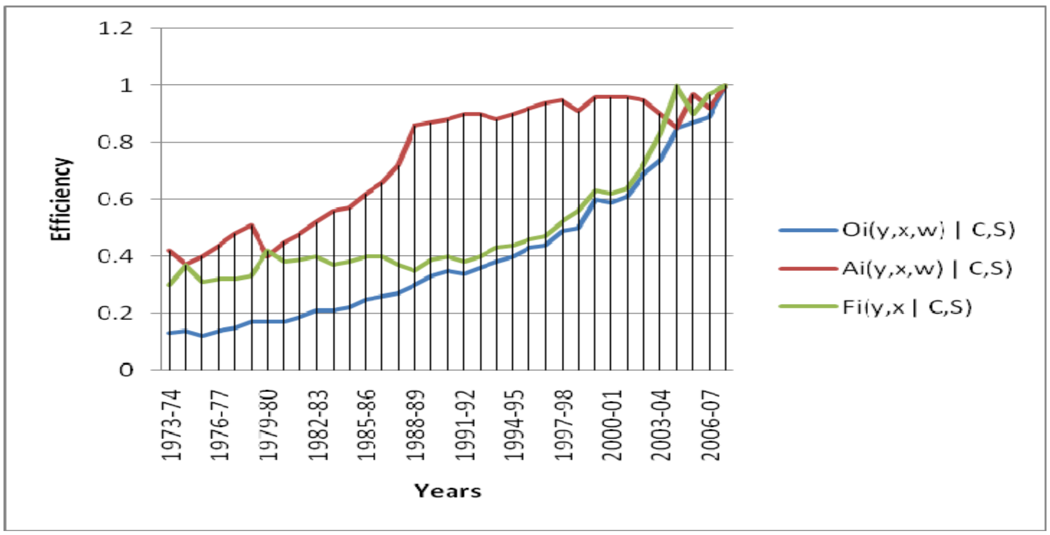
[1] Alexander Committee Report (India started liberalizing in early 1980s but in real sense the liberalization started in the 1990s).

Abid Husain Committee Report

The graph shows rising wage inequality between wage rate of skilled labour and wage rate of unskilled labour. We see a sharp rise in wage inequality between the both during 1989 onwards. To look into the reasons for this is an issue for discussion and research.

The paper intends to study the impact of trade, technology and liberalization on rising wage inequality in India. The paper also attempts to have a look on different efficiency measures such as cost efficiency, allocative efficiency and technical efficiency and their impact on cost share of skilled and unskilled labour.

The Cost efficiency refers to the efficiency of minimising cost at the lowest prices. Allocative efficiency refers to the efficient allocation for resources given their price. Technical efficiency refers to how judicious is the particular DMU (Decision Making Unit) in transforming inputs into outputs. All the three efficiency measure uses DEA (Data Envelopment Analysis)[2]



Literature Review:

Feenstra (2000) explained the effect of trade or technology on wages and employment. It was measured by estimating demand for skilled and unskilled labour through the translog functional form along with the share equation. The cost function includes structural variables (includes expenditures on computers and newly imported intermediate inputs etc). The result shows that trade in intermediate inputs (outsourcing) as well as computer use both explain a shift towards skilled labour in united states during the 80s, with the exact contribution of each being sensitive to how computer use is measured (i.e. as a share of capital stock or as an investment).

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[2] Data envelopment analysis (DEA) is a linear programming methodology to measure the efficiency of multiple decision-making units (DMUs) when the production process presents a structure of multiple inputs and outputs.

DEA uses for both production and cost data. Utilizing the selected variables, such as unit cost and output, DEA software searches for the points with the lowest unit cost for any given output, connecting those points to form the efficiency frontier. Any firm not on the frontier is considered inefficient.

Another paper by K.V. Ramaswamy (2008) investigates the question of wage inequality in Indian Manufacturing in the years pertaining to trade and investment liberalisation. The objective of the paper was to test the hypothesis of skill based technological change (SBTC) due to capital-skill complementarity and the impact of labour regulations on wage inequality between skilled and unskilled labour. The skill-wage bill share equation is estimated for a panel of 46 three-digit industries spanning the period 1981-2004 followed by 113 four-digit industries panel covering the period 1993 to 2004. The econometric results suggest the positive contribution of capital-output ratio and contract worker intensity to wage inequality in Indian manufacturing.

Ali M. Khalil (), in his paper on pulp and paper industry using the translog cost function along with the share equation shows that the industry operates at slightly increasing returns to capital utilisation and labour and energy are complements in production whereas materials is a substitute in production for other inputs. Technological progress generated 0.037% reduction in annual operating costs at the mean but the effect was asymmetric with a much larger impact during early part of the period.

In another paper by Raghbendra Jha and Balbir S Sahni (1991) estimated translog cost function with biased technical progress (coefficient of technical change/share of the input) for the Indian cement, lime and plaster industry using Annual Survey of Industries (henceforth ASI) database. The factor substitution, scale economies, and the nature of technical progress in this industry are also examined. Study covers the period 1960-61 to 1982-83 and use aggregative time series data provided by ASI. The results of translog cost function incorporating biased technological change show that production in this industry is characterised by significant economies of scale. The elasticity of cost with respect to output *(ec)* at mean level is 0.139 with a standard error of 0.390. Thus production in the cement, lime and plaster industry is characterised by economies of scale (since $ec < 1$ and is significant). Consequently, this industry can significantly reduce average cost by increasing output. There also exist substantial substitution possibilities between the factors of production. It was also discovered that technical progress in this industry has been capital saving and labour and EM using. This bias in technical progress has affected factor income distribution. Labour has gained relative to the suppliers of capital and EM.

Raghbendra Jha and Balbir Sahni (1994) again in another paper examined the trends in allocative efficiency over the period 1960-1961 to 1986-1987 in seven Indian industries, namely refining and manufacture of sugar; petroleum refining; manufacture of chemicals; fertilizers and pesticides locomotives and parts; locomotives; and cotton textiles. The translog cost function incorporating biased technical change was used again along with the share equations and Allen’s partial elasticity of substitution has also been worked out. It is discovered that allocative inefficiency has been non zero in each industry for every year. Allocative inefficiency has not declined over time in those industries where prices are administered, whereas in industries where prices are not administered it has. Industries that are predominantly in the public sector are not necessarily characterized by greater allocative inefficiency than those that are predominantly in the private sector.
For measuring the impact of technical change and scale effect in Indian Manufacturing, Sanja S.Pattnayak and Thangavelu (2003) used translog cost function along with the share equations.
Most industries revealed the bias towards capital- using technical change.
The paper on trade liberalisation and wage inequality by Prachi Mishra and Utsav Kumar (2005) also investigates the effect of trade policy on wages in Indian manufacturing industries in the last

two decades. The results suggest the significant relationship between trade policy and industry premiums. The increasing protection in the sector lowers wages in that sector. In sectors with largest tariff reduction, wages increased relative to the economy wide average.
The paper by Rubiana Chamarbagwala and Gunjan Sharma (2000) investigates the role of Industrial Deregulation and skill upgrading on wage inequality in India. The results indicate that industrial delicensing benefitted skilled labour via capital and output skill complementarities before India liberalised trade and investment. Thus much of the increase in demand for and returns to skill as a result of capital and output-skill complementarities, can be attributed to domestic rather than external sector reforms in India.

Objectives:

1. To find out the reasons for rising wage inequality in India.
2. To study the impact of trade, technology, liberalisation phase on wage inequality in India.
3. To study the impact of cost efficiency, allocative efficiency and technical efficiency on wage inequality in India.

Hypothesis:

1. Trade has led to reduction in wage inequality between skilled and unskilled labour (Stolper Samuelson Theorem).
2. Technology has helped in generating the demand for skilled workers, and in widening the skill wage gap.
3. Liberalisation has led to widening the wage gap between the skilled and unskilled labour.
4. Allocative as well as technical efficiency both have contributed towards the increased demand for skilled labour.

Data Sources:

Annual Survey of Industries (ASI): The data for industries output as well as for inputs have been taken from Annual Survey of Industries, published by the Central Statistical Organization (CSO), Government of India. The *Economic and Political Weekly* has created a systematic, electronic database using ASI results for the period 1973-74 to 2003-04 (hereafter, EPW database). This contains two digit and four digit industry level data and covers all registered factories with more than ten workers. India's National Industrial classification (NIC) changed in 1989-90 and 1998-99.ASI-EPW volume II presents a consistent series based on NIC-1998 at the 2-digit and 3-digit level of aggregation. We have used two digit level data for our analysis.

Data Description:

As we have considered Cost as a function of wages of skilled labour, wages of unskilled labour, capital, output, capital and technology. Here is description of all the variables (see appendix-1):

1. **Wage Rate of unskilled labour:** To work out the wage rate of unskilled workers we have taken wages to workers (deflated by CPIIW) and divided by no. of workers.

2. **Gross Output:** We have taken Gross output for the calculation deflated by wholesale price index for all commodities from the Central Statistical Organisation (CSO) site.

3. **Capital:** To get the capital stock, we have taken Interest paid divided by cost of capital. Here, interest paid has been deflated by implicit deflator. For cost of capital, we have taken value added minus wages to workers divided by value added, multiplied by hundred.

4. **Technology:** To measure the impact of technology, an Index of technology acquisition has been constructed using R&D expenditure as a percentage of GDP, trade as a percentage of GDP, Industry value added as a percentage of GDP, FDI as a percentage of GDP. The construction of index has been done using principal component analysis and taking the first principal component the index has been formed.

Methodology: We have started with the two digit data from Annual Survey of Industries. Here we have taken total of all Industries from the two digit Industry group from the year 1973-74 to 2007-08. We have taken cost as a function of wages of skilled labour, wages of unskilled labour, capital, output and technology. For estimating impact of technology on wage inequality we have taken translog cost function along with the share equation as given:

$C = f(Wsk, Wusk, Pk, O, t)$..(1)

Where C is total variable cost, Wsk and Wuk are the prices of variable inputs, namely, skilled And unskilled labour, Pk is the price of capital and O is real output.
The equation in (1) is assumed to take the translog function:

$$\ln C = \alpha_0 + \alpha_O \ln O + \alpha_k \ln Pk + \alpha_{sk} \ln Wsk + +\alpha_{u\,sk} \ln Wusk + \alpha_t t + 0.5\beta_{OO}(\ln O)^2 + \beta_{Ok}(\ln O \ln Pk) +$$
$$\beta_{Osk}(\ln O \ln Wsk) + \beta_{Ousk}(\ln O \ln Wusk) + \beta_{Ot}(\ln Ot) + 0.5\beta_{kk}(\ln Pk)^2 + \beta_{ksk}(\ln Pk \ln Wsk) +$$
$$\beta_{kusk}(\ln Pk \ln Wusk) + \beta_{kt}(\ln kt) + 0.5\beta_{sksk}(\ln Wsk)^2 + \beta_{skusk}(\ln Wsk \ln Wusk) + \beta_{skt}(\ln Wskt) +$$
$$0.5\beta_{uskusk}(\ln Wusk)^2 + \beta_{usk}(\ln Wuskt) + 0.5\beta_{tt}(tt)^2$$
.... (2)

The link between cost function parameters and factor demands is given by Shepherd Lemma. If cost is given as:

$C = S_{sk}P_{sk} + U_{sk}P_{usk} + KP_k$

Where S_{sk} denote demand for factor input skilled labour, given skilled labour price P_{sk}, $U_{sk}P_{usk}$ denote demand for unskilled labour, given price of unskilled labour denoted by P_{usk} and K is the demand for capital, given price of capital denoted by P_k. Now differentiating, cost function with respect to price of skilled labour gives,

$\partial C / \partial Psk = Sk$

Noting that

$$\frac{\partial \log(C)}{\partial \log Wsk} = \frac{Wsk}{C}\frac{\partial C}{\partial Wsk}$$

The lemma can also be written as stating that the logarithmic partial derivative of the cost function equals the factor share, namely,

$$\frac{\partial \log(C)}{\partial \log Wsk} = \frac{WskSk}{C}$$

So for the case of translog cost function, the log partial derivative for each input price is calculated as:

$$\frac{\partial \ln C}{\partial \ln Wsk} = \alpha_{sk} + \beta_{osk} \ln O + \beta_{ksk} \ln Pk + \beta_{sksk} \ln Wsk + \beta_{skusk} \ln Wusk + \beta_{skt} t$$

$$\frac{\partial \ln C}{\partial \ln Wusk} = \alpha_{u\,sk} + \beta_{ousk} \ln O + \beta_{kusk} \ln Pk + \beta_{skusk} \ln Wsk + \beta_{u\,skusk} \ln Wusk + \beta_{u\,skt} t$$

$$\frac{\partial \ln C}{\partial \ln Pk} = \alpha_{k} + \beta_{ok} \ln O + \beta_{kk} \ln Pk + \beta_{ksk} \ln Wsk + \beta_{kusk} \ln Wusk + \beta_{pkt} t$$

Properties of Cost Functions:

1. Homogeneity: Homogeneous of degree one in factor prices. With the symmetry restrictions imposed on (βjk), the homogeneity condition can be expressed as:

$$\alpha_k + \alpha_{sk} + \alpha_{usk} = 1$$
$$\beta_{ksk} + \beta_{sksk} + \beta_{skusk} = 0$$
$$\beta_{kusk} + \beta_{skusk} + \beta_{uskusk} = 0$$
$$\beta_{kk} + \beta_{ksk} + \beta_{kusk} = 0$$

2. Monotonicity: Non decreasing in factor prices.

3. Concavity: It requires that the Hessian (matrix of second order derivatives be negative) of a cost function C be negative semi definite (Berndt and Wood 1975).

Now imposing the homogeneity restrictions we can easily eliminate the three parameters say $(\beta_{ksk}, \beta_{kusk}, \beta_{kk})$. Then taking all the restrictions as adding up restrictions, homogeneity and symmetry restrictions all together, the system of share equations take the form (see appendix-2):

$$\frac{\partial \ln C}{\partial \ln Wsk} = \alpha sk + \beta_{osk} \ln O + \beta sksk \ln\left(\frac{Wsk}{Pk}\right) + \beta skusk \ln\left(\frac{Wusk}{Pk}\right) + \beta_{skt} t$$

$$\frac{\partial \ln C}{\partial \ln Wusk} = \alpha_{usk} + \beta_{ousk} \ln O + \beta_{skusk} \ln\left(\frac{Wsk}{Pk}\right) + \beta_{uskusk} \ln\left(\frac{Wusk}{Pk}\right) + \beta_{uskt} t$$

After adding an error term, the equations can be estimated by the OLS technique. Such estimates are consistent, however generally not as efficient as the SUR method, which amounts to generalized least squares (GLS). The seemingly unrelated regressions (SUR) or seemingly unrelated regression equations (SURE) model, proposed by Arnold Zellner in (1962), is a generalization of a linear regression model that consists of several regression equations, each having its own dependent variable and potentially different sets of exogenous explanatory variables. SURE is seemingly unrelated because of correlations in the error structures. Two important cases when SUR is in fact equivalent to OLS, are: either when the error terms are in fact uncorrelated between the equations (so that they are truly unrelated), or when each equation contains exactly the same set of repressors on the right-hand-side.

Finally, we calculate elasticities of substitution to find out how it has changed the scenario of demand for skilled and unskilled labor and contributed to wage inequality. One can measure the curvature of the isoquant by estimating Allen's and Moritima's partial elasticities of substitution. By Shephard duality, we can get ASE from estimated parameters of cost function and fitted estimated cost share of inputs as follows,

$$\sigma_{jk} = \frac{\beta_{jk} + S_{jk}}{S_{jk}} \; ; \qquad \sigma_{jj} = \frac{\beta_{jj} + S_j^2 - S_j}{S_j^2}$$

Here β_{jk} represent the estimated second order derivatives on the diagonal of Hessian matrix. S_j and S_k represent fitted cost share of inputs (Christensen, et al. 1971), (Diewert 1971), (Uzawa 1962). The own and cross factor price elasticities of substitution are defined as:

$$\varepsilon_{jk} = \frac{\beta_{jk} + S_j S_k}{S_j}; \quad \varepsilon jj = \frac{\beta_{jj} + S_j^2 - S_j}{S_j}$$

The moritima elasticities of substitution (MES) are defined as:

$$M_{jk} = \varepsilon_{kj} - \varepsilon_{jj}$$

Where ε_{kj} and ε_{jj} are cross and own price elasticities of substitution. The moritima elasticity estimate show that how the ratio of one input to the other input respond to the change in the first input.

For measuring the efficiency of Industries, Data envelopment analysis has been used.

Results and Discussion:

The results of translog cost function along with the share equations shows that R-square has come out to be very high for cost function as well as the share equations. Most of the coefficients are highly significant in cost function as well as the share equations. The share of skilled labor has positive relation with the technology, while share of unskilled labor has negative relation with technology, which signifies that technology tends to increase wage inequality.

Estimated Coefficients of the translog cost function:

Parameter	Value	Parameter	Value

α_0 (Constant)	80.7612 (57.44049)	β_{ot} (Coefficient of lnOt)	.0933701*** (.0291149)
α_o (coefficient of lnC)	-10.88477 (-10.88477)	β_{wskwsk} (Coefficient of lnWsk square)	.6246772 (.4373455)
α_{wsk} (coefficient of lnWsk)	21.00838*** (5.377162)	$\beta_{wskwusk}$ (Coefficient of lnWsklnWusk)	-.8233225** (.3787309)
α_{wusk} (Coefficient of lnWusk)	-21.49751*** (5.00187)	β_{wskPk} (Coefficient of lnWsklnPk)	-3.711671* (2.020413)
α_{Pk} (Coefficient of lnPk)	Dropped	β_{wskt} (Coefficient of lnWskt)	-.0574628*** (.0216974)
αt (Coefficient of lnt)	-.0813791 (.5781642)	$\beta_{wuskwusk}$ (Coefficient of lnWusk square)	1.706118 (.4182409)
β_{oo} (Coefficient of square of lnO)	.4837506 (1.165992)	β_{wuskPk} (Coefficient of lnWusklnPk)	4.612087*** (.8377654)
β_{owsk} (Coefficient of lnOlnWsk)	-.3036785 (.5836137)	β_{wuskt} (Coefficient of lnWuskt)	.0286771** (.0175266)
β_{owusk} (Coefficient of interaction lnOlnWusk)	-.1460904 (.3386464)	β_{PkPk} (Coefficient of lnPk square)	-5.102616 (9.512373)
β_{oPk} (Coefficient of interaction lnOlnPk)	1.638435 (4.114569)	β_{Pkt} (Coefficient of lnPkt)	-.2069454 (.1425654)
β_{tt} (Coefficient of tt square)	-.0060214** (.0033443)		
$R^2 = .99$			

Estimated Coefficients of the share equations:

Dependent Variable Skilled Labor Share		Dependent Variable Unskilled Labor Share	
β_{osk} (Coefficient of lnO)	-.0122616 (.0187418)	β_{ousk} (Coefficient of lnO)	.0138582 (.0181931)
β_{sksk} (Coefficient of lnWsk/Pk)	.0223168 (.0275668)	β_{skusk} (Coefficient of lnWsk/Pk)	-.0246092 (.0269449)
β_{skusk} (Coefficient of lnWusk/Pk)	-.0246092 (.0269449)	β_{uskusk} (Coefficient of lnWusk/Pk)	.0273338 (.0267867)
β_{skt} (Coefficient of t)	.0074814*** (.0016878)	β_{uskt} (Coefficient of t)	-.0074776*** (.0016856)
R^2 = .7650		R^2= .7576	

* 10% level of significance

**5% level of significance

***1% level of significance

Values in the parenthesis show standard errors

Multivariate regression technique has been used to have the impact of manufacturing trade, inflation (measured by Wholesale price index), liberalization (dummy 0 for the years before liberalization and 1 for the years after liberalization), cost efficiency, allocative efficiency and technical efficiency. As the different types of efficiencies may be correlated, we have taken them in regression one by one on the share equations.

Results when multivariate regression is run taking cost efficiency along with the rest of the variables:

Parameter	Value	Parameter	Value
Skilled labor share (Dependent Variable)		Unskilled labor (Dependent Variable)	
Manufacturing Trade	1.51e-06*** (3.35e-07)	Manufacturing Trade	-2.65e-06*** (8.91e-07)

Liberalization Phase	-.004982 (-.0093506)	Liberalization Phase	-.0519524** (.0248711)
Inflation	.0005742** (.0002613)	Inflation	-.00062 (.000695)
Cost Efficiency	-.1052424 (.0744334)	Cost Efficiency	.0964204 (.197981)
R^2	.94	R^2	.92

***1% level of significance

**5% level of significance

Values in parenthesis show standard error

The results reveal that manufacturing trade has positively contributed towards the cost share of skilled labor while it has negative impact on unskilled labor. Liberalization has negative and significant impact on unskilled labor. Here inflation has positive and significant impact on cost share of skilled labor. Cost efficiency although has negative relation with cost share of skilled labor and positive relation with unskilled labor but both are insignificant.

Results when multivariate regression is run along with the rest of the variables:

Parameter	Value	Parameter	Value
Skilled labor share (Dependent Variable)		Unskilled labor (Dependent Variable)	
Manufacturing Trade	9.73e-07*** (2.44e-07)	Manufacturing Trade	-3.33e-06*** (5.00e-07)
Liberalization Phase	-.0043819 (-.0090249)	Liberalization Phase	-.029278** (.0184699)
Inflation	.0004146** (.0001532)	Inflation	-.0004844 (.0003136)
Allocative Efficiency	-.0405467* (.0208445)	Allocative Efficiency	-.2086525*** (.0426595)
R^2	.94	R^2	.95

***1% level of significance

**5% level of significance

Values in parenthesis show standard error

The results reveal that manufacturing trade, liberalization and inflation again have the same impact as above. The allocative efficiency has negative impact on both skilled and unskilled labor.

Results when multivariate regression is run taking technical efficieny along with the rest of the variables:

Parameter	Value	Parameter	Value
Skilled labor share (Dependent Variable)		Unskilled labor (Dependent Variable)	
Manufacturing Trade	9.57e-07*** (2.91e-07)	Manufacturing Trade	-3.63e-06*** (6.63e-07)
Liberalization Phase	0045178 (.0099814)	Liberalization Phase	-.0231323 (.0227379)
Inflation	.0001523 (.0001605)	Inflation	-.0009726** (.0003656)
Technical Efficiency	.0469593 (.0393116)	Technical Efficiency	.2899802*** (.0895531)
R^2	.94	R^2	.94

***1% level of significance

**5% level of significance

Values in parenthesis show standard error

Regression results along with technical efficiency show that manufacturing trade has the same impact. While inflation has negative and significant impact on unskilled labor. In case of technical efficiency, it has negative and significant impact on cost share of unskilled labor.

Further, Tables in appendix-1, 2, and 3 reveal that capital input are revealed to be a substitute for skilled labor for almost all the thirty five years. Further, the extent of substitutability can be explained by the fact that a 1% increase in the relative price of capital increases the relative wage of skilled labor by .85%. Capital has come out to be a complement for unskilled labor but has turned out to be substitute from the year 1988-89. The other two inputs, skilled and unskilled labor are also substitutes and the degree of substitutability has been higher, when estimated with the help of Allen's partial elasticity of substitution measure.

The own price elasticity between skilled labor and capital is negative showing that input demand is inelastic since 1988-89 while it became elastic since 1989-90. While it is elastic for unskilled labor for all the thirty five years span.

The cross price elasticity results reveal that it has been positive between skilled and unskilled labor. Ranged from .64 in 1973-1974 to .28 in 2007-08, which shows that 1% increase in the price of skilled labor used to change the quantity demanded of the unskilled labor by .64% but gradually, over the years it had less impact on the demand of unskilled labor. This indicates that change in price of skilled labor now does not affect the demand for unskilled labor much. On the contrary, cross price elasticity between unskilled and skilled labor has been positive but increasing from .29 to .43. This indicates that earlier change in price of unskilled labor had less affect on the demand of skilled labor but now it has much more impact. It is negative between skilled labor and capital. Ranged from -.04 in 1973-74 to .16 in 2007-08. Until 1986-87 it was negative and turned out to be positive afterwards. This shows that before liberalization phase the change in the price of skilled labor used to reduce the demand for capital but afterwards the price of skilled labor has started increasing the demand for capital. For capital and skilled labor it has been positive and increasing from .27 in 1973-74 to .52 in 2008. Between unskilled labor and capital it ranged from .01 to .30, showing that it was although positive but meager. It increased substantially later, indicating the impact of increase in price of unskilled labor to have .30% increase in demand for capital input. And between capital and unskilled labor -.29 to .65 i.e. changed from negative to positive. In a nutshell, the demand of all the inputs have become more sensitive to each other's price changes except the sensitivity of demand for unskilled labor to the price of skilled labor.

The moritima elasticity estimates show that how the ratio of one input to the other input respond to the change in the first input. The table reveals that changes in the price of capital generates substitution between capital and skilled labor for all the years and complementarity between capital and unskilled labor for just few years.

Similarily, the changes in the price of skilled labor has generated greater substitution between skilled labor and unskilled labor. While the changes in the price of skilled labor has made them complementary for few years but they became substitutory for the later years.

And changes in the wages of unskilled labor have led to substitution between unskilled labor and skilled labor while it has turned out to be complementary for few intial years and then the change generated substitution between unskilled labor and capital.

From the results of elasticties of substitution, for few inputs it was found that they were complementary for few years but later became substitutes. Similarly, the demand for few inputs was inelastic such as for unskilled labor and capital but later it became elastic. Here one thing is important to note that all such transformation usually took place after 1989-90. The major industrial reforms as well as the policy of globalization, liberalization also took place during this period. Clearly, all the results signify that trade and technology both have contributed towards the rising wage inequality.

Conclusion and Policy Implications: The study analyzed the structure of costs in the Indian manufacturing industries. It is discovered that the translog cost function along with the share equations provides a good fit for the data. Most of the estimated parameters are significant.

Efficiency results reveal that overall technical efficiency is helpful for the unskilled labor as well as for skilled labor. But from the results it is clear that technical efficiency positively contributes towards increasing the cost share of unskilled labor so Industries should focus on enhancing technical efficiency. Allocative efficiency has negative impact on both skilled labor. Cost efficiency has negative impact on skilled labor and positive impact on unskilled labor. But result show that these are insignificant.

Further, elasticity's results show that on an average, skilled labor, unskilled labor and capital are all substitutes and the degree of substitution is quite higher after the liberalization phase started. This means that the change in the price of one input highly affects the demand for the other input. Hence it cannot be claimed that one factor or another acts as a constraint on output growth.

It is further discovered that both trade and technology contributed positively towards the cost share of skilled labor and negatively towards the cost share of unskilled labor. But this does not suggest that for reducing wage inequality, the trade and technology should be stopped. Here it is interesting to mention some key findings of an important essay by Suresh D. Tendulkar (2010), titled "Inequality and Equity during Rapid Growth Process". It explains that the rising inequalities would almost always advance equity so long as they are accompanied by an adequate rise in average real income.

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Appendix-1

Variables	Abbreviation	Description
Total Cost	C	Total Cost obtained taking price of skilled labour multiplied by no of skilled labour plus price of unskilled labour multiplied by no of unskilled labour plus price of capital multiplied by capital stock.
Gross Output	O	Includes the ex-factory value of products and by-products manufactured during the accounting year. It also includes the receipts for non-industrial services rendered to others, the receipt for work done for others on materials supplied by them, value of electricity produced and sold and net balance of goods sold in the same condition as purchased.
Price of Capital	Pk	Price of Capital is taken as the Value added minus wages divided by value added multiplied by hundred (to have the rate)
Wage Rate of Skilled Labour	Wsk	Total Emoluments minus Wages to workers divided by total persons engaged minus no of workers.
Wage Rate of Unskilled Labour	Wusk	Wages to workers divided by No of workers.
Technology	t	Index constructed using R&D as a percentage of GDP, FDI as a percentage of GDP, Trade as a percentage of GDP, Industry as a percentage of GDP.

Appendix-2:

Taking the homogeneity restrictions,

$$\alpha_k + \alpha_{sk} + \alpha_{usk} = 1$$
$$\beta_{ksk} + \beta_{sksk} + \beta_{skusk} = 0$$
$$\beta_{kusk} + \beta_{skusk} + \beta_{uskusk} = 0$$
$$\beta_{kk} + \beta_{ksk} + \beta_{kusk} = 0$$

Suppose, if we take β values from the second equation β_{ksk} becomes,

$$\beta_{ksk} = -\beta_{sksk} - \beta_{skusk}$$

Now the share equation of skilled labor becomes,

$$\frac{\partial \ln C}{\partial \ln Wsk} = \alpha sk + \beta_{osk} \ln O + (-\beta_{sksk} - \beta_{skusk}) \ln Pk + \beta_{sksk} \ln Wsk + \beta_{skusk} \ln Wusk + \beta_{skt} t$$

Now simplifying the equation gives the final form:

$$\frac{\partial \ln C}{\partial \ln Wsk} = \alpha sk + \beta_{osk} \ln O + \beta sksk \ln\left(\frac{Wsk}{Pk}\right) + \beta skusk \ln\left(\frac{Wusk}{Pk}\right) + \beta_{skt} t$$

Similarly, by imposing adding up and symmetry restrictions, we can again delete the third equation from the system. Later, we can find out the value of rest of the coefficients using the above restrictions.

Allen's Partial Elasticity of Substitution

Appendix-3

σpkwsk	σpkwusk	σwskwusk	σpkpk	σwskwsk	σwuskwusk
0.853441	-0.41087	0.8952078	0.020417	-1.8698	-0.42875137
0.875093	-0.3009	0.8991577	-0.08766	-1.71792	-0.45880104
0.850951	-0.687	0.8998667	0.162781	-1.60596	-0.51737561
0.850834	-0.70796	0.9001562	0.172821	-1.58842	-0.52419588
0.856292	-0.6622	0.9007027	0.136262	-1.56961	-0.52785295
0.826126	-0.9945	0.8990797	0.373681	-1.59921	-0.53412391
0.832541	-1.02524	0.9006469	0.368881	-1.51722	-0.56398632
0.829761	-1.14761	0.9014859	0.430385	-1.45813	-0.59154916
0.836763	-1.04103	0.9015709	0.362818	-1.46742	-0.58351341
0.825065	-1.17393	0.900981	0.456318	-1.48146	-0.58339077
0.808415	-1.28103	0.8993998	0.553081	-1.55058	-0.56141368
0.779145	-1.74632	0.8996426	0.842678	-1.49639	-0.59496581
0.765618	-1.80886	0.898431	0.910204	-1.55423	-0.57449764
0.755353	-1.8619	0.8975799	0.963138	-1.59332	-0.56165668
0.757974	-1.82592	0.8975838	0.939713	-1.59556	-0.56010407
1.09199	2.24855	0.8803243	-1.67614	-1.6019	-0.82900657
1.091303	2.296033	0.8818402	-1.69363	-1.53281	-0.85981286
1.093588	2.343891	0.8826857	-1.72229	-1.5107	-0.8640502
1.098852	2.443347	0.8841541	-1.78325	-1.4765	-0.86800859
1.086422	2.428784	0.8854118	-1.72447	-1.32411	-0.98177575
1.095248	2.479383	0.8853907	-1.78245	-1.3936	-0.91841569
1.088746	2.389648	0.8844384	-1.72034	-1.39377	-0.93489869
1.08219	2.383965	0.8849714	-1.6884	-1.30828	-1.00486451
1.082441	2.388904	0.8850389	-1.69138	-1.30709	-1.00478045
1.088008	2.478047	0.8860937	-1.7496	-1.30049	-0.99188308
1.097517	2.627692	0.8875413	-1.84679	-1.2933	-0.9722743
1.094541	2.590718	0.8872626	-1.82001	-1.28732	-0.98310772
1.086225	2.571954	0.8874414	-1.7731	-1.20069	-1.06629341
1.08931	2.582571	0.8874659	-1.79215	-1.23021	-1.03557475
1.087918	2.625507	0.8879848	-1.79933	-1.18112	-1.07628043
1.087341	2.664513	0.8883572	-1.80877	-1.14668	-1.1058037
1.085685	2.811664	0.8892518	-1.84347	-1.03574	-1.21423496
1.028748	1.90368	0.8554602	-1.16281	-0.91339	-2.14404927
1.028496	1.951402	0.8547086	-1.17187	-0.86376	-2.25595109
1.029	1.93828	0.8559987	-1.17492	-0.88388	-2.1865029

Cross and Own Price Elasticity

Appendix-4

Єskusk	Єskpk	Єuskpk	Єusksk	Єpksk	Єpkusk	Єsksk	Єpkpk	Єuskusk
0.647874	-0.04114	0.01985	0.29047	0.27694	-0.29735	-0.60673	0.02047	- 0.31029
0.6377532	-0.04668	0.016051	0.309367	0.301087	-0.21342	-0.59107	-0.08766	-0.32542
0.6144161	-0.03636	0.029355	0.323901	0.306295	-0.46908	-0.57806	0.162781	-0.35326
0.611956	-0.03607	0.030009	0.326356	0.308474	-0.4813	-0.57589	0.172821	-0.35637
0.6109113	-0.03738	0.028909	0.329113	0.312885	-0.44915	-0.57353	0.136262	-0.35802
0.6074022	-0.03018	0.036326	0.324518	0.298186	-0.67187	-0.57723	0.373681	-0.36084
0.5972373	-0.03051	0.037574	0.336417	0.310978	-0.67986	-0.56673	0.368881	-0.37399
0.5877984	-0.02916	0.040336	0.345373	0.317894	-0.74828	-0.55863	0.430385	-0.38571
0.5907322	-0.0308	0.038313	0.34402	0.31929	-0.68211	-0.55994	0.362818	-0.38233
0.5903899	-0.02851	0.04056	0.341721	0.312928	-0.76925	-0.56188	0.456318	-0.38228
0.5973591	-0.02626	0.041617	0.33126	0.297749	-0.85083	-0.5711	0.553081	-0.37288
0.585384	-0.02146	0.048098	0.339037	0.293627	-1.1363	-0.56392	0.842678	-0.38714
0.5919279	-0.02036	0.048108	0.330398	0.281556	-1.19176	-0.57157	0.910204	-0.37851
0.5960608	-0.01956	0.048218	0.324764	0.273303	-1.23644	-0.5765	0.963138	-0.37298
0.5966361	-0.01986	0.047843	0.324466	0.273999	-1.21371	-0.57678	0.939713	-0.37231
0.5020808	0.075476	0.155415	0.317397	0.393712	1.282429	-0.57756	-1.67614	-0.47281
0.4949452	0.07384	0.155354	0.327228	0.404954	1.288681	-0.56878	-1.69363	-0.48258
0.4943389	0.071515	0.153279	0.330624	0.40962	1.312672	-0.56585	-1.72229	-0.4839
0.4941544	0.067044	0.149076	0.336055	0.417659	1.365589	-0.5612	-1.78325	-0.48513
0.4675961	0.070865	0.158425	0.360062	0.441805	1.282669	-0.53846	-1.72447	-0.51849
0.4823689	0.066883	0.151407	0.348954	0.431664	1.35079	-0.54925	-1.78245	-0.50036
0.4779153	0.071362	0.156629	0.348553	0.429069	1.29127	-0.54928	-1.72034	-0.50518
0.4622105	0.073688	0.162327	0.362502	0.443287	1.245118	-0.5359	-1.6884	-0.52483
0.4622643	0.07344	0.162079	0.362728	0.443632	1.247748	-0.5357	-1.69138	-0.52481
0.4656829	0.068938	0.157014	0.364266	0.447272	1.302328	-0.53462	-1.7496	-0.52128
0.4708825	0.062552	0.149763	0.366074	0.45268	1.394115	-0.53343	-1.84679	-0.51584
0.4682722	0.064168	0.151883	0.366974	0.452705	1.367308	-0.53244	-1.82001	-0.51886
0.4503137	0.067024	0.158699	0.382369	0.468019	1.305085	-0.51734	-1.7731	-0.54107
0.4568214	0.065814	0.156035	0.377025	0.462775	1.329373	-0.52264	-1.79215	-0.53306
0.4485179	0.065217	0.15739	0.386235	0.473198	1.326134	-0.51373	-1.79933	-0.54363
0.4426943	0.064519	0.158104	0.392951	0.480968	1.327804	-0.50721	-1.80877	-0.55105
0.4224127	0.062093	0.160806	0.415981	0.50787	1.335597	-0.48451	-1.84347	-0.57679
0.2917239	0.164305	0.304043	0.427108	0.513626	0.649182	-0.45603	-1.16281	-0.73115
0.2820807	0.161217	0.305883	0.438652	0.527843	0.644024	-0.4433	-1.17187	-0.74453
0.2882635	0.160285	0.301922	0.434398	0.522192	0.652729	-0.44855	-1.17492	-0.73632

Moritima Elasticity of Substitution

Appendix-5

σpkskM	σpkuskM	σskuskM	σskpkM	σuskpkM	σuskskM
0.883668	0.012941	0.958165	-0.06156	-0.00061	0.897221
0.892162	0.111993	0.963171	0.040984	0.103713	0.900441
0.88435	-0.11582	0.967673	-0.19914	-0.13343	0.901957
0.884365	-0.12493	0.968322	-0.20889	-0.14281	0.902247
0.886414	-0.09112	0.968933	-0.17364	-0.10735	0.902641
0.875412	-0.31102	0.968247	-0.40386	-0.33735	0.901745
0.877703	-0.30587	0.971228	-0.39939	-0.33131	0.903143
0.876528	-0.36257	0.973508	-0.45955	-0.39005	0.904007
0.879227	-0.29978	0.973065	-0.39361	-0.3245	0.903956
0.874811	-0.38696	0.972671	-0.48482	-0.41576	0.903604
0.868845	-0.47795	0.970236	-0.57934	-0.51146	0.902356
0.857551	-0.74917	0.972519	-0.86414	-0.79458	0.902961
0.853121	-0.81325	0.970434	-0.93057	-0.8621	0.901963
0.849802	-0.86346	0.969043	-0.9827	-0.91492	0.901263
0.850774	-0.8414	0.968945	-0.95957	-0.89187	0.901242
0.971269	1.755242	0.974893	1.751618	1.831557	0.894954
0.973739	1.771263	0.977527	1.767475	1.848989	0.896013
0.975474	1.796574	0.978241	1.793807	1.875571	0.896478
0.978857	1.850719	0.979285	1.850292	1.932323	0.897253
0.980266	1.801156	0.986083	1.795339	1.882899	0.898523
0.980916	1.851152	0.98273	1.849337	1.933861	0.898206
0.978346	1.796452	0.983097	1.791702	1.876969	0.89783
0.979185	1.769947	0.98704	1.762092	1.850732	0.8984
0.979336	1.772554	0.987071	1.764819	1.853458	0.898432
0.981893	1.823608	0.986963	1.818538	1.906613	0.898887
0.986115	1.909952	0.98672	1.909347	1.996558	0.899509
0.985145	1.886165	0.987129	1.884181	1.971895	0.899414
0.985357	1.846153	0.991382	1.840127	1.931803	0.899707
0.985411	1.862434	0.989882	1.857963	1.948184	0.899661
0.986933	1.869759	0.992143	1.864549	1.956722	0.89997
0.988181	1.878859	0.993749	1.873291	1.966876	0.900164
0.992375	1.912384	0.999199	1.90556	2.004273	0.900486
0.969655	1.380332	1.022875	1.327112	1.46685	0.883137
0.971141	1.388559	1.026615	1.333084	1.47775	0.88195
0.970741	1.389049	1.024584	1.335206	1.476843	0.882947